NorthMet Dam Safety Permit Application

Hydrometallurgical Residue Facility

Prepared for Poly Met Mining, Inc.



July 2016



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Certifications

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.

Thomas J. Rachne_____ Thomas J. Badue

Thomas J. 🕅 adu PE #: 20951

July 11, 2016

Date

1.0 Introduction

This document constitutes an application for a Dam Safety Permit in the state of Minnesota for the NorthMet Project Hydrometallurgical Residue Facility (HRF). It provides the information required by Minnesota Rules, part 6115.0410 and the Minnesota Permitting and Reporting System (MPARS).

1.1 Project Description

Poly Met Mining, Inc. (PolyMet) is proposing to develop the NorthMet Project (Project) copper-nickelplatinum group elements mine and associated processing facilities. The Project is described in Section 1.1 of the NorthMet Mining Project and Land Exchange Final Environmental Impact Statement (FEIS) (Reference (1)). The Project is located south of the city of Babbitt and north of the city of Hoyt Lakes in St. Louis County, Minnesota, as shown on Large Figure 1. Existing infrastructure in the vicinity of the HRF is shown on Large Figure 2.

The Hydrometallurgical Plant, which will begin operations several years after mining commences, will generate up to approximately 313,000 tons of Residue annually, if the plant processes all the nickel flotation concentrate streams produced by the flotation process. Some nickel flotation concentrates may be sold directly, depending on customer requirements and project economics, in which case less Residue will be generated. The Residue will be a slurry of fine sand, silt, and clay-size particles, with individual particle diameter on the order of 0.5 millimeters or less. The slurry will be pumped from the Hydrometallurgical Plant to the HRF. Two additional wastes, consisting of relatively minor amounts of coal ash to be relocated from a closed on-site Coal Ash Landfill, and water treatment plant residue, also will be disposed of in the HRF.

The HRF will be one double-lined cell with geomembrane and geosynthetic clay liners. The Residue will settle out within the HRF and decanted water will be pumped back to the Hydrometallurgical Plant for reuse as process water. The slurry discharge will be configured such that the discharge point into the cell periodically can be adjusted (vertically and horizontally) to distribute Residue uniformly within the cell. Water will be lost from this closed loop system to evaporation from the cell surface and entrapment within the Residue's pore space. No leakage through the HRF double liner system is expected. Precipitation falling within the HRF will be retained. The HRF liner and dams will be constructed in increments (stages) to allow for Residue deposition for the life of the cell (approximately 17 to 18 years) after which the cell will be closed with a temporary and then a final cover system. This permit application covers all planned increments of HRF construction. For further description of HRF staging, see Section 2.2.1 of the Residue Management Plan (Reference (2)).

The Minnesota Department of Natural Resources (MDNR) has not yet classified the proposed Hydrometallurgical Residue Facility dams, but it is anticipated that they will be classified as Class II dams. The HRF dams have been designed to achieve necessary factors of safety (Geotechnical Data Package – Volume 2, [Reference (3)). However, if an HRF dam failure were to occur, consequences will be primarily environmental. The site is generally remotely located from any public roadways or utilities, it is separated from proposed Project infrastructure by natural high ground, and its design is such that even if a failure occurred, nearby rail embankments would likely be unaffected due to their location and configuration relative to proposed HRF dams (Section 3.5).

1.2 Definitions and Terms

In this document, the Hydrometallurgical Residue Facility (HRF) refers to the proposed NorthMet HRF impoundment. Residue is the slurry of fine sand, silt and clay-sized particles left over after nickel flotation concentrate streams are processed at the Hydrometallurgical Plant.

1.3 Dam Safety Permit Application Structure

The content requirements for this HRF Dam Safety Permit Application are summarized in Large Table 1, which is described further in Section 2.0. The majority of the required HRF Dam Safety Permit Application documentation and information was prepared to support the Project EIS process, has undergone extensive MDNR review and peer review, and is therefore already in the MDNR files and the public record. So as not to re-produce existing information, the approach for this application is to communicate where required application information can be found; requirements that are already met in other documentation are referenced in Large Table 1, as further described in Section 2.0. Any components not previously developed are presented in the subsequent sections of this application, as referenced in Large Table 1.

2.0 Permit Application Requirements

The requirements for Dam Safety Permit applications in Minnesota are laid out in Minnesota Rules, part 6115.0410 and the Minnesota Permitting and Reporting System (MPARS) application. Large Table 1 summarizes each requirement, provides the regulatory citation, and identifies the document which contains the information. Table 2-1 describes the configuration of Large Table 1.

Table 2-1 Dam Safety Permit Application Correlation Table (Large Table 1) Format Summary

Section	Citation	Requirement	Document	Section and Page Number
 Large Table 1 is divided into the five primary permit application content sections required by Minnesota Rules, part 6115.0410: General Permit Application Preliminary Design Report Final Design Report Plans and Specifications Permit Standards 	Provides the citation for the Minnesota Rules in which the permit application content requirement is stated.	Provides a synopsis of required permit application content.	Identifies the document currently on file with the MDNR and in the public record in which the required permit application content is presented.	Identifies the Section and Page Number of the document in which the required permit application content is presented.

Note: This HRF Dam Safety Permit Application consists of the content provided within this written document, and in the sections and on the pages of the documents referenced in Large Table 1

The MPARS application has previously been submitted as part of the Wetland Permit Application (Reference (4)) and to avoid duplication the MPARS application is not repeated herein.

3.0 Permit Application Supporting Content

The sections and pages of the documents referenced in Large Table 1 in aggregate constitute the majority of the HRF Dam Safety Permit Application. Additional application content not previously submitted to the MDNR is presented in the following subsections.

3.1 General Permit Application

The items required under the General Permit Application have been previously submitted to the MDNR and are referenced in Large Table 1.

3.2 Preliminary Design Report

Most items required under the Preliminary Design Report have been previously submitted to the MDNR and are referenced in Large Table 1. The following subsections present additional application information not previously submitted to the MDNR.

3.2.1 Preliminary Cost Estimate

Per Minnesota Rules, part 6115.0520, MDNR Dam Inspection Fees paid by PolyMet will be based on estimated costs of dam construction. At the end of each stage of construction, and in any case at intervals not exceeding five years in duration, PolyMet will file an affidavit of actual costs for each stage of construction. In cases where actual construction costs exceed estimates, PolyMet will pay the associated Inspection Fee difference. The initial Inspection Fee shall be based on the estimated initial year cost of dam construction, provided as Large Table 2.

The dam construction reflected by the estimated costs presented in Large Table 2 will be initiated a year or more following initiation of HRF site preparation activities, consisting of area preload construction for HRF foundation improvement. It is anticipated that the Dam Inspection Fee will not apply during the years of area preload construction, and that PolyMet will first be subject to Dam Inspection Fees in the year in which the initial phase of HRF dam and liner construction is initiated, because that will be the point in time at which the dams are constructed and first have the capability to retain water. Portions of the HRF construction costs unrelated to Residue containment and dam stability are excluded from the computation of Dam Inspection Fees and are noted as such on Large Table 2 and/or excluded from Large Table 2 in their entirety (e.g., preload and Residue discharge pipeline).

3.2.2 Ancillary Features

Some features that will be co-located with the HRF do not serve a Residue containment function and therefore are ancillary to overall dam safety permitting. Ancillary features and their general function and location are summarized in Table 3-1. Ancillary features are shown on the Permit Application Support Drawings incorporated as Attachment A of this permit application.

Table 0 1 Tryatometallorgical Residue Facility Allemary Features
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Item	Location	Function
Seepage Collection Drain	Along Toe of Slope of Interface of Cell 2W South Dam with HRF	Collection of Cell 2W Toe-of-Slope Seepage to Prevent Hydraulic Head Build-Up and Potential Uplift of HRF Liner Prior to Filling HRF for Initial Operations
Preload Lifts 1 through 5	Former LTV Steel Mining Company (LTVSMC) Emergency Basin Area	Preconsolidation of Existing LTVSMC Tailings to Improve HRF Foundation Prior to HRF Liner Construction; To Minimize Future HRF Liner Differential Settlement and Liner Strain
Residue Discharge Pipeline	North Side of HRF	Transport of Residue Slurry from Hydrometallurgical Plant to HRF
Process Water Transfer Pump Raft and Return Pipeline	North Side of HRF	Return of Process Water from HRF to Hydrometallurgical Plant
Residue Discharge Pipeline	Interior Side of HRF Perimeter Dam	Transport of Residue to Discharge on Perimeter of HRF
Access Roads	Crest of HRF Dam	Provide Vehicle Access onto Crest of HRF Dams

Note: Items noted in the table above are shown in the Permit Application Support Drawings provided in Attachment A to this Permit Application.

3.3 Final Design Report

Most items required under the Final Design Report have been previously submitted to the MDNR and are referenced in Large Table 1. The following subsections present additional application information not previously submitted to the MDNR.

3.3.1 Borrow and Aggregate Locations and Volumes

The borrow materials and aggregates required for HRF construction and closure are listed in Table 3-2, including estimated quantities and planned borrow locations.

Table 3-2 Borrow and Aggregate Locations and Volumes

Borrow Type and Use	Estimated Quantity	When Used	Planned Borrow Locations
Granular Filter Material for Preload Subgrade	121,000 Cubic Yards	HRF Site Preparation	PolyMet Discretion
Granular Drainage Material for Drainage Collection System	312,000 Cubic Yards	HRF Construction	PolyMet Discretion
Blast Rock for Preload	329,000 Cubic Yards	HRF Site Preparation	On-Site Bedrock Removal for HRF Construction
18" Minus Rock for Drainage Collection System	96,000 Cubic Yards	HRF Construction	PolyMet Discretion
1" Minus Rock for Drainage Collection System	315,000 Cubic Yards	HRF Construction	PolyMet Discretion
Bulk Tailings Borrow for HRF Perimeter Dams	1,647,000 Cubic Yards	HRF Construction	Tailings Basin Cell 1E/2E Dam, Cell 2W Dam,
Import Borrow for HRF Perimeter Dams and HRF Cover System	2,727,000 Cubic Yards	HRF Construction and Closure	PolyMet Discretion
Topsoil for HRF Perimeter Dams and HRF Cover System	264,000 Cubic Yards	HRF Construction and Closure	HRF Footprint Area Salvage and PolyMet Discretion
Class II Riprap for HRF Cover System	800 Cubic Yards	HRF Closure	PolyMet Discretion

Note: Material quantities listed above are approximate based on designs presented in the Permit Application Support Drawings provided in Attachment A to this Permit Application. Planned borrow locations listed are for cost estimate purposes; borrow locations will be refined based on additional data collected prior to construction.

3.3.2 Detailed Cost Estimate

A detailed cost estimate for the initial year of HRF liner construction is provided as Large Table 2. The cost estimate provides:

- a listing of each of the construction materials required for the initial year of HRF liner construction
- the unit of measure and quantity for each construction material
- an estimate of unit price for each construction material, based on evaluation of unit pricing provided by independent construction contractors
- the cost estimate extension
- comments providing additional context for the cost estimates

The detailed estimate is expected to serve as the basis for the first annual Dam Inspection Fee due from PolyMet to the MDNR. As noted in Section 3.2.1, it is anticipated that MDNR annual Inspection Fees for the HRF will initiate upon construction of the HRF liner system, which in turn is anticipated to begin the year following completion of preload construction. Estimates will subsequently be replaced by actual costs incurred at the time of construction. Some material types are included in Large Table 2 with quantities of

zero, because they will be used in future years but not the initial year of HRF construction. Quantities for these materials will be added at the time of the applicable cost estimate update.

3.4 Plans and Specifications

As previously noted, HRF Permit Application Support Drawings are provided in Attachment A. Attachment B provides construction specifications for HRF construction. The construction specifications have been prepared absent a final decision by PolyMet on project implementation approach (e.g., Design-Bid-Build, Engineer-Procure-Construct). Construction specifications will be updated as deemed appropriate by PolyMet once project permits are received and a project implementation approach selected.

3.5 Dam Break Analysis

The HRF dams have been designed to achieve necessary factors of safety (Geotechnical Data Package – Volume II, (Reference (3)), so a dam break is unlikely. A dam break analysis was completed to fulfill dam safety permitting requirements, and is included as Attachment C. No plausible HRF dam failure scenarios were identified. PolyMet has prepared a Contingency Action Plan for the HRF (Attachment K of Reference (2)) which supports the safe operation of the HRF dams by defining responsibilities and providing procedures for identifying and responding to unexpected and potentially hazardous conditions threatening the integrity and performance of the HRF.

3.6 Permit Standards

The items required under Permit Standards have been previously submitted to the MDNR and are referenced in Large Table 1.

4.0 References

1. Minnesota Department of Natural Resources, U.S. Army Corps of Engineers and United States Forest Service. Final Environmental Impact Statement: NorthMet Mining Project and Land Exchange. November 2015.

2. Poly Met Mining Inc. NorthMet Project Residue Management Plan (v5). July 2016.

3. —. NorthMet Project Geotechnical Data Package Vol 2 - Hydrometallurgical Residue Facility (v6). July 2016.

4. —. NorthMet Project Wetland Permit Application (v2). August 19, 2013.

5. —. NorthMet Project Project Description (v9). February 2015.

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

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

8. —. NorthMet Project Waste Characterization Data Package (v12). February 2015.

9. —. NorthMet Project Air Quality Management Plan - Plant (v7). December 2014.

10. **Foth Infrastructure and Environmental, LLC.** Permit to Mine Application. Prepared for Poly Met Mining Inc. NorthMet Project. estimated submittal August 2016.

11. Poly Met Mining Inc. NorthMet Project Flotation Tailings Management Plan (v6). July 2016.

Large Tables

Large Table 1 Hydrometallurgical Residue Facility Dam Safety Permit Requirements: Correlation Table

Subsection of Minnesota Rules				
Part 6115.0410(-)		Rule Requirement ⁽³⁾	Document ^(*)	Document Section and Page Number ⁽³⁾
	6115.0410 (2)(B)	Purpose	(Reference (2))	Section 1.0, pages 2-3.
	MPARS Application	Project purpose and need.	Final Environmental Impact Statement (Reference (1))	Section 1.3 (Overall Project), pages 11-13 of Section 1
			Residue Management Plan - Hydrometallurgical Residue Facility (Reference (2))	Section 1.0 (Hydrometallurgical Residue Facility), pages 2-3
	6115.0410 (2)(C)	Location, type, size, and height of the dam.	Residue Management Plan - Hydrometallurgical Residue Facility (Reference (2))	Section 2.2, pages 7-10
General Permit Application	6115.0410 (2)(D)	Storage capacity of impoundment.	Residue Management Plan - Hydrometallurgical Residue Facility (Reference (2))	Table 2-2, page 8
		Project description, including a description of all project elements that effect aquatic resources (wetlands, streams, etc.).	NorthMet Project Description (Reference (5))	Section 4.3.7, pages 62-63 and Section 4.4.3.2, page 75
	MPARS Application	Plans and cross-section or profile drawings showing the location, character,	Dam Safety Permit Application	Appendix A
		and dimensions of all proposed activities and aquatic resource impacts.	Wetland Data Package (Reference (6))	Large Figure 10 and Large Figure 25
		Description of direct or indirect impacts to aquatic resources.	Wetland Data Package (Reference (6))	Sections 5.1.6 and 5.2.2, pages 21, 48-56
	6115.0410 (3)(A)	A general statement setting forth the effect on the environment.	Final Environmental Impact Statement (Reference (1))	Section 4.0, page 1 of Section 4
	6115.0410 (3)(B)	Maps showing the location of county, township, and section lines; the	Dam Safety Permit Application	Large Figure 1, Large Figure 2
		outline of the impoundments; the location of state, county, and township		
		roads; the locations of utilities, e.g., pipelines, transmission, telegraph, and		
		telephone lines; the topography; and other structure or facilities including		
		dwellings affected by the proposed dam.		
	6115.0410 (3)(C)	A report of surface conditions, i.e., geology, topography.	Water Modeling Data Package - Plant Site (Reference (7))	Section 4.3, pages 14-16
	6115.0410 (3)(D)	Typical cross-sections of the dam accurately showing elevations, proposed impoundment levels and top width.	Dam Safety Permit Application – HRF Permit Application Support Drawings	Attachment A
		Logs of borings in the foundation and in the borrow areas.	Geotechnical Data Package Vol 2 - Hydrometallurgical Residue Facility (Reference (3))	Attachment B
	6115.0410 (3)(E)	Results of seismic and resistivity subsurface investigations, when they are readily available.	Reports are not readily available, therefore this requirements is not application	ble.
Preliminary Design Report	6115.0410 (3)(F)	Preliminary design assumptions, operational aspects, tentative conclusions	Geotechnical Data Package Vol 2 - Hydrometallurgical Residue Facility	Sections 4.0 through 6.0
		and references. The design assumptions shall pertain to such hydrologic	(Reference (3))	
		features as drainage area, rainfall data, runoff, inflow, area-capacity-		
		elevation data, and flood routing, in addition to structural, geologic, and		
		geotechnical assumptions.		
	6115.0410 (3)(G)	A preliminary cost estimate.	Dam Safety Permit Application	Large Table 2
	6115.0410 (3)(H)	Future plans on ultimate project size including dams and impoundments.	Dam Safety Permit Application – HRF Permit Application Support Drawings	Attachment A
	6115.0410 (3)(I)	A general description of all other activities and elements related to and		
		part of the total dam project, such as operational plans and details of		
		smaller dams, dikes, diversions, reclaim water facilities, and other facility	Dam Safety Dermit Application for UDE	Table 2.1
		and utility lines including pipelines, roads and railroads. The report shall		
		identify each element or activity of the total dam project which would		
		require a permit under the provisions of parts 6115.0150 to 6115.0260.		

Subsection of Minnesota Rules				
Part 6115.0410 ⁽¹⁾	Rule Citation ⁽²⁾	Rule Requirement ⁽³⁾	Document ⁽⁴⁾	Document Section and Page Number ⁽⁵⁾
		General description of the project, such as its service life, production rates, required storage and area(s).	Residue Management Plan - Hydrometallurgical Residue Facility (Reference (2))	Section 1.0, pages 2-3
		Geological considerations such as physiography, topography, geology, seismicity and groundwater conditions.	Geotechnical Data Package Vol 2 - Hydrometallurgical Residue Facility (Reference (3)	Section 3.2, pages 6-11
		Hydrologic Studies such as:		
		physical features, climatology	Water Modeling Data Package - Plant Site (Reference (7))	Sections 4.1 and 4.2, pages 13-14
		design storm and design flood characteristics, flood routing	Dam Safety Permit Application	Section 3.5, page 5
		water-material balance	Water Modeling Data Package - Plant Site (Reference (7))	Section 6.1.3, page 135
		free-board requirements	Residue Management Plan - Hydrometallurgical Residue Facility (Reference (2))	Section 4.1, pages 20-21
	6115 0/10 (6)(A)	dam-break flood	Dam Safety Permit Application	Section 3.5, page 4
	0113.0410 (0)(A)	geotechnical information, such as rock-soil sampling and logging, geophysical investigations, field and lab testing, instrumentation data	Geotechnical Data Package Vol 2 - Hydrometallurgical Residue Facility (Reference (3)	Attachments
		considerations of construction materials and their properties, such as quantities required, borrow and aggregate locations and volumes, field and lab work and investigations, concrete, waste materials generation and placement techniques	Dam Safety Permit Application	Table 3-2 (Construction Material Quantities and Borrow Locations), and Attachment B (Construction Specifications)
		investigation of the stored waste materials such as generation, transportation, mechanical/chemical/special testing, disposal practice	Geotechnical Data Package Vol 2 - Hydrometallurgical Residue Facility (Reference (3)	Section 4.0, pages 12-13
			Residue Management Plan - Hydrometallurgical Residue Facility (Reference (2))	Section 2.1, pages 4-7
			Waste Characterization Data Package (Reference (8))	Section 6.0, pages 42-46
Final Design Report		Seepage analysis	Geotechnical Data Package Vol 2 - Hydrometallurgical Residue Facility (Reference (3)	Section 5.3, pages 31-32
		Stability, deformation, and settlement analysis.	Geotechnical Data Package Vol 2 - Hydrometallurgical Residue Facility (Reference (3)	Section 6, pages 41-57
		Design details of facilities, such as dam, foundation, impoundment, abutments, spillways or decant facilities, diversions, outlet works, and instrumentation. Operational aspects, such as impoundment operating criteria, initial filling criteria, responsibility and coordination, emergency procedures and	Dam Safety Permit Application – HRF Permit Application Support Drawings	Attachment A
			Residue Management Plan - Hydrometallurgical Residue Facility (Reference (2))	Section 5.5 (Instrumentation), pages 27-28
			Residue Management Plan - Hydrometallurgical Residue Facility (Reference (2))	Section 4.4 (Operational Plan), page 22
	6115.0410 (6)(B)	warning systems.	Residue Management Plan - Hydrometallurgical Residue Facility (Reference (2))	Attachment K (Contingency Action Plan), pages 1-8 of Attachment K
		Air, water, and solid pollution controls, sedimentation, and erosion controls.	Air Quality Management Plan – Plant (Reference (9))	Attachment A (Fugitive Emissions Control Plan)
			Residue Management Plan - Hydrometallurgical Residue Facility (Reference (2))	Sections 2.2.2 and 4.3 (Double liner and leakage system), pages 8-15, and 22
			Dam Safety Permit Application	Appendix A
			Residue Management Plan - Hydrometallurgical Residue Facility (Reference (2))	Sections 5.0 and 7.0 (Erosion), pages 24-31, and 33-36
		Operational and post-operational maintenance and abandonment considerations.	Residue Management Plan - Hydrometallurgical Residue Facility (Reference (2))	Sections 4.0 and 7.0, pages 20-23, and 33-36
		Surveillance and inspection programs.	Residue Management Plan - Hydrometallurgical Residue Facility (Reference (2))	Section 5.0 and Attachment J, pages 24-31, and 1-6 of Attachment J
	6115.0410(6)(C)	Detailed cost estimate.	Dam Safety Permit Application	Large Table 2
		Plans	Dam Safety Permit Application – HRF Permit Application Support Drawings	Attachment A
Plans and Specifications	0115.0410 (7)(A-C)	General Provisions	Dam Safety Permit Application	Attachment B
		Technical Specifications	Dam Safety Permit Application	Attachment B

Subsection of Minnesota Rules Part 6115.0410 ⁽¹⁾	Rule Citation ⁽²⁾	Rule Requirement ⁽³⁾	Document ⁽⁴⁾	Document Section and Page Number ⁽⁵⁾
	6115.0410 (8)(B)	Lack of other suitable feasible and practical alternative sites and that the dam will benefit the population or socioeconomic base of the area involved.	Final Environmental Impact Statement (Reference (1))	Section 3
	6115.0410 (8)(C)	The need in terms of quantifiable benefits.	Final Environmental Impact Statement (Reference (1))	Section 1.3.2.1, page 11 of Section 1
Permit Standards	6115.0410 (8)(D)	The stability of the dam, foundation, abutments, and impoundment under all conditions of construction and operation, including consideration of liquefaction, shear, or seepage failure, overturning, sliding, overstressing and excessive deformation, under all loading conditions including earthquake. This determination must be based on current, prudent engineering practice, and the degree of conservatism employed must depend on hazards.	Geotechnical Data Package Vol 2 - Hydrometallurgical Residue Facility (Reference (3)	Section 6.0, page 41-57
	6115.0410 (8)(E)	Discharge and/or storage capacity capable of handling the design flood based on current, prudent engineering practice and the hazard classification.	Residue Management Plan - Hydrometallurgical Residue Facility (Reference (2))	Section 2.5, pages 17-18
	None. Information requested by MDNR on 10/31/13.	Financial Assurance.	Permit to Mine Application (Reference (10))	Section 15

(1) Section – Denotes the primary sub-sections of Minnesota Rules Part 6115.0410 for Dam Safety Permitting.

(2) Rule Citation – Denotes the sub-section of the Rule that the Permit Application content addresses.

(3) Rule Requirement – Provides a summary statement of the content requirement of each sub-section of the Rule.

(4) Document – Lists the document containing the content/information required by the cited Rule.

(5) Section and Page Number – Lists the document's section and page number on which the content/information required by the Rule is located.

Large Table 2 Hydrometallurgical Residue Facility Phase 1 Construction Cost Estimate

Itom	Description	Unit	Phase 1 Quantity	Contractor Estimate	Cost Extension ⁽¹⁾	
1	Mobilization and Demobilization	LS	1	\$448,000.00	\$448,000	Project Setup, Equipment Mob. and
2	Ancillary Activities			+ • • • • • • • • •	\$0	See Below
2.a.	Environmental Protection Measures	LS	1	\$4,800.00	\$5,000	Environmental Protection Requirem
2.b.	Temporary Dewatering and Pumping	LS			\$0	None
3	Strip Vegetation	Acre	0		\$0	None
4	Fine Grading and Surface Compaction - Liner Subgrade	SY	0		\$0	None
5	Bulk Earthwork				\$0	See Below
5.a.	Topsoil Excavation and Stockpile	CY	0		\$0	In-Place Cubic Yards
5.b.	Coarse Tailings Borrow	CY	0		\$0	In-Place Cubic Yards
5.c.	Common Borrow	CY	0		\$0	In-Place Cubic Yards
5.d.	Common Excavation and Stockpile	CY	0		\$0	In-Place Cubic Yards
6	Geosynthetics				\$0	See Below
6.a.	Geosynthetic Clay Liner	SF	2,169,900	\$0.66	\$1,423,000	CETCO CN or Engineer Approved E
6.b.	80 mil White LLDPE Geomembrane - Textured (Smooth on Base of HRF)	SF	2,169,900	\$0.72	\$1,562,000	GSE or Engineer Approved Equal W
6.c.	60 mil White LLDPE Geomembrane - Textured (Smooth on Base of HRF)	SF	2,169,900	\$0.60	\$1,302,000	GSE or Engineer Approved Equal W
6.d.	Non-woven Geotextile	SY	171,300	\$1.60	\$274,000	Between Granular Drainage Materia
7	Drainage Collection System				\$0	See Below
7.a.	Drainage Collection Trench	LF	0		\$0	Grading of Trench, Furnish and Inst
7.b.	Geocomposite Drainage Layer	SY	0		\$0	GSE 10 oz./sq.yd. Fabrinet HF or Eng
7.c.	20" Dia. DR 160 HDPE Sidewall Riser Pipe	LF	0		\$0	Includes Pipe, Geotextile, and Embe
7.d.	Furnish and Install Surepump	EA	0		\$0	Includes Pump, Sensors, Hose, and
7.e.	Geocomposite	SY	32,600	\$6.00	\$196,000	None
7.f.	Granular Drainage Material (geocomposite cover and miscellaneous)	CY	110,600	\$9.60	\$1,062,000	Assumed 2' Cover Over Basin Botto
7.g.	20" Dia. HDPE SDR 11 Sidewall Riser Pipe	LF	340	\$88.00	\$30,000	None
7.h.	12" Dia. HDPE SDR 11 Perforated Sump Pipe	LF	50	\$88.00	\$4,000	None
7.i.	12" Dia. HDPE SDR 11 14º Bend	EA	2	\$720.00	\$1,000	None
7.j.	Corrugated Metal Pipe Over Riser	LF	40	\$24.00	\$1,000	None
7.k.	Furnish and Install Pump and Skid Assembly	EA	2	\$18,754.00	\$38,000	None
7.I.	20"x12" HDPE SDR 11 Reducer	EA	2	\$960.00	\$2,000	None
8	Return Water System				\$0	See Below
8.a.	Furnish and Install Return Water Pumps ⁽¹⁾	LS	1	\$650,816.00	\$651,000	Incl. Pumps, Pump Raft, Floating Wa
8.b.	Furnish and Install 6-inch Diameter DR17 HDPE Pipe	LF	350	\$18.40	\$6,000	Pipe from Return Water Pump to Fl
8.c.	Furnish and Install Return Water Flow Meter	EA	1	\$12,800.00	\$13,000	Fittings, Meter, Valve, 6" 8'x10' Con
8.d.	Furnish and Install 8-inch Diameter DR17 HDPE Pipe	LF	3,700	\$24.00	\$89,000	Pipe from Flow Meter to Booster Pu
9	Various Mechanical				\$0	See Below
9.a.	Furnish and Install 6-inch Diameter DR11 HDPE Pipe	LF	6,900	\$20.00	\$138,000	Discharge Pipe and Auxiliary Pipe
9.b.	Furnish and Install Discharge Point	EA	6	\$4,800.00	\$29,000	Tee, Valve, 12" Casing, Valve Cover,
9.c.	Furnish and Install 6-foot Diameter Manhole	LF	24	\$600.00	\$14,000	None
9.d.	Furnish and Install 8-foot Diameter Manhole	LF	10	\$960.00	\$10,000	3 x 8'-Deep MH
9.e.	Furnish and Install Cleanout Valve	EA	6	\$4,800.00	\$29,000	None
9.f.	Furnish and Install Pig Launch Valve	EA	5	\$17,600.00	\$88,000	None
10	Exterior Dike Slope Erosion Control - Topsoil, Seed, Mulch and	Acre	0		\$0	4" Topsoil, Shallow Rooted Grasses,
11	Site Restoration	Acre	0		\$0	Seed, Fertilize and Mulch Disturbed
12	System Start-up and Trouble Shooting	LS	1	\$7,200.00	\$7,000	None

-						1
C	0	m	m	ie	n	ts

I Demob., Routine Project Admin., Health and Safety, Etc.

nents - Inspect and Repair Prior Year Installations

qual

hite Textured LLDPE

/hite Textured LLDPE

al and Geomembrane

all Granular Material and Geotextile

gineer Approved Equal

edment

all Pipe and Fittings up to Connection with 4" diam. Dewatering

m

alkway Access (200'), Fittings, Flexible Hose low Meter. Assumed 150' on Float and 200' to Flow Meter acrete Slab, and all Pipe up to 90 Bend Connection with 8" HDPE ump House

, 4" Compressor Pipe, Flexible Hose Connect and Necessary Fittings

Fertilizer, and Spray Applied Mulch Areas Including Stockpiles (See Item Above for Dike Slopes)

Item	Description	Unit	Phase 1 Quantity	Contractor Estimate	Cost Extension ⁽¹⁾	
13	Leakage Detection System				\$0	See Below
13.a.	Geocomposite	SY	241,100	\$6.00	\$1,447,000	None
13.b.	Granular Drainage Material	CY	2,400	\$20.00	\$48,000	None
13.c.	20" Dia. HDPE SDR 11 Sidewall Riser Pipe	LF	370	\$88.00	\$33,000	None
13.d.	12" Dia. HDPE SDR 11 Perforated Sump Pipe	LF	200	\$88.00	\$18,000	None
13.e.	12" Dia. HDPE SDR 11 14º Bend	EA	2	\$720.00	\$1,000	None
13.f.	Corrugated Metal Pipe Over Riser	LF	40	\$60.00	\$2,000	None
13.g.	Furnish and Install Pump and Skid Assembly	EA	2	\$69,754.00	\$140,000	None
13.h.	20"x12" HDPE SDR 11 Reducer	EA	2	\$960.00	\$2,000	None
14	Pipe Trench	LF	1,200	\$20.00	\$24,000	Trench for Discharge, Auxiliary and
	Constructio	Residue Facility Phase 1	\$9,140,000			

Note: Mine Year 5 is the first year of liner construction, the first year in which the HRF can retain water, and anticipated to be the first year in which MDNR dam safety inspections are expected to occur.

(1) Cost extensions rounded to nearest \$1,000.



Large Figures



Large Figure 1 Dam Safety Permit Application



Attachments

Attachment A

Permit Application Support Drawings - Hydrometallurgical Residue Facility

POLY MET MINING, INC. NORTHMET PROJECT PERMIT SUPPORT DRAWINGS HYDROMETALLURGICAL RESIDUE FACILITY HOYT LAKES, MINNESOTA



		PLANT DRAWING NUMBER:				
		HYDROMETALLURGICAL RESIDUE FACILTY LOCATION MAP AND SITE MAP				
N, DIRECT IULY	DRAWN: CAD	POLY MET MINING, INC POLYMET NORTHMET PROJECT HOYT LAKES, MINNESOT	;. ТА			
OF DUE	CHECKED: TJR BARR PROJECT NO.: 23/69-0C29	BARR ENGINEERING C 4700 WEST 77TH STE MINNEAPOLIS, MN. Ph: 1-800-632-2277	OMPANY REET			
51	SCALE: AS SHOWN	DWG. NO. HRF-001	REV			

GENERAL LEGEND

1000	EXISTING CONTOUR - MAJOR
	EXISTING CONTOUR - MINOR
1000	PROPOSED CONTOUR - MAJOR
	PROPOSED CONTOUR - MINOR
8	EXISTING POWER POLE
+++++++++++++++++++++++++++++++++++++++	EXISTING RAILROAD
	EXISTING ROAD
	EXISTING TRAIL
=======	EXISTING UNIMPROVED TRAIL
	EXISTING STRUCTURES
\sim	TREE LINE
<u>_</u>	WETLAND BOUNDARY
\rightarrow	EXISTING CULVERT
P	EXISTING PIPELINE
OE	OVERHEAD ELECTRIC
Ť	DISCHARGE POINT
Ť	DEWATERING OUTLET POINT
D	RETURN PUMP PAD
	DEWATERING PUMP
	SURFACE DRAINAGE
•	DRAINAGE COLLECTION STRUCTURE AND PIPE
	DRAINAGE AREA BOUNDARY
	PROPOSED DAMS
DW	PROPOSED DEWATERING PIPE
D	PROPOSED DISCHARGE PIPELINE
—— R ——	PROPOSED RETURN PIPELINE
\succ	PROPOSED CULVERT (NON-MINE DRAINAGE)
	PROPOSED SEEPAGE COLLECTION DRAIN
<	PROPOSED STORMWATER DRAIN
0	PROPOSED MANHOLE
	PROPOSED WICK DRAIN LATERAL PIPE
	PROPOSED RIP RAP
>	FILL SLOPE
>	CUT SLOPE

CDSM	-	CEMENT DEEP SOIL MIX
CMP	-	CORRUGATED METAL PIPE
CPEP	-	CORRUGATED POLYETHYLENE PIPE
CY	-	CUBIC YARD
DR	-	DIMENSION RATIO
DWG	-	DRAWING
EL.	-	ELEVATION
F	-	DIAMETER
FTB	-	FLOTATION TAILINGS BASIN
GCL	-	GEOSYNTHETIC CLAY LINER
HDPE	-	HIGH DENSITY POLYETHYLENE
HRF	-	HYDROMETALLURGICAL RESIDUE FAC
LDPE	-	LOW DENSITY POLYETHYLENE
LF	-	LINER FEET
LTVSMC	-	LTV STEEL MINING COMPANY
MCY	-	MILLION CUBIC YARDS
mil	_	one thousandth of an inch
MIN	-	мілімим
MSL	-	MEAN SEA LEVEL
NTS	-	NOT TO SCALE
SCH.	-	SCHEDULE
DR	-	DIMENSION RATIO
TYP.	-	TYPICAL

ABBREVIATIONS

APPROX. – APPROXIMATE

BASIN LINER THYLENE RESIDUE FACILITY THYLENE

OMPANY an inch

SHEET INDEX

SHEET NO. TITLE

GENERAL DRAWINGS

HRF-001 HRF-002	LOCATION MAP AND SITE MAP
HRF-003	EXISTING CONDITIONS
HRF-004	RESIDUE FACILITY LAYOUT - MINE YEAR 20
HRF-005	EMERGENCY BASIN EXCAVATIONS AND REMOV
HRF-006	SUBGRADE IMPROVEMENT AND SEEPAGE COL
HRF-007	EMERGENCY BASIN PRELOAD
HRF-008	PHASE 1 LAYOUT
HRF-009	PHASE 2 LATOUT
HRF-011	CROSS SECTIONS
HRF-012	CROSS SECTIONS
HRF-013	SUMP AND SIDE WALL RISER PLAN LAYOUT
HRF-014	SUMP AND SIDE WALL RISER SECTIONS
HRF-015	SUMP AND PUMP DETAILS
HRF-016	TYPICAL SECTIONS AND DETAILS
HRF-017	PIPING PLAN AND PROFILE
HRF-018	PIPING DETAILS
HRF-019	CLOSURE DEEDADATION DLAN
HRF-020	TEMPORARY COVER AND FINAL COVER GRAD
HRF-022	FINAL CLOSURE GRADING AND DRAINAGE
HRF-023	CLOSURE SECTIONS AND DETAILS
HRF-024	GEOTECHNICAL INSTRUMENTATION DETAILS

DRAWING NUMBERING



<u>NOTES</u>

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.

VER NO	DATE	DESCRIPTION		ISSUE STATUS		
1	10/14/11	RESIDUE MANAGEMENT PLAN - VERSION 1 - ATTACHMENT A	ISSUED	VERSION	DATE	I HEREBY CERTIFY THAT THIS PLAN.
2	06/29/12	RESIDUE MANAGEMENT PLAN - VERSION 1 - RESPONSE TO COMMENTS				SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DI
3	12/14/12	RESIDUE MANAGEMENT PLAN - VERSION 2 - ATTACHMENT A	FOR PERMITTING	4	5/19/15	SUPERVISION AND THAT I AM A DUL LICENSED PROFESSIONAL ENGINEER
4	5/19/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS				UNDER THE LAWS OF THE STATE OF MINNESOTA.
			FOR CONSTRUCTION			PRINTED NAME THOMAS J. RAD
						SIGNATURE / Romas . Kad
			NOT APPROVED FOR	CONSTRUCTION.		DATE 37 137 13 LICENSE# 20931

M

		HYDROMETALLURGICAL RESIDUE FACILTY LEGEND AND SHEET INDEX				
N, DIRECT DULY	DRAWN: CAD	POLYMET MINING, INC. NORTHMET PROJECT HOYT LAKES, MINNESOTA				
OF DUE	CHECKED: TJR BARR PROJECT NO.: 23/69-0C29	BARR ENGINEERING COMF 4700 WEST 77TH STREE MINNEAPOLIS, MN. Ph: 1-800-632-2277	PANY F			
<u>01</u>	SCALE: AS SHOWN	DWG. NO. HRF-002	EV			

PLANT DRAWING NUMBER:

-NTS = NOT TO SCALE

- DETAIL OR SECTION NUMBER, TYPICAL

VER GRADING

YEAR 20 ND REMOVALS PAGE COLLECTION DRAIN LAYOUT



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I, DIRECT ILY DRAWN: CAD CHECKED: TJR BARR PROJECT NO.: 23/69-0C29	POLYMET POLYMET POLYMET HOYT LAKES, I BARR EN 4700 WE MINNEAPC Ph: 1-800	NING, INC. PROJECT MINNESOTA GINEERING COMPANY ST 77TH STREET DLIS, MN. -632-2277



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		HYDROMETALLURGICAL RESIDUE FAC RESIDUE FACILITY LAYOUT MINE YEAR 20	LTY
N, DIRECT JULY	DRAWN: CAD	POLY MET MINING, INC NORTHMET PROJECT HOYT LAKES, MINNESOT	с. ГА
OF DUE	CHECKED: TJR BARR PROJECT NO.: 23/69-0C29	BARR ENGINEERING C 4700 WEST 77TH STF MINNEAPOLIS, MN. Ph: 1-800-632-2277	OMPANY REET
51	SCALE: AS SHOWN	DWG. NO. HRF-004	REV







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		PLANT DRAWING NUMBER:	
		HYDROMETALLURGICAL RESIDUE FACI EMERGENCY BASIN PRELOAD	LTY
N, DIRECT DULY R OF DUE <u>DUE</u>	DRAWN: CAD	POLY MET MINING, INC NORTHMET PROJECT HOYT LAKES, MINNESOT	А
	CHECKED: TJR BARR PROJECT NO.: 23/69-0C29	BARR ENGINEERING C 4700 WEST 77TH STE MINNEAPOLIS, MN. Ph: 1-800-632-2277	OMPANY REET
<u>1</u>	SCALE: AS SHOWN	DWG. NO. HRF-007	REV

NOTES:

1. PRELOAD AREA USING SOIL AND ROCK REMOVED FOR HRF (SEE DWG. HRF-005).

2. SOIL AND ROCK PRELOAD MATERIAL TO BE REMOVED TO HRF LINER GRADE AND UTILIZED FOR HRF DAM CONSTRUCTION.

3. NUMBER OF PRELOAD LIFTS IS PRELIMINARY.



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	NOTES: 1. UPPER LINER SURFACE SHOWN. 2. DRAINAGE COLLECTION GEOCOMPOSITE SHOWN (SHADED AREA).
	3. PLACE HRF LINER OVER BASE AND INTERIOR SLOPES OF CELL. SEE DWG. HRF-016.
	PLANT DRAWING NUMBER:
	HYDROMETALLURGICAL RESIDUE FACILTY LIFT 1 LAYOUT
N, DIRECT RCAD	POLY MET MINING, INC. NORTHMET PROJECT HOYT LAKES, MINNESOTA
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51 SCALE: AS SHOWN	DWG. NO.



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SEE RF-017 BOOSTER PUMP HOUSE		
NT	NOTES: 1. LIFT 2 CONSTRUCTION YEAR TO BE BASED ON HRF CAPACITY CONSUMPTION RATE. 2. UPPER LINER SURFACE SHOWN. 3. FOR LEAKAGE DETECTION SUMP SEE (1) 4. PLACE HRF LINER OVER BASE AND INTERIOR SLOPES OF CELL. SEE DWG. HRF-016. PLANT DRAWING NUMBER:	
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	- c - ese <u>NOTES:</u>
	1. LIFT 3 CONSTRUCTION YEAR TO BE BASED ON HRF CAPACITY CONSUMPTION RATE.
	3. PLACE HRF LINER OVER BASE AND INTERIOR SLOPES OF CELL, SEE DWG, HRF-016,
	PLANT DRAWING NUMBER:
	HYDROMETALLURGICAL RESIDUE FACILTY
AN, DIRECT DRAWN:	POLY MET MINING, INC.
ER CHECKED:	HOYT LAKES, MINNESOTA
ADUE BARR PROJECT NO.: Le 23/69-0C29	4700 WEST 77TH STREET MINNEAPOLIS, MN. Ph: 1-800-632-2277
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3	12/14/12	RESIDUE MANAGEMENT PLAN – VERSION 2 – ATTACHMENT A	FOR		5/19/15	
4	5/19/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS				
			FOR			PRINTED NAME THOMAS J. RADU
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						SIGNATURE / Komas J. Kach
			NOT APPROVED FOR CONSTRUCTION.		DATE 5/ 19/ 15 LICENSE# 2095	
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1. SEE DWG. HRF-004 FOR SECTION LOCATIONS.




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4	5/19/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS				UNDER THE LAWS OF THE STATE C MINNESOTA.
			FOR			PRINTED NAME THOMAS J. RAD
						SIGNATURE / Komas J. Kad
			NOT APPROVED FOR	CONSTRUCTION.		DATE 37 197 13 LICENSE# 2093

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		PLANT DRAWING NUMBER:	
		HYDROMETALLURGICAL RESIDUE FACILTY TYPICAL SECTIONS AND DETAILS	
AN, DIRECT DULY ER	DRAWN: CAD	POLY MET MINING, INC. NORTHMET PROJECT HOYT LAKES, MINNESOTA	
OF ADUE	CHECKED: TJR BARR PROJECT NO.: 23/69-0C29	BARR ENGINEERING COMPANY 4700 WEST 77TH STREET MINNEAPOLIS, MN. Ph: 1-800-632-2277	ŕ
51	SCALE: AS SHOWN	DWG. NO. REV	



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4	5/19/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS				UNDER THE LAWS OF THE STATE C MINNESOTA.
			FOR			PRINTED NAME THOMAS J. RAD
						SIGNATURE / Komas J. Kad
			NOT APPROVED FOR	CONSTRUCTION.		DATE 07 197 10 LICENSE# 2095





								PLANT DRAWING NUMBER:	
								HYDROMETA	LLURGICAL RESIDUE FACILTY PIPING DETAILS
VER NO	DATE	DESCRIPTION		ISSUE STATUS					POLY MET MINING INC
1	10/14/11	RESIDUE MANAGEMENT PLAN - VERSION 1 - ATTACHMENT A	ISSUED	VERSION	DATE	I HEREBY CERTIFY THAT THIS PLAN,		H	
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4	5/19/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS				UNDER THE LAWS OF THE STATE OF MINNESOTA.	CHECKED:		BARR ENGINEERING COMPANY
							TJR		4700 WEST 77TH STREET
			FOR CONSTRUCTION			PRINTED NAME THOMAS J. RADUE	BARR PROJECT NO .:	BA	RR MINNEAPOLIS, MN.
						SIGNATURE / Komas J. Kadne	23/69-0C29		Ph: 1-800-632-2277
			NOT APPROVED FOR	CONSTRUCTION.		DATE <u>3/19/13</u> LICENSE# 20951	SCALE: AS SHOWN	DWG. NO.	18 REV



NOT APPROVED FOR CONSTRUCTION.

8"ø DR17 HDPE RETURN WATER PIPE

ACCESS WALKWAY

6"ø FLEXIBLE HOSE FLOATING PUMP STATION

INCHES

		PLANT DRAWING NUMBER:	
		HYDROMETALLURGICAL RESIDUE FACILT RETURN WATER PUMP RAFT	Y
N, DIRECT DULY	DRAWN: CAD	POLYMET MINING, INC. NORTHMET PROJECT HOYT LAKES, MINNESOTA	
OF DUE	CHECKED: TJR BARR PROJECT NO.: 23/69-0C29	BARR ENGINEERING COMF 4700 WEST 77TH STREET MINNEAPOLIS, MN. Ph: 1-800-632-2277	PANY
51	SCALE: AS SHOWN	DWG. NO. HRF-019	EV









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15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS				UNDER THE LAWS OF THE STATE OF MINNESOTA.
		FOR			PRINTED NAME THOMAS J. RADUE
					SIGNATURE / homas J. Kache
		NOT APPROVED FOR	CONSTRUCTION.		DATE 3/ 19/ 13 LICENSE# 20951







NOTES: 1. PRIOR TO FINAL CLOSURE GRADE ANY LOW SPOTS CREATED DURING SETTLEMENT ALLOTMENT TIME. 2. INSTALL DRAIN TUBING AND SURFACE WATER INLETS.

VER NO	DATE	DESCRIPTION		SSUE STATUS		
1	10/14/11	RESIDUE MANAGEMENT PLAN - VERSION 1 - ATTACHMENT A	ISSUED	VERSION	DATE	I HEREBY CERTIFY THAT THIS PLA
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4	5/19/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS				UNDER THE LAWS OF THE STATE MINNESOTA.
			FOR			PRINTED NAME THOMAS J. RA
						SIGNATURE / Komas J. Ka
			NOT APPROVED FOR	CONSTRUCTION.		DATE 5/ 19/ 15 LICENSE# 209





CATCH BASIN		TOP OF 1	TEMPORARY COVER	
		6"ø CPI	EP DRAIN TUBING	
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SLOPE	\backslash	///	SLOPE 1%	
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	LINER SYSTEM-]		
	NC	TES.		
	<u>INC</u>	TLJ.		
	1. DR	TEMPORARY COVER I AWING SEE DETAIL 3	MATERIALS NOT SHOWN ON T	THS
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OF CHECKED:			BARR ENGINEERING COI	
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Attachment B

Construction Specifications – Hydrometallurgical Residue Facility

Technical Specifications for Permitting NorthMet Hydrometallurgical Residue Facility

Polymet Mining Corporation NorthMet Hoyt Lakes, MN

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SUMMARY OF WORK

PART 1 GENERAL

1.01 **SPECIFICATIONS**

- A. The format of these Specifications is based upon the CSI MASTERFORMAT, however differences in format and subject matter location do exist. These Specifications are written in imperative and streamlined form. This imperative language is directed to the Contractor, unless specifically noted otherwise. It is solely the Contractor's responsibility to thoroughly read and understand these Specifications and request written clarification of those portions which are unclear.
- B. Division of the Work as made in these Specifications is for the purpose of specifying and describing work which is to be completed. There has been no attempt to make a classification according to trade or agreements which may exist between Contractor, Subcontractors, or trade unions or other organizations. Such division and classification of the Work shall be solely the Contractor's responsibility.

1.02 EXISTING SITE CONDITIONS AND USES

- A. The Project Site is located at Poly Met Mining, Inc.'s NorthMet Project near Hoyt Lakes, Minnesota.
- The Hydrometallurgical Residue Facility (HRF) is located northwest of the plant area and B. adjacent to the southwest corner of Cell 2W.

WORK COVERED BY SPECIFICATIONS 1.03

- The overall scope of the Work which is more fully described in these Specifications includes, A. but is not necessarily limited to, furnishing all labor, tools, equipment, and materials necessary to:
 - 1. Emergency Basin Area Preparation
 - a. Remove water from basin area to allow for construction.
 - b. Excavate rock and soil, to lines and grades shown in the drawings, in preparation for HRF construction.
 - c. Remove railroad lines, structures, and pipelines as shown in drawings or as required to complete the Work.
 - d. Remove poles and relocate power line.
 - e. Install all necessary erosion control measures.
 - 2. Construct Seepage Collection Drain
 - a. Place perforated pipe as shown in the drawings.
 - b. Load, haul, and place Granular Drainage Material and Sand Layer to cover the seepage collection drain as shown in the Drawings.
 - Install Wick Drains (Optional Need to be confirmed by Engineer) and Header Pipe 3.
 - a. Install Wick Drains (Optional) according to the grid shown in the Drawings.
 - b. Install Header Pipe within Sand Layer as shown in the Drawings.

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- 4. Preload Emergency Basin
 - a. Preload area using rock and soil removed during Emergency Basin Excavation.
 - b. Place material in lifts as shown in the Drawings.
 - c. Remove soil and rock following preload to achieve Liner System subgrade.
- 5. Construct Perimeter Dam
 - a. Use soil and rock removed from the Preload Phase to construct Perimeter Dams.
 - b. Excavate, load, haul, place and compact additional Fill Materials needed for Perimeter Dam construction from areas approved by Owner.
- 6. Construct Liner System
 - a. Compact and prepare subgrade.
 - b. Furnish and install the Geosynthetic Clay Liner (GCL).
 - c. Furnish and install the Lower 60-mil Low Density Polyethylene (LLDPE) Geomembrane.
 - d. Furnish and install Middle Geocomposite.
 - e. Furnish and install Upper 80-mil LLDPE Geomembrane.
- 7. Construct Drainage Collection System
 - a. Furnish and install Geocomposite.
 - b. Place LTVSMC Coarse Tailings over Geocomposite.
- 8. Construct Leakage Collection Sump and Drainage Collection Sump
 - a. Construct Leakage and Drainage Collection Sumps
 - i. Construct Sump to lines and grades shown on the Drawings.
 - ii. Furnish and install GCL.
 - iii. Furnish and install Lower 60-mil LLDPE Geomembrane.
 - iv. Furnish and install 60-mil LLDPE or HDPE Rubsheet.
 - v. Furnish and install Leakage Collection Piping above 2 inches of aggregate.
 - vi. Place Coarse Aggregate over Leakage Collection Piping to lines and grades shown on the Drawings.
 - vii. Furnish and install Geocomposite
 - viii. Furnish and install Upper 80-mil LLDPE Geomembrane.
 - ix. Place 2 feet of LTVSMC Coarse Tailings over final Geocomposite layer.
 - b. Construct Leakage and Drainage Collection Sidewall Riser Pipes
- 9. Install Water Return Pipe and Residue Discharge System
 - a. Excavate pipe trench where shown in the Drawings.
 - b. Furnish and install Residue Discharge and Water Return Pipes.
 - c. Install Residue Discharge Points as shown in the Drawings.
- 10. Install Floating Pump Station
 - a. Furnish and install Water Return Pump Raft according to manufacturer's recommendations.
- 11. At Closure Construct Temporary Cover System
 - a. Regrade residue surface as shown in the Construction Drawings, using Sand or approved Common Borrow material as necessary to achieve contours as shown; design elevations will be confirmed at time of closure.
 - b. Furnish and install Geogrid over residues as shown in the Drawings.
 - c. Place Sand or approved Common Borrow over Geogrid as shown in the Drawings.
 - d. Place Rooting Zone soils and establish turf as shown in the Drawings or otherwise specified herein.

- 12. At Closure Construct Final Cover System
 - a. Salvage Rooting Soil from Temporary Cover.
 - b. Regrade the Temporary Cover to achieve the contours shown in the Drawings; design elevations will be determined at the time of closure.
 - c. Furnish and install 40-mil LLDPE Geomembrane, over GCL, over Temporary Cover System.
 - d. Place Topsoil, over Rooting Soil, over Granular Drainage Material, to elevations and thicknesses shown in the Drawings.
 - e. Install Drain Tubing, Surface Water Inlet Structures, and Storm Sewer Pipe as shown in the Drawings.
 - f. Construct Rip-Rap Spillway where shown in the drawings.
- 13. Submit construction documentation as specified.
- B. It is the intent of these Specifications to cover all aspects of the Project. Should there be some item or items not shown on the Drawings or not described in these Specifications which are required for the Work, those items and the furnishing of all labor, materials, and equipment shall be considered incidental to the Work and no additional compensation will be provided.
- C. The Work includes the furnishing of all labor, equipment, tools, machinery, materials, and other items required for the construction of a complete Project as specified and shown on the Drawings. Equipment furnished shall be in safe operating condition and of adequate size, capacity, and condition for the performance of the Work. Contractor shall obtain all measurements necessary for the Work and shall be responsible for establishing all dimensions, levels, and layout of the Work.
- D. Contractor shall be solely responsible for the coordination of its activities with regard to the Project and the activities of Subcontractors and Owner.
- E. Contractor shall utilize material sources designated by Owner and shall develop necessary access roads for material sources to the Project Site.
- F. Contractor shall provide soil testing as required in Section 02220.

1.04 WORK BY OWNER

- A. Owner will provide bench mark and site coordinate information necessary for construction of the Work. Once provided, it is Contractors responsibility to protect the bench marks. Contractor shall request benchmark and site coordinate information from Owner a minimum of five days prior to the time when such information is needed.
- B. Owner will provide electrical service and connection to the Contractor's trailer.

1.05 OWNER FURNISHED PRODUCTS

A. Owner will provide borrow sources for the construction of preload and perimeter dams. These are expected to be located in the HRF construction area and in tailings basin cell 2W.

1.06 CONTRACTOR USE OF PREMISES

A. Definition of Project Site: The Project Site is defined as the area within the construction limits shown on the Drawings, plus a nearby material and equipment storage and staging area, the

PolyMet Mining Corporation	Summary of Work	BARR
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location of which will be designated by Owner. Contractor shall limit operations, including material and equipment storage, to within those boundaries. Any disturbance outside the construction limits shall be fully restored at Contractor's expense in accordance with Laws and Regulations. Contractor shall obtain approval of Owner at all locations where Contractor uses land not included in the construction limits.

- B. Hours of Operation: Working hours shall be set by Contractor, subject to approval by Owner.
- C. Protection and Repair of Existing Facilities and Utilities: Contractor shall perform operations carefully and in such a manner as to protect existing facilities and utilities. Obstructions not shown on the Drawings may exist and shall be exposed by Contractor without damage. Contractor shall be responsible for damage to existing facilities and utilities resulting from Contractor's operations, and shall repair or replace damaged items to Owner's satisfaction. Groundwater monitoring wells shall be protected during construction unless directed otherwise by Owner.
- D. Unfavorable Construction Conditions: When unfavorable weather, soil, drainage, or other unsuitable construction conditions exist, Contractor shall confine operations to work which will not be adversely affected by such conditions. No portion of the Work shall be constructed under conditions which would adversely affect the quality of the Work, unless special means or precautions are taken to perform the Work in a proper, safe and satisfactory manner.
- E. Survey Markers: Contractor shall conduct operations so as to preserve bench marks, survey reference points, and stakes existing or established by Owner for the construction. Contractor will be charged the expense of repairing or replacing survey markers and shall be responsible for mistakes or lost time resulting from damage or destruction of survey markers due to Contractor's operations.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION [NOT USED]

END OF SECTION 01010

MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.01 GENERAL

- A. This Section of the Specifications describes the measurement and payment for the Work as set forth in the Contract Documents.
- B. Each lump sum or unit adjustment price stated on the Proposal Form shall constitute full compensation as herein specified for each item of work completed in accordance with the requirements of the Contract Documents.
- C. All costs in connection with the Work, including furnishing all materials, machinery, supplies and appurtenances; providing all construction equipment and tools; and performing all necessary labor, coordination, supervision, and management to fully complete the Work shall be included in the unit adjustment or lump sum prices quoted on the Proposal Form. All Work not specifically set forth as a separate bid item herein shall be considered an incidental obligation of the Contractor and all costs in connection therewith shall be included in the amounts and prices submitted on the Proposal Form.

1.02 INTENT OF PROPOSAL FORM ORGANIZATION

- A. Payment for all Work shall be in accordance with the terms and conditions set forth elsewhere in the Contract Documents and the Contractor's lump sum and unit adjustment prices set forth in Contractor's conformed Proposal Form. The items set forth in the Proposal Form subdivide the Project for purposes of measurement and payment only, and are intended to represent the entire and complete Project as set forth in the Contract Documents. The items set forth in the Proposal Form shall constitute full compensation to Contractor for providing all material, equipment, labor, and supplies to complete the Work in complete accordance with the Contract Documents.
- B. The Bid shall consist of a Lump Sum Price and Unit Adjustment Prices. General descriptions of the Work are provided in Section 01010. The Lump Sum Price shall be full compensation for completion of the Work. Unit Adjustment Prices will be used to adjust the Lump Sum Price based upon Changes to the Contract.
- C. Partial progress payments for Work completed under the Lump Sum Bids shall be made as follows:
 - 1. Partial progress payments will be made based upon monthly estimates of percent Project completion and the Schedule of Values.

1.03 LUMP SUM BID

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- A. The Lump Sum Bid shall constitute full compensation for furnishing all material, equipment, labor, and supplies and performing all operations necessary to complete the Work. The Lump Sum Bid shall constitute full compensation for the entire Project.
- B. Quantities will be used as a basis for payment only to the extent of determining percent complete for partial progress payments and to verify that that the Work has been completed to the neat lines shown on the Drawings.

Measurement and Payment

1.04 UNIT ADJUSTMENT PRICES

- A. The Unit Adjustment Prices will be used for Change Work under the Lump Sum Price to compensate the Contractor for modifications to the Work covered by Change Orders. The Unit Adjustment Prices will be used as described below.
 - 1. For soil materials to be incorporated in the Work, the volumes will be determined as constructed in-place based on neat line dimensions.
 - 2. For soil materials to be placed in temporary stockpile, the volumes will be determined based on surveyed data for the completed stockpile.
- B. The Unit Adjustment Price for Rock Excavation shall constitute full compensation for furnishing all material, equipment, labor, and supplies and performing all operations necessary to drill and blast or otherwise excavate virgin rock, load, haul, and stockpile rock at the location designated in the Drawings. Excavation of virgin rock shall <u>not</u> be included in the Lump Sum Bid. Excavation, loading, transport and placement of previously excavated rock from pre-existing stockpiles shall be included in the Lump Sum Bid.
- C. The Contractor shall measure the volume of the void left by excavation of virgin rock. The volume of the void left by excavation of virgin rock shall be determined from surveys by an independent registered land surveyor licensed in the State of Minnesota and retained by the Contractor. Survey data shall be collected at intervals necessary to compute the rock volume using the average end area method and/or computer earthwork volume programs. Contractor shall supply Owner with the appropriate survey data and quantity calculations.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION [NOT USED]

END OF SECTION 01025

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MEETINGS

PART 1 GENERAL

1.01 PRECONSTRUCTION CONFERENCE

- A. After Owner and Contractor have executed the Agreement, Owner will schedule a preconstruction conference at Project Site that shall be attended by Owner, Contractor, Engineer, Owner's On-site Representative, and others as appropriate. The meeting will be scheduled within twenty-eight (28) calendar days following formal agreement to Contract. The purpose of the meeting will be to ensure that all parties understand their responsibilities and the procedures that will be used to assure efficient completion of the Work.
- B. Agenda items may include:
 - 1. Distribution of Plans and Specifications.
 - 2. Designation of responsible personnel for all parties, lines of communication, and lines of authority.
 - 3. Scope of work and the anticipated schedule of operations.
 - 4. Critical work sequencing.
 - 5. Submittal and field test reporting procedures.
 - 6. Record documents and reporting.
 - 7. Project Site safety and security procedures.
 - 8. List of major subcontractors.
 - 9. Procedures for processing change orders.
 - 10. Use of premises including equipment and material storage.
 - 11. Major equipment deliveries.
 - 12. Housekeeping procedures.
 - 13. Other items for consideration during construction activities.

1.02 PROGRESS MEETINGS

- A. Weekly progress meetings will be scheduled by the Owner's On-Site Representative at a regular time mutually agreeable to the Owner, Contractor, and Owner's On-Site Representative. The Contractor shall attend these meetings and shall coordinate and require the attendance of subcontractors whose work may be in progress at the time or whose presence may be required for any purpose. Scheduling of required attendees shall meet with the approval of the Owner's On-Site Representative.
- B. Following each meeting, the Owner's On-Site Representative will prepare and distribute to Owner and Contractor copies of the minutes of the meeting. These will include a brief summary of the progress of the Work since the previous meeting.
- C. The weekly meeting agenda will include:
 - 1. Administrative/Purchasing issues.
 - 2. Technical/Construction issues.
 - 3. Design issues.
 - 4. Schedule/Progress issues.
 - 5. Project Site safety issues.
 - 6. Review status of required submittals

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1.03 UNSCHEDULED MEETINGS

A. The Contractor shall attend other unscheduled meetings which may be reasonably requested by Owner's On-Site Representative or Owner to discuss unanticipated changes in the Work or conditions at the Project Site and which must be resolved before progression of work.

1.04 BASIS FOR COMPENSATION

A. The Contractor's cost for work under this Section shall be included in the Lump Sum Bid price and no additional compensation will be provided.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION [NOT USED]

END OF SECTION 01200



SUBMITTALS

PART 1 GENERAL

1.01 GENERAL PROCEDURES

- A. This Section stipulates the requirements for transmission of submittals from Contractor to Owner's On-Site Representative and actions taken by Owner's On-Site Representative regarding submittals.
- B. Submittals shall be identified with the project name, name of submittal, and Specification Section for which the submittal is required.
- C. Owner's On-Site Representative will accept submittals only from Contractor. Submittals from subcontractors, vendors, suppliers, or others will be returned without review or action.
- D. Owner's On-Site Representative will accept only those submittals required by the Specifications. Unsolicited submittals will be returned without review or action.
- E. All engineering data, regardless of origin, shall be stamped with the approval of the Contractor. The Contractor's stamp of approval will be a representation to the Owner and Owner's On-Site Representative that the Contractor has assumed full responsibility for determining and verifying all quantities, dimensions, field construction criteria, materials, catalog numbers, and similar data, and that he has reviewed or coordinated each submittal with the requirements of the Specifications.
- F. All engineering data shall be identified by use of the nomenclature established by the Plans and Specifications. Equipment drawings shall have the equipment name and number clearly displayed. Material drawings shall have the structure name and structure number (when applicable) clearly displayed.
- 1.02 CORRESPONDENCE
 - A. Correspondence forwarding engineering data shall be addressed to the Owner and Owner's Onsite Representative as follows.

To the Owner: Poly Met Mining Inc. NorthMet Project P.O. Box 475; County Road 666 Hoyt Lakes, MN 55750-0475 Attention: **Mr. Jim Tieberg**

Copies to the Owner: Poly Met Mining Inc. Attention: _TBD_____

To the Owner's On-site Representative:

Poly Met Mining Inc. NorthMet Project P.O. Box 475; County Road 666 Hoyt Lakes, MN 55750-0475

Copies to the Project Engineer: TBD

B. A letter of transmittal shall accompany all submittals of engineering data and shall include a list of the data included in the transmittal. Lists shall include manufacturer's drawing numbers

		Description Operations
ARR	Submittals	Poly Met Mining Inc.

identified with the corresponding project equipment or structure nomenclature as applicable. The letter shall be identified by the project name.

1.03 PROGRESS SCHEDULE

- A. Submit an estimated progress schedule and a finalized progress schedule in accordance with the requirements of the General Conditions.
- B. Update the schedule on a weekly basis for presentation, discussion, and distribution at the weekly progress meeting.

1.04 SCHEDULE OF VALUES AND PROGRESS PAYMENT SCHEDULE

- A. Submit a schedule of values for the Work. The schedule shall be broken out as follows for each Bid Price item and each Unit Adjustment Price item on the Bid Form:
 - 1. Item description.
 - 2. Unit of measure upon which the item is based.
 - 3. Contractor's estimated quantity (number of units upon which the total price for the item is based: for Unit Adjustment Price items, enter $\underline{0}$ for quantity).
 - 4. Total unit price, including materials, equipment, labor, overhead, and profit (for Unit Adjustment Prices, shall be same unit price as on the Bid Form).
 - 5. Extension (total price for the item, calculated by multiplying the number of units by the total unit price).
- B. Submit a schedule of anticipated progress payment requests with the schedule of values. The proposed progress payment schedule shall be based on monthly or target-percentage invoicing for Work completed, and shall be closely coordinated with the schedule of values. Resubmit a revised schedule of anticipated progress payment requests whenever the progress schedule is updated or revised. Update the payment schedule each time an actual payment request varies more than 10 percent from the schedule. The progress payment schedule shall take into consideration retainage if applicable.
- C. The schedule of values and anticipated progress payment schedule shall be subject to review and approval by Owner. If, in the opinion of Owner, the schedules do not contain sufficient detail or appear to be unbalanced, the Owner may require Contractor to revise and resubmit the schedules and/or provide documentation to justify Contractor's distribution. Contractor shall correct such deficiencies and resubmit the schedules.

1.05 REVIEW OF SUBMITTALS

A. The Owner's On-Site Representative's review of engineering data will cover only general conformity of the data to the Specifications, external connections, and interfaces with equipment and materials furnished under separate specifications. The Owner's On-Site Representative's review does not indicate a thorough review of all dimensions, quantities, and details of the equipment, material, device, or item indicated or the accuracy of the information or documentation submitted; nor shall review or approval by the Owner's On-Site Representative be construed as relieving the Contractor from any and all responsibility for errors or deviations from the requirements of drawings and specifications.

1.06 SUBMITTAL FOR INFORMATION OR DOCUMENTATION

A. Submit 2 copies to Owner's On-Site Representative and 2 copies to Owner.

Poly Met Mining Inc.	Submittals	BARR
Permitting Specifications	01300-2	

- B. Unless otherwise specified, submittal shall be made at least 1 day before the subject of the submittal is to be incorporated into the Work.
- C. Submittal is for the purpose of formal verification that the subject of the submittal conforms to the requirements of the Specifications, for formal documentation of the Work, or both.
- D. No action is required by Owner or Owner's On-Site Representative. Owner's On-Site Representative will generally notify Contractor if deficiencies are identified; however Contractor is solely responsible for ensuring that the subject of the submittal conforms to the requirements of the Specifications.

1.07 SUBMITTAL FOR REVIEW

- A. Submit 2 copies to the Owner's On-Site Representative.
- B. Unless otherwise specified, submittal shall be made at least 10 days before the subject of the submittal is to be incorporated into the Work. Owner's On-Site Representative will respond within 5 days from receipt of submittal.
- C. Submittal is for the purpose of providing opportunity to Owner's On-Site Representative for review and comment on the subject of the submittal.
- D. Owner's On-Site Representative will respond to the submittal either with a list of comments or indicating no comments.
- E. If Owner's On-Site Representative's comments indicate a deficiency with respect to the requirement of the Specifications, Contractor shall amend the submittal and resubmit. Owner's On-Site Representative will again respond to the resubmittal.
- F. If Owner's On-Site Representative's comments are in regards to an issue which is based on Contractor's discretion, Contractor shall furnish additional information, provide justification, and otherwise cooperate in addressing and resolving Owner's On-Site Representative's comments.
- G. Contractor shall remain solely responsible for ensuring that the subject of the submittal conforms to the requirements of the Specifications.

1.08 RECORD DOCUMENTS

- A. Submit record documents prior to Substantial Completion.
- B. Record documents shall accurately reflect the as-constructed condition.

1.09 WARRANTY AND GUARANTEE CERTIFICATES

- A. Submit warranty and guarantee certificates prior to Substantial Completion.
- B. Warrantee and guarantee certificates shall be signed by Contractor, Installer, Manufacturer, and others as required by the Specifications.

1.10 BASIS FOR COMPENSATION

A. The Contractor's cost for work under this Section shall be included in the Bid Price and no additional compensation will be provided.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION [NOT USED]

END OF SECTION 01300



QUALITY CONTROL

PART 1 GENERAL

FIELD QUALITY CONTROL 1.01

- Complete construction quality control for the Work as described in these Specifications, unless A. specified as the responsibility of the Owner.
- B. Retain an independent registered land surveyor licensed in the State of Minnesota for performing quality control on line and grade of the Work. The quality control survey data shall be available for review at all times by Owner or Owner's On-Site Representative.
- C. Retain an independent soil and material testing firm(s) for performing the quality control testing. The quality control data shall be available for review at all times by Owner or Owner's On-Site Representative.
- All quality control test results will be used by Owner to demonstrate compliance with project D. permit requirements. Tests shall be performed and samples shall be collected at random locations such that the test results may be considered representative. Testing shall be performed or samples collected at specific locations determined by Owner's On-Site Representative, if requested.
- E. Owner's On-Site Representative shall have the authority to direct testing performed by Contractor's independent soil and material testing firm.

1.02 **SUBMITTALS**

- Submit for approval name(s) and qualifications of Contractor's independent registered land A. surveyor and Contractor's independent soil and material testing firm(s).
- Submit for information on a daily basis, the following information: B.
 - Survey data for each day that survey work is performed. 1.
 - Soil compaction data for each day that soil compaction data is collected. 2.
 - Other soil and material test data daily as it is available. 3.
- C. Submit for documentation a tabulation of all results of survey work performed. This submittal shall be made prior to substantial completion. The tabulation shall be signed by the registered land surveyor. The tabulation shall contain the following information for each survey location:
 - 1. A unique identification number.
 - 2. Coordinates.

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- Elevation of the finished surface of each material (e.g. top of Composite Liner subgrade, 3. top of Fill Material for Perimeter Dam construction, top of Temporary Cover, top of Final Cover Granular Drainage Material, top of Rooting Soil, top of Topsoil; existing surface and finished surface for stockpiles).
- Submit for documentation the results of all soil compaction testing performed. Test results shall D. be compiled in a report-format and submitted prior to substantial completion of Work.

PolyMet Mining Corporation	Quality Control	
Permitting Specifications	01400-1	

1.03 SURVEY VERIFICATION REQUIREMENTS

- A. Contractor's independent registered land surveyor shall verify that elevations, grades, slopes, and material thickness constructed by Contractor are within the tolerances specified in Section 02220. Surveying results will be used by Owner to demonstrate compliance with permit requirements. Material thickness shall be determined from the elevation difference between shots taken at the same coordinate location. On slopes, the surveyed vertical thickness shall be adjusted by calculating the thickness perpendicular to the slope for presentation in the submittals. The surveying work shall include determining elevations at specific locations on a matrix of survey points as described below.
 - 1. Perimeter Dams: For elevation, grade, and material thickness verification, survey shots shall be taken on the top of dam fill material. The toe, midpoint, and top of each dam shall be surveyed at 100-foot intervals along the dam alignment.
 - 2. Subgrade: For elevation and grade verification, survey shots shall be taken on the subgrade surface at points shown on the Drawings or to be specified by Owner's On-Site Representative.
 - 3. Wick Drain Header Pipe (applicable if Wick Drains are installed): For elevation and grade verification, survey shots will be taken on the top of pipe elevations at a maximum of 50-foot intervals (lineal) and at all changes in horizontal and vertical alignment.
 - 4. Liner System: For elevation and grade verification, survey shots will be taken on the top of the Liner System subgrade at a maximum of 50-foot grid pattern and at all changes in horizontal and vertical alignment.
 - 5. Water Return and Residue Discharge Pipes: For elevation and grade verification, survey shots shall be taken on the top of pipe elevations at a maximum of 50-foot intervals (lineal) in the areas where pipe has little or no significant change in elevation, and at changes in grade. Coordinate the location of these shots with Owner or Owner's On-Site Representative.

1.04 CONTRACTOR TESTING RESPONSIBILITIES

- A. Contractor shall retain an independent testing laboratory(s).
- B. Contractor shall be responsible to perform all the testing requirements described in these Technical Specifications unless noted as the responsibility of the Owner.

1.05 OWNER TESTING RESPONSIBILITIES

- A. Owner shall be responsible to perform specific testing requirements for the following construction materials:
 - 1. LTVSMC Coarse Tailings all testing specified in Section 02220
 - 2. Geomembranes 3rd Party Destructive Testing, see Section 02273
 - 3. Geocomposite Layers all testing specified in Section 02275
 - 4. Geosynthetic Clay Liner 3rd Party Testing, see Section 02274
- B. Contractor shall provide material samples, and/or coordinate with and provide access to work areas for Owner's On-Site Representative and Owner's independent testing firms for sampling and/or testing.



C. Work failing to meet Specifications shall be repaired at Contractor's expense. Owner will perform additional testing after repairs are completed. The expense of retesting may be charged to Contractor. Contractor may ask to review results of Owner's testing during construction.

1.06 PRESENTATION OF DATA

- A. All survey and compaction test data shall be summarized and submitted to Owner or Owner's On-Site Representative on a daily basis. Failure to submit data on a daily basis shall be cause for Owner to suspend Contractor's operations until submittals are made current. Contractor shall not be entitled to additional compensation for any suspension of operations ordered by Owner due to Contractor's failure to submit data on a daily basis.
- B. Survey data shall be summarized in a tabular format listing each survey point by unique identification number, coordinate, elevation, difference from previous elevation (material thickness), and required material thickness as appropriate. Required material thickness is measured perpendicular to the slope. Material thickness based upon survey shots at the same coordinate location shall be corrected to the perpendicular-to-slope thickness.
- C. Compaction test data shall be summarized in a tabular format listing each compaction test by unique identification number, horizontal coordinate, elevation (within 0.5 foot vertical of actual location), reference proctor, in-place moisture content, dry density, and percent compaction.

1.07 BASIS FOR COMPENSATION

A. The Contractor's cost for work under this Section shall be included in the Lump Sum Bid price and no additional compensation will be provided.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION [NOT USED]

END OF SECTION 01400

TEMPORARY UTILITIES

PART 1 GENERAL

1.01 TEMPORARY UTILITIES

- A. <u>Water</u>: Potable water is not available at the Project Site. Make all arrangements necessary to provide water for potable consumption. Water used for construction purposes need not be potable but must meet all applicable surface water quality criteria. Non-potable water will be available from an on-site location designated by Owner. The costs of furnishing potable and other water and water usage shall be included in the Bid Price and no additional compensation will be provided.
- B. <u>Sanitary Facilities</u>: Contractor shall provide sanitary facilities for use by Contractor's employees, subcontractors, suppliers, Owner's On-Site Representative, Owner and all other persons to be working on the Project Site. Sanitary facilities shall, as a minimum, comply with the requirements of applicable Laws and Regulations for temporary sanitary facilities and shall be emptied and sanitized at the frequency needed to be maintained in a clean and useable condition. Sanitary facilities shall be maintained until Substantial Completion unless earlier removal is approved by Owner or Owner's On-Site Representative. The cost of sanitary facilities shall be included in the Bid Price and no additional compensation will be provided.
- C. <u>Electricity</u>: Furnish portable electric power generators necessary for construction of the Work. Should Contractor need electric power service for Contractor's purposes, it shall be the Contractor's responsibility to arrange for and pay for such service. The cost shall be included in the lump sum price and no additional compensation will be provided. Owner will provide access to electric service connection at the location of the Contractor's office location, and provide electric service to the Office Trailer furnished for Owner's On-Site Representative's use.
- D. <u>Telephone and Fax</u>: Phone service is not readily available at the Project Site. Cellular phone service may not be available throughout the entire Project Site. Make arrangements for the Contractor's phone and fax service during the Project. The cost of Contractor's telephone service, fax service, and usage, shall be included in the Bid Price and no additional compensation will be provided.
- E. <u>Fire Protection</u>: Make all arrangements necessary to ensure that the Project Site and the Work have adequate fire protection services throughout the duration of the Work. Any special fees or charges imposed by governmental units or other organization to provide such services shall be paid by Contractor. The cost of fire protection shall be included in the Bid Price and no additional compensation will be provided.

1.02 OFFICE TRAILER

BARR

A. Contractor shall furnish office trailer space for use by Owner and Owner's On-Site Representative. The space for Owner's On-Site Representative shall have a minimum of 120 square feet of floor area, and at minimum be equipped with a desk, a table, and two chairs. The space shall be furnished with electrical service, operable lighting, heat, and air conditioning. This office space may be located in a trailer with other facilities but must be accessible to Owner and Owner's On-Site Representative at all times and must be secured by a separation wall and lockable door. Owner will provide 240 volt, 110 AMP service to the trailer and will make and disconnect electrical service as requested by the Contractor.

1.03 BASIS FOR COMPENSATION

A. The Contractor's cost for work under this Section shall be included in the Lump Sum Bid and no additional compensation will be provided.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION [NOT USED]

END OF SECTION 01510



STORM WATER EROSION PREVENTION AND SEDIMENT AND DUST CONTROL

PART 1 GENERAL

1.01 DESCRIPTION

- A. This section covers construction of all stormwater erosion prevention and sediment controls as needed to conduct the Work in accordance with the Technical Specifications, Drawings, Agreement, and in compliance with local, county, state, federal and other jurisdictional rules and regulations.
- B. This work consists of: 1) managing storm water runoff and project related water discharges in order to minimize sediment pollution during construction and over the life of the contract and 2) managing the discharges as set forth in any applicable regulatory agency permit. The work includes furnishing, installing, maintaining and utilizing storm water best management practices and any work specified in conjunction therewith as well as removing temporary sediment control devices when no longer necessary.
- C. Control dust generation on access roads to the Project Site and within construction limits. Comply with requirements of project-specific Air Quality Management Plans/Fugitive Emissions Control Plans.

1.02 BASIS FOR COMPENSATION

A. The Contractor's cost for work under this Section shall be included in the Bid Price and no additional compensation will be provided.

1.03 REFERENCES

- A. Protecting Water Quality in Urban Areas, MPCA 2000.
- B. Stormwater Management for Construction Activities, EPA 1992.
- C. Developing Pollution Prevention Plans and Best Management Practices, EPA 1992.
- D. Erosion Control Handbook, Mn/DOT 2006.
- E. Minnesota Stormwater Manual, Version 2, January 2008.
- F. Stormwater and Wetlands: Planning Evaluation Guidelines, MPCA 1997.
- G. Construction Stormwater Pollution Prevention Plan (SWPPP) NorthMet Project Plant Site, Barr 2016.

PART 2 PRODUCTS

2.01 MATERIALS

BARR

A. Water used for dust control may be obtained from an on-site location designated by Owner.

B. Acceptable temporary erosion control devices include, but are not necessarily limited to, silt fence, straw and hay bales, mulch, geotextiles, and vegetative cover.

2.02 EQUIPMENT

A. Water tank trucks equipped with water cannon capable of delivering water through either front or rear-mounted nozzles. Tank trucks shall be of sufficient size and mobility and carry a sufficient quantity of water to control dust generated by Contractor's activities.

PART 3 EXECUTION

BARR

3.01 STORM WATER SEDIMENT AND EROSION CONTROL

- A. The Owner is responsible for obtaining the MPCA General Stormwater Construction Permit (MNR 100001) for authorization to discharge storm water associated with the project construction activity under the National Pollutant Discharge Elimination System (NPDES) program and providing a copy of the permit to the Contractor prior to beginning construction activities at the Project site. The Contractor will be required to co-sign the MPCA Stormwater Permit Application and is jointly responsible for compliance with Parts II.B, Part II.C, and Part IV of the MPCA Stormwater Construction Permit (MNR 100001).
- B. The Owner is responsible for preparing the Storm Water Pollution Prevention Plan (SWPPP) required under the General Stormwater Construction Permit (MNR 100001) and providing a copy of the SWPPP to the Contractor prior to beginning construction activities at the Project Site.
- C. The Owner is responsible for coordinating and obtaining any City, Town, or County permits.
- D. The Contractor is responsible for conducting all construction activities in full compliance with the applicable requirements of the MPCA General Stormwater Construction Permit (MNR 100001), the SWPPP and any additional requirements that may be contained in any City, Town or County permits. The Owner will provide the Contractor with copies of all relevant permits and the SWPPP prior to the start of construction activities.
- E. The Contractor is responsible for compliance with all requirements specified in Section 3.01 D until construction is complete, and the Project Site has undergone final stabilization. Once the Owner is satisfied that these conditions have been met, the Owner will prepare and submit the Notice of Termination (NOT) to the MPCA.
- F. Install erosion control devices and materials at locations as directed by Owner or Owner's On-Site Representative where soil erosion at the Project Site may occur due to Contractor's activities.
- G. Install temporary erosion control devices during the progress of the work and maintain them until permanent erosion control (turf establishment, aggregate surfacing, etc.) has been established.

H. Strictly follow all additional requirements of Owner's SWPPP (to be provided by Owner under separate cover).

3.02 EROSION PREVENTION AND SEDIMENT CONTROL

- A. The Contractor has responsibility for charge and care of the Project and shall take necessary precautions against injury or damage to the Project by action of the elements. In addition, the Contractor shall take necessary precautions to prevent off site damage resulting from work conducted on the Project or Project related storm water runoff.
- B. The Contractor is responsible for preventing or minimizing sediment loss from the Project by directing storm water runoff to constructed ponds and sediment traps as well as installing temporary sediment control devices in drainage locations where runoff can leave the Project limits and/or enter into environmentally sensitive areas. The Contractor shall schedule, construct and/or install temporary sediment control and storm water management measures as required by the Contract and as stated in the permits required for the Project.
- C. The Contractor shall install temporary storm water management and sediment control devices in conformity with the details, typical sections, and elevation controls shown in the Drawings. The actual installation location of temporary storm water management and sediment control devices may be adjusted from that indicated in the Plan to better accommodate the actual field conditions and increase the effectiveness of a device.
- D. Sediment control measures must be installed down gradient prior to or in conjunction with soil disturbing activities. The Contractor shall schedule, install and maintain temporary sediment control measures as an ongoing effort on a site-by-site basis over the life of the Contract. The Contractor is responsible for minimizing the potential for sedimentation after temporary sediment control devices have been installed by implementing a good quality erosion control program and staging construction as needed.
- E. The Contractor shall schedule and phase construction in critical resource areas to the best of his ability in order to minimize the potential of sediment entering into a critical resource. Critical resources include but are not limited to, protected wetlands, surface waters, trout streams, Special Waters, impaired waters, rivers, and endangered species habitat. Measures to minimize sediment potential include practices such as hand clearing and grubbing, limited bare soil exposure time, and immediate final establishment of vegetation.

3.03 FUGITIVE DUST EMMISSIONS CONTROL

BARR

- A. The Owner is responsible for obtaining air quality permits and preparing and complying with a Fugitive Dust Emissions Control Plan.
- B. The Contractor is responsible for complying with the Fugitive Dust Emissions Control Plan. A copy of the Plan will be provided by the Owner.
- C. Apply water to roads used by Contractor's equipment as directed by Owner or Owner's On-Site Representative to control dust generated by wind or by Contractor's vehicle traffic.
- D. Apply water to ground surfaces within the construction limits as directed by Owner or Owner's On-Site Representative to control dust generated by Contractor's activities at the Project Site.

E. Strictly follow all additional requirements of Owner's Fugitive Emissions Control Plan (to be provided by Owner under separate cover).

END OF SECTION 01560

Storm Water Erosion Prevention and Sediment and Dust Control PolyMet Mining Corporation

BARR

EXCAVATING, BACKFILLING, AND COMPACTING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. All work included in this Section shall be performed in accordance with the following paragraphs, the General Requirements set forth in Division 1 of these Specifications, and the provisions of the other Contract Documents.
- B. Work covered by this section includes furnishing all supervision, labor, materials, and equipment required to complete all general or miscellaneous earthwork at the Site to grade and lines shown on the Drawings including, but not limited to:
 - 1. Material source development to obtain construction materials.
 - 2. Excavating, segregating, loading, hauling, and placing or stockpiling existing rock and soil in Emergency Basin Area as specified.
 - 3. Load, haul, and place sand and drainage aggregate for wick drain and seepage collection drain construction.
 - 4. Excavate, load, haul, and place Fill Material for Perimeter Dam construction.
 - 5. Placement of Rip-Rap at specified locations.
 - 6. Hauling and placing Coarse Aggregate.
 - 7. At Closure placing Temporary and Final Cover.
 - 8. Placement of erosion protection material.
 - 9. Controlling dust within work areas.

1.02 BASIS FOR COMPENSATION

A. Work included under this Section of these Specifications shall be included under the Lump Sum Bid and the Unit Adjustment Price for Rock Excavation

1.03 SUBMITTALS

BARR

- A. Submit soil testing and survey data as specified in Section 01400.
- B. Location of off-site source of materials.
- C. Testing of off-site source of materials as per the project Construction Quality Assurance Manual and these Specifications.
- D. Name, address, telephone number and contact person of independent soils laboratory.
- E. Proposed haul road plan for transportation of all off-site materials to the project site.
- F. Provide specified permeability and gradation testing on aggregate and drainage layer materials at least 21 days prior to installation for approval.
- G. Fugitive Dust Emissions Control Plan.
1.04 REFERENCES

- A. American Society for Testing and Materials, Current Edition, hereafter referred to as ASTM.
- B. Minnesota Department of Transportation Standard Specifications for Construction; 2005 Edition.

1.05 SEQUENCING AND SCHEDULING

- A. Owner will be evaluating results of the independent registered land surveyor's grade, slope, and material thickness verifications, collecting material samples, and conducting field testing of materials throughout the duration of the Project, as described in Section 01400 of these Specifications. Do not proceed with subsequent operations until Owner or Owner's On-Site Representative has been notified, has been given opportunity to test or review the Contractor's test data, and has informed the Contractor of any test results that have been gathered.
- B. The required completion date for the Work as described in these Contract Documents is specified elsewhere in these Contract Documents.

1.06 JOB CONDITIONS

- A. It shall be solely the Contractor's responsibility to review available tests and reports, conduct additional tests, and otherwise determine to its own satisfaction the location and nature of all surface and subsurface features and the soil and water conditions that may be encountered. Owner's information on site conditions may be reviewed at Owner's offices as scheduled with Owner.
- B. Use of explosives will not be permitted except as pre-approved by Owner.
- C. Contractor shall be solely responsible for determining the means and methods for meeting the excavation and compaction requirements unless otherwise specified herein, except that compaction by flooding or puddling or other means that involve saturation or over-wetting the soil will not be permitted.
- D. Provide all shoring, bracing, sheet piling, trench boxes, tie backs, and other measures required to perform all Work in accordance with Laws and Regulations. Specifically, all excavations shall conform to the requirements of OSHA set forth in 29 CFR 1926, Subpart P (Occupational Safety and Health Standards-Excavations).

1.07 QUALITY CONTROL

- A. Contract with a qualified soils testing firm, subject to approval by Owner, to conduct all sampling and testing of Fill Materials and other soil materials, as specified in these Specifications. The testing laboratory will perform appropriate tests including sieve analysis, standard Proctor moisture-density testing an in-place moisture-density testing, and other tests as needed.
- B. Provide testing firm safe access to the Work and materials to be tested, in accordance with the following minimum provisions:



Permitting Specifications

- 1. All Fill Material used will be assessed on a regular basis by testing firm and Owner or Owner's On-Site Representative. Owner or Owner's On-Site Representative will reject all material which does not conform to the material specifications herein as required for each fill zone. Rejected material placed shall be removed at Contractor's expense.
- 2. Particle size samples shall be taken of Fill Materials at least twice for each material source and at least once for every 20,000 cubic yards of material placed.
- C. Construction Testing: The following testing will be conducted during construction:
 - 1. Perform Standard Proctor moisture-density relationship analyses according to ASTM D 698 for at least two samples for each borrow source location.
 - 2. Conduct soil classification according to ASTM D 2487 for at least two samples for each borrow source location.
 - 3. Perform in-place moisture-density testing according to ASTM D 1556 (sand cone) or ASTM 2922 (nuclear densometer) at least once every lift at a minimum frequency of approximately 500 feet of dam length, and at least once a day when compaction activities are being performed.
 - 4. Report whether each in-place moisture-density test passed or failed. If any test fails, report what actions were taken to correct material compaction, and what additional tests will be submitted demonstrating acceptable (passed) compaction.
 - 5. Only passing tests will be considered in the count of material tests taken, as specified above.

PART 2 PRODUCTS

2.01 GENERAL

A. All Fill Materials shall be free of wood, organic soils, large boulders, topsoil, snow, ice, and other unsuitable materials detrimental to performance of the dam.

2.02 MATERIALS AND MATERIAL SOURCES

A. Fill Material: Materials conforming to the specifications for Fill Materials are located within designated Owner-supplied material sources. These materials include LTVSMC Coarse Tailings, and Common Borrow consisting of blasted bedrock. The general location of material sources shall be designated by Owner and will be shown in the Construction Drawings. All Contractor-supplied materials used must be approved by Owner or Owner's On-Site Representative. If unsuitable Owner supplied materials are encountered, Contractor shall notify Owner and Owner may choose to use the material or direct Contractor to alternate material source sites. The material for use as the dam fill shall consist of inorganic soil classified as a CL, SC, SM, or SP as defined by the Unified Soil Classification System.

B. Granular Drainage Material:

- 1. 100 percent passing 3/8-inch sieve and maximum 5 percent by weight which passes the #200 Sieve as specified.
- 2. $k \ge 1 \ge 10^{-3}$ cm/sec and $k \ge 1 \ge 10^{-2}$ as specified.
- 3. Rounded to sub-rounded particles per ASTM (when in contact with geomembrane).
- C. Coarse Aggregate:

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1. Granular material, bank-run sand and bank-run gravel, consisting of rounded durable particles. Crushed aggregate not allowed. Limestone not allowed.

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- 2. Grain size range from maximum diameter of 1-1/2 inches to minimum diameter of 5/8 inch (maximum 5 percent by weight passing #4 sieve).
- 3. Uniformity Coefficient: Less than 4.
- 4. Rounded particles per ASTM.
- D. Rooting Soil: (TBD)
- E. Topsoil: (TBD)
- F. Common Borrow: Common Fill on Detail 2/23(TBD)
- G. Rip-Rap: Rip-Rap materials used shall be in accordance with Section 3601 of Minnesota Department of Transportation's 2005 Edition of Standard Specifications for Construction.
- H. Fine Filter Aggregate

PART 3 EXECUTION

3.01 GENERAL

- A. Locate and protect overhead and underground utilities, unless indicated otherwise on the Drawings.
- B. Provide temporary controls such as diversions and dewatering equipment to prevent surface runoff from entering excavations and to remove ponded water from excavations. Maintain excavations in a dry and stable condition at all times.
- C. Examine the area prior to and while performing earthwork. If unsatisfactory conditions occur during the Work, Contractor shall not proceed with the Work until satisfactory conditions have been established.
- D. Determine the location and nature of all surface and subsurface obstacles and the soil and water conditions that will be encountered during construction.
- E. Institute and maintain, as directed by Owner, adequate dust control measures such as sprinkling, for all its work areas, haul routes, and parking areas.

3.02 PREPARATION

- A. Make arrangements to locate all existing utilities and underground facilities in the areas of the Work. If any are to remain in place, Contractor shall provide adequate means of protection during earthwork operations.
- B. Protect structures, fences, utilities, wells, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.
- C. Control surface water sufficiently to permit placement of materials in dry conditions.

Permitting Specifications

3.03 EXCAVATION

BARR

- A. Construct excavations in accordance with applicable Laws and Regulations.
- B. Excavate rock and soil in the Emergency Basin Area to the lines, elevations, slopes, and dimensions shown on the Drawings, or as necessary to complete the Work shown on the Drawings.
- C. Excavate additional Fill Materials from areas shown in the Construction Drawings as needed to complete the Work shown on the Drawings.
- D. Materials excavated for construction that are unsuitable for reuse in the project shall be neatly stockpiled as described in Subpart 3.07.

3.04 MATERIAL PLACEMENT AND COMPACTION

- A. Placement of Fill Materials will be performed over the existing ground as shown on the Drawings. Contractor shall keep Owner or Owner's On-Site Representative informed of its operations so that proper inspection and testing can be implemented. No fill material shall be placed on frozen subgrade unless approved by Owner or Owner's On-Site Representative.
- B. Finish all areas to the lines and grades shown on the Drawings within the tolerances provided in this Specification and as approved by Owner or Owner's On-Site Representative. All finish grading shall be accomplished using normal mechanical construction equipment. The final constructed dam tops shall be covered and finished with materials shown on the Drawings.
- C. Compact the placed Perimeter Dam Fill Materials as shown on the Drawings. All fill shall be compacted in approximately horizontal lifts. Compact each layer to required density for each area classification.
- D. Remove and replace fill that is too wet to permit compaction as specified.
- E. Compact the material around structures with hand-compaction equipment which is designed for the compaction of backfill. Heavy equipment shall not be utilized for compaction within three (3) feet of structures, or a greater distance if necessitated by equipment or site conditions.
- F. Place and compact Fill Materials as specified on the Drawings to an in place density as measured by ASTM D 698.
 - 1. Perimeter Dams: Uniformly compact the full depth of each lift with a smooth drum or Sheepsfoot vibratory compactor. Lifts shall not exceed 12 inches loose thickness prior to compaction. Compact each lift to at least 95% of standard Proctor maximum dry density. Control moisture as needed to achieve compaction specification.
 - 2. Pipe Trench Backfill: Place a minimum of 6-inches (unless shown otherwise on Drawings) of Pipe Bedding Material in bottom of trench before laying pipe. Place Coarse Aggregate (unless specified otherwise) on all sides and to depth of 6 inches above pipe. Backfill remainder of trench with Common Borrow or other approved Fill Material in maximum 12-inch loose lifts compacted to at least 95% standard Proctor maximum dry density.
- G. Place Coarse Aggregate within the Leakage and Drainage Collection sumps as shown on the Drawings.

Excavating, Backfilling, & Compacting

H. Place Rip-Rap as shown on the Drawings.

3.05 SITE GRADING

- A. Grade intermediate slopes to minimize erosion potential. Maintain temporary erosion controls as necessary to minimize erosion.
- B. Smooth-grade finished ground on exterior slopes of berms, along access roads, and other areas disturbed by Contractor's activities, to uniform levels or slopes between points where elevations are shown, or between such points and existing ground.

3.06 DISPOSAL OF EXCAVATED SOIL

A. All excavated materials not incorporated into the construction shall be stockpiled in a location designated by Owner. All stockpiles left in place by Contractor shall be appropriately graded so as to provide proper drainage and left in a neat condition.

3.07 TOLERANCES

- A. Construct the excavation and backfill work within the dimensional tolerances given below. Alignment, elevation and thickness tolerances are acceptable deviations from the elevations and material thicknesses shown on the Drawings. No compensation will be made for additional work on materials required by Contractor as a result of construction beyond specified elevations, thicknesses, or grades.
- B. Alignment Tolerances:
 - 1. Perimeter Dam Centerline Horizontal Alignment: +/- 0.5 foot.
 - 2. Crest of Slope Alignment Horizontal Alignment:
 - a. Interior slope: +/- 0.5 foot.
 - b. Exterior slope: +/-0.5 foot at any location, +/-0.5 foot average.
 - 3. Toe of Slope Horizontal Alignment:
 - a. Interior slope: +/- 0.5 foot.
 - b. Exterior slope: +/- 0.5 foot at any location, +/- 0.5 foot average.
- C. Elevation Tolerances:
 - 1. Crest of Perimeter Dams: + 0.2 foot, -0.0 foot.
 - 2. Liner System subgrade: +/- 0.2 feet; specified base slopes must be achieved as minimums.
- D. Thickness Tolerances
 - 1. Rip-Rap: -0.0 foot, +0.5 foot
 - 2. Coarse Aggregate: -0.0 foot, +0.2 foot
 - 3. Rooting Soil/Topsoil: -0.0 foot, +0.2 foot

Permitting Specifications

3.08 DEBRIS MANAGEMENT

A. Manage debris resulting from the Work or encountered on Site in accordance with applicable Laws and Regulations. Debris may include abandoned electrical cable, abandoned well materials, or other man-made objects.

END OF SECTION 02220



PolyMet Mining Corporation

SECTION 02240

DEWATERING AND DIVERSION

PART 1 GENERAL

1.01 DESCRIPTION

- A. All work included in this Section shall be done in accordance with the following paragraphs as well as the general requirements as outlined in Division 1 of these Specifications.
- B. The work covered by this section of the Specifications consists of furnishing all labor, equipment, and materials, and performing all operations necessary for dewatering the Project Site during construction.

1.02 REFERENCES

- A. Protecting Water Quality in Urban Areas, MPCA 2000.
- B. Stormwater Management for Construction Activities, EPA 1992.
- C. Developing Pollution Prevention Plans and Best Management Practices, EPA 1992.
- D. Erosion Control Handbook, Mn/DOT 2006.
- E. Minnesota Stormwater Manual, Version 2, January 2008.
- F. Stormwater and Wetlands: Planning Evaluation Guidelines, MPCA 1997.
- G. Construction Stormwater Pollution Prevention Plan (SWPPP) NorthMet Project Plant Site, Barr 2016.
- 1.03 BASIS FOR COMPENSATION
 - A. Work included under this Section of these Specifications shall be included under the Bid Price.

PART 2 PRODUCTS

2.01 PUMPS

A. Supply and maintain pumps capable of pumping water from excavation areas to permitted discharge locations in the event of heavy rains or runoff so work will not be significantly delayed and water will not saturate the soils.

Permitting Specifications

PART 3 EXECUTION

3.01 GENERAL

- A. Furnish and operate temporary controls such as diversions and dewatering equipment to prevent surface water and groundwater from entering and ponding in excavations and to allow construction under dry conditions.
- B. Contractor shall be aware that flows will vary in proportion to recent rainfall events, and with rapid and heavy rains, ponded water may accumulate. Contractor shall be responsible for and take measures to protect his personnel, equipment, and supplies from such an event.
- C. Discharge water from construction de-watering to an area designated by Owner. Identify conditions requiring water discharge and propose discharge points to Owner. Provide necessary measures to prevent erosion or transportation of sediments at the discharge locations. Remove and dispose of transported sediment.

END OF SECTION 02240



Permitting Specifications

SECTION 02271

RIP RAP

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Work included in this section includes providing the rip-rap and associated materials as shown on the Drawings and specified herein, including ditch check construction as may be required for erosion control but not shown on Drawings.
- 1.02 **BASIS FOR COMPENSATION**
 - Compensation for all Work included under this Section shall be included in the Bid Price. A.

1.03 **SUBMITTALS**

- A. Location of source and type of rip-rap material.
- B. Test results.
- C. Submit in accordance with Section 01300.

1.04 REFERENCES

- Minnesota Department of Transportation Standard Specifications for Construction; 2016 A. Edition.
- B. Latest edition of the following American Society for Testing and Materials (ASTM) standards:
 - 1. ASTM D 5519- Standard Test Methods for Particle Size Analysis of Natural and Man-Made Riprap Materials.

OUALITY CONTROL 1.05

- A. Contractor is responsible for completion of construction quality control as described below, except where specified as the responsibility of the Owner.
 - Rip-rap Soundness: 1 per source. 1.
 - Particle Size Analysis (ASTM D 5519): 1 per source. 2.

PART 2 PRODUCTS

- 2.01 MATERIALS
 - A. Rip-rap shall meet the requirements of MnDOT Construction Standard Specification 2511.2.
 - B. Filter Material shall meet the requirements of MnDOT Construction Standard Specification 2511.3.

	02271 1	Permitting Specification
BARR	Riprap	Poly Met Mining Inc

PART 3 EXECUTION

3.01 PREPARATION

- A. Grade and dress areas on which rip-rap is to be placed to lines and grades shown on Drawings or as required by Owner's On-Site Representative.
- B. Place filter material under rip-rap and cover completely. No filter material shall be exposed along edges or under rip-rap. Place rip-rap so filter material is not damaged.

3.02 INSTALLATION

- A. Place rip-rap in areas as shown on Drawings.
- B. Place rip-rap for ditch checks as needed for permit compliance and as specified herein.

END OF SECTION 02271

SECTION 02273

GEOMEMBRANES

PART 1: GENERAL

1.01 SUMMARY

A. This specification covers the technical requirements for the Manufacturing and Installation of the geomembrane. All materials shall meet or exceed the requirements of this specification, and all work will be performed in accordance with the procedures provided in these project specifications

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM)
 - 1. D 1004 Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
 - 2. D 1238 Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
 - 3. D 1505 Test Method for Density of Plastics by the Density-Gradient Technique.
 - 4. D 1603 Test Method for Carbon Black in Olefin Plastics.
 - 5. D 3895 Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry.
 - 6. D 4218 Standard Test Method for Determination of Carbon Black in Polyethylene Compounds.
 - 7. D 4833 Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
 - 8. D 5199 Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
 - 9. D 5397 Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test.
 - 10. D 5596 Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.
 - 11. D 5994 Standard Test Method for Measuring Core Thickness of Textured Geomembranes.
 - 12. D 6392 Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.
 - 13. D 6693 Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes.
 - 14. D 7240 Standard Practice for Leak Location using Geomembranes with an Insulating Layer in Intimate Contact with a Conductive Layer via Electrical Capacitance Technique (Conductive Geomembrane Spark Test).
- B. Geosynthetic Research Institute
 - 1. GRI GM 13 Test Properties, Testing Frequency and Recommended Warranty for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes.
 - 2. GRI GM 17 Test Properties, Testing Frequency and Recommended Warranty for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes.

1.03 DEFINITIONS

- A. Lot A quantity of resin (usually the capacity of one rail car) used in the manufacture of geomembranes. Finished rolls shall be identified by a roll number traceable to the resin lot used.
- B. Geomembrane Manufacturer (Manufacturer) The party responsible for manufacturing the geomembrane rolls.
- C. Geosynthetic Quality Assurance Laboratory (Testing Laboratory) Party, independent from the Owner, Owner's On-Site Representative, Manufacturer and Installer, responsible for conducting laboratory tests on samples of geosynthetics obtained at the site or during manufacturing, usually under the direction of the Owner's Representative.
- D. Installer Party responsible for field handling, transporting, storing, deploying, seaming and testing of the geomembrane seams.
- E. Panel- Unit area of a geomembrane that will be seamed in the field that is larger than 100 ft².
- F. Patch Unit area of a geomembrane that will be seamed in the field that is less than 100 ft².
- G. Subgrade Surface Soil layer surface which immediately underlies the geosynthetic material(s).

1.04 SUBMITTALS

- A. Furnish the following product data, in writing, to Owner's On-Site Representative prior to installation of the geomembrane material:
 - Resin Data shall include the following.
 a. Certification stating that the resin meets the specification requirements (Table 2.1).
 - 2. Geomembrane Roll
 - a. Statement certifying no recycled polymer and no more than 10% rework of the same type of material is added to the resin (product run may be recycled).
- B. The Installer shall furnish the following information to the Owner's On-Site Representative and Owner prior to installation:
 - 1. Installation layout drawings.
 - a. Must show proposed panel layout including field seams and details.
 - b. Must be approved prior to installing the geomembrane.
 - 2. Approved drawings will be for concept only and actual panel placement will be determined by site conditions.
 - 3. Installer's Geosynthetic Field Installation Quality Assurance Plan.
- C. The Installer shall, within 15 working days of their final demobilization from the Site, submit the following to the Owner's On-Site Representative:
 - 1. Certificate stating the geomembrane has been installed in accordance with the Contract Documents.
 - 2. Material and installation warranties.

3. As-built drawings showing actual geomembrane placement and seams including typical anchor trench detail.

1.05 QUALIFICATIONS

- A. Manufacturer
 - 1. Manufacturer shall have manufactured a minimum of 20,000,000 square feet of polyethylene geomembrane during the last year.
 - 2. Manufacturer shall have a minimum of ten years of continuous experience in the manufacture of low density polyethylene (LLDPE) geomembrane liner.

B. Installer

- 1. Installation shall be performed by Manufacturer and Owner-approved Installation Company.
- 2. Installer shall have installed a minimum of 50,000,000 square feet of polyethylene geomembrane for a minimum of 10 completed facilities.
- 3. Installer shall have worked in a similar capacity on at least 10 projects similar in complexity to the project described in the contract documents.
- 4. The Installation Supervisor shall have worked in a similar capacity on projects similar in size and complexity to the project described in the Contract Documents.
- 5. The Installer shall provide a minimum of one Master Seamer for work on the project who has completed a minimum of 1,000,000 square feet of geomembrane seaming work using the type of seaming apparatus proposed for the use on this Project.

1.06 MATERIAL LABELING, DELIVERY, STORAGE AND HANDLING

- A. Labeling Each roll of geomembrane delivered to the site shall be labeled by the Manufacturer. The label will identify:
 - 1. Manufacturer's name
 - 2. product identification
 - 3. thickness
 - 4. length
 - 5. width
 - 6. roll number
- B. Delivery- Rolls of liner shall be prepared to ship by appropriate means to prevent damage to the material and to facilitate off-loading.
- C. Storage- The on-site storage location for the geomembrane material, prepared by the Contractor to protect the geomembrane from punctures, abrasions and excessive dirt and moisture, shall have the following characteristics:
 - 1. level (no wooden pallets)
 - 2. smooth
 - 3. dry
 - 4. protected from theft and vandalism
 - 5. adjacent to the area being lined

D. Handling- Materials are to be handled so as to prevent damage.

1.07 WARRANTY

- A. Material shall be warranted against Manufacturer's defects for a period of 5 years from the date of geomembrane installation.
- B. Installation shall be warranted against defects in workmanship for a period of 1 year from the date of geomembrane completion.
- 1.08 MEASUREMENT AND PAYMENT
 - A. Compensation for all Work covered under this Section shall be included in the Lump Sum Contract Price Bid.
 - B. Partial payments by Owner for Geomembrane Liner are predicated on timely receipt of geomembrane submittals by Contractor.
 - C. Lump Sum Contract Price Bid shall include any allowances for waste, overlap, and anchoring.
 - D. Compensation shall include full compensation for furnishing all labor, material, tools, equipment, and incidentals.

PART 2: PRODUCTS

2.01 MATERIALS

- A. Raw Materials:
 - 1. LLDPE geomembrane, and extrudate rods used for this project shall be manufactured of new, first quality resins, designed specifically for use in flexible membrane liner installations.
 - 2. LLDPE resin used in manufacturing geomembranes used for this Project shall meet the specifications set forth in the latest revision of the Geosynthetics Research Institute (GRI) for LLDPE.
 - 3. Recycled Polymer shall not be added to the resin. However, the resin may contain polymer reclaimed during the manufacturing process if reclaimed polymer content does not exceed 2 percent by weight.
- B. Geomembrane Roll Goods:
 - 1. LLDPE geomembrane sheets used for this project shall meet the requirements set forth in the latest revision set forth by the Geosynthetics Research Institute (GRI) for LLDPE.
 - 2. The geomembranes shall consist of unreinforced low density polyethylene containing at a maximum 3 percent by weight additives, fillers, or extenders.
 - 3. The geomembranes shall be free of holes, blisters, striations, undispersed raw material, and contamination by foreign matter.

- C. Extrudate: Resin used in the polyethylene extrudate shall be the same as that used to manufacture the geomembrane sheets. Extrudate rods are to be delivered in original containers with the manufacturer's labeling. Extrudate rods shall be free of dirt, grease, moisture, other contaminants, and shall be free of damage.
- D. Neoprene Foam: Closed cell, weatherproof, black neoprene foam with adhesive backing suitable for long-term sun and liquid exposure. Dimensions shall be as specified on the Drawings.
- E. Clamped Boots: Boots required to seal the geomembrane to the structures passing through it shall be made of the same materials as the geomembrane. The boots shall be fabricated so that all field assembly, welding, and seam testing can be accomplished using equipment and procedures regularly employed in the field for geomembrane installation. Smooth geomembrane shall be used in all geomembrane boots.
- F. Banding Straps: Type 302 stainless steel banding straps or approved equal suitable for use on the pipe diameters shown on the Drawings or encountered in the field. All surfaces of the banding straps shall be machined smooth to prevent tearing or puncturing of the HDPE pipe boots. A sacrificial layer of geomembrane or geotextile shall separate all banding straps from geomembrane boots. Outer lip of boot shall be sealed with silicone sealant as shown on Drawings.

2.02 EQUIPMENT

- A. Extruding equipment shall be equipped with a temperature gauge at the barrel and nozzle.
- B. Fusion equipment shall be equipped with a temperature gauge capable of continuous monitoring.
- C. Provide digital or dial continuous temperature recording instruments, in satisfactory working condition, with each welding unit. Welding equipment shall not be operated without functioning temperature recording instruments for measuring geomembrane sheet temperature.
- D. A coupon cutter and a calibrated tensiometer shall be provided for in-field seaming prequalification testing and destructive sample testing.
- E. Store, transport, and operate all equipment to avoid damage to geomembranes.
- F. Glass top of each vacuum box must be clear and free of scratches for easy reading of pressure gauge. The sealing gasket shall be intact and functioning to form close seals during testing.
- G. Owner or Owner's Representative reserves the right to order the Installer to remove any equipment that in Owner's or Owner's Representative's opinion is not satisfactory. The Installer will remove the equipment promptly from the construction site and replace the unsatisfactory equipment with suitable equipment within 24 hours.
- H. An adequate number of welding apparati shall be available to avoid delaying work.

2.03 GEOMEMBRANE INSTALLERS

A. The following geomembrane installers are approved for this Project: Other installers may be acceptable, provided Owner approval is obtained prior Bid submittal.

1.	Western Industries P.O. Box 428 Miles City, Montana 59301	(406) 232-1680 (800) 488-3592
2.	J.C. Ramsdell Enviro Services Inc. P.O. Box 307 Flandreau, South Dakota 57028	(605) 997-3704 (800) 658-5571
3.	G.S.I. (Geo-Synthetics, Inc.) 428 N. Pewaukee Road Waukesha, Wisconsin 53188	(877) 950-4474

2.04 GEOMEMBRANE PROPERTIES

- A. Material shall be textured polyethylene geomembrane as shown on the drawings.
- B. Resin
 - 1. Resin shall be new, first quality, compounded and manufactured specifically for producing geomembrane.
 - 2. Natural resin (without carbon black) shall meet the following requirements:

Table 2.1: Raw Material Properties

Property	Test Method	LLDPE
Density (g/cm3)	ASTM D 1505	<u>≥</u> 0.915
Melt Flow Index (g/10 min)	ASTM D 1238 (190/2.16)	<u>≤</u> 1.0
OIT (minutes)	ASTM D 3895 (1 atm/200°C)	≥100

C. Geomembrane Rolls

- 1. Do not exceed a combined maximum total of 1 percent by weight of additives other than carbon black.
- 2. Geomembrane shall be free of holes, pinholes as verified by on-line electrical detection, bubbles, blisters, excessive contamination by foreign matter, and nicks and cuts on roll edges.
- 3. Geomembrane material is to be supplied in roll form. Each roll is to be identified with labels indicating roll number, thickness, length, width and Manufacturer.
- 4. All liner sheets produced at the factory shall be inspected prior to shipment for compliance with the physical properties specified and be tested by an acceptable method of inspecting for pinholes. If pinholes are located, identified and indicated during manufacturing, these pinholes may be corrected during installation.

D. Textured geomembrane shall meet the requirements shown in Table 2.2.

Table 2.2:	Linear Low	Density	Polyethylene	Textured	Geomembrane	(ref. Drawin	gs for mil
Specificati	on)						

Tested Property	Test Method Frequency			Minimum Av	erage Value	s
			40 mil	60 mil	80 mil	100 mil
Thickness, mil	ASTM D 5199	every roll	40	60	80	100
Lowest individual reading			36	54	72	90
Density, g/cm ³ (max.)	ASTM D 1505	200,000 lbs	0.939	0.939	0.939	0.939
Tensile Properties (each direction)	ASTM D 6693, Type IV	20,000 lbs				
Strength at Break, lb/in-width	Dumbbell, 2 ipm		60	90	120	150
Elongation at Break, %	G.L. 2.0 in		250	250	250	250
Tear Resistance, lb	ASTM D 1004	45,000 lbs	22	33	44	55
Puncture Resistance, lb	ASTM D 4833	45,000 lbs	44	66	88	110
Carbon Black Content, % (Range)	ASTM D 1603*/4218	20,000 lbs	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lbs	Note ⁽¹⁾	Note ⁽¹⁾	Note ⁽¹⁾	Note ⁽¹⁾
Asperity Height, mil	ASTM D 7466	second roll	18	18	18	18
Oxidative Induction Time, min	ASTM D 3895, 200°C; O ₂ , 1	200,000 lbs	>100	>100	>100	>100
	atm					
	Typical Roll Dimens	ions				
Roll Length ⁽²⁾ , ft	Double-Sided Textured		700	520	400	330
	Single-Sided Textured		650	420	320	250
Roll Width ⁽²⁾ , ft			22.5	22.5	22.5	22.5
Roll Area, ft ²	Double-Sided Textured		15,750	11,700	9,000	7,425
	Single-Sided Textured		14,625	9,450	7,200	5,625

NOTES:

• ⁽¹⁾Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.

 $\, \bullet \,$ $^{(2)}$ Roll lengths and widths have a tolerance of ±1%.

• *Modified.

E. Smooth geomembrane shall meet the requirements shown in Table 2.3.

Table 2.3:	Linear Low	/ Density I	Polyethylene	Smooth	Geomembrane	(ref.	Drawings for mil	
Specificati	ion)							

Tested Property	Test Method	Frequency		Minimum A	verage Value	
			40 mil	60 mil	80 mil	100 mil
Thickness, mil	ASTM D 5199	every roll	40	60	80	100
Lowest individual reading			36	54	72	90
Density, g/cm³ (max.)	ASTM D 1505	200,000 lbs	0.939	0.939	0.939	0.939
Tensile Properties (each direction)	ASTM D 6693, Type IV	20,000 lbs				
Strength at Break, Ib/in-width	Dumbbell, 2 ipm		152	228	304	380
Elongation at Break, %	G.L. 2.0 in		800	800	800	800
Tear Resistance, lb	ASTM D 1004	45,000 lbs	22	33	44	55
Puncture Resistance, lb	ASTM D 4833	45,000 lbs	56	84	112	140
Carbon Black Content, % (Range)	ASTM D 1603*/4218	20,000 lbs	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lbs	Note ⁽¹⁾	Note ⁽¹⁾	Note ⁽¹⁾	Note ⁽¹⁾
Oxidative Induction Time, min	ASTM D 3895, 200°C; O ₂ , 1	200,000 lbs	>100	>100	>100	>100
	atm					
Typical Roll Dimensions						
Roll Length ⁽²⁾ , ft			870	560	430	340
Roll Width ⁽²⁾ , ft			22.5	22.5	22.5	22.5
Doll Aroo ft?			10.575	12 600	0.675	7.650
			19,575	12,600	9,075	7,650
INUTES.						

• ⁽¹⁾Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.

• ⁽²⁾Roll lengths and widths have a tolerance of ±1 %.

• GSE UltraFlex is available in rolls weighing approximately 4,000 lb.

• All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM

D 746.

• *Modified.

PART 3: EXECUTION

3.01 EXAMINATION

- A. Examine and certify in writing acceptability of surface (supporting soil) to receive installation of geomembrane.
- B. Submit certification to Owner or Owner's On-Site Representative prior to installing geomembrane.
- 3.02 EARTHWORK PREPARATION
 - A. General:
 - 1. After supporting soil is accepted by installer, it is the installer's responsibility to indicate to Owner or Owner's On-Site Representative and to Contractor changes in supporting soil

3	A	R	R
	-	-	-

condition that may require repair Work. Maintain prepared soil surface. Damage to subgrade caused by installation shall be repaired at installer's expense.

- 2. Do not place geomembrane in area softened by precipitation.
- 3. Do not place geomembrane on slopes greater than 3 horizontal to 1 vertical unless specified otherwise on Contract Drawings.
- 4. Do not place geomembrane until subgrade certification survey is completed and approved by Owner's On-Site Representative.
- B. Anchoring System:
 - 1. Excavate anchor trench (if necessary) to lines and grades shown on Drawings, prior to geomembrane placement.
 - 2. Backfilling of Anchor Trench:
 - a. Backfill anchor trench as shown on the Drawings and compact to ≥95 percent of Standard Proctor Maximum Dry Density.
 - b. Prevent damage to geomembrane when backfilling trenches.

3.03 DEPLOYMENT

- A. Assign each panel a simple and logical identifying code. The coding system shall be subject to approval by Owner's On-Site Representative and shall be determined at the job site.
- B. Installer shall visually inspect the geomembrane during deployment for imperfections and mark faulty or suspect areas.
- C. Deploy geomembrane panels in a manner that will comply with the following guidelines:
 - 1. Geomembranes shall be installed according to site-specific specifications.
 - 2. Unroll geomembrane using methods that will not damage geomembrane and will protect underlying surface from damage (spreader bar, protected equipment bucket).
 - 3. Place ballast (commonly sandbags) on geomembrane which will not damage geomembrane to prevent wind uplift.
 - 4. Personnel walking on geomembrane shall not engage in activities or wear shoes that could damage it. Smoking will not be permitted on the geomembrane.
 - 5. Do not allow heavy vehicular traffic directly on geomembrane. Rubber-tired ATV's and trucks may be acceptable if wheel contact is less than 8 psi and pre-approval is obtained from Owner's Representative.
 - 6. Protect geomembrane in areas of heavy traffic by placing protective cover over the geomembrane.
- D. Provide sufficient material (slack) to allow for thermal expansion and contraction of the material.

3.04 FIELD SEAMING

- A. Seams shall meet the following requirements:
 - 1. To the maximum extent possible, orient seams parallel to line of slope, i.e., down and not across slope.
 - 2. Minimize number of field seams in corners, odd-shaped geometric locations and outside corners.

- 3. Slope seams (panels) shall extend a minimum of five-feet beyond the grade break into the flat area.
- 4. Use a sequential seam numbering system compatible with panel numbering system that is agreeable to the Owner's Representative and Installer.
- 5. Align seam overlaps consistent with the requirements of the welding equipment being used. A 6-inch overlap is commonly suggested.
- B. During Welding Operations
 - 1. Provide at least one Master Seamer who shall provide direct supervision over all other welders.
- C. Extrusion Welding
 - 1. Hot-air tack adjacent pieces together using procedures that do not damage the geomembrane.
 - 2. Clean geomembrane surfaces by disc grinder or equivalent.
 - 3. Purge welding apparatus of heat-degraded extrudate before welding.
- D. Hot Wedge Welding
 - 1. Welding apparatus shall be a self-propelled device equipped with an electronic controller which displays applicable temperatures.
 - 2. Clean seam area of dust, mud, moisture and debris immediately ahead of hot wedge welder.
 - 3. Protect against moisture build-up between sheets.
- E. Trial Welds
 - 1. Perform trial welds on geomembrane samples to verify welding equipment is operating properly.
 - 2. Make trial welds under the same surface and environmental conditions as the production welds, i.e., in contact with subgrade and similar ambient temperature.
 - 3. Minimum of two trial welds per day, per welding apparatus; one made prior to the start of work and one completed at mid shift.
 - 4. Cut four, one-inch wide by six-inch long test strips from the trial weld.
 - 5. Quantitatively test specimens for peel adhesion and for shear strength.
 - 6. Trial weld specimens shall pass when the results shown in the following table for LLDPE are achieved in both peel and shear test.

Table 3.1: Minimum Weld Values for LLDPE Geomembranes

Property	Test Method	30	40	60	80	100
Peel Strength (extrusion), ppi	ASTM D 6392 ASTM D 6392	36 38	48 50	72 75	96 100	120 125
Shear Strength (fusion & ext.), ppi	ASTM D 6392	45	60	90	120	150

- a. The break, when peel testing, shall occur in the liner material itself, not through peel separation (FTB).
- b. The break shall be a ductile break.



- 7. Repeat the trial weld, in its entirety, when any of the trial weld samples fail in either peel or shear.
- 8. No welding equipment or welder shall be allowed to perform production welds until equipment and welders have successfully completed trial weld.
- F. Seaming shall not proceed when ambient air temperature or adverse weather conditions jeopardize the integrity of the liner installation. Installer shall demonstrate that acceptable seaming can be performed by completing acceptable trial welds.
- G. Defects and Repairs
 - 1. Examine all seams and non-seam areas of the geomembrane for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter.
 - 2. Repair and non-destructively test each suspect location in both seam and non-seam areas. Do not cover geomembrane at locations that have been repaired until test results with passing values are available.

3.05 FIELD QUALITY ASSURANCE

- A. Manufacturer and Installer shall participate in and conform to all terms and requirements of the Owner's quality assurance program.
- B. Quality assurance requirements are as specified in this Section.
- C. Field Testing
 - 1. Non-destructive testing may be carried out as the seaming progresses or at completion of all field seaming.
 - a. Vacuum Testing
 - Shall be performed in accordance with ASTM D 5641, Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.
 - b. Air Pressure Testing
 - 1) Shall be performed in accordance with ASTM D 5820, Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes.
 - 2. Destructive Testing (performed by Installer)
 - a. Location and Frequency of Testing
 - 1) Collect destructive test samples at a frequency of one per every 500 lineal feet of seam length.
 - 2) Test locations will be determined after seaming.
 - 3) Exercise Method of Attributes as described by GRI GM-14 (Geosynthetic Research Institute, http://www.geosynthetic-institute.org) to minimize test samples taken.
 - b. Sampling Procedures are performed as follows:
 - 1) Installer shall cut samples at locations designated by the Owner's Representative as the seaming progresses in order to obtain field laboratory test results before the geomembrane is covered.
 - 2) Installer will number each sample, and the location will be noted on the installation as-built.

- 3) Samples shall be twelve (12) inches wide by minimal length with the seam centered lengthwise.
- 4) Cut a 2-inch wide strip from each end of the sample for field-testing.
- 5) Cut the remaining sample into two parts for distribution as follows:
 - a) One portion for Owner's On-Site Representative, 12-inches by 12 inches.
 - b) One portion for the Third Party laboratory, 12-inches by 18-inches.
 - c) Additional samples may be archived if required.
- 6) Destructive testing shall be performed in accordance with ASTM D 6392, Standard Test Method for Determining the Integrity of Non-Reinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.
- 7) Installer shall repair all holes in the geomembrane resulting from destructive sampling.
- 8) Repair and test the continuity of the repair in accordance with these Specifications.
- 3. Failed Seam Procedures
 - If the seam fails, Installer shall follow one of two options:
 - 1) Reconstruct the seam between any two passed test locations.
 - 2) Trace the weld to intermediate location at least 10 feet minimum or where the seam ends in both directions from the location of the failed test.
 - b. The next seam welded using the same welding device is required to obtain an additional sample, i.e., if one side of the seam is less than 10 feet long.
 - c. If sample passes, then the seam shall be reconstructed or capped between the test sample locations.
 - d. If any sample fails, the process shall be repeated to establish the zone in which the seam shall be reconstructed.

3.06 REPAIR PROCEDURES

a.

- A. Remove damaged geomembrane and replace with acceptable geomembrane materials if damage cannot be satisfactorily repaired.
- B. Repair any portion of unsatisfactory geomembrane or seam area failing a destructive or nondestructive test.
- C. Installer shall be responsible for repair of defective areas.
- D. Agreement upon the appropriate repair method shall be decided between Owner's On-Site Representative and Installer by using one of the following repair methods:
 - 1. Patching- Used to repair large holes, tears, undispersed raw materials and contamination by foreign matter.
 - 2. Abrading and Re-welding- Used to repair short section of a seam.
 - 3. Spot Welding- Used to repair pinholes or other minor, localized flaws or where geomembrane thickness has been reduced.
 - 4. Capping- Used to repair long lengths of failed seams.
 - 5. Flap Welding- Used to extrusion weld the flap (excess outer portion) of a fusion weld in lieu of a full cap.

- 6. Remove the unacceptable seam and replace with new material.
- E. The following procedures shall be observed when a repair method is used:
 - 1. All geomembrane surfaces shall be clean and dry at the time of repair.
 - 2. Surfaces of the polyethylene that are to be repaired by extrusion welds shall be lightly abraded to assure cleanliness.
 - 3. Extend patches or caps at least 6 inches for extrusion welds and 4 inches for wedge welds beyond the edge of the defect, and around all corners of patch material.
- F. Repair Verification
 - 1. Number and log each patch repair (performed by Installer).
 - 2. Non-destructively test each repair using methods specified in this Specification.
- G. Daily Installation Information:
 - 1. At the end of each working day, provide a signed detailed report and sketch of Work completed on that day. Report and sketch shall include but not be limited to:
 - a. Panel placement.
 - b. Trial welds.
 - c. Seams.
 - d. Seam testing and results.
 - e. Destructive testing and results.
 - f. Repair locations and log.
 - 2. Owner or Owner's On-Site Representative shall review and sign report acknowledging receipt of report.
- H. Complete Installation Information:
 - 1. Installation certification.
 - 2. "As-built" record Drawings showing panel layout including panel dimensions, number, roll number and location of destructive seam samples and repairs.
 - 3. Copy of warranty from manufacturer/fabricator, installer.
 - 4. Submittals required within 15 business days of geomembrane installer demobilization from site.

3.07 GEOMEMBRANE ACCEPTANCE

- A. Retain ownership and responsibility for geomembrane until acceptance by Owner. Geomembrane liner accepted by Owner when:
 - 1. Written certification letter, including "as-built" Drawings, signed by Registered Professional Engineer, received by Owner.
 - 2. Installation complete.
 - 3. Documentation of installation completed, including inspection of final report.
 - 4. Verification of adequacy of field seams and repairs, including associated testing, is complete.

END OF SECTION 02273



CERTIFICATE OF ACCEPTANCE OF GEOMEMBRANE SUBGRADE SURFACE BY INSTALLER

DESCRIPTION OF AREA TO BE CERTIFII	ED
INSTALLER	PROJECT
NAME:	LOCATION:
ADDRESS:	PROJECT:
AUTHORIZED REPRESENTATIVE:	OWNER:
The undersigned,	certifies that he is a representative of
(company), duly authorized to execute this cent	rtificate, that he visually inspected the subgrade surface
described above on (date) and for	ound the surface to be acceptable for installation of the
geomembrane.	
This certification is based on observations of t	the surface of the subgrade only. No sub-terrain inspections
or tests have been performed and	(company) makes no representations or warranties
regarding conditions which may exist below t	he surface of the subgrade.
DATE:	SIGNATURE:
	NAME:
	TITLE:
CERTIFICATE RECEIVED BY CONTRACTOR:	CERTIFICATE RECEIVED BY OWNER:
DATE:	DATE:
COMPANY:	COMPANY:
SIGNATURE:	SIGNATURE:
NAME:	NAME:
TITLE:	TITLE:

SECTION 02274

GEOSYNTHETIC CLAY LINER

PART 1: GENERAL

1.01 SUMMARY

A. Work under this section includes the geosynthetic clay liner (GCL) for composite liner.

1.02 DEFINITIONS

- A. Geosynthetic Clay Liner (GCL) A factory manufactured hydraulic barrier consisting of granular sodium bentonite clay, sandwiched between, supported and encapsulated by two geotextiles, held together by needle-punching.
- B. Geotextile A semi-permeable woven or nonwoven fabric used to contain the bentonite used in a GCL.
- C. Sodium Bentonite The high swelling clay component of GCLs consisting primarily of the mineral Montmorillonite.
- D. Needle-punching A GCL manufacturing process whereby boards of barbed needles incorporate the staple fibers from a nonwoven geotextile, through a sodium bentonite clay layer, into the matrix of a second geotextile layer.
- E. Thermal Locking A needle-punching enhancement process utilizing heat to bond the needlepunched fibers and more permanently lock them into the second geotextile to increase the internal shear strength characteristics.
- F. Polymer-Treated Specific GCL type treated with polymers to improve performance in the presence of increased cation concentration.
- G. Minimum Average Roll Value (MARV) The minimum average value of the material in a particular lot calculated as the mean of the tested values minus two standard deviations providing a 95% confidence level.

1.03 REFERENCES

- A. Latest edition of the following American Society for Testing and Materials (ASTM) standards:
 - 1. ASTM D 4632, "Standard Test Method for Grab Breaking Load and Elongation of Geotextiles"
 - 2. ASTM D 4643, "Determination of Water (Moisture) Content of Soil by the Microwave Oven Method"
 - 3. ASTM D 5084, "Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter"
 - 4. ASTM D 5261, "Standard Test Method for Measuring Mass Per Unit Area of Geotextiles"
 - 5. ASTM D 5321, "Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method"

IRR	Geosynthetic Clay Liner	PolyMet Mining Corporation
	02274-1	Permitting Specifications

- 6. ASTM D 5887, "Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter"
- 7. ASTM D 5888, "Standard Guide for Storage and Handling of Geosynthetic Clay Liners"
- 8. ASTM D 5889, "Standard Practice for Quality Control of Geosynthetic Clay Liners"
- 9. ASTM D 5890, "Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners"
- 10. ASTM D 5891, "Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners"

1.04 QUALIFICATIONS

- A. The GCL Manufacturer, Installer and Construction Quality Assurance (CQA) inspector shall all be skilled in accordance with the following experience requirements. Any exceptions must be approved by Owner prior to the project bid.
- B. GCL Manufacturer The GCL manufacturer selected for use on this project shall have successfully produced at least 10,000,000 square feet of needle-punched GCL product.

The following GCL suppliers are approved for this project (other suppliers may be acceptable, provided Engineer approval is obtained):

- 1.CETCO Lining Technologies
1500 W. Shure Drive
Arlington Heights, IL 60004(800) 527-9948
- 2. G.S.E. Lining Technology (800) 435-2008 19303 Gundle Road Houston, TX 77073
- C. Contractor request for approval of alternate supplier (if any) must be submitted to Owner and Engineer 5 business days prior to Bid opening. Contractor must obtain Owner and Engineer written approval of alternate supplier in order to include alternate in Bid.
- D. GCL Installer The installer shall provide to Owner sufficient evidence of installation experience and competence with the specified geosynthetic materials.
 - 1. GCL Only Installation The GCL installer shall demonstrate a minimum of 1,000,000 square feet of GCL installation experience, shall provide sufficient evidence of installation experience and competence with other geosynthetics or shall demonstrate an acceptable level of training and supervision will be utilized in order to ensure the quality of the installation.
 - 2. Multi-Component Composite Liner System The GCL shall be installed by the lining contractor responsible for the installation of the overlying geomembrane liner. The GCL/ geomembrane lining contractor shall demonstrate a minimum of 1,000,000 square feet of successfully completed multi-component composite liner installation experience or shall provide sufficient evidence of the appropriate level of installation experience and competence with other geosynthetics.

1.05 SUBMITTALS

- A. Three copies of the project submittals shall be forwarded to Owner or Owner's On-Site Representative as designated below.
- B. Information With Bid The following shall be submitted with the bid:
 - 1. Statement of experience from the proposed GCL Supplier.
 - 2. Statement of experience from the proposed GCL Installer.
 - 3. Project-Specific Polymer-Treated GCL specification.
- C. Prior to Installation The following information shall be supplied to Owner or Owner's Representative for review within 10 business days of the Contract Award to ensure that the materials and parties selected for use on the project meet the requirements of this specification:
 - 1. Samples of GCL proposed for use on the project.
 - 2. Reference list supplied by GCL Manufacturer indicating the appropriate experience level as required by the specification.
 - 3. Reference list supplied by the GCL Installer indicating the appropriate experience level as required by the specification.
- D. Prior to Deployment The following information shall be submitted by the Lining Contractor to Owner or Owner's Representative prior to the deployment of any GCL material to ensure that the materials and subgrade preparation meet the requirements of this specification:
 - 1. GCL Manufacturer's Quality Control Certifications.
 - 2. Certifications of subgrade acceptance for each area covered by GCL, signed by the earthwork Contractor and Owner's Representative.

1.06 BASIS FOR COMPENSATION

- A. Compensation for all Work covered under this Section shall be included in the Lump Sum Contract Price Bid.
- B. Partial payments by Owner for Geosynthetic Clay Liner (GCL) are predicated on timely receipt of GCL submittals by Contractor.
- C. The Lump Sum Contract Price Bid shall include any allowances for waste, overlap, and anchoring.

PART 2: PRODUCTS

- 2.01 GCL MATERIALS
 - A. The GCL product supplied to the project shall be in full accordance with the requirements of this section. The GCL shall be manufactured by mechanically bonding the geotextiles using a needle-punching process to enhance frictional and internal shear strength characteristics.
 - B. In order to maintain these characteristics, no glues, adhesives or other non-mechanical bonding processes shall be used in lieu of the needle-punch process. Their use to enhance the physical properties of the GCL is not permitted.

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- C. Description Acceptable GCL for this project include Resistex ST manufactured by CETCO Lining Technologies and BentoLiner CAR manufactured by G.S.E. Lining Technology, or other Engineer-approved needle-punched GCL which meet the requirements of this specification.
- D. The GCL product supplied for this project shall be a polymer-treated GCL manufactured specifically for use in the presence of liquids with elevated cation concentrations.

2.02 GCL MANUFACTURING

- A. The GCL supplied in accordance with this project shall be manufactured by needle-punching as described in Section 1.02 Definitions.
 - 1. The needle-punched GCL shall be thermally locked. The thermal lock process must heat set the nonwoven fibers where they protrude from the second geotextile (woven or nonwoven depending upon product) to more permanently secure the reinforcement in place. Other means may be used to lock the fibers in place if the process demonstrates similar performance to the thermal lock process.
 - 2. To demonstrate the uniformity of the manufacturing process, no delamination of the geotextile components from the bentonite core shall occur when the GCL is exposed to 80 degree tap water for one hour.

2.03 ALTERNATIVE MATERIALS

- A. Prior to considering an alternative GCL material, Contractor shall submit certified test results and statements of quality from the proposed GCL supplier to Owner or Owner's Representative, indicating without exception that the proposed GCL meets the requirements of this specification. Submittals shall be delivered to Owner or Owner's Representative a minimum of five business days in advance of the bid.
- B. No other manufacturing techniques shall be approved unless it can be suitably demonstrated that the GCL exhibits uniform shear strength characteristics across the entire width of the panel. Isolated sewn or stitched rows do not constitute uniform reinforcement for the purposes of this specification.

2.04 DIMENSIONS

- A. The minimum acceptable dimensions for the GCL panels shall be 15 feet wide and 125 feet long. Short rolls (rolls less than 125 feet long) may be supplied, but at a rate not to exceed 5% of the total square footage produced for this project.
- B. A minimum overlap guide-line and a construction match-line delineating the overlap zone shall be imprinted with non-toxic ink on both edges of the GCL panel to ensure the accuracy of the seam. The minimum overlap guideline shall indicate where the edge of the panel must be placed in order to achieve a full six inches of bentonite overlap for each panel.

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2.05 MANUFACTURING QUALITY CONTROL

- A. The GCL shall be tested for compliance with this specification by the test methods and frequencies indicated on the material specification. GCL materials may be tested pre-approved at the manufacturing location.
 - 1. Manufacturer Quality Control Certification Quality Control certificates shall be issued by the GCL manufacturer to Owner or Owner's On-Site Representative for each delivery of material. The certifications shall be signed by the quality control manager of the GCL manufacturer or other responsible party and shall include the following information:
 - a. Shipment Packing List A list indicating the rolls shipped on a particular truckload.
 - b. Bill of Lading The shipping documents for the truck used for the shipment.
 - c. Letter of Certification The letter indicating the material is in conformance with the physical properties specified.
 - d. Physical Properties Sheet The material specification for the GCL supplied in accordance with this specification.
 - 2. Manufacturer Quality Control Submittal Quality Control submittals shall be issued by the GCL manufacturer to Owner or Owner's Representative. The submittals shall include the following information:
 - a. Bentonite Manufacturer Certification Bentonite manufacturer quality documentation for the particular lot of clay used in the production of the rolls delivered.
 - b. Geotextile Manufacturer Certification Geotextile manufacturer quality control documentation for the particular lots of geotextiles used in the production of the rolls delivered.
 - c. GCL Manufacturer Tracking List Cross referencing list delineating the corresponding geotextile and bentonite lots for the materials used in the production of the rolls delivered.
 - d. Manufacturing Quality Control Data The manufacturing quality control test data indicating the actual test values obtained when tested at the appropriate frequencies for the properties specified.

2.06 PACKAGING

- A. All GCL rolls shall be packaged in moisture resistant plastic sleeves. The cardboard cores shall be sufficiently strong to resist collapse during transit and handling.
- B. Prior to shipment, the manufacturer shall label each roll, both on the GCL roll and on the surface of the plastic protective sleeve. Labels shall be resistant to fading and moisture degradation to ensure legibility at the time of the installation. At a minimum the roll labels shall identify the following:
 - 1. Length and width of roll
 - 2. Total weight of roll
 - 3. Type of GCL material
 - 4. Production Lot number and Individual Roll number

2.07 ACCESSORY BENTONITE

A. Any accessory bentonite used for sealing seams, penetrations, or repairs, shall be the same polymer-treated granular bentonite as used in the production of the GCL itself.

PART 3: EXECUTION

3.01 EXECUTION

A. The following installation procedures are as specific as possible while recognizing that the specific requirements of the project may necessitate minor modifications. Significant deviations from these procedures shall be pre-approved by Owner or Owner's Representative or other designated party.

B. Do not install GCL until subgrade certification survey is completed and approved by Owner's On-Site Representative.

3.02 SHIPPING AND HANDLING EQUIPMENT

- A. The party responsible for unloading the GCL shall contact the manufacturer prior to shipment to determine the correct unloading methods and equipment if different from the pre-approved and specified methods.
- B. GCL must be supported during handling to ensure worker safety and prevent damage to the liner. Under approved circumstances only, shall the rolls be dragged, lifted from one end, lifted with only the forks of a lift truck or pushed to the ground from the delivery vehicle.
- C. Owner or Owner's Representative shall verify that proper handling equipment exists which does not pose any danger to installation personnel or risk of damage or deformation to the liner material itself. Suitable handling equipment is described below:
 - 1. Spreader Bar Assembly A spreader bar assembly shall include both a core pipe or bar and a spreader bar beam. The core pipe shall be used to uniformly support the roll when inserted through the GCL core while the spreader bar beam will prevent chains or straps from chafing the roll edges. The cardboard roll supplied with the GCL shall not be used in place of a steel core pipe.
 - 2. Stinger A stinger is a rigid pipe or rod with one end directly connected to a forklift or other handling equipment. If a stinger is used, it should be fully inserted to its full length into the roll to prevent excessive bending of the roll when lifted.
 - 3. Roller Cradles Roller cradles consist of two large diameter rollers spaced approximately 3 inches apart, which both support the GCL roll and allow it to freely unroll. The use of roller cradles shall be permitted if the rollers support the entire width of the GCL roll.
 - 4. Straps Straps may be used to support the ends of spreader bars but are not recommended as the primary support mechanism. As straps may damage the GCL where wrapped around the roll and generally do not provide sufficient uniform support to prevent roll bending or deformation, great care must be exercised when this option is used.
- D. GCL Inspection Upon Delivery Each roll shall be visually inspected when unloaded to determine if any packaging or material has been damaged during transit. Repairs to damaged GCL shall be performed in accordance with this specification.

- 1. Rolls exhibiting damage shall be marked and set aside for closer examination during deployment.
- 2. Minor rips or tears in the plastic packaging shall be repaired with moisture resistant tape prior to being placed in storage to prevent moisture damage.
- 3. GCL rolls delivered to the project site shall be only those indicated on GCL manufacturing quality control certificates.

E. Storage / Stockpiling / Staging

- 1. Storage of the GCL rolls shall be the responsibility of the installer or other designated party. All GCL rolls shall be stock-piled and maintained dry in a flat location area away from high-traffic areas but sufficiently close to the active work area to minimize handling.
- 2. For needle-punched GCLs, the presence of free-flowing water within the packaging shall require that roll to be set aside for further examination to ascertain the extent of damage, if any. Free-flowing water within the packaging of unreinforced GCLs shall be cause for rejection of that roll.
- 3. GCL should be stored no higher than three to four rolls high or limited to the height at which the handling apparatus may be safely handled by installation personnel. Stacks or tiers of rolls should be situated in a manner that prevents sliding or rolling by "choking" the bottom layer of rolls.
- 4. Rolls shall not be stacked on uneven or discontinuous surfaces in order to prevent bending, deformation, damage to the GCL or cause difficulty inserting the core pipe.
- 5. An additional tarpaulin or plastic sheet shall be used over the stacked rolls to provide extra protection for GCL material stored outdoors.
- 6. Bagged bentonite material shall be stored and tarped next to GCL rolls unless other more protective measures are available. Bags shall be stored on pallets or other suitably dry surface which will prevent undue prehydration.

3.03 EXAMINATION

- A. The earthen subgrade shall be continuously inspected, approved and certified in writing prior to GCL placement.
- B. Submit certification to Owner or Owner's On-Site Representative prior to installing GCL.

3.04 SUBGRADE PREPARATION

- A. Earthen Subgrade The surface (Native subsoil or Controlled Fill) upon which the GCL will be installed shall be inspected by the installer and certified by the earthwork contractor to be in accordance with the following:
 - 1. Finished surface of Earthen Subgrade shall be free of all angular stones, and free of all stones greater than 3/8" protruding from the finished surface.
 - 2. Subgrade surface shall be smooth rolled to achieve a finished surface suitable for placement of GCL.
 - 3. The surfaces to be lined shall be smooth and free of any debris, vegetation, roots, sticks, sharp rocks, or other deleterious materials as well as free of any voids, large cracks or standing water or ice.
 - 4. Directly prior to deployment of the GCL, the subgrade shall be final-graded to fill remaining voids or desiccation cracks, and proof-rolled to eliminate sharp irregularities of abrupt elevation changes. All rocks greater than 3/8" protruding from the finished surface

shall be hand-picked and removed. The surfaces to be lined shall be maintained in this smooth condition.

- B. Anchor Trench (if necessary) An anchor trench shall be excavated by the earthwork contractor or liner installer to the lines and grades shown on the project Drawings.
 - 1. The anchor trench shall be constructed free of sharp edges or corners and maintained in a dry condition. No loose soil shall be permitted beneath the GCL within the trench.
 - 2. The anchor trench shall be inspected as well as approved by Owner or Owner's Representative prior to GCL placement, back-filling and compaction of the anchor key material.

3.05 GCL PLACEMENT

- A. GCL Material shall be placed in general accordance with the procedures specified below, or modified to account for site specific conditions.
- B. GCL Orientation In the absence of specific guidelines, GCL panels shall be placed per manufacturer recommendation on slopes to maximize the shear strength characteristics.
- C. In base or flat areas, the GCL shall be placed by placing the woven geotextile face of the GCL against the overlying geomembrane.
- D. GCL Panel Position Where possible, all slope panels should be installed parallel to the maximum slope while panels installed in flat areas require no particular orientation.
- E. Panel Deployment GCL materials shall be installed in general accordance with the procedures set forth in this section, subject to site specific conditions which would necessitate modifications.
- F. Reinforced GCL shall be used on both slopes as well as the flat areas to ensure the GCL withstands the rigors of the installation and subsequent low load hydration.
- G. Deployment should proceed from the highest elevation to the lowest to facilitate drainage in the event of precipitation.
- H. The GCL may be deployed on slopes by pulling the material from a suspended roll, or securing a roll end into an anchor trench and unrolling each panel as the handling equipment slowly moves backwards.
- I. Deployment on flat areas shall be conducted in the same manner as that for the slopes, however, care should be taken to minimize "dragging" the GCL. Slip-sheet may be used to facilitate positioning of the liner while ensuring the GCL is not damaged from underlying sources.
- J. Overlaps shall be a minimum of 6 inches and in no case less than specified on the Drawings, and be free of wrinkles, folds or "fish-mouths".
- K. Contractor shall only install as much GCL that can be covered at the end of the day. No GCL shall be left exposed overnight. The exposed edge of the GCL shall be covered by a temporary tarpaulin or other such water resistant sheeting until the next working day.

- L. Anchoring- All GCL material installed on slopes shall be anchored to prevent potential GCL panel movement.
 - 1. Standard Anchor The GCL shall be placed into and across the base of the excavated trench, stopping at the back wall of the excavation.
 - 2. "Run-Out" Anchor On gentle slopes or locations where it is difficult to create an anchor trench, the GCL may alternatively be anchored by a material run-out past the crest of the slope. The length of the run-out shall be pre-approved by Owner or Owner's Representative prior to the use of this method.
- M. Seaming A 6-inch lap line and a 9-inch match line shall be imprinted on both edges of the upper geotextile component of the GCL to assist in installation overlap quality control. Lines shall be printed as continuous dashes in easily observable non-toxic ink.
 - 1. Overlap seams shall be a minimum of six inches on panel edges and one foot on panel ends.
- N. Detailing Detail work, defined as the sealing of the liner to pipe penetrations, foundation walls, drainage structures, spillways, and other appurtenances, shall be performed as recommended by the GCL Manufacturer.
- O. Damage Repair Prior to cover material placement, damage to the GCL shall be identified and repaired by the installer. Damage is defined as any rips or tears in the geotextiles, delamination of geotextiles or a displaced panel.
 - Rip and Tear Repair (Flat Surfaces) Rips or tears may be repaired by completely exposing the affected area, removing all foreign objects or soil, and by then placing a patch cut from unused GCL over the damage (damaged material may be left in place), with a minimum overlap of 12 inches on all edges. Accessory bentonite should be placed between the patch edges and the repaired material at

Accessory bentonite should be placed between the patch edges and the repaired material at a rate of a quarter pound per lineal foot of edge spread in a continuous six inch fillet.

- 2. Rip and Tear Repair (Slopes) Damaged GCL material on slopes shall be repaired by the same procedures above; however, the edges of the patch should also be adhered to the repaired liner with an adhesive to keep the patch in position during backfill or cover operations.
- 3. Displaced Panels Displaced panels shall be adjusted to the correct position and orientation. The adjusted panel shall then be inspected for any geotextile damage or bentonite loss. Damage shall be repaired by the above procedure.
- 4. Premature Hydration If the GCL is prematurely hydrated, installer shall notify the QA/QC technician and Owner or Owner's Representative for a site specific determination as to whether the material is acceptable or if alternative measures must be taken to ensure the quality of the design dependent upon the degree of damage.

3.06 COVER MATERIAL

A. The cover materials (where specified) shall be compatible as well as suitable for use over the GCL, and placed in a manner appropriate to the particular subgrade. Regardless of the cover material, the uncovered edge of GCL panels shall be protected at the end of the working day with a waterproof sheet which is secured adequately with ballast.

- B. Geosynthetic Cover Precautions shall be taken to prevent damage to the GCL by restricting the use of heavy equipment over the liner system.
 - 1. Equipment Installation of the overlying geosynthetic component can be accomplished through the use of lightweight, rubber-tired equipment such as a 4-wheel all-terrain vehicle (ATV). This vehicle can be driven directly on the GCL, provided the ATV makes no sudden stops, starts, or turns.
 - 2. Placement Smooth geomembranes may be dragged across the GCL surface with equipment or by hand labor during positioning. Similarly, the geomembrane may be unrolled with the use of low ground pressure equipment.
 - 3. Use of Textured Geomembranes If a textured geomembrane is placed over the GCL, a slip sheet (such as 20-mil smooth HDPE) shall first be placed over the GCL in order to allow the geomembrane to slide into its proper position. Once the overlying geomembrane is properly positioned, the slip-sheet shall be carefully removed paying close attention to avoiding any movement to the geomembrane.

3.07 WARRANTY

- A. GCL material as well as installation warranties provided by the manufacturer and installer shall be made a part of the final submittal documents.
- B. The installer of the GCL material shall provide a one year installation workmanship warranty, repairing and or replacing any material not installed in full compliance with the requirements of the specification.

END OF SECTION 02274

SECTION 02275

GEOCOMPOSITE

PART 1: GENERAL

1.01 SUMMARY

A. This specification covers the technical requirements for the manufacturing and installation of the Geocomposite drainage layer (Geocomposite). All materials shall meet or exceed the requirements of this specification, and all work shall be performed in accordance with the procedures provided in these project specifications.

1.02 DEFINITIONS

- A. Construction Quality Assurance Consultant (Consultant) Party, independent from Manufacturer and Installer that is responsible for observing and documenting activities related to quality assurance during the lining system construction.
- B. Engineer The individual or firm responsible for the design and preparation of the project's Drawings and Specifications.
- C. Geocomposite Manufacturer (Manufacturer) The party responsible for manufacturing the geocomposite rolls.
- D. Geosynthetic Quality Assurance Laboratory (Testing Laboratory) Party, independent from the manufacturer, Installer, Owner, and Owner's On-Site Representative, responsible for conducting laboratory tests on samples of geosynthetics obtained at the site or during manufacturing, under the direction of the Engineer.
- E. Installer Party responsible for field handling, transporting, storing, and deploying the geocomposite.
- F. Lot A quantity of resin (typically the capacity of one rail car) used to manufacture polyethylene geocomposite rolls. The finished rolls with be identified by a roll number traceable to the resin lot.

1.03 REFERENCES

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM D 1238-01 Standard Test method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
 - 2. ASTM D 1505-98 Standard Test method for Density of Plastics by the Density-Gradient Technique
 - 3. ASTM D 1603-94 Standard Test Method for Carbon Black in Olefin Plastics
 - 4. ASTM D 4716-00 Standard Test Method for Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
 - 5. ASTM D 5035-95 Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)
 - 6. ASTM D 5199-99 Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes

- B. Relevant publications from the Environmental Protection Agency (EPA):
 - 1. Daniel, D.E. and R.M. Koerner, (1993) Technical Guidance Document: Quality Assurance and Quality Control for Waste Containment Facilities, EPA/600/R-93/182.

1.04 QUALIFICATIONS

- A. Manufacturer
 - 1. Geocomposite shall be manufactured by the following:
 - a. GSE Environmental
 - b. Engineer Approved Equal
 - 2. Manufacturer shall have manufactured a minimum of 10,000,000 square feet of polyethylene geocomposite material during the last year.
- B. Installer
 - 1. Installer shall have installed a minimum of 50,000,000 square feet of geocomposite in the last 10 years.
 - 2. Installer shall have worked in a similar capacity on at least 5 projects similar in complexity to the project described in the Contract Documents.
 - 3. The Installation Supervisor shall have worked in a similar capacity on projects similar in size and complexity to the project described in the Contract Documents.

1.05 WARRANTY

- A. Material shall be warranted, on a pro-rata basis against defects for a period of 1 year from the date of the geocomposite installation.
- B. Installation shall be warranted against defects in workmanship for a period of 1 year from the date of geocomposite completion.

1.06 SUBMITTALS

- A. Three copies of the project submittals shall be forwarded to Owner or Owner's On-Site Representative as designated below.
- B. Information With Bid The following shall be submitted with the bid:
 - 1. Statement of experience from the proposed geocomposite Supplier.
 - 2. Statement of experience from the proposed geocomposite Installer, including resume of Installation Supervisor committed to the project.
- C. Prior to Installation The following information shall be supplied to Owner or Owner's Representative for review within 10 business days of the Contract Award to ensure that the materials and parties selected for use on the project meet the requirements of this specification:
 - 1. Samples of geocomposite proposed for use on the project.

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- 2. Reference list supplied by geocomposite Manufacturer indicating the appropriate experience level as required by the specification.
- 3. Reference list supplied by the geocomposite Installer indicating the appropriate experience level as required by the specification.
- D. Prior to Deployment The following information shall be submitted by the Lining Contractor to Owner or Owner's Representative prior to the deployment of any geocomposite material to ensure that the materials and subgrade preparation meet the requirements of this specification:
 - 1. Geocomposite Manufacturer's Quality Control Certifications.
 - 2. Certifications of subgrade acceptance for each area covered by geocomposite, signed by the earthwork Contractor and Owner's Representative.
- 1.07 BASIS FOR COMPENSATION
 - A. Compensation for all Work covered under this Section shall be included in the Lump Sum Contract Price Bid.
 - B. Partial payments by Owner for geocomposite are predicated on timely receipt of geocomposite submittals by Contractor.
 - C. The Lump Sum Contract Price Bid shall include any allowances for waste, overlap, and anchoring.

PART 2: PRODUCTS

2.01 GEOCOMPOSITE MATERIAL LABELING, DELIVERY, STORAGE, AND HANDLING

- A. Labeling each roll of geocomposite delivered to the site shall be labeled by the Manufacturer. The label will identify:
 - 1. Manufacturer's Name
 - 2. Product Identification
 - 3. Length
 - 4. Width
 - 5. Roll Number
- B. Delivery Rolls of geocomposite will be prepared to ship by appropriate means to prevent damage to the material and to facilitate off-loading.
- C. Storage The on-site storage location for the geocomposite, provided by the Contractor to protect the geocomposite from abrasions, excessive dirt, and moisture shall have the following characteristics:
 - 1. Level (no wooden pallets)
 - 2. Smooth
 - 3. Protected from theft and vandalism
 - 4. Adjacent to the area lined

- D. Handling
 - 1. The CONTRACTOR and INSTALLER shall handle all geonet in such a manner as to ensure it is not damaged in any way.
 - 2. The INSTALLER shall take any necessary precautions to prevent damage to underlying layers during placement of the geonet.

2.02 GEOCOMPOSITE PROPERTIES

- A. The geocomposite shall be manufactured by extruding two crossing strands to form a bi-planar drainage net structure.
- B. The geocomposite specified shall have properties that meet or exceed the values listed in Table 2.1 below:

 Table 2.1: Geocomposite Properties

Property	Test Method	Test Frequency	Value
Transmissivity ⁽¹⁾ gal/min/ft (m²/sec)	ASTM D 4716	1/540,000 ft ²	24.0 (5 x 10 ⁻³)@25,000 psf
Density g/cm ³	ASTM D 1505	1/50,000 ft ²	0.94
Tensile Strength (MD) Ib/in	ASTM D 5035/7179	1/50,000 ft ²	100
Carbon Black Content %	ASTM D 1603 ⁽²⁾ /4218	1/50,000 ft ²	2.0
Geocomposite Thickness Mil	ASTM D 5199	1/50,000 ft ²	270

NOTES:

•⁽¹⁾ Gradient of 0.1, normal load of 10,000 psf, water at 70° F, between steel plates for 15 minutes.

• ⁽²⁾ Modified.

Table 2.2: Raw Material Properties

Property	Test Method ⁽¹⁾	Testing Frequencies	Value
Density (g/cm ³)	ASTM D 1505	Once Per Resin Lot	>0.94
Melt Flow Index (g/10 min)	ASTM D 1238	Once Per Resin Lot	<u><</u> 1.0

NOTES:

 $\bullet^{(1)}$ Some test procedures have been modified for application to geosynthetics.

2.03 MANUFACTURING QUALITY CONTROL

- A. The geocomposite shall be manufactured in accordance with the Manufacturer's Quality Control Plan submitted to and approved by the Engineer.
- B. The geocomposite shall be tested according to the test methods and frequencies listed in Table 2.1.

PART 3: EXECUTION

3.01 FAMILIARIZATION

A. Inspection

- 1. Prior to implementing any of the work in the Section to be lined, the Installer shall carefully inspect the installed work of all other Sections and verify that all work is complete to the point where installation of the Section may properly commence without adverse impact.
- 2. If the Installer has any concerns regarding the installed work of other Sections, Installer shall notify the Project Engineer.

3.02 MATERIAL PLACEMENT

- A. The geocomposite roll should be installed in the direction of the slope and in the intended direction of flow unless otherwise specified by the Engineer.
- B. If the project contains long, steep slopes, special care should be taken so that only full-length rolls are used at the top of the slope.
- C. In the presence of wind, all geocomposites shall be weighted down with sandbags or the equivalent. Such sandbags shall be used during placement and remain until replaced with cover material.
- D. If the project includes an anchor trench at the top of the slopes, the geocomposite shall be properly anchored to resist sliding. Anchor trench compacting equipment shall not come into direct contact with the geocomposite.
- E. In applying cover material, no equipment can drive directly across the geocomposite. The specified fill material shall be placed and spread utilizing vehicles with a low ground pressure.
- F. The cover soil shall be placed on the geocomposite in a manner that prevents damage to the geocomposite. Placement of the cover soil shall proceed immediately following the placement and inspection of the geocomposite.

3.03 SEEMS AND OVERLAPS

- A. Each component of the geocomposite shall be secured to the like component at overlaps.
- B. Geocomposite Components
 - 1. Adjacent edges of the geotextile along the length of the geocomposite roll shall be overlapped a minimum of 6" or as recommended by the Engineer.
 - 2. The overlapped edges shall be joined by tying to geocomposite structure with cable ties. These ties shall be spaced every 5 feet along the roll length.
 - 3. Geotextile of adjoining rolls across the roll width should be shingled down in the direction of the slope and the accompanying geocomposite joined together with cable ties spaced every foot along the roll width.

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4. The geonet component of the geocomposite shall be placed to connect to and discharge into the geonet of the adjacent roll, contained within the geotextile component of the geocomposite above and below, throughout the roll connection area.

3.04 REPAIR

- A. Prior to covering the deployed geocomposite, each roll shall be inspected for damage resulting from construction.
- B. Any rips, tears or damaged areas on the deployed geocomposite shall be removed and patched. The patch shall be secured to the original geocomposite by tying every 6 inches with the approved tying devices. If the area to be repaired is more than 50 percent of the width of the panel, the damaged area shall be cut out and the two portions of the geocomposite shall be joined in accordance with subsection 3.03.

END OF SECTION 02275

SECTION 02610

PIPES AND FITTINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Furnishing and installing 20" HDPE SDR 11 Leakage Collection and Drainage Collection Pipes.
- B. Furnishing and installing 6" HDPE SDR 11 Return Water, Residue Discharge, and Auxiliary Discharge Pipes.
- 1.02 BASIS FOR COMPENSATION
 - A. Work included under this Section of these Specifications shall be included under the Lump Sum Price.
- 1.03 REFERENCES
 - A. American Association of State Highway and Transportation Officials hereafter referred to as AASHTO.
 - B. American Society for Testing and Materials, current edition, hereafter referred to as ASTM.
 - C. American National Standards Institute, current edition, hereafter referred to as ANSI.

PART 2 PRODUCTS

2.01 HIGH-DENSITY POLYETHYLENE PIPE AND FITTINGS

- A. HDPE pipe shall be manufactured from materials meeting the requirement of ASTM D 1248 for Type III, Grade P34, Category 5, Class C, and have a PPE rating of PE3408. The pipe produced from this material shall have the dimensions and wall thickness as set forth in ASTM F 714 for the size and Standard Dimension Ration (SDR) shown on the Drawings.
- B. HDPE pipe shall be marked at maximum 5 foot intervals with the manufacturer's name or trademark, nominal size and SDR, cell classification, ASTM D 1248, and extrusion date, period of manufacture, or lot number.
- C. Polyethylene pipe fittings shall be manufactured from resin having the same classification and properties as the pipe resin, and shall be supplied by the pipe manufacturer. Molded fittings shall be used instead of fabricated fittings, if available. All fittings, bends, and couplings for the HDPE piping shall meet the requirements of this pipe specification and shall have an SDR at or lower than the pipe it is being connected to as shown on the Drawings.
- D. Electrofusion fittings (if needed) shall be Central Plastics PE3408 Black 3 Pin 150 Class, or approved equal. Electrofusion fittings shall be sized and installed in accordance with manufacturer recommendations for coupling HDPE pipe of the size and class shown on the Drawings.



2.02 VALVES AND VALVE BOXES

- A. Valves for pond return water supply/sump drain line shall be 2 ¹/₂" resilient-seated gate valves in conformance with AWWA C509.
- B. Valves:
 - 1. Flanged
 - 2. Non-rising stem
 - 3. Grade E bronze components
 - 4. Nitrile rubber O-rings and gaskets

2.03 FLANGES

- A. Bolts and Nuts for pipe flanges shall be carbon steel conforming to the requirements of ASTM A307, Grade B. Bolts shall have hex heads to conform to ANSI B18.2.1. Hex nuts conforming to ANSI B18.2.2 shall be used. Bolt and nut threads shall conform to ANSI B1.1. Plain washers shall conform with ANSI B18.22.1.
- B. Slip-on metal flanges shall be 150-lb. stainless steel and furnished with full-face rubber gaskets.
- C. Flange adapter and slip-on flanges shall be drilled to ANSI 16.1/16.47/16.5 Class 125/150 bolt circles and AWWA C-207 class D (type).

PART 3 EXECUTION

3.01 PIPE TRENCH BACKFILL AND COMPACTION

- A. See Specification 02220 for requirements.
- 3.02 HIGH-DENSITY POLYETHYLENE PIPE
 - A. GENERAL
 - 1. General steps for butt-fusion joints:
 - a. Surfaces of fusion tools, pipe, and fittings shall be free of contaminants prior to use. Pipe ends shall be trimmed as necessary prior to joining.
 - b. Heat both pipe ends simultaneously at specified temperature for specified time.
 - c. Remove heater and press melted surfaces together to form joint.
 - d. Maintain uniform pressure until solidified. Prevent rough handling (testing, stress movements, pulling, or laying) until fully cooled to ambient material temperatures.
 - 2. General steps for electrofusion:
 - a. Surfaces of fusion tools, pipe, and fittings shall be free of contaminants prior to use. Pipe ends shall be trimmed as necessary prior to joining.
 - b. Follow manufacturer's recommendations for electrofusion techniques.



B. FUSION UNIT OPERATORS

1. Each operator of fusion units shall demonstrate to Owner's or Owner's Representative's satisfaction that operator is qualified to perform consistently correct fusion joints acceptable to Owner. Contractor shall replace without additional cost to Owner any fusion unit operator to which Owner or Owner's Representative has reasonable objection based on the operator's failure to perform consistently correct fusion joints as recommended by pipe manufacturer or the provision of this Section.

C. PRESSURE TESTING

- 1. Testing will be done in sections not to exceed 700 feet in length. A final pressure test will be conducted after the pipes have been installed.
- 2. The contractor will fill the pipelines with water to a pressure of 160 psi for SDR 11 HDPE. The contractor will maintain this pressure in the pipe for a period of one hour.

D. INTERNAL FUSION BEAD REMOVAL

1. The internal fusion bead from each butt weld shall be removed. This equipment is manufactured by R & L manufacturing and distributed by:

Crookston Welding Highway 75 South Crookston, MN 56716 Phone: (218) 281-6911 Fax: (218) 281-7255

2. Quality control shall be by inspecting the external and extracted internal fusion bead. The internal bead shall also have a smooth root cut of the wall area; this may include wall mass that has been misaligned during fusion process. However any wall mass that is removed should not exceed 1/10th of the wall thickness of the pipe itself.

3.03 FIELD QUALITY CONTROL

- A. Pipe and pipe installations will be subject to rejection for any of the following reasons:
 - 1. Failure to conform to the specifications, particularly compaction under and around the pipe.
 - 2. Fractures or cracks passing through pipe wall.
 - 3. Chips or fractures on interior of pipes.
 - 4. Cracks which, in the opinion of Owner or Owner's On-site Representative, may impair strength, durability, or serviceability of pipe.
 - 5. Defects indicating improper proportioning, mixing, or molding.
 - 6. Damaged ends where such damage would prevent making a satisfactory joint.

END OF SECTION 02610

SECTION 15201

PUMPS AND APPURTENANCES

PART 1: GENERAL

1.01 DESCRIPTION

- A. All Work included in this Section shall be performed in accordance with the following paragraphs, the General Requirements set forth in these Specifications, and the provisions of the other Contract Documents.
- B. Work covered under this Section includes providing all materials, equipment, and labor to perform the required Work, including, but not limited to:
 - 1. Furnishing and installing submersible Leakage pump, valves, piping, and hoses, as required.
 - 2. Furnishing and installing submersible Drainage water pump, valves, piping, and hoses, as required.
- 1.02 BASIS FOR COMPENSATION
 - A. Compensation for all Work included under this Section of these Specifications shall be in accordance with the provisions set forth in Section 01025, Measurement and Payment.
 - B. Furnish and install all equipment required to provide a complete, functioning pumping system as shown on the Drawings.
- 1.03 REFERENCES
 - A. American Society for Testing and Materials (ASTM), latest edition:
 - 1. ASTM D3261 12 Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
 - 2. ASTM D3350 Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
 - 3. ASTM F714 Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter
 - 4. ASTM F2164 Standard Practice for Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure
- 1.04 RELATED SECTIONS
 - A. Section Not Used

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Pumps and Appurtenances

1.05 SUBMITTALS

- A. Submit for documentation shop drawings, manufacturer's literature, catalog cuts, pump curves and other manufacturers or fabricator's data showing materials, assemblies, and methods for the submersible pump and all appurtenant equipment specified in this Section.
- B. Submit product data for all materials specified in this Section to Owner or Owner's On-Site Representative at least two weeks prior to delivery of materials to the Site.
- C. If modifications to winch support are required to accommodate the approved winch supplied, submit layout and details of winch support structure construction for approval.
- D. Furnish operation and maintenance manual, spare parts list, and assembly drawings for pump and winch.

PART 2: PRODUCTS

2.01 SUBMERSIBLE VERTICAL TURBINE LEACHATE PUMPS

- A. Pumps:
 - 1. High Density Polyethylene (HDPE) shrouded vertical well pump.
 - 2. All 304 or higher stainless steel construction for wetted parts, hardware and fittings.
 - 3. Rubber parts: Viton or equal.
 - 4. Integral check valve modified to provide drainage of discharge pipe back to sump upon shut-down.
 - 5. Suitable for use with water contaminated with small amounts of hydrocarbons; suitable for inclined installation in sidewall riser pipe (3H:1V slope) with minimum submergence at the top of the pumping unit as shown in the Drawings.
 - 6. Environmental Pump Solutions Encapsulator Pump Model 300SRPF100-3A, or approved equal.

B. Motors:

- 1. 10 hp, 460v, 3 Phase.
- 2. Class1, Division 1 rating for explosive environments.
- 3. Environmental Pump Solutions Pollution Recovery Motor or approved equal.



- C. Motor Lead:
 - 1. Approximately 260 ft., continuous lead without splices between motor and control panel (or junction box for clean water pump).
 - 2. Sized for pump installation as shown on the Drawings.
 - 3. Provide suitable protective sheathing to protect from degradation by exposure to hydrocarbons and ultraviolet light.
 - 4. Confirm final length of cable in field prior to procuring pumping equipment.
- D. Minimum operating conditions:
 - 1. Primary Operating Condition: 300 gpm @ 97 ft. TDH
 - 2. Secondary Operating Condition: 350 gpm @ 75 ft. TDH
- E. Pump Accessories/Appurtenances:
 - 1. 300 ft. stainless steel pull cable per pump. Confirm length of cable in field prior to installation.
 - 2. Level sensor mounting slot welded to pump assembly.
- F. Provide three (3) pumping units total: two (2) leachate pump; one (1) back-up pump. All pumps supplied shall be identical.
- 2.02 SUBMERSIBLE LEVEL SENSOR PRESSURE TRANSDUCER
 - A. Constructed of materials capable of being fully submersed in residue process water and leachate.
 - B. Wetted materials shall be 316 stainless steel, welded body construction; Viton or similar hydrocarbon resistant wetted rubber parts.
 - C. Level sensor cable with self-sealing outer jacket which blocks water in the event of damage to the jacket. Vented for barometric pressure compensation; covered vent.
 - D. Output: 4-20 mA, ±0.1% Full Scale accuracy. Operation range is approximately 1 to 50 psi.
 - E. Lightning and surge protection.
 - F. 300 ft. of cable for each of three pumps. <u>Confirm final length of cable in field prior to procuring</u> <u>sensors.</u>
 - G. Provide three (3) transmitters total. All transmitters supplied shall be identical.
 - H. Environmental Pump Solutions Miniature Submersible Level Transmitter or approved equal.

2.03 HDPE DISCHARGE PIPE

- A. DR 17 HDPE, IPS size, maximum 40-ft sections, dimensions as shown on the Drawings.
- B. PE 4710 resin, ASTM D3350, ASTM F714, cell classification 445574C/E; ultraviolet stabilizer.
- C. Markings: manufacturer's logo, nominal size and OD base, material code, DR, pressure class, ASTM F714, production date (day, month and year.)
- 2.04 PUMP DISCHARGE HOSE
 - A. Two-ply, steel wire reinforced NBR hose with smooth inner wall, high oil resistance, flexible to minus 40 degrees F, minimum 150 psi working pressure, maximum weight 2.5 lb/ft
 - B. Hose diameter: 4-inch ID. Hose length: >6 ft. estimated for bidding purposes. <u>Confirm final</u> hose length required in field based on actual constructed layout and connecting pipe locations.
 - C. Flex-Devil by Thermoid/HBD Industries, or approved equal.
- 2.05 HDPE FITTINGS
 - A. DR 17 HDPE butt fusion fittings, IPS size, injection molded.
 - B. PE 4710 resin, ASTM D3350, ASTM D3261, cell classification 445574C/E; ultraviolet stabilizer.
 - C. Markings: in accordance with ASTM D3261.
- 2.06 CAMLOCK FITTINGS
 - A. For HDPE Pipe: Poly-cam Series 641 Camlock/HDPE transition for butt fusion joints, aluminum hard coat camlock, or approved equal.
 - B. For discharge hose: Aluminum hard coat camlock fittings, hose shank style, compatible with Poly-cam HDPE transition fittings.
 - C. Provide all standard accessories required for use, including but not limited to oil-resistant gaskets; stainless steel handles, ring pins and pull rings.
- 2.07 REMOVABLE PIPE INSULATION JACKET
 - A. Tight-fitting, non-asbestos hydrophobic anti-freeze insulation jacket for use to minus 40 degrees F.
 - B. Velcro closures with side flaps secured by tie cord, sized for exposed 4-inch hose and 6-inch pipe connection at top of sidewall riser.
 - C. ThermaXX LLC or equal

2.08 POWER WINCH

- A. 230V, 1 phase power winch, portable with plug-in power cord, TEFC UL-listed motor, all components rated for outdoor use.
- B. Winch capacity: Minimum 2000 lb. pulling capacity at 3H:1V slope, minimum 300 ft. drum capacity based on cable size provided with pumps. <u>Confirm cable size with pump supplier.</u>
- C. Automatic braking system, totally enclosed geartrain, basic Nema 4X two button handheld pendant control.
- D. Quick-mount brackets compatible with installation method shown in the Drawings.
- E. Confirm power requirements and coordinate with control panel supplier for appropriate power supply to convenience outlet in panel.

2.09 SOURCE QUALITY CONTROL

- A. Products supplied as specified under the specific paragraphs of this Section shall be of the same manufacturer and be identical and interchangeable with products of the same specification and size. Products of the same type, but of different diameter or size, shall be supplied by the same manufacturer.
- B. Contractor shall be responsible for ensuring that the products meeting the requirements of this Section are supplied. Contractor shall maintain records to establish that products supplied meet or exceed referenced standards as specified in this Section.

PART 3: EXECUTION

3.01 INSPECTION

- A. Contractor shall be responsible for all materials required to provide the products as specified and no defective products will be allowed for installation.
- 3.02 PUMP/DISCHARGE PIPE/TRANSDUCER INSTALLATION
 - A. Prior to installation in the sidewall riser, fully assemble the pump/pipe assembly at the surface to confirm that all parts are correct and functional. Disconnect pump and pressure test discharge piping using hydrostatic pressure in accordance with ASTM F714. Use test pressure of 50 psi.
 - B. Install pump and related accessories in strict accordance with the drawings, specifications, manufacturer's recommendations and referenced standards for a complete and operable system.
 - C. Place transducer in receptacle on pump. Securely tether the transducer cable and the pump motor cable to the discharge pipe with nylon straps a minimum of 20 places on each pipe section after the couplers are in place.
 - D. Verify the pump location within the sidewall riser/sump with Owner or Owner's On-Site Representative to provide adequate submergence. Keep accurate records of the final total length of the discharge pipe/pump assembly. Place a highly visible permanent mark on the near the

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upper end of the discharge pipe or coupling and sidewall riser to indicate the correct placement of the pump. Also place marks or words noting that the marked pipe section is the uppermost section to assure that the pump is accurately placed on subsequent installation.

E. Coil excess cable and store inside of sidewall riser pipe for leachate pump. Confirm final storage of excess motor and transducer cable for the clean water pump. Do not cut cables on any pumps or transducers to shorten.

3.03 BURIED HDPE PIPE INSTALLATION

- A. Remove all foreign matter and dirt from pipe before installing and keep pipe clean after installation. Blow out piping system with compressed air and flush with clean water at system operating pressure as required to ensure a clean piping system.
- B. Joints shall be thermal butt fused in accordance with manufacturer's recommendations by a factory qualified joining technician.
- C. Install buried pipe in accordance with manufacturer's recommendations. Do not exceed manufacturer's recommended bending radius.
- D. Pressure test buried HDPE pipe from sidewall riser to leachate pond in accordance with ASTM F2164 using hydrostatic pressure using a test pressure of 10 psi. Do not air test.

3.04 WINCH INSTALLATION

A. Install portable winch as directed by Owner's On-Site Representative. Confirm structural frame support configuration with actual winch supplied.

3.05 FIELD QUALITY CONTROL

- A. Establish and maintain quality control procedures for work performed under this Section to assure compliance with contract requirements and maintain records of his quality control for all construction operations including, but not limited to, the following:
 - 1. Materials and products used
 - 2. Lines and grades
 - 3. Tolerances, test procedures and results
- B. The Drawings indicate certain required pipe sizes and the general arrangement for the major piping and equipment. Field verify locations of all process piping and accessories in the field. In the event it should become necessary to change the location of any of the work due to interference with other work, consult with the Owner and Engineer before making any changes and all such changes shall be made without added cost to the Owner. Under no circumstances shall the pipe sizes indicated on the Drawings be changed without the written approval of the Owner and Engineer.

END OF SECTION 15201

Pumps and Appurtenances

Attachment C

Dam Break Analysis – Hydrometallurgical Residue Facility



Technical Memorandum

To:Poly Met Mining, Inc.From:Tom Radue, Barr Engineering Co.Subject:HRF Dam Break AnalysisDate:August 19, 2015Project:23690862

Barr Engineering Co. completed a dam break analysis for the Hydrometallurgical Residue Facility (HRF) dams to fulfill dam safety permitting requirements. The HRF dams have been designed to achieve necessary factors of safety (Geotechnical Data Package – Volume II, (Reference (1)), so a dam break is unlikely.

The HRF will be located along the boundary between the Embarrass River watershed and the Partridge River watershed in St. Louis County. The HRF will be three-sided:

- The northern and southwestern dams will be in the Unnamed (Mud Lake) Creek subwatershed of the Embarrass River watershed. The Unnamed (Mud Lake) Creek subwatershed is very sparsely populated. Potential flow paths from the HRF toward Unnamed (Mud Lake) Creek primarily would cross wetland areas interspersed with wooded uplands.
- The southeastern dam will be in the Second Creek subwatershed of the Partridge River watershed. Potential flow paths from the HRF toward Second Creek would be limited by railroad embankments to industrial portions of the PolyMet Plant Site.

Dam break analysis consists of identification of feasible events or a series of events at the HRF that, if not identified and resolved in a timely manner and/or if left unresolved once discovered, could lead to a failure of an HRF dam and the HRF liner system and subsequent release of contained process water or process water and Residue into the environment. For dams associated with liquid containment, such as the HRF dams, failure can be triggered by singular events, or more often, by a series of events. Examples of events that could trigger failure include but are not limited to the following:

- prolonged or massive overtopping of the dam due to uncontrolled discharge into the facility during operations or in combination with inflow from a historic rain event of large magnitude and duration
- uncontrolled or unmitigated seepage through the dam along with internal erosion of the structure of the dam (i.e., migration of soil particles from within the earthen structure of the dam out through the exterior dam face due to particle transport via seepage)
- regional or localized seismic events of sufficient magnitude, acceleration, and duration to damage the foundation or structure of the dam, typically resulting in cracking of the dam or deformation and overtopping
- over-steepening of the dam slopes, resulting in slope instability and failure

- failure of the facility liner system, resulting in uncontrolled seepage and either internal erosion of the dam and/or external sloughing of the dam slope due to saturation of the earthen fill, progressively transitioning to a large scale slope failure
- failure of a nearby piping system resulting in erosion of the body of the dam and potential undermining and failure of the liner system

For a facility with the design characteristics of the HRF it is typical that a chain of events would be required in order to initiate a dam break. Two examples are presented in Table 1.

	HRF Dam Break	Failure Chain Example 1	Failure Chain Example 2
		 Facility is operating at the maximum design water elevation 	1) A large tear develops through all layers of the double liner system
		2) Return water pipeline becomes inoperable	2) Pond water leaks through the tear and percolates into the HRF dam
	Event Sequence	 Residue transport pipeline discharge to HRF continues 	3) The HRF dam structural fill becomes saturated
		4) Historic rain event occurs at the HRF	4) Leakage progresses to the toe of slope and exits with sufficient velocity to cause internal erosion
	Overtopping occurs with overtopping flow concentrated at a single location along the dam crest, eroding a channel through the exterior face of the dam, with erosionInternal erosion evolves erosion of the dam slope failure and liner failure		Internal erosion evolves to progressive erosion of the dam slope, initiating slope failure and liner failure

Table 1 HRF Dam Break Failure Chain Examples

Note: The HRF Dam Break failure chains noted above are hypothetical.

Failure chain Example 1 consists of overtopping of the dam; an operations failure concurrent with a historic rain event. It assumes that the return water pipeline is inoperable for an extended period of time and that HRF operations personnel ignore this and the rising water in the facility. This could be accompanied by a significant rainfall that further increases water level and initiates an overtopping event. Such a failure scenario is improbable for the following reasons:

 The facility design and operation accommodates the probable maximum precipitation. Per Hydrometeorological Report number 51 (HMR 51), Probable Maximum Precipitation Estimates, United States East of the 105th Meridian, the 72-hour Probable Maximum Precipitation (PMP) event at the HRF is on the order of 32 inches. The freeboard to be maintained during HRF operations will be a minimum of 36 inches from the top of HRF liner system, with additional freeboard provided by the crest of dam liner system cover materials.

The failure would require prolonged mismanagement on the part of multiple facility operations personnel. This is improbable for the following reasons:

- Daily HRF inspections and water level monitoring would identify a notable change in the rate of water level rise in the HRF.
- The water returned to the Hydrometallurgical Plant is put back into the process to facilitate ongoing operations and to minimize water consumption. A long-term shutdown of the water return line would impact plant operations.
- The water is returned to the process to recover the metals in solution and increase metal recovery. A long-term shutdown of the water return line would impact the metal recovery.
- Under routine operating conditions but absent return water, several months would be required to discharge sufficient water into the HRF to initiate overtopping. At the projected HRF inflow rate of 218 gallons/minute, approximately 55 days would be required to raise the pond level a single foot; sufficient time to identify and resolve any operations issues.

Failure chain Example 2 consists of development of a large tear through all layers of the double liner system. For the HRF as proposed, with its relatively flat embankment slopes and intermediate benches to prevent development of strain in the liner system, the most probable initiation point of a tear would be at the base of the facility. This would be the result of large scale localized differential settlement of the HRF foundation materials. Settlement of sufficiently large scale would be required to induce strain in the liner system in excess of the liner system's strain tolerance. Another potential source of tears in the liner system would be from construction activities during initial liner construction. However, both liner tear scenarios are improbable and hence the overall failure scenario is improbable for the following reasons:

- The HRF foundation materials will be pre-loaded to induce settlement and to eliminate the potential for future large scale differential settlement, thereby minimizing strain in the liner system.
- The Linear Low Density Polyethylene (LLDPE) Geomembrane and the Geosynthetic Clay Liner (GCL) hydraulic barriers of the HRF liner system are selected for strain tolerance well in excess of the strain predicted to occur after pre-loading.
- The HRF embankments will be built using compacted structural fill that will not be subject to large scale differential settlement.
- Leak location surveys will be implemented on each geomembrane layer of the HRF liner system following completion of primary construction activities but prior to placing the HRF into service. Leak location surveys are effective at identifying holes in geomembrane liner systems.
- Larger holes and tears are readily detected by visual review of liner quality without the need for leak location surveys.
- Seam strength and integrity testing will be conducted on all seams of geomembrane panels and at geomembrane patch locations during construction.
- The volume of water required to fill all the pores in the embankment is large (millions of gallons) and its loss from the system should be noticed by operations.

- The material proposed to construct the HRF embankments is course, angular material not readily susceptible to piping failures/internal erosion.
- Seepage of significant quantity would be detected in the HRF leakage collection system and/or at the toe of slope of the facility, in the facility groundwater monitoring wells, and/or in the piezometers used for embankment performance monitoring. This data would serve as an early warning that leakage is occurring out of the HRF and mitigative measures could be implemented.

The failure scenarios described previously are two scenarios that, while theoretically possible, have a low probability of occurrence for the reasons summarized above. Further, the HRF dams will be constructed using compacted structural fill overlain by a multi-layer geosynthetic liner system. This type of liner system, when constructed by a qualified contractor using industry-standard quality control techniques, is highly effective at minimizing leakage. Finally, freeboard to be maintained within the HRF will accommodate addition of water and Residue over a period of months prior the threat of overtopping.

Additional hydrologic and hydraulic modeling to detail the extent of inundation from an HRF dam break is not warranted because no plausible HRF dam failure scenarios have been identified.

References

1. **Poly Met Mining Inc.** NorthMet Project Geotechnical Data Package Vol 2 - Hydrometallurgical Residue Facility (v6). July 2016.