POLYMET
MINING

NorthMet Project

Water Management Plan - Plant

Version 5 – Certified

Issue Date: July 11, 2016

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

I hereby certify that this report, with the exception of the sections listed below, 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.

Christie Kearney, P.E. — 07/11/2016 (Date)

PE #: 48864

I hereby certify that portions of this report were 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, specifically the preliminary design of the FTB, FTB Seepage Containment System, and HRF in Sections 2.1.2, 2.1.4, 2.2.2, 4.1.1, 4.1.2, 4.1.4, 4.4.1, 4.4.2, 4.4.4, and 7.3.3 of this report.

Tom Radue, P.E. — 07/11/2016 (Date)

PE #: 20951

I hereby certify that portions of this report were 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, specifically the preliminary design of the Stream Augmentation System in Section 2.6 of this report.

Anne Phares, P.E. — 07/11/2016 (Date)

PE #: 42022

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Acronyms, Abbreviations, and Units

Acronym	Stands For
BMP	Best Management Practice
Cliffs Erie	Cliffs Erie, LLC
FTB	Flotation Tailings Basin
gpm	gallons per minute
HRF	Hydrometallurgical Residue Facility
LTVSMC	LTV Steel Mining Company
MDNR	Minnesota Department of Natural Resources
MPCA	Minnesota Pollution Control Agency
NA	Not Available
N/A	Not Applicable
NPDES	National Pollutant Discharge Elimination System
PTM	Permit to Mine
SAP	Sampling and Analysis Plan
SDS	State Disposal System
SPCC	Spill Prevention Control and Countermeasures
SWPPP	Storm Water Pollution Prevention Plan
TBD	to be determined
TWP	Treated Water Pipeline
USGS	U.S. Geological Survey
WWTP	Plant Site Waste Water Treatment Plant

1.0 Introduction

This document presents the Water Management Plan - Plant for Poly Met Mining Inc.'s (PolyMet) NorthMet Project (Project). The Plant Site includes:

- a Beneficiation Plant for processing ore within existing and new buildings
- the existing Plant Reservoir, pipeline to Colby Lake, and Colby Lake Pumphouse
- a Hydrometallurgical Plant
- a Hydrometallurgical Residue Facility (HRF)
- the existing former LTV Steel Mining Company (LTVSMC) tailings basin (Tailings Basin), with a new Flotation Tailings Basin (FTB) constructed atop
- an FTB South Seepage Management System and an FTB Seepage Containment System to manage seepage from the Tailings Basin
- a Waste Water Treatment Plant (WWTP)
- existing and new supporting infrastructure (such as roads, electrical supply, rail connections, Area 1 Shop, Area 2 Shop, and a Sewage Treatment System)
- in reclamation, an FTB Cover System on the FTB beaches and pond bottom, to manage seepage and oxygen infiltration

Several specifically defined types of water will be managed at the Plant Site (Section 1 of Volume I of Reference (1)). During the environmental review process, all the following types of water were referred to as "process water"

- Process waste water is water used in mineral processing, as defined by 40 CFR 122.2 and 401.11(q)
- Tailings basin water is all water collected and stored in the Tailings Basin
- Tailings basin seepage is water that infiltrates through tailings deposits
- HRF water is water collected and stored in the HRF
- Mine drainage includes all water pumped from the Mine Site to the FTB via the Treated Water Pipeline

This document describes the design and operation of water management infrastructure associated with the Plant Site. It presents the estimated quantity of tailings basin seepage to be pumped from the FTB Seepage Containment System and the FTB South Seepage Management System (collectively referred to as the FTB seepage capture systems) and the estimated water quality at the appropriate water compliance points. It also presents operating plans, water quality and quantity monitoring plans, reporting requirements, and adaptive management approaches. Information from this report will become part of the Minnesota Department of Natural Resources (MDNR) Permit to Mine (PTM) application, the MDNR Water Appropriation Permit application, and Minnesota Pollution Control Agency (MPCA) National Pollutant Discharge Elimination System (NPDES) / State Disposal System (SDS) Permit application and is summarized in the NorthMet Project Description (Reference (2)). This and all other Management Plans will evolve through the environmental review, permitting, operating, reclamation, and long-term closure phases of the Project.

In this document, Flotation Tailings are the Project bulk Flotation Tailings; the FTB is the newly constructed NorthMet Flotation Tailings impoundment; the Tailings Basin is the existing former LTVSMC tailings basin, as well as the combined LTVSMC tailings basin and the FTB; the Emergency Basin is the existing former LTVSMC Emergency Basin; and Residue is the Project combined hydrometallurgical residue stored in the HRF.

The Plant Site is shown on Large Figure 21 in Reference (2). The area that contains the Beneficiation Plant, the Hydrometallurgical Plant, the WWTP, and the Plant Reservoir is collectively referred to as the Process Plant Area and is shown on Large Figure 22 in Reference (2).

In addition to the management of water at the Plant Site, this document also briefly describes the Plant Site water balance, as explained in detail in Section 6 of the Water Modeling Data Package Volume 2 – Plant Site (Reference (3)) and the quantity of water that will be discharged from the WWTP in operations, reclamation, and long-term closure, as modeled in Reference (3).

Several other Management Plans contain information that relates to the water management at the Plant Site. The NorthMet Project Flotation Tailings Management Plan (Reference (4)) includes design details for the FTB. The NorthMet Project Residue Management Plan (Reference (5)) includes design details for the HRF. The NorthMet Project Adaptive Water Management Plan (Reference (6)) contains details of adaptive engineering controls (WWTP and FTB Cover System) that will ensure compliance with applicable water quality standards at appropriate evaluation points.

Detailed reclamation plans for the water management systems are described in this document. The overall reclamation plan is described in the NorthMet Project Reclamation Plan (Reference (7)).

1.1 Objective

The objective of the Water Management Plan - Plant is to provide a safe and reliable system of managing the water at the Plant Site in a manner that results in compliance with applicable surface water and groundwater quality standards at appropriate Plant Site compliance points and water appropriations and withdrawal limits. Compliance is demonstrated by modeling outcomes discussed in Reference (3).

1.2 Outline

The outline of this document is:

Section 1.0 Introduction, objective, and description of the Plant Site baseline data and existing conditions

Section 2.0 Description of the water management systems at the Plant Site associated with the Beneficiation Plant, Hydrometallurgical Plant, WWTP, stormwater, and stream augmentation

Section 3.0 Description of key outcomes, including quantity of water required to be appropriated from Colby Lake and water quality at compliance points

Section 4.0 Description of operational management plans

Section 5.0 Overview of the approach for monitoring water quantity and quality. The specifics of monitoring, including specific locations, nomenclature, frequency, and parameters will be finalized during the NPDES/SDS and Water Appropriation permitting processes, and have been incorporated into each of the permit applications.

Section 6.0 Description of reporting and annual reporting requirements including comparison to modeled outcomes and compliance, adaptive management plans, and available mitigations

Section 7.0 Description of the reclamation and long-term closure plans for the Plant Site water management systems including the Contingency Reclamation Plan (assumes closure in the upcoming year) for Mine Years 0 and 1

Because this document is intended to evolve through the environmental review and permitting (NPDES/SDS, Water Appropriations, and PTM) processes, a Revision History is included at the end of the document.

1.3 Existing Conditions

The Plant Site was previously used as a taconite processing facility by LTVSMC, as described in Reference (2) and shown on Large Figure 21 of Reference (2). Several water management components have been acquired from LTVSMC for use on this Project, including:

- buildings and infrastructure at the Process Plant Area, including the Plant Reservoir

- the Colby Lake Pumphouse and water supply line from Colby Lake to the Plant Reservoir
- the inter-pit pipeline from the Plant Reservoir to the Area 1 Shops and Area 2 Shops
- the Tailings Basin and associated water management systems
- the Emergency Basin

Existing drainage patterns at the Plant Site are shown on Large Figure 1. Most of the drainage leaving the Process Plant Area and the Area 1 Shops and Area 2 Shops flows south to Second Creek. Second Creek is also known locally as Knox Creek, but for the purpose of this Project, it will be referred to as Second Creek.

The Tailings Basin is unlined and was constructed in stages beginning in the 1950's. It is configured as a combination of three adjacent cells, identified as Cell 1E, Cell 2E, and Cell 2W, shown on Large Figure 1. The Tailings Basin 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 an MDNR-approved Closure Plan currently managed by Cliffs Erie, LLC (Cliffs Erie).

As shown on Large Figure 1, there are several permitted surface discharge points along the perimeter of the Tailings Basin. In 2011, temporary pumpback systems were installed near (upstream of) surface discharge stations SD004, SD006, and SD026 to return seepage to the Tailings Basin pond as part of a short-term mitigation as required by a Consent Decree between Cliffs Erie and the MPCA. Large Figure 1 shows the locations of the existing surface discharge locations and the temporary pumpback systems around the Tailings Basin.

When first installed, the existing SD026 pumpback system recovered an estimated 200 to 1,400 gallons per minute (gpm) of seepage near the toe of the railroad embankment fill that forms the southern boundary of Cell 1E. System improvements were completed in fall 2014, which has resulted in an increase in recovered flows. The railroad embankment is a massive structure consisting of a mix of small to large diameter rock and overburden. The existing slope angle of the embankment fill averages approximately 1.4 (horizontal) to 1.0 (vertical). The maximum fill height, occurring at seeps 32 and 33 (Section 1.4.3), is approximately 160 feet. Seepage at this location does not currently represent a concern from a slope stability standpoint.

The existing SD026 pumpback system is located approximately 50 to 150 feet downstream (south) of seeps 32 and 33 and upstream of SD026. It consists of an impoundment that blocks the seepage and redirects it into a seepage recovery trench, where it is currently being pumped back into the Tailings Basin pond. Under the Consent Decree between Cliffs Erie and the MPCA, periodic data collection will continue to assess the efficiency of this pumpback system and its effect on downstream water quality and quantity.

1.4 Baseline Data

Section 4 of Reference (3) describes the baseline climate, land use, geology, surface water and groundwater data used in the water quantity and quality modeling at the Plant Site. This section provides a summary of the baseline surface water and groundwater data from Reference (3).

1.4.1 Surface Water Baseline Data

As described in Section 4 of Reference (3), the Plant Site is primarily located within the Embarrass River watershed, upstream of the Embarrass River chain of lakes (Large Figure 2). Approximately 20% of the Plant Site, including the SD026 discharge from the Tailings Basin and stormwater from the Process Plant Area, is tributary to Second Creek, which joins the Partridge River downstream of Colby Lake (Large Figure 2).

Upstream of the U.S. Geological Survey (USGS) gaging station 04017000 (Large Figure 2), the Embarrass River watershed covers approximately 88.3 square miles. The Embarrass River watershed upstream of surface water evaluation point PM-13, which receives approximately 80% of Plant Site drainage covers approximately 111.8 square miles. Tributaries to the Embarrass River located between the Tailings Basin and the Embarrass River that could potentially be affected by the Project include (east to west) Mud Lake Creek, Trimble Creek, and Unnamed Creek. Other tributaries located between the Tailings Basin and the Embarrass River that are not expected to be affected by the Project include (east to west) Spring Mine Creek, which drains LTVSMC's former Mine Area 5N, an unnamed creek, and Heikkilla Creek (Large Figure 1 to Large Figure 3). Section 4.4 of Reference (3) provides additional detail on the Embarrass River watershed, and Section 4.5 of Reference (3) and Section 4.4 of Reference (8) provide additional detail on the Partridge River watershed.

Daily flow data is available for the Embarrass River from the USGS gaging station 04017000 from 1942 to 1964. The hydrology data has been analyzed and validated for use on this Project, as described in Section 4.4.1 and Section 4.4.2 of Reference (3). Daily flow is also available for Second Creek from the USGS gaging station 04015500 from 1955 to 1980. The hydrology data from this gage on Second Creek is heavily impacted by mine pit dewatering between the SD026 discharge and the USGS gage (Large Figure 2); therefore this data has not been used for this Project.

Several surface water locations within the Embarrass River watershed have been monitored for water quality at some time since 2004, with the frequency of monitoring and list of parameters varying by location. These locations are shown on Large Figure 3 and include five monitoring locations on the Embarrass River above the chain of lakes, two locations along Spring Mine Creek, three locations along Mud Lake Creek, two locations along Trimble Creek, two locations on Unnamed Creek, and six locations in Wynne Lake, Sabin

Lake, and Embarrass Lake. The results of baseline monitoring upstream of the Embarrass River chain of lakes is presented in Large Table 4 of Reference (3). Baseline monitoring data from water collected in Wynne Lake, Sabin Lake, and Embarrass Lake is presented in Large Table 6 of Reference (3). Monitoring conducted from 2004 to 2008 generally includes fewer locations and a wider parameter list to characterize the baseline conditions within the Embarrass River watershed. Monitoring from 2008 to 2011 generally focused on a smaller list of constituents and locations to resolve specific issues with the data (e.g., ratio of dissolved to total aluminum, inadequate thallium detection limits). More extensive baseline monitoring was resumed in 2012, including additional locations along Embarrass River tributaries and a larger list of constituents.

Baseline water quality monitoring was performed at location PM-7 (Large Figure 2) in the Second Creek watershed in 2004, 2006, and 2007. Cliffs Erie continues to monitor this location as part of their ongoing NPDES monitoring requirements; this site is identified as surface discharge station SD026 for NPDES monitoring (Section 1.4.5). Data collected at PM-7 and SD026 is presented in Large Table 5 of Reference (3).

1.4.2 Groundwater Baseline Data

The quantity of water flowing through the saturated unconsolidated deposits in the vicinity of the Tailings Basin can be estimated based on observed hydraulic gradients and estimates of hydraulic conductivity and aquifer thickness. Inferred groundwater contours within the surficial aquifer are shown on Large Figure 4. These water table contours were developed using a combination of measured groundwater elevations in the monitoring wells surrounding the Tailings Basin, measured pond water elevations, and contours from the Plant Site MODFLOW model of current conditions. The thickness of the surficial deposits and surficial aquifer increases to the north and northwest, from the Tailings Basin to the Embarrass River. The average hydraulic gradient is approximately -0.00444 to the north of Cell 2E, -0.00514 to the north of Cell 2W, and -0.00736 to the west of Cell 2W. Assuming a mean hydraulic conductivity of 13.2 feet per day (ft/day) and a porosity of 0.3, the average linear velocity of groundwater north and west of the Tailings Basin ranges from 0.2 to 0.3 ft/day (Section 4.3.3 of Reference (3)). Locally, actual velocities likely range over several orders of magnitude, due to local variations in hydraulic gradient and hydraulic conductivity of the aquifer materials.

Sixteen existing monitoring wells provide information on groundwater in the surficial deposits in the area of the Plant Site. Some of the wells (GW001 through GW008, with the exception of GW003 and GW004, which have been dry in recent years) have been sampled regularly for more than 10 years as part of the NPDES permit for the existing Tailings Basin. The groundwater monitoring well network also includes four wells installed in 2009 specifically for evaluation of baseline conditions for this Project, and four additional wells installed as part of the Cliffs Erie Consent Decree. Groundwater monitoring data collected from monitoring wells in the surficial deposits are summarized in Large Table 3 in Reference (3). The locations of the groundwater monitoring wells are shown on Large Figure 4.

1.4.3 Tailings Basin Surface Seepage

Surface seepage from the Tailings Basin generally exits at or near the toe of slope of the existing dams or through existing pipes but is occasionally evident on the side slope of the existing dams slightly above the toe elevation. The surface seepage tends to occur in a random pattern in both vertical and horizontal dimensions along the toe and face of the lower portions of the existing dams.

The surface seeps along the Tailings Basin where flow has been observed in the last eight years (2007-2014) are shown on Large Figure 5 and listed in Table 1-1.

Table 1-1 Tailings Basin Surface Flows

Location[1]	Oct. 2007 (gallons per minute [gpm])	Aug. 2008 (gpm)	Oct. 2008 (gpm)	Oct. 2009 (gpm)	Oct. 2010 (gpm)	Oct. 2011 (gpm)	Oct. 2012 (gpm)	Oct. 2013 (gpm)	Oct. 2014 (gpm)
Seeps 13-17[2]	1	No Flow	No Flow	No Flow	No Flow	No Flow	No Flow	No Flow	No Flow
Culvert/ Pipe	1	1	1	1	0.5	0.5	0.5	0.3	0.5
SD006[3]	303	383	710	618	722	Not Applicable (N/A)	N/A	N/A	N/A
Seep 20	1.5	1.5	2.5	3	3	3.5	2.0	1.5	2.0
Seep 22 (SD004)	2	3	3	4	3	N/A	N/A	N/A	N/A
Seep 24	26	7	10	12	11	9	9	10	8.5
Seep 25	11	27	No Flow	No Flow	No Flow	No Flow	No Flow	No Flow	No Flow

Location(1)	Oct. 2007 (gallons per minute [gpm])	Aug. 2008 (gpm)	Oct. 2008 (gpm)	Oct. 2009 (gpm)	Oct. 2010 (gpm)	Oct. 2011 (gpm)	Oct. 2012 (gpm)	Oct. 2013 (gpm)	Oct. 2014 (gpm)
Seep 30	54	206	100	189	161	121	182	64	82
Seeps 32 & 33 (upstream of SD026)(4)	490	195	600	781	1379	N/A	N/A	N/A	N/A
Inflow (culvert)(5)	745	Not Available (NA)	80	116	NA	No Flow	39	69	21

(1) See Large Figure 5
(2) Seeps 13 through 17 are all connected along a ditch with outflow at Seep 17; therefore, the flow reported is cumulative.
(3) SD006 currently includes inflows from the Emergency Basin watershed, which do not originate as surface seepage from the Tailings Basin.
(4) Seeps 32 and 33 are located approximately ½ mile upstream of SD026 near the SD026 pumpback system. SD026 has a larger watershed than just these two seeps; therefore flows reported for SD026 are different than reported here.
(5) Inflow (culvert) consists of overland drainage flowing into the Tailings Basin (Cell 1E) from the northeast. There is no seepage from the Tailings Basin included in this flow.

1.4.4 Waste Streams (WSxxx) as Defined in NPDES Permit MN0054089

The existing NPDES permit for the Tailings Basin (MN0054089) includes 12 waste stream stations, summarized in Table 1-2 and shown on Large Figure 5 (with the exception of WS008, WS014, and WS015, which are waste streams for chemical dust suppressants that do not have a specific location). Only waste stream station WS009 is expected to be included in future permit requirements for this Project.

Table 1-2 Existing NPDES Permit MN0054089 Waste Stream Stations

Station	Local Name	Status
WS001	NW side of Emergency Basin	Will be inactivated following construction of the HRF; permit requirements not anticipated to continue during operations, reclamation or long-term closure
WS002	NW Seepage Collection Return Pumping to TB	No longer active; permit requirements not anticipated to continue during operations, reclamation or long-term closure
WS003	NE Seepage Collection Return Pumping to TB	No longer active; permit requirements not anticipated to continue during operations, reclamation or long-term closure
WS006	Biosolids transferred to POTW	No longer active; permit requirements not anticipated to continue during operations, reclamation or long-term closure
WS007	Treated Sewage to Emergency Basin	No longer active; permit requirements not anticipated to continue during operations, reclamation or long-term closure

Station	Local Name	Status
WS008	Ligninsulfonate applied for Dust Control	No specific location; dependent on location of application. No longer active; permit requirements not anticipated to continue during operations, reclamation or long-term closure
WS009	Culvert under RR grade, NE side of Cell 1E	Monitoring of flow and water quality; permit requirements anticipated to continue during operations until East Dam cuts off this inflow
WS011	Tailings Basin Seep 1	Seep currently dry; location will be disturbed by construction of HRF; permit requirements not anticipated to continue during operations, reclamation or long-term closure
WS012	Tailings Basin Seep 2	Seep currently dry; location will be disturbed by construction of HRF; permit requirements not anticipated to continue during operations, reclamation or long-term closure
WS013	Tailings Basin Seep 3	Seep currently dry; location will be disturbed by construction of HRF; permit requirements not anticipated to continue during operations, reclamation or long-term closure
WS014	Coherex applied for Dust Control	No specific location; dependent on location of application. No longer active; permit requirements not anticipated to continue during operations, reclamation or long-term closure
WS015	Nalco Dust-Bas 8803 for Dust Control	No specific location; dependent on location of application. No longer active; permit requirements not anticipated to continue during operations, reclamation or long-term closure

1.4.5 Surface Discharges (SDxxx) as Defined in NPDES Permit MN0054089 and MN0042536

The existing NPDES permit for the Tailings Basin (MN0054089) includes five surface discharge stations, summarized in Table 1-3. The existing NPDES permit for the Hoyt Lakes Mining Area (MN0042536) includes one surface discharge station relevant to the Project, summarized in Table 1-4. All six of these stations are shown on Large Figure 5. Three of these existing surface discharge stations (SD004, SD005, and SD006) will be combined into an internal waste stream of FTB seepage collected by the FTB Seepage Containment System. Only surface discharge station SD026, or a location near it, is expected to be included in future permit requirements as a surface discharge station for this Project.

Table 1-3 Existing NPDES Permit MN0054089 Surface Discharge Stations

Station	Local Name	Status
SD001	Northwest Seepage Collection Ditch	This location will no longer be considered a surface discharge station; permit requirements not anticipated to continue during operations, reclamation or long-term closure.
SD002	Northeast Seepage Collection Ditch	This location will no longer be considered a surface discharge station; permit requirements not anticipated to continue during operations, reclamation or long-term closure.
SD004	Tailings Basin Cell 2W Seep A	Seepage at this location will be collected by the FTB Seepage Containment System and will be part of a new internal waste stream included in Project monitoring
SD005	Tailings Basin Cell 2W Seep B	Seepage at this location will be collected by the FTB Seepage Containment System and will be part of a new internal waste stream included in Project monitoring
SD006	Power Line Access Road Culvert	Seepage at this location will be collected by the FTB Seepage Containment System and will be part of a new internal waste stream. The stream near SD006 (outside the FTB Seepage Containment System) will be a surface discharge station for the WWTP.

Table 1-4 Existing NPDES Permit MN0042536 Surface Discharge Stations

Station	Local Name	Status
SD026	Second Creek (aka Knox Creek) headwaters	Seepage upstream of this location will be collected by the FTB South Seepage Management System and will be part of a new internal waste stream. Second Creek, near SD026, will be a surface discharge station for the WWTP.

1.4.6 Surface Waters (SWxxx) as Defined in NPDES Permit MN0054089

Existing NPDES Permit MN0054089 has three surface water stations, summarized in Table 1-5 and shown on Large Figure 3. These monitoring stations are expected to be included in Project monitoring (Section 5.0).

Table 1-5 Existing MN0054089 Surface Water Monitoring Locations

Station	Local Name	Status
SW003	Unnamed Creek tributary to Embarrass River	This location is the same as PM-11
SW004	Embarrass River at CR620	This location is the same as PM-12
SW005	Embarrass River at Hwy 135 Bridge	This location is the same as PM-13

2.0 Water Management System Design

Water at the Plant Site will be managed to provide adequate water quantity and quality for operations and to control impacts to offsite water resources. Water used in the operation of the Beneficiation and Hydrometallurgical Plants will be recycled through the FTB and the HRF, and Plant Site stormwater within and around the FTB and within the HRF will be collected for use in mineral processing. Stormwater within the Process Plant Area, Area 1 Shops, and Area 2 Shops will be kept separate from process waste water, tailings basin water, tailings basin seepage, and HRF water, and will be routed off-site.

The Beneficiation Plant will use water as a means to move the ground ore, concentrate, and Flotation Tailings in Beneficiation processes, and the Hydrometallurgical Plant will use water as a means to move concentrate, precipitates, and Residue in the Hydrometallurgical processes. Process waste water from the Beneficiation Plant will be pumped with Flotation Tailings to the FTB. Water will be pumped from the Beneficiation Plant to the Hydrometallurgical Plant with the concentrate, and from the Hydrometallurgical Plant to the HRF with the Residue. Make-up water required by the Beneficiation Plant and the Hydrometallurgical Plant will primarily be drawn from the FTB Pond and the HRF Pond, respectively, with additional make-up water pumped from the Plant Reservoir, as needed.

The FTB will serve as the primary reservoir for water used at the Beneficiation Plant. In addition to receiving process waste water from the Beneficiation Plant in the Flotation Tailings slurry, it will also receive mine drainage from the Mine Site. Tailings basin seepage will be collected around the Tailings Basin by the FTB seepage capture systems. Because the FTB seepage capture systems will cut off seepage from the existing LTVSMC tailings basin that recharges downstream tributaries, the Project will augment these streams to avoid hydrologic impacts to them. During Project operations, the Plant Site will typically be a net water consumer, with discharge to the environment limited to what is necessary for stream augmentation; tailings basin seepage will be treated at the WWTP before being discharged for stream augmentation.

The Plant Reservoir is a 10 million gallon capacity concrete structure that is fed by water from Colby Lake. It will supply:

- make-up water for the Beneficiation and Hydrometallurgical Plants if additional water is needed beyond that supplied by the FTB Pond and the HRF Pond, respectively
- the treatment plant that feeds the Potable Water System – after use, this water reports to the new Plant Site Sewage Treatment System or the septic systems at the Area 1 Shop or Area 2 Shop
- service water used for cooling, seals, and other applications that require clean water – after use, this water reports to the Beneficiation or Hydrometallurgical Plant water systems
- fire water – only used in an emergency

The following sections describe the major components of the Plant Site water management systems.

2.1 Beneficiation Plant

Within the Beneficiation Plant, process waste water carries the ground ore and concentrate through the ore grinding and flotation steps, and then transports the Flotation Tailings to the FTB. To the extent possible, water that is used to transport Flotation Tailings to the FTB will be recycled to the Beneficiation Plant; however some losses will occur through evaporation and storage within the pores of the deposited Flotation Tailings.

2.1.1 Beneficiation Plant Water Balance

The Beneficiation Plant water balance is detailed in Section 6.1.1 of Reference (3) and summarized below. Most of the water used in the Beneficiation process is decanted tailings basin water from the FTB Pond. This water supply includes mine drainage that is piped to the FTB through the Treated Water Pipeline (TWP) from the Mine Site (Reference (9)). A relatively small amount of make-up water is pumped from the Plant Reservoir to meet the full demand of the Beneficiation Plant. The Beneficiation Plant discharges to the FTB in two methods: directly to the pond for subaqueous disposal of the Flotation Tailings and spigotting of Flotation Tailings along the dams to construct the beaches. The split between these two methods is dependent on the geometry of the basin, so that the beaches and pond rise at the same rate, and therefore the rate from each method varies over time. Table 2-1 summarizes the main flows of the Beneficiation Plant water balance at three different years in the life of the project: Mine Year 2 when only Cell 2E is operational, Mine Year 10 when Cell 2E and Cell 1E are combined (as Cell 1/2E), and Mine Year 20 when operations are coming to a close prior to the FTB being prepared for reclamation.

Table 2-1 Beneficiation Plant Water Balance

Flow Stream	Mine Year 2[1]		Mine Year 10[2]		Mine Year 20[3]	
	Average Annual Flow (gpm)[4]	90th Percentile Flow (gpm)[4]	Average Annual Flow (gpm)[4]	90th Percentile Flow (gpm)[4]	Average Annual Flow (gpm)[4]	90th Percentile Flow (gpm)[4]
Inflows to Beneficiation Plant						
From FTB Pond	12,273	13,017	13,146	13,167	12,738	13,165
From Plant Reservoir (make-up water)	897	1,618	24	62	432	1,023
Other Inflows[5]	652	652	652	652	652	652

Flow Stream	Mine Year 2(1)		Mine Year 10(2)		Mine Year 20(3)	
	Average Annual Flow (gpm)(4)	90th Percentile Flow (gpm)(4)	Average Annual Flow (gpm)(4)	90th Percentile Flow (gpm)(4)	Average Annual Flow (gpm)(4)	90th Percentile Flow (gpm)(4)
Outflows from Beneficiation Plant						
To FTB Pond	8,707	9,325	9,372	9,925	5,272	6,172
To FTB beaches	5,062	5,699	4,397	4,969	8,497	9,428
Other Outflows(6)	53	53	53	53	53	53

(1) Mine Year 2 represents 1 year < time ≤ 2 years
(2) Mine Year 10 represents 9 years < time ≤ 10 years
(3) Mine Year 20 represents 19 years < time ≤ 20 years
(4) Source of data: Section 6.1.1 of Reference (3). For the Average Annual Flow, the value represents the annual average of the mean model results for a given year. For the 90th Percentile Flow, the values represent the annual average of the 90th percentile for the given year.
(5) Other inflows include water in ore, water in reagents, gland water, and miscellaneous water inputs that result in minor individual flows.
(6) Other outflows include evaporation within the Beneficiation Plant and other minor flows.

2.1.2 Flotation Tailings Basin (FTB)

Flotation Tailings are transported to the FTB as a mixture of Flotation Tailings and process waste water. The Flotation Tailings settle out in the FTB, and tailings basin water is returned to the Beneficiation Plant for reuse. The FTB also receives treated mine drainage from the Mine Site via the TWP (Section 2.1 of Reference (9)). The FTB is fully described in Reference (4).

2.1.3 Flotation Tailings Basin (FTB) South Seepage Management System

The FTB South Seepage Management System will collect tailings basin seepage from the south side of Tailings Basin Cell 1E. Bedrock and surface topography create a narrow valley at the headwaters of Second Creek in this location. 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.

As described in Section 1.3, the temporary surface seepage pumpback system was installed in 2011 near the existing surface discharge station SD026 as part of a short-term mitigation required by a Consent Decree between Cliffs Erie and the MPCA. This system will become the FTB South Seepage Management System. The temporary pumpback system collects surface seepage from the south side of Cell 1E just upstream of SD026 (Large Figure 5 and Section 1.4.5). The pumpback 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 route this seepage back into the Tailings Basin Cell 1E Pond.

Water from the FTB South Seepage Management System will go to the FTB Pond and/or to the WWTP. Drawings in Attachment A show the current design of the SD026 seepage pumpback system, with the location shown on Large Figure 6. PolyMet and Cliffs Erie are currently working together to assess the effectiveness of this system. PolyMet has committed to collecting essentially all of the seepage from the Tailings Basin in this area and the design or operation will be modified if necessary.

2.1.4 Flotation Tailings Basin (FTB) Seepage Containment System

The FTB Seepage Containment System will collect tailings basin seepage along the north, northwest, west, and east toes of the Tailings Basin Dams, as shown on Large Figure 6. The FTB Seepage Containment System is designed to intercept the seepage that emerges as surface water near the toe (within several hundred feet) and the seepage that remains in the ground as groundwater, as well as surface runoff from the small watershed between the dam toe and the containment system. This containment system will replace the SD006 and SD004 pumpback systems installed as short-term mitigation in 2011. Seepage to the south of the Tailings Basin will be collected by the FTB South Seepage Management System described in Section 2.1.3.

The FTB Seepage Containment System consists of a cutoff wall (a low permeability hydraulic barrier) placed into the existing surficial deposits, with a drainage collection system installed on the upgradient side (Figure 2-1). The collection system has a collection trench filled with granular drainage material and a perforated drain pipe located near the bottom of the trench. Vertical risers extending above ground surface from the drain pipe will collect surface seepage discharging upgradient of the containment system. The containment system also includes a series of subsurface gravity drain pipes, sumps, and lift stations installed between the cutoff wall and the toe of the FTB dams. A schematic plan view of the containment system alignment is shown on Figure 2-2.

During operations, a portion of the collected seepage will be recycled to the FTB Pond for reuse in the beneficiation process, and a portion will be routed to the WWTP for treatment prior to discharge at stream augmentation outfalls. Collected seepage will be distributed so as to meet stream augmentation requirements and manage the FTB pond level (Section 2.3 and 2.6). Water collected on the western and northern sides of the Tailings Basin will be conveyed to one of two main pump stations through a control valve station, centrally located on the northern side of the Tailings Basin. From there it will be routed back to the FTB Pond, or to the WWTP for treatment and discharge, depending on the needs of the Project. Water collected on the eastern side of the Tailings Basin will be routed back to the FTB Pond by a containment system pump station located on the east side of the Tailings Basin. All pumps in the containment system will be operated using level sensors so that a desired water level is maintained in the sumps and lift stations. The containment system will continue to operate during reclamation and through long-term closure.

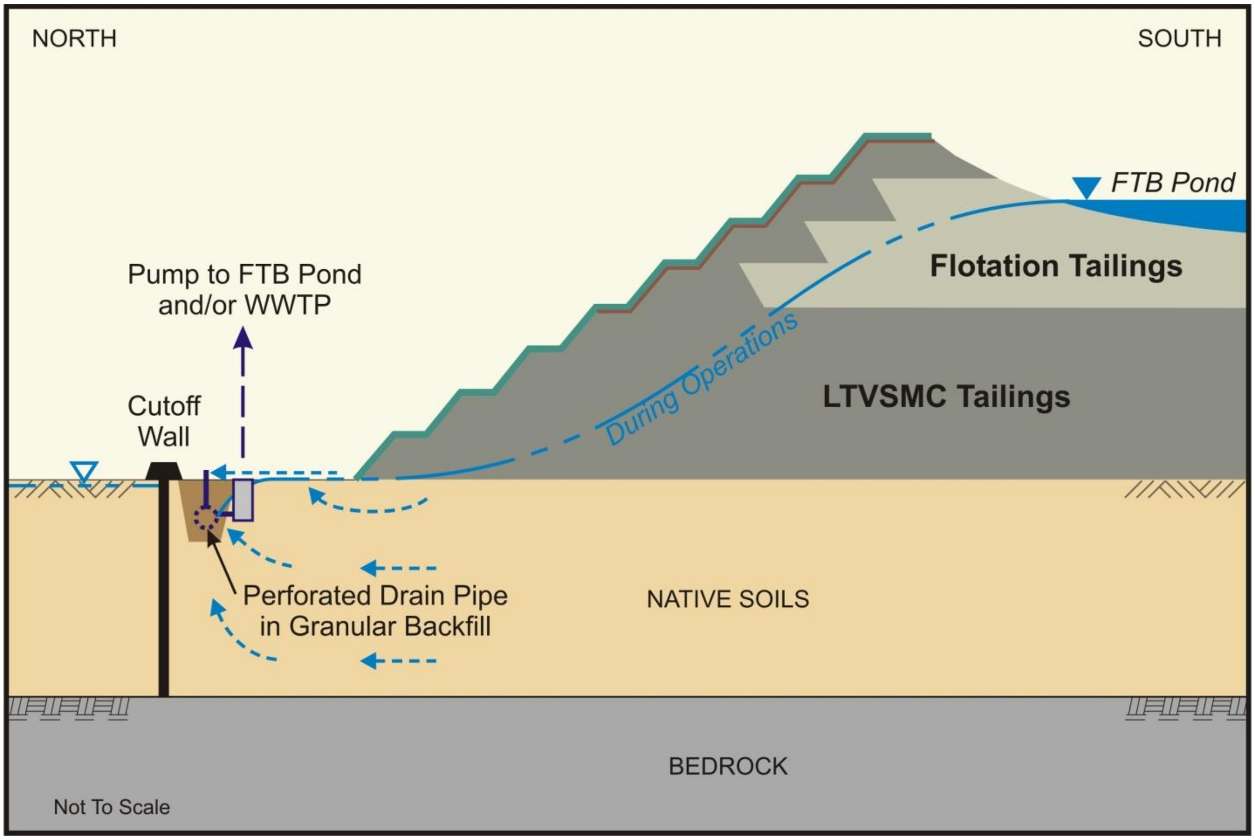

Figure 2-1 Conceptual Cross-Section: FTB Seepage Containment System

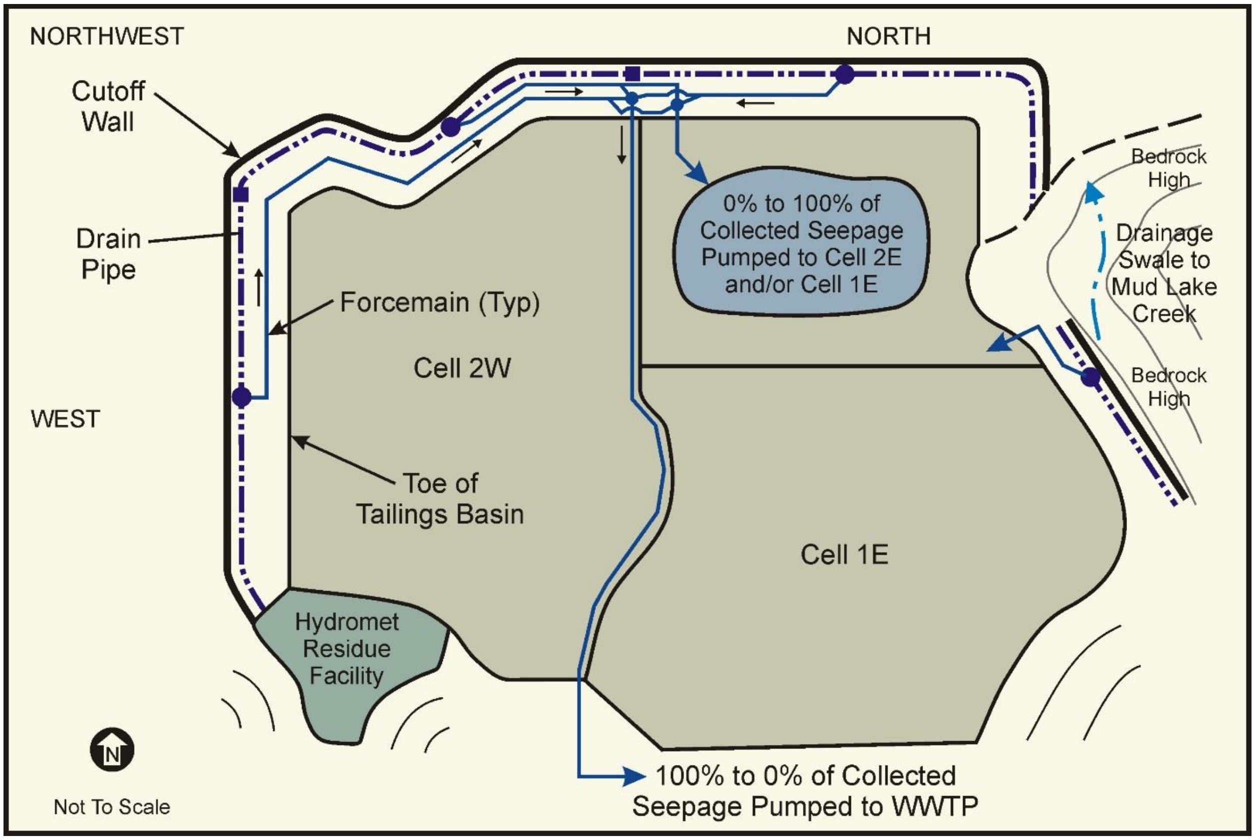

Figure 2-2 Conceptual Plan View: FTB Seepage Containment System

The containment system will collect the tailings basin seepage and draw down the water table on the Tailings Basin side of the cutoff wall, thereby maintaining an inward gradient along the cutoff wall and mitigating the potential for seepage to pass through the cutoff wall (i.e., leakage through the cutoff wall will be inward into the containment system). The cutoff wall will be extended to bedrock in order to minimize groundwater capture from downgradient of the system, thereby limiting the amount of water to be pumped and treated. The containment system alignment crosses a number of wetlands. Anticipated wetland impacts have been accounted for between the FTB and the FTB Seepage Containment System and downgradient of the FTB Seepage Containment System, as documented in Reference (10), Section 5.1.5 (direct wetland impacts) and Section 5.2 (indirect wetland impacts).

Attachment B contains the Permit Application Support Drawings for the FTB Seepage Containment System. The system will be designed and constructed in accordance with applicable requirements of Minnesota Rules, part 6132.2500, subpart 2. The choice of a slurry wall (often synonymous with cutoff wall), a geomembrane barrier, a natural clay barrier, or other type of hydraulic barrier is made on a project-specific basis, weighing factors such as characteristics of the surficial deposits to be excavated, rate of construction desired, and availability of construction materials. For this system, a variant of slurry wall technology (bentonite soil-filled trench; cutoff wall) was selected. Along the alignment of the containment system shown on the

Permit Application Support Drawings (Attachment B), the surficial deposits are up to 40 feet deep. Cutoff walls this deep can be constructed in-situ using continuous construction techniques which greatly reduce the need to dewater the surrounding soils. In the event that subsurface obstructions (i.e., cobbles or boulders) interfere with in-situ construction, then some open trenching will be used along these limited segments of the system and/or the system alignment will be modified to bypass the obstruction.

Much of the collection trench can also be constructed using in-situ techniques. For short sections of the collection trench, particularly where manholes are required, some open excavations and temporary dewatering will be required. This water, which normally percolates to the ground surface and discharges away from the Tailings Basin as surface water, will be pumped to a sedimentation basin to facilitate sediment removal prior to being discharged from the site.

The containment system design is based on data obtained from geotechnical and hydrogeologic evaluations performed at the site. Prior to construction of the containment system, additional subsurface exploration work will be performed to confirm the subsurface conditions along the containment system alignment. Although the existing subsurface data do not show the presence of cobbles and boulders along the proposed alignment, the final alignment will be adjusted if needed to minimize impacts to construction caused by cobbles or boulders.

The expected capture efficiency of the FTB Seepage Containment System has been assessed by reviewing industry use of similar systems, groundwater modeling, and hydrogeologic assessment. The combined use of a cutoff wall and a collection system is acknowledged by academic, governmental, and industry authorities and by construction markets as detailed in Attachment D of Reference (11). This type of containment system is commonly used at facilities where there is a need to manage groundwater flow and surface seepage, such as landfills, tailings basins, and paper sludge disposal facilities.

A groundwater flow model was developed to assess the ability of the proposed containment system to collect seepage near the toe of the Tailings Basin dams and to estimate the average flow rate to the collection system (Attachment C). This modeling predicts that the cutoff wall and collection trench system will accomplish the water resource objectives (i.e., meet applicable surface water standards in the three Embarrass River tributaries, meet applicable groundwater standards at the property boundary, and meet MPCA criteria with regard to sulfate at the three tributary headwaters, at PM-13, and at the Embarrass River) (Attachment A of Reference (3)). Capture efficiency depends on how much flow enters the bedrock, so the groundwater flow modeling, described in Attachment C, estimated capture efficiency for three different thicknesses of the bedrock fracture zone: 25 feet, 50 feet, and 100 feet. Results show that the containment system will collect all of the seepage along the north and northwest flow paths under all three bedrock fracture zone thicknesses considered. Effectiveness along the west flow path depends on the thickness of the upper fractured zone of the bedrock. The containment system will collect all of the seepage along the west flow path for bedrock fracture zone thicknesses of 25 feet and 50 feet. For a bedrock fracture zone 100 feet thick, up to 1% of the total seepage to this toe (7-8 gpm) is estimated to bypass the system. Given that site-specific bedrock fracture data indicate that the amount of fracturing decreases significantly in the upper 20 feet of the bedrock (Section 3.2.1 of Reference (12)), the estimates for the scenarios with the fracture zone assumed to be 25 and 50 feet are the most applicable, while the estimate for a bedrock fracture zone 100 feet thick should be considered conservative.

Hydrologic assessment was used to evaluate the effectiveness of the eastern section of the FTB Seepage Containment System, which was not modeled. Along most of the eastern side of the Tailings Basin, elevated bedrock will prevent groundwater seepage. In the area of the East Dam, groundwater flow is currently from the east toward the Tailings Basin because of the high hydraulic head in the high ground east of the Tailings Basin. Construction of the East Dam and the tailings deposition behind the dam will result in hydraulic heads that will allow water from a limited area at the eastern edge of the FTB to flow east towards the toe of the East Dam. The hydraulic gradient across the containment system cutoff wall will be inward, toward the Tailings Basin, because the hydraulic heads further east of the dam (near Spring Mine Lake) are higher than the ground surface near the toe of the dam, and because the collection system drain pipe will be at an elevation lower than the drainage swale, located to the east (Section 2.6). Overall, based on the existing topography, inward hydraulic gradients, the design of the containment system, and the construction of the drainage swale to manage surface runoff, the eastern section of the FTB Seepage Containment System is expected to have a capture efficiency of 100%.

2.2 Hydrometallurgical Plant

Within the Hydrometallurgical Plant, water is used to extract and isolate metals and to transport the Residue to the HRF. To the extent possible, water that transports Residue to the HRF will be returned to the Hydrometallurgical Plant; however, losses will occur during processing and through evaporation or storage within the pores of the deposited Residue at the HRF. Make-up water will be supplied from the Plant Reservoir. PolyMet expects that the Hydrometallurgical Plant will be operational approximately two to four years after mining commences, which corresponds to Mine Years 3 to 5.

2.2.1 Hydrometallurgical Plant Water Balance

The water used in the Hydrometallurgical process consists mainly of HRF water and make-up water from the Plant Reservoir. Because there are significant water losses through evaporation during processing, the demand for make-up water is much higher for the Hydrometallurgical Plant than for the Beneficiation Plant. The Hydrometallurgical Plant discharges process waste water to the HRF to transport the Residue. Table 2-2 summarizes the main flows in the Hydrometallurgical Plant water balance at three different years in the life of the project: Mine Year 5 which is early in the HRF life, Mine Year 10 and Mine Year 20 when operations are coming to a close prior to the HRF being prepared for reclamation. Details of the Hydrometallurgical Plant water balance are provided in Section 6.1.3 of Reference (3).

Table 2-2 Hydrometallurgical Plant Water Balance

Flow Stream	Mine Year 5[1]		Mine Year 10[2]		Mine Year 20[3]	
	Average Annual Flow (gpm)[4]	90th Percentile Flow (gpm)[4]	Average Annual Flow (gpm)[4]	90th Percentile Flow (gpm)[4]	Average Annual Flow (gpm)[4]	90th Percentile Flow (gpm)[4]
Inflows to Hydrometallurgical Plant						
Into Hydrometallurgical Plant from HRF Pond	182	219	172	203	163	197
Plant Reservoir Make-Up Water	224	252	235	262	244	276
Other Inflows[5]	36	36	36	36	36	36
Outflows from Hydrometallurgical Plant						
Discharge from Hydrometallurgical Plant to HRF	223	223	223	223	223	223
From Beneficiation Plant with Concentrate	48	48	48	48	48	48
Other Outflows[6]	267	267	267	267	267	267

(1) Mine Year 5 represents 4 year < time ≤ 5 years
(2) Mine Year 10 represents 9 years < time ≤ 10 years
(3) Mine Year 20 represents 19 years < time ≤ 20 years
(4) Source of data: Section 6.1.3 of Reference (3). For the Average Annual Flow, the value represents the annual average of the mean model results for a given year. For the 90th Percentile Flow, the values represent the annual average of the 90th percentile model results for the given year.
(5) Other inflows includes gland water and water in reagents; each of which result in minor individual flows.
(6) Other outflows includes Hydrometallurgical Plant vents, evaporation within the Hydrometallurgical Plant, water in the product, and chemically consumed water; each of which result in minor individual flows.

2.2.2 Hydrometallurgical Residue Facility (HRF)

Residue is transported to the HRF as a mixture of solids and process waste water. The solids settle out into the HRF, and the HRF water is returned to the Hydrometallurgical Plant for reuse. The HRF is a lined facility with a leakage collection system that returns any leachate to the HRF pond. The HRF is described in Reference (5) with details about water management within the HRF provided in Section 4 of Reference (5).

2.3 Waste Water Treatment Plant (WWTP)

Collected tailings basin seepage will be routed to the FTB Pond for reuse, and a portion will be routed to the WWTP for treatment prior to discharge (Section 2.6). The WWTP will treat this water to meet applicable surface water discharge limits. During operations and reclamation, reject concentrate from the WWTP will be sent to the Mine Site Waste Water Treatment Facility (WWTF) for further solute removal. During long-term closure, the concentrate will be evaporated and crystallized. The flow to the WWTP will vary significantly over the life of the Project. To address this variability, the WWTP can be expanded or treatment capabilities modified if required to meet water resource objectives. The details of the adaptive design are presented in Section 4 of Reference (6). The WWTP will be located near the FTB as shown on Large Figure 6.

Treated effluent from the WWTP will be discharged to three tributaries around the Tailings Basin (Trimble Creek, Unnamed Creek, and Second Creek), as described in Section 6.6 of Reference (3). The WWTP will discharge to wetlands in the headwater areas of Unnamed Creek and Trimble Creek (outside the FTB Seepage Containment System) and to Second Creek near SD026. Discharging to the downstream side of the containment system will most closely mimic existing conditions, where seepage from the Tailings Basin emerges in the wetland areas north and west of the basin. The effluent from the WWTP will be distributed to these tributaries in proportion to the flow required to prevent significant hydrologic impacts. See Section 2.6 for more details on stream augmentation.

2.4 Plant Site Sewage Treatment System

Sewage at the Plant Site will be treated at a new Stabilization Pond Facility, which will replace the existing Mechanical Sewage Treatment Plant, or at the septic systems at the Area 1 and Area 2 Shops. The existing sewage collection system will be refurbished to meet current performance standards and extended to service additional facilities as required. The Preliminary Sewage Treatment System Facility Plan, which provides the design basis of this system, is included in Attachment D.

2.5 Stormwater Management

Over most of the Process Plant Area, Area 1 Shops, and Area 2 Shops (Large Figure 1), stormwater will be separated from process waste water, tailings basin water, tailings basin seepage, and HRF water using dikes, ditches, and storm sewers. The design basis for the Plant Site stormwater system is described in Attachment E, and the Plant Site Stormwater Permit Application Support Drawings are provided in Attachment F.

The stormwater management infrastructure will be operated in accordance with the Construction Storm Water Pollution Prevention Plan (SWPPP), which will be developed prior to construction, and the Industrial SWPPP, which will be developed prior to the start of operations. These SWPPPs will be developed to meet the requirements of the Minnesota NPDES/SDS Construction Stormwater General Permit (Permit No. MN R100001) and the Minnesota NPDES/SDS Industrial Stormwater General Permit (Permit No. MNR050000), respectively. The Industrial SWPPP will contain the Plant Site drainage areas and directions of stormwater runoff, discharge outfalls from the site with name and location of receiving waters, locations of storm sewer inlets, and an indication of which, if any, structures have floor drains or loading dock drains that are connected to storm sewers. Both of these SWPPPs describe best management practices (BMPs) to be used at the Plant Site to reduce or eliminate pollutants to stormwater.

Stormwater falling within the tributary area to the FTB will be collected, either within the pond where it becomes tailings basin water or by the FTB Seepage Containment System. Stormwater management for the FTB is described in Section 2.5 of Reference (4).

Stormwater falling within the tributary area to the HRF pond will become HRF water. Stormwater management for the HRF is described in Section 2.5 of Reference (5).

2.6 Stream Augmentation

Construction of the FTB Seepage Containment System will significantly reduce the amount of seepage leaving the Tailings Basin relative to existing conditions; therefore reducing the amount of streamflow available to four downstream creeks, including Unnamed Creek, Trimble Creek, Mud Lake Creek, and Second Creek. As described in Section 5.2.2.9.1 and 6.6 of Reference (3), flow to Unnamed Creek, Trimble Creek, and Second Creek will be augmented by WWTP effluent to offset potential hydrologic impacts to these creeks.

Flow to Mud Lake Creek will be augmented by the construction of a drainage swale east of the FTB. Currently, an area east of Cell 1E drains into the Tailings Basin. A drainage swale will be constructed near the East Dam to reroute this watershed north to the Mud Lake Creek watershed. The drainage swale will prevent water from pooling at the toe of the East Dam and augment streamflow in Mud Lake Creek. The additional flow expected to Mud Lake Creek from the diverted watershed is approximately 300 gpm on an average annual basis, which will mitigate about 80% of the captured seepage flow by the FTB Seepage Containment System from this watershed. With this augmentation, the Mud Lake Creek flows will result in approximately 90% of its pre-Project average annual flow. The drainage swale will be constructed in Mine Year 0, which is a change in the Project timing as described in the Supplemental Draft Environmental Impact Statement, which was to construct the drainage swale in Mine Year 7 (Section 5.2.2.3.3 of Reference (13)).

Table 2-3 shows the minimum flow that must be discharged on an average annual basis to each of the three streams that require augmentation from the WWTP. The Stream Augmentation System Permit Application Support Drawings are included in Attachment A.

Table 2-3 WWTP Flow Requirements for Stream Augmentation

Description	Trimble Creek (gpm)	Unnamed Creek (gpm)	Second Creek (gpm)
Minimum Requirement from WWTP	1,178	336	184
Maximum Allowable from WWTP	2,066	836	276
Expected Flows from WWTP -Operations (Mine Years 0 to 21)	1,190 – 1,890	340 – 540	185 – 295(1)

Description	Trimble Creek (gpm)	Unnamed Creek (gpm)	Second Creek (gpm)
Expected Flows from WWTP -Reclamation (Mine Years 21 to 31)	1180	336	184
Expected Flows from WWTP -Long-Term Closure	1485	423	232

(1) Note the highest modeled flows to Second Creek did exceed the maximum allowable by about 20 gpm due to the simplified distribution of WWTP effluent in the modeling and the tight target flow range at SD026. However, the high flow rate (295 gpm) is within the observed flows at SD026 from July 1999 to September 2014 (range is from less than 10 gpm to nearly 2,500 gpm).

In long-term closure, it is expected that stream augmentation will continue to be needed from the WWTP. See Section 5.2.2.9.1 and 6.6 of Reference (3) for more details.

3.0 Key Outcomes

Water modeling (detailed in Section 5 of Reference (3)) provides water quantity and quality estimates used in the design of Plant Site water management systems. This modeling also projects the expected water quantity and quality outcomes resulting from these water management systems.

3.1 Water Quantity

The water balances of the Beneficiation Plant (including water from the Mine Site), the Hydrometallurgical Plant, and the FTB seepage capture systems combine to determine the overall quantity of Project water to be appropriated from Colby Lake and to be discharged from the WWTP, as described in Section 2.0.

Key outcomes of the water quantity modeling described in Reference (3) related to Project makeup water demand are summarized in Table 3-1. Additional groundwater appropriation will be needed for groundwater collected during construction at the Plant Site. Dewatering may be necessary during construction of the FTB Seepage Containment System, Plant Site stormwater infrastructure, Plant Site buildings and infrastructure, and Plant Site Sewage Treatment System. Estimated water appropriation flows for these groundwater needs will be provided in permitting. Tailings basin seepage collected by the FTB seepage capture systems will already have been appropriated from other sources; therefore it will not likely require a water appropriations permit.

Table 3-1 Water Appropriation for the Plant Site

Water Source Location	Source Water	90th Percentile Maximum Estimated Daily Volumes (Million Gallons per Day)(1)	90th Percentile Maximum Estimated Annual Volume (Million Gallons per Year)(1)
Operations Phase			
Colby Lake	Surface Water	15.1 MGD (Mine Year 1)	1,300 MGY (Mine Year 1)
HRF Wick Drain System(2)	Groundwater	TBD in permitting	TBD in permitting

(1) Source of data: Section 6.1.4 of Reference (8); this table lists the peak water need and year of the peak need
(2) The HRF wick drain system is an optional feature of the HRF and, if required, would tie into the FTB Seepage Containment System for collection. Appropriation quantities for the wick drain system will be determined in permitting, if required.

3.2 Water Quality

Key outcomes of the water quality modeling described in Reference (3) are provided as Large Tables:

- estimated water quality of the tailings basin water in the FTB Pond in Large Table 1

- estimated tailings basin seepage water quality in Large Table 2 to Large Table 5 from the north, northwest, west, south, and east toes, respectively
- estimated groundwater quality in Large Table 6 to Large Table 8 along the north, northwest, and west groundwater flow paths downstream of the Plant Site
- estimated surface water quality in Large Table 9 to Large Table 14 at three surface water locations along the Embarrass River and three surface water locations along the three tributaries (Mud Lake Creek, Trimble Creek, and Unnamed Creek) downstream of the Plant Site

4.0 Operating Plan

During operations, water at the Plant Site must be continually monitored, treated at the WWTP, and pumped to augment downstream tributaries, as necessary, to protect the environment and allow the Plant Site to function efficiently. This section describes operating plans for the water management systems at the Plant Site during the operational phase of the Project. Section 7.0 describes the management of water during reclamation and long-term closure.

4.1 Water for Mineral Processing

Water for mineral processing will primarily be contained within the FTB Pond and HRF Pond. Pond water levels will be maintained at safe operating elevations within these ponds. Tailings basin seepage collected in the FTB seepage capture systems help to maintain the water level in the FTB Pond.

4.1.1 Flotation Tailings Basin (FTB) Pond Level

The key water quantity management point is the water level in the FTB Pond. The overall management objective is to keep the FTB pond level as high as possible without exceeding the dam safety criteria. Environmental impacts are minimized by setting the pond level as high as safely possible – smaller beaches minimize fugitive dust generation and reduce the potential for oxidation of exposed Flotation Tailings. FTB pond level management is detailed in Section 4.2 of Reference (4).

The FTB Pond had a negative water balance; that is, the sources of water to the pond are less than the losses from the pond when pumpback from the FTB seepage capture systems is not considered. The FTB pond level will be managed by adjusting the amount of tailings basin seepage sent to the pond from the FTB seepage capture systems and the amount of tailings basin water returned to the Beneficiation Plant.

4.1.2 Hydrometallurgical Residue Facility (HRF) Pond Level

Another water quantity management point is the water level in the HRF pond. The overall management objective is to keep the HRF pond level as high as possible without exceeding the dam safety criteria, in order to minimize environmental impacts, as described in Section 4.1.1. HRF pond level management is detailed in Section 4 of Reference (5).

The Hydrometallurgical Plant is a net water consumer, and the pond level will be managed by adjusting the amount of make-up water added to the Hydrometallurgical Process from the Plant Reservoir.

4.1.3 Flotation Tailings Basin (FTB) South Seepage Management System

The FTB South Seepage Management System is already functional, as described in Section 2.1.3, and will be required to function until the release rates of constituents from the FTB have decreased to the point where water resource objectives are achieved without mechanical treatment.

Tailings basin seepage collected by the FTB South Seepage Management System will be routed from the system pump station through pipes to the WWTP for treatment prior to discharge, or to the FTB Pond for reuse, depending on operational requirements (Section 2.3 and 2.6). Water level controls at the FTB Pond and real time water balance data will dictate whether additional seepage, in excess of the minimum stream augmentation requirements, will be diverted to the WWTP for treatment and discharge. The pumps in the seepage management system will be operated using level sensors so that a desired water level is maintained in the sumps and lift stations.

The FTB South Seepage Management System will require periodic inspection and maintenance to remain effective. The periodic maintenance consists of visual inspection and testing of the pumping system.

4.1.4 Flotation Tailings Basin (FTB) Seepage Containment System

The FTB Seepage Containment System along the western and northern sides of the Tailings Basin must be functional when Flotation Tailings are first placed in the FTB and will be required to function until the release rates of constituents from the FTB have decreased to the point where water resource objectives are achieved without mechanical treatment or until non-mechanical treatment has been proven, as described in Section 6 of Reference (6). The eastern segment of the FTB Seepage Containment System will be constructed by Mine Year 7, prior to the merging of FTB Cells 2E and 1E and the construction of the East Dam. No seepage would be expected along the eastern side of the Tailings Basin prior to that time; FTB pond levels prior to that time are below an elevation that could induce seepage to the east.

Tailings basin seepage collected by the FTB Seepage Containment System along the northern and western sides of the Tailings Basin will be routed to the FTB Pond for reuse and/or to the WWTP for treatment. Collected seepage will be distributed so as to meet stream augmentation requirements and manage the FTB pond level Water level controls at the FTB Pond and real time water balance data will dictate whether additional seepage, in excess of the minimum stream augmentation requirements, must be diverted to the WWTP for treatment and discharge. Tailings basin seepage collected by the segment of the FTB Seepage Containment System at the toe of the East Dam will be pumped back to the FTB Pond. All system pumps will be operated using level sensors so that a desired water level is maintained in the sumps and lift stations.

The FTB Seepage Containment System will require periodic maintenance to remain effective. The periodic maintenance will be consistent with industry practice and will include monitoring of flow volumes, monitoring upgradient and downgradient hydraulic heads, occasional pipe cleaning, and if a problem is suspected based on changes in flow volumes or hydraulic head differential, inspection via video camera of the drain pipe to make sure it is not blocked by sediments or collapsed. If sediments are observed during inspection and are determined to be inhibiting system performance, they will be cleaned out by flushing. If a collapse is observed, the collapsed section will be repaired. Video inspection will be conducted once every 5 years unless monitoring of the amount of water collected by the containment system indicates there has been an unusual change in flow that could be caused by collapse or clogging. If it was determined that clogging of the trench was interfering with meeting system performance objectives, then corresponding segments of the trench would be reconstructed as needed, and if pipe collapse were to occur, pipe design specifications and construction methods would be reviewed and pipes replaced as necessary. For a system of this type, pipe collapse would not be expected because loading on the pipes is limited to that imposed by the collection trench backfill, something routinely designed for. While some pipe clogging could occur, particularly early in system operations due to normal construction related activities (i.e., sediment inflow to pipes), the potential for clogging thereafter should be limited due to the constant water flow anticipated in the system.

4.1.5 Waste Water Treatment Plant (WWTP)

During operations, a portion of the collected seepage will be recycled to the FTB Pond for reuse in the beneficiation process, and a portion will be routed to the WWTP for treatment prior to discharge at stream augmentation outfalls. WWTP systems will treat the tailings basin seepage to meet the appropriate discharge limits. The WWTP may also provide water for reuse in certain process steps in the Beneficiation Plant or the Hydrometallurgical Plant. The operation of the WWTP is further discussed in Section 4.2 of Reference (6).

4.2 Stormwater

The stormwater management infrastructure will be managed in accordance with the Construction SWPPP, which will be developed prior to construction, and the Industrial SWPPP, which will be developed prior to the start of operations, as described in Section 2.4. The intent of these SWPPPs is to protect water quality by preventing pollution of stormwater associated with construction and industrial activities at the Plant Site. These SWPPPs will identify and describe controls and BMPs to be used at the Plant to minimize the discharge of potential pollutants in stormwater runoff. The SWPPP will be updated as necessary to meet the requirements of the project permitting. A SWPPP is a “living” document that changes as the site changes. PolyMet will amend these SWPPPs whenever there is:

- a change in Plant Site facilities
- a change in the operating procedures of the facility
- a change that may impact the potential for pollutants to be discharged in stormwater

Inspections and recording activities are important parts of the continued success of these SWPPPs. The frequency and extent of the inspections will be defined in each SWPPP.

4.3 Spills

This section is a summary of the Plant Site Spill Prevention Control and Countermeasures (SPCC) Plan which will be developed prior to start of operations. The SPCC provides the procedures for response to spills. These procedures apply to all PolyMet employees, contractors, and vendors delivering, dispensing, or using petroleum or other products at the Plant Site. It is the policy of PolyMet to promote a long-term, continuous effort towards spill prevention first, and control and countermeasures where necessary. An SPCC Plan Administrator will be designated and is responsible for developing, implementing and maintaining the SPCC Plan. In the case of a spill, the procedures for emergency contacts and a spill contingency plan will be included in the SPCC Plan. Training sessions and spill prevention briefings for operating personnel will review the requirements of the SPCC Plan and highlight and describe recently developed precautionary measures.

4.4 Overflows

This section includes discussion of what will occur in the event of an overflow from the FTB, the HRF, the FTB seepage capture systems, the WWTP, or the Process Plants. An overflow may occur when a storm event exceeds the design storm or an extended power outage occurs at the Plant Site. In order to prevent and mitigate the effects of possible overflows, the following operational plan will be used.

In the unlikely event of overflows greater than the total design capacity of the controls in place to contain the overflows (sumps, ponds, etc.), overflows may ultimately flow into the Plant Site stormwater system and off-site. Actual location of discharge will depend on the location of the overflow, with drainage divides shown in Large Figure 2 and Large Figure 3.

4.4.1 Flotation Tailings Basin (FTB)

The FTB is designed as a closed system, with the pond level managed to remain at the design level (Section 4 of Reference (4)). No water will be released through overflow or outlet structures during operations. Precipitation falling within the FTB will flow to the FTB Pond. All precipitation that falls within the FTB perimeter will be contained by freeboard, including the precipitation from up to the 72-hour Probable Maximum Precipitation (PMP) event. 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. Overtopping of the dams will be avoided by operating the FTB Pond with sufficient freeboard to accommodate pond water level bounce due to a severe precipitation event, as described in Section 4 of Reference (4).

During long-term closure when there will be a positive water balance in the FTB, tailings basin water will be pumped from the FTB Pond to the WWTP to prevent overflow from the FTB Pond. An emergency overflow embedded in bedrock east of Cell 2E will be established during reclamation. The location and layout of the emergency overflow is provided on Drawings FTB-015 to FTB-018 in Attachment A of Reference (4). If pumping systems shut down due to a power outage simultaneous with a significant precipitation event, this overflow structure will prevent the washout of dams in the unlikely case of the water rising to elevations near the final dam elevation. Embedding the channel into bedrock will also minimize or eliminate any long-term maintenance requirements for the channel.

4.4.2 Hydrometallurgical Residue Facility (HRF)

Similar to the FTB, the HRF will function as a closed system, with the pond level managed to remain at the design level (Section 4 of Reference (5)). Precipitation falling within the HRF will flow to the HRF pond. Overtopping of the dams will be avoided by operating the HRF pond with sufficient freeboard to accommodate pond water level bounce due to a severe precipitation event, as described in Section 4.1 of Reference (5). Water level bounce from storm events is expected to be minimal, because the tributary area for the HRF is relatively small, as described in Section 2.5 of Reference (5). The cell is sized to accommodate up to 3 feet of freeboard so that some wave run-up and water level bounce can safely occur. Initial operations will be used to refine the minimum freeboard requirements.

Overtopping could potentially occur if the Return Water System were to fail or be accidentally shutdown while the Residue Transport and Deposition System continued to operate. To avoid this situation, the controls of these two systems will be integrated such that shutdown of the Return Water System shuts down the Residue Transport and Deposition System. In reclamation, the HRF pond will be dewatered and an engineered cover will be constructed to reduce future ponding within the HRF, as described in Section 7 of Reference (5).

4.4.3 Flotation Tailings Basin (FTB) South Seepage Management System

As described in Section 2.1.3 and Section 4.1.3, the FTB South Seepage Management System collects tailings basin seepage along the south side of the FTB. The current design, shown in Attachment A, includes an impoundment to block the seepage and a small sump with a submersible pumps. An emergency overflow is designed into the system, as shown in Attachment A, at an elevation of 1530 feet, which is approximate 5 feet above the top of the collection sump and approximately 2 feet below the top of the dam impounding the collection system. If the pumps in these sumps are shut down due to a power outage, tailings basin seepage draining to this sump will be contained up to the overflow elevation. Seepage water that reaches the elevation of the overflow will flow off-site at existing surface discharge station SD026 (Section 1.4.5).

4.4.4 Flotation Tailings Basin (FTB) Seepage Containment System

Similar to the FTB South Seepage Management System, the FTB Seepage Containment System will collect tailings basin seepage from the FTB as described in Section 2.1.4 and Section 4.1.4. The current design, shown in Attachment B, includes two lift stations with pumps along the north side of the FTB. Flows along the containment system will be routed to these lift stations from subsurface drain pipes. If the pumps in these sumps are shut down due to a power outage, tailings basin seepage draining in these pipes will back up and an overflow may occur from the two lift stations. Excess water not contained will flow off-site at the existing surface discharge station SD002 (Section 1.4.5).

4.4.5 Waste Water Treatment Plant (WWTP)

The WWTP overflow locations will be determined based on the final location of the WWTP. The water level in the WWTP Equalization Basins will be controlled by the upstream pumps pumping water to the WWTP and the rate of treatment. If there is a loss of power at the Plant, the upstream pumping systems will also likely be shut down due to this power outage. If the upstream pumping systems continued to pump while the WWTP was shut down, there may be an overflow from the WWTP Equalization Basins. If the water level in the WWTP Equalization Basins are nearing overflow, the upstream pumps will need to be shut off to prevent an overflow from occurring. If an overflow does occur, this drainage would either go through the Plant Site stormwater system or to the FTB Pond, depending on the location and timing of the overflow (with relation to the FTB South Dam construction).

4.4.6 Process Plants

The Hydrometallurgical Plant and the Beneficiation Plant designs include sufficient sump and process equipment capacity to prevent process waste water from leaving the Plant during power failure or other emergencies. Process waste water captured within these sumps will be recirculated back into their respective Plant systems.

5.0 Water Quantity and Quality Monitoring

Proper long-term management of water quality and quantity at the Plant Site will depend, in part, on a systematic monitoring plan, which will be finalized in permitting. As operations proceed, the monitoring plan will be updated as required. Monitoring will be used to determine project compliance with permits, improve model accuracy, identify potential causes of changes to water quality or quantity, and identify options, if necessary, to adapt the Project to ensure short-term and long-term compliance. The proposed water monitoring plans that PolyMet expects to be required by the various permits and regulations applicable to processing plant operations are being developed as part of each permit application process. The specifics of monitoring for the Project, including the specific locations, nomenclature, frequency, and parameters, have been outlined in the permit applications, and will be finalized during each applicable permitting process.

6.0 Reporting and Adaptive Management

Adaptive management is a system of management practices based on clearly defined outcomes and monitoring requirements to determine if management actions are meeting the desired outcomes; and, if not, to implement changes to ensure that outcomes are met or re-evaluated. Adaptive management recognizes the uncertainty associated with estimates based on natural systems as a result of the baseline monitoring data, waste characterization, scale of plan, decisions on modeling inputs, and other limiting factors. Adaptive management measures will be developed through the Environmental Review process, permitting, and during operations, reclamation, and long-term closure to define when changes are needed to the proposed water management systems.

A key component of adaptive management for water is the Adaptive Water Management Plan (Reference (6)) that describes adaptive engineering controls that manage water quality and quantity. Fixed engineering controls (dams, pumps, pipes, etc.) are described in this and other management plans. Contingency mitigation options that could be applied if engineering controls do not manage water quality and quantity properly are described in this document.

6.1 Monthly Reporting

The NPDES/SDS permit and the Water Appropriations permit will require and define routine water quality and quantity reporting and annual reporting requirements. The content required for those reports will be defined in those permits.

Routine water quality reports will be submitted to the MPCA, and monthly water quantity reports will be submitted to the MDNR. In addition to water quantity and quality monitoring described in Section 5.0, PolyMet anticipates that routine reports will include:

- sulfur content of Flotation Tailings
- monthly precipitation
- water flow and water quality parameters of water from the Mine Site
- identification and explanation of variations from permit requirements, if any

6.2 Annual Reporting

An Annual NPDES/SDS Report will be submitted to the MPCA. PolyMet anticipates that it will include:

- a comparison of actual seepage, leachate, and pond water chemistry to the water chemistry estimated by the Project water model from start of operations through the past year

- the total gallons of water pumped between the FTB and Beneficiation Plant, from the FTB Seepage Containment System, from the FTB South Seepage Management System, and to the FTB from the Mine Site for the past year
- identification of any changes made to the FTB Seepage Containment System, the HRF leakage collection system, or the FTB South Seepage Management System during the last year
- a summary of any previously reported variations from permit requirements during the past year if any
- identification of any changes planned for the FTB Seepage Containment System, the HRF leakage collection system, or the FTB South Seepage Management System during the coming year

An Annual PTM Report will be submitted to the MDNR. PolyMet anticipates that it will include:

- the total tons of Flotation Tailings placed in the FTB from the start of operations through the past year and remaining planned capacity, including the estimated breakdown of Flotation Tailings composition of fines and slimes
- a map showing where Flotation Tailings were placed and where vegetation was established for dust control or reclamation during the past year
- a map showing where Flotation Tailings are planned to be placed and where vegetation is planned to be established for dust control or reclamation during the coming year
- the total tons of Residue placed in the HRF from the start of operations through the past year and remaining planned capacity
- a map showing where Residue was placed and where vegetation was established for dust control or reclamation during the past year
- a map showing where Residue is planned to be placed and where vegetation is planned to be established for dust control or reclamation during the coming year
- identification of any planned changes in operations that could impact final reclamation
- an update of the Flotation Tailings waste characterization program
- an update of the Residue waste characterization program

- an update on any pilot-testing or monitoring for development of non-mechanical treatment systems, as described in Section 6 of Reference (6)
- an update of any Special Performance Monitoring defined in Reference (6)
- an update on the results of any Test Projects defined in Reference (6)

An Annual Appropriations Report will be submitted to the MDNR. It is anticipated that it will include the monitoring data collected in accordance with the permit including:

- monthly records of the amount of water appropriated or used for each appropriation
- total amount appropriated for the year

6.3 Annual Comparison to Model

Annual reports will include comparison of actual water quantity and quality to the quantity and quality estimated by the Project water quality model updated with the most recent monitoring data for the conditions existing at the time of the report.

6.4 Model Refinements

The Project water model developed in Reference (3) is an integrated model that includes all aspects of the Project. If the annual comparison to model shows differences that can be logically explained as being caused by modeling assumptions that have been demonstrated to be incorrect, the model will be refined.

The adjusted model will be used to update the Project water quantity and quality estimates. If the update indicates that outcomes will not be acceptable, adaptive management will be initiated.

6.5 Adaptive Management

There are adaptive management actions that could be implemented if there is an exceedance of a surface or groundwater standard detected as part of water quality monitoring or if the water model projects a future exceedance of surface or groundwater standards given observed conditions. In general the steps will be:

1. Initiate any field studies that may be necessary to determine the root cause of the exceedance.
2. Once the root cause is identified, implement any adjustments that can be made to the adaptive engineering controls described in Reference (6) that will remedy the root cause. Adjustments to the adaptive engineering controls include changing the scale or type of control and/or its design.

3. If the exceedances persist, implement contingency mitigation (Section 6.6) that will remedy the root cause and include that contingency mitigation as an adaptive engineering control in Reference (6).

4. Monitor and model effects to the environment with new or adjusted engineering control. If issue persists begin Step 1 again.

6.6 Contingency Mitigation

If monitoring or the refined model estimates show that with adaptive engineering controls water quantity or quality at compliance points is projected to not meet compliance parameters, mitigations are available that would address those situations. The contingency mitigations described in the following paragraphs are feasible but depend on site-specific conditions and do not include modifications to adaptive engineering controls that are described in Reference (6). These mitigations would be developed and designed if needed and coordinated with the MDNR and MPCA as appropriate.

A. New surface seepage locations emerge as the FTB is developed.

   i. The FTB Seepage Containment System or the FTB South Seepage Management System described in Sections 2.1.3 and 2.1.4 can be expanded to collect seepage from any new seepage locations.

B. FTB pond water quality is worse than expected.

   i. Additional treatment at the Mine Site WWTF could be used to reduce solute load delivered to the FTB Pond.

   ii. Water from the FTB seepage capture systems that is returned to the FTB Pond is not currently planned to be treated. The collected seepage, or some portion of it, could be sent to the WWTP for treatment before being returned to the FTB Pond.

   iii. Pond water could be sent to the WWTP for treatment and returned to the FTB Pond.

   iv. The FTB Pond could be treated in-situ with iron salts, fertilizer, or other methods tailored to the constituent of concern. For example, certain pit lake remediation technologies have successfully treated billion gallon pit lakes for contaminants including selenium, zinc, uranium, and nitrate. These technologies have been successfully applied at numerous sites and locations and have demonstrated successful remediation.

C. Groundwater or surface water downgradient of the FTB has compliance issues.

i. The containment system around the FTB could be inspected for breaches and repaired or interception wells could collect groundwater flows impacted by a breach.

ii. FTB Pond water quality could be improved by implementing mitigations described in B above.

iii. Interception wells could collect groundwater flows impacted by a leak from the FTB Seepage Containment System.

Several of the potential mitigation options discussed above include additional treatment of water at the WWTP. The WWTP is, by design, adaptive, as described in Section 4.2 of Reference (6). The WWTP treatment capacity can be expanded by adding additional parallel treatment trains to accommodate additional flow.

7.0 Incremental and Final Reclamation

Reclamation information included in this document is for the Plant Site water management systems only. This includes incremental reclamation, final reclamation, and long-term closure activities. Reclamation information for the FTB is in Reference (4). Reclamation information for the HRF is in Reference (5). Reclamation information for other Plant Site infrastructure is included in Reference (7).

7.1 Incremental Reclamation

No incremental reclamation of water management systems is anticipated at this time.

7.2 Final Reclamation

The FTB seepage capture systems and WWTP will continue to operate through reclamation and long-term closure periods. During reclamation, water from the FTB seepage capture systems and WWTP will be pumped through the TWP to the Mine Site for use in flooding the West Pit. The treatment objective for the WWTP during reclamation will be to provide a source of clean water for stream augmentation and to the West Pit as it is flooded with water. The operation of the WWTP during reclamation is discussed in Section 4.2 in Reference (6).

HRF drainage water will be sent to the WWTP for treatment and discharge. Details of closure of the HRF are described in Section 7 of Reference (5).

7.3 Long-Term Closure

Monitoring, reporting, and water treatment will continue during long-term closure, until release from these activities is granted by MDNR via the PTM and the MPCA via the NPDES/SDS permit. If any of the monitoring data shows that additional work is needed, a plan will be created and implemented to further improve water quality.

During long-term closure, the water level in the FTB will be maintained to prevent overflows, and water from the FTB seepage capture systems will continue to be collected and pumped to the WWTP for treatment to meet the appropriate water discharge limits as described in Section 4 of Reference (6). The ultimate objective is to transition from the mechanical treatment provided by the WWTP to a non-mechanical treatment system once the non-mechanical treatment system has been demonstrated to provide the required water treatment. Options for non-mechanical water treatment at the Plant Site during long-term closure are described in Section 6 of Reference (6).

7.3.1 Monitoring

The monitoring and reporting described in Section 5.0 and 6.0 will continue until MDNR releases the company from doing so under the PTM and the MPCA releases the company under the NPDES/SDS permit.

7.3.2 Flotation Tailings Basin (FTB) South Seepage Management

The FTB South Seepage Management System will operate during long-term closure until the seeps stop or water resource objectives are achieved without mechanical treatment.

7.3.3 Flotation Tailings Basin (FTB) Seepage Containment System

The FTB Seepage Containment System will operate during long-term closure until water resource objectives are achieved without mechanical treatment or until non-mechanical treatment has been proven, as described in Section 6 of Reference (6).

7.3.4 Water Treatment

The WWTP will continue to operate through reclamation and long-term closure, until non-mechanical treatment is proven as described in Section 6 of Reference (6). During long-term closure, the primary treatment objective for the WWTP will be to meet the appropriate discharge limits for any excess water that needs to be discharged to the environment. The WWTP will continue to treat water collected from the FTB seepage capture systems, and HRF drainage water, along with water from the FTB Pond as needed to prevent any overflow. The WWTP will be maintained operable until MDNR releases the company from active water treatment requirements under the PTM and the MPCA releases the company under the NPDES/SDS permit. Operation of the WWTP during long-term closure is discussed in Section 4.2 of Reference (6).

7.4 Contingency Reclamation Estimates

The following section provides an overview of the contingency reclamation plan for Mine Year 0 and Mine Year 1. For more specific details on reclamation and the associated cost estimates, see the permit-level version of the Reclamation Plan with the contingency reclamation estimates that will be part of the PTM application.

7.4.1 Contingency Reclamation Plan (Mine Years 0 and 1)

7.4.1.1 Mine Year 0 (end of construction/development)

If closure were to occur at the end of Mine Year 0, the activities described in Section 7.2 and 7.3 will be implemented. No Flotation Tailings will have been deposited in the FTB.

The WWTP will not have to be operated.

This plan is used to develop the Mine Year 0 Contingency Reclamation Estimate that will be the basis for financial assurance required by Minnesota Rules, part 6132.1200, which is required before a PTM can be granted.

7.4.1.2 Mine Year 1 (end of first year of operations)

If closure were to occur at the end of Mine Year 1, the activities described in Sections 7.2 and 7.3 will be implemented. The FTB will contain approximately 11 million tons of Flotation Tailings, and the FTB Pond will contain approximately 950 million gallons of water at elevation 1580 feet.

Water treatment by the WWTP is expected to continue until other non-mechanical methods can be proven and implemented to treat seepage from the Tailings Basin.

This plan will be used to develop the contingency reclamation estimate that will be the basis for financial assurance required by Minnesota Rules, part 6132.1200 the first or second calendar year (depending on construction progress) after the issuance of the PTM. The Reclamation Plan and contingency reclamation estimate will be updated annually to include contingency reclamation for the site conditions representative of the end of the upcoming year of operation.

. Revision History

Date	Version	Description
11/30/2011	1	Initial release
01/25/2013	2	Significant changes to incorporate project changes related to the decisions made in the AWMP Version 4 and 5 and Change Definition Forms pertaining to the Plant Site. These project changes include the use of long-term mechanical treatment, the potential for non-mechanical treatment in long-term closure and tributary flow augmentation.
01/12/2014	3	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 (no change to this document), 2) Coal Ash Landfill relocation (no change to this document), 3) the addition of the east side of the FTB Seepage Containment System (changes to figures and text), 4) adjustments made to the stream augmentation plan and West Pit flooding (changes to figures and text), and 5) changes made for the sewage treatment system (changes to figures and text). Additional changes were made for clarification (various sections throughout), to address agency comments (various sections throughout), to incorporate minor design changes and project refinements (Sections 2 and 4), and to incorporate the results of water modeling (Section 3).
03/10/2015	4	Minor changes were made to address agency comments (Sections 1.0, 1.2, 1.3, 2.0, 2.1.4, 2.3, 5.4.1, 5.4.3, 6.1, and 6.2, Large Table 9, Large Table 11, Large Table 14, Large Table 18, and Large Figure 3). Additional minor changes were made to address formatting.
07/11/2016	5	Certification page added; minor changes made to Large Figures to account for changes to the WWTF footprint; the FTB Seepage Containment and Stream Augmentation permit application support drawings were certified for permitting (Attachment B); references to the SWPPPs and the SPCCs were modified, as they will be developed prior to construction and operations (rather than included in Attachments C, D, and E); a description was added of the Sewage Treatment System along with the design basis memorandum (Attachment E), and the design basis memorandum for the Plant Site stormwater was included (Attachment F). Details on future monitoring contained in figures, tables, and text removed as this information will be provided in permit applications.

References

1. **Barr Engineering Co.** NPDES/SDS Permit Application Volume I – Introduction. Prepared for Poly Met Mining Inc. July 2016.

2. **Poly Met Mining Inc.** NorthMet Project Project Description (v9). February 2015.

3. —. NorthMet Project Water Modeling Data Package Volume 2 - Plant Site (v11). March 2015.

4. —. NorthMet Project Flotation Tailings Management Plan (v6). July 2016.

5. —. NorthMet Project Residue Management Plan (v5). July 2016.

6. —. NorthMet Project Adaptive Water Management Plan (v10). July 2016.

7. —. NorthMet Project Reclamation Plan (v7). July 2016.

8. —. NorthMet Project Water Modeling Data Package Volume 1 - Mine Site (v14). February 2015.

9. —. NorthMet Project Water Management Plan - Mine Site (v5). July 2016.

10. —. NorthMet Project Wetland Data Package (v11). April 2015.

11. —. NorthMet Project Rock and Overburden Management Plan (v8). July 2016.

12. **Barr Engineering Co.** Hydrogeology of Fractured Bedrock in the Vicinity of the NorthMet Project (v3). December 2014.

13. **Minnesota Department of Natural Resources, United States Army Corps of Engineers, United States Forest Service.** Supplemental Draft Environmental Impact Statement - NorthMet Mining Project and Land Exchange. November 2013.

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Large Table 1 Estimated FTB Pond Water Quality

Mine Year		Mine Year 5			Mine Year 20			Mine Year 30			Mine Year 60			Mine Year 100		
Constituent	Percentile / Units	Average P10[1]	Average P50[1]	Average P90[1]	Average P10[1]	Average P50[1]	Average P90[1]	Average P10[1]	Average P50[1]	Average P90[1]	Average P10[1]	Average P50[1]	Average P90[1]	Average P10[1]	Average P50[1]	Average P90[1]
Ag (Silver)	µg/L	0.20	0.20	0.20	0.20	0.20	0.20	0.10	0.11	0.13	0.05	0.06	0.08	0.05	0.06	0.07
Al (Aluminum)	µg/L	4.76	6.12	7.87	4.76	6.12	7.87	4.76	6.12	7.87	4.76	6.12	7.87	4.76	6.12	7.87
Alkalinity	mg/L	42.43	52.30	65.00	42.43	52.30	65.00	42.30	51.87	63.11	40.21	46.89	58.08	38.13	43.96	51.06
As (Arsenic)	µg/L	4.33	4.92	5.97	11.89	13.80	16.17	18.99	20.69	22.92	12.98	16.77	20.15	17.56	19.98	22.67
B (Boron)	µg/L	100.00	100.00	100.00	100.00	100.00	100.00	91.69	99.53	100.00	50.34	71.32	99.46	37.86	49.05	67.36
Ba (Barium)	µg/L	24.39	24.79	25.26	20.26	22.46	23.25	6.95	7.71	8.43	3.00	3.53	4.00	2.61	3.02	3.57
Be (Beryllium)	µg/L	0.36	0.39	0.40	0.36	0.40	0.40	0.26	0.30	0.35	0.18	0.22	0.29	0.18	0.21	0.24
Ca (Calcium)	mg/L	39.26	40.82	42.47	60.89	68.78	78.39	38.65	44.53	51.34	18.03	21.67	26.12	15.37	17.85	21.11
Cd (Cadmium)	µg/L	0.31	0.88	1.12	0.31	0.68	0.97	0.31	0.49	0.90	0.08	0.13	0.24	0.05	0.06	0.09
Cl (Chloride)	mg/L	22.19	24.78	28.94	21.00	25.12	31.16	4.68	5.50	6.66	0.97	1.13	1.36	0.92	1.10	1.35
Co (Cobalt)	µg/L	4.65	9.25	17.48	8.09	14.81	27.39	4.05	6.06	9.73	0.86	1.50	2.87	0.37	0.54	0.79
Cr (Chromium)	µg/L	1.45	1.57	1.71	2.11	2.39	2.66	2.14	2.44	2.72	0.47	0.62	0.93	0.33	0.40	0.50
Cu (Copper)	µg/L	23.87	39.72	119.42	23.87	39.72	121.82	23.86	38.69	73.96	5.32	6.39	7.71	3.11	3.68	4.39
F (Fluoride)	mg/L	0.66	0.72	0.78	0.41	0.48	0.54	0.19	0.22	0.25	0.05	0.05	0.06	0.05	0.05	0.06
Fe (Iron)	µg/L	23.78	39.19	53.71	23.78	39.19	53.71	23.78	39.19	53.71	23.78	39.19	53.71	23.78	39.19	53.71
K (Potassium)	mg/L	13.83	15.10	16.42	19.96	24.41	29.38	8.36	9.23	10.29	1.65	2.84	3.63	3.15	3.55	3.98
Mg (Magnesium)	mg/L	50.65	53.21	55.49	62.38	69.33	76.91	15.60	17.64	20.00	3.08	3.88	5.33	3.58	4.35	5.57
Mn (Manganese)	µg/L	145.20	212.71	274.82	145.20	212.71	274.88	145.20	212.71	274.88	45.52	59.59	85.67	49.88	65.80	90.18
Na (Sodium)	mg/L	68.11	74.66	81.71	63.34	75.95	89.12	14.43	16.37	18.57	1.59	1.80	2.31	1.46	1.74	2.19
Ni (Nickel)	µg/L	76.80	163.37	307.23	117.02	239.16	397.80	50.50	81.31	126.62	8.80	15.37	28.88	3.43	5.00	7.45
Pb (Lead)	µg/L	3.93	4.64	5.85	9.71	11.79	14.46	8.09	9.47	11.24	0.82	1.11	1.80	0.25	0.35	0.50
Sb (Antimony)	µg/L	7.51	8.32	9.16	6.06	7.13	8.15	5.75	6.62	7.54	3.37	3.89	4.42	3.63	4.11	4.63
Se (Selenium)	µg/L	1.52	1.66	1.83	1.51	1.73	2.04	1.21	1.49	1.84	0.30	0.39	0.56	0.25	0.30	0.37
SO4 (Sulfate)	mg/L	188.30	199.75	210.20	233.80	254.82	276.81	61.08	68.30	76.86	12.09	16.62	21.46	17.32	20.13	23.73
Tl (Thallium)	µg/L	0.09	0.09	0.10	0.09	0.10	0.12	0.07	0.08	0.10	0.03	0.03	0.05	0.02	0.03	0.04
V (Vanadium)	µg/L	3.89	5.31	8.05	4.61	6.44	9.67	3.05	3.45	3.88	0.35	0.65	1.30	0.11	0.20	0.33
Zn (Zinc)	µg/L	33.02	68.60	85.15	33.02	56.48	71.10	30.39	40.89	59.66	5.21	8.74	17.07	2.74	3.64	5.39

(1) Values shown are the average of the monthly P10, P50, and P90 values, as indicated, for the referenced Mine Year; see Section 6.3 of Reference (3).

Large Table 2 Estimated Tailings Basin Seepage Water Quality from the North Toe

Constituent	Mine Year	Mine Year 5			Mine Year 20			Mine Year 30			Mine Year 60			Mine Year 100		
	Percentile / Units	Average P10(1)	Average P50(1)	Average P90(1)	Average P10(1)	Average P50(1)	Average P90(1)	Average P10(1)	Average P50(1)	Average P90(1)	Average P10(1)	Average P50(1)	Average P90(1)	Average P10(1)	Average P50(1)	Average P90(1)
Ag (Silver)	µg/L	0.16	0.17	0.17	0.19	0.19	0.20	0.18	0.18	0.19	0.15	0.16	0.18	0.15	0.16	0.18
Al (Aluminum)	µg/L	11.46	11.54	11.60	1.47	1.79	2.16	2.23	3.44	4.54	2.80	5.68	8.69	2.92	6.35	9.87
Alkalinity	mg/L	242.65	244.20	245.41	49.11	55.05	60.04	70.48	85.86	95.42	78.91	89.32	99.07	78.12	88.98	99.46
As (Arsenic)	µg/L	4.91	5.01	5.15	49.69	52.89	55.74	19.59	21.35	23.79	23.82	26.28	28.87	25.75	28.33	30.97
B (Boron)	µg/L	296.57	298.13	299.34	109.63	112.92	118.12	132.64	141.78	155.63	164.05	181.46	198.99	174.23	195.10	215.06
Ba (Barium)	µg/L	162.58	163.52	164.23	20.17	20.89	21.83	22.17	22.87	24.60	26.68	27.64	29.07	29.93	30.96	32.30
Be (Beryllium)	µg/L	0.29	0.29	0.29	0.39	0.40	0.41	0.39	0.41	0.44	0.35	0.42	0.49	0.35	0.44	0.52
Ca (Calcium)	mg/L	45.65	45.93	46.32	148.07	198.65	267.34	104.05	127.67	147.93	77.52	91.15	106.25	77.02	91.06	108.19
Cd (Cadmium)	µg/L	0.19	0.19	0.21	1.18	1.79	3.85	1.16	1.45	2.00	0.68	0.87	1.81	0.49	0.65	1.56
Cl (Chloride)	mg/L	22.26	22.45	22.65	25.28	27.76	32.33	21.28	23.35	27.44	14.54	15.83	17.76	11.92	12.99	14.33
Co (Cobalt)	µg/L	2.32	2.55	2.99	13.19	27.77	65.34	9.73	19.33	34.72	5.67	10.91	22.02	4.64	9.26	20.69
Cr (Chromium)	µg/L	0.68	0.72	0.78	5.97	6.28	6.58	3.07	3.28	3.71	2.83	3.07	3.34	2.40	2.63	2.90
Cu (Copper)	µg/L	16.03	21.79	29.75	310.47	473.97	649.85	282.63	426.45	591.80	245.81	375.91	514.67	248.04	376.15	509.79
F (Fluoride)	mg/L	3.72	3.74	3.75	1.11	1.18	1.26	0.70	0.76	0.89	0.42	0.45	0.50	0.31	0.33	0.35
Fe (Iron)	µg/L	3,838.08	3,869.43	3,893.63	149.26	178.61	206.18	226.23	314.99	394.71	412.25	651.70	852.42	437.38	717.67	945.69
K (Potassium)	mg/L	10.12	10.21	10.31	33.99	35.20	36.30	25.05	26.54	28.33	20.61	22.11	23.58	17.90	19.35	20.72
Mg (Magnesium)	mg/L	79.78	80.29	80.66	75.40	84.46	96.28	72.30	79.48	87.46	59.97	69.90	80.94	56.15	67.16	80.27
Mn (Manganese)	µg/L	368.82	391.24	415.29	443.79	629.74	863.60	479.48	680.90	879.24	566.56	738.17	926.77	606.98	780.59	967.30
Na (Sodium)	mg/L	70.29	70.79	71.21	98.66	105.50	113.19	77.40	82.25	88.54	48.25	52.38	56.67	37.69	41.79	45.89
Ni (Nickel)	µg/L	8.24	12.42	20.47	207.82	425.49	892.65	145.26	298.76	554.66	81.94	159.78	307.83	65.08	131.64	265.52
Pb (Lead)	µg/L	1.74	1.89	2.11	51.45	54.69	57.77	19.88	21.81	24.31	22.35	24.95	27.82	21.31	24.44	27.95
Sb (Antimony)	µg/L	0.67	0.71	0.74	13.60	16.34	19.03	9.55	10.63	11.85	6.15	6.78	7.60	5.28	5.89	6.66
Se (Selenium)	µg/L	0.76	0.77	0.78	3.92	4.82	5.75	2.66	3.15	3.75	1.59	1.83	2.13	1.33	1.55	1.82
SO4 (Sulfate)	mg/L	335.79	338.29	340.16	342.74	377.24	423.79	261.86	286.99	318.32	160.27	182.14	201.98	135.14	155.73	176.56
Tl (Thallium)	µg/L	0.18	0.18	0.18	0.19	0.19	0.19	0.17	0.18	0.18	0.15	0.16	0.17	0.15	0.16	0.17
V (Vanadium)	µg/L	4.36	4.42	4.52	9.35	9.45	9.54	8.49	8.67	8.85	7.33	7.61	7.90	7.37	7.63	7.90
Zn (Zinc)	µg/L	14.53	15.01	15.74	129.04	160.40	257.26	122.12	141.34	170.87	67.95	81.14	129.31	47.00	57.68	104.92

(1) Values shown are the average of the monthly P10, P50, and P90 values, as indicated, for the referenced Mine Year; see Section 6.4 of Reference (3).

Large Table 3 Estimated Tailings Basin Seepage Water Quality from the Northwest Toe

Constituent	Mine Year	Mine Year 5			Mine Year 20			Mine Year 30			Mine Year 60			Mine Year 100		
	Percentile / Units	Average P10(1)	Average P50(1)	Average P90(1)	Average P10(1)	Average P50(1)	Average P90(1)	Average P10(1)	Average P50(1)	Average P90(1)	Average P10(1)	Average P50(1)	Average P90(1)	Average P10(1)	Average P50(1)	Average P90(1)
Ag (Silver)	µg/L	0.10	0.10	0.10	0.10	0.12	0.19	0.06	0.09	0.18	0.04	0.08	0.23	0.03	0.09	0.25
Al (Aluminum)	µg/L	21.25	21.32	21.39	16.49	22.14	27.84	10.77	17.66	24.69	9.59	21.46	33.52	8.76	22.11	35.46
Alkalinity	mg/L	228.89	229.68	230.41	221.70	238.15	254.64	169.45	189.36	208.88	193.59	227.41	261.20	194.14	232.48	270.96
As (Arsenic)	µg/L	1.31	1.31	1.32	5.85	6.61	7.50	5.20	6.00	6.94	1.40	1.89	2.85	1.41	1.99	3.00
B (Boron)	µg/L	465.67	467.30	468.80	456.85	488.25	522.16	349.46	387.59	426.93	400.35	466.44	530.85	403.24	476.01	550.53
Ba (Barium)	µg/L	23.94	24.02	24.10	24.33	25.05	26.28	18.83	19.61	21.03	20.97	22.14	24.51	21.32	22.53	25.13
Be (Beryllium)	µg/L	0.52	0.52	0.52	0.44	0.59	0.73	0.28	0.46	0.64	0.23	0.53	0.84	0.20	0.54	0.88
Ca (Calcium)	mg/L	94.31	94.65	94.96	108.62	118.02	127.33	86.17	96.66	106.48	81.76	95.64	109.89	81.98	97.94	113.91
Cd (Cadmium)	µg/L	0.12	0.12	0.12	0.28	0.36	0.56	0.13	0.22	0.43	0.05	0.11	0.26	0.04	0.11	0.28
Cl (Chloride)	mg/L	20.97	21.04	21.12	23.51	24.61	25.69	17.35	18.40	19.51	18.99	20.71	22.57	19.17	21.16	23.12
Co (Cobalt)	µg/L	2.13	2.15	2.19	3.49	5.41	9.68	2.60	4.55	8.48	1.08	2.12	4.76	0.95	2.11	5.13
Cr (Chromium)	µg/L	0.59	0.59	0.59	1.14	1.23	1.34	0.97	1.07	1.18	0.55	0.66	0.77	0.54	0.67	0.79
Cu (Copper)	µg/L	3.83	6.17	8.59	42.26	62.64	87.50	29.39	44.59	59.43	7.15	10.57	14.40	6.89	10.60	14.84
F (Fluoride)	mg/L	0.13	0.13	0.13	0.16	0.17	0.19	0.09	0.10	0.11	0.04	0.05	0.05	0.04	0.05	0.05
Fe (Iron)	µg/L	4,773.51	4,790.11	4,805.33	4,428.20	5,227.42	5,842.10	3,249.06	4,259.61	5,011.91	3,587.53	5,135.64	6,418.76	3,617.70	5,390.43	6,757.85
K (Potassium)	mg/L	9.85	9.89	9.92	12.93	14.01	15.13	9.79	11.06	12.34	8.16	10.21	12.29	8.04	10.36	12.67
Mg (Magnesium)	mg/L	161.05	161.61	162.13	156.47	172.75	193.70	116.54	136.43	161.28	124.35	159.07	201.56	124.35	161.92	208.56
Mn (Manganese)	µg/L	1,135.85	1,140.01	1,143.98	1,113.25	1,242.78	1,378.18	826.59	978.67	1,133.73	880.28	1,144.26	1,407.39	875.73	1,174.23	1,465.96
Na (Sodium)	mg/L	54.91	55.11	55.30	62.31	67.98	73.54	43.66	49.89	56.24	43.74	54.61	65.21	43.35	55.38	67.56
Ni (Nickel)	µg/L	5.02	5.43	6.23	27.99	54.26	103.38	21.96	42.91	89.39	5.15	9.10	15.71	4.46	8.71	15.44
Pb (Lead)	µg/L	0.20	0.20	0.21	4.95	5.63	6.49	4.61	5.39	6.29	0.79	0.93	1.12	0.76	0.92	1.12
Sb (Antimony)	µg/L	0.35	0.36	0.36	1.92	2.29	2.70	1.09	1.34	1.69	0.27	0.41	0.79	0.24	0.41	0.83
Se (Selenium)	µg/L	0.44	0.44	0.44	0.82	0.97	1.24	0.58	0.73	1.06	0.24	0.40	0.90	0.23	0.40	0.97
SO4 (Sulfate)	mg/L	313.28	314.37	315.39	328.84	381.11	424.46	239.70	305.56	358.25	233.89	334.63	417.34	235.66	352.44	442.03
Tl (Thallium)	µg/L	0.07	0.07	0.07	0.07	0.09	0.13	0.05	0.06	0.12	0.03	0.05	0.14	0.02	0.06	0.15
V (Vanadium)	µg/L	0.89	0.90	0.91	1.83	1.96	2.09	1.30	1.42	1.55	0.71	0.88	1.05	0.71	0.90	1.09
Zn (Zinc)	µg/L	3.69	3.75	3.85	22.57	26.70	36.31	9.75	13.33	22.98	3.82	5.03	6.77	3.47	4.82	6.60

(1) Values shown are the average of the monthly P10, P50, and P90 values, as indicated, for the referenced Mine Year; see Section 6.4 of Reference (3).

Large Table 4 Estimated Tailings Basin Seepage Water Quality from the West Toe

Constituent	Mine Year / Percentile / Units	Mine Year 5			Mine Year 20			Mine Year 30			Mine Year 60			Mine Year 100		
		Average P10(1)	Average P50(1)	Average P90(1)	Average P10(1)	Average P50(1)	Average P90(1)	Average P10(1)	Average P50(1)	Average P90(1)	Average P10(1)	Average P50(1)	Average P90(1)	Average P10(1)	Average P50(1)	Average P90(1)
Ag (Silver)	µg/L	0.11	0.11	0.11	0.11	0.13	0.20	0.07	0.10	0.19	0.04	0.09	0.25	0.04	0.09	0.27
Al (Aluminum)	µg/L	21.31	21.38	21.44	14.28	19.83	25.64	10.00	17.12	24.42	9.28	21.21	33.28	8.59	21.80	35.04
Alkalinity	mg/L	230.39	231.10	231.75	200.45	217.04	233.31	164.81	185.47	205.84	191.17	225.04	259.20	191.71	229.86	267.85
As (Arsenic)	µg/L	1.42	1.42	1.43	11.04	12.40	14.01	4.96	5.65	6.47	1.81	2.35	3.44	1.87	2.52	3.64
B (Boron)	µg/L	464.55	465.98	467.31	416.30	447.46	480.52	340.10	380.18	420.87	395.36	462.17	526.42	398.60	471.13	544.52
Ba (Barium)	µg/L	26.27	26.35	26.42	23.62	24.36	25.74	18.96	19.85	21.56	20.53	21.77	24.36	20.86	22.12	24.90
Be (Beryllium)	µg/L	0.52	0.52	0.52	0.42	0.57	0.71	0.28	0.47	0.65	0.22	0.53	0.84	0.20	0.54	0.88
Ca (Calcium)	mg/L	93.60	93.89	94.16	109.73	120.89	132.89	81.61	91.55	101.41	81.55	95.59	109.83	81.77	97.77	113.50
Cd (Cadmium)	µg/L	0.12	0.12	0.12	0.37	0.51	0.87	0.20	0.29	0.47	0.07	0.13	0.30	0.06	0.13	0.32
Cl (Chloride)	mg/L	20.88	20.94	21.01	23.87	25.10	26.44	18.15	19.25	20.45	18.96	20.69	22.54	19.05	21.03	22.99
Co (Cobalt)	µg/L	2.30	2.31	2.33	4.54	7.48	13.74	2.85	4.63	8.23	1.24	2.44	5.38	1.12	2.43	5.74
Cr (Chromium)	µg/L	0.58	0.58	0.58	1.68	1.83	1.99	0.98	1.07	1.16	0.59	0.70	0.81	0.58	0.70	0.82
Cu (Copper)	µg/L	2.66	2.74	3.09	72.08	108.06	151.40	43.76	66.72	90.32	12.13	18.05	24.26	11.91	18.11	24.57
F (Fluoride)	mg/L	0.17	0.17	0.17	0.26	0.29	0.32	0.13	0.14	0.15	0.05	0.05	0.06	0.05	0.05	0.05
Fe (Iron)	µg/L	5,206.46	5,222.43	5,237.05	4,005.82	4,873.61	5,546.78	3,166.79	4,319.16	5,201.90	3,681.21	5,503.51	7,056.63	3,749.48	5,841.07	7,452.93
K (Potassium)	mg/L	9.78	9.81	9.84	15.32	16.52	17.70	10.50	11.79	13.05	8.38	10.44	12.54	8.18	10.52	12.79
Mg (Magnesium)	mg/L	159.99	160.48	160.94	145.82	162.39	182.63	113.66	134.36	159.86	122.77	157.59	200.24	122.84	160.00	206.20
Mn (Manganese)	µg/L	1,125.68	1,129.25	1,132.72	1,051.18	1,177.19	1,311.50	821.52	981.70	1,142.35	875.84	1,138.53	1,402.86	873.32	1,166.27	1,454.54
Na (Sodium)	mg/L	54.81	54.98	55.14	66.18	71.91	77.70	46.08	52.77	59.55	43.81	54.77	65.41	43.28	55.18	67.16
Ni (Nickel)	µg/L	5.23	5.41	5.79	44.78	87.51	166.84	24.49	46.90	86.10	7.38	12.39	20.92	6.24	11.50	19.89
Pb (Lead)	µg/L	0.20	0.20	0.20	10.32	11.71	13.27	4.38	5.01	5.68	1.15	1.32	1.55	1.10	1.29	1.55
Sb (Antimony)	µg/L	0.36	0.37	0.37	3.14	3.68	4.33	1.50	1.75	2.07	0.40	0.56	0.97	0.36	0.54	1.01
Se (Selenium)	µg/L	0.47	0.48	0.48	1.10	1.31	1.58	0.60	0.74	1.07	0.28	0.45	1.00	0.26	0.46	1.09
SO4 (Sulfate)	mg/L	340.63	341.69	342.66	330.56	387.27	437.30	238.50	316.26	376.80	242.44	361.22	460.74	245.57	383.10	488.38
Tl (Thallium)	µg/L	0.08	0.08	0.08	0.09	0.10	0.15	0.05	0.07	0.13	0.03	0.06	0.16	0.03	0.06	0.17
V (Vanadium)	µg/L	0.84	0.84	0.85	2.62	2.80	2.99	1.72	1.85	1.98	0.85	1.02	1.19	0.85	1.04	1.22
Zn (Zinc)	µg/L	3.75	3.78	3.81	33.42	39.53	59.97	17.90	21.28	29.70	5.43	6.93	9.24	4.68	6.30	8.50

(1) Values shown are the average of the monthly P10, P50, and P90 values, as indicated, for the referenced Mine Year; see Section 6.4 of Reference (3).

Large Table 5 Estimated Tailings Basin Seepage Water Quality from the South Toe

Constituent	Mine Year	Mine Year 5			Mine Year 20			Mine Year 30			Mine Year 60			Mine Year 100		
	Percentile / Units	Average P10(1)	Average P50(1)	Average P90(1)	Average P10(1)	Average P50(1)	Average P90(1)	Average P10(1)	Average P50(1)	Average P90(1)	Average P10(1)	Average P50(1)	Average P90(1)	Average P10(1)	Average P50(1)	Average P90(1)
Ag (Silver)	µg/L	0.12	0.13	0.13	0.20	0.20	0.20	0.16	0.17	0.18	0.13	0.14	0.16	0.13	0.14	0.16
Al (Aluminum)	µg/L	10.27	10.28	10.29	1.24	1.35	1.49	2.72	4.50	6.13	3.50	7.79	12.68	3.58	8.55	13.73
Alkalinity	mg/L	202.63	203.21	203.78	39.41	42.06	44.67	80.74	99.24	112.90	89.54	104.32	120.83	90.43	107.43	126.76
As (Arsenic)	µg/L	3.94	3.98	4.04	96.91	98.44	99.43	73.66	78.73	83.58	59.34	65.55	71.09	59.03	64.89	70.63
B (Boron)	µg/L	258.25	258.43	258.64	104.80	106.28	107.87	144.62	159.42	176.42	190.58	220.34	254.77	199.04	235.35	269.94
Ba (Barium)	µg/L	153.82	154.03	154.22	17.95	18.83	19.66	17.98	19.36	21.41	28.72	30.49	32.82	30.14	32.03	34.16
Be (Beryllium)	µg/L	0.26	0.26	0.26	0.40	0.40	0.41	0.37	0.41	0.45	0.33	0.44	0.55	0.33	0.45	0.58
Ca (Calcium)	mg/L	39.09	39.24	39.39	197.41	280.79	392.55	231.31	320.77	467.97	132.59	185.36	247.72	138.49	190.65	263.74
Cd (Cadmium)	µg/L	0.15	0.16	0.16	0.54	1.69	5.34	0.46	1.28	4.90	0.08	0.47	3.35	0.08	0.53	3.19
Cl (Chloride)	mg/L	21.36	21.56	21.80	27.35	30.28	35.72	16.15	19.96	25.55	5.55	6.71	8.23	6.18	7.51	8.93
Co (Cobalt)	µg/L	1.46	1.70	2.18	16.89	37.39	96.70	16.06	38.72	110.13	3.73	15.74	52.30	3.92	15.99	55.95
Cr (Chromium)	µg/L	0.52	0.53	0.54	9.82	9.91	9.99	7.54	8.10	8.66	6.16	6.76	7.30	6.13	6.69	7.24
Cu (Copper)	µg/L	5.19	7.37	16.64	328.96	511.11	694.83	260.13	401.13	548.86	213.73	336.57	462.23	212.12	334.83	458.77
F (Fluoride)	mg/L	4.03	4.05	4.06	1.33	1.42	1.51	0.74	0.87	1.03	0.30	0.35	0.40	0.30	0.34	0.40
Fe (Iron)	µg/L	1,846.23	1,853.76	1,861.83	161.38	190.21	220.42	394.56	521.12	671.71	384.56	577.44	765.97	413.92	636.89	849.24
K (Potassium)	mg/L	8.68	8.77	8.83	45.71	46.55	47.40	36.13	38.69	40.96	30.77	33.71	36.19	30.83	33.85	36.36
Mg (Magnesium)	mg/L	67.73	67.91	68.05	85.85	99.13	117.54	105.05	123.71	150.86	65.77	82.25	101.34	68.97	88.39	111.90
Mn (Manganese)	µg/L	330.26	365.28	402.30	416.45	603.65	893.09	484.21	652.48	855.61	535.14	764.81	968.94	558.89	793.82	1,012.96
Na (Sodium)	mg/L	67.92	68.37	68.79	111.50	121.23	132.34	64.80	76.92	92.07	22.71	28.74	35.70	21.14	27.75	33.96
Ni (Nickel)	µg/L	6.37	11.07	20.55	265.91	551.74	1,249.01	248.58	560.70	1,378.10	46.23	209.26	627.55	47.56	214.59	654.95
Pb (Lead)	µg/L	1.32	1.36	1.42	97.70	98.67	99.54	72.96	77.84	82.64	58.99	65.41	70.95	58.90	64.77	70.50
Sb (Antimony)	µg/L	0.60	0.64	0.68	16.29	20.24	24.94	10.08	13.76	18.66	3.84	5.51	7.93	3.95	5.60	8.17
Se (Selenium)	µg/L	0.58	0.59	0.60	4.94	6.36	7.89	4.41	5.99	8.05	2.00	2.69	3.54	2.03	2.76	3.69
SO4 (Sulfate)	mg/L	197.37	198.05	198.69	414.19	475.81	552.91	399.68	469.82	575.82	152.35	183.34	227.34	157.06	191.34	235.36
Tl (Thallium)	µg/L	0.15	0.15	0.15	0.20	0.20	0.20	0.16	0.16	0.18	0.12	0.14	0.15	0.12	0.14	0.15
V (Vanadium)	µg/L	4.05	4.13	4.28	9.81	9.91	9.99	7.44	7.92	8.38	6.18	6.78	7.30	6.18	6.74	7.29
Zn (Zinc)	µg/L	13.59	14.26	14.81	58.30	118.74	316.74	46.35	102.65	265.93	7.33	36.91	208.55	7.10	37.78	205.92

(1) Values shown are the average of the monthly P10, P50, and P90 values, as indicated, for the referenced Mine Year; see Section 6.4 of Reference (3).

Large Table 6 Estimated Water Quality along the North Groundwater Flow Path at the Property Boundary

Constituent	Mine Year	Water Quality Standard	Mine Year 1			Mine Year 50			Mine Year 100			Mine Year 160			Mine Year 200(2)		
	Percentile / Units		Average P10(1)	Average P50(1)	Average P90(1)	Average P10(1)	Average P50(1)	Average P90(1)	Average P10(1)	Average P50(1)	Average P90(1)	Average P10(1)	Average P50(1)	Average P90(1)	Average P10(1)	Average P50(1)	Average P90(1)
Ag (Silver)	µg/L	30	0.10	0.11	0.12	0.09	0.10	0.11	0.08	0.09	0.10	0.08	0.09	0.10	0.08	0.09	0.10
Al (Aluminum)(3)	µg/L	--	22.27	29.98	40.10	29.99	38.82	50.01	36.25	45.69	58.63	41.29	51.25	64.69	42.88	53.01	66.43
Alkalinity	mg/L	--	182.09	215.31	241.43	151.99	180.79	207.59	123.68	152.31	181.78	93.17	120.92	155.20	84.72	102.21	135.85
As (Arsenic)	µg/L	10	2.48	3.21	3.76	2.47	3.21	3.75	2.46	3.20	3.74	2.45	3.19	3.73	2.45	3.18	3.72
B (Boron)	µg/L	1000	162.57	211.35	247.61	123.62	161.80	202.18	85.43	122.44	163.82	53.95	83.77	127.53	46.78	66.90	103.13
Ba (Barium)	µg/L	2000	131.47	157.48	178.33	107.64	131.93	154.87	85.70	111.16	135.80	58.59	85.97	117.07	50.44	70.72	103.84
Be (Beryllium)(4)	µg/L	0.49	0.18	0.19	0.20	0.18	0.19	0.20	0.17	0.19	0.20	0.17	0.19	0.22	0.18	0.20	0.23
Ca (Calcium)	mg/L	--	33.33	36.16	38.30	30.80	33.58	36.13	28.66	31.58	34.70	28.88	32.54	40.94	29.63	34.57	43.56
Cd (Cadmium)	µg/L	4	0.12	0.13	0.13	0.12	0.13	0.13	0.12	0.13	0.14	0.12	0.15	0.28	0.14	0.20	0.34
Cl (Chloride)	mg/L	250	11.78	15.34	18.02	8.90	11.67	14.65	6.08	8.72	11.82	4.20	6.41	9.31	3.50	5.32	8.04
Co (Cobalt)	µg/L	--	0.79	1.02	1.20	0.60	0.79	0.98	0.45	0.63	0.84	0.48	0.80	3.01	0.59	1.33	3.86
Cr (Chromium)	µg/L	100	0.62	0.68	0.79	0.68	0.77	0.87	0.73	0.84	0.97	0.83	1.01	1.42	0.94	1.19	1.52
Cu (Copper)	µg/L	--	1.93	2.04	2.19	1.93	2.05	2.19	1.93	2.05	2.19	1.93	2.05	2.19	1.93	2.05	2.19
F (Fluoride)	mg/L	2	**2.13**	**2.84**	**3.38**	1.56	**2.11**	**2.71**	0.99	1.53	**2.14**	0.41	0.92	1.59	0.22	0.55	1.21
Fe (Iron)(3)	µg/L	--	1,115.10	1,495.30	1,779.30	810.23	1,108.90	1,422.60	516.07	798.35	1,118.80	244.05	507.17	847.56	151.12	325.84	666.22
K (Potassium)	mg/L	--	5.88	7.27	8.37	4.63	5.83	6.93	3.53	4.68	5.80	3.25	4.32	5.92	3.34	4.46	6.53
Mg (Magnesium)	mg/L	--	41.50	52.51	60.82	32.24	41.49	50.18	23.85	32.36	41.63	18.78	25.30	34.04	17.15	22.96	30.53
Mn (Manganese)(3),(4)	µg/L	1,506	239.80	263.52	289.10	229.89	265.47	301.92	221.51	269.05	314.00	228.19	287.03	351.92	241.41	308.71	383.53
Na (Sodium)	mg/L	--	37.56	49.56	58.42	28.10	37.45	47.33	18.74	27.60	37.79	12.86	20.04	29.42	10.41	16.31	25.28
Ni (Nickel)	µg/L	100	3.36	3.58	3.94	3.36	3.58	3.95	3.36	3.58	3.95	3.36	3.59	3.96	3.37	3.59	3.96
Pb (Lead)	µg/L	--	0.80	1.00	1.15	0.64	0.80	0.96	0.52	0.68	0.87	0.60	1.24	4.57	0.84	2.67	5.81
Sb (Antimony)	µg/L	6	0.32	0.35	0.39	0.32	0.35	0.39	0.32	0.35	0.39	0.32	0.35	0.39	0.32	0.35	0.40
Se (Selenium)	µg/L	30	0.64	0.68	0.72	0.66	0.71	0.77	0.68	0.74	0.82	0.71	0.82	1.07	0.77	0.93	1.10
SO4 (Sulfate)	mg/L	250	118.58	158.45	188.42	86.26	117.57	150.78	56.24	85.40	119.15	37.60	63.70	94.17	29.54	51.65	82.02
Tl (Thallium)	µg/L	0.6	0.16	0.17	0.18	0.15	0.17	0.19	0.15	0.17	0.19	0.15	0.17	0.20	0.15	0.17	0.20
V (Vanadium)	µg/L	50	4.75	4.88	5.07	4.83	5.02	5.24	4.92	5.15	5.41	5.03	5.36	5.82	5.19	5.55	5.97
Zn (Zinc)	µg/L	2,000	12.12	12.74	13.69	12.08	13.04	14.23	12.10	13.47	15.29	12.90	16.16	27.55	14.39	20.75	31.09

NOTE: Values above the applicable water quality standard are shown in bold with light red shading.
(1) Values shown are the average of the monthly P10, P50, and P90 values, as indicated, for the referenced Mine Year; see Section 6.5 of Reference (8).
(2) Model runs evaluated through Mine Year 200.
(3) Not evaluated against the secondary groundwater standard.
(4) Evaluated against the site-specific evaluation criteria shown.

Large Table 7 Estimated Water Quality along the Northwest Groundwater Flow Path at the Property Boundary

Constituent	Mine Year	Water Quality Standard	Mine Year 1			Mine Year 50			Mine Year 100			Mine Year 160			Mine Year 200[2]		
	Percentile		Average P10[1]	Average P50[1]	Average P90[1]	Average P10[1]	Average P50[1]	Average P90[1]	Average P10[1]	Average P50[1]	Average P90[1]	Average P10[1]	Average P50[1]	Average P90[1]	Average P10[1]	Average P50[1]	Average P90[1]
	Units																
Ag (Silver)	µg/L	30	0.09	0.10	0.10	0.08	0.09	0.10	0.08	0.09	0.09	0.07	0.08	0.09	0.07	0.08	0.10
Al (Aluminum)[3]	µg/L	--	25.15	31.65	41.39	32.51	40.28	49.99	37.81	47.46	58.44	43.03	52.84	64.84	45.08	54.76	66.89
Alkalinity	mg/L	--	161.62	185.36	205.31	137.16	158.71	179.54	115.02	137.34	159.08	100.00	119.17	139.69	96.33	112.87	131.91
As (Arsenic)	µg/L	10	0.83	0.95	1.04	0.83	0.95	1.04	0.83	0.94	1.04	0.83	0.94	1.04	0.83	0.94	1.04
B (Boron)	µg/L	1000	257.56	324.12	383.19	185.26	245.91	305.06	122.10	180.33	243.40	81.78	127.67	187.71	72.54	110.30	165.81
Ba (Barium)	µg/L	2000	29.98	36.47	46.36	33.45	42.33	54.30	36.55	47.47	61.48	38.34	50.80	67.22	38.87	51.72	68.73
Be (Beryllium)[4]	µg/L	0.49	0.18	0.19	0.20	0.18	0.19	0.20	0.17	0.19	0.20	0.17	0.19	0.23	0.18	0.21	0.26
Ca (Calcium)	mg/L	--	62.19	72.80	81.84	50.73	60.36	69.72	41.03	50.31	60.03	35.33	42.62	51.65	33.47	39.69	48.56
Cd (Cadmium)	µg/L	4	0.11	0.11	0.12	0.11	0.12	0.12	0.11	0.12	0.13	0.12	0.13	0.14	0.11	0.13	0.15
Cl (Chloride)	mg/L	250	11.75	14.65	17.19	8.65	11.20	13.78	5.91	8.33	11.10	4.16	6.18	8.76	3.77	5.35	7.76
Co (Cobalt)	µg/L	--	1.18	1.49	1.76	0.86	1.13	1.40	0.58	0.84	1.13	0.46	0.71	1.03	0.39	0.66	1.07
Cr (Chromium)	µg/L	100	0.68	0.73	0.82	0.73	0.81	0.90	0.77	0.86	0.97	0.81	0.92	1.05	0.83	0.94	1.06
Cu (Copper)	µg/L	--	2.11	2.25	2.37	2.11	2.25	2.37	2.11	2.25	2.37	2.11	2.25	2.37	2.11	2.24	2.37
F (Fluoride)	mg/L	2	0.09	0.10	0.11	0.10	0.11	0.13	0.11	0.12	0.14	0.12	0.13	0.15	0.12	0.13	0.15
Fe (Iron)[3]	µg/L	--	2,537.30	3,264.00	3,903.30	1,759.50	2,415.20	3,053.80	1,077.40	1,700.50	2,382.90	647.55	1,136.60	1,812.40	545.82	965.39	1,550.50
K (Potassium)	mg/L	--	6.01	7.25	8.32	4.70	5.81	6.88	3.57	4.63	5.79	2.91	3.75	4.87	2.71	3.44	4.54
Mg (Magnesium)	mg/L	--	89.70	112.59	132.89	64.48	85.60	105.42	42.46	62.60	84.61	28.98	44.95	66.00	25.99	39.86	58.35
Mn (Manganese)[3],[4]	µg/L	1,506	722.93	860.30	974.49	575.81	702.07	821.89	446.77	575.62	707.95	358.90	472.11	605.98	335.81	439.25	559.15
Na (Sodium)	mg/L	--	30.76	38.35	45.05	22.40	29.43	36.08	15.34	21.90	29.06	10.87	16.21	23.21	9.63	14.20	20.63
Ni (Nickel)	µg/L	100	4.45	4.73	4.96	4.45	4.72	4.96	4.45	4.72	4.96	4.45	4.72	4.96	4.45	4.72	4.96
Pb (Lead)	µg/L	--	0.21	0.22	0.23	0.22	0.23	0.23	0.23	0.24	0.26	0.24	0.35	0.74	0.29	0.47	0.73
Sb (Antimony)	µg/L	6	0.31	0.33	0.37	0.30	0.33	0.37	0.30	0.33	0.37	0.30	0.33	0.37	0.30	0.33	0.38
Se (Selenium)	µg/L	30	0.52	0.56	0.63	0.57	0.62	0.70	0.61	0.68	0.77	0.65	0.73	0.83	0.66	0.75	0.84
SO4 (Sulfate)	mg/L	250	165.63	212.30	**253.08**	116.24	158.07	198.56	73.21	112.57	155.86	46.90	78.22	120.45	39.58	66.93	105.53
Tl (Thallium)	µg/L	0.6	0.09	0.10	0.13	0.10	0.12	0.15	0.11	0.13	0.16	0.12	0.15	0.18	0.12	0.15	0.18
V (Vanadium)	µg/L	50	1.80	2.39	3.12	2.58	3.21	3.85	3.17	3.88	4.49	3.74	4.42	4.95	3.98	4.56	5.06
Zn (Zinc)	µg/L	2,000	5.52	6.89	8.86	7.22	8.67	10.66	8.44	10.30	12.40	9.88	12.15	14.43	10.66	12.64	14.80

NOTE: Values above the applicable water quality standard are shown in bold with light red shading.
(1) Values shown are the average of the monthly P10, P50, and P90 values, as indicated, for the referenced Mine Year; see Section 6.5 of Reference (8).
(2) Model runs evaluated through Mine Year 200.
(3) Not evaluated against the secondary groundwater standard.
(4) Evaluated against the site-specific evaluation criteria shown.

Large Table 8 Estimated Water Quality along the West Groundwater Flow Path at the Property Boundary

Constituent	Mine Year / Percentile / Units	Water Quality Standard	Mine Year 1 Average P10[1]	Mine Year 1 Average P50[1]	Mine Year 1 Average P90[1]	Mine Year 50 Average P10[1]	Mine Year 50 Average P50[1]	Mine Year 50 Average P90[1]	Mine Year 100 Average P10[1]	Mine Year 100 Average P50[1]	Mine Year 100 Average P90[1]	Mine Year 160 Average P10[1]	Mine Year 160 Average P50[1]	Mine Year 160 Average P90[1]	Mine Year 200[2] Average P10[1]	Mine Year 200[2] Average P50[1]	Mine Year 200[2] Average P90[1]
Ag (Silver)	µg/L	30	0.09	0.10	0.11	0.08	0.09	0.10	0.08	0.09	0.10	0.07	0.08	0.09	0.07	0.08	0.09
Al (Aluminum)[3]	µg/L	--	29.64	37.41	48.27	35.30	43.65	55.22	39.48	49.15	61.47	43.35	54.01	66.82	45.30	56.31	69.68
Alkalinity	mg/L	--	142.90	168.35	190.34	128.56	147.91	170.05	112.73	130.94	153.69	97.97	115.62	138.00	92.11	108.15	128.71
As (Arsenic)	µg/L	10	0.83	0.97	1.11	0.83	0.97	1.11	0.83	0.97	1.10	0.83	0.97	1.10	0.83	0.96	1.10
B (Boron)	µg/L	1000	200.60	272.52	339.02	159.06	213.79	279.45	114.37	163.55	228.28	73.82	118.59	179.65	61.40	95.72	153.04
Ba (Barium)	µg/L	2000	35.40	42.16	53.79	37.37	46.37	59.85	38.91	49.89	65.35	40.05	53.04	70.21	40.56	53.85	72.08
Be (Beryllium)[4]	µg/L	0.49	0.18	0.19	0.20	0.17	0.19	0.20	0.17	0.18	0.20	0.17	0.18	0.21	0.17	0.19	0.22
Ca (Calcium)	mg/L	--	52.89	63.86	73.96	46.57	55.00	64.94	39.48	47.25	57.41	33.10	40.07	49.89	31.40	36.96	46.40
Cd (Cadmium)	µg/L	4	0.12	0.12	0.13	0.12	0.12	0.13	0.11	0.12	0.13	0.12	0.12	0.13	0.12	0.13	0.14
Cl (Chloride)	mg/L	250	9.21	12.37	15.24	7.48	9.89	12.68	5.47	7.66	10.43	3.79	5.64	8.35	3.21	4.74	7.23
Co (Cobalt)	µg/L	--	1.00	1.36	1.70	0.79	1.07	1.40	0.57	0.82	1.14	0.41	0.61	0.91	0.36	0.55	0.83
Cr (Chromium)	µg/L	100	0.70	0.78	0.88	0.74	0.83	0.93	0.77	0.87	0.99	0.80	0.91	1.05	0.82	0.94	1.08
Cu (Copper)	µg/L	--	2.15	2.34	2.52	2.14	2.34	2.52	2.14	2.34	2.52	2.14	2.34	2.52	2.14	2.34	2.52
F (Fluoride)	mg/L	2	0.16	0.17	0.18	0.16	0.17	0.18	0.15	0.16	0.17	0.14	0.16	0.17	0.14	0.15	0.17
Fe (Iron)[3]	µg/L	--	2,066.40	2,905.20	3,680.10	1,584.60	2,217.20	2,989.00	1,054.20	1,636.40	2,390.70	582.66	1,105.30	1,825.60	444.57	841.48	1,512.70
K (Potassium)	mg/L	--	4.96	6.26	7.44	4.24	5.20	6.31	3.35	4.26	5.41	2.65	3.47	4.52	2.46	3.15	4.07
Mg (Magnesium)	mg/L	--	69.04	92.93	115.48	55.28	73.49	94.99	40.06	56.34	78.13	26.62	40.76	61.71	22.01	33.43	53.13
Mn (Manganese)[3],[4]	µg/L	1,506	611.82	743.70	866.48	519.07	630.09	753.66	422.69	537.91	662.34	345.45	447.28	571.84	312.39	410.32	525.85
Na (Sodium)	mg/L	--	24.43	32.72	40.19	19.60	25.90	33.49	14.35	20.12	27.47	9.96	14.91	22.18	8.39	12.61	19.12
Ni (Nickel)	µg/L	100	4.51	4.86	5.17	4.51	4.86	5.17	4.50	4.86	5.17	4.50	4.86	5.17	4.50	4.85	5.17
Pb (Lead)	µg/L	--	0.22	0.22	0.23	0.22	0.23	0.24	0.23	0.24	0.24	0.23	0.24	0.36	0.24	0.29	0.59
Sb (Antimony)	µg/L	6	0.32	0.35	0.40	0.31	0.35	0.40	0.31	0.35	0.40	0.31	0.35	0.40	0.31	0.35	0.40
Se (Selenium)	µg/L	30	0.57	0.63	0.69	0.61	0.67	0.74	0.64	0.70	0.78	0.66	0.74	0.83	0.68	0.76	0.84
SO4 (Sulfate)	mg/L	250	138.20	192.57	243.27	106.45	148.14	197.84	72.08	110.08	159.62	42.39	75.82	122.03	32.96	59.56	101.75
Tl (Thallium)	µg/L	0.6	0.10	0.12	0.14	0.11	0.13	0.16	0.12	0.14	0.17	0.13	0.15	0.18	0.13	0.15	0.19
V (Vanadium)	µg/L	50	2.32	2.99	3.73	2.92	3.54	4.14	3.41	4.04	4.62	3.89	4.51	5.04	4.14	4.72	5.20
Zn (Zinc)	µg/L	2,000	6.83	8.39	10.40	8.07	9.61	11.45	8.99	10.72	12.62	9.98	11.86	14.11	10.50	12.66	14.76

NOTE: Values above the applicable water quality standard are shown in bold with light red shading.
(1) Values shown are the average of the monthly P10, P50, and P90 values, as indicated, for the referenced Mine Year; see Section 6.5 of Reference (8).
(2) Model runs evaluated through Mine Year 200.
(3) Not evaluated against the secondary groundwater standard.
(4) Evaluated against the site-specific evaluation criteria shown.

Large Table 9 Estimated Surface Water Quality for the Embarrass River at PM-12 (Existing NPDES Station SW004)

Mine Year			Mine Year 2			Mine Year 13			Mine Year 25			Mine Year 40			Mine Year 100[2]		
Constituent	Units	Water Quality Standard	Average P10[1]	Average P50[1]	Average P90[1]	Average P10[1]	Average P50[1]	Average P90[1]	Average P10[1]	Average P50[1]	Average P90[1]	Average P10[1]	Average P50[1]	Average P90[1]	Average P10[1]	Average P50[1]	Average P90[1]
Ag (Silver)	µg/L	1	0.09	0.11	0.12	0.09	0.11	0.12	0.09	0.11	0.13	0.09	0.11	0.13	0.09	0.11	0.13
Al (Aluminum)	µg/L	125	60.61	93.74	**185.15**	58.96	92.09	**164.57**	61.45	92.46	**172.10**	61.63	93.31	**165.92**	62.75	93.48	**172.45**
Alkalinity	mg/L	--	9.81	43.30	85.65	10.21	42.88	84.79	9.86	43.51	91.08	10.42	43.09	84.14	9.54	43.24	87.35
As (Arsenic)	µg/L	53	0.40	1.04	3.48	0.37	1.03	3.78	0.39	1.06	3.61	0.38	1.07	4.36	0.40	1.04	3.65
B (Boron)	µg/L	500	16.11	21.88	26.19	16.14	21.91	26.25	16.35	21.88	26.39	16.09	21.84	26.13	16.11	21.87	26.32
Ba (Barium)	µg/L	--	5.08	16.60	47.55	5.07	16.96	47.48	5.06	16.86	47.21	5.07	16.75	47.79	5.07	16.73	47.07
Be (Beryllium)	µg/L	--	0.07	0.10	0.15	0.07	0.10	0.15	0.07	0.10	0.15	0.07	0.10	0.15	0.07	0.10	0.15
Ca (Calcium)	mg/L	--	3.93	12.77	22.72	3.57	12.93	23.07	3.78	12.92	22.28	3.60	12.95	23.14	3.82	12.82	22.24
Cd (Cadmium)[3]	µg/L	--	0.08	0.09	0.11	0.07	0.09	0.11	0.08	0.09	0.11	0.08	0.09	0.11	0.07	0.09	0.11
Cl (Chloride)	mg/L	230	2.50	4.24	8.95	2.55	4.24	8.98	2.50	4.23	8.96	2.49	4.27	9.15	2.56	4.18	8.95
Co (Cobalt)	µg/L	5	0.38	0.85	2.31	0.39	0.85	2.36	0.39	0.84	2.42	0.38	0.84	2.50	0.38	0.85	2.45
Cr (Chromium)	µg/L	11	0.20	0.66	1.45	0.19	0.67	1.69	0.20	0.67	1.53	0.20	0.66	1.61	0.19	0.67	1.63
Cu (Copper)[3]	µg/L	--	0.22	0.99	1.87	0.21	0.98	1.85	0.22	0.98	1.91	0.23	0.98	1.95	0.22	0.98	1.90
F (Fluoride)	mg/L	--	0.02	0.09	0.18	0.03	0.09	0.19	0.02	0.09	0.18	0.02	0.09	0.20	0.02	0.09	0.18
Fe (Iron)	µg/L	--	1,154.60	3,305.21	10,828.00	1,186.30	3,247.56	11,264.00	1,137.50	3,205.58	10,495.00	1,164.90	3,274.75	10,839.00	1,237.00	3,273.76	10,795.00
K (Potassium)	mg/L	--	0.19	0.91	1.89	0.19	0.92	1.97	0.21	0.93	2.08	0.18	0.91	2.07	0.18	0.93	1.97
Mg (Magnesium)	mg/L	--	1.54	5.69	10.45	1.52	5.62	11.24	1.44	5.64	10.60	1.29	5.67	10.57	1.43	5.62	10.34
Mn (Manganese)	µg/L	--	64.98	289.35	1,141.60	69.33	289.69	1,099.90	69.19	291.02	1,025.50	74.08	288.95	971.86	76.08	291.11	1,061.50
Na (Sodium)	mg/L	--	1.99	3.53	5.00	1.98	3.56	4.88	1.95	3.56	5.13	1.95	3.53	4.79	2.02	3.55	4.99
Ni (Nickel)[3]	µg/L	--	0.46	1.30	3.13	0.45	1.32	3.17	0.45	1.32	3.15	0.45	1.30	3.11	0.46	1.30	3.16
Pb (Lead)[3]	µg/L	--	0.12	0.24	0.44	0.11	0.24	0.45	0.12	0.24	0.45	0.12	0.24	0.46	0.12	0.24	0.45
Sb (Antimony)	µg/L	31	0.21	0.24	0.35	0.21	0.24	0.35	0.21	0.24	0.35	0.21	0.24	0.35	0.21	0.24	0.35
Se (Selenium)	µg/L	5	0.27	0.53	0.74	0.27	0.53	0.75	0.26	0.53	0.75	0.25	0.53	0.75	0.27	0.53	0.74
SO4 (Sulfate)	mg/L	--	0.74	3.94	10.83	0.64	3.99	12.19	0.63	3.91	10.97	0.66	3.95	11.65	0.66	3.96	10.45
Tl (Thallium)	µg/L	0.56	0.00	0.04	0.13	0.00	0.04	0.12	0.00	0.04	0.12	0.00	0.04	0.13	0.00	0.04	0.13
V (Vanadium)	µg/L	--	0.20	1.35	3.61	0.20	1.38	3.65	0.20	1.38	3.61	0.19	1.36	3.58	0.19	1.36	3.58
Zn (Zinc)[3]	µg/L	--	1.10	6.80	14.97	1.31	6.87	15.81	1.29	6.76	18.89	1.31	6.79	16.56	1.23	6.80	16.45
Hardness	mg/L	500	21.45	57.67	94.09	19.95	57.77	95.50	20.23	57.81	93.46	21.35	57.74	93.48	20.67	57.43	92.43

NOTE: Values above the applicable water quality standard are shown in bold with light red shading.

(1) Values shown are the average of the monthly P10, P50, and P90 values, as indicated, for the referenced Mine Year; see Section 6.7 of Reference (8).

(2) Model runs evaluated through Mine Year 100.

(3) Standard is hardness-based and variable; see Section 6.7.1.2 and Section 6.7.2 of Reference (8).

Large Table 10 Estimated Surface Water Quality for the Embarrass River at PM-12.2

Constituent	Mine Year / Percentile / Units	Water Quality Standard	Mine Year 2 Average P10[1]	Mine Year 2 Average P50[1]	Mine Year 2 Average P90[1]	Mine Year 13 Average P10[1]	Mine Year 13 Average P50[1]	Mine Year 13 Average P90[1]	Mine Year 25 Average P10[1]	Mine Year 25 Average P50[1]	Mine Year 25 Average P90[1]	Mine Year 40 Average P10[1]	Mine Year 40 Average P50[1]	Mine Year 40 Average P90[1]	Mine Year 100[2] Average P10[1]	Mine Year 100[2] Average P50[1]	Mine Year 100[2] Average P90[1]
Ag (Silver)	µg/L	1	0.10	0.11	0.13	0.10	0.11	0.13	0.10	0.11	0.13	0.10	0.11	0.13	0.10	0.11	0.13
Al (Aluminum)	µg/L	125	53.86	83.13	**178.00**	54.30	81.02	**158.65**	53.90	81.61	**165.11**	53.82	82.55	**158.79**	53.98	82.47	**165.43**
Alkalinity	mg/L	--	12.80	48.28	86.90	13.40	47.77	85.66	13.28	48.37	92.82	13.56	47.95	81.47	12.43	47.93	84.68
As (Arsenic)	µg/L	53	0.43	1.07	3.38	0.40	1.06	3.75	0.42	1.08	3.42	0.42	1.10	4.15	0.43	1.07	3.53
B (Boron)	µg/L	500	22.18	41.50	67.40	22.34	41.79	69.19	22.09	41.61	69.30	22.15	41.74	68.75	22.26	41.55	69.37
Ba (Barium)	µg/L	--	5.03	13.90	37.09	5.02	14.11	37.40	5.01	13.99	37.14	5.02	13.99	37.58	5.02	13.90	37.68
Be (Beryllium)	µg/L	--	0.08	0.10	0.14	0.08	0.10	0.14	0.08	0.10	0.14	0.08	0.10	0.14	0.08	0.10	0.14
Ca (Calcium)	mg/L	--	7.29	23.23	40.00	7.12	23.40	40.92	7.21	23.34	40.81	7.16	23.42	40.75	7.38	23.28	40.97
Cd (Cadmium)[3]	µg/L	--	0.08	0.09	0.11	0.08	0.09	0.11	0.08	0.09	0.11	0.08	0.09	0.11	0.08	0.09	0.11
Cl (Chloride)	mg/L	230	2.72	4.33	8.69	2.78	4.33	8.80	2.65	4.33	8.73	2.79	4.36	8.96	2.72	4.27	8.82
Co (Cobalt)	µg/L	5	0.41	0.81	2.22	0.39	0.81	2.29	0.40	0.80	2.33	0.38	0.80	2.41	0.39	0.81	2.38
Cr (Chromium)	µg/L	11	0.21	0.63	1.41	0.20	0.63	1.64	0.21	0.63	1.49	0.22	0.63	1.53	0.20	0.63	1.58
Cu (Copper)[3]	µg/L	--	0.29	1.07	1.87	0.27	1.07	1.85	0.29	1.07	1.90	0.30	1.07	1.91	0.28	1.07	1.88
F (Fluoride)	mg/L	--	0.03	0.09	0.17	0.03	0.10	0.18	0.03	0.09	0.17	0.03	0.09	0.19	0.03	0.09	0.18
Fe (Iron)	µg/L	--	986.42	2,923.51	10,131.00	946.71	2,883.70	10,988.00	902.86	2,865.64	9,837.10	934.80	2,917.76	10,179.00	962.70	2,939.88	10,321.00
K (Potassium)	mg/L	--	2.27	8.31	17.65	2.25	8.32	18.15	2.26	8.31	18.33	2.21	8.34	18.07	2.25	8.35	18.29
Mg (Magnesium)	mg/L	--	11.58	40.37	83.82	11.44	40.44	87.30	11.23	40.20	86.65	11.15	40.37	86.24	11.16	40.26	87.45
Mn (Manganese)	µg/L	--	99.74	368.84	1,127.80	100.56	371.30	1,089.00	103.45	370.91	1,044.00	104.25	367.63	952.55	106.90	373.03	1,048.20
Na (Sodium)	mg/L	--	5.60	15.88	31.47	5.63	15.96	32.45	5.62	15.89	32.63	5.65	15.93	32.10	5.69	15.89	32.48
Ni (Nickel)[3]	µg/L	--	0.57	1.57	3.31	0.57	1.59	3.36	0.57	1.58	3.34	0.57	1.58	3.30	0.57	1.57	3.33
Pb (Lead)[3]	µg/L	--	0.12	0.22	0.43	0.12	0.22	0.44	0.12	0.22	0.43	0.12	0.22	0.44	0.12	0.22	0.44
Sb (Antimony)	µg/L	31	0.21	0.24	0.33	0.21	0.24	0.32	0.21	0.24	0.33	0.21	0.24	0.33	0.21	0.24	0.33
Se (Selenium)	µg/L	5	0.28	0.55	0.73	0.28	0.55	0.73	0.28	0.55	0.74	0.27	0.54	0.73	0.29	0.55	0.73
SO4 (Sulfate)	mg/L	--	41.55	159.47	352.30	41.79	160.69	367.07	42.03	160.09	365.88	41.24	161.35	363.98	41.10	160.27	366.68
Tl (Thallium)	µg/L	0.56	0.01	0.05	0.12	0.01	0.05	0.12	0.01	0.05	0.12	0.01	0.05	0.12	0.01	0.05	0.12
V (Vanadium)	µg/L	--	0.39	1.85	4.16	0.38	1.88	4.22	0.38	1.88	4.18	0.38	1.87	4.16	0.38	1.86	4.17
Zn (Zinc)[3]	µg/L	--	1.17	5.97	13.54	1.39	6.06	14.55	1.37	5.95	18.28	1.36	5.96	15.93	1.29	6.02	15.53
Hardness	mg/L	500	71.40	224.89	440.33	70.94	226.20	456.86	70.19	224.74	456.46	70.52	225.90	453.55	69.89	224.62	461.32

NOTE: Values above the applicable water quality standard are shown in bold with light red shading.
(1) Values shown are the average of the monthly P10, P50, and P90 values, as indicated, for the referenced Mine Year; see Section 6.7 of Reference (8).
(2) Model runs evaluated through Mine Year 100.
(3) Standard is hardness-based and variable; see Section 6.7.1.2 and Section 6.7.2 of Reference (8).

Large Table 11 Estimated Surface Water Quality for the Embarrass River at PM-13 (Existing NPDES Station SW005)

Constituent	Mine Year / Percentile / Units	Water Quality Standard	Mine Year 2			Mine Year 13			Mine Year 25			Mine Year 40			Mine Year 100[2]		
			Average P10[1]	Average P50[1]	Average P90[1]	Average P10[1]	Average P50[1]	Average P90[1]	Average P10[1]	Average P50[1]	Average P90[1]	Average P10[1]	Average P50[1]	Average P90[1]	Average P10[1]	Average P50[1]	Average P90[1]
Ag (Silver)	µg/L	1	0.10	0.11	0.12	0.11	0.12	0.15	0.11	0.12	0.13	0.09	0.11	0.13	0.09	0.11	0.13
Al (Aluminum)	µg/L	125	43.99	79.59	**178.59**	36.46	72.87	**154.23**	43.25	77.15	**165.62**	43.18	79.10	**160.66**	45.42	77.96	**163.99**
Alkalinity	mg/L	--	12.72	53.85	92.85	13.16	52.25	91.55	12.70	51.57	93.34	12.99	52.58	90.11	12.15	53.65	89.24
As (Arsenic)	µg/L	53	0.52	1.65	3.47	0.65	2.84	5.49	0.60	2.44	4.40	0.61	2.43	4.52	0.63	2.57	4.77
B (Boron)	µg/L	500	22.20	67.67	151.32	21.33	57.29	136.09	20.98	51.38	116.22	20.88	53.09	107.13	23.02	64.44	144.08
Ba (Barium)	µg/L	--	5.09	13.77	33.23	5.08	13.28	30.95	5.07	13.78	32.88	5.09	13.77	33.14	5.07	13.58	33.61
Be (Beryllium)	µg/L	--	0.08	0.12	0.19	0.08	0.15	0.30	0.08	0.13	0.26	0.08	0.12	0.24	0.08	0.13	0.29
Ca (Calcium)	mg/L	--	5.76	19.20	32.95	5.50	20.01	33.87	5.46	19.19	33.02	5.35	19.12	32.96	5.56	19.25	32.13
Cd (Cadmium)[3]	µg/L	2.36	0.08	0.10	0.13	0.09	0.23	0.69	0.09	0.21	0.70	0.08	0.13	0.27	0.08	0.12	0.26
Cl (Chloride)	mg/L	230	2.60	4.14	8.61	2.38	3.97	8.67	2.55	4.13	8.74	2.59	4.15	8.98	2.50	3.92	8.73
Co (Cobalt)	µg/L	5	0.48	1.20	2.36	0.58	1.71	2.81	0.57	1.51	2.45	0.57	1.49	2.58	0.58	1.56	2.61
Cr (Chromium)	µg/L	11	0.21	0.63	1.41	0.30	1.62	3.36	0.28	1.28	2.48	0.23	0.77	1.57	0.23	0.79	1.63
Cu (Copper)[3]	µg/L	8.93	0.30	1.63	3.48	0.39	2.45	5.29	0.36	2.09	4.51	0.37	2.08	4.49	0.40	2.22	4.37
F (Fluoride)	mg/L	--	0.03	0.09	0.17	0.03	0.09	0.18	0.03	0.09	0.17	0.03	0.09	0.19	0.03	0.09	0.17
Fe (Iron)	µg/L	--	859.61	2,873.88	10,268.00	724.99	2,707.10	10,814.00	782.18	2,834.36	9,768.60	811.50	2,872.94	10,348.00	789.08	2,794.44	10,310.00
K (Potassium)	mg/L	--	0.92	2.97	5.77	0.90	2.79	5.43	0.92	2.95	5.95	0.87	2.97	5.92	0.90	2.92	5.96
Mg (Magnesium)	mg/L	--	5.16	16.32	30.82	4.98	15.32	28.64	4.91	16.16	30.93	4.78	16.11	30.91	4.79	15.47	30.66
Mn (Manganese)	µg/L	--	81.43	280.03	1,124.30	79.82	268.49	1,068.40	78.85	280.01	1,024.50	83.66	279.79	933.86	84.23	274.00	1,008.10
Na (Sodium)	mg/L	--	3.23	7.32	12.22	3.24	6.99	11.52	3.22	7.29	12.33	3.24	7.25	12.13	3.25	7.00	12.13
Ni (Nickel)[3]	µg/L	49.95	0.59	3.34	10.22	1.00	9.75	25.95	0.84	7.69	20.82	0.83	7.57	20.88	0.96	8.20	19.66
Pb (Lead)[3]	µg/L	2.98	0.14	0.39	0.65	0.18	0.73	1.60	0.17	0.62	1.28	0.16	0.62	1.29	0.18	0.65	1.22
Sb (Antimony)	µg/L	31	0.21	0.30	0.53	0.29	1.66	4.21	0.28	1.63	4.37	0.24	0.76	1.88	0.24	0.73	1.89
Se (Selenium)	µg/L	5	0.28	0.53	0.72	0.32	0.81	1.42	0.32	0.91	1.83	0.27	0.57	0.86	0.29	0.56	0.86
SO4 (Sulfate)	mg/L	--	14.58	51.25	108.40	14.65	48.19	104.70	14.62	50.84	111.47	14.36	51.20	110.94	14.14	49.21	111.43
Tl (Thallium)	µg/L	0.56	0.01	0.06	0.14	0.01	0.06	0.15	0.01	0.06	0.14	0.00	0.05	0.12	0.00	0.05	0.12
V (Vanadium)	µg/L	--	0.29	1.78	4.16	0.34	2.52	5.86	0.30	2.10	5.01	0.27	1.54	3.49	0.29	1.57	3.66
Zn (Zinc)[3]	µg/L	114.72	1.28	7.09	14.02	2.79	19.24	46.37	2.41	16.83	41.75	1.82	9.69	21.32	1.69	8.91	18.89
Hardness	mg/L	500	41.44	117.04	203.82	39.67	115.05	197.03	38.36	116.58	203.16	39.17	115.72	203.69	39.23	113.71	201.95

NOTE: Values above the applicable water quality standard are shown in bold with light red shading.
(1) Values shown are the average of the monthly P10, P50, and P90 values, as indicated, for the referenced Mine Year; see Section 6.7 of Reference (8).
(2) Model runs evaluated through Mine Year 100.
(3) Standard is hardness-based and hardness-based and evaluated at a hardness of 95 mg/L. See Section 6.7.1.2 and Section 6.7.4 of Reference (8).

Large Table 12 Estimated Surface Water Quality for Mud Lake Creek at MLC-2

Constituent	Mine Year / Percentile / Units	Water Quality Standard	Mine Year 2			Mine Year 13			Mine Year 25			Mine Year 40			Mine Year 100(2)		
			Average P10(1)	Average P50(1)	Average P90(1)	Average P10(1)	Average P50(1)	Average P90(1)	Average P10(1)	Average P50(1)	Average P90(1)	Average P10(1)	Average P50(1)	Average P90(1)	Average P10(1)	Average P50(1)	Average P90(1)
Ag (Silver)	µg/L	1	0.09	0.11	0.12	0.09	0.11	0.12	0.09	0.11	0.13	0.09	0.11	0.13	0.08	0.11	0.12
Al (Aluminum)	µg/L	125	53.08	85.37	**184.35**	54.42	83.51	**163.75**	53.86	84.37	**171.54**	54.38	85.75	**165.94**	56.35	86.44	**171.58**
Alkalinity	mg/L	--	11.88	64.01	132.01	11.76	63.00	128.20	11.92	63.26	127.90	11.97	61.49	124.60	10.72	57.98	112.05
As (Arsenic)	µg/L	53	0.42	1.32	3.51	0.40	1.30	3.82	0.42	1.32	3.69	0.42	1.34	4.44	0.41	1.31	3.68
B (Boron)	µg/L	500	18.21	41.24	94.54	18.25	41.19	91.29	17.78	40.20	89.10	17.45	39.01	84.49	17.55	34.56	68.46
Ba (Barium)	µg/L	--	5.68	31.43	92.38	5.67	32.08	91.53	5.64	31.26	90.29	5.59	30.52	89.54	5.49	27.92	81.40
Be (Beryllium)	µg/L	--	0.07	0.11	0.18	0.07	0.11	0.18	0.07	0.11	0.18	0.07	0.11	0.18	0.07	0.11	0.18
Ca (Calcium)	mg/L	--	4.26	15.54	28.96	3.86	15.71	29.70	4.01	15.67	29.25	3.83	15.52	29.03	3.99	15.18	28.21
Cd (Cadmium)(3)	µg/L	--	0.08	0.10	0.13	0.08	0.10	0.13	0.08	0.10	0.13	0.08	0.10	0.13	0.08	0.10	0.13
Cl (Chloride)	mg/L	230	2.81	5.65	9.31	2.86	5.61	9.18	2.75	5.53	9.27	2.88	5.48	9.24	2.73	4.96	9.07
Co (Cobalt)	µg/L	5	0.42	0.85	2.32	0.45	0.85	2.36	0.43	0.84	2.41	0.43	0.83	2.51	0.38	0.81	2.44
Cr (Chromium)	µg/L	11	0.19	0.66	1.45	0.19	0.67	1.70	0.20	0.68	1.53	0.20	0.67	1.60	0.19	0.69	1.64
Cu (Copper)(3)	µg/L	--	0.23	1.11	2.12	0.21	1.11	2.13	0.23	1.11	2.13	0.24	1.11	2.15	0.24	1.11	2.16
F (Fluoride)	mg/L	--	0.05	0.38	1.13	0.05	0.38	1.09	0.05	0.37	1.05	0.04	0.34	0.97	0.04	0.28	0.74
Fe (Iron)	µg/L	--	883.32	2,977.96	10,518.00	846.15	2,927.65	11,246.00	810.41	2,882.04	10,260.00	788.03	2,929.38	10,717.00	734.07	2,887.23	10,711.00
K (Potassium)	mg/L	--	0.25	1.65	3.78	0.26	1.65	3.68	0.27	1.62	3.64	0.24	1.56	3.48	0.22	1.45	2.97
Mg (Magnesium)	mg/L	--	2.06	10.93	25.94	2.01	10.86	24.84	1.88	10.64	24.44	1.72	10.41	23.37	1.76	9.30	19.87
Mn (Manganese)	µg/L	--	66.94	274.29	1,140.50	67.90	278.85	1,090.70	67.65	277.33	1,030.20	72.36	277.62	978.50	73.29	279.47	1,046.80
Na (Sodium)	mg/L	--	2.53	8.39	20.96	2.51	8.34	20.21	2.45	8.14	19.49	2.45	7.78	18.35	2.36	6.72	14.54
Ni (Nickel)(3)	µg/L	--	0.46	1.54	3.84	0.46	1.57	3.95	0.46	1.56	3.91	0.46	1.55	3.87	0.46	1.55	3.98
Pb (Lead)(3)	µg/L	--	0.13	0.34	0.54	0.12	0.33	0.53	0.13	0.33	0.52	0.13	0.32	0.50	0.13	0.30	0.46
Sb (Antimony)	µg/L	31	0.21	0.25	0.38	0.21	0.25	0.39	0.21	0.25	0.39	0.21	0.25	0.39	0.21	0.25	0.39
Se (Selenium)	µg/L	5	0.27	0.55	0.78	0.27	0.55	0.79	0.26	0.55	0.79	0.25	0.55	0.80	0.28	0.56	0.80
SO4 (Sulfate)	mg/L	--	2.04	20.59	63.05	1.86	20.51	60.61	1.75	19.61	58.10	1.70	18.79	53.95	1.43	14.82	41.04
Tl (Thallium)	µg/L	0.56	0.00	0.06	0.16	0.00	0.06	0.17	0.00	0.06	0.16	0.00	0.06	0.17	0.00	0.06	0.17
V (Vanadium)	µg/L	--	0.21	1.72	4.84	0.21	1.77	4.89	0.21	1.76	4.89	0.21	1.75	4.82	0.21	1.77	4.88
Zn (Zinc)(3)	µg/L	--	1.15	7.48	15.11	1.35	7.59	16.14	1.37	7.45	18.97	1.40	7.51	16.59	1.22	7.64	16.50
Hardness	mg/L	500	24.86	85.38	174.99	23.09	85.61	173.08	22.91	84.55	171.14	23.89	83.03	164.61	22.23	77.62	148.87

NOTE: Values above the applicable water quality standard are shown in bold with light red shading.
(1) Values shown are the average of the monthly P10, P50, and P90 values, as indicated, for the referenced Mine Year; see Section 6.7 of Reference (8).
(2) Model runs evaluated through Mine Year 100.
(3) Standard is hardness-based and variable; see Section 6.7.1.2 and Section 6.7.3.1 of Reference (8).

Large Table 13 Estimated Surface Water Quality for Trimble Creek at TC-1

Constituent	Mine Year / Percentile / Units	Water Quality Standard	Mine Year 2			Mine Year 13			Mine Year 25			Mine Year 40			Mine Year 100(2)		
			Average P10(1)	Average P50(1)	Average P90(1)	Average P10(1)	Average P50(1)	Average P90(1)	Average P10(1)	Average P50(1)	Average P90(1)	Average P10(1)	Average P50(1)	Average P90(1)	Average P10(1)	Average P50(1)	Average P90(1)
Ag (Silver)	µg/L	1	0.11	0.12	0.12	0.14	0.18	0.21	0.12	0.15	0.19	0.07	0.09	0.14	0.06	0.10	0.19
Al (Aluminum)	µg/L	125	12.64	28.47	109.15	4.18	19.66	88.81	6.17	23.58	104.92	7.81	27.20	106.63	8.20	28.70	107.05
Alkalinity	mg/L	--	39.65	88.96	100.00	38.01	73.28	100.00	37.94	75.31	100.00	36.54	85.36	100.00	43.98	89.78	100.00
As (Arsenic)	µg/L	53	1.92	4.09	5.10	3.97	8.84	10.00	3.36	8.56	10.00	3.22	8.56	10.00	3.79	8.77	10.00
B (Boron)	µg/L	500	91.03	248.15	314.31	66.11	148.36	244.55	65.82	145.76	241.94	62.49	158.92	215.06	109.76	225.70	356.22
Ba (Barium)	µg/L	--	4.67	4.93	5.00	4.71	4.94	5.00	4.67	4.93	5.00	4.67	4.93	5.00	4.70	4.94	5.00
Be (Beryllium)	µg/L	--	0.12	0.22	0.27	0.19	0.37	0.48	0.16	0.33	0.50	0.13	0.27	0.45	0.15	0.32	0.64
Ca (Calcium)	mg/L	--	14.22	30.72	35.10	15.82	31.58	35.10	13.46	30.75	35.10	13.12	30.72	35.10	14.78	31.30	35.10
Cd (Cadmium)(3)	µg/L	--	0.09	0.13	0.18	0.31	0.80	1.67	0.26	0.85	1.98	0.14	0.32	0.67	0.14	0.28	0.65
Cl (Chloride)	mg/L	230	1.30	1.89	5.58	1.30	1.79	5.59	1.30	1.88	5.84	1.30	1.91	5.75	1.30	1.79	5.10
Co (Cobalt)	µg/L	5	1.07	2.61	4.85	2.30	4.49	5.00	1.96	4.37	5.00	1.80	4.33	5.00	2.06	4.41	5.00
Cr (Chromium)	µg/L	11	0.35	0.59	1.04	2.19	5.17	6.59	1.58	4.24	5.44	0.65	1.43	1.81	0.72	1.38	1.76
Cu (Copper)(3)	µg/L	--	1.18	4.74	8.86	3.27	7.80	9.00	2.59	7.56	9.00	2.57	7.54	9.00	3.13	7.75	9.00
F (Fluoride)	mg/L	--	0.03	0.05	0.12	0.04	0.05	0.11	0.03	0.05	0.11	0.03	0.05	0.11	0.03	0.05	0.11
Fe (Iron)	µg/L	--	300.00	916.49	5,661.00	300.00	802.97	5,570.40	271.81	897.90	5,925.00	300.00	911.73	6,182.60	300.00	829.80	6,043.70
K (Potassium)	mg/L	--	0.30	0.50	1.18	0.31	0.50	1.07	0.31	0.50	1.23	0.28	0.50	1.30	0.32	0.50	1.14
Mg (Magnesium)	mg/L	--	2.07	3.02	6.52	2.12	3.02	6.36	1.94	3.01	6.94	1.88	3.01	6.32	1.99	3.01	5.86
Mn (Manganese)	µg/L	--	50.00	78.19	712.15	50.00	74.12	507.26	49.71	80.20	568.06	50.00	79.78	568.58	49.96	74.28	588.20
Na (Sodium)	mg/L	--	1.93	2.15	3.59	1.95	2.12	3.56	1.92	2.15	3.80	1.93	2.15	3.62	1.96	2.13	3.52
Ni (Nickel)(3)	µg/L	--	3.03	15.14	46.17	16.16	42.80	50.00	12.41	41.27	50.00	11.83	41.08	50.00	15.17	42.25	50.00
Pb (Lead)(3)	µg/L	--	0.49	1.12	1.32	1.12	2.60	3.00	0.89	2.51	3.00	0.89	2.51	3.00	1.07	2.58	3.00
Sb (Antimony)	µg/L	31	0.28	0.60	1.99	2.72	7.32	11.15	2.45	8.84	13.50	1.12	3.49	6.28	1.03	3.11	6.08
Se (Selenium)	µg/L	5	0.39	0.56	0.67	0.95	1.84	2.45	1.15	2.82	4.26	0.48	0.77	1.20	0.46	0.69	1.33
SO4 (Sulfate)	mg/L	--	3.44	8.09	9.66	4.00	8.25	9.82	3.36	8.07	9.64	3.29	8.07	10.19	3.61	8.21	9.39
Tl (Thallium)	µg/L	0.56	0.04	0.13	0.16	0.06	0.14	0.18	0.04	0.12	0.16	0.02	0.06	0.10	0.02	0.06	0.13
V (Vanadium)	µg/L	--	1.19	3.62	4.45	2.71	6.79	8.72	1.64	5.43	7.07	0.69	2.06	2.61	0.97	2.19	3.01
Zn (Zinc)(3)	µg/L	--	4.70	11.01	14.25	28.14	67.46	99.50	21.21	68.75	100.00	9.84	24.75	44.56	8.65	18.52	40.86
Hardness	mg/L	500	49.55	90.68	100.05	53.54	92.48	100.05	46.83	90.53	100.05	46.04	90.37	100.05	50.38	91.84	100.05

NOTE: Values above the applicable water quality standard are shown in bold with light red shading.
(1) Values shown are the average of the monthly P10, P50, and P90 values, as indicated, for the referenced Mine Year; see Section 6.7 of Reference (8).
(2) Model runs evaluated through Mine Year 100.
(3) Standard is hardness-based and variable; see Section 6.7.1.2 and Section 6.7.3.2 of Reference (8).

Large Table 14 Estimated Surface Water Quality for Unnamed Creek at PM-11 (Existing NPDES Station SW003)

Constituent	Mine Year / Percentile / Units	Water Quality Standard	Mine Year 2			Mine Year 13			Mine Year 25			Mine Year 40			Mine Year 100[2]		
			Average P10[1]	Average P50[1]	Average P90[1]	Average P10[1]	Average P50[1]	Average P90[1]	Average P10[1]	Average P50[1]	Average P90[1]	Average P10[1]	Average P50[1]	Average P90[1]	Average P10[1]	Average P50[1]	Average P90[1]
Ag (Silver)	μg/L	1	0.11	0.12	0.13	0.12	0.16	0.20	0.11	0.14	0.18	0.08	0.10	0.14	0.07	0.10	0.19
Al (Aluminum)	μg/L	125	12.80	49.31	**156.15**	4.96	39.93	**137.63**	7.79	45.14	**151.37**	8.87	48.50	**146.45**	10.60	47.81	**151.36**
Alkalinity	mg/L	--	18.33	71.86	99.98	18.47	62.77	99.85	18.04	62.02	99.95	17.66	68.87	99.89	19.56	73.93	99.96
As (Arsenic)	μg/L	53	0.89	3.33	4.86	1.52	6.92	10.00	1.40	6.48	9.99	1.35	6.44	9.99	1.45	6.77	9.98
B (Boron)	μg/L	500	35.56	177.09	312.96	31.18	114.20	237.58	29.79	106.61	234.54	29.16	115.87	207.91	41.03	166.33	338.81
Ba (Barium)	μg/L	--	4.58	4.82	5.00	4.59	4.84	5.00	4.58	4.82	5.00	4.57	4.82	5.00	4.58	4.84	5.00
Be (Beryllium)	μg/L	--	0.08	0.18	0.27	0.10	0.29	0.47	0.09	0.25	0.48	0.09	0.21	0.43	0.09	0.24	0.61
Ca (Calcium)	mg/L	--	7.02	24.08	35.07	7.40	25.70	35.09	6.46	24.19	35.07	6.35	24.20	35.06	7.00	25.19	35.03
Cd (Cadmium)[3]	μg/L	--	0.08	0.12	0.16	0.14	0.60	1.63	0.12	0.61	1.91	0.09	0.25	0.65	0.10	0.22	0.63
Cl (Chloride)	mg/L	230	1.31	2.75	7.67	1.30	2.58	7.99	1.31	2.74	8.01	1.31	2.78	8.18	1.31	2.58	7.45
Co (Cobalt)	μg/L	5	0.66	2.16	4.39	1.13	3.64	5.00	0.96	3.46	4.99	0.93	3.40	4.99	1.02	3.56	4.98
Cr (Chromium)	μg/L	11	0.23	0.57	1.33	0.81	3.90	6.42	0.61	3.18	5.34	0.34	1.19	1.74	0.34	1.17	1.74
Cu (Copper)[3]	μg/L	--	0.51	3.41	8.16	1.12	5.89	9.00	0.89	5.48	8.99	0.89	5.45	8.98	1.08	5.76	8.97
F (Fluoride)	mg/L	--	0.02	0.05	0.15	0.03	0.05	0.16	0.02	0.05	0.15	0.02	0.05	0.14	0.03	0.05	0.15
Fe (Iron)	μg/L	--	306.27	1,804.93	9,248.50	301.51	1,613.01	9,569.10	305.58	1,762.20	8,786.20	306.42	1,804.40	9,799.70	312.61	1,669.21	8,881.10
K (Potassium)	mg/L	--	0.19	0.50	1.58	0.20	0.50	1.49	0.21	0.50	1.67	0.18	0.50	1.78	0.19	0.51	1.72
Mg (Magnesium)	mg/L	--	1.50	3.09	8.91	1.53	3.06	8.81	1.40	3.07	8.83	1.30	3.07	8.54	1.39	3.07	8.25
Mn (Manganese)	μg/L	--	50.13	124.31	1,039.30	50.01	115.13	903.24	50.11	127.70	857.56	50.19	127.12	832.69	49.91	119.49	914.73
Na (Sodium)	mg/L	--	1.86	2.38	4.42	1.90	2.34	4.44	1.84	2.38	4.65	1.88	2.39	4.34	1.92	2.34	4.25
Ni (Nickel)[3]	μg/L	--	1.04	9.85	38.22	4.29	31.26	49.98	3.14	28.71	49.93	3.03	28.42	49.89	4.00	30.15	49.79
Pb (Lead)[3]	μg/L	--	0.24	0.86	1.31	0.43	1.97	3.00	0.35	1.83	3.00	0.34	1.82	2.99	0.40	1.93	2.99
Sb (Antimony)	μg/L	31	0.23	0.46	1.55	0.84	5.32	9.74	0.72	6.19	12.01	0.42	2.48	5.40	0.41	2.25	5.25
Se (Selenium)	μg/L	5	0.30	0.53	0.70	0.49	1.46	2.40	0.52	2.09	4.10	0.33	0.68	1.17	0.34	0.62	1.26
SO4 (Sulfate)	mg/L	--	1.56	6.61	10.39	1.64	6.95	11.22	1.41	6.61	10.44	1.42	6.63	11.36	1.46	6.86	9.86
Tl (Thallium)	μg/L	0.56	0.01	0.09	0.16	0.02	0.10	0.18	0.01	0.08	0.16	0.01	0.04	0.10	0.01	0.04	0.13
V (Vanadium)	μg/L	--	0.39	2.53	4.38	0.78	4.93	8.51	0.49	3.83	6.85	0.27	1.46	2.54	0.34	1.61	2.93
Zn (Zinc)[3]	μg/L	--	2.21	9.16	14.49	8.77	50.09	97.40	7.31	48.90	99.17	3.71	19.14	42.74	3.63	14.72	38.33
Hardness	mg/L	500	29.92	76.11	100.00	31.66	79.12	100.04	27.88	76.33	99.99	27.78	76.07	99.99	28.31	78.12	99.96

NOTE: Values above the applicable water quality standard are shown in bold with light red shading.
(1) Values shown are the average of the monthly P10, P50, and P90 values, as indicated, for the referenced Mine Year; see Section 6.7 of Reference (8).
(2) Model runs evaluated through Mine Year 100.
(3) Standard is hardness-based and variable; see Section 6.7.1.2 and Section 6.7.3.3 of Reference (8).

Large Figures

Surface Water Evaluation Location PM-13

Project Areas

Existing Surface Discharge Station

Existing Surface Discharge Station and Temporary Pumpback System

USGS Gage

Stormwater Flow Lines

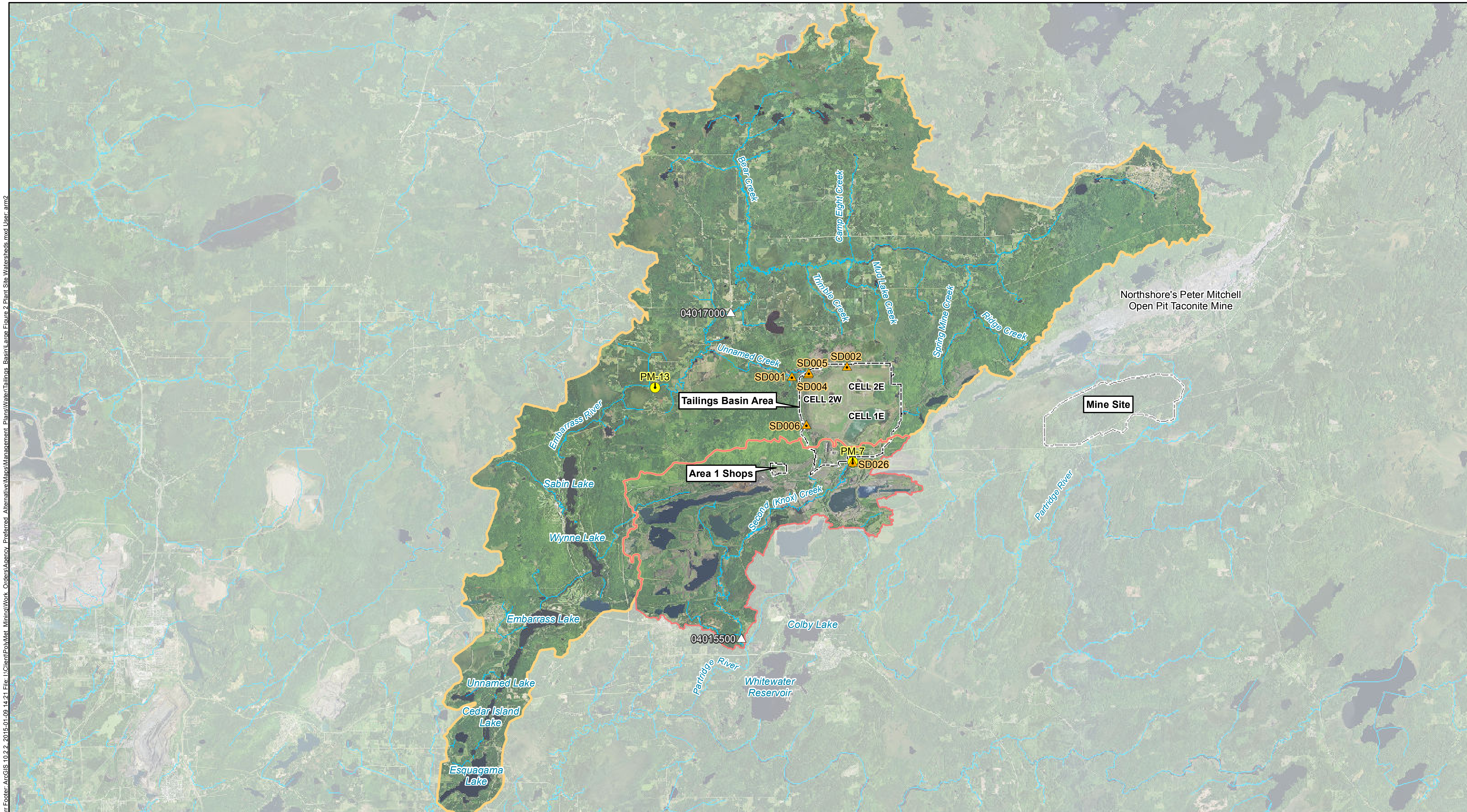
Streams and Rivers

0 1,750 3,500 7,000

Feet

Large Figure 1
EXISTING TAILINGS BASIN
NorthMet Project
Poly Met Mining, Inc.
Hoyt Lakes, MN

Barr Footer: ArcGIS 10.2.2, 2015-01-09 14:52 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Preferred_Alternative\Maps\Management_Plans\Water\Tailings_Basin\Large Figure 1 Existing Tailings Basin.mxd User: arm2



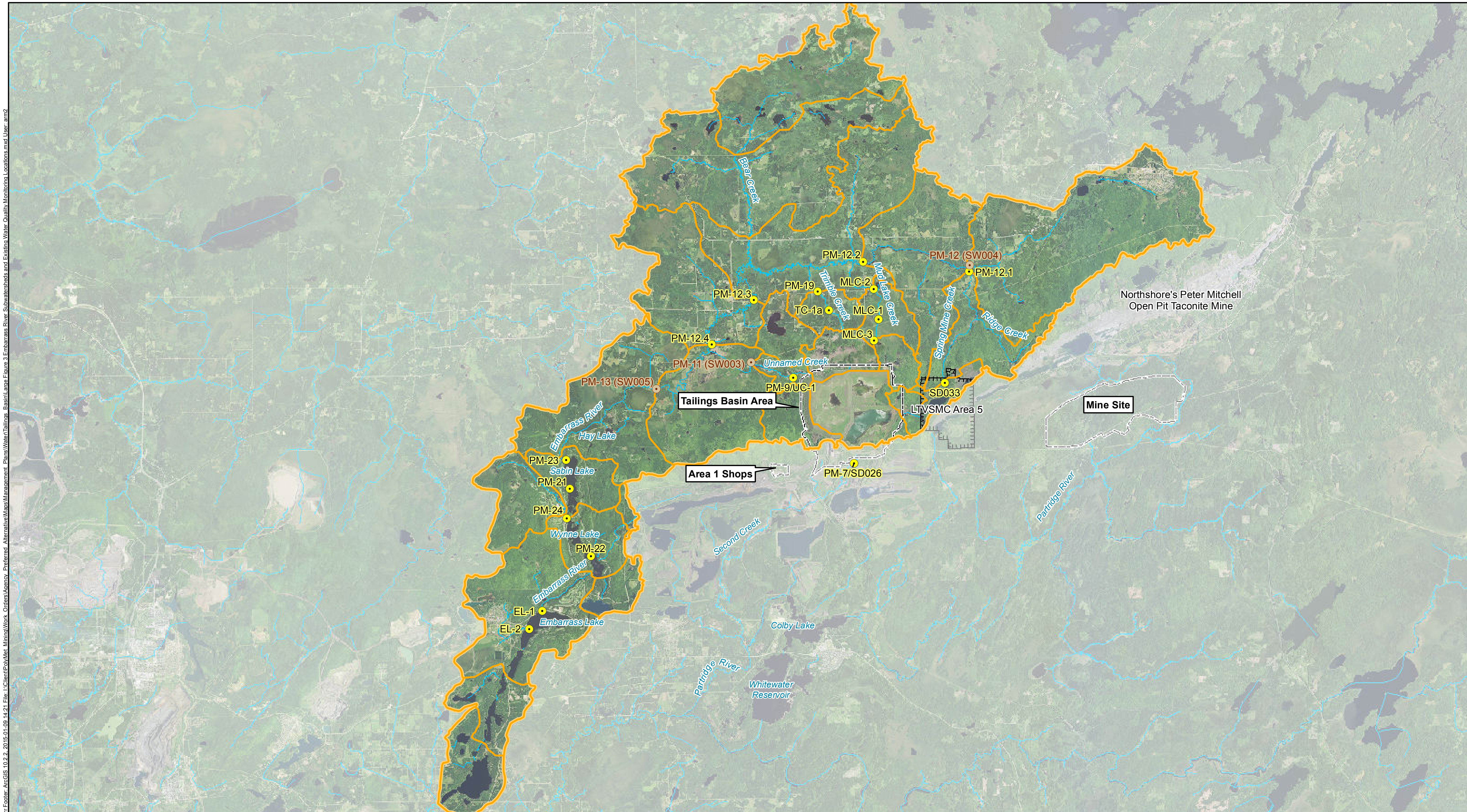
Barr Footer: ArcGIS 10.2.2, 2015-01-09 14:21 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Preferred_Alternative\Maps\Management_Plans\Water\Tailings_Basin\Large Figure 2 Plant Site Watersheds.mxd User: arm2

Existing Surface Discharge Station
Surface Water Evaluation Location
USGS Gages
Second Creek Watershed
Embarrass River Watershed
Project Areas
Streams/Rivers

Note: Surface water monitoring location PM-7/SD026 is a surface water monitoring location for the Plant Site in the Partridge River watershed.

0 1.25 2.5 5
Miles

Large Figure 2
PLANT SITE WATERSHEDS
NorthMet Project
Poly Met Mining, Inc.
Hoyt Lakes, MN

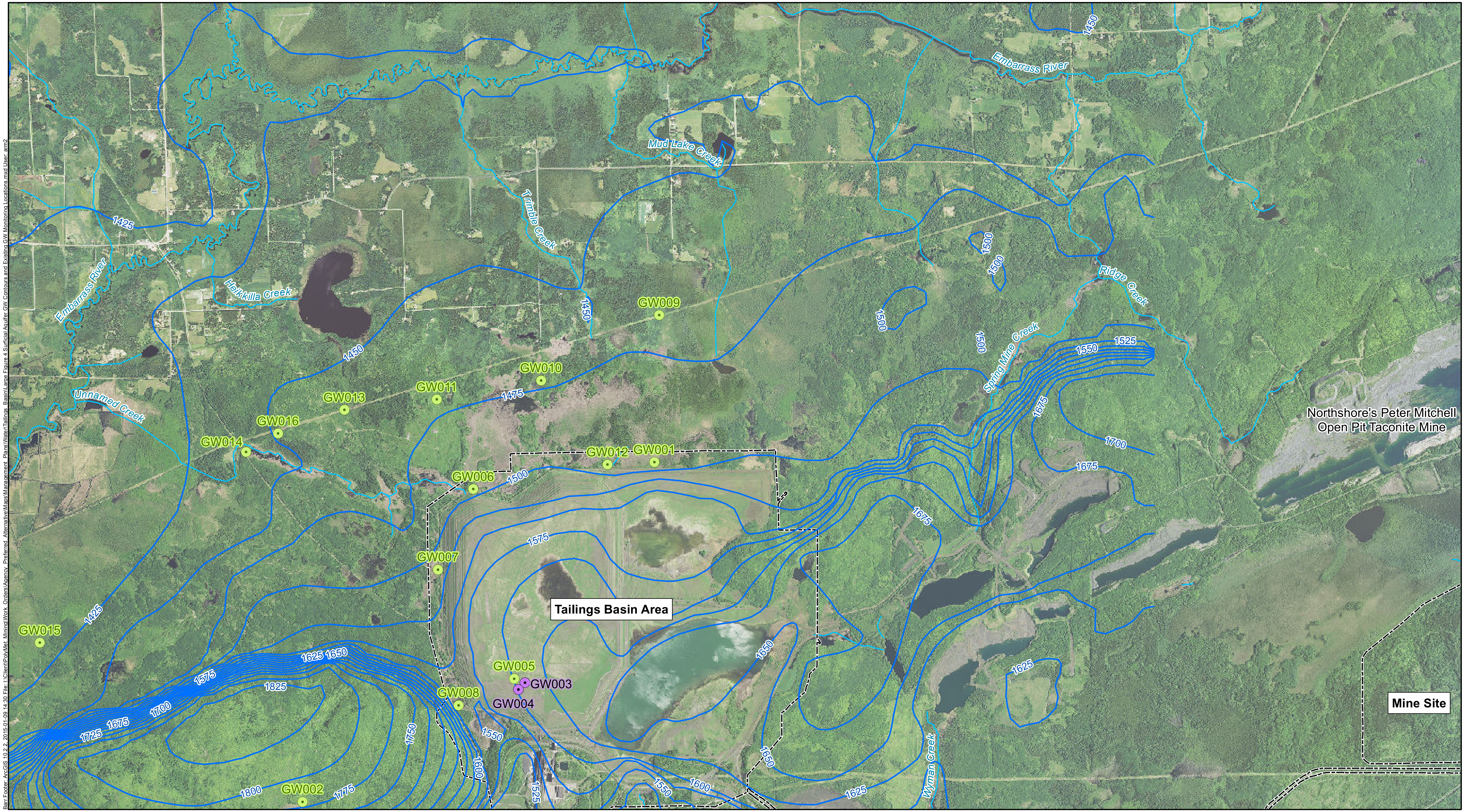


Existing Surface Water Stations
Surface Water Monitoring Locations
Embarrass River Subwatersheds
Embarrass River Watershed
LTVSMC Area 5
Project Area
Streams and Rivers

0 1.25 2.5 5
Miles

Large Figure 3
EMBARRASS RIVER SUBWATERSHEDS AND EXISTING WATER QUALITY MONITORING LOCATIONS
NorthMet Project
Poly Met Mining, Inc.
Hoyt Lakes, MN

Note: PM-7/SD026 is a surface water monitoring location on Second Creek, a tributary to the Partridge River.
All other surface water monitoring locations and stations shown are within the Embarrass River watershed.



Groundwater Monitoring Wells

Groundwater Monitoring Wells - Intermittent Sampling (Dry)

Surficial Aquifer Groundwater Contours - Inferred

Rivers & Streams

Project Areas

0 1,750 3,500 7,000

Feet

Large Figure 4
SURFICIAL AQUIFER GROUNDWATER CONTOURS
AND EXISTING GROUNDWATER MONITORING LOCATIONS
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN

Existing Surface Discharge Station

Seep Temporary Pumpback System

Existing Waste Stream Station

Culvert

Seeps

Rivers & Streams

Railroads

0 2,000 4,000

Feet

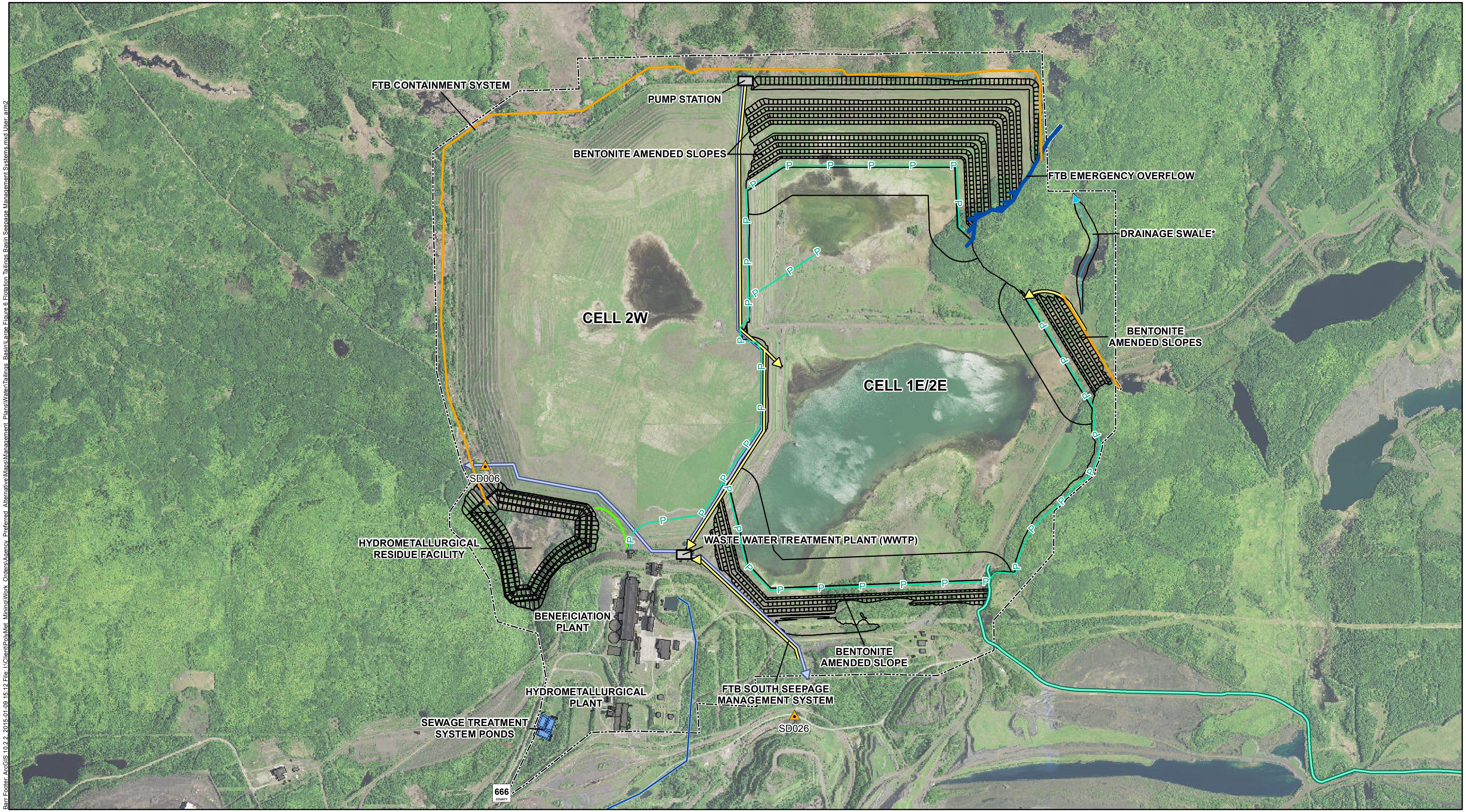
Large Figure 5

EXISTING SEEPS AND EXISTING TAILINGS BASIN NPDES MONITORING STATIONS

NorthMet Project

Poly Met Mining Inc.

Hoyt Lakes, MN



Existing NPDES Discharge Stations
Treated Water Discharge Pipe
Seepage Water Pipe
Flotation Tailings Pipeline
FTB Containment System
Hydrometallurgical Residue Pipeline
Plant Site
Treated Water Pipeline
Drainage Flow Direction

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

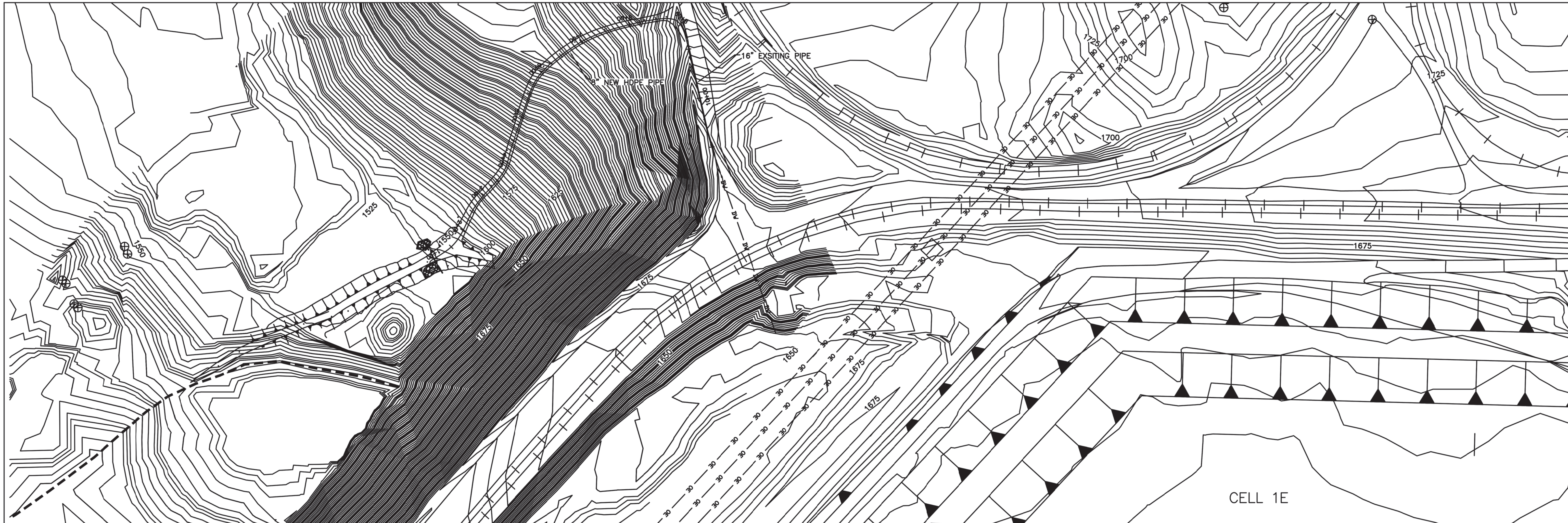
0 2,000 4,000
Feet

Large Figure 6
FLOTATION TAILINGS BASIN SEEPAGE CAPTURE SYSTEMS
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN

Attachments

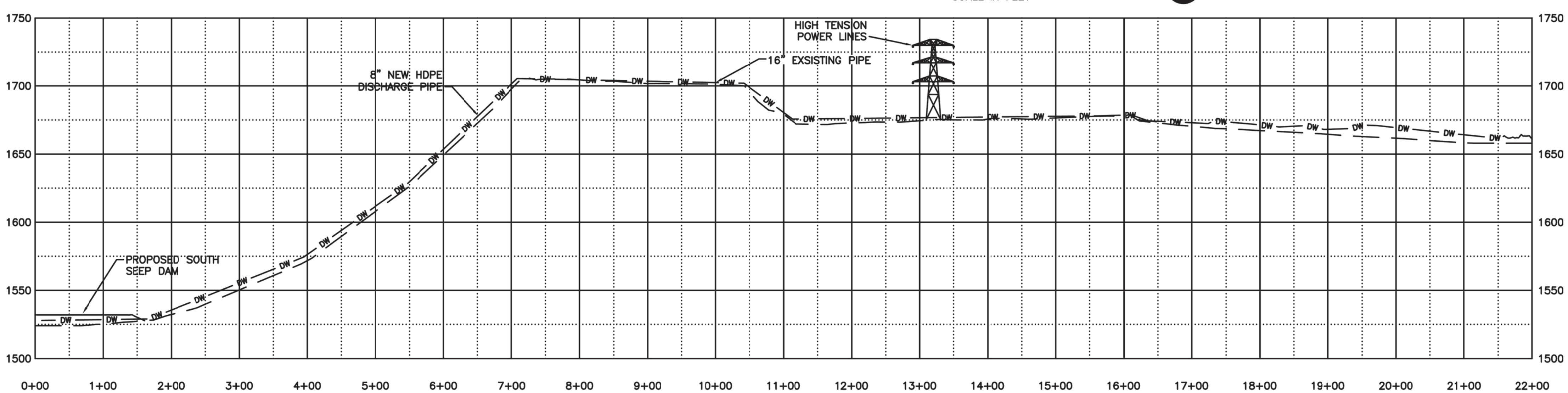
Attachment A

Seepage Management System Design Drawings



1 PLAN: CELL 1E SEEP PIPE ALIGNMENT

0 100 200
SCALE IN FEET



2 ELEVATION: CELL 1E SEEP PIPE PROFILE

0 100 200
HORZ. SCALE IN FEET

0 50 100
VERT. SCALE IN FEET

POLYMET DRAWING REVIEW	
☐ APPROVED	
☐ APPROVED AS NOTED	
☐ REVISE AND RESUBMIT	
BY:	DATE:

LEGEND:

EXISTING 25' MAJOR CONTOUR	EXISTING POWER POLES
EXISTING 5' MINOR CONTOUR	— DE — EXISTING POWER LINES
EXISTING RAILROAD TRACKS	— DW — SEEPAGE DISCHARGE PIPELINE
EXISTING ROADWAY	PROPOSED DIKE ALIGNMENT
— — — EXISTING TRAIL	

REV NO	DATE	REVISIONS	BY	CHKR
1	1/2013	SUMP LOCATION	DWH	–
–	–	–	–	–
–	–	–	–	–
–	–	–	–	–
–	–	–	–	–
–	–	–	–	–
–	–	–	–	–
–	–	–	–	–

DRAWING STATUS					
ISSUED	REV	DATE	SDE	PEM	
PRELIMINARY	–	–	–	–	
APPROVED FOR CONSTRUCTION	–	–	–	–	
NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED AND DATED. DESTROY ALL PRINTS BEARING EARLIER DATE AND/OR REV.NO.					

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: DH	DATE: 8/4/10
CHECKED: PB	DATE: 8/510
SCALE: –	
SHEET 1 OF 3	

TAILINGS BASIN CONSENT DCREE
TEMPORARY SEEPAGE COLLECTION SYSTEM
CELL 1E SEEP 026 – PLAN AND PROFILE

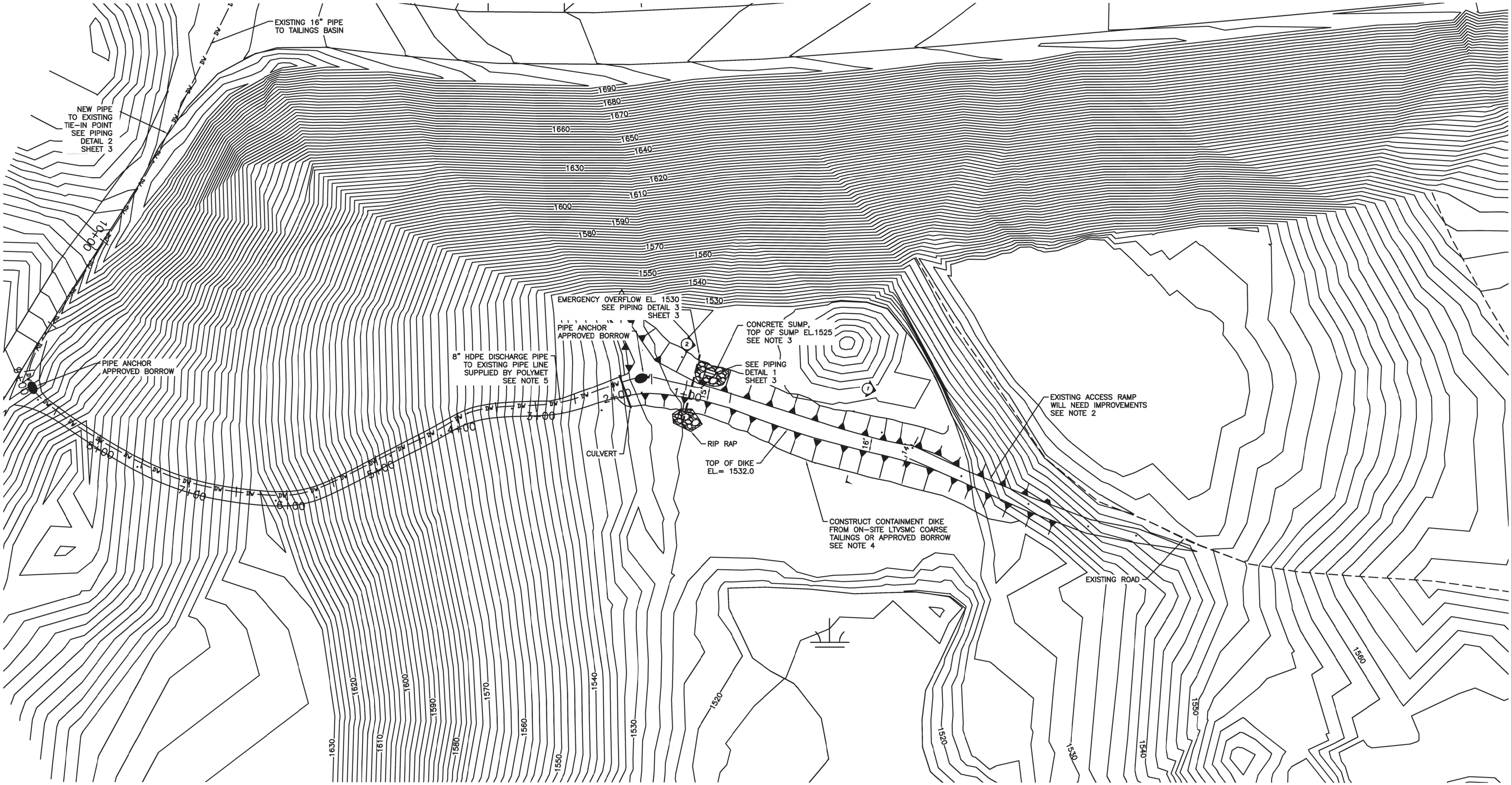
POLYMET MINING

POLYMET MINING INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

DWG. NO. TJ–2–001

REV 1

INCHES 1 2



NOTE:

1) ALL MECHANICAL HARDWARE, PIPING, AND ELECTRICAL COMPONENTS SUPPLIED BY POLYMET.
2) EXISTING ROAD AND RAMP HAS BEEN IMPROVED.
3) CONCRETE SUMP SUPPLIED BY POLYMET 2000 GAL. 156" X 81"X 60" DEEP
4) EXCAVATION REQUIRED TO LOCATE SUITABLE GROUND FROM WHICH TO BUILD DIKE.
5) 8" HDPE PIPE MUST HAVE A CONTIUOUS SLOPE OF ⅛" PER 12" TO ASSURE PROPER DRAINAGE.

1 PLAN: CELL 1E SEEP AREA DIKE LAYOUT

0 50 100
SCALE IN FEET

N

POLYMET DRAWING REVIEW	
☐ APPROVED	
☐ APPROVED AS NOTED	
☐ REVISE AND RESUBMIT	
BY:	DATE:

LEGEND:

- EXISTING 10' MAJOR CONTOUR
- EXISTING 2' MINOR CONTOUR
- EXISTING ROAD
- DW — NEW SEEPAGE DISCHARGE PIPELINE
- DW — EXISTING SEEPAGE DISCHARGE LINE

INCHES 1 2

REV NO	DATE	REVISIONS	BY	CHKR
1	1/2013	SUMP LOCATION AND DETAIL	DWH	–
–	–	–	–	–
–	–	–	–	–
–	–	–	–	–
–	–	–	–	–
–	–	–	–	–
–	–	–	–	–
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DRAWING STATUS					
ISSUED	REV	DATE	SDE	PEM
PRELIMINARY	–	–	–	–
APPROVED FOR CONSTRUCTION	–	–	–	–

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PRINTED NAME ______
DATE ______ REG. NO. ______

DRAWN: DH	DATE: 8/4/2010
CHECKED: PB	DATE: 8/5/2010
SCALE: –	
SHEET 2 OF 3	

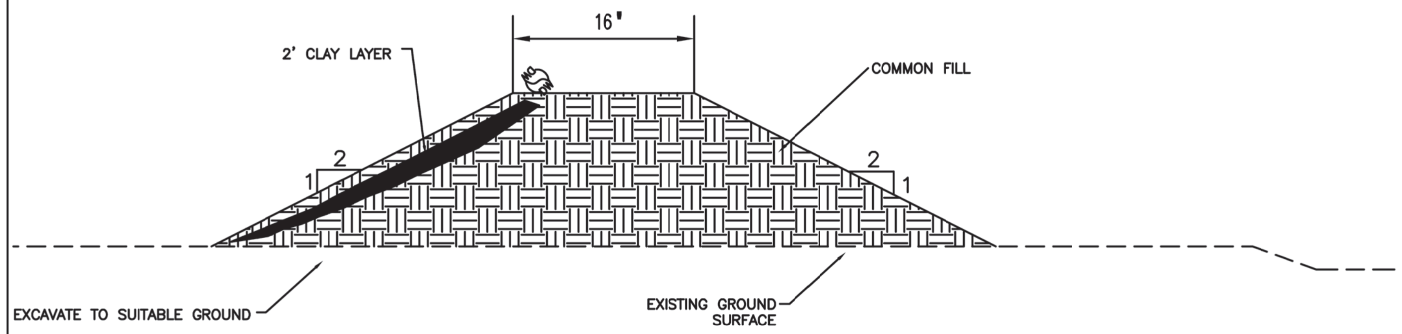
TAILINGS BASIN CONSENT DECREE TEMPORARY SEEPAGE COLLECTION SYSTEM

CELL 1E SEEP 026– DIKE LAYOUT

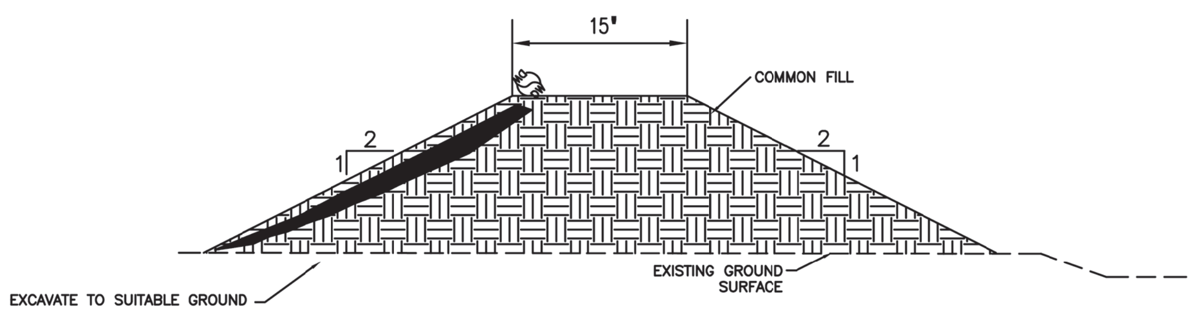
POLYMET MINING

POLYMET MINING INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

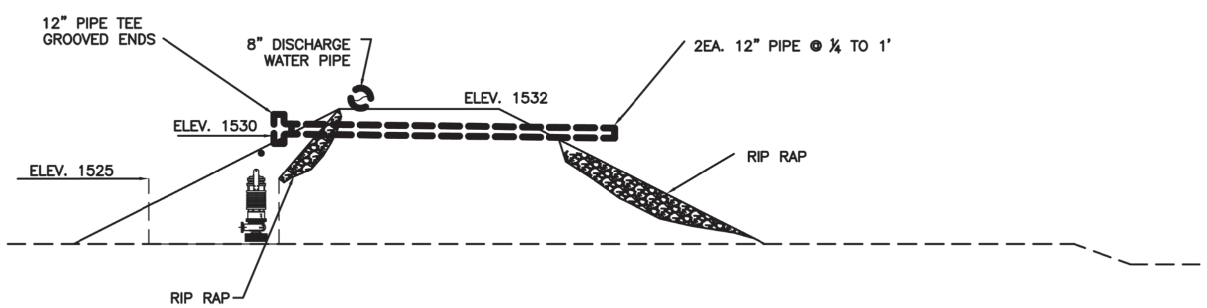
DWG. NO. TJ–2–001 REV 1



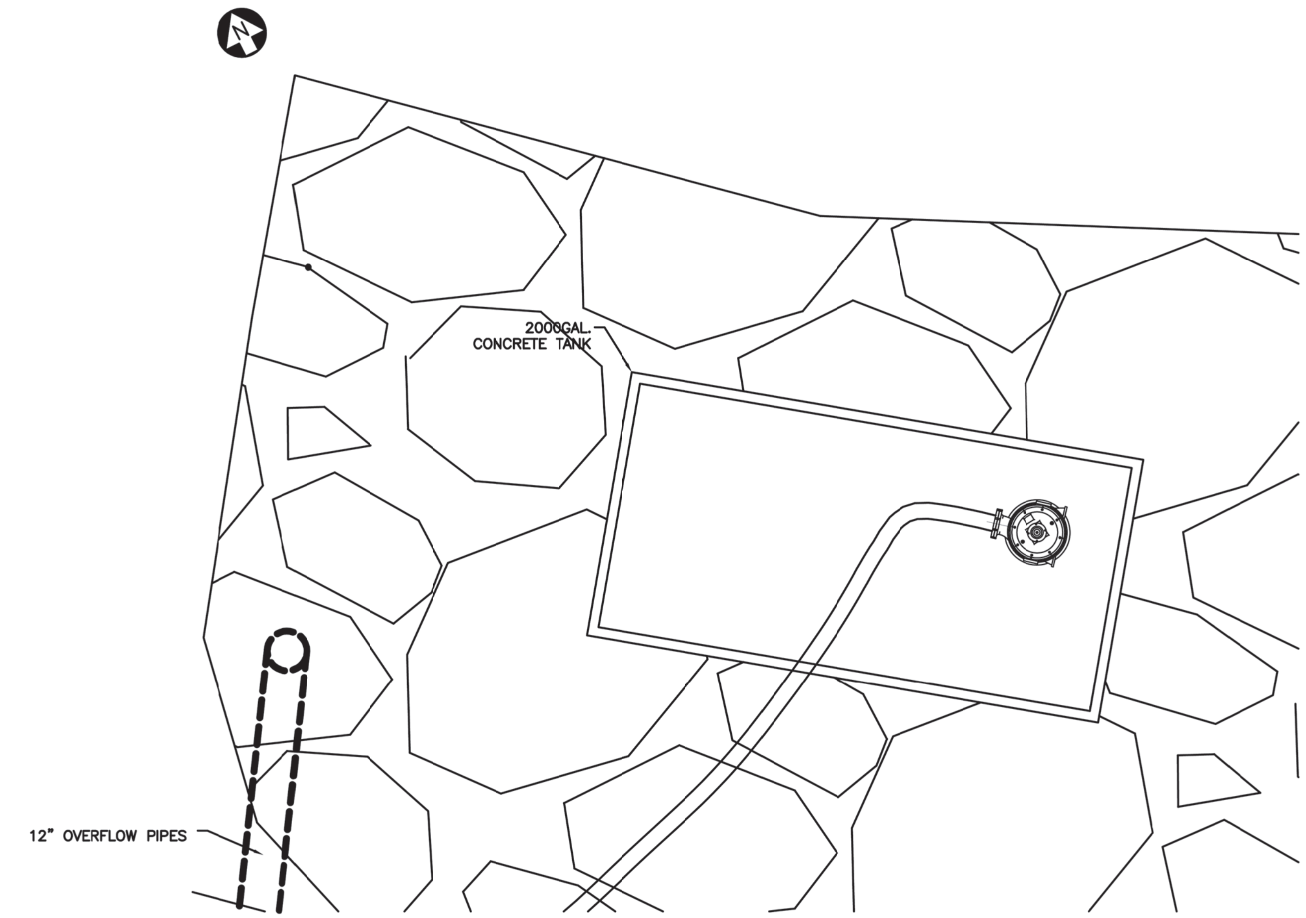
1 SH2 SECTION: DIKE



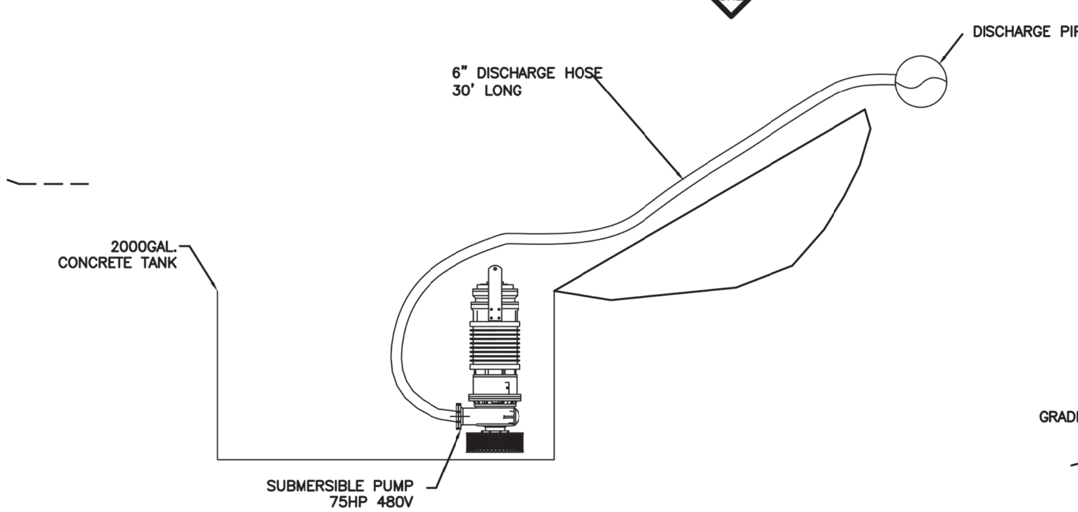
2 SH2 SECTION: DIKE



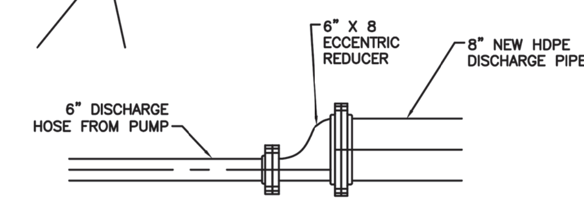
3 SH2 OVER FLOW DETAIL



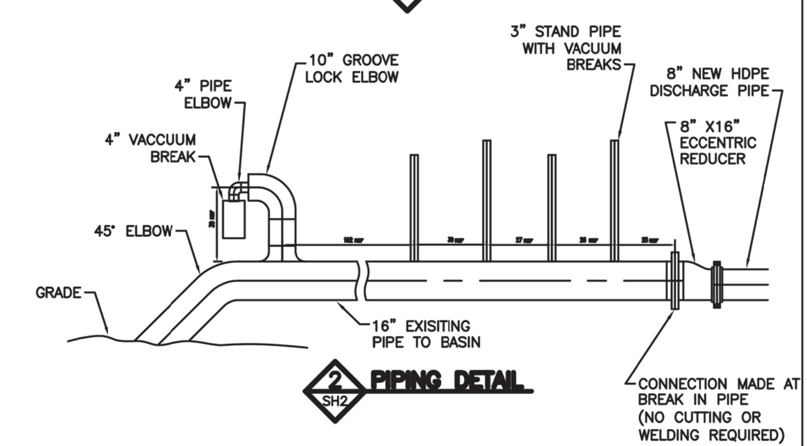
1 SH2 PIPING & SUMP DETAIL PLAN VIEW



1 SH2 PIPING & SUMP DETAIL ELEVATION VIEW



1 SH2 PIPING DETAIL



2 SH2 PIPING DETAIL

POLYMET DRAWING REVIEW	
☐ APPROVED	
☐ APPROVED AS NOTED	
☐ REVISE AND RESUBMIT	
BY:	DATE:

REV NO	DATE	REVISIONS	BY	CHKR
1	1/2013	SUMP DETAIL	DWH	–
–	–	–	–	–
–	–	–	–	–
–	–	–	–	–
–	–	–	–	–
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DRAWING STATUS					
ISSUED	REV	DATE	SDE	PEM	
PRELIMINARY	–	–	–	–	
APPROVED FOR CONSTRUCTION	–	–	–	–	

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CHECKED: PB	DATE: 8/5/2010
SCALE: –	
SHEET 3 OF 3	

TAILINGS BASIN CONSENT DCREE
TEMPORARY SEEPAGE COLLECTION SYSTEM
CELL 1E SEEP 026 – DETAILS

POLYMET MINING

POLYMET MINING INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

DWG. NO. TJ–2–001 REV 1

INCHES 1 2

Attachment B

FTB Seepage Containment and Stream Augmentation Systems Permit Application Support Drawings

Errata Sheet

Poly Met Mining Inc. NorthMet Project

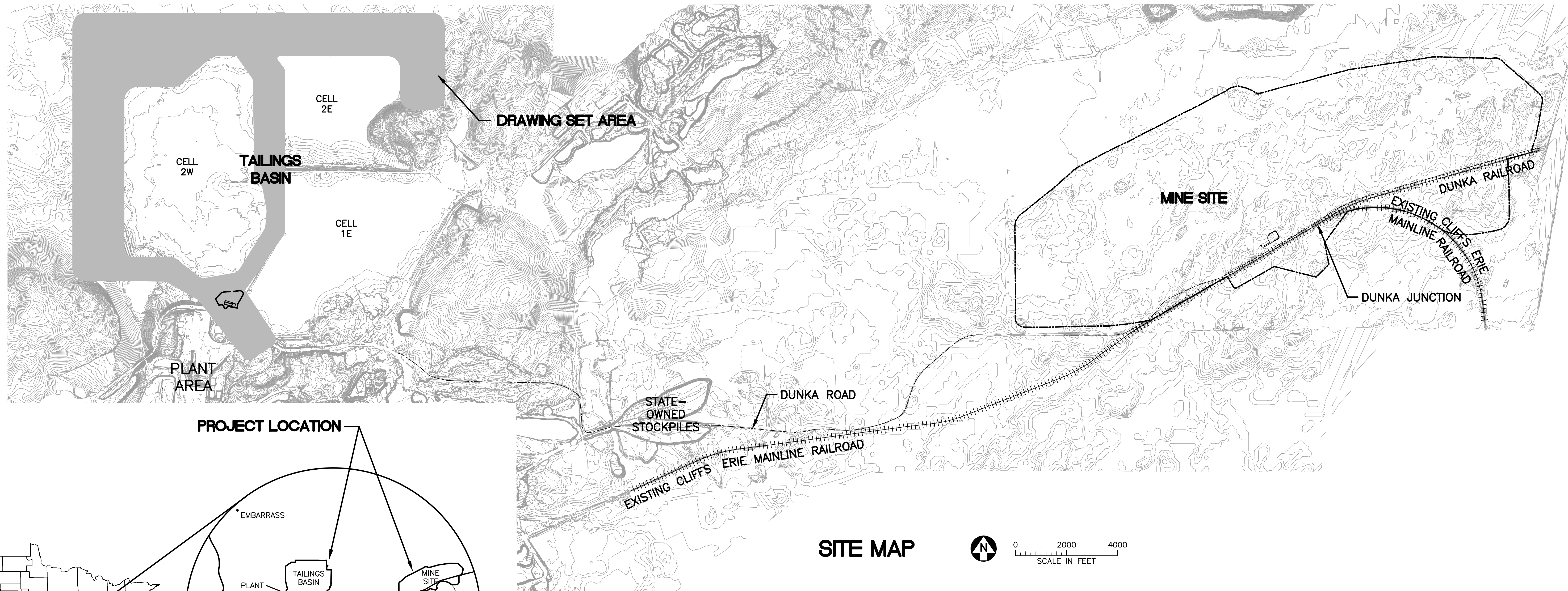
Permit Application Support Drawings: FTBCA

May 2016

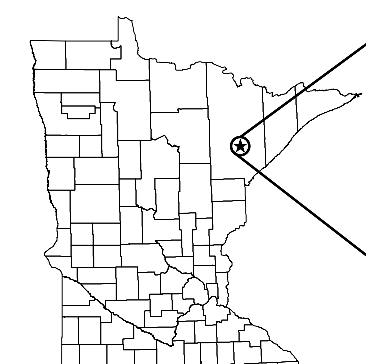
The table below lists changes that were identified during completion of the Construction Stormwater Pollution Prevention Plans (SWPPPs) and have not yet been incorporated in the attached permit application support drawings within this set. These changes and additional details developed during final design will be incorporated into the final design drawing set.

Drawing Sheet(s)	Change
Global change to all sheets, as needed	The terminology "stream augmentation" system as noted in these drawings has been changed to "surface water discharge" system.
FTBCA-013, FTBCA-015	The cross slope on the perimeter access road surface was revised so that it slopes entirely towards the FTB, instead of being crowned in the center.
FTBCA-013, FTBCA-015	To eliminate additional fill in wetlands, the monitoring wells located outside of the perimeter access road were moved to within the road embankment.
FTBCA-003, FTBCA-004	The alignment of the stream augmentation pipe was revised to a more optimal layout.

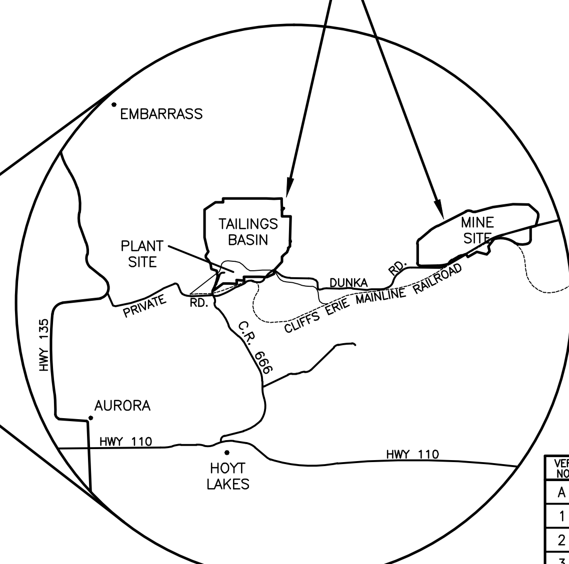
POLY MET MINING, INC. NORTHMET PROJECT
FTB SEEPAGE CONTAINMENT
AND STREAM AUGMENTATION SYSTEMS
HOYT LAKES, MINNESOTA



SITE MAP



LOCATION MAP
NOT TO SCALE



VICINITY MAP
NOT TO SCALE

VER NO	DATE	DESCRIPTION
A	09/28/12	WATER MANAGEMENT PLAN – PLANT– VERSION 2 – ATTACHEMENT B
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PRINTED NAME THOMAS J. RADUE
SIGNATURE Thomas J. Radue
DATE 5/28/15 LICENSE# 20951

DRAWN: BDP
CHECKED: DVS/AMP
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

FTB SEEPAGE CONTAINMENT
AND STREAM AUGMENTATION SYSTEMS
LOCATION MAP AND SITE MAP

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR
BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. FTBCA-001
REV

CADD USER: Terri J. Toms FILE: K:\DESIGN\23690C29.10\PERMIT_NMT-10-CU-001.DWG PLOT SCALE: 1:2 PLOT DATE: 6/9/2015 10:50 AM

INCHES 1 2

GENERAL LEGEND

- 1000 — EXISTING CONTOUR – MAJOR
- EXISTING CONTOUR – MINOR
- 1000 — PROPOSED CONTOUR – MAJOR
- PROPOSED CONTOUR – MINOR
- EXISTING POWER POLE
- EXISTING RAILROAD
- EXISTING ROAD
- EXISTING TRAIL
- EXISTING UNIMPROVED TRAIL
- EXISTING STRUCTURES
- TREE LINE
- WETLAND BOUNDARY
- EXISTING CULVERT
- P — EXISTING PIPELINE
- CUTOFF WALL ALIGNMENT
- OVERHEAD ELECTRIC
- SURFACE DRAINAGE
- PROPOSED DEWATERING PIPE
- PROPOSED DISCHARGE PIPELINE
- PROPOSED RETURN PIPELINE
- PROPOSED CULVERT (NON–MINE DRAINAGE)
- PROPOSED SEEPAGE COLLECTION DRAIN
- PROPOSED STORMWATER DRAIN
- PROPOSED MANHOLE
- PROPOSED RIP RAP
- ROTASONIC BORING
- ROTASONIC BORING WITH PIEZOMETER
- SPT BORING
- SPT BORING WITH PACKER
- (M) FLOW METER

ABBREVIATIONS

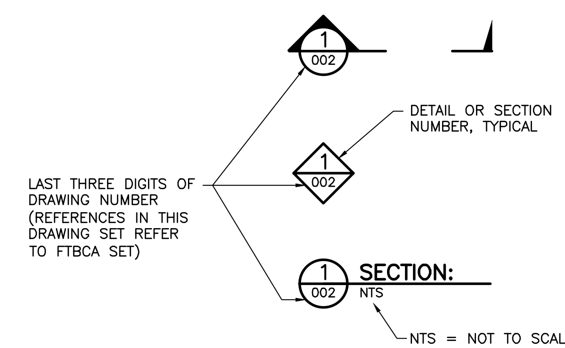
APPROX.	–	APPROXIMATE
CDSM	–	CEMENT DEEP SOIL MIX
CMP	–	CORRUGATED METAL PIPE
CPEP	–	CORRUGATED POLYETHYLENE PIPE
CY	–	CUBIC YARD
DR	–	DIMENSION RATIO
DWG	–	DRAWING
EL.	–	ELEVATION
ø	–	DIAMETER
FTB	–	FLOTATION TAILINGS BASIN
GCL	–	GEOSYNTHETIC CLAY LINER
HDPE	–	HIGH DENSITY POLYETHYLENE
HRF	–	HYDROMETALLURGICAL RESIDUE FACILITY
LDPE	–	LOW DENSITY POLYETHYLENE
LF	–	LINER FEET
LTVSMC	–	LTV STEEL MINING COMPANY
MCY	–	MILLION CUBIC YARDS
mil	–	one thousandth of an inch
MIN	–	MINIMUM
MSL	–	MEAN SEA LEVEL
NTS	–	NOT TO SCALE
SCH.	–	SCHEDULE
DR	–	DIMENSION RATIO
TYP	–	TYPICAL
N–MH–XX	–	NORTH SECTION MANHOLE
NW–MH–XX	–	NORTHWEST SECTION MANHOLE
W–MH–XX	–	WEST SECTION MANHOLE
N–MH/PS–XX	–	NORTH SECTION MANHOLE/PUMP STATION
NW–MH/PS–XX	–	NORTHWEST SECTION MANHOLE
W–MH/PS–XX	–	WEST SECTION MANHOLE/PUMP STATION

SHEET INDEX

SHEET NO. TITLE

GENERAL DRAWINGS

DRAWING NUMBERING



NOTES

1. COORDINATE SYSTEM IS MINNESOTA STATE PLANE NORTH ZONE, NAD83.
2. ELEVATIONS ARE MEAN SEA LEVEL (MSL), NAVD88.
3. EXISTING TOPOGRAPHIC INFORMATION SHOWN ON THE DRAWINGS WAS PREPARED BY AEROMETRIC, INC. FROM LIDAR DATA COLLECTED ON MARCH 17, 2010.
4. EXISTING TOPOGRAPHIC INFORMATION WAS UPDATED FOR AREAS SOUTH EAST OF COAL ASH LANDFILL AND EAST OF OUTCROP BETWEEN CELLS 1E AND 2E USING CONTOURS FROM DATA COLLECTED IN 1999.

VER NO	DATE	DESCRIPTION
A	09/28/12	WATER MANAGEMENT PLAN – PLANT– VERSION 2 – ATTACHEMENT B
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ISSUE STATUS		
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SIGNATURE Thomas J. Radue
DATE 5/28/15 LICENSE# 20951

DRAWN: BDP
CHECKED: DVS/AMP
BARR PROJECT NO.: 23/69–0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

FTB SEEPAGE CONTAINMENT AND STREAM AUGMENTATION SYSTEMS
LEGEND AND SHEET INDEX

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR
BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1–800–632–2277

DWG. NO. FTBCA–002
REV

CADD USER: Adepluser FILE: \\PWEDINA\EDINA PW\EDINA PW IN\1863E0E6-BFF8-4ADD-A31A-2092BF300E7C\E4EAB35-1D90-4541-8216-9587DC37BB78\PERMIT_NMT-10-CU-002.DWG PLOT SCALE: 1:2 PLOT DATE: 6/8/2015 4:49 PM

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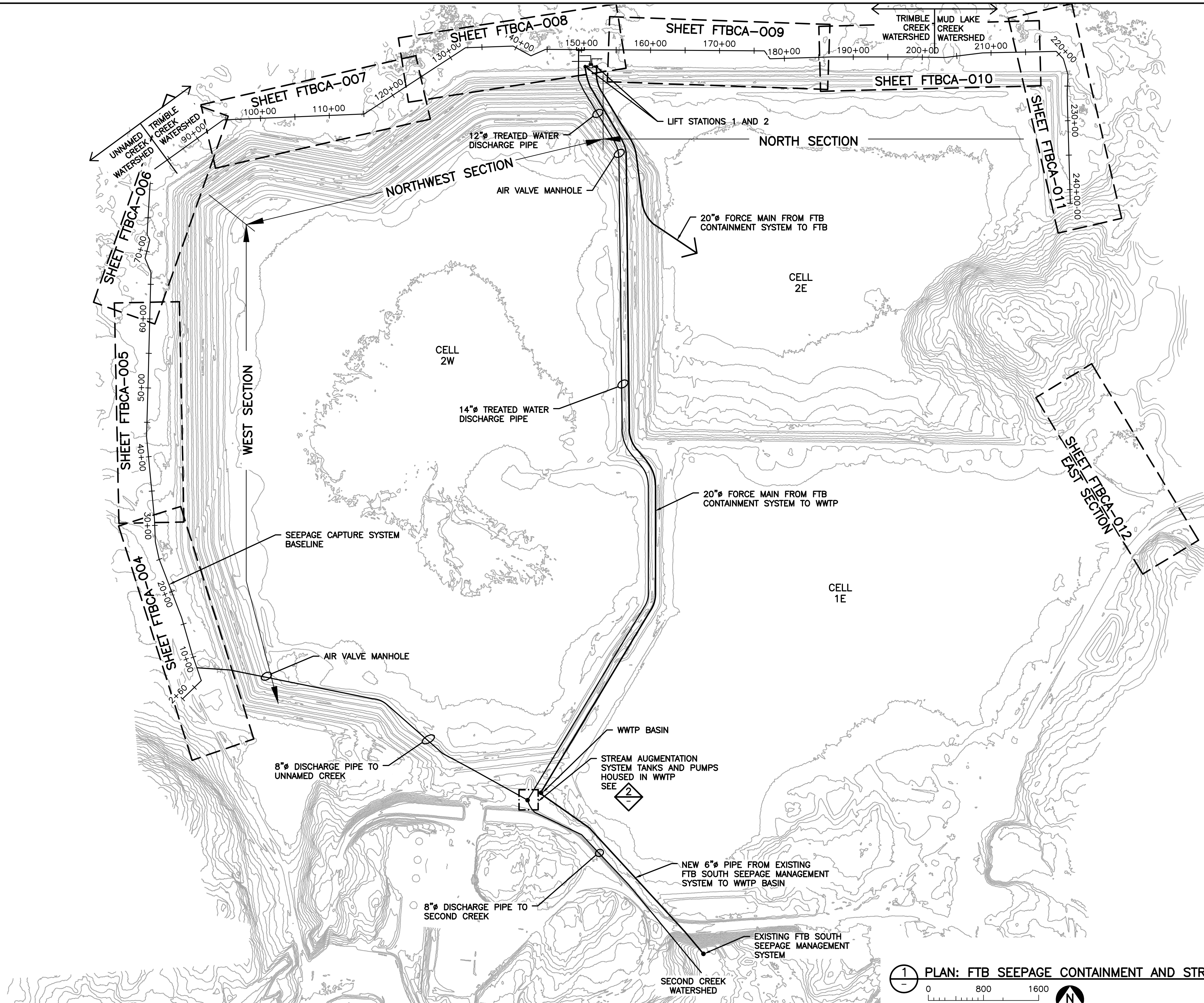

1 — PLAN: FTB SEEPAGE CONTAINMENT AND STREAM AUGMENTATION LAYOUT

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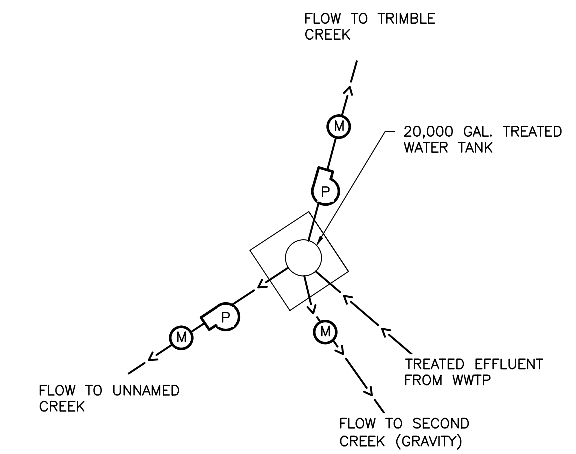

2 — DETAIL: CONCEPTUAL STREAM AUGMENTATION SYSTEM SUPPLY
NOT TO SCALE

NOTES

1. SEEPAGE CAPTURE SYSTEMS INCLUDE THE FTB CONTAINMENT SYSTEM ALONG THE WEST, NORTH AND EAST SIDES OF THE FTB, THE SOUTH SEEPAGE MANAGEMENT SYSTEM ON THE SOUTH SIDE OF THE FTB AND CONVEYANCE TO THE WWTP EQUALIZATION BASIN.
2. STREAM AUGMENTATION SYSTEM INCLUDES TREATED WATER CONVEYANCE AND DISCHARGE TO UNNAMED CREEK, TRIMBLE CREEK, AND SECOND CREEK WATERSHEDS.
3. FTB SEEPAGE CONTAINMENT AND STREAM AUGMENTATION SYSTEMS DESIGN REFERENCE BASELINE SHOWN ON THIS SHEET. SEE SUBSEQUENT SHEETS FOR PROPOSED LAYOUT OF SYSTEMS ALONG BASELINE.

VER NO	DATE	DESCRIPTION
A	09/28/12	WATER MANAGEMENT PLAN – PLANT– VERSION 2 – ATTACHEMENT B
1	09/09/14	WATER MANAGEMENT PLAN – PLANT– VERSION 3 – ATTACHEMENT B
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SIGNATURE Thomas J. Radue
DATE 5/28/15 LICENSE# 20951

DRAWN: BDP
CHECKED: DVS
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

FTB SEEPAGE CONTAINMENT AND STREAM AUGMENTATION SYSTEMS PLAN SHEET LAYOUT

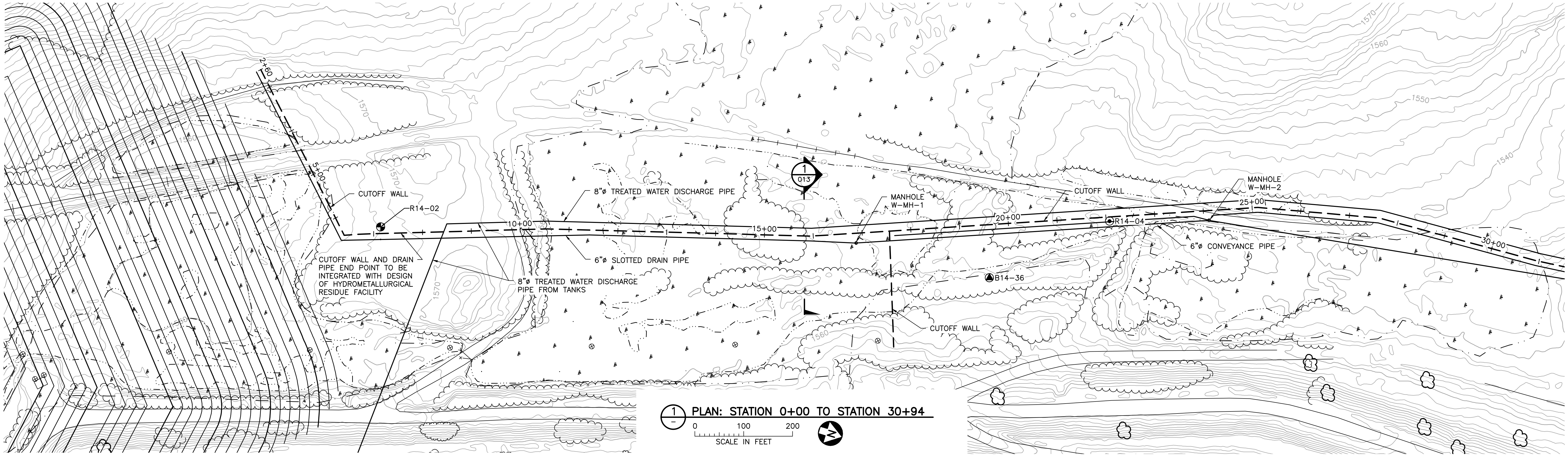
POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

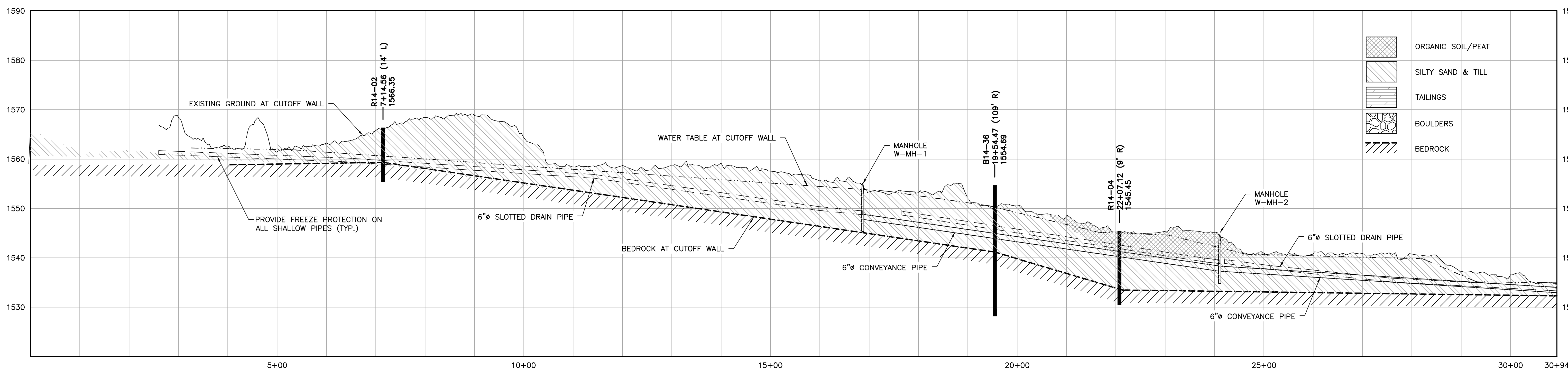
DWG. NO. FTBCA-003

REV



1 PLAN: STATION 0+00 TO STATION 30+94

0 100 200 SCALE IN FEET



2 PROFILE: STATION 0+00 TO STATION 30+94

0 100 200 SCALE IN FEET HORIZONTAL — 0 10 20 SCALE IN FEET VERTICAL

NOTES:

1. HORIZONTAL LOCATION OF FORCE MAIN, SEEPAGE CONVEYANCE PIPES AND STREAM AUGMENTATION PIPES/DISCHARGE POINTS ON THIS SHEET AND SUBSEQUENT SHEETS SHOWN FOR CLARITY. ACTUAL LOCATION TO BE DETERMINED DURING FINAL DESIGN.
2. MANHOLE LOCATIONS ON THIS SHEET AND SUBSEQUENT SHEETS ARE PRELIMINARY.
3. ACCESS ROAD NOT SHOWN ON THIS SHEET AND SUBSEQUENT SHEETS.
4. TREATED WATER DISCHARGE PIPES NOT SHOWN IN PROFILE ON THIS SHEET AND SUBSEQUENT SHEETS.
5. WATER TABLE ELEVATIONS ARE ESTIMATED BASED ON PIEZOMETERS, BORING LOGS, SOIL TYPES AND AERIAL PHOTOGRAPHY.
6. GROUND SURFACE ELEVATIONS ARE BASED ON 2010 LIDAR DATA (NAVD88). BORING ELEVATIONS SHOWN ARE BASED ON 2010 LIDAR DATA (NAVD88) ADJUSTED AFTER GEOTECHNICAL EXPLORATION (03-11-2014 THRU 05-20-2014). STRATIGRAPHY AND WATER TABLES ARE BASED ON THE 2014 FIELD INVESTIGATION LOGS.
7. BORING LOCATION OFFSETS FROM PROPOSED CUTOFF WALL ALIGNMENT ARE SHOWN. SUBSURFACE CONDITIONS ON WALL ALIGNMENT WILL DIFFER FROM THOSE SHOWN.
8. AREAS OF COBBLES AND BOULDERS BETWEEN BORING LOCATIONS AND ADJACENT BORING LOCATIONS SHOULD BE ASSUMED TO EXIST.

VER NO	DATE	DESCRIPTION
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DRAWN: BJH
CHECKED: DVS/AMP
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

FTB SEEPAGE CONTAINMENT AND STREAM AUGMENTATION SYSTEMS PLAN & PROFILE STATION 0+00 TO 30+94

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. FTBCA-004

REV

CADD USER: Terri J. Toms FILE: K:\DESIGN\23690C29.10\PERMIT_NMT-10-CU-004.DWG PLOT SCALE: 1:2 PLOT DATE: 6/9/2015 10:55 AM

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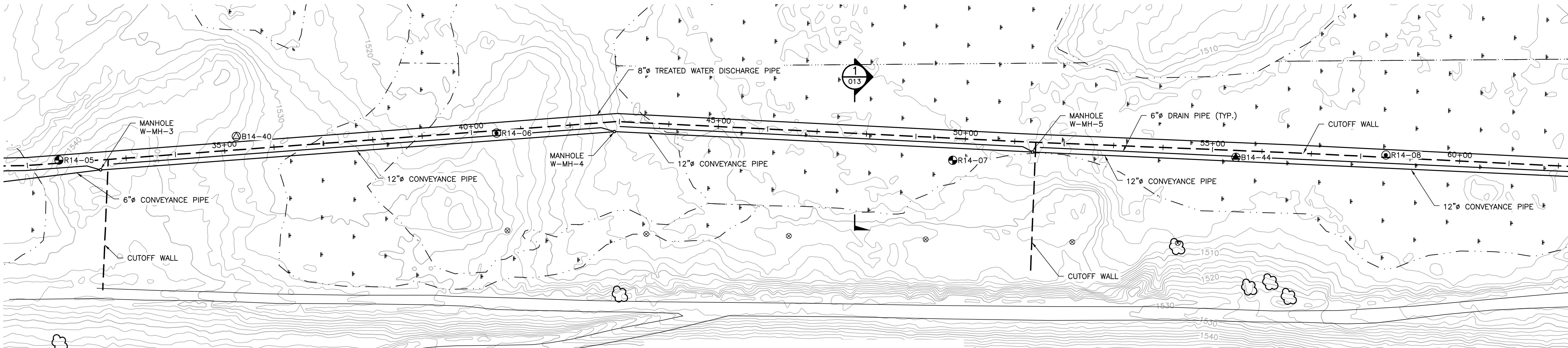
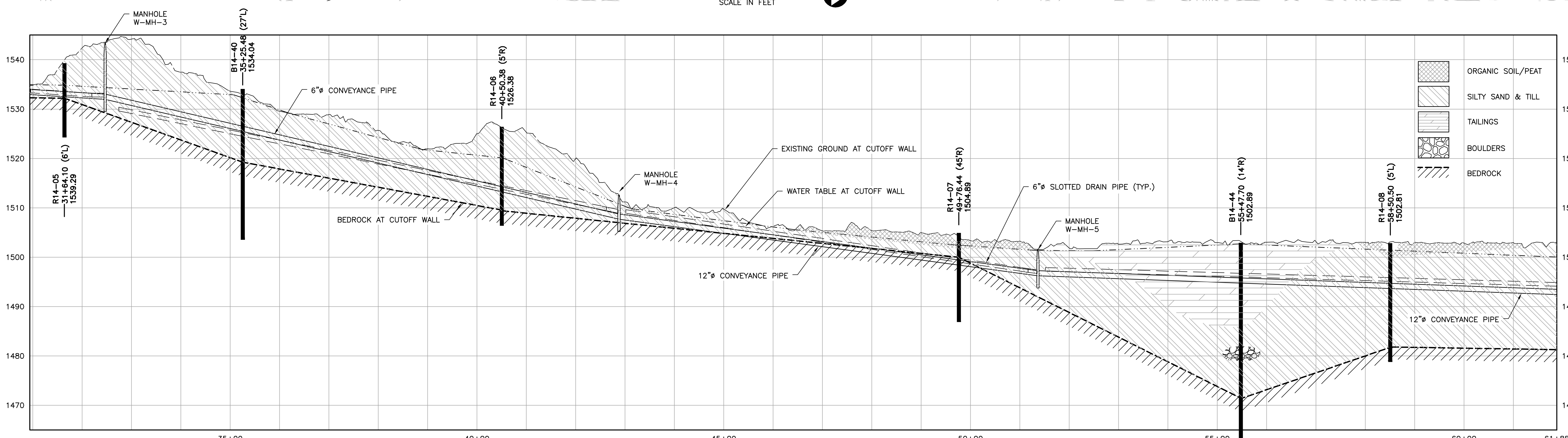


1 PLAN: STATION 30+94 TO STATION 61+88

0 100 200 SCALE IN FEET



2 PROFILE: STATION 30+94 TO STATION 61+88

0 100 200 SCALE IN FEET HORIZONTAL

0 10 20 SCALE IN FEET VERTICAL

VER NO	DATE	DESCRIPTION
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SCALE: AS SHOWN

PLANT DRAWING NUMBER:

FTB SEEPAGE CONTAINMENT AND STREAM AUGMENTATION SYSTEMS
PLAN & PROFILE STATION 30+94 TO 61+88

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. FTBCA-005

REV

CADD USER: Adeptuser FILE: \\PWEDINA\EDINA PW\EDINA PW IN\1863E0E6-BFF8-4AD0-A31A-2092BF3D0E7C\17A78CE8-2DEB-4404-9082-D9BFF2434068\PERMIT_NMT-10-CU-005.DWG PLOT SCALE: 1:2 PLOT DATE: 6/8/2015 4:58 PM

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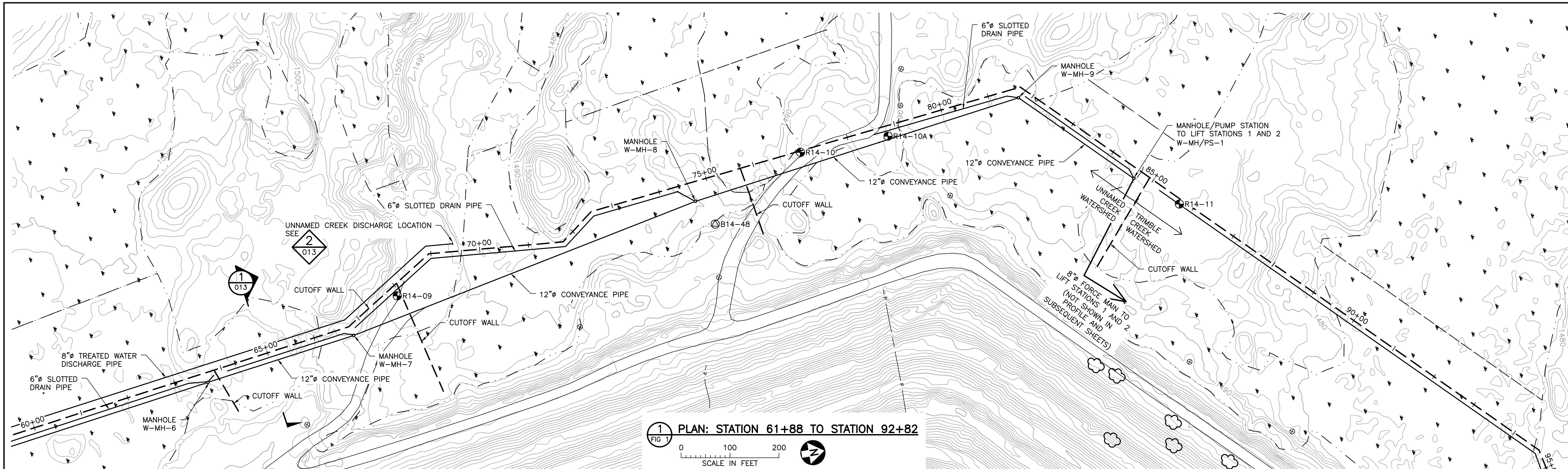
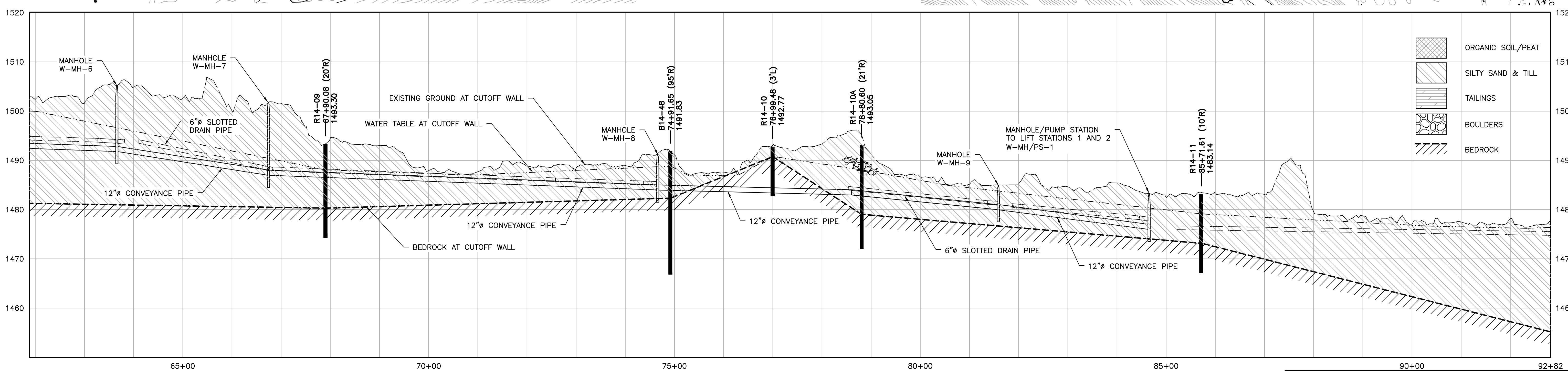


1 PLAN: STATION 61+88 TO STATION 92+82 (FIG 1)



2 PROFILE: STATION 61+88 TO STATION 92+82

0 100 200 SCALE IN FEET HORIZONTAL — 0 10 20 SCALE IN FEET VERTICAL

PLANT DRAWING NUMBER:

FTB SEEPAGE CONTAINMENT AND STREAM AUGMENTATION SYSTEMS
PLAN & PROFILE STATION 61+88 TO 92+82

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

VER NO	DATE	DESCRIPTION
A	09/28/12	WATER MANAGEMENT PLAN – PLANT– VERSION 2 – ATTACHEMENT B
1	09/09/14	WATER MANAGEMENT PLAN – PLANT– VERSION 3 – ATTACHEMENT B
2	12/31/14	WATER MANAGEMENT PLAN – PLANT– VERSION 3,4 – ATTACHEMENT B
3	5/28/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS

ISSUE STATUS	ISSUED VERSION	DATE
FOR PERMITTING	3	5/28/15
FOR CONSTRUCTION	–	–
NOT APPROVED FOR CONSTRUCTION.		

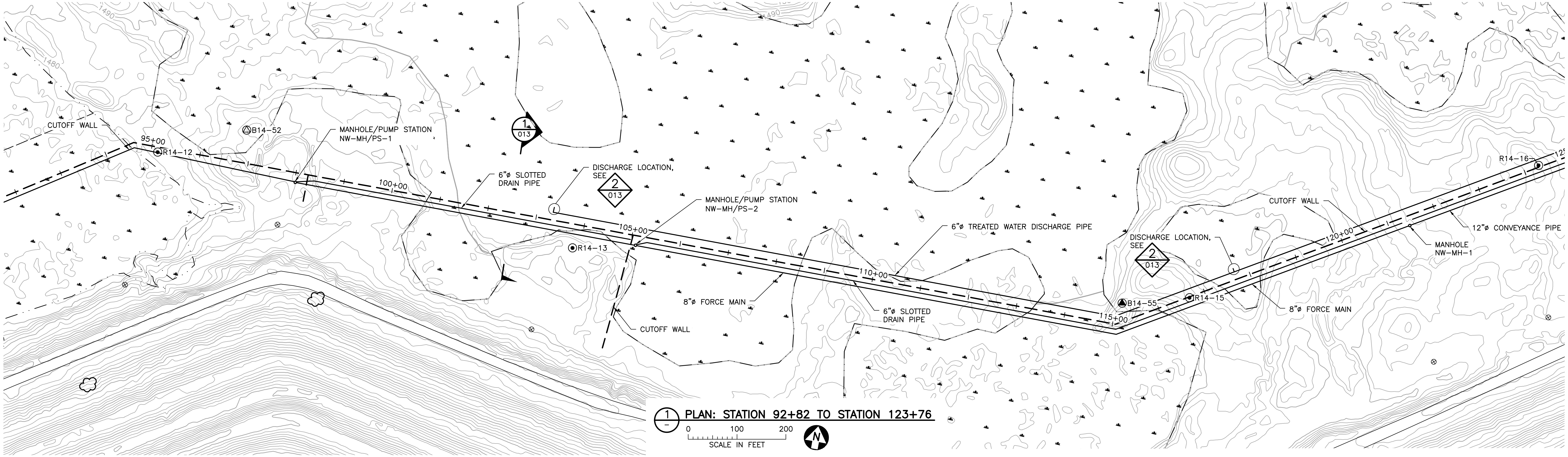
I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

PRINTED NAME THOMAS J. RADUE
SIGNATURE Thomas J. Radue
DATE 5/28/15 LICENSE# 20951

DRAWN: BJH
CHECKED: DVS/AMP
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN
DWG. NO. FTBCA-006
REV

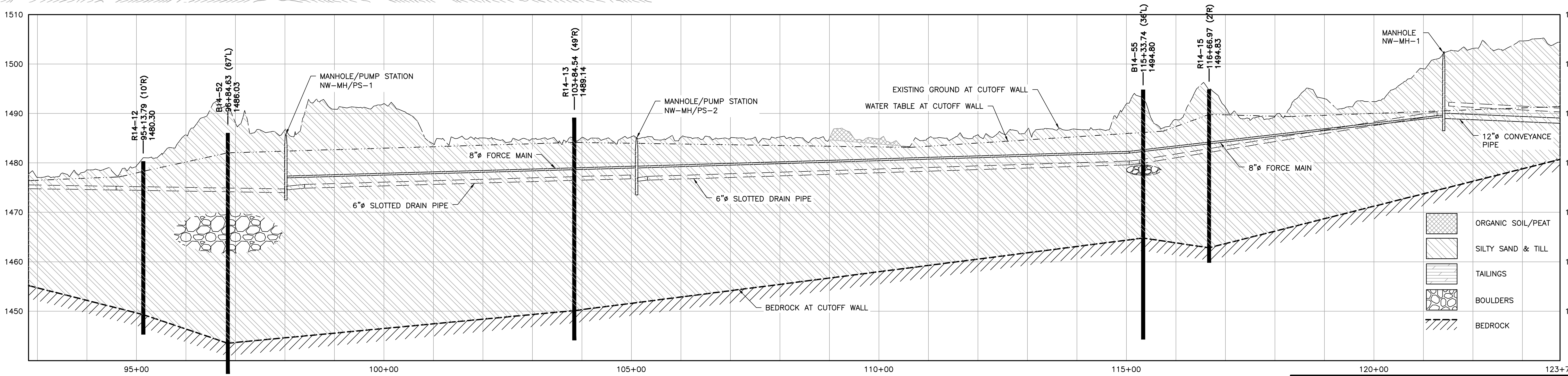
CADD USER: Adeptuser FILE: \\PWEDINA\EDINA PW\EDINA PW IN\1863E0E6-BFF8-4AD0-A31A-2092BF3D0E7C\31FA4041-28C0-4E0B-93B4-06AFA11A4A5A8\PERMIT_NMT-10-CU-006.DWG PLOT SCALE: 1:2 PLOT DATE: 6/8/2015 5:00 PM

INCHES 1 2



1 PLAN: STATION 92+82 TO STATION 123+76

0 100 200 SCALE IN FEET



2 PROFILE: STATION 92+82 TO STATION 123+76

0 100 200 SCALE IN FEET HORIZONTAL

0 10 20 SCALE IN FEET VERTICAL

PLANT DRAWING NUMBER:

FTB SEEPAGE CONTAINMENT AND STREAM AUGMENTATION SYSTEMS PLAN & PROFILE STATION 92+82 TO 123+76

VER NO	DATE	DESCRIPTION
A	09/28/12	WATER MANAGEMENT PLAN – PLANT– VERSION 2 – ATTACHEMENT B
1	09/09/14	WATER MANAGEMENT PLAN – PLANT– VERSION 3 – ATTACHEMENT B
2	12/31/14	WATER MANAGEMENT PLAN – PLANT– VERSION 3,4 – ATTACHEMENT B
3	5/28/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS

ISSUE STATUS		
ISSUED	VERSION	DATE
FOR PERMITTING	3	5/28/15
FOR CONSTRUCTION	–	–

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PRINTED NAME THOMAS J. RADUE

SIGNATURE Thomas J. Radue

DATE 5/28/15 LICENSE# 20951

DRAWN: BJH

CHECKED: DVS/AMP

BARR PROJECT NO.: 23/69-0C29

SCALE: AS SHOWN

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

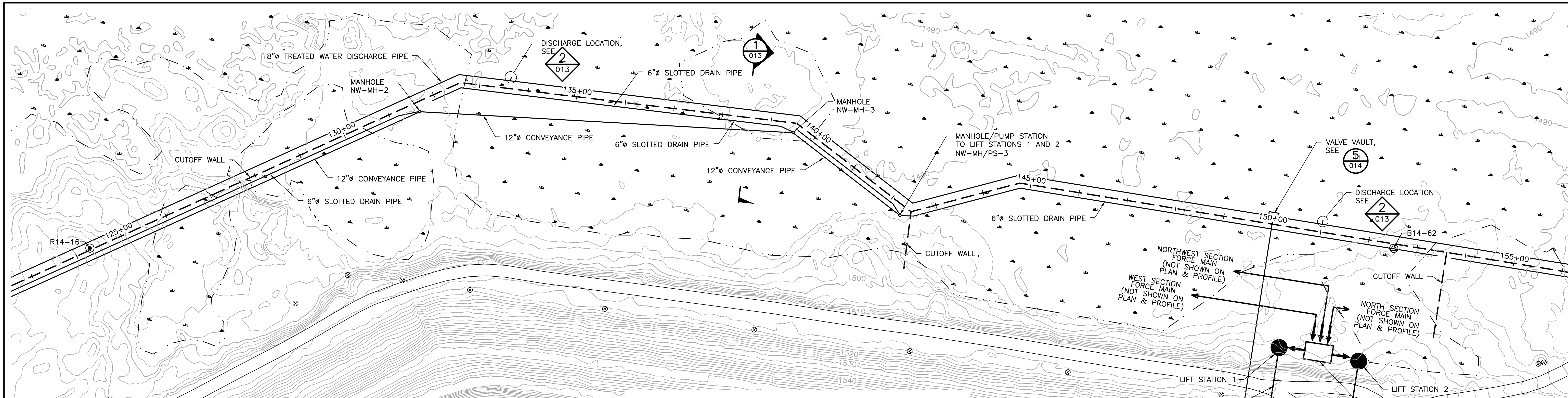
BARR

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. FTBCA-007

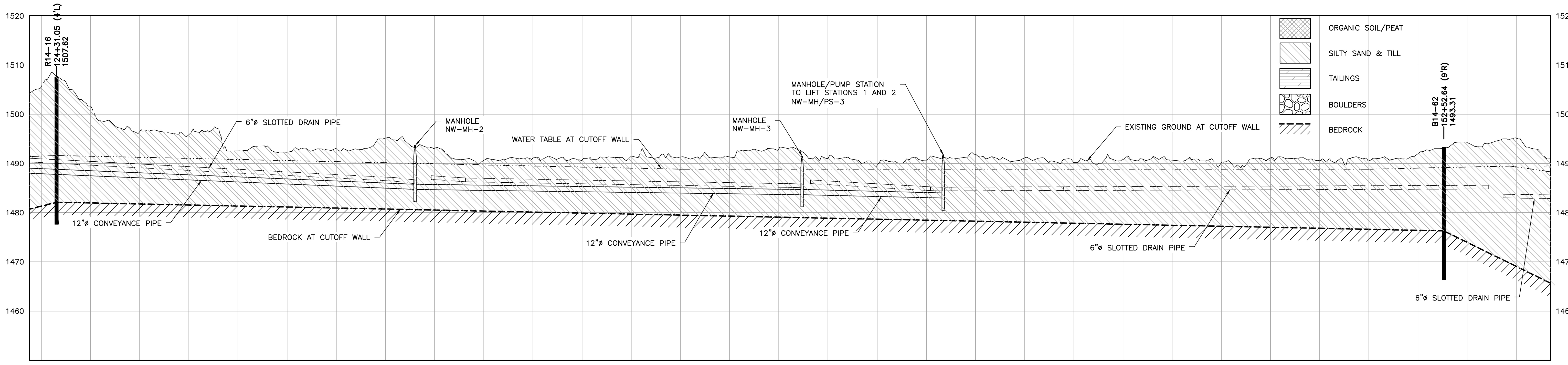
REV

INCHES 1 2



1 PLAN: STATION 123+76 TO STATION 154+70

0 100 200 SCALE IN FEET



2 PROFILE: STATION 123+76 TO STATION 154+70

0 100 200 SCALE IN FEET HORIZONTAL

0 10 20 SCALE IN FEET VERTICAL

PLANT DRAWING NUMBER:

FTB SEEPAGE CONTAINMENT AND STREAM AUGMENTATION SYSTEMS
PLAN & PROFILE STATION 123+76 TO 154+70

VER NO	DATE	DESCRIPTION
A	09/28/12	WATER MANAGEMENT PLAN – PLANT– VERSION 2 – ATTACHEMENT B
1	09/09/14	WATER MANAGEMENT PLAN – PLANT– VERSION 3 – ATTACHEMENT B
2	12/31/14	WATER MANAGEMENT PLAN – PLANT– VERSION 3,4 – ATTACHEMENT B
3	5/28/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS

ISSUE STATUS		
ISSUED	VERSION	DATE
FOR PERMITTING	3	5/28/15
FOR CONSTRUCTION	–	–

NOT APPROVED FOR CONSTRUCTION.

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PRINTED NAME THOMAS J. RADUE
SIGNATURE Thomas J. Radue
DATE 5/28/15 LICENSE# 20951

DRAWN: BJH
CHECKED: DVS/AMP
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

POLYMET MINING

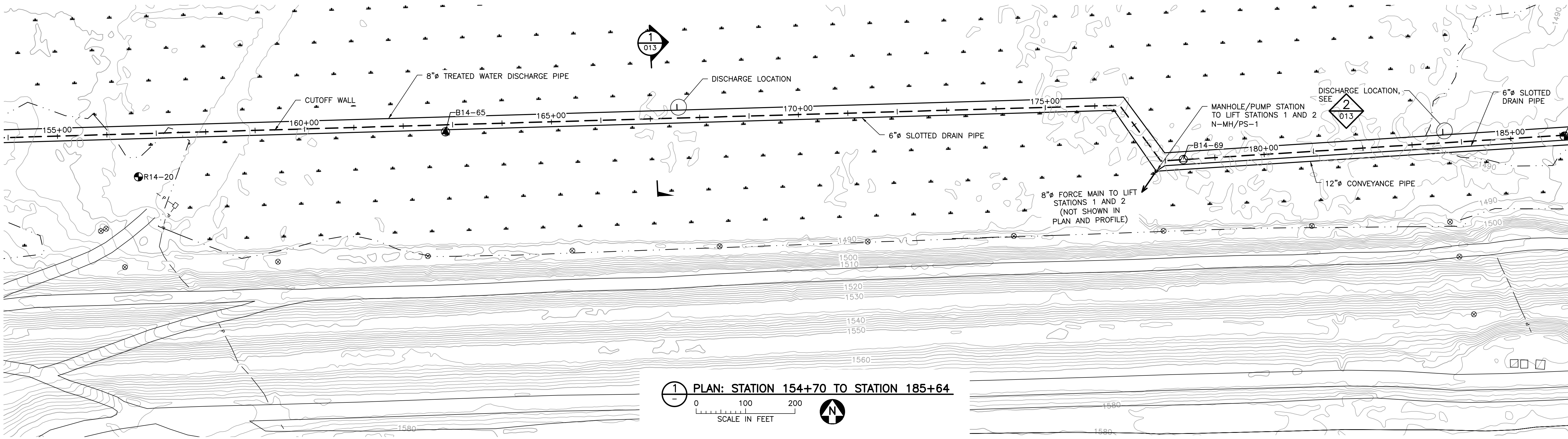
POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. FTBCA-008

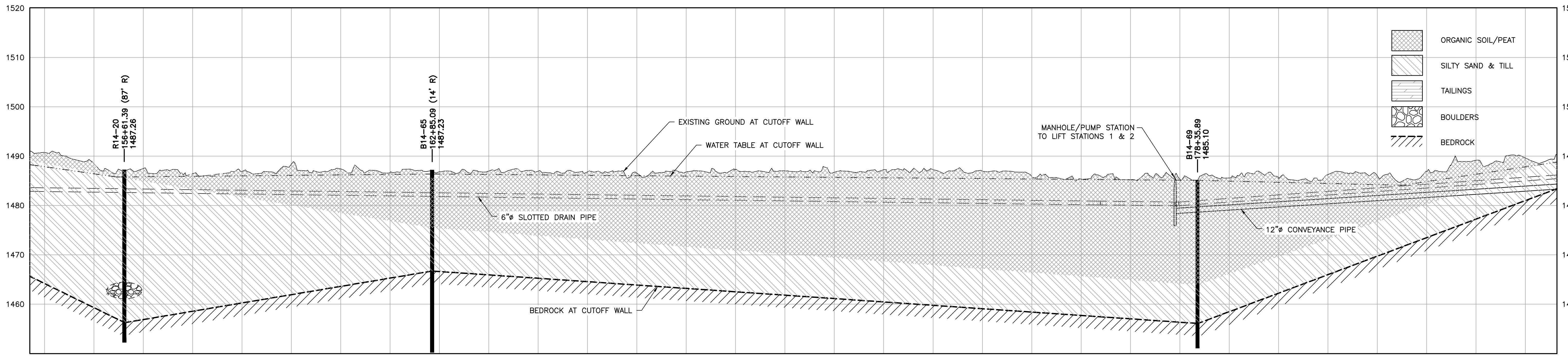
REV

INCHES 1 2



1/– PLAN: STATION 154+70 TO STATION 185+64

0 100 200 SCALE IN FEET



2/– PROFILE: STATION 154+70 TO STATION 185+64

0 100 200 SCALE IN FEET HORIZONTAL

0 10 20 SCALE IN FEET VERTICAL

VER NO	DATE	DESCRIPTION
A	09/28/12	WATER MANAGEMENT PLAN – PLANT– VERSION 2 – ATTACHEMENT B
1	09/09/14	WATER MANAGEMENT PLAN – PLANT– VERSION 3 – ATTACHEMENT B
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3	5/28/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS

ISSUE STATUS			
	ISSUED	VERSION	DATE
	FOR PERMITTING	3	5/28/15
	FOR CONSTRUCTION	–	–

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PRINTED NAME THOMAS J. RADUE
SIGNATURE Thomas J. Radue
DATE 5/28/15 LICENSE# 20951

DRAWN: BJH
CHECKED: DVS/AMP
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

FTB SEEPAGE CONTAINMENT AND STREAM AUGMENTATION SYSTEMS PLAN & PROFILE STATION 154+70 TO 185+64

POLYMET MINING

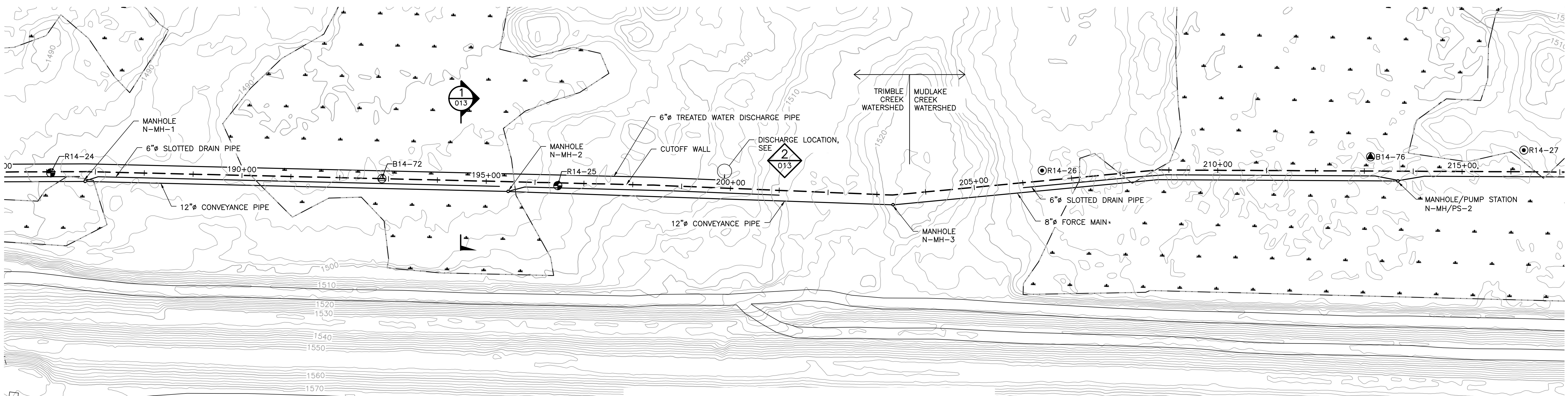
POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. FTBCA-009

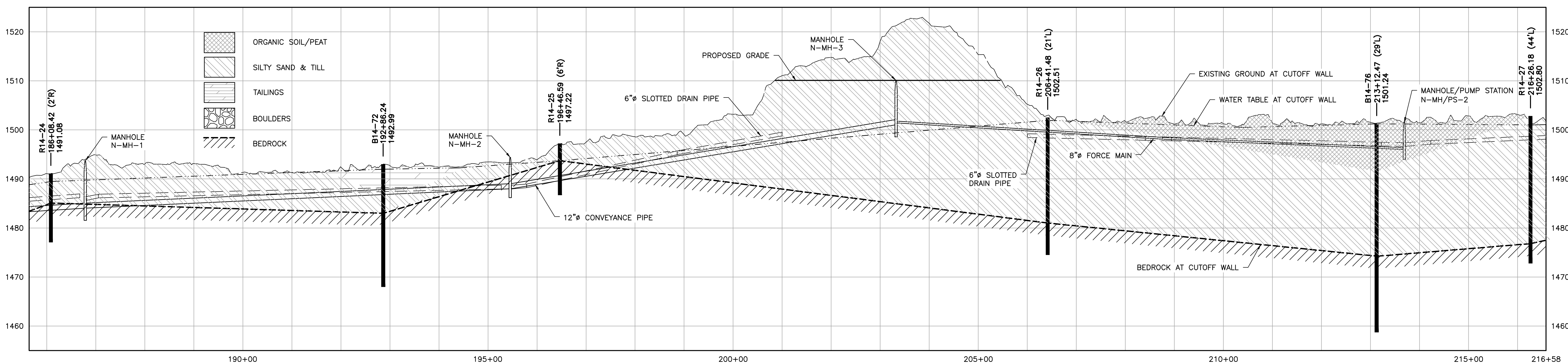
REV

INCHES 1 2



1 PLAN: STATION 185+64 TO STATION 216+58

SCALE IN FEET: 0 100 200



2 PROFILE: STATION 185+64 TO STATION 216+58

SCALE IN FEET HORIZONTAL: 0 100 200

SCALE IN FEET VERTICAL: 0 10 20

VER NO	DATE	DESCRIPTION
A	09/28/12	WATER MANAGEMENT PLAN – PLANT– VERSION 2 – ATTACHEMENT B
1	09/09/14	WATER MANAGEMENT PLAN – PLANT– VERSION 3 – ATTACHEMENT B
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3	5/28/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS

ISSUE STATUS		
ISSUED	VERSION	DATE
FOR PERMITTING	3	5/28/15
FOR CONSTRUCTION	–	–

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PRINTED NAME THOMAS J. RADUE

SIGNATURE Thomas J. Radue

DATE 5/28/15 LICENSE# 20951

DRAWN: BJH

CHECKED: DVS/AMP

BARR PROJECT NO.: 23/69-0C29

SCALE: AS SHOWN

PLANT DRAWING NUMBER:

FTB SEEPAGE CONTAINMENT AND STREAM AUGMENTATION SYSTEMS PLAN & PROFILE STATION 185+64 TO 216+58

POLYMET MINING

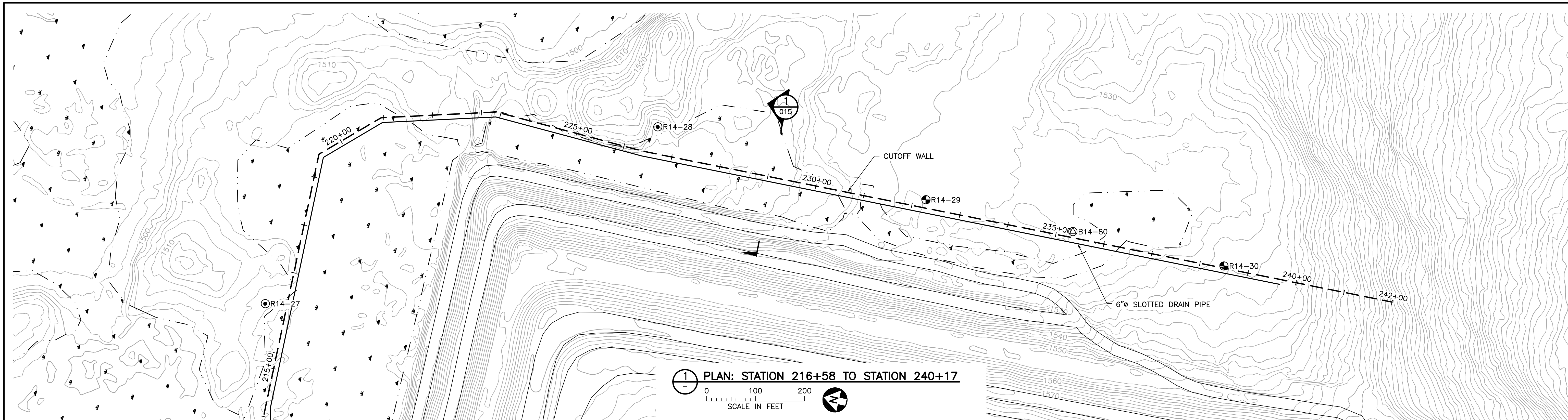
POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

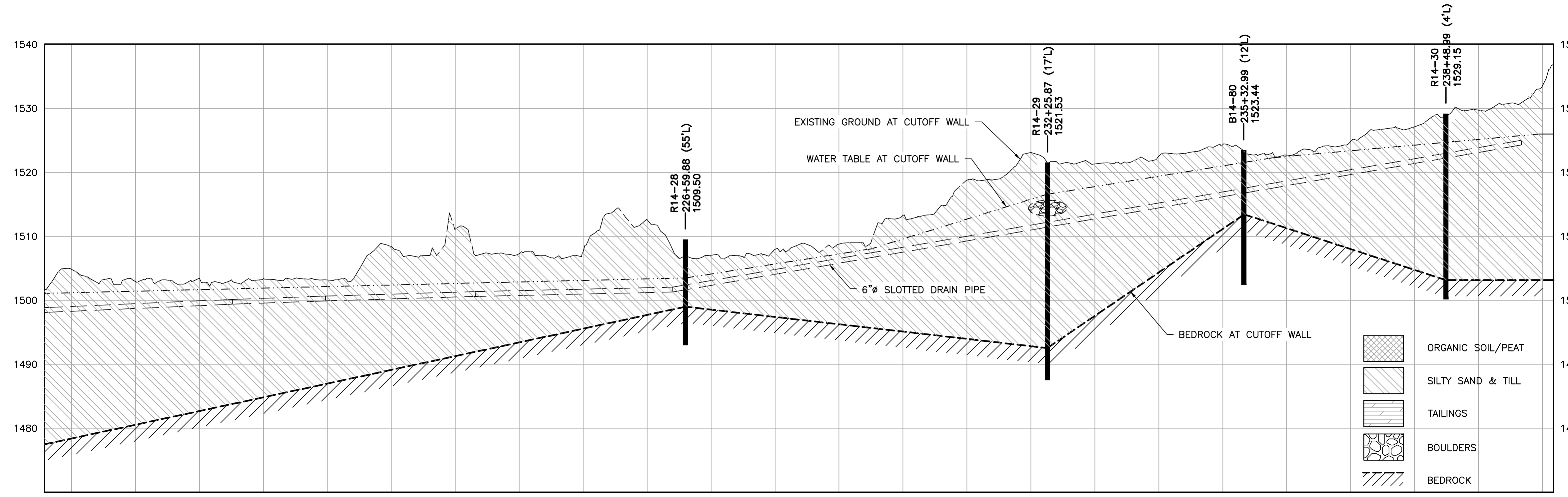
DWG. NO. FTBCA-010

REV

INCHES 1 2



1 PLAN: STATION 216+58 TO STATION 240+17



2 PROFILE: STATION 216+58 TO STATION 240+17

0 100 200 SCALE IN FEET HORIZONTAL

0 10 20 SCALE IN FEET VERTICAL

PLANT DRAWING NUMBER:

FTB SEEPAGE CONTAINMENT
AND STREAM AUGMENTATION SYSTEMS
PLAN & PROFILE STATION 216+58 TO 240+17

VER NO	DATE	DESCRIPTION
A	09/28/12	WATER MANAGEMENT PLAN – PLANT– VERSION 2 – ATTACHEMENT B
1	09/09/14	WATER MANAGEMENT PLAN – PLANT– VERSION 3 – ATTACHEMENT B
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PRINTED NAME THOMAS J. RADUE
SIGNATURE Thomas J. Radue
DATE 5/28/15 LICENSE# 20951

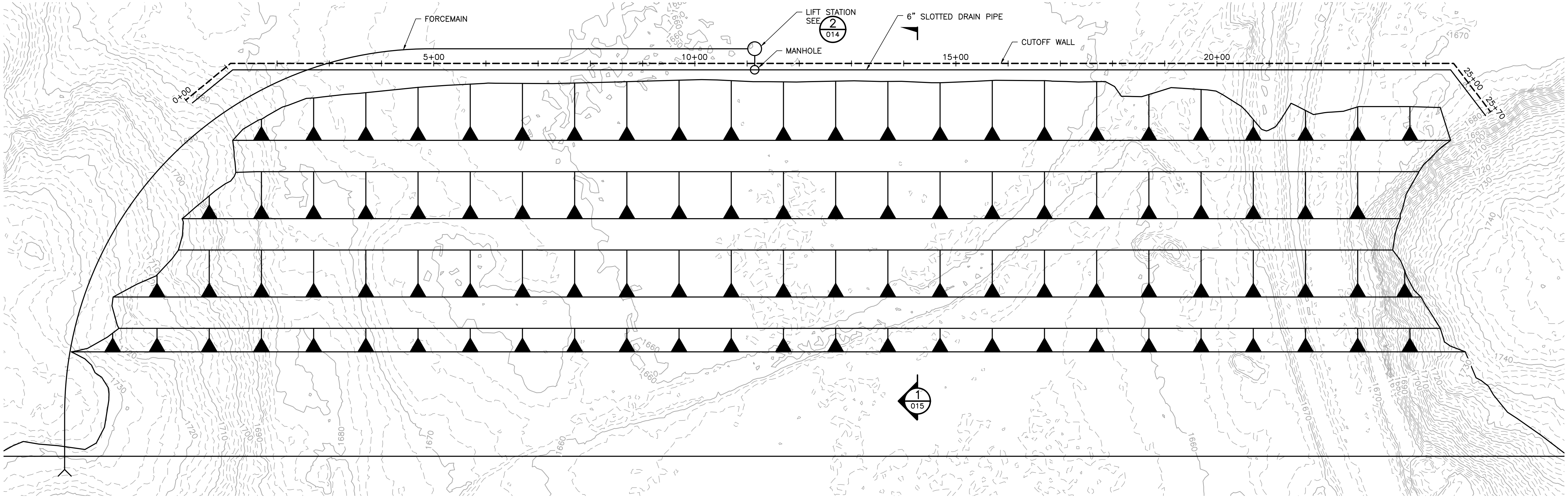
DRAWN: BJH
CHECKED: DVS/AMP
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

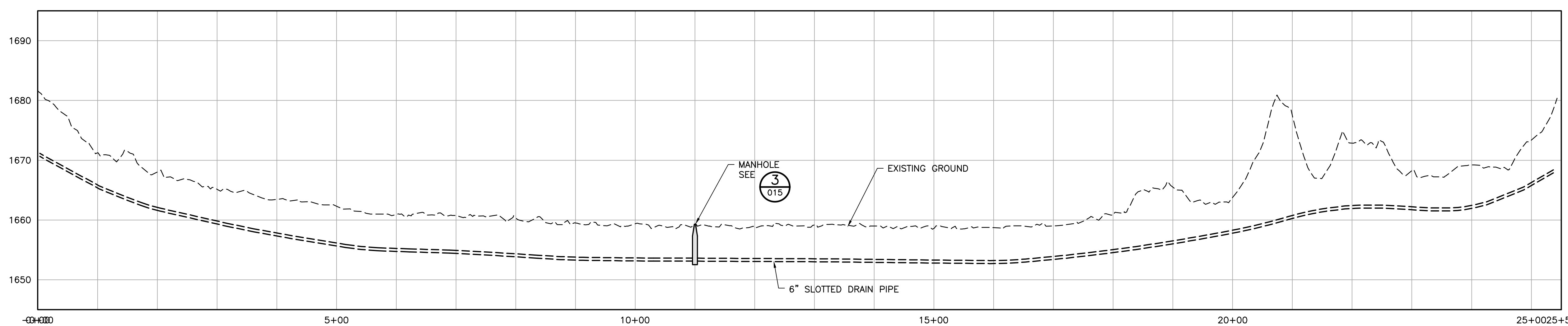
DWG. NO. FTBCA-011 REV

INCHES 1 2



1 PLAN: STATION 0+00 TO STATION 23+33

0 100 200 SCALE IN FEET



1 PLAN: STATION 0+00 TO STATION 23+33

0 100 200 SCALE IN FEET HORIZONTAL

0 10 20 SCALE IN FEET VERTICAL

CADD USER: Terri J. Toms FILE: K:\DESIGN\23690C29.10\PERMIT_NMT-10-CU-012.DWG PLOT SCALE: 1:2 PLOT DATE: 6/9/2015 10:52 AM

VER NO	DATE	DESCRIPTION
A	09/28/12	WATER MANAGEMENT PLAN – PLANT– VERSION 2 – ATTACHEMENT B
1	09/09/14	WATER MANAGEMENT PLAN – PLANT– VERSION 3 – ATTACHEMENT B
2	12/31/14	WATER MANAGEMENT PLAN – PLANT– VERSION 3,4 – ATTACHEMENT B
3	5/28/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS

ISSUE STATUS		
ISSUED	VERSION	DATE
FOR PERMITTING	3	5/28/15
FOR CONSTRUCTION		

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PRINTED NAME THOMAS J. RADUE
SIGNATURE Thomas J. Radue
DATE 5/28/15 LICENSE# 20951

DRAWN: BDP
CHECKED: DVS/AMP
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

FTB SEEPAGE CONTAINMENT AND STREAM AUGMENTATION SYSTEMS PLAN & PROFILE STATION 0+00 TO 25+43

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

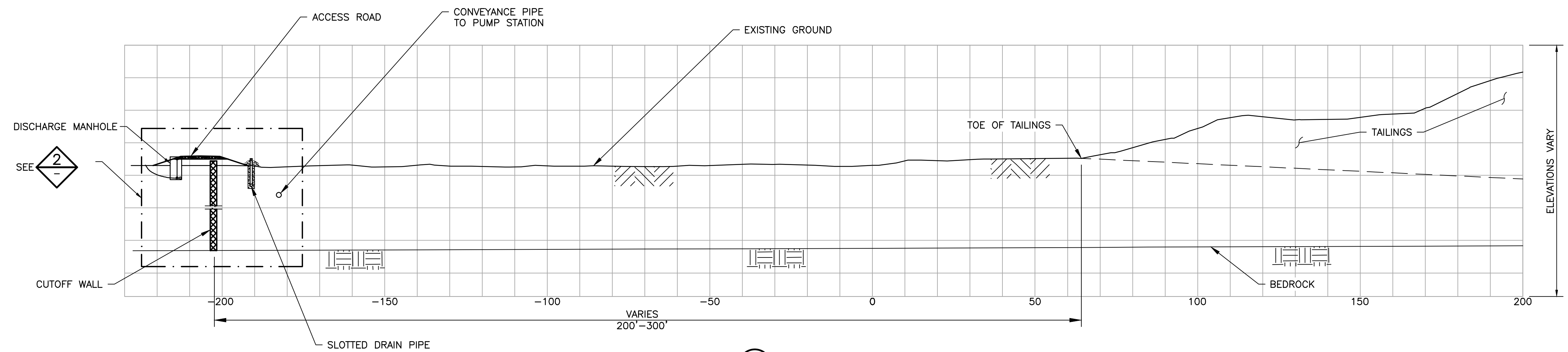
POLYMET MINING

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. FTBCA-012

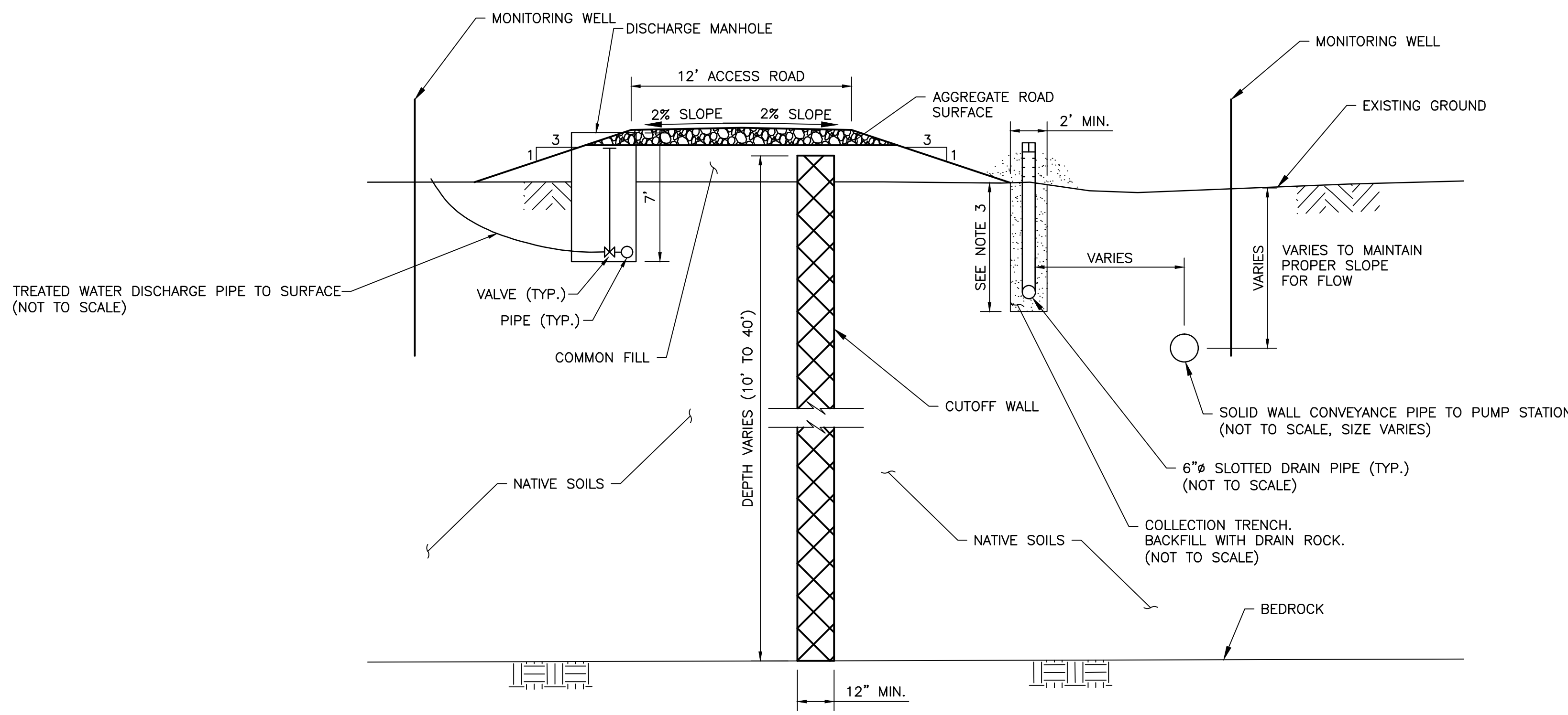
REV

INCHES 1 2



1 TYPICAL SECTION

0 20 40 SCALE IN FEET



2 TYPICAL DETAIL

0 5 10 SCALE IN FEET

NOTES:

1. DIFFUSER TO BE INSTALLED ON DISCHARGE PIPES AS REQUIRED TO PREVENT EROSION.
2. CUTOFF WALL MAXIMUM DESIGN HYDRAULIC CONDUCTIVITY = $1X10^{-6}$CM/SEC
3. 7' TYPICAL BUT MAY BE LESS IN AREAS WITH SHALLOW BEDROCK

VER NO	DATE	DESCRIPTION
A	09/28/12	WATER MANAGEMENT PLAN – PLANT– VERSION 2 – ATTACHEMENT B
1	09/09/14	WATER MANAGEMENT PLAN – PLANT– VERSION 3 – ATTACHEMENT B
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ISSUE STATUS		
ISSUED	VERSION	DATE
FOR PERMITTING	3	5/28/15
FOR CONSTRUCTION		

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PRINTED NAME THOMAS J. RADUE
SIGNATURE Thomas J. Radue
DATE 5/28/15 LICENSE# 20951

DRAWN: BDP
CHECKED: DVS/AMP
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

FTB SEEPAGE CONTAINMENT AND STREAM AUGMENTATION SYSTEMS DETAILS

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR

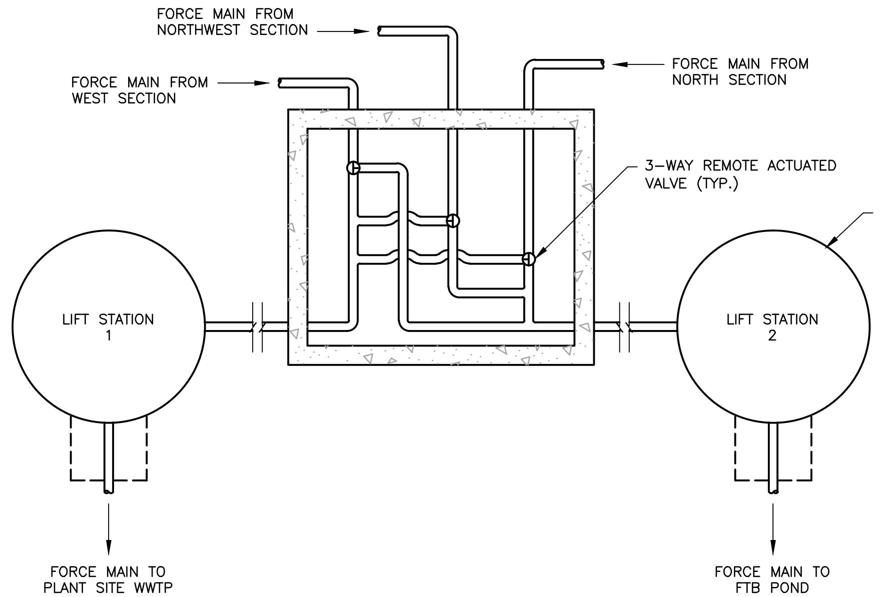
BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. FTBCA-013

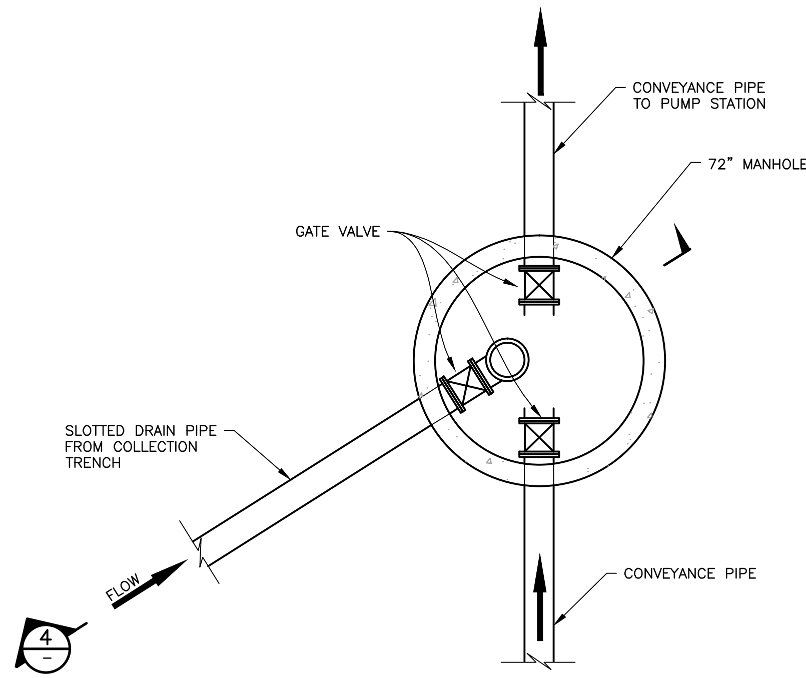
REV

CADD USER: Adeptuser FILE: \\PWEDINA\EDINA PW\EDINA PW IN\1863E0E6-BFF8-4ADD-A31A-2092BF300E7C\3B491C2E-ED6C-4C88-B530-B5B08F32884E\PERMIT_NMT-10-CU-013.DWG PLOT SCALE: 1:2 PLOT DATE: 6/8/2015 5:18 PM

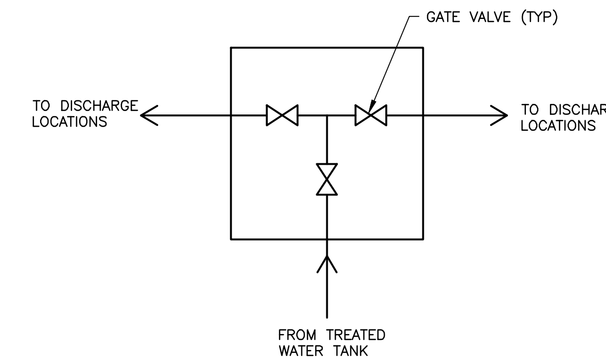
INCHES 1 2



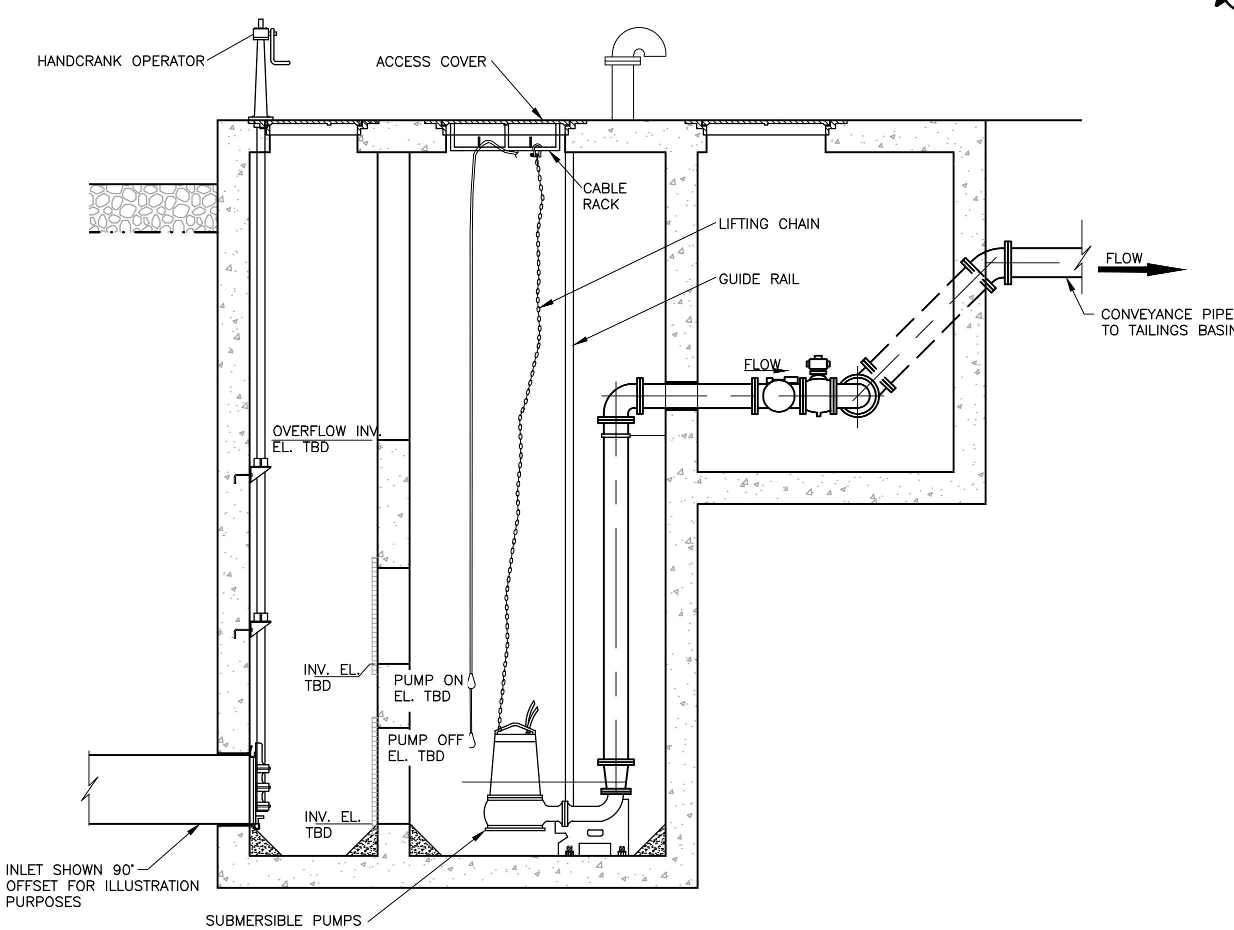
1 / 008 PLAN: VALVE AND MANIFOLD MANHOLE
NOT TO SCALE



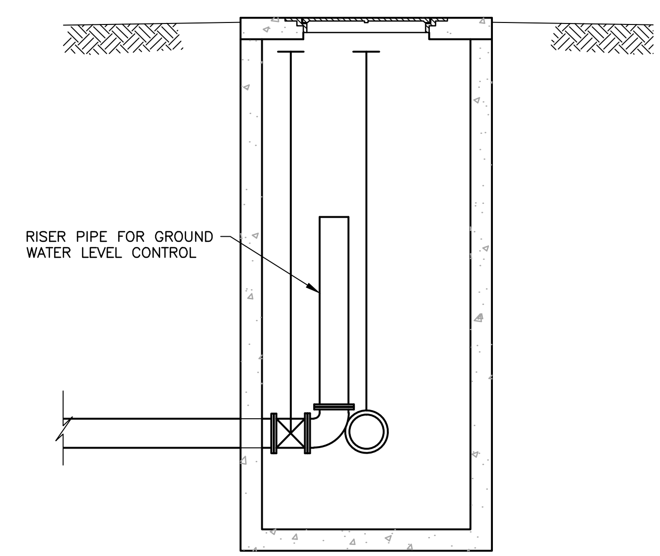
3 PLAN: MANHOLE (TYP.)
NOT TO SCALE



5 / 008 PLAN: VALVE VAULT
NOT TO SCALE



2 SECTION: LIFT STATION (TYP.)
NOT TO SCALE



4 SECTION: MANHOLE (TYP.)
NOT TO SCALE

NOTES:

1. LIFT STATION, MANHOLE AND VAULT CONFIGURATIONS SHOWN ON THIS SHEET ARE INTENDED TO BE REPRESENTATIVE OF TYPICAL FACILITIES NEEDED FOR OPERATION OF THE SEEPAGE CONTAINMENT AND STREAM AUGMENTATION SYSTEMS. THE ACTUAL DESIGN FOR EACH LIFT STATION, PUMP STATION, MANHOLE, AND VAULT WILL BE DEVELOPED DURING DETAILED DESIGN TO REFLECT THE SPECIFIC EQUIPMENT REQUIREMENTS FOR EACH LOCATION.
2. PUMP STATIONS WILL BE SIMILAR TO MANHOLE SHOWN IN 3 WITH SMALL SUBMERSIBLE PUMP.
3. FLOW METERS WILL BE PROVIDED FOR DISCHARGE FROM ALL LIFT AND PUMP STATIONS AND AT OTHER LOCATIONS AS REQUIRED FOR OPERATIONS.

VER NO	DATE	DESCRIPTION
A	09/28/12	WATER MANAGEMENT PLAN – PLANT– VERSION 2 – ATTACHEMENT B
1	09/09/14	WATER MANAGEMENT PLAN – PLANT– VERSION 3 – ATTACHEMENT B
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ISSUE STATUS		
ISSUED	VERSION	DATE
FOR PERMITTING	3	5/28/15
FOR CONSTRUCTION		

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PRINTED NAME THOMAS J. RADUE
SIGNATURE Thomas J. Radue
DATE 5/28/15 LICENSE# 20951

DRAWN: BDP
CHECKED: DVS/AMP
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

FTB SEEPAGE CONTAINMENT AND STREAM AUGMENTATION SYSTEMS DETAILS

POLYMET MINING

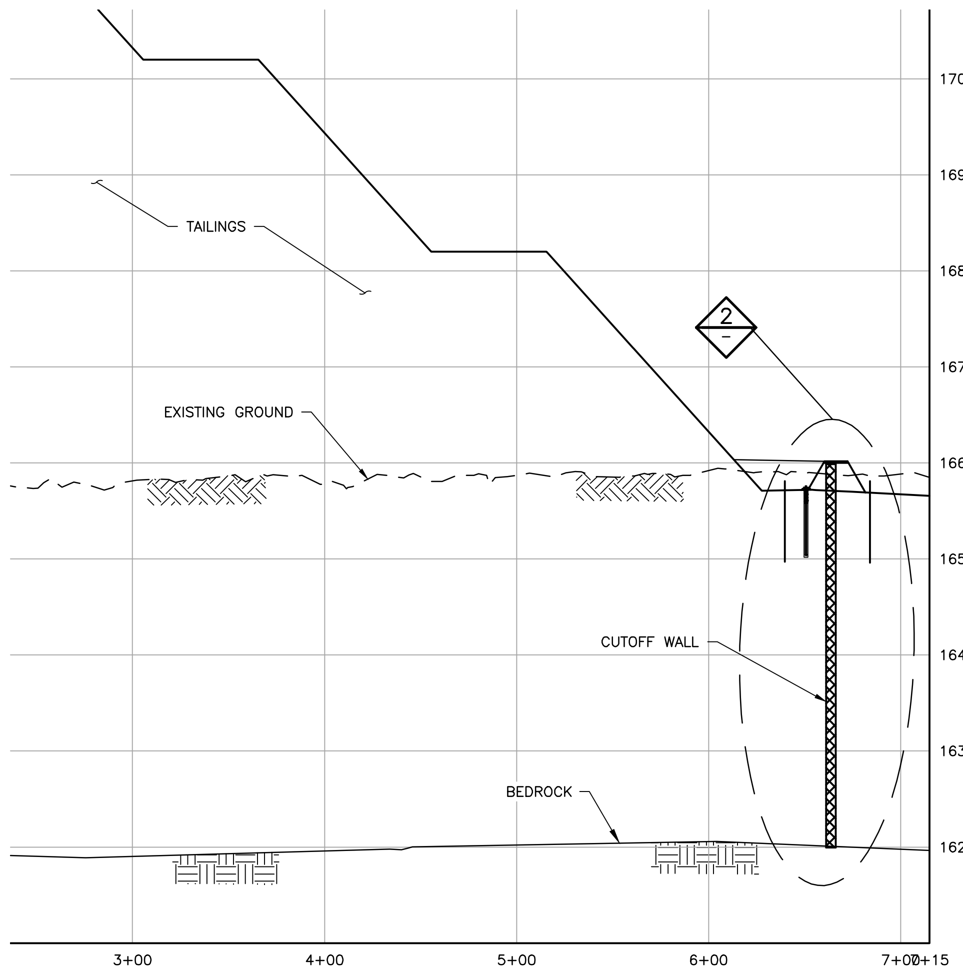
POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

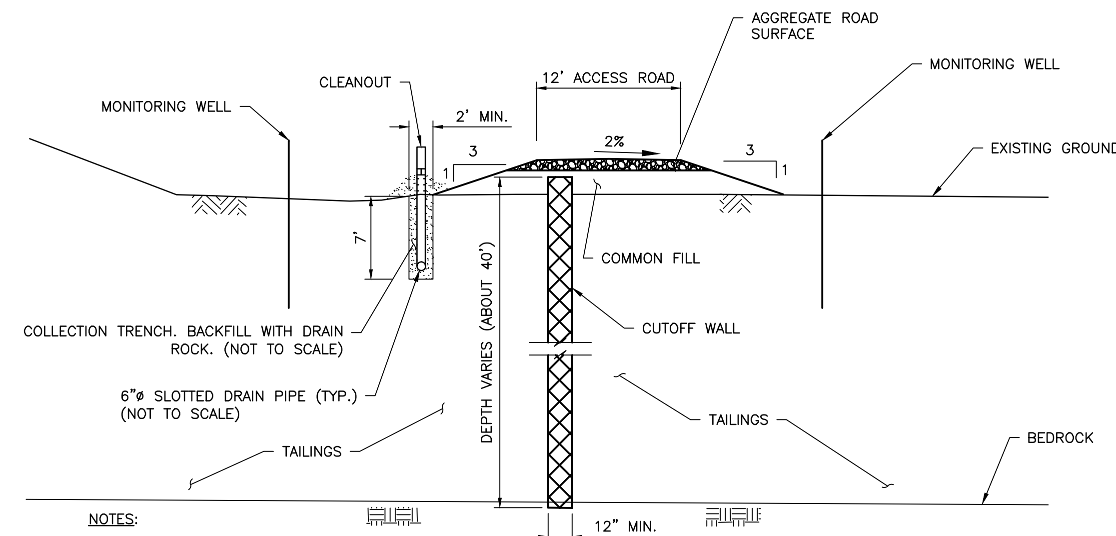
DWG. NO. FTBCA-014
REV

INCHES 1 2



1 / 11 SECTION: EAST DAM SEEPAGE CONTAINMENT SYSTEM

0 50 100 SCALE IN FEET

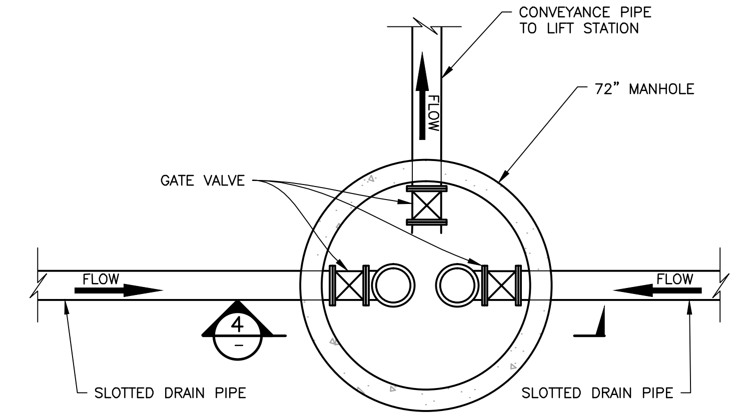


NOTES:

1. CUTOFF WALL MAXIMUM DESIGN HYDRAULIC CONDUCTIVITY = $1X10^{-6}$CM/SEC

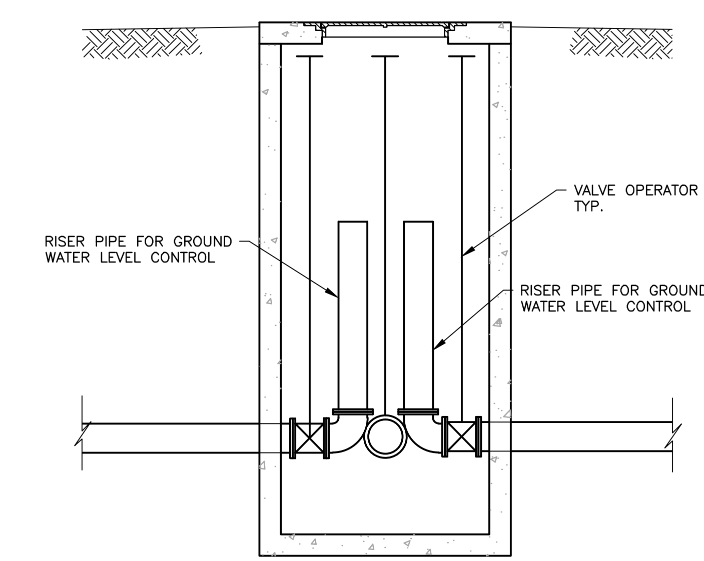
2 / – TYPICAL DETAIL

0 4 8 12 16 SCALE IN FEET



3 / – PLAN: MANHOLE (TYP.)

NOT TO SCALE



4 / – SECTION: MANHOLE (TYP.)

NOT TO SCALE

NOTES:

1. LIFT STATION, MANHOLE AND VAULT CONFIGURATIONS SHOWN ON THIS SHEET ARE INTENDED TO BE REPRESENTATIVE OF TYPICAL FACILITIES NEEDED FOR OPERATION OF THE SEEPAGE CONTAINMENT SYSTEM. THE ACTUAL DESIGN FOR EACH LIFT STATION, PUMP STATION, MANHOLE, AND VAULT WILL BE DEVELOPED DURING DETAILED DESIGN TO REFLECT THE SPECIFIC EQUIPMENT REQUIREMENTS FOR EACH LOCATION.

2. FLOW METERS WILL BE PROVIDED FOR DISCHARGE FROM ALL LIFT AND PUMP STATIONS AND AT OTHER LOCATIONS AS REQUIRED FOR OPERATIONS.

VER NO	DATE	DESCRIPTION
A	09/28/12	WATER MANAGEMENT PLAN – PLANT– VERSION 2 – ATTACHEMENT B
1	09/09/14	WATER MANAGEMENT PLAN – PLANT– VERSION 3 – ATTACHEMENT B
2	12/31/14	WATER MANAGEMENT PLAN – PLANT– VERSION 3,4 – ATTACHEMENT B
3	5/28/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS

ISSUE STATUS: ISSUED	VERSION	DATE
FOR PERMITTING	3	5/28/15
FOR CONSTRUCTION		

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.

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SCALE: AS SHOWN

PLANT DRAWING NUMBER:

FTB SEEPAGE CONTAINMENT AND STREAM AUGMENTATION SYSTEMS DETAILS

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. FTBCA-015

REV

INCHES 1 2

Attachment C

Groundwater Modeling of the NorthMet Flotation Tailings Basin Seepage Containment System

Groundwater Modeling of the NorthMet Flotation Tailings Basin Containment System

Supporting Document for Water Management Plan – Plant

Prepared for
PolyMet Mining Inc.

January 2015

4700 West 77th Street
Minneapolis, MN 55435-4803
Phone: 952.832.2600
Fax: 952.832.2601

Groundwater Modeling of the NorthMet Flotation Tailings Basin Containment System

January 2015

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1.0 Introduction

This report describes the technical approach, rationale, and scope for the two-dimensional (i.e., flow path) groundwater modeling that was conducted to support the design of the Flotation Tailings Basin (FTB) Containment System at the PolyMet NorthMet Project (Project) Plant Site and to support the assumptions made in the GoldSim water quality model regarding FTB Containment System capture effectiveness (Reference (1)). Groundwater modeling objectives, methods, and results are presented. The modeling was based on the current understanding of the Plant Site conditions and the Project description (Reference (2)) developed for the Final Environmental Impact Statement (FEIS).

In this report, the FTB is the newly constructed NorthMet Flotation Tailings impoundment, and the Tailings Basin is the existing LTV Steel Mining Company (LTVSMC) Tailings Basin as well as the combined LTVSMC Tailings Basin and the FTB.

Groundwater flow path models were used to assess the effectiveness of the FTB Containment System along the north, northwest, and west flow paths defined in the GoldSim water quality model (Section 5.1.1.2 of Reference (1)). The flow path models originate at the toe of the North, Northwest, and West FTB Dams and terminate at the Embarrass River. Each model simulates groundwater flow along one of these three paths, representing a narrow, cross-sectional slice of aquifer spanning the length of a groundwater flow path. The locations of the flow-path models are shown on Figure 1-1.

Groundwater flow path models for tailings basin seepage to the south and east were not developed. Eastern and southern groundwater flow paths were not modeled in GoldSim (Section 5.1.1.2 of Reference (1)) because the modeling assumes complete capture for these portions of the FTB Containment System (i.e., all water from the FTB that reports to these portions of the FTB Containment System, both surface and/or groundwater, is captured). This assumption for complete capture of seepage to the east was based on the existing topography, inward hydraulic gradients during current conditions and long-term closure, and the design of the FTB Containment System and the swale to control unimpacted water (Section 3.4 of Reference (3)). For seepage to the south, the capture assumption is also based on the existing topography, which causes seepage in this direction to emerge as surface seepage within a short distance of the dam toe rather than being transported via subsurface flow. PolyMet has also committed to collect essentially all seepage to the south (Section 4.4 of Reference (3)).

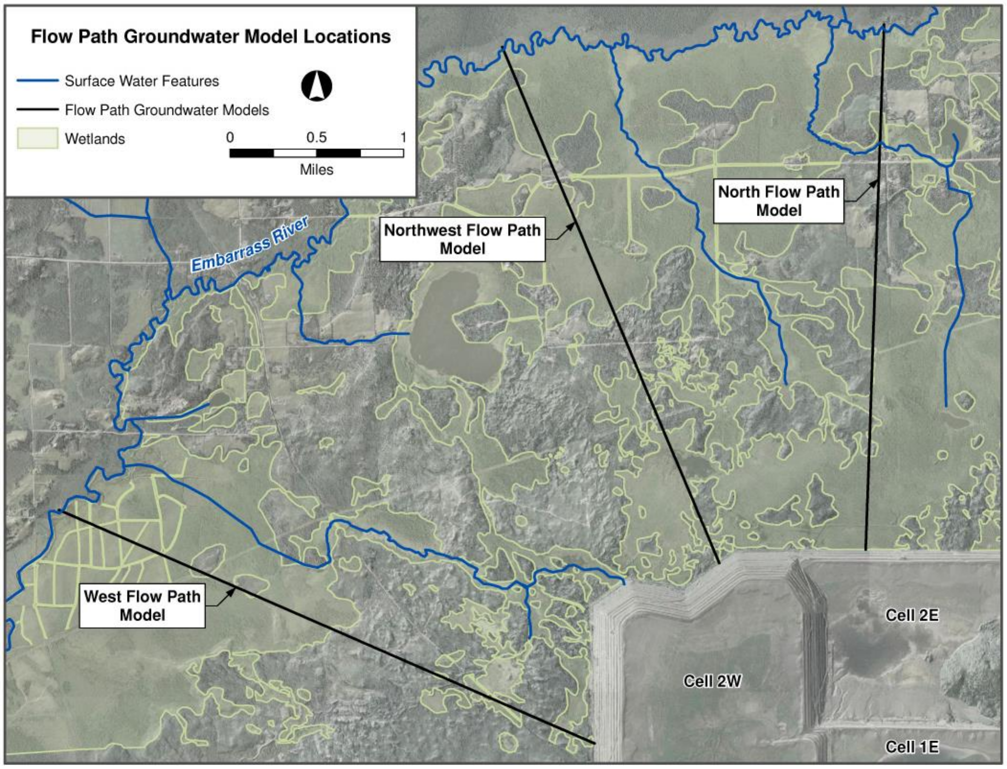

Figure 1-1 Locations of Flow Path Models Used to Evaluate the FTB Containment System

1.1 Objectives

The rate of groundwater seepage from the Tailings Basin was estimated by the Plant Site groundwater flow model (Section 4.2.1 in Attachment A of Reference (1)). The fate of that seepage was then evaluated using the Plant Site GoldSim model (Reference (1)), which assumed capture efficiencies for the FTB Containment System of: 100% of surface water and 90% of groundwater. The flow path models described in this report were developed to support the simplifying assumption that 90% of groundwater will be captured by the FTB Containment System. The objective of the flow path models was to estimate the rate of seepage from the Tailings Basin that will pass beyond the FTB Containment System.

1.2 Background

Estimates of tailings basin seepage entering each of the groundwater flow paths under operations and long-term closure conditions from the three-dimensional Plant Site models were used as input to the flow path models. The three-dimensional Plant Site models were first developed during the Draft Environmental Impact Statement (DEIS) process (Attachment A-6 of Reference (4), Attachment A-6 of Reference (5)). The DEIS versions of the model calibrations were steady-state and did not simulate changes in water levels within the basin. As part of the modeling effort for the Supplemental Draft Environmental Impact Statement (SDEIS), the calibration of the groundwater model was updated to represent transient conditions following LTVSMC closure until present. For the FEIS modeling effort, the groundwater models were updated to incorporate groundwater elevation data collected through 2013 and changes as recommended by the Co-lead Agencies (Attachment A of Reference (1)). The flow path models were updated using results from the FEIS version of the three-dimensional Plant Site models, and this report documents the current version of the flow path models developed for the FEIS.

1.2.1 Containment System Overview

A containment system, comprising a collection trench, drain pipe, and low-permeability cutoff wall, will be installed to capture seepage leaving the northern, northwestern, western and eastern sides of the Tailings Basin (Section 2.1.4 of Reference (6)). This containment system was not included in the three-dimensional Plant Site models, because the three-dimensional Plant Site model was developed to understand the fate and the transport of water that enters the footprint of the Tailings Basin. While the area outside the Tailings Basin (including where the containment system will be installed) was included in the three-dimensional model for continuity, the model was not developed to evaluate transport of the seepage outside the footprint of the Tailings Basin.

By intercepting seepage from the Tailings Basin and returning captured water for reuse or treatment, the system is designed to reduce the constituent load from the Tailings Basin entering the downgradient surface and groundwater system. The cutoff wall will extend through the full thickness of unconsolidated deposits (approximately 10 to 30 feet thick) to the top of bedrock, and will direct groundwater flow toward the collection trench and drain pipe. The collection trench will be installed immediately upgradient of the cutoff wall, i.e., on the side nearest the Tailings Basin, and will be backfilled with granular, transmissive material. A drain pipe will be placed at the base of the collection trench at a depth of approximately five to eight feet below grade.

The FTB Containment System will decrease flows to tributaries of the Upper Embarrass River and to Second Creek (also known locally as Knox Creek), a tributary to the lower Partridge River. The Project will implement stream augmentation measures to prevent potential hydrologic impacts to Unnamed Creek, Mud Lake Creek, Trimble Creek, and Second Creek. Stream flow in Trimble Creek, Unnamed Creek, and Second Creek will be augmented with treated effluent from the WWTP. Stream flow in Mud Lake Creek will be augmented with non-contact stormwater runoff diverted via the drainage swale constructed east of the FTB East Dam. WWTP effluent discharge for stream augmentation will be directed downstream of the FTB seepage capture systems.

1.3 Report Organization

This report is organized into five sections, including this introduction. Section 2.0 presents the conceptual model used to develop the flow path groundwater flow models. Section 3.0 describes the construction of the flow path models, and Section 4.0 presents model results. Summary and conclusions are presented in Section 5.0.

2.0 Conceptual Model

A *hydrogeologic conceptual model* is a schematic description of how water enters, flows through, and leaves the groundwater system. Its purpose is to describe the major sources and sinks of water, the grouping or division of hydrostratigraphic units into aquifers and aquitards, the direction of groundwater flow, the interflow of groundwater between aquifers, and the interflow of water between surface waters and groundwater. The hydrogeologic conceptual model is both scale-dependent (e.g., local conditions may not be identical to regional conditions) and dependent upon the objectives. It is important when developing a conceptual model to strive for an effective balance: the model should be kept as simple as possible while still adequately representing the system to analyze the objectives at hand.

2.1 Geologic Units

This section provides an overview of the Plant Site geology and the hydraulic properties of each geologic unit, particularly as they pertain to the development of the groundwater flow models. A more detailed summary of the current understanding of bedrock structure and hydrogeology at the Mine Site and the Plant Site, and description of the regional and local bedrock geology and hydrogeology, including the nature of fractured bedrock, can be found in Reference (7).

2.1.1 Surficial Deposits

The native unconsolidated deposits in the vicinity of Plant Site are a relatively thin mantle of Quaternary-age glacial till and associated reworked sediments, most of which were deposited and reworked by the retreating Rainy Lobe during the last glacial period in association with the development of the Vermillion moraine complex (Reference (8)). Near the Tailings Basin, unconsolidated deposits have been characterized based on soil borings and monitoring wells, which have been completed to the north and west of the Tailings Basin. The unconsolidated deposits generally consist of discontinuous lenses of silty sand to poorly graded sand with silt, to poorly graded sand with gravel. Very little silt or clay has been encountered, with the exception of the soil boring drilled near monitoring well GW006, where several feet of silt is interbedded with silty sand (Reference (9)). In places, the till is overlain by organic peat deposits. Depth to bedrock in the area surrounding the Tailings Basin is generally less than 50 feet. The unconsolidated deposits generally thicken in a northerly direction toward the Embarrass River. Wetland areas also become more common to the north, off the northern flank of the Giant's Range, the granite outcrops located adjacent to the Tailings Basin. These wetland areas are underlain by thin glacial drift and lacustrine deposits, which were deposited by the retreating Rainy Lobe and associated lakes that were trapped between the retreating ice margin and the Giant's Range.

Siegel and Ericson (Reference (10)) indicate that the till of the Rainy Lobe has an estimated hydraulic conductivity range of 0.1 to 30 feet/day. In-situ pumping tests were conducted at monitoring wells GW001, GW006, GW007, GW009, GW010, GW011, and GW012 to estimate hydraulic conductivity, as described in detail in Attachment F of Reference (11). The data collected during the tests was used to estimate the hydraulic conductivity of the unconsolidated deposits using three different methods; the Moench solution (Reference (12)), the Theis solution (Reference (13)), and using specific capacity data (Reference (14)). The hydraulic conductivity estimates from each solution are different at each location.

Not only is there spatial variability, shown by differences between wells, but there is uncertainty in the hydraulic conductivity at any given well, shown by the differences in the estimates at each well. Table 2-1 shows the estimates of hydraulic conductivity at each well (Reference (9)). GW009 generally has the lowest estimates of hydraulic conductivity (around 0.5 feet/day) and GW010 generally has the highest estimates of hydraulic conductivity (around 50 feet/day). The arithmetic and geometric means of the average hydraulic conductivity estimates at the test locations are approximately 13 feet/day and 5 feet/day, respectively.

Table 2-1 Hydraulic Conductivity Measured During Single-Well Pumping Tests in Unconsolidated Materials.

Monitoring Well	Moench Solution(1) (feet/day)	Theis Solution(2) (feet/day)	Specific Capacity (feet/day)
GW001	1.3	1.8	1.6
GW006	9.6	5.7	10.7
GW007	11.5	30.4	14.8
GW009	0.4	0.5	0.6
GW010	52.0	31.9	64.8
GW011	8.6	15.9	11.4
GW012	0.7	2.4	0.7

(1) Reference (12)
(2) Reference (13)

Additional characterization of hydraulic properties of the unconsolidated deposits was conducted as part of a geotechnical investigation during 2014 (Attachment F of Reference (11)). Slug tests were conducted in ten standpipe piezometers and two monitoring wells screened in the native unconsolidated deposits: R14-04, R14-06, R14-08, R14-12, R14-13, R14-15, R14-16, R14-26, R14-27, R14-28, GW001, and GW012. Hydraulic conductivity estimates from the slug tests ranged from 0.15 to 132 feet/day. The results of those analyses are shown in Table 2-2.

Table 2-2 Hydraulic Conductivity Measured in Unconsolidated Materials Using Slug Tests

Well	Test	K feet/day
R14-04	test 3 - in	2.86
	test 3 - out	3.57
R14-06	test 2 - out	131.76
	test 3 - out	88.13
R14-08	test 1 - in	1.19
	test 2 - out	1.42
R14-12	test 1 - out	0.15
	test 2 - out	0.16
R14-13	test 2 - out	2.12
	test 3 - in	1.53
R14-15	test 1 - in	20.84
	test 2 - out	31.04
R14-16	test 2 - out	18.52
	test 3 - in	16.77
R14-26	test 2 - out	51.65
	test 3 - in	24.45
R14-27	test 2 - out	114.65
	test 3 - out	104.54
R14-28	test 1 - in	0.38
	test 2 - out	0.77
GW001	test 1 - in	0.99
	test 3 - out	1.24
GW012	test 1 - in	0.44
	test 2 - in	0.33

2.1.2 Bedrock

The uppermost bedrock at the Plant Site consists of quartz monzonite and monzodiorite of the Neoarchean Giant’s Range batholith. These pink to dark-greenish gray, hornblende-bearing, coarse-grained rocks are referred to collectively as the “Giant’s Range granite”. The granite locally outcrops as a northeast-southwest trending ridge and drainage divide that makes up the highest topography in the area; the Giant’s Range. The Giant’s Range granite has been scoured by glaciers, creating local depressions and linear valleys. In this report, “bedrock hills” is used to describe the Giant’s Range granite outcrops located adjacent to the Tailings Basin.

Groundwater flow within the bedrock is primarily through fractures and other secondary porosity features, as the rock has low primary hydraulic conductivity. The upper portions of the rock are more likely than rock at depth to contain a fracture network capable of transmitting water. The literature-based assessment of the upper fractured zone suggests that groundwater flow in the Giants Range granite likely occurs mostly in the upper 300 feet of the bedrock; however, the site-specific fracture data indicate that the amount of fracturing decreases significantly in the upper 20 feet of the bedrock surface (Reference (7)).

Siegel and Ericson (Reference (10)) measured specific capacity in one well in the upper 200 feet of the Giant’s Range granite and measured hydraulic conductivity of 2.6 x 10^{-2} feet/day. This well was located less than 1 mile to the east of the Plant Site. Specific capacity data from a residential well located north of the Plant Site suggests that the hydraulic conductivity of the upper 47 feet of the granite at that location is approximately 42 feet/day. The log for this well indicates that the top of bedrock is at 18 feet below grade, and the casing also extends to 18 feet below grade. Because the well casing apparently does not extend into bedrock, it is possible that the higher hydraulic conductivity estimate at this well may reflect some degree of hydraulic connection with the unconsolidated deposits.

Packer testing was conducted at five boreholes in the uppermost portions (<20 feet) of the Giant’s Range granite during a 2014 geotechnical investigation in the Plant Site area (Attachment F of Reference (11)). The results from that testing are shown on Table 2-3. Hydraulic conductivity values for the upper portion of the Giant’s Range granite at the Plant Site range from effectively zero (i.e., no water was produced in three of the packer test intervals) to 3 feet/day, with a geometric mean of 0.14 feet/day (for the purposes of calculating a geometric mean, the lowest hydraulic conductivity value measured during the investigation was used for the three intervals that did not produce water).

Table 2-3 Hydraulic conductivity measured in bedrock during packer tests.

Boring	Test Interval (feet)	Kr feet/day
B14- 36	14 - 18.5	<0.00411
	20.5 - 26.5	0.0041
B14-55	37 - 41.5	3.1
	41.5 - 46.5	<0.00411
	46 - 50.5	<0.00411
B14-44	34 - 42	0.11
	42 - 46	0.23
B14-65	24 - 30	0.15
	27.5 - 33.5	0.65
B14-76	37 - 42	0.29

(1) For packer test results where zero inflow was observed during testing, permeability values were selected based on inference from lowest packer test result obtained.

2.2 Sources and Sinks for Water

The Tailings Basin receives water from direct precipitation and runoff from watershed areas to the east. Water falling within the tailings basin watershed collects in the ponds in Cell 1E and Cell 2E or infiltrates through dams and beaches. The ponds lose water to evaporation from the water surface and to seepage through the pond bottom. Most groundwater in the Plant Site vicinity flows to the north and northwest toward the Embarrass River; however, some portion of the water entering the Tailings Basin flows south and discharges to Second Creek, a tributary of the Partridge River.

2.3 Local Flow System

Regionally, groundwater flows primarily northward, from the bedrock hills to the Embarrass River (Reference (10)). Groundwater elevations in the network of monitoring wells located around the Tailings Basin indicate that groundwater in the unconsolidated deposits flows primarily to the north and northwest, toward the Embarrass River. Groundwater flow to the south and east is constricted by bedrock outcrops of the Giant's Range granite (Reference (15)). However, a gap in the bedrock hills near the southern end of the Tailings Basin allows some water to flow southward (south seeps), forming the headwaters of Second Creek, a tributary to the lower Partridge River. A second gap in the bedrock hills is present near the eastern side of the Tailings Basin. Under current conditions, seepage does not flow from the Tailings Basin to the east, because the Cell 1E pond is topographically lower than the surface water features to the east. Groundwater in the native unconsolidated material currently flows to the northwest toward the Tailings Basin. Following the completion of the FTB East Dam, groundwater within the unconsolidated deposits is generally expected to continue to flow from the east toward the Tailings Basin. The presence of the FTB Pond will not alter the existing regional groundwater flow direction, but may result in radial flow away from the Tailings Basin area on a local scale. Some water could seep through the unconsolidated material below the East Dam. Based on topography and the inferred groundwater divides to the area east of the Tailings Basin, this seepage would likely discharge near the toe of the East Dam, and it is not anticipated to flow east toward the Area 5NW pit or Spring Mine Lake (Reference (16)). The eastern segment of the FTB Containment System will be constructed in this area to capture any seepage that would discharge in this area (Reference (6)).

As the Tailings Basin was built up over time, a groundwater mound formed beneath the basin due to seepage from the basin ponds, altering local flow directions and rates. Therefore, the Tailings Basin determines patterns of runoff and infiltration at the Plant Site. Under current conditions, water that infiltrates through the Tailings Basin (from precipitation and seepage from the existing ponds) seeps downward to the native unconsolidated deposits.

Beneath the unconsolidated deposits, low-permeability crystalline bedrock impedes further downward groundwater flow; based on the contrast in hydraulic conductivity between the unconsolidated deposits and bedrock described above, groundwater flow through the bedrock is likely negligible relative to flow through the unconsolidated deposits. Because the unconsolidated deposits are thin and have relatively low hydraulic conductivity, and because the water table is close to the ground surface (which effectively limits the hydraulic gradient), the unconsolidated deposits have a limited capacity to transport Tailings Basin seepage. Therefore, a large portion of that seepage discharges to wetland areas near the Tailings Basin dams, while a small portion remains in the unconsolidated deposits and flows away from the basin laterally as groundwater.

2.4 Hydrologic Model Selection

The flow path models were developed using MODFLOW-NWT (Reference (17)), a formulation of the industry-standard finite-difference groundwater modeling code MODFLOW (Reference (18); Reference (19); Reference (20)). MODFLOW solves the following three-dimensional, differential equation of groundwater flow for saturated steady-state and transient conditions Equation 2-1:

$$\frac{\partial}{\partial x}\left(K_{xx}\frac{\partial h}{\partial x}\right)+\frac{\partial}{\partial y}\left(K_{yy}\frac{\partial h}{\partial y}\right)+\frac{\partial}{\partial z}\left(K_{zz}\frac{\partial h}{\partial z}\right)-W=S_s\frac{\partial h}{\partial t}$$

Equation 2-1

Where K_{xx}, K_{yy}, and K_{zz} are the three principal directions of the hydraulic conductivity tensor, W represents sources and sinks, S_s represents specific storage, h is hydraulic head, and t is time. MODFLOW was developed by the U.S. Geological Survey and is in the public domain. MODFLOW-NWT was selected over other MODFLOW formulations because it is more stable for nonlinear hydrogeologic conditions, such as the drying of model cells near the FTB Containment System drain. Due to the way the models were set up (using ground surface as the top of the model) and the vertical discretization used, it was anticipated that some cells would be located near or above the water table and may be dry during some simulations. MODFLOW-NWT accommodates drying and rewetting by using the Newton method for solving nonlinear equations (described in Reference (17)). Hereinafter, MODFLOW-NWT will be referred to as MODFLOW.

The particle-tracking code MODPATH (Reference (21)) was used to estimate the rate of seepage bypassing the FTB Containment System. MODPATH uses output files from MODFLOW simulations to compute three-dimensional flow paths by tracking particles throughout the model domain until they reach a boundary, enter an internal source or sink, or are terminated in a process specified by the modeler. MODPATH also keeps track of the time-of-travel for simulated particles as they move though the model domain.

The models were developed using the graphical user interface Groundwater Vistas (Version 6; Reference (22)).

3.0 Model Construction

For each of the three groundwater flow path models, six simulations were completed. Each flow path was simulated under two seepage conditions (operations and long-term closure), using three assumed values for the thickness of the upper fractured zone in the granite bedrock (25, 50, and 100 feet) as shown on Figure 3-1.

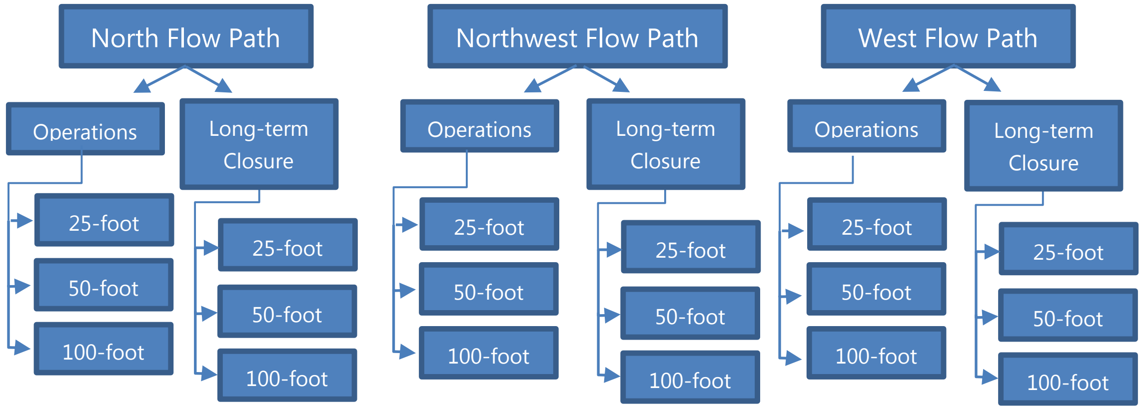

Figure 3-1 Model Simulations for the Flow Path Groundwater Models for Two Different Flow Conditions and Three Different Bedrock Thicknesses

Cross-sectional diagrams of the three flow paths, detailing model discretization and key model parameter values are shown in Large Figure 1 through Large Figure 3. In each figure, the model cells are shown in gray outline, and individual cells are colored to indicate either a boundary condition or hydraulic conductivity zone. The figures each depict three surfaces for the bottom of the model: one surface corresponding to the model with a bedrock thickness of 25 feet, one for the model with a bedrock thickness of 50 feet, and one for the model with a bedrock thickness of 100 feet. Model discretization is discussed in detail in Section 3.1, boundary conditions in Section 3.2, model parameters in Section 3.3, and simulated components of the FTB Containment System in Section 3.4.

3.1 Model Domain and Discretization

Each flow-path model grid consists of a single row, oriented approximately parallel to groundwater flow in one of the three flow paths defined in the GoldSim model (Reference (1)). The origin of each grid is located at the toe of the Tailings Basin dam, and the last column of each model intersects the Embarrass River; see Section 3.2 for a discussion of the boundary conditions used to represent these endpoints. Column spacing varies over the length of each model. A two-foot spacing is used in the primary area of interest, i.e., the 500 feet nearest the Tailings Basin; this is followed by a gradual transition over 50 cells to a 150-foot spacing, which is used over the remaining distance to the Embarrass River. Each model's single row is one foot wide.

The domain of each model is bounded at the top by the ground surface and at the bottom by a specified depth below the bedrock surface. Several GIS datasets were used to define the ground and bedrock surfaces. A LiDAR-based, three-meter resolution Digital Elevation Model (DEM), available through the Minnesota Elevation Mapping Project (Reference (23)), was used to calculate ground elevations. Bedrock elevations were calculated using a combined bedrock dataset, derived from a regional, 30-meter resolution Minnesota Geological Survey (MGS) bedrock surface (Reference (24)), into which local bedrock data were incorporated. Groundwater wells and borings completed in the vicinity of the Tailings Basin, for which estimated bedrock elevations were available, were buffered a distance of 3,280.4 feet (or 1,000 meters). The area within the buffer was then clipped from the MGS bedrock surface. Finally, the coordinates of each well, its associated bedrock elevation and the remaining regional grid data were provided as input to a new surface interpolation. The resulting surface matches the regional grid outside the 1,000-meter buffer and within, smoothly transitions to match the field-measured site data.

To calculate the ground surface and bedrock surface elevation in each column, centerlines spanning each model's single row were generated and divided into segments corresponding to model columns. These centerlines were then intersected with ground and bedrock raster datasets; in the process, the one or more cells in each raster dataset coincident with each column segment were identified. Length-weighted average elevations for each model column were calculated by applying Equation 3-1 to the intersected ground and bedrock datasets in turn:

$$E_a = \sum_{i=1}^{n} \frac{E_i \times L_i}{L_t}$$ **Equation 3-1**

Where E_i is the elevation of a given coincident raster cell, L_i is the length of the column segment within that raster cell, L_t is the total length of the column segment and E_a is the average elevation of the column segment.

The upper portion of each flow path model representing the unconsolidated deposits was discretized vertically into layers of equal thickness, evenly subdividing the thickness of unconsolidated deposits. During the SDEIS modeling, the number of layers was selected such that layers were approximately two feet thick at the end of the model nearest the Tailings Basin. This target thickness matched the two-foot column spacing used within the first 500 feet and resulted in regular grid geometry over this area of primary interest. For the FEIS modeling, the depth to bedrock was updated, resulting in thinner model layers for the northwest flow path. The average thickness of unconsolidated deposits between the Tailings Basin and the FTB Containment System cutoff wall, as well as vertical discretization of the unconsolidated deposits, are summarized in Table 3-1.

Table 3-1 Vertical Discretization of Unconsolidated Deposits between the Tailings Basin and the FTB Containment System

Flow Path Model	Average Thickness of Unconsolidated Deposits between Tailings Basin and FTB Containment System Cutoff Wall	Number of Model Layers Representing Unconsolidated Deposits	Average Thickness of Layers Representing Unconsolidated Deposits between Tailings Basin and FTB Containment System Cutoff Wall
North	21.2 Feet	10	2.1 Feet
Northwest	16.5 Feet	14	1.2 Feet
West	14.4 Feet	7	2.1 Feet

The bedrock was divided into layers of equal thickness, each approximately 2 feet thick, for each flow-path model set. The number of layers was selected to match the target bedrock thickness with layers approximately two feet thick at the end of the model nearest the Tailings Basin. This target thickness matched the two-foot column spacing used within the first 500 feet and resulted in regular grid geometry over this area of primary interest. Vertical discretization of bedrock is summarized in Table 3-2.

Table 3-2 Number of Model Layers Representing Bedrock

Bedrock Thickness	North	Northwest	West
25 feet	10	11	13
50 feet	20	22	26
100 feet	40	44	52

3.2 Boundary Conditions

Seepage from the Tailings Basin and distributed meteoric recharge, described in Sections 3.2.1 and 3.2.2, respectively, are the primary groundwater sources in each flow path model. Groundwater is allowed to leave the modeled system via wetlands, described in Section 3.2.3, and the containment system drain pipe, described in Section 3.4. The Embarrass River, described in Section 3.2.4, comprises the downgradient flow boundary in the flow path models.

3.2.1 Representation of Tailings Basin Seepage

Specified-flux cells were used to represent tailings basin seepage; this boundary condition is implemented using Well Package in MODFLOW, used to inject or extract water from a model at a specified rate (Reference (18)). The first column of each model is coincident with the toe of a tailings basin dam; therefore, one specified-flux cell was placed in each layer of the first column, as shown in Large Figure 1 through Large Figure 3.

The rate of seepage from the Tailings Basin at each flow path was estimated using the Plant Site groundwater model (Attachment A of Reference (1)). The seepage rates used in operations simulations represent Mine Year 7 conditions; these rates were selected in order to evaluate the performance of the FTB Containment System under conditions during which the maximum seepage is expected. The seepage rates used in long-term closure simulations represent conditions after the reclamation of the Tailings Basin. These rates are lower due to the planned application of the FTB cover system, cessation of tailings deposition on the FTB beaches, and gradual dissipation of the groundwater mound beneath the Tailings Basin. Output from the Plant Site model which was used as input to the flow-path models consisted of a seepage rate from the Tailings Basin in units of cubic length per time, i.e., gpm, which corresponds to a length along the perimeter of the Tailings Basin. Because the flow-path models represent a one-foot-wide segment of the flow path, the seepage rate was divided by the flow path width (i.e., the corresponding length along the perimeter of the Tailings Basin) to obtain the rate per linear foot, which was the total seepage rate used as input in the model. Seepage rates used in each model are summarized in Table 3-3.

Table 3-3 Seepage Estimates under Operations and Long-Term Closure Conditions

Flow Path	Flow Path Width (Feet)	Seepage from Tailings Basin Dam (GPM)		Seepage from Tailings Basin Dam (GPM / Linear Foot of Dam)	
		Operations (Mine Year 7)	Long-term Closure	Operations (Mine Year 7)	Long-term Closure
North	8460	1600	570	0.19	0.067
Northwest	5415	580	410	0.11	0.076
West	11065	960	690	0.087	0.062

Seepage rates applied in the model were scaled to reflect the differences in hydraulic conductivity and thickness of the unconsolidated deposits and bedrock. To calculate the scaled seepage rate in the unconsolidated deposits, Equation 3-2 was applied:

$$q_s = q_{total} \frac{K_s t_s}{(K_s t_s + K_b t_b)}$$

Equation 3-2

Where q_s is the scaled seepage rate in the unconsolidated deposits, q_{total} is the total seepage rate, K_s is the hydraulic conductivity of the unconsolidated deposits, t_s is the thickness of the unconsolidated deposits, K_b is the hydraulic conductivity of the bedrock, and t_b is the thickness of the bedrock. The same equation, with the bedrock and surficial values reversed, is used to calculate the scaled seepage rate in bedrock. These rates were then divided by the number of layers (unconsolidated or bedrock) to obtain the rate assigned to each specified-flux cell in the model. The scaled seepage rates applied in the model are shown on Table 3-4.

Table 3-4 Seepage Estimates Applied to the North, Northwest, and West Flow Paths, Scaled by Transmissivity

Flow Path Model	Bedrock Thickness (feet)	Unconsolidated Deposits Scaled Seepage Rate gpm/linear ft		Bedrock Scaled Seepage Rate gpm/linear ft	
		Operations (Mine Year 7)	Long-term Closure	Operations (Mine Year 7)	Long-term Closure
North	25	0.187	0.0667	0.002	0.0007
	50	0.185	0.0660	0.004	0.0014
	100	0.181	0.0646	0.008	0.0028
Northwest	25	0.106	0.0750	0.001	0.0007
	50	0.105	0.0743	0.002	0.0015
	100	0.103	0.0729	0.004	0.0029
West	25	0.0854	0.0614	0.0014	0.0010
	50	0.0841	0.0604	0.0027	0.0020
	100	0.0815	0.0586	0.0053	0.0038

3.2.2 Recharge

Distributed recharge was applied uniformly across the top of each model via the Recharge Package in MODFLOW (Reference (18)); the median recharge rate of 0.61 inches/year, which was calculated based on the watershed area and baseflow in the Embarrass River (Reference (1)), was used for both operations and long-term closure simulations.

3.2.3 Representation of Wetlands

Wetland areas were represented in the MODFLOW models using river cells downgradient of the FTB Containment System and drain cells upgradient of the system (i.e., between the Tailings Basin and the FTB Containment System). A river cell, implemented via the River Package in MODFLOW, is a head-dependent boundary condition. If the modeled hydraulic head in the aquifer is higher than the river cell control elevation, the cell removes water from the aquifer. Conversely, if the head in the aquifer is lower than the control elevation, the cell contributes water to the aquifer. This flux is regulated by the river cell conductance, a function of the hydraulic conductivity, area and thickness of the riverbed deposits represented by the boundary condition (Reference (18)). A drain cell, implemented via the Drain Package in MODFLOW, functions similarly to a river cell but cannot contribute water to the aquifer (Reference (18)). Because the containment system drain pipe induces a strong downward hydraulic gradient, drain cells were selected to represent wetlands between the Tailings Basin and the FTB Containment System; this prevented the modeled wetlands from contributing more water to the FTB Containment System than would actually be available in the wetlands.

Wetland locations in each MODFLOW model were determined using a combined wetlands dataset, derived from National Wetlands Inventory data (Reference (25)), into which site wetland delineations were incorporated. Model centerlines (described in Section 3.1) were used to determine wetland placement in the models; the centerlines were intersected with the wetlands dataset, and the length of each column segment within wetland areas was calculated. A river or drain cell was placed in the top model layer in columns fully or partly coincident with wetlands, with the exception of model cells downgradient of the FTB Containment System for the northwest flow path. Though delineated wetlands are not present there, river cells were added from the cutoff wall to 50 feet downgradient of the wall to represent the head control that will be realized from flow augmentation downgradient of the FTB Containment System. Delineated wetlands are present downgradient of the FTB Containment System for the north and west flow paths, and additional boundary conditions were not necessary to represent the head control that will be realized from flow augmentation in these locations.

To calculate each cell's conductance, the length of overlap between column segment and wetland was used in Equation 3-3:

$$C = K\frac{LW}{M}$$ **Equation 3-3**

Where *K* is the hydraulic conductivity of the riverbed or drain material, *L* is length of the cell within wetland areas, *W* is the cell width and *M* is the thickness of the riverbed or drain material. A constant value was specified for all variables other than length: a hydraulic conductivity of 49.2 feet/day (representative of relatively conductive material) and a width and thickness of one foot were used. Groundwater flux to or from the aquifer is regulated by this conductance and is dependent on the difference between the hydraulic head in the aquifer and the river or drain control elevation; to represent wetland areas, control elevations were set to the ground surface elevation of each river or drain cell.

3.2.4 Representation of the Embarrass River

Specified-head cells were used to represent the Embarrass River in the MODFLOW models. The location of the river was determined using the National Hydrography Dataset (Reference (26)), and each model was extended from the Tailings Basin such that the last model column intersected the river. Specified-head cells were placed in all model layers in the last column; these cells maintain a specific hydraulic head in the aquifer below the river (Reference (18)). In each model, the ground surface elevation of the last column, representative of the stage of the Embarrass River, was used to set the boundary's hydraulic head. The distance from the Tailings Basin to the river, and the river stage used in each model, are listed in Table 3-5.

Table 3-5 Embarrass River Parameters

Model	Distance from Tailings Basin to Embarrass River (Feet)	Embarrass River Elevation (Feet Mean Sea Level)
North	15,820	1428.3
Northwest	16,870	1425.6
West	17,620	1411.9

3.2.5 No-Flow Boundaries

The bottoms of the flow path models, as well as the long sides of each model's single row, are no-flow boundaries. While these boundaries constrain and simplify the modeled groundwater flow fields, they conceptually represent general flow conditions. The long sides of each model's single row are parallel to the flow paths, and the bottom model boundary conceptually represents the depth at which the bedrock can be considered impermeable, as it has significantly lower hydraulic conductivity than the unconsolidated deposits and the more shallow portions of the bedrock. . Simulation of three different bedrock thicknesses was completed to capture the uncertainty in the range at which this depth may be encountered.

3.3 Hydraulic Conductivity and Porosity

Hydraulic conductivity and porosity (needed for particle tracking simulations) in the unconsolidated deposits and the bedrock, were simulated in the model as two homogeneous zones: one zone representing the unconsolidated deposits, and one zone representing bedrock. At the direction of the co-lead agencies, a horizontal hydraulic conductivity value of 13 feet per day, the representative average value from single-well pumping tests near the perimeter of the Tailings Basin (Reference (9)), and an assumed porosity value of 0.3 was assigned to the unconsolidated deposits in the model. The ratio of horizontal to vertical hydraulic conductivity was assumed to be 2.5:1, which is consistent with Freeze and Cherry (Reference (27)). A horizontal hydraulic conductivity value of 0.14 feet per day, the geometric mean value from packer tests conducted in borings near the Tailings Basin (Reference (11)), and an assumed porosity value of 0.05 was assigned to bedrock in the model. Because bedrock in the model represents the upper, fractured portion of bedrock, it was assumed to be isotropic. For the model realizations with bedrock thicknesses of 50 and 100 feet, applying the geometric mean hydraulic conductivity throughout the bedrock interval is a conservative assumption. In reality, the hydraulic conductivity of the bedrock likely decreases significantly with depth. RQD data from the bedrock that underlies the area to the north and west of the Plant Site indicate the influence of the upper fractured bedrock: average RQD increases from about 60% to 85% from the bedrock surface to 20 feet below the top of bedrock (Reference (7)).

3.4 Representation of the Containment System

Three primary components of the FTB Containment System were explicitly represented in the MODFLOW models: the cutoff wall, the drain pipe and the collection trench containing the drain pipe. The cutoff wall was implemented in each model via the Horizontal-Flow Barrier (HFB) Package in MODFLOW, used to simulate thin, vertical features with low hydraulic conductivity. Consistent with the FTB Containment System design, the wall was extended through model layers representing the unconsolidated deposits, from the ground surface to the bedrock; the hydraulic conductivity of the wall was set to 0.0028 feet/day, and a thickness of one foot was specified.

The distance between the Tailings Basin and the cutoff wall in each model was based on the proposed barrier alignment and is listed in Table 3-6. These distances may be longer than the direct distance between the perimeter of the Tailings Basin and the FTB Containment System, as they represent measurements along the groundwater flow paths, which are not necessarily orthogonal to the Tailings Basin.

Table 3-6 FTB Containment System Parameters

Model	Cutoff Wall Depth (Feet)	Distance from Tailings Basin to Cutoff Wall (Feet)	Drain Pipe Depth (Feet)
North	21.3	262	8
Northwest	15.0	334	8
West	11.7	364	5

The FTB Containment System drain pipe was represented in each flow-path model using a single drain cell, with a control elevation set five to eight feet below the ground surface; drain depths, listed in Table 3-6 are consistent with the FTB Containment System design, intended to prevent the system from freezing in winter (Reference (6)). Because the unconsolidated deposits are generally thinner in the vicinity of the FTB Containment System along the western groundwater flow path, the drain was placed closer to the ground surface in the west flow path model. In each model, the drain cell was positioned immediately inside the cutoff wall, in the model layer corresponding to the control elevation. The drain cell was assigned a hydraulic conductivity of 567 feet/day, which was used to calculate the drain cell conductance. The cells immediately above the drain were assigned a hydraulic conductivity of 284 feet/day, representative of the gravel backfill material to be used in the collection trench.

4.0 Results

Two simulations were conducted for each set of flow path models using MODFLOW: one representative of groundwater flow conditions during operations and one of conditions during long-term closure. The seepage rates were determined using the Plant Site groundwater model, as described in Attachment A of Reference (1) The models were run in steady-state.

Following the MODFLOW simulation, particle tracking was completed with MODPATH. One particle was started in the first column of each model layer in each model, where seepage is specified, and tracked forward through the modeled groundwater flow fields. In all simulations, the particles that originated in the model layers representing the unconsolidated deposits were captured by the FTB Containment System. The seepage from the Tailings Basin to bedrock was divided equally between the model layers representing bedrock. To calculate the seepage rate bypassing the FTB Containment System, the number of bedrock particles that bypassed the FTB Containment System were counted. The number of particles bypassing was then divided by the total number of bedrock particles and this proportion was multiplied by the total seepage from the Tailings Basin to bedrock to obtain the flow bypassing the FTB Containment System. Because the models were run in steady-state, the MODPATH results represent the long-term conditions; in reality, operations conditions may not be maintained for long enough for the system to reach steady-state. Particle tracking results under operations conditions are shown in Large Figure 4 through Large Figure 6; results under long-term closure conditions are shown in Large Figure 7 through Large Figure 9.

The results of the modeling indicate nearly all seepage from the Tailings Basin is captured by the FTB Containment System, as summarized in Table 4-1.

Table 4-1 Tailings Basin Seepage in GPM Bypassing the Containment System

Bedrock Fracture Zone Thickness	North Flow Path		Northwest Flow Path		West Flow Path	
	Operations (Mine Year 7)	Long-Term Closure	Operations (Mine Year 7)	Long-term Closure	Operations (Mine Year 7)	Long-Term Closure
25 feet	0	0	0	0	0	0
50 feet	0	0	0	0	0	0
100 feet	0	0	0	0	8	7

5.0 Summary and Conclusions

Groundwater modeling of groundwater seepage from the Tailings Basin to the north, northwest, and west flow paths was conducted to support the GoldSim water quantity and quality modeling. The objective of the flow-path models was to estimate the rate of seepage from the Tailings Basin that will pass beyond the FTB Containment System, thereby determining the effectiveness of the capture system.

Three MODFLOW flow path models, north, northwest, and west, corresponding to groundwater flow paths defined in the GoldSim model, were constructed. The flow path models originate at the toe of the tailings basin dams and terminate at the Embarrass River. Each model simulates groundwater flow along one of these three paths, representing a narrow, cross-sectional slice of aquifer spanning the length of a groundwater flow path. Model parameters and boundary conditions were set using data from onsite investigations and Project description; seepage from the Tailings Basin to each flow path was determined using the Plant Site model (Attachment A of Reference (1)).

Steady-state model simulations were completed for each flow path under operations and long-term closure conditions and for each of three assumed thicknesses of the more permeable fractured zone at the top of the bedrock. In total, 18 model simulations were completed. Model results indicated that all seepage from the Tailings Basin will be captured from the north and northwest flow paths under all assumptions of bedrock fracture zone thickness. From the west flow path all seepage is captured for bedrock fracture zone thicknesses of 25 feet and 50 feet; however, when the bedrock fracture zone thicknesses is assumed to be 100 feet, the model estimates that 8 gpm of seepage bypasses the FTB Containment System under operations conditions, and 7 gpm of seepage bypasses the FTB Containment System under long-term closure conditions. These flow rates correspond to 0.8% and 1% of total seepage toward the west flow path for operations and long-term closure conditions, respectively. Relative to the average aquifer capacity of the west flow path (110 gpm; Reference (1)), the rate of bypassing seepage is approximately 7% and 6% for operations and closure, respectively.

These results indicate that the Plant Site GoldSim model assumption (that seepage equal to 10% of the aquifer capacity bypasses the FTB Containment System) (Section 5.2.2. of Reference (1)) is conservative. The modeling shows that, at most, seepage equal to 7% of the aquifer capacity bypasses the system.

6.0 References

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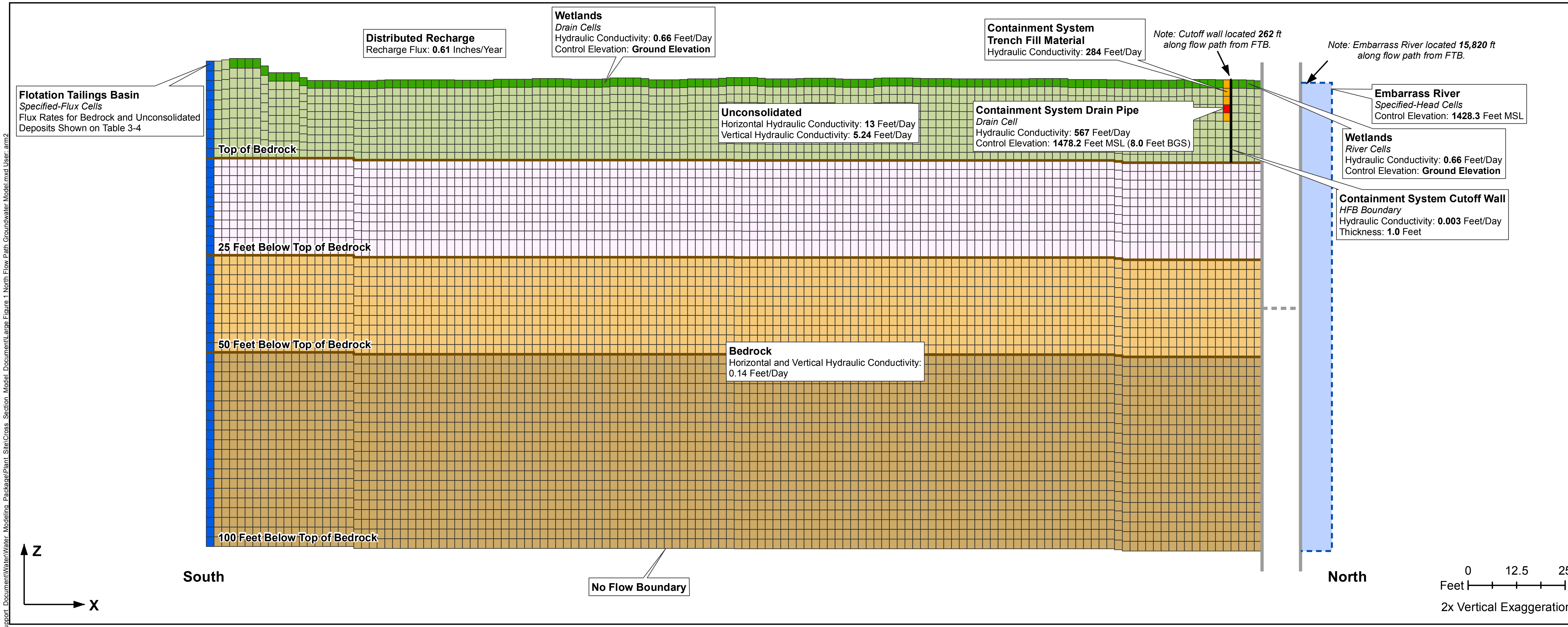
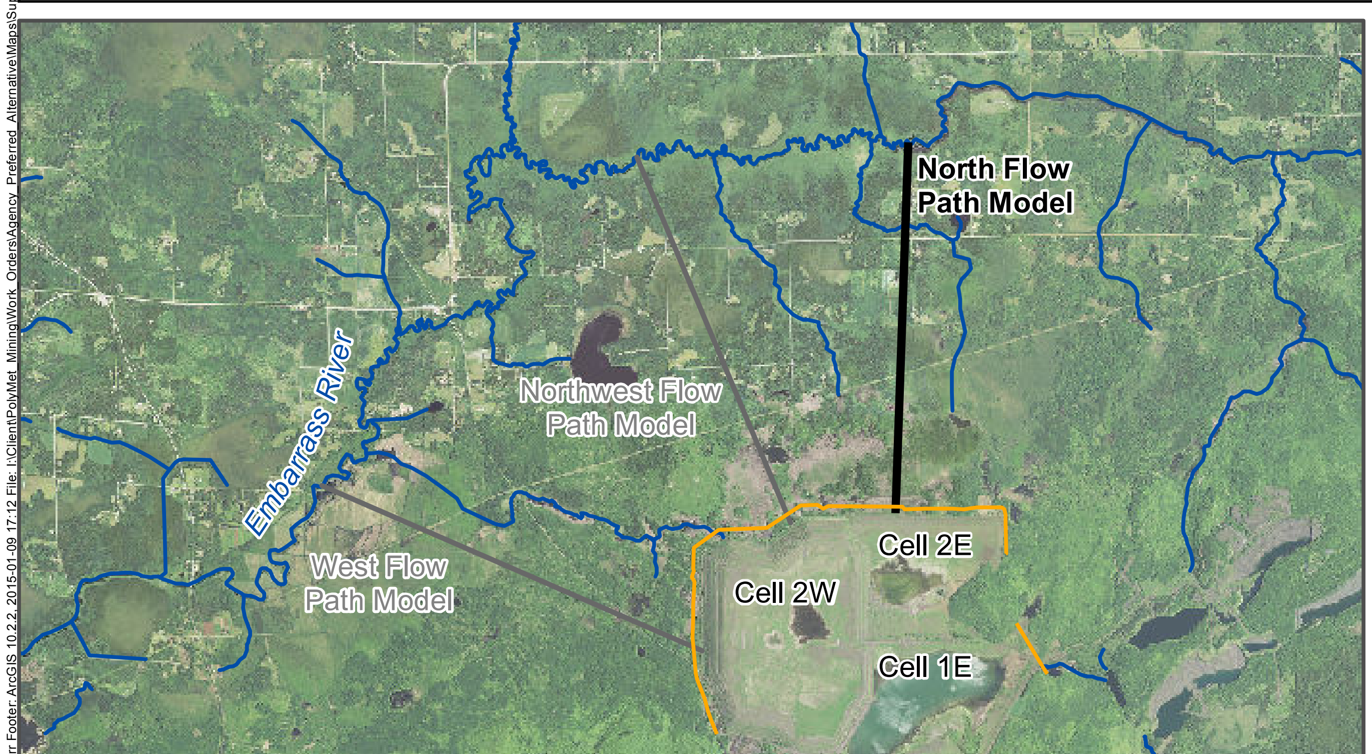
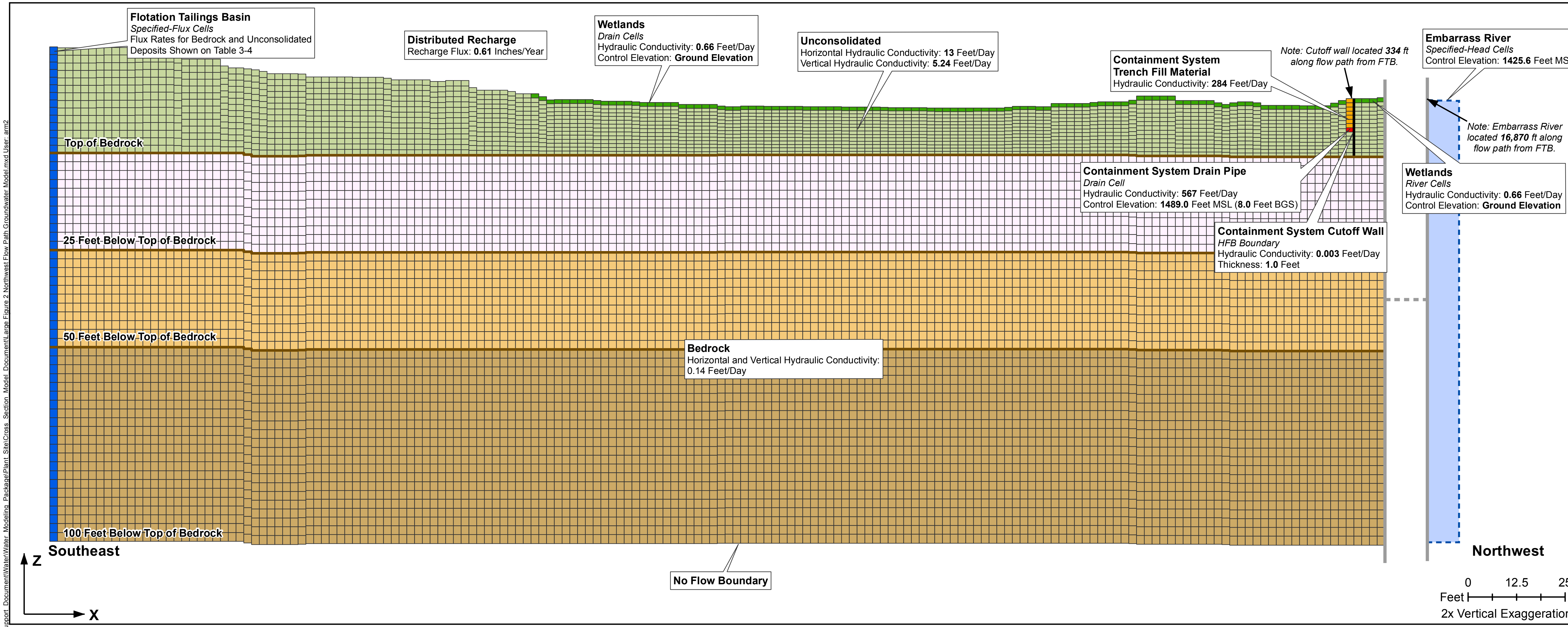
Large Figures

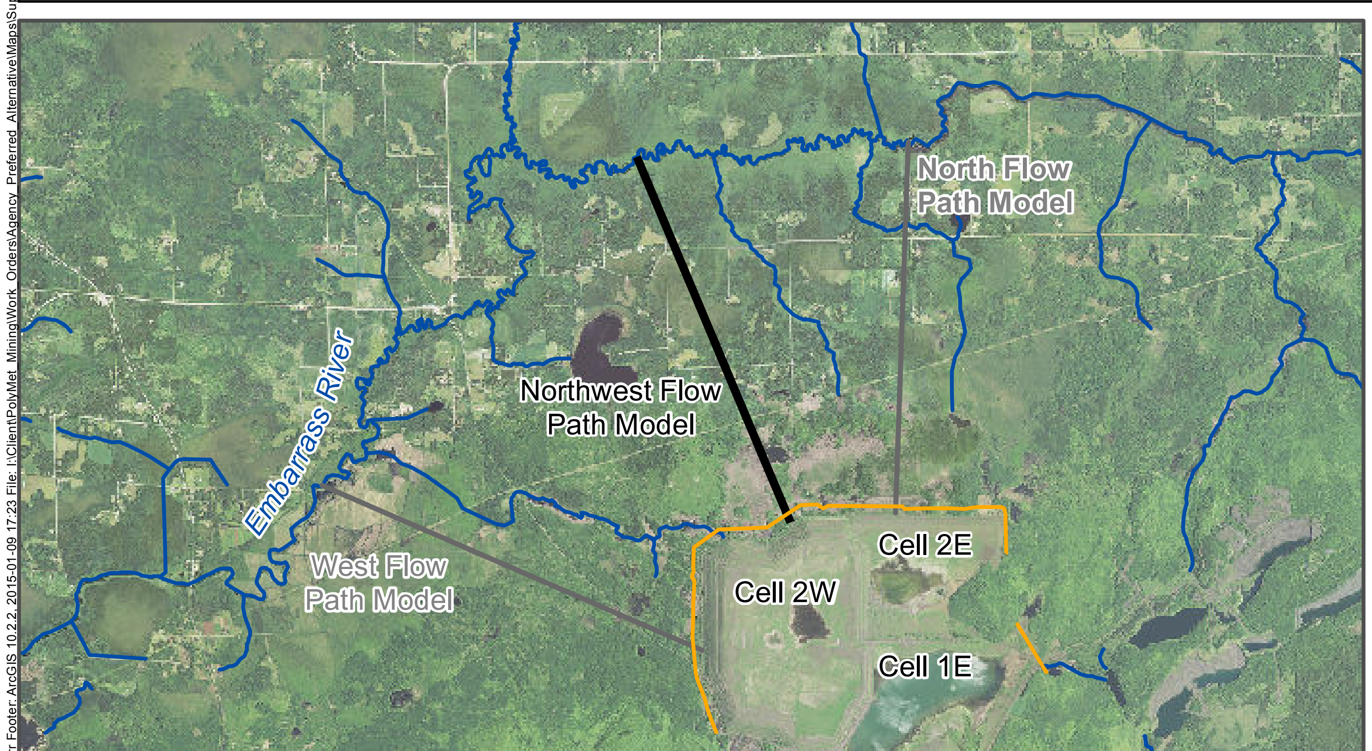


Note: North Flow Path Models included the top 25, 50, or 100 feet of bedrock. The total depth shown represents 100 feet of bedrock with the 25- and 50-foot depth intervals shown.



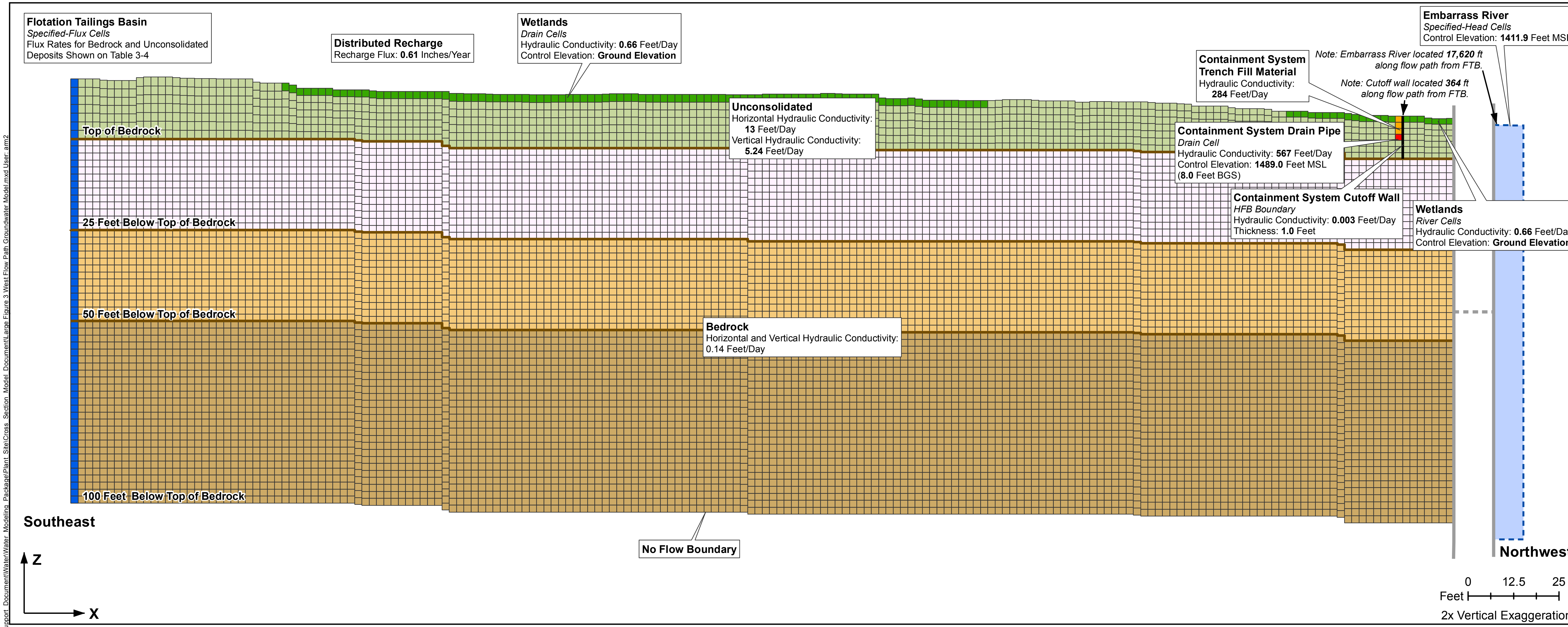
Large Figure 1
NORTH FLOW PATH GROUNDWATER MODEL
NorthMet Project
Poly Met Mining, Inc.
Hoyt Lakes, MN



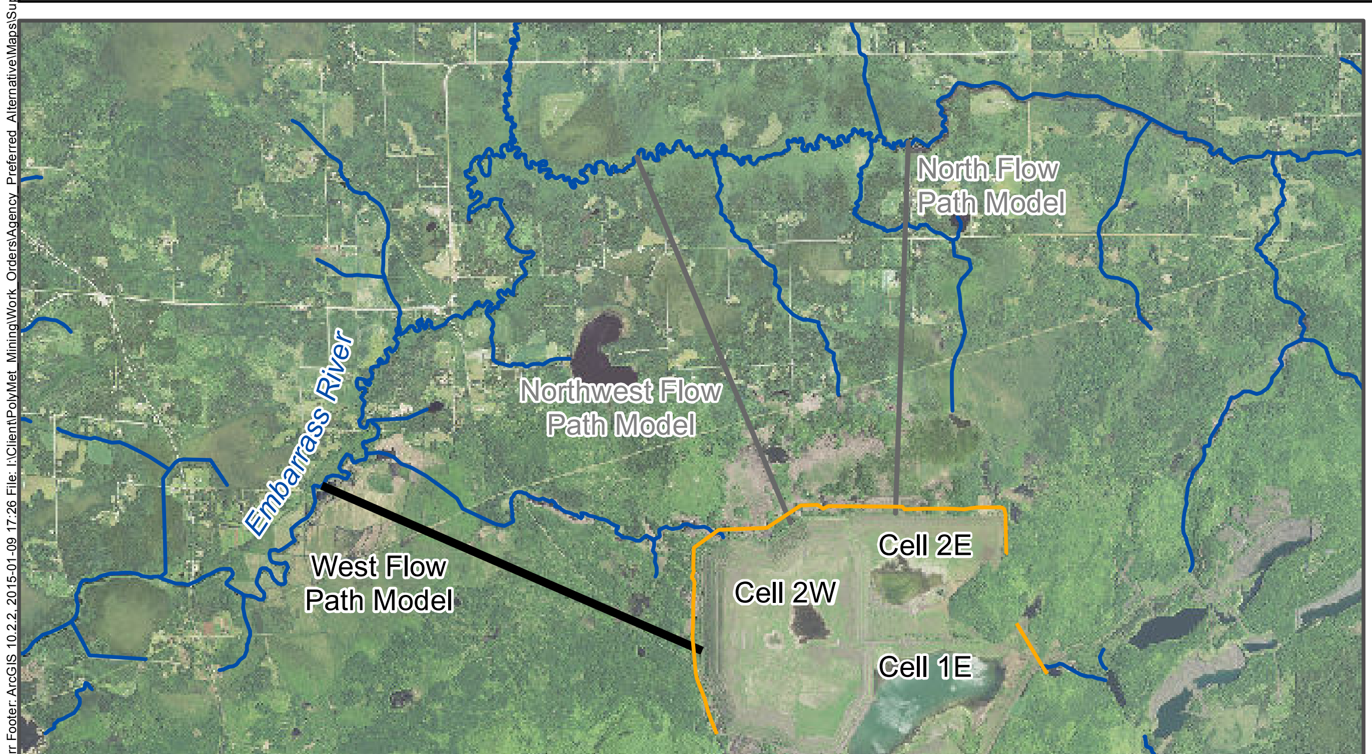


Note: Northwest Flow Path Models included the top 25, 50, or 100 feet of bedrock. The total depth shown represents 100 feet of bedrock with the 25- and 50-foot depth intervals shown.

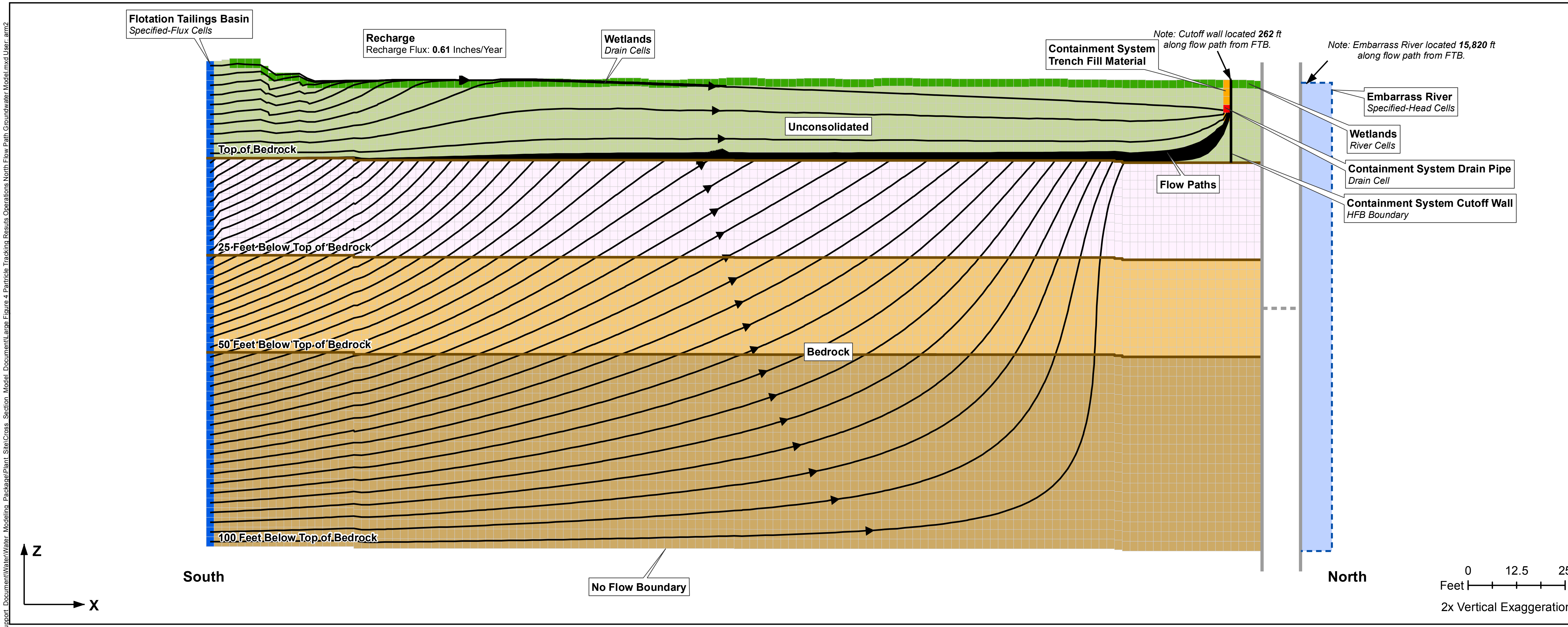
Large Figure 2
NORTHWEST FLOW PATH GROUNDWATER MODEL
NorthMet Project
Poly Met Mining, Inc.
Hoyt Lakes, MN

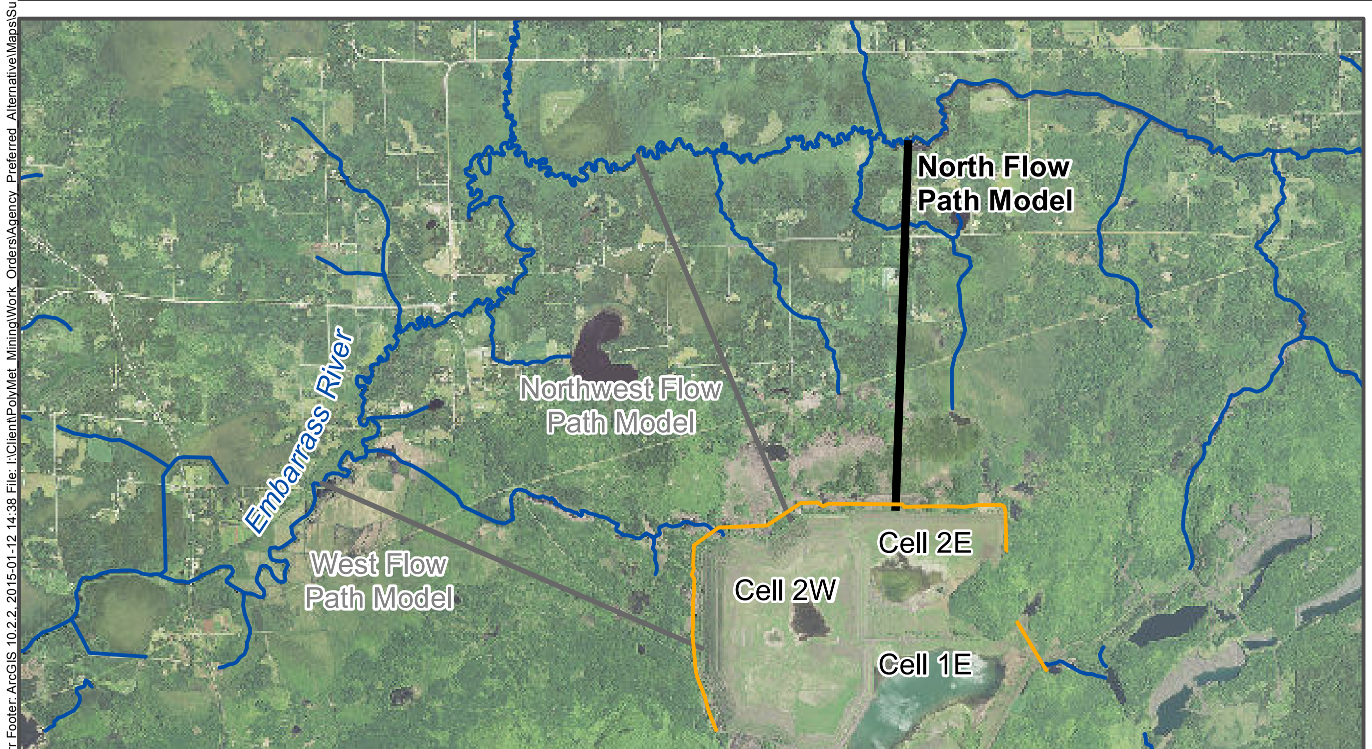


Note: West Flow Path Models included the top 25, 50, or 100 feet of bedrock. The total depth shown represents 100 feet of bedrock with the 25- and 50-foot depth intervals indicated.



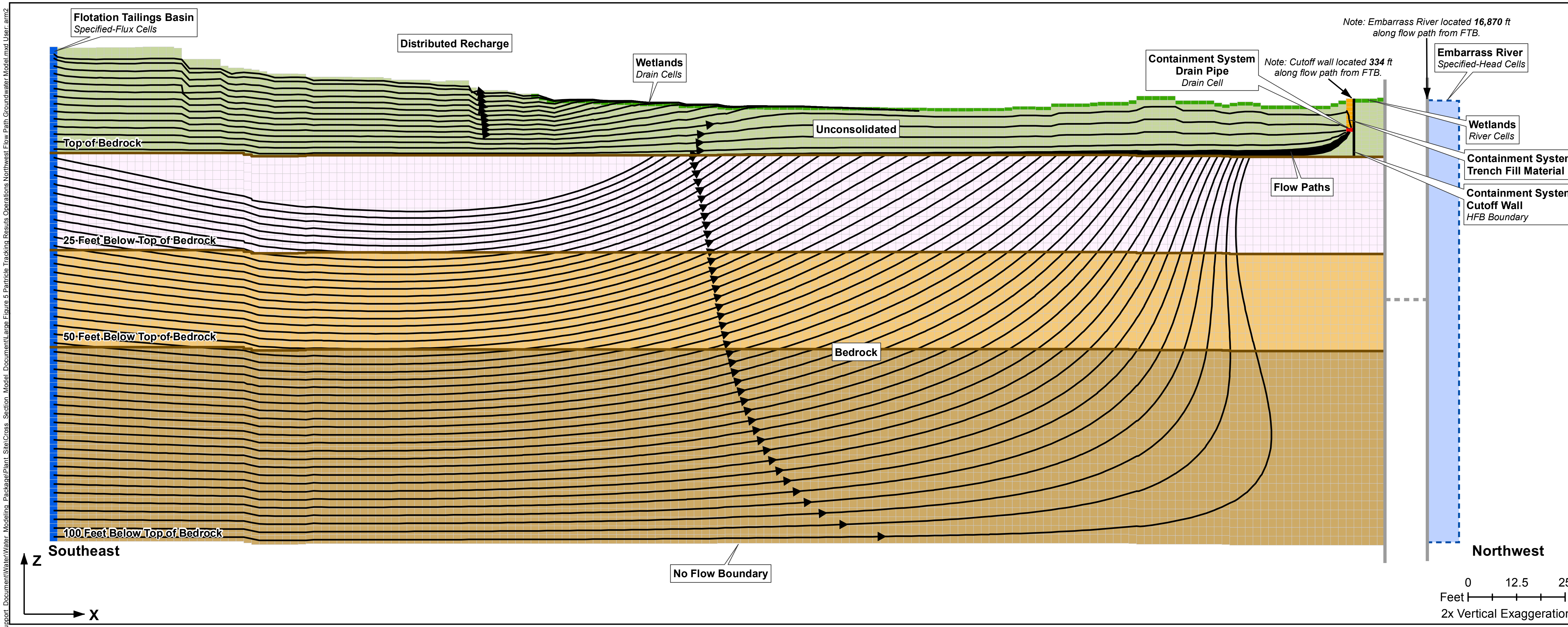
Large Figure 3
WEST FLOW PATH
GROUNDWATER MODEL
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN

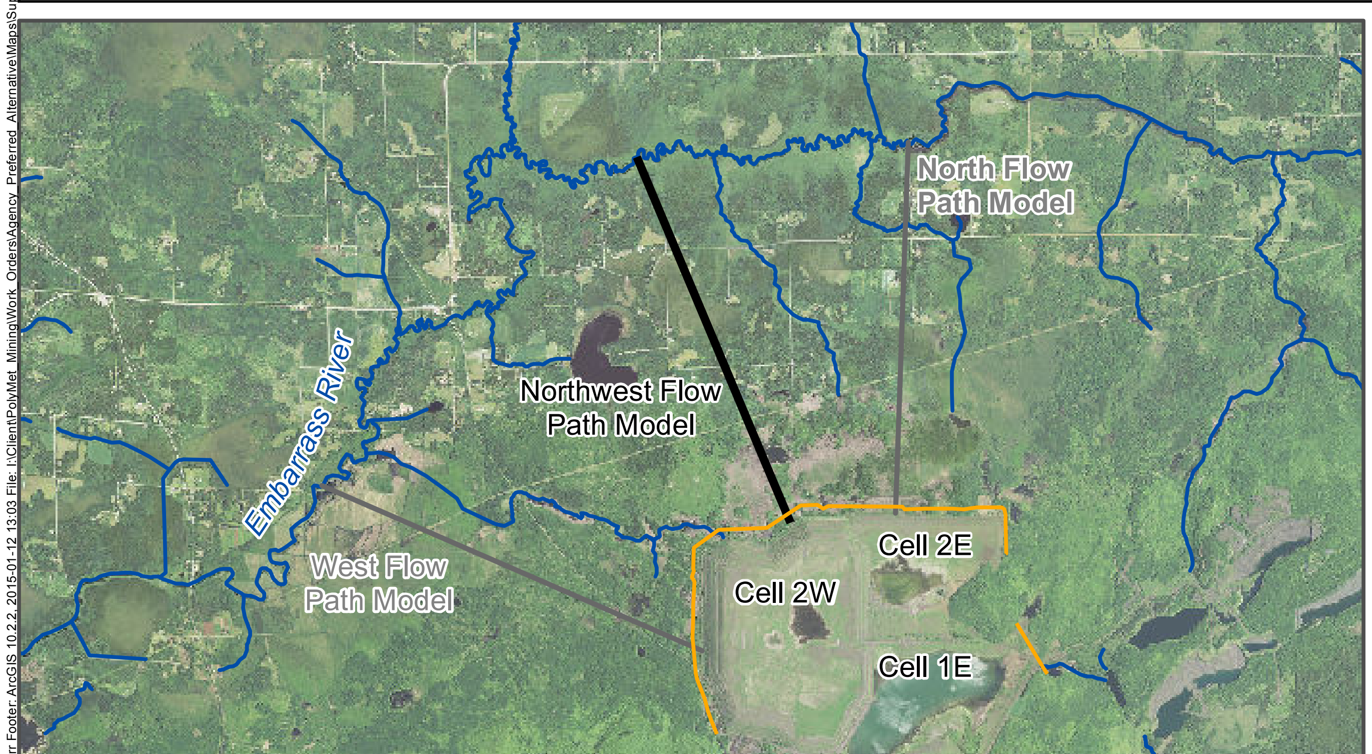




Note: North Flow Path Models included the top 25, 50, or 100 feet of bedrock. The total depth shown represents 100 feet of bedrock with the 25- and 50-foot depth intervals indicated. Particle tracking results are only shown for the simulation with 100 feet of bedrock.

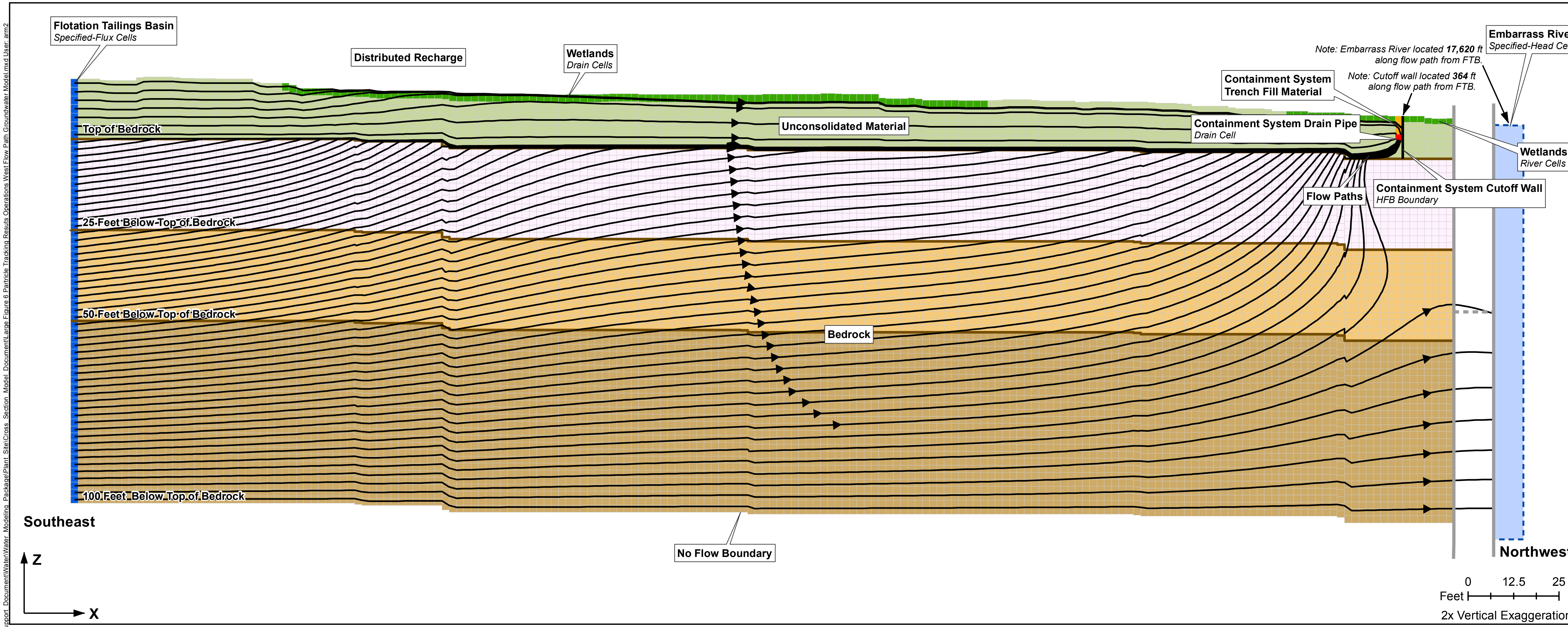
Large Figure 4
PARTICLE TRACKING RESULTS, OPERATIONS
NORTH FLOW PATH GROUNDWATER MODEL
NorthMet Project
Poly Met Mining, Inc.
Hoyt Lakes, MN

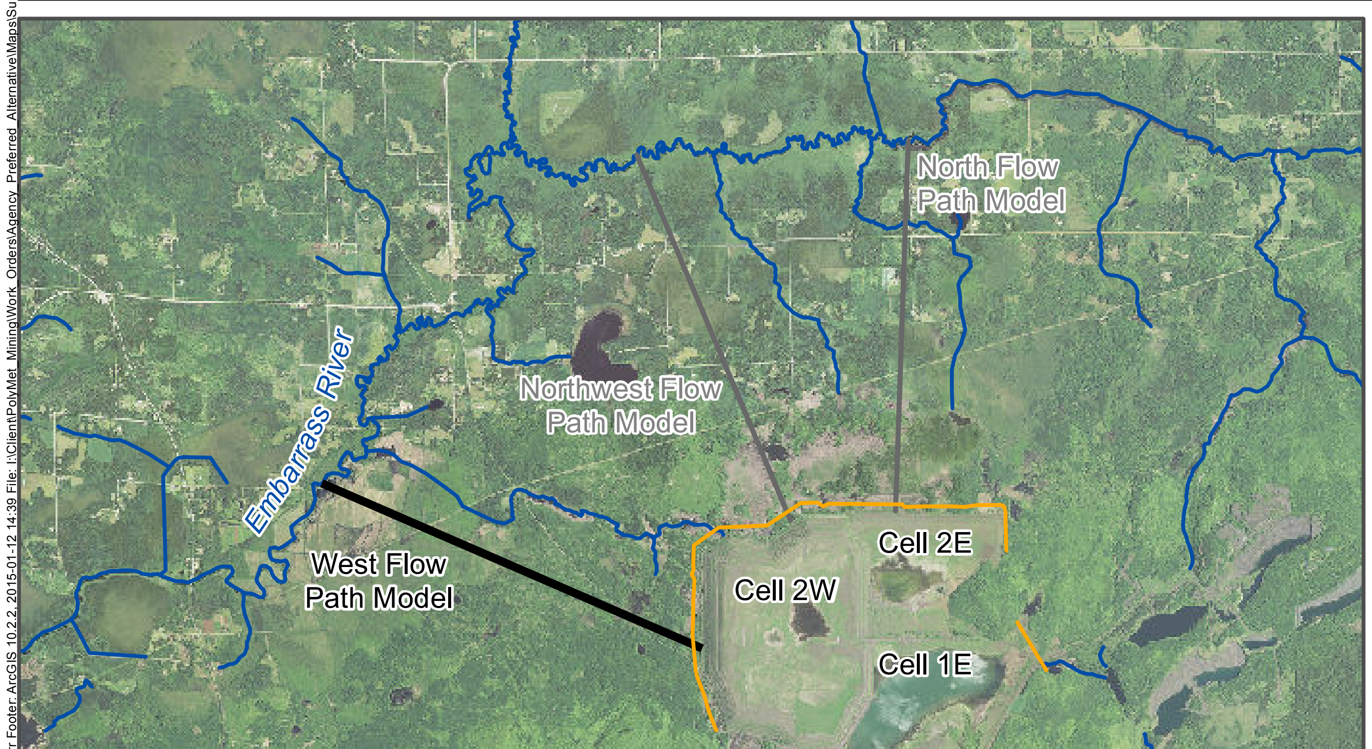




Note: Northwest Flow Path Models included the top 25, 50, or 100 feet of bedrock. The total depth shown represents 100 feet of bedrock with the 25- and 50-foot depth intervals indicated. Particle tracking results are only shown for the simulation with 100 feet of bedrock.

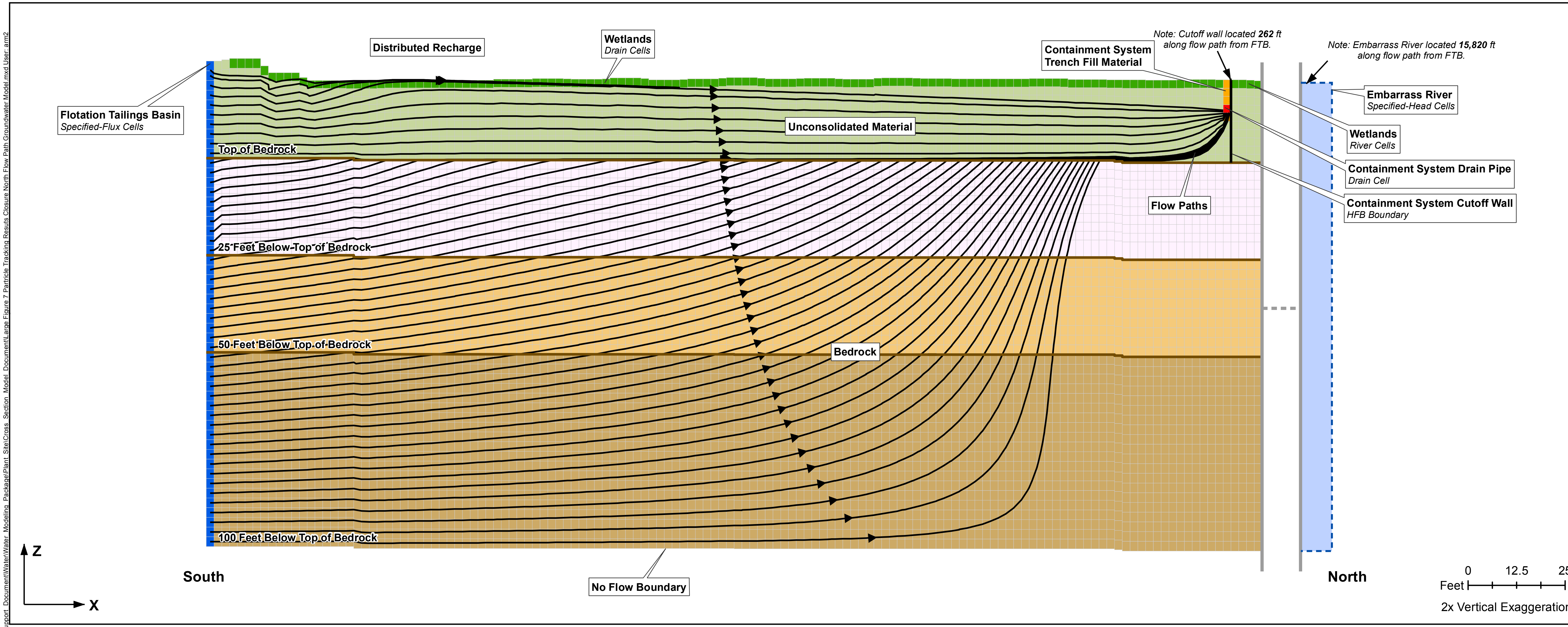
Large Figure 5
PARTICLE TRACKING RESULTS, OPERATIONS
NORTHWEST FLOW PATH GROUNDWATER MODEL
NorthMet Project
Poly Met Mining, Inc.
Hoyt Lakes, MN

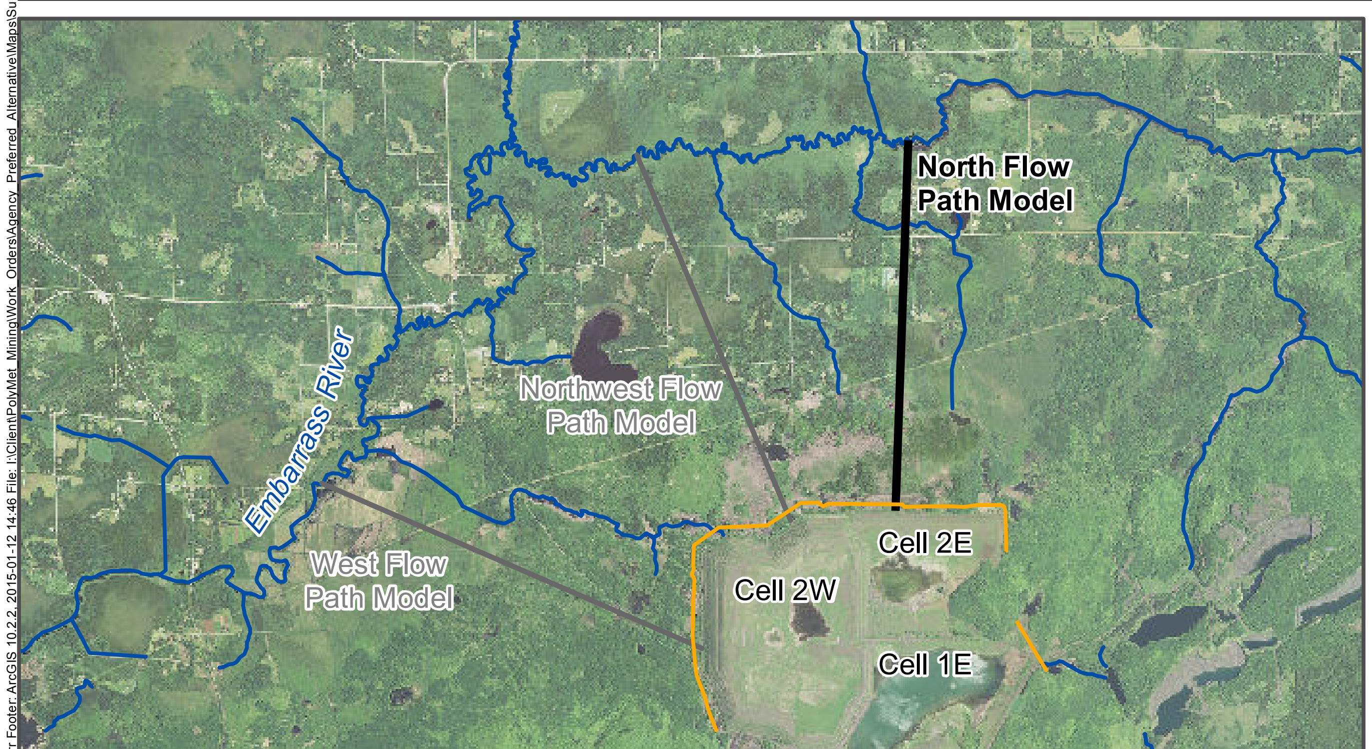




Note: West Flow Path Models included the top 25, 50, or 100 feet of bedrock. The total depth shown represents 100 feet of bedrock with the 25- and 50-foot depth intervals indicated. Particle tracking results are only shown for the simulation with 100 feet of bedrock.

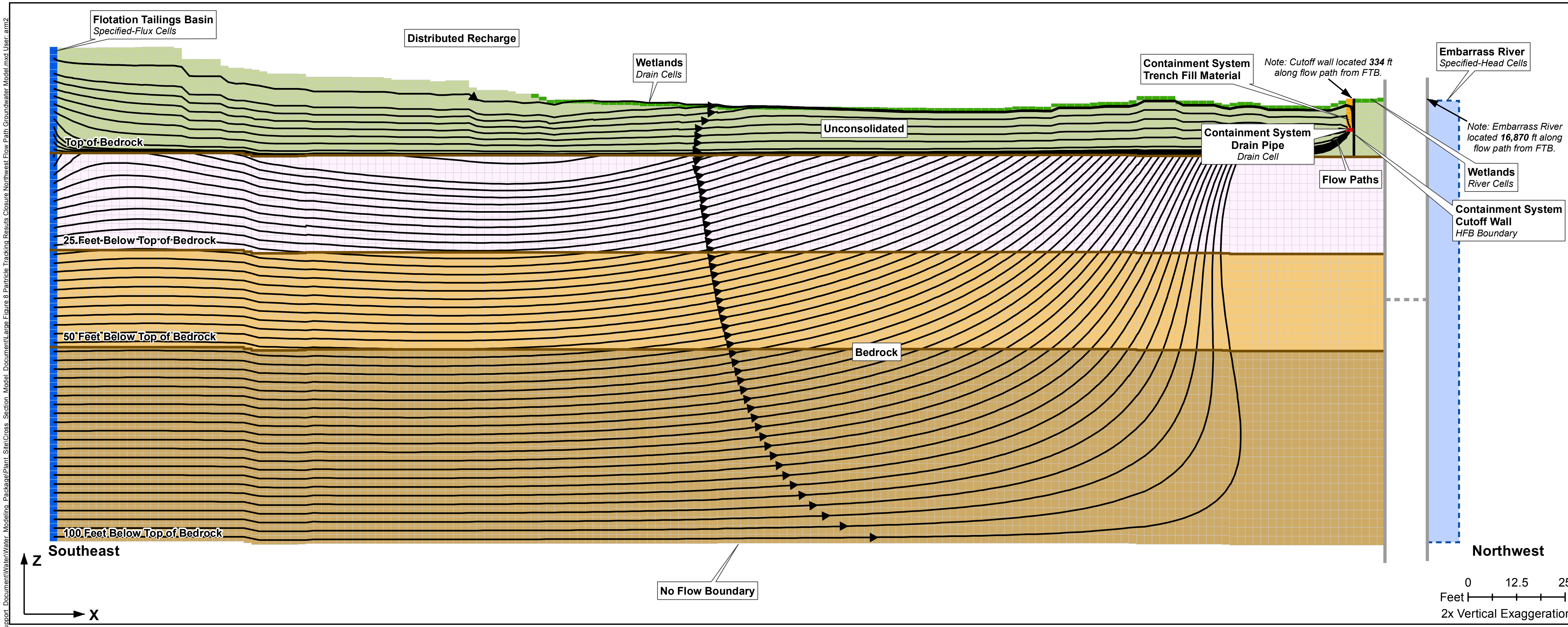
Large Figure 6
PARTICLE TRACKING RESULTS, OPERATIONS
WEST FLOW PATH GROUNDWATER MODEL
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN

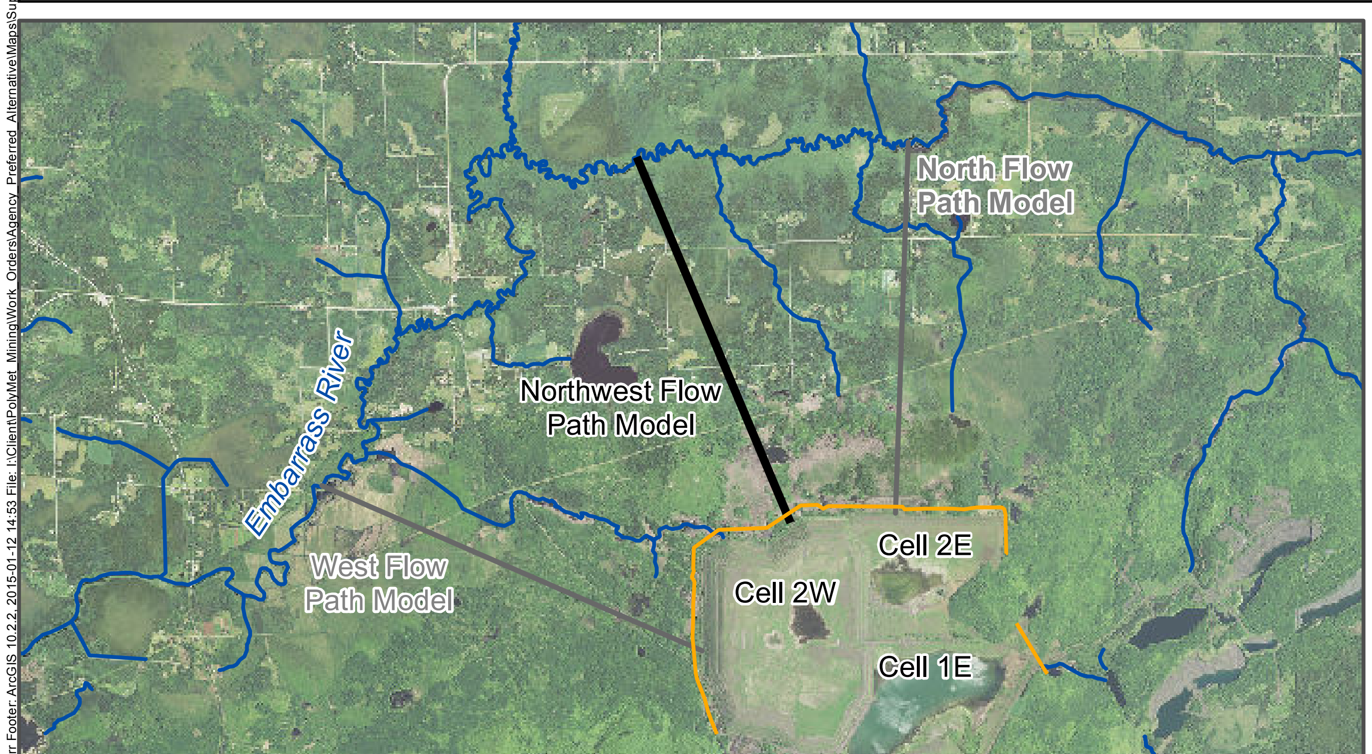




Note: North Flow Path Models included the top 25, 50, or 100 feet of bedrock. The total depth shown represents 100 feet of bedrock with the 25- and 50-foot depth intervals indicated. Particle tracking results are only shown for the simulation with 100 feet of bedrock.

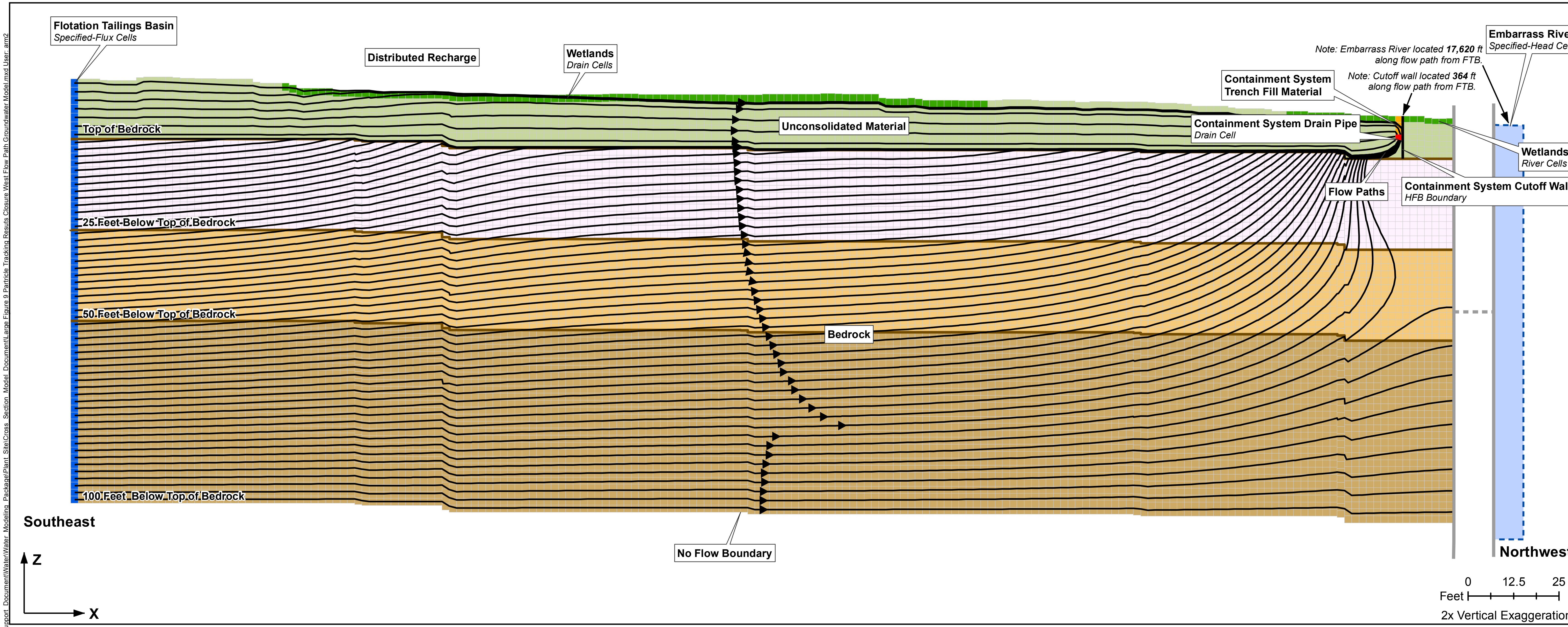
Large Figure 7
PARTICLE TRACKING RESULTS, CLOSURE
NORTH FLOW PATH GROUNDWATER MODEL
NorthMet Project
Poly Met Mining, Inc.
Hoyt Lakes, MN

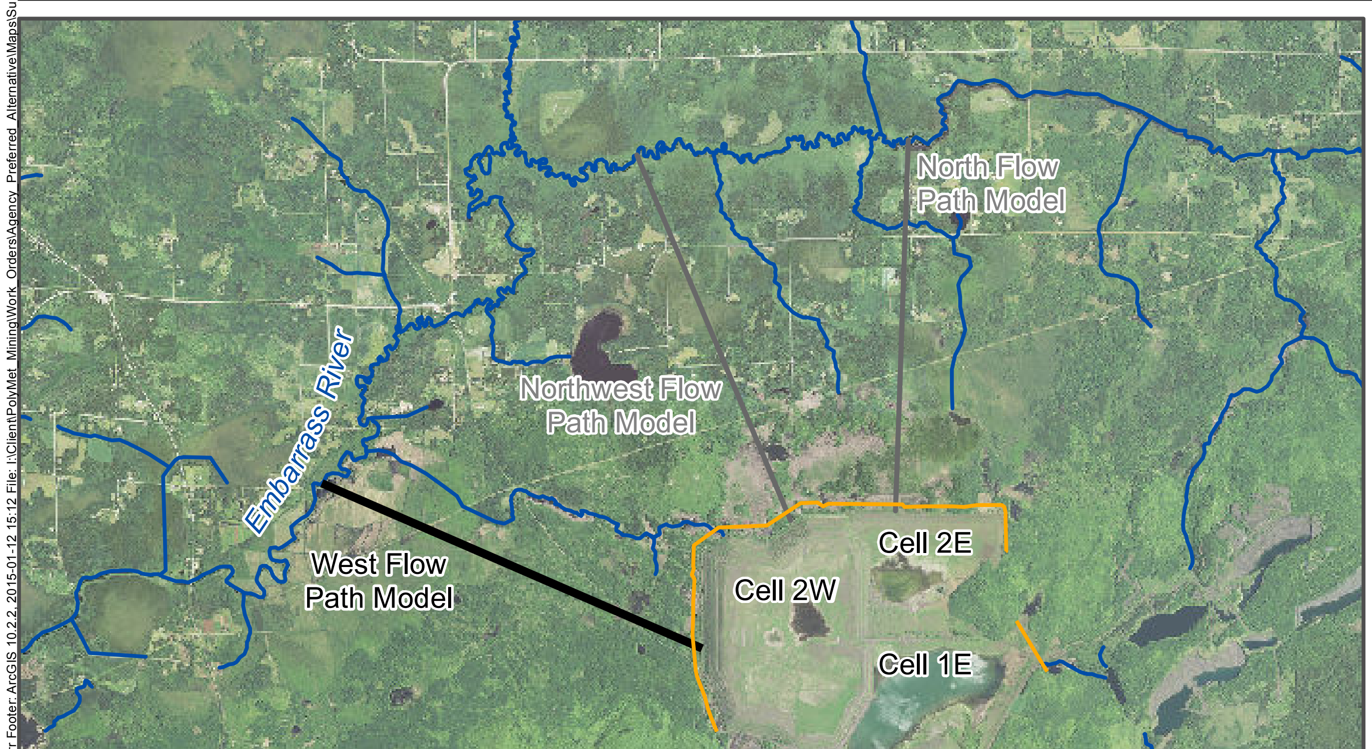




Note: Northwest Flow Path Models included the top 25, 50, or 100 feet of bedrock. The total depth shown represents 100 feet of bedrock with the 25- and 50-foot depth intervals indicated. Particle tracking results are only shown for the simulation with 100 feet of bedrock.

Large Figure 8
PARTICLE TRACKING RESULTS, CLOSURE
NORTHWEST FLOW PATH GROUNDWATER MODEL
NorthMet Project
Poly Met Mining, Inc.
Hoyt Lakes, MN





Note: West Flow Path Models included the top 25, 50, or 100 feet of bedrock. The total depth shown represents 100 feet of bedrock with the 25- and 50-foot depth intervals shown. Particle tracking results are only shown for the simulation with 100 feet of bedrock.

Large Figure 9
PARTICLE TRACKING RESULTS, CLOSURE
WEST FLOW PATH GROUNDWATER MODEL
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN

Attachment D

Preliminary Sewage Treatment System Facility Plan

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BARR

Technical Memorandum

To: Paul Brunfelt
From: Jon M. Minne, P.E.
Subject: Preliminary Sewage Treatment System Facility Plan
Date: December 18, 2014
Project: NorthMet Mine Site and Tailings Basin
Pre-Development Engineering and Construction Oversite
Project #23690C29

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: Jon M Minne
Typed or Printed Name: Jon M Minne
Date: June 23, 2015
Lic. No. 25080

1.0 Background

Poly Met Mining Inc. (PolyMet) located near Hoyt Lakes, MN plans to update its sanitary sewage treatment system prior to re-opening the site of its repurposed taconite processing facility. Only a small number of administrative employees currently occupy the site since it ceased taconite operations in 2001 and retired its mechanical type sanitary sewage treatment facility. The wastewater generated by the administration building is now routed to a drain field that was added in 2001. Upon reopening the site for copper/nickel processing, sanitary sewage will be routed to a treatment system designed to accommodate the anticipated sanitary sewer contributions. The decommissioned mechanical sanitary sewage treatment facility from 2001 remains onsite, but PolyMet personnel have determined that, due to the age and condition, replacement of the treatment facility is needed. Additionally, the collection system currently in place will require thorough review and refurbishment.

2.0 Purpose

The purpose of this preliminary sewage treatment facility plan is to identify and outline the process that has been used for selecting the proposed changes needed to the sewage treatment system prior to re-opening the PolyMet mine site. First, this plan provides a review the existing (expired) NPDES permit. Next, a preliminary evaluation of the existing sanitary sewer systems has been completed. Third, the calculations of design flows and loads for a proposed new sewage treatment system are presented. An alternatives evaluation for the proposed improvements along with a summary and conclusion section completes the memo.

Suggested improvements to the collection system have been outlined and two alternatives for sanitary sewage treatment were explored in this memo. Both alternatives follow the removal and disposal of the existing sewage treatment plant and refurbishment of the existing collection system.

- construct a stabilization pond system
- install a package-type mechanical treatment plant

Anticipated site use and design flows for the future system were calculated based on MPCA guidelines and historical treatment data. Sizing of the mechanical treatment system components and the stabilization pond considered past NPDES limitations when applied to the anticipated daily flows. Descriptions of the two alternatives for sanitary sewage treatment provide adequate information, as required by the MPCA, for the permitting process prior to construction.

3.0 NPDES Permit

Cliffs Erie, LLC was issued an NPDES permit (No. MN0054089) for its taconite processing facility on May 4, 2001. The existing permit applies to the facility as it was operating at the time of permit issuance and has since expired on November 30, 2005. The existing permit states that design plans and specifications for replacement and upgrades of the sewage treatment system are required in the event of renovation or replacement of the sewage treatment system after September 30, 2001 (Chapter 8, Section 6).

The design criteria for the preliminary Sewage Treatment System Facility Plan were based on the existing (expired) permit, although the volume of flow will be significantly different. The existing system was permitted for an average wet weather design flow of 0.105 MGD (Permitted Facility Description, p.4). The permitted effluent discharge water quality requirements in accordance with the existing (expired) permit are summarized in Table 3-1.

Table 3-1 Existing (Expired) Permitted Effluent Water Quality Requirements

Parameter	Limit	Limit Type	Effective Period	Sampling Type	Frequency
CBOD5	9.9 kg/day 25 mg/L 16 kg/day 40 mg/L	Calendar month average Calendar month average Maximum calendar week average Maximum calendar week average	Jan - Dec Jan - Dec Jan - Dec Jan - Dec	8-Hour Flow Composite	2 x Month
Chlorine, total residual	Monitor only (mg/L)	Daily maximum	Jan - Dec	Grab	1 x Day
Fecal coliform, MPN or Membrane Filter 44.5C	200 #/100 mL Monitor only	Calendar month geometric mean Maximum calendar week average	May - Oct	Grab	2 x Month
Flow	Monitor Only	Calendar Month Average Calendar Month Maximum Calendar Month Total	Jan - Dec	Measurement, Continuous	1 x Day
pH, Field	9.0 6.0	Instantaneous Maximum Instantaneous Minimum	Jan – Dec	Grab	2 x Month
Solids, Total Suspended	12 kg/day 30 mg/L 18 kg/day 45 mg/L	Calendar month average Calendar month average Maximum calendar week average Maximum calendar week average	Jan - Dec Jan - Dec Jan - Dec Jan - Dec	8-Hour Flow Composite	2 x Month

4.0 Preliminary Evaluation of Existing Sewage Facilities

This section summarizes the existing sanitary sewage facilities at the PolyMet plant site near Hoyt Lakes. The plant site sewage facilities consist of pump stations, gravity and pressure collection piping, and sewage treatment facilities to treat the waste generated by employees. In addition to domestic wastes generated from restroom use, showers wash facilities, and a lunchroom area; the sewage system treated wastewater from the Heating Plant and the facility potable water treatment plant.

The preliminary evaluation of the plant site sewage treatment system consists of two parts: the collection system refurbishment and the sewage treatment plant.

4.1 Collection System

The existing collection system is primarily original construction. Based on available drawings, the collection system consists of various sizes of sanitary sewer piping (4-inch to 10-inch diameter) and manholes originally constructed in 1955. The type of pipe within the existing tunnels under the plant is cast iron. The type of pipe in the yard areas and near the coarse crusher is not disclosed on the available historical drawings. The manholes are reinforced concrete sections with cast iron castings, based on the historical drawings provided. The collection system is described in the sections below,, which correspond to the site plan of the existing facilities shown on the attached SWGT-001, Sewage Treatment Plant - Overall Site Plan.

Segment A:

This segment encompasses existing collection systems in the southern part of plant site. The administration building has an existing septic tank and a submersible pump lift station located on the south side of the building. The forcemain carries the wastewater around the east side of the building and then follows the road north to an existing drain field. An abandoned forcemain continues from this point northeast to the sewage treatment plant.

Segment B:

This segment encompasses existing collection systems in the northern part of plant site. The booster pump house at the north end of the plant site has a gravity line leading to an existing drain field on the northwest side of the building.

Segment C:

This segment encompasses existing collection systems in the central part of plant site. The plant site collection system begins on the north end at Sanitary Manhole #12 located just outside the southeast corner of the Coarse Crusher Building. From here, the sanitary sewer follows the road to the south between the Concentrator and the Drive House. Just north of the Fine Crusher, the sanitary sewer collects the flow from the fine crusher and turns west to collect the flow from the Concentrator. Sewage piping from the Garage General Shop areas connects in between the fine crusher and the Concentrator. The piping then continues to the southwest until it reaches Sanitary Manhole #1.

Sewage piping from the demolished pellet plant location area serving the Concentrate Loadout area runs northwesterly until connecting to Sanitary Manhole #1. From Sanitary Manhole #1, the sanitary sewage is combined conveyed south to the abandoned sewage treatment plant.

4.2 Existing Sewage Treatment Plant

The existing plant (to be abandoned) includes a, comminutor, primary clarifier, aerator clarifier, chlorine contact tank, chlorine room, office/pump room and digester. The existing sewage treatment plant is in poor condition. The above grade building is cinder block with numerous dark areas within the mortar, cracks along the blocks and air gaps between the blocks, the below grade treatment tanks and digester are cast in-place concrete. The concrete wall of the digester abutting the aeration tank is cracked. The condition of the concrete foundation is unknown and may be salvageable.

Originally, effluent was discharged near the plant into a ditch that flowed to Second Creek. A pump station was later added to discharge effluent to the northeast where it discharged into the Emergency Basin. The effluent pumping station is flooded with groundwater signifying possible structural issues

5.0 Design Basis Flows and Loads

The sanitary wastewater flows and loads for the new PolyMet facility have been estimated based on typical design values for industrial facilities, predictive future flows based on mine employee increases, and historical flow and loading data based on the expired NPDES permit. The computations were completed using the MPCA *Design Flow and Loading Determination Guidelines for Wastewater Treatment Plants*. Attachment A includes the document and associated worksheets. The planning period for wastewater treatment facilities recommended by Board of State and Provincial Public Health and Environment Managers, Recommended Standards for Wastewater Facilities (*Ten States Standards* Reference (1)), is 20 years. The current mine life is expected to be 20 years. Based on this, the planning period of 20 years is appropriate, however, if mining plans change sooner than 20 years, this facility plan will need to be reviewed and updated as necessary.

5.1 Employment

This section presents the employment levels based on the current mining plans. The numbers of plant employees listed below are those employees contributing flows directly to the sewage treatment system at the plant site. There will be another 120 workers reporting to the Mine Site and the wastewater generated from them will be properly handled at the mine site with a holding tank or portable restrooms; this wastewater could be treated at the sewage treatment system so it is included in the flow and load calculations. The wastewater from the Area 2 shops will be treated by a septic system and is not included in the flows and loads to the sewage treatment system.

- initial employees/ day:
    - plant = 200
    - mine = 120
- future estimate employees/ day
    - plant = 350
    - mine = 120

5.2 Historical Flows

The NPDES permit states the treatment plant was designed to treat an average wet weather flow of 0.105 MGD. The peak employment at the facility has been reported to be approximately 3,000 employees.

Dividing the wet weather design flow by the peak employees gives 35 gpd/employee. Historical data from the mid-1990s at the sewage facility shows that the sewage treatment plant influent flows a ranged from 40,000 to 80,000 gpd. According to a news release, (Reference (2)) 1,400 workers were employed at its closure in 2001 which included miners not located at the plant site. In addition to wastewater generated by employees, the sewage treatment plant treated backwashed solid wastes and wastewater generated by the facility potable water treatment plant, annual blow down flow from the Heating Plant compressor boiler cooling water system, and the Heating Plant cooling water and floor drains. The fluctuation of 40,000 gpd in the influent flow is likely associated with inflow and infiltration (I/I) into the collection system. This value is reflected in the Design Flow and loading worksheet. Anticipated reductions in I/I shown in the worksheet are based on allowable I/I for newer collection systems and corresponds well with published anticipated reductions when refurbishing existing collection systems (Reference (3).

5.3 Proposed Design Values

Improvements to the collection system are expected to achieve a reduction of 60-70% of the combined inflow and infiltration (Reference (4)). The design flows and loads for the system are calculated with the assumption that all collection system refurbishments have been completed.

The following summarizes the design values for sanitary waste generated at the plant site that have been used for this facility plan:

Flow = 35 gal/capita-d dry weather

Biological Oxygen Demand (BOD_5) = 220 mg/L

Total Suspended Solids (TSS) = 220 mg/L

Ammonia Nitrogen (NH_3-N) = 25 mg/L

Phosphorus (P) = 8 mg/L

The following summarizes the design values for sanitary waste generated at the mine site from portable restrooms and holding tanks that were used for this facility plan:

Holding Tank Flow = 20 gal/capita-d

Portable Restrooms Flow = 1 portable/ 8 capita @ 20 gal/week/portable

Biological Oxygen Demand (BOD_5) = 7,000 mg/L

Total Suspended Solids (TSS) = 15,000 mg/L

Ammonia Nitrogen (NH3-N) = 150 mg/L

Phosphorus (P) = 250 mg/L

The plant site dry and wet weather flow was based on limited available historical flow data from previous records and has been verified by text book values (Reference (5), Reference (1)) for similar facilities. The mine site holding tank flows were based on text book values for similar facilities (Reference (1), Reference (6)). The mine site portable restroom flows were based on data provided by a portable restroom supplier with mining facility experience in northern Minnesota. The loads were based on text book values for average strength sanitary sewer wastewater from the plant and septic strength wastewater from the mine (Reference (1), Reference (6)).

Table 5-1 summarizes the design flows and loading calculated using the MPCA design calculations worksheets (Attachment A).

Table 5-1 Design Flows and Loading Summary

			BOD5 (lb/day)		TSS (lb/day)		NH3-N (lb/day)		P (lb/day)	
	ADF (gpd)	AWWF (gpd)	ADF	AWWF	ADF	AWWF	ADF	AWWF	ADF	AWWF
Initial	8,502	21,502	22	42	30	54	2.3	4.5	0.85	1.5
Future	13,752	26,752	36	36	50	50	3.25	3.25	1.4	1.4

ADF = Average Daily Flow
AWWF = Average Wet Weather Flow

6.0 Alternatives Development and Evaluation

6.1 Alternatives Evaluation Criteria

The following evaluation criteria were used to guide the development of the potential alternatives for the sewage treatment system.

Treatment Effectiveness

The ability to effectively treat the sanitary sewage generated on the site needs to be the primary consideration in the development of the alternatives..

Reliability

Developing a reliable alternative is also critical. The alternatives must be able to provide effective treatment 100% of the time. The alternatives will use worst case scenario to assure their reliability.

Regulatory Considerations

Due to the rigorous permitting requirements by the MPCA, consideration must be given to the ability and schedule to permit the alternatives. For the purposes of this report it was assumed that all discharges must meet the past permitted discharge standards for a surface water discharge with the exception of TSS for stabilization ponds.

Cost Considerations

PolyMet has prepared capital cost estimates for the alternatives. Maintenance and operation costs were not formally calculated.

6.2 Description of Alternatives

Proposed Collection System Refurbishments

The following are the proposed refurbishments for the sanitary sewage collection system:

- administration building lift station renovation
- force main relocation to the west side of the administration building
- force main installation from the existing drain field north of the administration building to the sewage treatment plant
- air relief manhole installation at high point along force main
- sanitary sewer replacement from Manhole #12 to a point 382 feet south of Manhole #11
- force main installation from Manhole #12 northeast to the plant site process waste water treatment plant
- grinder pump installation at the plant site process waste water treatment plant
- force main installation from the tailings booster pump house to the concentrator
- grinder pump installation at the tailings booster pump house
- sanitary sewer service installation for the new Floatation Building
- sanitary sewer service installation for the new Concentrate Loadout Building addition
- replacement of the concrete filled MH #2
- complete cleaning and televising of all buried pipes
- replacement of 30% of piping and in-situ lining of 70% of piping

These proposed refurbishments are required to either serve new facilities at the plant site, or refurbish existing piping to ensure the excess I/I does not enter the system and overwhelm the treatment facility (Attachment B). Doing nothing to the collection system would result in no sanitary service to new buildings, require over-sizing the sewage treatment facility to treat clear water from I/I, and potentially negatively impact the environment.

Stabilization Pond Facility

Description

The first alternative would be to construct a stabilization pond facility with lined ponds and a controlled discharge. Stabilization ponds store and treat wastewater, have an operating depth of four feet, and typically consist of 2 primary ponds and one secondary pond. A controlled discharge would be completed from the ponds in the spring and fall of each year and would typically last 10 to 14 days depending on weather conditions. Operation and maintenance would consist of regular grass mowing in the summer, occasional transfer/control of wastewater flows, and discharge sampling and monitoring in the spring and fall. The ponds would be discharged to an effluent pump station where it would then be pumped to the flotation tailing basin cell 1E for final disposal.

Detention Time Based Design

Preliminary pond sizes were calculated following MPCA guidelines for pond systems north of Brainerd, MN to store the future AWWF for 210 days. Based on the future AWWF of 26,752 gpd and 210 days of storage,17.24 acre feet of storage would be required for the entire pond system or 2.41 acres of primary pond(s) to meet the required pond BOD_5 loading of 22 lbs/acre/day. Three 1.44 acre ponds would provide the required detention time and meet the BOD_5 loading design for the future AWWF. If PolyMet desires, two 1.91 acre ponds (one primary and a secondary) could be constructed to treat the initial AWWF of 21,502 gpd and BOD load of 42 lb/day, with another primary pond added when needed to treat the future flows.

Construction and Operation

The required separation distances from bedrock and groundwater would need to be met at the current treatment site. The pond liner type has been assumed to be a geomembrane type of liner. Pond control manholes and piping would be provided to operate the ponds in parallel or series and to transfer wastewater between ponds prior to discharge. An influent pump station would likely be required to pump into the ponds. Annual removal and disposal of sludge is not required for a typical stabilization pond system.

Other Pond Design Requirements

The pond design would be completed following the MPCA *Recommended Pond Design Criteria* (Reference (6)). Key design factors are summarized below.

Pond Shape

The pond shape would have a length to width ratio of no more than 4:1 with corners at angles of 45 degrees or greater.

Maximum Pond Depth

The maximum high water depth would be 6 feet and the dike top elevation would be 3 feet above the high water depth. The pond design depth accommodates seasonal flow variations.

Dike Top Width and Surface Material

The dike width is proposed to be twelve feet to permit access of maintenance vehicles around the perimeter of the ponds. A Class IV material would be used for the dike.

Max and Min Dike Slope

Inner slopes will be no steeper than a 3:1 slope (run to rise) and will be no flatter than a 4:1 (run to rise) slope. Outer slopes will be uniformly graded at a maximum slope of 3:1.

Erosion Control-Interior Dike

Rip rap would be required on dikes from the pond bottom to one foot above the high water for non-aerated ponds, and it is acceptable to include rip rap to the top of the interior dikes. The interior dikes shall have a minimum cover layer of four inches of fertile topsoil with seed where rip rap is not used.

Erosion Control-Exterior Dike

The exterior dikes shall have a minimum cover layer of four inches of fertile topsoil to promote establishment of an adequate vegetative growth. Perennial type, low growing, spreading grasses that withstand erosion and inundation and can be mowed are preferred for seeding of exterior dikes.

Liner Requirements

The ponds would be lined with a geomembrane type liner that will provide permeability as low as possible and in no case allow leakage loss through the seal exceeding 500 gallons/acre/day.

Mechanical Treatment Facility Alternative

Description

The second alternative considered was to construct a new mechanical sewage treatment plant to replace the existing facility. A "packaged" treatment plant was proposed for this alternative (Attachment C). It would include an influent equalization chamber, anaerobic chamber, anoxic chamber, aeration chamber, clarifier, sludge holding chamber /aerobic digester, tertiary filter, disinfection, corrosion prevention, and service walkway. The plant would be installed on a buried concrete footing and covered with a building. The plant would be discharged to an effluent pump station where it would then be pumped to the flotation tailing basin cell 1E for final disposal.

Design Capacity Evaluation

For this evaluation, the facility was sized to treat the future estimated flows to the most recent effluent limits. Minimum design specifications for the packaged mechanical treatment system were calculated using design guidelines for contact stabilization systems recommended by *Ten States Standards* (Reference (1)), and the Activated Sludge section of *Wastewater Treatment* (Reference (7)). The design of the unit was governed by the average daily flows described in Section 4.4. The following Table 6-1contains the minimum sizing for each component.

The proposed activated sludge system would be designed to remove suspended solids, carbonaceous biological oxygen demand, and *E.coli* form to meet the existing NPDES permitted effluent levels. Design considerations would include operating pH and temperature, suspended solids loading; recycle rates, load variation, aeration time, and amount of organic matter in the system. Operation and maintenance would consist of daily monitoring of water quality and providing regular upkeep for pumps and other mechanical equipment.

Table 6-1 Minimum Component Size

Treatment Component	Parameter	Design Criteria	Maximum Flow Capacity ADF (gpd)[1]	MDF (gpd)[2]	CBOD5 (lb/day)[3]	Design Value
Influent equalization chamber	Volume	1 day holding time at AWWF		Initial: 21,502 Future: 26,752		21,502 gal initial 26,752gal future
Anaerobic and Anoxic chambers	Volume	ADF- 2-3 hour detention[4][6]	Initial: 8,502 Future: 13,752			708 - 1062 gal initial; 1164 - 1746 gal future
Aeration chamber	Volume	ADF- 2-3 hour detention[4][6] Load[5]- 50 lb BOD5/d/1000cu Recycle- 100% of ADF (50-150%)[5]	Initial: 8,502 Future: 13,752		Initial:22 Future:36	3102 - 3456 gal initial; 4904 – 5486 gal future
Clarifier	Volume	ADF: 2-3 hour detention	Initial: 8,502 Future: 13,752			1416 – 2124 gal initial; 2328 - 3492 gal future
Sludge holding chamber/ aerobic digester	Volume	ADF: 4-6 hour detention[4][6] Recycle- 100% of daily flow (50-150%)[5]	Initial: 8,502 Future: 13,752			2832 – 4248 gal initial; 4656 – 6984 gal future
Tertiary filter and clearwell chamber	Total Surface Area	2-5 gal/ ft2/minute[5]	Initial: 8,502 Future: 13,752			1.18 - 2.95 ft^2 initial; 1.94 – 4.85 ft^2 future
	Volume	ADF: 2-3 hour detention	Initial: 8,502 Future: 13,752			708 – 1062 gal initial; 1164 – 1746 gal future
Ultraviolet radiation disinfection; Open channel	Dosage	Minimum dosage[2]	65% min. UV transmittance @ 254 nm; BOD & TSS < 30 mg/L			30,000 $\mu W \cdot s/cm^2$

(1) average daily flow in gallons per day
(2) maximum daily flow in gallons per day
(3) 5 day carbonaceous biological oxygen demand in pounds per day
(4) Reference (7)
(5) Reference (1)
(6) Reference (5)

The attached process flow diagram for the proposed mechanical treatment facility includes two parallel package plants equally sized to treat one half of the future wet weather flow rate. One package plant would be constructed to treat the initial AWWF and a duplicate second plant constructed when needed to treat the future flows.

6.3 Alternatives Evaluation

Collection system

Treatment Effectiveness

The existing collection system can be refurbished to meet current design standards to properly transport sewage to the treatment system. The proposed refurbishment of the existing piping to reduce I/I will keep peak flow rates lower so as not to surcharge the collection system or hinder the transport of sewage to the treatment system. Other refurbishments will be designed per current standard to effectively transport sewage to the treatment system

Reliability

The gravity portions of the piping system provide the most reliable means of sewage transport to the treatment facility. The portions of pumped sewage transport facilities will rely on redundant pumps to provide reliability. Redundant power supply for pumps should also be considered if adequate storage capacity is not available in wet wells.

Regulatory Considerations

We expect that the collection system would be regulated by the MPCA for additional connection approvals and the Minnesota Department of Labor and Industry for plumbing code requirements. Approval of construction plans would be needed from both regulators before the proposed refurbishments are constructed.

Cost Considerations

PolyMet has obtained capital costs for the proposed refurbishment. Additional operation and maintenance costs were not included but are not expected to be significantly different for the proposed refurbishment.

Stabilization Pond

Treatment Effectiveness

Stabilization pond treatment technology is a proven method used to treat wastewater at the estimated flows and loads to the effluent limits with the exception of TSS (Attachment D). It is anticipated the TSS effluent limit for a pond facility would be 45mg/l based on similar facilities in the area. If the discharge permit requires a 1 mg/l phosphorus limit, chemical addition using alum or ferric chloride may be required to meet this limit. Using ferric chloride for chemical removal of phosphorus would require approximately 175 gallons per year to meet this effluent limit.

Reliability

When properly sized for the flows and loads, stabilization ponds provide reliable treatment. According to MPCA ("Stabilization Pond Systems"), a stabilization pond can achieve a BOD removal of 80-95%.

Regulatory Considerations

Due to the capacity of the facility, it is anticipated that a pond system would be permitted as a Class C facility with the same effluent limits as the new mechanical treatment plant. MPCA approval would be needed to construct this facility. A construction SWPPP would also be needed.. This option would require a larger area of land disturbance outside the current facility footprint, which may require additional permits for environmental mitigation. Future effluent limits requirements may require additional facility modifications.

Cost Considerations

PolyMet has obtained capital cost estimates for this option. Operation and maintenance costs are anticipated to less than the mechanical treatment option.

Mechanical Treatment Plant

Treatment Effectiveness

The activated sludge type of treatment technology is a proven method used to treat wastewater at the estimated flows and loads to the expected effluent limits. This type of facility uses numerous mechanical items to treat the wastewater requiring consistent and proper operator attention. If the discharge permit requires a 1 mg/l phosphorus limit, chemical addition using alum or ferric chloride may be required to meet this limit. Using ferric chloride for chemical removal of phosphorus would require approximately 175 gallons per year to meet this effluent limit.

Reliability

When properly sized and provided with adequate redundancy, a package plants would provide reliable treatment. Operation of this type of treatment would require adjustments over time to reliably treat the wastewater as conditions change. Historically, activated sludge process can achieve a BOD and TSS removal of 80-95%.

Regulatory Considerations

Due to the capacity of the proposed facility, a package plant would be permitted as a Class C facility with effluent limits similar to the most recent permit. MPCA approval would be needed to construct this facility. A construction SWPPP would also be needed.. This facility would require similar space requirements to the old sewage treatment facility. Future effluent limits requirements may require additional facility modifications.

Cost Considerations

PolyMet has obtained capital cost estimates for this option. Additional operation and maintenance costs are not included but are expected to be higher than the stabilization pond option.

7.0 Summary and Conclusions

The purpose of this preliminary plan is to suggest improvements to the current collection system and to present two design alternatives for replacement of the sanitary sewage treatment facility.

The new sewage treatment system would be designed to treat an ADF of 8,500 GPD and AWWF of 21,500 gpd initially and an ADF of 13,750 GPD and AWWF of 26,750 future daily flow. The system would be designed to achieve a $CBOD_5$ effluent limit of 25 mg/L, TSS effluent limit of 30 mg/L for a mechanical facility, TSS effluent limit of 45 mg/L for a stabilization pond and fecal coli form effluent limit of 200#/100mL.

Existing and future flows were calculated for a 20-year planning period and used for the alternatives description.

Based on review of the alternatives, PolyMet has chosen to proceed with the collection system refurbishment and the stabilization pond alternative.

8.0 References

1. **Great Lakes - Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers.** Recommended Standards for Wastewater Facilities - Policies for the Design, Review, and Approval of Plans and Specifications for Wastewater Collection and Treatment Facilities. *Ten States Standards.* 2004.

2. **LTV Corporation.** LTV Steel Announces Intention to Close Minnesota Iron Mining Operations (press release). *PR Newswire - A UBM plc company.* [Online] May 24, 2000. http://www.prnewswire.com/news-releases/ltv-steel-announces-intention-to-close-minnesota-iron-mining-operations-73304187.html.

3. **American Society of Civil Engineers and the Water Pollution Control Federation.** Design And Construction Of Sanitary And Storm Sewers (ASCE-Manuals and Reports on Engineering Practice No. 37; WPCF Manual of Practice No. 9). 1970.

4. **Hough, Robert A. and Harding, Charles F.** Princeton (New Jersey) Sewer Operating Committee's Infiltration / Inflow (I/I) Reduction Program – Rehabilitation of Sewer Laterals. s.l. : Water Environment Federation, 2010.

5. **Metcalf & Eddy.** *Wastewater Engineering: Treatment and Reuse*. Fourth. s.l. : McGraw-Hill, 2002.

6. **Meyer, P., G. Erickson, D. Sahli, N. Groh, B. Smith, V. Sathyaseelan.** *Recommended Pond Design Criteria. Document wq-wwtp5-53.* s.l. : Minnesota Pollution Control Agency, December 2009.

7. **American Society of Civil Engineers, Water Pollution Control Federation.** Wastewater Treatment Plant Design (WPCF Manual of Practice No. 8, ASCE Manual on Engineering Practice No. 36, 2nd Printing. 1977.

Attachments

Attachment A

MPCA Design Flow and Loading Determination document and worksheets

Minnesota Pollution Control Agency

Water Quality

Wastewater Review and Guidance

Design Flow and Loading Determination Guidelines for Wastewater Treatment Plants

Water/Wastewater Technical Review and Guidance/#5.20, November 2001

Contents:

The determination of design flows and pollutant loadings is one of the most important items in the planning of a new or expanded wastewater treatment facility. A detailed analysis of existing flow conditions and the use of adequate flow estimates will determine the hydraulic and pollutant removal capacity needed to properly treat the wastewater and comply with permit conditions. It is necessary to include all contributing flow streams and pollutant loading sources in this analysis, including all residential, seasonal, institutional, commercial, industrial, inflow, infiltration, return and recycle streams and any other unique aspect of flow and pollutant contributions.

These guidelines are the recommended procedures for estimating the design flow and pollutant loading conditions, and are considered to be the minimum values necessary to assure adequate treatment facility capacity. It is expected that sound engineering judgment will be used to determine the appropriate design conditions for each individual treatment facility and that consideration will be given to impacts of decisions on upstream and downstream unit processes.

Introduction

The flow monitoring period for any particular project must record flow data during critical peak wet weather flow events which have occurred during a sustained wet weather flow period. Data collected during this flow period are used to estimate the four flow conditions that are critical to the design and operation of wastewater treatment plants (see Table 1): average dry weather (ADW), average wet weather (AWW), peak hourly wet weather (PHWW), and peak instantaneous wet weather (PIWW).

The average dry weather flow is the daily average flow when the ground water is at or near normal and a runoff condition is not occurring.

Average wet weather flow is the daily average flow for the wettest 30 consecutive days for mechanical plants or for the wettest 180 consecutive days for controlled discharge pond systems. The 180 consecutive days for pond systems should be based on either the storage period from approximately November 15 through May 15 or the storage period from approximately May 15 through November 15.

The peak hourly wet weather flow is the peak flow during the peak hour of the day at a time when the ground water is high and a five-year one-hour storm event is occurring. To determine this five-year one-hour storm event for the specific project, please refer to the attached Map Number 1.

The peak instantaneous wet weather flow is the peak instantaneous flow during the day at a time when the ground water is high and a twenty-five year one-hour storm event is occurring. To determine the appropriate twenty-five year one-hour storm event, please refer to Map Number 2.

Minnesota Pollution Control Agency, 520 Lafayette Road North, St. Paul, Minnesota 55155-4194
(651) 296-6300, toll-free (800) 657-3864, TTY (651) 282-5332 or (800) 657-3864

Table 1: Design Flow Condition Summary

Item	Description	Purpose
ADW	Average Dry Weather Flow. Assumes normal ground water with no runoff.	Facility designed to meet the calendar month average permit limitations and to determine if flow equalization should be evaluated.
AWW	Average Wet Weather Flow (the wettest 30-day average for mechanical plants and wettest 180-day average of controlled discharge pond systems). Assumes high ground water with inflow.	Facility designed to meet the calendar month average permit limitations and to determine if flow equalization should be evaluated.
PHWW	Peak Hourly Wet Weather Flow. Assumes high ground water with inflow due to a five-year one-hour storm event.	Clarifier and disinfection sizing and to determine if flow equalization should be evaluated.
PIWW	Peak Instantaneous Wet Weather Flow. Assumes high ground water with inflow due to a twenty-five year one-hour storm event.	Hydraulic design sizing for preliminary units, screens, filters, piping, and pumping at the treatment facility.

Where the Minnesota Pollution Control Agency (MPCA) determines that the above design flow considerations will not provide adequate protection to the receiving waters, facility capacity in excess of peak instantaneous wet weather flow may be required.

In cases where flow studies are over five years old, or where the consultant designing the treatment or transmission facility did not perform the flow study, a verification of the acceptability of the flow data should be performed.

Table 2 contains a summary of the minimum recommended flow and loading conditions for only a select group of processes. Specific design parameter details for individual treatment process units shall be in accordance with Ten States Standards.

Table 2: Design Flow and Loading Condition Summary

Treatment Unit	Hydraulic Design Flow
Collection System	Must be capable of transporting all flow to the treatment facility without bypassing.
Lift Station	Must be capable of transporting all flow to the treatment facility without bypassing.
Sanitary Sewers	100 gpcd (Other flows may be approved provided adequate justification is provided. In no case will a flow of less than 75 gpcd be approved.) + 80 gpcd for seasonal visitors + 20 gpcd for out-of-town student + commercial, industrial, and other non-residential flow
	Minimum BOD of 0.17 #pcd plus commercial, industrial, and other non-residential flow
	Minimum TSS of 0.20 #pcd plus commercial, industrial, and other non-residential flow

Continued on next page.

Continued from previous page.

Table 2: Design Flow and Loading Condition Summary Continued

Peak Hourly Wet Weather	Ten States Standards Figure 1, Chapter 10; or 2.5 times AWW for residential, commercial + peak hourly industrial flow
Peak Instantaneous Wet Weather	Actual flow data; or 2.5 times AWW for residential, commercial + peak hourly industrial flow
Flow Equalization Basin	If PHWW/ADW ≥ 3, flow equalization must be considered. If PHWW/AWW ≥ 3, flow equalization must be considered. If equalization is not provided, a discussion of how the facility will handle the transition in flow must be included.
Facility Piping and Pumping	PIWW
Preliminary Treatment Unit (screens, grit removal, influent filters, etc.)	PIWW
Biological Treatment Units	PHWW + recirculation flow
Clarifiers (surface settling rate and weir loading rate)	PHWW + recirculation flow
Disinfection (detention time)	PHWW

Bypass/Overflow

All bypass/overflow structures shall be manually controlled and kept locked at all times. All bypassing is regulated by permit and is prohibited. An upset defense may be available if: 1) bypass was unavoidable to prevent loss of life, personal injury or severe property damage; 2) there was no feasible alternative to the bypass; or 3) the permittee gives previous notice of an anticipated bypass.

Any bypassing must be reported to the MPCA in a report consistent with permit requirements. This report shall include, but not be limited to, the bypass duration, estimated volume and associated meteorological conditions. Refer to the facility permit for specific bypass requirements. All bypasses and overflows must be immediately reported to the MN Duty Officer at 1-800-422-0798 (outstate) or 651-649-5451 (Twin Cities Metro Area).

The MPCA may require a corrective action plan to mitigate frequent and/or unjustified bypass events. Failure to follow the proper bypass notification procedures or resolve problems in a timely manner may subject the permittee to enforcement actions, including monetary penalties.

Treatment Systems with New Sanitary Sewer Collection Systems

For mechanical plants, if the industrial flow varies during the day or week, the design flow should be based on the average flow on the peak day during the period when the industry or industries are operating. This condition is called “rated flow.” For example, if the industry discharges 10,000 gallons over eight of the twenty-four hours, the rated flow is 30,000 gallons per day. For controlled discharge pond systems, if the industrial flow varies during the day or week, the average design flow may be based on a weekly average.

The peak hourly wet weather design flow are the sum of the average wet weather design flow for residential (full-time and seasonal), commercial and out-of-town students multiplied by a peaking factor, plus the peak hourly industrial flow. The peaking factor shall be determined in accordance with Figure 1, in Chapter 10 of Ten States Standards.

The MPCA may approve of an alternative flow design with appropriate justification. For determining the design of the collection system (including design flow), refer to Chapter 20 Design of Sewers from “Recommended

Standards for Sewage Works" (Ten States Standards).

Some form of permit "control language" may be included if the per capita design flow is less than what is recommended in this document. For example it may be a permit violation with "no more connections" when the permitted design flow is reached. Violation of the permitted flow could result in the requirement for submittal of a report that examines the flow in comparison to the number of connections and the number of people using the system. The permittee could also be required to plan, design, and build additional treatment units upon reaching the design capacity.

Mechanical Treatment Plants with Existing Sanitary Sewer Systems

For a mechanical plant, if a separate sanitary sewer system exists, the attached Table 3 should be used to determine the peak hourly wet weather flow, the peak instantaneous wet weather flow, the average dry weather flow, and the average wet weather flow.

Part A of Table 3 and Figure 1 are used to determine the peak hourly wet weather flow. The measured flow should be plotted for a twenty-four hour period when ground water is at or near normal and a runoff condition is not occurring (Curve X on Figure 1). The ground water elevation in relation to the sewer elevation should be noted. The present peak hourly dry weather flow [(1) on Figure 1 and Table 3] is peak hourly flow during the twenty-four hour period when the ground water is at or near normal and a runoff condition is not occurring. The measured flow should be plotted for a twenty-four hour period when ground water is high and a runoff condition is not occurring (Curve Y). The ground water elevation in relation to the sewer elevation should be noted. Number (2) on Figure 1 and Table 3 is the peak hourly flow during a high groundwater period for that specific area and system when a runoff condition is not occurring. This flow (2) minus the present peak hourly dry weather flow (1) is the peak hourly infiltration.

The measured flow should be plotted for a twenty-four hour period when the ground water is high and a runoff condition is not occurring (Curve Z). This should include overflow, bypasses, and emergency pumping. The amount of rainfall and its duration should be plotted on the same graph. The peak inflow is represented by the greatest distance between Curve Y and Curve Z. The present hourly flow at the point of greatest distance between Curve Y and Z [(5) on Figure 1 and Table 3] minus the present hourly flow during high ground water at the same time of day [(6) on Figure 1 and Table 3] is the peak hourly inflow. It may be necessary to adjust the measured flow based on a relationship between the data attained during a major storm event and the five-year one-hour designed storm event. Items (10) and (13) are determined through a cost effectiveness evaluation. The gpcd contribution for population increase in item (15) [also in (25), (33), and (41)] should be 100 gpcd.

Part B of the table determines the peak instantaneous wet weather flow. The present peak hourly inflow adjusted for a five-year one-hour rainfall event [see part A(8)] is subtracted from the peak hourly wet weather flow [see part A(19)]. To this number, add the present peak hourly inflow adjusted for a twenty-five year one-hour storm event. The resulting number is the peak instantaneous wet weather flow.

Part C of Table 3 determines the average dry weather flow. The present average dry weather flow (24) is the average flow received over a twenty-four hour period when the ground water is at or near normal and a runoff condition is not occurring. If the industrial flow varies during the day or week, the present average dry weather flow should be based on the average flow of the peak day during the period when the industry or industries are operating (rated flow). This also applies to the average flow from industrial increases.

Part D of the table determines the thirty-day average wet weather design flow. The average infiltration and inflow after rehabilitation (where rehabilitation is cost effective) is the wettest thirty-day average. The amount of infiltration after rehabilitation averaged over the thirty wettest days should be the same or nearly the same as the peak infiltration after rehabilitation. This is due to the fact that the ground water could stay high for a fairly extended period of time. The amount of inflow after rehabilitation averaged over the thirty wettest days depends on the type of sources, their location, the amount of rainfall that affects the source, etc.

Part E of Table 3 correlates all related information that can impact the degree of accuracy of the determination of design flows. It is recommended that a minimum of six months of accurate data be recorded. Minnesota Rules 7077.0150 subp. 2(b) requires a minimum of 30 consecutive days of actual flow monitoring. Data associated with the critical peak wet weather flow events for a sustained wet weather period are essential for accurate estimation of design flows. Critical peak wet weather flow events typically occur in the spring (March-

June) and must include the condition of high ground water with inflow.

Controlled Discharge Pond Systems with Existing Sanitary Sewer Systems

The peak hourly wet weather and the peak instantaneous wet weather design flows to a pond system with an existing sanitary sewer system are arrived at in the same manner as in Parts A and B of the previous section. If the present industrial flow varies during the day or week, the present average dry weather flow (24) and (30) may be based on a weekly average. When computing the average wet weather flow, the average infiltration after rehabilitation (31), and the average inflow after rehabilitation (32) are averages over the wettest 180 consecutive days.

Flow Equalization

This section applies to all treatment facilities except pond systems. During a period of high ground water for that area and system, if the ratio of peak hourly wet weather design flow to average wet weather design flow [which is (19) divided by (37)] is three or more, flow equalization shall be evaluated. When the ratio is three or more and flow equalization is not employed, an explanation must be included outlining how the plant will handle this transition from average wet weather design flow to peak hourly wet weather design flow.

During a normal ground water period, if the ratio of the peak hourly design flow during the five-year one-hour storm event [(1)+(14)+(15)+(17)+(18)] to the average dry weather design flow (29) is three or more, flow equalization shall be evaluated. When the ratio is three or more and flow equalization is not employed, an explanation must be included outlining how the plant will handle this flow transition.

Infiltration and Inflow (I/I)

Inflow means water other than wastewater that enters a sewer system from sources such as roof leaders, foundation drains, yard drains, manhole covers, cross connections between storm sewers and sanitary sewers, catch basins, storm water runoff and other drainage structures.

Infiltration means water other than wastewater that enters the sewer system from the ground through defective pipe, pipe joints, and manholes.

I/I is a part of every collection system and must be taken into account in the determination of an appropriate design flow.

Excessive infiltration means the quantity of flow that is more than 120 gpcd (domestic base flow and infiltration).

Excessive inflow means the quantity of flow during storm events that results in chronic operational problems related to hydraulic overloading of the treatment system or that results in a total flow of more than 275 gpcd (domestic and industrial base flow plus infiltration and inflow). Chronic operational problems may include surcharging, backups, bypasses, and overflows.

If excessive levels of infiltration or inflow exist in the system, a comparison of alternatives for elimination of the excessive flow and treating the excessive flow shall be included with the design summary.

Essential Project Components Percentage

Minnesota Rules 7077.0111 to 7077.0292 apply to the MPCA's administration of financial assistance programs for the construction of municipal wastewater treatment systems. The assistance programs include the Wastewater Infrastructure Fund (WIF) and the State Revolving Fund (SRF) loan program. These rules require the calculation of an "essential project components percentage." The percentage will be used by the Public Facilities Authority (PFA) in their determination of a project's cost that may qualify for assistance with the WIF. Please see Table 4 for more information on calculating an essential project components percentage.

Wastewater Treatment Plant Design Loading

Table 5 should be used to determine the design loadings for the upgraded wastewater treatment plant.

For More Information

Please contact the engineer assigned to the project or District. If the engineer is unknown, contact the Customer Assistance Center.

Customer Assistance Center .... (651) 297- 2274

MPCA .... (651) 296-6300

Toll-free .... (800) 657-3864

TTY.. (651) 282-5332

Figure 1: Determination of Peak Hourly Flows Before Adjustment for Storm Event

N/A

Note: All flow measurements taken at treatment plant with adjustments for bypasses, overflows, and emergency pumping.
Groundwater elevation in relation to sewers should be stated for several points in the sewer system.
Dates of flow measurement should be stated.

PROJECT NAME <u>NorthMet Mine Site and Tailing Basin- Sewage Treatment System</u>

LOCATION <u>NorthMet Mine Site, Hoyt Lakes, MN</u>

COMPLETED BY <u>**Jon Minne P.E.**</u> **DATE** <u>**11/6/2014**</u>

Table 3: Determination of Design Flows

(A) For determination of peak hourly wet weather design flows (PHWW): Gallons Per Day

1	Present peak hourly dry weather flow **200 employees*35 gpcd + mine area**	7,202
2	Present peak hourly flow during high ground water period (no runoff)	NA
3	Present peak hourly dry weather flow [same as (1)]	NA
4	Present peak hourly infiltration	16,000
5	Present hourly flow during high ground water period and runoff at point of greatest distance between Curves Y and Z	NA
6	Present hourly flow during high ground water (no runoff) at same time of day as (5) measurement	NA
7	Present peak hourly inflow	24,000
8	Present peak hourly inflow adjusted for a 5-year 1-hour rainfall event	NA
9	Present peak hourly infiltration [same as (4)]	See (4)
10	Peak hourly infiltration cost effective to eliminate	-10,800
11	Peak hourly infiltration after rehabilitation (where rehabilitation is cost effective)	**5,200**
12	Present peak hourly adjusted inflow [same as (8)]	NA
13	Peak hourly inflow cost effective to eliminate	-16,200
14	Peak hourly inflow after rehabilitation (where rehabilitation is cost effective)	**7,800**
15	Population increase _150_@_35_ gpcd	5,250
16	Peak hourly flow from planned industrial increase	NA
17	Estimated peak hourly flow from future unidentified industries	NA
18	Peak hourly flow from other future increases **(contractor's employees, other)**	1,300
19	Peak hourly wet weather design flow [(1)+(11)+(14)+(15)+(16)+(17)+(18)] = **(PF = 4) 4x26,752**	107,008

(B) For determination of peak instantaneous wet weather design flow (PIWW): Gallons Per Day

20	Peak hourly wet weather design flow [same as (19)]	107,008
21	Present peak hourly inflow adjusted for a 5-year 1-hour rainfall event [same as (8)]	NA
22	Present peak inflow adjusted for a 25-year 1-hour rainfall event	NA
23	Peak instantaneous wet weather design flow	107,008

(C) For determination of average dry weather design flow (ADW): Gallons Per Day

24	Present average dry weather flow **200 employees*35 gpcd + mine area**	7,202
25	Population increase _150_@_35_ gpcd	5,250
26	Average flow from planned industrial increase	0
27	Estimated average flow from other future unidentified industries	0
28	Average flow from other future increases **(contractor's employees, other)**	1,300
29	Average dry weather design flow [(24)+(25)+(26)+(27)+(28)]	13,752

(D) For determination of average wet weather design flow (30-day average for mechanical plants and 180-day average for controlled discharge ponds) (AWW): Gallons Per Day

30	Present average **wet** weather flow **200 employees*35 gpcd + mine area**	7,202
31	Average infiltration after rehabilitation (where rehabilitation is cost effective)	5,200
32	Average inflow after rehabilitation (where rehabilitation is cost effective)	7,800
33	Population increase _150_@_35_gpcd	5,250
34	Average flow from planned industrial increase	0
35	Estimated average flow from other future unidentified industries	0
36	Average flow from other future increases **(contractor's employees, other)**	1,300
37	Average wet weather design flow [(30)+(31)+(32)+(33)+(34)+(35)+(36)]	26,752

(E) Critical data (including a graphical display similar to Figure 1), methodology, and a discussion on the following items shall be included with the above calculations:

38	Dates during which actual flow data was recorded and its probable degree of accuracy. **N/A**
39	Ground water elevation data relative to the collection system, during the time period when flow data was recorded. **N/A**
40	Rainfall data during the time period when flow data was recorded and how the amount of rainfall compares to normal seasons. **N/A**
41	Probable degree of accuracy of flow reduction due to proposed or completed I/I correction or elimination of bypasses. **N/A**

Table 4: Essential Project Components Percentage

Definitions:

"Essential project components" means those components of a wastewater disposal system that are necessary to convey or treat a municipality's existing wastewater flows and loadings and future flows and loadings based on the projected residential growth of the municipality for a 20-year period.

Mass Loading (lbs./day) = Flow (MGD) X Concentration (mg/l) X 8.34

	Total Existing Daily Conditions	Total Proposed 20-year Design Conditions
Flow (MGD)	8.5E-3	13.75E-3
$CBOD_5$ (mg/l)	220	220
Mass Loading (lbs./day)	15.6	25.2

Essential Project Components Percentage = 100 X $\frac{\text{Total Existing CBOD}_5\text{ Mass Loading}}{\text{Total 20-year Growth Mass Loading}}$

= 100 X $\frac{(26 \text{ lbs./day})}{(36 \text{ lbs./day})}$

= ____72____%

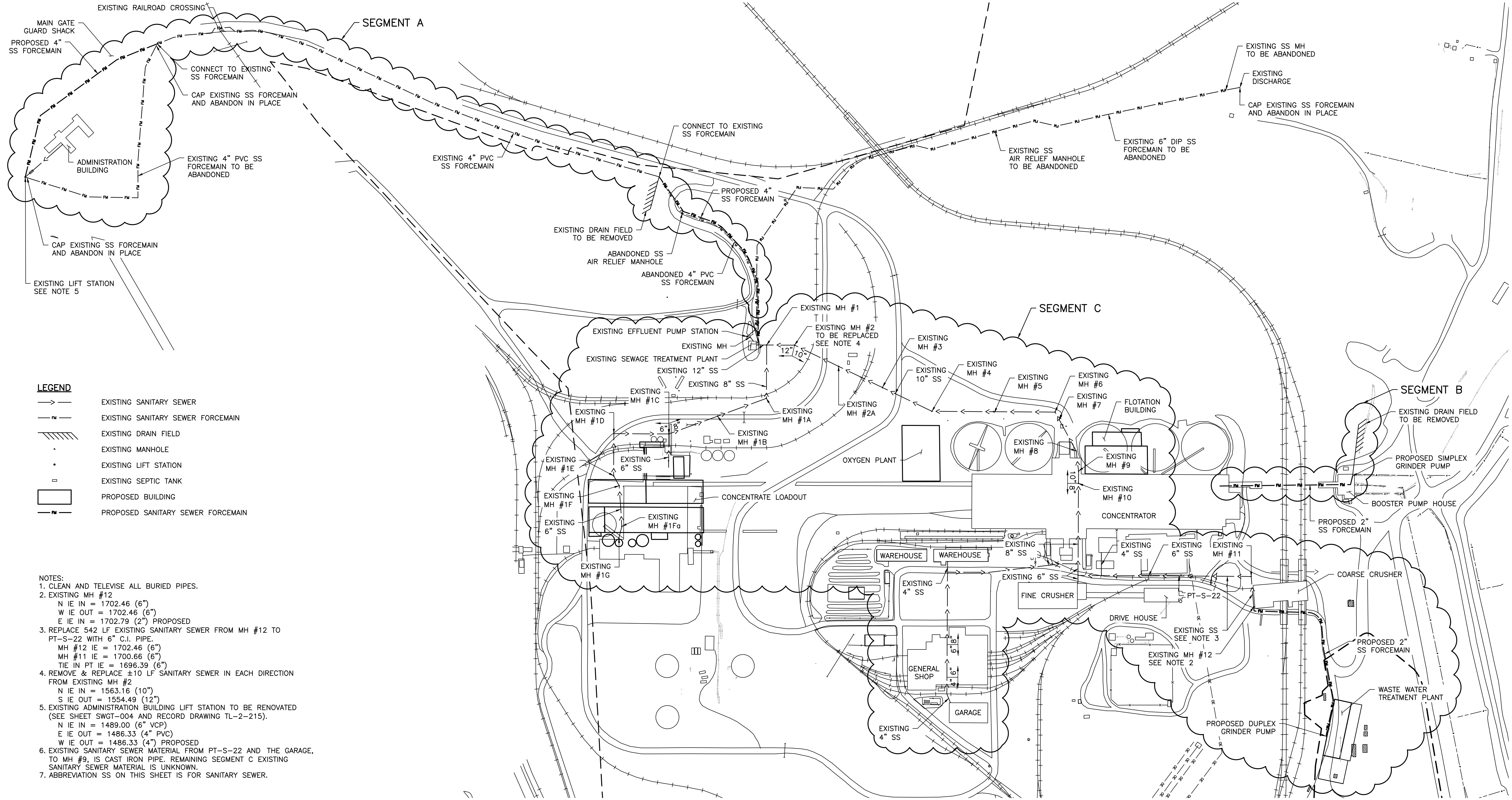
Table 5: Determination of Design Loadings

		Unit Basis	ADW	AWW
Residential Waste	Population	N/A		
	Flow, GPD			
	BOD_5, #/day			
	TSS, #/day			
	NH_3-N, #/day			
	P, #/day			
Plant Site/Other	Number-Workers	200		
	Flow, GPD	200*35gpdc dry+1300 other	8,300	8,300
	BOD_5, #/day	220 mg/l	15	15
	TSS, #/day	220 mg/l	15	15
	NH_3-N, #/day	25 mg/l	2	2
	P, #/day	8 mg/l	0.6	0.6
Mine Area-Holding	Number-workers	8		
	Flow, GPD	8*20gpdc	160	160
	BOD_5, #/day	7,000 mg/l	9	9
	TSS, #/day	15,000 mg/l	20	20
	NH_3-N, #/day	150 mg/l	0.2	0.2
	P, #/day	250 mg/l	0.3	0.3
Mine Area-Portable	Number-workers	120		
	Flow, GPD	120/8 portc*20 gpw/7dpw	42	42
	BOD_5, #/day	7,000 mg/l	2	2
	TSS, #/day	15,000 mg/l	5	5
	NH_3-N, #/day	150 mg/l	0.05	0.05
	P, #/day	250 mg/l	0.1	0.1
Future Employees	Flow, GPD	150 employees @ _(wet/dry)_ gpdc	(150*35gpdc) = 5250	(150*35 gpdc) = 5,250
	Rated Flow, GPD	Wet Weather PF = 4	~~NA~~	~~NA~~
	BOD_5, #/day	220 mg/l	10	10
	TSS, #/day	220 mg/l	10	10
	NH_3-N, #/day	25 mg/l	1	1
	P, #/day	8 mg/l	0.4	0.4
Infiltration	GPD		0 - dry	7,800
Inflow	GPD		0 – dry	5,200
Total	Flow, GPD		**13,752**	**26,752**
	Rated Flow, GPD		NA	NA
	BOD_5, mg/l		313	161
	BOD_5, #/day		**36**	**36**
	TSS, mg/l		435	224
	TSS, #/day		**50**	**50**
	NH_3-N, mg/l		28	15
	NH_3-N, #/day		**3.25**	**3.25**
	P, mg/l		12	6
	P, #/day		**1.4**	**1.4**

* It may be necessary to also test for TKN for certain industrial contributors.

Attachment B

SWGT-001 Sewage Treatment Plant - Overall Site Plan



LEGEND

—> —	EXISTING SANITARY SEWER
— FM —	EXISTING SANITARY SEWER FORCEMAIN
//////	EXISTING DRAIN FIELD
·	EXISTING MANHOLE
•	EXISTING LIFT STATION
▭	EXISTING SEPTIC TANK
▭	PROPOSED BUILDING
— FM —	PROPOSED SANITARY SEWER FORCEMAIN

NOTES:
1. CLEAN AND TELEVISE ALL BURIED PIPES.
2. EXISTING MH #12
   N IE IN = 1702.46 (6")
   W IE OUT = 1702.46 (6")
   E IE IN = 1702.79 (2") PROPOSED
3. REPLACE 542 LF EXISTING SANITARY SEWER FROM MH #12 TO PT-S-22 WITH 6" C.I. PIPE.
   MH #12 IE = 1702.46 (6")
   MH #11 IE = 1700.66 (6")
   TIE IN PT IE = 1696.39 (6")
4. REMOVE & REPLACE ±10 LF SANITARY SEWER IN EACH DIRECTION FROM EXISTING MH #2
   N IE IN = 1563.16 (10")
   S IE OUT = 1554.49 (12")
5. EXISTING ADMINISTRATION BUILDING LIFT STATION TO BE RENOVATED (SEE SHEET SWGT-004 AND RECORD DRAWING TL-2-215).
   N IE IN = 1489.00 (6" VCP)
   E IE OUT = 1486.33 (4" PVC)
   W IE OUT = 1486.33 (4") PROPOSED
6. EXISTING SANITARY SEWER MATERIAL FROM PT-S-22 AND THE GARAGE, TO MH #9, IS CAST IRON PIPE. REMAINING SEGMENT C EXISTING SANITARY SEWER MATERIAL IS UNKNOWN.
7. ABBREVIATION SS ON THIS SHEET IS FOR SANITARY SEWER.

PLAN 0 250 500 SCALE IN FEET

CADD USER: Veronica Sackett FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-56-CU-001.DWG PLOT SCALE: 1:2 PLOT DATE: 6/23/2015 8:44 AM

INCHES 1 2

VER NO	DATE	DESCRIPTION
1	6/23/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS

ISSUE STATUS		
ISSUED	VERSION	DATE
FOR PERMITTING	1	6/23/15
FOR CONSTRUCTION		
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.

PRINTED NAME JON M. MINNE
SIGNATURE [signature]
DATE 6/23/15 LICENSE# 25080

DRAWN: VJS
CHECKED: JMM3
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

SEWAGE TREATMENT PLANT
OVERALL SITE PLAN

POLYMET MINING

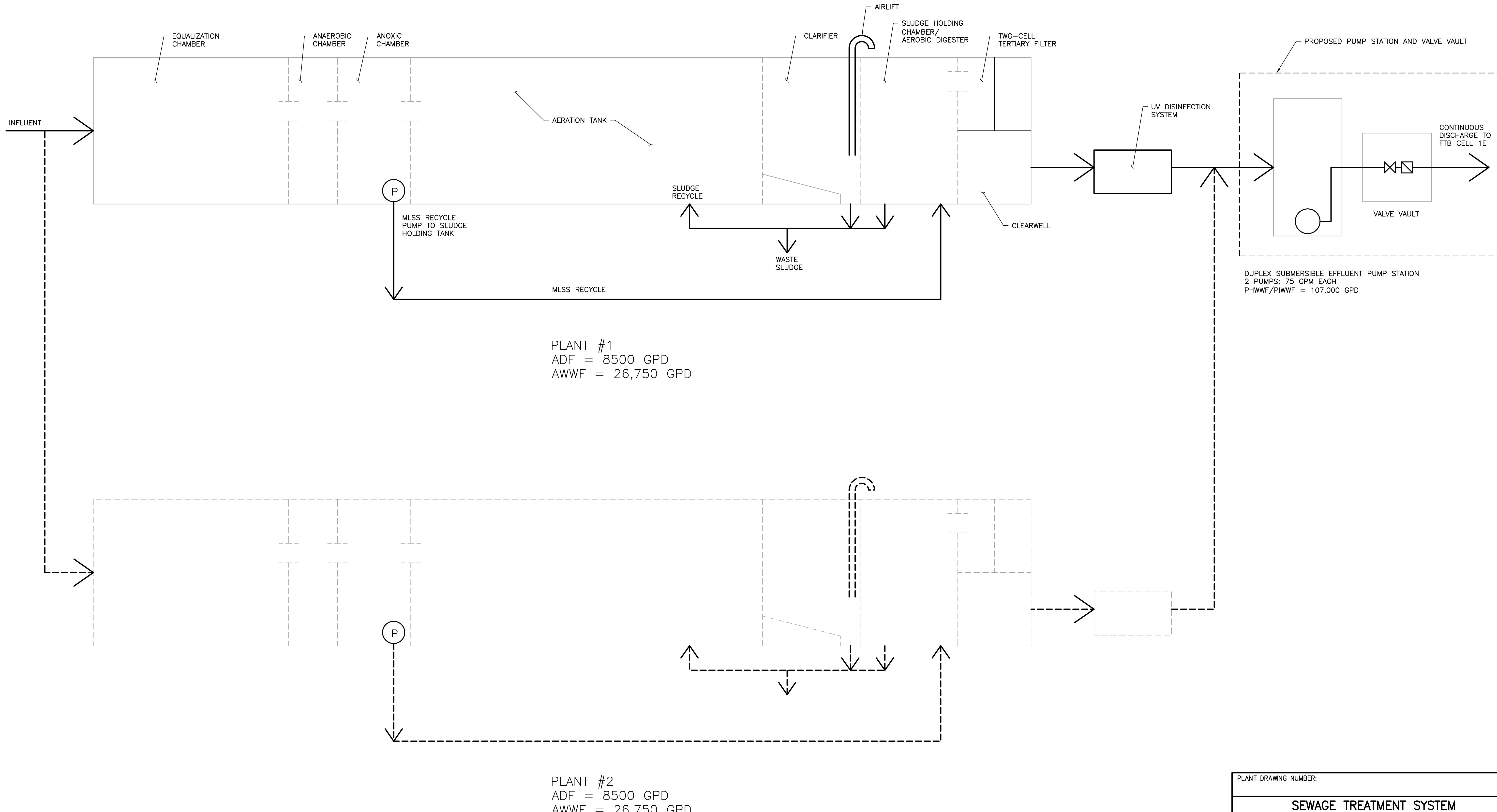
POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. SWGT-001 REV

Attachment C

SWGT-008 Preliminary Process Flow Diagram – Mechanical Treatment Plant



CADD USER: Veronica Sackett FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-56-MF-008.DWG PLOT SCALE: 1:2 PLOT DATE: 6/23/2015 9:14 AM

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PRINTED NAME JON M. MINNE
SIGNATURE
DATE 6/23/15 LICENSE# 25080

DRAWN: KRM
CHECKED: JMM3
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

SEWAGE TREATMENT SYSTEM
PACKAGED SEWAGE TREATMENT PLANT OPTION
PROCESS FLOW DIAGRAM

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR

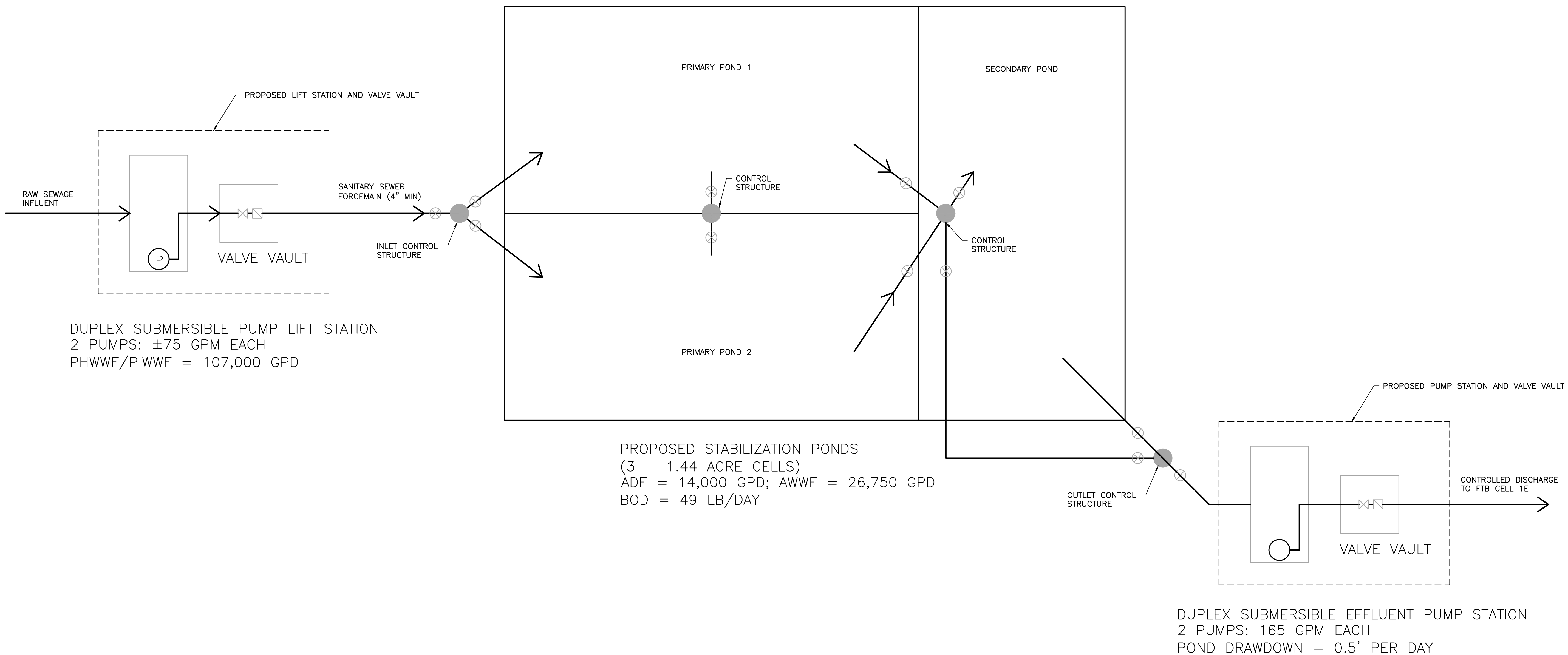
BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. SWGT-008

REV

Attachment D

SWGT-007 Preliminary Process Plan Flow Diagram – Stabilization Pond



PLANT DRAWING NUMBER:

SEWAGE TREATMENT SYSTEM
STABILIZATION PONDS OPTION
PROCESS FLOW DIAGRAM

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

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ISSUE STATUS		
ISSUED	VERSION	DATE
FOR PERMITTING	1	6/23/15
FOR CONSTRUCTION		
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.

PRINTED NAME JON M. MINNE
SIGNATURE
DATE 6/23/15 LICENSE# 25080

DRAWN: KRM
CHECKED: JMM3
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. SWGT-007
REV

Attachment E

Plant Site Design Basis Memorandum

resourceful. naturally.
engineering and environmental consultants

BARR

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: ______________________
Name: Brian K. LeMon
Date: April 28, 2016
License # 20789 Expires: 06/30/2016

Technical Memorandum

To: Jim Tieberg
From: Brian LeMon, P.E.
Subject: Preliminary Design Basis Report for Plant Site Stormwater
Date: April 28, 2016
Project: NorthMet Project – Mine Site and Tailings Basin – Plant Site Stormwater Design

1.0 Introduction

This memo presents the design basis for the NorthMet Project (Project) Plant Site Stormwater (PSSW) system which will be owned and operated by Poly Met Mining Inc. (PolyMet). Ore extracted from the nearby mine will be processed at a plant historically used as the Erie Mining Company and LTV Steel Mining Company (LTVSMC) processing plant. This design basis memo covers two areas. The first is the main processing plant shown in Large Figure 1 and Large Figure 2 which includes the main processing facilities and surrounding rail yard. The limits of the analysis for this area are the subwatersheds that contain the plant site which are shown in purple on Large Figure 2. The second area is related to a new section of railroad track that will be constructed to connect the mine to the plant site. This site is shown on Large Figure 3. The design basis presented in this memo will be used to guide design of stormwater systems for these two areas.

The primary objectives guiding the design of the stormwater systems include:

- Support the NPDES/SDS Permit Application for the Project, which will be submitted to the MPCA.
- Route runoff created by rainfall and snow melt away from the sites in a way that allows uninterrupted plant and rail operation up to a selected design event.
- Provide the volume of runoff storage on site needed to meet regulatory requirements.
- Provide treatment of runoff prior to release into the environment to meet regulatory requirements.

Stormwater refers to runoff which will be managed as construction and industrial stormwater. Based on preliminary discussions with the Minnesota Pollution Control Agency (MPCA), it is expected that stormwater features at the Plant Site will need to meet the requirements of the Industrial Stormwater Multi-Sector General Permit (ISW Permit - Reference (1)) during operations and the Construction Stormwater General Permit (CSW Permit - Reference (2)) during construction.

The PSSW must take into account 1) existing infrastructure to remain in place, 2) changes to the existing structures 3) facilities needed to accommodate new processes, 4) the impacts of structures to be removed and 5) the construction of new buildings and facilities at the Plant Site. The PSSW design is based on record/historical drawings of the infrastructure for the Plant Site which were provided by PolyMet. Additional knowledge of the existing stormwater infrastructure at the Plant Site was gained through discussions with PolyMet staff, site visits and site surveys. Some existing Plant Site stormwater features on site from the previous operations are either no longer functional or are in poor condition. A larger capacity system than originally designed will be necessary to convey stormwater across the site due to the change of roof drains being routed externally rather than being collected internally.

Information for the proposed site was also obtained from PolyMet and those working on Plant Site design. Certain aspects of the proposed site are still to be determined (e.g., precise building footprints). The design will be updated as the Project progresses towards final design. Because of this the PSSW is shown schematically in this memo. Final detailed design of PSSW features will not occur until the proposed site is fully planned out. The PSSW design presented here has been documented through a series of three memos that describe the design as well as options to address challenges, assumptions, and further work that is necessary before final design can be completed (Reference (3), Reference (4), Reference (5)).

This introductory section provides background and basic understanding of the purpose of the design. Section 2 Site Characteristics, provides a review of overall Plant Site information applicable to the design. Section 3 Permit Design Calculations, provides details on the ISW Permit, CSW Permit and water quality sampling that is in progress at the Plant Site. Section 4 Stormwater Modeling, describes the water quantity and quality modeling that was used to design the stormwater system. Section 5 Stormwater System Preliminary Design, includes the preliminary design information for the PSSW that will be used to convey stormwater at the Plant Site to discharge off site.

2.0 Site Characteristics

The Plant Site is located approximately eight miles west of the Mine Site near the city of Hoyt Lakes, Minnesota and is shown on Large Figure 1. Construction of a new section of railroad track that will connect the mine to the Plant Site is included in this design basis and is shown on Large Figure 3.

2.1 Design Storm Event

The runoff event chosen by PolyMet which will be used to guide the design of the PSSW system is the Atlas 14 10-year 24-hour storm event, which is 3.55 inches for this location (Reference (6)), this is consistent with the stormwater design at the Mine Site. This storm was used in the water quality and quantity models, discussed in Section 4.0, to determine the size of PSSW infrastructure, including ditches, culverts, pipes, and ponds. Infrastructure will be sized to handle this event and route stormwater away from the site in a way that should result in little or no disruption of activities at the site. Ponding will be restricted to stormwater features designed for containing water.

The model was also used to test the Atlas 14 50-year and 100-year, 24-hour storm events in order to assess the impacts to buildings and other critical infrastructure. The rainfall depth for both of these storms is shown in Table 2-1. The maximum depth of flooding within the two inundated flat areas for the 50-year and 100-year storm events is also listed, along with the likelihood of the 50-year and 100-year storm events occurring over a 20-year and 50-year life of the mine.

The model also predicted that for the 100-year 24-hour storm, there will be flow outside of the ditches and culverts that will cause some localized inundation over railroads, roads and fields where there currently are no other structures. The ditch closest to the proposed Sewage Treatment Ponds, Alignment Z as shown on drawing PSSW-008 (Attachment A), will overflow during this storm but the existing site grading is directed away from the Sewage Treatment Pond area towards the Southwest Stormwater Pond. Therefore, based on this modeling, impacts to the Sewage Treatment Ponds from runoff events up to and including the 100-year storm event are not expected. However, it should be pointed out that flows in the sanitary system can be impacted by infiltration and inflow. For example, floor drains connected to the sanitary system and sanitary manholes can be inundated in some runoff events causing significant additional flow to the proposed Sewage Treatment Ponds via the sanitary system. It is beyond the scope of this effort to identify the location and likelihood of such inundation.

Table 2-1 Summary of 100-Year, 24-Hour and 50-Year, 24-Hour Storm Events

Storm Event (24-hour)	Storm Size (inches)	Peak depth of flooding over given area(1)		Probability of at least one event occurring over plant operations	
		East of Concentrator	Near Hydrometallurgical Plant	20 Years	50 Years
100-year	5.71	6 inches	12 inches	18%	39%
50-year	5.01	5 inches	11 inches	33%	64%

(1) The depth of flooding provided is the peak depth over the given areas by applying the model water elevations with designed ditches to the existing Plant Site topography (using LiDAR data). The flood elevations provided in this table should be taken as an estimate. Certain locations have deeper inundations than listed, but were excluded as they are local flooding in existing depressions across the generally flat areas.

2.2 Site Topography, Watersheds and Soils

The Plant Site is constructed on multiple flat terraces that are separated by steep grade changes. Significant changes will occur in some areas after the Plant Site is modified to accommodate all future construction. Watershed divides of the future Plant Site after proposed construction were determined based on existing topography from LiDAR data that was verified by onsite field observations and proposed Project designs.

There are two main watersheds at the existing Plant site that dissect the area from north to south; the East Plant watershed and the West Plant watershed as shown on Large Figure 1. After the plant site is developed, the area north and west of the West Plant watershed with the south boundary being the railroad that accesses the Coarse Crusher from the west, will be cut off from its current flow path to the northwest due to the development of the Hydrometallurgical Residue Facility (HRF) in the existing Emergency Basin. The development of the HRF will sub-divide this area creating the West Plant HRF – Subwatershed 1 and Subwatershed 2, as shown on Large Figure 2.

2.2.1 East Plant Watershed

Development in the East Plant watershed includes construction of proposed new buildings needed for mineral processing at the Plant Site, as shown on Large Figure 1. These buildings will be built on the footprint of buildings that have been removed or through repurposing of existing buildings, which means there is no increase in the impervious footprint in the East Plant watershed. A combination of new and existing infrastructure will be utilized to convey water across the site. The analysis contained in this memo assumes that existing drainage infrastructure is fully functional. During on site observations it was noted that many culverts and ditches were filled with sediment or otherwise compromised and not functioning at full capacity. In some cases they were not functioning at all. Existing culverts that are to be reused must be cleaned out and assessed for condition. Damaged culverts must be repaired or replaced. In addition to this, ditches must cleaned out, regraded and/or re-established to provide increased drainage capacity as noted in the plans.

There are currently two locations where stormwater leaves the East Plant watershed via culverts, hereafter referred to as the East Plant #1 and East Plant #2 discharges at the locations shown on Large Figure 1. Barr recommends that both of these locations be maintained as discharge points during and following Plant Site development. Due to the similarities between the two discharge areas, only one of these points will likely require industrial stormwater monitoring for the purpose of ISW Permit compliance.

2.2.2 West Plant Watershed

Most of the planned new construction (new buildings and rail modifications [Reference (7)]) occur within the West Plant watershed. Site modeling for this watershed, as discussed in Section 4, shows that the existing system is not adequate to contain a significant storm event. Similar to the East Plant watershed, a combination of new and existing infrastructure will be utilized to convey water across the site. In general, stormwater will be routed through a series of ditches, culverts, pipes, drop structures, manholes, catch basins and stormwater ponds to the southwest corner of the Plant Site. The most downstream pond will discharge off-site through an existing culvert at the West Plant discharge location, as shown on Large Figure 2.

2.2.3 West Plant – HRF Subwatershed 1

The West Plant – HRF Subwatershed 1 is located north of the West Plant watershed. This subwatershed will be bound by new Flotation Tailings Basin (FTB) dam construction to the east, the existing tailings basin to the north, the new HRF construction to the west and the rail road grade to the south. This watershed will include the new construction for the Waste Water Treatment Plant. The HRF dam will cut off the current flow path to the northwest; drainage from this subwatershed will be re-directed to a proposed pond that will include an overflow pipe to the south under the railroad tracks into the West Plant watershed, as shown on Large Figure 2.

2.2.4 West Plant – HRF Subwatershed 2

The West Plant – HRF Subwatershed 2 is located west of the West Plant watershed. This subwatershed will include the new dam for the HRF but no additional construction is planned within the subwatershed. The HRF dam will cut off the current flow path to the northwest; drainage from this subwatershed will be re-directed to the south in a new ditch that will replace existing rail tracks as shown on Large Figure 2.

2.2.5 Watershed Soils and impervious Surfaces

Soils at the Plant Site have been classified into hydrologic soil types, which indicate the rate of infiltration that will occur after prolonged wetting. The hydrologic soil ratings for the Plant Site were developed based on data from the Gridded Soil Survey Geographic Database for Minnesota published by the United

States Department of Agriculture, Natural Resources Conservation Service. The majority of the site is classified as hydrologic soil group C, which has low infiltration rates when thoroughly wetted and consists of soils with restrictive layers that impede infiltration. Some soils were not in the database and were assigned hydraulic groups based on site observations. This includes loamy Udorthents (cut and fill land) and iron mine dumps, which were assigned hydrologic groups C and A respectively.

Impervious areas across the Plant Site were calculated based on the 2013 aerial imagery of the site with the addition of the buildings and rail construction (Reference (7)). All existing impervious surfaces were assumed to remain impervious in the future, which was verified based on the conceptual layout for the Project.

The existing Plant Site building roof drains will be modified thereby increasing the runoff rate and quantity. Historically, most of the roof drains were routed into the underground sump and tunnel network for use in the iron ore process. Many of these roof drains were combined with floor drains. Any existing roof drains that are not currently directed to the stormwater system will be modified to do so, and new buildings will be designed to direct their roof drainage to the stormwater system.

2.3 Site Visit and Evaluation of Existing Stormwater Infrastructure

Three site visits were completed by Barr staff to verify watershed delineations, conduct a survey and evaluate existing stormwater infrastructure. The site visits also included discussions with PolyMet staff and record drawing reviews.

Surveyed elevation data collected on existing stormwater infrastructure and surrounding ground areas was compared to the elevation data compiled from LiDAR and record drawings to create the stormwater model of future Plant Site conditions. Where feature inverts could not be surveyed, elevation information from record drawings and/or LiDAR were referenced to determine a reasonable assumption for the feature elevation.

2.3.1 Condition of Existing Stormwater Infrastructure

In general, the existing stormwater infrastructure is in poor condition from minimal maintenance and activities that blocked the stormwater conveyance paths that have occurred since LTVSMC ceased taconite production in 2001. Future stormwater infrastructure (including labeled structure names) is shown on Large Figure 2 and in the stormwater permit level drawing set included as Attachment A.

2.3.1.1 Culverts

Based on the condition of the exposed stormwater culverts it should be expected that the majority will need to be removed and replaced. Existing culverts have sediment buildup, crushed ends and, in some cases, are entirely collapsed. Culverts to be reused will need to be cleaned out and inspected for damage.

2.3.1.2 Ditches

Most of the ditches around the site are filled with sediment and will need to be re-established to restore their original planned capacity. In many cases they will need to be excavated deeper and/or wider than their original planned cross-section to increase capacity. This excavation will be limited by the existing topography, bedrock and infrastructure.

2.3.1.3 Drop Structures

The two existing drop structures west of the Concentrator and north of the proposed Oxygen Plant will continue to be utilized for stormwater conveyance. They are shown as 40-inch and 36-inch drop structures on drawings PSSW-005 and PSSW-006, respectively (Attachment A). These structures must be cleaned out, inspected and replaced if necessary. The potential re-use of these structures is discussed in Section 5.2.

2.3.1.4 Catch Basins and Manholes

The existing catch basins and manholes show signs of disrepair. All structures and connecting pipes that will be re-used in the stormwater design must be cleaned out inspected and evaluated for refurbishment or replacement. Specific existing structures are described below.

- Catch basin (CB #1), manholes (MH #13 through 17) and associated pipe connections convey water from near the future location of the Hydrometallurgical Plant and related buildings to the Southwest Stormwater Pond. These structures and associate piping are shown on Large Figure 2 and on drawings PSSW-008 and PSSW-009 (Attachment A). Discussions with PolyMet confirmed that this system was sealed by LTVSMC in closure by filling manhole #13 with concrete. This stormwater conveyance route will need to be re-established and is discussed in Section 5.2.

- Catch basin #2 south of the Central Stormwater Pond is shown on drawing PSSW-006 (Attachment A). Based on discussions with PolyMet, it is assumed that this catch basin is connected to an underground pipe that routes water from the Central Stormwater Pond to an existing ditch north of the existing Sewage Treatment Plant building. This structure will be replaced and is discussed in Section 5.2.

- Manhole #3, as shown on Large Figure 2, is shown in record drawings to collect drainage from the railroad trestles near the Coarse Crusher. This manhole currently collects water from the roof drains of the Coarse Crusher building. Field review of this manhole found that, in addition to the roof drains, there are two additional pipes that could not be identified on record drawings. Further review of flows from this area will be necessary to verify that the water collected in these drains and in Manhole #3 can be classified as stormwater (as opposed to floor drainage from the Coarse Crusher) and discharged to the surface.

- Existing manholes to the east of the Hydrometallurgical Plant and related buildings, as shown on drawing PSSW-009 and as identified through record drawings, have been taken offline and are not planned to be utilized for conveyance. These structures are still in place underground.

- Record drawings show floor drains collecting in manholes that discharge to the surface from the General Shop and Rebuild Garage buildings; see Large Figure 1 for building locations. These manholes are not planned to be utilized for stormwater conveyance. Floor drains from any building planned for use in the future must be disconnected from the PSSW system and redirected to a facility that can treat the water as needed to meet quality requirements or directed back to the process for reuse. The main point is that floor drains must NOT be discharged as stormwater.

3.0 Permit Design Calculations

3.1 Permits

PolyMet and Barr are in the process of developing an application for an individual NPDES/SDS permit for discharges from the Project. Based on preliminary discussions with the MPCA, it is expected that the language in this permit for stormwater discharges from the Plant Site during operations will be based on the ISW Permit (Reference (1)). Therefore, stormwater features at the Plant Site will need to meet the minimum requirements of the ISW Permit during operations and CSW Permit (Reference (2)) during construction.

3.2 Water Quality

The ISW Permit sets the benchmark monitoring values for Total Suspended Solids (TSS) for metal mine sites as 100 mg/L. This limit will be further discussed, along with the modeling software for TSS, in section 4.2 of this report.

Floor drains will be collected and not discharged to stormwater. This is critical, as the ISW Permit specifically does not allow floor drains from process areas to be discharged as stormwater (Part B.1.b of Reference (1)). Any existing floor drains that are currently being routed to the stormwater system will need to be redesigned and rerouted during Plant refurbishment for collection and sent to the FTB, WWTP or captured for use in the process.

Other water sources that are not explicitly excluded from being discharged to the stormwater system may be combined and discharged with stormwater as discussed in Section 5. This will only occur after water quality sampling and design is complete to confirm that the water will meet water quality standards set by the permit and that the water will not come into contact with process water. This effort is ongoing and will be determined through the final design process.

4.0 Stormwater Modeling

Two computer models of the proposed future Plant Site were developed to represent the area during rainfall events. The stormwater quantity model includes ditches, culverts, and ponds in order to estimate the necessary capacity of each component in the system. This model is used to size the stormwater features to reduce, to the extent reasonable, the likelihood of flooding under the selected design event identified earlier in this memo. The TSS model represents the water quality in the runoff and as it is conveyed. This model is used to determine the necessary detention time and related capacity in the stormwater ponds to meet stormwater quality standards.

It should be mentioned that uncertainty is inherent to models involving complex systems, such as this stormwater system, and many assumptions must be made during model design. Given the available information, it is believed that the simplifications made for this model are reasonable and result in a model that is suitable for the intended purpose. However, differences between the conceptual model and the actual system may result in outcomes that are different than those estimated by the model. Appropriate safety factors are applied during design to account for this uncertainty.

4.1 Stormwater Quantity Modeling

An XP-SWMM stormwater model was developed to evaluate the current design of the system and identify areas where additional features are needed or where the capacity of the existing features will not be sufficient to achieve the goals of the Project. Information from record drawings, surveys, site visits, LiDAR, and knowledge gained from experience at similar sites was used to develop the model of the facility. Through this process, attempts were made to minimize the number of changes to the original infrastructure that will need to be made. However, as has already been noted, not all of the infrastructure modeled was located, and much of what was located was in poor to very poor condition and will need to be repaired or replaced.

The model was used to analyze the 10-year, 50-year and 100-year, 24-hour storm events, as discussed in Section 2.1. These storm events were applied to the proposed Plant Site watershed areas discussed in Section 2.2, and routed through existing and proposed stormwater infrastructure. The design storm chosen by PolyMet is the Atlas 14 10-year 24-hour storm event, consistent with the stormwater design at the Mine Site, which is 3.55 inches for this site (Reference (6)). This storm was used in the model to estimate the size of the infrastructure, including ditches, culverts, pipes, and ponds needed to convey and/or store the design event. This information was then used to complete permit level design, which is discussed in Section 3.0. Infrastructure sized to handle this event will route stormwater away from the site in a way that should result in little to no disruption of activities at the site. Planning of PSSW infrastructure is intended to restrict ponding during this event to stormwater features designed for containing water. Note that the design event is used to size PSSW infrastructure and is not the same as flood protection. Please refer to the Phase 2 memo (Reference 4) for information related to how much of the site is inundated under greater runoff events.

The Plant Site stormwater evaluation and model is based on the following assumptions:

- Grading within each of the Plant Site watersheds will be minimal, limited to grading around new buildings or features; therefore there will be minimal impact to the current stormwater features and flow directions. The exception to this is the grading for the HRF and FTB.
- The following features will be incorporated into the stormwater design, as shown in Large Figure 1:
    - The dam of the HRF
    - The dam of the FTB
    - Several new buildings
- No additional roads or railroads other than those shown on Large Figure 1 will be constructed; if additional roads and railroads are required, they will need to be added to this stormwater evaluation.

- Roof drains will be directed to the stormwater system. Historically, most of the roof drains were routed into the underground sump and tunnel network for use in the process. Many of these roof drains were combined with floor drains. Any existing roof drains that are not currently directed to the stormwater system will be modified to do so, and new buildings will be designed to direct their roof drainage to the stormwater system.

- Floor drains must be disconnected from the PSSW system. This is critical, as the ISW Permit specifically does not allow floor drains from process areas to be discharged as stormwater (Part B.1.b of Reference (1)). Any existing floor drains that are currently being routed to the PSSW will need to be redesigned during Plant refurbishment for collection and sent to the FTB, Waste Water Treatment Plant (WWTP) or for use in the process.

- The MPCA in Reference (1) includes "foundation or footing drains where flows are not contaminated" as an authorized (non-stormwater) discharge (Part A.2.i). The water quality of groundwater flows from the french drain systems in place across the Plant Site will be compared to surface water quality standards to determine if it can be routed to the stormwater system or if it needs to be collected and treated based on this permit language. This pertains to the groundwater flows from the Concentrator foundation drains.

The model includes inflows from two sources that are not direct results of stormwater runoff: flows from the concentrator foundation drains and effluent from the sewage treatment ponds based on MPCA discharge guidance (Reference (8)). Both of these flows are still being evaluated for where they will discharge and if they can be discharged with stormwater. They were included in the model to account for the quantity of water that may be in the system when the storm occurs.

4.2 Total Suspended Solids (TSS) Modeling

Water quality modeling for the West Plant watershed was developed using Version 3.4 of the P8 water quality model (Program for Predicting Polluting Particle Passage thru Pits, Puddles, and Ponds). P8 is a model used for estimating the generation and transport of stormwater runoff pollutants in developed watersheds. The model tracks the movement of particulate matter (fine sand, dust, soil particles, etc.) as it is carried by stormwater runoff. Particle deposition in ponds is tracked in order to estimate the amount of pollutants carried by the particles that eventually reach a water body.

The P8 model requires a variety of inputs beyond the watershed characteristics and pollutant removal device (ponds, etc.) characteristics. P8 also requires hourly precipitation data for either a single storm event or for a long-term climatic period. Pollutant characteristic information is also required. The default pollutant and particle information, contained in the P8 NURP50 particle file, was used as a starting point for the water quality components of the stormwater runoff. The NURP50 particle file was developed as part of the Nationwide Urban Runoff Program (NURP), a research program conducted by the U.S. Environmental Protection Agency, and provides default parameters for several water quality components, based upon calibration to median, event-mean concentrations reported by NURP (Reference (9)). Pervious curve numbers were determined for each subwatershed in P8 based on area-weighting the curve numbers for the respective proposed land cover (assuming fair or 50 to 75% ground cover) and soil type combination, as published in Soil Conservation Service guidance (Reference (10)).

TSS concentrations were only evaluated at the West Plant discharge because the majority of the site changes and new impervious areas are located in the West Plant watershed. The East Plant watershed will primarily remain the same, with very little change to existing infrastructure or imperviousness. The evaluation of the base case was conducted using literature values for inputs to estimate the expected TSS concentrations in runoff generated at the site with no best management practices (BMPs) in place (Reference (11)). The modeled overall average TSS concentration for simulation of the 10-year, Type II storm event was compared with the available literature for various industrial runoff source areas (paved parking, storage and driveway areas), which generally will be expected to correspond with an average runoff concentration of 281 mg/L TSS from the literature (Reference (12)).

Literature sources are used as standard practice to compare to the expected TSS runoff concentrations because site-specific data is frequently not available. The initial simulation of the average West Plant watershed runoff TSS concentration was 50% lower than the literature estimate, therefore the P8 Model water quality components scale factor was increased from 1.0 to 1.5 in the base model, which increased the predicted average runoff concentration to the expected levels noted above. The remaining default P8 water quality parameters were maintained in the model without further adjustment.

The P8 model was then used to estimate the reduction in TSS achieved by the addition of various BMPs as part of the design. The ISW Permit sets the benchmark monitoring values for TSS for metal mine sites as 100 mg/L. BMPs were added to the model to achieve the goals of an outflow TSS concentration of less than 100 mg/L and to reach a 70% reduction in inflow TSS, based on the TSS evaluation and commitments made for the Project. The model results showed that the installation of three overflow weirs along the Southwest Stormwater Pond meets the permit requirements during the Atlas 14 10-year 24-hour storm. The overflow weir elevations were set so that the 10-year storm event passes through a 30-inch culvert and larger storms overflow the weir. These three culverts and weirs were placed at two existing invert changes along the pond and at the outlet to the existing stormwater ditch. This design is shown on permit-level drawings PSSW-010 and 024 (Attachment A). By routing the 10-year storm through the three stormwater ponds, the P8 model predicts that the 10-year stormwater is treated to 99 mg/L of TSS at the discharge for a 64% overall TSS removal. During final design an appropriate factor of safety will be included in the design of ponds where regulatory permit sampling will occur.

Other design options were identified for potential evaluation through final design. Further modeling and evaluation of the capacity in the Southwest Pond Area is necessary to verify that the alternatives will work with other planned infrastructure changes and improve treatment for TSS. These options can be evaluated in final design to determine the configuration that will best meet the site and permit constraints.

5.0 Stormwater System Preliminary Design

The preliminary PSSW design drawings are included in Attachment A. The PSSW design includes stormwater ponds, ditches, culverts, drop structures, catch basins, manholes and pipes as discussed in the following sections.

5.1 Stormwater Ponds

The stormwater ponds are needed in the site design in order to reduce the suspended solids in the runoff water and contain stormwater to minimize flooding at the Plant Site during the 10-year storm event. The dimensions of the ponds were limited by the existing infrastructure in the area, as shown on drawings PSSW-005, PSSW-006, PSSW-008 and PSSW-010 (Attachment A). Large Table 1 lists the design assumptions and peak water elevations during the 10- and 100-year storm events for each stormwater pond. Water levels for the Southwest Stormwater Pond may be dependent on downstream ditch and culvert capacities, which have not yet been determined and will be analyzed as part of final design.

The areas for stormwater pond development were evaluated during the site visits and are shown on Large Figure 2. There are currently no plans for construction of a stormwater pond in the East Plant watershed, and no anticipated need for it in the future. If a pond is determined to be necessary due to industrial stormwater monitoring results, there is room available to develop a pond upstream of the East Plant #2 discharge location. There is limited space near the East Plant #1 discharge location, but there is room for future stormwater pond development a short distance upstream, if one is deemed necessary during final design.

5.1.1 Southwest Stormwater Pond

The Southwest Stormwater Pond is the furthest downstream pond in the West Plant watershed before discharging offsite, as shown on Large Figure 2. It will be located at the southwest corner of the Plant Site where there currently is a long wide ditch. The ditch will be graded and widened to the west to obtain additional capacity. A series of culvert and overflow weirs will be constructed perpendicular to the flow of the pond to reduce the velocity of water and restrict particle movement through the pond. The pond discharges into an existing ditch to the south, through a culvert under a railroad grade, and eventually flows into Second Creek.

5.1.2 Central Stormwater Pond

The Central Stormwater Pond will be constructed west of the future Oxygen Plant, as shown on Large Figure 2. Currently there is a small depression that holds water in this area. Expansion of this depression will be limited by the slope to the east and roads on the other three sides. This depression has an outlet pipe that drains southwest toward the Southwest Stormwater Pond.

5.1.3 North Stormwater Pond

The North Stormwater Pond will be constructed west of the Concentrator, as shown on Large Figure 2. Currently this area is large, relatively flat, and covered in tailings. PolyMet staff have indicated that bedrock is located close to the surface near the Concentrator, but drops off sharply in the direction of the pond. The pond discharges through a culvert, for flows up to the 10-year storm, and tops the overflow weir during larger storms; water then drains through a series of ditches and culverts before entering the Central Stormwater Pond.

5.1.4 HRF Stormwater Pond

The HRF Stormwater Pond design will be included as part of the final design of the HRF. The HRF Stormwater Pond will be designed and constructed to provide retention of runoff from this area prior to routing it through the railroad embankment to the North Stormwater Pond in the West Plant watershed as shown on drawing PSSW-005 (Attachment A). The water retention capacity in the HRF Stormwater Pond after a storm event will be important to delay the runoff from this large subwatershed area and remove TSS prior to being routed to the West Plant watershed stormwater system through the proposed overflow pipe.

5.2 Stormwater Structures

Refer to Large Table 2, Large Table 3 and Large Table 4 for a list of each structure in the West Plant stormwater system along with design assumptions and locations. Sizes and details of all new structures will be determined in final design.

All existing drop structures and manholes that are to be reused in this preliminary design must be cleaned out, inspected, and evaluated for re-use. If the structure is found insufficient it will either be refurbished or removed and replaced.

5.2.1 Drop Structures

The two existing drop structures west of the Concentrator and north of the future Oxygen Plant will continue to be utilized for stormwater conveyance. They are shown as 40 inch and 36 inch drop structures on drawings PSSW-005 and PSSW-006, respectively (Attachment A). These structures will be cleaned out, inspected and replaced if necessary. One new 48 inch drop structure will be located southwest of the future Oxygen Plant on Stormwater Alignment M, as shown on drawing PSSW-006 (Attachment A). This structure is necessary to collect water from ditches and direct it to the Central Stormwater Pond.

5.2.2 Catch Basins

Two new catch basins are needed to replace existing structures. This is necessary due to changes in invert elevations and sizes of the pipes connecting to the structures. This includes Catch Basin (CB) #1 shown on drawing PSSW-009 and CB #2 shown on drawing PSSW-006 (Attachment A).

5.2.3 Manholes

Downstream from CB #1 manholes MH #13 through #17 and associated pipe connections convey water from near the future location of the Hydrometallurgical Plant and related buildings to the Southwest Stormwater Pond as shown on Large Figure 2 and on drawings PSSW-008 and PSSW-009 (Attachment A). Manhole #13 was filled with concrete during closure activities of LTVSMC and will need to be replaced. Manholes #14, 15 and 16 will be inspected and based on the inspection it will be determined if they can be refurbished or should be replaced. Manhole #17 will be removed.

Two additional new manholes will be added to the system. The first MH #1A will be added along the East Plant watershed drainage system near the Rebuild Garage to transition from multiple smaller pipes under a railroad to one larger pipe for the remaining underground length, as shown on drawing PSSW-012 (Attachment A). The second new manhole MH #1B will be added to allow access for cleaning out the two pipes downstream of CB #2 on Stormwater Alignment P, as shown on drawings PSSW-006 and PSSW-020 (Attachment A).

5.2.4 Sediment Trap

A sediment trap will be installed at the west side of the Limestone storage yard prior to combining stormwater runoff from this area with other stormwater flows. This will help reduce the TSS in the runoff from the limestone stockpiles. The sediment trap location is shown on drawing PSSW-008 (Alignment W near station 1+30) and details are shown on PSSW-032 (Attachment A).

5.3 Ditches

Ditches will be expanded, constructed or cleaned out as necessary and as space allows across the Plant Site. Ditches are designed to convey water across the site to the three discharge locations (West Plant, East Plant #1 and East Plant #2). Riprap along ditches is currently included on steep ditch slopes; location and size will be further evaluated in final design.

The new ditch that serves as the outlet for HRF – Subwatershed 2 directs water along Stormwater Alignment PP, as shown on drawing PSSW-007 and PSSW-030 (Attachment A). Stormwater Alignment PP routes water to the Southwest Stormwater pond.

Two locations have been identified with potential design constraints that will be worked through in final design. These are described in the following sections.

5.3.1 Ditch or Pipe North of the Concentrator

The ditch that flows to the west, north of the Concentrator (Stormwater Alignment E), is typically dry at one location a short distance northwest of the Concentrator. After visiting the site it appears that this ditch is infiltrating through the railroad embankment and flowing to the Emergency Basin, which is planned as the future location of the HRF. The design of this ditch has constraints including expected shallow depths to bedrock and steep slopes resulting in high velocities. Drawings PSSW-004, 005, and 017 (Attachment A), show grading for an unlined ditch at this location with the note that the ditch will be replaced with a pipe. The details of this design will be determined in final design.

5.3.2 Existing Infrastructure Inhibiting Ditch Modifications

Two of the ditches east of the Concentrator are unable to be designed with the modeled capacity due to existing adjacent infrastructure. One ditch (Stormwater Alignment B) directs water from the south to the north between the road and the railroad track east of the Concentrator. The second ditch (Stormwater Alignment CC) routes water between the toe of the rock wall from the Plant Reservoir and a railroad. These ditches are shown as Stormwater Alignments B and CC on drawings PSSW-004, 011, 012, 016, 025, and 026 (Attachment A). Additional ditches that feed into these ditches also are unable to be designed with the required capacity as estimated in the model due to adjacent infrastructure. These ditches include a note in the drawings that the ditch will be cleaned out and details will be determined in final design.

Currently the top side slopes of the inhibited ditches are directly at the rail tracks. The rail tracks should be removed or for rail safety, ditches should be offset from the rail tracks. In some locations the ditch may be designed to fit in the space available but with much steeper side slopes and greater depth than is typical for rail designs and could make the existing section of track unstable.

Two options for these ditches are being evaluated. The first option is to conduct maintenance on the existing ditches and utilize them to the greatest extent possible. This will involve cleaning the ditches out, grading in select spots to maintain drainage, and replacing culverts to maintain flow and access to buildings. The size of the culverts will be based on the depths of the existing ditches and maintaining cover over the culverts rather than conveying the 10-year design storm. Model results show that flooding will result outside of the ditches over the area east of the Concentrator but the exact extent of the flooding is unknown. The second option is to remove these two sections of track inhibiting the ditches or potentially relocate them. This will allow for the full capacity ditch to be constructed and contain the 10-year event. This evaluation will be completed during final design.

5.4 Pipes and Culverts

The drawings in Attachment A make a distinction between pipes and culverts. Culverts are typically open on either end and are used to convey water under an obstruction in the flow path, such as an access road. Pipes on the other hand connect to other structures, as seen on drawing PSSW-022 (Attachment A), Alignment V where a series of pipes are connected by manholes. Large Table 5 and Large Table 6 give the design assumptions and the estimated 10 and 100 year velocity and flow rates for each culvert and pipe at the site, respectively.

All existing pipes that are planned for re-use will be inspected and evaluated for refurbishment or replacement. This includes the pipes connecting CB #1 and MHs #13 through #17. With the removal of MH #17 the pipe downstream of the manhole will need to be removed or abandoned in place as well, as seen on drawing PSSW-008 (Attachment A). Other new pipes will be needed at the discharges of the Central Stormwater Pond and connecting to the drop structures located east of the Central Stormwater Pond, as seen on drawings PSSW-005, 006 and 008 (Attachment A).

During one of the site visits a location was identified where water currently flows through the railroad ballast without a culvert. This is shown on Stormwater Alignment CC near station 34+00 on drawings PSSW-015 and 026 (Attachment A). With the improvements upstream of this location along the same alignment, adding a culvert at this location should be evaluated in final design for the stability of the railroad.

5.4.1 Outlet Culverts

The outlet culverts for the three Plant Site discharges are all located outside of PolyMet's Project Area Boundary as shown on Large Figure 1. Two of the outlet culverts are sufficiently sized to convey the 10-year storm from the site, and one outlet culvert is not. Further evaluation is needed to verify that downstream infrastructure will not be impacted by the Plant Site Improvements. Each discharge location is discussed further below.

Based on the modeling, the West Plant watershed discharge culvert is already of adequate size with the addition of the control structures planned for the Southwest Stormwater Pond. This analysis did not include further evaluation of the downstream ditch, including the portion that flows behind the Administration Building.

The East Plant watershed #1 discharge culvert and additional culverts immediately downstream were determined to not be sufficient to convey the 10-year storm. New culverts sized for the 10-year storm are included in the recommended design, although this series of culverts is south of PolyMet's current Project Area Boundary. The model shows that not making these improvements results in flooding upstream and over the road at this discharge location during the 10-year design event. This area of the Plant Site is topographically flat so the flooding in this location could quickly spread to areas near the Hydrometallurgical Plant. The design of East Plant watershed #1 discharge is shown on drawing PSSW-013 and 029 (Attachment A) as Stormwater Alignment NN. The ditch immediately upstream of this outlet is also located just outside of the Project Area Boundary. This ditch needs grading improvements as shown on drawing PSSW-013 (Attachment A).

The East Plant watershed #2 discharge conveys water through a series of culverts under railroad tracks. The stormwater model currently shows stormwater for the 10-year design storm adequately passing through the first culvert at its current size. The design is shown on drawing PSSW-015 and 026 (Attachment A) as Stormwater Alignment CC. The watershed areas and infrastructure downstream of the discharge culvert were not included in the model, so the stormwater impacts beyond this location could not be sufficiently evaluated. Barr recommends further analysis of this discharge route in final design to verify that the design storm does not adversely impact the rail yard immediately downstream.

5.5 Other Design Features

In addition to the conveyance of stormwater across the Plant Site two additional design features related to the stormwater are discussed in the following sections. This includes water flowing into the Emergency Drainage Tunnel Manhole from the Concentrator footing drains and the stormwater along the Connection Track.

5.5.1 Emergency Drainage Tunnel Manhole

Currently water is routed from the Concentrator to the Emergency Basin through the Emergency Drainage Tunnel Manhole located just west of the Concentrator building. The design of the HRF requires that the Emergency Drainage Tunnel be blocked off at the discharge location near the HRF. The end of this tunnel at the Emergency Drainage Tunnel Manhole will be blocked as part of the PSSW design thus trapping the water draining from the Concentrator foundation drains in the manhole. One option for routing this water from the manhole is to drain it by gravity to the surface and discharge it with the stormwater. The location of the manhole and the design of this option is shown on drawing PSSW-005, and a plan for blocking off this tunnel is shown on drawing PSSW-033 (Attachment A).

Discharge of this Concentrator foundation drain water to the stormwater system is dependent on the results of further water quality testing of the water draining to the Emergency Drainage Tunnel Manhole and site design relating to the removal of the thickeners. These factors will dictate if and how the water can be discharged to the stormwater system.

5.5.2 Connection Track Stormwater

Krech Ojard & Associates (KOA) designed the connection track located southeast of PolyMet's Plant Site. This design includes ditches along the railroad embankment and one planned stormwater discharge location at the southeast end of the rail connection. The ditch and approximate location of the planned stormwater discharge, shown on Large Figure 3, are based on the design drawings for this alignment (Reference (13)) and subsequent 2016 modifications for the Construction SWPPP process (Reference (14)).

Stormwater controls along the connection track need to meet the requirements of the CSW Permit. One specific requirement of the CSW Permit that is applicable to the connection track is the need for collection and treatment of runoff when 1 or more acres of new impervious surface is created.

Approximately the first half of the connection track, from Station 11+00 (the beginning of the new track) to approximately Station 45+00, will be built along the existing impervious road. South of Station 45+00, a new embankment will be built to extend the railroad to connect with the Cliffs Mainline Track at approximately Station 66+63. This new track will be considered new impervious area. As shown on Large Figure 3, three infiltration basins along the connection track are planned to infiltrate stormwater and meet the CSW permit requirement related to treatment of runoff from new impervious areas. Two of the infiltration basins are located west and east of the Connection Track at approximately Station 32+00. The third infiltration basin is located north of the Connection Track near where it connects to the Cliffs Mainline Track at approximately Station 66+00.

The CSW Permit requires that the first 1 inch of runoff from the new impervious surface created by the Project be retained on-site through infiltration, unless the area will not allow infiltration, such as with shallow bedrock, hydrologic class D soils, or high groundwater (Part III.D. of the CSW Permit). According to the CSW Permit, if there is an impediment to infiltration, other treatment methods, such as wet sedimentation ponds, can be used prior to the discharge of this stormwater to surface waters.

A site visit was made to evaluate the southern discharge location. A few scattered small rocks and a few very large boulders were observed along the alignment in the vicinity of Station 66+00. The drainage in this area is to the east into a large wetland, which is an indication of high groundwater in this area. This discharge location is along a portion of the connection track alignment that will require a large cut. Additional cut will be needed for a stormwater feature in this location. In final design a geotechnical investigation will be necessary to determine the depth to bedrock and confirmation of the depth to the water table prior to final design determination on the stormwater feature (infiltration basin, wet sedimentation pond, swale, or other methods).

6.0 References

1. **Minnesota Pollution Control Agency.** Authorization to Discharge Stormwater Associated with Industrial Activity under the National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) Permit Program. Expiration Date: April 5, 2020. *Minnesota Pollution Control Agency / Water / Water types and programs / Stormwater / Industrial Stormwater.* [Online] April 5, 2015. https://www.pca.state.mn.us/sites/default/files/wq-strm3-67a.pdf.

2. —. General Permit Authorization to Discharge Stormwater Associated with Construction Activity under the National Pollutant Discharge Elimination System/State Disposal System Permit Program. Expiration Date: August 1, 2018. *Minnesota Pollution Control Agency / Water / Water types and programs / Stormwater / Construction Stormwater.* [Online] August 1, 2013. https://www.pca.state.mn.us/sites/default/files/wq-strm2-68a.pdf.

3. **Barr Engineering Co.** PolyMet Plant Site Stormwater Evaluation and Modeling Technical Memorandum to Jennifer Saran, Paul Brunfelt, and Jim Tieberg, Poly Met Mining Inc. August 14, 2014.

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7. **Krech Ojard & Associates, P.A.** New Rail Construction for Plant Site Rail Drawings. Prepared for PolyMet Mining Corporation - NorthMet Project. 2013.

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10. **U.S. Department of Agriculture; National Resource Conservation Service; Conservation Engineering Division.** Urban Hydrology for Small Watersheds (Technical Release 55). June 1986.

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12. **Pitt, Robert, et al.** Sources of Pollutants in Urban Areas (Part 2) - Recent Sheetflow Monitoring. [ed.] William James, et al. *Effective Modeling of Urban Water Systems, Monograph 13.* Ontario : CHI, Guelph, 2004, pp. 485-506.

13. **Krech Ojard & Associates, P.A.** New Rail Construction from PolyMet Connection Track to Cliffs Erie Mainline Drawings. Prepared for PolyMet Mining Corporation - Northmet Project. 2013.

14. —. Connection Track Proposed Track Improvements Plan & Profile Drawings. Prepare for PolyMet Mining Corporation - NorthMet Project. 2013.

Large Tables

Large Table 1 Table of Infrastructure - Ponds

ID	Bottom Elevation	Normal Water Elevation	Overflow Elevation	10 Year Peak Water Elevation	100 Year Peak Water Elevation	Side Slopes
North stormwater pond	1608	1609	1615.5	1614.1	1616.3	3:1
Central stormwater pond	1569	1571.5	1585.5	1577.9	1582.7	3:1
Southwest stormwater pond	TBD	TBD	TBD	TBD	TBD	3:1

Large Table 2 Table of Infrastructure - Drop Structure

Stormwater Alignment	Nominal Drop Shaft Diameter (in)	Name	Top Elevation	Bottom Elevation	Drawing Number
J	40	DS J	1614	1594	PSSW-018
K	36	DS K	1612	1586	PSSW-018
M	48	DS M	1616	1593	PSSW-018

Large Table 3 Table of Infrastructure - Catch Basins

Stormwater Alignment	Approximate Station	Name	Rim Elevation	Invert Elevation	Existing/ Proposed	Drawing Number
S	11+40	CB #1	1578.85	1573.85	Proposed	PSSW-009
P	2+00	CB #2	1578.40	1569.24	Proposed	PSSW-006

Large Table 4 Table of Infrastructure - Manholes

Stormwater Alignment	Approximate Station	Name	Rim Elevation	Invert Elevation	Existing/ Proposed	Drawing Number
CC	14+40	MH #1A	1711.45	1707.60	Proposed	PSSW-012
P	5+40	MH #1B	1581.00	1567.10	Proposed	PSSW-006
V	0+60	MH #13	1581.35	1574.53	Proposed	PSSW-009
V	2+40	MH #14	1581.35	1559.35	Existing	PSSW-009
V	5+10	MH #15	1565.26	1536.55	Existing	PSSW-009
V	5+80	MH #16	1542.30	1533.47	Existing	PSSW-009
V	10+20	MH #17	N/A	N/A	Existing	PSSW-008

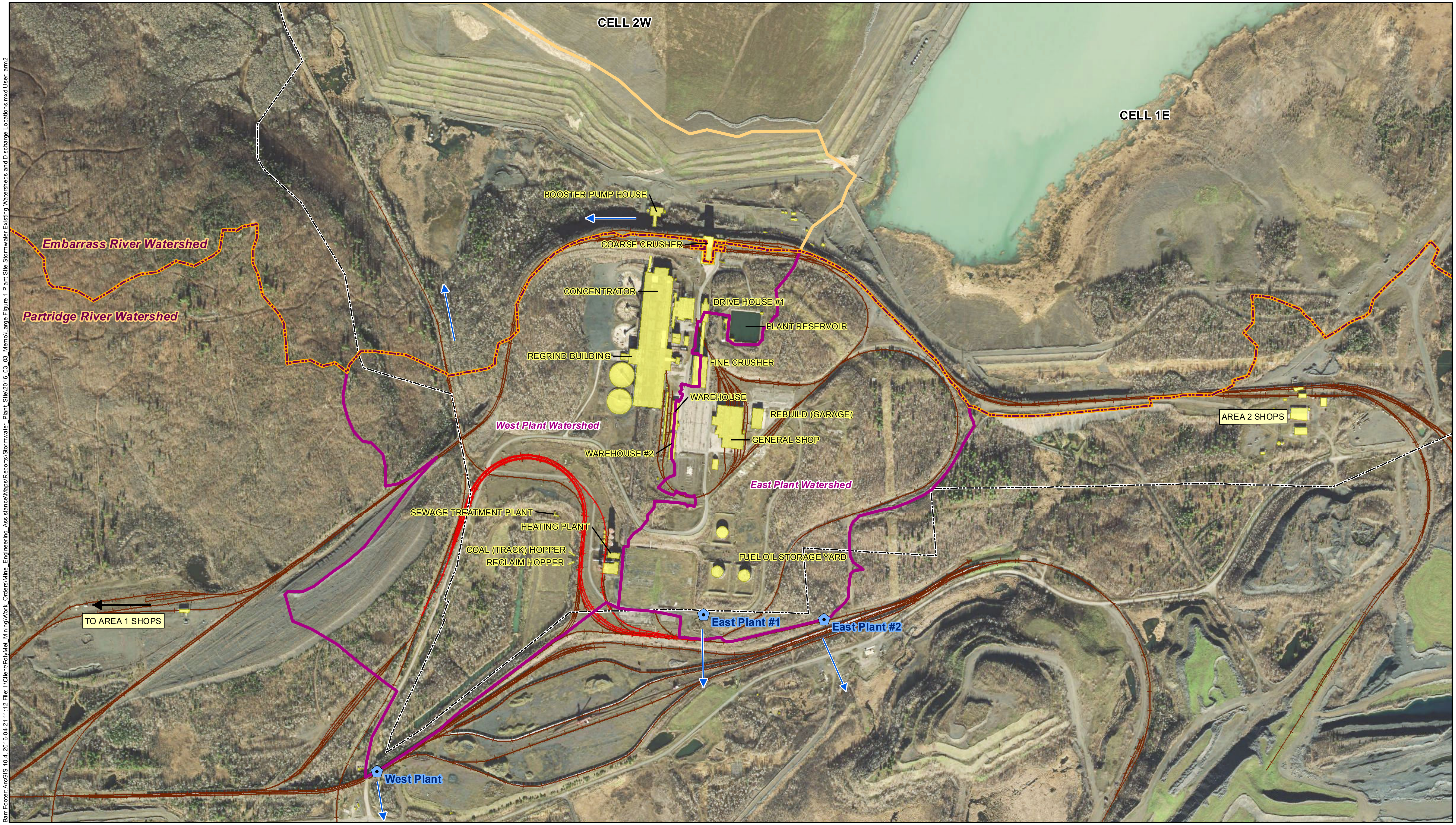
Large Table 5 Table of Infrastructure - Culverts

Stormwater Alignment	Approximate Upstream Station	Function	Length (ft)	Slope %	Nominal Pipe Size (in)	Upstream Invert Elevation	Downstream Invert Elevation	Drawing Number	Max Flow Rate 10 Year (cfs)	Max Velocity 10 Year (ft/s)	Max Flow Rate 100 Year (cfs)	Max Velocity 100 Year (ft/s)
A	1+50	Under existing road grade	48	-3.81	12	1707.50	1705.69	PSSW-016	1	6.2	1	6.5
B	0+50	N/A	42	TBD	TBD	TBD	TBD	PSSW-004	4	1.0	5	1.1
B	4+10	N/A	45	TBD	TBD	TBD	TBD	PSSW-004	8	2.4	12	3.9
B	8+40	N/A	55	TBD	TBD	TBD	TBD	PSSW-004	15	2.4	24	3.3
C	1+00	N/A	49	TBD	TBD	TBD	TBD	PSSW-004	4	4.4	4	3.7
D	0+40	Under existing road grade	67	-0.73	24	1707.50	1707.00	PSSW-016	21	6.7	21	6.7
E	1+80	Under existing road grade	45	-0.27	30	1706.21	1706.10	PSSW-017	26	5.2	27	5.5
E	2+20	Under existing railroad grade	24	-1.25	36	1706.10	1705.80	PSSW-017	36	5.1	43	6.1
E	2+60	Under existing ground	25	-0.40	36	1705.80	1705.70	PSSW-017	39	5.3	45	6.3
E	3+00	Under existing road grade	213	-0.33	42	1705.70	1705.00	PSSW-017	39	4.9	45	5.2
F	0+00	Outlet from north stormwater pond	80	-4.59	12	1609.00	1605.33	PSSW-018	9	2.4	47	4.1
F	9+05	Under existing road grade	81	-1.59	24	1580.27	1579.00	PSSW-018	25	8.1	29	9.3
H	0+00	Under existing road grade	95	-0.20	12	1585.69	1585.50	PSSW-018	6	6.9	6	7.0
I	0+00	N/A	N/A	-44.73	36	1611.43	1599.76	PSSW-018	21	16.2	33	17.2
K	2+20	Under proposed road grade	21	-0.61	27	1612.43	1612.31	PSSW-019	28	7.3	32	8.1
M	2+40	Under proposed road grade	30	-0.48	24	1617.18	1617.04	PSSW-019	4	2.8	7	3.0
N	7+60	Under existing road grade	30	-2.22	30	1575.91	1575.24	PSSW-020	31	0.5	113	0.5
P	9+70	Under existing road grade	44	-5.00	2-36	1541.58	1539.42	PSSW-020	79	6.5	120	9.9
T	8+60	Under existing road grade	42	-0.33	18	1577.75	1577.61	PSSW-022	6	3.3	5	2.9
T	9+80	Under proposed railroad grade	32	-0.16	27	1577.50	1577.45	PSSW-022	6	2.4	6	2.4
U	4+10	Under existing access road	36	-0.11	12	1577.99	1577.95	PSSW-022	3	4.2	3	4.4
W	1+40	Under existing road grade	47	-0.84	30	1536.16	1535.76	PSSW-023	21	4.4	32	6.7
Y	2+20	Under existing road grade	95	-0.26	21	1538.00	1537.75	PSSW-023	7	3.3	11	4.8
BB	3+90	Under existing road grade	41	-3.13	24	1537.82	1536.53	PSSW-023	11	6.3	22	-6.9
SP	12+00	Overflow weir	44	-2.27	30	1531.00	1530.00	PSSW-024	49	9.9	52	10.4
SP	18+00	Overflow weir	47	-2.13	30	1526.00	1525.00	PSSW-024	53	11.1	68	13.8
SP	26+00	Overflow weir	44	-2.27	30	1525.00	1524.00	PSSW-024	59	3.4	251	4.1
SP	32+00	N/A	N/A	N/A	60	N/A	N/A	PSSW-024	N/A	N/A	N/A	N/A
CC	13+60	Under existing railroad grade	72	-0.42	3-24	1707.89	1707.59	PSSW-025	12	3.8	13	4.0
CC	14+40	Under existing road/railroad grade	180	-0.96	36	1707.72	1706.00	PSSW-025	37	6.8	30	4.3
CC	16+60	Under existing road grade	40	-1.25	36	1705.50	1705.00	PSSW-025	22	3.8	8	6.4
CC	18+00	Under existing road grade	35	-1.44	36	1704.00	1703.50	PSSW-025	1	2.2	1	2.7
CC	27+40	Under existing road grade	82	-2.12	48	1643.00	1641.28	PSSW-025	49	6.9	67	6.9
CC	44+20	Under existing road/railroad grade	N/A	-1.56	42	N/A	N/A	PSSW-026	231	29.9	367	38.7
DD	0+20	N/A	60	TBD	TBD	TBD	TBD	PSSW-026	6	3.7	7	3.9
DD	5+00	N/A	45	TBD	TBD	TBD	TBD	PSSW-026	11	2.4	13	2.6
EE	0+20	N/A	50	TBD	TBD	TBD	TBD	PSSW-026	13	3.9	7	3.2
FF	0+00	N/A	20	TBD	TBD	TBD	TBD	PSSW-026	17	6.0	59	6.1
GG	0+00	N/A	40	TBD	TBD	TBD	TBD	PSSW-027	12	14.2	10	9.9
II	0+00	Under existing railroad grade	N/A	-2.29	18	N/A	N/A	PSSW-027	8	8.5	9	8.5
JJ	2+40	Under existing railroad grade	54	-0.95	24	1707.50	1707.00	PSSW-028	13	3.9	19	6.1
JJ	5+10	Under existing railroad grade	180	-7.77	36	1705.92	1692.00	PSSW-028	22	13.0	25	13.0
JJ	12+40	Under proposed access road	100	-0.66	24	1641.07	1640.41	PSSW-028	22	8.0	25	8.3
KK	2+10	Under existing road grade	45	-0.53	36	1707.24	1707.00	PSSW-029	10	2.9	18	2.8
NN	9+00	Under existing road grade	96	-0.72	30	1576.07	1574.88	PSSW-029	39	25.6	39	16.4
NN	10+80	Under existing ground	32	-1.27	30	1574.20	1573.80	PSSW-029	38	7.6	39	7.8
NN	11+60	Under existing road grade	30	-3.98	30	1572.74	1571.54	PSSW-029	38	7.7	39	8.0
NN	12+00	Under existing railroad grade	60	-0.66	30	1571.40	1571.00	PSSW-029	39	7.9	42	8.6

Large Table 6 Table of Infrastructure - Pipes

Stormwater Alignment	Approximate Upstream Station	Length (ft)	Slope %	Nominal Pipe Size (in)	Upstream Invert Elevation	Downstream Invert Elevation	Drawing Number	Max Flow Rate 10 Year (cfs)	Max Velocity 10 Year (ft/s)	Max Flow Rate 100 Year (cfs)	Max Velocity 100 Year (ft/s)
J	0+30	78	-12.80	18	1594.00	1584.00	PSSW-019	22	14.5	34	17.9
K	3+20	125	-4.02	15	1585.00	1580.00	PSSW-019	28	2.6	41	2.9
M	4+00	114	-2.65	18	1593.00	1590.00	PSSW-019	18	10.6	30	16.6
P	0+00	204	-0.64	2-30	1570.54	1569.24	PSSW-020	36	7.3	44	8.8
P	2+00	346	-0.62	2-30	1569.24	1567.10	PSSW-020	41	8.3	49	9.9
P	5+40	376	-0.62	2-30	1567.10	1564.79	PSSW-020	41	8.3	49	9.9
V	0+00	67	-0.36	15	1575.85	1575.61	PSSW-022	8	6.4	9	6.9
V	0+60	173	-0.31	2-12	1575.53	1575.00	PSSW-022	4	5.1	4	5.5
V	2+40	273	-2.23	18	1560.35	1554.27	PSSW-022	8	8.1	9	8.2
V	5+10	75	-3.46	18	1537.55	1534.97	PSSW-022	8	8.5	9	8.5
V	5+90	423	-0.93	24	1534.47	1530.47	PSSW-022	8	5.7	9	5.3

Large Figures

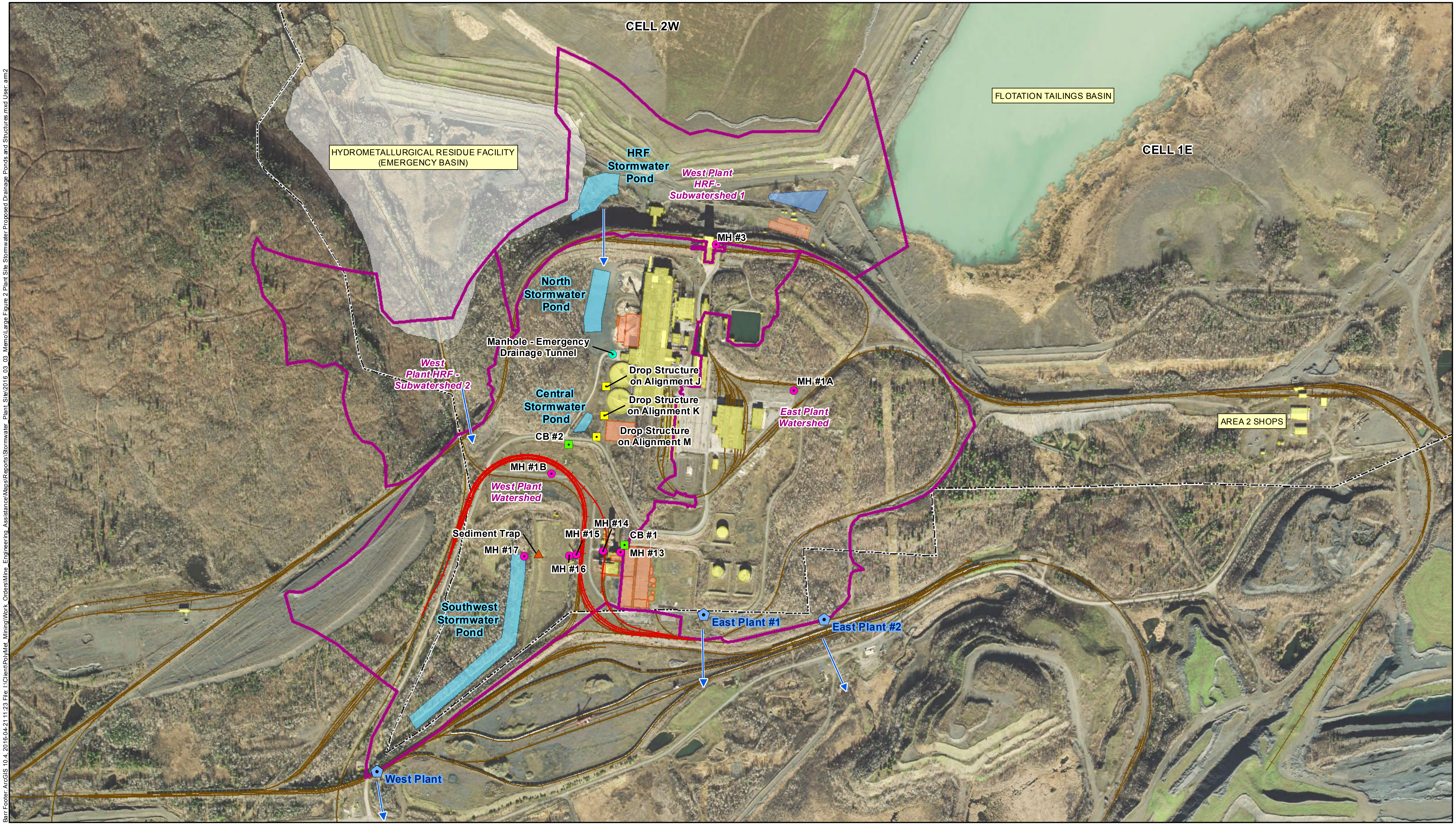


- Project Area
- Plant Site Watersheds
- Embarrass River Subwatersheds
- Watershed Divide
- Existing Building
- Plant Site Stormwater Discharge Location
- Existing Outflows
- Proposed Railroad
- Existing Railroad

Note: Only the area within the Plant Site watershed boundaries has been included in this stormwater evaluation.

0 450 900 1,800
Feet

Large Figure 1
PLANT SITE STORMWATER
EXISTING WATERSHEDS AND DISCHARGE LOCATIONS
NorthMet Project
Poly Met Mining, Inc.
Hoyt Lakes, Minnesota



Project Area
Partridge River Subwatersheds
Proposed Building
Existing Building
Existing Railroads
Proposed Railroads
Plant Site Stormwater Discharge Location
Catch Basin
Manhole
Manhole - Emergency Drainage Tunnel
Sediment Trap
Drop Structure
Proposed Outflows
Proposed Stormwater Pond

0 450 900 1,800
Feet

Large Figure 2
PLANT SITE STORMWATER
PROPOSED DRAINAGE, PONDS, AND STRUCTURES
NorthMet Project
Poly Met Mining, Inc.
Hoyt Lakes, Minnesota

Barr Footer: ArcGIS 10.4, 2016-04-21 11:23 File: I:\Client\PolyMet_Mining\Work_Orders\Mine_Engineering_Assistance\Maps\Reports\Stormwater_Plant_Site\2016_03_Memo\Large Figure 2 Plant Site Stormwater Proposed Drainage Ponds and Structures.mxd User: arm2

- Connection Track Stationing
- Connection Track
- Dunka Road
- Treated Water Pipeline
- Existing Culvert
- Culvert Extension
- Connection Track Culvert
- Connection Track Ditch
- Infiltration Basin
- Wetland
- Approximate Connection Track Discharge Point
- Approximate Discharge Direction

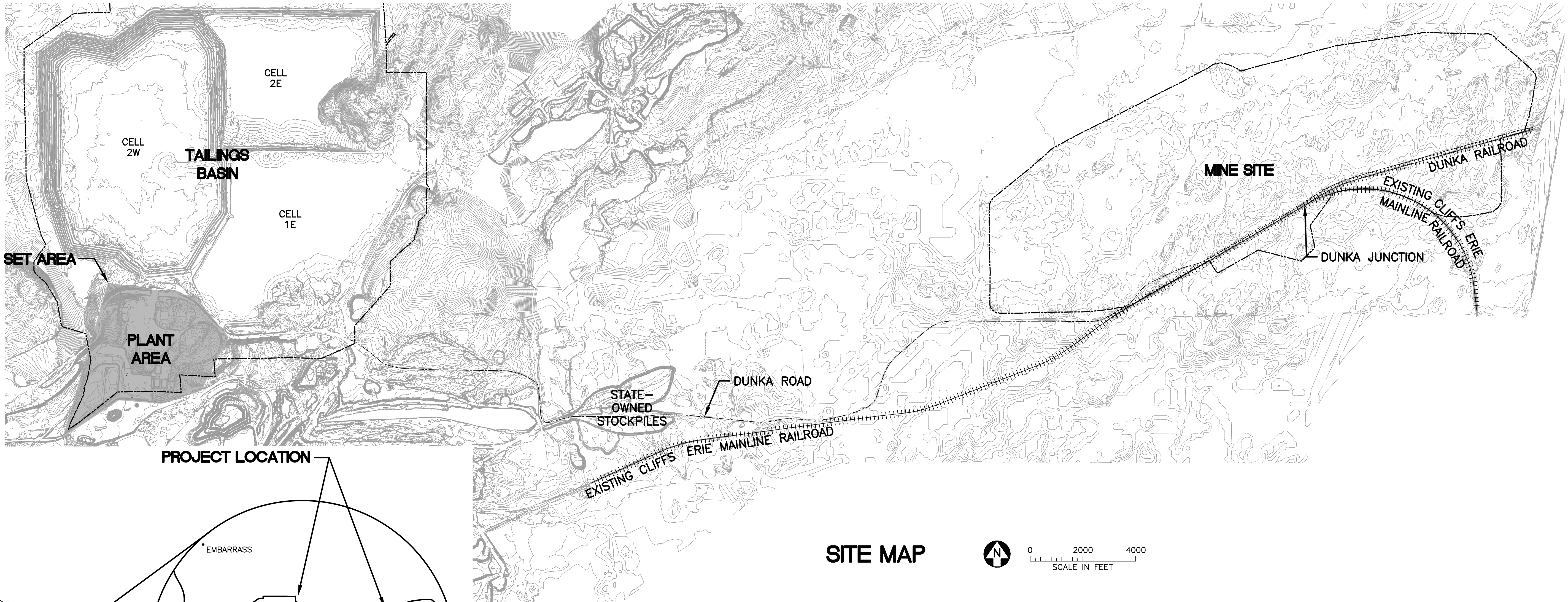
0 200 400 800
Feet

Large Figure 3
CONNECTION TRACK STORMWATER
NorthMet Project
Poly Met Mining, Inc.
Hoyt Lakes, Minnesota

Attachment A

Plant Site Stormwater Permit Level Design Drawings

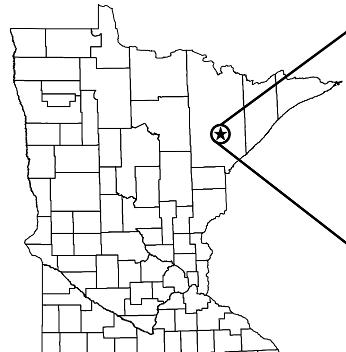
POLY MET MINING, INC. NORTHMET PROJECT
PERMIT APPLICATION SUPPORT DRAWINGS
PLANT SITE STORMWATER
HOYT LAKES, MINNESOTA

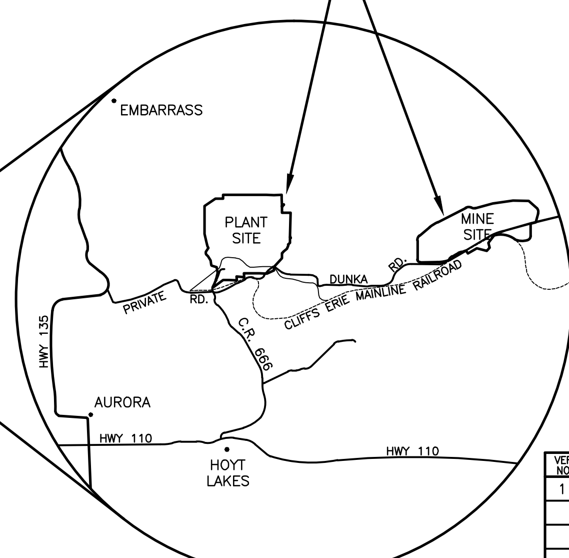


PROJECT LOCATION

SITE MAP

0 2000 4000 SCALE IN FEET





LOCATION MAP
NOT TO SCALE

VICINITY MAP
NOT TO SCALE

Client Review Draft 5/15/2015

VER NO	DATE	DESCRIPTION
1	5/15/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS

ISSUE STATUS		
ISSUED	VERSION	DATE
FOR PERMITTING	1	5/15/15
FOR CONSTRUCTION		
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.

PRINTED NAME CRISTIAN A. DIAZ
SIGNATURE
DATE 5/15/15 LICENSE# 46593

DRAWN: VJS
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GENERAL DWGS
LOCATION MAP AND SITE MAP

POLYMET MINING
POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR
BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-001
REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-001.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 9:36 AM

INCHES 1 2

PLANT SITE STORMWATER LEGEND

EXISTING

- 1000 — EXISTING CONTOUR – MAJOR 10'
- EXISTING CONTOUR – MINOR 2'
- EXISTING RAILROAD
- WATER EDGE/CREEK CENTER LINE
- EXISTING ROAD
- EXISTING STRUCTURES
- TREE LINE
- EXISTING MANHOLE/CATCH BASIN
- EXISTING CULVERT
- X — EXISTING FENCE
- WETLAND BOUNDARY

PROPOSED

- 1000 — PROPOSED CONTOUR – MAJOR 5'
- PROPOSED CONTOUR – MINOR 1'
- 1+00X — PROPOSED CENTERLINE STATIONING
- PROPOSED CULVERT (STORMWATER)
- PROPOSED PIPE
- PROPOSED MANHOLE/CATCH BASIN
- PROPOSED RIPRAP
- PROJECT AREA BOUNDARY
- FLOW PATH

PROPOSED OTHER FACILITY

- PROPOSED STRUCTURES
- PROPOSED RAILROAD

NOTES

1. COORDINATE SYSTEM IS MINNESOTA STATE PLANE NORTH ZONE, NAD83.
2. ELEVATIONS ARE MEAN SEA LEVEL (MSL), NAVD88.
3. EXISTING TOPOGRAPHIC INFORMATION SHOWN ON THE DRAWINGS WAS PREPARED BY AEROMETRIC, INC. FROM LIDAR DATA COLLECTED ON MARCH 17, 2010.

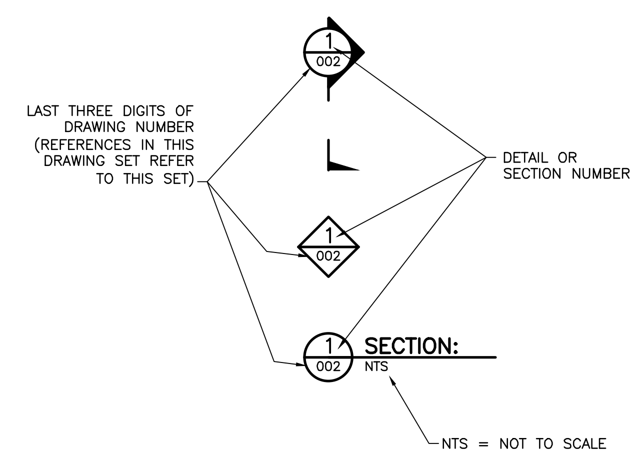
SHEET INDEX

SHEET NO.	TITLE
PLANT SITE STORMWATER DRAWINGS	
PSSW-001	LOCATION MAP & SITE MAP
PSSW-002	LEGEND & SHEET INDEX
PSSW-003	GENERAL LAYOUT & SHEET INDEX MAP
PSSW-004 TO PSSW-015	GRADING PLANS
PSSW-016 TO PSSW-030	GRADING PROFILES
PSSW-031 TO PSSW-033	SECTIONS & DETAILS

ABBREVIATIONS

- AC-FT – ACRE-FEET
- AVE – AVERAGE
- CB – CATCH BASIN
- ℄ – CENTERLINE
- CMP – CORRUGATED METAL PIPE
- DS – DOWNSTREAM
- DV – DRAIN VALVE
- DWG – DRAWING
- EL. – ELEVATION
- FTB – FLOTATION TAILINGS BASIN
- GAL – GALLONS
- GPM – GALLONS PER MINUTE
- HDPE – HIGH-DENSITY POLYETHYLENE
- INV – INVERT
- LF – LINEAR FEET
- MH – MANHOLE
- MIN – MINIMUM
- NWL – NORMAL WATER LEVEL
- PSSW – PLANT SITE STORMWATER
- SDR – STANDARD DIMENSION RATIO
- STA – STATION
- TYP – TYPICAL
- US – UPSTREAM

DRAWING NUMBERING



PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GENERAL DWGS
LEGEND AND SHEET INDEX

VER NO	DATE	DESCRIPTION
1	5/15/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS

ISSUE STATUS		
ISSUED	VERSION	DATE
FOR PERMITTING	1	5/15/15
FOR CONSTRUCTION		
NOT APPROVED FOR CONSTRUCTION		

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PRINTED NAME CRISTIAN A. DIAZ
SIGNATURE
DATE 5/15/15 LICENSE# 46593

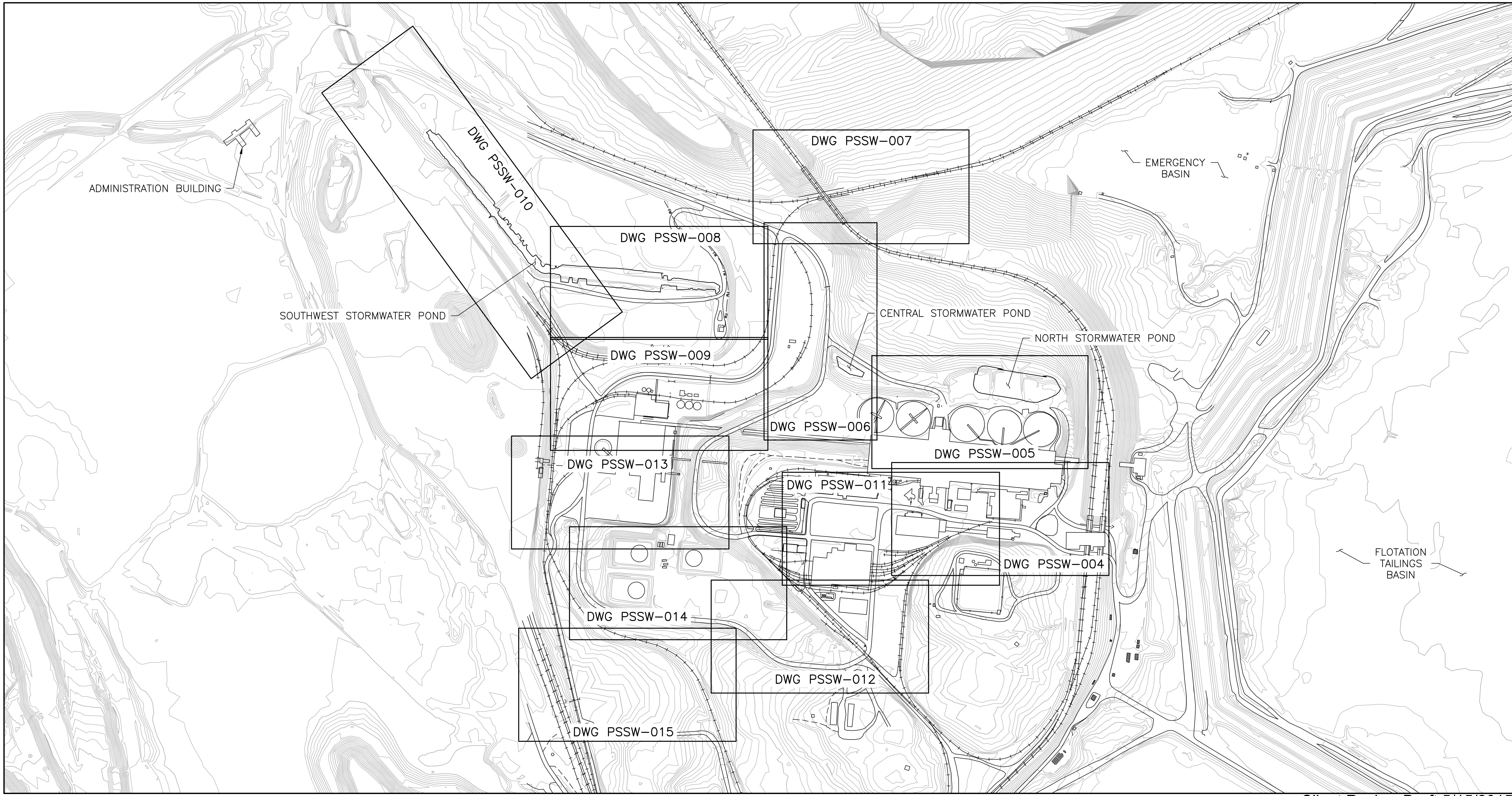
DRAWN: VJS
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-002
REV

INCHES 1 2



1 PLAN: SHEET INDEX

0 350 700
SCALE IN FEET

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PLANT DRAWING NUMBER:

PLANT SITE STORMWATER
GENERAL LAYOUT AND SHEET INDEX MAP

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

VER NO	DATE	DESCRIPTION
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DRAWN: VJS
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-003
REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-003.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 9:39 AM

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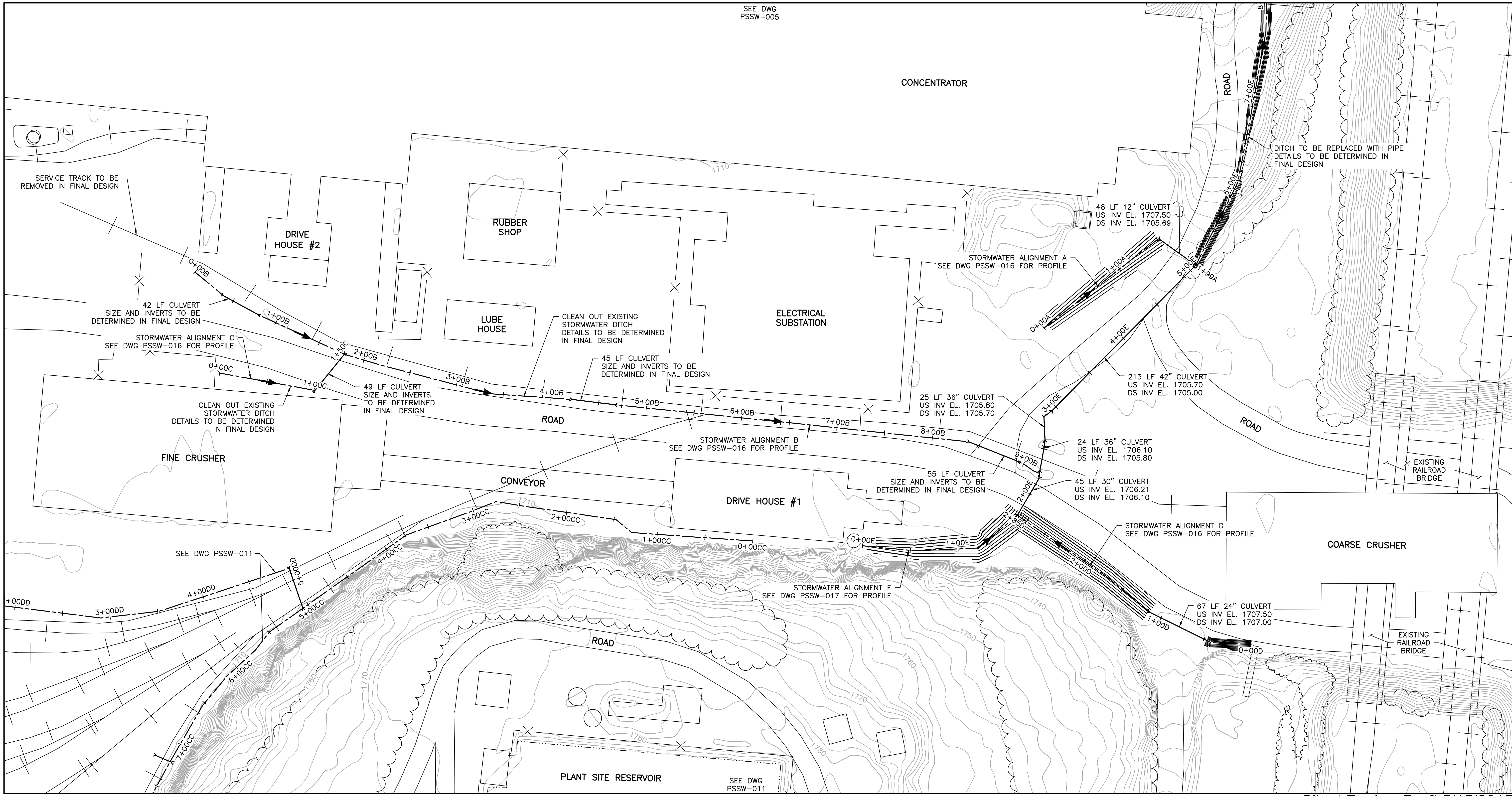

1 PLAN: STORMWATER ALIGNMENTS A–E

NOTE:

ALL PIPES AND CULVERTS ARE PROPOSED UNLESS INDICATED.

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SIGNATURE
DATE 5/15/15 LICENSE# 46593

DRAWN: VJS
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PLAN

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-004
REV

CADD USER: Cristion A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-004.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 9:48 AM

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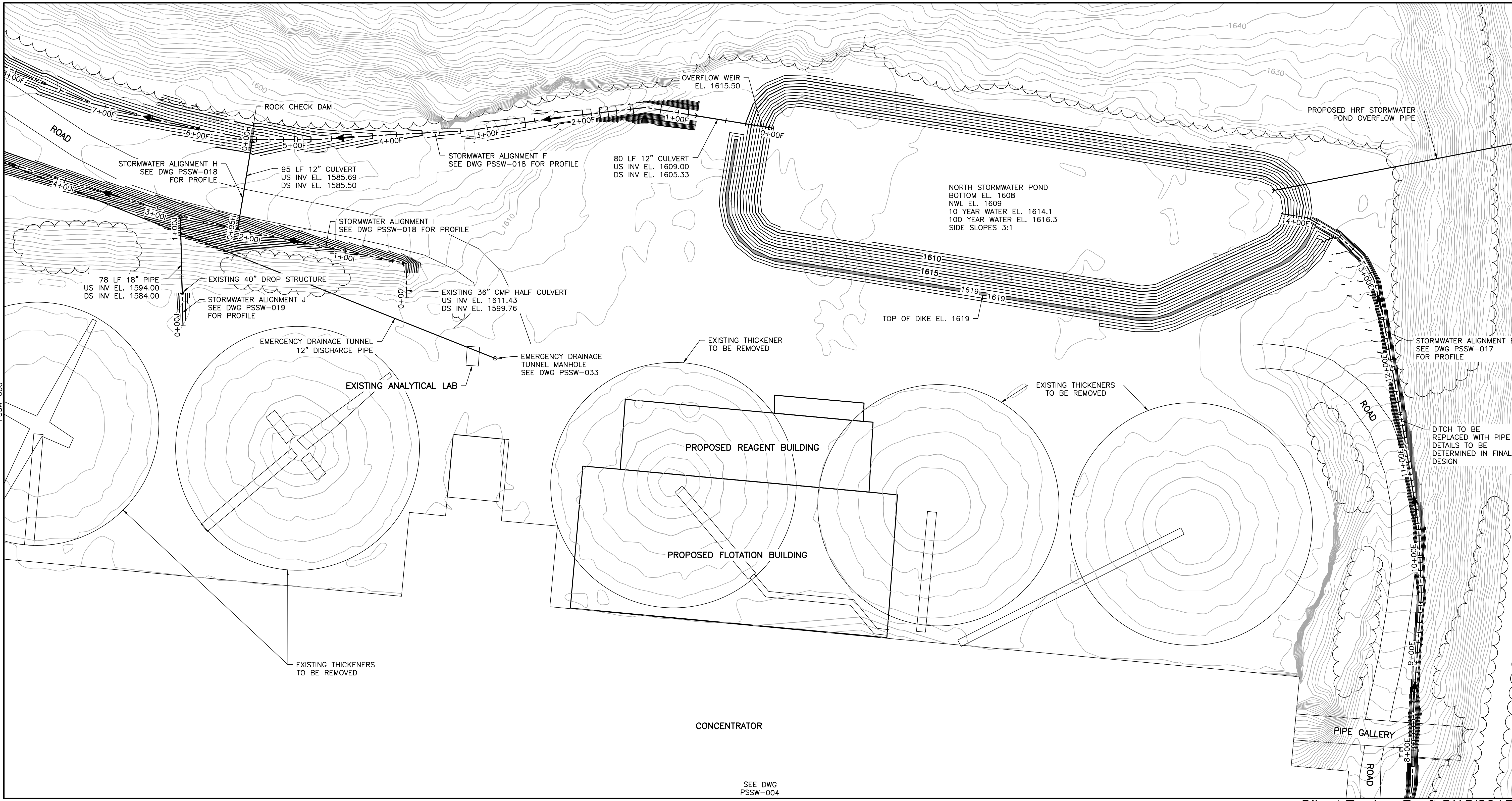

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1 PLAN: STORMWATER ALIGNMENTS E, F, H-J

NOTE:

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0 50 100
SCALE IN FEET

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DRAWN: VJS
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER
GRADING PLAN

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-005

REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-005.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 9:55 AM

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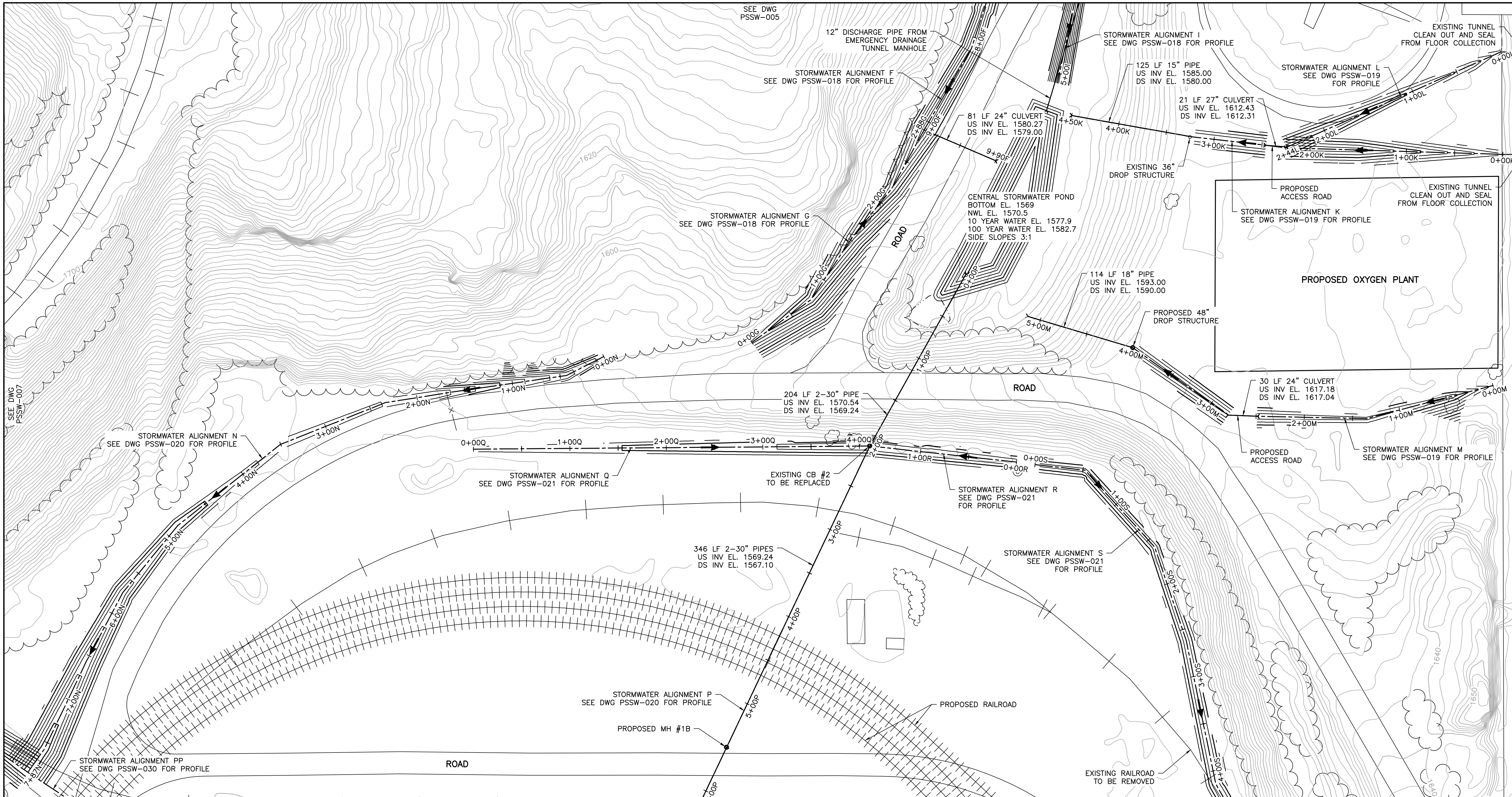

SEE DWG PSSW-008

SEE DWG PSSW-009

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PLANT DRAWING NUMBER:

1 PLAN: STORMWATER ALIGNMENTS F, G, I, K-N, P-S

NOTE:

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PLANT SITE STORMWATER GRADING PLAN

0 50 100
SCALE IN FEET

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SCALE: AS SHOWN

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-006

REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-006.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 9:57 AM

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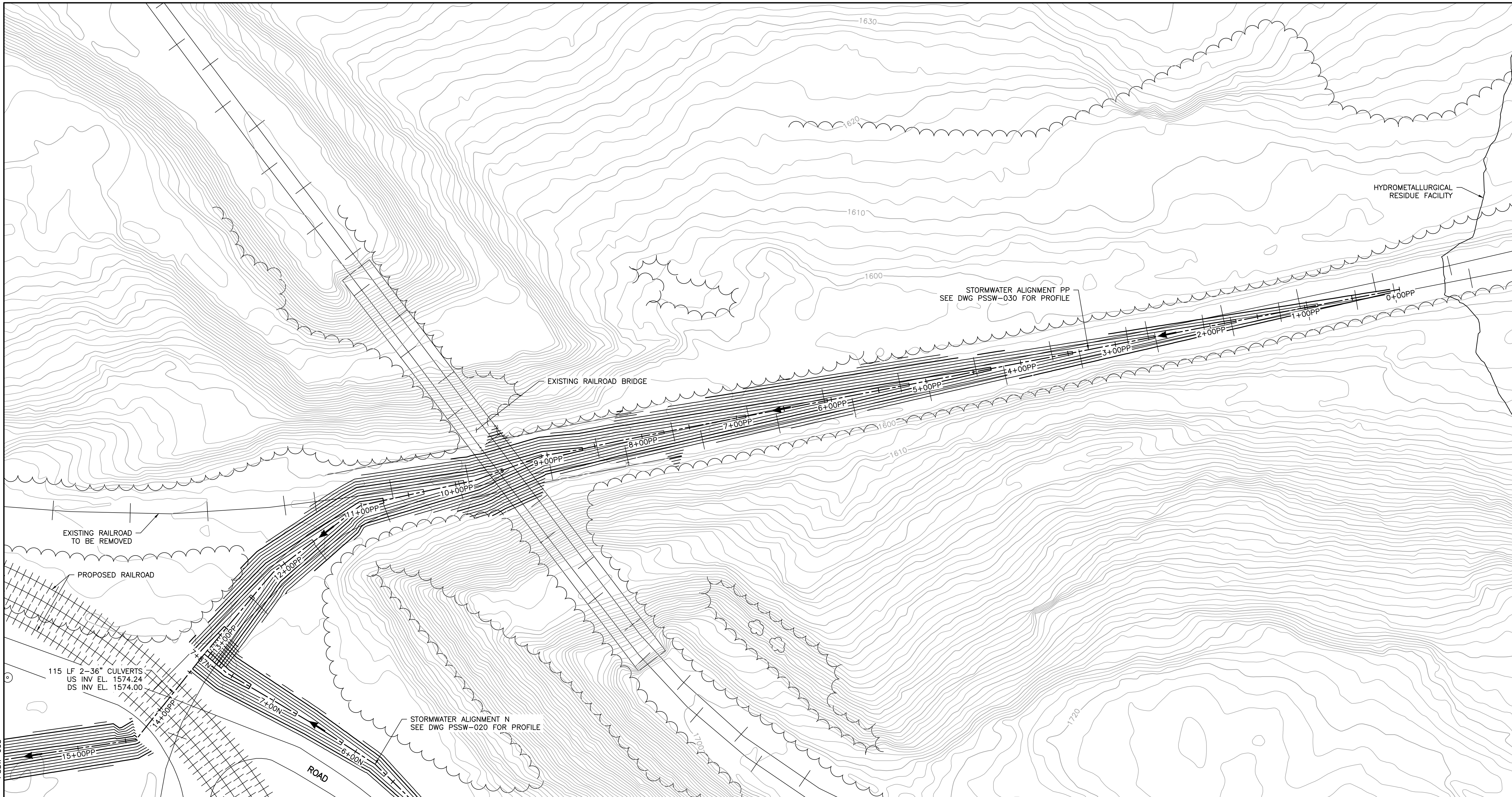

SEE DWG PSSW-006

1 PLAN: STORMWATER ALIGNMENTS N AND PP

NOTE:

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0 50 100
SCALE IN FEET

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-007.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 10:00 AM

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PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PLAN

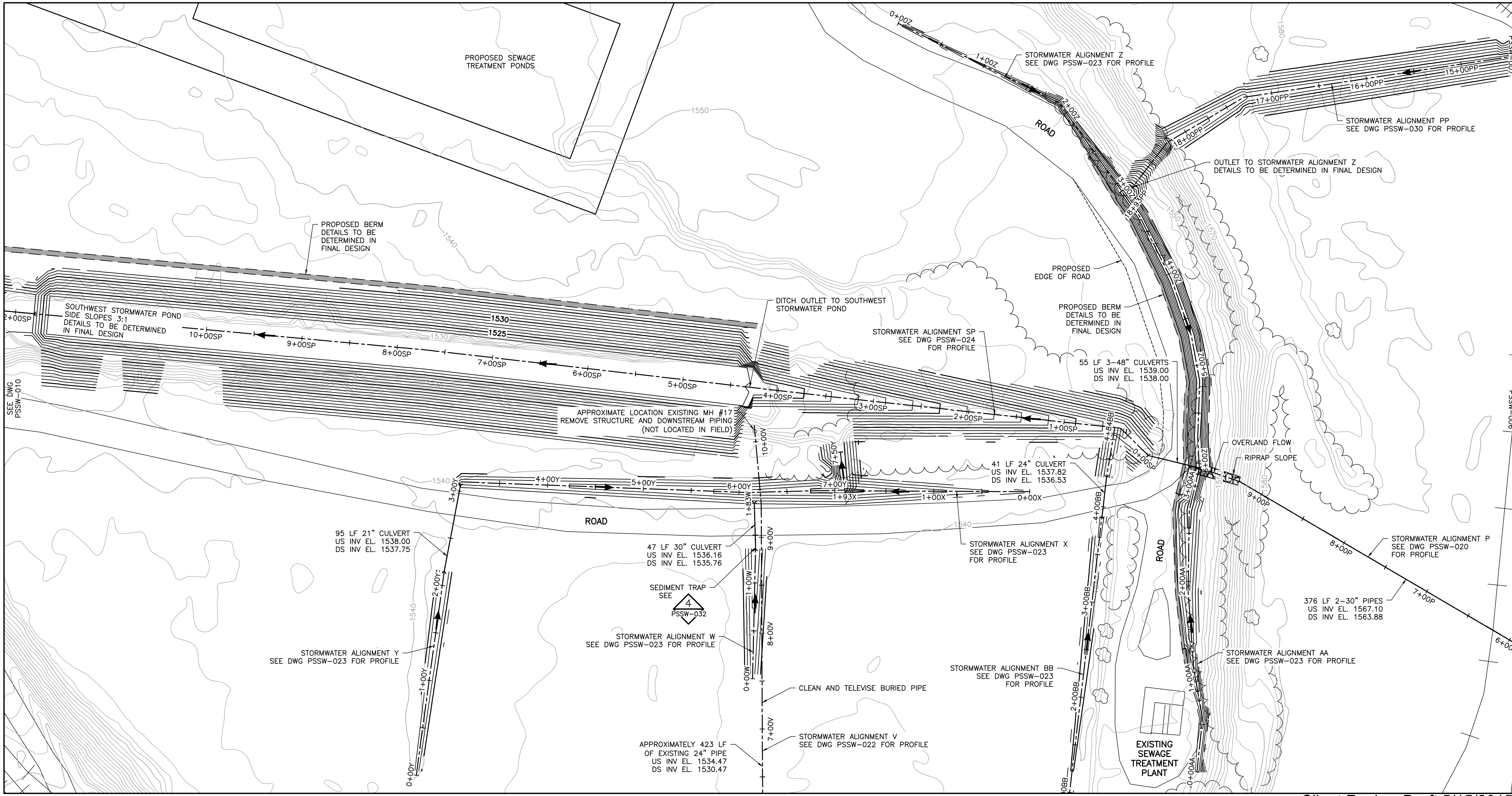
POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-007 REV



SEE DWG PSSW-009

Client Review Draft 5/15/2015

1 PLAN: STORMWATER ALIGNMENTS V–Z, AA, BB, SP

NOTE:

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0 50 100
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SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PLAN

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR

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DWG. NO. PSSW-008 REV

INCHES 1 2

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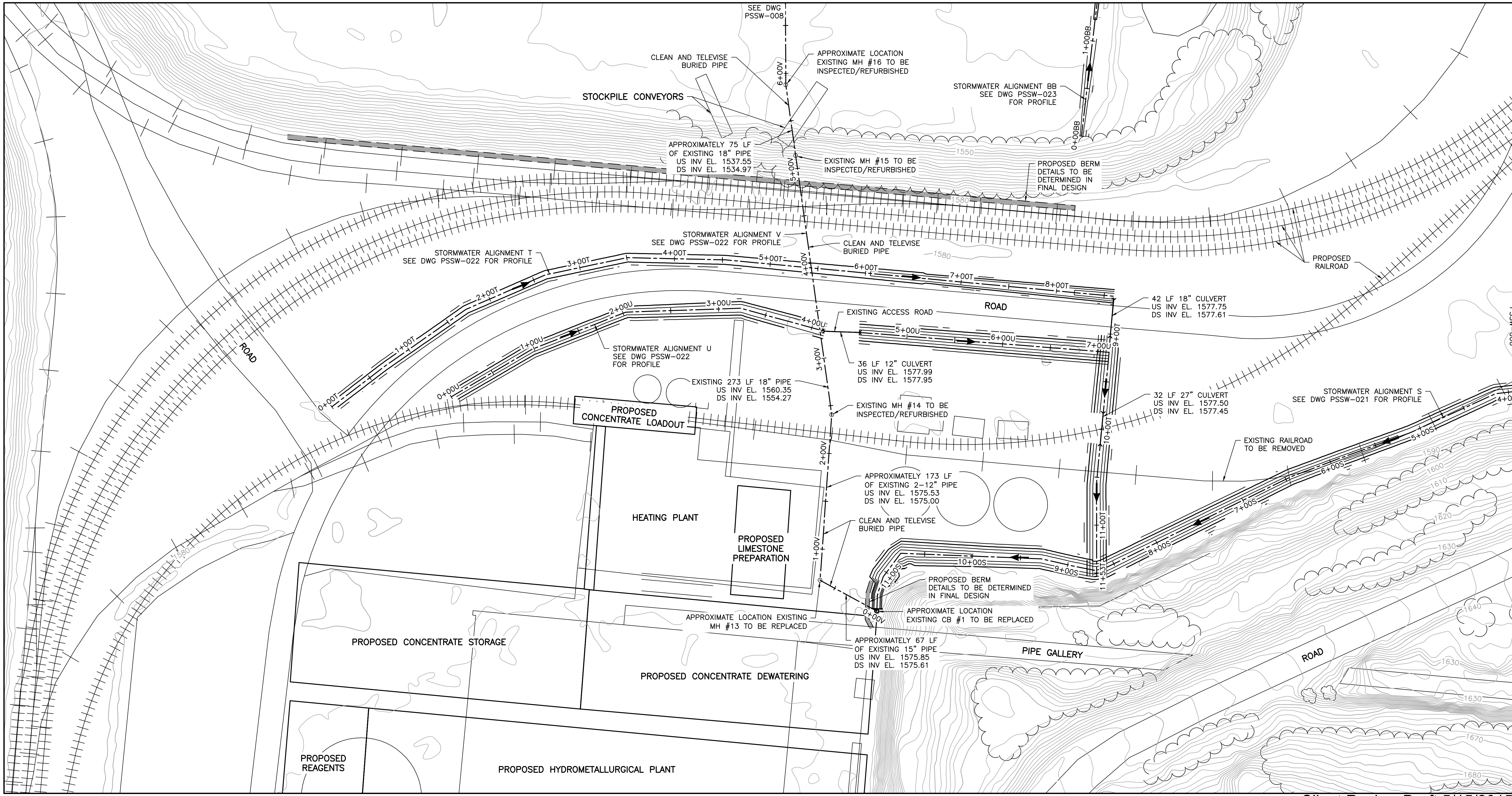

1 PLAN: STORMWATER ALIGNMENTS S-V, BB

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NOTE:

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0 50 100
SCALE IN FEET

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SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PLAN

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR

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4700 WEST 77TH STREET
MINNEAPOLIS, MN.
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DWG. NO. PSSW-009 REV

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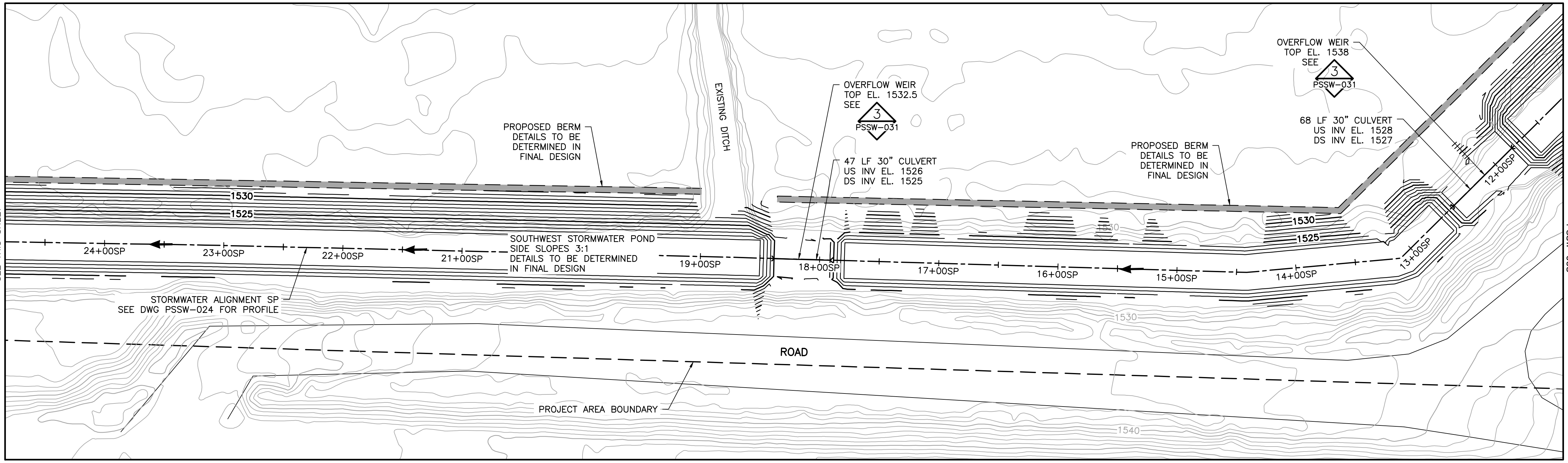

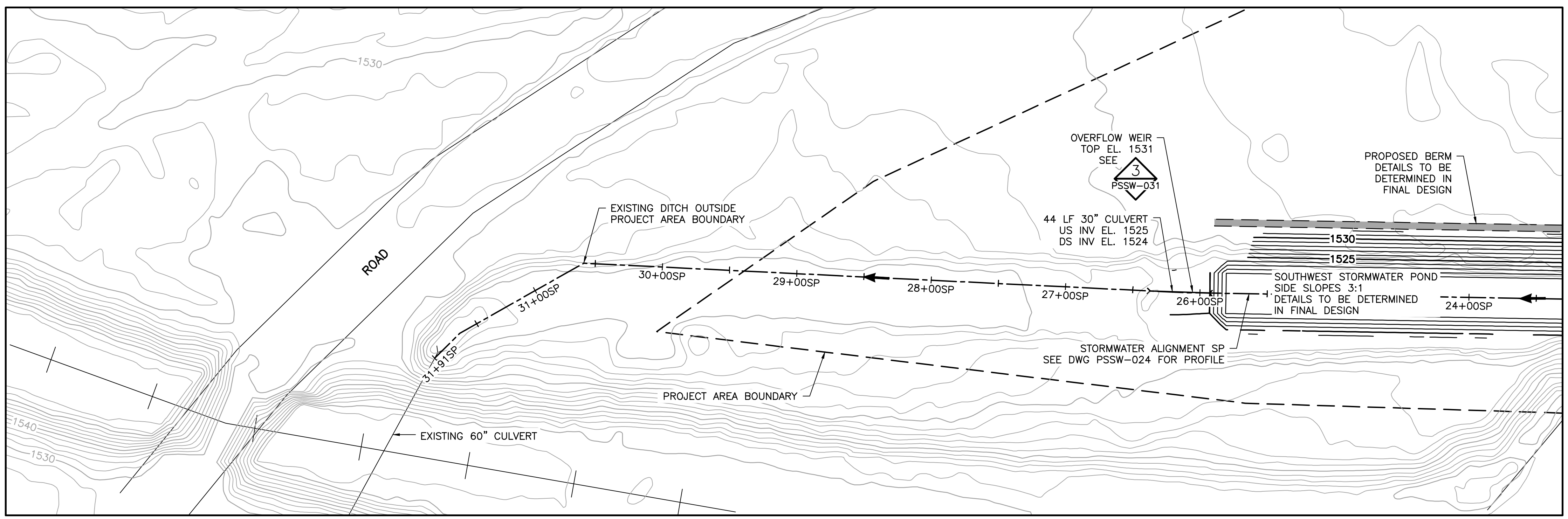

1 PLAN: STORMWATER ALIGNMENT SP

0 50 100
SCALE IN FEET

NOTE:

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Client Review Draft 5/15/2015

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER
GRADING PLAN

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

POLYMET MINING

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

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DRAWN: VJS
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN
DWG. NO. PSSW-010
REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-010.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 10:18 AM

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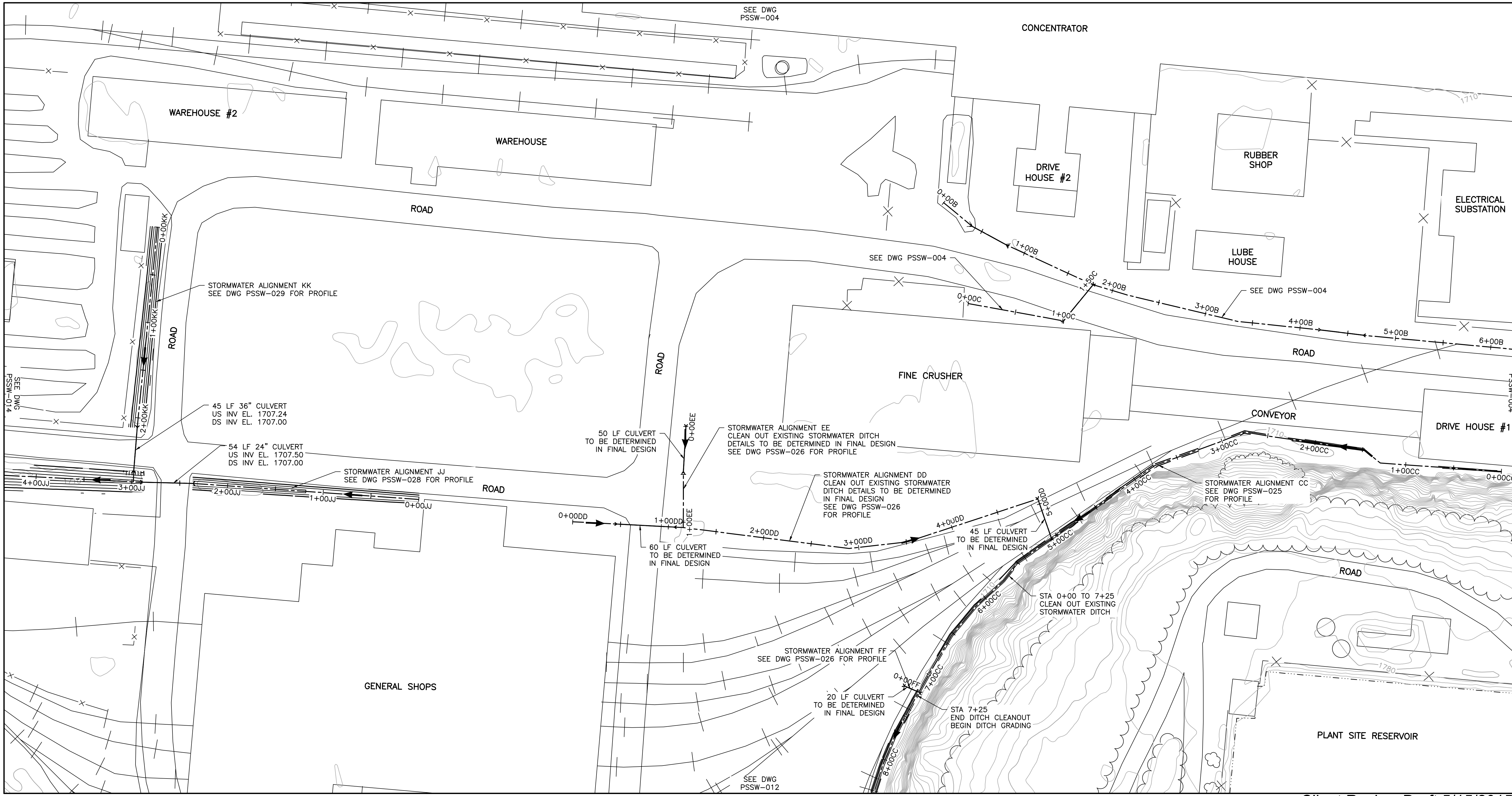

Client Review Draft 5/15/2015

1 PLAN: STORMWATER ALIGNMENTS CC, DD, EE, FF, JJ, AND KK

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SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER
GRADING PLAN

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
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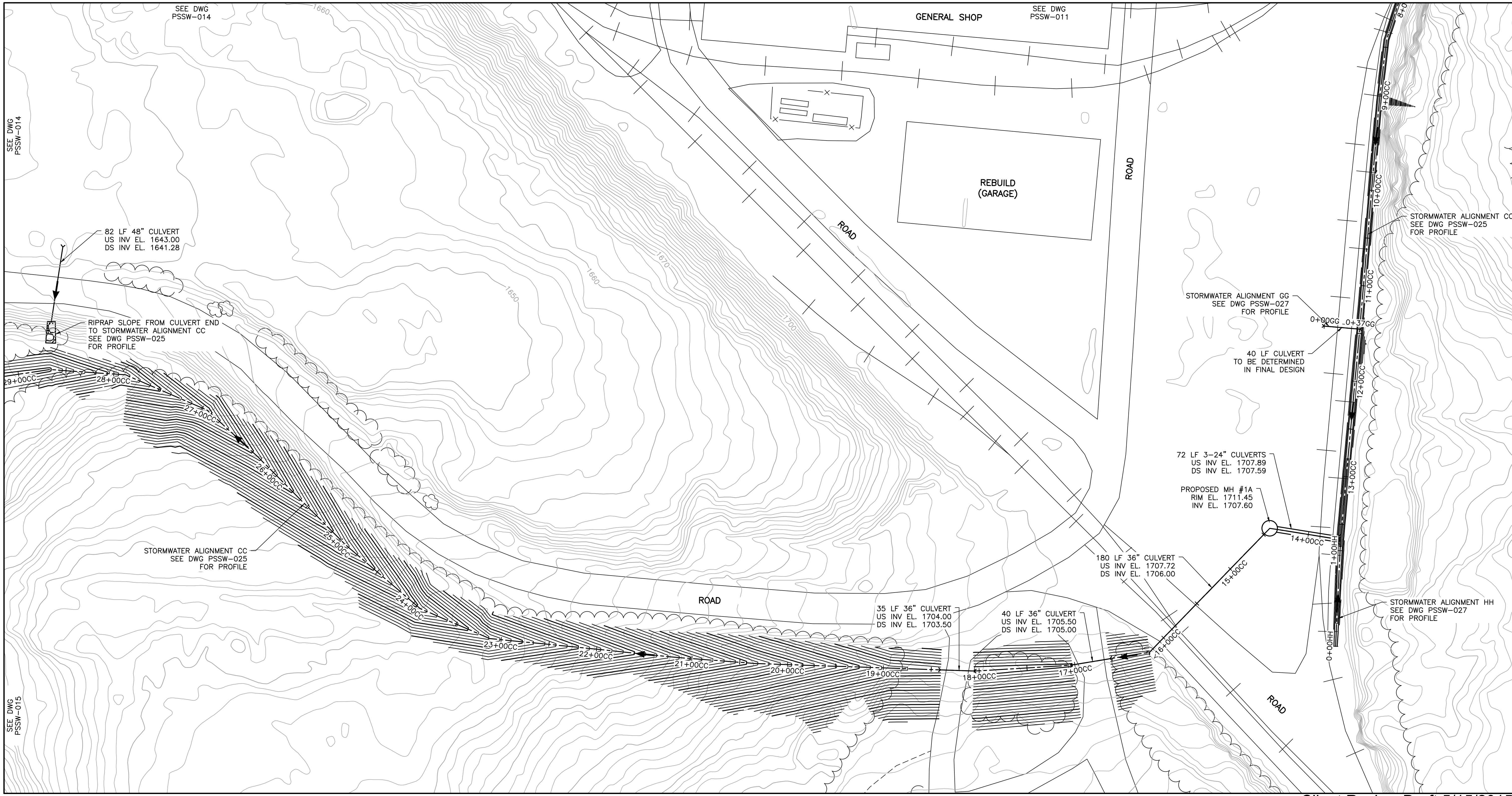
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-011
REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-011.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 10:20 AM

INCHES 1 2



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1 PLAN: STORMWATER ALIGNMENTS CC AND HH

NOTE:

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0 50 100
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PLANT SITE STORMWATER GRADING PLAN

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-012 REV

INCHES 1 2

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(1) PLAN: STORMWATER ALIGNMENTS JJ, MM, AND NN

NOTE:

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0 50 100
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POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-013

REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-013.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 10:24 AM

INCHES 1 2

1 PLAN: STORMWATER ALIGNMENTS CC AND JJ

0 50 100
SCALE IN FEET

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NORTHMET PROJECT
HOYT LAKES, MINNESOTA

POLYMET MINING

BARR ENGINEERING COMPANY
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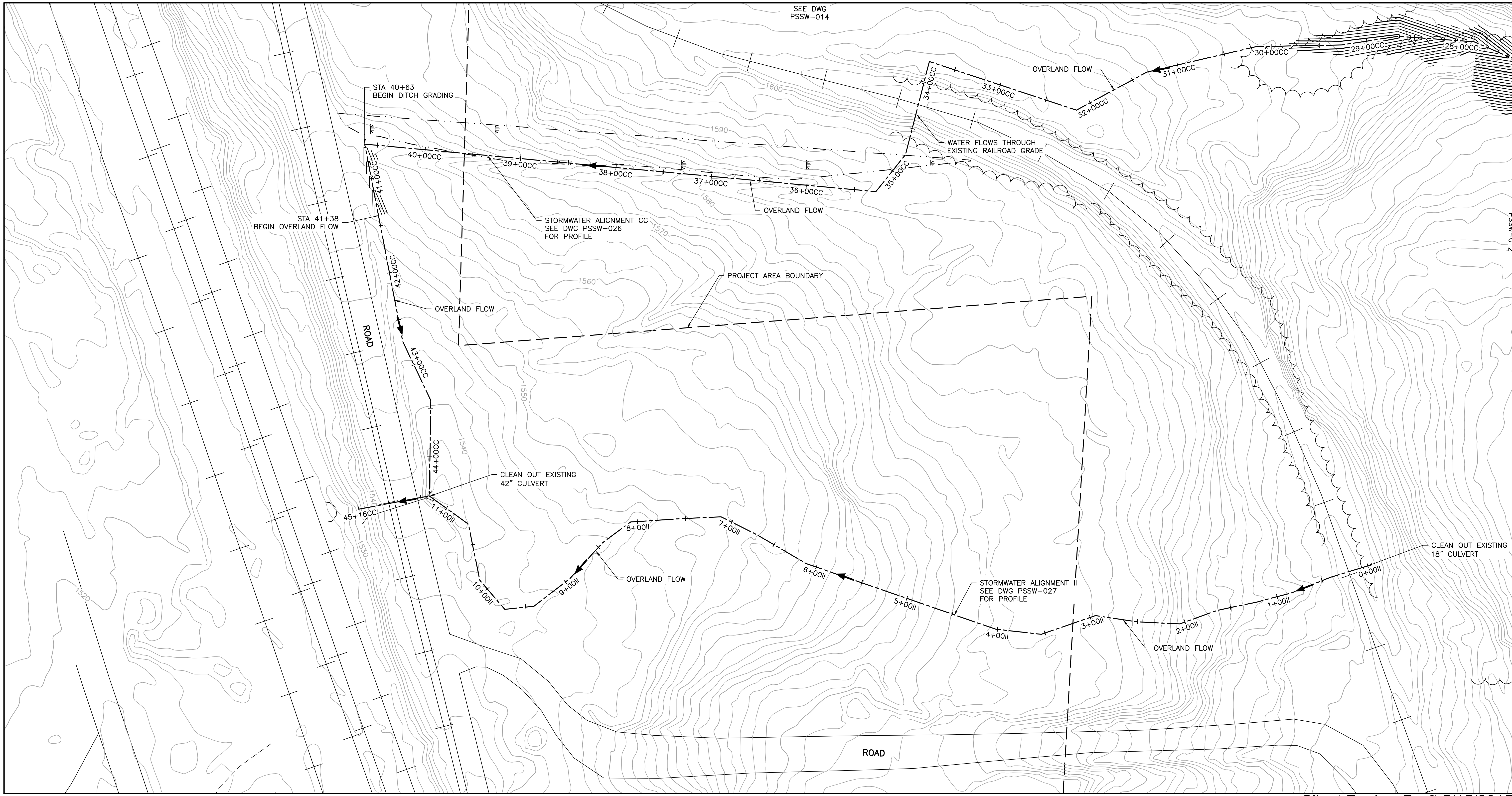
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-014
REV

CADD USER: Cristion A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-014.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 10:26 AM

INCHES



1 PLAN: STORMWATER ALIGNMENTS CC AND II

NOTE:

ALL PIPES AND CULVERTS ARE PROPOSED UNLESS INDICATED.

0 50 100
SCALE IN FEET

Client Review Draft 5/15/2015

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PLAN

VER NO	DATE	DESCRIPTION	ISSUED	VERSION	DATE
1	5/15/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS	FOR PERMITTING	1	5/15/15
			FOR CONSTRUCTION		
			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.

PRINTED NAME CRISTIAN A. DIAZ
SIGNATURE
DATE 5/15/15 LICENSE# 46593

DRAWN: PRT
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

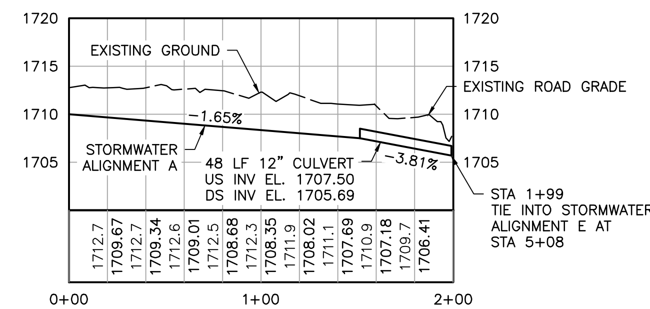
POLYMET MINING
POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR
BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-015 REV

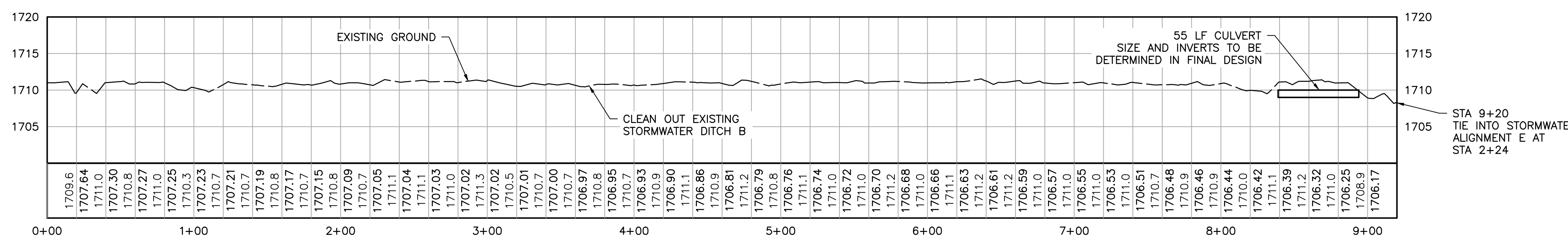
CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-015.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 10:45 AM

INCHES 1 2



A PROFILE: STORMWATER ALIGNMENT A
PSSW-004

0 50 100 HORIZONTAL SCALE IN FEET — 0 10 20 VERTICAL SCALE IN FEET

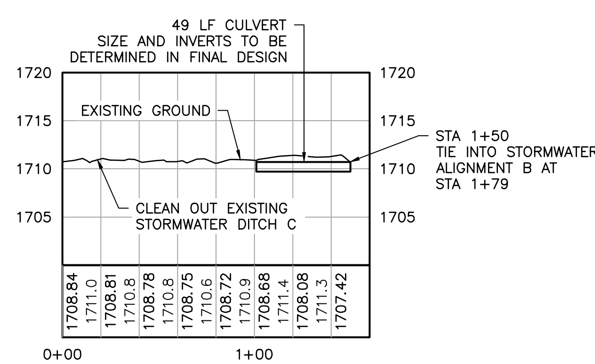


NOTE:

STORMWATER DITCH HAS CONSTRAINTS RESTRICTING CONSTRUCTION. DESIGN OPTIONS HAVE BEEN IDENTIFIED. THIS PROFILE SHOWS CLEAN-OUT OF THE EXISTING DITCH, WHICH DOES NOT HAVE THE CAPACITY AS REQUIRED TO RESTRICT FLOODING.

B PROFILE: STORMWATER ALIGNMENT B
PSSW-004

0 50 100 HORIZONTAL SCALE IN FEET — 0 10 20 VERTICAL SCALE IN FEET

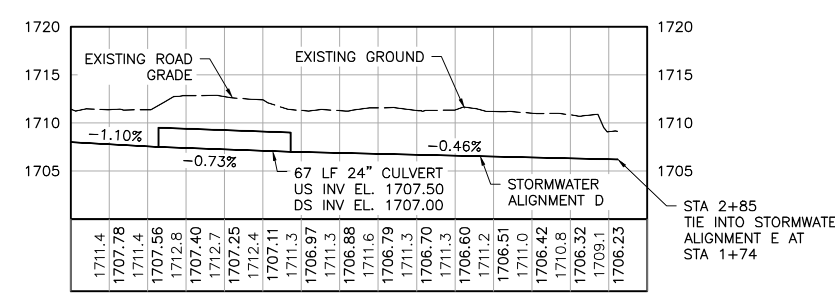


NOTE:

STORMWATER DITCH HAS CONSTRAINTS RESTRICTING CONSTRUCTION. DESIGN OPTIONS HAVE BEEN IDENTIFIED. THIS PROFILE SHOWS CLEAN-OUT OF THE EXISTING DITCH, WHICH DOES NOT HAVE THE CAPACITY AS REQUIRED TO RESTRICT FLOODING.

C PROFILE: STORMWATER ALIGNMENT C
PSSW-004

0 50 100 HORIZONTAL SCALE IN FEET — 0 10 20 VERTICAL SCALE IN FEET



D PROFILE: STORMWATER ALIGNMENT D
PSSW-004

0 50 100 HORIZONTAL SCALE IN FEET — 0 10 20 VERTICAL SCALE IN FEET

NOTE:

ALL PIPES AND CULVERTS ARE PROPOSED UNLESS INDICATED.

Client Review Draft 5/15/2015

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PROFILES

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FOR CONSTRUCTION		

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PRINTED NAME CRISTIAN A. DIAZ
SIGNATURE
DATE 5/15/15 LICENSE# 46593

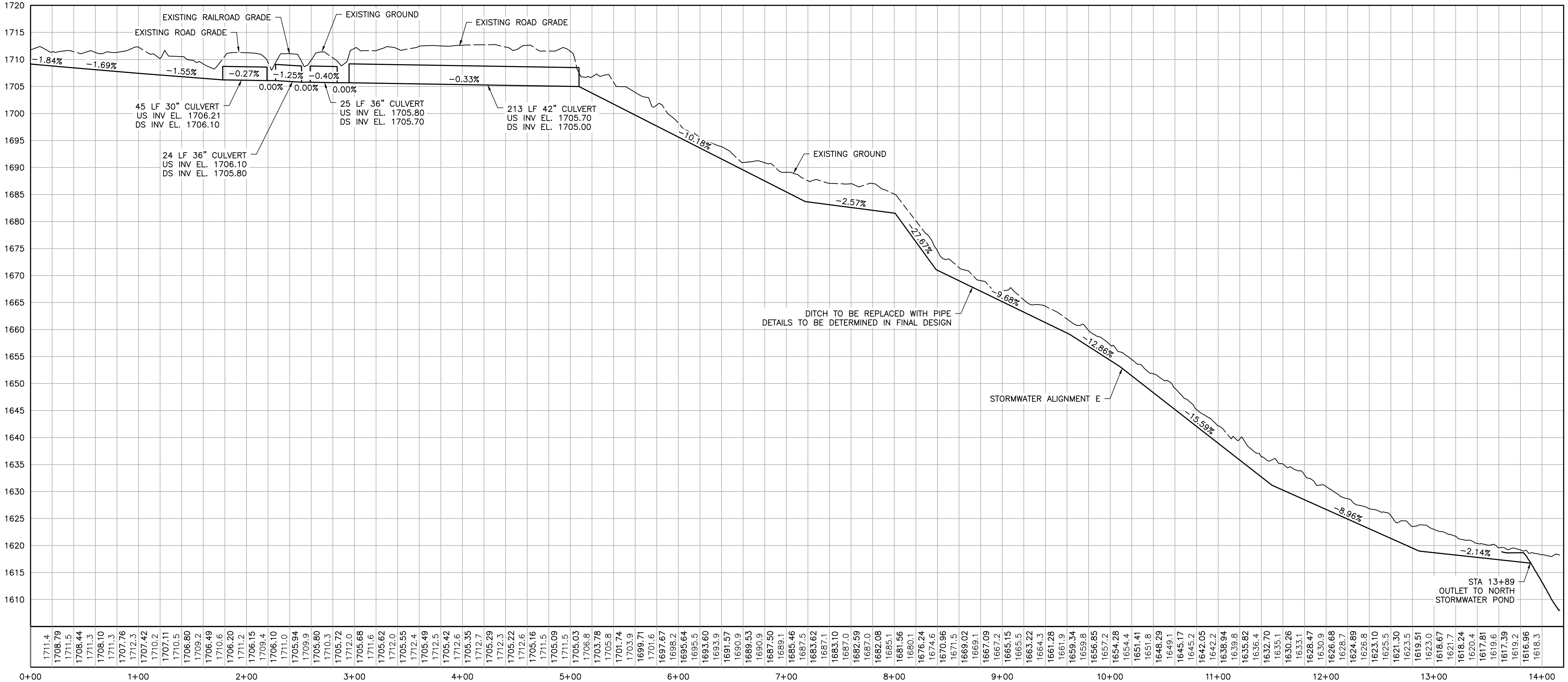
DRAWN: VJS
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-016 REV

INCHES 1 2



E PROFILE: STORMWATER ALIGNMENT E

PSSW-004,005

HORIZONTAL SCALE IN FEET (0, 50, 100)

VERTICAL SCALE IN FEET (0, 10, 20)

NOTE:

ALL PIPES AND CULVERTS ARE PROPOSED UNLESS INDICATED.

Client Review Draft 5/15/2015

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PROFILES

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

VER NO	DATE	DESCRIPTION
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ISSUE STATUS	ISSUED	VERSION	DATE
FOR PERMITTING		1	5/15/15
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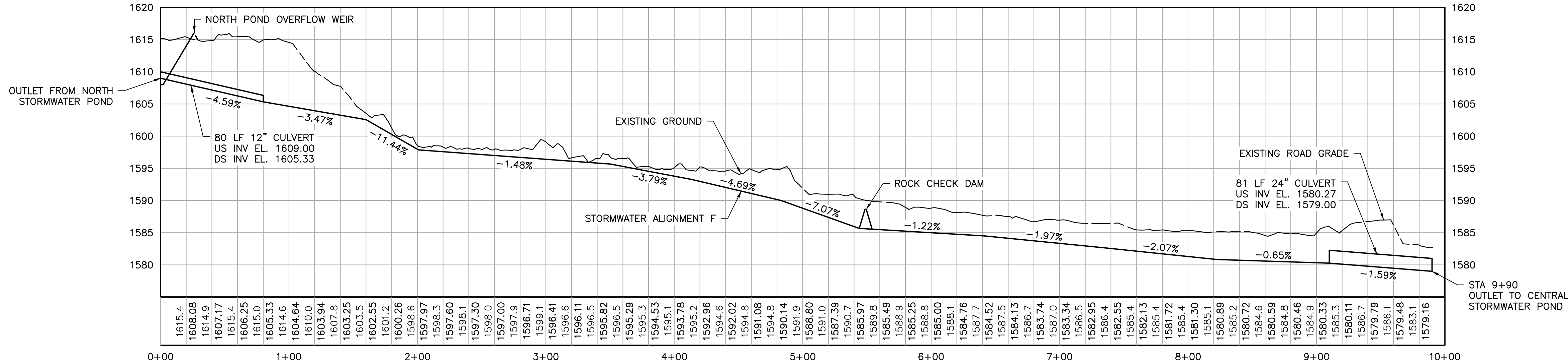
SIGNATURE
DATE 5/15/15 LICENSE# 46593

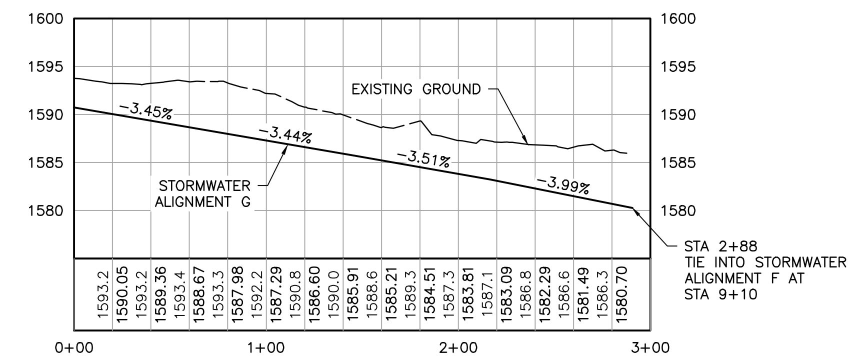
DRAWN: VJS
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN
DWG. NO. PSSW-017
REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-017.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 10:58 AM

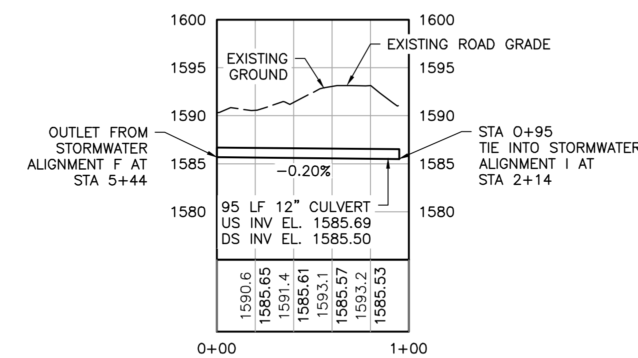
INCHES 1 2



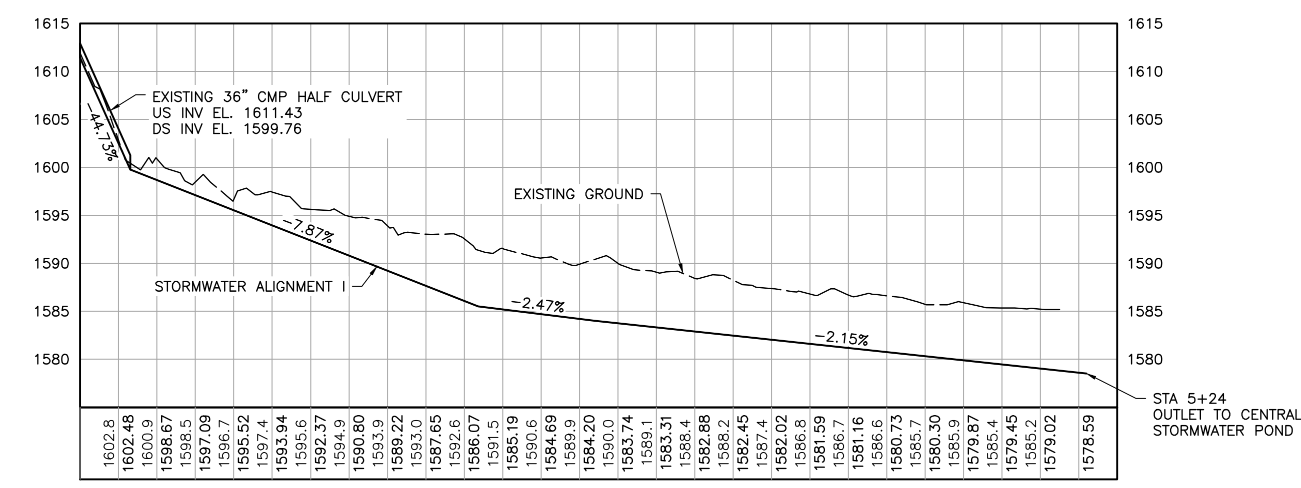
F PROFILE: STORMWATER ALIGNMENT F
PSSW-005,006
HORIZONTAL SCALE IN FEET (0, 50, 100) — VERTICAL SCALE IN FEET (0, 10, 20)



G PROFILE: STORMWATER ALIGNMENT G
PSSW-006
HORIZONTAL SCALE IN FEET (0, 50, 100) — VERTICAL SCALE IN FEET (0, 10, 20)



H PROFILE: STORMWATER ALIGNMENT H
PSSW-005
HORIZONTAL SCALE IN FEET (0, 50, 100) — VERTICAL SCALE IN FEET (0, 10, 20)



I PROFILE: STORMWATER ALIGNMENT I
PSSW-005,006
HORIZONTAL SCALE IN FEET (0, 50, 100) — VERTICAL SCALE IN FEET (0, 10, 20)

NOTE:
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PRINTED NAME CRISTIAN A. DIAZ
SIGNATURE
DATE 5/15/15 LICENSE# 46593

DRAWN: VJS
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

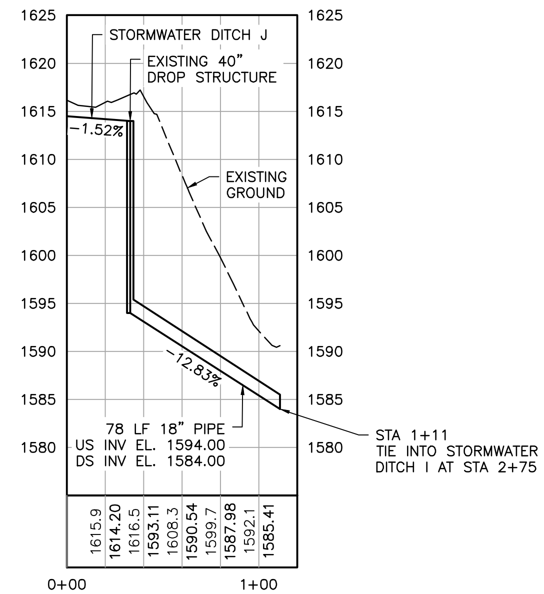
POLYMET MINING
POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR
BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

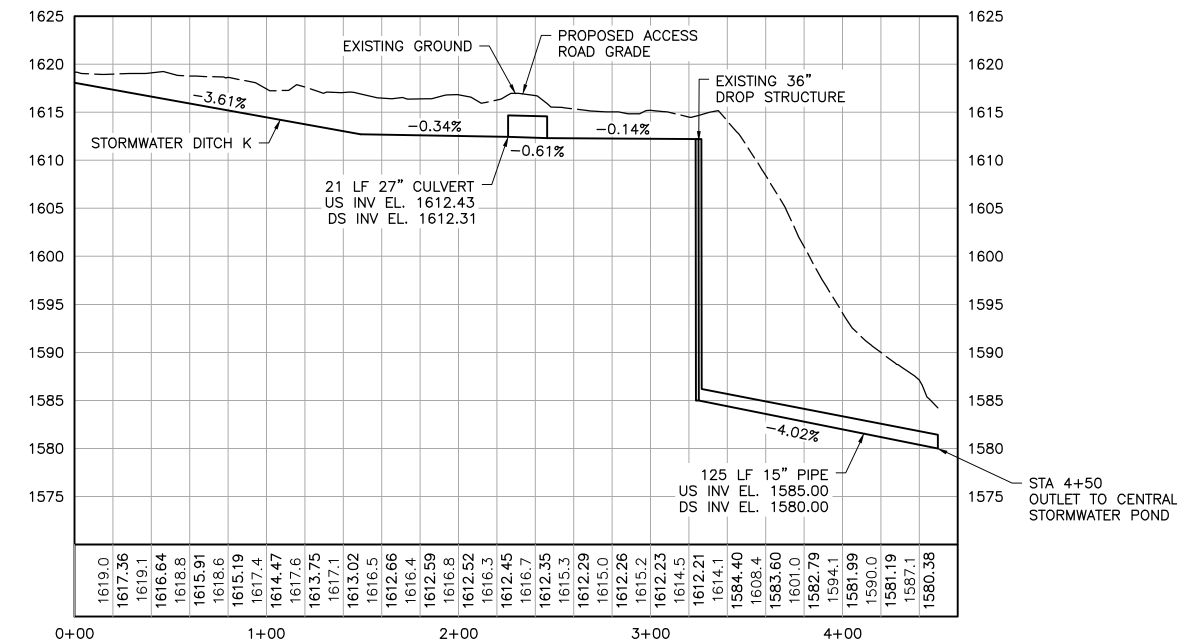
DWG. NO. PSSW-018
REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-018.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 11:12 AM

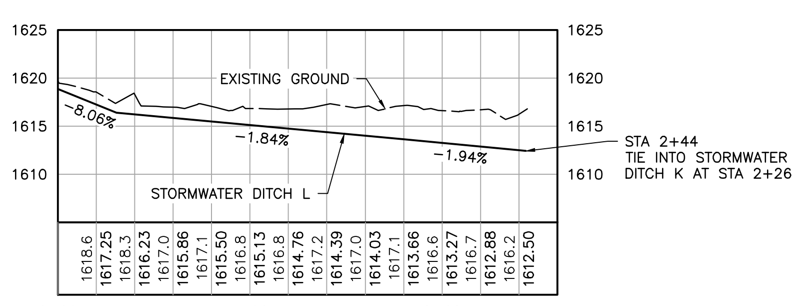
INCHES 1 2



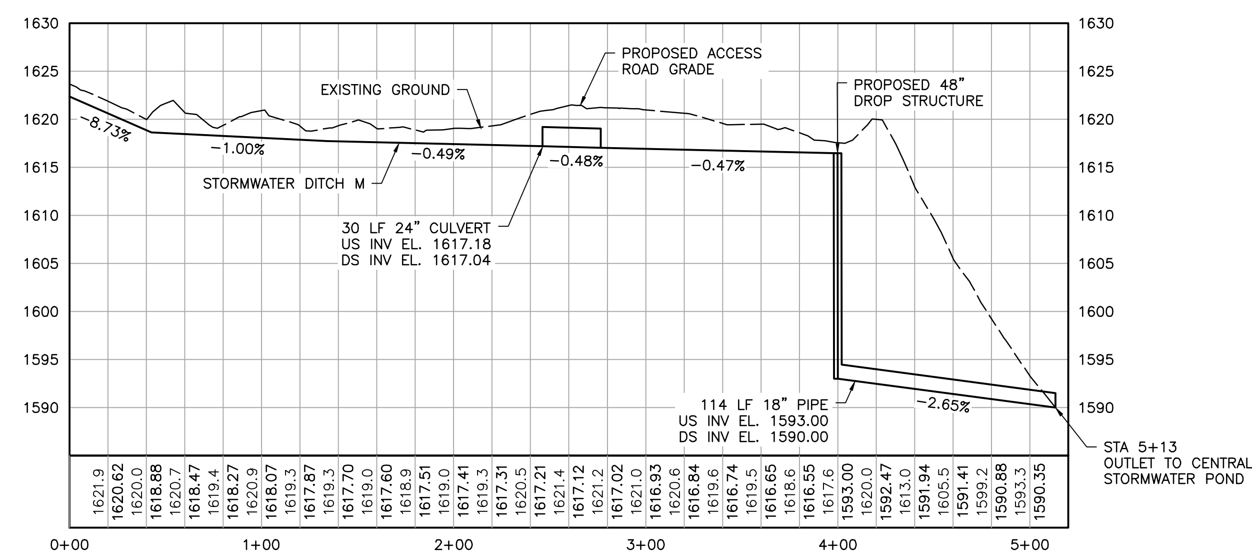
J PROFILE: STORMWATER ALIGNMENT J
PSSW-005
0 50 100 HORIZONTAL SCALE IN FEET
0 10 20 VERTICAL SCALE IN FEET



K PROFILE: STORMWATER ALIGNMENT K
PSSW-006
0 50 100 HORIZONTAL SCALE IN FEET
0 10 20 VERTICAL SCALE IN FEET



L PROFILE: STORMWATER ALIGNMENT L
PSSW-006
0 50 100 HORIZONTAL SCALE IN FEET
0 10 20 VERTICAL SCALE IN FEET



M PROFILE: STORMWATER ALIGNMENT M
PSSW-006
0 50 100 HORIZONTAL SCALE IN FEET
0 10 20 VERTICAL SCALE IN FEET

NOTE:

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Client Review Draft 5/15/2015

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PRINTED NAME CRISTIAN A. DIAZ
SIGNATURE
DATE 5/15/15 LICENSE# 46593

DRAWN: VJS
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR

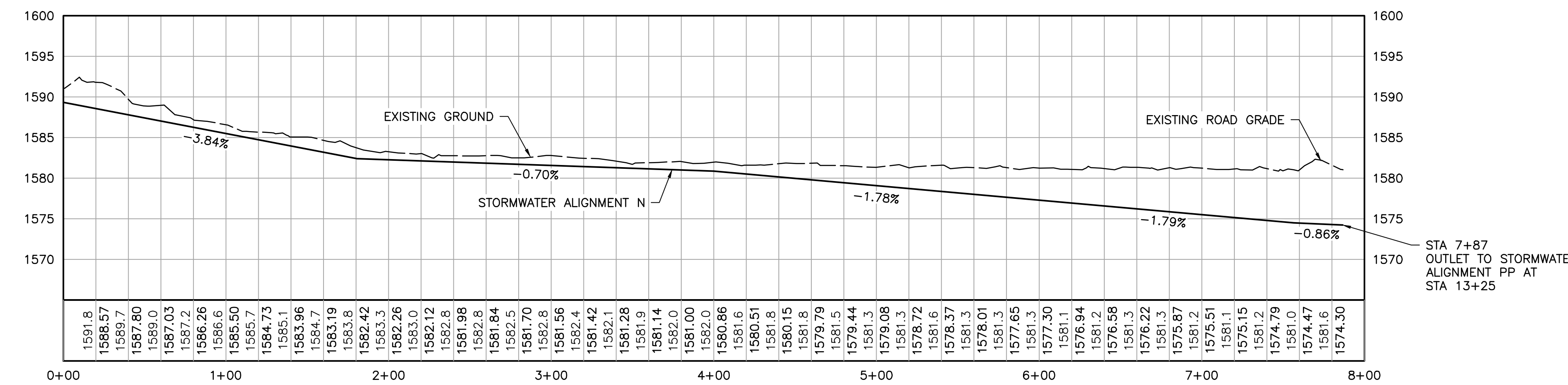
BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-019

REV

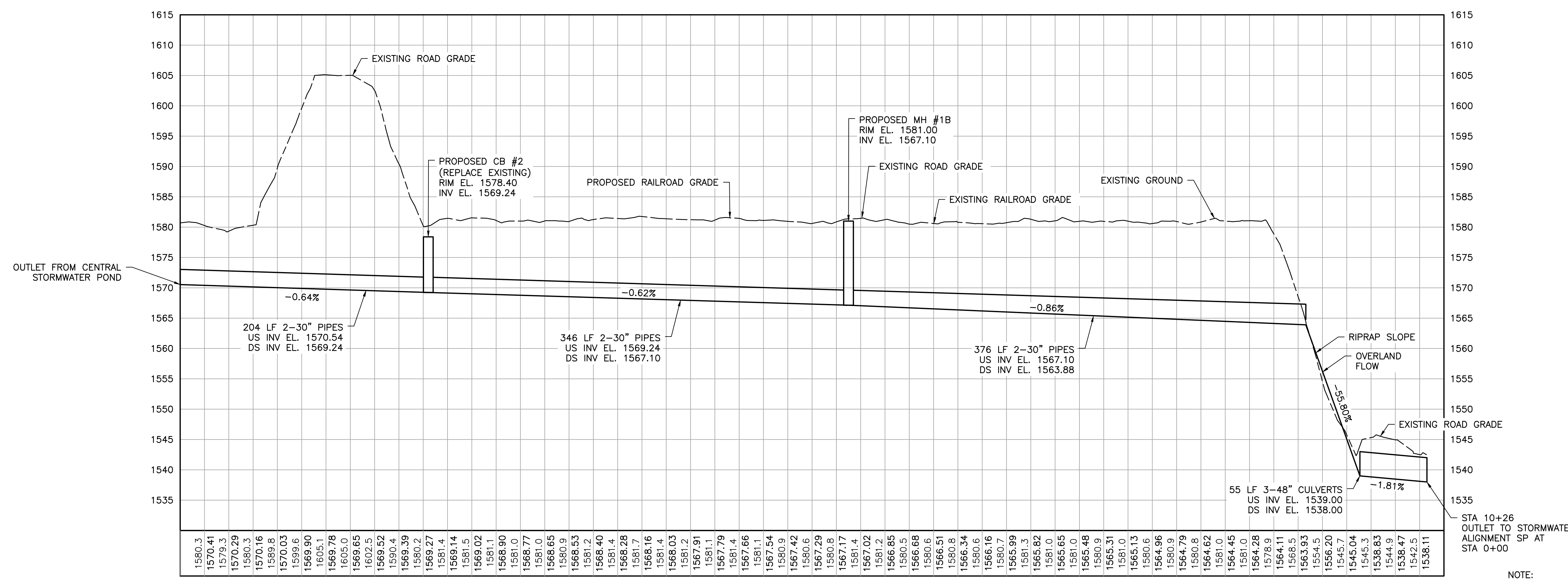
CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-019.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 11:14 AM

INCHES 1 2



(N) PSSW-006 **PROFILE: STORMWATER ALIGNMENT N**

HORIZONTAL SCALE IN FEET: 0 – 50 – 100
VERTICAL SCALE IN FEET: 0 – 10 – 20



(P) PSSW-006,008 **PROFILE: STORMWATER ALIGNMENT P**

HORIZONTAL SCALE IN FEET: 0 – 50 – 100
VERTICAL SCALE IN FEET: 0 – 10 – 20

NOTE:

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Client Review Draft 5/15/2015

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SIGNATURE
DATE 5/15/15 LICENSE# 46593

DRAWN: VJS
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PROFILES

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

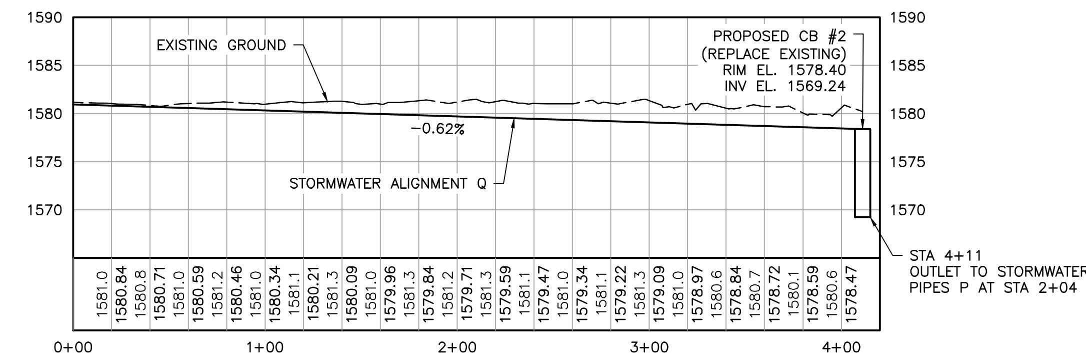
BARR

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-020 REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-020.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 11:18 AM

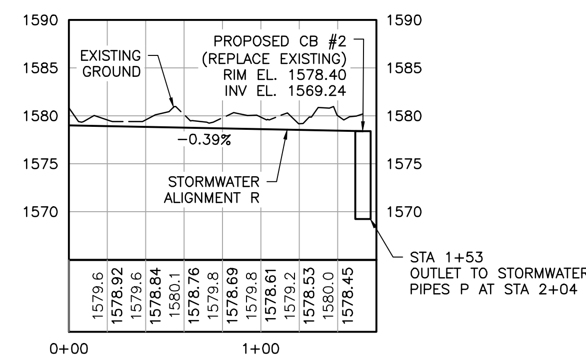
INCHES 1 2



(Q) PROFILE: STORMWATER ALIGNMENT Q

PSSW-006

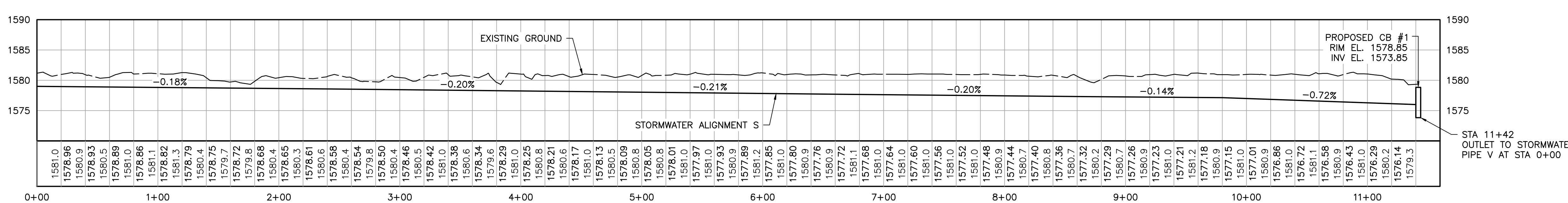
HORIZONTAL SCALE IN FEET (0, 50, 100) VERTICAL SCALE IN FEET (0, 10, 20)



(R) PROFILE: STORMWATER ALIGNMENT R

PSSW-006

HORIZONTAL SCALE IN FEET (0, 50, 100) VERTICAL SCALE IN FEET (0, 10, 20)



(S) PROFILE: STORMWATER ALIGNMENT S

PSSW-006,009

HORIZONTAL SCALE IN FEET (0, 50, 100) VERTICAL SCALE IN FEET (0, 10, 20)

NOTE:

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Client Review Draft 5/15/2015

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PROFILES

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

POLYMET MINING

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

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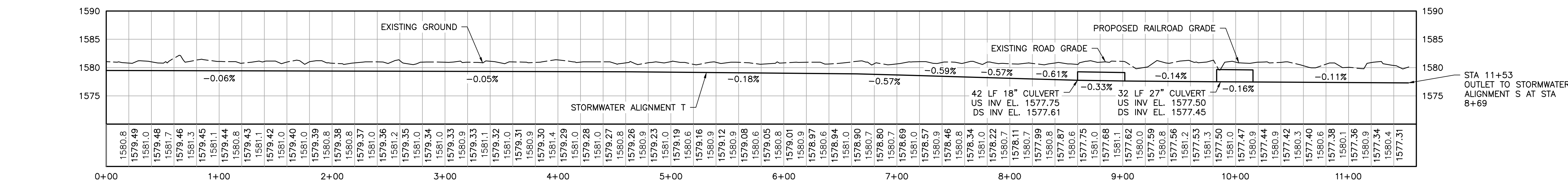
SIGNATURE
DATE 5/15/15 LICENSE# 46593

DRAWN: VJS
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

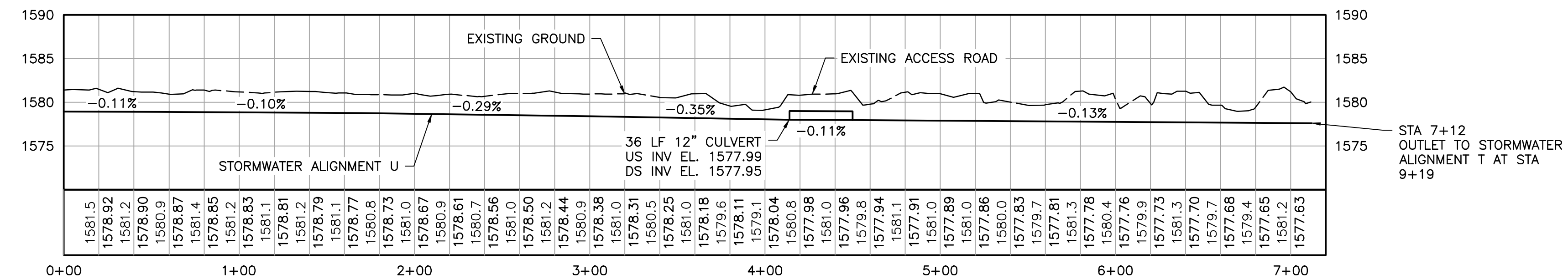
DWG. NO. PSSW-021 REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-021.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 11:21 AM

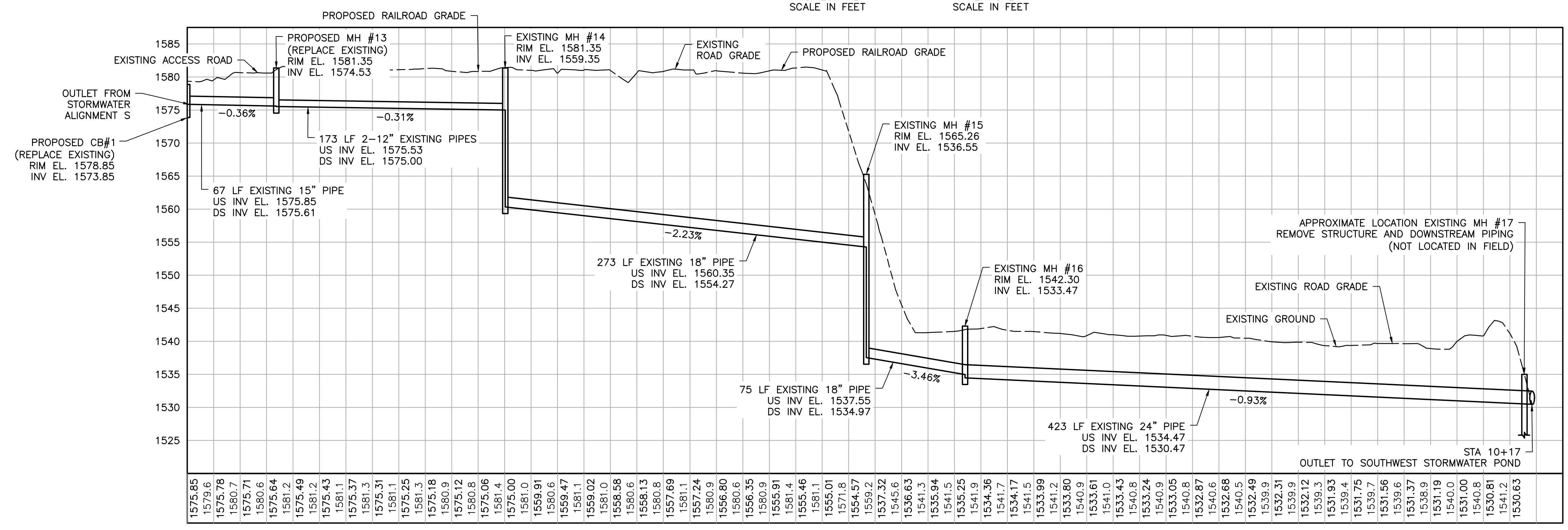
INCHES 1 2



T PROFILE: STORMWATER ALIGNMENT T
PSSW-009
HORIZONTAL SCALE IN FEET
VERTICAL SCALE IN FEET



U PROFILE: STORMWATER ALIGNMENT U
PSSW-009
HORIZONTAL SCALE IN FEET
VERTICAL SCALE IN FEET



V PROFILE: STORMWATER ALIGNMENT V
PSSW-008,009
HORIZONTAL SCALE IN FEET
VERTICAL SCALE IN FEET

NOTE:

CLEAN AND TELEVISE BURIED PIPE.

NOTE:

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Client Review Draft 5/15/2015

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PROFILES

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SIGNATURE
DATE 5/15/15 LICENSE# 46593

DRAWN: VJS
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

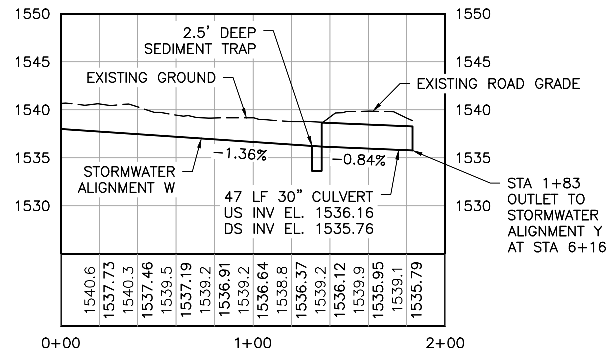
BARR

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

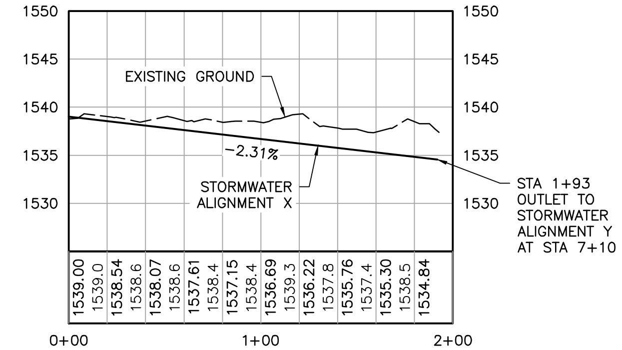
DWG. NO. PSSW-022
REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-022.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 11:24 AM

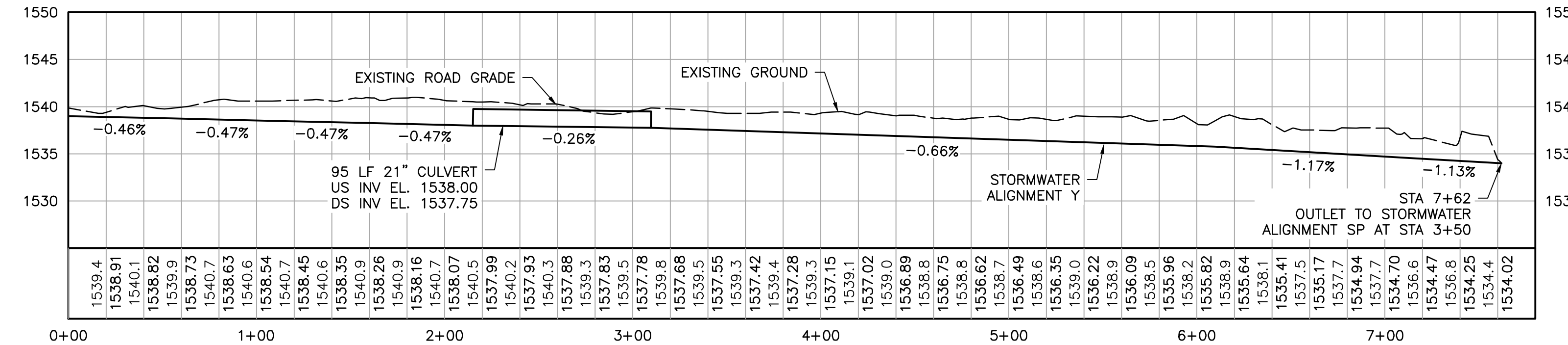
INCHES



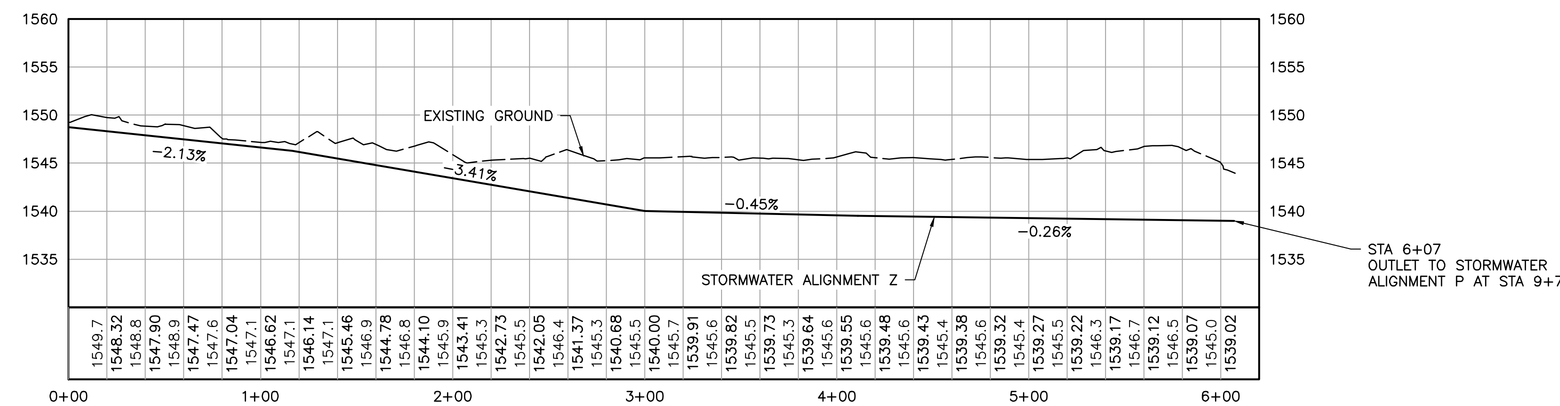
W PROFILE: STORMWATER ALIGNMENT W
PSSW−008
0 50 100 HORIZONTAL SCALE IN FEET
0 10 20 VERTICAL SCALE IN FEET



X PROFILE: STORMWATER ALIGNMENT X
PSSW−008
0 50 100 HORIZONTAL SCALE IN FEET
0 10 20 VERTICAL SCALE IN FEET



Y PROFILE: STORMWATER ALIGNMENT Y
PSSW−008
0 50 100 HORIZONTAL SCALE IN FEET
0 10 20 VERTICAL SCALE IN FEET



Z PROFILE: STORMWATER ALIGNMENT Z
PSSW−008
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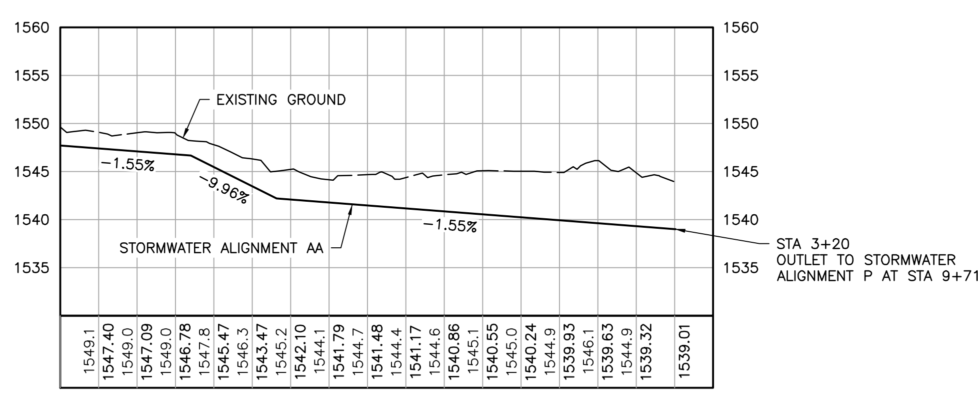
0 10 20 VERTICAL SCALE IN FEET



AA PROFILE: STORMWATER ALIGNMENT AA
PSSW−008
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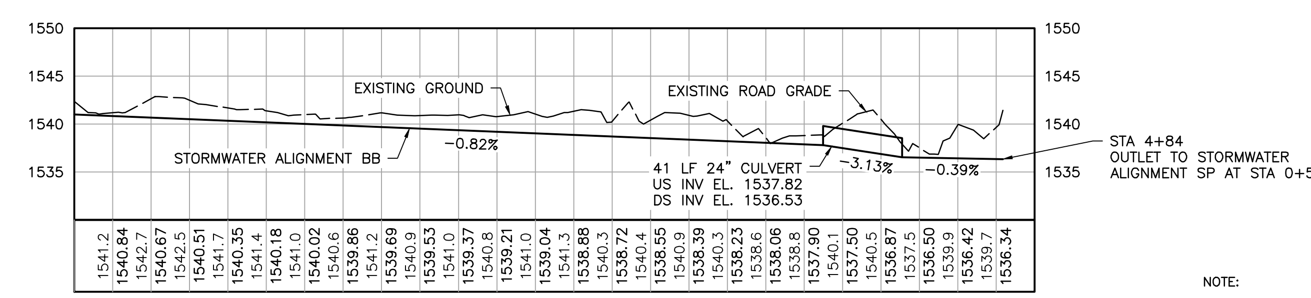
0 10 20 VERTICAL SCALE IN FEET



BB PROFILE: STORMWATER ALIGNMENT BB
PSSW−008,009
0 50 100 HORIZONTAL SCALE IN FEET
0 10 20 VERTICAL SCALE IN FEET

NOTE:

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PRINTED NAME CRISTIAN A. DIAZ
SIGNATURE
DATE 5/15/15 LICENSE# 46593

DRAWN: VJS
CHECKED: CMK2
BARR PROJECT NO.: 23/69−0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER
GRADING PROFILES

POLYMET MINING

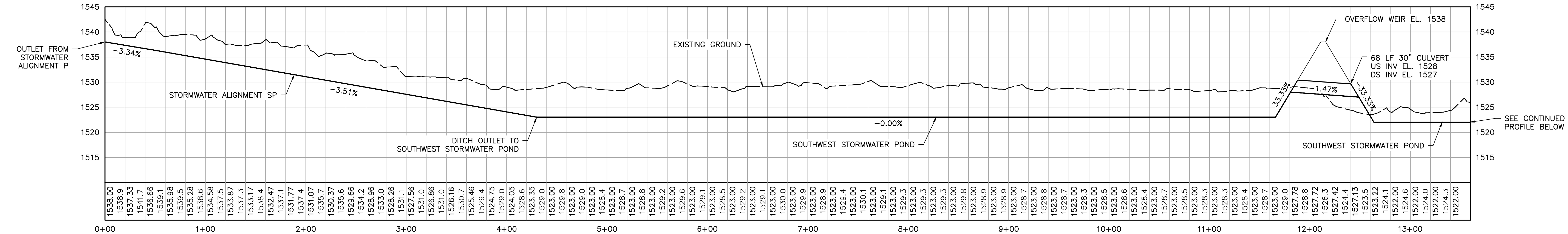
POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1−800−632−2277

DWG. NO. PSSW−023
REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP−63−CS−023.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 11:28 AM

INCHES 1 2

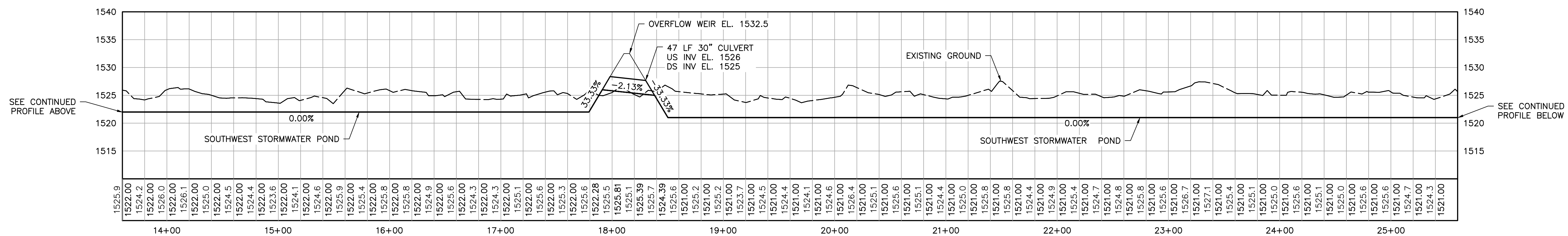


PSSW-008,010 (SP) **PROFILE: STORMWATER ALIGNMENT SP**

0 50 100 HORIZONTAL SCALE IN FEET — 0 10 20 VERTICAL SCALE IN FEET

NOTE:

SOUTHWEST STORMWATER POND TO BE OPTIMIZED IN FINAL DESIGN.

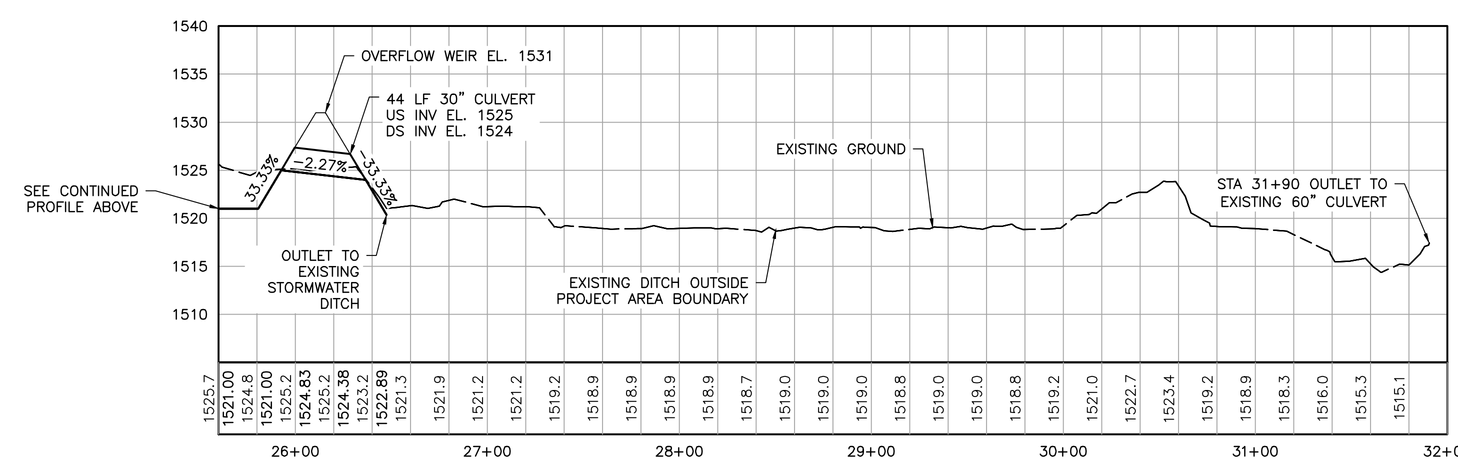


PSSW-008,010 (SP) **PROFILE: STORMWATER ALIGNMENT SP**

0 50 100 HORIZONTAL SCALE IN FEET — 0 10 20 VERTICAL SCALE IN FEET

NOTE:

SOUTHWEST STORMWATER POND TO BE OPTIMIZED IN FINAL DESIGN.



PSSW-008,010 (SP) **PROFILE: STORMWATER ALIGNMENT SP**

0 50 100 HORIZONTAL SCALE IN FEET — 0 10 20 VERTICAL SCALE IN FEET

NOTE:

SOUTHWEST STORMWATER POND TO BE OPTIMIZED IN FINAL DESIGN.

NOTE:

ALL PIPES AND CULVERTS ARE PROPOSED UNLESS INDICATED.

Client Review Draft 5/15/2015

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PROFILES

VER NO	DATE	DESCRIPTION	ISSUED	VERSION	DATE
1	5/15/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS	FOR PERMITTING	1	5/15/15
			FOR CONSTRUCTION		
			NOT APPROVED FOR CONSTRUCTION		

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PRINTED NAME CRISTIAN A. DIAZ
SIGNATURE
DATE 5/15/15 LICENSE# 46593

DRAWN:	VJS
CHECKED:	CMK2
BARR PROJECT NO.:	23/69-0C29
SCALE:	AS SHOWN

POLYMET MINING

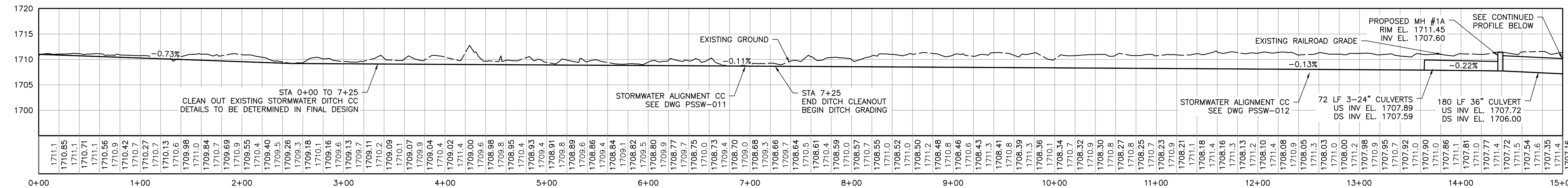
POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-024 REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-024.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 11:31 AM

INCHES 1 2



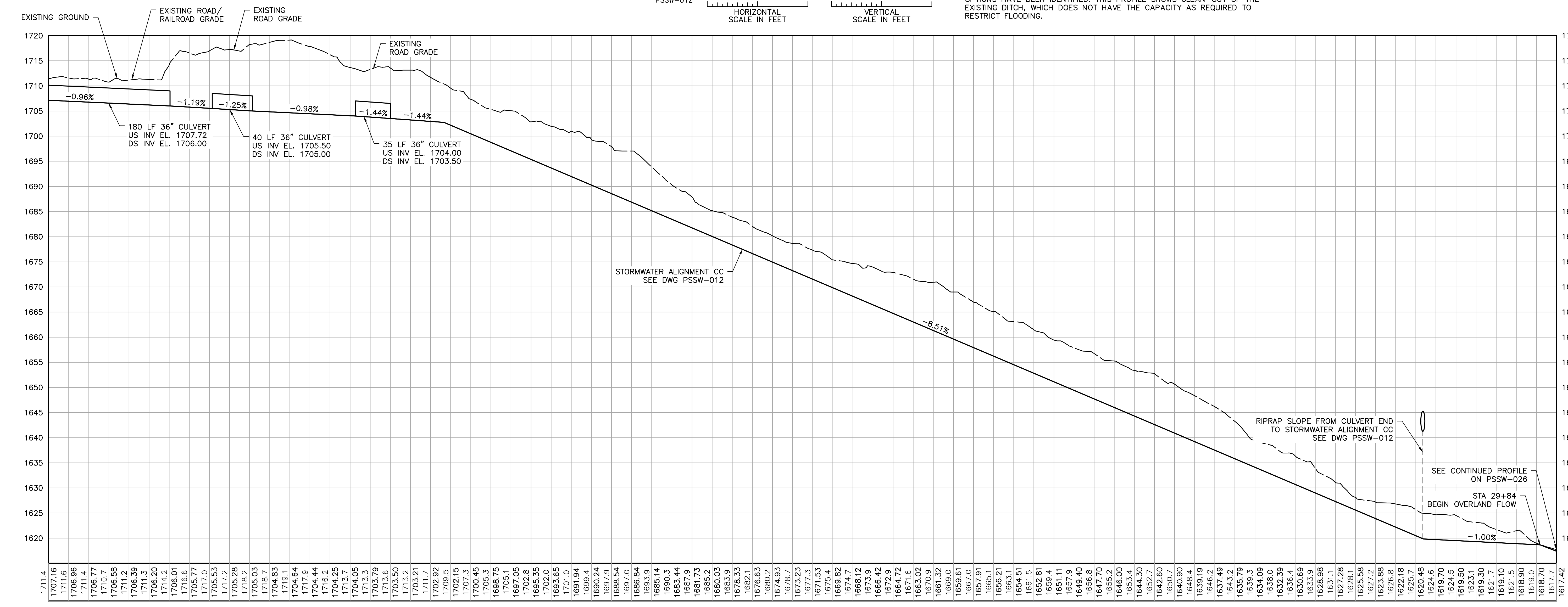
(CC) PROFILE: STORMWATER ALIGNMENT CC

PSSW-011 / PSSW-012

HORIZONTAL SCALE IN FEET (0, 50, 100) — VERTICAL SCALE IN FEET (0, 10, 20)

NOTE:

STORMWATER DITCH HAS CONSTRAINTS RESTRICTING CONSTRUCTION. DESIGN OPTIONS HAVE BEEN IDENTIFIED. THIS PROFILE SHOWS CLEAN-OUT OF THE EXISTING DITCH, WHICH DOES NOT HAVE THE CAPACITY AS REQUIRED TO RESTRICT FLOODING.



Client Review Draft 5/15/2015

(CC) PROFILE: STORMWATER ALIGNMENT CC

PSSW-012

HORIZONTAL SCALE IN FEET (0, 50, 100) — VERTICAL SCALE IN FEET (0, 10, 20)

NOTE:

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PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PROFILES

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SIGNATURE
DATE 5/15/15 LICENSE# 46593

DRAWN: PRT
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

POLYMET MINING

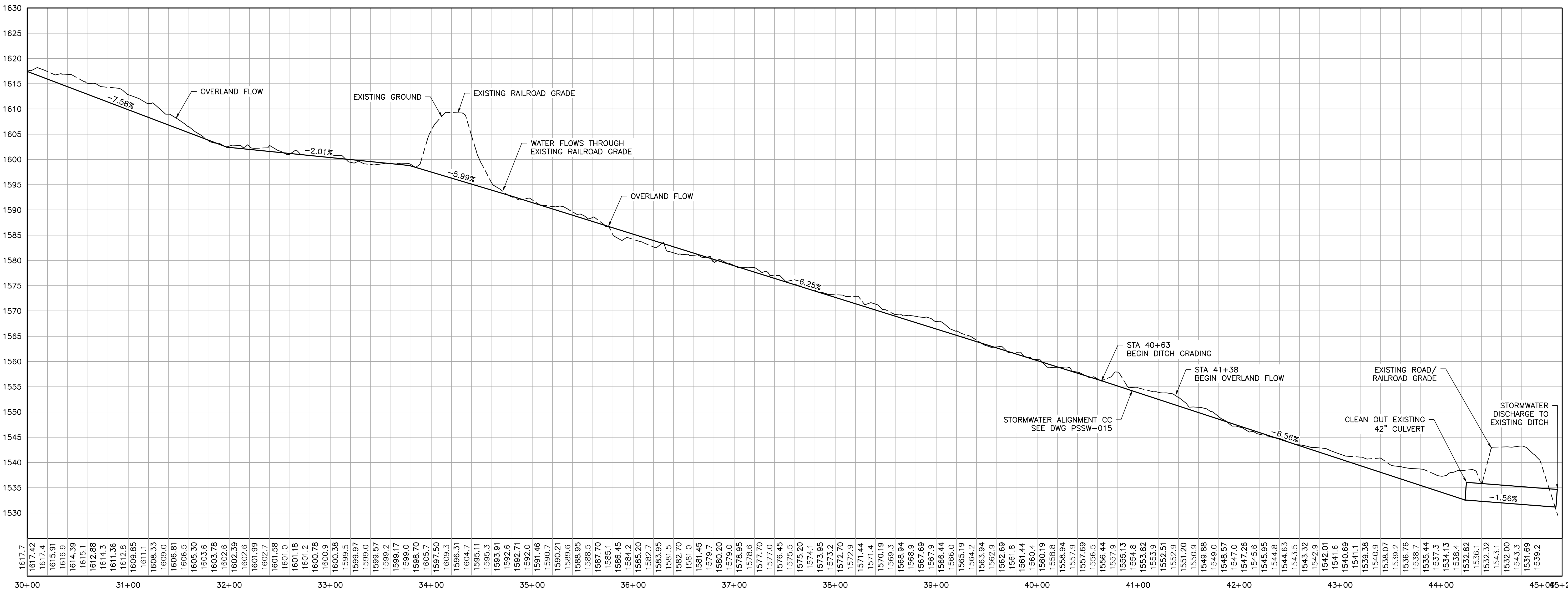
POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

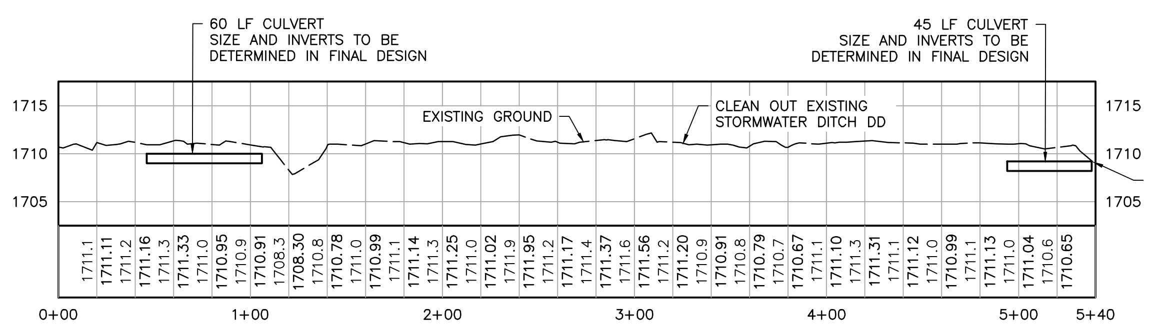
DWG. NO. PSSW-025 | REV

INCHES 1 2



CC PSSW−015 **PROFILE: STORMWATER ALIGNMENT CC**

HORIZONTAL SCALE IN FEET (0, 50, 100) — VERTICAL SCALE IN FEET (0, 10, 20)

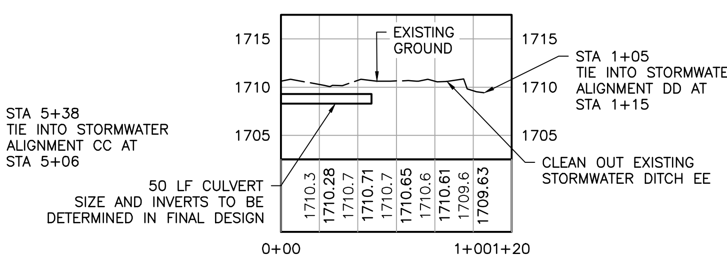


DD PSSW−011 **PROFILE: STORMWATER ALIGNMENT DD**

HORIZONTAL SCALE IN FEET (0, 50, 100) — VERTICAL SCALE IN FEET (0, 10, 20)

NOTE:

STORMWATER DITCH HAS CONSTRAINTS RESTRICTING CONSTRUCTION. DESIGN OPTIONS HAVE BEEN IDENTIFIED. THIS PROFILE SHOWS CLEAN−OUT OF THE EXISTING DITCH, WHICH DOES NOT HAVE THE CAPACITY AS REQUIRED TO RESTRICT FLOODING.

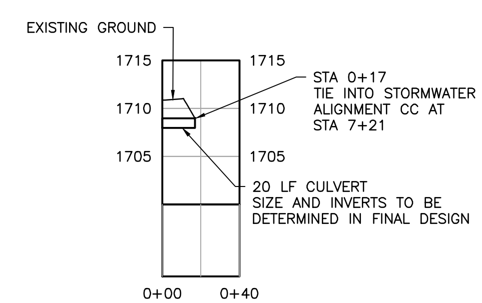


EE PSSW−011 **PROFILE: STORMWATER ALIGNMENT EE**

HORIZONTAL SCALE IN FEET (0, 50, 100) — VERTICAL SCALE IN FEET (0, 10, 20)

NOTE:

STORMWATER DITCH HAS CONSTRAINTS RESTRICTING CONSTRUCTION. DESIGN OPTIONS HAVE BEEN IDENTIFIED. THIS PROFILE SHOWS CLEAN−OUT OF THE EXISTING DITCH, WHICH DOES NOT HAVE THE CAPACITY AS REQUIRED TO RESTRICT FLOODING.



FF PSSW−011 **PROFILE: STORMWATER ALIGNMENT FF**

HORIZONTAL SCALE IN FEET (0, 50, 100) — VERTICAL SCALE IN FEET (0, 10, 20)

NOTE:

STORMWATER DITCH HAS CONSTRAINTS RESTRICTING CONSTRUCTION. DESIGN OPTIONS HAVE BEEN IDENTIFIED. THIS PROFILE SHOWS CLEAN−OUT OF THE EXISTING DITCH, WHICH DOES NOT HAVE THE CAPACITY AS REQUIRED TO RESTRICT FLOODING.

NOTE:

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Client Review Draft 5/15/2015

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PLANT SITE STORMWATER GRADING PROFILES

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DRAWN: PRT
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BARR PROJECT NO.: 23/69−0C29
SCALE: AS SHOWN

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1−800−632−2277

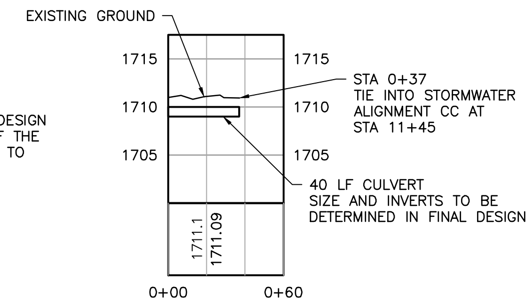
DWG. NO. PSSW−026 REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-026.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 11:36 AM

INCHES 1 2

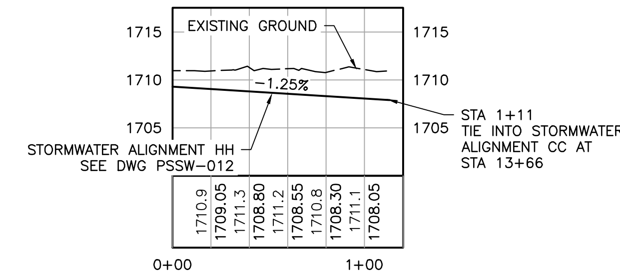
NOTE:

STORMWATER DITCH HAS CONSTRAINTS RESTRICTING CONSTRUCTION. DESIGN OPTIONS HAVE BEEN IDENTIFIED. THIS PROFILE SHOWS CLEAN-OUT OF THE EXISTING DITCH, WHICH DOES NOT HAVE THE CAPACITY AS REQUIRED TO RESTRICT FLOODING.



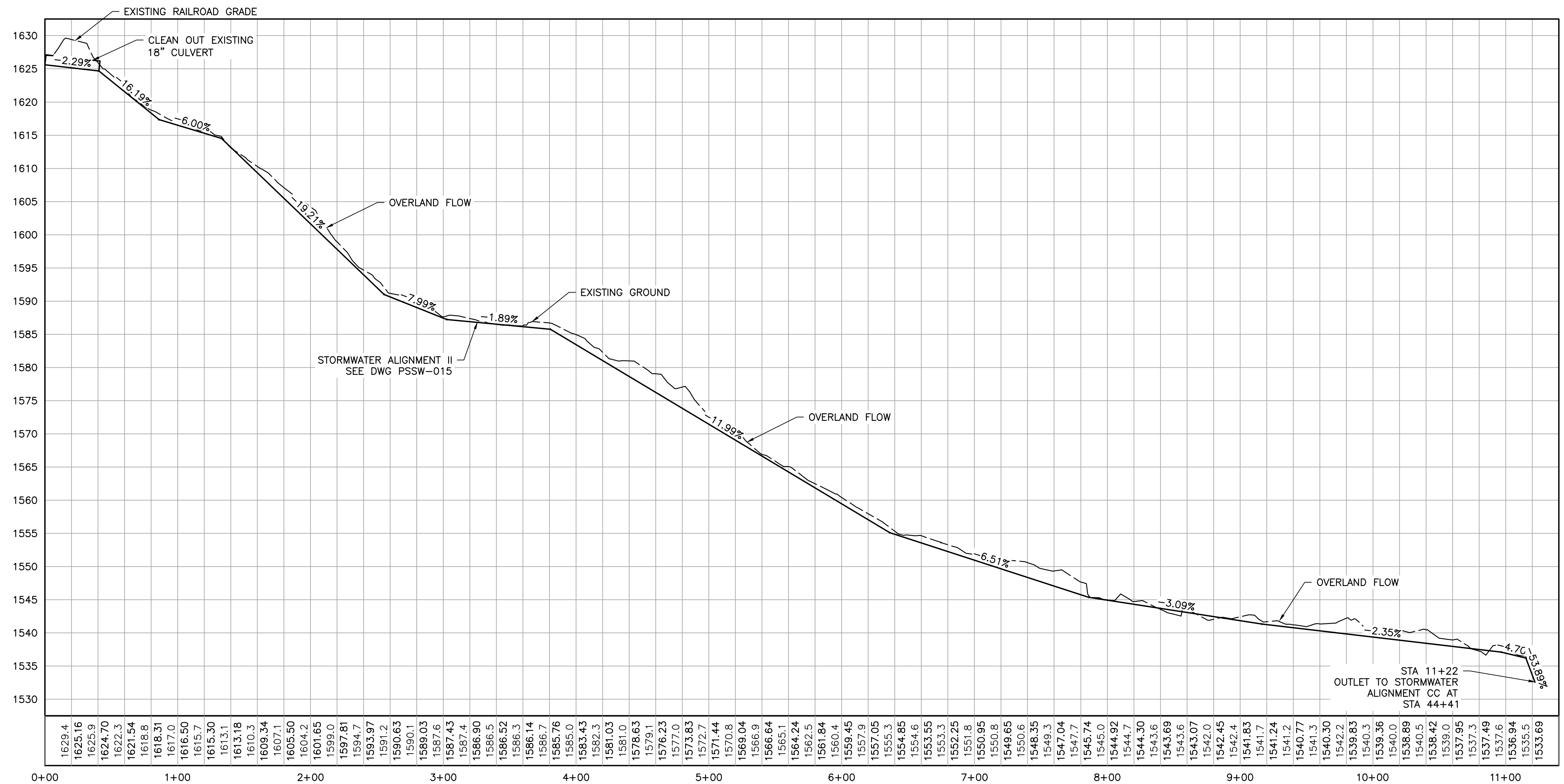
GG PSSW-012 PROFILE: STORMWATER ALIGNMENT GG

0 50 100 HORIZONTAL SCALE IN FEET — 0 10 20 VERTICAL SCALE IN FEET



HH PSSW-012 PROFILE: STORMWATER ALIGNMENT HH

0 50 100 HORIZONTAL SCALE IN FEET — 0 10 20 VERTICAL SCALE IN FEET



II PSSW-015 PROFILE: STORMWATER ALIGNMENT II

0 50 100 HORIZONTAL SCALE IN FEET — 0 10 20 VERTICAL SCALE IN FEET

NOTE:

ALL PIPES AND CULVERTS ARE PROPOSED UNLESS INDICATED.

Client Review Draft 5/15/2015

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DATE 5/15/15 LICENSE# 46593

DRAWN: PRT
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PROFILES

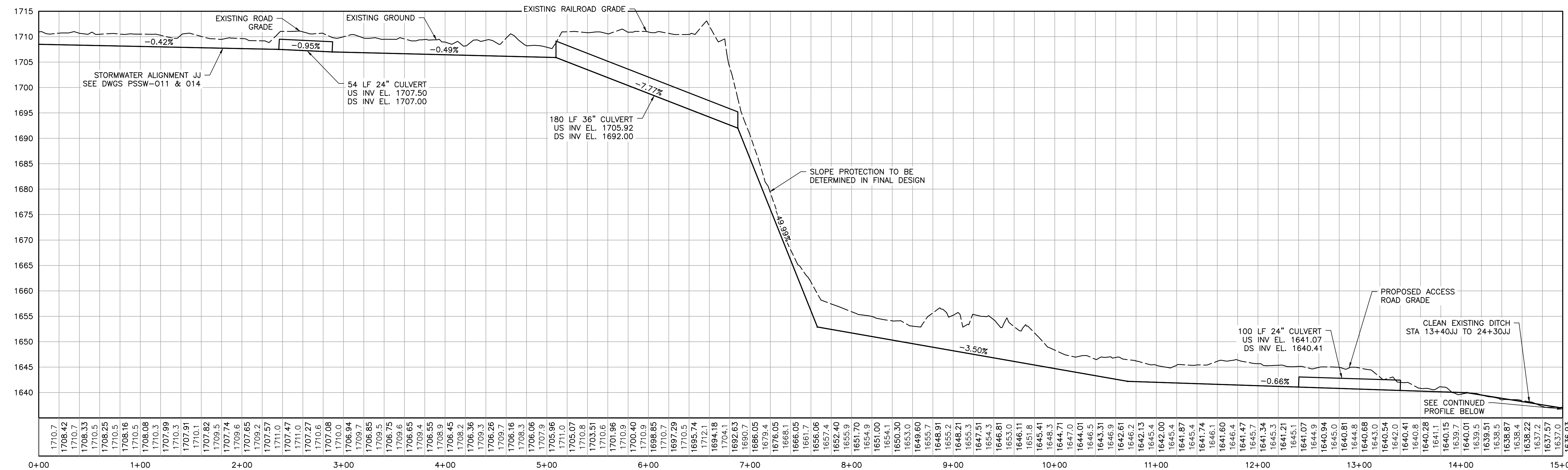
POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-027
REV

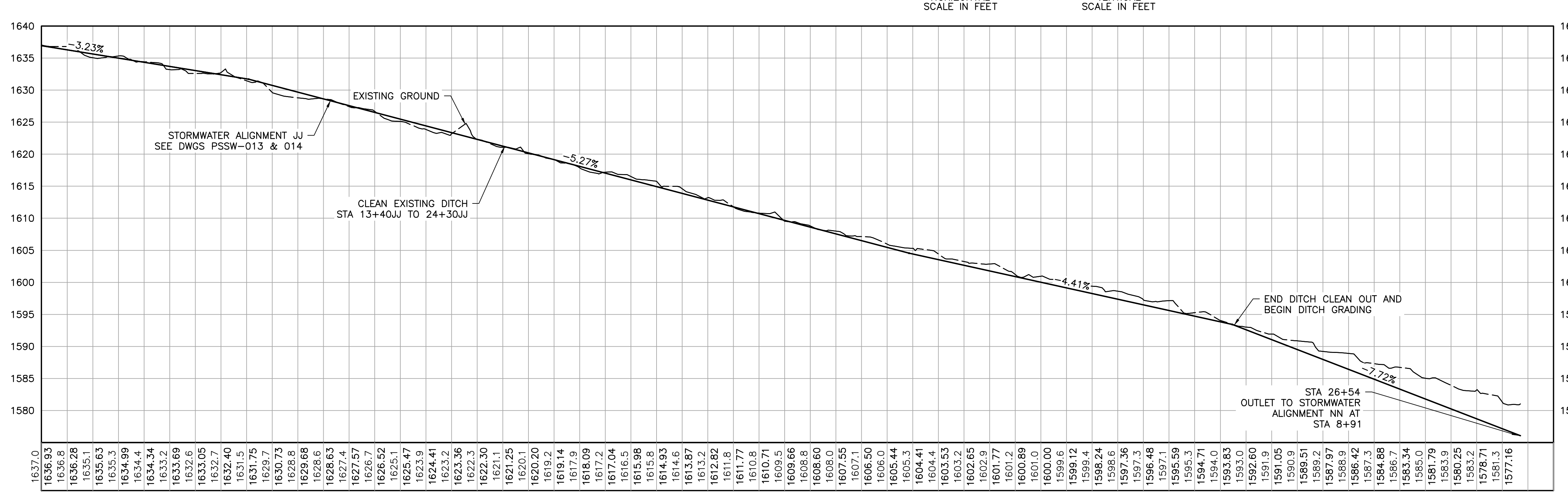
CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-027.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 11:39 AM

INCHES 1 2



JJ PSSW-011 PSSW-014 **PROFILE: STORMWATER ALIGNMENT JJ**

0 50 100 HORIZONTAL SCALE IN FEET — 0 10 20 VERTICAL SCALE IN FEET



JJ PSSW-013 PSSW-014 **PROFILE: STORMWATER ALIGNMENT JJ**

0 50 100 HORIZONTAL SCALE IN FEET — 0 10 20 VERTICAL SCALE IN FEET

NOTE:

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BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PROFILES

POLYMET MINING

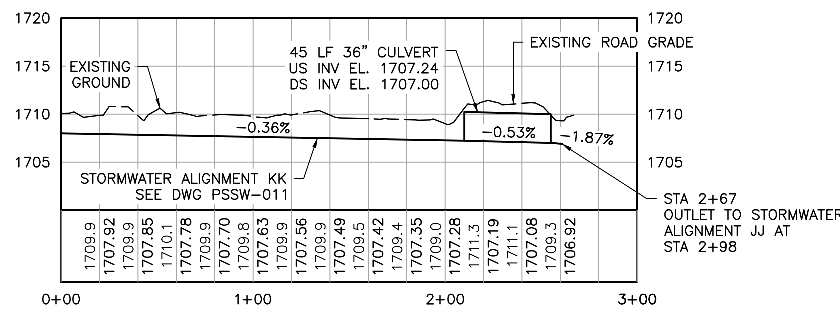
POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-028 REV

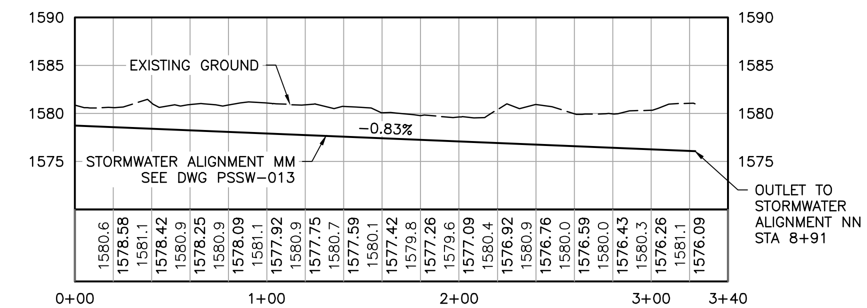
CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-028.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 11:43 AM

INCHES 1 2



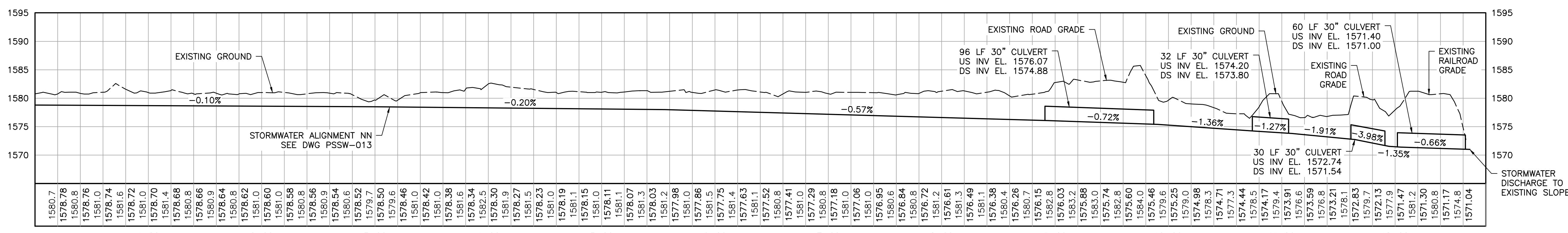
KK PSSW-011 **PROFILE: STORMWATER ALIGNMENT KK**

0 50 100 HORIZONTAL SCALE IN FEET — 0 10 20 VERTICAL SCALE IN FEET



MM PSSW-013 **PROFILE: STORMWATER ALIGNMENT MM**

0 50 100 HORIZONTAL SCALE IN FEET — 0 10 20 VERTICAL SCALE IN FEET



NN PSSW-013 **PROFILE: STORMWATER ALIGNMENT NN**

0 50 100 HORIZONTAL SCALE IN FEET — 0 10 20 VERTICAL SCALE IN FEET

NOTE:

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Client Review Draft 5/15/2015

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SIGNATURE
DATE 5/15/15 LICENSE# 46593

DRAWN: PRT
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

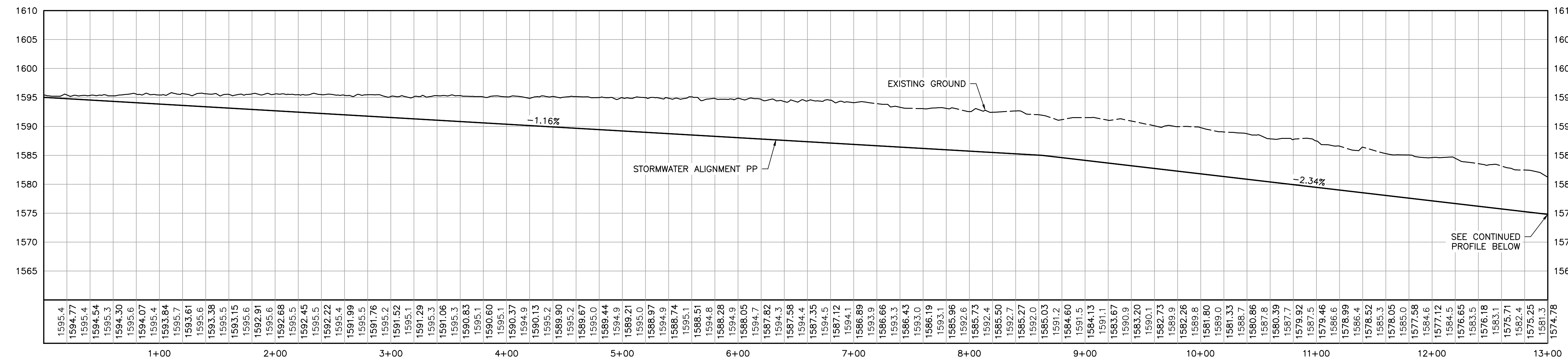
POLYMET MINING
POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR
BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-029 REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-029.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 11:45 AM

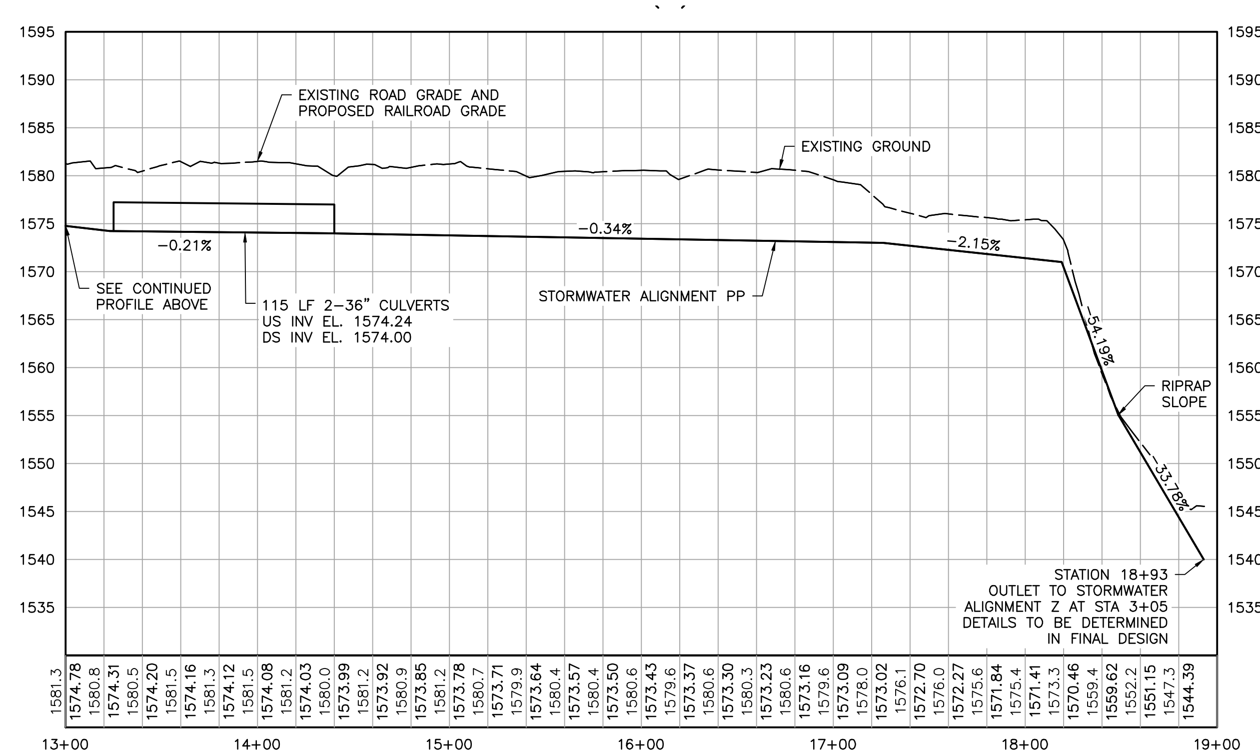
INCHES 1 2



PP PSSW-007 PROFILE: STORMWATER ALIGNMENT PP

0 50 100 HORIZONTAL SCALE IN FEET

0 10 20 VERTICAL SCALE IN FEET



PP PSSW-008 PROFILE: STORMWATER ALIGNMENT PP

0 50 100 HORIZONTAL SCALE IN FEET

0 10 20 VERTICAL SCALE IN FEET

NOTE:

ALL PIPES AND CULVERTS ARE PROPOSED UNLESS INDICATED.

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SIGNATURE

DATE 5/15/15 LICENSE# 46593

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CHECKED: CMK2

BARR PROJECT NO.: 23/69-0C29

SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PROFILES

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR

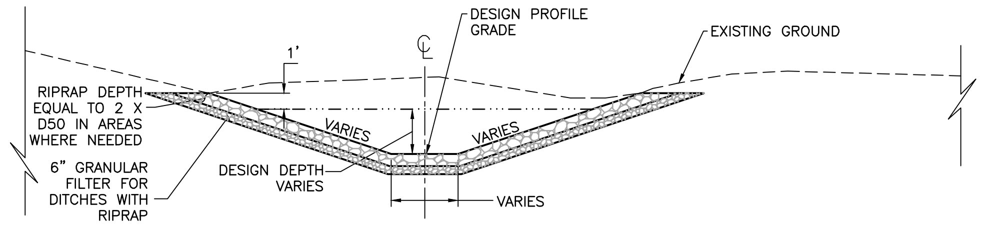
BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-030

REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-030.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 11:49 AM

INCHES 1 2

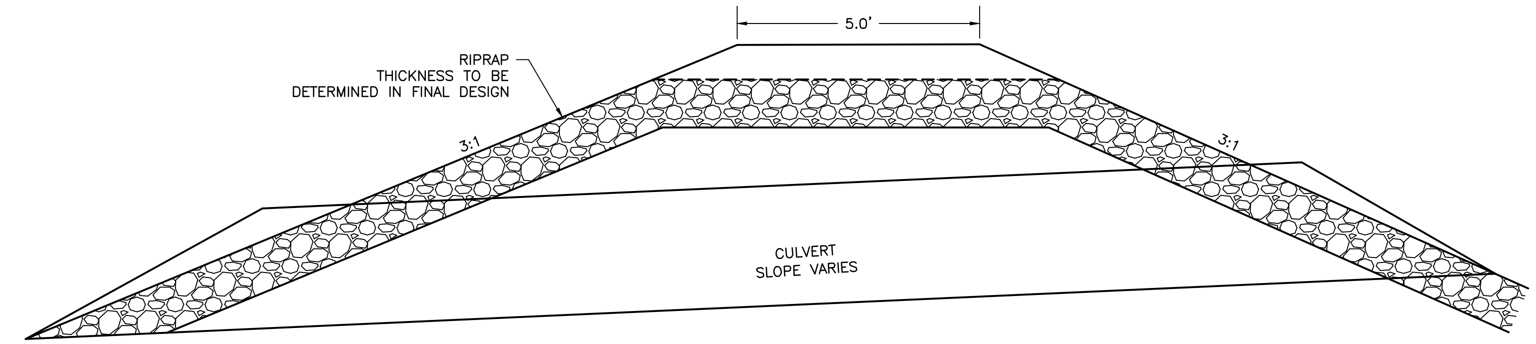


1 SECTION: TYPICAL DITCH

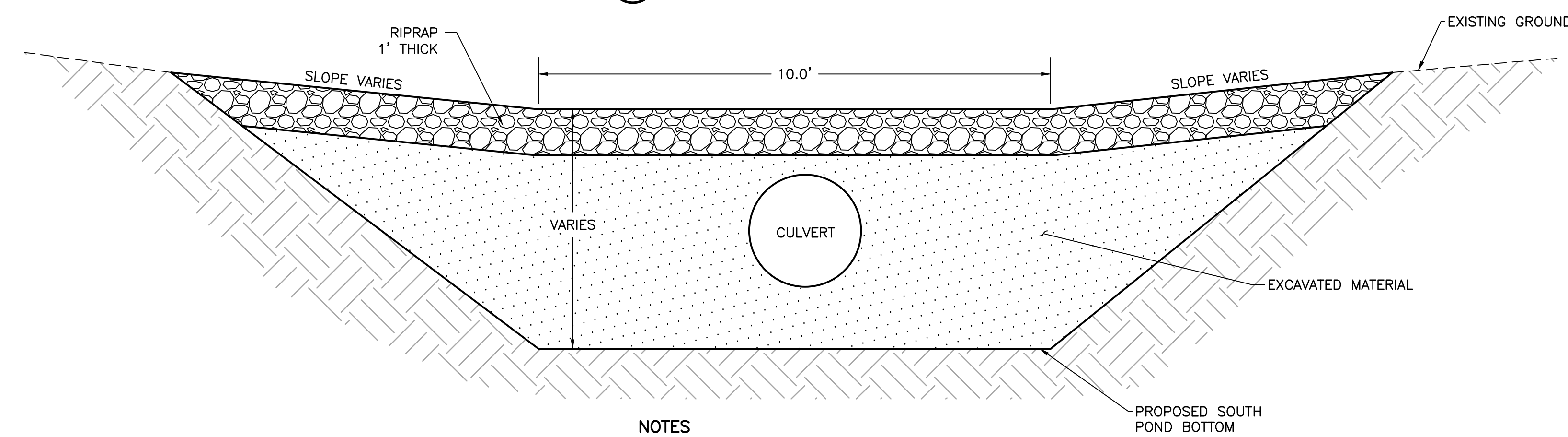
0 6 12
SCALE IN FEET

NOTES

1. DITCHES NOT REQUIRING RIPRAP WILL BE CONSTRUCTED WITH NATIVE SOILS AND 4" TOPSOIL TO DESIGN PROFILE GRADE.
2. DITCHES CONSTRUCTED IN BEDROCK WILL NOT REQUIRE RIPRAP OR TOPSOIL.
3. RESTORE ALL DISTURBED AREAS NOT STABILIZED WITH RIPRAP.
4. DITCH CROSS SECTIONS VARY. DETAILS WILL BE TABULATED IN FINAL DESIGN.
5. DITCHES THAT REQUIRE LARGE DIAMETER RIPRAP MAY REQUIRE AN ADDITIONAL LAYER BETWEEN THE RIPRAP AND THE GRANULAR FILTER, TO BE DETERMINED IN FINAL DESIGN.



A SECTION: OVERFLOW WEIR SIDE VIEW
NOT TO SCALE

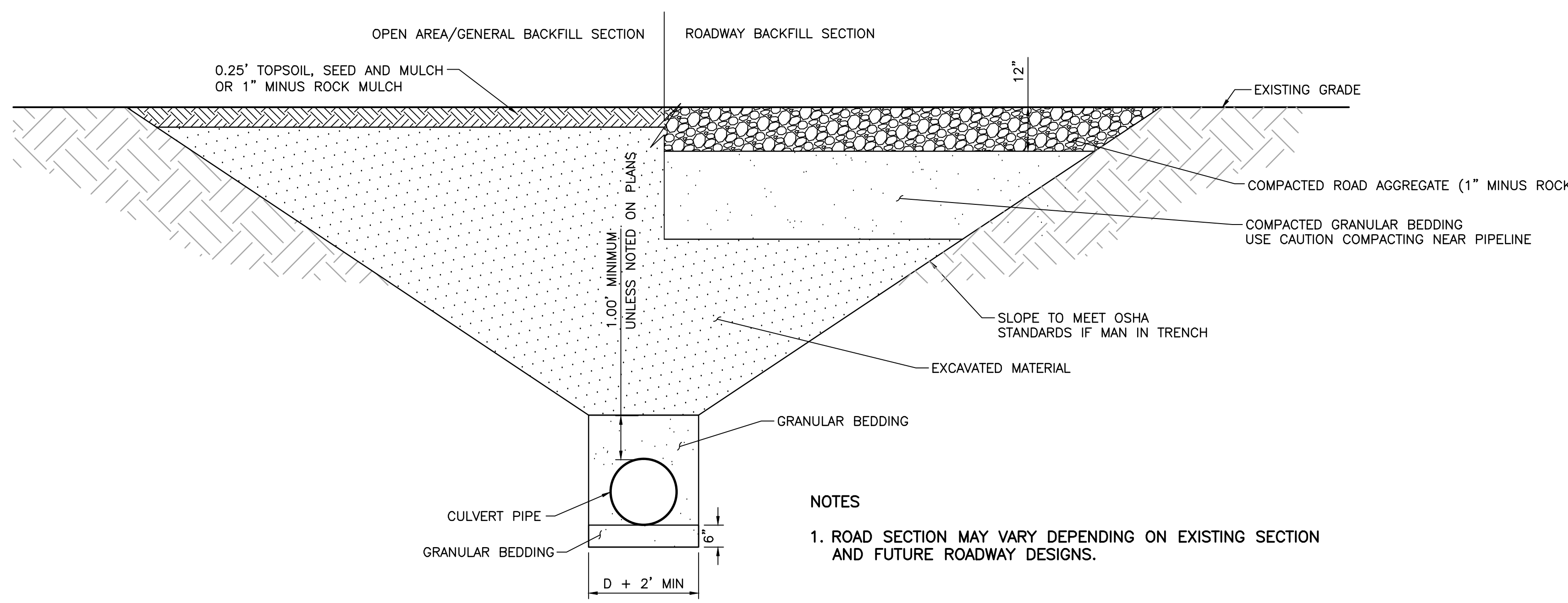


NOTES

1. WEIR CROSS SECTIONS VARY. DETAILS WILL BE TABULATED IN FINAL DESIGN.

B SECTION: OVERFLOW WEIR CROSS SECTION
NOT TO SCALE

3 DETAIL: SOUTH POND OVERFLOW WEIRS
PSSW-010,024 NOT TO SCALE



NOTES

1. ROAD SECTION MAY VARY DEPENDING ON EXISTING SECTION AND FUTURE ROADWAY DESIGNS.

2 SECTION: PIPELINE AND CULVERT TRENCH CONSTRUCTION

0 1 2 3 4
SCALE IN FEET

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SIGNATURE
DATE 5/15/15 LICENSE# 46593

DRAWN: VJS
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER SECTIONS AND DETAILS

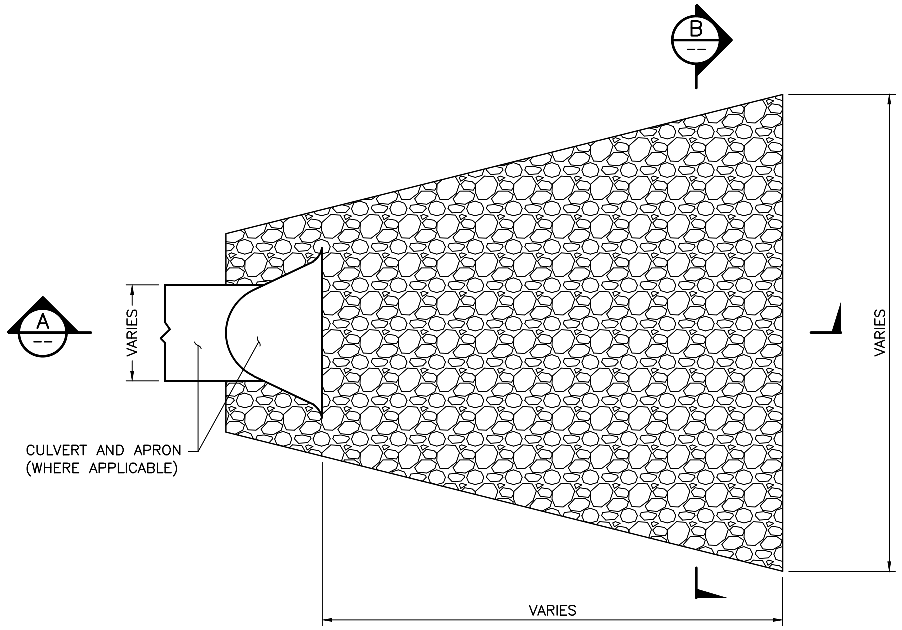
POLYMET MINING
POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR
BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

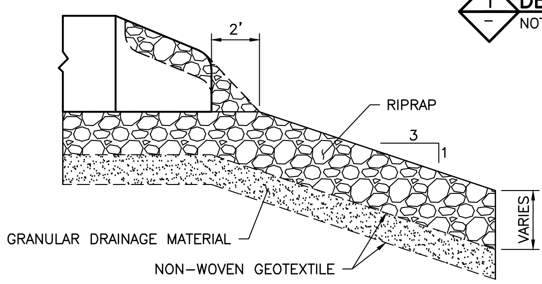
DWG. NO. PSSW-031
REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-031.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 11:50 AM

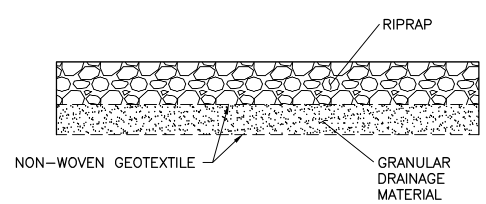
INCHES 1 2



1 DETAIL: RIPRAP SLOPE
NOT TO SCALE



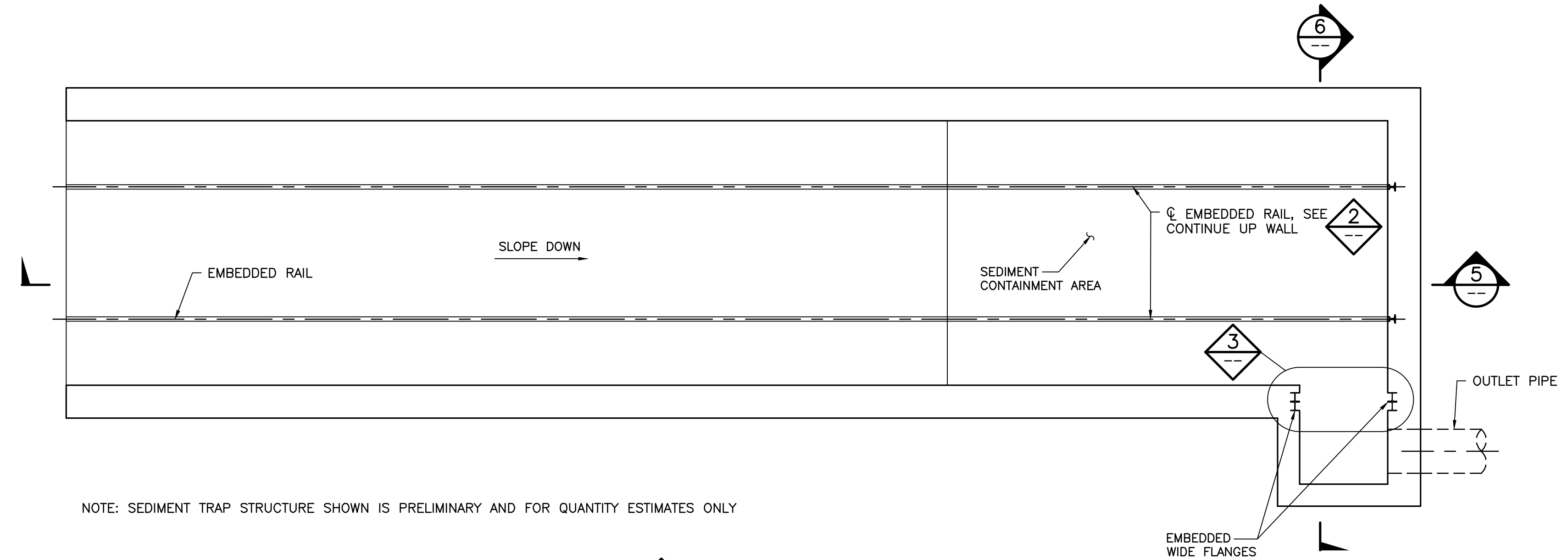
A SECTION: RIPRAP SLOPE
NOT TO SCALE



B SECTION: RIPRAP SLOPE
NOT TO SCALE

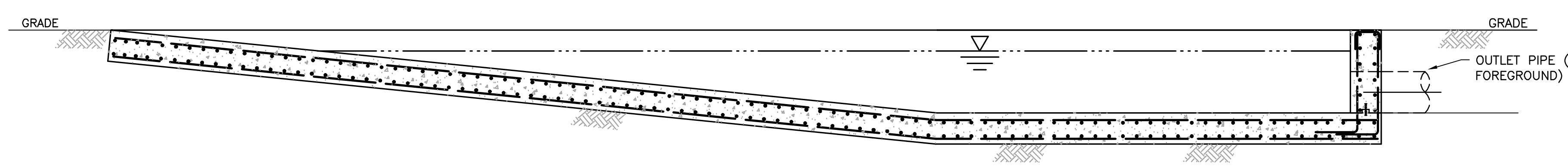
NOTES:

1. RIPRAP GRADATION BASED ON EXPECTED VELOCITIES FROM 10 YEAR 24-HOUR STORM EVENT.
2. RIPRAP DIMENSIONS AND CLASSES VARY. DETAILS WILL BE TABULATED IN FINAL DESIGN.
3. ALL CULVERT UPSTREAM AND DOWNSTREAM ENDS SHALL HAVE FLARED END SECTIONS.

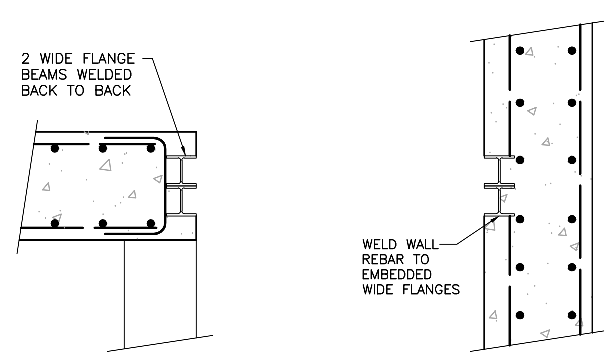


NOTE: SEDIMENT TRAP STRUCTURE SHOWN IS PRELIMINARY AND FOR QUANTITY ESTIMATES ONLY

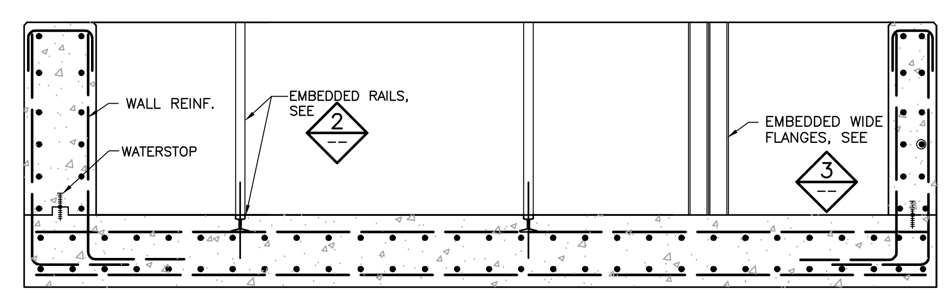
4 PLAN: SEDIMENT TRAP
PSSW-007
NOT TO SCALE



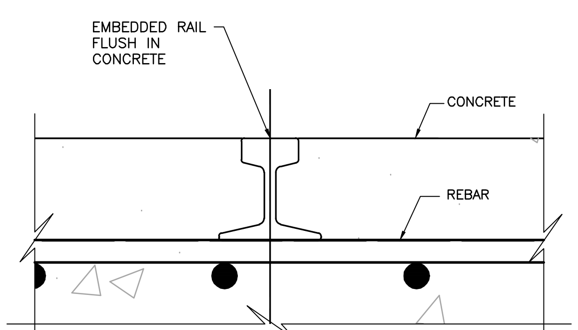
5 SECTION: SEDIMENT TRAP
NOT TO SCALE



3 DETAIL: EMBEDDED WIDE FLANGES
NOT TO SCALE



6 SECTION: SEDIMENT TRAP
NOT TO SCALE



2 DETAIL: EMBEDDED RAIL
NOT TO SCALE

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PRINTED NAME CRISTIAN A. DIAZ
SIGNATURE
DATE 5/15/15 LICENSE# 46593

DRAWN: VJS
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER
SECTIONS AND DETAILS

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-032
REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-032.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 11:51 AM

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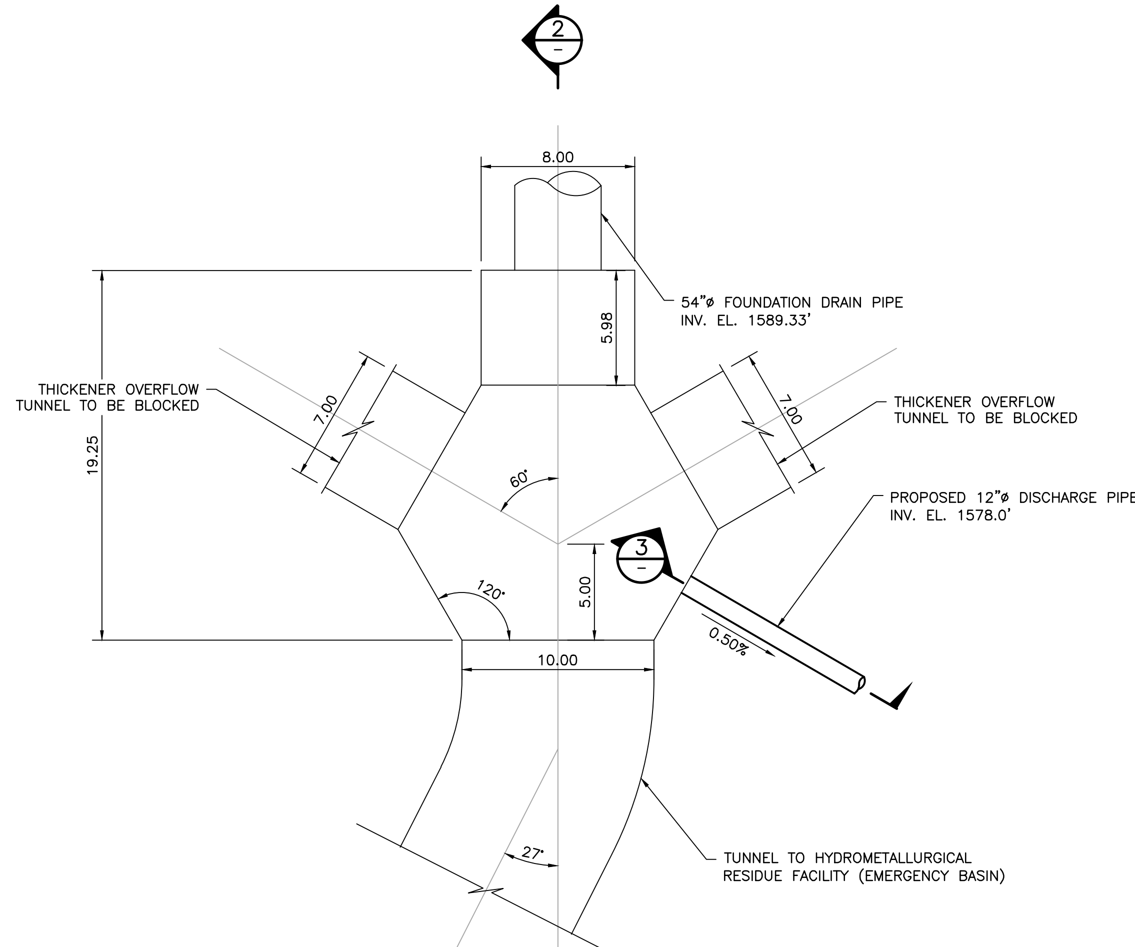
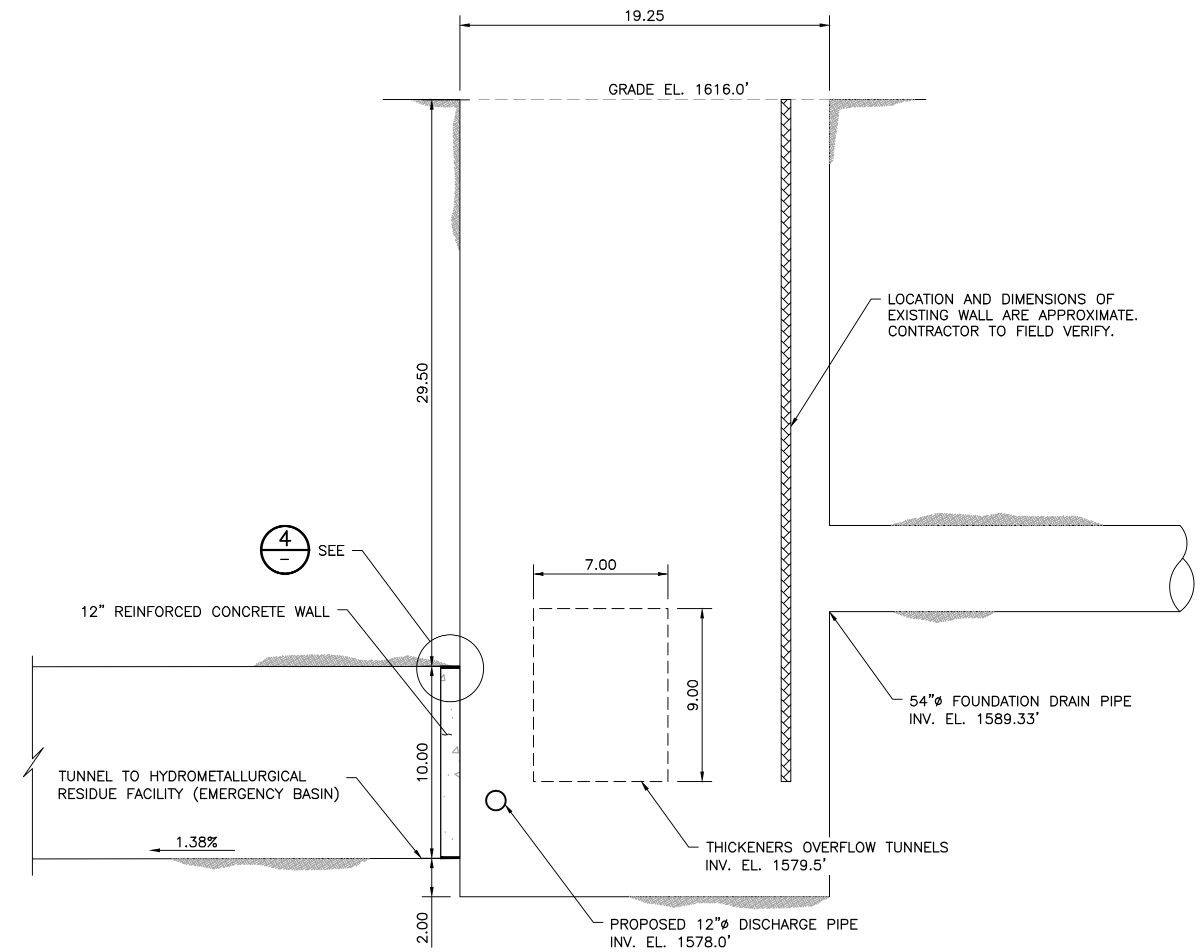


NOTE:

1. WATER ROUTING FROM THE EMERGENCY DRAINAGE TUNNEL MANHOLE TO BE DETERMINED IN FINAL DESIGN.

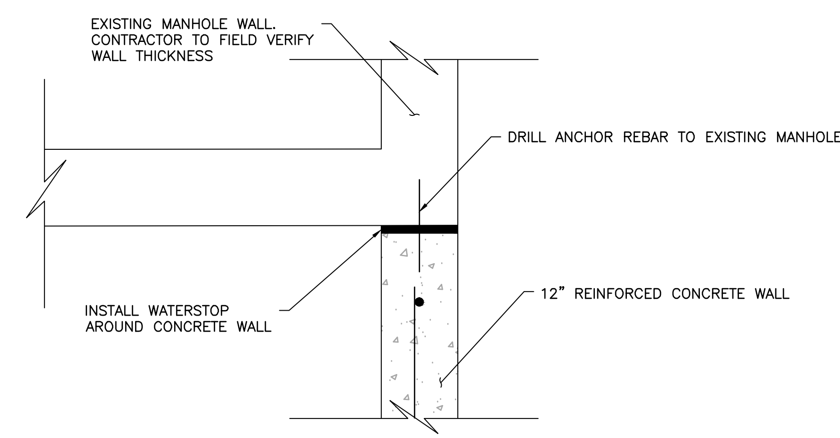
1 PSSW-005 PLAN: EXISTING EMERGENCY DRAINAGE TUNNELS AND MANHOLE

0 5 10 SCALE IN FEET



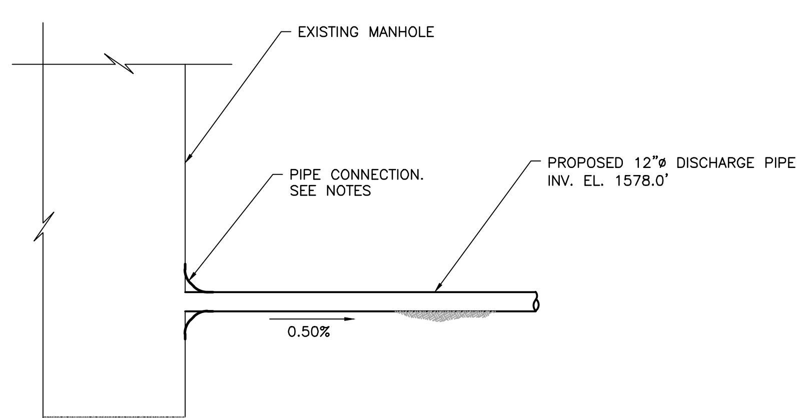
2 PSSW-005 SECTION: EXISTING EMERGENCY DRAINAGE TUNNELS AND MANHOLE

0 5 10 SCALE IN FEET



NOTES:

1. DIMENSIONS SHOWN ARE BASED ON DRAWINGS TB-651, TB-679 AND TJ-63, APPROVED ON 08/06/54. ACTUAL DIMENSIONS MAY VARY.
2. CORE THROUGH EXISTING MANHOLE TO PROVIDE SPACE FOR PLACEMENT OF NEW PIPE.
3. CONTRACTOR TO PLACE WATERTIGHT CONNECTION BOOT.
4. BACKFILL SHALL BE PLACED WITH CARE OVER PIPE TO AVOID SETTLEMENT AND DISRUPTION TO THE CONNECTION WITH MANHOLE.



4 PSSW-005 SECTION: ANCHOR AND WATER STOP DETAIL (TYP.)
NOT TO SCALE

3 PSSW-005 SECTION: PROPOSED PIPE CONNECTION

0 5 10 SCALE IN FEET

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SIGNATURE
DATE 5/15/15 LICENSE# 46593

DRAWN: CMB2
CHECKED: CAD
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GENERAL DWGS
EMERGENCY DRAINAGE TUNNEL MANHOLE
CONNECTION AND BLOCKAGE DETAILS

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR

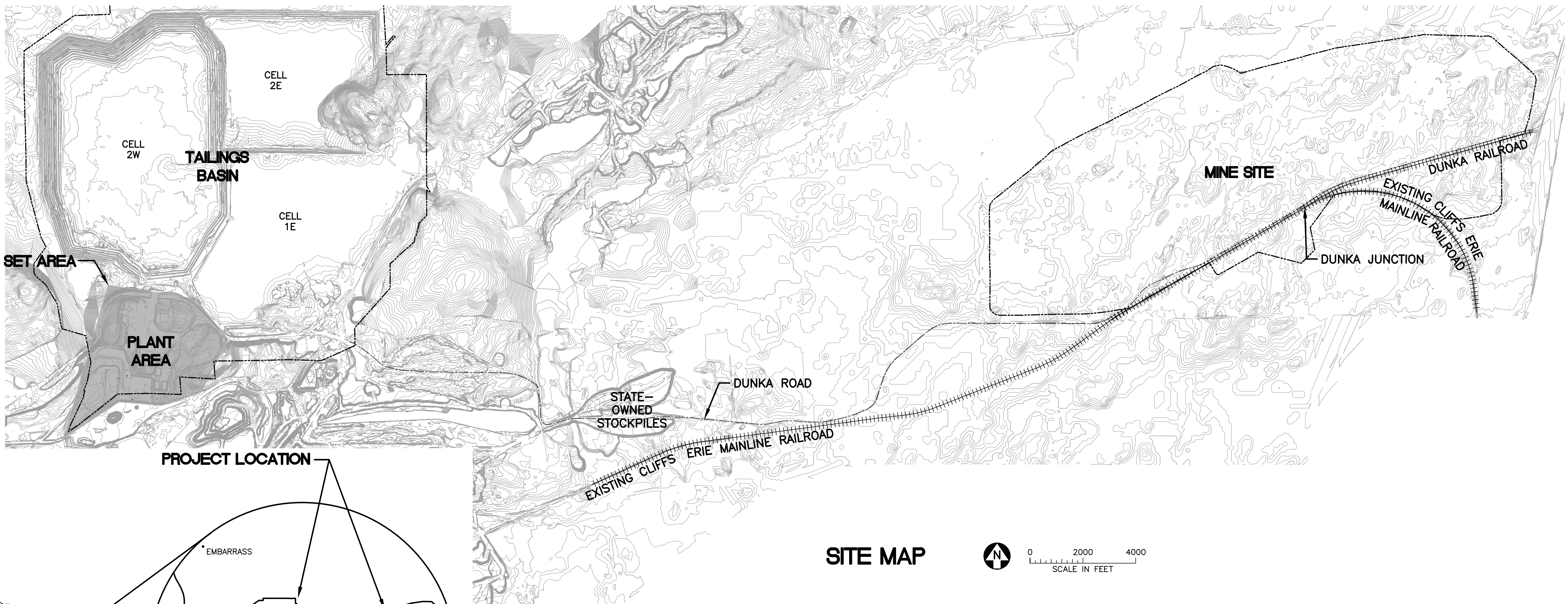
BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-033 REV

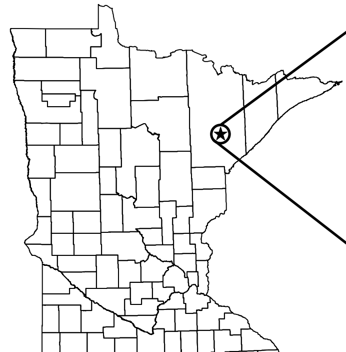
Attachment F

Plant Site Stormwater Permit Application Support Drawings

POLY MET MINING, INC. NORTHMET PROJECT
PERMIT APPLICATION SUPPORT DRAWINGS
PLANT SITE STORMWATER
HOYT LAKES, MINNESOTA

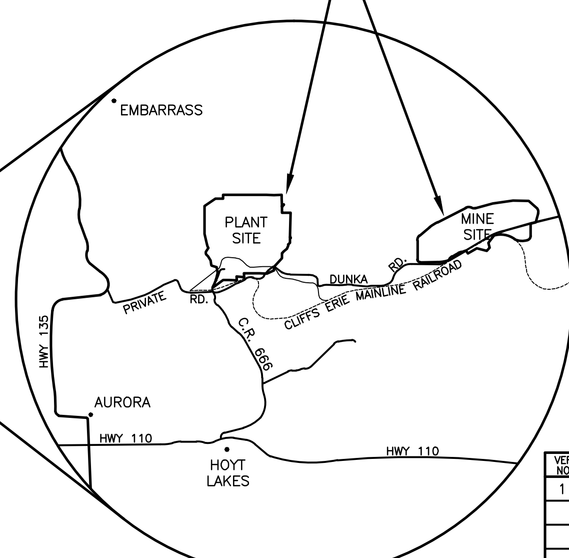


SITE MAP



LOCATION MAP

NOT TO SCALE



VICINITY MAP

NOT TO SCALE

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DRAWN: VJS
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GENERAL DWGS
LOCATION MAP AND SITE MAP

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-001
REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-001.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 9:36 AM

INCHES 1 2

PLANT SITE STORMWATER LEGEND

EXISTING

- 1000 — EXISTING CONTOUR – MAJOR 10'
- EXISTING CONTOUR – MINOR 2'
- EXISTING RAILROAD
- WATER EDGE/CREEK CENTER LINE
- EXISTING ROAD
- EXISTING STRUCTURES
- TREE LINE
- EXISTING MANHOLE/CATCH BASIN
- EXISTING CULVERT
- X — EXISTING FENCE
- WETLAND BOUNDARY

PROPOSED

- 1000 — PROPOSED CONTOUR – MAJOR 5'
- PROPOSED CONTOUR – MINOR 1'
- 1+00X — PROPOSED CENTERLINE STATIONING
- PROPOSED CULVERT (STORMWATER)
- PROPOSED PIPE
- PROPOSED MANHOLE/CATCH BASIN
- PROPOSED RIPRAP
- PROJECT AREA BOUNDARY
- FLOW PATH

PROPOSED OTHER FACILITY

- PROPOSED STRUCTURES
- PROPOSED RAILROAD

NOTES

1. COORDINATE SYSTEM IS MINNESOTA STATE PLANE NORTH ZONE, NAD83.
2. ELEVATIONS ARE MEAN SEA LEVEL (MSL), NAVD88.
3. EXISTING TOPOGRAPHIC INFORMATION SHOWN ON THE DRAWINGS WAS PREPARED BY AEROMETRIC, INC. FROM LIDAR DATA COLLECTED ON MARCH 17, 2010.

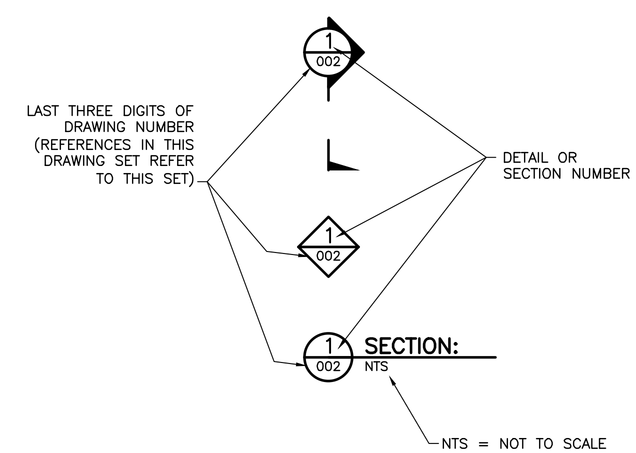
SHEET INDEX

SHEET NO.	TITLE
PLANT SITE STORMWATER DRAWINGS	
PSSW–001	LOCATION MAP & SITE MAP
PSSW–002	LEGEND & SHEET INDEX
PSSW–003	GENERAL LAYOUT & SHEET INDEX MAP
PSSW–004 TO PSSW–015	GRADING PLANS
PSSW–016 TO PSSW–030	GRADING PROFILES
PSSW–031 TO PSSW–033	SECTIONS & DETAILS

ABBREVIATIONS

AC–FT	–	ACRE–FEET
AVE	–	AVERAGE
CB	–	CATCH BASIN
℄	–	CENTERLINE
CMP	–	CORRUGATED METAL PIPE
DS	–	DOWNSTREAM
DV	–	DRAIN VALVE
DWG	–	DRAWING
EL.	–	ELEVATION
FTB	–	FLOTATION TAILINGS BASIN
GAL	–	GALLONS
GPM	–	GALLONS PER MINUTE
HDPE	–	HIGH–DENSITY POLYETHYLENE
INV	–	INVERT
LF	–	LINEAR FEET
MH	–	MANHOLE
MIN	–	MINIMUM
NWL	–	NORMAL WATER LEVEL
PSSW	–	PLANT SITE STORMWATER
SDR	–	STANDARD DIMENSION RATIO
STA	–	STATION
TYP	–	TYPICAL
US	–	UPSTREAM

DRAWING NUMBERING



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PRINTED NAME CRISTIAN A. DIAZ
SIGNATURE [signature]
DATE 5/15/15 LICENSE# 46593

DRAWN: VJS
CHECKED: CMK2
BARR PROJECT NO.: 23/69–0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GENERAL DWGS
LEGEND AND SHEET INDEX

POLYMET MINING
POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR
BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1–800–632–2277

DWG. NO. PSSW–002
REV

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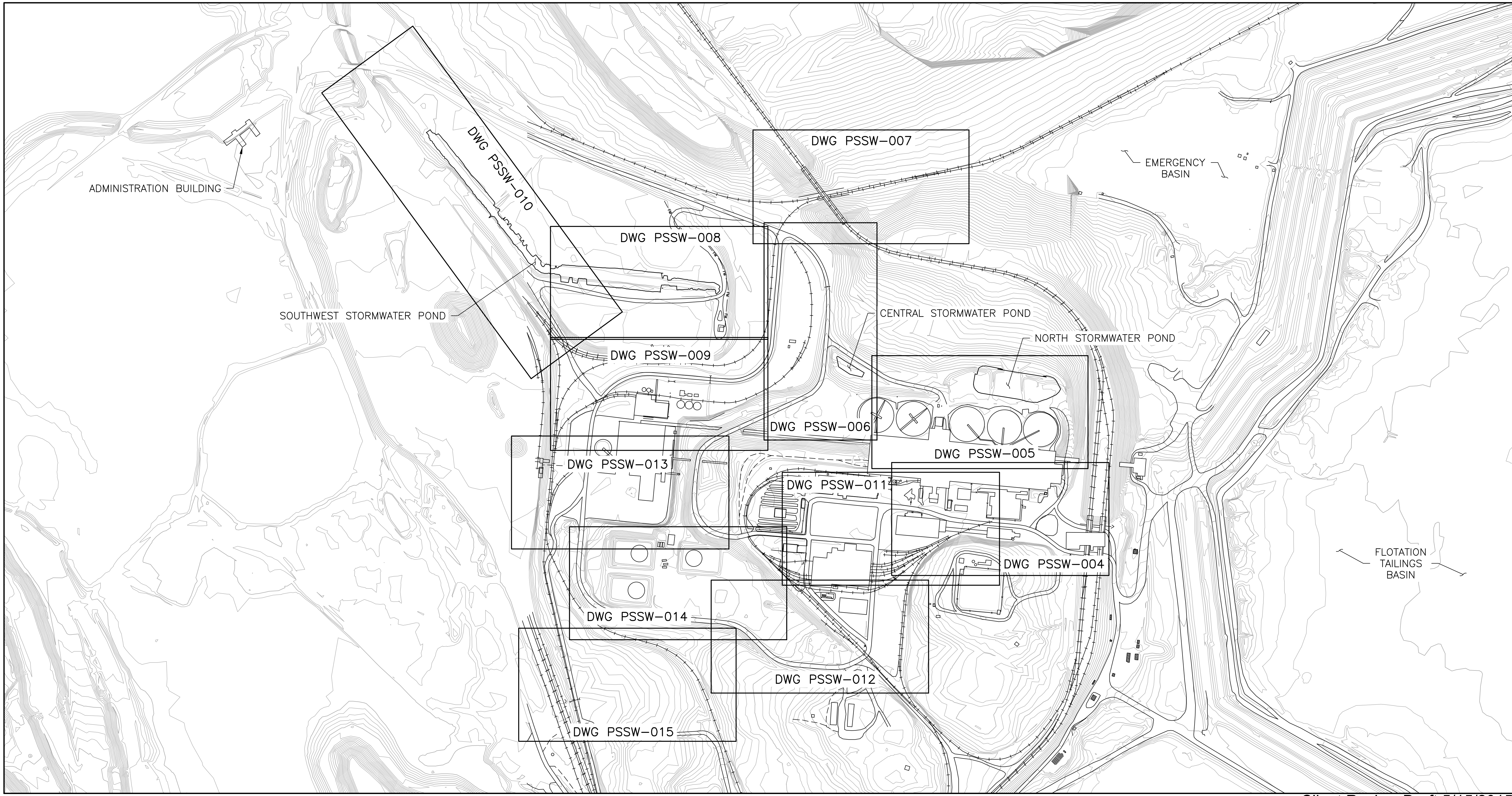

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1 PLAN: SHEET INDEX

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CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER
GENERAL LAYOUT AND SHEET INDEX MAP

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

POLYMET MINING

BARR
BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-003

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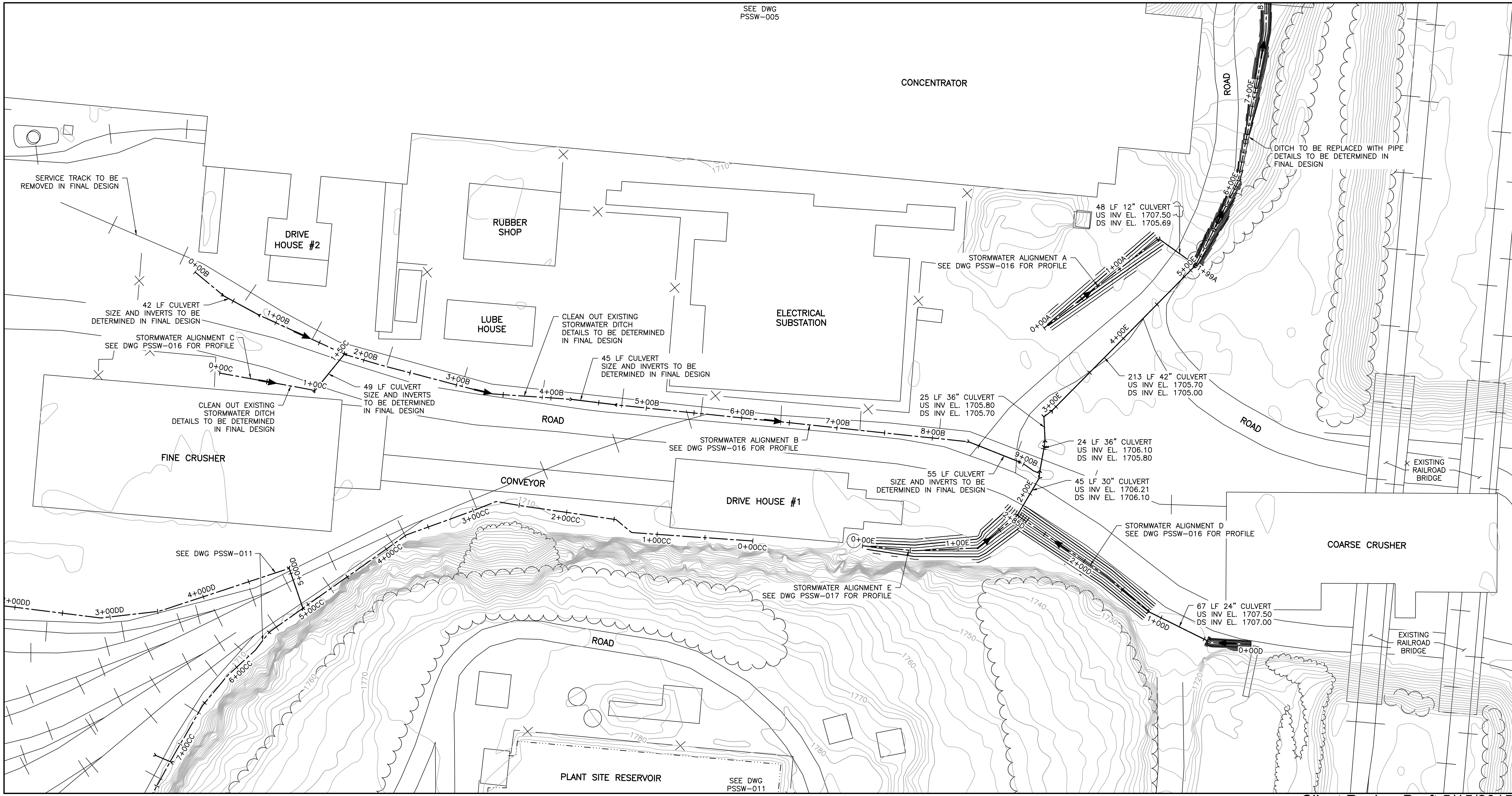
INCHES 1 2



1 PLAN: STORMWATER ALIGNMENTS A–E

NOTE:

ALL PIPES AND CULVERTS ARE PROPOSED UNLESS INDICATED.

0 50 100
SCALE IN FEET

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PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PLAN

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

POLYMET MINING

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-004

REV

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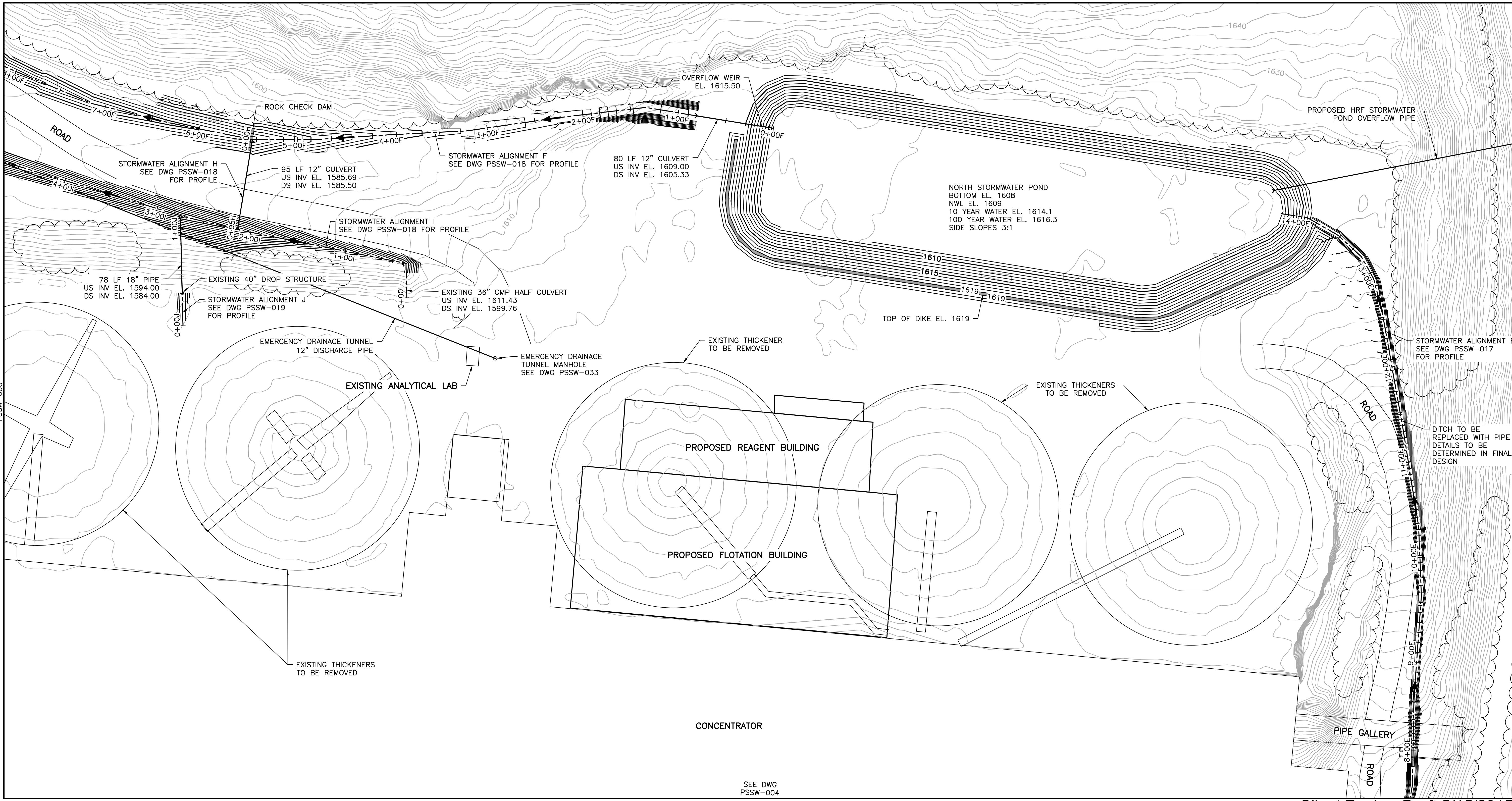

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1 PLAN: STORMWATER ALIGNMENTS E, F, H–J

NOTE:

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0 50 100
SCALE IN FEET

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PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PLAN

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR

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4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-005

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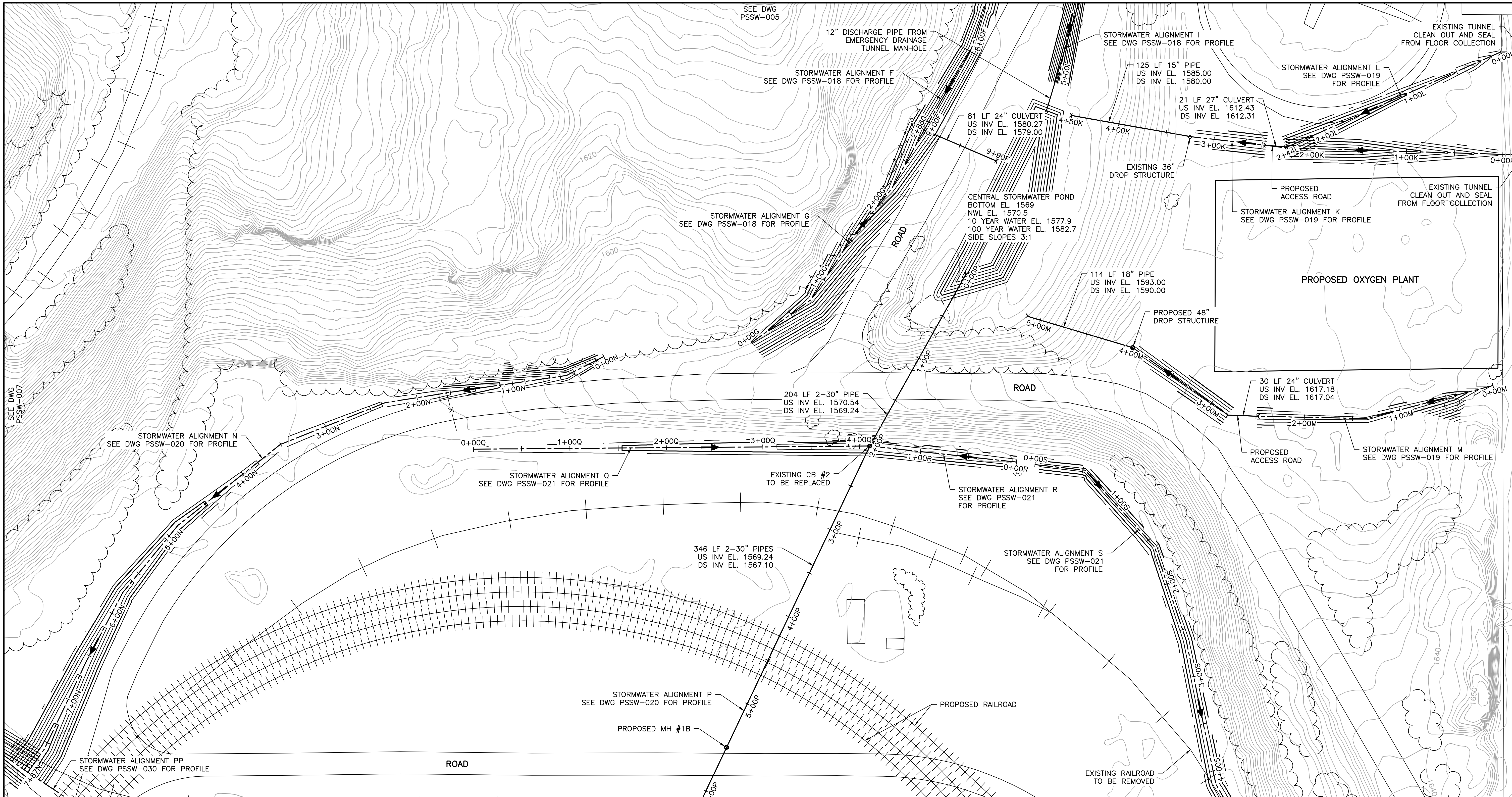

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PLANT DRAWING NUMBER:

1 PLAN: STORMWATER ALIGNMENTS F, G, I, K-N, P-S

NOTE:

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0 50 100 SCALE IN FEET

PLANT SITE STORMWATER GRADING PLAN

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

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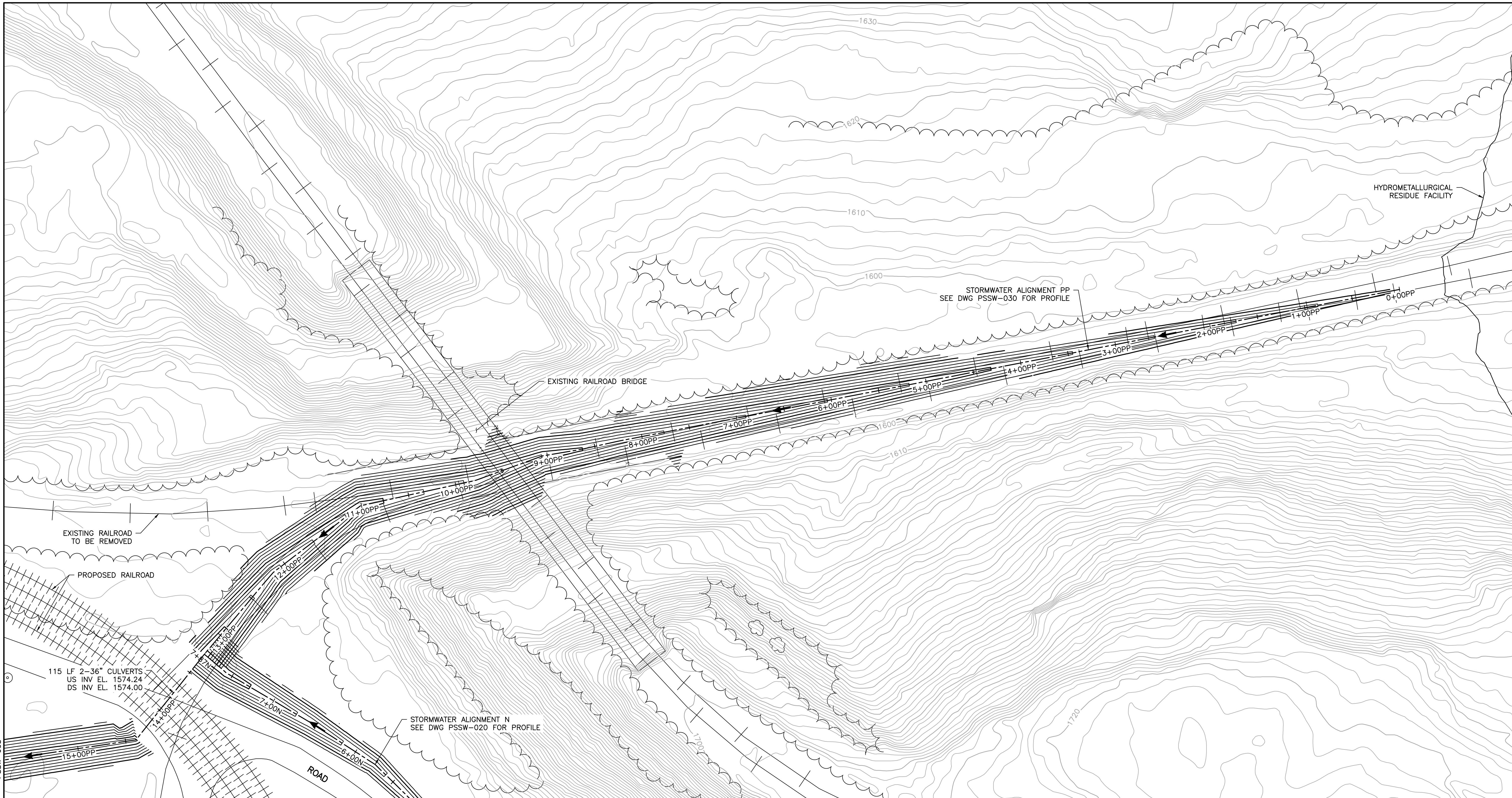
DATE 5/15/15 LICENSE# 46593

DRAWN: VJS
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-006 REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-006.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 9:57 AM



SEE DWG PSSW-006

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1 PLAN: STORMWATER ALIGNMENTS N AND PP

0 50 100
SCALE IN FEET

NOTE:

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CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PLAN

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR
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4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-007
REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-007.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 10:00 AM

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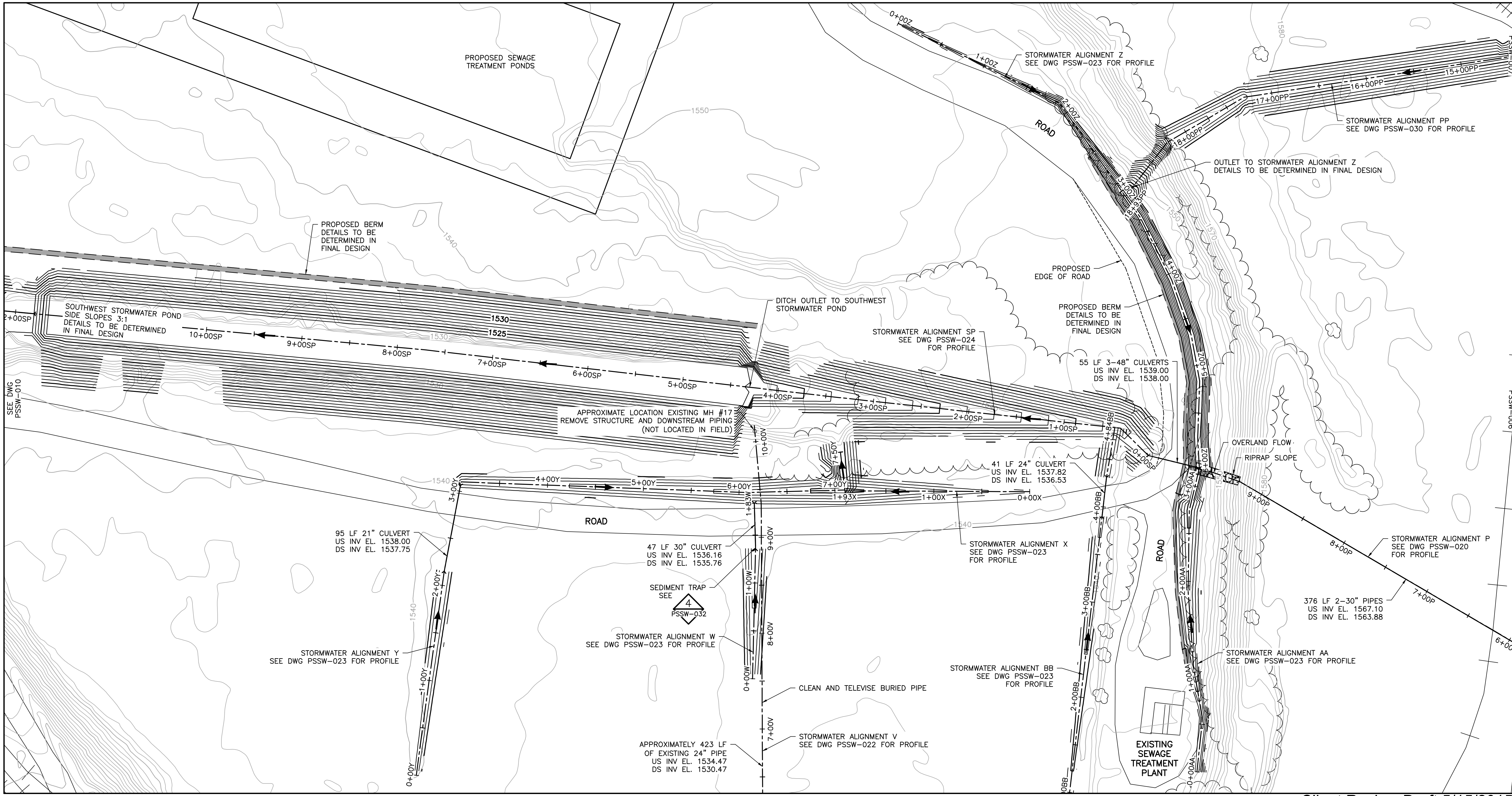

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(1) PLAN: STORMWATER ALIGNMENTS V-Z, AA, BB, SP

NOTE:

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0 50 100
SCALE IN FEET

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SIGNATURE
DATE 5/15/15 LICENSE# 46593

DRAWN: VJS
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PLAN

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

POLYMET MINING

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-008 REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-008.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 10:13 AM

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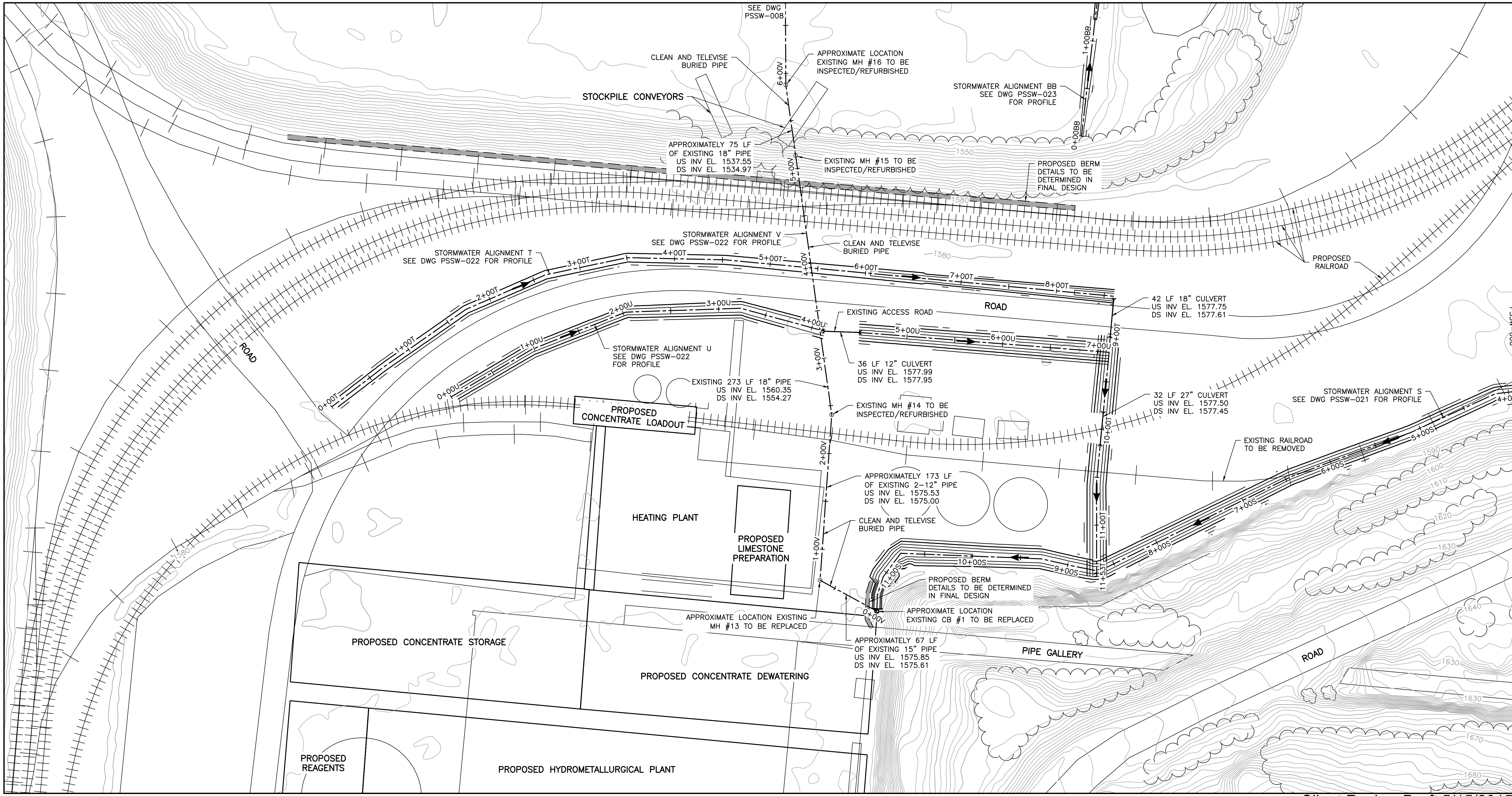

Client Review Draft 5/15/2015

1 PLAN: STORMWATER ALIGNMENTS S-V, BB

NOTE:

ALL PIPES AND CULVERTS ARE PROPOSED UNLESS INDICATED.

0 50 100
SCALE IN FEET

VER NO	DATE	DESCRIPTION
1	5/15/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS

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FOR PERMITTING	1	5/15/15
FOR CONSTRUCTION		
NOT APPROVED FOR CONSTRUCTION		

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PRINTED NAME CRISTIAN A. DIAZ
SIGNATURE
DATE 5/15/15 LICENSE# 46593

DRAWN: VJS
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PLAN

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-009 REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-009.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 10:15 AM

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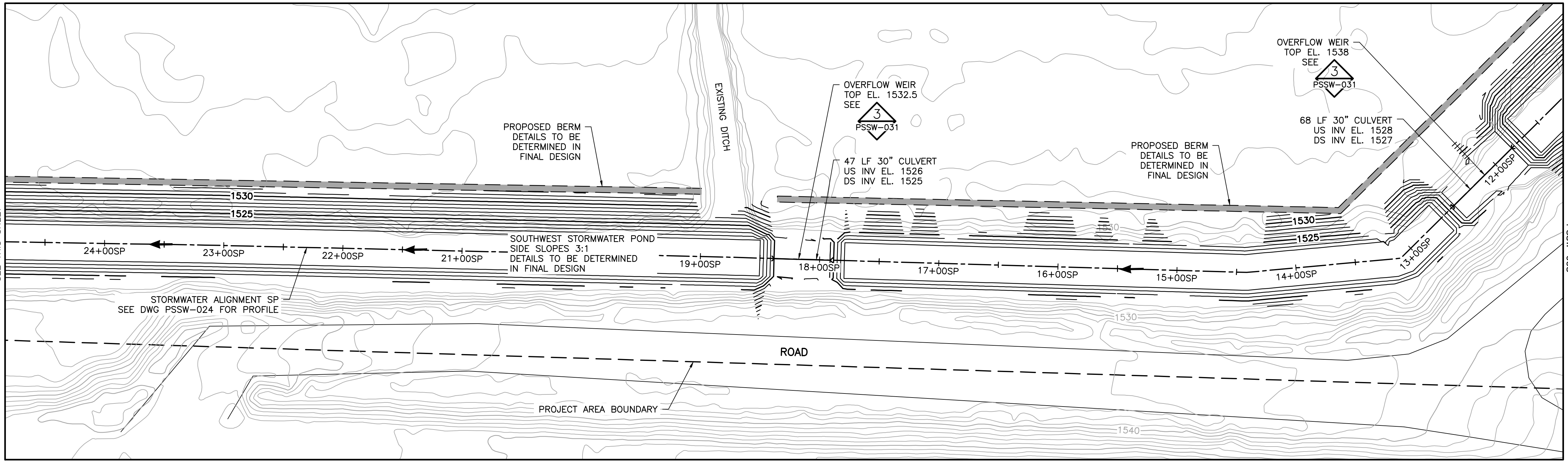

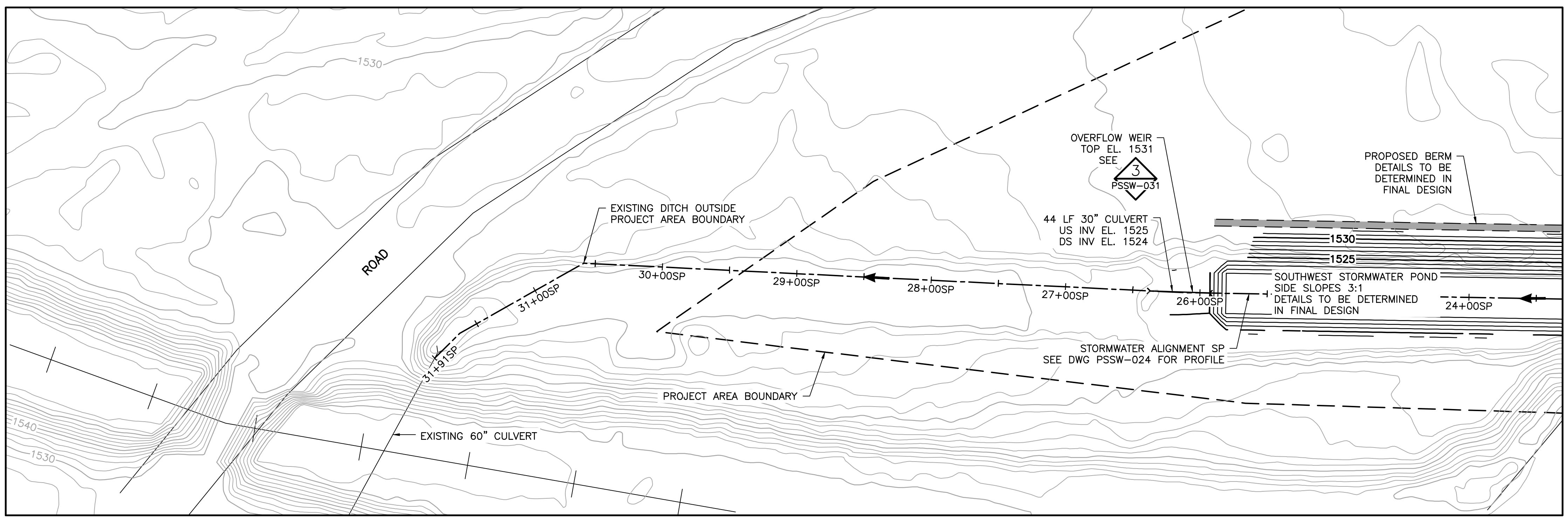

(1) PLAN: STORMWATER ALIGNMENT SP

NOTE:

ALL PIPES AND CULVERTS ARE PROPOSED UNLESS INDICATED.

0 50 100
SCALE IN FEET

Client Review Draft 5/15/2015

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PRINTED NAME CRISTIAN A. DIAZ
SIGNATURE
DATE 5/15/15 LICENSE# 46593

DRAWN: VJS
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER
GRADING PLAN

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR

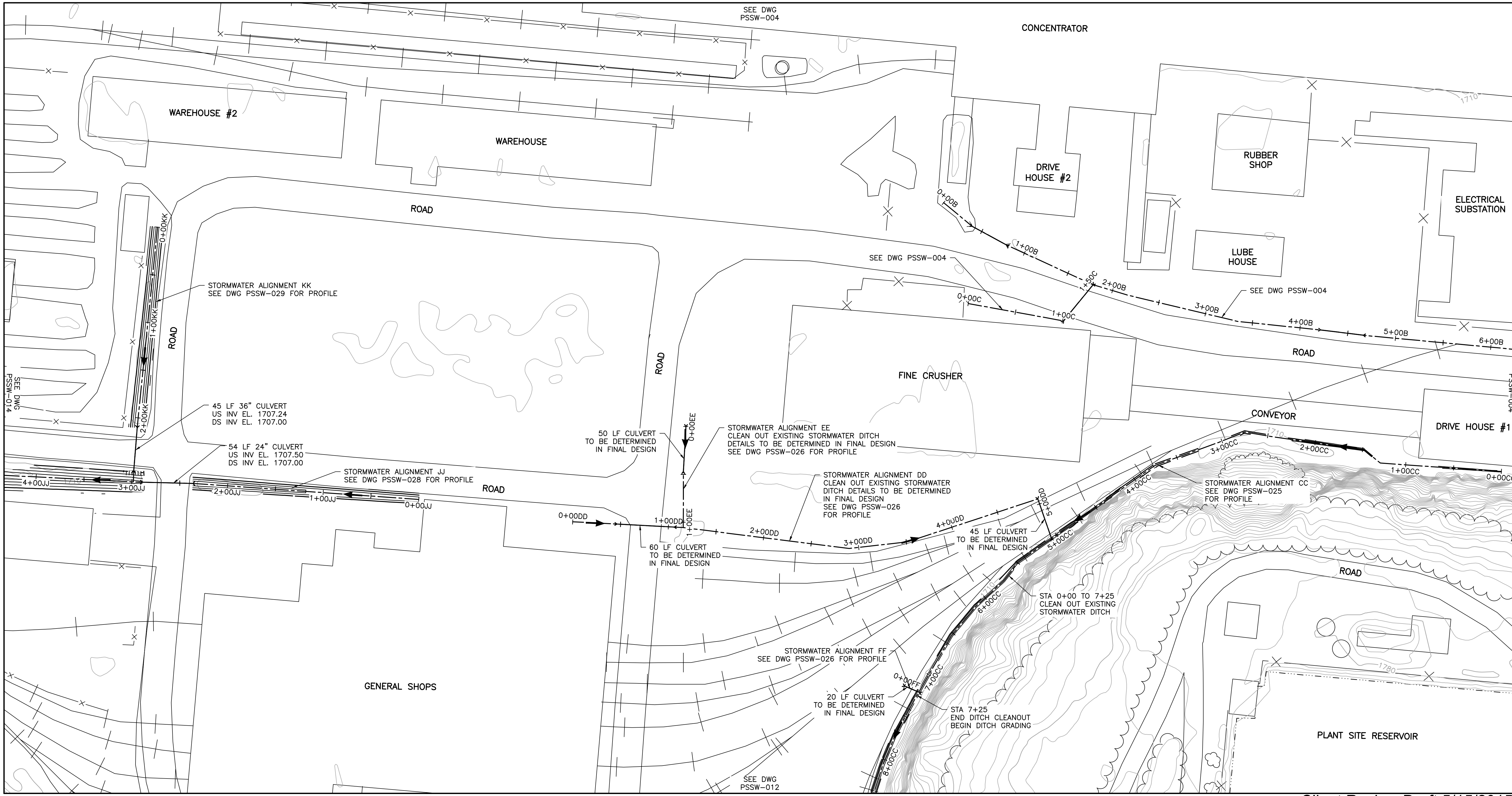
BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-010

REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-010.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 10:18 AM

INCHES 1 2



Client Review Draft 5/15/2015

1 PLAN: STORMWATER ALIGNMENTS CC, DD, EE, FF, JJ, AND KK

0 50 100
SCALE IN FEET

NOTE:

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SIGNATURE
DATE 5/15/15 LICENSE# 46593

DRAWN: PRT
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PLAN

POLYMET MINING

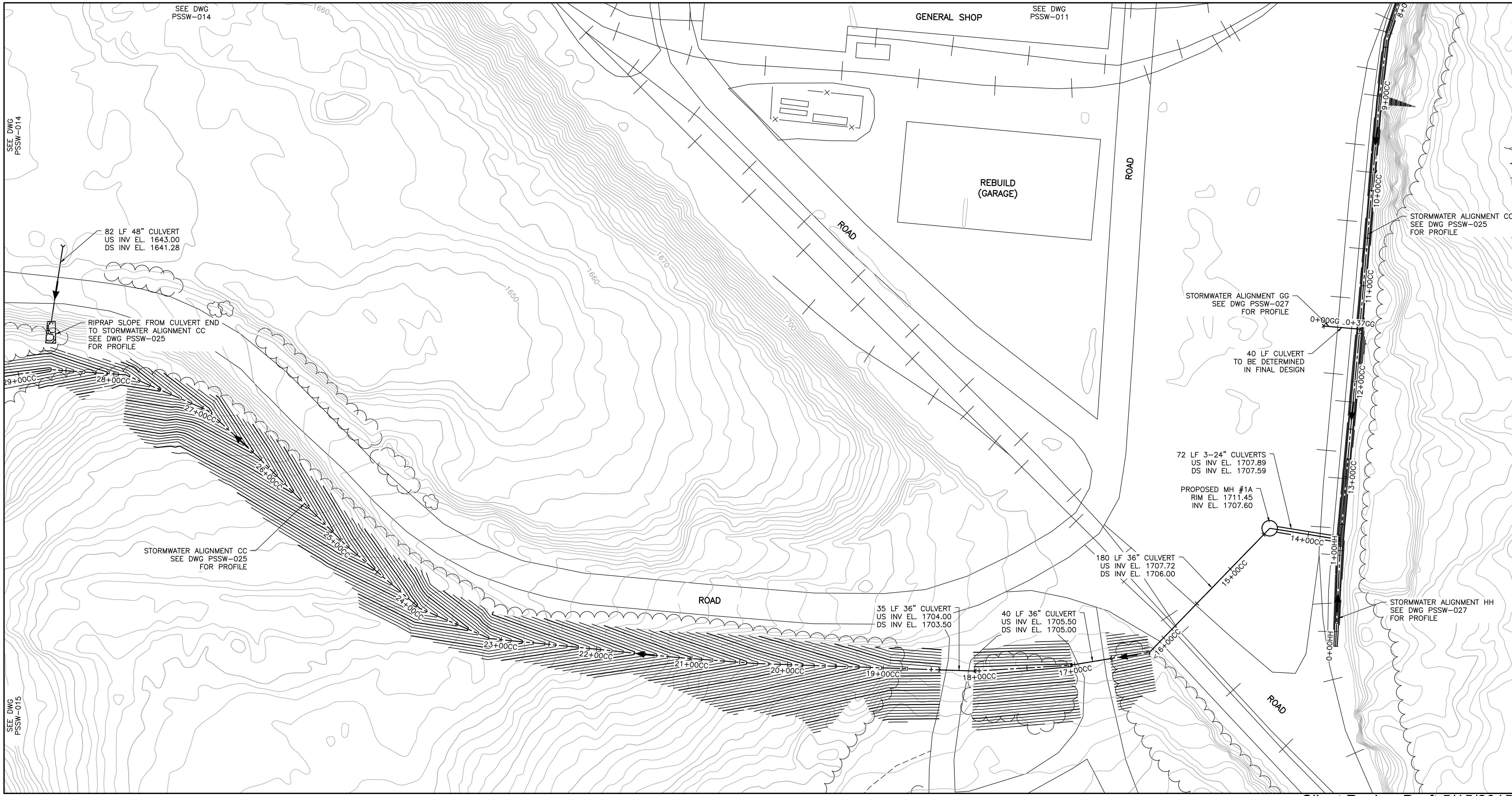
POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-011 REV

CADD USER: Cristion A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-011.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 10:20 AM

INCHES



Client Review Draft 5/15/2015

1 PLAN: STORMWATER ALIGNMENTS CC AND HH

NOTE:

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0 50 100
SCALE IN FEET

VER NO	DATE	DESCRIPTION
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ISSUED	VERSION	DATE
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SIGNATURE
DATE 5/15/15 LICENSE# 46593

DRAWN: PRT
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER
GRADING PLAN

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-012

REV

INCHES 1 2

Client Review Draft 5/15/2015

1 PLAN: STORMWATER ALIGNMENTS JJ, MM, AND NN

NOTE:

ALL PIPES AND CULVERTS ARE PROPOSED UNLESS INDICATED.

0 50 100
SCALE IN FEET

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DRAWN: PRT
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER
GRADING PLAN

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-013
REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-013.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 10:24 AM

INCHES 1 2

Client Review Draft 5/15/2015

1 PLAN: STORMWATER ALIGNMENTS CC AND JJ

NOTE:

ALL PIPES AND CULVERTS ARE PROPOSED UNLESS INDICATED.

0 50 100
SCALE IN FEET

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-014.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 10:26 AM

VER NO	DATE	DESCRIPTION
1	5/15/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS

ISSUE STATUS		
ISSUED	VERSION	DATE
FOR PERMITTING	1	5/15/15
FOR CONSTRUCTION		
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SIGNATURE
DATE 5/15/15 LICENSE# 46593

DRAWN: PRT
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PLAN

POLYMET MINING

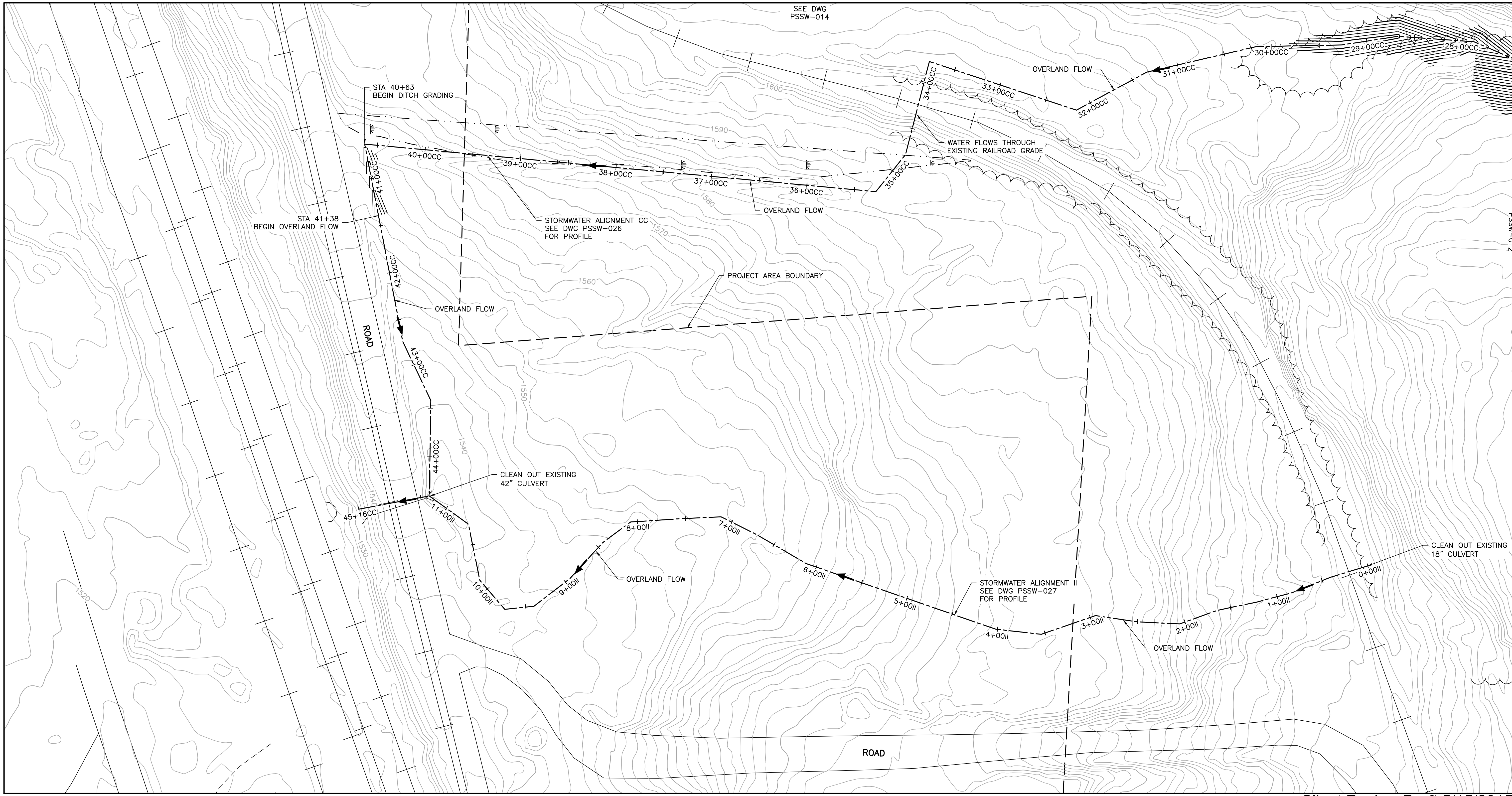
POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR
BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-014

REV

INCHES 1 2



Client Review Draft 5/15/2015

1 PLAN: STORMWATER ALIGNMENTS CC AND II

NOTE:

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0 50 100
SCALE IN FEET

INCHES 1 2

VER NO	DATE	DESCRIPTION
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DRAWN: PRT
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PLAN

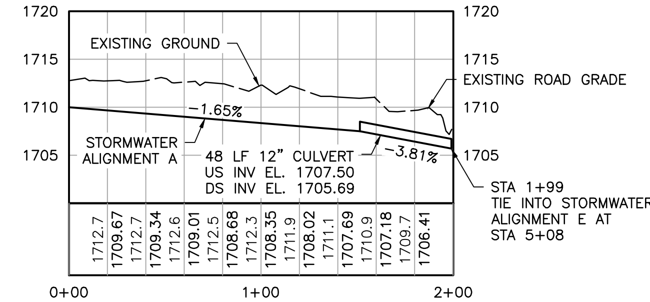
POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

POLYMET MINING

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-015

REV

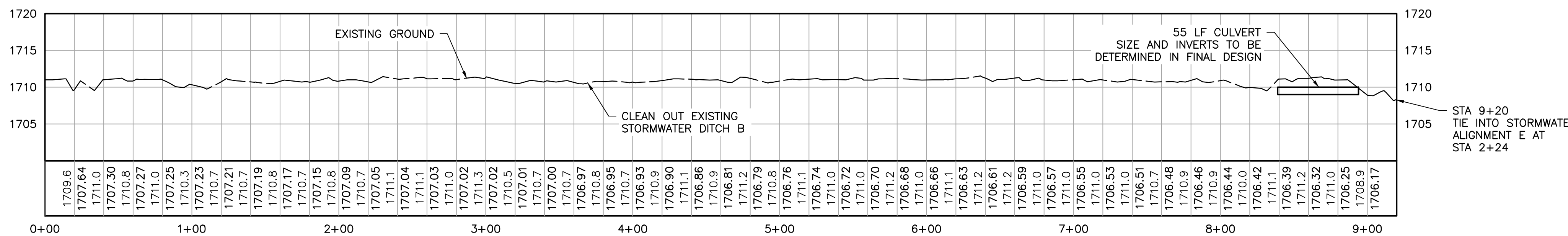


(A) PROFILE: STORMWATER ALIGNMENT A

PSSW-004

0 50 100 HORIZONTAL SCALE IN FEET

0 10 20 VERTICAL SCALE IN FEET



NOTE:

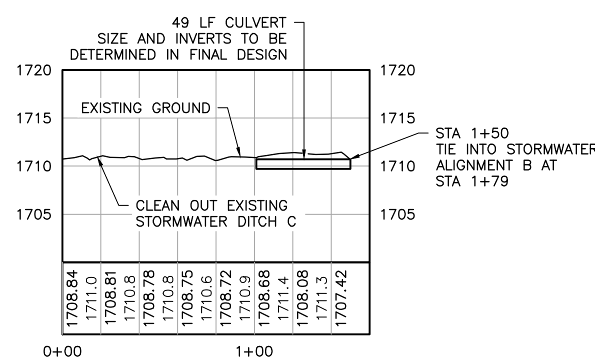
STORMWATER DITCH HAS CONSTRAINTS RESTRICTING CONSTRUCTION. DESIGN OPTIONS HAVE BEEN IDENTIFIED. THIS PROFILE SHOWS CLEAN-OUT OF THE EXISTING DITCH, WHICH DOES NOT HAVE THE CAPACITY AS REQUIRED TO RESTRICT FLOODING.

(B) PROFILE: STORMWATER ALIGNMENT B

PSSW-004

0 50 100 HORIZONTAL SCALE IN FEET

0 10 20 VERTICAL SCALE IN FEET



NOTE:

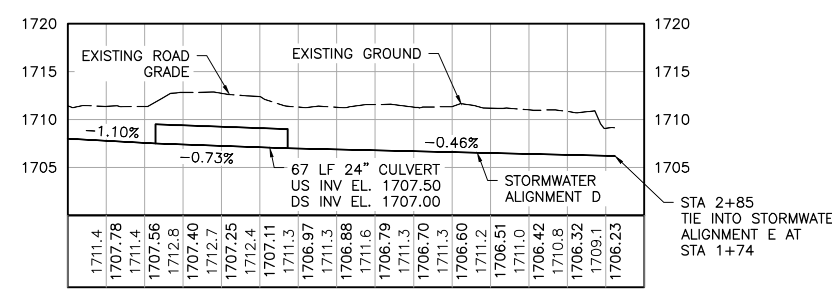
STORMWATER DITCH HAS CONSTRAINTS RESTRICTING CONSTRUCTION. DESIGN OPTIONS HAVE BEEN IDENTIFIED. THIS PROFILE SHOWS CLEAN-OUT OF THE EXISTING DITCH, WHICH DOES NOT HAVE THE CAPACITY AS REQUIRED TO RESTRICT FLOODING.

(C) PROFILE: STORMWATER ALIGNMENT C

PSSW-004

0 50 100 HORIZONTAL SCALE IN FEET

0 10 20 VERTICAL SCALE IN FEET



(D) PROFILE: STORMWATER ALIGNMENT D

PSSW-004

0 50 100 HORIZONTAL SCALE IN FEET

0 10 20 VERTICAL SCALE IN FEET

NOTE:

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Client Review Draft 5/15/2015

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PROFILES

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SIGNATURE

DATE 5/15/15 LICENSE# 46593

DRAWN: VJS

CHECKED: CMK2

BARR PROJECT NO.: 23/69-0C29

SCALE: AS SHOWN

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-016

REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-016.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 10:49 AM

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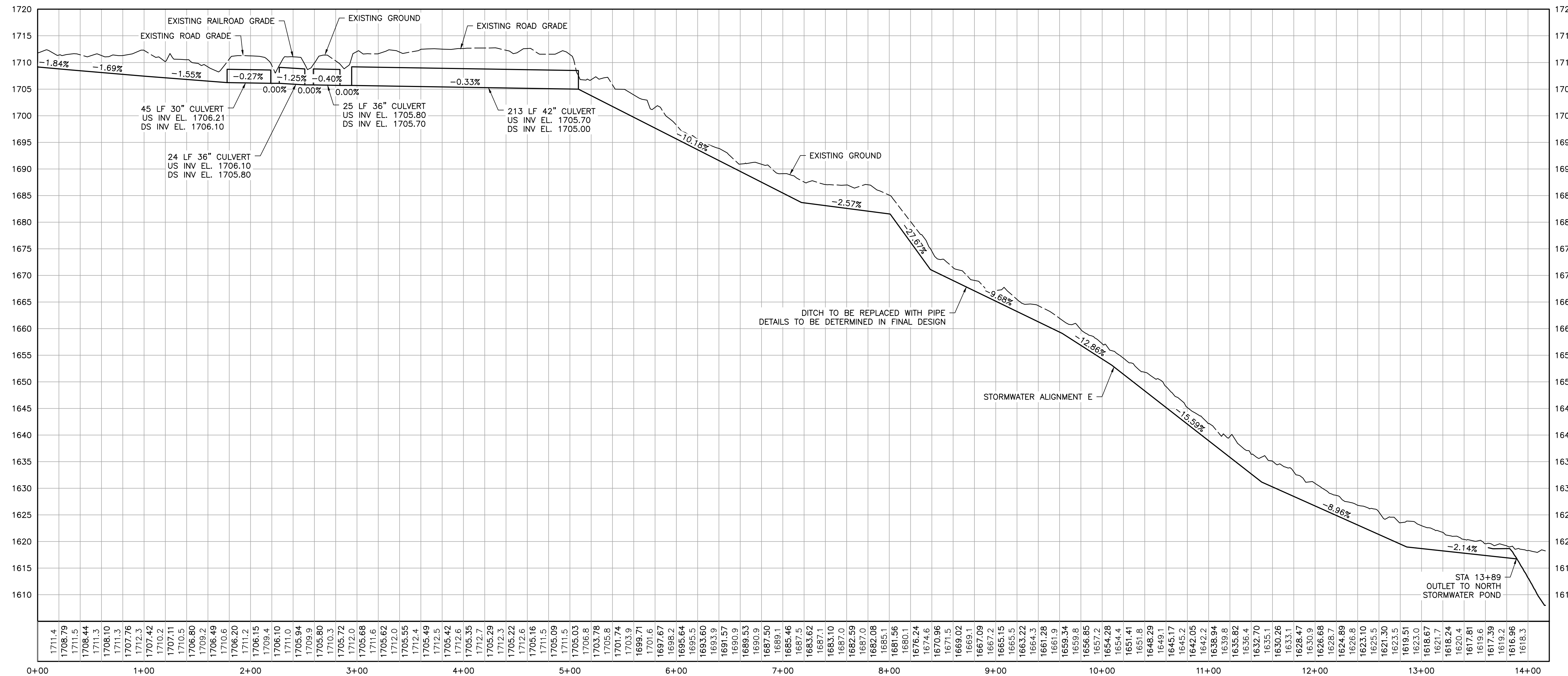

E PROFILE: STORMWATER ALIGNMENT E
PSSW-004,005

0 50 100 HORIZONTAL SCALE IN FEET

0 10 20 VERTICAL SCALE IN FEET

NOTE:

ALL PIPES AND CULVERTS ARE PROPOSED UNLESS INDICATED.

Client Review Draft 5/15/2015

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PROFILES

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

POLYMET MINING

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

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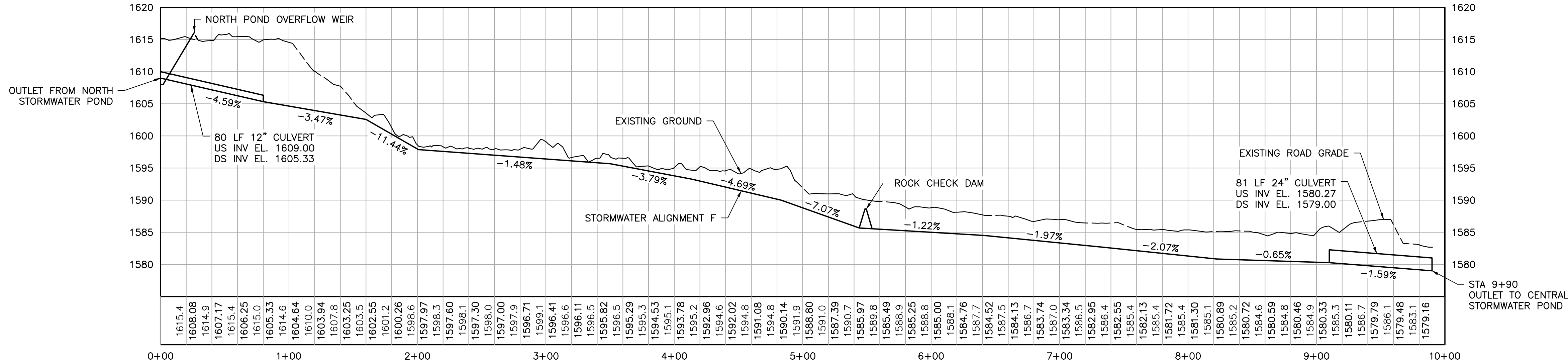
SIGNATURE
DATE 5/15/15 LICENSE# 46593

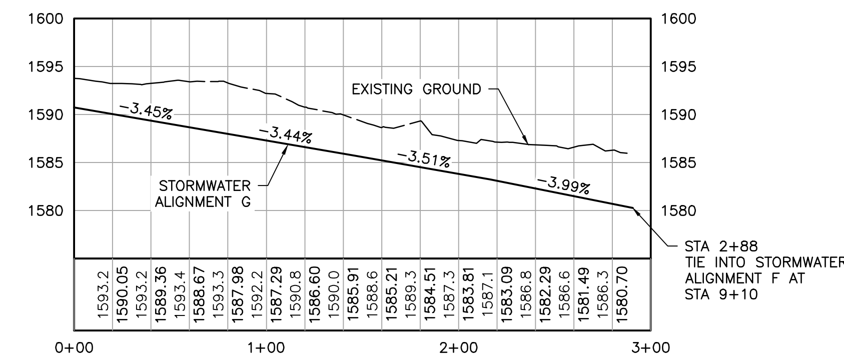
DRAWN: VJS
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN
DWG. NO. PSSW-017
REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-017.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 10:58 AM

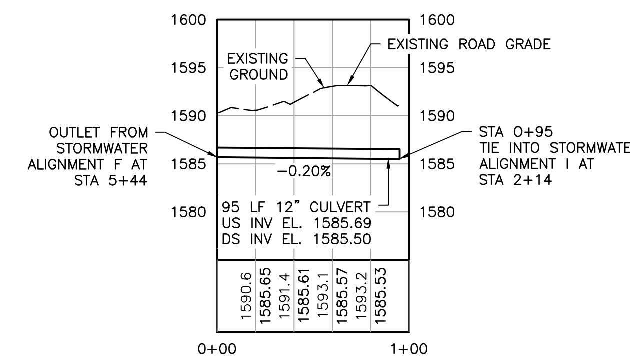
INCHES 1 2



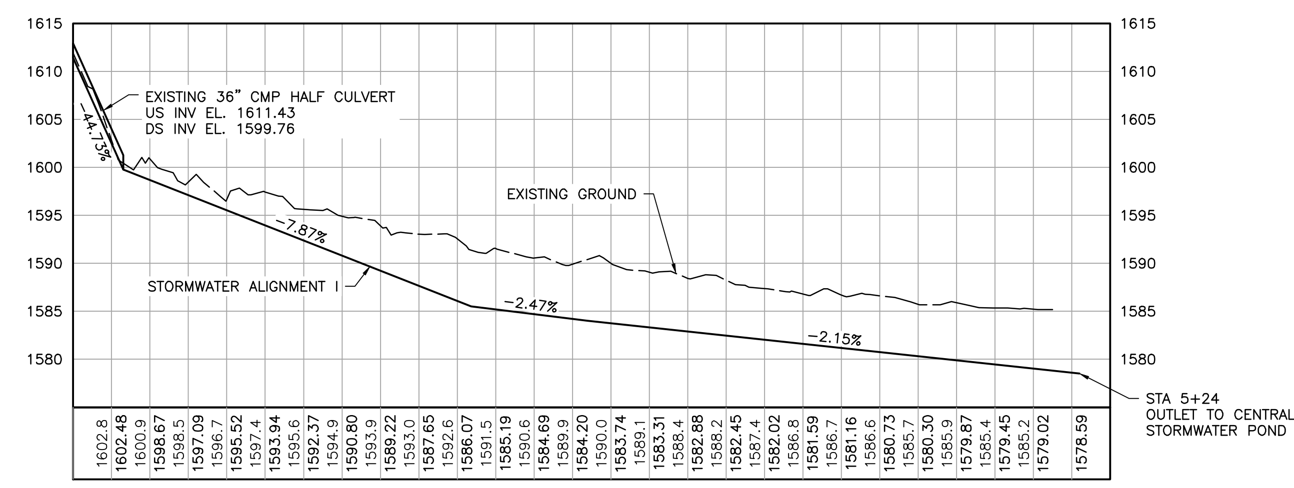
F PROFILE: STORMWATER ALIGNMENT F
PSSW-005,006
HORIZONTAL SCALE IN FEET 0 50 100
VERTICAL SCALE IN FEET 0 10 20



G PROFILE: STORMWATER ALIGNMENT G
PSSW-006
HORIZONTAL SCALE IN FEET 0 50 100
VERTICAL SCALE IN FEET 0 10 20



H PROFILE: STORMWATER ALIGNMENT H
PSSW-005
HORIZONTAL SCALE IN FEET 0 50 100
VERTICAL SCALE IN FEET 0 10 20



I PROFILE: STORMWATER ALIGNMENT I
PSSW-005,006
HORIZONTAL SCALE IN FEET 0 50 100
VERTICAL SCALE IN FEET 0 10 20

NOTE:

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SIGNATURE
DATE 5/15/15 LICENSE# 46593

DRAWN: VJS
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PROFILES

POLYMET MINING

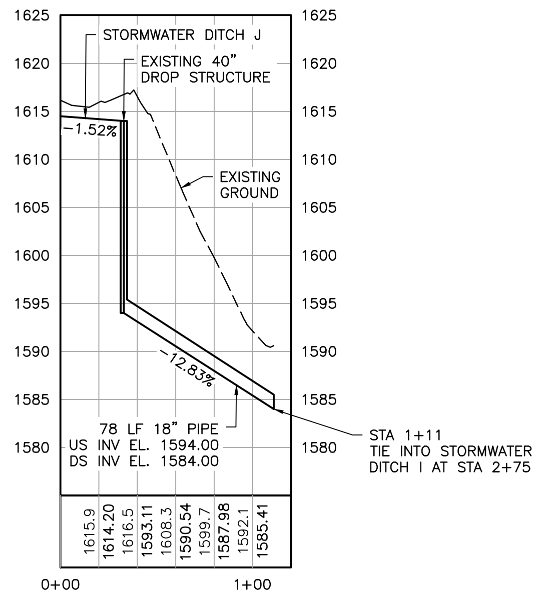
POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR
BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-018
REV

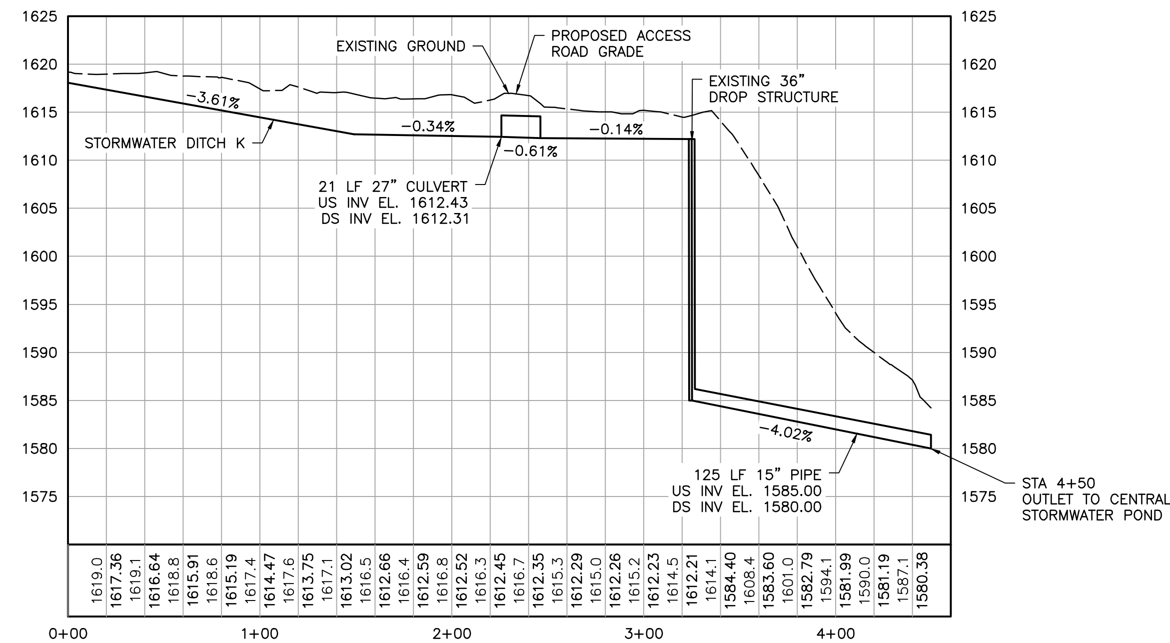
CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-018.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 11:12 AM

INCHES 1 2



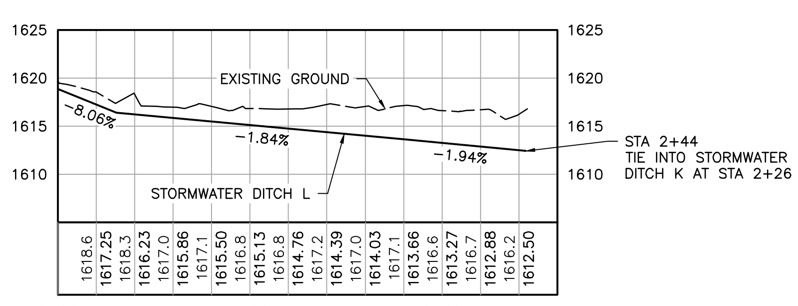
PSSW-005 J PROFILE: STORMWATER ALIGNMENT J

HORIZONTAL SCALE IN FEET 0 50 100 — VERTICAL SCALE IN FEET 0 10 20



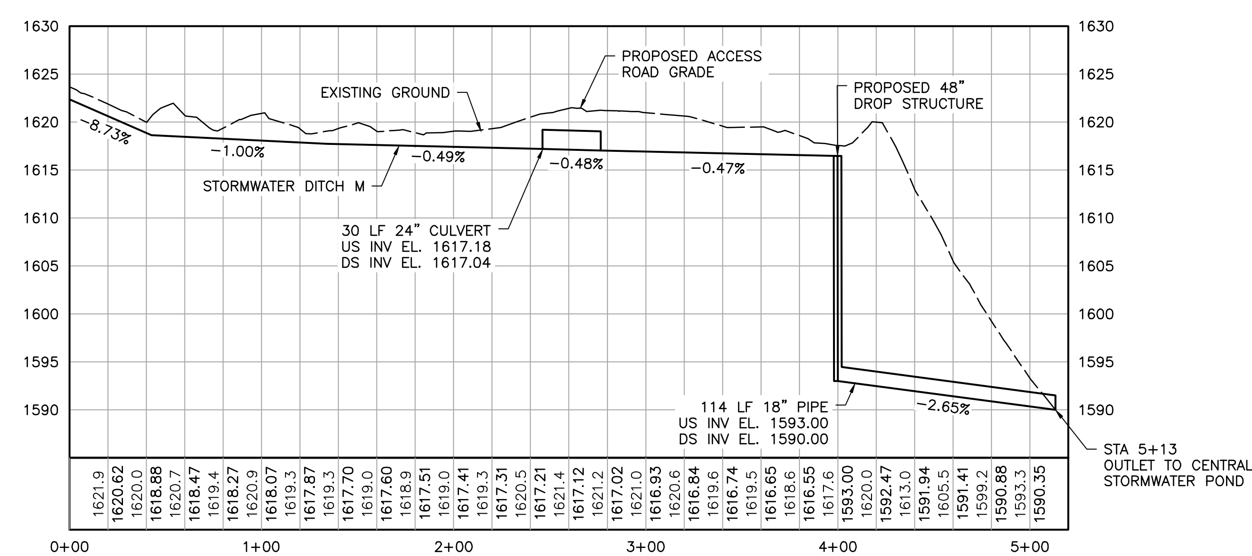
PSSW-006 K PROFILE: STORMWATER ALIGNMENT K

HORIZONTAL SCALE IN FEET 0 50 100 — VERTICAL SCALE IN FEET 0 10 20



PSSW-006 L PROFILE: STORMWATER ALIGNMENT L

HORIZONTAL SCALE IN FEET 0 50 100 — VERTICAL SCALE IN FEET 0 10 20



PSSW-006 M PROFILE: STORMWATER ALIGNMENT M

HORIZONTAL SCALE IN FEET 0 50 100 — VERTICAL SCALE IN FEET 0 10 20

NOTE:

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Client Review Draft 5/15/2015

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PLANT SITE STORMWATER GRADING PROFILES

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PRINTED NAME CRISTIAN A. DIAZ
SIGNATURE
DATE 5/15/15 LICENSE# 46593

DRAWN: VJS
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

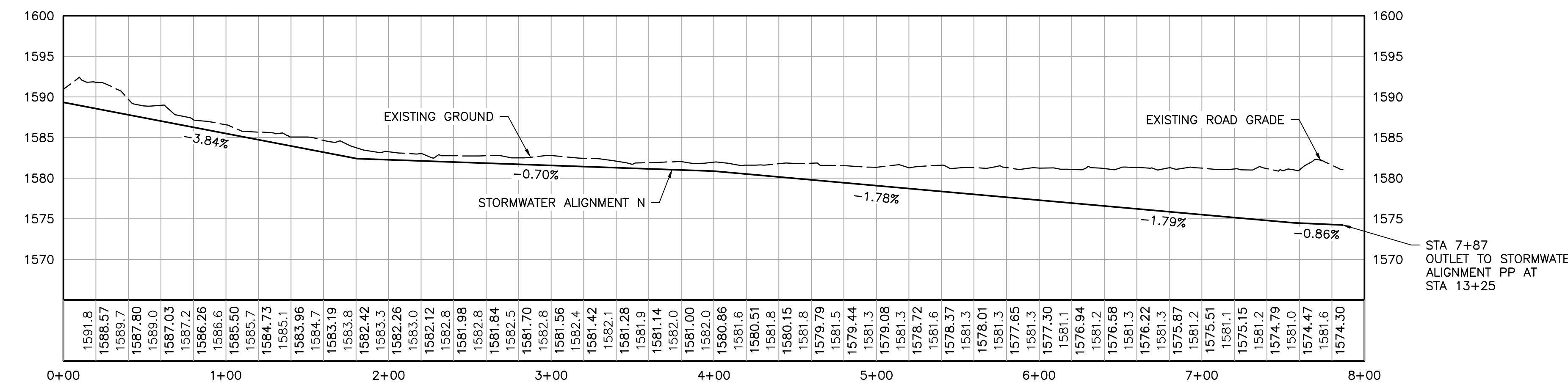
BARR

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-019 REV

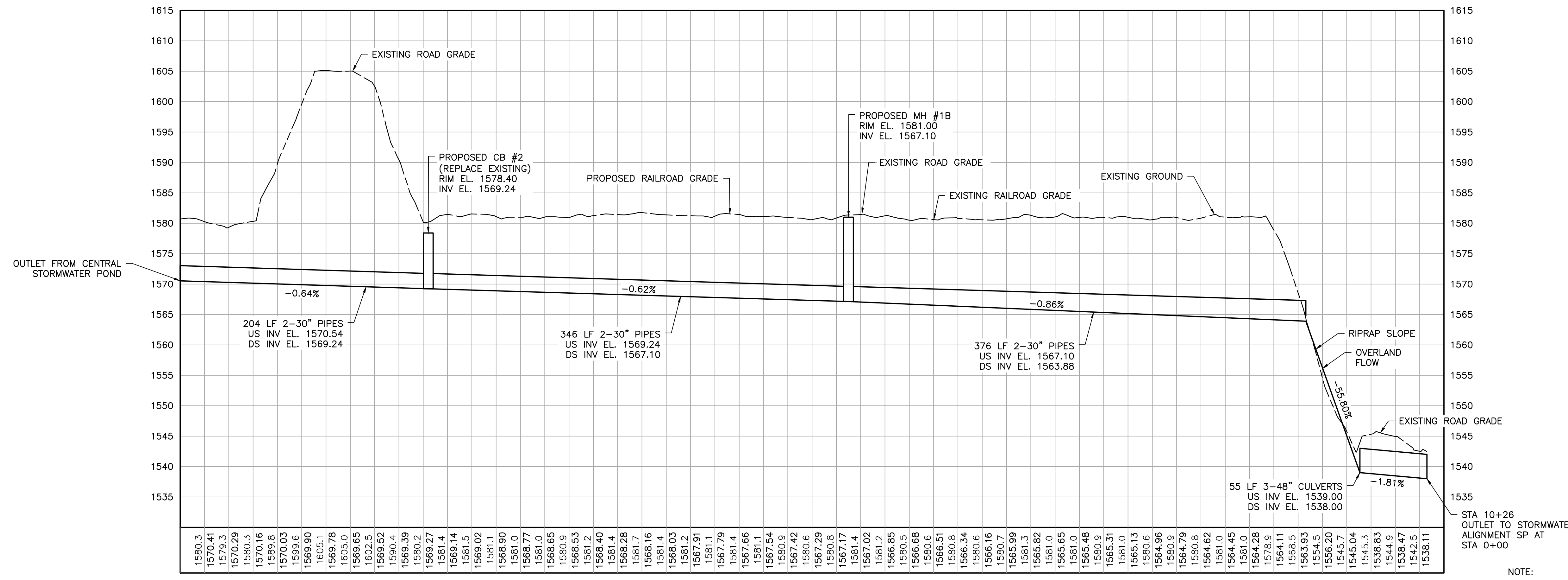
CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-019.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 11:14 AM

INCHES 1 2



N PSSW-006 PROFILE: STORMWATER ALIGNMENT N

HORIZONTAL SCALE IN FEET (0 50 100) VERTICAL SCALE IN FEET (0 10 20)



P PSSW-006,008 PROFILE: STORMWATER ALIGNMENT P

HORIZONTAL SCALE IN FEET (0 50 100) VERTICAL SCALE IN FEET (0 10 20)

NOTE:

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Client Review Draft 5/15/2015

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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.

PRINTED NAME CRISTIAN A. DIAZ
SIGNATURE
DATE 5/15/15 LICENSE# 46593

DRAWN: VJS
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

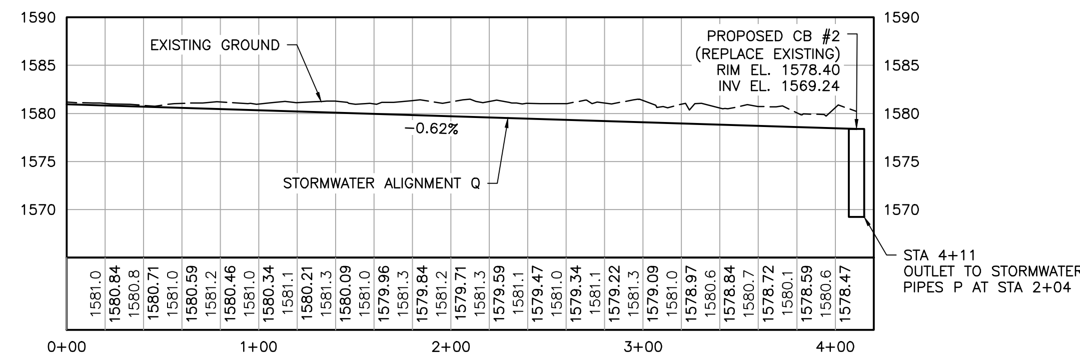
BARR
BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-020

REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-020.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 11:18 AM

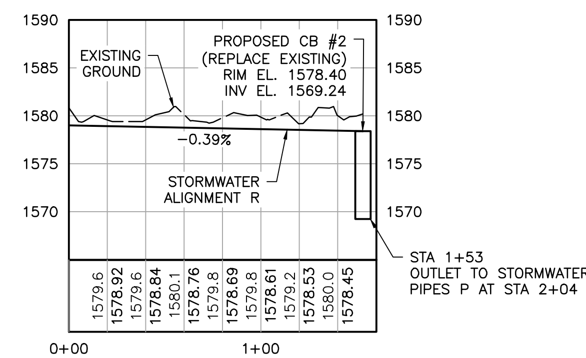
INCHES 1 2



Q PSSW-006 **PROFILE: STORMWATER ALIGNMENT Q**

0 50 100 HORIZONTAL SCALE IN FEET

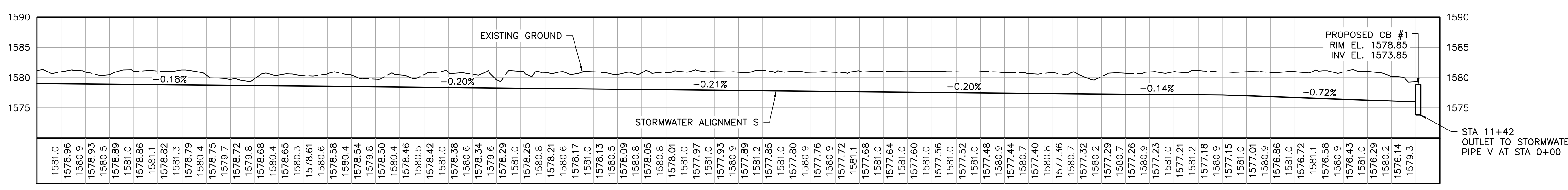
0 10 20 VERTICAL SCALE IN FEET



R PSSW-006 **PROFILE: STORMWATER ALIGNMENT R**

0 50 100 HORIZONTAL SCALE IN FEET

0 10 20 VERTICAL SCALE IN FEET



S PSSW-006,009 **PROFILE: STORMWATER ALIGNMENT S**

0 50 100 HORIZONTAL SCALE IN FEET

0 10 20 VERTICAL SCALE IN FEET

NOTE:

ALL PIPES AND CULVERTS ARE PROPOSED UNLESS INDICATED.

Client Review Draft 5/15/2015

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PROFILES

VER NO	DATE	DESCRIPTION
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ISSUE STATUS		
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FOR PERMITTING	1	5/15/15
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NOT APPROVED FOR CONSTRUCTION		

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BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

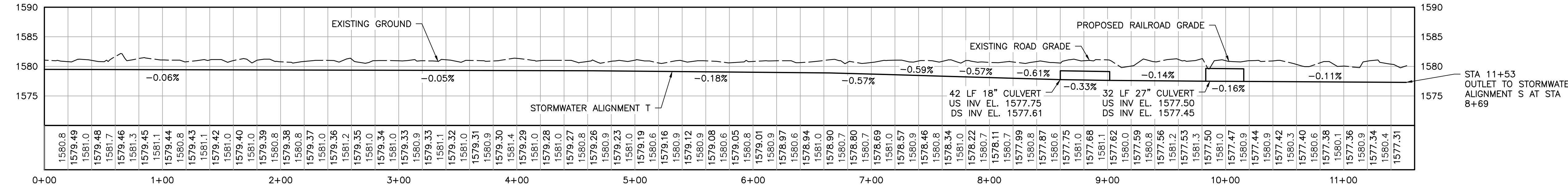
BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-021

REV

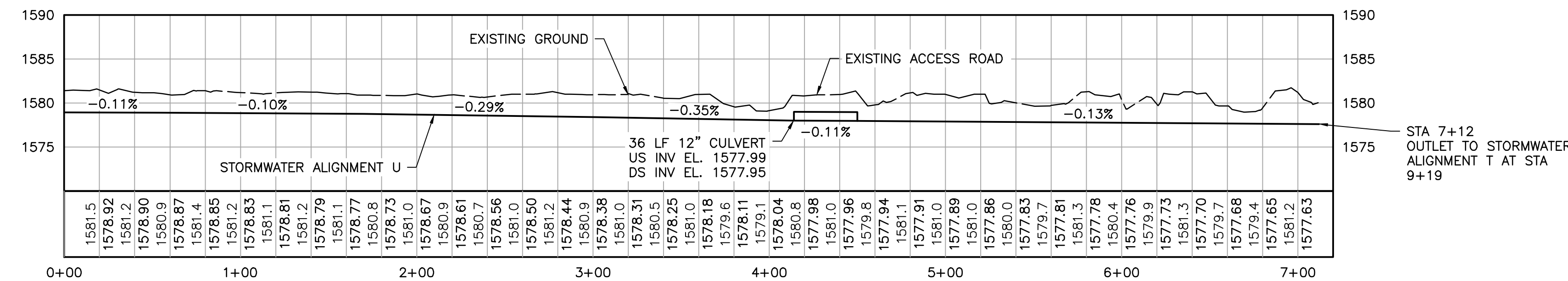
CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-021.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 11:21 AM

INCHES 1 2



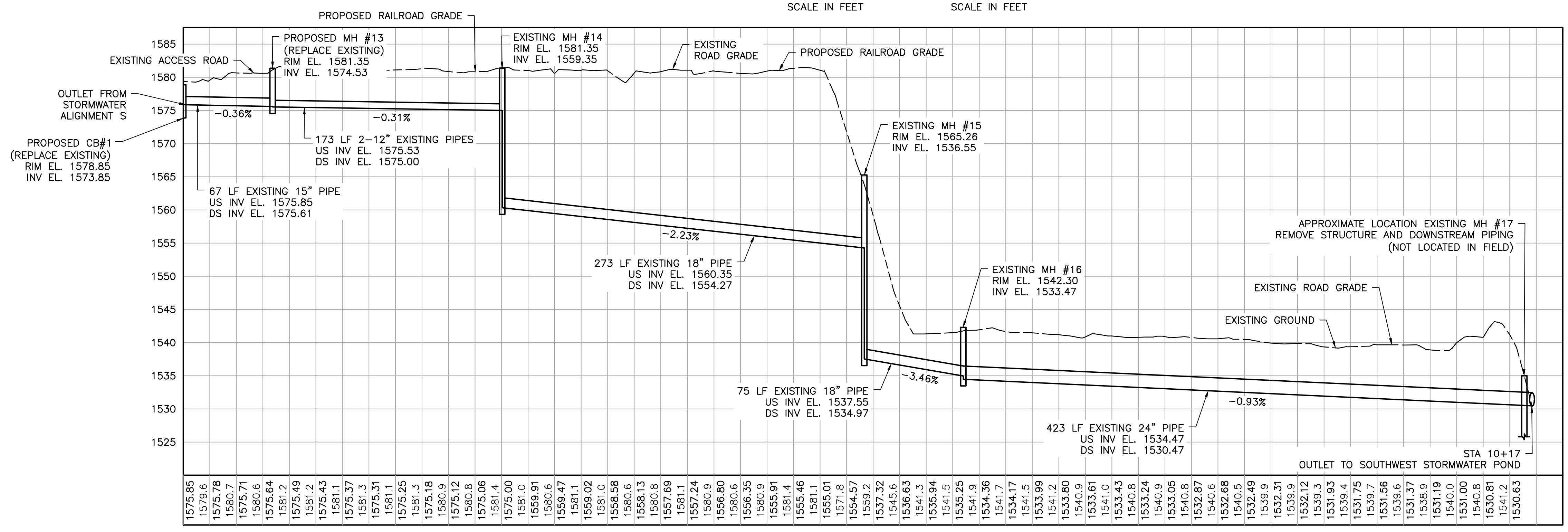
T PSSW−009 **PROFILE: STORMWATER ALIGNMENT T**

HORIZONTAL SCALE IN FEET (0, 50, 100) — VERTICAL SCALE IN FEET (0, 10, 20)



U PSSW−009 **PROFILE: STORMWATER ALIGNMENT U**

HORIZONTAL SCALE IN FEET (0, 50, 100) — VERTICAL SCALE IN FEET (0, 10, 20)



V PSSW−008,009 **PROFILE: STORMWATER ALIGNMENT V**

HORIZONTAL SCALE IN FEET (0, 50, 100) — VERTICAL SCALE IN FEET (0, 10, 20)

NOTE:

CLEAN AND TELEVISE BURIED PIPE.

NOTE:

ALL PIPES AND CULVERTS ARE PROPOSED UNLESS INDICATED.

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CHECKED: CMK2
BARR PROJECT NO.: 23/69−0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PROFILES

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

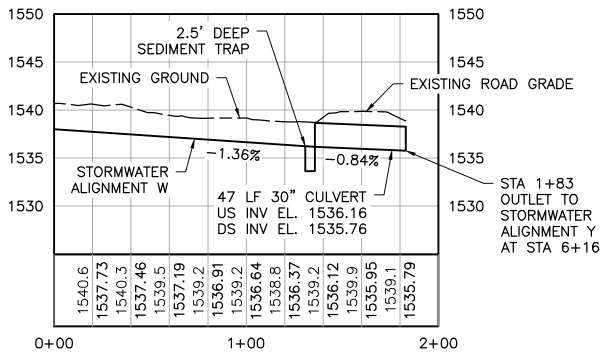
BARR

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1−800−632−2277

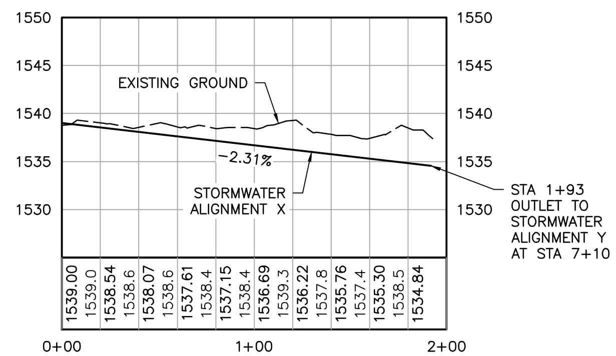
DWG. NO. PSSW−022 REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP−63−CS−022.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 11:24 AM

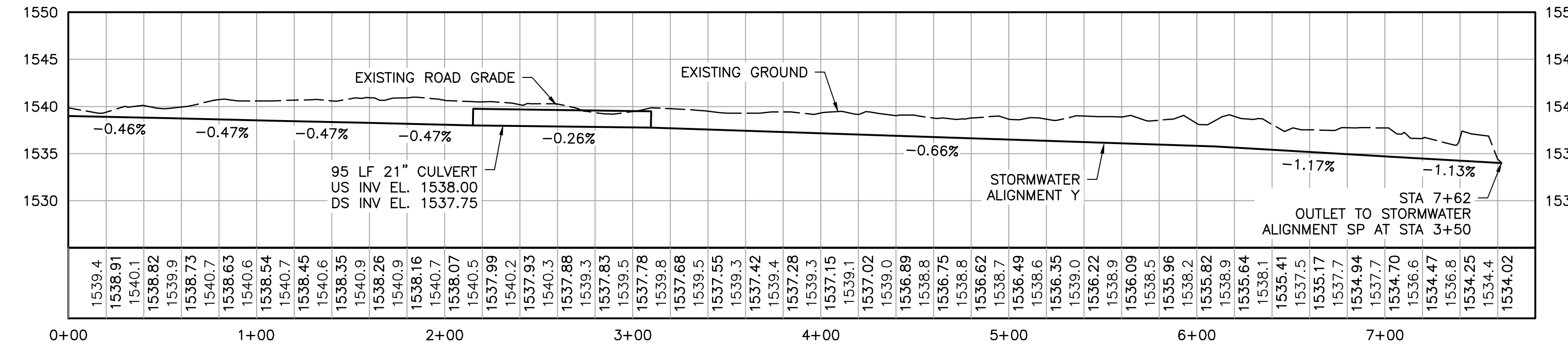
INCHES 1 2



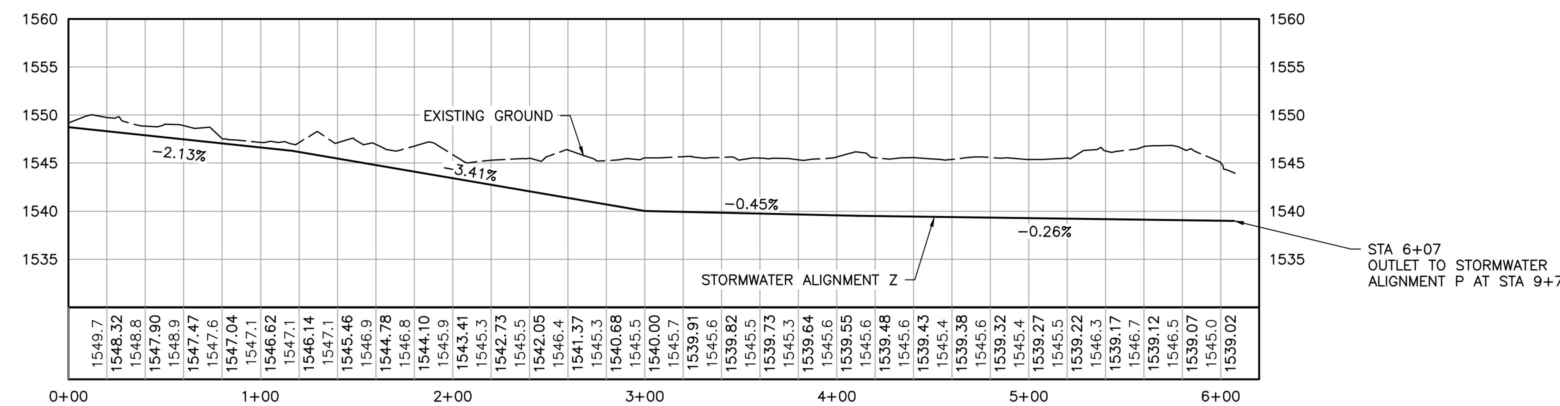
W PROFILE: STORMWATER ALIGNMENT W
PSSW-008
HORIZONTAL SCALE IN FEET (0, 50, 100) — VERTICAL SCALE IN FEET (0, 10, 20)



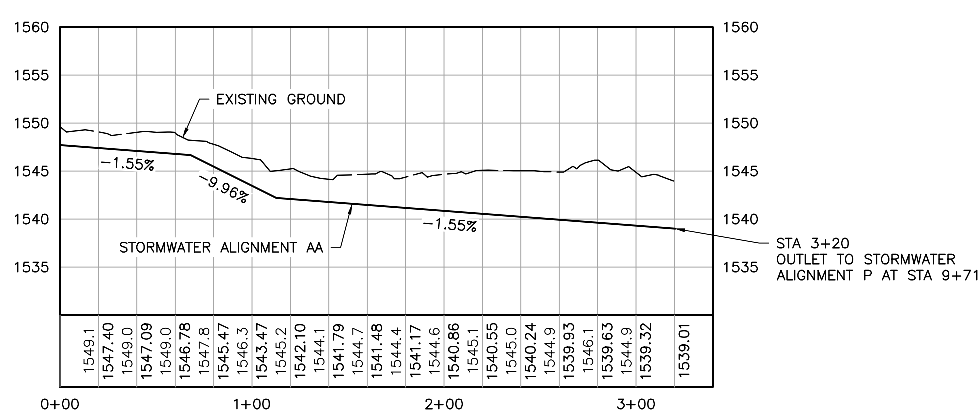
X PROFILE: STORMWATER ALIGNMENT X
PSSW-008
HORIZONTAL SCALE IN FEET (0, 50, 100) — VERTICAL SCALE IN FEET (0, 10, 20)



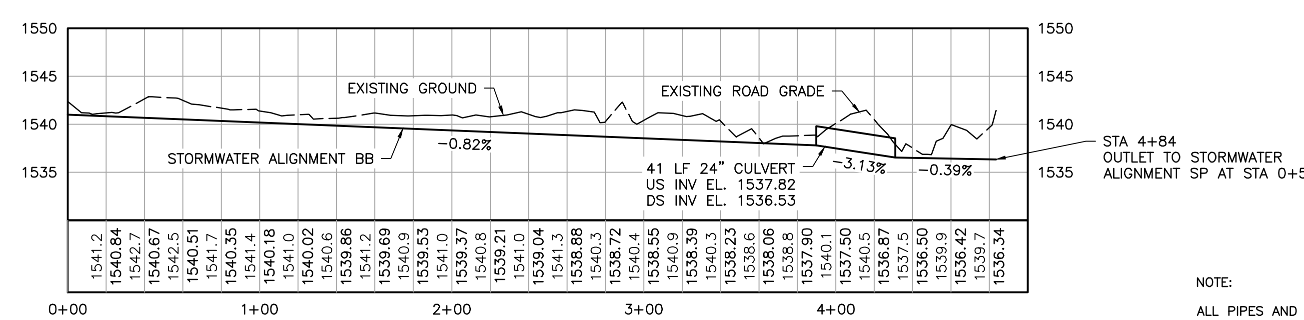
Y PROFILE: STORMWATER ALIGNMENT Y
PSSW-008
HORIZONTAL SCALE IN FEET (0, 50, 100) — VERTICAL SCALE IN FEET (0, 10, 20)



Z PROFILE: STORMWATER ALIGNMENT Z
PSSW-008
HORIZONTAL SCALE IN FEET (0, 50, 100) — VERTICAL SCALE IN FEET (0, 10, 20)



AA PROFILE: STORMWATER ALIGNMENT AA
PSSW-008
HORIZONTAL SCALE IN FEET (0, 50, 100) — VERTICAL SCALE IN FEET (0, 10, 20)



BB PROFILE: STORMWATER ALIGNMENT BB
PSSW-008,009
HORIZONTAL SCALE IN FEET (0, 50, 100) — VERTICAL SCALE IN FEET (0, 10, 20)

NOTE:

ALL PIPES AND CULVERTS ARE PROPOSED UNLESS INDICATED.

Client Review Draft 5/15/2015

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-023.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 11:28 AM

VER NO	DATE	DESCRIPTION
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DATE 5/15/15 LICENSE# 46593

DRAWN: VJS
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PROFILES

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

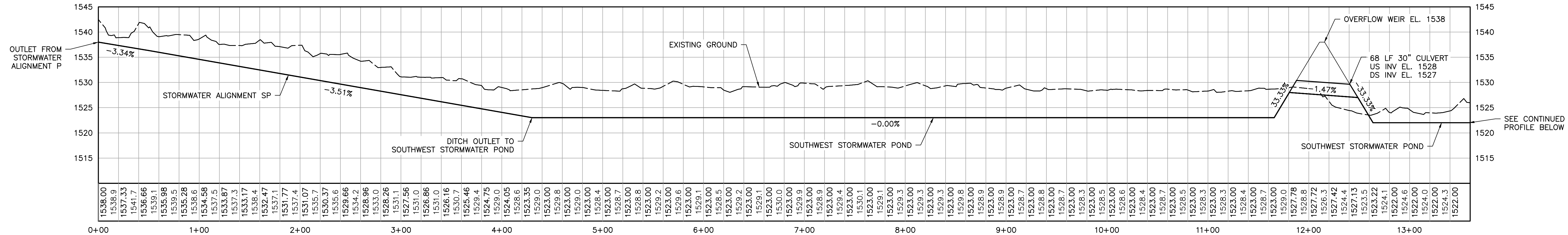
BARR

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-023

REV

INCHES 1 2

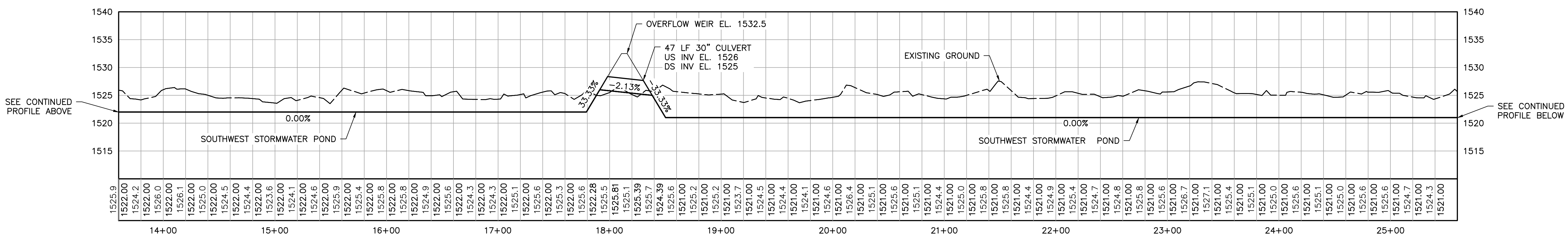


(SP) PROFILE: STORMWATER ALIGNMENT SP
PSSW-008,010

HORIZONTAL SCALE IN FEET (0, 50, 100) VERTICAL SCALE IN FEET (0, 10, 20)

NOTE:

SOUTHWEST STORMWATER POND TO BE OPTIMIZED IN FINAL DESIGN.

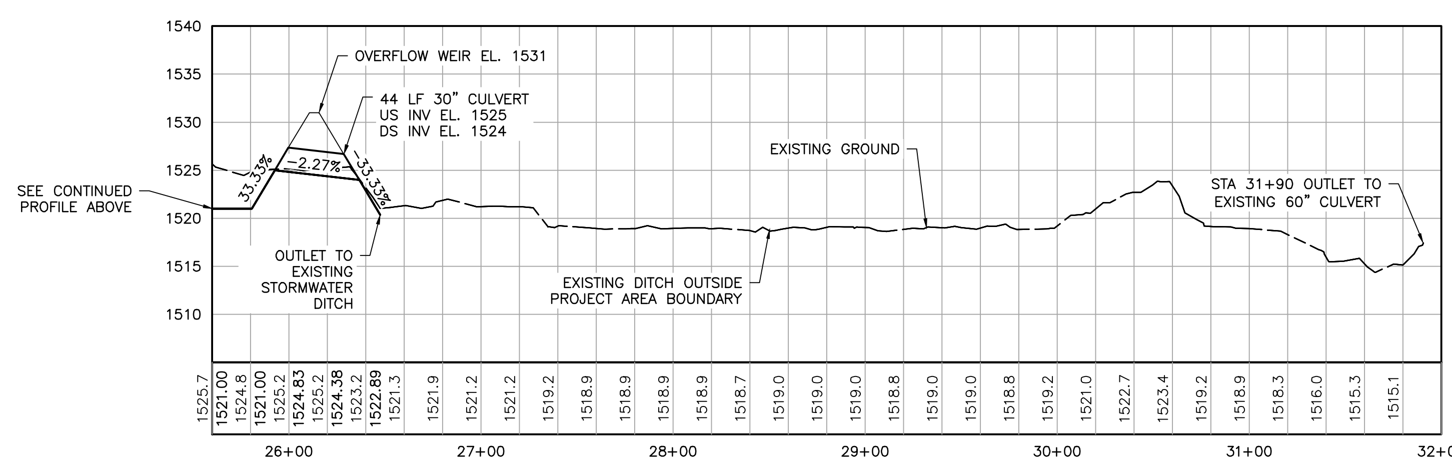


(SP) PROFILE: STORMWATER ALIGNMENT SP
PSSW-008,010

HORIZONTAL SCALE IN FEET (0, 50, 100) VERTICAL SCALE IN FEET (0, 10, 20)

NOTE:

SOUTHWEST STORMWATER POND TO BE OPTIMIZED IN FINAL DESIGN.



(SP) PROFILE: STORMWATER ALIGNMENT SP
PSSW-008,010

HORIZONTAL SCALE IN FEET (0, 50, 100) VERTICAL SCALE IN FEET (0, 10, 20)

NOTE:

SOUTHWEST STORMWATER POND TO BE OPTIMIZED IN FINAL DESIGN.

NOTE:

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Client Review Draft 5/15/2015

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PRINTED NAME CRISTIAN A. DIAZ
SIGNATURE
DATE 5/15/15 LICENSE# 46593

DRAWN: VJS
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

POLYMET MINING

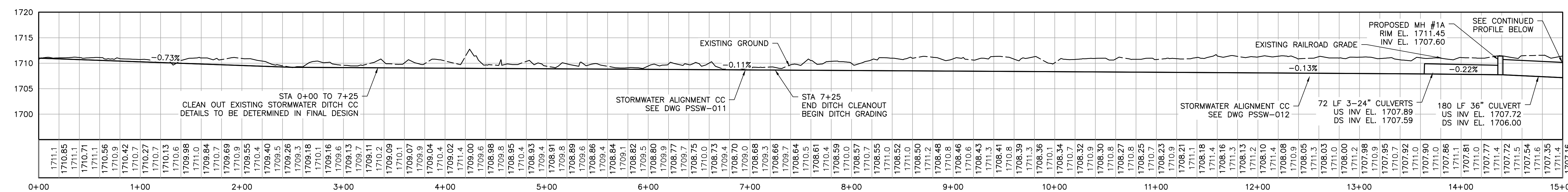
POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR
BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-024 REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-024.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 11:31 AM

INCHES 1 2



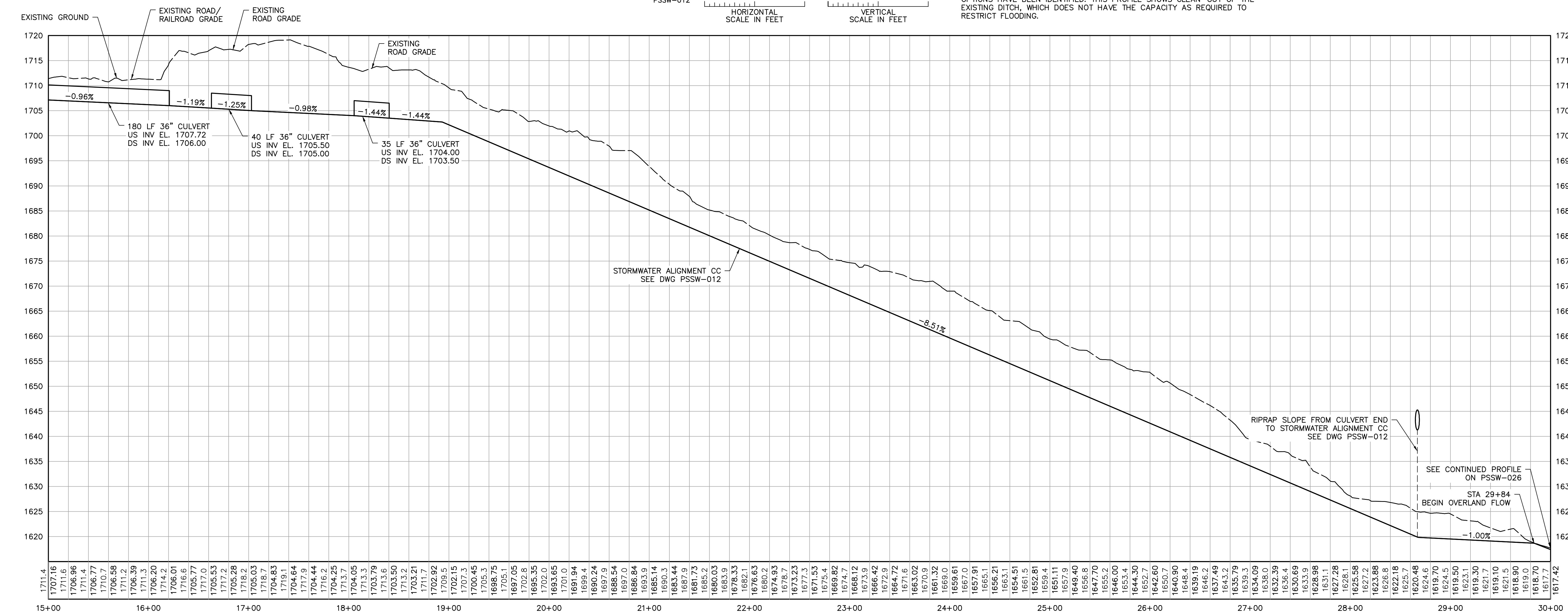
CC PROFILE: STORMWATER ALIGNMENT CC

PSSW-011 / PSSW-012

HORIZONTAL SCALE IN FEET (0, 50, 100) — VERTICAL SCALE IN FEET (0, 10, 20)

NOTE:

STORMWATER DITCH HAS CONSTRAINTS RESTRICTING CONSTRUCTION. DESIGN OPTIONS HAVE BEEN IDENTIFIED. THIS PROFILE SHOWS CLEAN-OUT OF THE EXISTING DITCH, WHICH DOES NOT HAVE THE CAPACITY AS REQUIRED TO RESTRICT FLOODING.



Client Review Draft 5/15/2015

CC PROFILE: STORMWATER ALIGNMENT CC

PSSW-012

HORIZONTAL SCALE IN FEET (0, 50, 100) — VERTICAL SCALE IN FEET (0, 10, 20)

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SIGNATURE

DATE 5/15/15 LICENSE# 46593

DRAWN: PRT

CHECKED: CMK2

BARR PROJECT NO.: 23/69-0C29

SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PROFILES

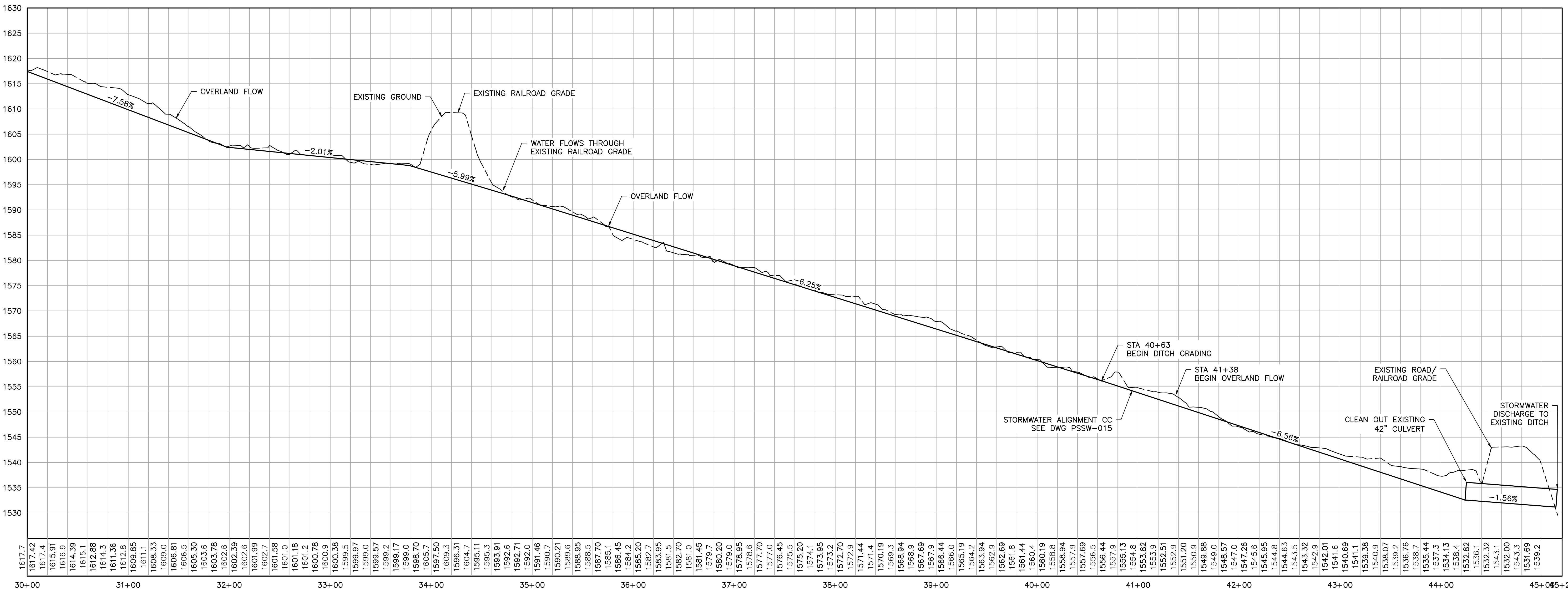
POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-025 REV

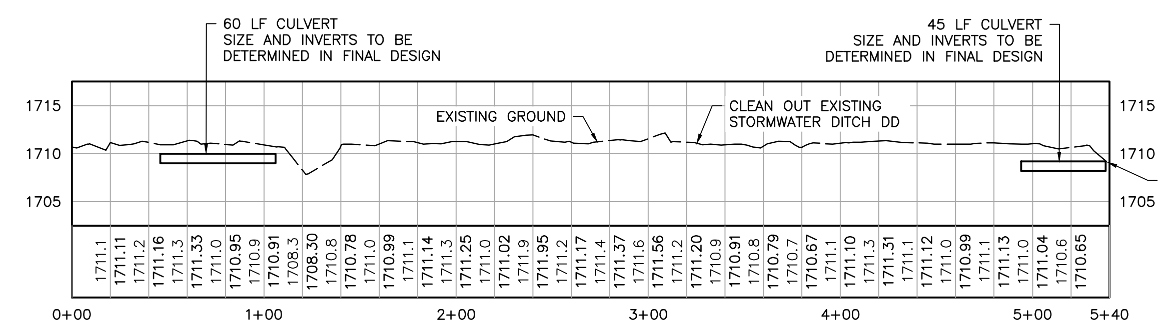
CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-025.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 11:33 AM

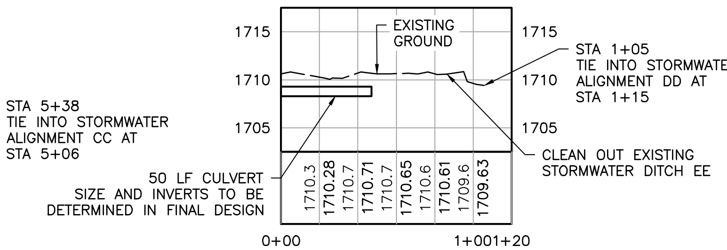
INCHES 1 2

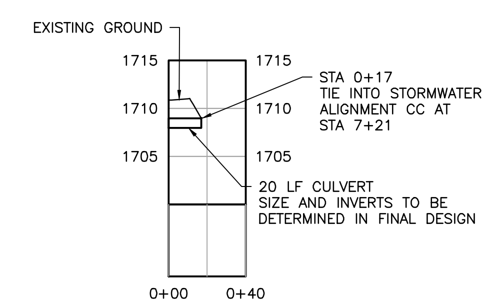


CC PSSW-015 PROFILE: STORMWATER ALIGNMENT CC

0 50 100 HORIZONTAL SCALE IN FEET — 0 10 20 VERTICAL SCALE IN FEET







DD PSSW-011 PROFILE: STORMWATER ALIGNMENT DD

0 50 100 HORIZONTAL SCALE IN FEET — 0 10 20 VERTICAL SCALE IN FEET

NOTE:

STORMWATER DITCH HAS CONSTRAINTS RESTRICTING CONSTRUCTION. DESIGN OPTIONS HAVE BEEN IDENTIFIED. THIS PROFILE SHOWS CLEAN-OUT OF THE EXISTING DITCH, WHICH DOES NOT HAVE THE CAPACITY AS REQUIRED TO RESTRICT FLOODING.

EE PSSW-011 PROFILE: STORMWATER ALIGNMENT EE

0 50 100 HORIZONTAL SCALE IN FEET — 0 10 20 VERTICAL SCALE IN FEET

NOTE:

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FF PSSW-011 PROFILE: STORMWATER ALIGNMENT FF

0 50 100 HORIZONTAL SCALE IN FEET — 0 10 20 VERTICAL SCALE IN FEET

NOTE:

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PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PROFILES

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

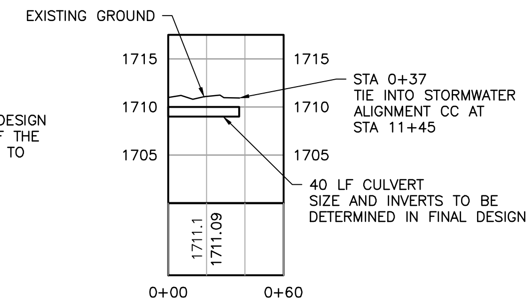
BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-026 REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-026.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 11:36 AM

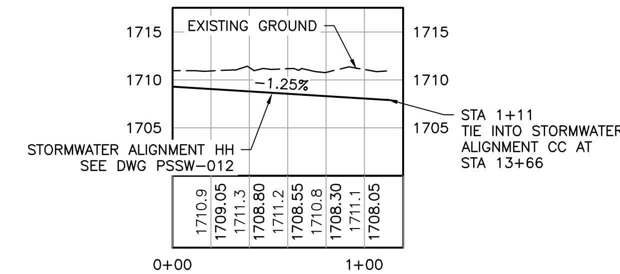
NOTE:

STORMWATER DITCH HAS CONSTRAINTS RESTRICTING CONSTRUCTION. DESIGN OPTIONS HAVE BEEN IDENTIFIED. THIS PROFILE SHOWS CLEAN-OUT OF THE EXISTING DITCH, WHICH DOES NOT HAVE THE CAPACITY AS REQUIRED TO RESTRICT FLOODING.



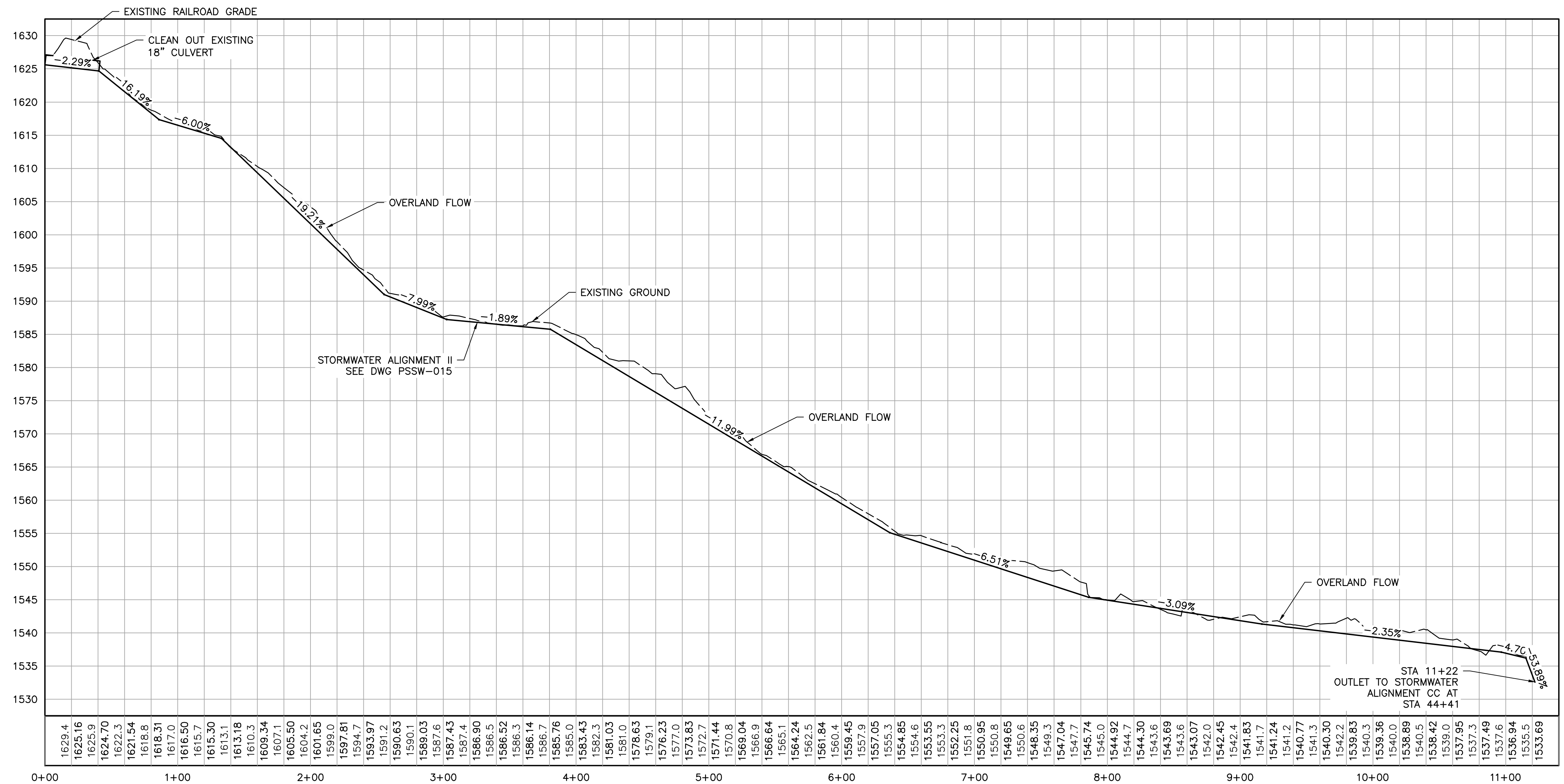
GG PSSW-012 PROFILE: STORMWATER ALIGNMENT GG

HORIZONTAL SCALE IN FEET 0 50 100 — VERTICAL SCALE IN FEET 0 10 20



HH PSSW-012 PROFILE: STORMWATER ALIGNMENT HH

HORIZONTAL SCALE IN FEET 0 50 100 — VERTICAL SCALE IN FEET 0 10 20



II PSSW-015 PROFILE: STORMWATER ALIGNMENT II

HORIZONTAL SCALE IN FEET 0 50 100 — VERTICAL SCALE IN FEET 0 10 20

NOTE:

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SCALE: AS SHOWN

POLYMET MINING

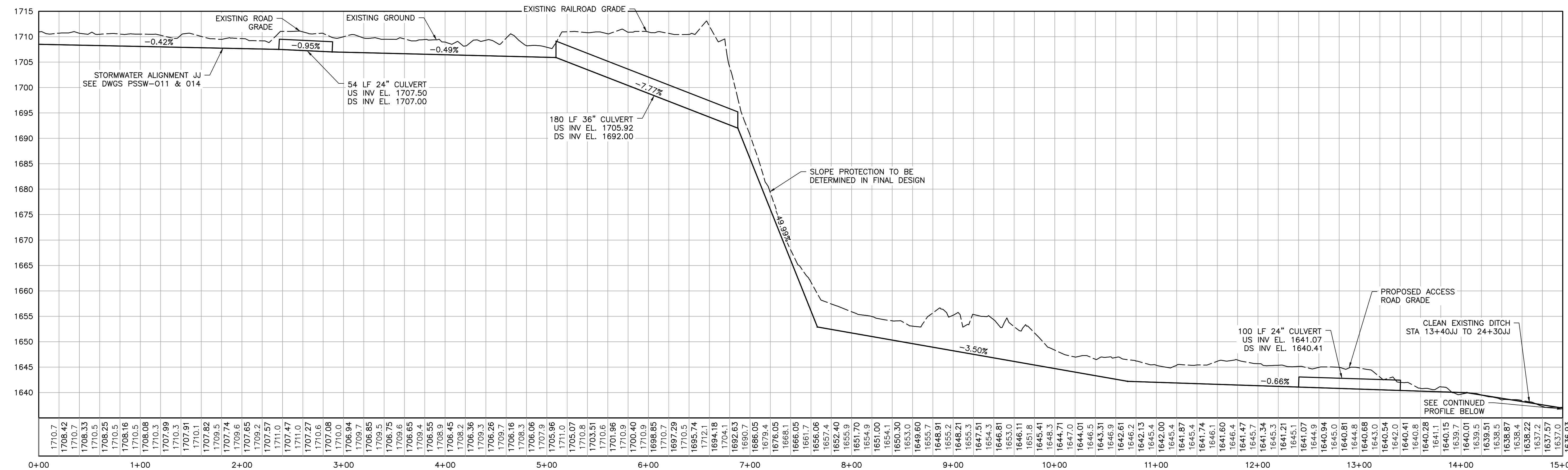
POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-027 REV

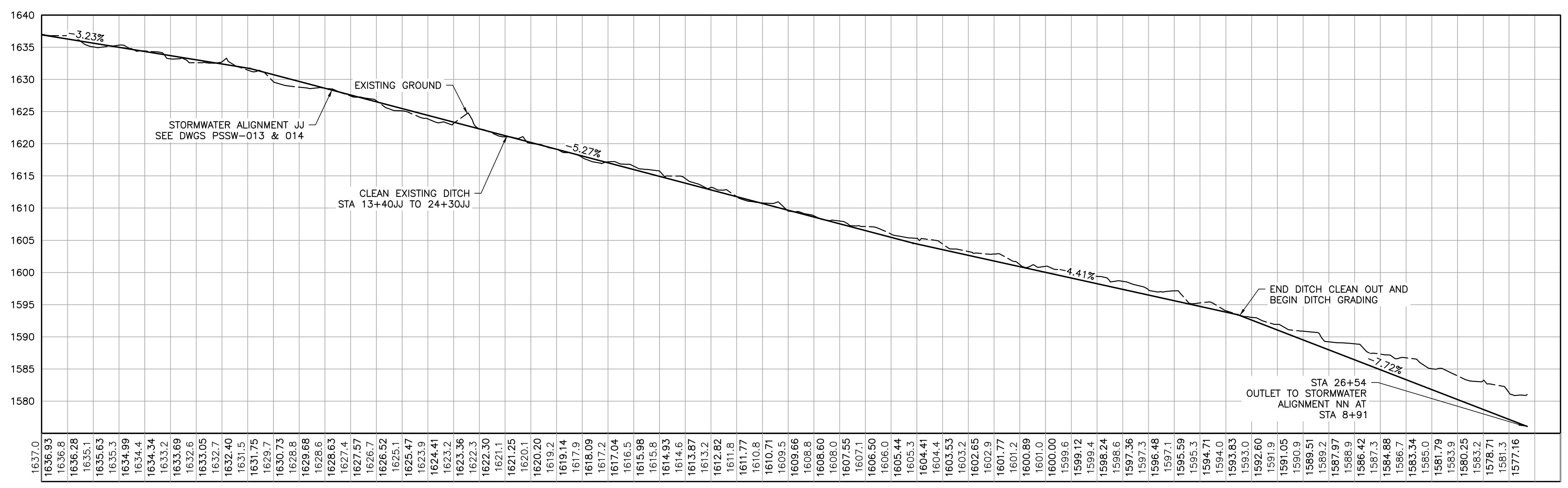
CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-027.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 11:39 AM

INCHES 1 2



JJ PSSW-011 PSSW-014 **PROFILE: STORMWATER ALIGNMENT JJ**

0 50 100 HORIZONTAL SCALE IN FEET — 0 10 20 VERTICAL SCALE IN FEET



JJ PSSW-013 PSSW-014 **PROFILE: STORMWATER ALIGNMENT JJ**

0 50 100 HORIZONTAL SCALE IN FEET — 0 10 20 VERTICAL SCALE IN FEET

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DRAWN: PRT
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR
BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-028 REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-028.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 11:43 AM

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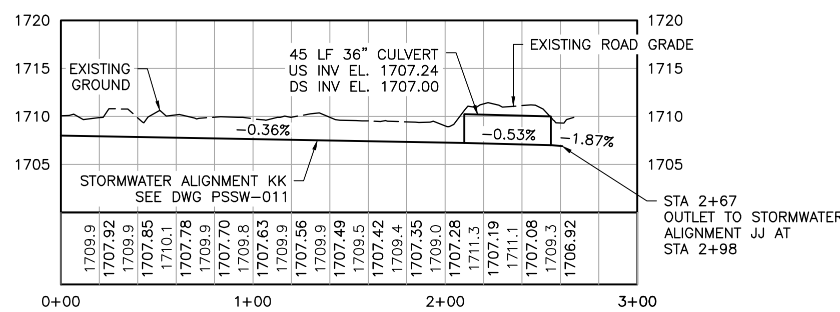
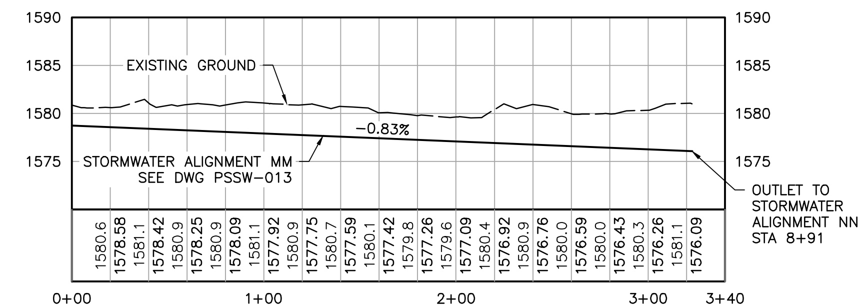


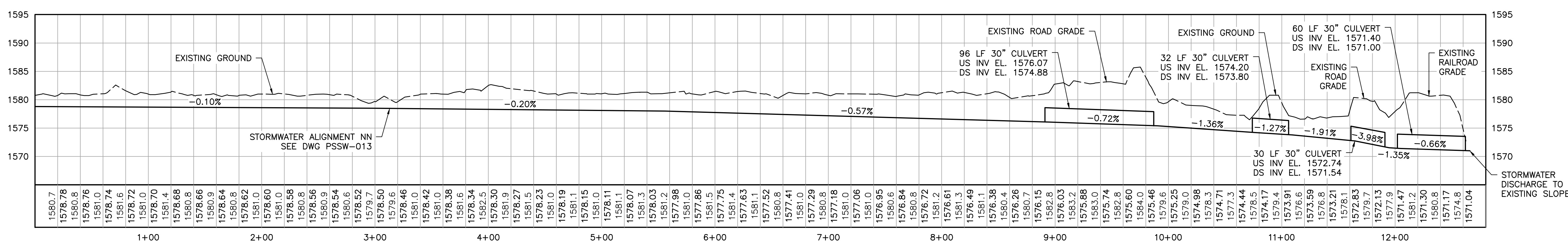
KK PSSW-011 **PROFILE: STORMWATER ALIGNMENT KK**

0 50 100 HORIZONTAL SCALE IN FEET — 0 10 20 VERTICAL SCALE IN FEET



MM PSSW-013 **PROFILE: STORMWATER ALIGNMENT MM**

0 50 100 HORIZONTAL SCALE IN FEET — 0 10 20 VERTICAL SCALE IN FEET



NN PSSW-013 **PROFILE: STORMWATER ALIGNMENT NN**

0 50 100 HORIZONTAL SCALE IN FEET — 0 10 20 VERTICAL SCALE IN FEET

NOTE:

ALL PIPES AND CULVERTS ARE PROPOSED UNLESS INDICATED.

Client Review Draft 5/15/2015

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PROFILES

VER NO	DATE	DESCRIPTION
1	5/15/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS

ISSUE STATUS		
ISSUED	VERSION	DATE
FOR PERMITTING	1	5/15/15
FOR CONSTRUCTION		
NOT APPROVED FOR CONSTRUCTION		

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PRINTED NAME CRISTIAN A. DIAZ
SIGNATURE
DATE 5/15/15 LICENSE# 46593

DRAWN: PRT
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

POLYMET MINING

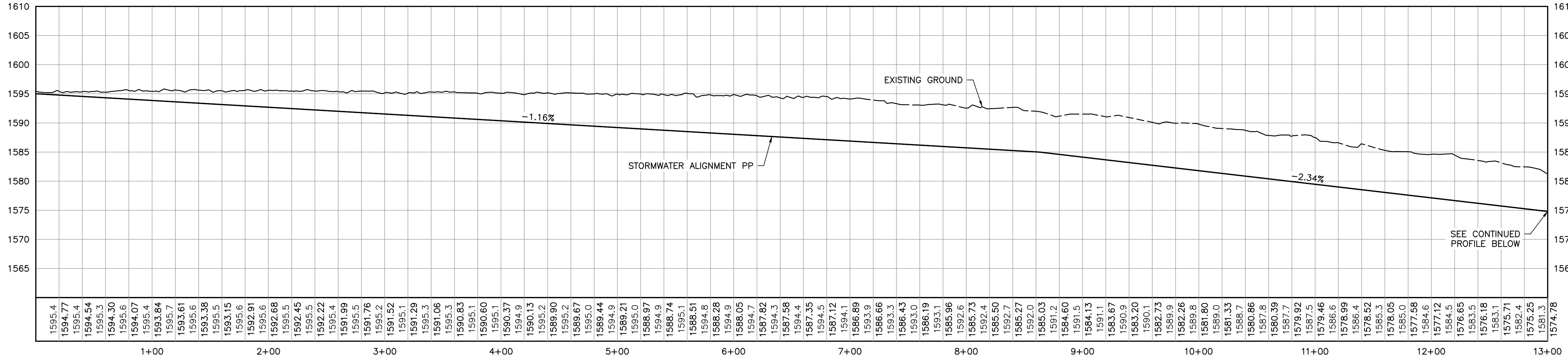
POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-029 REV

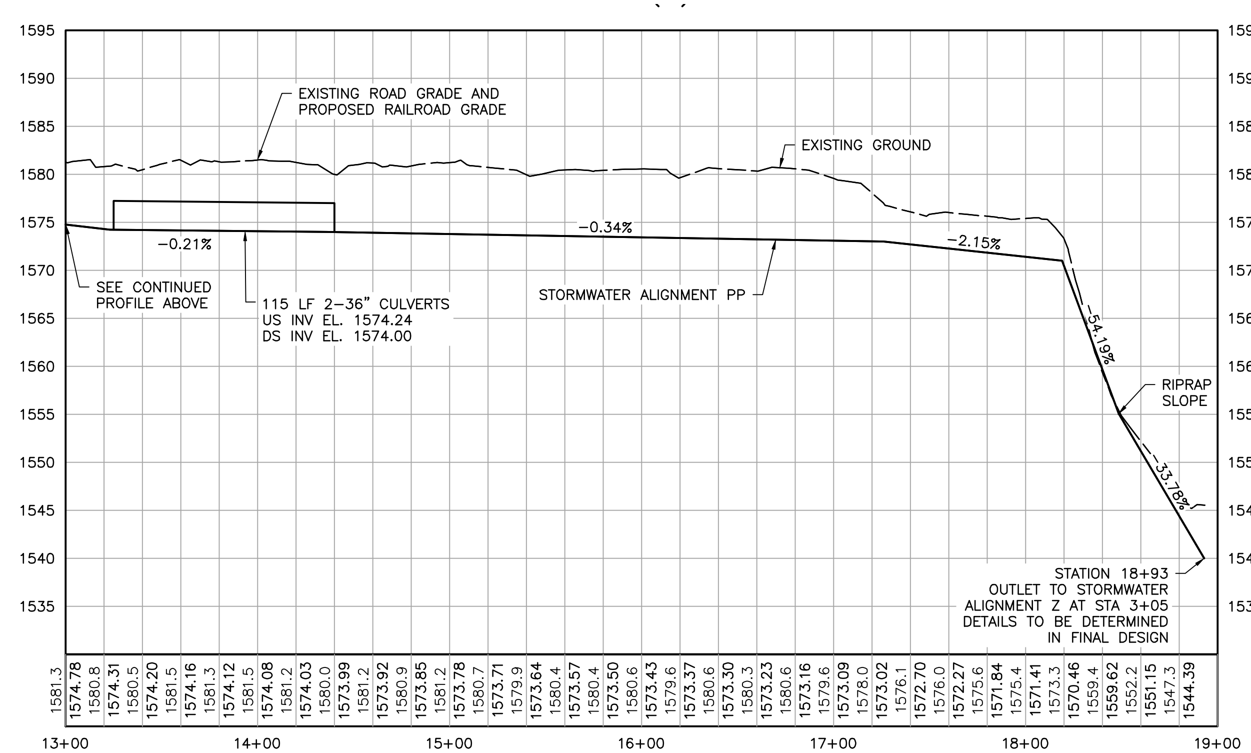
CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-029.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 11:45 AM

INCHES 1 2



PP PSSW-007 **PROFILE: STORMWATER ALIGNMENT PP**

0 50 100 HORIZONTAL SCALE IN FEET — 0 10 20 VERTICAL SCALE IN FEET



PP PSSW-008 **PROFILE: STORMWATER ALIGNMENT PP**

0 50 100 HORIZONTAL SCALE IN FEET — 0 10 20 VERTICAL SCALE IN FEET

NOTE:

ALL PIPES AND CULVERTS ARE PROPOSED UNLESS INDICATED.

Client Review Draft 5/15/2015

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			NOT APPROVED FOR CONSTRUCTION		

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SIGNATURE
DATE 5/15/15 LICENSE# 46593

DRAWN: PRT
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GRADING PROFILES

POLYMET MINING

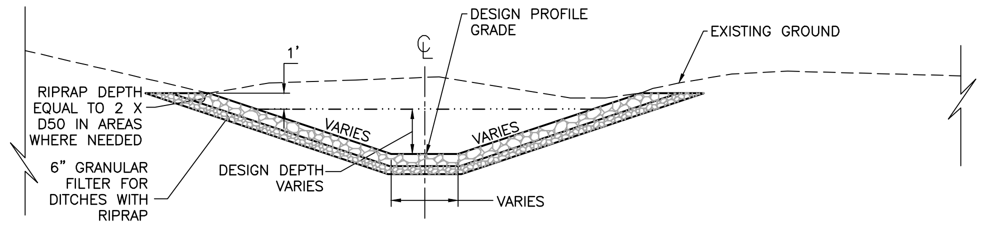
POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR
BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-030 REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-030.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 11:49 AM

INCHES 1 2

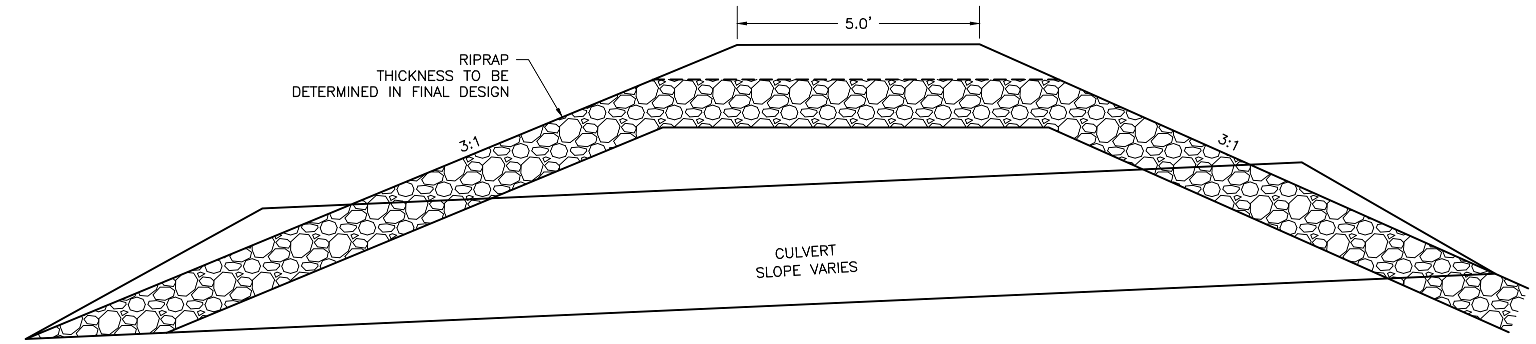


1 SECTION: TYPICAL DITCH

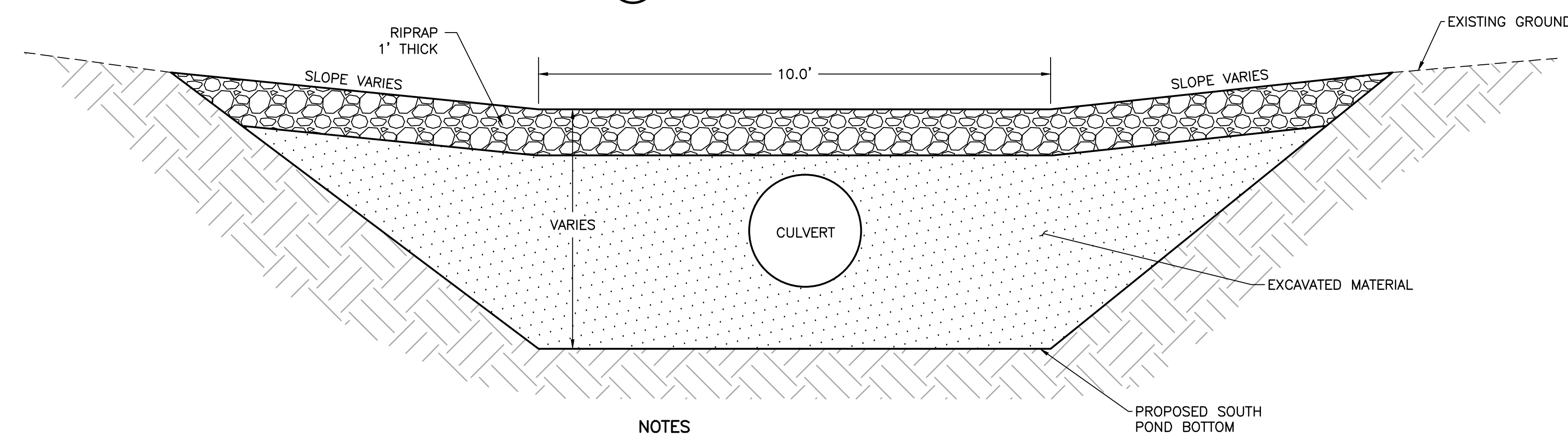
0 6 12
SCALE IN FEET

NOTES

1. DITCHES NOT REQUIRING RIPRAP WILL BE CONSTRUCTED WITH NATIVE SOILS AND 4" TOPSOIL TO DESIGN PROFILE GRADE.
2. DITCHES CONSTRUCTED IN BEDROCK WILL NOT REQUIRE RIPRAP OR TOPSOIL.
3. RESTORE ALL DISTURBED AREAS NOT STABILIZED WITH RIPRAP.
4. DITCH CROSS SECTIONS VARY. DETAILS WILL BE TABULATED IN FINAL DESIGN.
5. DITCHES THAT REQUIRE LARGE DIAMETER RIPRAP MAY REQUIRE AN ADDITIONAL LAYER BETWEEN THE RIPRAP AND THE GRANULAR FILTER, TO BE DETERMINED IN FINAL DESIGN.



A SECTION: OVERFLOW WEIR SIDE VIEW
NOT TO SCALE

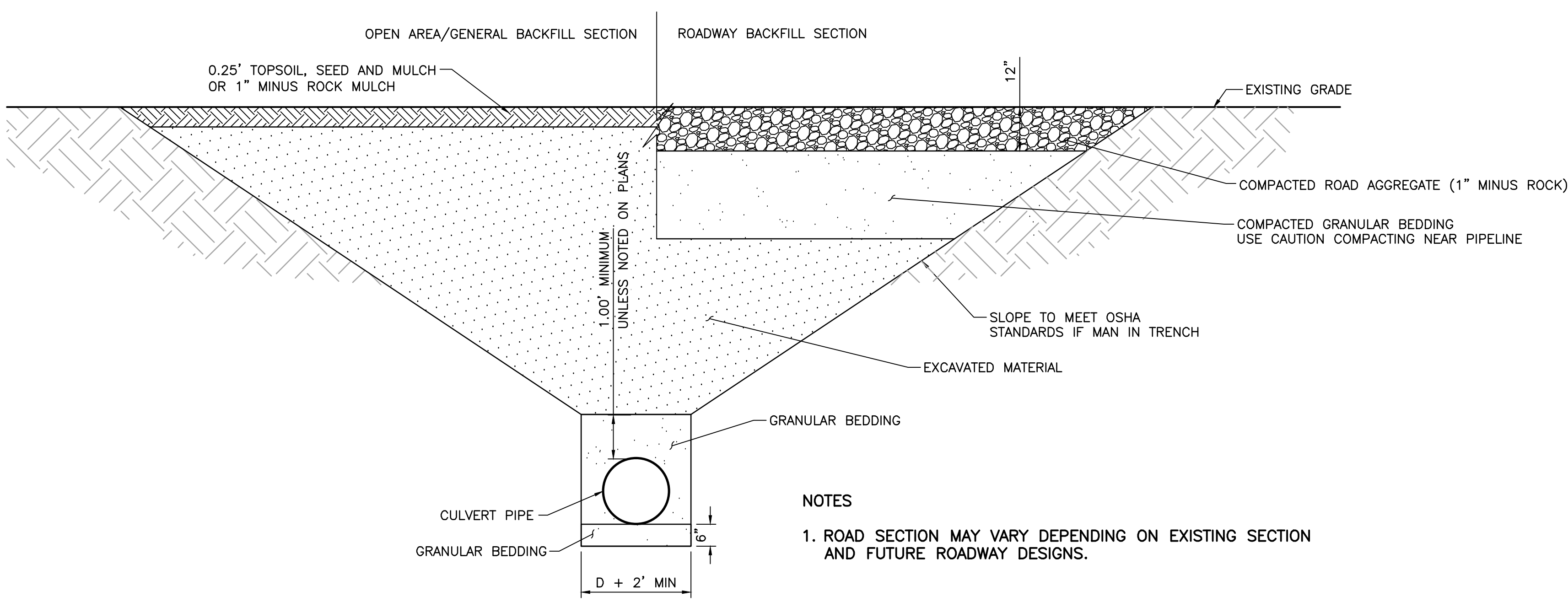


NOTES

1. WEIR CROSS SECTIONS VARY. DETAILS WILL BE TABULATED IN FINAL DESIGN.

B SECTION: OVERFLOW WEIR CROSS SECTION
NOT TO SCALE

3 DETAIL: SOUTH POND OVERFLOW WEIRS
PSSW-010,024 NOT TO SCALE



NOTES

1. ROAD SECTION MAY VARY DEPENDING ON EXISTING SECTION AND FUTURE ROADWAY DESIGNS.

2 SECTION: PIPELINE AND CULVERT TRENCH CONSTRUCTION

0 1 2 3 4
SCALE IN FEET

Client Review Draft 5/15/2015

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PRINTED NAME CRISTIAN A. DIAZ
SIGNATURE
DATE 5/15/15 LICENSE# 46593

DRAWN: VJS
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER SECTIONS AND DETAILS

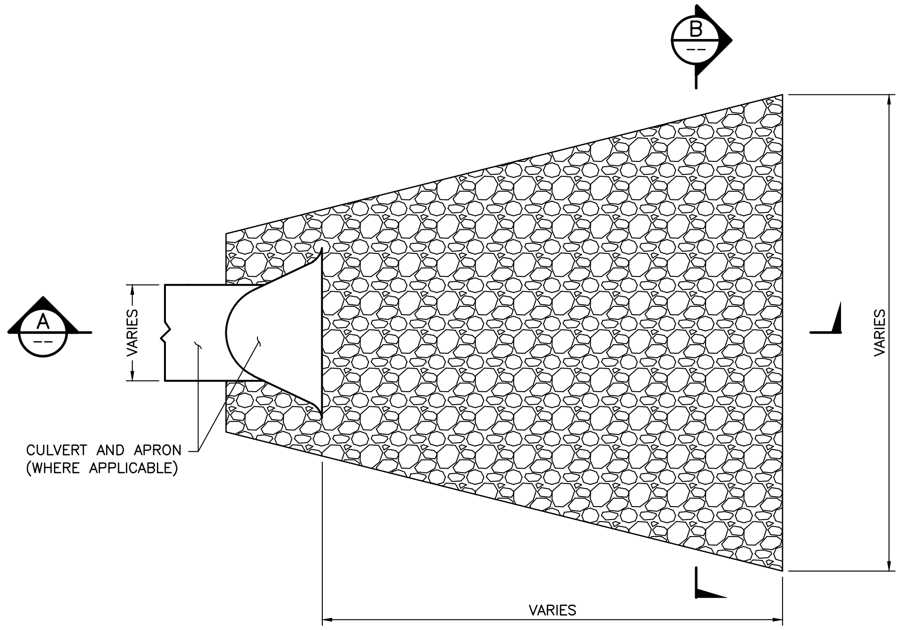
POLYMET MINING
POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR
BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

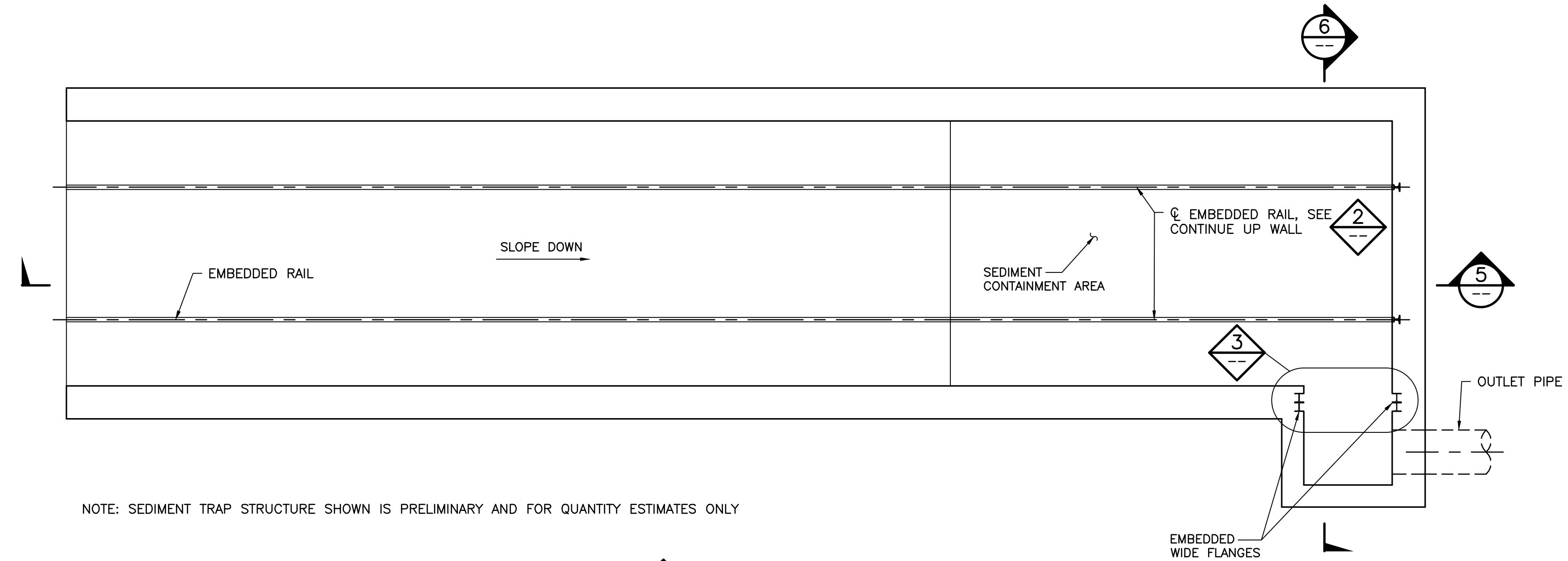
DWG. NO. PSSW-031
REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-031.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 11:50 AM

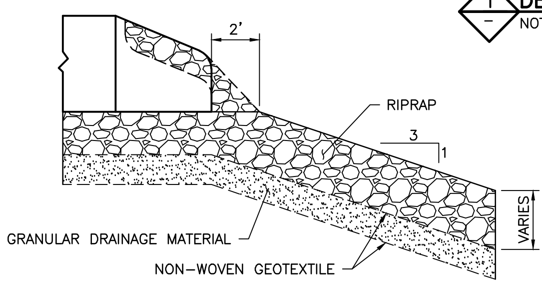
INCHES 1 2



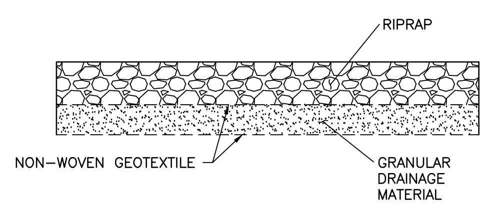
1 DETAIL: RIPRAP SLOPE
NOT TO SCALE



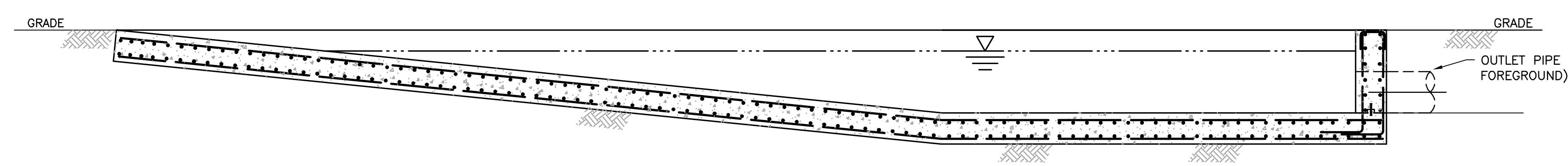
4 PLAN: SEDIMENT TRAP
PSSW-007
NOT TO SCALE



A SECTION: RIPRAP SLOPE
NOT TO SCALE



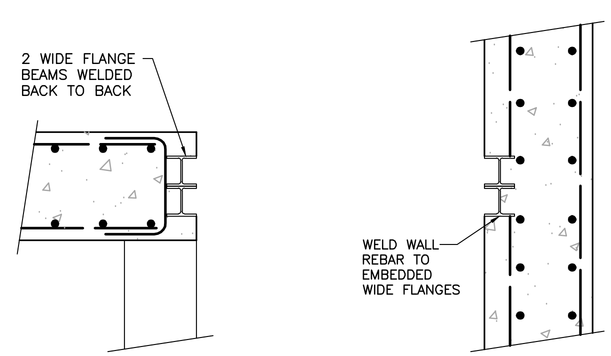
B SECTION: RIPRAP SLOPE
NOT TO SCALE



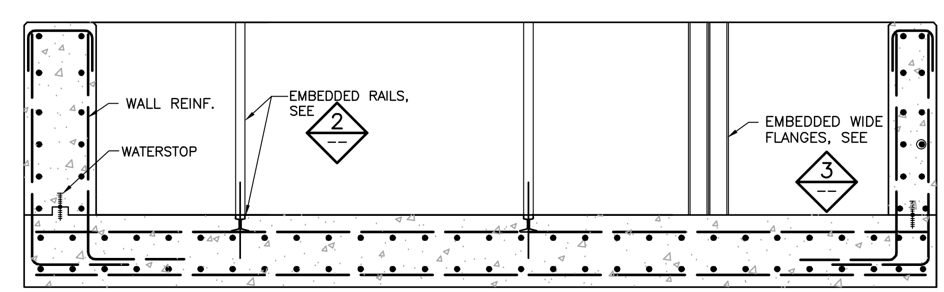
5 SECTION: SEDIMENT TRAP
NOT TO SCALE

NOTES:

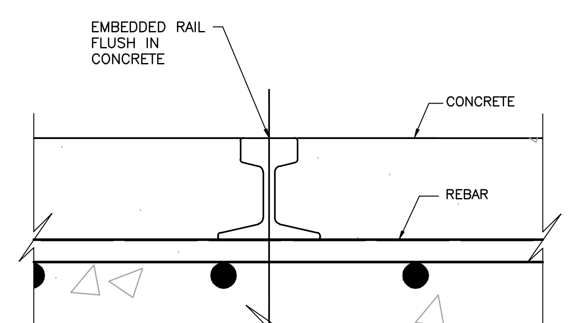
1. RIPRAP GRADATION BASED ON EXPECTED VELOCITIES FROM 10 YEAR 24-HOUR STORM EVENT.
2. RIPRAP DIMENSIONS AND CLASSES VARY. DETAILS WILL BE TABULATED IN FINAL DESIGN.
3. ALL CULVERT UPSTREAM AND DOWNSTREAM ENDS SHALL HAVE FLARED END SECTIONS.



3 DETAIL: EMBEDDED WIDE FLANGES
NOT TO SCALE



6 SECTION: SEDIMENT TRAP
NOT TO SCALE



2 DETAIL: EMBEDDED RAIL
NOT TO SCALE

Client Review Draft 5/15/2015

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER
SECTIONS AND DETAILS

VER NO	DATE	DESCRIPTION
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ISSUE STATUS		
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FOR PERMITTING	1	5/15/15
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NOT APPROVED FOR CONSTRUCTION		

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PRINTED NAME CRISTIAN A. DIAZ
SIGNATURE
DATE 5/15/15 LICENSE# 46593

DRAWN: VJS
CHECKED: CMK2
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

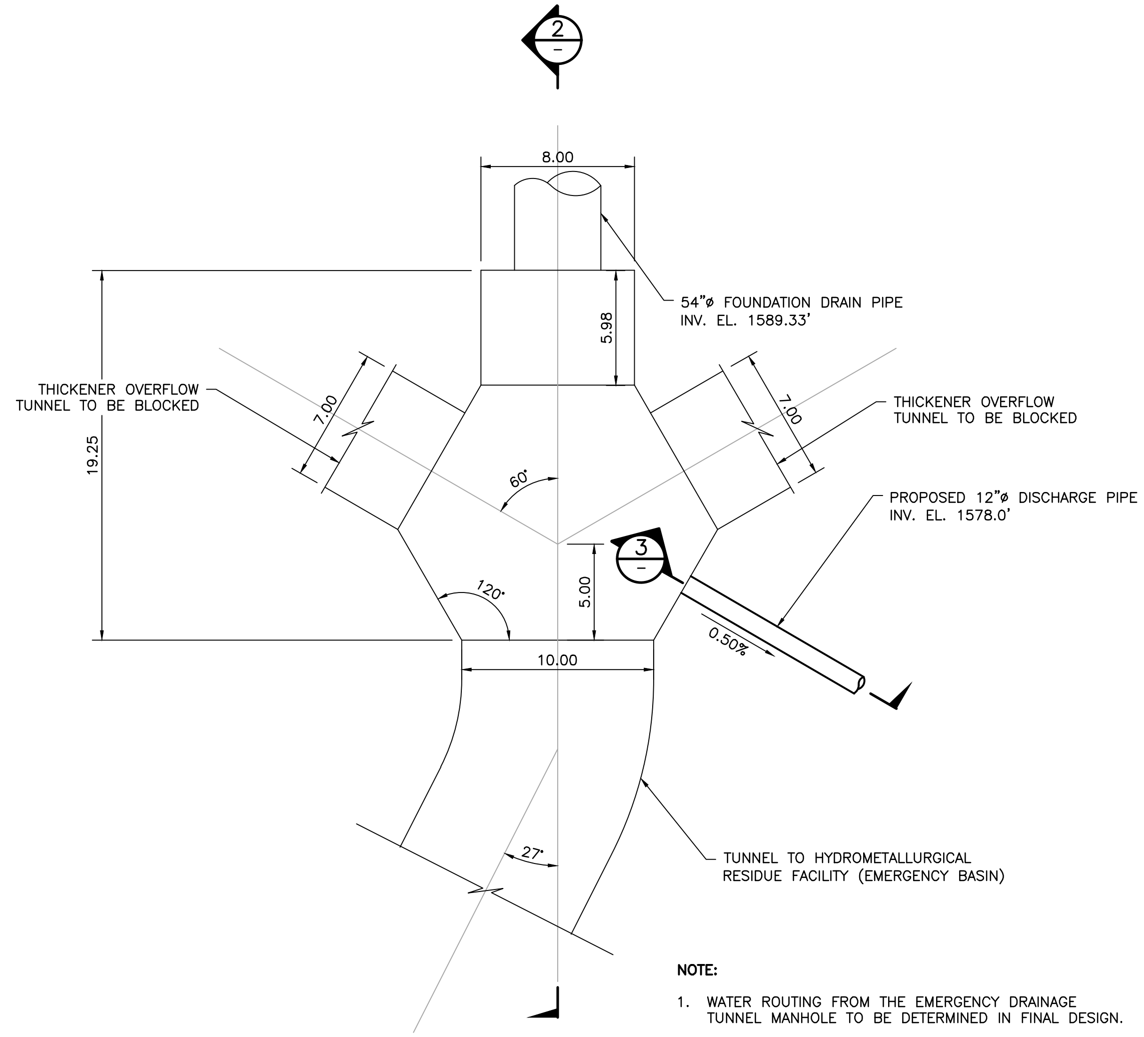
POLYMET MINING
POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR
BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-032
REV

CADD USER: Cristian A. Diaz FILE: K:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-032.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 11:51 AM

INCHES 1 2

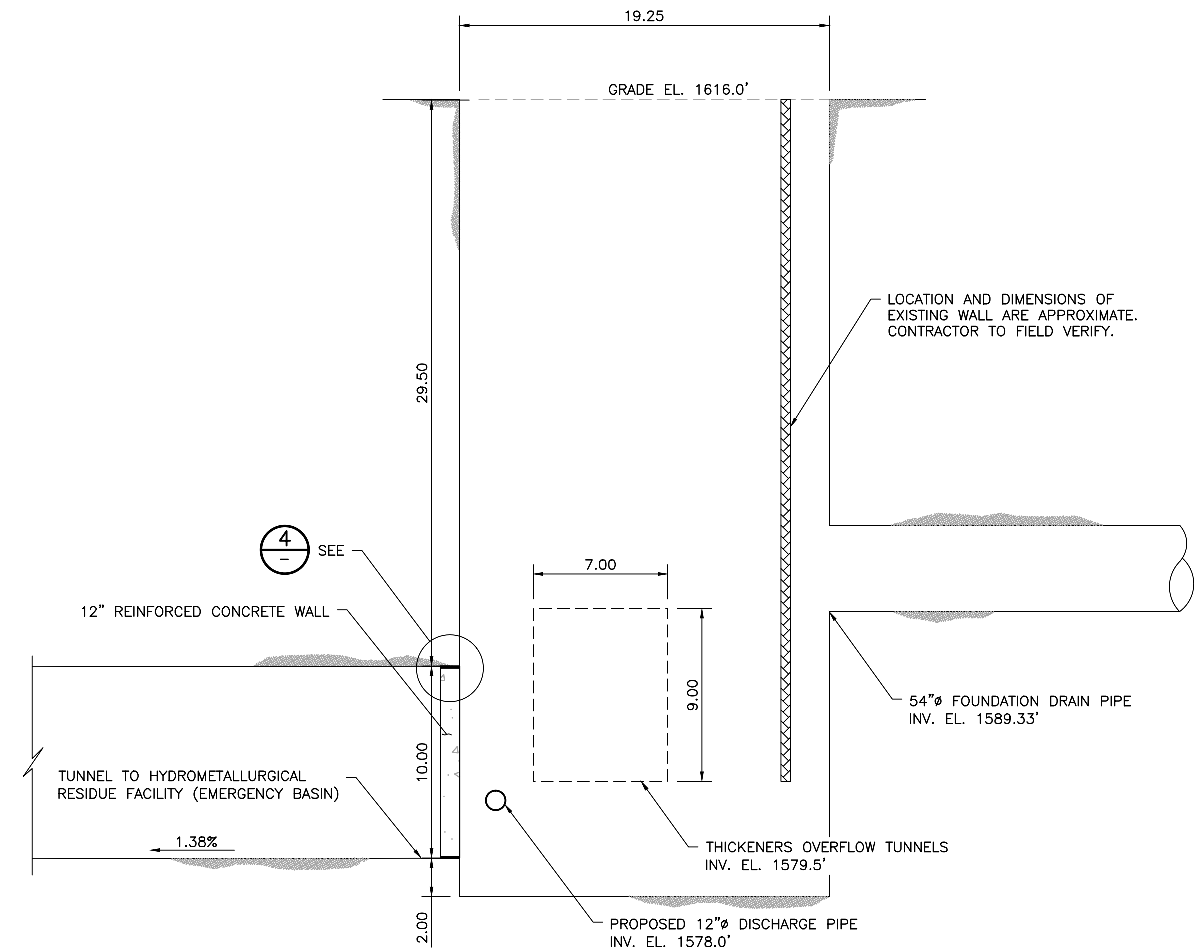


NOTE:

1. WATER ROUTING FROM THE EMERGENCY DRAINAGE TUNNEL MANHOLE TO BE DETERMINED IN FINAL DESIGN.

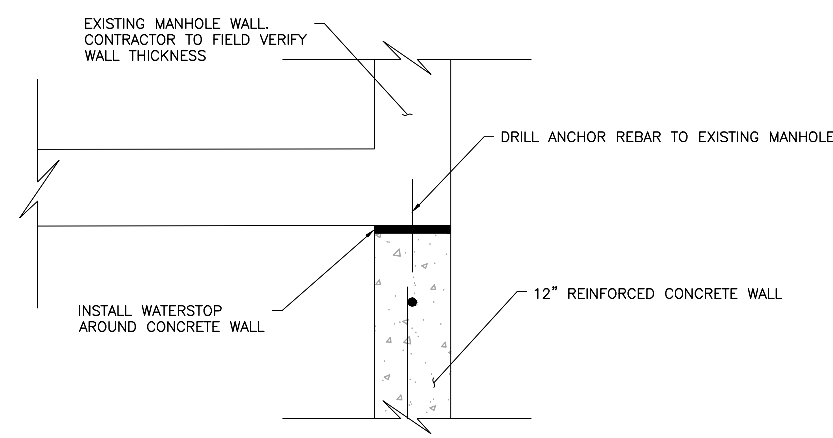
1 PSSW-005 PLAN: EXISTING EMERGENCY DRAINAGE TUNNELS AND MANHOLE

0 5 10 SCALE IN FEET

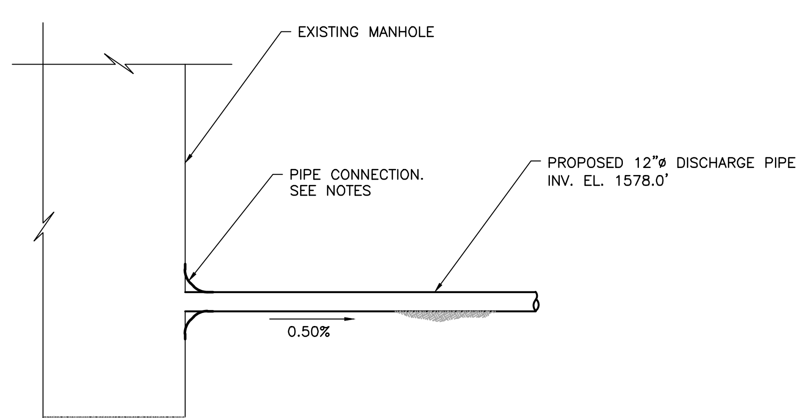


2 PSSW-005 SECTION: EXISTING EMERGENCY DRAINAGE TUNNELS AND MANHOLE

0 5 10 SCALE IN FEET



4 PSSW-005 SECTION: ANCHOR AND WATER STOP DETAIL (TYP.)
NOT TO SCALE



3 PSSW-005 SECTION: PROPOSED PIPE CONNECTION

0 5 10 SCALE IN FEET

NOTES:

1. DIMENSIONS SHOWN ARE BASED ON DRAWINGS TB-651, TB-679 AND TJ-63, APPROVED ON 08/06/54. ACTUAL DIMENSIONS MAY VARY.
2. CORE THROUGH EXISTING MANHOLE TO PROVIDE SPACE FOR PLACEMENT OF NEW PIPE.
3. CONTRACTOR TO PLACE WATERTIGHT CONNECTION BOOT.
4. BACKFILL SHALL BE PLACED WITH CARE OVER PIPE TO AVOID SETTLEMENT AND DISRUPTION TO THE CONNECTION WITH MANHOLE.

Client Review Draft 5/15/2015

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SIGNATURE
DATE 5/15/15 LICENSE# 46593

DRAWN: CMB2
CHECKED: CAD
BARR PROJECT NO.: 23/69-0C29
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

PLANT SITE STORMWATER GENERAL DWGS
EMERGENCY DRAINAGE TUNNEL MANHOLE
CONNECTION AND BLOCKAGE DETAILS

POLYMET MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

DWG. NO. PSSW-033 REV

INCHES 1 2
CADD USER: Cristian A. Diaz FILE: M:\DESIGN\23690C29.10\PERMIT_NMP-63-CS-033.DWG PLOT SCALE: 1:2 PLOT DATE: 5/15/2015 11:52 AM
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