



POLYMET
MINING

NorthMet Project

Air Quality Management Plan - Mine

Version 4

Issue Date: December 4, 2014



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Acronyms, Abbreviations and Units

Acronym	Stands For
FEC	Fugitive Emission Control
MPCA	Minnesota Pollution Control Agency
NESHAP	National Emission Standard for Hazardous Air Pollutants
NSPS	New Source Performance Standard
PSD	Prevention of Significant Deterioration
SDEIS	Supplemental Draft Environmental Impact Statement
VMT	Vehicle Miles Traveled
WWTF	Waste Water Treatment Facility
USEPA	U.S. Environmental Protection Agency



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1.0 Introduction

This document presents the air quality management plan for the Mine Site area of the NorthMet Project (Project). The plan describes how point and fugitive source emissions will be controlled and monitored. This document also includes a discussion of mitigation measures implemented at the Mine Site for Federal Class I Area visibility impacts as well as other potential mitigation measures.

1.1 Objective and Overview

The objective of the air quality management plan is to propose a framework designed to maintain compliance with anticipated air emissions permit conditions at the Mine Site. This plan or a successor document will be updated after permit issuance to reflect the actual permit conditions.

1.2 Outline

The remainder of this document is organized as follows:

- Section 2.0 Description of the emission control systems for point and fugitive sources including a discussion of mitigation measures implemented at the Mine Site for Federal Class I Area visibility impacts as well as other potential mitigation measures.
- Section 3.0 Description of air quality modeling outcomes.
- Section 4.0 Description of operating plans for emission controls and fugitive dust control.
- Section 5.0 Description of air quality related monitoring.
- Section 6.0 Description of air quality reporting and adaptive management.

This document is intended to evolve through the environmental review, permitting, operating, reclamation and long-term closure phases of the project. A Revision History is included at the end of the document.



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2.0 Air Quality Management System Design

The majority of air emission sources at the Mine Site are fugitive in nature, but there are a few point sources as well. The information below relies on preliminary discussions with the Minnesota Pollution Control Agency (MPCA) as to which sources are considered fugitive and which are considered point sources. These classifications were arrived at considering the application of the definition of a fugitive source from the federal Prevention of Significant Deterioration (PSD) program to the Project emission sources. While this document relies on the current anticipated categorization of emission sources, the final classification of sources as fugitive or point may change during the air permitting process.

2.1 Point Sources

Point sources include fuel combustion at the Waste Water Treatment Facility (WWTF), a Lime Silo, Lime Mix Tank, and one portable generator. These point sources and their associated emission controls are described below.

The WWTF will include propane fired heaters and a backup diesel fired generator. The backup generator will be certified to meet the applicable New Source Performance Standard (NSPS) and will meet any applicable NSPS fuel standards. The propane burned in space heaters is considered to be a low emission fuel.

A Lime Silo and Lime Mix Tank will be located at the WWTF to store and process lime used in wastewater treatment processes. Emissions from the Lime Silo Vent may occur during silo filling. Emissions may also occur when lime is added to the Lime Mix Tank inside the WWTF building. The Lime Silo Vent will be equipped with a fabric filter or similarly effective Control Equipment. The lime mixer will employ an enclosed loading system that will minimize emissions into the WWTF building that could potentially be emitted to the outdoor air.

A portable generator (truck or trailer mounted) will be used at the Mine Site to provide motive power to the large, electric powered mining equipment (excavators, blast hole drill) when they need to be moved beyond the range of electrical cables. The generator will not power the equipment when it is engaged in mining operations. The generator will be diesel powered and will meet applicable non-road emission standards based on the model year of the engine.

2.1.1 Location of Point Sources

Large Figure 1 shows the location of the point sources at the Mine Site.

2.1.2 Emission Controls

Most of the point sources at the Mine Site will be inherently low emitting. Where required by applicable rules or otherwise necessary, additional control measures will be implemented.

Table 2-1 shows the emission controls for the Mine Site point sources. For the EU-xx, CE-xx and SV-xx designators the “xx” will be determined in permitting.

Table 2-1 Mine Site Point Source Emission Controls

System	Equipment Served	Proposed Controls	Emission Unit (EU) Number	Control Equipment (CE) Number	Stack Vent (SV) Number
WWTF	Backup Generator	Low emitting fuel; NSPS certified engine and applicable fuel standards	EU-xx	NA	SV-xx
WWTF	Propane Space Heaters	Low emitting fuel	EU-xx	NA	SV-xx
WWTF	Lime Silo	Fabric filter or similar	EU-xx	CE-xx	SV-xx
WWTF	Lime Mix Tank	Enclosed loading system	EU-xx	NA	SV-xx
Mining Operations	Generator to move electrical equipment	Low emitting fuel; meet applicable emission standards	EU-xx	NA	SV-xx

2.2 Fugitive Sources

Fugitive emissions at the Mine Site will be primarily generated by the open pit mining activities including: 1) loading and unloading of overburden, waste rock, and ore, 2) unpaved mine roads, and 3) drilling and blasting. Other fugitive sources include traffic on the Dunka Road, a Portable Crushing Plant that may be operated at the Mine Site to produce aggregate for construction purposes, and overburden screening operations used to produce construction material from excavated overburden. Emissions from the stockpiles at the Mine Site due to wind erosion were evaluated per U. S. Environmental Protection Agency USEPA approved procedures, but are not considered to be fugitive sources as it was determined that wind erosion will not occur.

The Mine Site Fugitive Emission Control (FEC) Plan (Attachment A) describes emission control procedures, such as haul road watering and the minimization of drop heights, which will be implemented to control emissions from fugitive sources.

Many sources in the Portable Crushing Plant will be subject to the applicable NSPS based on the definition of the affected source in the standard (e.g., crushing, screening, conveyor transfer). Water sprays or similarly effective controls will be used to comply with the standard.



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The material processed in the overburden screening operation will have a natural moisture content >10%, so emissions will be minimal from this operation. However, if overburden is stockpiled and then screened and dry conditions make dusting a potential concern, appropriate dust control measures will be implemented.

2.2.1 Location of Fugitive Sources

Large Figure 2 and Large Figure 3 show the location of the roads and mine operating areas for Mine Years 11 and 20, respectively. These layouts are representative of the years with worst case emissions for the temporary stockpile (Mine Year 8) and in-pit disposal (Mine Year 13), which were used as the basis for the air dispersion modeling.

2.3 Mitigations included in Project

Poly Met Mining Inc. (PolyMet) has committed to the mitigations described in this section.

2.3.1 Class I Visibility

The following mitigations will be implemented due to concerns over potential impacts in Class I Areas:

- GenSet locomotives
- electric Primary Excavators
- phase in of Tier 4 compliant mining equipment

Modeling performed for the Supplemental Draft Environmental Impact Statement (SDEIS) indicates that with these mitigation measures the Project will show no adverse impacts in the Class I areas (Reference (1)). The mitigation measures are described further below.

2.3.1.1 GenSet Locomotives

Locomotives used for Project will be new GenSet locomotives (also referred to as multi-engine locomotives), which offer improved efficiency and reduced emissions relative to conventional locomotives and result in lower fuel usage and associated emissions. Conventional locomotives have a single 2,000 to 3,000 horsepower (Hp) diesel engine driving a single electric generator that powers electric traction motors. The GenSet locomotives have three or four 700 to 750 Hp diesel engines that meet USEPA Tier III nonroad standards, driving individual electric generators that power electric traction motors. The GenSet diesel engines start and stop automatically as required by engine loading demands. For example, when at idle, only one 700 or 750 Hp engine will be running, when pulling uphill, loaded, all three or four engines may be running. The Project application involves moving loaded cars uphill (high engine loading demand), moving empty cars downhill (low engine loading demand) and moving trains one car



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length at a time for loading at the Rail Transfer Hopper and unloading at the coarse crusher (low engine loading demand). GenSet locomotives are well suited to this variable engine demand, resulting in improved efficiency and lower fuel usage for the GenSet locomotives when compared to conventional locomotives. Furthermore, the GenSet locomotives employ Tier III engines which reduce NOx emissions by 48% to 67% below USEPA Tier II Rail Limits on a gram per horsepower-hour basis.

2.3.1.2 Electric Primary Excavators

The Project will use electric powered rather than diesel powered Primary Excavators to reduce direct emissions at the Mine Site.

2.3.1.3 Tier 4 Compliant Mining Vehicles

When PolyMet purchases or leases the initial mining fleet, Tier 4 compliant options are not scheduled to be available for all vehicle types. Therefore, a schedule was developed to phase in Tier 4 compliant vehicles, taking into account the useful lifespan of the initial mining vehicle fleet and indicating the minimum emission limits that equipment will meet during each year of operation. The Mine Site is expected to operate 100% Tier 4 vehicles by Operating Year 11 at the latest. This phasing in of Tier 4 vehicles was accounted for in the Class I modeling through the evaluation of multiple emission scenarios over the projected mine life.



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3.0 Air Quality Modeling Outcomes

Air quality modeling is described and results presented in Reference (2). The following sections summarize those results.

3.1 Class II Modeling

Modeling demonstrated that the Mine Site emission sources will not cause or contribute to a violation of the National Ambient Air Quality Standards (NAAQS) or Minnesota Ambient Air Quality Standards (MAAQS) for PM₁₀ and PM_{2.5}. Mine Site impacts were shown to be below the Significant Impact Level (SIL) for SO₂ and NO₂, so no further analysis was conducted for these pollutants. A Class II increment evaluation was also conducted for PM₁₀ which showed that the Mine Site and nearby sources do not consume all of the available increment.

3.2 Class I Modeling

The Mine Site was modeled along with the Plant Site to assess potential impacts in the nearby Class I Areas: the Boundary Waters Canoe Area Wilderness, Voyageurs National Park, Isle Royale National Park and the Rainbow Lake Wilderness Area. Class I increment consumption as well as the applicable Air Quality Related Values were evaluated at each Class I area. The modeling showed that the Project will cause no adverse impacts in the Class I areas.

3.3 Air Emissions Risk Analysis

An Air Emission Risk Analysis was conducted for the Mine Site. Inhalation based, acute, chronic non-cancer and chronic cancer risk was evaluated at the Mine Site boundary. Multi-pathway risk for resident and farmer receptors was evaluated at the boundary of the mining/industrial district (nearest location where farms or residences can be located). Human health based risk was shown to meet guideline values.



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4.0 Operating Plan

This section describes operating and maintenance procedures that will be implemented at the Mine Site to ensure that emissions are well controlled for both point and fugitive sources.

4.1 Point Sources

The subsections below provide a reasonable initial proposal for operating and maintenance requirements, based on knowledge of applicable regulations and professional experience and judgment. The final operating and maintenance requirements will be agreed upon between PolyMet and MPCA, the permitting authority, during the permitting process. Other regulatory agencies and concerned parties will have the opportunity to comment on operating and maintenance provisions during the permit public comment period(s).

4.1.1 Lime Silo (EU-xx)

The Control Equipment for the Lime Silo will be a fabric filter or similarly effective device called the Lime Silo Filter (CE-xx).

4.1.1.1 Operating

The Lime Silo Filter must be running before lime is added to the Lime Silo and remain running 15 minutes after lime filling is complete.

4.1.1.2 Maintenance

The following maintenance procedures will be implemented for the Lime Silo Filter:

- Inspect monthly or as required by manufacturer specifications all components that are subject to wear or plugging for example: bearings, belts, fans and ducts. Record the findings from the inspection and any corrective action resulting from the inspection.
- Inspect quarterly or as required by manufacturer specifications all components that are not subject to wear or plugging including structural components, housings and ducts. Record the findings from the inspection and any corrective action resulting from the inspection.
- Calibrate the pressure gauge(s) annually or as often as required by manufacturer specifications and record the calibrations and any corrective action resulting from the calibration.
- Corrective action will be taken as soon as possible if any of the following occur:
 - Periodic Monitoring (see 5.4) indicates that the Lime Silo Filter is not performing as designed; or



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- the Lime Silo Filter or any of its components are found during the inspections to need repair.

The corrective action will consist of initiating a Maintenance Work Order or similar to repair the Lime Silo Filter. A record of the maintenance performed on the Lime Silo Filter will be kept.

4.2 Fugitive Sources

Emissions from fugitive sources will be controlled through the implementation of the Mine Site FEC Plan. The Mine Site FEC Plan provides a reasonable initial proposal for operating and maintenance requirements, based on knowledge of applicable regulations and professional experience and judgment. The final Mine Site FEC Plan will be agreed upon between PolyMet and MPCA, the permitting authority, during the permitting process. Other regulatory agencies and concerned parties will have the opportunity to comment on the implementation of fugitive dust control practices at the Mine Site during the permit public comment period(s). The following is a brief summary of pollution control measures that will be undertaken:

- Use of water sprays or a similarly performing technique for the Portable Crushing Plant.
- Reliance on natural moisture content of overburden to minimize dusting during screening operations or addition of water sprays or other control measures if dictated by dry conditions
- Use of water application down the blast holes during drilling operations
- Minimizing of drop distances for rock, ore and overburden handling operations
- Use of water application and/or chemical dust suppressants to control emissions from unpaved roads.



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5.0 Monitoring

Monitoring will be conducted to verify compliance with the air emission permit limits. Specific monitoring requirements are dictated by applicable federal and state air quality rules, proposed synthetic minor limits and the Mine Site FEC Plan (see Attachment A) in addition to any other requirements included in the permit. The subsections below provide a reasonable initial proposal for monitoring requirements, based on knowledge of applicable regulations and professional experience and judgment. The final monitoring requirements will be agreed upon between PolyMet and MPCA, the permitting authority, during the permitting process. Other regulatory agencies and concerned parties will have the opportunity to comment on monitoring provisions during the permit public comment period(s).

5.1 Point Source Tons Processed or Operating Hours

PolyMet proposes that the monthly quantity of lime loaded into the Lime Silo and the daily quantity transferred to the Lime Mix Tank will be recorded. These data will be used to calculate annual particulate emission for emission inventory purposes.

5.2 Boiler/Heater/Stationary Engine Fuel Usage

PolyMet proposes that fuel usage will be tracked as an input for annual emission calculations for stationary emission sources. Fuel usage tracking methods and emission calculation methods are detailed for each relevant point source below.

In order to calculate emissions from the propane fired heaters at the WWTP, monthly deliveries of propane to the Mine Site will be recorded based on vendor invoices. Alternately, PolyMet proposes the option of installing sight glasses or similar tank level indicators or fuel meters to measure actual propane consumption if tracking deliveries is not believed to produce accurate results. Emissions will be calculated using published emission factors.

PolyMet proposes that generator emission calculations will rely on operating hour information to calculate total fuel use. Monthly operating hours for the backup generator at the WWTF and the portable Mine Site generator will be recorded. Fuel use will be calculated assuming the engines operate at full capacity for all hours operated unless the operating capacity levels information is available from an engine monitoring system. Emissions will be calculated using published emission factors or emission data from the manufacturer.

PolyMet proposes that diesel fuel sulfur content for each delivery of fuel to be burned in the generators will be recorded. The sulfur content will be used to show compliance with the applicable limits and to calculate monthly SO_x emissions for annual emission inventory purposes.



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5.3 Stack Tests

Any visible emission testing required by NSPS subpart OOO (Standards of Performance for Nonmetallic Mineral Processing Plants) will be completed in the timeframe required. Other testing is not anticipated based on the size and type of sources present.

5.4 Compliance Assurance Monitoring/Periodic Monitoring System

Compliance Assurance Monitoring requirements are not expected to apply to any emission sources at the Mine Site. However, periodic monitoring beyond the recordkeeping described above will likely be required for the Lime Silo because it will have Control Equipment (fabric filter or equivalent). Proposed monitoring will include recording the pressure drop across the Lime Silo Filter once during each filling of the Lime Silo. If the pressure drop is not within the manufacturer's recommended range, the corrective action specified in Section 4.1.1 will be initiated.

5.5 Material Handling Tons and Rates for Fugitive Emissions

PolyMet proposes that fugitive emissions will be calculated based on material handling and throughput information. Annual fugitive emissions from material handling will be calculated based on total quantity of overburden, waste rock, and ore loaded and unloaded from the Haul Trucks as well as total number of railcars loaded. The total quantity of overburden, waste rock (by category), and ore loaded and unloaded will be recorded and each load's source and destination will be tracked by the GPS based Mine Management System. The total number of railcars loaded with ore will also be recorded to calculate emissions from railcar loading. The crushing and screening plant emissions will be calculated based on the quantity of rock processed in the Portable Crushing Plant, recorded monthly. The quantity of overburden screened will also be recorded monthly for use in emission calculations.

5.6 Mobile Equipment VMT

PolyMet proposes that mobile equipment vehicle miles traveled (VMT) will be used to provide data for annual emission calculations as well as to keep records required by the Mine Site FEC Plan. The Mine Management System will track Vehicle Miles Traveled (VMT) for the haul truck fleet. The system will be capable of tracking the specific route of the Haul Trucks. VMT for other Project vehicles will be tracked by monthly recording of odometer readings if they are not equipped with a GPS monitoring system.

5.7 Ambient Air Monitoring

Ambient air monitors will be installed at the Mine Site at the ambient air boundary or other agreed upon locations to evaluate the effectiveness of the Mine Site FEC Plan. The monitored pollutant will be PM₁₀, because this is the size range of particulate matter that will be most strongly related to emissions from fugitive dust sources. Monitors will be located at opposite



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ends of the Mine Site so that contributions from the Project can be isolated from impacts from offsite sources. Air dispersion modeling results, prevailing wind directions, physical land features and the location of nearby sources will be considered when locating the monitors. A draft special purpose monitoring plan (Reference (3)) has been submitted to MPCA. Specific monitoring locations and monitoring equipment are not included in the current draft plan, but they will be added to subsequent revisions as the air permitting process proceeds.

The monitoring requirements will be described in the facility air emission permit. Monitoring will be continued until such time as the MPCA acknowledges in writing that PolyMet has satisfied the criteria included in the air permit to discontinue the monitoring program or issues a permit amendment removing the requirement to conduct the monitoring.

PolyMet has proposed the following criteria for discontinuing the PM₁₀ monitoring:

- 1) Two consecutive years of monitoring data that show high-second-high 24-hr calendar day average results less than 50% of the 24-hr NAAQS or 75 $\mu\text{g}/\text{m}^3$; or
- 2) Two consecutive years of monitoring data that show no 24-hr calendar day downwind minus upwind monitored value above 75% of the 24-hr PM₁₀ increment or 22.5 $\mu\text{g}/\text{m}^3$.

The final criteria for discontinuing monitoring will be agreed upon during the air permitting process.

5.8 Other Monitoring

Additional monitoring and recordkeeping has been proposed in the Mine Site FEC Plan.

5.9 Monitoring based on Class I Modeling

Additional monitoring requirements will be included in the permit to provide assurance that visibility impacts in the nearby Class I areas are acceptable. This monitoring may include fuel usage, fuel composition, operating hours, and/or records of the number of mining vehicles operated and their certified emission level. The final monitoring requirements will be agreed upon between PolyMet and MPCA. Other parties will have the opportunity to comment on monitoring requirements during the permit public comment period(s).

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6.0 Reporting and Adaptive Management

One time and periodic reporting will be required by the air emission permit. Specific reporting requirements are dictated by applicable federal and state air quality rules, the Mine Site FEC Plan and any other requirements that will be indicated in the permit. The subsections below provide a reasonable initial proposal for reporting requirements, based on knowledge of applicable regulations and professional experience and judgment. The final reporting requirements will be agreed upon between PolyMet and MPCA, the permitting authority, during the permitting process. Other regulatory agencies and concerned parties will have the opportunity to comment on reporting provisions during the permit public comment period(s).

6.1 General Reporting Requirements

This section lists reporting requirements that are included in all or nearly all Title V/Part 70 operating permits. These requirements include:

- reporting of shutdowns, breakdowns and malfunctions as required by Minnesota Rules
- immediate reporting of deviations (when required by rule)
- semi-annual deviation reports
- annual compliance certifications
- notifications and reports required under NSPS and NESHAP standards
- submittal of stack test reports

6.2 Additional Reporting

Additional reporting requirements may include the following:

- proposed revisions to Mine Site FEC Plan.
- changes to the special purpose monitoring program for PM₁₀.

6.3 Adaptive Management

The Mine Site FEC Plan includes some adaptive management provisions to address the potential need for adjustments or modifications to the plan. Data from the meteorological monitoring system will be integrated with the data from the Mine Management System (water/chemical application, road usage, observed dust notifications) along with daily fugitive dust observation forms. These data will be reviewed, at a minimum, on a semi-annual basis to aid in analyzing



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trends and to determine if FECs are effective. The Mine Site FEC Plan will be modified as needed based on these reviews or other improvements that have been identified.

6.4 Available Mitigations

Additional mitigations are available if necessary to achieve compliance, including:

- revision to Mine Site FEC Plan
- planting of trees or other vegetation along unpaved roads or around other potential dust generating activities to aid dust settling before reaching the ambient air boundary



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Revision History

Date	Version	Description
12/1/2010	1	Initial release to provide requested information
11/30/2011	2	Updates to reflect current proposed project and additional information added on monitoring, mitigation and reporting for use in SDEIS preparation.
12/14/2012	3	Updates to reflect current project description. Addition of Section 4.0 Operating Plan.
12/4/2014	4	Updated to address comments received and incorporate other minor edits for the Final EIS.



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List of References

1. **Barr Engineering Company.** Class I Area Air Dispersion Modeling (v2). May 2012.
2. **Poly Met Mining Inc.** NorthMet Project Air Data Package (v5). December 2014.
3. **Barr Engineering Co.** Fugitive Emission Control Plan: Special Purpose Monitoring - NorthMet Mine Site. April 2014.

List of Tables

Table 2-1 Mine Site Point Source Emission Controls..... 3

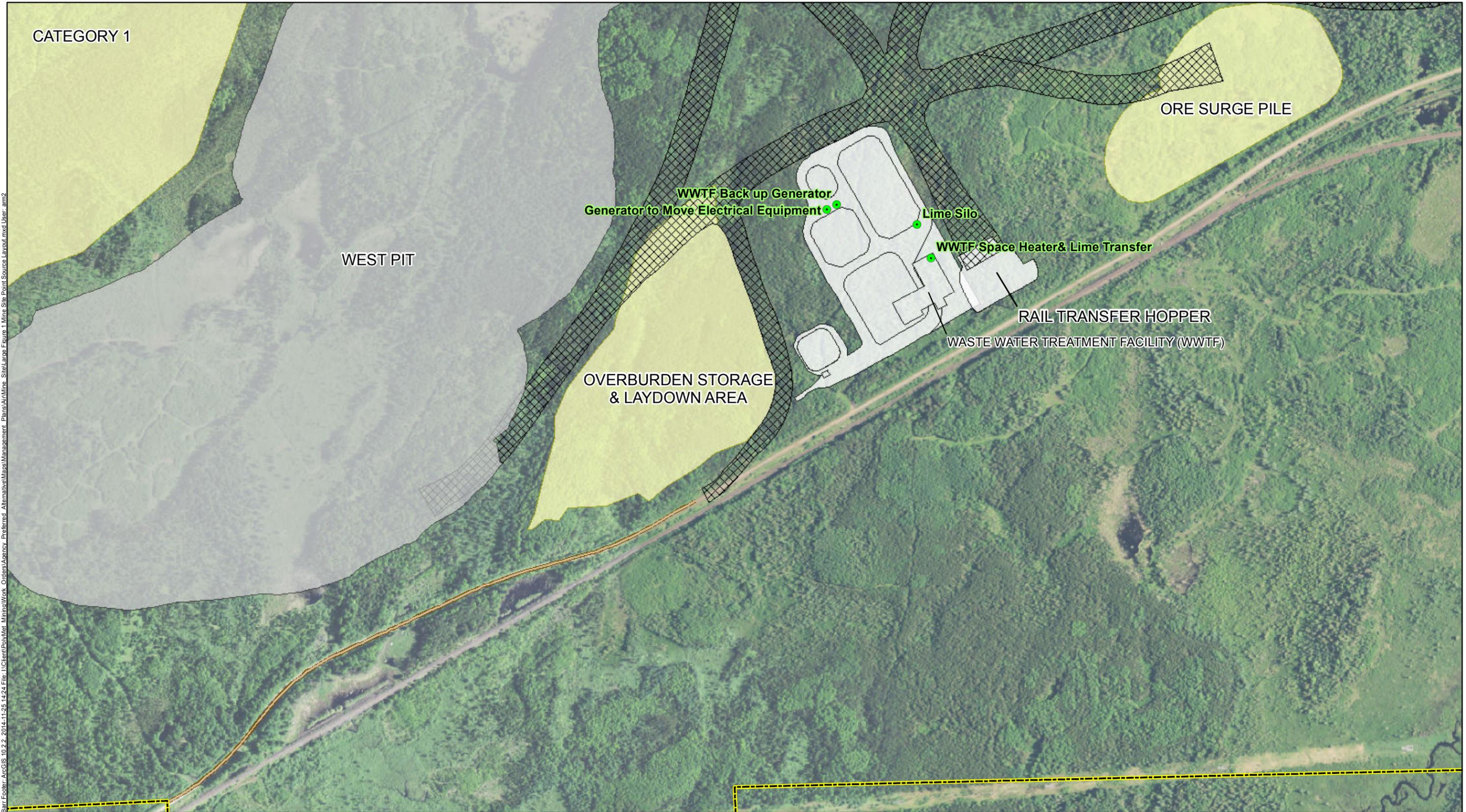
List of Large Figures

- Large Figure 1 Mine Site Point Source Layout
- Large Figure 2 Mine Year 11 Mine Site Layout
- Large Figure 3 Mine Year 20 Mine Site Layout

List of Attachments

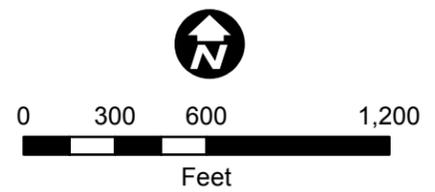
- Attachment A PolyMet Standard Procedure – Mine Site Fugitive Emission Control (FEC) Plan (ER09)

Large Figures



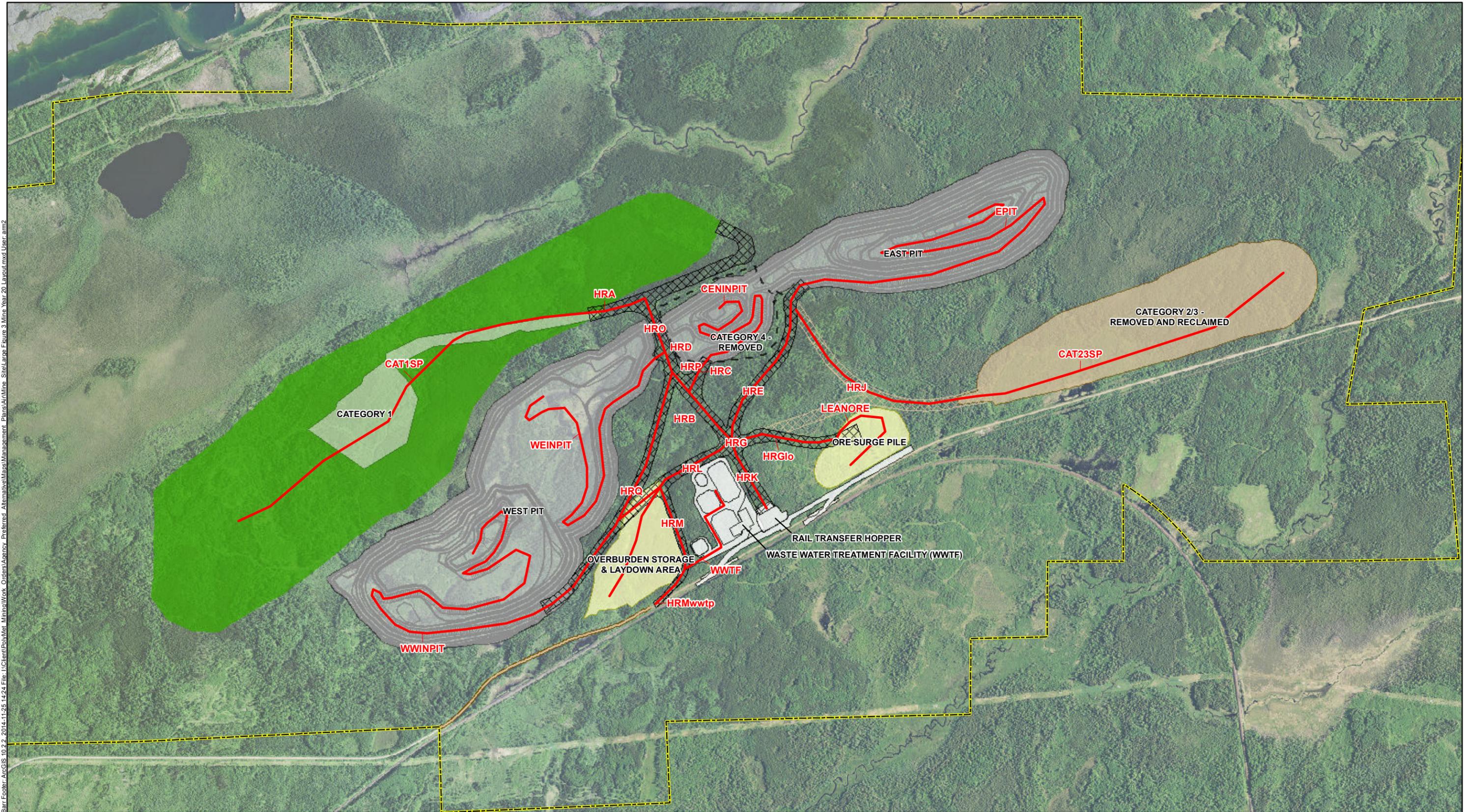
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- Point Sources
- Dunka Road
- Ambient Air Boundary
- Mine Pit
- Haul Roads
- Active Stockpile

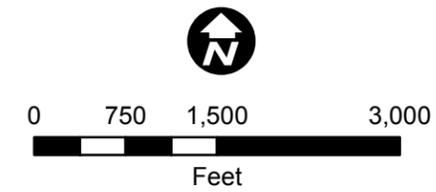


Large Figure 1
 MINE SITE POINT SOURCE LAYOUT
 NorthMet Project
 Poly Met Mining, Inc.
 Hoyt Lakes, Minnesota

Bar Footer: ArcGIS 10.2.2 - 2014-11-25 14:24 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Prefered_Alternative\MapManagement_Plans\AntLine_Site\Large_Figure 3 Mine Year 20 Layout.mxd User: am2



- Mine Year 20 Haul Roads
- Dunka Road
- Ambient Air Boundary
- Mine Pit
- Open Stockpile
- Covered Stockpile
- Active Stockpile
- Removed and Reclaimed Stockpiles
- Haul Roads
- Reclaimed Haul Roads
- Removed Stockpile



Large Figure 3
MINE YEAR 20 LAYOUT
NorthMet Project
Poly Met Mining, Inc.
Hoyt Lakes, Minnesota

Attachment A

PolyMet Standard Procedure – Mine Site Fugitive Emission Control (FEC) Plan (ER09)



Hoyt Lakes, Minnesota STANDARD PROCEDURE

Mine Site Fugitive Emission Control (FEC) Plan

General Manager's Approval _____ Manager's Approval _____ Initiator _____	Date Effective 03/28/13	SP Number ER09
History: 2/15/07 Preliminary version to support Detailed Project Description 11/11/11 Version 2: Revised to reflect increased control on unpaved roads and other minor revisions to multiple sections 12/7/11 Version 3: Revised to make changes agreed upon during 12/1/11 meeting with MPCA and to address comments received. 12/14/12 Version 4: Minor edits before submittal with version 3 of Air Quality Management Plan - Mine 03/28/13 Version 5: edited for permitting discussion 10/22/13 Version 6: updated to address MPCA comments 04/01/14 Version 7: updated to reflect Special Purpose Monitoring Plan 12/05/14 Version 8: updated for the Final EIS		

1.0 Introduction

Poly Met Mining Inc. (PolyMet) expects to be issued an Air Emissions Operating Permit (air emission permit) upon completion of environmental review and processing of an Air Emissions Permit Application (permit application) for its NorthMet Project (Project). The proposed Project consists of the operation of a base and precious metals mine and processing plant located near Hoyt Lakes, Minnesota. This Fugitive Emission Control (FEC) Plan covers activities at the Mine Site. This version of the FEC Plan reflects PolyMet’s current proposal and includes incorporation of comments received from MPCA, especially related to the control of potential dust emissions from unpaved roads. The plan is currently in draft form and will be finalized as part of the air permitting process.

Note:

This preliminary document is written to apply to the operating and fully staffed facility. It is not intended to apply to the current non-operating situation. The referenced procedures and manuals do not yet exist.

2.0 Objectives

The objective of the FEC Plan is to outline the basic procedures to prevent or minimize the release of fugitive emissions according to the expected requirements of the anticipated air emission permit. The plan outlines the practices to be followed to control emissions, the methods used to determine when emissions require corrective action, the procedures that will be employed to manage the emissions, and the recordkeeping that will be used to demonstrate fugitive emission control. The plan targets a control efficiency of 90% for Mine Haul Roads and satisfies Level III-B requirements for achieving > 80% control efficiency on a 24 hour basis from unpaved roads as outlined by Minnesota Pollution Control Agency (MPCA) guidance (Reference (1)). The Dunka Road, used for site access, will have much lower traffic levels, so Level III-A controls with an assumed control efficiency of 80% was found sufficient to produce acceptable modeling results. Therefore, Level III-A controls will be implemented on this road.

The fugitive emission sources outlined in the permit application are discussed in the next section including a general description of each process that will generate fugitive emissions and associated fugitive emission control procedures.

PolyMet may periodically revise this plan to improve performance, efficiency or usability without prior approval from MPCA. PolyMet will submit a revised plan to MPCA within 14 days of implementing any substantive changes to the plan. PolyMet may follow the revised plan until such time as MPCA raises objection to the revisions at which time PolyMet will revert to the previous version of the plan until agreement is reached with MPCA on plan revisions.

3.0 Fugitive Emission Sources

The following offers an overview of the fugitive emission sources and the steps that will be employed to control fugitive emissions.

3.1 Drilling and Blasting

Blasting activity will be managed to address safety, noise reduction, and emission control. Several steps may be taken to comply with applicable regulations including:

1. Obtaining required weather data from a weather monitoring and forecasting service such as Universal Weather and Aviation;
2. Employing aircraft flying service to monitor meteorological conditions and conduct safety surveillance;

3. Following proper blast hole loading, stemming and blast pattern timing procedures to control noise and emissions by directing the blast energy into the rock, instead of into the atmosphere; and/or
4. Timing drilling and blasting to take advantage of natural conditions (e.g. humidity, precipitation) that are favorable for controlling fugitive emissions.

The experience and judgment of the blasting team is critical in abating and minimizing noise and fugitive emissions. The key to reducing potential impacts is for the team to only proceed with blasts when it has been verified that conditions are suitable.

During the blasthole drilling operation, water will be mixed with the compressed bailing air to minimize the fugitive dust generation (FS050).

3.2 Loading and Unloading Material

The fugitive emission sources for material loading and unloading at the Mine Site in the permit application are listed below:

Table 1 Loading and Unloading Sources

Source ID Number(s)	Description
FS001, FS002, FS014 and FS019	Surface overburden truck loading and unloading
FS007, FS009 and FS020	Ore truck loading and unloading
FS004, FS005, FS401, and FS402	Waste rock truck loading and unloading
FS010	Ore railcar loading

The amount of fugitive emissions generated by truck loading and unloading and railcar loading is influenced by a number of factors:

1. The type of materials (surface, waste rock, ore, etc.)
2. The nominal size of the material
3. The dumping procedure (direct or dump and push)
4. The natural conditions of the environment such as the moisture content of the material being loaded and unloaded.

The drop distance from the shovel or loader to the truck will be minimized by the operator during loading operations to avoid injuries to truck drivers and harm to equipment. As a result, fugitive emissions will be minimized during surface overburden truck loading (FS001, 019), ore truck loading (FS007) and waste rock truck loading (FS004, FS401). The drop distance at the Rail Transfer Hopper is also minimized to control fugitive emissions during ore rail loading (FS010). Fugitive emission control for the loading and dumping of onsite material (ore, waste rock, surface overburden) is dependent upon the natural conditions of the environment as

mentioned previously. The fugitive emissions that may be created are also dependent upon the fines content and the moisture content of the material.

3.3 Haulage Roads

The transport emission sources identified in the permit application include emissions from transport on haulage roads and other unpaved roads (FS011, FS012A, FS058, and FS049). Natural conditions in the environment control fugitive emissions during material transport in addition to procedures implemented with this plan.

MPCA guidance includes specific requirements for various levels of control on unpaved roads up to Level III-A. Level III-B controls must be agreed upon with MPCA on a case by case basis. The enumerated items below indicate where measures are needed to fulfill Level III-A requirements and identify measures that go beyond Level III-A requirements and should be considered part of the proposal for Level III-B controls. A control efficiency of 80% was assumed for the Dunka Road source (FS012A) in the emission inventory and air dispersion modeling, so only the Level III-A requirements apply to this road section.

Controlling fugitive emissions from haulage and unpaved roads is important for employee safety and industrial hygiene as well as the environment. Procedures to control these emissions include the measures described below. These measures are further detailed in Sections 3.3.1 through 3.3.4:

- 1) Fugitive emission control will be achieved with the application of water and/or MPCA approved commercial dust suppressants (Level III-A).
- 2) During the winter months, application of salts ($\text{NaCl}/\text{CaCl}_2/\text{MgCl}_2$), application of sand mixtures, scarification of the road surface, and/or application of new road material will be used to enhance safety and control fugitive emissions from the roads (use of chemical dust suppressants would require MPCA Water Quality Division approval – salts such as those listed above are frequently approved and used at mines in Minnesota). Snow may also be applied on roads and under the appropriate conditions based on the experience of mine management personnel. In addition, very light applications of water can be effective in freezing conditions (Level III-A).
- 3) The haulage roads will be surfaced with crushed rock having low fines content, thus affording proper traction and vehicle support, minimizing tire wear, and reducing fugitive emissions.
- 4) A Mine Management System utilizing Global Positioning Systems (GPS) will be implemented at the Mine Site. This system will be utilized to automatically record data relevant to the FEC Plan and perform other tasks related to fugitive dust control including:
 - a) GPS units and flowmeters on the water trucks will provide tracking of water truck routes, times of operation and amount of water applied. Equipment operators (haul trucks, loaders, graders) will manually enter locations where dust is observed into the Mine Management System from their equipment. Mine supervisors will also have the ability to

- manually enter locations where dust is observed into the Mine Management System. The Mine Management System can then dispatch a water truck to the area where dust is observed or implement other emission reduction measures based on meteorological and operating conditions. It will be the Mine supervisors' responsibility to ensure an appropriate response to any observation of dusty conditions is initiated immediately. The Mine Management System will maintain an electronic history of specific road segments where dust is observed and noted, as well as the times and amount of water applied to specific road segments. This system will document responses to notification of fugitive emissions, including the time the notification was made, the corrective action taken and the time corrective action was initiated. (Reporting of the presence of excessive dust, corrective action taken and recording quantity of total water applied during a 24-hour period would be part of Level III-A. Use of the GPS based system and flow-metering of water application would be beyond this and therefore Level III-B).
- b) The Mine Management System will also record the routes of the haul trucks and the total vehicle miles travelled (VMT) for the fleet (VMT record required for Level III-A, using GPS based system = Level III-B).
 - c) Wind speed and direction, temperature, and precipitation will be gathered and recorded from a meteorological station operated by PolyMet. The on-site meteorological station data will be integrated into the Mine Management System and an electronic history maintained (recording precipitation is a Level III-A requirement, but on-site monitoring is not required, additional parameters and integration with Mine Management System is Level III-B).
 - d) The Mine Management System electronic history (meteorological data, water/chemical application, road usage, observed dust notifications), along with daily fugitive dust observation forms and data from the Special Purpose PM₁₀ monitors, will be reviewed at a minimum on a semi-annual basis to aid in analyzing trends and to determine if fugitive emission controls are effective. This FEC Plan will be modified as needed based on these semi-annual reviews or other improvements that have been identified. The information described in this FEC Plan stored by the Mine Management System will be available for review during inspections (Level III-B).
- 5) In addition to the continuous evaluation of the effectiveness of dust control by equipment operators and other personnel, once per day during daylight hours a trained Visual Emissions (VE) evaluator will make observations of the presence or absence of fugitive dust on each active haul road. These observations will be recorded on a Fugitive Emission Observation Form (Level III-A).
 - 6) All Mine operations personnel will have responsibilities related to the control of fugitive dust and receive training as described in Section 5. (Level III-A)
 - 7) Sufficient water truck capacity will be maintained to provide control during all non-freezing conditions. The proposed water trucks are described in detail in Section 3.1.1 below (Level III-A).
 - 8) Detailed Mine layout figures, showing haul road locations, are included in the Air Quality Management Plan – Mine and will be updated as necessary during the approvals process and during operations at the Mine Site. The current figures will be reviewed at least semi-

annually after Mine Site operations commence and they will be updated after the review if needed. Information on road length along with projected traffic levels for the various road segments are presented for each year of operations in the Mine Site emission calculation spreadsheet. (Level III-A)

- 9) An exception is a condition where the control strategies detailed in the FEC Plan cannot be implemented or are ineffective. Items simply noted as deficiencies on the daily inspection report are not considered exceptions by themselves unless the necessary corrective actions were ineffective or could not be implemented in a timely manner. The date of an exception and the actions taken to address it will be identified on the daily Fugitive Emission Observation Form. These items will be clearly identified as “Exceptions” and will be differentiated from routine visible emissions inspection findings (Level III-A). Exceptions will be reported in the semi-annual deviation reports required by the air emission permit.
- 10) As a further evaluation of the effectiveness of the FEC Plan, PM₁₀ monitors will be installed at the Mine Site. This is discussed in more detail in the Section 3.3.4 below (Level III-B).

3.3.1 Road Watering

PolyMet will operate a water truck or trucks with the capacity to apply water to all active haul roads rapidly during non-freezing conditions as the primary control method for fugitive emissions from unpaved roads. The length of road to be watered will vary throughout the life of the mine and will be approximately 3.7 miles for the first year of operation and about 11 miles in the fifth year of operation. A water truck traveling at 10 miles per hour could water the Mine Year 1 roads in approximately 22 minutes and the Mine Year 5 roads in approximately 66 minutes (not considering time for water tank refilling). These times could be cut in half by operating a second truck as needed.

For the first year of operation there will be two Cat 777, or equivalent, 18,000 to 20,000 gallon water trucks, with the ability to water a path 80 feet wide, whereas the haul roads are 85 feet wide. Assuming a 1,500 gpm application rate, these water trucks could apply their water in about 15 minutes. Allowing these trucks 45 minutes to replenish their tanks provides a watering capacity of 24 tank loads per day per truck. At least one water truck will be outfitted with a water monitor for spot application of water to otherwise unreachable areas such as slopes, steep ramps, etc.

Equation 3-2 from the EPA publication *Control of Open Fugitive Dust Sources* (Reference (2)) was used to verify that the proposed watering truck capacity is reasonable. The equation reads as follows:

$$C = 100 - \frac{0.8 * p * d * t}{i}$$

Where:

- C = average control efficiency, percent
- p = potential average hourly daytime evaporation rate, mm/hr
- d = average hourly daytime traffic rate (trips/hr)
- t = time between applications, hours

i = application intensity, liters/m²

The above equation can be rearranged to solve for “i” based on Mine Year 5 operations with C = 90%, p = 0.21 mm/hr (Reference (3), value for Hoyt Lakes in July), d = 7.8 (752849 max annual VMT/11.13 miles of haul road for Year 5 layout), and t = 24 hours to find total daily application required. The result is a watering rate of 3.15 L/m² or 77.4 gallons per 1000 ft². The total watering required can be calculated from this rate, the 11.13 miles total haul road length and 85 foot road width by: total daily watering = 77.4 gallons/1000 ft² /1000 * 11.13 miles * 5280 feet/mile * 85 feet = 390,000 gallons/day or about 19.5 20,000 gallon tank loads per day which is well below the two truck capacity of 48 tank loads per day. The reason for two trucks is to make sure that one is always available.

Fugitive dust control water will be drawn from mine pit dewatering collection sumps within the open pits, haul road drainage water ponds, the Overburden Storage and Laydown pond or the Central Pumping Station basin.

Water trucks will be integrated into the GPS based Mine Management System. Water trucks will be equipped with GPS and on board flowmeters. The Mine Management System will maintain an electronic history of date, time and quantity of water applied to each road segment. Haul trucks will also be tracked in this same system and an electronic history of haul truck usage by road segment will be maintained. This will allow documentation of water application relative to road usage.

Use of the water trucks will vary depending upon the meteorological conditions. Monitoring of the site conditions, along with visual observations, experience and professional judgment will determine the daily water activities. Each active haul road will be watered as required, except when weather or safety conditions preclude the necessity or practicality of watering. The following sections on Chemical Application and Other Dust Control Measures describe dust control measures available when meteorological conditions make road watering unsafe or ineffective.

3.3.2 Chemical Application

Chemical application to unpaved roads will provide added protection in a proactive manner against fugitive emissions, especially during freezing conditions. Application of these chemicals will be by a vendor using a tank truck and spray system. Determination of the appropriate timing of application will be based upon expected meteorological conditions (such as seasonal transitions to freezing conditions, or expected periods of hotter temperatures and low humidity), review of past records, experience and professional judgment.

Poly Met will continue to evaluate new technologies in emission abatement for their effectiveness and economic feasibility.

3.3.3 Other Dust Control Measures

In addition to chemical application during the winter months, sand mixtures or snow may be applied on roads, and under the right conditions, very light applications of water can be effective in freezing conditions. Scarification of the road surface, and/or application of new road material will also be used to enhance safety and control fugitive emissions from the roads.

3.3.4 Special Purpose PM₁₀ Monitoring

Particulate monitors will be installed at the Mine Site at agreed upon locations as an additional evaluation of the effectiveness of the FEC Plan. The monitored size fraction will be PM₁₀, because this is the size range of particulate matter that would be most strongly related to emissions from fugitive dust sources. Air dispersion modeling results, prevailing wind directions, physical land features and the location of nearby sources will be considered when locating the monitors. Monitors will be located at opposite ends of the Mine Site so that contributions from the Project can be isolated from impacts from offsite sources as needed. A specific proposal for the number and location of monitors will be made in the Special Purpose Monitoring Plan. A pre-permit draft monitoring plan is currently under review. A complete, interim final plan will be submitted to MPCA for approval within 120 days of air emission permit issuance.

3.3.4.1 Purpose of Monitoring

Special Purpose monitors will be used in multiple ways to ensure that fugitive dust is properly controlled at the Mine Site:

1. The monitors will be used as one indicator of ambient PM₁₀ levels at the Mine Site. PolyMet may revise the monitoring plan and/or additional monitoring can be implemented if the results show the potential for an exceedance of an action level.
2. PM₁₀ monitors that can provide data hourly (or a similar short timeframe) will be installed at some or all monitoring locations to provide a rapid indication of elevated ambient concentrations. Meteorological data will be used to indicate which, if any, Project sources are likely contributing to elevated concentrations and corrective action will be taken if warranted.
3. Action levels based on ambient PM₁₀ concentrations are proposed below. PolyMet shall report these exceedances of these action levels in its semiannual deviation reports if prompt corrective action is not taken or if the corrective action is not effective. The cause of any exceedances will be investigated and identification of potential refinements or changes to the FEC Plan to prevent future occurrences will be conducted as part of the periodic review of the fugitive dust control procedures.
4. The Project is proposed as a synthetic minor source for PSD purposes, but the 24-hr PSD increment for PM₁₀, along with other information, will be used to develop criteria for acceptable ambient concentrations.

3.3.4.2 Duration of Monitoring

Monitoring will be continued until agreement is reached with MPCA that it is no longer necessary per the applicable terms of the facility air emission permit.

3.3.4.3 Proposed Action Levels

The proposed action levels are described in Table 1 of the Special purpose monitoring plan. If the action levels are triggered, mine management and/or environmental staff will determine appropriate dust control measures based on their knowledge and experience and the measures described in this plan.

3.4 Surface Overburden, Ore and Waste Rock (Including Lean Ore) Stockpiles

The surface overburden (FS043) and waste rock (FS013, FS022, FS041) stockpiles and ore surge pile (FS042) may release minimal fugitive emissions during construction and operation depending on:

1. Nominal size of the material
2. Natural conditions of the environment

Fugitive emission control during the construction of these stockpiles is primarily dependent on natural conditions of the environment; however the relatively large size of most of the surface and run-of-mine rock minimizes the potential for fugitive emissions. Once waste rock placement is completed, reclamation of the Category 1 stockpile will follow the Mineland Reclamation Rules set forth in Minnesota Rules. The stockpile will be benched and sloped as needed and a geomembrane cover will be applied beginning in Mine Year 14. Suitable material will be placed underneath and on top of the cover. The surface material will then be vegetated. Vegetation provides erosion control, wildlife habitat, and aesthetic value.

The stockpiled ore and waste rock will be run-of-mine material with secondary breakage as needed for handling and loading into haul trucks. The overburden will have its natural size distribution. Based on the anticipated size distribution on the stockpiles, meteorological data, and approved fugitive emission calculation procedures, wind erosion will not occur on the stockpile surface.

3.5 Other Sources

Other sources of fugitive emissions will include a Portable Crushing Plant (FS023) on site and small truck traffic around the property.

Contractors may also operate up to three screens and associated activities onsite (FS015, FS039) to separate overburden into fractions usable for construction purposes. The natural moisture content of the overburden will prevent fugitive dust generation under most conditions.

Dust from small truck traffic will be controlled when the trucks travel on the main haul roads. Water and or dust suppressants will be applied to the service roads in and around the mine area as required by traffic and weather conditions.

4.0 Operating Practices and Control Measures

The operating practices and control measures that will be implemented and recorded for the significant fugitive emission sources are summarized below.

4.1 Drilling and Blasting (FS050-drilling)

Primary Control: Natural conditions (i.e. humidity, precipitation, and moisture content)
Water application down drill holes (drilling)

Contingent Control: None

Practices: Blast under safe meteorological conditions
Direct blast into rock rather than vertically into atmosphere
Conduct test blast
Daily visible emission check for drilling

Records: Weather data from Universal Weather and Aviation
Decibel readings
Time and location of blast
Records of visible emission checks and any corrective action taken
Number of blastholes drilled each operating day

4.2 Truck Loading and Unloading (FS001, FS002, FS014, FS007, FS009, FS020, FS019, FS004, FS005, FS401, FS002, FS010) & Storage Piles (FS043, FS042, FS013, FS022, FS041)

Primary Control: Natural moisture content
Rock size
Environmental conditions

Contingent Control: None

Practices: Minimize drop distances
Follow dumping procedure
Daily Visible Emission Checks

Records: Fugitive emissions reports including daily checks

4.3 Railcar Loading (FS010)

Primary Control: Environmental conditions

Contingent Control: None

Practices: Minimize drop distances

Operator report dusty conditions
 Conduct one observation/check per train

Records: Number of railcar loads
 Fugitive emissions reports

4.4 Haulage and Service Roads (FS012A, FS058, FS049 and FS011) – haulage roads are subject to frequent haul truck traffic – service roads are subject to occasional haul truck traffic as haul trucks access fueling or maintenance facilities

Primary Control: Water and/or dust suppressant application
 Rain during non-freezing conditions
 Snow during freezing conditions
 Road maintenance including crushed rock surfacing and grading

Contingent Control: Other dust suppressant application

Practices: Employees notify shift manager or appropriate personnel of fugitive emissions
 Conduct daily inspection of active roads
 Conduct road maintenance
 Use water trucks to apply water

Records: Fugitive emissions reports including daily checks
 GPS tracking records for haul and water trucks
 Application records for water and sand trucks
 Chemical application or other dust control measures implemented
 Meteorological data
 Monthly haul vehicle-miles-traveled (VMT) and annual totals
 Shift logs
 Identification of any exceptions related to road dust

4.5 Overburden Screening (FS015, FS039)

Primary Control: Natural conditions (overburden naturally wet at site)

Contingent Control: Portable water sprays used where conditions require

Practices: Minimize drop distances
 Daily visible emission checks when operated

Records: Fugitive emission reports including daily checks
 Daily tons screened
 Records of any corrective action taken

4.6 Contractor Construction Rock Crushing (023)

<i>Primary Control:</i>	Water sprays (or similarly performing techniques)
<i>Contingent Control:</i>	Use of chemical dust suppressants
<i>Practices:</i>	Inspect water sprays once per operating day and implement corrective action if needed Conduct one daily visible emission observation/check when operating NSPS required performance testing (all except Truck Loading)
<i>Records:</i>	Tons throughput per operating day Daily checks Any corrective action taken Test reports

5.0 Training

An integral part of the implementation of the FEC Plan is training the personnel involved in implementing the measures detailed in the plan.

At least two individuals (more if needed to assure daily coverage) will be trained to observe fugitive emissions sources and their control system(s). Personnel responsible for making these observations will be certified VE evaluators or will complete training to become a certified VE evaluator.

All Haul Truck, Excavator, Front End Loader, Bulldozer, Locomotive, Grader and Water Truck Operators as well as Laborers, Mine Dispatchers and Mine Shift Supervisors will receive annual training specific to haul road fugitive dust including training on the importance of eliminating fugitive emissions, methods used to control fugitive emissions, and the procedures and process for reporting and controlling fugitive emissions.

All mine managers, supervisors, Mine Dispatchers and those individuals trained as VE evaluators will receive annual training on the FEC Plan as a whole including the importance of controlling fugitive emissions, the process for reporting and controlling fugitive emissions and associated record keeping.

Specific training will be given to each person as it pertains to his or her job. Records of their names, dates of training and subjects of each training exercise will be maintained. Training exercises will cover at a minimum the following:

1. Employee responsibilities
2. Reporting
3. Recordkeeping

4. Corrective actions
5. Maintenance
6. Dust observation
7. Weather observations

The mine supervisors and managers will be responsible for making sure that all employees understand their roles and responsibilities related to fugitive dust control and undertake them properly. The supervisors shall take appropriate action, such as ordering additional training or individual counseling for employees, as necessary to ensure employee compliance with applicable requirements. Records of any additional training given and the topics covered will be kept with the training records.

6.0 Records

The following records regarding fugitive emission controls will be maintained at PolyMet as required. These records will be made available to MPCA during an inspection or upon request.

1. Drilling and blasting records including weather data from Universal Weather and Aviation, decibel readings, and time and location of blast.
2. Commercial dust suppressant information (applications, permits, etc.)
3. Fugitive emission reports (visible emission observations, daily check forms (see attached example forms¹), corrective actions taken and any exceptions that occur).
4. Mine Management System electronic history consisting of (1) date, time and road segment where dust is observed, (2) corrective action taken to address observed dust including time action initiated (3) date, time, amount of water application to each road segment (4) date and time of each haul truck use of a road segment and (5) 15 minute average data from on-site meteorological station. Information will be recorded by the Mine Management system on a continuous basis as it is generated. Electronic records will be maintained for a minimum of five years.
5. Training records
6. MPCA Fugitive Emission Control Plan approval letter
7. Shift Coordinator's report
8. Air Emission Inventory Reports
9. Records of rail and truck loading and unloading
10. Summaries of the results of the fugitive dust control procedure review to be conducted at least semi-annually and superseded versions of the fugitive dust control plan. If it is determined that no revisions to the FEC Plan are warranted during a review, a notation to this effect will be added to the electronic and/or paper files for the FEC Plan.
11. Fugitive Emission Control monitoring data (i.e. PM₁₀ monitoring) along with records of any exceedance of ambient air quality standards and any deviations from the requirements of the air emission permit.
12. Records of any calibrations, audits, or maintenance performed on the PM₁₀ monitors.

¹ Forms are attached to show the minimum information that will be recorded and not necessarily the format of the form. Actual data collection may also be done on a computer, tablet or other electronic device.

13. Records of contractor construction rock crushing tons throughput
14. Records of NSPS required performance testing (affected sources in Portable Crushing Plant)
15. Records of quantity of overburden screened

7.0 Reporting

Information related to the FEC Plan will be included in the semi-annual deviation reports that will be required by the air emission permit. This information will include:

1. Exceptions from the FEC Plan and any corrective actions taken to address them.
2. Occurrences where the Fugitive Emission Control monitoring action levels were exceeded and corrective action was not implemented in a timely manner or the corrective action was ineffective.

All other records described in this plan will be available for review during an inspection or will be provided upon request from MPCA.

References

1. **IMA-MPCA Fugitive Emissions Workgroup.** Taconite Industry Haul Truck Unpaved Road Fugitive Particulate Emission Factor and Control Efficiency. (Attachment to Letter from Todd Biewen of MPCA to Larry Salmela of U.S. Steel Company dated November 24, 1998). November 18, 1998.
2. **U.S. Environmental Protection Agency; Office of Air Quality Planning and Standards.** Control of Open Fugitive Dust Sources (EPA-450/3-88-008).
3. **Farnsworth, Richard K. and Thompson, Edwin S.** Mean Monthly, Seasonal, and Annual Pan Evaporation for the United States. Washington, D.C. : Office of Hydrology; National Weather Service, 1982.