Report

Michigan Air Use Permit - Permit to Install Application

Copperwood Resources Inc.
Gogebic County, Michigan

August 2023

Project I.D.: 23H001

Solving our clients' toughest science and engineering challenges.

2121 Innovation Court, Suite 100
P.O. Box 5095
De Pere, WI 54115-5095
(920) 497-2500
foth.com

August 21, 2023

Charline Miville-Deschenes
Highland Copper Company Inc.
1111 St-Charles West
East Tower, Suite 1155
Longueuil, Quebec
Canada J4K 5G4

Re: Michigan Air Use Permit – Permit to Install Application
Copperwood Project

Dear Charline Miville-Deschenes:

Enclosed for your distribution is the Michigan Air Use Permit – Permit to Install Application. This application was prepared in accordance with Michigan Air Pollution Control Rules, Parts 1 and 2 and Michigan Department of Environmental Quality guidelines described in the Michigan Air Use Permit Technical Manual. The format used for this application is consistent with Rule 336.1203 and guidance outlined in Chapters 5 and 6 of the Permit to Install Workbook.

Sincerely,

Foth Infrastructure & Environment, LLC

Andrea Martin, PE
Lead Environmental Engineer
Licensed in MI, WI, IL, MN

Jakob Wartman
Project Manager

Stephen V. Donohue, PH
Vice President Mining

cc: Pierre Miville-Deschene, Highland Copper, Inc.
Nicolas Menard, Highland Copper, Inc.

Enclosure

Michigan Air Use Permit - Permit to Install

Distribution

No. of Copies	Sent To
Electronic	Charline Miville-Deschenes Highland Copper Company Inc. 1111 St-Charles West East Tower, Suite 1155 Longueuil, Quebec Canada J4K 5G4
2 Hard Copies	Andy Drury Senior Engineer Michigan Department of Environment, Great Lakes, and Energy Constitution Hall, 3rd Floor North 525 West Allegan Street P.O. Box 30260 Lansing, MI 48909
Electronic	Melanie Humphrey District Geologist Michigan Department of Environment, Great Lakes, and Energy Oil, Gas, and Minerals Division 1504 West Washington Street Marquette, MI 49855

Michigan Air Use Permit - Permit to Install

Project ID: 23H001

Prepared for

Copperwood Resources Inc.

Gogebic County, Michigan

Prepared by

Foth Infrastructure & Environment, LLC

August 2023

2121 Innovation Court • De Pere, WI 54115 • (920) 497-2500

foth.com

Michigan Air Use Permit - Permit to Install

Table of Contents

Table of Contents (continued)

Table of Contents (continued)

Tables

(Tables located after Tables tab)

Figures

(Figures located after Figures tab)

Table of Contents (continued)

Appendices

List of Abbreviations, Acronyms, and Symbols

AER	Allowable Emission Rate
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
AQR	air quality region
BACT	Best Available Control Technology
BTU	British thermal Unit
cfm	cubic feet per minute
CFR	Code of Federal Regulations
CI	compression ignition
CO	carbon monoxide
CRI	Copperwood Resources Inc.
EGLE	Michigan Department of Environment, Great Lakes, and Energy
FEL	front end loader
Foth	Foth Infrastructure & Environment, LLC
GHG	Greenhouse Gas
HAP	Hazardous Air Pollutant
IRSL	Initial Risk Screening Level
ITSL	Initial Threshold Screening Level
kW	kilowatt
LAER	Lowest Achievable Emission Rate
lb	pound
LHD	load-haul-dump
MACT	Maximum Achievable Control Technology
MAERS	Michigan Air Emission Reporting System
MIBC	methyl isobutyl carbinol
mm	millimeter
MMBtu/hr	million British thermal Units per hour
NAAQS	National Ambient Air Quality Standard
NAICS	North American Industry Classification System
NESHAP	National Emission Standard for Hazardous Air Pollutants
NO_2	nitrogen dioxide
mph	miles per hour
NREPA	Natural Resources and Environmental Protection Act
NSPS	New Source Performance Standard
NSR	New Source Review
PAI	Predicted Ambient Impact
PM	Particulate Matter
$PM_{2.5}$	Particulate Matter less than 2.5 microns
PM_{10}	Particulate Matter less than 10 microns
Project	Copperwood Project
PSD	Prevention of Significant Deterioration
PTE	Potential to Emit
PTI	Permit to Install
RACT	Reasonably Available Control Technology
RBLC	RACT/BACT/LAER Clearinghouse
SAG	Semi-Autogenous Grinding
SCR	Selective Catalytic Reduction
SDS	Safety Data Sheets
SIC	Standard Industrial Classification
SIP	State Implementation Plan
SO_2	sulfur dioxide

List of Abbreviations, Acronyms, and Symbols (continued)

SRSL	Secondary Risk Screening Level
TAC	Toxic Air Contaminant
T-BACT	Toxic Air Pollutants and Consideration of Best Available Control Technologies
TDF	Tailings Disposal Facility
ULSD	Ultra Low Sulfur Diesel
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
WWTP	wastewater treatment plant

1. Introduction

Copperwood Resources Inc. (CRI) is submitting this Air Permit to Install Application for a proposed nonferrous mine and ore processing facility to be located in Ironwood and Wakefield Townships, Gogebic County, Michigan. The Copperwood Project (Project) will produce a copper-silver concentrate that will be transported off site for further processing. The Project will be operated by CRI, a company owned by Highland Copper Company, Inc. This facility to mine, extract, and process a nonferrous ore body is permitted by the state of Michigan under the Natural Resources and Environmental Protection Act, Act 451 of 1994 as amended (NREPA), Part 632. The Project site is located in Ironwood and Wakefield Townships at approximately 90° 0.5´W and 46° 40.75´N, shown on Figure 1-1.

1.1 Purpose

Copperwood was issued Air Permit to Install 180-11A in 2018, which expires October 16, 2023. Under this permit, however, the Project is not authorized to install and operate power generation equipment that is now needed for the Project. Negotiations and schedule with Xcel Power to install a power line from the Norrie Substation near Ironwood, Michigan concluded that prime power generation at site is needed during construction and early operations and thereafter, to supplement line power. This application provides Michigan Department of Environment, Great Lakes and Energy (EGLE) with updated Project information including information on power generation equipment and operation not currently addressed in Permit 180-11A.

CRI is seeking approval of a Michigan Air Use Permit – Permit to Install to address all planned emissions sources. This application is similar to the application supporting Permit 180-11A with several differences:

- Addition of power generation equipment:
  - Initial generator – Caterpillar C27 725 kilowatt (kW) diesel
  - Prime power generators – 3 Caterpillar G3520 Natural Gas 2000 kW
- Underground ore excavation will be accomplished by a combination of drill, blast, and the use of a roadheader.
- A diesel fire water pump has been added, located adjacent to the mill.
- A lime silo has been added, located adjacent to the reagent area of the mill.

This application was prepared in accordance with Michigan Air Pollution Control Rules, Parts 1 and 2 and EGLE guidelines described in the Permit to Install Guidebook (EGLE, 2021). The format used for this application is in accordance with R 336.1203 and guidance outlined in Chapters 5 and 6 of the Permit to Install Guidebook (EGLE, 2021). Gogebic County, where the Project is sited, is an attainment area for all criteria air pollutants.

Throughout the application, equipment and reagents are described and are the basis of proposed emissions. Equipment continues to be further developed and may be revised. Planned equipment models and operating information are provided in Appendix A, reagent safety data sheets in Appendix B. CRI reserves the right to make equipment and vendor substitutions within the specifications of this document as the Project proceeds. Changes inconsistent with the application or the permit will be presented to EGLE for review and if needed, approval.

Throughout most of this document, English units are used to describe air emission rates. This will facilitate comparison against air permitting major source thresholds. Discussion and presentation of modeling results will be in metric units. Units are noted where appropriate in accordance with generally recognized abbreviations and as shown on pages vi and vii of this document.

1.2 Project Air Permit Regulatory Considerations

In the context of the Michigan Permit to Install, the following considerations pertain to the application and permit sought:

Permit Sought

Michigan has delegated air authority from the federal government to write and administer air permits in the state, adopted under Part 55, Air Pollution Control of the NREPA. Michigan's Air Quality Division provides applicants with two types of permits: Permit to Install (PTI)/New Source Review (NSR), and Renewable Operating Permit (ROP)/Title V. The PTI is applicable on the basis of facility emissions and is the appropriate permit for the Project. The ROP in general applies to major emissions sources, those having criteria pollutants in excess of 100 tons per year.

Categorical Sources

The Project, a metallic minerals mine and processing facility, is not included in the list of 28 "categorical" sources defined in R 336.1116. Major source applicability, therefore, does not include fugitive emissions of criteria pollutants. Table 1-1 shows overall Project facility emissions. With stack (non-fugitive) emissions for each criteria pollutant less than 100 tons per year, the Project will not be categorized as a major source under Title V of the federal Clean Air Act or under the federal Prevention of Significant Deterioration (PSD) regulations for New Source Review. Further, the facility's Hazardous Air Pollutant (HAP) emissions are less than the major source thresholds of 10 tons per year individually and 25 tons per year for all combinations of HAPs.

Facility-wide Emissions

Facility-wide emissions with controls are presented as Maximum Controlled Emissions (Table 1-1). The emission estimates are based on physical limits of the operation, such as equipment capacity and include the reductions provided by air pollution control equipment and practices. Included in the Maximum Controlled Emissions is the portion noted as Potential to Emit (PTE). The PTE estimate for particulate matter (PM) and other criteria air pollutants includes controlled stack emissions, but no fugitive emissions from sources such as roadways, wind erosion, or management of materials outdoors.

New Source Performance Standards

New Source Performance Standard (NSPS) Subpart LL was developed after 1980. Considering that the facility is not a major source and therefore not subject to Maximum Achievable Control Technology (MACT) standards, fugitive emissions are not included in PTE. Control equipment is expected to be addressed in the permit and will be a legally enforceable requirement of operation; therefore, controlled stack emissions are a basis of PTE. PTE for HAPs are based on both stack and fugitive emissions per R 336.1116(n). HAPs are detailed in Section 5.2.

Industrial Classification Codes and Associated Federal Regulations

Standard Industrial Classification (SIC) codes and North American Industry Classification System (NAICS) codes for this facility are:

- SIC Codes
  - 1021 – Copper Ore: Establishments primarily engaged in mining, milling, or otherwise preparing copper ores.

- NAICS Codes
  - 212234 – Copper Ores: Primarily engaged in: 1) developing the mine site, mining, and/or beneficiating (i.e., preparing) copper and/or nickel ores; and 2) recovering copper concentrates by the precipitation, leaching, or electrowinning of copper ore.

Anticipated Permit Requirements

This application anticipates and requests a PTI that includes legally enforceable operation of pollution control equipment and practices. Further discussion of proposed permit conditions is provided in Section 7.

2. Permit to Install Application Form

Pursuant to EGLE air permitting requirements, the Permit to Install Application form EQP 5615E (Rev 1/2021) has been completed as part of this permit application. The completed form is included in this section. Additional supporting documentation is described in other sections of this application.

EGLE

MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES AND ENERGY

PERMIT TO INSTALL APPLICATION

For authority to install, construct, reconstruct, relocate, or modify process, fuel-burning or refuse burning equipment and/or control equipment. Permits to install are required by administrative rules pursuant to Section 5505 of 1994

FOR EGLE USE
APPLICATION NUMBER

Please type or print clearly. The "Application Instructions" and "Information Required for an Administratively Complete Permit to Install Application" are available on the Air Quality Division (AQD) Permit Web Page.
Please call the AQD at 517-899-6252, if you have not been contacted within 15 days of your application submittal.

1. FACILITY CODES: State Registration Number (SRN) and North American Industry Classification System (NAICS)
SRN: P 0 3 0 4 NAICS: 2 1 2 2 3 4

2. APPLICANT NAME: (Business License Name of Corporation, Partnership, Individual Owner, Government Agency)
Copperwood Resources Inc.

3. APPLICANT ADDRESS: (Number and Street): 310 East US Highway 2, Suite B
MAIL CODE:
CITY: (City, Village or Township): Wakefield | STATE: MI | ZIP CODE: 49968 | COUNTY: United States

4. EQUIPMENT OR PROCESS LOCATION: (Number and Street – if different than Item 3)
Ironwood (T49N R46W) & Wakefield (T49N R45W) Townships
CITY: (City, Village or Township): Ironwood and Wakefield Townships | ZIP CODE: N/A | COUNTY: Gogebic

5. GENERAL NATURE OF BUSINESS:
Copper mining and ore processing

6. EQUIPMENT OR PROCESS DESCRIPTION: (A Description MUST Be Provided Here. Include Emission Unit IDs. Attach additional sheets if necessary; number and date each page of the submittal.)
Underground copper mine, excavating ore, transporting to surface, milling to produce copper/silver concentrate to sell. The milling process produces waste (tailings) which will be pumped to a tailings disposal facility on site. Emission Units are identified on the attached table.

7. REASON FOR APPLICATION: (Check all that apply.)
- [x] INSTALLATION / CONSTRUCTION OF NEW EQUIPMENT OR PROCESS
- [ ] RECONSTRUCTION / MODIFICATION / RELOCATION OF EXISTING EQUIPMENT OR PROCESS – **DATE INSTALLED:**
- [ ] OTHER – DESCRIBE

8. IF THE EQUIPMENT OR PROCESS THAT WILL BE COVERED BY THIS PERMIT TO INSTALL (PTI) IS CURRENTLY COVERED BY ANY ACTIVE PERMITS, LIST THE PTI NUMBER(S): N/A

9. DOES THIS FACILITY HAVE AN EXISTING RENEWABLE OPERATING PERMIT (ROP)? [x] NOT APPLICABLE [ ] PENDING APPLICATION [ ] YES
PENDING APPLICATION OR ROP NUMBER:

10. AUTHORIZED EMPLOYEE: Denis Miville-Deschenes | TITLE: President | PHONE NUMBER: (Include Area Code) 581-988-8436
SIGNATURE: Denis Miville-Deschenes | DATE: August 16, 2023 | E-MAIL ADDRESS: Denis.Miville-Deschenes@highlandcopper.com

11. CONTACT: (If different than Authorized Employee. The person to contact with questions regarding this application)
Andrea Martin, P.E.
PHONE NUMBER: (Include Area Code) 920-496-6854
CONTACT AFFILIATION: Foth Infrastructure & Environment, LLC
E-MAIL ADDRESS: Andrea.martin@foth.com

12. IS THE CONTACT PERSON AUTHORIZED TO NEGOTIATE THE TERMS AND CONDITIONS OF THE PERMIT TO INSTALL? [x] YES [ ] NO

FOR EGLE USE ONLY - DO NOT WRITE BELOW

DATE OF RECEIPT OF ALL INFORMATION REQUIRED BY RULE 203:	PERMIT NUMBER:
DATE PERMIT TO INSTALL APPROVED:	SIGNATURE:
DATE APPLICATION / PTI VOIDED:	SIGNATURE:
DATE APPLICATION DENIED:	SIGNATURE:

A PERMIT CERTIFICATE WILL BE ISSUED UPON APPROVAL OF A PERMIT TO INSTALL

MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES AND ENERGY

PERMIT TO INSTALL APPLICATION INSTRUCTIONS

INFORMATION

A permit to install is required to install, construct, reconstruct, relocate, or modify any process or process equipment, including control equipment pertaining thereto, which may emit an air contaminant (R 336.1201). A process is an action, operation, or a series of actions or operations at a source that emits or has the potential to emit an air contaminant. Process equipment is all equipment, devices, and auxiliary components, including air pollution control equipment, stacks, and other emission points, used in a process. An emission unit is any part of a stationary source that emits or has the potential to emit an air contaminant. Air pollution control equipment is any method, process, or equipment that removes, reduces, or renders less noxious air contaminants discharged into the atmosphere. An application may be submitted for one or more interrelated processes at a source.

ADDITIONAL REQUIREMENTS

An administratively complete application must include reasonable responses to all requests for information on the application form and in these instructions. Additional detailed information may be attached to the application form and must be submitted in duplicate. In addition to the general information requested on the application form, the following information must be included for the application to be considered administratively complete:

A. **Process Description** - In addition to the general process description which must be included in Item 6 on the application form, attach a written description in appropriate detail of each process covered by this application. State the size and type along with the make and model (if known) of the proposed process equipment, including any air pollution control equipment. Create a unique descriptive identifier (Emission Unit ID) for each emission unit. Specify the proposed operating schedule of the process equipment in hours per day, days per week, and weeks per year. Provide details of the type and feed rate of each material used in or produced by the process, in pounds per hour or similar measure. Describe any fuels and associated firing devices used in the process. Describe any waste generated by the process or equipment and methods of disposal or treatment. Applications for complex or multiple processes should also include a block diagram showing the flow of materials and intermediate and final products.

B. **Regulatory Discussion** - Describe all federal, state, or local air pollution control regulations which you believe are applicable to the proposed process or process equipment. Include a discussion of how you believe the proposed process or process equipment complies with these regulations.

C. **Control Technology Analysis** - Describe how the air contaminant emissions from the proposed process equipment will be controlled or otherwise minimized. Provide sufficient control method detail to show the extent and efficiency of any air pollution control devices. Air pollution control includes pollution prevention or other methods which result in reduced emissions from the process.

D. **Emissions Summary and Calculations** - Explain clearly and in appropriate detail the nature, quantity (both controlled and uncontrolled), concentration, particle size, pressure, temperature, etc. of all air contaminants, including all toxic air contaminants, that are reasonably anticipated to be discharged to the atmosphere due to the operation of the source. Summarize these emissions calculations in tabular form for all equipment covered by the application and for each stack/vent.

E. **Stack/Vent Parameters** - For each stack or vent related to the proposed process equipment provide the following information (including ranges if appropriate): the minimum height above the ground, maximum internal diameter or dimensions, discharge orientation (e.g., vertical, horizontal), maximum exhaust volume flow rate in cubic feet per minute (indicate actual or standard), maximum exhaust gas temperature, a description of any rain protection device, and location of any stack testing ports.

F. **Site Description and Process Equipment Location Drawings** - Submit legible scale drawings which show a plan view of the owner’s property to the boundary lines. Locate and identify the proposed equipment. Locate and identify all adjacent properties, include outline and height of all structures within 150 feet of proposed equipment and show any fence lines. Locate and identify all stacks/vents or other emission points related to the proposed process equipment and indicate the distance to the nearest property line. Indicate the scale of the plan and north direction on the drawing.

Additional information beyond that identified above may be required to complete the technical review of any individual application. Further information or clarification concerning permits to install, including the document “Information Required for an Administratively Complete Application,” can be obtained from the address listed below, the Internet, or by calling 517-899-6252.

ADDITIONAL REQUIREMENTS FOR USE OF ELECTRONIC APPLICATION

The electronic version of the Permit to Install Application is a WORD template. This template may be downloaded and completed electronically. The department is **not** accepting electronic submittal of the application. Create three (3) paper copies of the application. Mail three (3) copies of this application along with two (2) copies of any plans, specifications, or drawings required by the above instructions to the address below. The application must include the original signature of an authorized employee of the applicant certifying the truth of the information in the application. Applicant should retain a copy of the application.

US Post:
Michigan Department of Environment, Great Lakes, and Energy, Air Quality Division – Permit Section
P.O. BOX 30260 Lansing, MI 48909-7760

For Priority/Express Mail:
Michigan Department of Environment, Great Lakes, and Energy, Air Quality Division – Permit Section
Constitution Hall, 2nd Floor South
525 W Allegan Street, Lansing, MI 48933-1502

Permit to Install Application: Emission Units

Emission Unit	Process, Equipment, Activity
EUMINEVENT	3 mine vents (West Mine Exhaust Vent, Portal Mine Exhaust Vent, West Mine Exhaust Vent) Underground mine heat exhaust (propane, natural gas), drilling, blasting, continuous mining, excavation, travel, and transfer activities.
EUMINEHTRPROP	Heats incoming mine air during colder months. Initially a propane heater until a natural gas heater is delivered to site. The heater will be located in the air intake building. Combustion exhaust flows with ventilation intake air, exhausts in EUMINEVENT.
EUMINEHTRNG	Heats incoming mine air during colder months. When a natural gas heater is delivered to site, this heater will replace the propane heater. The heater will be located in the air intake building. Combustion exhaust flows with ventilation intake air, exhausts in EUMINEVENT.
EUOREHANDLING	F001 - Ore Transfer from Portal to First Transfer Point
	F002 - Surplus Ore Transfer to Ore Stockpile
	F003 - Transfer points within the Ore Bins/Reclaim Area
	F004 - Management of Ore within the Ore Stockpile
	F005 - Transfer points at the SAG Mill
EUCONCENTRATE	F006 - Concentrate Handling Operations
EUREAGENTMIX	F009 - Reagent handling emissions
EUSTOCKPILE	F007 - Ore Stockpile Wind Erosion
EUTDF	F008 - Tailings Disposal Facility Wind Erosion
EUCONGENERATOR	Diesel Construction Generator
EUNGGENERATOR1 EUNGGENERATOR2 EUNGGENERATOR3	Natural Gas Generators
EUFIREPUMP	Emergency Fire Water Pump
EULIMESILO	Lime Silo
EUHAULROADS	Truck Traffic on Unpaved Roads

3. Project and Process Description

3.1 Project Overview

The Project will be an underground mining operation with an adjacent mineral processing facility at surface to process copper ore. The saleable product from the facility will include copper and silver concentrate. Figure 3-1 shows the facility layout, including the underground mine access point, ore stockpile, Process Plant, power generation equipment, and a Tailings Disposal Facility (TDF). Figure 3-2 provides a more focused and detailed layout for the Ore Bins/Reclaim Area, conveyors, Process Plant, Reagents Area, Concentrator Loadout, emergency generator, facility roads, and wastewater treatment plant (WWTP).

Figures showing the facility operation and systems are presented in general order of processing. The figures addressing all facility and operations are:

Figure	Title
1-1	Regional Site Location Map
3-1	Mining Area Plan
3-2	Process Plant Area
3-3	Overall Process Plant Flow Diagram

3.2 Process Description

Facility processes are categorized by activity: Underground Mine Operations, Surface Ore Management, Process Plant, Reagent Management, TDF, and Accessory Equipment. Each is briefly described below. Stack and fugitive emission sources are labeled SV (stack) and F (fugitive). These labels appear on figures and in air emissions calculations in Appendix C.

3.2.1 Underground Mine Operations

Ore will be excavated underground in a room-and-pillar method with two approaches: conventional drill and blast, and continuous mining with a roadheader. Overall, drill and blast will accomplish 44% of ore extraction, continuous mining 56%. Once ore has been fragmented, ore will be removed with a load-haul-dump (LHD), placed into a hopper and rolls/rock breaker for distribution onto belt conveyors for transport to the main mine conveyor, and be transported to the surface. The mine excavation and production schedule are shown on Table 3-1.

The mine is divided into two sectors: Eastern and Western. The underground mine will be sequentially developed over the 12-year life of the mine. Air emissions estimates are based on the fully developed mine at maximum production using air flow during Year 7 of operations. Ventilation requirements for the fully developed mine is estimated to be approximately 850,000 cubic feet per minute (cfm). Intake ventilation will be through one shaft at the northwestern corner of the Project. During colder months, the incoming air will be heated with a natural gas heater, although in early development, a smaller propane heater will be used. Once the mine is fully developed, exhaust ventilation will be provided through three ventilation raises. Ventilation raises will be the West Mine Exhaust Vent (SV-001), East Mine Exhaust Vent (SV-002), and the Portal Mine Exhaust Vent (SV-003). These locations are depicted on Figures 3-1 and 3-2.

3.2.2 Surface Ore Management

Ore conveyed to surface via the main transfer belt conveyor will be routed to a series of conveyors to the crushed ore bins. The two 1,500-ton ore bins will be equipped with two pan feeders, each to reclaim material to feed the Process Plant.

Also part of surface ore management, the Ore Stockpile will provide surge capacity from underground mine production. Ore designated for the Ore Stockpile will be deposited to a surge pile from a stacker conveyor located at the Ore Stockpile (F002). From the surge pile, a front-end loader (FEL) will arrange the ore to maintain the stockpile. When it is called for, the ore will be moved back into the ore processing circuit through use of the FEL. The FEL will deposit the ore into the Surplus Ore Hopper for transfer to the crushed ore bins. See Figures 3-1 and 3-2 for the layout of this operation and the process flow, respectively.

3.2.3 Process Plant Operations

From the Ore Bins/Reclaim Area, ore will be transferred via enclosed belt conveyor to the grinding circuit at the Process Plant. The first step in the grinding circuit process is the Semi-Autogenous Grinding (SAG) Mill. The grinding circuit will receive ore at a nominal top size of 203 millimeters (mm) with an 80% passing size of 150 mm with raw water added to achieve a desired slurry density. The SAG Mill will be in closed circuit with a screen and ball mill along with a cyclone cluster to achieve the desired initial grind size of 80% passing 45 mm for the flotation circuit. Once the ore enters the SAG Mill, it becomes a slurry and emissions in the form of PM are minimal in that all materials are in a wet state. Figure 3-3 provides a flow diagram of the SAG Mill and subsequent processing operations.

The flotation circuit configuration, residence times, and reagent addition have been selected based on laboratory metallurgical test work. Chemical reagents will be added at various stages in the grinding and flotation circuits to facilitate recovery of a concentrated ore product. Rougher flotation is the first separation step between the copper bearing minerals in the ore and the host materials. The wet concentrate of rougher flotation is directed to further grinding, while the tailings waste product becomes a portion of the final waste (tailings) from the Process Plant for transfer to the TDF.

Rougher concentrate slurry reports to a regrind cyclone circuit, along with tailings from the second state of cleaner flotation, for size classification. Oversized material is directed to a regrind mill where water and a conditioner reagent (if required) will be added to achieve the desired milling density and operating pH, respectively. Undersized material meeting the desired final size of 80% passing 20 microns is sent directly to the three-stage flotation circuit.

Cleaner flotation will consist of three stages of closed-circuit cleaning. The objective of the regrind circuit and cleaner flotation is to produce the highest possible copper grade in the ore concentrate without adversely affecting overall mass recovery of copper in the ore feed. The tailings waste product forms the first cleaner scavenger state of the cleaning circuit, combining with the rougher flotation tailings to make a combined final waste product of tailings. Figure 3-3 provides a flow diagram of the flotation circuit.

3.2.4 Concentrate Production

Final concentrate from the cleaner flotation circuit will be pumped to a high-rate thickener with a flocculent solution added to enhance settling of the finely ground concentrate particles. Thickener overflow is sent to the process water tank for re-use and thickener underflow, at approximately 60% solids, will be pumped to a concentrate filter feed tank.

Thickened concentrate will be pumped in batches to a concentrate filter press that will remove water from the concentrate to meet a target moisture content of approximately 9%. A FEL will be used to remove concentrate from beneath the filter press and transfer it to a loadout hopper where it will be transferred to concentrate product haul trucks via a concentrate feeder and truck loading conveyor for shipment to an off-site transfer facility. This concentrate is the final product of the mine facility. Figure 3-3 shows details of the concentrate processing circuit.

3.2.5 Reagents

Reagents are used at various points in the milling process to facilitate reactions and assist in separating the particles rich in target metals from those particles with low levels of target metals. Reagents will also be used as flocculants. Reagents will be mixed with water and then metered into target processes. With the exception of products such as Sodium Isobutyl Xanthate (C-3430), alkylaryl dithiophosphate (A-249), carboxymethyl Cellulose Sodium, hydrated lime, and flocculent, most reagents will be received in pre-mixed or liquid form and stored in the reagent area located at the northwest side of the Process Plant (Figure 3-2). With exception of lime, all dry reagents will be brought into the reagent area in sacks or covered containers and mixed inside the building. Bulk lime will be trucked to the site and by enclosed transfer mechanism, transferred into a lime silo on the exterior of the building. A bin vent controls and filters the air flow exiting the bin as it is filled. Transfers of lime will be done inside the building.

Safety Data Sheets (SDS) for reagents appear in Appendix B. Table 3-2 summarizes the major reagents, annual usage rates, product form (solid or liquid, etc.) and type of transport and storage containers.

3.2.6 Tailings Disposal Facility

Ore processing will generate a tailings slurry (solids content 50%) from two steps of the operation. Rougher tailings will comprise approximately 61% of tailings generated, while first cleaner scavenger tailings will comprise the remaining 39%. Particle size distributions for each of the tailings show the rougher tails to contain approximately 88% silt, while the first clean scavenger tailings will contain approximately 99% silt. From the Process Plant, the tailings will be pumped through a piping system to the TDF. The TDF will be constructed in three stages from east to west, shown on Figure 3-1.

The TDF will be constructed with coarse tailings in layers and stages and will be developed over the approximately 12-year life of the mine. The overall surface area of tailings within the TDF at full build out will be approximately 230 acres, with a pond on top. Surrounding the pond will be a beach of exposed tailings, totaling approximately 40 acres. Of the beach area, approximately 75% will be wet beach area, while 25% will be a dry beach area (9.4 acres). The TDF layout is shown on Figure 3-1.

3.2.7 Generators

The Project is located in a remote area without available line power. Construction and early operations will need to rely on power generating equipment. Negotiations with Xcel Energy, the utility that serves the region, has established a plan to construct a 115 kV power line from the Norrie substation near Ironwood to the Project, a distance of about 25 miles. The power line construction may take several years. Until then, the following generating equipment will be employed:

<u>Construction Generator</u>: During construction, power needs will be served by a Caterpillar XQ800 diesel generator, 725 kW. The engine is United States Environmental Protection Agency (USEPA) certified Tier 4 interim Cat C27 heavy duty diesel engine. At this point in the Project, the diesel generator is anticipated to operate approximately 7 days per week, 10 hours per day. Appendix A-1 provides further information on the equipment. The generator stack SV-004 is shown on Figure 3-1.

<u>Natural Gas Generators</u>: Upon delivery of three natural gas generators, two will be installed adjacent to the Process Plant and operated for prime power generation. The third generator will be installed near the portal, replacing the diesel generator, which will be removed. The prime power generators will operate 24/7, with the third available as emergency back up. All three natural gas generators will be Caterpillar G3520 2000 kW generators. Each will be equipped with a Selective Catalytic Reduction (SCR) and Oxidation Catalyst system for controlling emissions of nitrogen dioxide (NO_2) and Oxidation Catalyst for reducing emissions of carbon monoxide (CO). The generator stacks SV-005, SV-006, and SV-007 are shown on Figure 3-1. Appendix A-2 provides further information on both the generator and SCR/Oxidation Catalyst system.

Upon construction of the 115 kV power line, the three generators will remain in place and available for operation. The capacity of the powerline is limited to 21 mega volt-amps, however, the power needs at peak facility demand (i.e., when the mill starts up) require supplemental power. The three natural gas generators serve that purpose, one running 8,760 hours per year, the others running approximately 10% of the time (900 hours per year). The generator stacks SV-005, SV-006, and SV-007 are shown on Figure 3-1. Appendix A-2 provides further information on both the generator and SCR.

3.3 Emission Units and Controls

Emission unit and stack naming terminology are shown in Table 3-3. Emission units are both point sources (stacks) and fugitive. While certain point sources may be routed through control equipment; fugitive emissions will be controlled through dust management practices and/or enclosure. Emission units and controls are summarized in Table 3-3. Table 3-4 provides information on stacks. Maintenance intervals for the emitting equipment and controls are summarized in Table 3-5. Point sources are associated with underground ventilation raises, stacks associated with the natural gas and diesel generators. Manufacturer's literature on proposed equipment in this section appears in Appendix A.

Emission units are further described in Appendix C, Emission Calculations, where detailed emission summaries are provided. Equipment selection has not been finalized at the time of this application. CRI reserves the right to make equipment substitutions at the time of Project construction within the specifications described in this document.

3.3.1 Emissions from Underground Activities

EUMINEVENT (SV-001, SV-002, SV-003)
EUMINEHTPROP
EUMINEHTNG
Underground mine ventilation is drawn in from the air intake ventilation raise by two large fans, located to the northwest of the Project site. The underground mine ventilation circulates as the mine develops and will exhaust through three exhausts: the Western Mine Vent Exhaust SV-001, the Eastern Mine Vent Exhaust SV-002, and the Portal Exhaust Vent SV-003. Figure 3-1 shows the locations of the intake and exhaust ventilation raises. The exhaust will contain emissions from the following:

- Mine heat provided by a heater used during the winter months: first a propane heater, thereafter a natural gas heater. The clean burning heaters will exhaust into the mine with the heated air.
- Drilling and blasting addressing 44% of mine rock fragmentation; and continuous mining with a roadheader addressing 56% of mine rock fragmentation.
- Ore processing and transfer including transport and placement to a feed hopper and rolls/rock breaker to reduce oversized fragments.
- Ore transport (travel emissions) provided by a load-haul-dump (LDH) suited for the underground mine. Appendix A-3 provides more details on this vehicle.
- Additional travel emissions addressed in the calculations for the roadheader. Appendix A-4 provides more details on this equipment.
- Ore transfer and placement to a series of conveyors. Smaller portable conveyors will transport ore to the main belt conveyor for transport to the surface.

Water sprays will be used at the mine face, travel areas, and conveyor transfer points to control particulate emissions underground. Underground particulate emissions will also be subject to settling. Underground conditions are anticipated to be damp to wet.

In addition to particulate emissions, other pollutants will be emitted. The use of ammonium nitrate fuel oil (ANFO) emulsion as a blasting agent will result in periodic emissions of NO_2, sulfur dioxide (SO_2), and CO. Also, the mine heater combustion products will be carried through the ventilation. All emissions are tabulated in Appendix C.

Air emissions estimates are based on the fully developed mine at maximum production using air flow during Year 7 of operations. Ventilation requirements for the fully developed mine are estimated to be approximately 850,000 cfm. Exhaust partitioning is based on the fully developed mine.

3.3.2 Emissions from Ore Management, Processing, and Reagent Management

Once the ore reaches the surface, PM will be generated by transfer and transport of ore to various surface locations on the site.

EUOREHANDLING
F001 – Ore conveyed from underground will be transferred to the crushed ore transfer conveyor, which discharges onto a bidirectional/reversible conveyor which in turn feeds ore to the bins. This is a fugitive source that comprises multiple transfer points at this location. Emissions will be controlled through use of belt conveyor enclosure and enclosure of transfer points.

F002 – Surplus Ore Transfer to Ore Stockpile. Ore that is not directed to the Ore Bins/Reclaim Area will be transferred to the Ore Stockpile. Ore will be transferred on an enclosed stacker belt conveyor with an enclosure over the drop point at the Ore Stockpile.

F003 – Transfer Points within the Ore Bins/Reclaim Area. This emission source represents all transfer points within the Ore Bins/Reclaim Area. It includes transfer of ore to the bins, transfer to ore feeders at the base of the ore bins, and transfer to the SAG Mill conveyor for transfer to the Process Plant. Enclosures will be installed over transfer points to minimize dust.

F004 – Management of Ore within the Ore Stockpile. This fugitive emission source represents particulate emissions that may occur during management and handling of ore within the Ore Stockpile, including handling of the material by a FEL within the footprint of the stockpile. Particulate emissions will be controlled through work practices such as minimizing drop heights of the FEL bucket. In addition, the particle size distribution for material in the stockpile shows the silt content to be low at 2%, which should aid in minimizing particulate emissions. Movement of the FEL along a transfer route within the Ore Stockpile is calculated separately.

F005 – Transfer Points at the SAG Mill. This includes fugitive particulate emissions from conveyor transfer points at the SAG Mill prior to the material becoming a slurry. Once the material becomes a slurry, all material transfers further in the processing will be minimal. Controls will include enclosure of the belt conveyor and enclosure the transfer point at the SAG Mill.

EUCONCENTRATE
F006 – Concentrate Handling Operations. The flow for concentrate handling is depicted on Figure 3-3. Wet concentrate will flow through a filter system to remove excess moisture with the cake stored in a pile within the building. A FEL will transfer material to a loadout hopper, where it will transfer via a feeder to a feed conveyor to a truck. All material handling will occur inside a building and it is expected that particulate emissions from handling should be further reduced due to the relatively high concentrate moisture content at 9%.

EUREAGENTMIX
F009 – Reagent Mixing Area. Reagents are used in the milling process to facilitate reactions and assist in separating the particles rich in target metals from those particles with low levels of target metals. Reagents will also be used as flocculants. Both wet and dry reagents will be mixed in reagent mixing tanks and then pumped as a liquid into the target processes. Table 3-2 lists reagents, their forms, and annual usage. As noted in Section 3.2, most reagents will be received in pre-mixed or liquid form and stored in the reagent area located at the northwest side of the Process Plant (Figure 3-2). Fugitive emissions due to PM is expected to be minimal due to handling techniques and management of reagents inside a building.

EULIMESILO (SV-009)
Lime delivery will be done in bulk. Delivery trucks will offload granular lime into the lime silo in a standard enclosed system, located adjacent to the Reagent Mixing Area. Transfer from truck to silo generates emissions from the silo bin vent, which exhausts air as the silo is filled. The bin vent will be equipped with a filter that removes a minimum of 99% PM.

3.3.3 Wind Erosion at Outdoor Material Storage Locations

Two large outdoor stockpiles subject to wind erosion will be part of operations: the Ore Stockpile, and the TDF, both shown on Figure 3-2. The facility will manage surplus ore from the underground mine at the surface in the Ore Stockpile. Tailings from the Process Plant will be managed in the TDF. Below is further detail on these emission sources and controls.

EUSTOCKPILE
F007 – Wind Erosion at the Ore Stockpile. The maximum footprint of the Ore Stockpile is approximately 13 acres. Wind erosion emissions will be calculated assuming the entire area contains ore. Wind erosion will be mitigated due to the low silt content (approximately 2%) based on a particulate distribution curve (see Appendix A-5).

EUTDF
F008 – Wind Erosion at the TDF. The maximum surface area of the tailings within the TDF will be approximately 230 acres, with most of that area being covered by a pond. Particulate emissions from wind erosion are based on the expected area of exposed dry tailings (9.4 acres). It will be assumed there will be an additional 98% control due to formation of a crust layer over the dry exposed tailings and remaining moisture content. Layout for the TDF is shown on Figure 3-1, while Particle Size Distributions for the tailings are provided in Appendix A-4.

3.3.4 Power Generating Equipment

Power generators support the Project. Generator emissions depend on the fuel, engine size, and control equipment.

EUCONGENERATOR – Diesel Construction Generator
Initial construction generation will be served by a Caterpillar XQ800 diesel generator, 725 kW. The engine is USEPA certified Tier 4 interim Cat C27 heavy duty diesel engine. Appendix A-1 provides further information on the equipment. The generator stack SV-004 is shown on Figure 3-1.

EUNGGENERATOR1, EUNGGENERATOR2, EUNGGENERATOR3 – Natural Gas Generators
As power needs increase, natural gas generators will be installed. Three identical generators will be installed, Caterpillar model G3520 2000 kW. Each will be equipped with a SCR system for controlling emissions of NO_2 and Oxidation Catalyst for reducing emissions of CO. Two generators (SV-005, SV-006) will be installed adjacent to the Process Plant; the third generator (SV-007) will take the place of the

Diesel Construction Generator, which will be removed. Stack locations are shown on Figure 3-1. Appendix A-2 provides further information on both the generator and SCR.

The three generators will continue to serve the facility after the Xcel power line is constructed and in service. Two operating scenarios are described in Section 3.2.7. Prior to power line installation, the third generator will be operated as emergency backup. While the generator would be subject to a permit exemption under R 336.1235, it is nonetheless described as an emission unit due to its operation during post powerline installation. Emissions are included in air dispersion modeling for the facility, described in Section 6 and the Air Quality Impact Analysis report, Appendix E. During facility operations, the third generator will serve as an emergency generator and be operated approximately once per week for testing purposes. The PTE for this emergency unit will be 500 hours per year, as outlined in a USEPA memorandum dated September 6, 1995 (USEPA, 1995).

3.3.5 Emergency Fire Water Pump

EUFIREPUMP – as with any industrial facility, firefighting equipment and preparation is mandatory. Part of the fire protection system includes a water system for fire extinguishing. A 100,000-gallon fire water tank will be equipped with one diesel pump, one electrical pump, and one jockey pump to maintain pressure within the fire protection distribution network. A Clarke 175 hp diesel fire pump is planned for the facility. Product description is provided in Appendix A-6. Emissions from this diesel pump have been included in the calculations and modeling analysis. It will be tested regularly in accordance with National Fire Protection Association and Mining Safety and Health Administration rules.

3.3.6 Fugitive Emissions from On-Site Access and Haul Roads

EUHAULROADS (HR-01 through HR-07)
There are seven haul roads on site:
HR-01 – Vehicle travel on Ore Stockpile
HR-02 – Concentrate truck travel on access road
HR-03 – Water truck travel on access road
HR-04 – Reagents and grinding media delivery on access road
HR-05 – Explosives delivery on access road
HR-06 – Natural gas delivery on access road
HR-07 – Diesel and propane delivery on access road

Location of the access road and Ore Stockpile along with proposed haul routes are shown on Figure 3-1. All of the above haul roads will be unpaved. Particulate emissions from movement of trucks along the access roads will be mitigated by use of a water truck along the traffic area and limiting speed of vehicles to no more than 15 miles per hour (mph). It is also anticipated the silt content of the access road can be maintained at 2% by conducting regulator road maintenance, such as grading and periodic replacement with fresh aggregate. Various other service vehicles will travel occasionally to the facility to provide reagents and supplies to the Process Plant. However, these occasional uses of the access road have not been assessed in this application. Control practices for haul routes are further described in the *Fugitive Dust Control Plan*, Appendix D.

3.4 Permit to Install Exemptions

Certain emission units are considered exempt under Part 2 Air Use Approval rules. Identified exempt emission units include the following:

- Crucible furnaces in Assay Lab (R 336.1282).

- Fuel burning equipment for office and building space heat and service water heating. The facility will use propane-fired space heaters for heating the buildings (R 336.1282).

- Propane storage vessels less than 40,000 gallons. Propane will be used for building space heating and early mine ventilation heat. The propane storage tank for the facility is planned to be approximately 30,00 gallons or less (R 336.1284).

- Internal combustion engines that have less than 10 million British thermal units per hour (MMBtu/hr) maximum heat input. The construction generator meets this exemption; however, it was included in the emissions calculations and modeling for comprehensiveness. Manufacturer's literature on the unit is provided in Appendix A-1.

- Laboratory equipment in Assay Lab (R 336.1283).

- Storage of No. 2 fuel oil. No. 2 diesel fuel will be used for the construction generator, the fire pump, and for fueling of on-site mobile equipment (R 336.1284).

- Incidental maintenance shop and compressor plant emissions. The maintenance shop may have one or more portable welding units and use incidental aerosol products (R 336.1284).

- Pressurized storage of acetylene, hydrogen, oxygen, nitrogen, helium, or other substances in quantities less than 500 gallons. Small amounts of these gases may be used in the maintenance shop for welding, cutting, and brazing as part of general maintenance (R 336.1284).

- Storage or transfer operations of volatile organic compounds (VOC) or noncarcinogenic liquids in a vessel that has a capacity of not more than 40,000 gallons where the contents have a true vapor pressure of not more than 1.5 pounds per square inch absolute at the actual storage location. This exemption applies to the storage and transfer of methyl isobutyl carbinol (MIBC), a liquid reagent used in the flotation cell operations. The storage vessel will be less than 40,000 gallons and according to the SDS (Appendix B), the vapor pressure is 4.7 mm mercury (Hg) at 20°C or 0.0909 pounds per square inch. Calculations for MIBC emissions are provided in Appendix C (R 336.1284).

- Replacement of fans, pumps, or motors which does not alter the operation of a source or performance of air pollution control equipment (R 336.1285).

- Lagoons, process water treatment equipment, wastewater treatment equipment, and sewage treatment equipment (R 336.1285). This exemption applies to an on-site WWTP and a sewage lagoon system at the facility.

4. Regulatory Discussion – Federal, State, and Other Regulations

Compliance with applicable federal, state, and local air pollution control regulations are discussed in this section. In addition, since this Permit to Install Application is for a nonferrous metallic mining facility, Part 632 of the Michigan NREPA (Michigan Compiled Laws §324.63201 et. seq.) and rules promulgated under R 425.101 et. seq of the Michigan Administrative Code are discussed. The following statutes and regulations are addressed:

- Michigan Act 451 of 1994, as amended, the Natural Resources and Environmental Protection Act, Part 55 (the Act).
- Michigan Air Pollution Control Rules.
- Federal Clean Air Act.
- 40 CFR Part 52.21 – PSD.
- 40 CFR Part 60 – NSPS.
- 40 CFR Part 63 – National Emission Standard for Hazardous Air Pollutants (NESHAP) for Source Categories.
- Michigan's Nonferrous Metallic Mining Regulations (Part 632).

As discussed in Section 1.2, the federal PSD program is not applicable to this proposed facility in that it will not be a major source of emissions as defined by the regulation. Therefore, the air permitting process for this operation will not need to consider impact on PSD Class I increment values established for nearby PSD Class I areas.

4.1 Michigan Act 451 of 1994

The appropriate definitions and requirements of Part 55 Air Pollution Control of this Act apply to the Project construction and operation. The Project will be a non-major source with PTE of listed criteria pollutants being less than 100 tons per year. Maximum controlled emissions of criteria pollutants are summarized in Table 1-1 and include PM, nitrogen oxides, CO, VOCs, SO_2, and lead. All federal HAPs are also below major source status. Specific sections of the Act are addressed below with Act references in parentheses.

The facility is subject to Section 111 of the federal Clean Air Act NSPS, therefore the Project is classified as a Category II facility, (§324.5501 Definitions). The appropriate permitting for the proposed facility includes a PTI prior to construction (§324.5505 Issuance of Permit to Install).

4.2 Michigan Air Pollution Control Rules

The following parts of Michigan Air Pollution Control Rules have been evaluated for the Project:

- Part 1 General Provisions.
- Part 2 Air Use Approval.
- Part 3 Emission Limitations and Prohibitions—Particulate Matter.
- Part 4 Emission Limitations and Prohibitions—Sulfur-Bearing Compounds.
- Part 8 Emission Limitations for Oxides of Nitrogen.
- Part 9 Emission Limitations and Prohibitions—Miscellaneous.
- Part 10 Intermittent Testing and Sampling.

- Part 11 Continuous Emission Monitoring.

Part 1 covers definitions and is recognized as generally applicable to the Project for guidance as required Part 6 and Part 7 were evaluated and found to be not applicable.

4.2.1 Michigan Air Pollution Control Rules Part 2 Air Use Approval

Part 2 is generally applicable to emissions of any air contaminant as a result of installation, construction, reconstruction, or modification of any process or process equipment, including control equipment. Details regarding the PTI process are set forth in R 336.1201 through R 336.1209.

R 336.1224 through R 336.1232 cover Toxic Air Pollutants and Consideration of Best Available Control Technologies (T-BACT) and Air Toxic Review for new sources of air toxics. These sections discuss screening, exemptions, and methods of demonstrating compliance. These sections are discussed in Section 5.2 and Section 6.3 of this application.

R 336.1240 through R 336.1241 address required air quality models and demonstration requirements. Modeling was performed for this permit application in accordance with this section. Further explanation of modeling appears in Section 6 and Appendix E – *Air Quality Impact Analysis* in this application.

R 336.1280 through R 336.1285 describes exemptions from PTI requirements. It was determined these exemptions apply to a number of identified emission units at the facility. Exempt emission sources are listed and discussed further in Section 3.4 of this application.

4.2.2 Michigan Air Pollution Control Rules Part 3 Emission Limitations and Prohibitions – Particulate Matter

A review of this rule indicates the following sections apply to the Project:

R 336.1301 Standards for density of emissions paragraph shall be met as set forth in this section, however, more stringent federal and state requirements may apply to emissions of PM for this facility. Opacity shall be determined utilizing the qualified observer and reference methods as indicated in R 336.1303.

R 336.1331 Emission of PM applies to all stacks and has been calculated to meet the R 336.1331, Table 31, J emission limit value of 0.10 pound (lb) particulate per 1,000 lb of gas. Compliance with this limit is shown in the calculations in Appendix C.

R 336.1370 Collected Air Contaminants paragraph (1) will be part of the operating procedures.

R 336.1371 through R 336.1372 cover Fugitive Dust Control Programs other than areas listed in R 336.1371, Table 36. These sections will apply to the Project. A *Fugitive Dust Control Plan* has been prepared to meet these requirements and is included as Appendix D.

4.2.3 Michigan Air Pollution Control Rules Part 4 Emission Limitations and Prohibitions – Sulfur-Bearing Compounds

R 336.1402 requires emissions of SO_2 from combustion of any oil fuel source to meet the emission standard of 1.7 lb SO_2 per million BTU fuel. This standard is met for the one type of identified combustion sources proposed for the facility, the three emergency generators, and is shown in the calculations in Appendix C.

4.2.4 Michigan Air Pollution Control Rules Part 8 Emission Limitations and Prohibitions – Oxides of Nitrogen

This Part does not apply to the Project. The power plant natural gas generators proposed for this Project do not emit more than 25 tons per year of NO_2, and the five units combined do not have a maximum rated heat input capacity more than 250 million BTU per hour.

4.2.5 Michigan Air Pollution Control Rules Part 9 Emission Limitations and Prohibitions – Miscellaneous

The general paragraphs covering air contaminant and water vapor (R 336.1901), diluting and concealing emissions (R 336.1906), and air cleaning devices (R 336.1910) will apply to the Project. A *Malfunction Abatement Plan* will be prepared upon issuance of the PTI in accordance with the description contained in R 336.1911. The *Plan* will address procedures to monitor performance of each of the emission control devices proposed for use in this Project.

R 336.1912, R 336.1915, and R 336.1916 addressing abnormal, start-up, shutdown, and malfunction conditions are generally applicable to the Project.

4.2.6 Michigan Air Pollution Control Rules Part 10 – Intermittent Testing and Sampling

The applicable rules for testing and sampling will be followed as appropriate.

4.2.7 Michigan Air Pollution Control Rules Part 11 – Continuous Emission Monitoring

It is not anticipated that continuous emission monitors will be required or needed for this Project.

4.3 Federal Regulations

4.3.1 Federal Clean Air Act

The state of Michigan has been delegated the authority to implement the Federal Clean Air Act through its approved State Implementation Plan (SIP). Through the Michigan Air Pollution Control Rules and various state laws, the Federal Clean Air Act is defined and enforced in the state of Michigan. Applicable parts of the Clean Air Act are discussed in sections of this report addressing Michigan rule applicability.

4.3.2 40 CFR Part 52.21 – Prevention of Significant Deterioration

In the process of applying for a PTI, NSR must be addressed. NSR applies to all new sources in an attainment area. The NSR is implemented under the PSD program found in 40 CFR 52.21. The Project will be located in an attainment area and is designated as Class II under the PSD program. The state of Michigan implements the PSD program under delegation of authority from the USEPA.

Under PSD, a “major stationary source” is a source belonging to a list of 28 source categories having the PTE of 100 tons per year of any regulated pollutant. The Project does not fall into one of the 28 source categories. Therefore, the trigger for PSD permitting would be PTE greater than 250 tons per year of a regulated pollutant. The Project does not have the PTE more than the 250 tons per year of a regulated pollutant. However, the PSD increment must be evaluated for all proposed sources. At the Project site, evaluating the PSD increment consumption must be done for NO_2, SO_2, particulate matter less than 10 microns (PM_{10}) and particulate matter less than 2.5 microns ($PM_{2.5}$). Given the minor source increment for $PM_{2.5}$ was triggered in this air quality region (AQR 126) on March 31, 2016, evaluation of PSD increments for $PM_{2.5}$ is now required. Therefore, the PSD increment for $PM_{2.5}$ has been evaluated as part of this application. This evaluation appears in the *Air Quality Impact Analysis*, which appears in Appendix E.

In addition to the above, until recently the PSD rule also required facilities to conduct an analysis of Greenhouse Gas (GHG) emissions to determine the applicability of the USEPA "tailoring rule" to facilities emitting quantifiable amounts of GHGs. While this requirement was rescinded under 40 CFR 52.21 (w) in 2015, CRI has nonetheless conducted an analysis of GHG emissions as part of this Permit to Install Application. Emission calculations for GHG emissions are included in Appendix C. The calculations demonstrate that GHG emissions are well below the previous major source permitting threshold of 100,000 tons per year on a carbon dioxide equivalent basis.

4.3.3 40 CFR Part 60 – New Source Performance Standards

Three NSPS rules apply to the Project:

- NSPS Subpart LL – Standards of Performance for Metallic Mineral Processing Plants.
- NSPS Subpart IIII – Standards of Performance for Stationary Compression Ignition Engines (emergency generators).
- NSPS Subpart JJJJ – Standards of Performance for Stationary Spark Ignition Internal Combustion Engines (natural gas power plant generators).

4.3.3.1 40 CFR Part 60 – Subpart LL – Standards of Performance for Metallic Mineral Processing Plants

Subpart LL (40 CFR 60.380 through 60.386) applies to emission points including conveyor belt transfer points described in the air permit application. After initial start-up, process fugitive emissions must be less than or equal to 10% opacity. Process fugitive emissions are defined as PM emissions from an affected facility that are not collected by a capture system.

For affected facilities, the following PM standards apply to any stacks (paragraph 60.382):

- PM must be less than or equal to 0.05 grams per dry standard cubic meter (0.02 grains/dry standard cubic foot).
- Exhibit less than or equal to 7% opacity unless the stack emissions are discharged through a wet scrubber.

Further requirements regarding monitoring, recordkeeping, and reporting apply to the Project.

4.3.3.2 40 CFR 60 – Subpart IIII – Standards of Performance for Stationary Compression Ignition Internal Combustion Engines

This rule was promulgated by USEPA on July 11, 2006, and is applicable to manufacturers, owners, and operators of stationary compression ignition (CI) internal combustion engines manufactured after that date. Section 60.4205 describes requirements for owners or operators of emergency engines. Under this section, the owner or operator must meet the requirements in Section 60.4211, which state that emergency units must be operated and maintained in accordance with manufacturer's emission-related written instructions. The facility may change only those emission-related settings that are permitted by the manufacturer. Manufacturers of this equipment must certify the engines meet these requirements for the specified model year.

It should be noted that while there is also a NESHAP standard for Reciprocating Internal Combustion Engines at 40 CFR 63 – Subpart ZZZZ, it would generally not be applicable to new engines that are covered under the NSPS standard.

4.3.3.3 40 CFR 60 – Subpart JJJJ – Standards of Performance for Stationary Spark Ignition Internal Combustion Engines

This rule applies to new, modified, and reconstructed spark ignition engines such as the natural gas power generators that will be used at CRI. Given the units will be non-emergency lean burn generators that use natural gas, they will be subject to emission standards for larger engines with horsepower greater than 500 horsepower. This will require the engine to either be certified for the year in which it was manufactured or the facility will need to demonstrate compliance with emission standards through source testing.

4.3.4 40 CFR Part 63 – NESHAP for Major Source Categories

The Project will not be a major source of air pollutants, therefore, this section of the regulations is not applicable. All federally-listed HAPs will have a PTE less than 10 tons of a single HAP and less than 25 tons of all HAPs combined.

4.4 Michigan's Nonferrous Metallic Mining Regulations (Part 632)

This Permit to Install Application is for a nonferrous metallic mine that will be regulated under Part 632. The Project was initially issued Mining Permit MP 01 2012 on April 30, 2012. Currently, two amendments have been granted.

5. Control Technology Analysis

Control technology discussion in this section is presented for the emission units and processes that contribute to them. Table 3-3 lists emission units and their descriptions.

5.1 Control Device Descriptions

Particulate emissions from ore handling activities will occur both underground and at the surface. In general, underground activities will be controlled using water sprays at various material transfer points and a portion of particulate emissions settles. Particulate emissions that reach the surface will be vented through one of three ventilation raises. Particulate emissions at the surface will be in the form of fugitive emissions from various material handling transfer points. Emissions will be controlled through use of a combination of enclosure for material transfer and use of water to control fugitive dust along vehicle roadways. Emission calculations appear in Appendix C. More information on control of fugitive dust is included in the *Fugitive Dust Control Plan* in Appendix D.

5.1.1 Emissions from Underground Activities

EUMINEVENT (SV-001, SV-002, SV-003)
Drilling, blasting, and ore transfer to further handling operations will take place within the underground mine area. Drilling and blasting will be sporadic, with emissions being controlled by using good industry practice during drilling and blasting activities and following other work practices to reduce the potential for dust emissions during transfer to a feed hopper, rolls/rock breaker, and conveyor transfer.

For transfer points, water spray suppression techniques will be used to minimize dust emissions at the feed hopper, rolls/rock breakers and various conveyor transfer points. Work practices for ore transfer will include minimizing the drop point between the LHD machine bucket and the feed hopper. In addition, particulate emissions are reduced to a certain extent by settling underground. In addition, the particle size distribution chart for ore indicates that the percent particle sizes in the silt range are low.

5.1.2 Fugitive Emissions form Surface Ore Transfer and Handling Activities

EUOREHANDLING, EUCONCENTRATE, EUREAGENTMIX (F001, F002, F003, F004, F005, F006, F009)
All particulate emission sources at the surface will be in the form of fugitive emissions. Fugitive emission release points are identified on Figures 3-1 and 3-2. Emission points and associated controls are further described in Section 3.3.2.

5.1.3 Wind Erosion at Outdoor Material Storage Locations

EUORESTOCKPILE, EUTDF (F007 and F008)
As described in Section 3.3.3, surplus ore will be stored at the Ore Stockpile while tailings from the Process Plant will be managed at the TDF. Given these materials will be stored outdoors, potential for fugitive emissions due to wind erosion has been estimated. Wind erosion potential at the Ore Stockpile has been characterized as an area source and is identified as F007, while wind erosion at the TDF (F008) has also been characterized as an area source. Controls are described in Section 3.3.3.

5.1.4 Construction Generator

EUCONGENERATOR (SV-004)
The diesel-fired generator used early in the Project development. The unit is designed to meet Tier 4 standards, details provided in Appendix A-1. The units will burn Ultra Low Sulfur Diesel (ULSD) at 15 parts per million sulfur.

5.1.5 Natural Gas Generators

EUGENERATORS (SV-005, SV006, SV007)
To achieve low emissions, each generator will be equipped with both a SCR and Oxidation Catalyst for reducing emissions of NO_2 and CO. Expected emissions of these pollutants when using this control technology is included in Appendix A-2. SCR-Oxidation Catalyst technology is mature and widely used in a variety of applications.

5.1.6 Fugitive Dust from On-Site Access and Haul Roads

EUHAULROADS (HR-01 through HR-07)
Several methods will be used to reduce dust emissions from haul roads at the facility. It is possible trucks may be used to transport additional water to the site using the access road. In addition, a FEL will be used at the Ore Stockpile to move surplus ore within the footprint of the Ore Stockpile.

All roadways for haul truck traffic will be unpaved and will be regularly maintained. While it is expected that the ground will be frozen and/or snow-covered during approximately five months of the year, dust suppression methods will be employed during dry and warmer times of the year. Dust suppression will include use of a water truck to wet roadway areas along the access road and for the haul road area within the Ore Stockpile. Alternative dust suppression techniques will include use of chemical dust suppressants. Maintaining the road surface along the access road will be part of controlling dust emissions. Generation of fugitive dust will also be controlled through use of enforced on-site speed limits. More details on control of fugitive dust from haul roads are discussed in the *Fugitive Dust Control Plan* in Appendix D.

5.2 Identification of Toxic Air Pollutants and Consideration of Best Available Control Technology

Pursuant to EGLE regulations, a T-BACT review must be performed as part of the air permit application for any proposed new or modified emissions source when identified Toxic Air Contaminants (TAC) are present in the emissions. The goal of this review is to attain the maximum degree of emission reduction which is reasonably achievable for each process emitting TAC, taking into account energy, environmental and economic impacts, and other costs. The review is performed in three steps:

1. Identify pollutants.
2. Identify emission units and activities to be evaluated for Best Available Control Technology (BACT).
3. Search for and determine what BACT is optimum for a particular emission unit, activity, and pollutant.

The pollutants and emission units for the Project have been identified as described throughout this document. USEPA provides technical review of BACT technology, as well as Reasonably Available Control Technology (RACT) and Lowest Achievable Emission Rate (LAER) technology on its website. Review of the USEPA RACT/BACT/LAER Clearinghouse (RBLC) website confirmed certain controls applied are considered BACT. Results of this search appear in Appendix F. The following is a summary of the T-BACT analysis for the Project.

5.2.1 Pollutant Applicability

TACs have been comprehensively identified in the emissions calculations in Appendix C. Trace TACs are present in PM emissions (ore, concentrate, tailings, native soils all emit PM when transferred and managed) and combustion products. TACs fall into two categories: metal constituents that occur naturally in the ore, tailings, soils, and waste rock plus trace metals in some natural gas combustion produces; and organic compounds emitted from reagents and combusting natural gas and diesel.

Copper and silver are target metals for the mill operations. Additional metals occur as incidental constituents in soils, ore, and ore byproducts. Nineteen constituents in the ore are listed with TAC screening levels. TACs will occur at an estimated rate from certain steps of the operation. Because the TACs occur naturally in the processed materials, substitutions are not an option to reduce those TACs.

Additional TACs occur in reagents used in the milling operations. Identified TACs are MIBC (listed as methyl isobutyl carbinol or methyl amyl alcohol) and n-dodecyl mercaptan. All chemicals will be mixed in the Reagent Area and used inside the Process Plant.

Combustion products from natural gas and diesel use contain trace metals and organics. Through the life of the Project, several power supply provisions are employed including ultimately line power. Even with line power, however, the facility needs supplemental power for operations thus will continue to use the natural gas generators.

Emission calculations for the Project appear in Appendix C and were prepared using conservative assumptions. Metals data used in estimating emissions of metal TACs were obtained from CRI. They are largely based on data generated in past studies of ore, concentrate, tailings, and native soil for the Project. Further information on sources of these data are provided in Appendix C. To be conservative, the trace metals are based on total PM emissions rather than PM_{10} or $PM_{2.5}$ emissions.

A list of the TACs and the facility-wide proposed Maximum Controlled Emission rates are included in the calculations. Additional discussion on the Maximum Controlled Emission rates and modeling demonstration can be found in Section 6 and the *Air Quality Impact Analysis* included as Appendix E.

5.2.2 Emission Unit Applicability

Point source TAC emissions will occur during underground ore handling and will be vented through ventilation raises. In addition, fugitive emissions will occur during outside ore handling activities, indoor concentrate handling, and during haul road travel by vehicles. In addition, windblown emissions will occur at the Ore Stockpile and TDF. Table 3-3 lists emission units, sources, and controls.

5.2.3 Potential Sensitive Concerns

At the Project site, all TACs will be controlled using conventional control technology. This includes the use of water suppression techniques, enclosures, and an on-site haul road watering program. There are no significant issues involving either energy or economics that would prevent TACs from being adequately controlled.

Predicted Ambient Impacts (PAI) based on air dispersion modeling, use of the screening algorithm in R 336.1227 (a) (1), and Maximum Controlled Emission calculations demonstrate all TACs will be in compliance with applicable standards. Further information is provided in Section 6. Based on this review, no potentially sensitive concerns have been identified involving energy, economics, or the environment.

5.2.4 Review and Selection of Control Strategy

Processes at the facility were reviewed for best control technology. Available technology considered is listed on the RBLC website. Appendix F contains summaries from the review. The following summarizes the process evaluation.

5.2.4.1 Emissions from Underground Activities

The first steps of the facility operations will be to mine and transfer ore from underground stopes and ore handling areas to initial surface ore handling and storage areas. Underground mine activities will include drilling, blasting, transfer of ore to a feed hopper and conveyor transfer locations, and conveyor transfer to the surface for further handling. Ore will contain certain TACs regulated by EGLE. Drilling, blasting, and continuous mining will be conducted using standard industry techniques to control release of material.

During transfer of ore from the underground muck pile to the conveyor transfer area, water sprays will be used to control dust that may be generated at key transfer points. The facility will also rely on settling to reduce dust emissions underground. Use of water sprays at transfer points underground is considered to be best management practices for reduction of dust emissions during transfer of ore-bearing materials and are considered to be BACT for these activities. In addition, the relatively large particle size of the ore (see particle size distribution in Appendix A-5) should assist in controlling dust generation.

5.2.4.2 Fugitive Emissions from Surface Ore Transfer and Handling Activities

Upon completion of underground activities, ore material will be conveyed to the surface via enclosed conveyor from the mine portal through the ore transfer to either the Ore Stockpile or to the Ore Bins/Reclaim Area. All transfer conveyors will have covers installed on the equipment, with material being deposited through enclosed discharge chutes when moving on to the next step. The bins at the Ore Bins/Reclaim Area will be enclosed and will transfer material to enclosed feed conveyors at the bottom of each bin (see Figure 3-3). Mill feed conveyors will be covered as they transfer material to the SAG Mill. As the material is discharged to the ball mill chute at the mill, it will be immediately slurried and mixed into the ball mill.

All transfer points are subject to NSPS limits found in 40 CFR 60.380 -386. These standards specify emission and opacity limitations for affected facilities. It is anticipated this operation will be in compliance with NSPS opacity limits.

It is believed that through enclosure of the conveyors, the stockpiles, and each transfer point, an emission reduction of 95% can be anticipated. The emission point will be subject to an NSPS opacity limitation of 10% for fugitive sources found in 40 CFR 60.382 (b). It is believed this limit should be considered to be BACT for this operation and that the process will be in compliance.

In addition to the above, a review was made of the RBLC website to determine what additional controls are recognized as BACT for this type of process. Several examples of use of partial enclosure were noted that demonstrate that partial enclosure can be considered BACT for these types of processes. Examples of these types of controls are found at the RBLC website for LA-0209, VA-0292, and AR-0074. Copies of summary descriptions for these controls are provided in Appendix F.

Copper concentrate will be produced from Process Plant operations. Both concentrate products will be dropped directly from the filter press into an indoor storage pile hopper for loading and shipment on concentrate trucks. As the materials drop from the presses, the moisture content will be approximately 9%, which inherently dampens emissions. The operation will also be conducted inside a building which provides full containment. Full enclosure of the process and high moisture content are considered to be BACT for this final step of the operation.

5.2.4.3 Wind Erosion at Outdoor Material Storage Locations

At the Ore Stockpile, the facility will rely on the relatively large particle size of the ore to control the potential for fugitive dust emissions due to wind erosion. The facility will also utilize a water truck to control dust on haul roads used by a FEL to transport stored ore to the Feed Ore Conveyor at F001. Use of these methods are considered to be BACT for this activity.

Most tailings at the TDF are in a wet state. The expected area of exposed dry tailings subject to potential wind erosion will be relatively small (9.4 acres). While dry exposed tailings were considered for wind erosion potential, it is also expected that the surface of the dry exposed tailings will be controlled due to formation of a crust layer over the tailings and remaining moisture content. Maintaining most of the tailings in a pond or wet state and minimizing exposure of dry tailings to wind erosion potential is considered to be BACT for this operation.

5.2.4.4 Fugitive Emissions from Access and Haul Roads

Unpaved access roads will be used for transport of concentrate product from the concentrate loadout area to the main gate access point on the east side of the facility. A portion of this access road may also be used to transport water to a location west of the TDF for use in operations. Due to the climate in this area, the site may be covered with snow and subject to freezing conditions during approximately five to six months of the year. During drier times of the year, the facility will rely on water suppression to control dust on facility haul roads and service roads. Fugitive dust control will also be managed through implementation of a *Fugitive Dust Control Plan*. This *Plan* details measures the facility will take to verify fugitive dust is controlled to the best extent that is reasonably available. This *Plan* is attached to this Permit to Install Application as a separate report in Appendix D.

The *Fugitive Dust Control Plan* will rely in part on use of water to reduce emissions of road dust from the site. During situations when freezing conditions are occurring but no snow cover is in place, the facility may also rely upon approved dust suppressants for application to unpaved roadways on an as-needed basis. Water trucks will resume during warmer months.

The facility will also make use of crushed aggregate on roadways to reduce the silt content to a minimal level. Aggregate will be replaced as necessary. In a review of information on the BACT Clearinghouse website, use of dust suppressants such as water in conjunction with a control plan on unpaved roadways is considered as BACT. Examples of this are found in RBLC, ID Numbers UT-0060, UT-0061, AR-0124, and LA-0209 in Appendix F. The *Fugitive Dust Control Plan* included as Appendix D provides additional information on how controls will be implemented.

5.2.4.5 Construction Generator

As noted in Section 3.3, the construction generator will be used in initial mine development. The generator will be a Tier 4 unit designed to meet NSPS requirements of 40 CFR 60, Subpart IIII for stationary compression ignition internal combustion engines. Additionally, the use of ULSD greatly minimizes SO_2 emissions. Design of the units to meet these requirements is considered to be BACT for these emission units.

5.2.4.6 Natural Gas Generators

Each generator will be equipped with a combination SCR to reduce emissions of NO_2 and CO emissions. Based on this information, use of the SCR system is considered BACT for controlling emissions of organic HAPs from the natural gas generator system. In addition, the power generators will be required to meet emission requirements of 40 CFR 60, Subpart JJJJ – Standards of Performance for Stationary Spark Ignition Internal Combustion Engines.

6. Air Quality Impact Analysis

6.1 Modeling Description

Air dispersion modeling was performed to assess ambient air quality impacts to the surrounding area from emissions of criteria pollutants and certain Michigan TACs. EGLE guidance was relied upon in preparing the modeling.

The air dispersion model was USEPA approved American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD). This model was approved by USEPA on November 9, 2005, and adopted as the preferred model by EGLE as of January 2006. CRI has chosen to use a Windows-based version of AERMOD developed by Breeze® software. Breeze® Version 8.0.0.39 includes the latest updates to the AERMOD model as prepared by USEPA. AERMOD Version 16116r was used for all air dispersion modeling.

The ambient air boundary is shown on Figure 6-1. Public access will be prevented with a combination of fencing, barriers, and signage. The Project is located in a remote area with little population nearby.

6.2 Compliance with National Ambient Air Quality Standards

Criteria pollutants at this site regulated by the National Ambient Air Quality Standards (NAAQS) and requiring inclusion in the air impact analysis include:

- Particulate Matter as PM_{10}
- Particulate Matter as $PM_{2.5}$
- Nitrogen Dioxide
- Sulfur Dioxide
- Carbon Monoxide
- Lead

Combustion gas criteria pollutants at the facility will be the following equipment, which does not run simultaneously:

- 1 – Construction Generator (Diesel)
- 3 – Natural Gas Generators
- 1 – Fire Pump (Diesel)
- 1 – Propane Mine Heater
- 1 – Natural Gas Mine Heater

EGLE guidance states that only facilities being permitted as PSD sources require five years of meteorological data be used in the dispersion modeling. In that the Project will not be a PSD source, modeling based on one year of data would be satisfactory. However, CRI has chosen to model PM using five years of the most recent meteorological data as provided by EGLE through its website. Lead is emitted at very low levels, so only meteorological data from the most recent meteorological year (2022) was used to evaluate this pollutant. Similar to the NAAQS evaluation, emissions from certain exempt sources are included in the PSD source evaluation increment analysis.

Based on the air dispersion modeling analysis, all criteria pollutants comply with NAAQS and Class II PSD increments. Ambient background levels were provided by EGLE for use in the NAAQS analysis. A more detailed description of the modeling procedure and a discussion of the findings are included in the *Air Quality Impact Analysis,* included in Appendix E. The report includes results for modeling runs, including tables showing compliance for NAAQS and PSD increment for each applicable averaging time.

6.3 Air Toxic Review Demonstration of Compliance Health-Based Screening Levels

Compliance with health-based screening levels is required for facilities not regulated under the federal MACT standards, Section 112 of the Federal Clean Air Act. The Project is not a major source for federal HAPs as defined by R 336.1211 and MACT standards do not apply to this facility. Therefore, the rules in R 336.1225 apply.

Based on R 336.1225, after application of BACT, a new or modified facility may not emit an identified TAC exceeding a contaminant-specific, health-based screening level. There are three types of screening levels:

- Initial Threshold Screening Level (ITSL).
- Initial Risk Screening Level (IRSL).
- Secondary Risk Screening Level (SRSL).

Acceptable screening levels are published and updated periodically on the EGLE website (EGLE, 2023a, 2023b). To assess compliance with health-based screening levels, a review was made of all proposed operations. Emission calculations for airborne metals were prepared using conservative assumptions as described in Section 5.2.1 and as presented in Appendix C. The proposed maximum controlled emission rates were compared to the Allowable Emission Rate (AER) outlined in R 336.1227(a)(1). The EGLE provides a spreadsheet on their website to assist in identifying TACs not passing very conservative thresholds. TACs not passing the AER screening need modeling to demonstrate compliance with health-based levels.

TACs associated with this Project fall into one of two categories: metals present in PM emitted from processes involving ore and some combustion emissions; and organic TACs from combustion emissions and reagents. For the ore, copper and silver are the target metals for the mining operations with the remaining metals occurring as incidental constituents. Because the metals occur naturally within the ore, substitutions are not an option to reduce TACs. Of the 19 TACs associated with ore processing and combustion emissions, several metals did not pass the screening analysis. These contaminants are listed on Table 6-1 and were modeled using AERMOD to demonstrate compliance with health-based screening levels. A presentation of the screening methodology and modeling results appears in the *Air Quality Impact Analysis,* Appendix E.

Several combustion sources produce organic TACs, which were evaluated in the facility emissions, Appendix C and listed on Table 6-1. With the variety of fuels and types of equipment coupled with several equipment operation scenarios, organic TACs were evaluated on a worst-case individual basis. Reagent emissions have been estimated and found to be quite small, mainly due to the selection of dry granular chemicals that are safer to transport and produce minimal emissions. Two reagents were screened for the need to model. Both chemicals pass screening thresholds and did not require modeling to demonstrate compliance. Screening results are included in Appendix E.

A small amount of TACs associated with operation of the power plant and emergency generator were considered. All TACs associated with natural gas and diesel fuel combustion were screened. Most of the combustion emissions pass the screening thresholds, however, several required modeling to demonstrate compliance. Screening and air dispersion modeling results for TACs are included in Appendix E.

Air dispersion modeling and Maximum Controlled Emission calculations showed that all identified TAC emissions will be in compliance with the applicable screening levels. Detailed discussion of this analysis is included in the *Air Quality Impact Analysis* report included in Appendix E.

7. Proposed Permit Conditions

The Project will be a non-major source of criteria pollutants and HAPs, however, certain controls and work practices will be required to verify compliance with the federal and state air pollution regulations:

- NAAQS for PM.
- NSPS, subpart LL – Standards of Performance for Metallic Minerals Processing Plants (40 CFR 60.380-60.386).
- NSPS Subpart JJJJ – Standards of Performance for Stationary Spark Ignition Internal Combustion Engines (natural gas power plant generators).
- NSPS Subpart IIII – Standards of Performance for Stationary Compression Ignition Engines (emergency generators).
- Michigan Health Based Screening Levels for Toxic Air Contamination, (EGLE, 2023a).

7.1 Emission Control Equipment

CRI proposes to use an SCR/Oxidation catalyst system to control emissions of NO_2 and CO. Based on information provided by Caterpillar and Miratech, emissions of these pollutants should be reduced to levels by 80%.

A detailed description of emission control units is provided in Sections 3.3 and 5.1 of this application. During operations, emission control devices will be properly maintained in accordance with an inspection and maintenance procedures outlined in a *Malfunction Abatement Plan* to be provided at a later date in accordance with air permit conditions.

For fugitive dust from roadways, CRI proposes to use a water truck to control potential dust emissions. Enclosures will be used on outdoor ore transfer conveyors and transfer points. Dust control measures are discussed in more detail in the *Fugitive Dust Control Plan* in Appendix D.

7.2 NSPS Limitations

In accordance with NSPS requirements, the facility will be required to meet the following limitations:

- PM emissions from affected stacks must be less than or equal to 0.05 grams per dry standard cubic meter (0.02 grains/dry standard cubic foot).
- Emissions from affected stacks shall exhibit less than or equal to 7% opacity, unless the emissions are discharged through a wet scrubber.
- After initial start-up, process fugitive emissions must be less than or equal to 10% opacity.

Process fugitive emissions are defined as PM emissions from an affected facility that are not collected by a capture system. The facility will maintain records and reports to demonstrate compliance with applicable requirements. These are outlined in more detail in Appendix G.

8. Statement of Compliance

To the best of its knowledge, operations, and controls described in this Permit to Install Application for the Project proposed by CRI will comply with all applicable federal and state air pollution control rules, regulations, and methods used to meet specific requirements.

9. Permit to Install Application Checklist

Included in this section is a completed checklist using a form excerpted from the Michigan Air Use Permit Technical Manual. This checklist was completed to demonstrate how the Permit to Install Application complies with all administrative requirements of EGLE rules.

APPENDIX A: AIR PERMIT TO INSTALL - APPLICATION CHECKLIST

for submitting an administratively complete application

The Application Form:

- [x] The application form (EQP 5615 or EQP 5615E) is dated "Rev. 08/2019" or later.
- [x] The application form includes the applicant's name and address along with the complete location of the equipment in Items 2, 3, and 4.
- [x] The application form includes a brief description of the proposed process or process equipment in Item 6. The description includes why the application is being filed (e.g., install new equipment, modify existing permitted equipment, permit existing equipment not previously permitted, modify existing permit w/o change in equipment, limit potential to emit).
- [x] The application form has an original, pen-on-paper, signature of an authorized employee of the applicant. (Agents ***may not*** sign the application.)
- [x] Your submittal must include the original-signature application form, 2 additional copies of the signed form, and 2 copies of all attachments.

Technical Attachments:

Process Description, including the following

Section 3.2 A complete written description of each piece of proposed process equipment.

Table 3-1 A unique descriptive identifier (Emission Unit ID) for each proposed emission unit.

App C, p. 2 The normal and maximum operating schedules of the proposed process(es).

Tables 3-1, 3-2 The type and feed rates of materials to be used in the proposed process(es).

Section 3 The fuels and firing devices (if any) to be used in the proposed process(es).

Section 3 A description of any wastes generated and the reuse, treatment, or disposal methods.

Figure 3-3 A flow diagram for complex processes or multiple emission units.

Regulatory Discussion, including the following:

Section 4 A description of the regulatory requirements that apply to the proposed process(es).

Section 5 A description of how the proposed process(es) will comply with those requirements.

N/A Is the equipment a new or reconstructed major source of Hazardous Air Pollutants (HAPs) that is not covered by a 40 CFR Part 63 major source standard? If so, include the MACT Information Checklist form from Policy and Procedure AQD-015 and all information requested on that form.

Control Technology Analysis, including the following:

Section 5	A description of the proposed control technology or technologies.
Section 5	The efficiency or effectiveness of the proposed control equipment and the basis.
Section 5	A description of pollution prevention techniques being used to reduce emissions from the proposed process(es) or process equipment.

Emissions Summary & Calculations, including the following:

App. C	The total emissions of all pollutants, including regulated New Source Review pollutants, criteria pollutants, and HAPs (both individual and aggregate) from each stack/vent, including any related emissions increases from existing equipment. A summary table may be used.
App. C and E	The total emissions of each toxic air contaminant (TAC) from each stack/vent and a demonstration that the emissions comply with Rule 225. A summary table may be used.
Appendix C	All calculations used to determine the emission rates and a description of any assumptions made or emission factors used.
X	If possible, include the emission calculations in an unlocked Excel-compatible spreadsheet. Sent to Andy Drury, EGLE
X	Note that assumptions used in the emission calculations may appear in permit conditions.

Stack/Vent Information, including the following:

For each stack or vent:

Table 3-4	Minimum height above ground
Table 3-4	Maximum internal diameter or other dimensions perpendicular to exhaust flow
Table 3-4	Description of rain protection (e.g., cap, no-loss rain sleeve, etc.)
Table 3-4	Discharge orientation (e.g., vertical, horizontal, etc.)
Table 3-4	Volumetric flow rate
Table 3-4	Exhaust gas temperature
Table 3-4	Location of any stack testing ports — Detail to be provided in final engineering plans

Site Description and Process Equipment Location Drawings, including the following:

Figure 3-1, to scale	Building dimensions	X	Property and fence lines
Figures 1-1 and 3-1	Adjacent properties and structures	Figure 3-2	Proposed equipment locations
Figure 3-2	Stack/emission point locations	Figures to scale	Distances to all property lines
X	North direction	X	Scale

10. References

Michigan Department of Environment, Great Lakes, and Energy – Air Quality Division, 2021. *Permit to Install Guidebook – A Practical Guide to Completing an Air Permit Application*. November 2021.

Michigan Department of Environment, Great Lakes, and Energy – Air Quality Division, 2023a. Toxic Air Contaminants – Demonstrating Compliance with Rule 225. Undated. Accessed on EGLE website August 2, 2023: Toxic Air Contaminants - Demonstrating Compliance with Rule 225 (michigan.gov)

Michigan Department of Environment, Great Lakes, and Energy – Air Quality Division, 2023b. Demonstrating Compliance with Rule 225 – Rule 227 Spreadsheet. Accessed on EGLE website on July 15, 2023: Toxics (michigan.gov) (link source).

United States Environmental Protection Agency. Updated. AP-42 Fifth Edition, Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Air Sources.

United States Environmental Protection Agency, 1995. Memorandum on *Calculating Potential to Emit (PTE) for Emergency Generators*, September 6, 1995.

Tables

Table 1-1
Emissions of Criteria Pollutants

Potential to Emit (PTE) in tons per year	NO_X	SO_X	CO	VOC	Lead	PM	PM_{10}	$PM_{2.5}$
Stack Emissions	60.1	24.0	80.8	17.4	2.20E-04	23.2	8.8	4.5
Potential to Emit (PTE) in tons per year	**60.1**	**24**	**80.8**	**17.4**	**2.20E-04**	**23.2**	**8.8**	**4.5**
Fugitive Emissions					4.35E-04	37.2	10.0	2.0
Maximum Controlled Emissions for the Facility	**60.1**	**24**	**80.8**	**17.4**	**6.55E-04**	**60.4**	**18.8**	**6.5**

Prepared by: AKM
Checked by: CED1

Notes:
Units: tons per year
Criteria Pollutants:
NO_X = oxides of nitrogen with nitrogen dioxide as the indicator
SO_X = oxides of sulfur with sulfur dioxide as the indicator
CO = carbon monoxide
VOC = volatile organic compounds
PM = particulate matter
PM_{10} = particulate matter less than 10 microns
$PM_{2.5}$ = particulate matter less than 2.5 microns

Table 3-1
Mine Excavation and Production Schedule

	Total	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12
Development Mining	1,967	85	378	455	107	102	309	319	211				
Production Mining	26,308	2	14	1,582	2,564	2,633	2,442	2,442	2,521	2,752	2,752	2,752	2,746
Total Mining	28,273	88	392	2,037	2,671	2,736	2,752	2,761	2,732	2,752	2,752	2,752	2,746

Notes:
Information source: Feasibility Study Update, Copperwood Project, April 2023.
Units are thousands of short tons.

Prepared by: AKM
Checked by: CED1

Table 3-2
Reagents

Reagent	Consumption		Form	Packaging	Reagent Function
Sodium Hydrosulfide (NaHS)	2,886	tons per year	liquid	drum or IBC	Conditioner
Sodium Isobutyl Xanthate (C-3430)	839	tons per year	granular	sack	Collector
Methyl Isobutyl Carbinol (MIBC)	87	tons per year	liquid	drum or IBC	Frother
Dowfroth 250 (D-250)	198	tons per year	liquid	drum or IBC	Frother
Alkylaryl Dithiophosphate (A249)	887	tons per year	liquid	drum or IBC	Conditioner
n-Dodecyl Mercaptan (NDM)	237	tons per year	liquid	drum or IBC	Conditioner
Sodium Silicates	261	tons per year	liquid	drum or IBC	Conditioner
Carboxymethyl Cellulose Sodium	365	tons per year	granular	sack	Conditioner
Hydrated Lime	8,008	tons per year	granular	bulk	Conditioner
Flocculant (To be determined)	1.1	tons per year	liquid	drum or IBC	Particle Attraction
Anti-Scalant (To be determined)	6,182	gallons per year	liquid	drum or IBC	Scale inhibitor

Notes:
Information provided by Highland Copper
IBC = Intermediate Bulk Container

Prepared by: AKM
Checked by: CED1

Table 3-3
Emission Units and Controls

Emission Unit	Process, Equipment, Activity, Controls	Stack	Description of Controls
EUMINEVENT	3 mine vents (West Mine Exhaust Vent, Portal Mine Exhaust Vent, East Mine Exhaust Vent) Underground mine heat exhaust (propane, natural gas), drilling, blasting, continuous mining, excavation, travel, and transfer activities. PM generated by material handling will be controlled by dust supression systems including water sprays.	SV-001, SV-002, SV-003	Water sprays at tranfer points and the underground mine acts as a settling chamber whereby particulate matter emissions settle within the mine and do not exhaust through the stacks.
EUMINEHTRPROP	Heats incoming mine air during colder months. Initially a propane heater until a natural gas heater is delivered to site. The heater will be located in the air intake building. Combustion exhaust flows with ventilation intake air, exhausts in EUMINEVENT.	NA	Propane is clean burning. No additional controls.
EUMINEHTRNG	Heats incoming mine air during colder months. When a natural gas heater is delivered to site, this heater will replace the propane heater. The heater will be located in the air intake building. Combustion exhaust flows with ventilation intake air, exhausts in EUMINEVENT.	NA	Natural gas is clean burning. No additional controls.
EUOREHANDLING	F001 - Ore Transfer from Portal to First Transfer Point	Fugitive	Belt conveyors and transfer points will be enclosed.
	F002 - Surplus Ore Transfer to Ore Stockpile	Fugitive	Enclosure over ore stockpile drop point.
	F003 - Transfer points within the Ore Bins/Reclaim Area	Fugitive	Enclosure of transfer points.
	F004 - Management of Ore within the Ore Stockpile	Fugitive	Work practices such as minimizing drop heights.
	F005 - Transfer points at the SAG Mill	Fugitive	Enclosure of conveyer and transfer points.
EUCONCENTRATE	F006 - Concentrate Handling Operations	Fugitive	Process enclosure and concentrate moisture of 8-10%
EUREAGENTMIX	F009 - Reagent handling emissions	Fugitive	Handling practices and building enclosure.
EUSTOCKPILE	F007 - Ore Stockpile Wind Erosion	Fugitive	Watering program as described in the Fugitive Dust Plan, Appendix D.
EUTDF	F008 - TDF Wind Erosion	Fugitive	Tailings will be pumped in slurry form at 50% solids content. The TDF will be covered by a large pond. There will be a dry beach area exposed to wind erosion and will be monitored and watered as described in the Fugitive Dust Plan, Appendix D.
EUCONGENERATOR	Diesel Construction Generator	SV-004	Generator will burn Ultra Low Sulfur Diesel (ULSD) with no more than 15 ppm sulfur.
EUNGGENERATOR1 EUNGGENERATOR2 EUNGGENERATOR3	Natural Gas Generators	SV-005, SV-006, SV-007	Three natural gas generators operating in two scenarios. Each generator will be equipped with a Selective Catalytic Reactor/ Oxidation Catalyst System to reduce pollutants in the exhaust.
EUFIREPUMP	Emergency Fire Water Pump	SV-008	Operates only in fire conditions.
EULIMESILO	Lime Silo	SV-009	Silo is fitted with a bin vent filtering the exhaust air as the silo is being filled.
EUHAULROADS	Truck Traffic on Unpaved Roads	HR-01, HR-02, HR-03, HR-04, HR-05, HR-06, HR-07	Watering program, use of larger size roadway aggregate and periodic replacement, and limiting vehicular speeds to 15 mph as described in the Fugitive Dust Plan, Appendix D.

Abbreviations:
mph = miles per hour
ppm = parts per million

Prepared by: AKM
Checked by: CED1

Table 3-4
Stack Data

Stack	Emission Unit	Exhaust Flow Rate (cfm)	Exhaust Temperature (◦F)	Stack Height (m)	Stack Diameter (m)	Moisture Content	Stack Orientation	Rainhat Y/N
SV-001	West Mine Exhaust Vent	330,000	60	9	2	Ambient	Vertical	N
SV-002	East Mine Exhaust Vent	340,000	60	9	2	Ambient	Vertical	N
SV-003	Portal Mine Exhaust Vent	180,000	60	1	4.77	Ambient	Vertical	N
SV-004	Construction Generator	1,845	860	4.5	0.2	Ambient	Vertical	N
SV-005	Natural Gas Generator	1,845	860	4.5	0.2	Ambient	Vertical	N
SV-006	Natural Gas Generator	6,030	881	4.5	0.38	Ambient	Vertical	N
SV-007	Natural Gas Generator	6,030	881	4.5	0.38	Ambient	Vertical	N
SV-008	Fire Pump	1,100	1,000	4.5	0.15	Ambient	Vertical	N
SV-009	Lime Silo Vent	300	60	4.5	0.2	Ambient	Vertical	N

Notes:

[1] Exhaust outlets from the portal will be rectangular. For purposes of air dispersion modeling, the outlet is converted to a circular outlet through the formula 1.124 * SQRT (Area of Exhaust Outlet).

Stack testing port locations and configuration to be specified in final engineering plans and specifications.

Abbreviations:
°F = degrees Fahrenheit
cfm = cubic feet per minute
m = meters

Prepared by: AKM
Checked by: CED1

Table 3-5

Maintenance Intervals for Emitting Equipment and Controls

Emitting Equipment	Maintenance Interval
EUMINEHTRPROP EUMINEHTRNG EUMINEVENT	Maintenance of equipment will be performed according to manufacturer's instructions and industry practice. Underground activities will take place during two 10 hour shifts per day. Maintenance and servicing of all equipment and dust controls can take place daily as needed.
EUOREHANDLING EUCONCENTRATE EUREAGENTMIX	Surface activities will take place during two 10 hour shifts per day. Maintenance and servicing can take place daily as needed.
	The transfer points will operate on various schedules allowing opportunity to service equipment, including making necessary adjustments and lubrication.
	Concentrate thickeners and filter presses that feed packaging areas will be inspected, lubricated and adjusted in accordance with a regular maintenance schedule.
	Enclosure hoods for ventilation pick-ups and wet sprays will be inspected, adjusted, cleaned, and repaired as needed. Further detail will be provided in a Malfunction Abatement Plan to be prepared.
EUTDF, EUORESTOCKPILE	Dust dampening strategies are described in the Fugitive Dust Control Plan. Dust control is evaluated on daily conditions.
EUCONGENERATOR EUGENERATOR1 EUGENERATOR2 EUGENERATOR3	Maintenance of emission control equipment will be performed according to manufacturer's instructions and industry practice.
EUFIREPUMP	Testing will take place monthly, which will include making any maintenance and repairs as needed.
EULIMESILO	Regular equpment inspection and maintenance will be practiced on all mill equipment including the lime silo.
EUHAULROADS	Roadway aggregate will be inspected and repaired, with aggregate replaced as needed.

Prepared by: AKM
Checked by: CED1

Table 6-1

Toxic Air Contaminants Modeled for Air Dispersion

Toxic Air Contaminant	Category	Source
Aresenic	Metal	PM emissions; some types of natural gas combustion
Copper	Metal	PM emissions; some types of natural gas combustion
Lead	Metal	PM emissions; some types of natural gas combustion
Cobalt	Metal	PM emissions; some types of natural gas combustion
Manganese	Metal	PM emissions; some types of natural gas combustion
Barium	Metal	PM emissions; some types of natural gas combustion
Beryllium	Metal	PM emissions; some types of natural gas combustion
Cadmium	Metal	PM emissions; some types of natural gas combustion
Nickel	Metal	PM emissions; some types of natural gas combustion
Acetaldehyde	Organic	Combustion product
Benzene	Organic	Combustion product
1,2-Butadiene	Organic	Combustion product
Benzo(a)pyrene	Organic	Combustion product
Ehylene Dibromide [1]	Organic	Combustion product
Acrolein	Organic	Combustion product
Formaldehyde	Organic	Combustion product

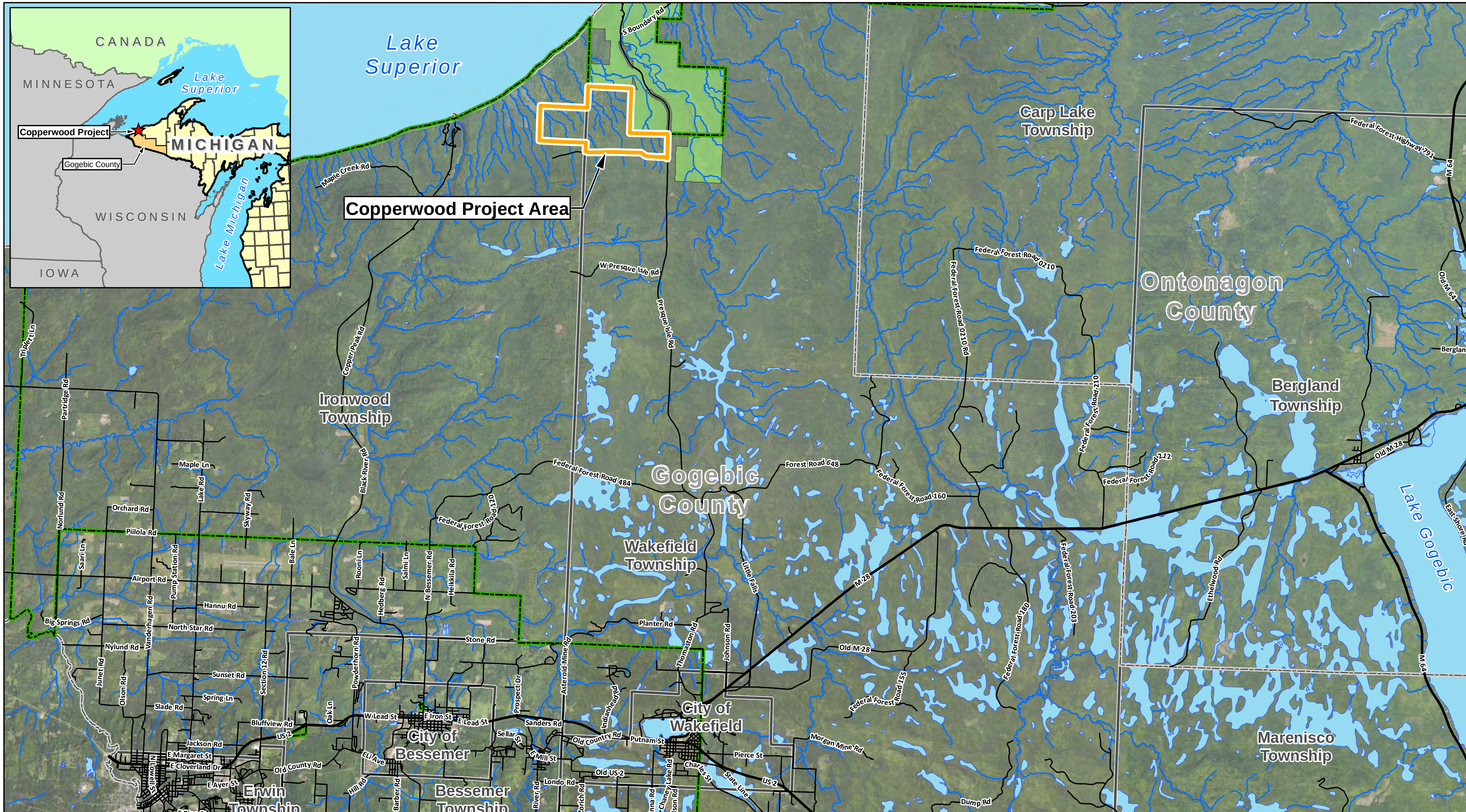
Notes:

[1] Ethylene dibromide is the same as 1,2-dibromoethane, CAS # 106934

Prepared by: AKM

Checked by: CED1

Figures



NOTES:
1. Base air photo from the USDA.
2. Horizontal coordinate system is NAD1983 UTM Zone, 16N, units in meters.
3. Hydrographic data from the USGS.
4. Road and boundary data from Michigan GIS Open Data and the USFS.

This drawing is neither a legally recorded map nor a survey and is not intended to be used as one. This drawing is a compilation of records, information and data used for reference purposes only.

LEGEND

- Major Road
- Minor Road
- River/Stream
- Lake/Pond
- Property Boundary
- Municipal Boundary
- County Boundary
- Ottawa National Forest Boundary
- Porcupine Mountains Wilderness State Park

HIGHLAND Copper Company Inc.

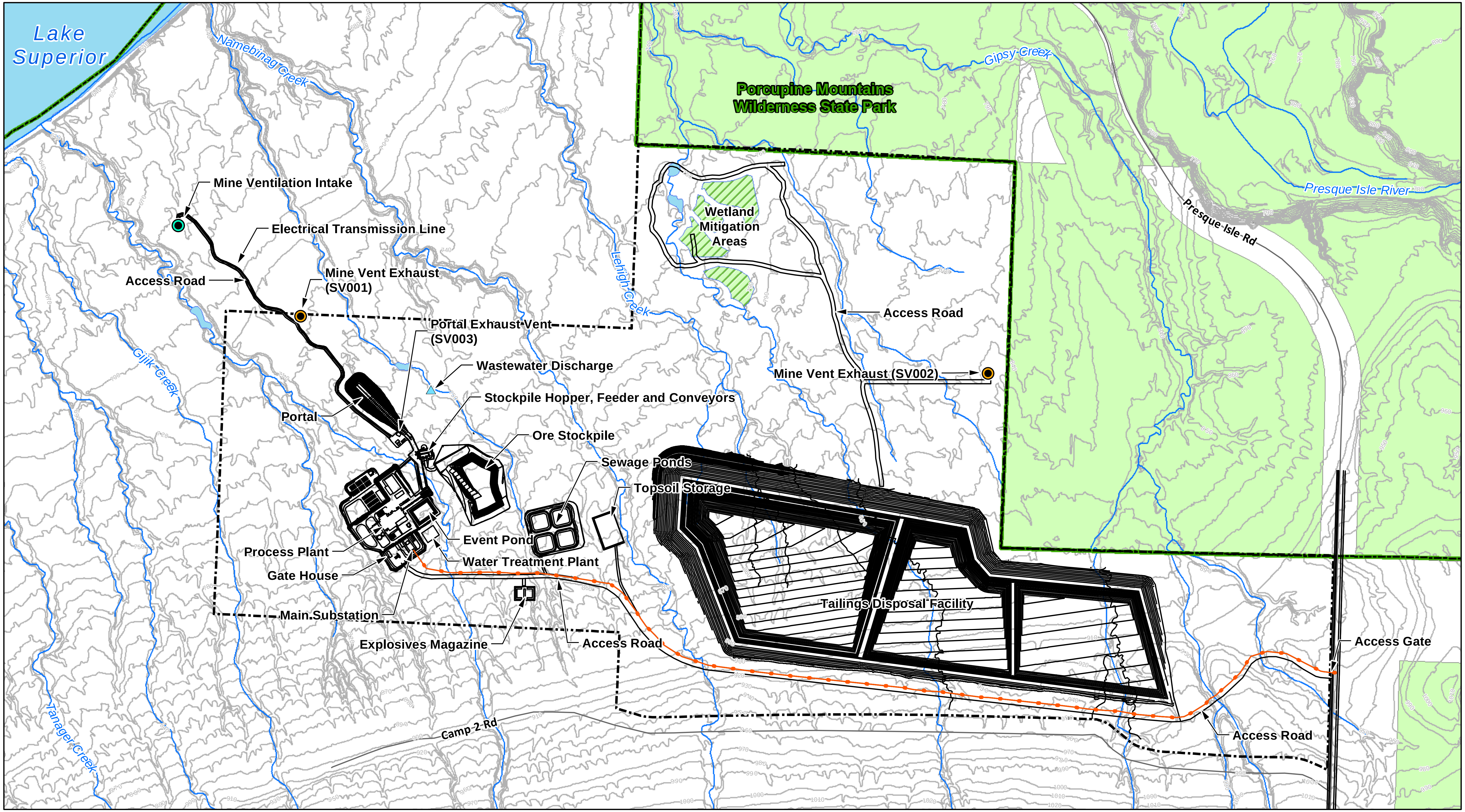
Foth

N

0 1 2 Miles

HIGHLAND COPPER		
FIGURE 1-1 SITE LOCATION MAP AIR PERMIT TO INSTALL APPLICATION COPPERWOOD PROJECT, GOGEBIC COUNTY, MI		
Date: AUGUST 2023	Revision Date:	
Drawn By: BJW1	Checked By: AKM	Project: 23H001

Path: Q:\Highland Copper\23H001\GIS\mxd\Air Permit to Install Application\Figure 1-1 Site Location Map.mxd Date: 8/18/2023



NOTES:

1. Horizontal coordinate system is NAD1983 UTM Zone 16N, units in meters.
2. Hydrographic data from the USGS.
3. Road and boundary data from Michigan GIS Open Data and the USFS.
4. Contour data generated from USGS 1-meter digital elevation model (DEM).

LEGEND

- Exhaust Raise
- Intake Raise
- Wastewater Discharge
- Mine Site Feature
- Electrical Transmission Line
- 10' Topographic Contour
- Minor Road
- River/Stream
- Lake/Pond
- Property Boundary
- Ottawa National Forest Boundary
- Porcupine Mountains Wilderness State Park

SV = Stack Vent

This drawing is neither a legally recorded map nor a survey and is not intended to be used as one. This drawing is a compilation of records, information and data used for reference purposes only.

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Foth

N

0 600 1,200 Feet

HIGHLAND COPPER

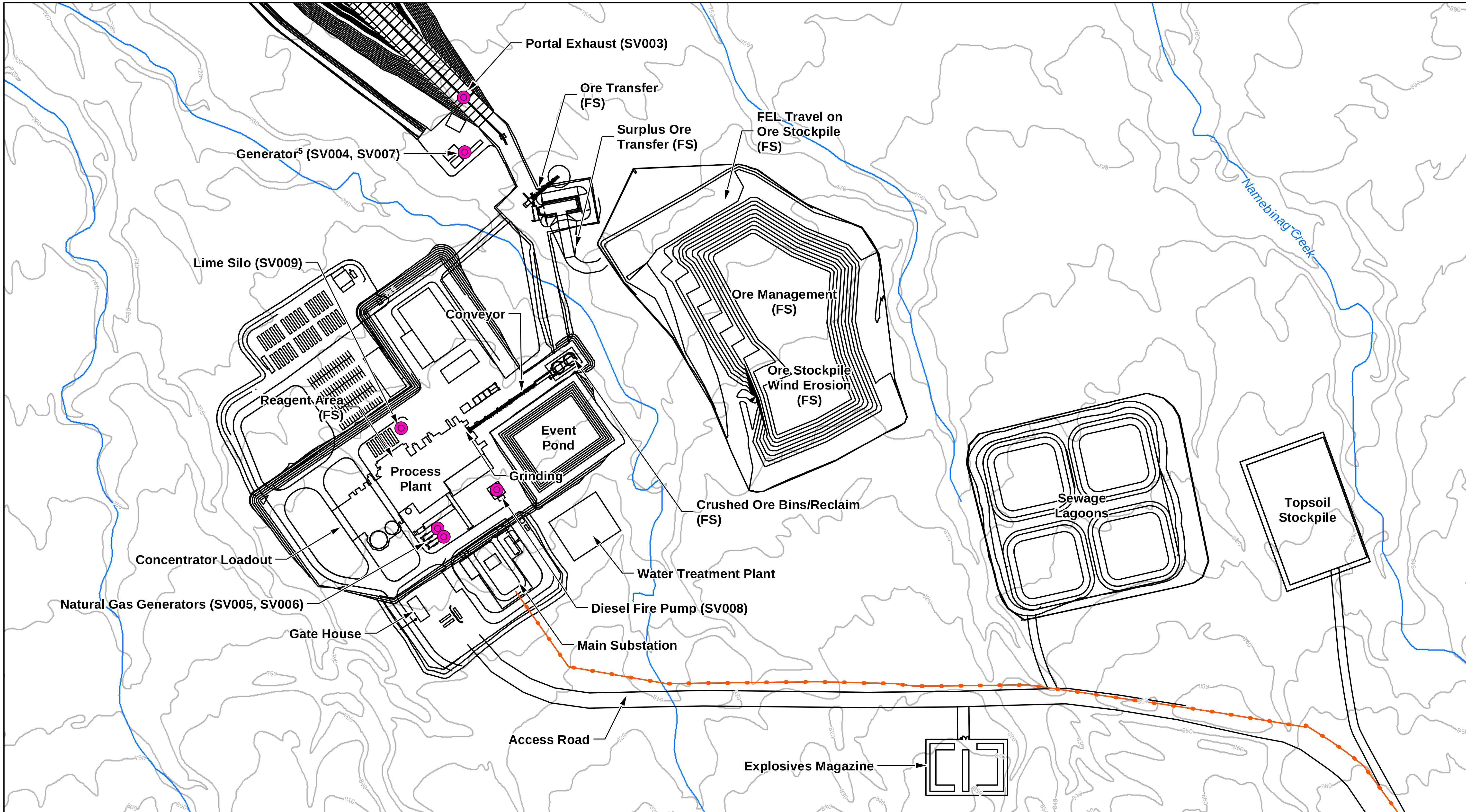
FIGURE 3-1

MINE AREA PLAN
AIR PERMIT TO INSTALL APPLICATION
COPPERWOOD PROJECT, GOGEBIC COUNTY, MI

Date: AUGUST 2023	Revision Date:

Drawn By: BJW1	Checked By: AKM	Project: 23H001

Path: Q:\Highland Copper\23H001\GIS\mxd\Air Permit to Install Application\Figure 3-1 Mine Area.mxd Date: 8/18/2023



NOTES:
1. Horizontal coordinate system is NAD1983 UTM Zone16N, units in meters.
2. Hydrographic data from the USGS.
3. Road and boundary data from Michigan GIS Open Data and the USFS.
4. Contour data generated from USGS 1-meter digital elevation model (DEM).
5. SV004 is the diesel generator used during initial construction. It will be replaced with a natural gas generator when available at same location.

LEGEND
- Stack Location
- Mine Site Feature
- Electrical Transmission Line
- 10' Topographic Contour
- River/Stream
- Property Boundary

SV = Stack Vent
FS = Fugitive Source
Note: Not all fugitive dust sources are shown.

This drawing is neither a legally recorded map nor a survey and is not intended to be used as one. This drawing is a compilation of records, information and data used for reference purposes only.

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Foth

0 150 300 Feet

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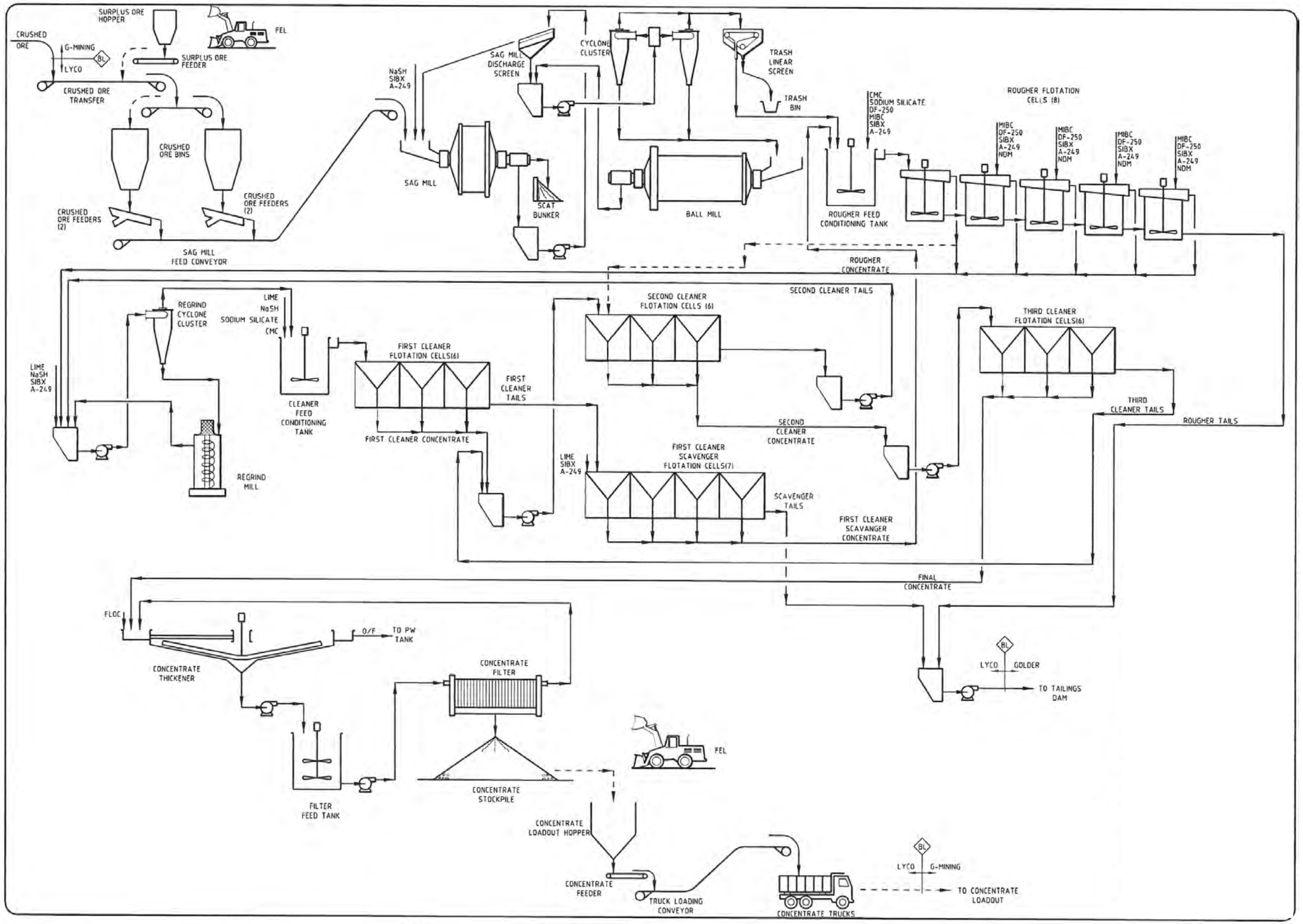
FIGURE 3-2

STACK AND FUGITIVE EMISSION LOCATIONS
AIR PERMIT TO INSTALL APPLICATION
COPPERWOOD PROJECT, GOGEBIC COUNTY, MI

Date: AUGUST 2023	Revision Date:
Drawn By: BJW1	Checked By: AKM
Project: 23H001	

Path: Q:\Highland Copper\23H001\GIS\mxd\Air Permit to Install Application\Figure 3-2 Stack and Fugitive Emissions Locations.mxd Date: 8/18/2023



NOTES:
1. Graphic supplied by Lycopodium Minerals Canada Ltd.

This drawing is neither a legally recorded map nor a survey and is not intended to be used as one. This drawing is a compilation of records, information and data used for reference purposes only.

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NOT TO SCALE

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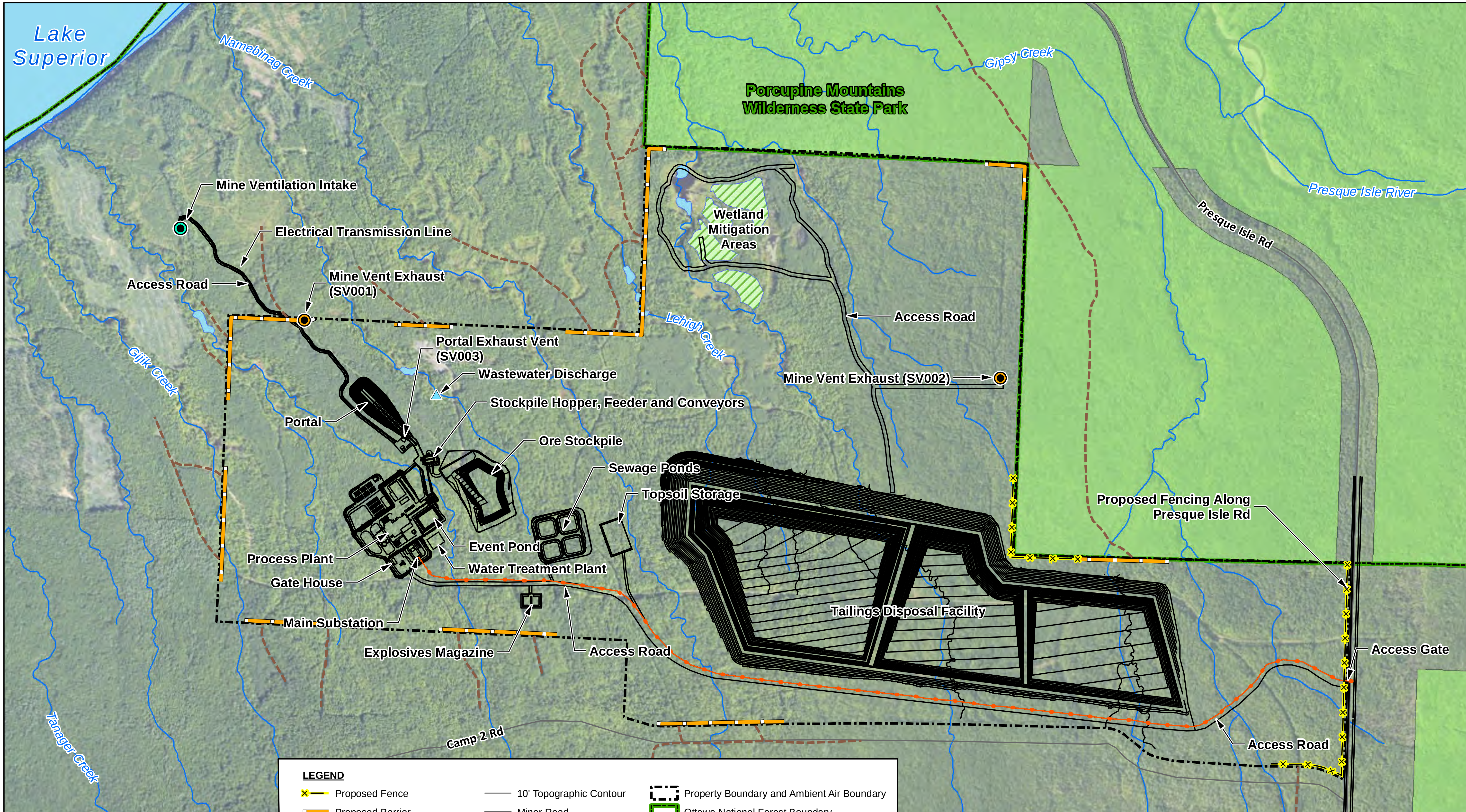
FIGURE 3-3

OVERALL PROCESS FLOW DIAGRAM
AIR PERMIT TO INSTALL APPLICATION
COPPERWOOD PROJECT, GOGEBIC COUNTY, MI

Date: AUGUST 2023	Revision Date:

Drawn By: BJW1	Checked By: AKM	Project: 23H001

Path: Q:\Highland Copper\23H001\GIS\mxd\Air Permit to Install Application\Figure 3-3 Overall Process Flow Diagram.mxd Date: 8/18/2023



LEGEND

- Proposed Fence
- Proposed Barrier
- Trail Segment
- Exhaust Raise
- Intake Raise
- Wastewater Discharge
- Mine Site Feature
- Electrical Transmission Line
- 10' Topographic Contour
- Minor Road
- River/Stream
- Lake/Pond
- Property Boundary and Ambient Air Boundary
- Ottawa National Forest Boundary
- Porcupine Mountains Wilderness State Park

SV = Stack Vent

NOTES:
1. Base air photo from the USDA
2. Horizontal coordinate system is NAD1983 UTM Zone 16N, units in meters.
3. Hydrographic data from the USGS.
4. Road and boundary data from Michigan GIS Open Data and the USFS.
5. Contour data generated from USGS 1-meter digital elevation model (DEM).
6. Trail segments digitized from USDA NAIP 2022 air photo and have not been field verified.

HIGHLAND Copper Company Inc.

Foth

0 600 1,200 Feet

N

HIGHLAND COPPER

FIGURE 6-1

AMBIENT AIR BOUNDARY
AIR PERMIT TO INSTALL APPLICATION
COPPERWOOD PROJECT, GOGEBIC COUNTY, MI

Date: AUGUST 2023	Revision Date:	
Drawn By: BJW1	Checked By: AKM	Project: 23H001

Path: Q:\Highland Copper\23H001\GIS\mxd\Air Permit to Install Application\Figure 6-1 Ambient Air Boundary.mxd Date: 8/18/2023

Appendix A

Manufacturer's Literature

A-1 Construction Diesel Generator
A-2 Natural Gas Generators and Emission Control
A-3 Wheel Loaders – 966M and R1600
A-4 Roadheader
A-5 Particle Size Distribution Curves for Ore and Tailings
A-6 Diesel Fire Pump
A-7 Lime Silo
A-8 Emulsion Specifications

A-1
Construction Diesel Generator

Cat® XQ800 Rental

STANDBY 795 kW
PRIME 725 kW
POWER MODULE
50 Hz 1500 rpm
60 Hz 1800 rpm

Frequency	Voltage	Standby kW (kVA)	Prime kW (kVA)
60 Hz	480/277V	795 (994)	725 (906)
60 Hz	240/139V	795 (994)	725 (906)
60 Hz	208/120V	795 (994)	725 (906)
60 Hz	600V	795 (994)	725 (906)
50 Hz	400V	660 (825)	600 (750)

FEATURES

FUEL/EMISSIONS STRATEGY
- EPA Tier 4 Interim

DESIGN CRITERIA
- Accepts 100% rated load in one step per NFPA 110 and meets ISO 8528-5 transient response
- CSA Approved

SINGLE-SOURCE SUPPLIER
- Factory designed and fully prototype tested with certified torsional vibration analysis available
- ISO 9001:2000 compliant facility

WORLDWIDE PRODUCT SUPPORT
- Cat® dealers provide extensive post sale support including maintenance and repair agreements
- Cat dealers have over 1600 dealer branch stores operating in 200 countries
- The Cat S•O•S℠ program effectively detects internal engine component condition, even the presence of unwanted fluids and combustion byproducts

CAT C27 ATAAC DIESEL ENGINE
- Utilizes ACERT™ Technology
- Reliable, rugged, durable design
- Four-stroke diesel engine combines consistent performance and excellent fuel economy with minimum weight
- Electronic engine control

PRODUCT LINK ASSET MONITORING
- Total Hours & Total Fuel Consumption
- Events & Diagnostic
- GPS Location
- kWh Measurement

CAT GENERATOR
- Matched to the performance and output characteristics of Cat engines
- Single point access to accessory connections
- UL 1446 Recognized Class H insulation

CAT EMCP 4.4 CONTROL PANEL
- Simple user friendly interface and navigation
- Integrated, automatic genset paralleling facilitates multi-unit systems meeting a wide range of customer applications
- Integrated Control System and Communications Gateway

CAT DIGITAL VOLTAGE REGULATOR (CAT DVR)
- Three-phase sensing
- Adjustable volts-per-hertz regulation
- Provides precise control, excellent block loading, and constant voltage in the normal operating range

SOUND ATTENUATED CONTAINER
- Provides ease of transportation and protection
- Meets 74 dB(A) at 7 meters per SAE J1074 measurement procedure at 110% prime load

REDUCED ENVIRONMENTAL IMPACT
- 110% spill containment of onboard engine fluids

FACTORY INSTALLED STANDARD EQUIPMENT

SYSTEM	STANDARD EQUIPMENT
Engine	EPA certified Tier 4 interim Cat C27 heavy duty diesel engine Heavy duty air cleaner with pre-cleaner and service indicator 65-Amp charging alternator Fuel filters – Duplex primary with integral water separator and change-over valve, engine mounted secondary filter Fuel cooler and electric priming pump Lubricating oil system including pump, integral oil cooler, lube oil, filter, filtered crankcase breather system and oil drain line with internal valve routed to connection point accessible from exterior 500 hour oil change intervals Jacket water heater (6kW) Electronic ADEM™ A4 controls 24V electric starting motors with battery rack and cables
Generator	SR4B, three-phase, brushless, salient pole, 0.6667 pitch, permanent magnet excited, Class H insulation Anti-condensation heaters (120V, 600V) 12-lead design, with voltage changeover link board 6-lead design, (600V) Cat Digital Voltage Regulator (Cat DVR) with VAR/PF control
Product Link Asset Monitoring	Product Link functionality features include: · Total Hours and Total Fuel Consumption · GPS Location · Geo-Fencing · kWh Measurement · Start/Stop Times · Events and Diagnostic (via supported datalink)
Containerized Module	30' ISO high cube container 2-axle, 30' ISO container chassis Sound attenuated air intake louvers and 3 lockable personnel doors with panic release Interior walls and ceilings insulated with 100 mm of acoustic paneling Floor of container insulated with acoustic glass and covered with galvanized steel Sound attenuated 74 dB(A) @ 7m Side bus bar access door, external access load connection bus bars Shore power connection via distribution block connections for jacket water heater, battery charger, and generator condensate heaters Lighting 3 DC, one single duplex service receptacle, 2 external emergency stop push buttons 1,250 gal fuel tank, UL listed, double wall, 24 hr runtime @ 75% prime +10% rating (ULC + CGSB43-146) Internal connections for fuel Spill containment 110% of all engine fluids Fuel transfer system and controls Two oversized maintenance-free batteries, battery rack and 20-Amp battery charger, and solar powered battery maintainer Hospital grade, internally insulated, disc shaped exhaust silencer with vertical discharge Vibration isolators, corrosion resistant hardware and hinges External drain access to standard fluids Two 4.5 kg (10lb) carbon dioxide fire extinguishers Standard Cat rental decals and painted standard Cat power module white
Cooling	Standard cooling provides 43° C ambient capability at prime +10% rating Vertically mounted radiator, with vertical air discharge from the container Coolant drain line with internal valve Coolant sight gauge, level switch and shutdown 50/50 Ethylene Extended Life Glycol
Genset Controls and Protection	EMCP 4.4 genset mounted controller Automatic start/stop with cool down timer Generator Protection features: 32, 46, 50/51, 27/59, 81 O/U, and phase sequence Utility multi-function relay (UMR) protection features: 25, 27/59, 32, 47, 40Z, 51, 51N, 60FL, 81O, 81U **(Optional)** Reverse compatible for interface to legacy power modules 3000A electrically operated generator circuit breaker Multi-mode operation (island, multi-unit island and utility parallel (requires optional UMR)) Manual and automatic paralleling capability, with load sharing (multi-unit only)

	Metering display: voltage, current, frequency, power factor, kW, WHM, kVAR, and synchroscope
Quality	Factory testing of standard generator set and complete power module UL, NEMA, ISO, IEEE, CSA standards O&M manuals

Technical Data

CAT GENERATOR

Frame Size 598
Pitch 0.6667
No. of poles 4
Excitation . . . . Static regulated brushless PM excited
Number of bearings. . . . . Single bearing, close coupled
Insulation. . . . . Class H
Enclosure . . . . Drip proof IP23
Alignment. . . . .Pilot shaft
Overspeed capability – % of rated . . . . 125% of rated
Voltage regulator . . . . 3 phase sensing with Volts-per-Hertz
Voltage regulation. . . . . Less than ± 1⁄2% voltage gain
Adjustable to compensate for engine speed droop and line loss
Wave form deviation 3%
Telephone Influence Factor (TIF). Less than 50
Harmonic Distortion (THD). . . . . Less than 5%

CAT DIESEL ENGINE

C27 ATAAC, V-12 4-stroke water cooled diesel
Bore – mm (in). . . . . 137.2 mm (5.4 in)
Stroke – mm (in) . . . . 152.4 mm (6.0 in)
Displacement – L (cu in) . . . . 27.03 L (1958.9 in^3)
Compression ratio. 16:1
Aspiration. . . . . TA
Fuel system . . . . MEUIC
Governor type . . . . ADEM A4

Generator Set Technical Data		50Hz	50 Hz	60 Hz	60Hz
	Units	Prime	Standby	Prime	Standby
Power Rating	kW (KVA)	600 (750)	660 (825)	725 (906)	795 (994)
Performance Specification					-
Lubricating System Oil pan capacity with filter change	L (gal)	99 (26)	99 (26)	99 (26)	99 (26)
Fuel System Fuel consumption					
100% Load	L/hr (gal/hr)	142 (37.4)	178 (47.1)	203 (53.5)	223 (58.8)
75% Load	L/hr (gal/hr)	108 (28.5)	135 (35.7)	152 (40.2)	167 (44.2)
50% Load	L/hr (gal/hr)	74 (19.6)	92 (24.4)	109 (28.7)	118 (31.1)
Fuel Tank Capacity	L (gal)	4730 (1250)	4730 (1250)	4730 (1250)	4730 (1250)
Running time @ 75% rating	Hr	44	35	31	28
Cooling System Ambient Capability	°C (°F)	43 (109)	43 (109)	43 (109)	43 (109)
Radiator &enginecoolant capacity	L (gal)	100.7 (26.6)	100.7 (26.6)	100.7 (26.6)	100.7 (26.6)
Engine coolant capacity	L (gal)	70 (18.5)	70 (18.5)	70 (18.5)	70 (18.5)
Air Requirements Combustion air flow	m^3/min (cfm)	42.5 (1500)	45.3 (1600)	54.6 (1927)	57.9 (2044)
Maximum dirty air cleaner restriction	kPa (in H_2O)	2.5 (10)	2.5 (10)	2.5 (10)	2.5 (10)
Exhaust System Exhaust flow at rated	m^3/min (cfm)	106 (3743)	116 (4097)	135 (4766)	148 (5224)
Exhaust temperature at rated kW – dry exhaust	°C (°F)	470 (878)	493 (919)	460 (860)	485 (905)
Noise Rating (with enclosure)* @ 7 meters (23 feet)	dB(A)	71	71	73	73
Emissions (Regulation) NO_x	g/hp-hr	2.6	2.6	2.6	2.6
CO	g/hp-hr	0.11	0.11	0.11	0.11
HC	g/hp-hr	0.03	0.03	0.03	0.03
PM	g/hp-hr	0.075	0.075	0.075	0.075

Cat® XQ800 Rental

Model XQ800	Length mm (in)	Width mm (in)	Height mm (in)
XQ800 w/o chassis	9,144 (360)	2,438 (96)	2,896 (114)
XQ800 w/ chassis	9,144 (360)	2,438 (96)	4,115 (162)

	Weight kg (lb)
Lube Oil & Coolant – Empty Fuel Tank	16,129 (35,500)
Fuel Tank 200 Gallons of Fuel	16,777 (36,930)
Full Fuel Tank	21,113 (46,547)
Chassis Weight Addition	x4,355 (9,660)

STANDARD FEATURES

EMCP 4.4 LOCAL CONTROL PANEL

- Generator mounted EMCP 4.4 provides power metering, protective relaying and engine and generator control and monitoring
- UL508 recognized
- Convenient service access for Cat Service tools (not included)
- Integration with the Cat DVR provides enhanced system monitoring
- Ability to view and reset diagnostics of all controls networked on primary CAN datalink eliminates need for separate service tools for troubleshooting
- True RMS AC metering, 3 phase
- Multiple stored setpoint group selection via switched input eliminates need to reprogram control when switching voltages and frequencies

EMCP 4.4 ENGINE OPERATOR INTERFACE

- Controls
  - Run/Auto/Stop
  - Speed Adjust
  - Voltage Adjust
  - Emergency Stop
  - Cycle crank
  - Cool-down timer
- Digital indication for
  - RPM
  - Operating hours
  - Coolant Temperature
  - DC Volts
  - Oil pressure
  - Oil Temperature
  - L-L volts, L-N volts, phase amps, Hz
  - ekW, kVA, kVAR, kW-hr, %kW, PF
- Shutdowns with common indicating light for
  - Low oil pressure
  - High Coolant Temp
  - Low Coolant level
  - Overspeed
  - High Oil Temperature
  - Emergency stop
  - Failure to Start (Overcrank)
- Emergency stop pushbutton
- Display navigation keys including four shortcut keys for Engine Parameters, Generator Parameters, Control and main menu
- Fuel level monitoring and control

VOLTAGE REGULATION AND POWER FACTOR CONTROL CIRCUITRY

- Generator mounted automatic voltage regulator, microprocessor based
- Automatic voltage and VAR/power factor control for maintaining constant generator power factor while paralleled with the utility. Voltage and power factor adjustments are performed on the Generator Paralleling Control
- Includes RFI suppression, exciter limiter and exciter diode monitoring

CIRCUIT BREAKER

- 3000A fixed type, 3 poles, genset mounted, electrically operated, insulated case circuit breaker
- Solid state trip unit for overload (time overcurrent) and fault (instantaneous) overcurrent protection
- 100 KA-interrupting capacity at 480 VAC
- Under-voltage release

CURRENT TRANSFORMERS

- CT's rated 3000:5 with 200:5 secondaries wired to shorting terminal strips

POTENTIAL TRANSFORMERS

- 4:1 ratio with primary and secondary fuse Protection (with optional UMR)

BUS BARS

- Three phase, plus full rated neutral, bus bars are tin-plated copper with NEMA standard hole pattern for connection of customer load cables and generator cables
- Bus bars are sized for full load capacity of the generator set at 0.8 power factor
- Includes ground studs for connection to the generator frame ground and field ground cable

EMCP 4.4 GENERATOR PROTECTIVE RELAYING
- Generator protective features provided by EMCP 4.4
  - Phase over/under voltage (Device 27/59)
  - Over/Under frequency (Device 81 O/U)
  - Reverse Power (Device 32/32RV)
  - Current Balance (46)
  - Overcurrent (Device 50/51)
  - Bus Phase Sequence

CONTAINER
- 30' ISO high cube container designed to meet CSC but not certified
- Painted standard Cat Power Module white
- Sound attenuated air intake louvers
- Floor insulated with acoustic glass and covered by galvanized steel
- Three lockable personnel doors with panic release
- Two fire extinguishers
- External drain access to standard fluids

EXHAUST SILENCER
- Hospital grade, internally insulated, disc shaped exhaust silencer with vertical discharge

FUEL TANK
- UL Listed 1250 gallon double walled tank provides 24 hr runtime at 75% prime +10% rating (ULC + TC (CGSB43-146))
- AC Fuel transfer system connected to shore and generator power with automatic switchover

SHORE POWER
- Two shore power connections for jacket water heaters and fuel transfer pump
- One for generator space heater and battery charger

INTERNAL LIGHTING
- Three internal DC lights with one timer installed at the container door
- One single duplex service receptacle connected to shore and generator power with automatic switchover

BATTERY CHARGER AND BATTERIES
- 24 VDC/20A battery charger with float/equalize modes and charging ammeter
- Two oversized maintenance free batteries
- Solar power battery maintainer

EMERGENCY STOP PUSHBUTTON
- Two external, emergency stop pushbuttons (ESP) located near each access door

TRAILER
- Two axle with Anti-lock brake system
- 295/75R225 Load Range G Tires
- Air suspension chassis (optional)

LINK BOARD ASSEMBLY
- 3000A link board for 208/240/400/480 wye operation
- Reconnection via movable link board
- Includes switch to determine the mode of operation

AC DISTRIBUTION
- Provides 120 VAC for all module accessories
- Includes controls to de-energize jacket water heaters and generator space heater when the engine is running

UTILITY MULTI-FUNCTION RELAY (UMR) (OPTIONAL)
Basler Utility Multi-function Relay (UMR) BE1-11i provides the following utility/intertie protection features:

- Synch Check (Device 25)
- Phase under voltage, 2 stage (Device 27)
- Reverse Power (Device 32)
- Negative sequence overvoltage (Device 47)
- Phase time overcurrent (Device 51)
- Neutral overcurrent (Device 51N)
- Phase overvoltage, 2 stage (Device 59)
- Under frequency, 2 stage (Device 81U)
- Over frequency (Device 81O)
- Loss of field (Device 402)

MODES OF OPERATION

- Provides for single unit stand-alone operation, island mode paralleling and load sharing with other power modules, and single unit-to-utility mode paralleling for base load control (with open transition between paralleling modes)
- Island mode paralleling features:
  - Lead unit select control allows single unit to connect to a dead bus or HWDBA Hard Wired Dead Bus Arbitration to allow first unit up to voltage and speed to be first unit to connect to a dead bus
  - Auto synchronization (voltage & phase matching)
  - Load sharing (kW) analog signal (like units & legacy compatible)
  - Load sharing (kVAR) analog signal (like units only)
- Utility mode paralleling features:
  - Auto synchronization (voltage & phase matching)
  - Base-load control (programmable set-point or potentiometer adjust)
  - Soft load/unload (programmable, shared set-point)
  - Power Factor control (programmable set-point)

SINGLE UNIT STAND-ALONE AND MULTI-UNIT ISLAND OPERATION

1. Utility Standby Mode (Normal)
   a. The utility is providing power for the plant loads.
   b. The PM Generator breaker is open.
   c. The PM is in automatic standby mode to respond to a utility failure.

2. Emergency Mode (Emergency)
   a. Utility Failure
      1) The customer protective relaying senses a utility abnormal condition.
      2) A run request is sent to the PM Generator plant.
      3) The first PM generator to reach rated to voltage and frequency is closed to the bus.
      4) In Multi-Unit Island Mode, the remaining PM Generators are paralleled to the bus as they reach rated voltage and frequency. This function is performed via the lead unit select jumper and interconnect wiring connected between the Power Modules.
      5) Plant load is transferred to the Power Modules, which share load equally via load share lines.

SINGLE UNIT BASE LOAD OPERATION

1. Utility Mode (Normal)
   a. The utility is providing power for the plant loads.
   b. The PM is in auto mode and the generator breaker is open.
   c. The PM is interconnected to the utility breaker aux contact, lead unit jumper is not installed and load share lines are not connected
   d. The Paralleling controls automatically detect utility parallel mode when the utility aux contact is closed.

2. Base Load Mode
   a. Unit receives remote run request and starts
   b. Unit reaches rated voltage and frequency.
   c. UMR performs sync-check to permit generator breaker to close.
   d. Unit ramps to Base-Load setpoint at programmed ramp time.
   e. Unit continues to run until remote run request is removed or unit is stopped at control panel.

Cat® XQ800 Rental

FABICK CAT

RATING DEFINITIONS AND CONDITIONS

Meets or Exceeds International Specifications:
AS1359, CSA, IEC60034-1, ISO3046, ISO8528, NEMA MG 1-22, NEMA MG 1-33, 72/23/EEC, 98/37/EC, 2004/108/EC

Prime - Output available with varying load for an unlimited time. Average power output is 70% of the prime power rating. Typical peak demand is 100% of prime rated ekW with 10% overload capability for emergency use for a maximum of 1 hour in 12. Overload operation cannot exceed 25 hours per year. Prime power in accordance with ISO3046. Prime ambients shown indicate ambient temperature at 100% load which results in a coolant top tank temperature just below the alarm temperature.

Ratings are based on SAE J1349 standard conditions. These ratings also apply at ISO3046 standard conditions.

Fuel rates are based on fuel oil of 35º API [16º C (60º F)] gravity having an LHV of 42 780 kJ/kg (18,390 Btu/lb) when used at 29º C (85º F) and weighing 838.9 g/liter (7.001 lbs/U.S. gal.). Additional ratings may be available for specific customer requirements, contact your Caterpillar representative for details. For information regarding Low Sulfur fuel and Biodiesel capability, please consult your Cat dealer.

For more information:
www.fabickcat.com

LEHX0009-07 (12/13)

www.Cat-ElectricPower.com

A-2
Natural Gas Generators and Emission Control

Application & Performance Warranty Data

Project Information

Site Location:	MI
Project Name:	9456542 Aftertreatment G3520
Application:	Prime Power
Number Of Engines:	1
Operating Hours per Year:	TBD

Engine Specifications

Engine Manufacturer:	CAT
Model Number:	G3520
Rated Speed:	1800 RPM
Generator Power:	2000 ekW
Type of Fuel:	Natural Gas
Type of Lube Oil:	0 sulfated ash or less
Number of Exhaust Manifolds:	1

Engine Cycle Data

Load	Speed	Power	Exhaust Flow	Exhaust Temp.	Fuel Cons.	NO_x	CO	O_2	H_2O
%		*bhp*	*lb/hr*	*° F*		*g bhp-hr*	*g bhp-hr*	*%*	*%*
100	Rated	2,952	27,670	917		0.999238	1.41683	10	1.84

Emission Data (100% Load)

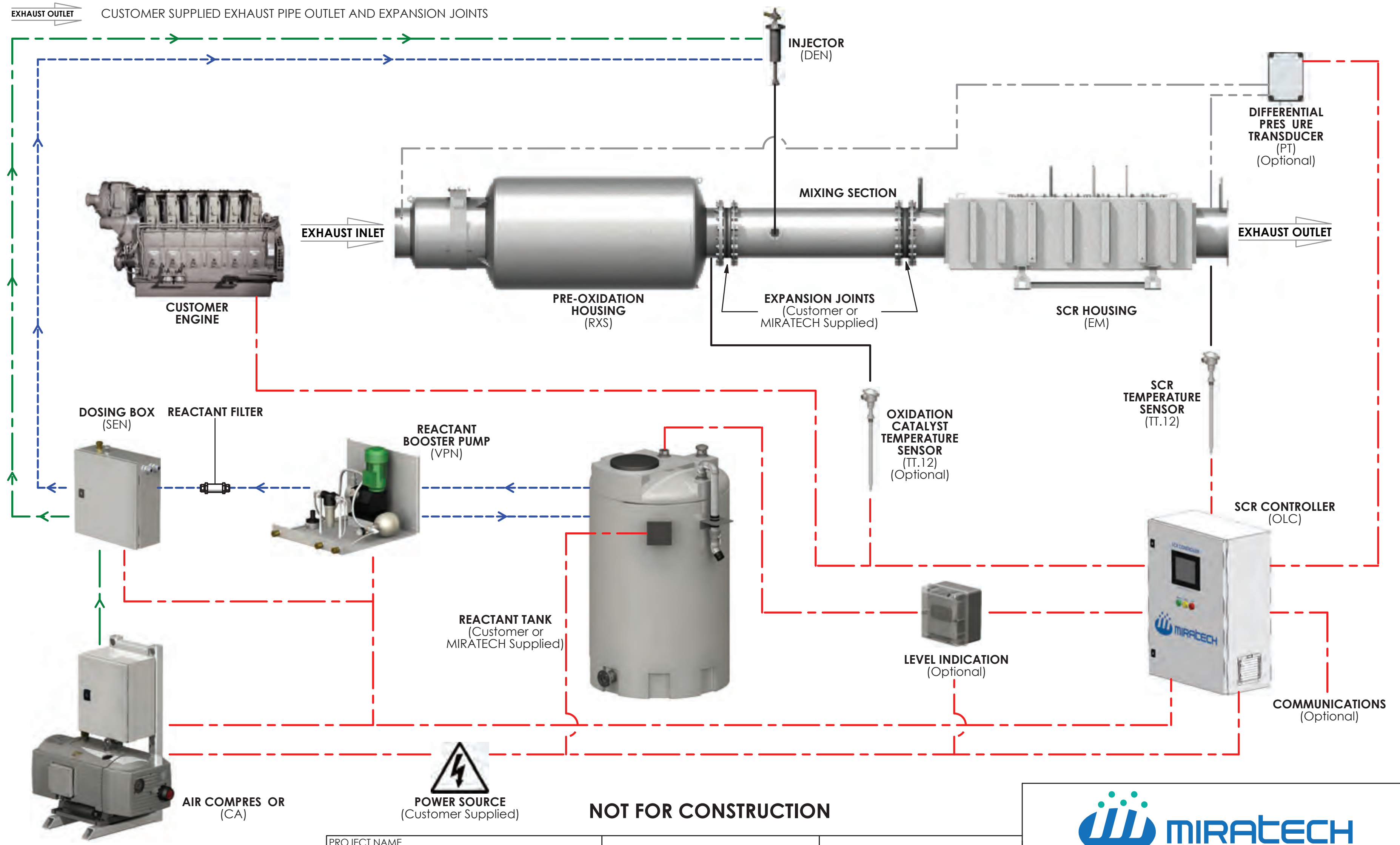
Emission	Raw Engine Emissions						Target Outlet Emissions						Calculated Reduction
	g/bhp-hr	*tons/yr*	*ppmvd @ 15% O*	*ppmvd*	*g/kW-hr*	*lb/MW-hr*	*g/bhp-hr*	*tons/yr*	*ppmvd @ 15% O*	*ppmvd*	*g/kW-hr*	*lb/MW-hr*	
NO_x	1	0.65	82	151	1.34	2.95	0.2	0 13	16	30	0 268	0.59	80%
CO	1.42	0.92	190	352	1.9	4 19	0 28	0 18	38	70	0 38	0 84	80%

MW referenced as NO_2

NOTES:

EXHAUST INLET — CUSTOMER SUPPLIED EXHAUST PIPE NLET AND EXPANSION JOINTS

EXHAUST OUTLET — CUSTOMER SUPPLIED EXHAUST PIPE OUTLET AND EXPANSION JOINTS



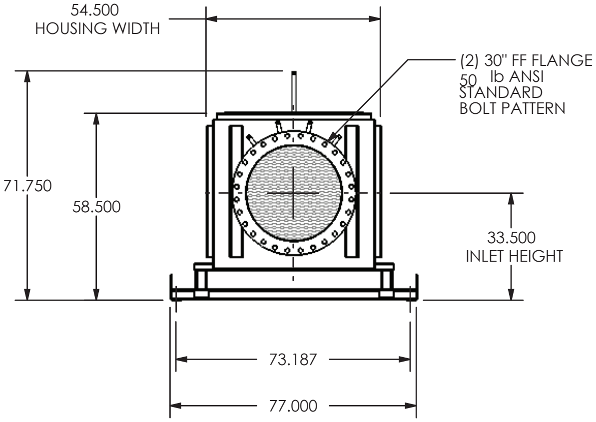
Air
Wire
Reactant
Direct Connect
Exhaust Sample Tubing

NOT FOR CONSTRUCTION

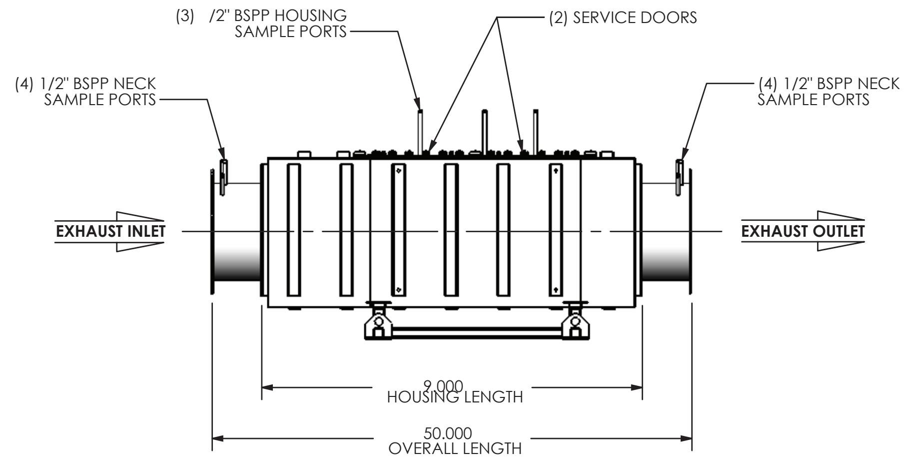
PROJECT NAME	**PROPRIETARY AND CONFIDENTIAL**	DIMENSIONS ARE APPROXIMATE IN INCHES UNLESS OTHERW SE SPECIF ED	MIRATECH
PROPOSAL NUMBER	THE NFORMAT ON CONTAINED N THIS DRAWING S THE SOLE PROPERTY OF MIRATECH GROUP, LLC ANY REPRODUCT ON N PART OR AS A WHOLE W THOUT THE WR TTEN PERM SS ON OF MIRATECH GROUP, LLC S PROH B TED	DO NOT SCALE DRAWING	**EM ACIS-3 LITE RX System Overview Drawing**
SALES ORDER NO		DRAWN: GFS — DATE: 22/2018	DRAWING: EM$_A$ C S-3 LITE-RXS SOD — REV
CUSTOMER P O.		REV EWED BY: AJM — DATE: 22/2018	SIZE: A — NOT TO SCALE — SHEET OF

HOUSING WEIGHTS (APPROXIMATE)	
EMPTY HOUSING	2883 lb
ONE (1) FULL SCR CATALYST LAYER	476 lb
FULLY LOADED HOUSING	4787 lb

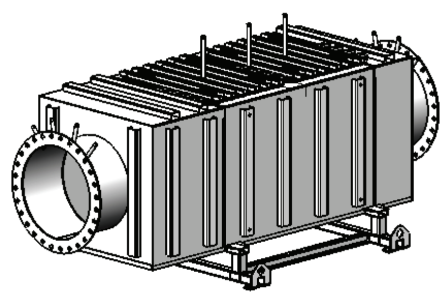
- HOUSING HAS CAPACITY FOR (4) FULL CATALYST LAYERS

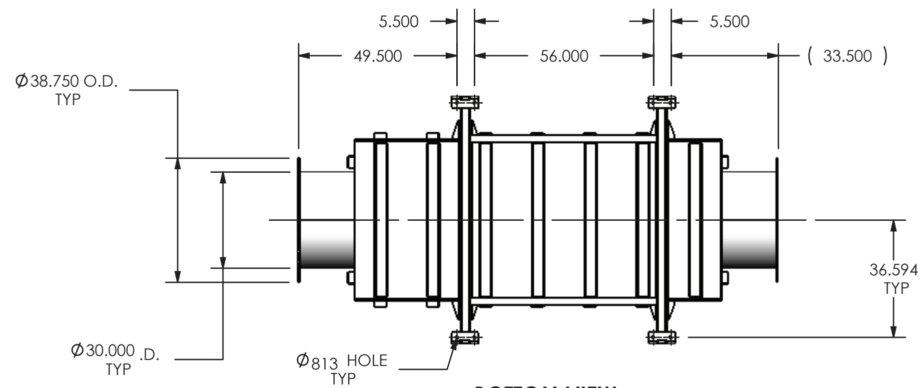


FRONT VIEW



RIGHT VIEW





BOTTOM VIEW

NOTES:

- ONLY USE MOUNTING FEET TO LIFT ASSEMBLED HOUSING
- MUST BE MOUNTED HORIZONTALLY
- NO FORCES OR MOMENTS MAY BE APPLIED TO THE FLANGES
- ALLOW MINIMUM 40" CLEARANCE FROM SERVICE DOOR FOR LOADING AND MAINTENANCE

MATERIAL CONSTRUCTION:

- CARBON STEEL

PROJECT NAME

PROPOSAL NUMBER

SALES ORDER NO

CUSTOMER P O.

PROPRIETARY AND CONFIDENTIAL

DIMENS ONS ARE APPROXIMATE N NCHES UNLESS OTHERW SE SPECIFIED

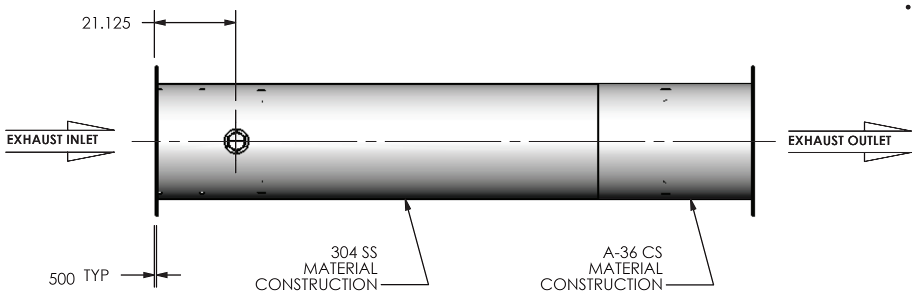
DO NOT SCALE DRAWING

DRAWN	DATE
JCU	3/12/2010
REVIEWED BY	DATE
AJM	3/12/2010

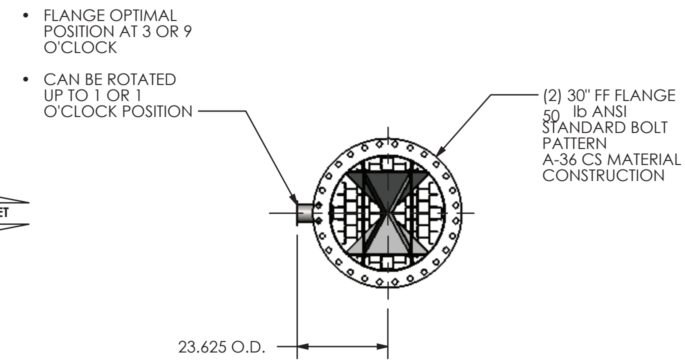
MIRATECH

EM56.10-30
Sales Drawing

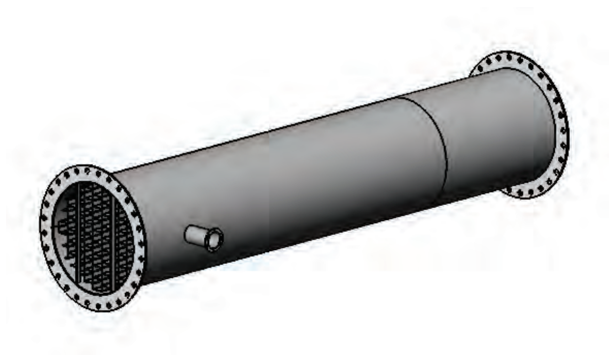
DRAWING			REV
EM56.20- 3			0
SIZE A	SCALE :6	WE GHT: 3166 lb	SHEET OF

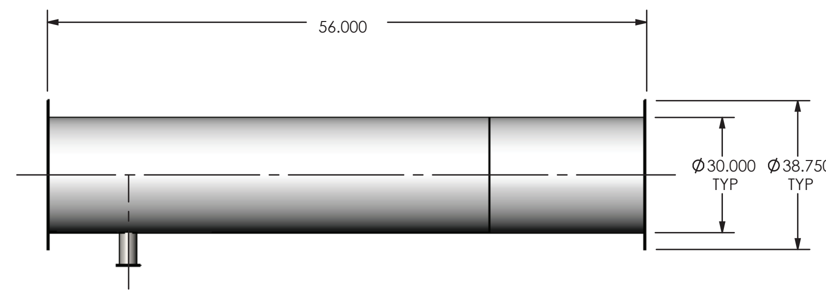


FRONT VIEW



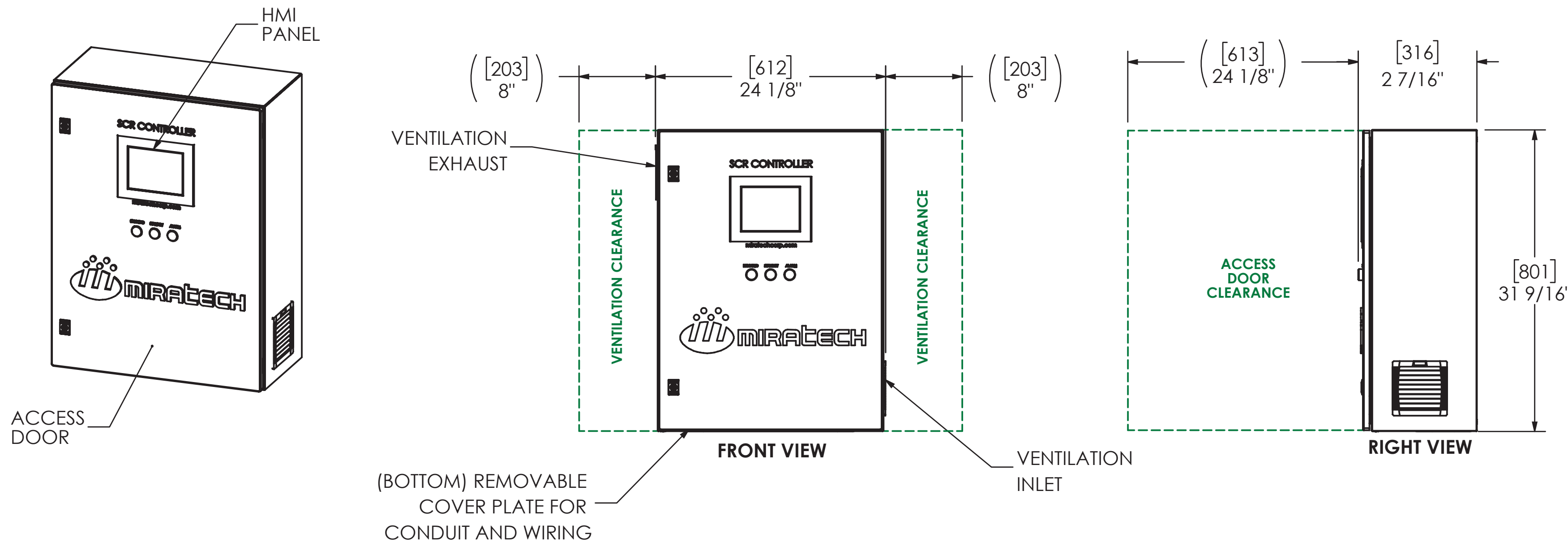
RIGHT VIEW

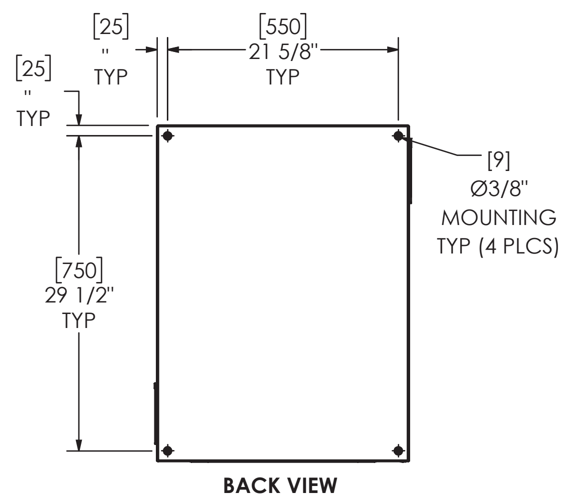




TOP VIEW

PROJECT NAME	**PROPRIETARY AND CONFIDENTIAL**	DIMENS ONS ARE APPROXIMATE N NCHES UNLESS OTHERW SE SPECIFIED	MIRATECH
PROPOSAL NUMBER	THE NFORMAT ON CONTAINED N THIS DRAWING S THE SOLE PROPERTY OF MIRATECH CORPORAT ON. ANY REPRODUCT ON N PART OR AS A WHOLE W THOUT THE WR TTEN PERM SS ON OF MIRATECH CORPORAT ON S PROHIB TED.	DO NOT SCALE DRAWING	**30" Mixing Section (Mixer) Sales Drawing**
SALES ORDER NO		DRAWN AJM / DATE 5/2010	DRAWING 30 Mixing Section (2 Mixer) SD / REV
CUSTOMER P O.		REVIEWED BY JWS / DATE 5/2010	SIZE A / SCALE :5 / WE GHT: 849 lb / SHEET OF





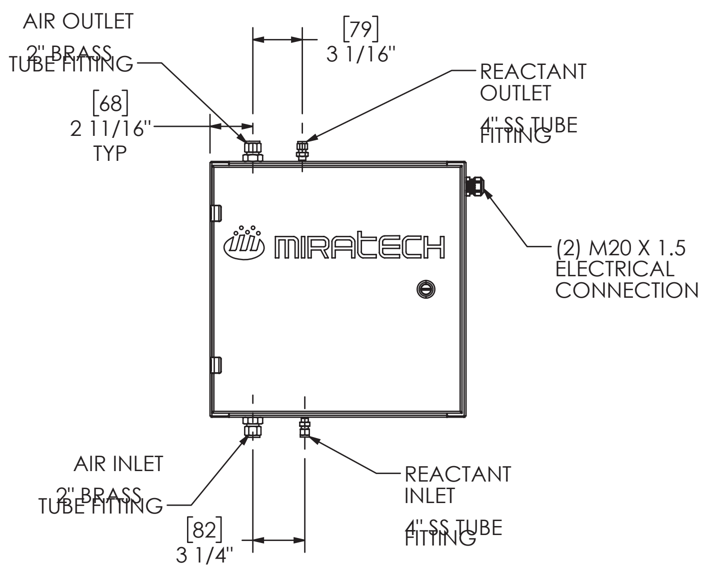
NOTES:

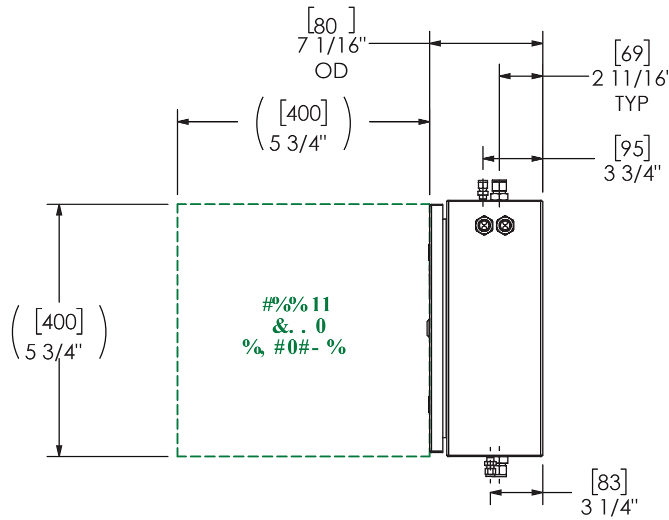
- POWER CONSUMPTION: 3 W MAX
- VOLTAGE: 230 VAC +/- 10%, SINGLE Φ, 50 - 60 HZ
- CURRENT DRAW: 15 A
- POWER CONSUMPTION OF THE REACTANT BOOSTER PUMP AND DOSING PANEL ARE SUPPLIED USING THE SAME CIRCUIT AS THE OLC; REFERENCE THESE DRAWINGS FOR THEIR ADDED POWER CONSUMPTION
- OPERATING TEMPERATURE: 32°F - 122°F (0°C - 50°C) (NON-CONDENSING)
- UL COMPLIANT

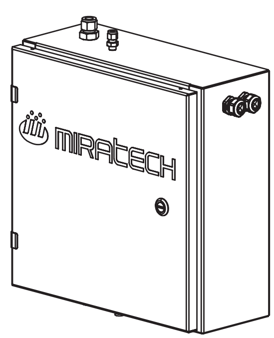
INSTALLATION INSTRUCTIONS:

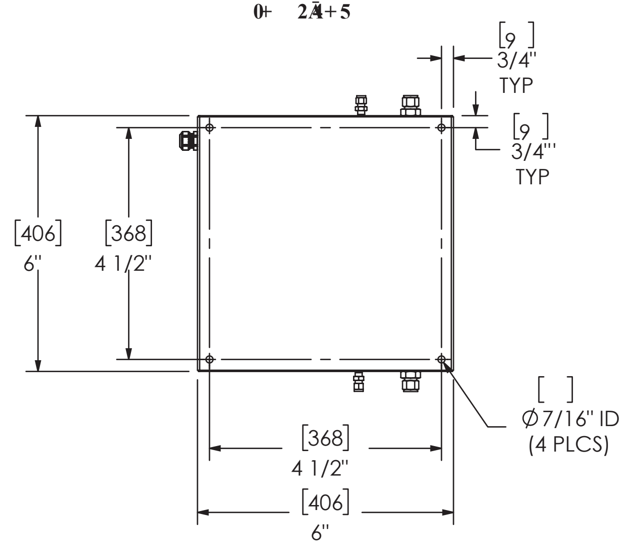
- ENCLOSURE RATED IP55 (NEMA 12 EQUIVALENT)
- INSTALLATION LOCATION MUST BE VENTILATED AND TEMPERATURE CONTROLLED TO MAINTAIN PROPER OPERATING TEMPERATURE.
- UNIT MAY BE WALL MOUNTED OR INSTALLED ON A BASE
- POWDER COATED GRAY

PROJECT NAME	**PROPRIETARY AND CONFIDENTIAL**	DIMENSIONS ARE APPROXIMATE IN INCHES UNLESS OTHERWISE SPECIFIED	MIRATECH
PROPOSAL NUMBER	THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF MIRATECH GROUP, LLC. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF MIRATECH GROUP, LLC IS PROHIBITED.	DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED: ANGLES MACH: ±2° BEND: ±3°; INCHES: ±0.25 MILLIMETERS: ±3	**A3C-20-HMI Controller Sales Drawing**
SALES ORDER NO.		DO NOT SCALE DRAWING	
		DRAWN: TES / DATE: 5/18/2022	DRAWING: A3C-20-HMI SD / REV: 0
CUSTOMER P.O.		REVIEWED BY: GFS / DATE: 5/18/2022	SIZE: A / SCALE: 8 / WEIGHT: 76lb / SHEET 1 OF 1







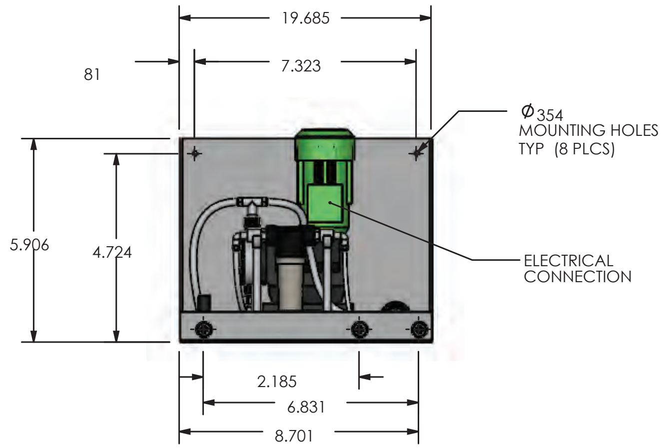


-. 2 1"

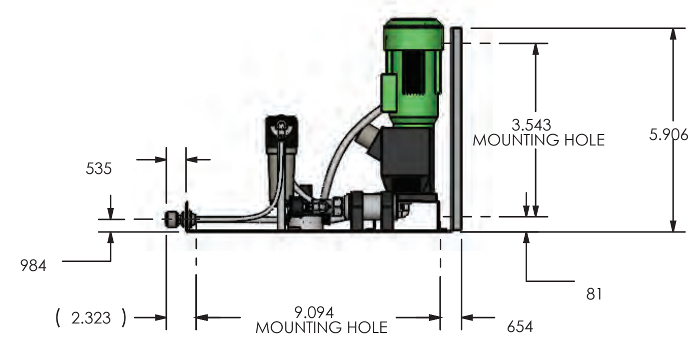
- POWER CONSUMPTION: 5.75 W MAX
- POWER: SUPPLIED FROM SCR CONTROLLER
- OPERATION TEMPERATURE: 40-122°F (5-50°C)
- OPERATING PRESSURE:
  - REACTANT: 3 BAR (43.5 PSI)
  - AIR: 1 BAR (14.5 PSI)
- SUITABLE FOR INDOOR/OUTDOOR USE PER IP55 RATING
- OPERATING FLOW RATE:
  - REACTANT: 10 L/HR MAX (2.6 GAL/HR)
  - AIR: 160 L/MIN (5.6 CFM)

- IF UNIT IS INSTALLED IN AN ENCLOSURE, THE ENCLOSURE MUST BE VENTILATED AND TEMPERATURE CONTROLLED TO MAINTAIN PROPER OPERATION TEMPERATURE.
- UNIT TO BE MOUNTED SO THAT IT IS ACCESSIBLE WHILE ENGINE IS IN OPERATION AND TUBING IS NO MORE THAN 6.5 FEET (2 M) TO DOSING INJECTOR.
- UREA LINES SHOULD BE HEAT TRACED IF AMBIENT CONDITIONS FALL BELOW 32°F (0°C)

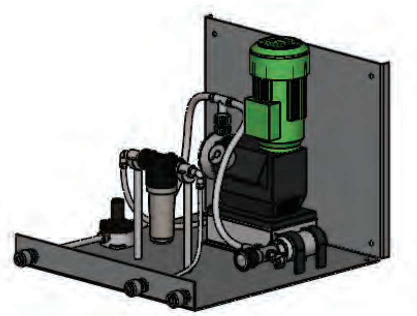
PROJECT NAME	THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF MIRATECH GROUP, LLC. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF MIRATECH GROUP, LLC IS PROHIBITED.	DIMENSIONS ARE APPROXIMATE IN INCHES UNLESS OTHERWISE SPECIFIED		MIRATECH
PROPOSAL NUMBER		DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED — ANGLES MACH: ±2° BEND: ±3°; INCHES: ±1/8 MILLIMETERS: ±3		
SALES ORDER NO.		DO NOT SCALE DRAWING		
		DRAWN MLC	DATE 5/17/2022	DRAWING SEN10-U SD — REV
CUSTOMER P.O.		REVIEWED BY GEP	DATE 5/17/2022	SIZE A — SCALE 1:12 — WEIGHT: 42 lb — SHEET 1 OF 1

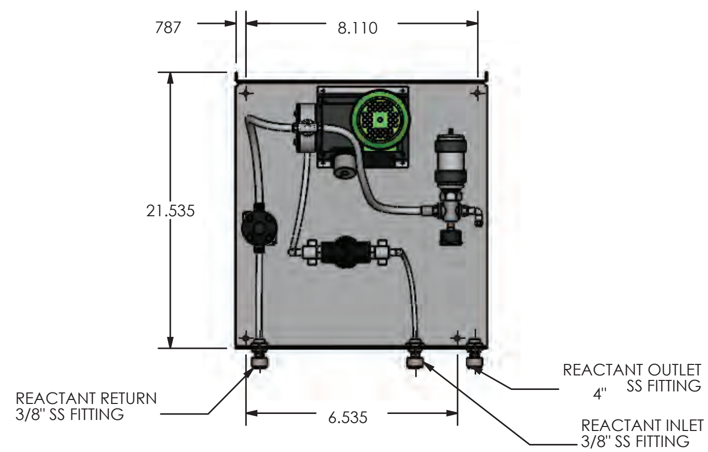


FRONT VIEW



RIGHT VIEW





TOP VIEW

NOTES:

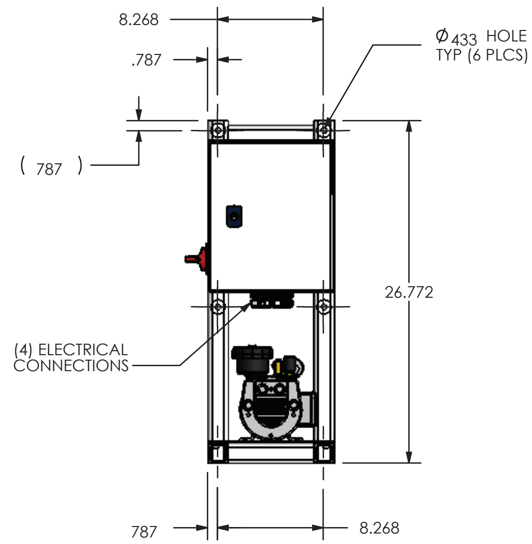
- *POWER CONSUMPTION:* 250 W MAX SUPPLIED BY SNQ CONTROLLER
- *OPERATION TEMPERATURE:* 40°F 4 °F

INSTALLATION INSTRUCTIONS:

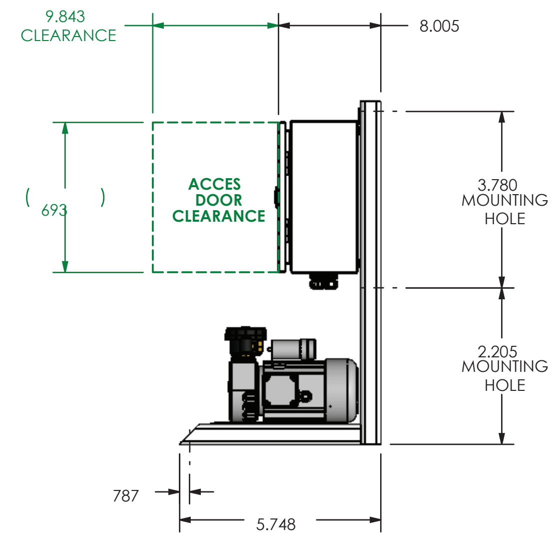
- UNIT TO BE MOUNTED SO THAT THE MAXIMUM SUCTION HEIGHT S LESS THAN 5 FEET
- UREA LINES SHOULD BE HEAT TRACED F AMBIENT CONDITIONS FALL BELOW 40° F

PROJECT NAME	**PROPRIETARY AND CONFIDENTIAL**	DIMENS ONS ARE APPROXIMATE N NCHES UNLESS OTHERW SE SPECIFIED	MIRATECH
PROPOSAL NUMBER	THE FORM ATION CONTAIED THIS DRAW G S THE SOLE PROPERTY OF RATECH GROUP, C. Ay REPRODUCTION PART OR AS A W OLE W THOUT THE WRITTEN PERM SSION OF RATECH GROUP, C S PROHIBITED.	DO NOT SCALE DRAWING	**VPN20 Booster Pump Sales Drawing**
SALES ORDER NO		DRAWN CLV / DATE 2015	DRAWING VPN20 SD / REV
CUSTOMER P O.		REVIEWED BY EQJ / DATE	SIZE A / SCALE : 5 / WE GHT: lb / SHEET OF

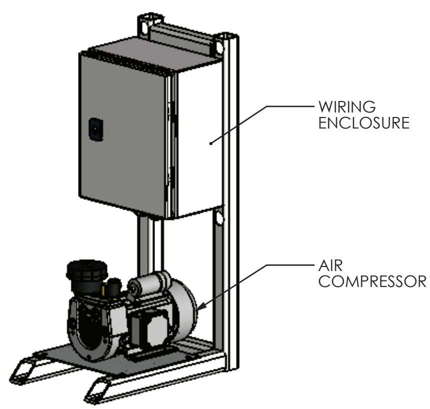
2015

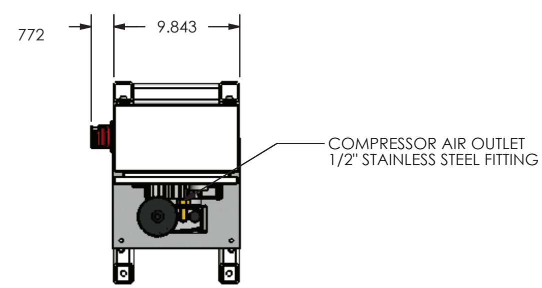


FRONT VIEW



RIGHT VIEW





TOP VIEW

NOTES:

- *POWER CONSUMPTION:* 420 W MAX
- *VOLTAGE:* 230 VAC +/- 10%, SINGLE Φ, 60 Hz
- *CURRENT DRAW:* 3.40 A
- OPERATION TEMPERATURE: 32°F 4 °F

INSTALLATION INSTRUCTIONS:

- IF UNIT S NSTALLED IN AN ENCLOSURE, THE ENCLOSURE MUST BE VENTILATED AND TEMPERATURE CONTROLLED TO MAINTAIN PROPER OPERATION TEMPERATURE

PROJECT NAME	**PROPRIETARY AND CONFIDENTIAL**	DIMENS ONS ARE APPROXIMATE N NCHES UNLESS OTHERW SE SPECIFIED		MIRATECH
PROPOSAL NUMBER	THE NFORMAT ON CONTAINED N THIS DRAWING S THE SOLE PROPERTY OF MIRATECH CORPORAT ON. ANY REPRODUCT ON N PART OR AS A WHOLE W THOUT THE WR TTEN PERM SS ON OF MIRATECH CORPORAT ON S PROHIB TED.	DO NOT SCALE DRAWING		**CA20 Air Compressor Sales Drawing**
SALES ORDER NO		DRAWN JFS	DATE 8/22/2011	DRAWING CA20 SD; REV
CUSTOMER P O.		REVIEWED BY AJM	DATE 8/22/2011	SIZE A; SCALE : 5; WE GHT: 64 lb; SHEET OF

G3520

GAS ENGINE TECHNICAL DATA

CATERPILLAR®

ENGINE SPEED (rpm):	1800	RATING STRATEGY:	STANDARD
COMPRESSION RATIO:	11.5	PACKAGE TYPE:	WITH RADIATOR
AFTERCOOLER TYPE:	SCAC	RATING LEVEL:	CONTINUOUS
AFTERCOOLER - STAGE 2 INLET (°F):	130	FUEL:	NAT GAS
AFTERCOOLER - STAGE 1 INLET (°F):	192	FUEL SYSTEM:	CAT LOW PRESSURE WITH AIR FUEL RATIO CONTROL
JACKET WATER OUTLET (°F):	210		
ASPIRATION:	TA	FUEL PRESSURE RANGE(psig): (See note 1)	0.5-5.0
COOLING SYSTEM:	JW+OC+1AC, 2AC	FUEL METHANE NUMBER:	85
CONTROL SYSTEM:	ADEM4 W/ IM	FUEL LHV (Btu/scf):	905
EXHAUST MANIFOLD:	DRY	ALTITUDE CAPABILITY AT 77°F INLET AIR TEMP. (ft):	8825
COMBUSTION:	LOW EMISSION	POWER FACTOR:	0.8
NOx EMISSION LEVEL (g/bhp-hr NOx):	1.0	VOLTAGE(V):	440-13800
FAN POWER (bhp):	139		

RATING		NOTES	LOAD	100%	75%	50%
PACKAGE POWER	(WITH FAN)	(2)(3)	ekW	2000	1500	1000
PACKAGE POWER	(WITH FAN)	(2)(3)	kVA	2500	1875	1250
ENGINE POWER	(WITHOUT FAN)	(3)	bhp	2952	2252	1560
GENERATOR EFFICIENCY		(2)	%	95.4	95.2	94.4
PACKAGE EFFICIENCY(@ 1.0 Power Factor)	(ISO 3046/1)	(4)(5)	%	38.0	36.6	33.4
THERMAL EFFICIENCY		(4)(6)	%	44.5	45.1	46.8
TOTAL EFFICIENCY (@ 1.0 Power Factor)		(4)(7)	%	82.5	81.7	80.2

ENGINE DATA						
PACKAGE FUEL CONSUMPTION	(ISO 3046/1)	(8)	Btu/ekW-hr	9048	9394	10280
PACKAGE FUEL CONSUMPTION	(NOMINAL)	(8)	Btu/ekW-hr	9268	9624	10531
ENGINE FUEL CONSUMPTION	(NOMINAL)	(8)	Btu/bhp-hr	6279	6409	6750
AIR FLOW (77°F, 14.7 psia)	(WET)	(9)	ft3/min	6030	4767	3519
AIR FLOW	(WET)	(9)	lb/hr	26738	21139	15602
FUEL FLOW (60°F, 14.7 psia)			scfm	341	266	194
COMPRESSOR OUT PRESSURE			in Hg(abs)	88.1	70.1	55.3
COMPRESSOR OUT TEMPERATURE			°F	330	274	212
AFTERCOOLER AIR OUT TEMPERATURE			°F	136	133	130
INLET MAN. PRESSURE		(10)	in Hg(abs)	77.2	59.8	43.2
INLET MAN. TEMPERATURE	(MEASURED IN PLENUM)	(11)	°F	136	133	130
TIMING		(12)	°BTDC	30	30	28
EXHAUST TEMPERATURE - ENGINE OUTLET		(13)	°F	881	889	917
EXHAUST GAS FLOW (@engine outlet temp, 14.5 psia)	(WET)	(14)	ft3/min	16197	12866	9690
EXHAUST GAS MASS FLOW	(WET)	(14)	lb/hr	27670	21865	16132
MAX INLET RESTRICTION		(15)	in Hg(abs)	10.04	10.04	10.04
MAX EXHAUST RESTRICTION		(15)	in Hg(abs)	20.07	20.07	20.07

EMISSIONS DATA - ENGINE OUT					
NOx (as NO2)	(16)(17)	g/bkW-hr	1.34	1.34	1.34
CO	(16)(18)	g/bkW-hr	1.90	1.99	2.19
THC (mol. wt. of 15.84)	(16)(18)	g/bkW-hr	3.34	3.74	4.15
NMHC (mol. wt. of 15.84)	(16)(18)	g/bkW-hr	0.53	0.60	0.66
NMNEHC (VOCs) (mol. wt. of 15.84)	(16)(18)(19)	g/bkW-hr	0.37	0.41	0.46
HCHO (Formaldehyde)	(16)(18)	g/bkW-hr	0.32	0.33	0.35
CO2	(16)(18)	g/bkW-hr	587	615	670
EXHAUST OXYGEN	(16)(20)	% DRY	10.0	9.8	9.6
LAMBDA	(16)(20)		1.79	1.82	1.84

ENERGY BALANCE DATA						
LHV INPUT		(21)	Btu/min	308949	240589	175510
HEAT REJECTION TO JACKET WATER (JW)		(22)(30)	Btu/min	33505	28582	23731
HEAT REJECTION TO ATMOSPHERE	(INCLUDES GENERATOR)	(23)	Btu/min	15636	13205	11307
HEAT REJECTION TO LUBE OIL (OC)		(24)(30)	Btu/min	9895	8918	7739
HEAT REJECTION TO EXHAUST (LHV TO 77°F)		(25)(26)	Btu/min	102299	81812	62559
HEAT REJECTION TO EXHAUST (LHV TO 248°F)		(25)	Btu/min	78152	62464	48181
HEAT REJECTION TO A/C - STAGE 1 (1AC)		(27)(30)	Btu/min	14223	6780	1113
HEAT REJECTION TO A/C - STAGE 2 (2AC)		(28)(31)	Btu/min	12508	8843	5048
PUMP POWER		(29)	Btu/min	1231	1231	1231

CONDITIONS AND DEFINITIONS

Engine rating obtained and presented in accordance with ISO 3046/1. (Standard reference conditions of 77°F, 29.60 in Hg barometric pressure.) No overload permitted at rating shown. Consult the altitude deration factor chart for applications that exceed the rated altitude or temperature.

Emission levels are at engine exhaust flange prior to any after treatment. Values are based on engine operating at steady state conditions, adjusted to the specified NOx level at 100% load. Tolerances specified are dependent upon fuel quality. Fuel methane number cannot vary more than ± 3.

For notes information consult page three.

FUEL USAGE GUIDE

CAT METHANE NUMBER	<32	32	35	40	45	50	55	60	65	70	75	80	85	100
SET POINT TIMING	-	18	18	18	18	18	18	18	21	23	27	28	30	30
DERATION FACTOR	0	0.56	0.60	0.67	0.74	0.81	0.88	0.95	0.98	1	1	1	1	1

ALTITUDE DERATION FACTORS AT RATED SPEED

INLET AIR TEMP °F	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
130	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating
120	0.73	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating
110	1	1	0.98	0.93	0.89	0.85	0.80	0.76	0.66	0.53	No Rating	No Rating	No Rating
100	1	1	1	1	1	1	0.93	0.86	0.79	0.63	No Rating	No Rating	No Rating
90	1	1	1	1	1	1	1	0.96	0.85	0.71	No Rating	No Rating	No Rating
80	1	1	1	1	1	1	1	1	1	0.81	No Rating	No Rating	No Rating
70	1	1	1	1	1	1	1	1	1	0.94	No Rating	No Rating	No Rating
60	1	1	1	1	1	1	1	1	1	1	No Rating	No Rating	No Rating
50	1	1	1	1	1	1	1	1	1	1	No Rating	No Rating	No Rating

ALTITUDE (FEET ABOVE SEA LEVEL)

AFTERCOOLER HEAT REJECTION FACTORS (ACHRF)

INLET AIR TEMP °F	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
130	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating
120	1.30	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating
110	1.22	1.28	1.33	1.39	1.45	1.50	1.56	1.62	1.69	1.74	No Rating	No Rating	No Rating
100	1.15	1.20	1.26	1.31	1.37	1.42	1.48	1.54	1.60	1.65	No Rating	No Rating	No Rating
90	1.07	1.13	1.18	1.23	1.29	1.34	1.40	1.46	1.52	1.57	No Rating	No Rating	No Rating
80	1	1.05	1.10	1.15	1.21	1.26	1.32	1.38	1.44	1.48	No Rating	No Rating	No Rating
70	1	1	1.02	1.08	1.13	1.18	1.24	1.29	1.35	1.40	No Rating	No Rating	No Rating
60	1	1	1	1	1.05	1.10	1.16	1.21	1.27	1.31	No Rating	No Rating	No Rating
50	1	1	1	1	1	1.02	1.07	1.13	1.18	1.23	No Rating	No Rating	No Rating

ALTITUDE (FEET ABOVE SEA LEVEL)

FUEL USAGE GUIDE:

This table shows the derate factor and full load set point timing required for a given fuel. Note that deration and set point timing adjustment may be required as the methane number decreases. Methane number is a scale to measure detonation characteristics of various fuels. The methane number of a fuel is determined by using the Caterpillar methane number calculation.

ALTITUDE DERATION FACTORS:

This table shows the deration required for various air inlet temperatures and altitudes. Use this information along with the fuel usage guide chart to help determine actual engine power for your site. The derate factors shown assume a specific air-to-core temperature rise and zero additional air flow restriction on the standard packaged radiator. Refer to TMI Systems Data for fan air flow and air-to-core temperature rise values. Increased fan airflow restriction or a different air-to-core rise value requires a Special Rating Request to determine actual engine power at your site. Additional rating may be available with a larger, custom radiator.

ACTUAL ENGINE RATING:

To determine the actual rating of the engine at site conditions, one must consider separately, limitations due to fuel characteristics and air system limitations. The Fuel Usage Guide deration establishes fuel limitations. The Altitude/ Temperature deration factors and RPC(reference the Caterpillar Methane Program) establish air system limitations. RPC comes into play when the Altitude/Temperature deration is less than 1.0 (100%). Under this condition, add the two factors together. When the site conditions do not require an Altitude/Temperature derate (factor is 1.0), it is assumed the turbocharger has sufficient capability to overcome the low fuel relative power, and RPC is ignored. To determine the actual power available, take the lowest rating between 1) and 2).

1) Fuel Usage Guide Deration
2) 1 - ((1 - Altitude / Temperature Deration) +(1 - RPC))

AFTERCOOLER HEAT REJECTION FACTORS(ACHRF):

To maintain a constant air inlet manifold temperature, as the inlet air temperature goes up, so must the heat rejection. As altitude increases, the turbocharger must work harder to overcome the lower atmospheric pressure. This increases the amount of heat that must be removed from the inlet air by the aftercooler. Use the aftercooler heat rejection factor (ACHRF) to adjust for inlet air temp and altitude conditions. See notes (30) and (31) for application of this factor in calculating the heat exchanger sizing criteria. Failure to properly account for these factors could result in detonation and cause the engine to shutdown or fail.

INLET AND EXHAUST RESTRICTIONS FOR ALTITUDE CAPABILITY:

The altitude derate chart is based on the maximum inlet and exhaust restrictions provided on page 1. Contact factory for restrictions over the specified values. Heavy Derates for higher restrictions will apply.

NOTES:

1. Fuel pressure range specified is to the engine fuel control valve. Additional fuel train components should be considered in pressure and flow calculations.
2. Generator efficiencies, power factor, and voltage are based on standard generator. [Package Power (ekW) is calculated as: (Engine Power (bkW) - Fan Power (bkW)) x Generator Efficiency], [Package Power (kVA) is calculated as: (Engine Power (bkW) - Fan Power (bkw)) x Generator Efficiency / Power Factor]
3. Rating is with two engine driven water pumps. Tolerance is (+)3, (-)0% of full load.
4. Efficiency represents a Closed Crankcase Ventilation (CCV) system installed on the engine.
5. Package Efficiency published in accordance with ISO 3046/1, based on a 1.0 power factor.
6. Thermal Efficiency is calculated based on energy recovery from the jacket water, lube oil, 1st stage aftercooler, and exhaust to 248°F with engine operation at ISO 3046/1 Package Efficiency, and assumes unburned fuel is converted in an oxidation catalyst.
7. Total efficiency is calculated as: Package Efficiency + Thermal Efficiency. Tolerance is ±10% of full load data.
8. ISO 3046/1 Package fuel consumption tolerance is (+)5, (-)0% at the specified power factor. Nominal package and engine fuel consumption tolerance is ± 2.5% of full load data at the specified power factor.
9. Air flow value is on a 'wet' basis. Flow is a nominal value with a tolerance of ± 5 %.
10. Inlet manifold pressure is a nominal value with a tolerance of ± 5 %.
11. Inlet manifold temperature is a nominal value with a tolerance of ± 9°F.
12. Timing indicated is for use with the minimum fuel methane number specified. Consult the appropriate fuel usage guide for timing at other methane numbers.
13. Exhaust temperature is a nominal value with a tolerance of (+)63°F, (-)54°F.
14. Exhaust flow value is on a 'wet' basis. Flow is a nominal value with a tolerance of ± 6 %.
15. Inlet and Exhaust Restrictions are maximum allowed values at the corresponding loads. Increasing restrictions beyond what is specified will result in a significant engine derate.
16. Emissions data is at engine exhaust flange prior to any after treatment.
17. NOx tolerances are ± 18% of specified value.
18. CO, CO2, THC, NMHC, NMNEHC, and HCHO are the maximum values expected under steady state conditions. THC, NMHC, and NMNEHC do not include aldehydes. An oxidation catalyst may be required to meet Federal, State or local CO or HC requirements.
19. VOCs - Volatile organic compounds as defined in US EPA 40 CFR 60, subpart JJJJ
20. Exhaust Oxygen tolerance is ± 0.5; Lambda tolerance is ± 0.05. Lambda and Exhaust Oxygen level are the result of adjusting the engine to operate at the specified NOx level.
21. LHV rate tolerance is ± 2.5%.
22. Heat rejection to jacket water value displayed includes heat to jacket water alone. Value is based on treated water. Tolerance is ± 10% of full load data.
23. Heat rejection to atmosphere based on treated water. Tolerance is ± 50% of full load data.
24. Lube oil heat rate based on treated water. Tolerance is ± 20% of full load data.
25. Exhaust heat rate based on treated water. Tolerance is ± 10% of full load data.
26. Heat rejection to exhaust (LHV to 77°F) value shown includes unburned fuel and is not intended to be used for sizing or recovery calculations.
27. Heat rejection to A/C - Stage 1 based on treated water. Tolerance is ±5% of full load data.
28. Heat rejection to A/C - Stage 2 based on treated water. Tolerance is ±5% of full load data.
29. Pump power includes engine driven jacket water and aftercooler water pumps. Engine brake power includes effects of pump power.
30. Total Jacket Water Circuit heat rejection is calculated as: (JW x 1.1) + (OC x 1.2) + (1AC x 1.05) + [0.75 x (1AC + 2AC) x (ACHRF - 1) x 1.05]. Heat exchanger sizing criterion is maximum circuit heat rejection at site conditions, with applied tolerances. A cooling system safety factor may be multiplied by the total circuit heat rejection to provide additional margin.
31. Total Second Stage Aftercooler Circuit heat rejection is calculated as: (2AC x 1.05) + [(1AC + 2AC) x 0.25 x (ACHRF - 1) x 1.05]. Heat exchanger sizing criterion is maximum circuit heat rejection at site conditions, with applied tolerances. A cooling system safety factor may be multiplied by the total circuit heat rejection to provide additional margin.

FREE FIELD MECHANICAL & EXHAUST NOISE

MECHANICAL: Sound Power (1/3 Octave Frequencies)

Gen Power With Fan	Percent Load	Engine Power	Overall	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz
ekW	%	bhp	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
2000	100	2952	126.1	100.0	107.1	100.9	103.8	110.3	116.1	110.2	112.2	115.0	113.5
1500	75	2252	125.1	100.4	107.4	99.5	103.4	109.3	116.2	109.3	112.1	114.6	112.8
1000	50	1560	124.1	100.2	107.3	98.8	103.4	109.3	115.9	109.7	112.0	114.3	112.7

MECHANICAL: Sound Power (1/3 Octave Frequencies)

Gen Power With Fan	Percent Load	Engine Power	1 kHz	1.25 kHz	1.6 kHz	2 kHz	2.5 kHz	3.15 kHz	4 kHz	5 kHz	6.3 kHz	8 kHz	10 kHz
ekW	%	bhp	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
2000	100	2952	115.1	113.3	114.4	115.3	114.1	114.0	112.8	116.1	113.6	111.5	105.2
1500	75	2252	114.2	112.1	112.6	112.0	112.0	112.6	112.8	115.3	112.1	109.1	104.8
1000	50	1560	113.8	111.7	111.4	111.1	111.2	111.5	112.4	109.6	106.0	106.8	100.1

EXHAUST: Sound Power (1/3 Octave Frequencies)

Gen Power With Fan	Percent Load	Engine Power	Overall	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz
ekW	%	bhp	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
2000	100	2952	127.1	93.9	109.7	120.8	117.9	119.1	119.1	114.3	113.3	111.9	110.8
1500	75	2252	125.3	95.2	109.8	119.7	114.4	115.5	115.3	114.9	112.0	109.2	107.9
1000	50	1560	120.8	94.0	109.7	113.0	111.0	111.6	110.2	109.3	105.9	105.0	104.5

EXHAUST: Sound Power (1/3 Octave Frequencies)

Gen Power With Fan	Percent Load	Engine Power	1 kHz	1.25 kHz	1.6 kHz	2 kHz	2.5 kHz	3.15 kHz	4 kHz	5 kHz	6.3 kHz	8 kHz	10 kHz
ekW	%	bhp	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
2000	100	2952	110.6	111.0	109.7	108.8	106.7	104.1	100.1	94.9	86.7	78.5	74.2
1500	75	2252	107.7	107.6	106.7	106.8	105.7	103.2	98.8	93.5	84.4	77.6	73.7
1000	50	1560	104.2	104.6	103.9	104.6	103.5	100.9	96.3	89.8	79.9	75.0	71.9

SOUND PARAMETER DEFINITION:
Sound Power Level Data - DM8702-03

Sound power is defined as the total sound energy emanating from a source irrespective of direction or distance. Sound power level data is presented under two index headings:
Sound power level -- Mechanical
Sound power level -- Exhaust

Mechanical: Sound power level data is calculated in accordance with ISO 3747. The data is recorded with the exhaust sound source isolated.

Exhaust: Sound power level data is calculated in accordance with ISO 6798 Annex A. Exhaust data is post-catalyst on gas engine ratings labeled as "Integrated Catalyst".

Measurements made in accordance with ISO 3747 and ISO 6798 for mechanical and exhaust sound level only. Frequency bands outside the displayed ranges are not measured, due to physical test, and environmental conditions that affect the accuracy of the measurement. No cooling system noise is included unless specifically indicated. Sound level data is indicative of noise levels recorded on one engine sample in a survey grade 3 environment.

How an engine is packaged, installed and the site acoustical environment will affect the site specific sound levels. For site specific sound level guarantees, sound data collection needs to be done on-site or under similar conditions.

Load Acceptance chart represents the 'Standard' response for a heat soaked engine

Transient Load Acceptance

Load Step	Frequency Deviation +/- (%)	Voltage Deviation +/- (%)	Recovery Time (sec)	Classification as Defined by ISO 8528 - 5	Notes
100	+0/-25	+1/-53	10.3/33.8		(5)
75	+0/-17	+1/-42	9/28.2		(5)
60	+0/-13	+1/-29	6.6/48.8		(5)
50	+0/-14	+1/-24	5.9/10	G1	(2)(5)
40	+1/-12	+1/-20	5.1/6.9	G1	(2)(5)
30	+1/-10	+1/-16	5	G2	(3)
25	+1/-8	+1/-13	5	G2	(3)
10	+1/-3	+1/-4	2.2	G2	(3)
-25	+6/-1	+2/-0	5		
-50	+7/-17	+11/-23	4.4		
Breaker Open	+12/-9	+10/-26	5.2		(1)
Recovery Specification	+1.75/-1.75	+5/-5			
Steady State Specification	+0.48/-0.48	+0.25/-0.25			(6)

Transient Information

The transient load steps listed above are stated as a percentage of the engine's full rated load as indicated in the appropriate performance technical data sheet. Site ambient conditions, fuel quality, inlet/exhaust restriction and emissions settings will all affect engine response to load change. Engines that are not operating at the standard conditions stated in the Technical data sheet should be set up according to the guidelines included in the technical data; applying timing changes and/or engine derates as needed. Adherence to the engine settings guidelines will allow the engines to retain the transient performance stated in the tables above as a percentage of the site derated power (where appropriate).Fuel supply pressure and stability is critical to transient performance. Proper installation requires that all fuel train components (including filters, shut off valves, and regulators) be sized to ensure adequate fuel be delivered to the engine. The following are fuel pressure requirements to be measured at the engine mounted fuel control valve.

a. Steady State Fuel Pressure Stability +/- .15 psi/sec
b. Transient fuel Pressure Stability +/- .15 psi/sec

Inlet water temperature to the SCAC must be maintained at specified value for all engines. It is important that the external cooling system design is able to maintain the Inlet water temp to the SCAC to within +/- 1 °C during all engine-operating cycles. The SCAC inlet temperature stability criterion is to maintain stable inlet manifold air temperature. The Air Fuel Ratio control system requires up to 30 seconds to converge after a load step has been performed for NOx to return to nominal setting. If the stabilization time is not met between load steps the transient performance listed in the document may not be met. Differences in generator inertia may change the transient response of engine. Engine Governor gains and Voltage regulator settings may need to be tuned for site conditions. The time needed to start and stabilize at rated engine speed is a minimum of 30 seconds after a successful crank cycle. Engines must be maintained in accordance to guidelines specified in the Caterpillar Service Manuals applicable to each engine. Wear of components outside of the specified tolerances will affect the transient capability of the engine.

NOTES:

1. For unloading the engine to 0% load from a loaded condition no external input is needed. The engine control algorithm employs a load sensing strategy to determine a load drop. In the event that the local generator breaker opens the strategy provides control to the engine that resets all control inputs to the rated idle condition. This prevents engine over speeding and will allow the engine to remain running unloaded at the rated synchronous speed.
2. The engines specified above have been tested against the voltage deviation, frequency deviation, and recovery time requirements defined in ISO 8528 - 5. At this time the engines stated above will meet class G1 transient performance as defined by ISO 8528 - 5 with exceptions.
3. The engines specified above have been tested against the voltage deviation, frequency deviation, and recovery time requirements defined in ISO 8528 - 5. At this time the engines stated above will meet class G2 transient performance as defined by ISO 8528 - 5 with exceptions.
4. The engines specified above have been tested against the voltage deviation, frequency deviation, and recovery time requirements defined in ISO 8528 - 5. At this time the engines stated above will meet class G3 transient performance as defined by ISO 8528 - 5 with exceptions.
5. Air flow is critical for turbocharged engines during transients. As the exhaust temperature increases, the air flow or turbo response increases to enhance the genset transient response. Therefore, the recovery time for an engine's "First" load step after start up may differ from the "Standard" response for a heat soaked engine. If different, the load step recovery times are illustrated as Standard/First.
6. Steady state voltage and frequency stability specified at +/-2 sigma or better.

A-3
Wheel Loaders

Caterpillar Wheel Loader 966M
Caterpillar Underground LHD R1600H

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966M WHEEL LOADER | FRONT LOADER | TIER 4

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MEDIA

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966M Medium Wheel Loader

DOCUMENTS

- 966M Product Brochure
- 966M Key Features and Benefits
- 966M Technical Specifications – Eur
- 966M Technical Specifications – Global Excluding EU

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SPECIFICATIONS

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Engine

SPEC	VALUE
NET POWER – ISO 9249	276 HP
EMISSIONS	Tier 4/Stage IV
MAXIMUM NET POWER – 1,700 RPM – SAE J1349	276 HP
MAXIMUM POWER – 1,800 RPM – SAE J1995 – METRIC	315 HP
MAXIMUM NET POWER – 1,700 RPM – SAE J1349 – METRIC	280 HP
PEAK GROSS TORQUE – 1,200 RPM – SAE J1995	1179 ft·lbf
MAXIMUM POWER – 1,800 RPM – ISO 14396 – METRIC	311 HP
DISPLACEMENT	568 in³
MAXIMUM POWER – 1,800 RPM – ISO 14396	307 HP
PEAK GROSS TORQUE – 1,200 RPM – ISO 14396	1166 ft·lbf

SPEC	VALUE
MAXIMUM POWER – 1,800 RPM – SAE J1995	311 HP
ENGINE MODEL	Cat C9.3
MAXIMUM NET TORQUE – 1,000 RPM	1126 ft·lbf
MAXIMUM NET POWER – 1,700 RPM – ISO 9249 – METRIC	280 HP
MAXIMUM NET POWER – 1,700 RPM – ISO 9249	276 HP
NOTE	The air conditioning system on this machine contains the fluorinated greenhouse gas refrigerant R134a (Global Warming Potential = 1430). The system contains 1.6 kg of refrigerant which has a CO2 equivalent of 2.288 metric tonnes.

Weights

SPEC	VALUE
OPERATING WEIGHT	51176 lb
NOTE	Weight based on a machine configuration with Michelin 26.5R25 XHA2 L3 radial tires, full fluids, operator, standard counterweight, cold start, roading fenders, Product Link™, manual diff lock/open axles (front/rear), power train guard, secondary steering, sound suppression and a 4.2 m³ (5.5 yd³) general purpose bucket with BOCE.

Buckets

SPEC	VALUE
BUCKET CAPACITIES	3.20-7.40 m^3 (4.19-9.68 yd^3)

Operating Specifications

SPEC	VALUE
STATIC TIPPING LOAD – FULL 37° TURN – WITH TIRE DEFLECTION	32329 lb
STATIC TIPPING LOAD – FULL 37° TURN – NO TIRE DEFLECTION	34873 lb
BREAKOUT FORCE	38984 lbf
NOTE (2)	Full compliance to ISO 143971:2007 Sections 1 thru 6, which requires 2% verification between calculations and testing.
NOTE (1)	For a machine configuration as defined under "Weight."

Transmission

SPEC	VALUE
FORWARD – 1	4 mile/h
FORWARD – 3	14.6 mile/h
REVERSE – 2	8.9 mile/h

SPEC	VALUE
FORWARD – 4	24.5 mile/h
REVERSE – 4	24.5 mile/h
FORWARD – 2	8.1 mile/h
REVERSE – 3	16.1 mile/h
REVERSE – 1	4.4 mile/h
NOTE	Maximum travel speed in standard vehicle with empty bucket and standard L3 tires with 826 mm (32.5 in) roll radius.

Hydraulic System

SPEC	VALUE
IMPLEMENT SYSTEM – MAXIMUM OPERATING PRESSURE	4496 psi
HYDRAULIC CYCLE TIME – TOTAL	10.1 s
IMPLEMENT SYSTEM – MAXIMUM PUMP OUTPUT AT 2,200 RPM	95 gal/min
IMPLEMENT PUMP TYPE	Variable Displacement Piston

Service Refill Capacities

SPEC	VALUE
FUEL TANK	79.8 gal (US)

SPEC	VALUE
DIFFERENTIAL – FINAL DRIVES – FRONT	15.1 gal (US)
CRANKCASE	6.5 gal (US)
TRANSMISSION	14.3 gal (US)
DIFFERENTIAL – FINAL DRIVES – REAR	15.1 gal (US)
HYDRAULIC TANK	33 gal (US)
DEF TANK	4.4 gal (US)
COOLING SYSTEM	18.9 gal (US)

Sound

SPEC	VALUE
WITH COOLING FAN SPEED AT MAXIMUM VALUE – OPERATOR SOUND PRESSURE LEVEL (ISO 6396:2008)	70 dB(A)
WITH COOLING FAN SPEED AT MAXIMUM VALUE – EXTERIOR SOUND PRESSURE LEVEL (SAE J88:2013)	76 dB(A)*
WITH COOLING FAN SPEED AT MAXIMUM VALUE – EXTERIOR SOUND POWER LEVEL (ISO 6395:2008)	109 dB(A)
WITH COOLING FAN SPEED AT 70% OF MAXIMUM VALUE – OPERATOR SOUND PRESSURE LEVEL (ISO 6396:2008)**	69 dB(A)
NOTE (3)	***European Union Directive 2000/14/EC as amended by 2005/88/EC.

SPEC	VALUE
WITH COOLING FAN SPEED AT 70% OF MAXIMUM VALUE – EXTERIOR SOUND POWER LEVEL (ISO 6395:2008)**	108 LWA***
NOTE (1)	*Distance of 15 m (49.2 ft), moving forward in second gear ratio.
NOTE (2)	**For machines in European Union countries and in countries that adopt the EU Directives.

Dimensions - High Lift

SPEC	VALUE
TREAD WIDTH	7.33 ft
HINGE PIN HEIGHT AT MAXIMUM LIFT	15.75 ft
HINGE PIN HEIGHT AT CARRY	2.58 ft
GROUND CLEARANCE	1.42 ft
OVERALL LENGTH – WITHOUT BUCKET	26.58 ft
HEIGHT – TOP OF ROPS	11.75 ft
LIFT ARM CLEARANCE AT MAXIMUM LIFT	13.58 ft
CENTERLINE OF REAR AXLE TO EDGE OF COUNTERWEIGHT	8.17 ft
RACK BACK AT GROUND	39 degrees
HEIGHT – TOP OF HOOD	9.25 ft
CENTERLINE OF REAR AXLE TO HITCH	5.83 ft

SPEC	VALUE
NOTE	All dimensions are approximate and based on L3 XHA2 tires.
HEIGHT – TOP OF EXHAUST PIPE	11.58 ft
MAXIMUM WIDTH OVER TIRES	9.83 ft
WHEEL BASE	11.67 ft
RACK BACK – MAXIMUM LIFT	71 degrees
RACK BACK – CARRY HEIGHT	49 degrees

Dimensions - Standard Lift

SPEC	VALUE
HINGE PIN HEIGHT AT MAXIMUM LIFT	13.92 ft
GROUND CLEARANCE	1.42 ft
CENTERLINE OF REAR AXLE TO HITCH	5.83 ft
LIFT ARM CLEARANCE AT MAXIMUM LIFT	11.92 ft
HEIGHT – TOP OF ROPS	11.75 ft
HEIGHT – TOP OF EXHAUST PIPE	11.58 ft
RACK BACK – MAXIMUM LIFT	62 degrees
WHEEL BASE	11.67 ft
TREAD WIDTH	7.33 ft
NOTE	All dimensions are approximate and based on L3 XHA2 tires.

SPEC	VALUE
HINGE PIN HEIGHT AT CARRY	2.08 ft
CENTERLINE OF REAR AXLE TO EDGE OF COUNTERWEIGHT	7.17 ft
OVERALL LENGTH – WITHOUT BUCKET	23.92 ft
HEIGHT – TOP OF HOOD	9.25 ft
MAXIMUM WIDTH OVER TIRES	9.83 ft
RACK BACK AT GROUND	42 degrees
RACK BACK – CARRY HEIGHT	50 degrees

Bucket Capacities

SPEC	VALUE
BUCKET RANGE	3.20-7.40 m^3 (4.19-9.68 yd^3)

Engine - Tier 4 Final/Stage IV

SPEC	VALUE
EMISSIONS	Tier 4/Stage IV

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PRODUCT SPECIFICATIONS FOR R1600H

ENGINE

Engine Model	Cat® C11
Engine Power - Tier 3 Engine - ISO 14396:2002	271 HP
Engine Power - VR Engine - ISO 14396:2002	271 HP
Bore	5.1 in
Stroke	5.5 in
Displacement	680.4 in³
Note (1)	Power ratings apply at a rated speed of 1,800 rpm when tested under the reference conditions for the specified standard.
Note (2)	All rating conditions are based on ISO/TR14396:2002, inlet air standard conditions with a total barometric pressure of 100 kPa (29.5 in Hg), with a vapor pressure of 1 kPa (0.295 in Hg), and 25° C (77° F). Performance measured using fuel to EPA specifications in 40 CFR Part 1065 and EU specifications in Directive 97/68/EC with a density of 0.845-0.850 kg/L @ 15° C (59° F) and fuel inlet temperature 40° C (104° F).
Note (3)	No engine derating required up to 3048 m (10,000 ft) for Tier 3 Engine and 1828 m (6,000 ft) for VR Engine.
Note (4)	Optional Ventilation Reduction package available.
Note (5)	Optional engine with emissions equivalent to U.S. EPA Tier 3 and EU Stage IIIA is also available.

OPERATING SPECIFICATIONS

Nominal Payload Capacity	22487 lb
Gross Machine Mass	97453 lb
Static Tipping Load - Straight Ahead - Lift Arms Horizontal	57110 lb
Static Tipping Load - Full Turn - Lift Arms Horizontal	46067 lb
Breakout Force - Tilt (ISO)	39524 lb
Breakout Force - Lift (ISO)	42333 lb

WEIGHTS

Operating Mass*	66469 lb
Operating Mass* - Front Axle	28404 lb
Operating Mass* - Rear Axle	38065 lb
Operating Mass + Rated Payload*	88956 lb
Operating Mass + Rated Payload* - Front Axle	62011 lb
Operating Mass + Rated Payload* - Rear Axle	26944 lb
Note	*Calculated weights.

TRANSMISSION

Forward - 1	2.8 mile/h
Forward - 2	5.6 mile/h
Forward - 3	10.4 mile/h
Forward - 4	17.1 mile/h
Reverse - 1	3.1 mile/h
Reverse - 2	6.8 mile/h
Reverse - 3	11.8 mile/h
Reverse - 4	18.2 mile/h

HYDRAULIC CYCLE TIMES

Raise	7.6 s
Dump	1.6 s
Lower, Empty, Float Down	2 s
Total Cycle Time	11.2 s

BUCKET CAPACITIES

Bucket Capacities	4.2-5.9 m^3 (5.5-7.7 yd^3)
Dump Bucket - 1	5.5 yd^3
Dump Bucket - 2 - Standard Bucket	6.3 yd^3
Dump Bucket - 3	7.3 yd^3
Dump Bucket - 4	7.7 yd^3
Ejector Bucket	6.3 yd^3
Bolt Together Bucket	6.9 yd^3

TURNING DIMENSIONS

Outside Clearance Radius*	261.3 in
Inner Clearance Radius*	129.6 in
Axle Oscillation	10°
Articulation Angle	42.5°
Note	*Clearance dimensions are for reference only.

TIRES

Tire Size 18 × R25

SERVICE REFILL CAPACITIES

Engine Crankcase - With Filter	8.98 gal (US)
Transmission	12.4 gal (US)
Hydraulic Tank	33 gal (US)
Cooling System	16.1 gal (US)
Front Differential and Final Drives	21.1 gal (US)
Rear Differential and Final Drives	21.1 gal (US)
Fuel Tank	105.7 gal (US)
Secondary Fuel Tank - If Equipped	87.2 gal (US)

STANDARDS

Standards	ROPS/FOPS Certified Cab

R1600H STANDARD EQUIPMENT

ELECTRICAL

- Alarm, reversing
- Alternator, 95 amp
- Battery disconnect switch, ground level
- Batteries, low maintenance
- Diagnostic connector

- Engine shutdown switch
- Lighting:
  - – External, front, rear, halogen
  - – Stop, single, halogen
- Receptacle group, auxiliary start
- Starter, electric, 24-volt
- Starting and charging system

TIRES, RIMS, AND WHEELS

- Tires must be selected from the Mandatory Attachments section
  - – Tire, 18 × R25 VSMS L5S Bridgestone

OPERATOR ENVIRONMENT

- Automatic Brake Application (ABA)
- Cab, ROPS and/or FOPS certified
- Color Multi Purpose Display (CMPD):
  - – Front and rear brake gauges
  - – Transmission pressure
  - – System diagnostics
  - – Residual brake warning
- Horns, electric
- Instrumentation/gauges:
  - – Speedometer/tachometer
  - – Fuel level
  - – Hydraulic oil temperature
  - – Engine coolant temperature
  - – Transmission oil temperature
- Operator Presence System
- Pilot hydraulic implement controls (single joystick)
- Suspension operator seat with retractable seat belt:
  - – Seat, suspension, vinyl
- Secondary steering system
- STIC™ steering
- Throttle:
  - – Pedal, throttle

OTHER STANDARD EQUIPMENT

- Brake axle cooling
- Cap, radiator, manual release
- Catalytic exhaust purifier/muffler
- Bucket dump (4.8 m3/6.3 yd3)
- Decals, international picto graphics
- Draw bar attachment, bolt-on
- Fast Fill System:
  - – Coolant
  - – Engine oil
  - – Fuel
  - – Hydraulic oil
  - – Transmission oil
- Fenders, front, rear
- Firewall
- Guards, engine and transmission
- Handholds
- Lubrication system:
  - – Semi central
- Protection bars, rear frame
- Radiator grill, swing out
- Service oil sample
- Valve, drain, transmission oil filter
- Windows:
  - – Window, single pane

POWER TRAIN

- Brakes, full hydraulic enclosed wet multiple-disc (SAFR™)
- Engine:
  - – Cat. C11 6 cylinder, diesel
  - – Air-to-air aftercooler (ATAAC)
- Fuel adapters:
  - – Fuel tank, single, standard adapter
- Fuel priming aid

- Heat shields
- Precleaner, engine air intake
- Torque converter with automatic lock up clutch
- Transmission, automatic planetary power shift (4F/4R)
- Transmission neutralizer

R1600H OPTIONAL EQUIPMENT

ELECTRICAL

- Lighting:
  - – Work lights, LED

POWER TRAIN

- Brakes, full hydraulic enclosed wet multiple-disc (SAFR™)
- Engine:
  - – After-Treatment Options – DPF (Flow Thru)
- Engine options:
  - – Engine, VR
  - – VR engine, Flow Thru Ready
  - – Engine, Tier 3
- Fuel adapters:
  - – Fuel tank, dual, standard adapter
  - – Fuel tank, single, fast fill
  - – Fuel tank, dual, fast fill
- Park brake switch engagement – push to apply/pull to apply
- Radiator, high efficiency
- Reversible steering

OPERATOR ENVIRONMENT

- Operators station ROPS/FOPS enclosed:
  - – Air conditioning
  - – Cab pressurizer and filter
  - – Dome light
  - – Door strut
  - – Heater
  - – Radio ready compartment for radio and speakers
  - – Wiper control, intermittent
- Duct, air, flow diverter

- Idle timer (enclosed cab or open cab)
- Suspension operator seat with retractable seat belt:
    - – Seat, suspension, TEE, vinyl
    - – Seat, suspension, air, vinyl
    - – Seat, suspension, TEE, air
    - – Seat cover
- Throttle:
    - – Pedal, throttle

TECHNOLOGY

- Command for Underground*
- * Please consult with your regional commercial or technology representative prior to upgrading your machine to Command for Underground.
- Remote control interface (excludes transmitter and receiver), includes warning lights (green)
    - – Cattron
    - – RCT

TIRES, RIMS, AND WHEELS

- Rims:
    - – Spare, tubeless
    - – Rim identification numbering

OTHER OPTIONAL EQUIPMENT

- Brake release arrangements, includes steering release:
    - – Recovery hook
    - – Recovery bar
- Buckets:
    - – Various sizes, dump (4.2 m3/5.5 yd3, 5.6 m3/7.3 yd3, 5.9 m3/7.7 yd3)
    - – Bolt-together (5.3 m3/6.9 yd3)
    - – Ejector (4.8 m3/6.3 yd3)
    - – Standard lip or bolt-on lip
    - – Cutting edge, bolt-on
    - – Cutting edge, Cat modular weld on
    - – Lip fully welded or tack welded
    - – Heel shrouds, ejector and dump buckets
    - – Mechanically Attached Wear Plate System (MAWPS)
    - – Wear bars, ejector and dump buckets
    - – Wear liner
- Draw bar attachment, bolt-on
- Fast Fill System:
    - – Coolant
    - – Engine oil
    - – Fuel

  - – Hydraulic oil
  - – Transmission oil

- Fluids:
  - – Arctic fuel
  - – Arctic coolant

- Guards, light and window

- Lifting Group, Mine Transfer

- Lubrication system:
  - – Centralized
  - – Automatic

- Ride Control System

- Service tools

- Wear protection bars:
  - – Cab
  - – Hydraulic tank
  - – Radiator

- Wheel chocks

- Windows:
  - – Window, single pane

A-4
Roadheader

SANDVIK

MH621 ROADHEADER FOR HARDROCK

MH621 ROADHEADER FOR HARDROCK

Sandvik MH621 hard-rock miner is an electrically powered and crawler-mounted roadheader that is engineered to excavate roadways and galleries in strong rock formations. This heavy-duty machine has a powerful transverse cutter head mounted on an extremely robust telescopic cutter boom. It is designed to excavate rock with high compressive strengths.

MH621 is available as a PLC (programmable logical controller) controlled machine. Country-specific FLP certifications by various international approval authorities are possible.

Advantages

- Improved safety features ensure safe underground working conditions and less operational hazards.
- Heavy duty, robust machine design and ICUTROC cutting technology for hard rock application increase machine availability and reduce machine service costs.
- Different cutter heads for a wide range of rock conditions and applications serve for high versatility in machine operation.
- Optional machine guidance system significantly improves profile accuracy and decreases tunneling costs.

- Various digitalization options like Cutronic (automated cutting cycle), which enables semi-autonomous machine operation, optimize customer value.

Technical data	
Weight	120,000 kg
Dimension (L-W-H)	13,300 x 3,500 x 2,600 mm
Cutting height (max)	5,800 mm
Cutting width (max)	8,500 mm
Cutter motor power	300 kW
Ground pressure	0.19 MPa
Loading capacity	300 m3/h
Max. tram speed	17 m/min
Installed power	504 kW

A PARADIGM SHIFT

CRESCENT VALLEY, NEVADA. At Barrick Gold's iconic Cortez mine, one of the world's largest roadheaders is steadily cutting two new declines to the lower section of the operation's underground deposit.

VISIT MINESTORIES ARTICLE

A-5
Particle Size Distribution Curves for Ore and Tailings

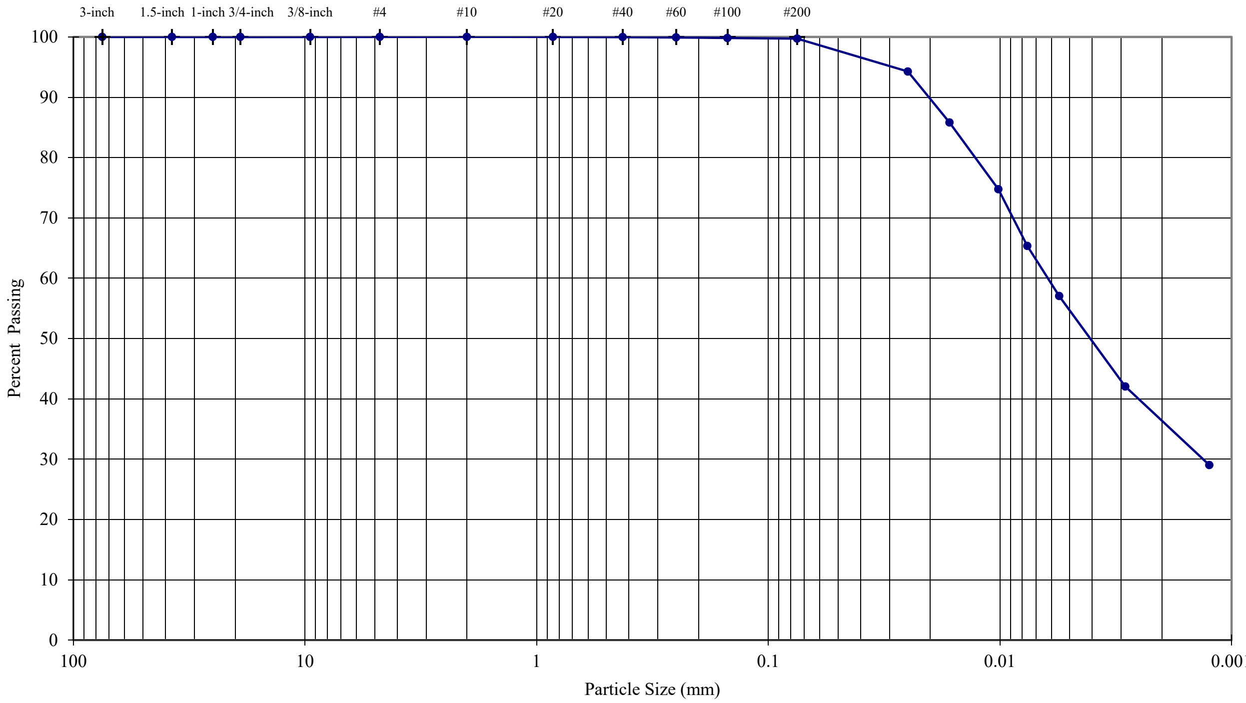
Golder Associates

DRAFT

January-18 | 1784880

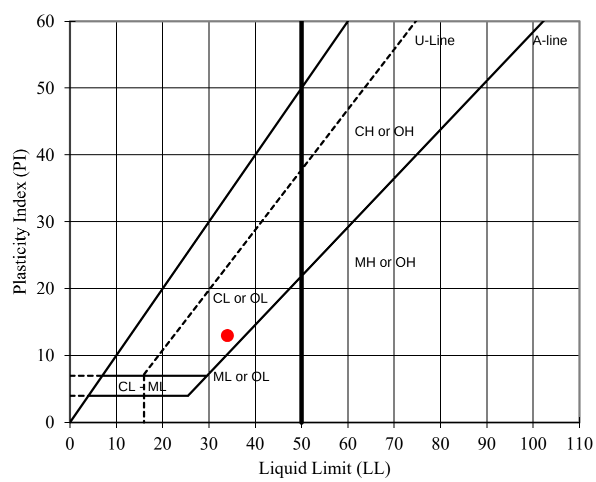
PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS
ASTM D421, D422, D4318

PROJECT NAME: **Highland/Copperwood Project/MI**
SAMPLE ID: **BF9 - 1st Clean** DEPTH (ft): **--**
TYPE: **Pail**



Sieve Analysis (Initial Separation on No. 4 Sieve) / Hydrometer Analysis

Sieve	Particle Size (mm)	% Passing	Description	Percentage
3-inch	75.0	**100.0**		
1.5-inch	37.5	**100.0**	Coarse Gravel	**0.00**
1-inch	25.0	**100.0**		
3/4-inch	19.0	**100.0**		
3/8-inch	9.5	**100.0**	Fine Gravel	**0.00**
#4	4.75	**100.0**		
#10	2.0	**100.0**	Coarse Sand	**0.00**
#20	0.85	**100.0**	Medium Sand	**0.02**
#40	0.425	**100.0**		
#60	0.25	**99.9**	Fine Sand	**0.26**
#100	0.15	**99.8**		
#200	0.075	**99.7**		
	0.025	**94.3**	Silt or Clay Fines	**99.72**
	0.017	**85.8**		
	0.010	**74.8**		
	0.008	**65.4**		
	0.006	**57.0**		
	0.003	**42.1**		
	0.001	**29.0**		



USCS Description (ASTM D 2487):
Lean clay, gray, dry

LL	PL	PI	SpG
34	**21**	**13**	**2.83**

As-Received Moisture Content (%): **#DIV/0!**

USCS Group Symbol: CL

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample mechanically dispersed using Stirring Apparatus A for about 1 minute
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	RD/PRH
DATE	19-Jan-2018
REVIEW	PRH

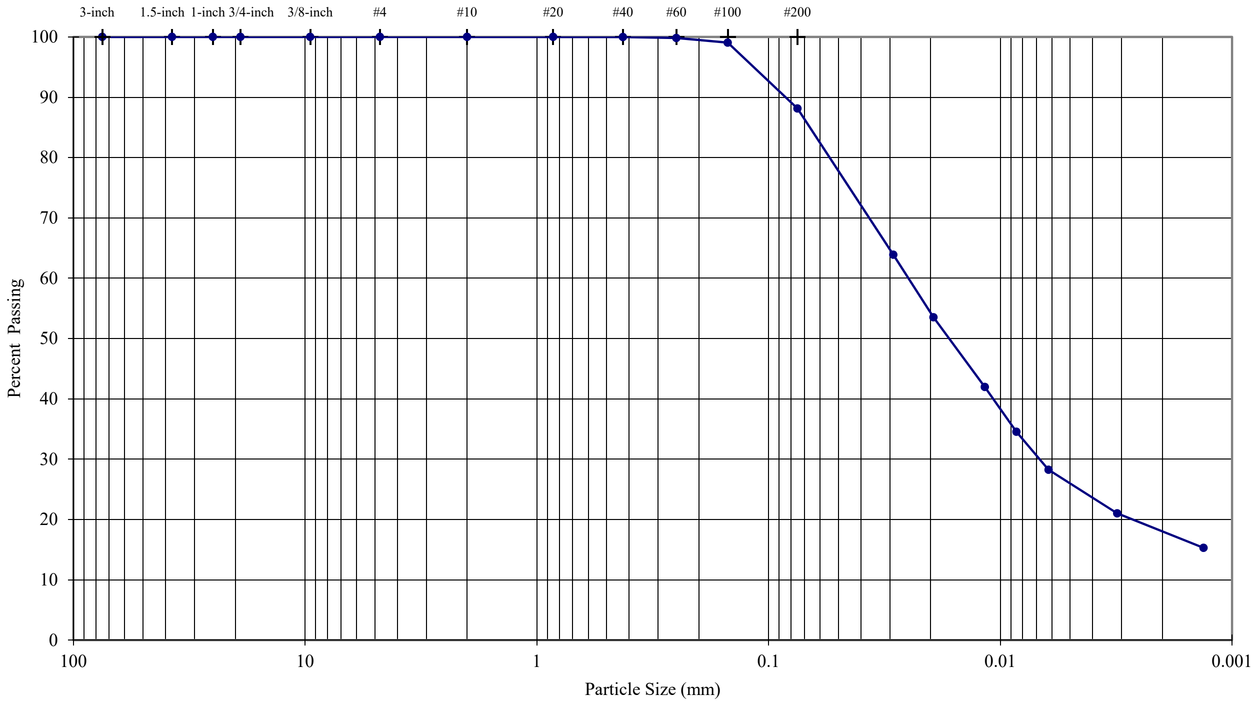
Golder Associates

DRAFT

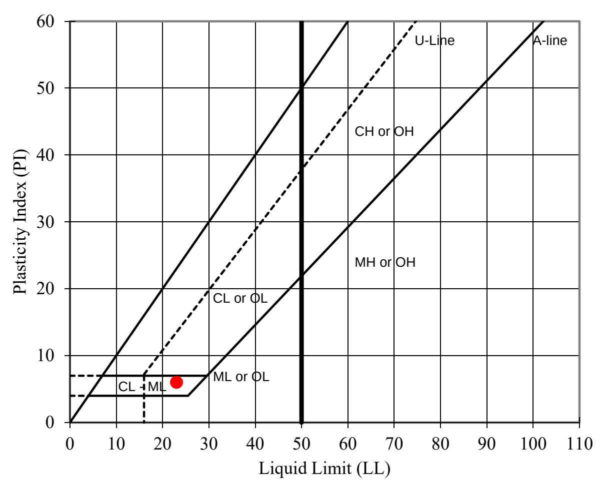
January-18 1784880

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS
ASTM D421, D422, D4318

PROJECT NAME: **Highland/Copperwood Project/MI**
SAMPLE ID: **BF9 - Rougher** DEPTH (ft): **--**
TYPE: **Pail**



	Sieve	Particle Size (mm)	% Passing	Description	Percentage
Sieve Analysis (Initial Separation on No. 4 Sieve)	3-inch	75.0	**100.0**		
	1.5-inch	37.5	**100.0**	Coarse Gravel	**0.00**
	1-inch	25.0	**100.0**		
	3/4-inch	19.0	**100.0**		
	3/8-inch	9.5	**100.0**	Fine Gravel	**0.00**
	#4	4.75	**100.0**		
	#10	2.0	**100.0**	Coarse Sand	**0.00**
	#20	0.85	**100.0**	Medium Sand	**0.02**
	#40	0.425	**100.0**		
	#60	0.25	**99.8**	Fine Sand	**11.85**
	#100	0.15	**99.1**		
	#200	0.075	**88.1**		
Hydrometer Analysis		0.029	**63.9**	Silt or Clay Fines	**88.14**
		0.019	**53.5**		
		0.012	**42.0**		
		0.009	**34.5**		
		0.006	**28.2**		
		0.003	**21.0**		
		0.001	**15.3**		



LL	PL	PI	SpG
23	**17**	**6**	**2.81**

USCS Description (ASTM D 2487):
Silty clay, gray, dry

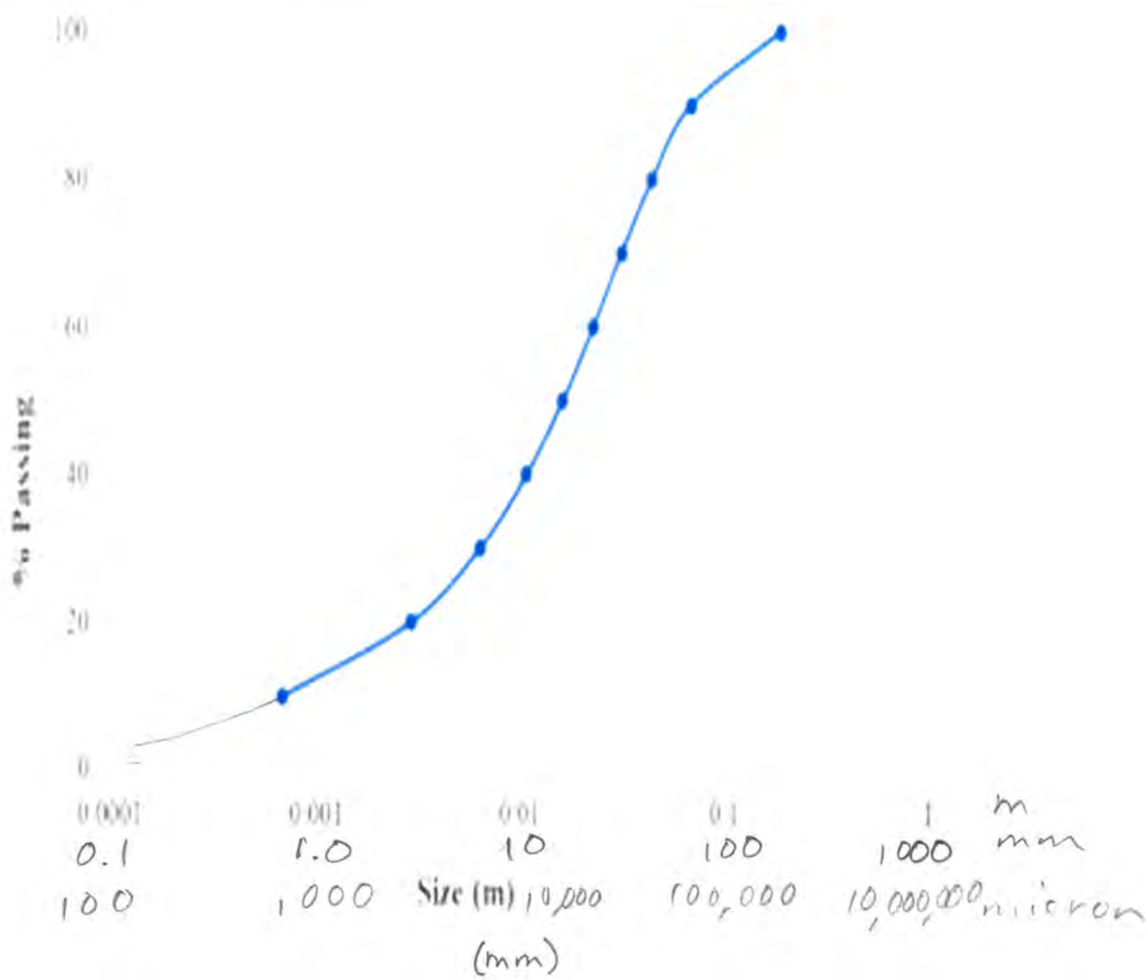
As-Received Moisture Content (%): **#DIV/0!**

USCS Group Symbol: CL-ML

Notes: 0 g of particles up to 4.75 mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample mechanically dispersed using Stirring Apparatus A for about 1 minute
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	RD/PRH
DATE	19-Jan-2018
REVIEW	PRH

Grain Size Distribution for Ore Stockpile



A-6
Diesel Fire Pump

CLARKE®

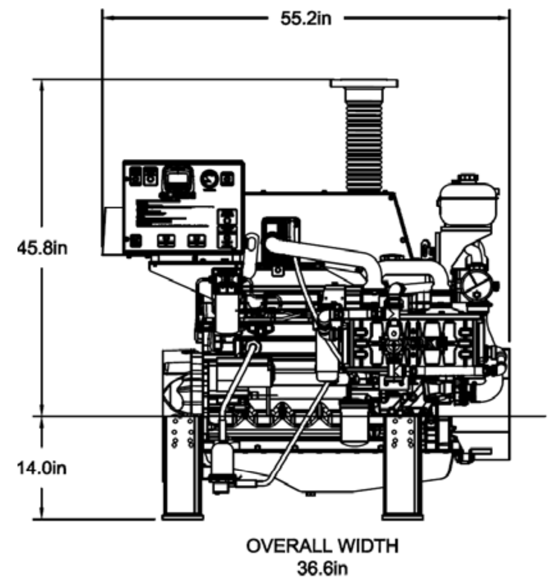
FIRE PUMP ENGINES

MODELS

JU6H-UFADM8
JU6H-UFADMG
JU6H-UFAD58
JU6H-UFADNG
JU6H-UFADN0
JU6H-UFADP0
JU6H-UFADP8
JU6H-UFADQ0
JU6H-UFAD88
JU6H-UFADR0
JU6H-UFADR8
JU6H-UFADS8
JU6H-UFADS0
JU6H-UFADT0
JU6H-UFADW8
JU6H-UFADX8
JU6H-UFAD98

FM-UL-cUL APPROVED RATINGS BHP/*KW*

JU6H MODEL ♦	RATED SPEED 1760		2100		2350		2400		US-EPA (NSPS) Available Until ●
	BHP	*KW*	BHP	*KW*	BHP	*KW*	BHP	*KW*	
UFADM8	**175**	*131*							*No Expiration*
UFADMG			**175**	*131*	**175**	*131*			*No Expiration*
UFAD58	**183**	*137*							*No Expiration*
UFADNG	**190**	*142*	**181**	*135*	**183**	*137*	**183**	*137*	*No Expiration*
UFADN0	**197**	*147*	**197**	*147*	**200**	*149*	**200**	*149*	*No Expiration*
UFADP0			**209**	*156*	**211**	*157*	**211**	*157*	*No Expiration*
UFADP8	**220**	*164*							*No Expiration*
UFADQ0			**224**	*167*	**226**	*169*	**226**	*169*	*No Expiration*
UFAD88	**237**	*177*							*No Expiration*
UFADR0			**238**	*177.5*	**240**	*179*	**240**	*179*	*No Expiration*
UFADR8	**250**	*187*							*No Expiration*
UFADS8	**260**	*194*							*No Expiration*
UFADS0			**260**	*194*	**268**	*200*	**268**	*200*	*No Expiration*
UFADT0			**274**	*204*	**275**	*205*	**275**	*205*	*No Expiration*
UFADW8	**282**	*211*							*No Expiration*
UFADX8	**305**	*227.5*							*No Expiration*
UFAD98	**315**	*235*							*No Expiration*



● USA EPA (NSPS) Tier 3 Emissions Certified Off-Road (40 CFR Part 89) and NSPS Stationary (40 CFR Part 60 Sub Part IIII). Meet EU Stage IIIA emission levels.

♦ All Models available for Export

SPECIFICATIONS

ITEM	JU6H MODELS: M8	MG	58	NG	N0	P8	88	P0	Q0	R0	S0	T0	R8	S8	W8	X8	98
Number of Cylinders	6																
Aspiration	TRWA																
Rotation*	CW																
Weight – lb (kg)	1747 (791)																
Compression Ratio	19.0:1							17.0:1									
Displacement – cu. in. (L)	415 (6.8)																
Engine Type	4 Stroke Cycle – Inline Construction																
Bore & Stroke – in. (mm)	4.19 x 5.00 (106 x 127)																
Installation Drawing	D628																
Wiring Diagram AC	C07591																
Wiring Diagram DC	C071367, C071360, C071361							C071368, C071360, C071761									
Engine Series	John Deere 6068 Series Power Tech E							John Deere 6068 Series Power Tech Plus									
Speed Interpolation	N/A																

Abbreviations: CW – Clockwise TRWA – Turbocharged with Raw Water Aftercooling N/A - Not Available

*Rotation viewed from Heat Exchanger / Front of engine

CERTIFIED POWER RATING

- Each engine is factory tested to verify power and performance.
- FM-UL power ratings are shown at specific speeds, Clarke engines can be applied at a single rated RPM setting ± 50 RPM.

ENGINE RATINGS BASELINES

- Engines are to be used for stationary emergency standby fire pump service only. Engines are to be tested in accordance with NFPA 25.
- Engines are rated at standard SAE conditions of 29.61 in. (752.1 mm) Hg barometer and 77°F (25°C) inlet air temperature [approximates 300 ft. (91.4 m) above sea level] by the testing laboratory (see SAE Standard J 1349).
- A deduction of 3 percent from engine horsepower rating at standard SAE conditions shall be made for diesel engines for each 1000 ft. (305 m) altitude above 300 ft. (91.4 m)
- A deduction of 1 percent from engine horsepower rating as corrected to standard SAE conditions shall be made for diesel engines for every 10°F (5.6°C) above 77°F (25°C) ambient temperature.

Meets NFPA 20 Requirements

FM APPROVED

ENGINE EQUIPMENT

EQUIPMENT	STANDARD	OPTIONAL
Air Cleaner	Direct Mounted, Washable, Indoor Service with Drip Shield	Disposable, Drip Proof, Indoor Service Outdoor Type, Single or Two Stage
Alternator	12V-DC, 42 Amps with Poly-Vee Belt and Guard	24V-DC, 40 Amps with Poly-Vee Belt and Guard
Exhaust Protection	Metal Guards on Manifolds and Turbocharger	
Coupling	Bare Flywheel	UL Listed Driveshaft and Guard, JU6H-UFAD58/NG/ADMG/ADM8/K0/N0/Q0/R0-CDS30-S1; JU6H-UFADP8/P0/T0/88/R8/S8/S0/W8/X8/98- CDS50-SC at 1760/2100 RPM only
Electronic Control Module	12V-DC, Energized to Stop, Primary ECM always Powered on	24V-DC, Energized to Stop, Primary ECM always Powered on
Exhaust Flex Connection*	Stainless Steel Flex, 150# ANSI Flanged Connection, 5" for JU6H-UFAD58/M8/MG/K0/NG/N0/P8/88; Stainless Steel Flex, 150# ANSI Flanged Connection, 6" for JU6H-UFADP0/Q0/R0/S0/T0/R8/S8/W8/X8/98	Stainless Steel Flex, 150# ANSI Flanged Connection, 6" for JU6H-UFAD58/M8/MG/K0/NG/N0/P8/88; Stainless Steel Flex, 150# ANSI Flanged Connection, 8" for JU6H-UFADP0/Q0/R0/S0/T0/R8/S8/W8/X8/98
Flywheel Housing	SAE #3	
Flywheel Power Take Off	11.5" SAE Industrial Flywheel Connection	
Fuel Connections	Fire Resistant, Flexible, USA Coast Guard Approved, Supply and Return Lines	Stainless Steel, Braided, cUL Listed, Supply and Return Lines
Fuel Filter	Primary Filter with Priming Pump	
Fuel Injection System	High Pressure Common Rail	
Engine Heater	115V-AC, 1360 Watt	230V-AC, 1360 Watt
Governor, Speed	Dual Electronic Control Modules	
Heat Exchanger	Tube and Shell Type, 60 PSI (4 BAR), NPT(F) Connections – Sea/Salt Water Compatible	
Instrument Panel	Multimeter to Display English and Metric, Tachometer, Hourmeter, Water Temperature, Oil Pressure and One (1) Voltmeter with Toggle Switch, Front Opening	
Junction Box	Integral with Instrument Panel; For DC Wiring Interconnection to Engine Controller	
Lube Oil Cooler	Engine Water Cooled, Plate Type	
Lube Oil Filter	Full Flow with By-Pass Valve	
Lube Oil Pump	Gear Driven, Gear Type	
Manual Start Control	On Instrument Panel with Control Position Warning Light	
Overspeed Control	Electronic, Factory Set, Not Field Adjustable	
Raw Water Solenoid Operation	Automatic from Fire Pump Controller and from Engine Instrument Panel	
Run – Stop Control	On Instrument Panel with Control Position Warning Light	
Starters	Two (2) 12V-DC	Two (2) 24V-DC
Throttle Control	Adjustable Speed Control by Increase/Decrease Button, Tamper Proof in Instrument Panel	
Water Pump	Centrifugal Type, Poly-Vee Belt Drive with Guard	

Abbreviations : DC – Direct Current, AC – Alternating Current, SAE – Society of Automotive Engineers, NPT(F) – National Pipe Tapered Thread (Female), ANSI – American National Standards Institute

*JU6H-UFADP8/P0/Q0/R0/S0/T0/R8/S8/W8/X8/98 – All provided with orifice plate mounted in flex exhaust.

Note: Engine Controller needs 2 additional signals: Injector Failure, Alternate ECM Selected

MODEL NOMENCLATURE: (10 Digit Models)

JU6H - UFADR0

- John Deere Base Engine
- 350 Series
- 6 Cylinders
- Heat Exchanger Cooled
- Power Curve Number
- EPA Tier 3 Certified
- Built in USA
- FM Approved
- UL Listed

CLARKE®

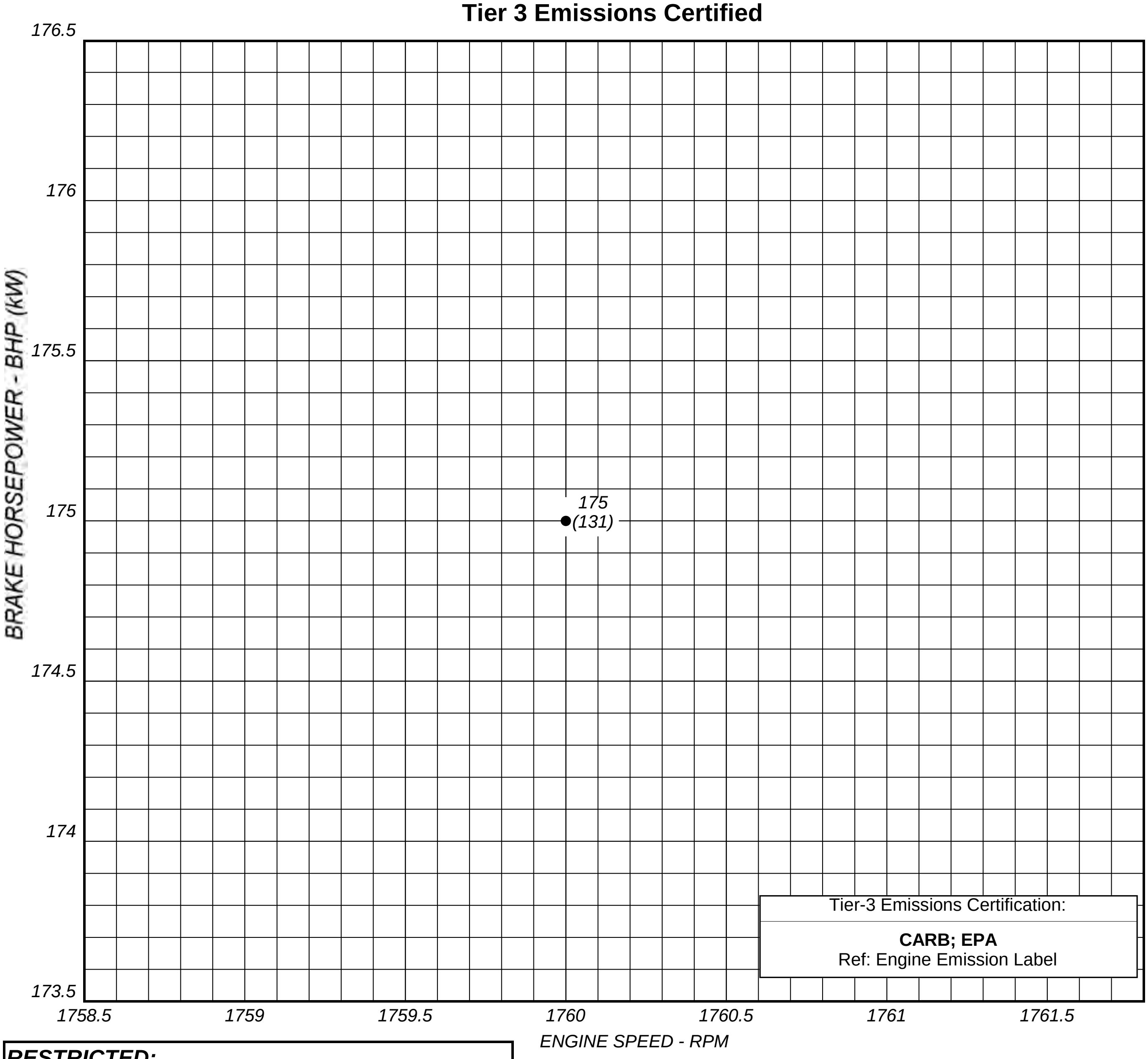
CLARKE Fire Protection Products, Inc.
3133 E. Kemper Rd., Cincinnati, Ohio 45241
United States of America
Tel +1-513-475-FIRE(3473) Fax +1-513-771-0726
www.clarkefire.com

CLARKE UK, Ltd.
Grange Works, Lomond Rd., Coatbridge, ML5-2NN
United Kingdom
Tel +44-1236-429946 Fax +44-1236-427274
www.clarkefire.com

CLARKE

Fire Protection Products, Inc.

FIRE PUMP MODEL: JU6H-UFADM8
Heat Exchanger Cooled
Raw Water Charge Cooling
Tier 3 Emissions Certified



RESTRICTED:

USE ONLY FOR STAND-BY FIRE PUMP APPLICATIONS

ENGINE PERFORMANCE:

STANDARD CONDITIONS: (SAE J1349, ISO 3046)
77°F (25°C) AIR INLET TEMPERATURE
29.61 IN. (751.1MM) HG BAROMETRIC PRESSURE
#2 DIESEL FUEL (SEE C13940)

KEVIN KUNKLER 02DEC10

●——● *NAMEPLATE BHP (MAXIMUM PUMP LOAD)*

CREATED KJK
DATE CREATED 12/02/10

ENGINE MODEL JU6H-UFADM8

DRAWING NO. C133746
REV A

CLARKE Fire Protection Products, Inc.

JU6H-UFADM8
INSTALLATION & OPERATION DATA (I&O Data)
USA Produced

Basic Engine Description

Engine Manufacturer	John Deere Co.
Ignition Type	Compression (Diesel)
Number of Cylinders	6
Bore and Stroke - in (mm)	4.19 (106) X 5 (127)
Displacement - in³ (L)	415 (6.8)
Compression Ratio	19.0:1
Valves per cylinder	
Intake	1
Exhaust	1
Combustion System	Direct Injection
Engine Type	In-Line, 4 Stroke Cycle
Fuel Management Control	Electronic, High Pressure Common Rail
Firing Order (CW Rotation)	1-5-3-6-2-4
Aspiration	Turbocharged
Charge Air Cooling Type	Raw Water
Rotation, viewed from front of engine, Clockwise (CW)	Standard
Engine Crankcase Vent System	Open
Installation Drawing	D628
Weight - lb (kg)	1747 (792)

Power Rating	**1760**
Nameplate Power - HP (kW)	175 (131)

Cooling System - [C051386]	**1760**
Engine Coolant Heat - Btu/sec (kW)	90 (95)
Engine Radiated Heat - Btu/sec (kW)	40 (42.2)
Heat Exchanger Minimum Flow	
60°F (15°C) Raw $H_2$0 - gal/min (L/min)	13 (49.2)
95°F (35°C) Raw $H_2$0 - gal/min (L/min)	20 (75.7)
Heat Exchanger Maximum Cooling Raw Water	
Inlet Pressure - psi (bar)	60 (4.1)
Flow - gal/min (L/min)	40 (151)
Typical Engine $H_2$0 Operating Temp - °F (°C)[1]	180 (82.2) - 195 (90.6)
Thermostat	
Start to Open - °F (°C)	180 (82.2)
Fully Opened - °F (°C)	203 (95)
Engine Coolant Capacity - qt (L)	20.5 (19.4)
Coolant Pressure Cap - lb/in² (kPa)	15 (103)
Maximum Engine Coolant Temperature - °F (°C)	230 (110)
Minimum Engine Coolant Temperature - °F (°C)	160 (71.1)
High Coolant Temp Alarm Switch - °F (°C)	235 (113)

Electric System - DC	**Standard**		**Optional**	
System Voltage (Nominal)	12		24	
Battery Capacity for Ambients Above 32°F (0°C)				
Voltage (Nominal)	12	[C07633]	24	[C07634]
Qty. Per Battery Bank	1		2	
SAE size per J537	8D		4D	
CCA @ 0°F (-18°C)	1400		1050	
Reserve Capacity - Minutes	430		290	
Battery Cable Circuit, Max Resistance - ohm	0.0012		0.0012	
Battery Cable Minimum Size				
0-120 in. Circuit Length[2]	00		00	
121-160 in. Circuit Length[2]	000		000	
161-200 in. Circuit Length[2]	0000		0000	
Charging Alternator Maximum Output - Amp,	40	[C071363]	55	[C071365]
Starter Cranking Amps, Rolling - @60°F (15°C)	440	[RE69704/RE70404]	250	[C07819/C07820]

NOTE: This engine is intended for indoor installation or in a weatherproof enclosure. [1]Engine H_2O temperature is dependent on raw water temperature and flow. [2]Positive and Negative Cables Combined Length.

CLARKE Fire Protection Products, Inc.

JU6H-UFADM8
INSTALLATION & OPERATION DATA (I&O Data)
USA Produced

	Standard	Optional
Exhaust System	**1760**	
Exhaust Flow - ft.³/min (m³/min)	1100 (31.1)	
Exhaust Temperature - °F (°C)	1000 (538)	
Maximum Allowable Back Pressure - in H_20 (kPa)	30 (7.5)	
Minimum Exhaust Pipe Dia. - in (mm) [3]	5 (127)	
Fuel System	**1760**	
Fuel Consumption - gal/hr (L/hr)	10.4 (39.4)	
Fuel Return - gal/hr (L/hr)	15.4 (58.3)	
Fuel Supply - gal/hr (L/hr)	25.8 (97.7)	
Fuel Pressure - lb/in² (kPa)	3 (20.7) - 6 (41.4)	
Minimum Line Size - Supply - in.	.50 Schedule 40 Steel Pipe	
Pipe Outer Diameter - in (mm)	0.848 (21.5)	
Minimum Line Size - Return - in.	.375 Schedule 40 Steel Pipe	
Pipe Outer Diameter - in (mm)	0.675 (17.1)	
Maximum Allowable Fuel Pump Suction Lift with clean Filter - in H_20 (mH_20)	80 (2)	
Maximum Allowable Fuel Head above Fuel pump, Supply or Return - ft (m)	6.6 (2)	
Fuel Filter Micron Size	2	
Heater System	**Standard**	**Optional**
Engine Coolant Heater		
Wattage (Nominal)	1360	1360
Voltage - AC, 1 Phase	115 (+5% -10%)	230 (+5%, -10%)
Part Number	[C123640]	[C123644]
Air System	**1760**	
Combustion Air Flow - ft.³/min (m³/min)	360 (10.2)	
Air Cleaner	**Standard**	**Optional**
Part Number	[C03396]	[C03327]
Type	Indoor Service Only, with Shield	Canister, Single-Stage
Cleaning method	Washable	Disposable
Air Intake Restriction Maximum Limit		
Dirty Air Cleaner - in H_20 (kPa)	10 (2.5)	10 (2.5)
Clean Air Cleaner - in H_20 (kPa)	6 (1.5)	6 (1.5)
Maximum Allowable Temperature (Air To Engine Inlet) - °F (°C)[4]	130 (54.4)	
Lubrication System		
Oil Pressure - normal - lb/in² (kPa)	40 (276) - 60 (414)	
Low Oil Pressure Alarm Switch - lb/in² (kPa)	30 (207)	
In Pan Oil Temperature - °F (°C)	220 (104) - 245 (118)	
Total Oil Capacity with Filter - qt (L)	21.1 (20)	
Lube Oil Heater	**Optional**	**Optional**
Wattage (Nominal)	150	150
Voltage	120V (+5%, -10%)	240V (+5%, -10%)
Part Number	C04430	C04431
Performance	**1760**	
BMEP - lb/in² (kPa)	190 (1310)	
Piston Speed - ft/min (m/min)	1467 (447)	
Mechanical Noise - dB(A) @ 1m	C133847	
Power Curve	C133746	

[3]Based on Nominal System. Back pressure flow analysis must be done to assure maximum allowable back pressure is not exceeded. (Note: minimum exhaust Pipe diameter is based on: 15 feet of pipe, one 90° elbow, and a silencer pressure drop no greater than one half of the maximum allowable back pressure.) [4]Review for horsepower derate if ambient air entering engine exceeds 77°F (25°C). [ ] indicates component reference part number.

JU4H, JU4R & JU6H, JU6R ENGINE MODELS
ENGINE MATERIALS AND CONSTRUCTION

Air Cleaner
Type………………………. .. Indoor Usage Only
Oiled Fabric Pleats
Material……………………. Surgical Cotton
Aluminum Mesh

Air Cleaner - Optional
Type…………………………Canister
Material……………………. Pleated Paper
Housing……………………. Enclosed

Camshaft
Material……………………..Cast Iron
Chill Hardened
Location……………………. In Block
Drive…………………………Gear, Spur
Type of Cam………………..Ground

Charge Air Cooler (JU6H-60,62,68,74,84, ADK0, AD58, ADNG, ADN0, ADQ0, ADR0, AAQ8, AARG, ADP8, ADP0, ADT0, AD88, ADR8, AD98, ADS0, ADW8, ADX8, AD98 only)
Type……….. ………………Raw Water Cooled
Materials (in contact with raw water)
Tubes…… …………………90/10 CU/NI
Headers …………………36500 Muntz
Covers …………………83600 Red Brass
Plumbing …………………316 Stainless Steel/ Brass
90/10 Silicone

Charge Air Cooler (JU6R-AA67, 59, 61, PF, Q7, RF, S9, 83 only)
Type…...……………………Air to Air Cooled
Materials
Core…………………………Aluminum

Coolant Pump
Type…….. …………………. Centrifugal
Drive…….. ………………… Poly Vee Belt

Coolant Thermostat
Type…………………………Non Blocking
Qty……………………………1

Cooling Loop (Galvanized)
Tees, Elbows, Pipe……….. Galvanized Steel
Ball Valves…………………. Brass ASTM B 124,
Solenoid Valve……………. Brass
Pressure Regulator……….. Bronze
Strainer………………………Cast Iron (1/2" - 1" loops) or
Bronze (1.25" - 2" loops)

Cooling Loop (Sea Water)
Tees, Elbows, Pipe……….. 316 Stainless Steel
Ball Valves…………………. 316 Stainless Steel
Solenoid Valve……………. 316 Stainless Steel
Pressure Regulator/Strainer Cast Brass ASTM B176
C87800

Cooling Loop (316SS)
Tees, Elbows, Pipe……….. 316 Stainless Steel
Ball Valves…………………. 316 Stainless Steel
Solenoid Valve……………. 316 Stainless Steel
Pressure Regulator/Strainer 316 Stainless Steel

Connecting Rod
Type…………………………I-Beam Taper
Material……………………. Forged Steel Alloy

Crank Pin Bearings
Type…………………………Precision Half Shell
Number……………………. 1 Pair Per Cylinder
Material……………………. Wear-Guard

Crankshaft
Material……………………. Forged Steel
Type of Balance…………… Dynamic

Cylinder Block
Type…………………………One Piece with
Non-Siamese Cylinders
Material……………………. Annealed Gray Iron

Cylinder Head
Type…….. ………………… Slab 2 Valve
Material…………………….Annealed Gray Iron

Cylinder Liners
Type…….. ………………… Centrifugal Cast, Wet Liner
Material…………………..… Alloy Iron Plateau, Honed

Fuel Pump
Type…….. ………………… Diaphragm
Drive…………………………Cam Lobe

Heat Exchanger (USA) - JU4H & JU6H Only
Type………………………… Tube & Shell
Materials
Tube & Headers…………. Copper
Shell……. ………………… Copper
Electrode…………………. Zinc

Heat Exchanger (UK) - JU4H & JU6H Only
Type………………………… Tube & Bundle

Materials
Tube & Headers…………. Copper
Shell……….……………… Aluminum

Injection Pump
Type……………………….. Rotary
Drive…………………………Gear

Lubrication Cooler
Type………………………… Plate

Lubrication Pump
Type………………………… Gear
Drive…………………………Gear

Main Bearings
Type………………………… Precision Half Shells
Material…………………….Steel Backed-Aluminum
Lined

Piston
Type and Material……….. Aluminum Alloy with
Reinforced Top Ring Groove
Cooling……………………. Oil Jet Spray

Piston Pin
Type………………………… Full Floating - Offset

Piston Rings
Number/Piston…………… 3
Top…………………………. Keystone Barrel Faced -
Plasma Coated
Second……………………. Tapered Cast Iron
Third…………………………Double Rail Type
w/Expander Spring

Radiator - JU4R & JU6R Only
Type……………………… Plate Fin
Materials
Core……………………… Copper & Brass
Tank & Structure……….. Steel

Optional
Marine Coating…………… Baked Phenolic

Valves
Type…….. ………………… Poppet
Arrangement………… …..Overhead Valve
Number/Cylinder…………1 intake
1 exhaust
Operating Mechanism……Mechanical Rocker Arm
Type of Lifter…………….. Large Head
Valve Seat Insert…………Replaceable

DO NOT SCALE

DATUMS:

-A- - MOUNTING FACE OF FLYWHEEL

-B- - ENGINE CRANKSHAFT HORIZONTAL CENTERLINE

-C- - ENGINE CRANKSHAFT VERTICAL CENTERLINE

- CENTER OF GRAVITY OF ENGINE

- CLOCKWISE ROTATION WHEN VIEWED FROM FRONT OF ENGINE

NOTE:
THE LOOP SHOWN IS BASED ON STANDARD LOOP CONSTRUCTION AND FM SIZING CONDITIONS

FOR ALTERNATE LOOP CONSTRUCTION (STAINLESS STEEL, SEA WATER, AND HIGH PRESSURE) SIZES MAY VARY

DRAWING SUBJECT TO CHANGE WITHOUT NOTICE

CAUTION:

ALL PLUMBING MUST BE SUPPORTED AND/OR ISOLATED SO THAT NO WEIGHT OR STRESS IS APPLIED TO ANY ENGINE COMPONENT

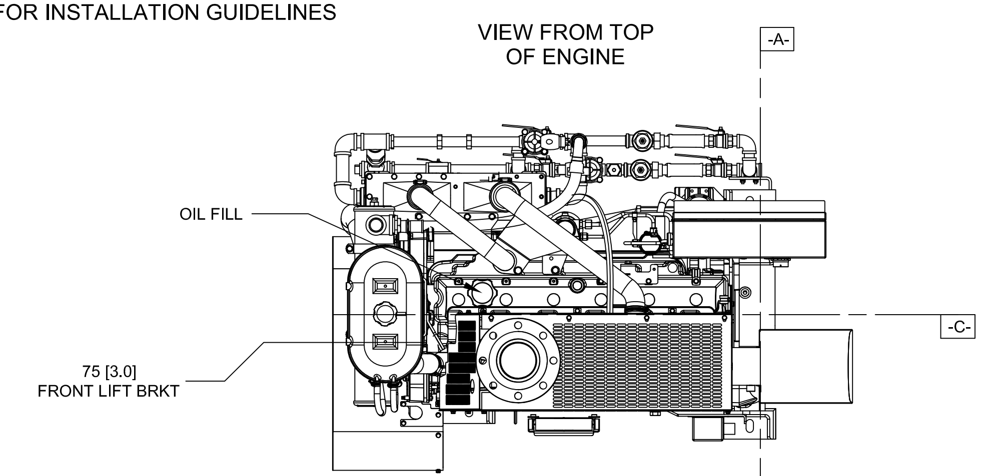
ATTENTION

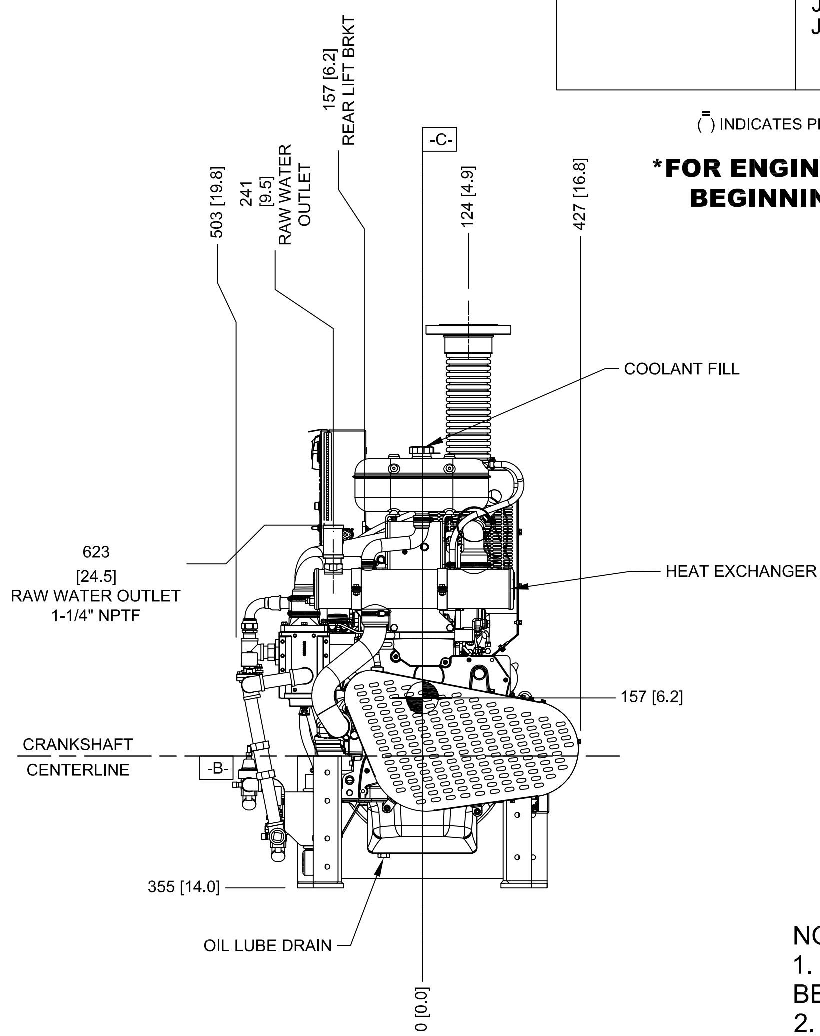
REFER TO THE SPECIFIC MODEL "INSTALLATION AND OPERATION DATA" FOR INSTALLATION GUIDELINES

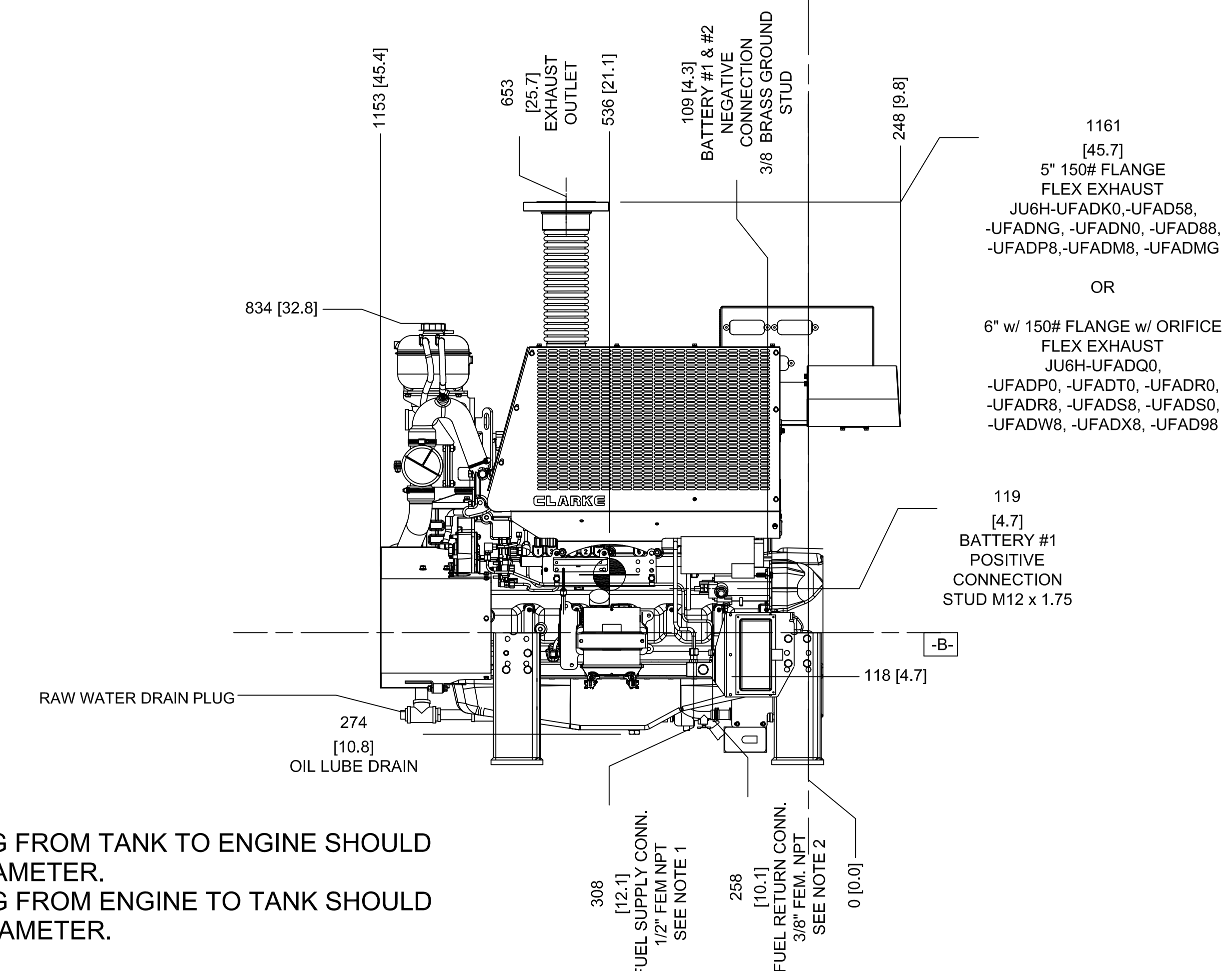
"TRWA" (TURBOCHARGED w/ RAW WATER AFTERCOOLING) MODELS	JU6H-UFAD58, -UFAD88 JU6H-UFADK0(*) , -UFADNG JU6H-UFADP8, -UFADN0 JU6H-UFADM8, -UFADMG JU6H-UFADP8 (MODELS SHOWN)
	JU6H-UFAD98 -UFADP0 JU6H -UFADQ0, -UFADR0 JU6H-UFADR8, -UFADS0 JU6H-UFADS8, -UFADT0 JU6H-UFADW8,-UFADX8 SEE PG. 3 FOR RAW WATER INLET DIMENSIONS

(*) INDICATES PLD ENINGE MODEL ONLY

***FOR ENGINES BUILT IN USA BEGINNING APRIL 2015**







NOTES:

1. FUEL SUPPLY PIPING FROM TANK TO ENGINE SHOULD BE 1/2" MINIMUM PIPE DIAMETER.
2. FUEL RETURN PIPING FROM ENGINE TO TANK SHOULD BE 3/8" MINIMUM PIPE DIAMETER.

REV	DESCRIPTION	ECN#	DWN	APVD	DATE
J	UPDATED MOUNTING FEET AND HEATER SETUP	2063	AMC	MJD	19JUL12
K	RAW WATER OUTLET WAS 1" NPTF	2649	MOH	KJK	04DEC12
L	ADDED PIPING KIT/COOLING LOOP	3631	BKK	ASC	25NOV14
M	ADDED FLYWHEEL INFORMATION	4071	JGV	MAL	04AUG15
N	REVISED ENGINE FOOT MOUNTING HOLE LOCATIONS PAGE 2	4275	CMM	ASC	01OCT15
P	ADDED GROUND STUD LOCATION	4359	DKP	ASC	11OCT15
Q	ADDED RAW WATER INLET DIMENSION TO PAGE 2. UPDATED COOLING LOOP GEOMETRY ON PAGE 3	4741	MJM	JCA	03FEB16
R	PAGE 3 DATUM A & B WERE INCORRECTLY POSITIONED	4788	RDR	MAL	11NOV16
S	ADDED DIMS TO ENGINE LIFTING BRACKETS	5061	MDM	MAL	21JUN17

MACHINE TOLERANCE

DECIMAL	mm	inch
X.	± 1.5	
X.X	± 0.8	± 0.06
X.XX	± 0.3	± 0.03
X.XXX	± 0.025	± 0.01
X.XXXX		± 0.001

ANGULAR: ± 0.5°

FABRICATION TOLERANCE

DECIMAL	mm	inch
X.	± 3	
X.X	± 1.5	± 0.12
X.XX		± 0.06

ANGULAR: ± 1.0°

YES NO
CONTROLLED DRAWING

CLARKE
Fire Protection Products, Inc.

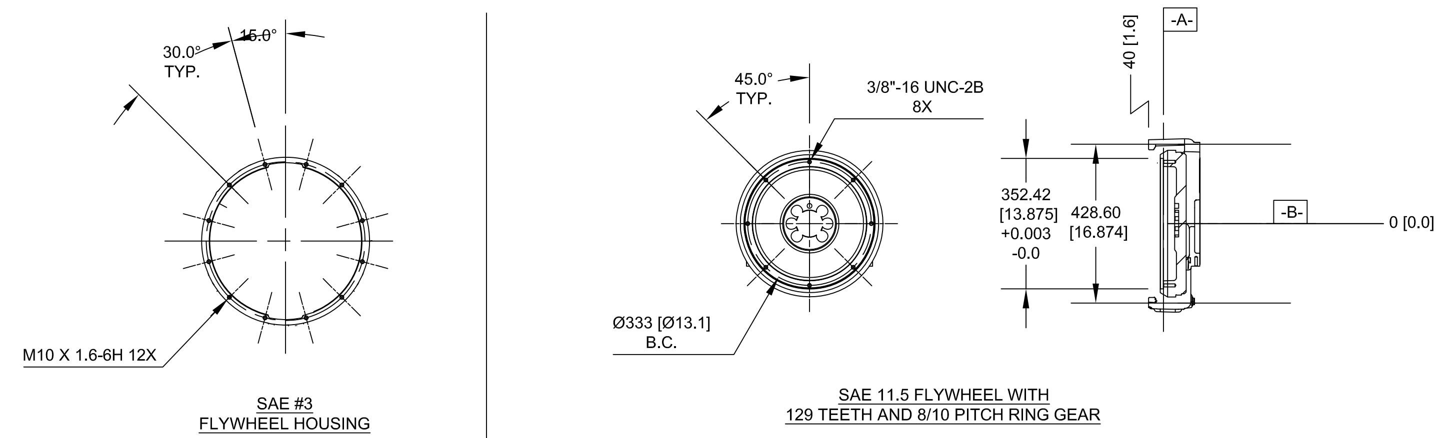
DRWN	MWLEMING
DATE	2/25/2009
ENGR	KJKUNKLER
MATERIAL	
ASSEMBLY	

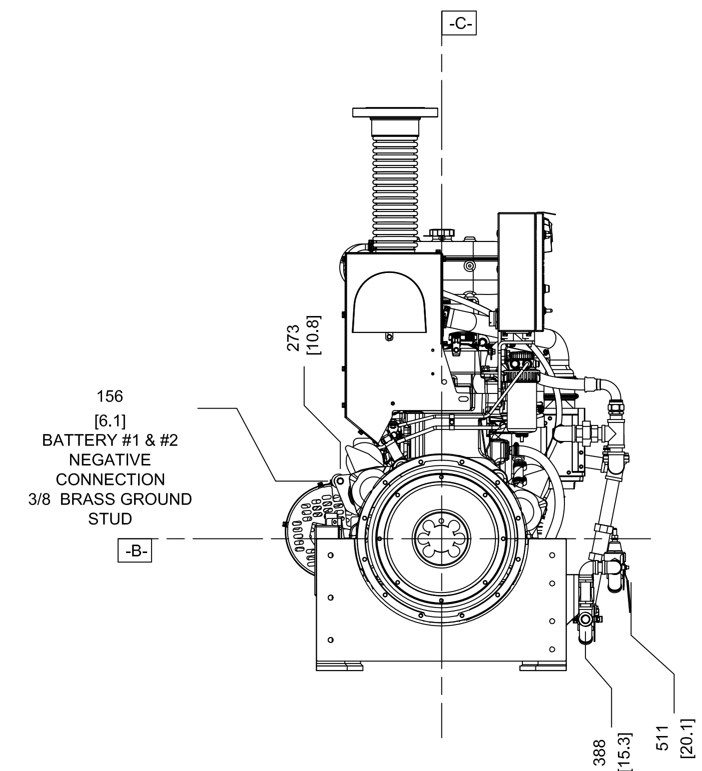
NAME: INSTALLATION DRAWING, FIRE PUMP ENGINE JU6H TIER 3 MODELS

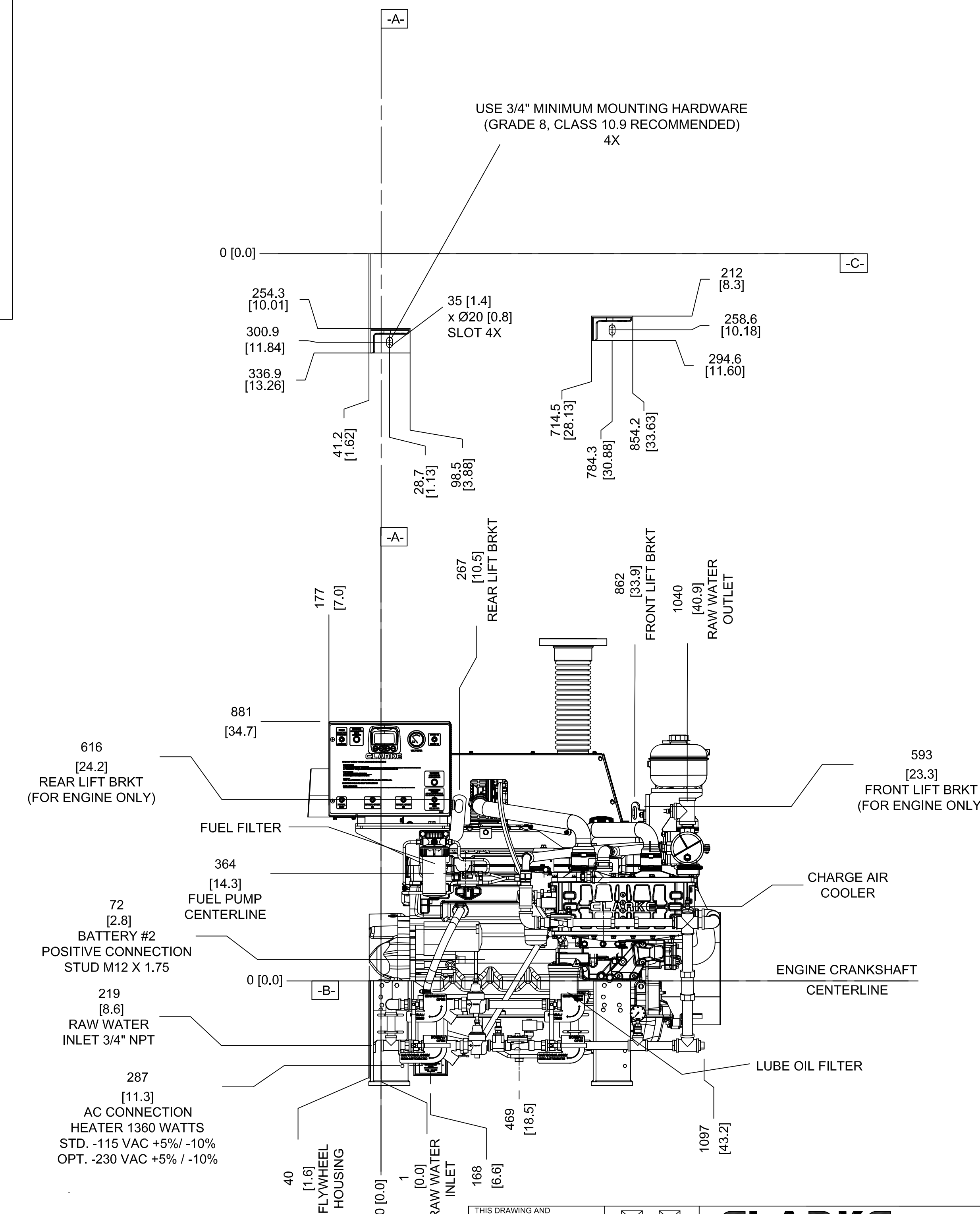
PART NO. D628 — REV S

SCALE NTS — UNITS MM [INCH] — PAGE 1 OF 3

DETAIL DATUM -A-







***FOR ENGINES BUILT IN USA**
BEGINNING APRIL 2015

FOR ENGINE SPECIFIC OPTIONS
SEE www.CLARKEFIRE.com

DRAWING SUBJECT
TO CHANGE
WITHOUT NOTICE

MACHINE TOLERANCES

DECIMAL	mm	inch
X.	±1.5	
X.X	±0.8	±0.06
X.XX	±0.4	±0.03
X.XXX	±0.025	±0.01
X.XXXX		±0.001

ANGULAR: ±0.5°

FABRICATION TOLERANCES

DECIMAL	mm	inch
X.	±3	
X.X	±1.5	±0.12
X.XX		±0.06

ANGULAR: ±1.0°

YES NO
CONTROLLED DRAWING

CLARKE
Fire Protection Products, Inc.

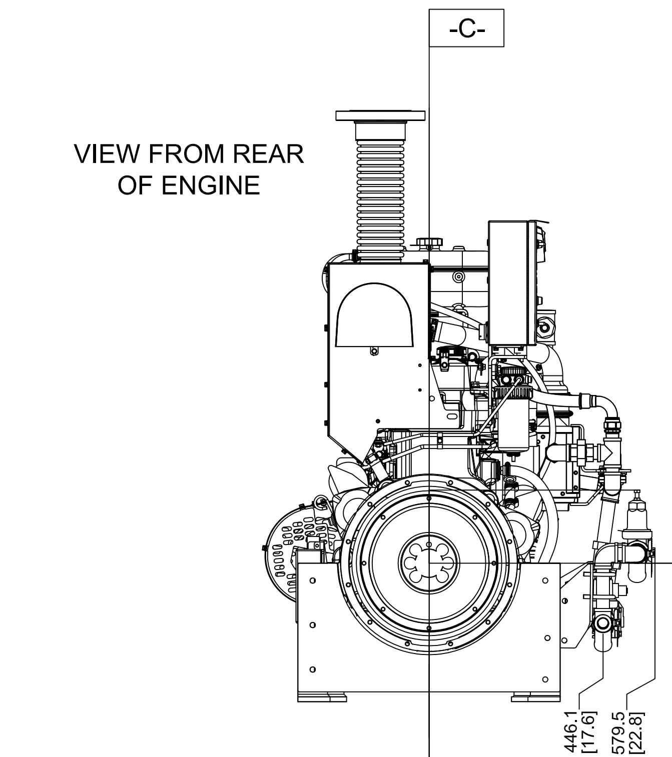
DRWN	MWLEMING
DATE	2/25/2009
ENGR	KKUNKLER
MATERIAL	
ASSEMBLY	

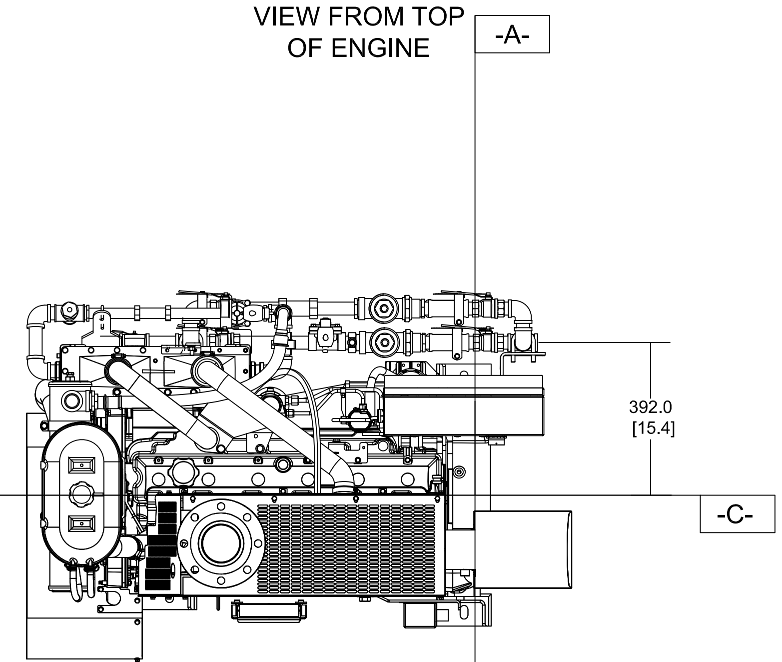
NAME: INSTALLATION DRAWING, FIRE PUMP ENGINE JU6H TIER 3 MODELS

PART NO.: D628 — REV: S

SCALE: NTS — UNITS: MM [INCH] — PAGE 2 OF 3

DO NOT SCALE



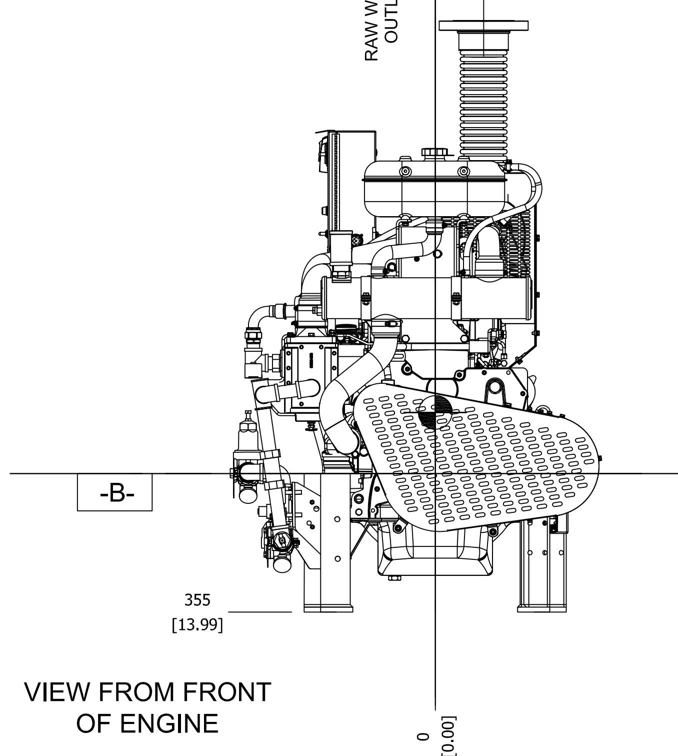


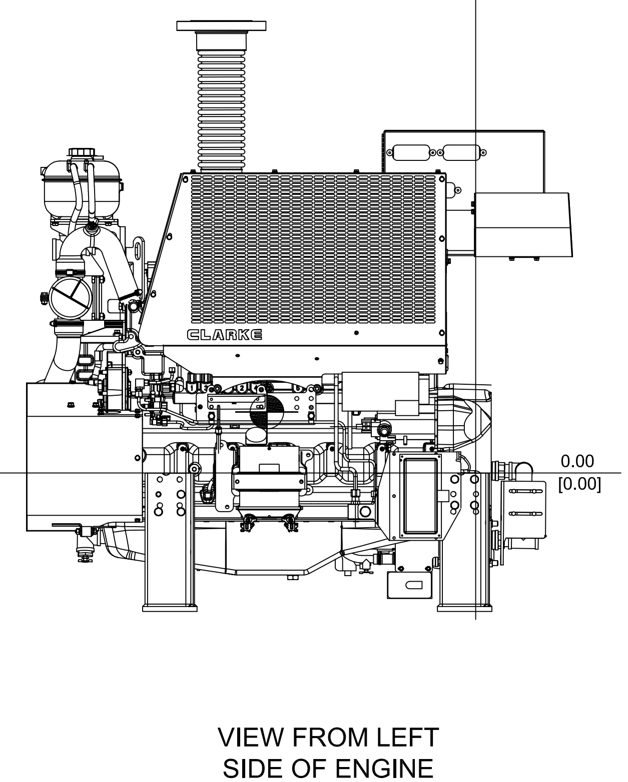
TRWA 1" LOOP w/ 1 ½" REGULATORS MODELS	JU6H-UFAD98 -UFADP0 JU6H -UFADQ0, -UFADR0 JU6H-UFADR8, -UFADS0 JU6H-UFADS8, -UFADT0 JU6H-UFADW8,-UFADX8

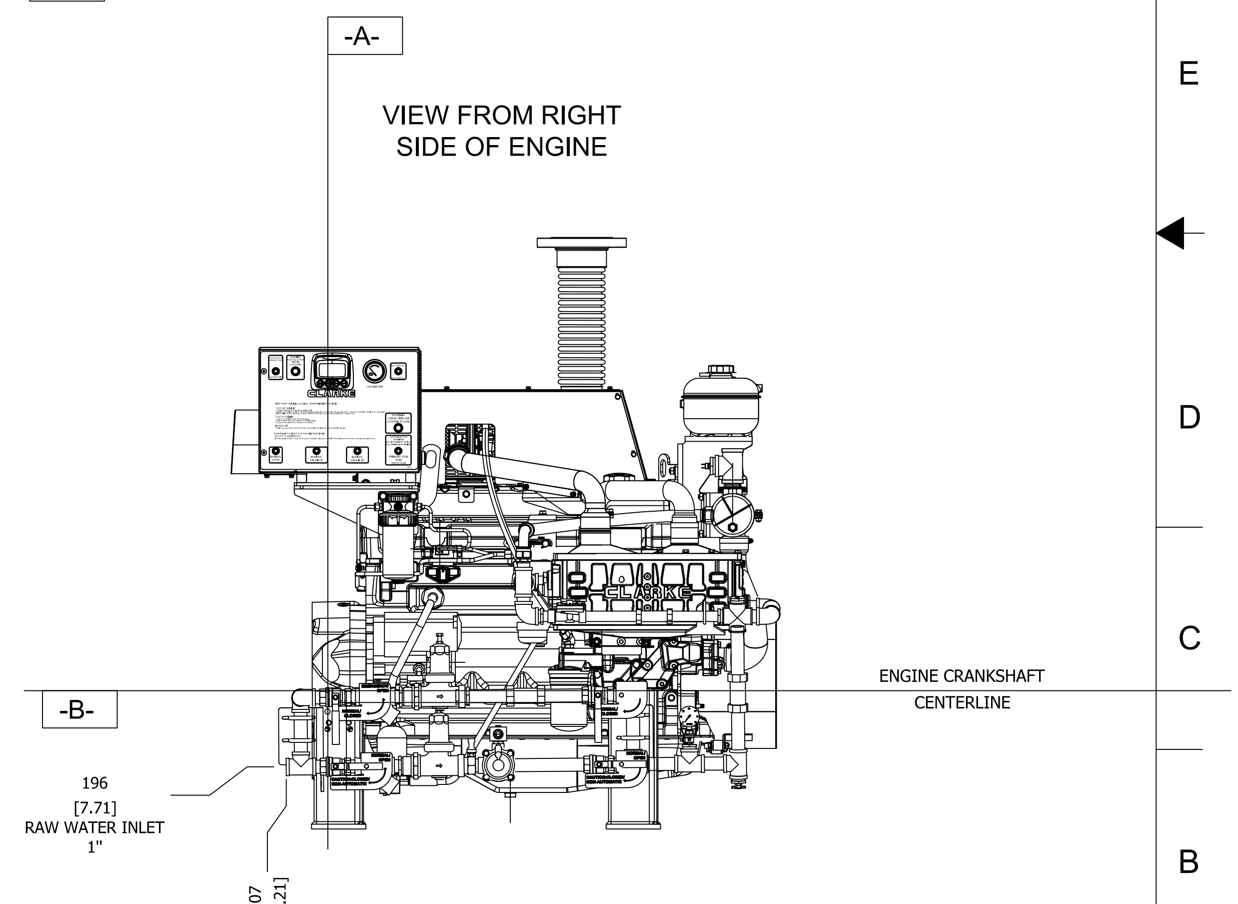
FOR ALL OTHER MODELS SEE PAGE 2

DATUMS

- -A- - MOUNTING FACE OF FLYWHEEL
- -B- - ENGINE CRANKSHAFT HORIZONTAL CENTERLINE
- -C- - ENGINE CRANKSHAFT VERTICAL CENTERLINE
- CENTER OF GRAVITY OF ENGINE
- CLOCKWISE ROTATION WHEN VIEWED FROM FRONT OF ENGINE







MACHINE TOLERANCE

DECIMAL	mm	Inch
X.	± 1.5	
X.X	± 0.8	± 0.06
X.XX	± 0.3	± 0.03
X.XXX	± 0.025	± 0.01
X.XXXX		± 0.001

ANGULAR: ± 0.5'

FABRICATION TOLERANCE

DECIMAL	mm	Inch
X.	± 3	
X.X	± 1.5	± 0.12
X.XX		± 0.06

ANGULAR: ± 1.0'

YES NO CONTROLLED DRAWING

CLARKE
Fire Protection Products, Inc.

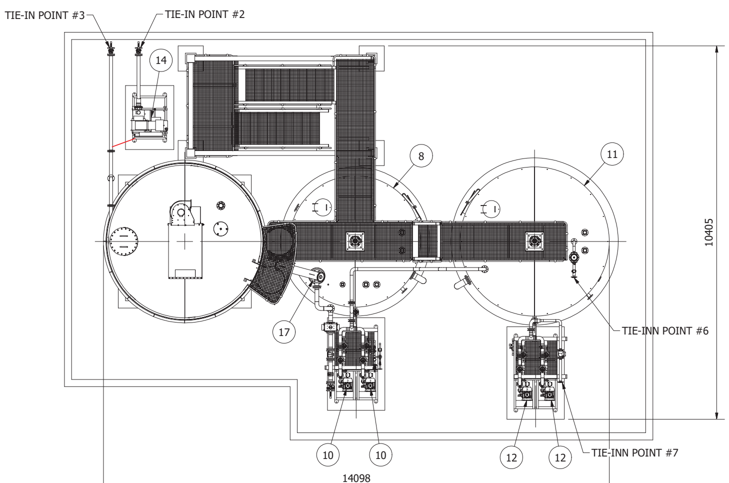
DRWN	PMKOWALL
DATE	11SEP09
ENGR	ACRISTOFARO
MATERIAL	
REFERENCE	EC1626

NAME: INSTALLATION DRAWING FIRE PUMP ENGINE JU6H TIER 3 MODELS

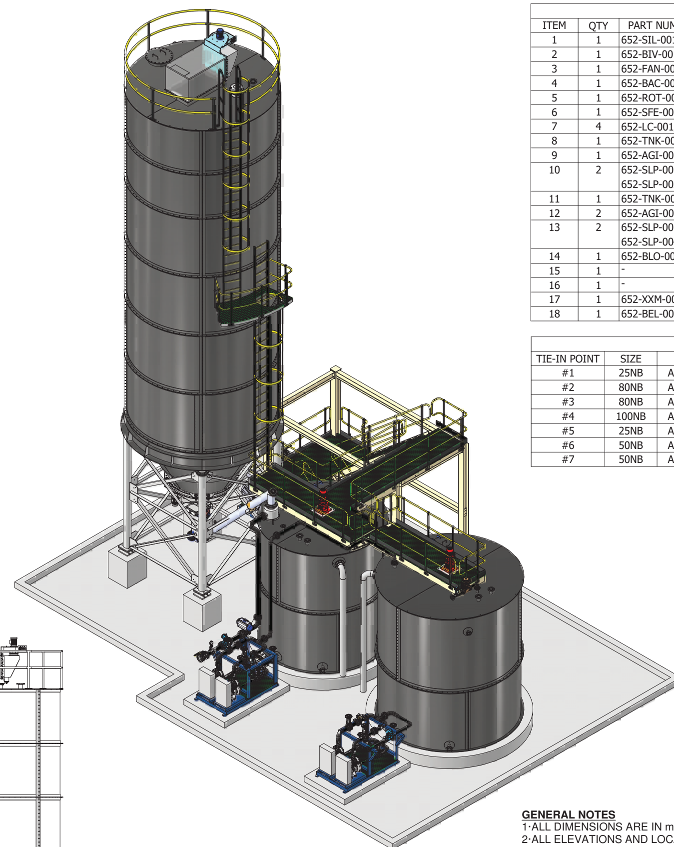
PART NO. D628 REV S

SCALE NTS | UNITS MM [INCH] | PAGE 3 OF 3

A-7
Lime Silo



TOP VIEW
SCALE 1 / 70



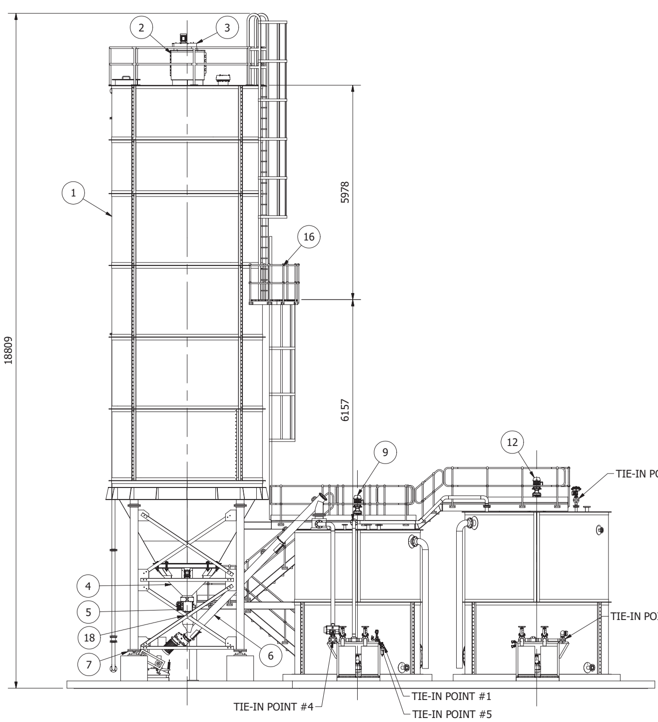
ISOMETRIC VIEW

PARTS LIST				
ITEM	QTY	PART NUMBER	DESCRIPTION	MATERIAL
1	1	652-SIL-001	160m^3 - LIME SILO	S355JR
2	1	652-BIV-001	DE-DUSTER UNIT	-
3	1	652-FAN-001	0.75kW EXUAST FAN	-
4	1	652-BAC-001	1.1kW - BIN ACTIVATOR	S355JR
5	1	652-ROT-001	0.75kW - ROTARY VALVE	-
6	1	652-SFE-001	2.2kW - SCREW FEEDER	S355JR
7	4	652-LC-001/2/3	40TON - LOAD CELLS	-
8	1	652-TNK-001	37m^3 - PREPARATION TANK	S355JR
9	1	652-AGI-001	5.5kW - MIXING AGITATOR	-
10	2	652-SLP-001 652-SLP-002	5.5kW - TRANSFER PUMP #1 (DUTY) 5.5kW - TRANSFER PUMP #2 (STANDBY)	-
11	1	652-TNK-001	57m^3 - DISTRIBUTION TANK	S355JR
12	2	652-AGI-002	3kW - MIXING AGITATOR	-
13	2	652-SLP-003 652-SLP-004	15kW - DOSING PUMP #1 (DUTY) 15kW - DOSING PUMP #2 (STANDBY)	-
14	1	652-BLO-001	11kW - BLOWER	-
15	1	-	ACCESS STAIRCASE	S355JR
16	1	-	CAT LADDER	S355JR
17	1	652-XXM-001	LIME SPRAY BOX	304 S/S
18	1	652-BEL-001	200NB BELLOW	-

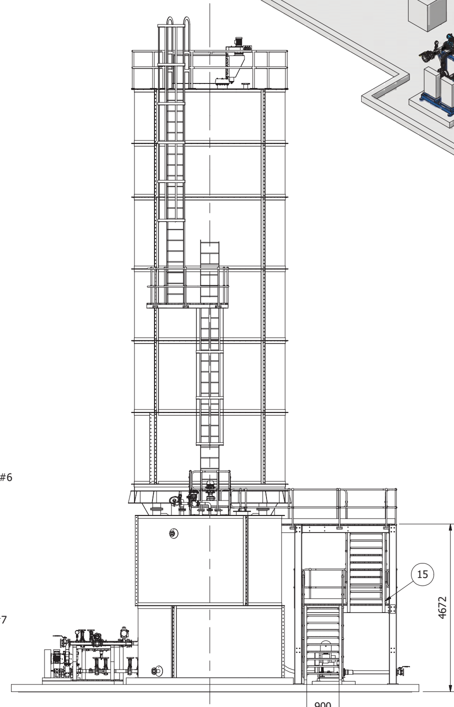
NOZZLE SHEDULE			
TIE-IN POINT	SIZE	FLANGE SPEC	COMMODITY/FUNCTION
#1	25NB	ANSI B16.5 #150	PLANT AIR
#2	80NB	ANSI B16.5 #150	TRUCK OFF-LOADING
#3	80NB	ANSI B16.5 #150	TRUCK OFF-LOADING
#4	100NB	ANSI B16.5 #150	PROCESS WATER
#5	25NB	ANSI B16.5 #150	GLAND SEAL WATER
#6	50NB	ANSI B16.5 #150	RING MAIN RETURN
#7	50NB	ANSI B16.5 #150	RING MAIN DOSSING

GENERAL NOTES

1·ALL DIMENSIONS ARE IN mm UNLESS STATED OTHERWISE INDICATED
2·ALL ELEVATIONS AND LOCATIONS ARE MEASURED FROM REFERENCE TANGENT LINES UNLESS OTHERWISE INDICATED.
3·NOZZLE STANDOUT NOT TO PROTRUDE MORE THAN 150mm FROM TANK UNLESS OTHERWISE INDICATED.
4·ALL FLANGES SHALL BE IN ACCORDANCE WITH ANSI B16.5 150lbs
5·TEMPORARY ATTACHMENTS SHALL BE KEPT TO A MINIMUM.
6·ALL SURFACES TO BE WELDED SHALL BE CLEAN AND FREE FROM PAINT,OIL,DIRT,SCALE,OXIDE,AND OTHER CONTAMINANTS DETRIMENTAL TO WELDING.
7·SANDBLASTING SHALL BE IN ACCORDANCE WITH SA 2.5.
8·ALL CARBON STEEL WELDS SHALL BE IN ACCORDANCE WITH AWS D1.1.
9·ALL STAINLESS STEEL WELDS SHALL BE IN ACCORDANCE WITH AWS D1.6.
10.ALL CARBON PIPE WELDS SHALL BE IN ACCORDANCE WITH ASME IX-
11.ALL STAINLESS STEEL PIPE WELDS SHALL BE IN ACCORDANCE WITH ASME IX-
12·RUBBER COATING TO BE USED WHERE NECESSARY - NOT RUBBER LINING.
13·FOR PAINT SPEC SEE DOCUMENT PAINT_SPECIFICATION_AS_01.



FRONT VIEW
SCALE 1 / 70



SIDE VIEW
SCALE 1 / 70

AS AUTOMECH SOLUTIONS (PTY) LTD.			
G-MINING	DRAWN BY:	T.N	DATE: 18.08.2022
TOCANTINZINHO PROJECT BRTZ-A-MC-P029-RFQ-0001 LIME PREPARATION & DOSING SYSTEM GENERAL ARRANGEMENT	CHECKED BY:	N.C	DATE: 18.08.2022
	APPROVED BY:	J.S	DATE: 18.08.2022

DWG NUMBER:	T1113_P029_LS_CY_GA_REV_0			
PROJECT NO:	SERIES OR EQUIPMENT NO:	SHEET NO:	SCALE	REV
T1113_JS	MC-P029	1 of 1	AS SHOWN	1

SHEET SIZE
A1

REVISIONS:				
REV:	DATE:	DESCRIPTION	BY	CH'KD
1	24.03.2023	ISSUED FOR APPROVAL	N.C	M.H
0	27.01.2023	FIRST FORMAL SUBMISSION	T.N	N.C

A-8
Emulsion Specifications

Hydromite® *Advance*

AUSTIN POWDER

A TRADITION OF SAFETY, STRENGTH AND SERVICE.

Booster Sensitive Bulk Emulsion for Underground, Underwater and other Construction Blasting Applications.

DESCRIPTION

Hydromite *Advance* bulk emulsion is specifically formulated to provide the maximum advance in underground, underwater and other construction blasting applications.

BENEFITS

- 100% borehole coupling and high energy produce the maximum performance for each blast hole.
- Excellent water resistance and superior resistance to dynamic pre-compression assures performance even in the most critical situations.

PROPERTIES

Product	Density [g/cc]	RBS	VOD*		Fume Class	Minimum Diameter	
			[ft/s]	[m/s]		[in]	[mm]
Hydromite *Advance* 120 & 220	1.20	113	17,000	5,200	1	1 ¾ “	44
Hydromite *Advance* 125 & 225	1.25	117	18,000	5,500	1	2 ½ “	63

Hydromite *Advance* 200 series utilize a food grade mineral oil fuel to provide greater environmental compatibility.
RBS – Relative Bulk Strength (AN/FO @ 0.82 g/cc = 100)
**3” confined*

PRIMING

Hydromite *Advance* is a booster sensitive explosive and must be in direct contact with an appropriately sized Cast Booster or equivalent primer. Use with detonating cord is not recommended.

Hydromite *Advance*

For more information and service locations in your area, please contact Austin Powder Company's headquarters:

Austin Powder Company
25800 Science Park Drive
Cleveland, Ohio, USA 44122

Phone: 1-800-321-0752
Fax: 1-216-464-4418
Web: www.austinpowder.com
Email: info@austinpowder.com

STORAGE
Store in accordance with all applicable local, state, provincial and federal laws.

SHELF LIFE
Six months from date of manufacture under good storage conditions.

UN CLASSIFICATION
Shipping Name: Explosive, Blasting, Type E
Class & Division: 1.5D
ID Number: UN 0332

DOT REFERENCE NUMBER
EX-2008120354

Disclaimer of Warranties and Limitations of Liabilities

"Products described in this bulletin are sold by Austin Powder Company without warranty; express, implied or statutory or as to MERCHANTABILITY, except as expressly stated in Austin Powder's straight bill of lading. Under no circumstances shall seller be liable for loss of anticipated profits, consequential damages or incidental damages."

[1/2/02 | 3/16/17]

Appendix B

Safety Data Sheets

B-1	Sodium Hydrosulfide
B-2	Sodium Isobutyl Xanthate
B-3	Methyl Isobutyl Carbinol
B-4	Dowfroth 250
B-5	Alkylaryl Dithiophosphate
B-6	n-Dodecyl Mercaptan
B-7	Sodium Silicates
B-8	Carboxymethyl Cellulose Sodium
B-9	Hydrated Lime

B-1
Sodium Hydrosulfide

SAFETY DATA SHEET

1. Identification

Product identifier Sodium Hydrosulfide Solution

Other means of identification

Product number GENLP-TDC-001

Recommended use Product is a unique alkaline material, playing a vital role in many industrial processes.

Recommended restrictions Use in accordance with supplier's recommendations.

Manufacturer/Importer/Supplier/Distributor information

Manufacturer TDC, L.L.C. and TDC Services, LLC

Address 1916 Farmerville Hwy
Ruston, LA 71270

Telephone Customer Service (800) 422-6274

Email TDCcustomerservice@genlp.com

CHEMTREC: 800-424-9300 (Domestic – North America)

CHEMTREC: +1-703-527-3887 (International)

2. Hazard(s) identification

Physical hazards	Corrosive to metals	Category 1
Health hazards	Acute toxicity, oral	Category 3
	Skin corrosion/irritation	Category 1B
	Serious eye damage/eye irritation	Category 1
Environmental hazards	Hazardous to the aquatic environment, acute hazard	Category 1
OSHA defined hazards	Not classified.	

Label elements

Signal word Danger

Hazard statement May be corrosive to metals. Toxic if swallowed. Causes severe skin burns and eye damage. Very toxic to aquatic life.

Precautionary statement

Prevention Keep only in original container. Do not breathe mist or vapor. Wash thoroughly after handling. Do not eat, drink or smoke when using this product. Avoid release to the environment. Wear protective gloves/protective clothing/eye protection/face protection.

Response If swallowed: Immediately call a poison center/doctor. Rinse mouth. Do NOT induce vomiting. If on skin (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower. Wash contaminated clothing before reuse. If inhaled: Remove person to fresh air and keep comfortable for breathing. If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a poison center/doctor. Absorb spillage to prevent material damage.

Storage Store locked up. Store in corrosive resistant container with a resistant inner liner.

Disposal Dispose of contents/container in accordance with local/regional/national/international regulations.

Hazard(s) not otherwise classified (HNOC) None known.

Supplemental information None.

3. Composition/information on ingredients

Mixtures

Chemical name	CAS number	%
Sodium hydrosulfide	16721-80-5	5-49
Sodium carbonate	497-19-8	<5
Sodium sulfide	1313-82-2	<5

Composition comments Components not listed are either non-hazardous or are below reportable limits. All concentrations are in percent by weight unless ingredient is a gas. Gas concentrations are in percent by volume.

4. First-aid measures

Inhalation Move to fresh air. Call a physician if symptoms develop or persist.

Skin contact Take off immediately all contaminated clothing. Rinse skin with water/shower. Call a physician or poison control center immediately. Chemical burns must be treated by a physician. Wash contaminated clothing before reuse.

Eye contact Immediately flush eyes with plenty of water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Call a physician or poison control center immediately.

Ingestion Call a physician or poison control center immediately. Rinse mouth. Do not induce vomiting. If vomiting occurs, keep head low so that stomach content doesn't get into the lungs. Do not give mouth-to-mouth resuscitation. Induce artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.

Most important symptoms/effects, acute and delayed Burning pain and severe corrosive skin damage. Causes serious eye damage. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Permanent eye damage including blindness could result. Toxic if swallowed. Causes digestive tract burns.

Indication of immediate medical attention and special treatment needed Provide general supportive measures and treat symptomatically. Chemical burns: Flush with water immediately. While flushing, remove clothes which do not adhere to affected area. Call an ambulance. Continue flushing during transport to hospital. Keep victim warm. Keep victim under observation. Symptoms may be delayed.

General information Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves. Show this safety data sheet to the doctor in attendance.

5. Fire-fighting measures

Suitable extinguishing media Use fire-extinguishing media appropriate for surrounding materials.

Unsuitable extinguishing media No restrictions known.

Specific hazards arising from the chemical During fire, gases hazardous to health may be formed. Hydrogen sulfide (H2S) may be given off when this material is heated. Do not depend on sense of smell for warning.

Special protective equipment and precautions for firefighters Self-contained breathing apparatus and full protective clothing must be worn in case of fire.

Fire fighting equipment/instructions Cool containers exposed to heat with water spray and remove container, if no risk is involved.

Specific methods Use standard firefighting procedures and consider the hazards of other involved materials.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures Keep unnecessary personnel away. Keep people away from and upwind of spill/leak. Wear appropriate protective equipment and clothing during clean-up. Do not breathe mist or vapor. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Ensure adequate ventilation. Local authorities should be advised if significant spillages cannot be contained. For personal protection, see section 8 of the SDS.

Methods and materials for containment and cleaning up This material is classified as a water pollutant under the Clean Water Act and should be prevented from contaminating soil or from entering sewage and drainage systems which lead to waterways.

Large Spills: Stop the flow of material, if this is without risk. Dike the spilled material, where this is possible. Absorb spillage to prevent material damage. Use a non-combustible material like vermiculite, sand or earth to soak up the product and place into a container for later disposal. Recover as much material as possible.

Small Spills: Wipe up with absorbent material (e.g. cloth, fleece). Clean surface thoroughly to remove residual contamination. For waste disposal, see section 13 of the SDS. Recover the product and place in a suitable container for reuse. Neutralization/oxidation of residue using dilute bleach or peroxide. Recover as much product as possible.

Environmental precautions Avoid release to the environment. Inform appropriate managerial or supervisory personnel of all environmental releases. Prevent further leakage or spillage if safe to do so. Avoid discharge into drains, water courses or onto the ground.

7. Handling and storage

Precautions for safe handling Do not breathe mist or vapor. Do not get in eyes, on skin, or on clothing. Do not taste or swallow. Hydrogen sulfide, a very toxic gas, may be present with this material. Keep face clear of tank and/or tank car openings. When using, do not eat, drink or smoke. Provide adequate ventilation. Wear appropriate personal protective equipment. Wash hands thoroughly after handling. Avoid release to the environment. Observe good industrial hygiene practices.

Conditions for safe storage, including any incompatibilities Store locked up. Store in a cool, dry place out of direct sunlight. Store in corrosive resistant container with a resistant inner liner. Keep only in the original container. Store away from incompatible materials (see Section 10 of the SDS). Protect from heat and direct sunlight. Store at temperature below 150°F. Provide appropriate secondary containment.

8. Exposure controls/personal protection

Occupational exposure limits

US. OSHA Table Z-2 (29 CFR 1910.1000)

Components	Type	Value
Hydrogen sulfide (CAS 7783-06-4)	Ceiling	20 ppm

US. ACGIH Threshold Limit Values

Components	Type	Value
Hydrogen sulfide (CAS 7783-06-4)	STEL	5 ppm
	TWA	1 ppm

US. NIOSH: Pocket Guide to Chemical Hazards

Components	Type	Value
Hydrogen sulfide (CAS 7783-06-4)	Ceiling	15 mg/m3
		10 ppm

Biological limit values No biological exposure limits noted for the ingredient(s).

Appropriate engineering controls Good general ventilation should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level. Eye wash facilities and emergency shower must be available when handling this product.

Individual protection measures, such as personal protective equipment

Eye/face protection Wear chemical splash goggles and face shield.

Skin protection

Hand protection Neoprene gloves are recommended. Wear appropriate chemical resistant gloves.

Skin protection

Other Wear appropriate chemical resistant clothing.

Respiratory protection Do not breathe dust/fume/gas/mist/vapors/spray. In case of insufficient ventilation, wear suitable respiratory equipment. Use a positive-pressure air-supplied respirator if there is any potential for an uncontrolled release, exposure levels are not known, or any other circumstances where air-purifying respirators may not provide adequate protection.

Thermal hazards Wear appropriate thermal protective equipment.

General hygiene considerations Keep away from food and drink. Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

9. Physical and chemical properties

Appearance

Physical state Liquid.

Form Liquid.

Color Yellow to red to dark green or black.

Odor Rotten egg or mercaptan odor typical.

Odor threshold Not available.

pH 11.5 - 12.5

Melting point/freezing point	Not available.
Initial boiling point and boiling range	253 - 269 °F (122.8 - 131.7 °C)
Flash point	Not available.
Evaporation rate	Not available.
Flammability (solid, gas)	Not applicable.
Upper/lower flammability or explosive limits	
Explosive limit - lower (%)	4 % (hydrogen sulfide)
Explosive limit - upper (%)	46 % (hydrogen sulfide)
Vapor pressure	17 mm Hg (68 °F (20 °C))
Vapor density	1.17 (Air= 1)
Relative density	1.152 - 1.331 (H20=1)
Solubility(ies)	
Solubility (water)	Completely soluble in water.
Partition coefficient (n-octanol/water)	Not available.
Auto-ignition temperature	Not available.
Decomposition temperature	Not available.
Viscosity	Not available.
Other information	
Explosive properties	Not explosive.
Oxidizing properties	Not oxidizing.
Pounds per gallon	9.6 - 11.1 lb/gal

10. Stability and reactivity

Reactivity	Reacts violently with strong acids. This product will react with oxidizing agents. May be corrosive to metals. Reacts violently with diazonium salts.
Chemical stability	Material is stable under normal conditions.
Possibility of hazardous reactions	Heating this product will evolve toxic fumes of hydrogen sulfide, sulfoxides and sodium oxide. Fire conditions will also cause the production of sulfur dioxide. Contact with acids increases the formation of hydrogen sulfide. Hydrogen sulfide may form flammable mixtures with air. Heating to decomposition emits toxic fumes of sulfoxides and sodium oxide.
Conditions to avoid	Contact with incompatible materials. Do not mix with other chemicals.
Incompatible materials	Acids, alkalis, oxidizing agents, light metals, aldehydes or organic anhydrides. Alkylene oxides. Aldehydes. Alcohols. Glycols. Phenols.
Hazardous decomposition products	Uncontrolled heating of this product will evolve toxic fumes of hydrogen sulfide, sulfoxides and sodium oxide. Fire conditions will also cause the production of sulfur dioxide.

11. Toxicological information

Information on likely routes of exposure	
Inhalation	May cause irritation to the respiratory system.
Skin contact	Causes severe skin burns.
Eye contact	Causes serious eye damage.
Ingestion	Toxic if swallowed. Causes digestive tract burns.
Symptoms related to the physical, chemical and toxicological characteristics	Burning pain and severe corrosive skin damage. Causes serious eye damage. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Permanent eye damage including blindness could result. Toxic if swallowed. Causes digestive tract burns.
Information on toxicological effects	
Acute toxicity	Toxic if swallowed.

Components	Species	Test Results
Sodium carbonate (CAS 497-19-8)		
Acute		
Dermal		
LD50	Rabbit	> 2000 mg/kg
Oral		
LD50	Rat	2080 mg/kg
Sodium hydrosulfide (CAS 16721-80-5)		
Acute		
Oral		
LD50	Rat	100 - 215 mg/kg
Sodium sulfide (CAS 1313-82-2)		
Acute		
Oral		
LD50	Rat	208 mg/kg

Skin corrosion/irritation Causes severe skin burns.

Serious eye damage/eye irritation Causes serious eye damage.

Respiratory or skin sensitization

Respiratory sensitization Not a respiratory sensitizer.

Skin sensitization This product is not expected to cause skin sensitization.

Germ cell mutagenicity No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.

Carcinogenicity This product is not considered to be a carcinogen by IARC, ACGIH, NTP, or OSHA.

IARC Monographs. Overall Evaluation of Carcinogenicity

Not listed.

NTP Report on Carcinogens

Not listed.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1053)

Not listed.

Reproductive toxicity This product is not expected to cause reproductive or developmental effects.

Specific target organ toxicity - single exposure Not classified.

Specific target organ toxicity - repeated exposure Not classified.

Aspiration hazard Not an aspiration hazard.

Further information No other specific acute or chronic health impact noted.

12. Ecological information

Ecotoxicity Very toxic to aquatic life.

Components		Species	Test Results
Sodium carbonate (CAS 497-19-8)			
Aquatic			
Acute			
Crustacea	EC50	Ceriodaphnia dubia	200 mg/l, 48 Hours
Fish	LC50	Lepomis macrochirus	300 mg/l, 96 Hours
Sodium hydrosulfide (CAS 16721-80-5)			
Aquatic			
Acute			
Fish	LC50	Lepomis macrochirus	> 0.0478 mg/l, 96 Hours
Chronic			
Fish	LOAEL	Lepomis macrochirus	> 0.0041 mg/l, 97 days

Components		Species	Test Results
Sodium sulfide (CAS 1313-82-2)			
Aquatic			
Acute			
Crustacea	LC50	Crustacea	0.08 mg/l, 48 Hours

Persistence and degradability No data is available on the degradability of this product.

Bioaccumulative potential No data available.

Mobility in soil This product is water soluble and may disperse in soil.

Other adverse effects The product may affect the acidity (pH-factor) in water with risk of harmful effects to aquatic organisms.

13. Disposal considerations

Disposal instructions Collect and reclaim or dispose in sealed containers at licensed waste disposal site. Do not allow this material to drain into sewers/water supplies. Do not contaminate ponds, waterways or ditches with chemical or used container. Dispose of contents/container in accordance with local/regional/national/international regulations.

Local disposal regulations Dispose in accordance with all applicable regulations.

Hazardous waste code D002: Waste Corrosive material [pH <=2 or =>12.5, or corrosive to steel]
D003: Waste Reactive material
The waste code should be assigned in discussion between the user, the producer and the waste disposal company.

Waste from residues / unused products Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner.

Contaminated packaging Since emptied containers may retain product residue, follow label warnings even after container is emptied. Empty containers should be taken to an approved waste handling site for recycling or disposal.

14. Transport information

DOT

UN number	UN2922
UN proper shipping name	Corrosive liquids, toxic, n.o.s. (Sodium hydrosulfide)
Transport hazard class(es)	
Class	8
Subsidiary risk	6.1
Label(s)	8, 6.1
Packing group	II
Environmental hazards	
Marine pollutant	Yes
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
Special provisions	B3, IB2, T7, TP2
Packaging exceptions	154
Packaging non bulk	202
Packaging bulk	243

IATA

UN number	UN2922
UN proper shipping name	Corrosive liquid, toxic, n.o.s. (Sodium hydrosulfide)
Transport hazard class(es)	
Class	8
Subsidiary risk	6.1
Label(s)	8, 6.1
Packing group	II
Environmental hazards	Yes
ERG Code	8P
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

IMDG

UN number	UN2922
UN proper shipping name	CORROSIVE LIQUID, TOXIC, N.O.S. (SODIUM HYDROSULFIDE)
Transport hazard class(es)	
Class	8

Subsidiary risk	6.1
Packing group	II
Environmental hazards	
Marine pollutant	Yes
EmS	F-A, S-B
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code	Not applicable.
General information	DOT Regulated Marine Pollutant.

15. Regulatory information

US federal regulations This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)

Not regulated.

CERCLA Hazardous Substance List (40 CFR 302.4)

Sodium hydrosulfide (CAS 16721-80-5) Listed.

SARA 304 Emergency release notification

Not regulated.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1053)

Not listed.

Toxic Substances Control Act (TSCA) All components of the mixture on the TSCA 8(b) inventory are designated “active”.

Superfund Amendments and Reauthorization Act of 1986 (SARA)

SARA 302 Extremely hazardous substance

Not listed.

SARA 311/312 Hazardous chemical Yes

Classified hazard categories
Corrosive to metal
Acute toxicity (any route of exposure)
Skin corrosion or irritation
Serious eye damage or eye irritation

SARA 313 (TRI reporting)

Not regulated.

Other federal regulations

Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List

Not regulated.

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)

Not regulated.

Safe Drinking Water Act (SDWA) Contains component(s) regulated under the Safe Drinking Water Act.

US state regulations

US. Massachusetts RTK - Substance List

Sodium hydrosulfide (CAS 16721-80-5)
Sodium sulfide (CAS 1313-82-2)

US. New Jersey Worker and Community Right-to-Know Act

Sodium hydrosulfide (CAS 16721-80-5)
Sodium sulfide (CAS 1313-82-2)

US. Pennsylvania Worker and Community Right-to-Know Law

Sodium hydrosulfide (CAS 16721-80-5)

US. Rhode Island RTK

Sodium hydrosulfide (CAS 16721-80-5)

California Proposition 65

WARNING: This product may expose you to trace chemicals, which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov.

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	Yes
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	Yes
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
Taiwan	Taiwan Chemical Substance Inventory (TCSI)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates this product complies with the inventory requirements administered by the governing country(s).
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information, including date of preparation or last revision

Issue date 16-Aug-2016

Revision date 04-May-2020

Version # 02

NFPA ratings

List of abbreviations
EC50: Effective Concentration, 50%.
LOAEC: Lowest observed adverse effect concentration.
LC50: Lethal Concentration, 50%.
IC50: Inhibitory concentration, 50%.
TWA: Time weighted average.
STEL: Short term exposure limit.

Disclaimer TDC, L.L.C. cannot anticipate all conditions under which this information and its product, or the products of other manufacturers in combination with its product, may be used. It is the user's responsibility to ensure safe conditions for handling, storage and disposal of the product, and to assume liability for loss, injury, damage or expense due to improper use. The information in the sheet was written based on the best knowledge and experience currently available.

B-2
Sodium Isobutyl Xanthate

FloMin Inc.

MATERIAL SAFETY DATA

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

2-14
P1 BX
A-317

Product name:	**Flomin C 3430 Collector**
Chemical Name:	Sodium isobutyl xanthate
Synonyms:	Dithio-O-isobutyl ester
Molecular Formula:	$C_4H_9OCS_2Na$
Molecular Weight:	172.2
Manufacturer:	Flomin Inc. 7500 FM 1405 Baytown, TX 77520
Emergency Phones:	800-424-9300 CHEMTREC (North America) +1-703-527-3887 CHEMTREC (World Wide)

2. COMPOSITION / INFORMATION ON INGREDIENTS

Component	***CAS #***	***Weight, %***	***Exposure Limit***
Sodium isobutyl xanthate	25306-75-6	> 90	Not established

3. HAZARDS IDENTIFICATION

WARNING! Product is spontaneously combustible. Avoid contact with heat, moist air, and water. Product dust or mist may be irritating to nose, throat, and respiratory system. Product dust and liquid solutions may cause eye and skin burns. Harmful if swallowed. Excessive heating or contact with moisture may liberate toxic and flammable carbon disulfide (CS_2).

POTENTIAL HEALTH EFFECTS: (*See Section 11 for toxicological data.)*

Eye: Mild to severe irritant. May cause tearing, blurring of vision and corneal damage.

Skin: Mild to severe skin irritant. Effects of prolonged skin contact may include rash and burns.

Ingestion: Ingestion can cause irritation or burns of the mouth, throat, esophagus, and stomach with nausea and vomiting. Central nervous system effects may include headaches, weakness, and nausea.

Inhalation: Prolonged inhalation of mist or dust may cause irritation to the nose, throat and respiratory system. Central nervous system effects may include headaches, weakness, dizziness and nausea. Excessive heating or contact with moisture can release poisonous, flammable carbon disulfide gas. Carbon disulfide has a characteristic "garlic like" odor. The TWA (8-hour) exposure level for carbon disulfide is 20 ppm. The IDLH exposure level for carbon disulfide is 500 ppm.

4. FIRST AID MEASURES

Inhalation: Move to fresh air immediately. Administer oxygen if necessary. Seek medical attention if symptoms persist.

Skin contact: Remove contaminated clothing immediately and wash affected skin with soap and water. Get medical treatment for burns and persistent irritation. Launder contaminated clothing before reuse.

Eye contact: Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician. Keep eye wide open while rinsing and lift upper and lower lids to ensure complete removal of chemical.

Ingestion: Do not induce vomiting. Drink large quantities of water. Call a physician immediately.

5. FIRE FIGHTING MEASURES

Flammable properties (for carbon disulfide):

- ***Flash point*** -22°F (-30°C) TCC
- ***Flammable limits*** LEL = 0.6%, UEL = 60%
- ***Autoignition temp.*** 194-203°F (90-95°C)
- ***Decomposition temp.*** N/A

Extinguishing media: Use carbon dioxide, dry chemical, or foam.

Fire fighting precautions: Avoid contact with dusts, mists and liquids. Keep personnel removed and upwind of fire.

Protective equipment: Wear NIOSH approved, positive pressure, self-contained respirator. Wear full protective equipment for body and eyes.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions: Wear full protective equipment for eyes, body and respiratory system. Ventilate spill area. Remove all sources of ignition.

Clean up methods: Sweep up spills and collect for disposal or reuse. Flush spill area with water.

Environmental: Keep flush material out of waterways. Dispose of cleanup material in an approved manner.

7. HANDLING AND STORAGE

Handling: Wear protective equipment for eyes, body and respiratory system.

Storage: Store in closed containers in a cool area away from sources of heat or ignition. Precautions should be taken to avoid static electricity discharge. Store in steel, stainless steel, polyethylene, or polypropylene containers.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Personal protection equipment:

- ***Respiratory:*** Wear a properly fitted NIOSH/MSA approved respirator whenever significant exposure to vapor or mist is likely.
- ***Hand:*** Neoprene, polyvinyl, butyl rubber or nitrile rubber gloves are suitable.
- ***Eye:*** Wear chemical splash proof goggles or face shield.
- ***Skin:*** Wear coveralls and/or chemical apron and rubber footwear where physical contact can occur.

Hygiene: Wash hands before breaks and immediately after handling the product. Do not eat or store food and drinks where this product is used.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance:	Light yellow to green pellets
Odor:	Disagreeable
Boiling point:	N/A
Melting point:	522°F (272°C)
Vapor pressure:	N/A
Bulk density:	40 lbs/cu. ft. (0.64 g/cc)
Vapor density:	N/A (Air =1)
pH:	N/A (>12 for aqueous solutions)
Water solubility:	Soluble
Viscosity:	N/A

10. STABILITY AND REACTIVITY

Stability: Stable at normal conditions. No hazardous polymerization will occur.

Conditions to avoid: High temperatures and ignition sources. Avoid moisture, strong acids & oxidizing agents. Not compatible with copper or its alloys.

Hazardous decomposition Products: Carbon disulfide, isobutyl alcohol, and carbon monoxide may form under fire conditions.

11. TOXICOLOGICAL INFORMATION

Acute toxicity:

- Oral: Acute oral LD_{50} (rat) = 500 - 2000 mg/kg for 10% solution

- Dermal: Acute dermal LD_{50} (rabbit) = 44 mg/kg

- Inhalation: N/A

Irritation:

- Skin: Mild to severe skin irritant.

- Eyes: Mild to severe eye irritant.

Sensitization: May sensitize some individuals toward asthmatic conditions and allergic skin reactions.

12. ECOLOGICAL INFORMATION

Aquatic toxicity: N/A. Expected to be toxic to aquatic life.

Biodegradation: N/A

13. DISPOSAL CONSIDERATIONS

Disposal: Dispose of only in accordance with regulations. Do not contaminate any lakes, streams, ponds, groundwater or soil.

Containers: Empty containers retain product residues (liquid and vapor) and can be dangerous. Do not cut or burn or expose empty containers to heat, flame or sources of ignition. Empty containers should be completely emptied and disposed in accordance with regulations.

14. TRANSPORT INFORMATION

Agency	Proper shipping name, Hazard class, UN#, Packing group
DOT:	Xanthates, 4.2, UN 3342, II, Spontaneously Combustible This product is regulated as a hazardous material as defined by the DOT.
IMO:	Xanthates, 4.2, UN 3342, II, Spontaneously Combustible This product is regulated as a dangerous good as defined by the IMDG code for marine transport.
ICAO/IATA:	Xanthates, 4.2, UN 3342, II, Spontaneously Combustible This product is regulated as a dangerous good as defined by the ICAO/IATA for air transport.
Canada:	Xanthates, 4.2, UN 3342, II, Spontaneously Combustible This product is regulated as a dangerous good as defined by the WHIMS classification.

15. REGULATORY INFORMATION

Components of this product are listed on the TSCA (US), DSL (Canada) and EINECS (Europe) inventories.

SARA 302: Contains no chemicals subject to 40 CFR 302 reporting.

SARA 311/312: Immediate (acute) health hazard, fire hazard, reactive.

SARA 313: Contains no chemicals subject to 40 CFR 313 reporting.

16. OTHER INFORMATION

Hazard Ratings

	Health	Flammability	Reactivity
- NFPA	2	2	2

B-3
Methyl Isobutyl Carbinol

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1 Product identifier

- Trade name AEROFROTH® 70 FROTHER

1.2 Relevant identified uses of the substance or mixture and uses advised against

Uses of the Substance / Mixture

- Frother

1.3 Details of the supplier of the safety data sheet

Company

CYTEC INDUSTRIES INC.
504 CARNEGIE CENTER
PRINCETON, NJ 08540 USA
Telephone: +1-973-357-3193

1.4 Emergency telephone

FOR EMERGENCIES INVOLVING A SPILL, LEAK, FIRE, EXPOSURE OR ACCIDENT, CONTACT CHEMTREC (24-Hour Number): 800-424-9300 within the United States and Canada, or 703-527-3887 for international collect calls.

Disclaimer

The ® indicates a Registered Trademark in the United States and the ™ indicates a trademark in the United States. The mark may also be registered, subject of an application for registration, or a trademark in other countries.

SECTION 2: Hazards identification

Although OSHA has not adopted the environmental portion of the GHS regulations, this document may include information on environmental effects.

2.1 Classification of the substance or mixture

HCS 2012 (29 CFR 1910.1200)

Flammable liquids, Category 3	H226: Flammable liquid and vapor.
Eye irritation, Category 2A	H319: Causes serious eye irritation.
Specific target organ systemic toxicity - single exposure, Category 3	H335: May cause respiratory irritation. (Respiratory system)

2.2 Label elements

HCS 2012 (29 CFR 1910.1200)

Pictogram

Signal Word

- Warning

Hazard Statements

-	H226	Flammable liquid and vapor.
-	H319	Causes serious eye irritation.
-	H335	May cause respiratory irritation.

Precautionary Statements

Prevention

-	P210	Keep away from heat/sparks/open flames/hot surfaces. No smoking.
-	P233	Keep container tightly closed.
-	P240	Ground/bond container and receiving equipment.
-	P241	Use explosion-proof electrical/ ventilating/ lighting/ equipment.
-	P242	Use only non-sparking tools.
-	P243	Take precautionary measures against static discharge.
-	P261	Avoid breathing dust/ fume/ gas/ mist/ vapors/ spray.
-	P264	Wash skin thoroughly after handling.
-	P271	Use only outdoors or in a well-ventilated area.
-	P280	Wear protective gloves/ eye protection/ face protection.

Response

-	P303 + P361 + P353	IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
-	P304 + P340 + P312	IF INHALED: Remove person to fresh air and keep comfortable for breathing. Call a POISON CENTER/doctor if you feel unwell.
-	P305 + P351 + P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
-	P337 + P313	If eye irritation persists: Get medical advice/ attention.
-	P370 + P378	In case of fire: Use dry sand, dry chemical or alcohol-resistant foam to extinguish.

Storage

-	P403 + P233	Store in a well-ventilated place. Keep container tightly closed.
-	P403 + P235	Store in a well-ventilated place. Keep cool.
-	P405	Store locked up.

Disposal

-	P501	Dispose of contents/ container to an approved waste disposal plant.

2.3 Other hazards which do not result in classification

None identified

SECTION 3: Composition/information on ingredients

3.1 Substance

-	Chemical nature	Mineral processing reagent

Hazardous Ingredients and Impurities

Chemical name	Identification number CAS-No.	Concentration [%]
2-Pentanol, 4-methyl-	108-11-2	98 - 100
4-Heptanone, 2,6-dimethyl-	108-83-8	<= 2
2-Pentanone, 4-methyl-	108-10-1	< 1

The specific chemical identity and/or exact percentage (concentration) of composition has been withheld as a trade secret.

3.2 Mixture

- Not applicable, this product is a substance.

SECTION 4: First aid measures

4.1 Description of first-aid measures

In case of inhalation

- Quickly move the person away from the contaminated area. Make the affected person rest.
- Always obtain medical attention.
- Show this sheet to the doctor.
- Be aware to maintain life support if necessary.

In case of skin contact

- Wash off immediately with plenty of water for at least 15 minutes.
- Use appropriate protective equipment when treating a contaminated person.
- Always obtain medical attention.
- Show this sheet to the doctor.
- Be aware to maintain life support if necessary.

In case of eye contact

- Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes.
- Keep eye wide open while rinsing.
- Show this sheet to the doctor.
- Always obtain medical advice, even if there are no symptoms.
- Be aware to maintain life support if necessary.

In case of ingestion

- Do NOT induce vomiting.
- Obtain medical attention.
- Show this sheet to the doctor.
- Do not give anything to drink.
- Be aware to maintain life support if necessary.

4.2 Most important symptoms and effects, both acute and delayed

Effects

- Effects on health may appear after exposure.
- The effects will depend on target organs.
- Ingestion may cause gastrointestinal irritation, nausea, vomiting and diarrhea.
- respiratory tract irritation

- Risk of respiratory disorder
- bronchitis
- Nose bleeding
- Chemical pneumonitis
- pulmonary edema
- May cause skin damage.
- Chronic exposure may cause dermatitis.
- May cause irreversible eye damage.
- Loss of the eye

Symptoms

- Symptoms will depend on the target organs.
- Inhalation may provoke the following symptoms:
- Cough
- Breathing difficulties
- Irritation
- Redness
- Swelling of tissue
- Ingestion may provoke the following symptoms:
- Nausea
- Diarrhea
- Abdominal pain
- Asphyxia
- Unconsciousness
- May cause respiratory tract irritation.
- Dermatitis
- Causes skin burns.
- Lachrymation
- Conjunctivitis
- Causes eye burns.

4.3 Indication of any immediate medical attention and special treatment needed

Notes to physician

- Be aware to maintain life support if necessary.
- Take victim to hospital if symptoms persist.
- Get medical advice/ attention.
- Consult with an ophthalmologist if eye symptoms persist.
- Burns must be treated by a physician.
- Treat symptomatically.
- Contact a poison control center.
- Keep under medical follow up for at least 48 hours.

SECTION 5: Firefighting measures

Flash point	106 °F (41 °C) closed cup
Autoignition temperature	680.5 °F (360.3 °C)
Flammability / Explosive limit	Lower flammability/explosion limit : 1.00 %(V)
	Upper flammability/explosion limit : 5.50 %(V)

5.1 Extinguishing media

Suitable extinguishing media

- Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

Unsuitable extinguishing media

- Water may be ineffective.

5.2 Special hazards arising from the substance or mixture

- Under fire conditions:
- Will burn
- On combustion, toxic gases are released.

5.3 Advice for firefighters

Special protective equipment for fire-fighters

- In the event of fire, wear self-contained breathing apparatus.
- Personal protective equipment comprising: suitable protective gloves, safety goggles and protective clothing
- For further information refer to section 8 "Exposure controls / personal protection."

Specific fire fighting methods

- Cool containers/tanks with water spray.
- Do not use a solid water stream as it may scatter and spread fire.

Further information

- Standard procedure for chemical fires.
- Collect contaminated fire extinguishing water separately. This must not be discharged into drains.
- Fire residues and contaminated fire extinguishing water must be disposed of in accordance with local regulations.

SECTION 6: Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

- Where exposure level is not known, wear approved, positive pressure, self-contained respirator.
- Where exposure level is known, wear approved respirator suitable for level of exposure.
- In addition to the protective clothing/equipment in Section 8 (Exposure Controls/Personal Protection), wear impermeable boots.

6.2 Environmental precautions

- Stop the leak. Turn leaking containers leak-side up to prevent the escape of liquid.
- Contain the spilled material by diking.
- Do not let product enter drains.
- Do not allow uncontrolled discharge of product into the environment.

- Spills may be reportable to the National Response Center (800-424-8802) and to state and/or local agencies

6.3 Methods and materials for containment and cleaning up

- Remove all sources of ignition.
- Stop leak if safe to do so.
- Keep in properly labeled containers.
- Keep in suitable, closed containers for disposal.
- Wash nonrecoverable remainder with large amounts of water.
- Soak up with inert absorbent material and dispose of as hazardous waste.
- Decontaminate tools, equipment and personal protective equipment in a segregated area.

- Dispose of in accordance with local regulations.
- Never return spills in original containers for re-use.

6.4 Reference to other sections

- 7. HANDLING AND STORAGE
- 8. EXPOSURE CONTROLS/PERSONAL PROTECTION
- 13. DISPOSAL CONSIDERATIONS

SECTION 7: Handling and storage

7.1 Precautions for safe handling

- Containers must be bonded and grounded when pouring or transferring material.
- This material contains a flammable or combustible liquid and vapor.

Hygiene measures

- Handle in accordance with good industrial hygiene and safety practice.
- Wash hands before breaks and at the end of workday.
- When using do not eat, drink or smoke.
- Eye wash bottles or eye wash stations in compliance with applicable standards.
- Ensure that eyewash stations and safety showers are close to the workstation location.

7.2 Conditions for safe storage, including any incompatibilities

Technical measures/Storage conditions

- Observe the general rules of industrial fire protection.
- Areas containing this material should have fire safe practices and electrical equipment in accordance with applicable regulations and/or guidelines. Standards are primarily based on the material`s flashpoint, but may also take into account properties such as miscibility with water or toxicity. All local and national regulations should be followed. |par In the Americas, National Fire Protection Association (NFPA) 30: Flammable and Combustible Liquids Code, is a widely used standard. NFPA 30 establishes storage conditions for the following classes of materials: Class I Flammable Liquids, Flashpoint <37.8 °C. Class II Combustible Liquids, 37.8 °C < Flashpoint <60 °C. Class IIIa Combustible Liquids, 60 °C < Flashpoint < 93 °C. Class IIIb Combustible Liquids, Flashpoint > 93 °C.
- Keep away from sources of ignition - No smoking.

Requirements for storage rooms and vessels

Recommended storage temperature: 68 °F (20 °C)

- Keep away from sources of ignition - No smoking.
- Mixture may charge electrostatically: always use grounding leads when transferring from one container to another.
- To guarantee safety keep according to Storage temperature and conditions.

7.3 Specific end use(s)

- no data available

SECTION 8: Exposure controls/personal protection

Introductory Remarks: These recommendations provide general guidance for handling this product. Because specific work environments and material handling practices vary, safety procedures should be developed for each intended application. Assistance with selection, use and maintenance of worker protection equipment is generally available from equipment manufacturers.

8.1 Control parameters

Components with workplace occupational exposure limits

Components	Value type	Value	Basis
2-Pentanol, 4-methyl-	TWA	25 ppm 100 mg/m3	National Institute for Occupational Safety and Health
	Potential for dermal absorption		
2-Pentanol, 4-methyl-	ST	40 ppm 165 mg/m3	National Institute for Occupational Safety and Health
	Potential for dermal absorption		
2-Pentanol, 4-methyl-	TWA	25 ppm	American Conference of Governmental Industrial Hygienists
	Danger of cutaneous absorption		
2-Pentanol, 4-methyl-	STEL	40 ppm	American Conference of Governmental Industrial Hygienists
	Danger of cutaneous absorption		
2-Pentanol, 4-methyl-	TWA	25 ppm 100 mg/m3	Occupational Safety and Health Administration - Table Z-1 Limits for Air Contaminants
	Skin designation, The value in mg/m3 is approximate.		
2-Pentanol, 4-methyl-	PEL	25 ppm 100 mg/m3	
	Skin		
2-Pentanol, 4-methyl-	STEL	40 ppm 165 mg/m3	
	Skin		
4-Heptanone, 2,6-dimethyl-	TWA	25 ppm 150 mg/m3	National Institute for Occupational Safety and Health
4-Heptanone, 2,6-dimethyl-	TWA	25 ppm	American Conference of Governmental Industrial Hygienists
4-Heptanone, 2,6-dimethyl-	TWA	50 ppm 290 mg/m3	Occupational Safety and Health Administration - Table Z-1 Limits for Air Contaminants
	The value in mg/m3 is approximate.		

4-Heptanone, 2,6-dimethyl-	PEL	25 ppm 150 mg/m3	
2-Pentanone, 4-methyl-	TWA	50 ppm 205 mg/m3	National Institute for Occupational Safety and Health
2-Pentanone, 4-methyl-	ST	75 ppm 300 mg/m3	National Institute for Occupational Safety and Health
2-Pentanone, 4-methyl-	TWA	20 ppm	American Conference of Governmental Industrial Hygienists
2-Pentanone, 4-methyl-	STEL	75 ppm	American Conference of Governmental Industrial Hygienists
2-Pentanone, 4-methyl-	TWA	100 ppm 410 mg/m3	Occupational Safety and Health Administration - Table Z-1 Limits for Air Contaminants
	The value in mg/m3 is approximate.		
2-Pentanone, 4-methyl-	PEL	50 ppm 205 mg/m3	
2-Pentanone, 4-methyl-	STEL	75 ppm 300 mg/m3	
2-Pentanone, 4-methyl-	PEL	50 ppm 205 mg/m3	
2-Pentanone, 4-methyl-	STEL	75 ppm 300 mg/m3	

NIOSH IDLH (Immediately Dangerous to Life or Health Concentrations)

Components	CAS-No.	Concentration
2-Pentanol, 4-methyl-	108-11-2	400 ppm
4-Heptanone, 2,6-dimethyl-	108-83-8	500 ppm
2-Pentanone, 4-methyl-	108-10-1	500 ppm

Biological Exposure Indices

Components	Value type	Value	Basis
2-Pentanone, 4-methyl-	BEI	1 mg/l methyl isobutyl ketone Urine End of shift (As soon as possible after exposure ceases)	American Conference of Governmental Industrial Hygienists

8.2 Exposure controls

Control measures

Engineering measures
- Ensure adequate ventilation.
- Apply technical measures to comply with the occupational exposure limits.

Individual protection measures

Respiratory protection
- Self-contained breathing apparatus in confined spaces/insufficient oxygen/in case of large uncontrolled emissions/in all circumstances when the mask and cartridge do not give adequate protection.
- Use only respiratory protection that conforms to international/ national standards.
- Respirator with a vapor filter (EN 141)
- Respirator with a full face mask.
- Use the indicated respiratory protection if the occupational exposure limit is exceeded.

Hand protection
- Take note of the information given by the producer concerning permeability and break through times, and of special workplace conditions (mechanical strain, duration of contact).
- Impervious gloves

Eye protection
- Chemical resistant goggles must be worn.
- Tightly fitting safety goggles

Skin and body protection
- Impervious clothing
- Change working clothes after each work-shift.
- Contaminated work clothing should not be allowed out of the workplace.

Hygiene measures
- Handle in accordance with good industrial hygiene and safety practice.
- Wash hands before breaks and at the end of workday.
- When using do not eat, drink or smoke.
- Eye wash bottles or eye wash stations in compliance with applicable standards.
- Ensure that eyewash stations and safety showers are close to the workstation location.

SECTION 9: Physical and chemical properties

Physical and Chemical properties here represent typical properties of this product. Contact the business area using the Product information phone number in Section 1 for its exact specifications.

9.1 Information on basic physical and chemical properties

Appearance	Physical state:	liquid
	Color:	colorless to white
Odor	mild	
Odor Threshold	No data available	
Molecular weight	102 g/mol	
pH	No data available	

Melting point/freezing point	Melting point/range: -195 °F (-126 °C)
Initial boiling point and boiling range	Boiling point/boiling range: 270 °F (132 °C)
Flash point	106 °F (41 °C) closed cup
Evaporation rate (Butylacetate = 1)	0.26 - 0.43
Flammability (solid, gas)	No data available
Flammability (liquids)	No data available
Flammability / Explosive limit	Lower flammability/explosion limit: Type: Lower flammability limit 1.00 %(V) Upper flammability/explosion limit: Type: Upper flammability limit 5.50 %(V)
Autoignition temperature	680.5 °F (360.3 °C)
Vapor pressure	3.7 - 4.7 mmHg (4.93 - 6.27 hPa) (68 °F (20 °C))
Vapor density	3.5 (Air = 1.0)
Density	0.81 g/cm3 (68 °F (20 °C))
Relative density	No data available
Solubility	Water solubility: 17 - 18.2 g/l (68 °F (20 °C))soluble
Partition coefficient: n-octanol/water	Not applicable
Decomposition temperature	No data available
Viscosity	Viscosity, dynamic : 5.2 mPa.s (68 °F (20 °C)) Viscosity, kinematic : 6.4 mm2/s (68 °F (20 °C))
Explosive properties	No data available
Oxidizing properties	Not considered as oxidizing.

9.2 Other information

Corrosion of Metals	Not corrosive to metals.

Peroxides	The substance or mixture is not classified as organic peroxide.

SECTION 10: Stability and reactivity

10.1 Reactivity

- no data available

10.2 Chemical stability

- Stable

10.3 Possibility of hazardous reactions

- no data available

10.4 Conditions to avoid

- Keep away from flames and sparks.
- To avoid thermal decomposition, do not overheat.

10.5 Incompatible materials

- Acids
- Oxidizing agents

10.6 Hazardous decomposition products

Thermal decomposition

- Carbon oxides

SECTION 11: Toxicological information

11.1 Information on toxicological effects

Acute toxicity

Acute oral toxicity	The product has a low acute toxicity According to the available data on the components. According to the classification criteria for mixtures. Unpublished reports and/or published data.
Acute inhalation toxicity	The product has a low acute toxicity According to the available data on the components. According to the classification criteria for mixtures. Unpublished reports and/or published data.
Acute dermal toxicity	The product has a low acute toxicity According to the available data on the components. According to the classification criteria for mixtures. Unpublished reports and/or published data.
Acute toxicity (other routes of administration)	Not applicable

Skin corrosion/irritation

Mild skin irritant
According to the available data on the components.
According to the classification criteria for mixtures.
Unpublished reports and/or published data.

Serious eye damage/eye irritation

Irritating to eyes.
According to the available data on the components.
According to the classification criteria for mixtures.
Unpublished reports and/or published data.

Respiratory or skin sensitization

Does not cause skin sensitization.
According to the available data on the components.
According to the classification criteria for mixtures.
Unpublished reports and/or published data.

Does not cause respiratory sensitization.
According to the available data on the components.
According to the classification criteria for mixtures.
Unpublished reports and/or published data.

Mutagenicity

Genotoxicity in vitro

Product is not considered to be genotoxic
According to the available data on the components.
According to the classification criteria for mixtures.
Unpublished reports and/or published data.

Genotoxicity in vivo

Product is not considered to be genotoxic
According to the available data on the components.
According to the classification criteria for mixtures.
Unpublished reports and/or published data.

Carcinogenicity

The product is not considered to be carcinogenic.
According to the available data on the components.
According to the classification criteria for mixtures.
Unpublished reports and/or published data.

Components	CAS-No.	Rating	Basis
2-Pentanone, 4-methyl-	108-10-1	Group 2B: Possibly carcinogenic to humans	IARC

This product does not contain any ingredient designated as probable or suspected human carcinogens by:
NTP
OSHA

Toxicity for reproduction and development

Toxicity to reproduction / fertility	The product is not considered to affect fertility.,According to the available data on the components. According to the classification criteria for mixtures. Unpublished reports and/or published data.
Developmental Toxicity/Teratogenicity	The product is not considered to be toxic for development.,According to the available data on the components. According to the classification criteria for mixtures. Unpublished reports and/or published data.

STOT

STOT-single exposure	Target Organs: Respiratory system The substance or mixture is classified as specific target organ toxicant, single exposure, category 3 with respiratory tract irritation according to GHS criteria. According to the available data on the components. According to the classification criteria for mixtures. Unpublished reports and/or published data.
STOT-repeated exposure	The substance or mixture is not considered to cause damage to organs through prolonged or repeated exposure. According to the available data on the components. According to the classification criteria for mixtures. Unpublished reports and/or published data. The product itself has not been tested.

Neurological effects

2-Pentanone, 4-methyl-	Rat, No neurotoxic effects observed., Published data

Experience with human exposure

Experience with human exposure : Inhalation

No data is available on the product itself.

Experience with human exposure : Skin contact

No data is available on the product itself.

Experience with human exposure : Eye contact

No data is available on the product itself.

Experience with human exposure : Ingestion

No data is available on the product itself.

CMR effects

Carcinogenicity

2-Pentanone, 4-methyl-	This substance has been reported to cause tumors in certain animal species. Not classified as a carcinogen according to GHS criteria: the mechanism or mode of action of tumour formation is considered not relevant for humans.

Mutagenicity

2-Pentanone, 4-methyl-	Tests on bacterial or mammalian cell cultures did not show mutagenic effects. In vivo tests did not show mutagenic effects

Teratogenicity

2-Pentanone, 4-methyl-	Did not show teratogenic effects in animal experiments.

Reproductive toxicity

2-Pentanone, 4-methyl-	Animal testing did not show any effects on fertility.

Aspiration toxicity — No aspiration toxicity classification, According to the available data on the components, According to the classification criteria for mixtures.

SECTION 12: Ecological information

12.1 Toxicity

Aquatic Compartment

Acute toxicity to fish	LC50 - 96 h : > 100 mg/l - Oncorhynchus mykiss (rainbow trout) static test Method: OECD Test Guideline 203 Published data
Acute toxicity to daphnia and other aquatic invertebrates	EC50 - 48 h : 710 mg/l - Daphnia magna (Water flea) static test Method: OECD Test Guideline 202 Published data
Toxicity to aquatic plants	The product itself has not been tested.
Toxicity to microorganisms	The product itself has not been tested.
Chronic toxicity to fish	The product itself has not been tested.
Chronic toxicity to daphnia and other aquatic invertebrates	The product itself has not been tested.

Sediment compartment

Toxicity to benthic organisms	The product itself has not been tested.

Terrestrial Compartment

Toxicity to soil dwelling organisms	The product itself has not been tested.
Toxicity to terrestrial plants	The product itself has not been tested.
Toxicity to above ground organisms	The product itself has not been tested.

12.2 Persistence and degradability

Abiotic degradation

Stability in water	Conclusion is not possible for a mixture as a whole.
Photodegradation	Conclusion is not possible for a mixture as a whole.
Other Physicochemical reactions	Conclusion is not possible for a mixture as a whole.

Physical- and photo-chemical elimination

Physico-chemical removability	Conclusion is not possible for a mixture as a whole.

Biodegradation

Biodegradability	As (bio)degradability is not relevant for mixtures, all the components of the mixture were assessed individually (rapid degradability assessment available below). > 70 % - 28 Days
Ratio BOD / COD	Conclusion is not possible for a mixture as a whole.
Ratio BOD / ThOD	Conclusion is not possible for a mixture as a whole.
Biochemical Oxygen Demand (BOD)	Conclusion is not possible for a mixture as a whole.
Dissolved organic carbon (DOC)	Conclusion is not possible for a mixture as a whole.
Chemical Oxygen Demand (COD)	Conclusion is not possible for a mixture as a whole.
Adsorbed organic bound halogens (AOX)	Conclusion is not possible for a mixture as a whole.

Degradability assessment	All or most of the components are considered to be rapidly degradable in the environment Unpublished reports Published data

12.3 Bioaccumulative potential

Partition coefficient: n-octanol/water	Conclusion is not possible for a mixture as a whole.
Bioconcentration factor (BCF)	Conclusion is not possible due to incomplete or heterogeneous data on the components Unpublished reports Published data

12.4 Mobility in soil

Adsorption potential (Koc)	Conclusion is not possible for a mixture as a whole.
Known distribution to environmental compartments	Conclusion is not possible due to incomplete or heterogeneous data on the components

12.5 Results of PBT and vPvB assessment	This mixture contains no substance considered to be persistent, bioaccumulating and toxic (PBT). This mixture contains no substance considered to be very persistent and very bioaccumulating (vPvB).

12.6 Other adverse effects

Ecotoxicity assessment

Short-term (acute) aquatic hazard	No acute environmental hazard identified. According to the available data on the components. According to the classification criteria for mixtures. Unpublished reports and/or published data.
Long-term (chronic) aquatic hazard	No chronic environmental hazard identified. According to the available data on the components. According to the classification criteria for mixtures. Unpublished reports and/or published data.

SECTION 13: Disposal considerations

13.1 Waste treatment methods

Product Disposal

- The Company encourages the recycle, recovery and reuse of materials, where permitted. If disposal is necessary, The Company recommends that organic materials, especially when classified as hazardous waste, be disposed of by thermal treatment or incineration at approved facilities. All local and national regulations should be followed.

SECTION 14: Transport information

Transportation status: IMPORTANT! Statements below provide additional data on listed transport classification.
The listed Transportation Classification does not address regulatory variations due to changes in package size, mode of shipment or

other regulatory descriptors.

DOT

14.1 UN number	UN 2053
14.2 Proper shipping name	METHYL ISOBUTYL CARBINOL
14.3 Transport hazard class	3
Label(s)	3
14.4 Packing group	
Packing group	III
ERG No	129
14.5 Environmental hazards	NO
Marine pollutant	

TDG

14.1 UN number	UN 2053
14.2 Proper shipping name	METHYL ISOBUTYL CARBINOL
14.3 Transport hazard class	3
Label(s)	3
14.4 Packing group	
Packing group	III
ERG No	129
14.5 Environmental hazards	NO
Marine pollutant	

NOM

14.1 UN number	UN 2053
14.2 Proper shipping name	METHYL ISOBUTYL CARBINOL
14.3 Transport hazard class	3
Label(s)	3
14.4 Packing group	
Packing group	III
ERG No	129
14.5 Environmental hazards	NO
Marine pollutant	

IMDG

14.1 UN number	UN 2053
14.2 Proper shipping name	METHYL ISOBUTYL CARBINOL
14.3 Transport hazard class	3
Label(s)	3
14.4 Packing group	
Packing group	III
14.5 Environmental hazards	NO
Marine pollutant	
14.6 Special precautions for user	
EmS	F-E , S-D

For personal protection see section 8.

IATA

14.1 UN number	UN 2053
14.2 Proper shipping name	METHYL ISOBUTYL CARBINOL
14.3 Transport hazard class	3
Label(s):	3
14.4 Packing group	
Packing group	III
Packing instruction (cargo aircraft)	366
Max net qty / pkg	220.00 L
Packing instruction (passenger aircraft)	355
Max net qty / pkg	60.00 L
14.5 Environmental hazards	NO

14.6 Special precautions for user
For personal protection see section 8.

Note: The above regulatory prescriptions are those valid on the date of publication of this sheet. Given the possible evolution of transportation regulations for hazardous materials, it would be advisable to check their validity with your sales office.

SECTION 15: Regulatory information

15.1 Notification status

Inventory Information	Status
EU. European Registration, Evaluation, Authorisation and Restriction of Chemical (REACH)	- When purchased from a European Solvay legal entity, this product is compliant with the registration provisions of the REACH Regulation (EC) No. 1907/2006 as all its components are either excluded, exempt, and/or registered. When purchased from a legal entity outside of Europe, please contact your local representative for additional information.
United States TSCA Inventory	- Listed on Inventory
Canadian Domestic Substances List (DSL)	- Listed on Inventory
Australia Inventory of Chemical Substances (AICS)	- Listed on Inventory
Japan. CSCL - Inventory of Existing and New Chemical Substances	- Listed on Inventory
Korea. Korean Existing Chemicals Inventory (KECI)	- Listed on Inventory
China. Inventory of Existing Chemical Substances in China (IECSC)	- Listed on Inventory
Philippines Inventory of Chemicals and Chemical Substances (PICCS)	- Listed on Inventory
Taiwan Chemical Substance Inventory (TCSI)	- Listed on Inventory

15.2 Federal Regulations

US. EPA EPCRA SARA Title III

SARA Hazard Designation Sections 311/312 (40 CFR 370)

Flammable (gases, aerosols, liquids, or solids)	Yes
Serious eye damage or eye irritation	Yes
Specific target organ toxicity (single or repeated exposure)	Yes

The categories not mentioned are not relevant for the product.

Section 313 Toxic Chemicals (40 CFR 372.65)
This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

Section 302 Emergency Planning Extremely Hazardous Substance Threshold Planning Quantity (40 CFR 355)
This material does not contain any components with a section 302 EHS TPQ.
Section 302 Emergency Planning Extremely Hazardous Substance Reportable Quantity (40 CFR 355)
This material does not contain any components with a SARA 302 RQ.

Section 304 Emergency Release Notification Reportable Quantity (40 CFR 355)
This material does not contain any components with a section 304 EHS RQ.

US. EPA CERCLA Hazardous Substances and Reportable Quantities (40 CFR 302.4)

Components	CAS-No.	Reportable quantity
2-Pentanone, 4-methyl-	108-10-1	5000 lb

15.3 State Regulations

US. California Safe Drinking Water & Toxic Enforcement Act (Proposition 65)

This product is not sold or intended to be sold as a "consumer product" as defined under California's Proposition 65 statute and regulations. If you require information, please contact your local sales representative.

SECTION 16: Other information

NFPA (National Fire Protection Association) - Classification

Health	2 moderate
Flammability	2 moderate
Instability or Reactivity	0 minimal

Date Prepared: 10/15/2018

Key or legend to abbreviations and acronyms used in the safety data sheet

- PEL	Permissible exposure limit
- ST	STEL - 15-minute TWA exposure that should not be exceeded at any time during a workday
- STEL	Short term exposure limit
- TWA	8-hour, time-weighted average
- ACGIH	American Conference of Governmental Industrial Hygienists
- OSHA	Occupational Safety and Health Administration
- NTP	National Toxicology Program
- IARC	International Agency for Research on Cancer
- NIOSH	National Institute for Occupational Safety and Health

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information, and belief at the date of its publication. Such information is only given as a guidance to help the user handle, use, process, store, transport, dispose, and release the product in satisfactory safety conditions and is not to be considered as a warranty or quality specification. It should be used in conjunction with technical sheets but do not replace them. Thus, the information only relates to the designated specific product and may not be applicable if such product is used in combination with other materials or in any other manufacturing process, unless otherwise specifically indicated. It does not release the user from ensuring he is in conformity with all regulations linked to its activity.

B-4
Dowfroth 250

Material Safety Data Sheet
The Dow Chemical Company

Product Name: DOWFROTH* 250 FLOTATION FROTHER

Issue Date: 02/27/2008
Print Date: 20 Mar 2008

The Dow Chemical Company encourages and expects you to read and understand the entire (M)SDS, as there is important information throughout the document. We expect you to follow the precautions identified in this document unless your use conditions would necessitate other appropriate methods or actions.

1. Product and Company Identification

Product Name
DOWFROTH* 250 FLOTATION FROTHER

COMPANY IDENTIFICATION
The Dow Chemical Company
2030 Willard H. Dow Center
Midland, MI 48674
USA

Customer Information Number: 800-258-2436

EMERGENCY TELEPHONE NUMBER
24-Hour Emergency Contact: 989-636-4400
Local Emergency Contact: 989-636-4400

2. Hazards Identification

Emergency Overview
Color: Yellow to brown
Physical State: Liquid
Odor: Ether
Hazards of product:

> WARNING! Causes eye irritation. May cause skin irritation. May cause anesthetic effects. May be harmful if swallowed. Isolate area. Keep upwind of spill.

OSHA Hazard Communication Standard
This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

Potential Health Effects
Eye Contact: May cause moderate eye irritation. May cause moderate corneal injury. Effects may be slow to heal.
Skin Contact: Brief contact is essentially nonirritating to skin. Prolonged contact may cause moderate skin irritation with local redness. May cause more severe response if skin is abraded (scratched or

cut). May cause more severe response on covered skin (under clothing, gloves). May cause drying and flaking of the skin.
Skin Absorption: Prolonged or repeated exposure to very large amounts of component(s) in this mixture may cause dizziness or drowsiness.
Inhalation: At room temperature, exposure to vapor is minimal due to low volatility; single exposure is not likely to be hazardous. If material is heated or aerosol/mist is produced, concentrations may be attained that are sufficient to cause respiratory irritation and other effects. Symptoms of excessive exposure may be anesthetic or narcotic effects; dizziness and drowsiness may be observed.
Ingestion: Low toxicity if swallowed. Small amounts swallowed incidentally as a result of normal handling operations are not likely to cause injury; however, swallowing larger amounts may cause injury. Observations in animals include: Tremors. Convulsions.

3. Composition Information

Component	CAS #	Amount
Polypropylene glycol monomethyl ether	37286-64-9	> 99.0 %
Potassium hydroxide	1310-58-3	< 1.0 %

4. First-aid measures

Eye Contact: Wash eyes immediately and continuously with water for 30 minutes. Remove contact lenses after the first 5 minutes and continue washing. Seek medical attention immediately, preferably from an ophthalmologist. Wash eyes en route if possible.
Skin Contact: Wash skin with plenty of water.
Inhalation: Move person to fresh air. If not breathing, give artificial respiration; if by mouth to mouth use rescuer protection (pocket mask, etc). If breathing is difficult, oxygen should be administered by qualified personnel. Call a physician or transport to a medical facility.
Ingestion: If swallowed, seek medical attention. Do not induce vomiting unless directed to do so by medical personnel.
Notes to Physician: Eye irrigation may be necessary for an extended period of time to remove as much caustic as possible. Duration of irrigation and treatment is at the discretion of medical personnel. Maintain adequate ventilation and oxygenation of the patient. Attempt seizure control with diazepam 5-10 mg (adults) intravenous over 2-3 minutes. Repeat every 5-10 minutes as needed. Monitor for hypotension, respiratory depression, and need for intubation. Consider second agent if seizures persist after 30 mg. If seizures persist or recur administer phenobarbital 600-1200 mg (adults) intravenous diluted in 60 ml 0.9% saline given at 25-50 mg/minute. Evaluate for hypoxia, dysrhythmia, electrolyte disturbance, hypoglycemia (treat adults with dextrose 100 mg intravenous). No specific antidote. Treatment of exposure should be directed at the control of symptoms and the clinical condition of the patient.
Medical Conditions Aggravated by Exposure: Skin contact may aggravate preexisting dermatitis.

5. Fire Fighting Measures

Extinguishing Media: Water fog or fine spray. Dry chemical fire extinguishers. Carbon dioxide fire extinguishers. Foam. Do not use direct water stream. May spread fire. Alcohol resistant foams (ATC type) are preferred. General purpose synthetic foams (including AFFF) or protein foams may function, but will be less effective.
Fire Fighting Procedures: Keep people away. Isolate fire and deny unnecessary entry. Use water spray to cool fire exposed containers and fire affected zone until fire is out and danger of reignition has passed. Burning liquids may be extinguished by dilution with water. Do not use direct water stream. May spread fire. Burning liquids may be moved by flushing with water to protect personnel and minimize property damage.
Special Protective Equipment for Firefighters: Wear positive-pressure self-contained breathing apparatus (SCBA) and protective fire fighting clothing (includes fire fighting helmet, coat, trousers,

boots, and gloves). For protective equipment in post-fire or non-fire clean-up situations, refer to the relevant sections.
Unusual Fire and Explosion Hazards: Violent steam generation or eruption may occur upon application of direct water stream to hot liquids.
Hazardous Combustion Products: During a fire, smoke may contain the original material in addition to combustion products of varying composition which may be toxic and/or irritating. Combustion products may include and are not limited to: Carbon monoxide. Carbon dioxide.

6. Accidental Release Measures

Steps to be Taken if Material is Released or Spilled: Small spills: Absorb with materials such as: Sand. Vermiculite. Collect in suitable and properly labeled containers. Large spills: Contain spilled material if possible. Pump into suitable and properly labeled containers. See Section 13, Disposal Considerations, for additional information.
Personal Precautions: Isolate area. Keep upwind of spill. Ventilate area of leak or spill. Refer to Section 7, Handling, for additional precautionary measures. Keep unnecessary and unprotected personnel from entering the area. Use appropriate safety equipment. For additional information, refer to Section 8, Exposure Controls and Personal Protection.
Environmental Precautions: Prevent from entering into soil, ditches, sewers, waterways and/or groundwater. See Section 12, Ecological Information.

7. Handling and Storage

Handling
General Handling: Do not get in eyes. Do not swallow. Avoid breathing vapor. Avoid contact with skin and clothing. Wash thoroughly after handling. Keep container closed. Use with adequate ventilation. Spills of these organic materials on hot fibrous insulations may lead to lowering of the autoignition temperatures possibly resulting in spontaneous combustion. See Section 8, EXPOSURE CONTROLS AND PERSONAL PROTECTION.
Other Precautions: Avoid contact with vapor from head space of containers.

Storage
To avoid uncontrolled emissions, vent vapor from container to storage tank. Store in the following material(s): Carbon steel. Stainless steel. Phenolic lined steel drums. Do not store in: Aluminum. Copper. Galvanized iron. Galvanized steel. See Section 10 for more specific information.

Bulk 6 Months
Metal drums. 18 Months

8. Exposure Controls / Personal Protection

Exposure Limits

Component	List	Type	Value
Potassium hydroxide	ACGIH	Ceiling	2 mg/m3

Personal Protection
Eye/Face Protection: Use chemical goggles. Eye wash fountain should be located in immediate work area.
Skin Protection: Use protective clothing chemically resistant to this material. Selection of specific items such as face shield, boots, apron, or full body suit will depend on the task. Remove contaminated clothing immediately, wash skin area with soap and water, and launder clothing before reuse or dispose of properly.

Hand protection: Use gloves chemically resistant to this material. Examples of preferred glove barrier materials include: Butyl rubber. Polyethylene. Ethyl vinyl alcohol laminate

("EVAL"). Examples of acceptable glove barrier materials include: Viton. Neoprene. Natural rubber ("latex"). Polyvinyl chloride ("PVC" or "vinyl"). Nitrile/butadiene rubber ("nitrile" or "NBR"). NOTICE: The selection of a specific glove for a particular application and duration of use in a workplace should also take into account all relevant workplace factors such as, but not limited to: Other chemicals which may be handled, physical requirements (cut/puncture protection, dexterity, thermal protection), potential body reactions to glove materials, as well as the instructions/specifications provided by the glove supplier.

Respiratory Protection: Respiratory protection should be worn when there is a potential to exceed the exposure limit requirements or guidelines. If there are no applicable exposure limit requirements or guidelines, wear respiratory protection when adverse effects, such as respiratory irritation or discomfort have been experienced, or where indicated by your risk assessment process. For most conditions, no respiratory protection should be needed; however, if material is heated or sprayed, use an approved air-purifying respirator. The following should be effective types of air-purifying respirators: Organic vapor cartridge with a particulate pre-filter.

Ingestion: Use good personal hygiene. Do not consume or store food in the work area. Wash hands before smoking or eating.

Engineering Controls

Ventilation: Use local exhaust ventilation, or other engineering controls to maintain airborne levels below exposure limit requirements or guidelines. If there are no applicable exposure limit requirements or guidelines, general ventilation should be sufficient for most operations. Local exhaust ventilation may be necessary for some operations.

9. Physical and Chemical Properties

Physical State	Liquid
Color	Yellow to brown
Odor	Ether
Flash Point - Closed Cup	149 °C (300 °F) *Literature*
Flammable Limits In Air	**Lower**: Not determined **Upper**: Not determined
Autoignition Temperature	Not determined
Vapor Pressure	< 0.01 mmHg @ 20 °C *Literature*
Boiling Point (760 mmHg)	245 °C (473 °F) *Literature* .
Vapor Density (air = 1)	No test data available
Specific Gravity (H2O = 1)	0.98 25 °C/25 °C *Literature*
Liquid Density	0.98 g/cm3 @ 25 °C
Freezing Point	No test data available
Melting Point	Not applicable
Solubility in Water (by weight)	partially miscible
pH	11 *Measured*
Kinematic Viscosity	21.7 mm2/s @ 25 °C *DIN 51562*

10. Stability and Reactivity

Stability/Instability

Stable under recommended storage conditions. See Storage, Section 7.

Conditions to Avoid: Do not distill to dryness. Product can oxidize at elevated temperatures. Generation of gas during decomposition can cause pressure in closed systems.

Incompatible Materials: Avoid contact with: Strong acids. Strong bases. Strong oxidizers.

Hazardous Polymerization

Will not occur.

Thermal Decomposition
Decomposition products depend upon temperature, air supply and the presence of other materials. Decomposition products can include and are not limited to: Aldehydes. Ketones. Organic acids.

11. Toxicological Information

Acute Toxicity
Ingestion
Single dose oral LD50 has not been determined.
For similar material(s): LD50, Rat 1,260 - 2,520 mg/kg
Skin Absorption
The dermal LD50 has not been determined.
Developmental Toxicity
Contains component(s) which did not cause birth defects or any other fetal effects in lab animals.
Genetic Toxicology
In vitro genetic toxicity studies were negative for component(s) tested.

12. Ecological Information

CHEMICAL FATE

Movement & Partitioning
Based on information for a similar material: No bioconcentration is expected because of the relatively high water solubility. Potential for mobility in soil is very high (Koc between 0 and 50).

Persistence and Degradability
Based on information for a similar material: Biodegradation under aerobic static laboratory conditions is low (BOD20 or BOD28/ThOD between 2.5 and 10%).
Biological oxygen demand (BOD):

BOD 5	BOD 10	BOD 20	BOD 28
		8.5 %	

Chemical Oxygen Demand: 2.07 mg/mg
Theoretical Oxygen Demand: 2.12 mg/mg
ECOTOXICITY
Based on information for a similar material: Material is practically non-toxic to fish on an acute basis (LC50 > 100 mg/L).

Fish Acute & Prolonged Toxicity
Based on information for a similar material: LC50, emerald shiner (Notropis atherinoides): > 100 mg/l
Based on information for a similar material: NOEC mortality, emerald shiner (Notropis atherinoides): > 100 mg/l

13. Disposal Considerations

DO NOT DUMP INTO ANY SEWERS, ON THE GROUND, OR INTO ANY BODY OF WATER. All disposal practices must be in compliance with all Federal, State/Provincial and local laws and regulations. Regulations may vary in different locations. Waste characterizations and compliance with applicable laws are the responsibility solely of the waste generator. DOW HAS NO CONTROL OVER THE MANAGEMENT PRACTICES OR MANUFACTURING PROCESSES OF PARTIES HANDLING OR USING THIS MATERIAL. THE INFORMATION PRESENTED HERE PERTAINS ONLY TO THE PRODUCT AS SHIPPED IN ITS INTENDED CONDITION AS DESCRIBED IN MSDS SECTION: Composition Information. FOR UNUSED & UNCONTAMINATED PRODUCT, the preferred options include sending to a licensed, permitted: Incinerator or other thermal destruction device. As a service to its customers, Dow can provide names of information resources to help identify waste management companies and other facilities which recycle, reprocess or manage chemicals or plastics, and that manage used drums. Telephone Dow's Customer Information Group at 1-800-258-2436 or 1-989-832-1556 (U.S.), or 1-800-331-6451 (Canada) for further details.

14. Transport Information

DOT Non-Bulk
NOT REGULATED

DOT Bulk
NOT REGULATED

IMDG
NOT REGULATED

ICAO/IATA
NOT REGULATED

This information is not intended to convey all specific regulatory or operational requirements/information relating to this product. Additional transportation system information can be obtained through an authorized sales or customer service representative. It is the responsibility of the transporting organization to follow all applicable laws, regulations and rules relating to the transportation of the material.

15. Regulatory Information

OSHA Hazard Communication Standard
This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

Superfund Amendments and Reauthorization Act of 1986 Title III (Emergency Planning and Community Right-to-Know Act of 1986) Sections 311 and 312

Immediate (Acute) Health Hazard	Yes
Delayed (Chronic) Health Hazard	No
Fire Hazard	No
Reactive Hazard	No
Sudden Release of Pressure Hazard	No

Superfund Amendments and Reauthorization Act of 1986 Title III (Emergency Planning and Community Right-to-Know Act of 1986) Section 313
To the best of our knowledge, this product does not contain chemicals at levels which require reporting under this statute.

Pennsylvania (Worker and Community Right-To-Know Act): Pennsylvania Hazardous Substances List and/or Pennsylvania Environmental Hazardous Substance List:
To the best of our knowledge, this product does not contain chemicals at levels which require reporting under this statute.

Pennsylvania (Worker and Community Right-To-Know Act): Pennsylvania Special Hazardous Substances List:
To the best of our knowledge, this product does not contain chemicals at levels which require reporting under this statute.

California Proposition 65 (Safe Drinking Water and Toxic Enforcement Act of 1986)
This product contains no listed substances known to the State of California to cause cancer, birth defects or other reproductive harm, at levels which would require a warning under the statute.

US. Toxic Substances Control Act
All components of this product are on the TSCA Inventory or are exempt from TSCA Inventory requirements under 40 CFR 720.30
CEPA - Domestic Substances List (DSL)
All substances contained in this product are listed on the Canadian Domestic Substances List (DSL) or are not required to be listed.

16. Other Information

Product Literature
Additional information on this product may be obtained by calling your Dow Chemical Company sales or customer service contact.

Hazard Rating System

NFPA	Health	Fire	Reactivity
	1	1	0

Recommended Uses and Restrictions
Flotation frother.

Revision
Identification Number: 50295 / 0000 / Issue Date 02/27/2008 / Version: 2.0
Most recent revision(s) are noted by the bold, double bars in left-hand margin throughout this document.

Legend

N/A	Not available
W/W	Weight/Weight
OEL	Occupational Exposure Limit
STEL	Short Term Exposure Limit
TWA	Time Weighted Average
ACGIH	American Conference of Governmental Industrial Hygienists, Inc.
DOW IHG	Dow Industrial Hygiene Guideline
WEEL	Workplace Environmental Exposure Level
HAZ_DES	Hazard Designation
Action Level	A value set by OSHA that is lower than the PEL which will trigger the need for activities such as exposure monitoring and medical surveillance if exceeded.

The Dow Chemical Company urges each customer or recipient of this (M)SDS to study it carefully and consult appropriate expertise, as necessary or appropriate, to become aware of and understand the data contained in this (M)SDS and any hazards associated with the product. The information herein is provided in good faith and believed to be accurate as of the effective date shown above. However, no warranty, express or implied, is given. Regulatory requirements are subject to change and may differ between various locations. It is the buyer's/user's responsibility to ensure that his activities comply with all federal, state, provincial or local laws. The information presented here pertains only to the product as shipped. Since conditions for use of the product are not under the control of the manufacturer, it is the buyer's/user's duty to determine the conditions necessary for the safe use of this product. Due to the proliferation of sources for information such as manufacturer-specific (M)SDSs, we are not and cannot be responsible for (M)SDSs obtained from any source other than ourselves. If you have obtained an (M)SDS from another source or if you are not sure that the (M)SDS you have is current, please contact us for the most current version.

B-5
Alkylaryl Dithiophosphate

CYTEC

Technology ahead of its time™

MSDS: 0000610
Date: 10/09/2003
Supercedes: 05/24/2001

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name:	**AEROFLOAT® 249 Promoter, Aqueous**
Synonyms:	None
Chemical Family:	Alkylaryl Dithiophosphate
Molecular Formula:	Mixture
Molecular Weight:	Mixture

CYTEC INDUSTRIES INC., FIVE GARRET MOUNTAIN PLAZA, WEST PATERSON, NEW JERSEY 07424, USA
For Product Information call 1-800/652-6013. Outside the USA and Canada call 1-973/357-3193.
EMERGENCY PHONE: For emergency involving spill, leak, fire, exposure or accident call CHEMTREC: 1-800/424-9300. Outside the USA and Canada call 1-703/527-3887.

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2. COMPOSITION/INFORMATION ON INGREDIENTS

OSHA REGULATED COMPONENTS

Component / CAS No.	% (w/w)	OSHA (PEL):	ACGIH (TLV)	Carcinogen
Sodium hydroxide 1310-73-2	0.5 - 1.0	2 mg/m^3	2 mg/m^3 ceiling	-
Sodium di(methyl-isobutylcarbinol) dithiophosphate 58237-08-4	25.0 - 35.0	Not Established	Not Established	-

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

APPEARANCE AND ODOR:

Color:	colorless to pale yellow
Appearance:	clear, nonviscous liquid
Odor:	slight sulfur

STATEMENTS OF HAZARD:
DANGER! CAUSES BURNS OF EYES AND SKIN

POTENTIAL HEALTH EFFECTS

EFFECTS OF OVEREXPOSURE:

The acute oral (rat) and dermal (rabbit) LD50 values are estimated to be greater than 5,000 mg/kg and greater than 2,000 mg/kg, respectively. Direct contact with this material may cause severe eye and skin irritation. Contact with acid may cause liberation of hydrogen sulfide. Hydrogen sulfide has a strong rotten-egg odor, however, some people are unable to smell the gas and exposure will deaden the sense of smell. Therefore, odor is an unreliable indicator of exposure. Repeated or prolonged dermal contact with this material may cause severe allergic skin reactions. Such allergic reactions may be incapacitating for an extended period of time. Overexposure to hydrogen sulfide gas may cause severe eye or respiratory tract irritation, rapid development of coma and respiratory failure. Low levels of hydrogen sulfide may cause headache, dizziness, staggering gait, neurological damage and gastritis. Refer to Section 11 for toxicology information on the regulated components of this product.

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4. FIRST AID MEASURES

Ingestion:
If swallowed, call a physician immediately. Only induce vomiting at the instruction of a physician. Never give anything by mouth to an unconscious person.

Skin Contact:
Take off immediately all contaminated clothing. Wear impermeable gloves. Wash immediately with plenty of water and soap. Pay particular attention to skin crevices, nail folds, etc. Do not reuse contaminated clothing without laundering. Do not reuse contaminated leatherware.

Eye Contact:
Rinse immediately with plenty of water for at least 15 minutes. Obtain medical attention immediately.

Inhalation:
Remove to fresh air. If breathing is difficult, give oxygen. Apply artificial respiration if patient is not breathing. Obtain medical attention immediately.

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5. FIRE-FIGHTING MEASURES

Extinguishing Media:
Use water spray or fog, carbon dioxide or dry chemical.

Protective Equipment:
Firefighters, and others exposed, wear self-contained breathing apparatus. Wear full firefighting protective clothing. See Section 8 (Exposure Controls/Personal Protection).

Special Hazards:
Sulfur dioxide or hydrogen sulfide may be formed under fire conditions. Do not flush to sewer which may contain acid. This could result in generation of toxic and explosive hydrogen sulfide gas.

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6. ACCIDENTAL RELEASE MEASURES

Personal Precautions:
Where exposure level is not known, wear approved, positive pressure, self-contained respirator. Where exposure level is known, wear approved respirator suitable for level of exposure. In addition to the protective clothing/equipment in Section 8, wear a two piece PVC suit with hood or PVC overalls with hood.

Methods For Cleaning Up:
Cover spills with some inert absorbent. Sweep up into containers for disposal. Flush spill area with water.

Environmental Precautions:
Use appropriate containment to avoid environmental contamination.

7. HANDLING AND STORAGE

HANDLING

Precautionary Measures: Do not get in eyes, on skin or on clothing. Wash thoroughly after handling.

Handling Statements: This product should not be mixed with acids since evolution of toxic and explosive hydrogen sulfide gas could result. This precaution does not, of course, apply to addition of this reagent to flotation pulps in amounts customarily used in flotation.

STORAGE

None

Storage Temperature: Room temperature
Reason: Integrity

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Measures:
Utilize a closed system process where feasible. Where this material is not used in a closed system, good enclosure and local exhaust ventilation should be provided to control exposure.

Respiratory Protection:
Where exposures are below the established exposure limit, no respiratory protection is required. Where exposures exceed the established exposure limit, use respiratory protection recommended for the material and level of exposure.

Eye Protection:
Prevent eye and skin contact. Provide eye wash fountain and safety shower in close proximity to points of potential exposure. Wear eye/face protection such as chemical splash proof goggles or face shield.

Skin Protection:
Prevent contamination of skin or clothing when removing protective equipment. Wear impermeable gloves and suitable protective clothing.

Additional Advice:
Food, beverages, and tobacco products should not be carried, stored, or consumed where this material is in use. Before eating, drinking, or smoking, wash face and hands thoroughly with soap and water.

9. PHYSICAL AND CHEMICAL PROPERTIES

Color:	colorless to pale yellow
Appearance:	clear, nonviscous liquid
Odor:	slight sulfur
Boiling Point:	Not available
Melting Point:	Not available
Vapor Pressure:	Not available
Specific Gravity:	1.048 @ 25 °C
Vapor Density:	Not available
Percent Volatile (By Wt.):	~64(water)
pH:	>12.0
Saturation In Air (% By Vol.):	Not available
Evaporation Rate:	Not available
Solubility In Water:	Complete

Volatile Organic Content:	Not available
Flash Point:	>99 °C 210 °F Setaflash Closed Cup
Flammable Limits (% By Vol):	Not available
Autoignition Temperature:	Not available
Decomposition Temperature:	Not available
Partition coefficient (n-octanol/water):	Not available
Odor Threshold:	See Section 2 for exposure limits.

10. STABILITY AND REACTIVITY

Stability:	Stable
Conditions To Avoid:	None known
Polymerization:	Will not occur
Conditions To Avoid:	None known
Materials To Avoid:	Avoid contact with strong acids and oxidizing agents.
Hazardous Decomposition Products:	carbon monoxide carbon dioxide oxides of sulfur (includes sulfur di and tri oxides) oxides of phosphorus

11. TOXICOLOGICAL INFORMATION

Toxicological information for the product is found under Section 3. HAZARDS IDENTIFICATION.
Toxicological information on the regulated components of this product is as follows:

Acute overexposure to sodium hydroxide mists or dusts causes severe respiratory irritation. A solution of sodium hydroxide can produce irreversible damage to eyes and skin.

Sodium di(methylisobutyl carbinol) dithiophosphate has estimated acute oral (rat) and dermal (rabbit) LD50 values of greater than 5000 mg/kg, respectively. Direct contact with this material may cause eye burns and skin corrosion.

12. ECOLOGICAL INFORMATION

Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
The ecological assessment for this material is based on an evaluation of its components.

13. DISPOSAL CONSIDERATIONS

The information on RCRA waste classification and disposal methodology provided below applies only to the Cytec product, as supplied. If the material has been altered or contaminated, or it has exceeded its recommended shelf life, the guidance may be inapplicable. Hazardous waste classification under federal regulations (40 CFR Part 261 et seq) is dependent upon whether a material is a RCRA `listed hazardous waste`or has any of the four RCRA `hazardous waste characteristics.`Refer to 40 CFR Part 261.33 to determine if a given material to be disposed of is a RCRA `listed hazardous waste`; information contained in Section 15 of this MSDS is not intended to indicate if the product is a `listed hazardous waste.`RCRA Hazardous Waste Characteristics: There are four characteristics defined in 40 CFR Section 261.21-61.24: Ignitability, Corrosivity, Reactivity, and Toxicity. To determine Ignitability, see Section 9 of this MSDS (flash point). For Corrosivity, see Sections 9 and 14 (pH and DOT corrosivity). For Reactivity, see Section 10 (incompatible materials). For Toxicity, see Section 2 (composition). Federal regulations are subject to change. State and local requirements, which may differ from or be more stringent than the federal regulations, may also apply to the classification of the material if it is to be disposed. Cytec encourages the recycle, recovery and reuse of materials, where permitted, as an alternate to disposal as a waste. Cytec recommends that organic materials classified as RCRA hazardous wastes be disposed of by thermal treatment or incineration at EPA approved facilities. Cytec has provided the foregoing for information only; the person generating the waste is responsible for determining the waste classification and disposal method.

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14. TRANSPORT INFORMATION

This section provides basic shipping classification information. Refer to appropriate transportation regulations for specific requirements.

US DOT

Proper Shipping Name: Caustic alkali liquid, n.o.s.
Hazard Class: 8
Packing Group: II
UN/ID Number: UN1719
Transport Label Required: Corrosive
Marine Pollutant
Technical Name (N.O.S.): Contains dithiophosphate salt and sodium hydroxide
Hazardous Substances:
Not applicable
Comments: DOT requirements specific to marine pollutants do not apply to non-bulk packagings transported by motor vehicles, rail cars or aircraft.

TRANSPORT CANADA

Proper Shipping Name: Caustic alkali liquid, n.o.s.
Hazard Class: 8
Packing Group: II
UN Number: 1719
Transport Label Required: Corrosive
Marine Pollutant
Technical Name (N.O.S.): Contains dithiophosphate salt and sodium hydroxide

ICAO / IATA

Proper Shipping Name: Caustic alkali liquid, n.o.s.
Hazard Class: 8
Packing Group: II
UN Number: 1719
Transport Label Required: Corrosive
Packing Instructions/Maximum Net Quantity Per Package:
Passenger Aircraft: 809; 1L
Cargo Aircraft: 813; 30L

Technical Name (N.O.S.): Contains dithiophosphate salt and sodium hydroxide

IMO

Proper Shipping Name: Caustic alkali liquid, n.o.s.
Hazard Class: 8
UN Number: 1719
Packing Group: II
Transport Label Required: Corrosive
Marine Pollutant
Technical Name (N.O.S.): Contains dithiophosphate salt and sodium hydroxide

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15. REGULATORY INFORMATION

INVENTORY INFORMATION

United States (USA): All components of this product are included on the TSCA Inventory in compliance with the Toxic Substances Control Act, 15 U. S. C. 2601 et. seq.

Canada: This product contains components not on the Domestic Substances List. These components are on the Non-Domestic Substances List.

European Union (EU): All components of this product are included in the European Inventory of Existing Chemical Substances (EINECS) in compliance with Council Directive 67/548/EEC and its amendments.

OTHER ENVIRONMENTAL INFORMATION

The following components of this product may be subject to reporting requirements pursuant to Section 313 of CERCLA (40 CFR 372), Section 12(b) of TSCA, or may be subject to release reporting requirements (40 CFR 307, 40 CFR 311, etc.) See Section 13 for information on waste classification and waste disposal of this product.

This product does not contain any components regulated under these sections of the EPA

PRODUCT HAZARD CLASSIFICATION UNDER SECTION 311 OF SARA

- Acute

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16. OTHER INFORMATION

NFPA Hazard Rating (National Fire Protection Association)

Health: 3 - Materials that, under emergency conditions, can cause serious or permanent injury.

Fire: 1 - Materials that must be preheated before ignition can occur.

Reactivity: 0 - Materials that in themselves are normally stable, even under fire exposure conditions.

Reasons For Issue: New Format
Revised Section 6
Revised Section 12
Revised Section 14

Randy Deskin, Ph.D., DABT +1-973-357-3100

B-6
n-Dodecyl Mercaptan

1 PRODUCT AND COMPANY IDENTIFICATION

Thio and Fine Chemicals
Arkema Inc.
2000 Market Street
Philadelphia, PA 19103

EMERGENCY PHONE NUMBERS:
Chemtrec: (800) 424-9300 (24hrs) or (703) 527-3887
Medical: Rocky Mountain Poison Control Center
(866) 767-5089 (24Hrs)

Information Telephone Numbers	Phone Number	Available Hrs
Customer Service	1-800-628-4453	8:30 to 5:30 EST

Product Name	n-DODECYL MERCAPTAN
Product Synonym(s)	NDM, NDDM
Chemical Family	Alkyl Mercaptan
Chemical Formula	C12H26S
Chemical Name	1-Dodecanethiol
EPA Reg Num	
Product Use	

2 COMPOSITION / INFORMATION ON INGREDIENTS

Ingredient Name	CAS RegistryNumber	Typical Wt. %	OSHA
n-Dodecyl mercaptan	112-55-0	99.5%	Y

The substance(s) marked with a "Y" in the OSHA column, are identified as hazardous chemicals according to the criteria of the OSHA Hazard Communication Standard (29 CFR 1910.1200)

This material is classified as hazardous under Federal OSHA regulation.

The components of this product are all on the TSCA Inventory list.

3 HAZARDS IDENTIFICATION

Emergency Overview
Colorless liquid; heavy offensive mercaptan odor.
DANGER!
CAUSES EYE BURNS. MAY CAUSE BLINDNESS.
MAY CAUSE NAUSEA, HEADACHE OR DIZZINESS.

Potential Health Effects

Inhalation and skin contact are expected to be the primary routes of occupational exposure to this material. Based on single exposure animal tests, it is considered to be slightly toxic to practically non-toxic if swallowed or inhaled, no more than slightly toxic if absorbed through skin, corrosive to eyes and non-irritating to skin. This material has a strong objectionable odor that may cause nausea, headache, or dizziness. Vapor or aerosol can be severely irritating to the respiratory tract leading to lung injury. Medical conditions which may be aggravated by overexposure to this material include lung disease or limited respiratory capacity.

4 FIRST AID MEASURES

IF IN EYES, immediately flush with plenty of water for at least 15 minutes. Get medical attention immediately.

IF ON SKIN, immediately wash with soap and plenty of water. Remove contaminated clothing and shoes. Get medical attention if symptoms occur. Wash clothing before reuse. Thoroughly clean shoes before reuse.

IF SWALLOWED, do NOT induce vomiting. Give water to drink. Get medical attention immediately. NEVER GIVE ANYTHING BY MOUTH TO AN UNCONSCIOUS PERSON.

IF INHALED, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

5 FIRE FIGHTING MEASURES

Fire and Explosive Properties

Auto-Ignition Temperature	NE		
Flash Point	>200F	Flash Point Method	TCC
Flammable Limits- Upper	NE		
Lower	NE		

Extinguishing Media

Use water spray, carbon dioxide, foam or dry chemical.

Fire Fighting Instructions

Use water spray to cool containers exposed to fire. Contain run-off from fire. Fire fighters and others who may be exposed to products of combustion should wear full fire fighting turn out gear (full Bunker Gear) and self-contained breathing apparatus (pressure demand NIOSH approved or equivalent). Fire fighting equipment should be thoroughly decontaminated after use

Fire and Explosion Hazards

When burned, the following hazardous products of combustion can occur:
Oxides of carbon
Sulfur oxides
Hydrogen sulfide

6 ACCIDENTAL RELEASE MEASURES

In Case of Spill or Leak

Ventilate the area. Contain spill by building a dike using absorbent material. Consult with environmental engineer or professional to determine if neutralization is appropriate and for handling procedures for residual materials. Do not use solid bleach for neutralization, as fire or violent reaction can occur. Collect the liquid and solid absorbent into a drum approved for waste disposal. Flush area with water. Consult a regulatory specialist to determine appropriate state or local reporting requirements, for assistance in waste characterization and/or hazardous waste disposal and other requirements listed in pertinent environmental permits.

7 HANDLING AND STORAGE

Handling

Do not get in eyes, on skin or on clothing.
Keep container closed.

7 HANDLING AND STORAGE

Use only with adequate ventilation.
Wash thoroughly after handling.

Emptied container retains vapor and product residue. Observe all labeled safeguards until container is cleaned, reconditioned or destroyed.

Storage

This material is not hazardous under normal storage conditions; however, material should be stored in closed containers, in a secure area to prevent container damage and subsequent spillage.

8 EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering Controls

Investigate engineering techniques to reduce exposures. Provide ventilation if necessary to minimize exposure. Dilution ventilation is acceptable, but local mechanical exhaust ventilation preferred, if practical, at sources of air contamination such as open process equipment.

Eye / Face Protection

Where there is potential for eye contact, wear a face shield, chemical goggles, and have eye flushing equipment immediately available.

Skin Protection

Wear appropriate chemical resistant protective clothing and chemical resistant gloves to prevent skin contact. Consult glove manufacturer to determine appropriate type glove material for given application. Wear chemical goggles, a face shield, and chemical resistant clothing such as a rubber apron when splashing may occur. Rinse immediately if skin is contaminated. Remove contaminated clothing promptly and wash before reuse. Clean protective equipment before reuse. Provide a safety shower at any location where skin contact can occur. Wash skin thoroughly after handling.

Respiratory Protection

Avoid breathing vapor or mist. Where airborne exposure is likely, use NIOSH approved respiratory protection equipment appropriate to the material and/or its components. Full facepiece equipment is recommended and, if used, replaces need for face shield and/or chemical goggles. If exposures cannot be kept at a minimum with engineering controls, consult respirator manufacturer to determine appropriate type equipment for given application. Observe respirator use limitations specified by NIOSH or the manufacturer. For emergency and other conditions where there may be a potential for significant exposure, use an approved full face positive-pressure, self-contained breathing apparatus or positive-pressure airline with auxiliary self-contained air supply. Respiratory protection programs must comply with 29 CFR § 1910.134.

Airborne Exposure Guidelines for Ingredients

Exposure Limit		Value
n-Dodecyl mercaptan		
ACGIH Sensitizer Designator	-	Y
ACGIH TWA	-	0.1 ppm

-Only those components with exposure limits are printed in this section.
-Skin contact limits designated with a "Y" above have skin contact effect. Air sampling alone is insufficient to accurately quantitate exposure. Measures to prevent significant cutaneous absorption may be required.
-ACGIH Sensitizer designator with a value of "Y" above means that exposure to this material may cause allergic reactions.
-WEEL-AIHA Sensitizer designator with a value of "Y" above means that exposure to this material may cause allergic skin reactions.

9 PHYSICAL AND CHEMICAL PROPERTIES

Appearance/Odor	Colorless liquid; heavy offensive mercaptan odor.
pH	NE
Specific Gravity	0.845 @ 20 C
Vapor Pressure	< 0.1 psia
Vapor Density	7
Melting Point	NA
Freezing Point	-8 C (17.6 F)
Boiling Point	269-285 C (516-545 F)
Solubility In Water	Negligible
Solubility in Other Materials	Hydrocarbons, alcohols
Evaporation Rate	NE
Percent Volatile	100
Viscosity	3.24 cP @ 20 C
Molecular Weight	202.41
Other Physical Data	Refractive index: 1.459 @ 20 C Odor threshold: 0.5 ppm Critical temperature: 454 C Critical pressure: 18200 mbar

10 STABILITY AND REACTIVITY

Stability

This material is chemically stable under normal and anticipated storage and handling conditions.

Incompatibility

Contact with combustible materials may enhance the risk of fire. Acids, solid bleach (or strong oxidizers) may cause violent reaction and fire.

Hazardous Decomposition Products

None known.

11 TOXICOLOGICAL INFORMATION

Toxicological Information

Data on this material and/or its components are summarized below.

Single exposure (acute) studies indicate:
Oral - Slightly Toxic to Practically Non-toxic to Rats (LD50 1,960 - >5,000 mg/kg)
Dermal - No More than Slightly Toxic to Rats (LD50 >2,000 mg/kg)
Inhalation - Practically Non-toxic to Rats (4-hr LC50 >8-9 ppm; no deaths following exposure to saturated vapor)
Eye Irritation - Corrosive to Rabbits
Skin Irritation - Non-irritating to Rabbits (24-hr exposure)

11 TOXICOLOGICAL INFORMATION

Skin allergy was observed in guinea pigs following repeated exposure in some tests, but not others. A potential for irritation and allergic reactions in humans has been reported. Following repeated inhalation exposures, rats and mice exhibited eye, nasal and respiratory tract irritation and breathing difficulties, followed by death which was associated with lung damage. A repeated inhalation exposure study in mice produced microscopic liver changes. Following a longer-term inhalation exposure study, rats showed reduced growth, reduced liver and adrenal function, general congestion of the internal organs and microscopic changes in lungs, liver, kidney, heart and brain. No birth defects were observed in the offspring of rats exposed by inhalation during pregnancy, even at amounts which produced significant adverse effects on the mothers. No genetic changes were observed in tests using bacteria or animal cells.

12 ECOLOGICAL INFORMATION

Ecotoxicological Information

No data are available.

Chemical Fate Information

No data are available.

13 DISPOSAL CONSIDERATIONS

Waste Disposal

Incineration is the recommended method for disposal observing all local, state and federal regulations. Note: Chemical additions to, processing of, or otherwise altering this material may make this waste management information incomplete, inaccurate, or otherwise inappropriate. Furthermore, state and local waste disposal requirements may be more restrictive or otherwise different from federal laws and regulations.

14 TRANSPORT INFORMATION

DOT Name	Not Regulated by DOT
DOT Technical Name	
DOT Hazard Class	
UN Number	
DOT Packing Group	PG
RQ	
DOT Special Information	AIR SHIPMENT USE THE FOLLOWING: Aviation Regulated Liquid, n.o.s. (n-Dodecyl mercaptan) 9 UN 3334

15 REGULATORY INFORMATION

Hazard Categories Under Criteria of SARA Title III Rules (40 CFR Part 370)

Immediate (Acute) Health	Y	Fire	N
Delayed (Chronic) Health	N	Reactive	N
		Sudden Release of Pressure	N

The components of this product are all on the TSCA Inventory list.

Ingredient Related Regulatory Information:

SARA Reportable Quantities	CERCLA RQ	SARA TPQ
n-Dodecyl mercaptan	NE	

Pennsylvania Right to Know

This product does contain the following chemical(s), as indicated below, currently on the Pennsylvania Hazardous Substance List.

n-Dodecyl mercaptan

16 OTHER INFORMATION

Revision Information

Revision Date	11 OCT 2004	Revision Number 7
Supercedes Revision Dated	02-MAR-2004	

Revision Summary

ATOFINA Chemicals, Inc. has changed its name to Arkema Inc.

Key

NE= Not Established NA= Not Applicable (R) = Registered Trademark

B-7
Sodium Silicates

SAFETY DATA SHEET

SECTION 1: IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY/UNDERTAKING

1.1 Product identifier

Product Name	**N® Sodium Silicate Solution** **3.22 weight ratio sodium silicate**
Alternative names	Sodium silicate solution
CAS No.	1344-09-8
EINECS No.	215-687-4

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified use(s)	General purpose industrial chemical for use in a wide range of applications. Binding agent ; Corrosion inhibitor ; Dust binding agent ; Flame retardant or fire preventing agent ; Flotation agent ; Stabiliser ; Viscosity control agent
Uses advised against	None known.

1.3 Details of the supplier of the safety data sheet

Company Identification	PQ Corporation P.O. Box 840 Valley Forge PA 19482 USA
Telephone:	+1 610-651-4200
E-Mail (competent person)	sds.uk@pqcorp.com

Distributed by:
The Science Company
7625 W Hampden Ave, #14
Lakewood CO 80227
Ph: 303-777-3777
Fax: 303-777-3331

Cat.No. NC-0882, NC-2598, NC-5424, NC-11830

1.4 Emergency telephone number

Emergency Phone No.	+1 800-424-9300

SECTION 2: HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

GHS Classification	(anticipated) Skin Irrit. 2 Eye Irrit. 2
Hazards summary	Alkaline. Irritating to eyes and skin.

2.2 Label elements

Hazard pictogram(s)

Signal word(s)	Warning
Hazard statement(s)	H315: Causes skin irritation. H319: Causes serious eye irritation.

Precautionary statement(s)	P262: Do not get in eyes, on skin, or on clothing. P280: Wear protective gloves/protective clothing/eye protection/face protection. P303+P361+P353: IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower. P305+P351+P338: IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
2.3 Other hazards	Not applicable.

SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS

Regulation (EC) No. 1272/2008 (CLP)

Ingredient(s)	%W/W	CAS No.	EINECS No. / REACH Registration	Hazard symbol(s) and hazard statement(s)
Silicic acid, sodium salt	37.5	1344-09-8	215-687-4 01-2119448725-31	H315 : Skin Irrit. 2 ; H319 : Eye Irrit. 2 ; H335 : STOT SE 3 ;
Water	62.5	7732-18-5	231-791-2	

SECTION 4: FIRST AID MEASURES

4.1 Description of first aid measures

Eye Contact	Irrigate with eyewash solution or clean water, holding the eyelids apart, for at least 15 minutes. Obtain immediate medical attention.
Skin Contact	Wash affected skin with plenty of water. If symptoms develop, obtain medical attention.
Inhalation	Remove patient from exposure, keep warm and at rest. Obtain medical attention.
Ingestion	Do not induce vomiting. Wash out mouth with water and give 200-300 ml (half a pint) of water to drink. Obtain medical attention.
4.2 Most important symptoms and effects, both acute and delayed	Alkaline. Irritating to eyes and skin. The toxicity of sodium silicate is dependent on the silica to alkali ratio and on the pH.
4.3 Indication of any immediate medical attention and special treatment needed	Obtain immediate medical attention.

SECTION 5: FIRE-FIGHTING MEASURES

5.1 Extinguishing media

Suitable Extinguishing Media	Compatible with all standard fire fighting techniques.
Unsuitable extinguishing Media	None known.
5.2 Special hazards arising from the substance or mixture	Not applicable. Aqueous solution. Non-combustible.
5.3 Advice for fire-fighters	None.

SECTION 6: ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures	Wear suitable protective clothing. Wear eye/face protection.

6.2 Environmental precautions	Do not allow to enter drains, sewers or watercourses. Advise Authorities if spillage has entered water course or sewer or has contaminated soil or vegetation.
6.3 Methods and materials for containment and cleaning up	Caution - spillages may be slippery. Contain spillages with sand, earth or any suitable adsorbent material. Transfer to a container for disposal or recovery.
6.4 Reference to other sections	See Also Section 8.

SECTION 7: HANDLING AND STORAGE

7.1 Precautions for safe handling	Avoid contact with eyes, skin and clothing. Avoid generation of mist. Provide adequate ventilation. Emergency shower and eye wash facilities should be readily available. See Also Section 8
7.2 Conditions for safe storage, including any incompatibilities	Keep at a temperature not exceeding (°C): 50 Do not allow material to freeze. Provide an adequate bund wall. Unsuitable containers: Aluminium See Also Section 10.
7.3 Specific end use(s)	See also Annex to the extended Safety Data Sheet.

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 Control parameters

SUBSTANCE.	Occupational Exposure Limits
Silicic acid, sodium salt	No Occupational Exposure Limit assigned. An exposure limit of 2 mg/m3 (15 min TWA) is recommended by analogy with sodium hydroxide (UK EH40).

8.2 Exposure controls	Wear protective equipment to comply with good occupational hygiene practice. Do not eat, drink or smoke at the work place.
8.2.1 Appropriate engineering controls	Engineering methods to prevent or control exposure are preferred. Methods include process or personnel enclosure, mechanical ventilation (dilution and local exhaust), and control of process conditions.
8.2.2 Personal Protection	
Respiratory protection	Respiratory protection not normally required. Advice on respiratory protective equipment is given in the HSE (Health and Safety Executive) publication HS(G)53.
Eye/face protection	Chemical goggles (EN 166).
Skin protection	Wear suitable protective clothing and gloves. Plastic or rubber gloves. For example EN374-3, level 6 breakthrough time (>480min). Wear suitable overalls.
8.2.3 Environmental Exposure Controls	The primary hazard of sodium silicate is the alkalinity. Avoid release to the environment.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

Appearance	Liquid. Almost colourless.
Odour	Odourless.
Odour Threshold (ppm)	Not applicable.
pH (Value)	Alkaline.
Freezing Point (°C)	Not applicable.
Melting Point (°C)	Not applicable.
Boiling Point (°C)	100
Flash Point (°C) [Closed cup]	Not applicable.

Evaporation rate	Not applicable.
Flammability (solid, gas)	Not applicable.
Explosive Limit Ranges	Not applicable.
Vapour Pressure (mm Hg)	Not applicable.
Vapour Density (Air=1)	No data.
Density (g/ml)	No data.
Solubility (Water)	Soluble.
Solubility (Other)	No data.
Partition Coefficient	No data.
Auto Ignition Point (°C)	Not applicable.
Decomposition Temperature (°C)	Not applicable.
Viscosity (mPa. s)	Not applicable.
Explosive properties	Not applicable.
Oxidising Properties	Not applicable.
9.2 Other information	No data.

SECTION 10: STABILITY AND REACTIVITY

10.1 Reactivity	See Section: 10.3
10.2 Chemical stability	Stable.
10.3 Possibility of hazardous reactions	When arc welding vessels containing aqueous solutions of this material, take care to control any explosion risk from hydrogen evolved by electrolysis. Aqueous solutions will react with aluminium, zinc, tin and their alloys evolving hydrogen gas which can form an explosive mixture with air. Can react violently if in contact with acids. Can react with sugar residues to form carbon monoxide.
10.4 Conditions to avoid	See Section: 10.3
10.5 Incompatible materials	See Section: 10.3
10.6 Hazardous decomposition product(s)	None known.

SECTION 11: TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity	
Ingestion	All symptoms of acute toxicity are due to high alkalinity. Material will cause irritation. Oral LD50 (rat) 3400 mg/kg bw
Inhalation	Mist is irritant to the respiratory tract. All symptoms of acute toxicity are due to high alkalinity. Inhalation LC50 (rat) >2.06 g/m³
Skin Contact	Material will cause irritation. Dermal LD50 (rat) >5000 mg/kg bw
Eye Contact	Material will cause irritation.
Skin corrosion/irritation	Irritating to skin.
Serious eye damage/irritation	Irritating to eyes.
Sensitisation	Not sensitising.
Mutagenicity	No evidence of genotoxicity. In vitro/in vivo negative.
Carcinogenicity	No structural alerts.
Reproductive toxicity	No evidence of reproductive toxicity or developmental toxicity.
STOT - single exposure	Not classified
STOT - repeated exposure	Not classified. NOAEL oral (rat) >159 mg/kg bw/d
Aspiration hazard	Not classified
Other information	

SECTION 12: ECOLOGICAL INFORMATION

12.1 Toxicity	Fish (Brachydanio rerio) LC50 (96 hour) 1108 mg/l Aquatic invertebrates: (Daphnia magna) EC50 (48 hour) 1700 mg/l

12.2 Persistence and degradability	Inorganic. Soluble silicates, upon dilution, rapidly depolymerise into molecular species indistinguishable from natural dissolved silica.
12.3 Bioaccumulative potential	Inorganic. The substance has no potential for bioaccumulation.
12.4 Mobility in soil	Not applicable.
12.5 Results of PBT and vPvB assessment	Not classified as PBT or vPvB.
12.6 Other adverse effects	The alkalinity of this material will have a local effect on ecosystems sensitive to changes in pH.

SECTION 13: DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods	Dispose of this material and its container to hazardous or special waste collection point. This material is classified as hazardous waste under EC Directive 2008/98/EC. This material is classified as hazardous waste under the Hazardous Waste (England and Wales) Regulations SI 2005 No. 894. This material is classified as hazardous waste under the Hazardous Waste (England and Wales) Regulations SI 2005 No. 894. Disposal should be in accordance with local, state or national legislation.

SECTION 14: TRANSPORT INFORMATION

14.1 UN number	Not classified according to the United Nations ‘Recommendations on the Transport of Dangerous Goods’. Not classified as hazardous under DOT or US Transport Recommendations. International Maritime Dangerous Goods (IMDG) Code: Not classified as hazardous
14.2 Proper Shipping Name	Not applicable.
14.3 Transport hazard class(es)	Not applicable.
14.4 Packing group	Not applicable.
14.5 Environmental hazards	Not classified as a Marine Pollutant.
14.6 Special precautions for user	Unsuitable containers: Aluminium
14.7 Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code	Not applicable.

SECTION 15: REGULATORY INFORMATION

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

TSCA Inventory Status: Reported/Included.
AICS Inventory Status: Reported/Included.
DSL/NDSL Inventory Status: Reported/Included. SARA TITLE III: Not an Extremely Hazardous Substance under §302. Not a Toxic Chemical under §313. Hazard Categories under §§311/312: Acute

German Water Hazard Classification VwVwS: Product ID number 1314, WGK class 1 (low hazard to water).
2,0,0

15.2 Chemical Safety Assessment Information available on request.

SECTION 16: OTHER INFORMATION

Data referenced in this eSDS is from company-owned information and from data legitimately accessed by PQ Corporation through membership of Industry Consortia or other agreements. This includes data relating to toxicology, ecotoxicology, DNELs, PNECs and other information in this eSDS and its annex.

This SDS was last reviewed: 01/2013
The following sections contain revisions or new statements: All sections.

GHS Classification	(anticipated) Skin Irrit. 2 Eye Irrit. 2
Signal word(s)	Warning
Hazard pictogram(s)	
Hazard statement(s)	H315: Causes skin irritation. H319: Causes serious eye irritation.
Precautionary statement(s)	P262: Do not get in eyes, on skin, or on clothing. P280: Wear protective gloves/protective clothing/eye protection/face protection. P303+P361+P353: IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower. P305+P351+P338: IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

Information contained in this publication or as otherwise supplied to Users is believed to be accurate and is given in good faith, but it is for the Users to satisfy themselves of the suitability of the product for their own particular purpose. PQ Corporation gives no warranty as to the fitness of the product for any particular purpose and any implied warranty or condition (statutory or otherwise) is excluded except to the extent that exclusion is prevented by law. PQ Corporation accepts no liability for loss or damage (other than that arising from death or personal injury caused by defective product, if proved), resulting from reliance on this information. Freedom under Patents, Copyright and Designs cannot be assumed.

B-8
Carboxymethyl Cellulose Sodium

SAFETY DATA SHEET

Revision Date 25-Dec-2021 **Revision Number** 4

1. Identification

Product Name	**Carboxymethyl cellulose, sodium salt**
Cat No. :	**AC332640000; AC332640010; AC332641000**
Synonyms	Sodium Carboxymethyl Cellulose; Aquaplast; Carboxymethyl Cellulose
Recommended Use	Laboratory chemicals.
Uses advised against	Food, drug, pesticide or biocidal product use.

Details of the supplier of the safety data sheet

Company
Fisher Scientific Company
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Acros Organics
One Reagent Lane
Fair Lawn, NJ 07410

Emergency Telephone Number
For information **US** call: 001-800-ACROS-01 / **Europe** call: +32 14 57 52 11
Emergency Number **US:**001-201-796-7100 / **Europe:** +32 14 57 52 99
CHEMTREC Tel. No.**US:**001-800-424-9300 / **Europe:**001-703-527-3887

2. Hazard(s) identification

Classification
Classification under 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

This chemical is not considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Label Elements
None required

Hazards not otherwise classified (HNOC)
None identified

3. Composition/Information on Ingredients

Component	CAS No	Weight %
Sodium carboxymethyl cellulose	9004-32-4	100

4. First-aid measures

Eye Contact Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Get medical attention.

Skin Contact Wash off immediately with soap and plenty of water while removing all contaminated clothes and shoes. Get medical attention.

Inhalation Remove from exposure, lie down. Remove to fresh air. If not breathing, give artificial respiration. Get medical attention.

Ingestion Clean mouth with water. Get medical attention.

Most important symptoms and effects No information available.

Notes to Physician Treat symptomatically

5. Fire-fighting measures

Suitable Extinguishing Media Water spray. Carbon dioxide (CO_2). Dry chemical. Chemical foam.

Unsuitable Extinguishing Media No information available

Flash Point No information available
Method - No information available

Autoignition Temperature 370 °C / 698 °F

Explosion Limits
Upper No data available
Lower No data available
Sensitivity to Mechanical Impact No information available
Sensitivity to Static Discharge No information available

Specific Hazards Arising from the Chemical
Keep product and empty container away from heat and sources of ignition.

Hazardous Combustion Products
Carbon monoxide (CO). Carbon dioxide (CO_2).
Protective Equipment and Precautions for Firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

NFPA

Health	Flammability	Instability	Physical hazards
0	1	0	N/A

6. Accidental release measures

Personal Precautions Ensure adequate ventilation. Use personal protective equipment as required.
Environmental Precautions See Section 12 for additional Ecological Information.

Methods for Containment and Clean Up Sweep up and shovel into suitable containers for disposal.

7. Handling and storage

Handling	Avoid contact with skin and eyes. Do not breathe dust.
Storage.	Keep in a dry, cool and well-ventilated place. Keep container tightly closed.

8. Exposure controls / personal protection

Exposure Guidelines This product does not contain any hazardous materials with occupational exposure limitsestablished by the region specific regulatory bodies.

Engineering Measures None under normal use conditions.

Personal Protective Equipment

Eye/face Protection	Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
Skin and body protection	Wear appropriate protective gloves and clothing to prevent skin exposure.
Respiratory Protection	No protective equipment is needed under normal use conditions.
Hygiene Measures	Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Physical State	Powder Solid
Appearance	Beige
Odor	Odorless
Odor Threshold	No information available
pH	6.5-8 1% aq.sol
Melting Point/Range	300 °C / 572 °F
Boiling Point/Range	No information available
Flash Point	No information available
Evaporation Rate	Not applicable
Flammability (solid,gas)	No information available
Flammability or explosive limits	
Upper	No data available
Lower	No data available
Vapor Pressure	No information available
Vapor Density	Not applicable
Specific Gravity	No information available
Solubility	No information available
Partition coefficient; n-octanol/water	No data available
Autoignition Temperature	370 °C / 698 °F
Decomposition Temperature	No information available
Viscosity	Not applicable

10. Stability and reactivity

Reactive Hazard	None known, based on information available
Stability	Stable.
Conditions to Avoid	Incompatible products.
Incompatible Materials	Strong oxidizing agents

Hazardous Decomposition Products Carbon monoxide (CO), Carbon dioxide (CO_2)

Hazardous Polymerization No information available.

Hazardous Reactions None under normal processing.

11. Toxicological information

Acute Toxicity

Product Information No acute toxicity information is available for this product
Oral LD50 Based on ATE data, the classification criteria are not met. ATE > 2000 mg/kg.
Dermal LD50 Based on ATE data, the classification criteria are not met. ATE > 2000 mg/kg.
Mist LC50 Based on ATE data, the classification criteria are not met. ATE > 5 mg/l.
Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Sodium carboxymethyl cellulose	LD50 = 27000 mg/kg (Rat)	Not listed	LC50 > 5800 mg/m³ (Rat) 4 h

Toxicologically Synergistic Products No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation No information available

Sensitization No information available

Carcinogenicity The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	CAS No	IARC	NTP	ACGIH	OSHA	Mexico
Sodium carboxymethyl cellulose	9004-32-4	Not listed	Not listed	Not listed	Not listed	Not listed

Mutagenic Effects No information available

Reproductive Effects No information available.

Developmental Effects No information available.

Teratogenicity No information available.

STOT - single exposure None known
STOT - repeated exposure None known

Aspiration hazard No information available

Symptoms / effects,both acute and delayed No information available

Endocrine Disruptor Information No information available

Other Adverse Effects The toxicological properties have not been fully investigated.

12. Ecological information

Ecotoxicity
.

Persistence and Degradability Soluble in water Persistence is unlikely based on information available.

Bioaccumulation/ Accumulation No information available.

Mobility Will likely be mobile in the environment due to its water solubility.

13. Disposal considerations

Waste Disposal Methods	Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

14. Transport information

DOT	Not regulated
TDG	Not regulated
IATA	Not regulated
IMDG/IMO	Not regulated

15. Regulatory information

United States of America Inventory

Component	CAS No	TSCA	TSCA Inventory notification - Active-Inactive	TSCA - EPA Regulatory Flags
Sodium carboxymethyl cellulose	9004-32-4	X	ACTIVE	XU

Legend:
TSCA US EPA (TSCA) - Toxic Substances Control Act, (40 CFR Part 710)
X - Listed
'-' - Not Listed
XU - Indicates a substance exempt from reporting under the Inventory Update Rule, i.e. Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(B)

TSCA 12(b) - Notices of Export   Not applicable

International Inventories
Canada (DSL/NDSL), Europe (EINECS/ELINCS/NLP), Philippines (PICCS), Japan (ENCS), Japan (ISHL), Australia (AICS), China (IECSC), Korea (KECL).

Component	CAS No	DSL	NDSL	EINECS	PICCS	ENCS	ISHL	AICS	IECSC	KECL
Sodium carboxymethyl cellulose	9004-32-4	X	-	-	X	X	X	X	X	KE-05354

KECL - NIER number or KE number (http://ncis.nier.go.kr/en/main.do)

U.S. Federal Regulations

SARA 313	Not applicable
SARA 311/312 Hazard Categories	See section 2 for more information
CWA (Clean Water Act)	Not applicable
Clean Air Act	Not applicable
OSHA - Occupational Safety and Health Administration	Not applicable
CERCLA	Not applicable
California Proposition 65	This product does not contain any Proposition 65 chemicals.
U.S. State Right-to-Know Regulations	Not applicable

U.S. Department of Transportation
Reportable Quantity (RQ): N
DOT Marine Pollutant N
DOT Severe Marine Pollutant N

U.S. Department of Homeland Security This product does not contain any DHS chemicals.

Other International Regulations

Mexico - Grade No information available

Authorisation/Restrictions according to EU REACH

Safety, health and environmental regulations/legislation specific for the substance or mixture

Component	CAS No	OECD HPV	Persistent Organic Pollutant	Ozone Depletion Potential	Restriction of Hazardous Substances (RoHS)
Sodium carboxymethyl cellulose	9004-32-4	Not applicable	Not applicable	Not applicable	Not applicable

Component	CAS No	Seveso III Directive (2012/18/EC) - Qualifying Quantities for Major Accident Notification	Seveso III Directive (2012/18/EC) - Qualifying Quantities for Safety Report Requirements	Rotterdam Convention (PIC)	Basel Convention (Hazardous Waste)
Sodium carboxymethyl cellulose	9004-32-4	Not applicable	Not applicable	Not applicable	Not applicable

16. Other information

Prepared By Regulatory Affairs
Thermo Fisher Scientific
Email: EMSDS.RA@thermofisher.com

Revision Date 25-Dec-2021
Print Date 25-Dec-2021
Revision Summary This document has been updated to comply with the US OSHA HazCom 2012 Standard replacing the current legislation under 29 CFR 1910.1200 to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

Disclaimer
The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text

End of SDS

B-9
Hydrated Lime

SAFETY DATA SHEET

SECTION 1	IDENTIFICATION

Product

Name: Hydrated Lime

Other Names: Hydrate; High-Calcium Hydrated Lime

Recommended Uses: Water Treatment; pH adjustment; FGT; Construction

Company Identification:

US Operations:

Lhoist North America, Inc.
5600 Clearfork Main St, Ste. 300
Fort Worth, TX 76109
817-732-8164

Canadian Operations:

Lhoist North America of Canada, Inc.
20303-102B Ave.
Langley, BC V1M 3H1
604-888-4333

Emergency Phone Number:

Chemtrec 1-800-424-9300

SECTION 2	HAZARDS(S) IDENTIFICATION

Classification

Eye Damage – Category 1

Carcinogen – Category 1

Skin Irritation – Category 2

Specific Target Organ Toxicity Single Exposure – Category 3 (Respiratory System)

Specific Target Organ Toxicity Repeat Exposure – Category 1 (Respiratory System)

Labeling:

Pictograms:

Signal Word(s): Danger

Hazard Statements: Causes serious eye damage.

Causes skin irritation.

May cause respiratory irritation.

Causes damage to lungs through prolonged or repeated exposure when inhaled.

May cause cancer through inhalation.

Precautionary Statements:

Wear protective gloves and eye protection. Wash exposed skin thoroughly after handling. Do not breathe dust. Use only outdoors or in a well-ventilated area. Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Do not eat, drink or smoke when using this product.

If on skin: wash exposed skin with plenty of water. If skin irritation occurs: Get medical attention. Take off contaminated clothing and wash it before reuse.

If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do. Continue rinsing. Seek medical attention immediately. If inhaled: Remove person to fresh air and keep comfortable for breathing. Seek medical attention if you feel unwell.

If exposed or concerned: Get medical advice

Dispose of contents or containers in accordance with applicable regulations.

Other Hazards: None.

SECTION 3	COMPOSITION/ INFORMATION ON INGREDIENTS

Chemical Name: Calcium hydroxide

Common names and synonyms: Hydrate; High-Calcium Hydrated Lime

Chemical Identity	CAS #	Concentration, % Wt.
Calcium Hydroxide	1305-62-0	> 90%
Magnesium Oxide	1309-48-4	< 3%
Crystalline Silica	14808-60-7	< 2%

SECTION 4	FIRST AID MEASURES

Eye Contact: Contact can cause severe irritation or burning of eyes, including permanent damage. Immediately flush eyes with generous amounts of water for as long as needed. This may take several minutes. Pull back the eyelid to ensure that all lime dust has been washed out. Seek medical attention immediately. Do not rub eyes.

Inhalation: This product can cause severe irritation of the respiratory system. Move victim to fresh air. Seek medical attention if necessary. If breathing has stopped, give artificial respiration.

Skin Contact: Contact can cause severe irritation or burning of skin, especially in the presence of moisture. Wash exposed area with large amounts of water. Seek medical attention immediately.

Ingestion: This product can cause severe irritation or burning of gastrointestinal tract if swallowed. Do not induce vomiting. Seek medical attention immediately. Never give anything by mouth unless instructed to do so by medical personnel.

Most important symptoms and effects, both acute and delayed: Irritation of skin, eyes, gastrointestinal tract or respiratory tract. Long-term exposure by inhalation may cause permanent damage. This product contains crystalline silica, which has been classified by IARC as (Group I) carcinogenic to humans when inhaled. Inhalation of silica can also cause a chronic lung disorder, silicosis.

Note to Physician: Provide general supportive measures and treat symptomatically.

SECTION 5	FIREFIGHTING MEASURES

Extinguishing Media

Appropriate Extinguishing Media: Use dry chemical fire extinguisher

Inappropriate Extinguishing Media: Do not use halogenated compounds.

Firefighting

Fire Hazards: Hydrated Lime is not combustible or flammable. Hydrated Lime is not considered to be an explosive hazard, although reaction with incompatible materials may rupture containers.

Hazardous Combustion Products: None

Special Protective Equipment and Fire Fighting Instructions: Keep personnel away from and upwind of fire. Wear full fire-fighting turn-out gear (full Bunker gear), and respiratory protection (SCBA).

SECTION 6	ACCIDENTAL RELEASE MEASURES

Personal Precautions: Use proper protective equipment.

Environmental Precautions: For large spills, as much as possible, avoid the generation of dusts. Prevent release to sewers or waterways.

Methods and Materials for Containment and Cleaning Up:

Small Spills: Use dry methods to collect spilled materials. Avoid generating dust. Do not clean up with compressed air. Store collected materials in dry, sealed plastic or metal containers. Residue on surfaces may be washed with water or dilute vinegar.

Large Spills: Use dry methods to collect spilled materials. Evacuate area downwind of clean-up operations to minimize dust exposure. Store spilled materials in dry, sealed plastic or metal containers.

SECTION 7	HANDLING AND STORAGE

Precautions for Safe Handling: Keep in tightly closed containers. Protect containers from physical damage. Avoid direct skin contact with the material.

Conditions for Safe Storage, Including any Incompatibilities: Store in a cool, dry, and well-ventilated location. Do not store near incompatible materials (see Section 10 below). Keep away from moisture. Do not store or ship in aluminum containers.

SECTION 8	EXPOSURE CONTROLS/ PERSONAL PROTECTION

Control Parameters:

Component	CAS #	Exposure Limits
Calcium Hydroxide	1305-62-0	OSHA PEL: 15 mg/m3 (total) 5 mg/m3 (respirable) ACGIH TLV: 5 mg/m3
Magnesium Oxide	1309-48-4	OSHA PEL: 15 mg/m3 ACGIH TLV: 10 mg/m3
Crystalline Silica	14808-60-7	OSHA PEL: 0.050 mg/m3 as an 8 hr. TWA (respirable) ACGIH TLV: 0.025 mg/m3 (respirable)

Appropriate Engineering Controls: Provide ventilation adequate to maintain PELs.

Personal Protection

Respiratory Protection: Use NIOSH approved respirators if airborne concentration exceeds PEL.

Eye Protection: Use safety glasses with side shields or safety goggles. Contact lenses should not be worn when working with lime products.

Skin Protection: If there is a risk of skin contact, wear appropriate clothing and gloves to prevent contact.

Other: Eye wash fountain and emergency showers are recommended.

SECTION 9	PHYSICAL AND CHEMICAL PROPERTIES

Appearance

Physical State: Solid

Color: White

Odor: Odorless

Odor Threshold: N/ A

pH: 12.44 @ 25° C when made into a saturated solution

Melting Point: N/ AF

Initial Boiling Point: N/ A

Freezing Point: N/ A

Flash Point: N/ A

Evaporation Rate: N/ A

Flammability (solid, gas): Non-flammable

Explosion Limits: N/ A

Vapor Pressure: N/ A

Vapor Density: N/ A

Relative Density: 0.4 – 0.7 g/ cm^3 (apparent)

Solubility(ies): Solubility is 1.6 g/L at 25° C

Partition coefficient: Relatively insoluble

Auto-ignition Temperature: N/ A

Decomposition Temperature: 580º C / 1076º F

Viscosity: N/A

SECTION 10	STABILITY AND REACTIVITY

Reactivity:

Chemical Stability: Hydrated Lime is chemically stable.

Possibility of Hazardous Reactions: See reactivity above

Conditions to Avoid: Do not allow Hydrated Lime to come into contact with incompatible materials.

Incompatible Materials: Hydrated Lime should not be mixed or stored with the following materials, due to the potential for violent reaction and release of heat:

Acids (unless in a controlled process)
Reactive Fluoridated Compounds
Reactive Brominated Compounds
Reactive Powdered Metals
Organic Acid Anhydrides
Nitro-Organic Compounds
Reactive Phosphorous Compounds
Interhalogenated Compounds

Hazardous Decomposition Products: None

SECTION 11	TOXICOLOGICAL INFORMATION

Health Effects: see First Aid discussion in Section 4

Routes of Exposure: see First Aid discussion in Section 4

Symptoms Related to Exposure: see First Aid discussion in Section 4

Carcinogen Listing: Hydrated Lime is not listed by MSHA, OSHA, or IARC as a carcinogen, but this product contains crystalline silica, which has been classified by IARC as (Group I) carcinogenic to humans when inhaled.

SECTION 12	ECOLOGICAL INFORMATION

Ecotoxicity: Because of the high pH of this product, it would be expected to produce significant ecotoxicity upon exposure to aquatic organisms and aquatic systems in high concentrations.

Persistence and Degradability: Reacts with atmospheric CO_2 over time to form calcium carbonate

Bioaccumulation Potential: This material shows no bioaccumulation effect or food chain concentration toxicity.

Mobility in Soil: Minimal mobility in soil. Reacts with clay portion of soil to form calcium silicates and calcium aluminates

Other Adverse Effects: This material is alkaline and if released into water or moist soil will cause an increase in pH

SECTION 13	DISPOSAL CONSIDERATIONS

Disposal Recommendations: Dispose of in accordance with all applicable federal, state, and local environmental regulations.

Regulatory Disposal Information: If this product as supplied, and unmixed, becomes a waste, it will not meet the criteria of a hazardous waste as defined under the Resource Conservation and Recovery Act.

SECTION 14	TRANSPORT INFORMATION

UN Number: Not Regulated

UN Proper Shipping Name: Not Regulated

Transport Hazard Class(es): Not Regulated

Packing Group: Not Regulated

Marine Pollutant (y/n): This material is alkaline and if released into water or moist soil will cause an increase in pH.

Special Precautions: None

SECTION 15	REGULATORY INFORMATION

National Chemical Inventory Listings:

All chemical ingredients are listed on the USEPA TSCA Inventory List.

US Regulations:

RCRA Hazardous Waste Number: not listed (40 CFR 261.33)
RCRA Hazardous Waste Classification (40 CFR 261): not classified
CERCLA Hazardous Substance (40 CFR 302.4) unlisted specific per RCRA, Sec. 3001; CWA, Sec. 311 (b) (4); CWA, Sec. 307(a), CAA, Sec. 112
CERCLA Reportable Quantity (RQ) not listed.
SARA 311/312 Codes: not listed.
SARA Toxic Chemical (40 CFR 372.65): not listed.
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed, Threshold Planning Quantity (TPQ): not listed

Specific State Regulations: ⚠WARNING: This product can expose you to chemicals, including crystalline silica, which is known to the State of California to cause cancer. For more information, go to www.P65Warnings.ca.gov
These naturally occurring impurities may also be regulated by other States.

Canadian DSL: Listed

Canadian NPRI: None of the components are listed

CEPA Toxic Substances: None of the components are listed

SECTION 16	OTHER INFORMATION

Prepared By: Lhoist North America Technical Services

Date Prepared: January 27, 2020

Revision: 2020-1

Abbreviations:

N/A	Not Available or Not Applicable
IARC	International Agency for Research on Cancer
IATA	International Air Transport Association
	ACGIH American Conference of Governmental
ACGIH	Industrial Hygienists
TWA	Time Weighted Average
PEL	Permissible Exposure Limit
TLV	Threshold Limit Value
REL	Recommended Exposure Limit

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Appendix C

Emissions Calculations

Client:	Copperwood Resources, Inc.	Project ID.:	0023H001.00
Project:	Air Permit Application Emissions Calculations		
Prepared by:	MMD	Date:	05/10/23
Checked by:	AKM	Date:	08/17/23

Table of Contents

Client:	Copperwood Resources, Inc.	Project ID.:	0023H001.00
Project:	Air Permit Application Emissions Calculations		
Prepared by:	MMD	Date:	05/10/23
Checked by:	AKM	Date:	08/17/23

Topic	2018 Application	2023 Application
Power Supply	2-diesel generators served as emergency use.	Initial construction power will be provided by 1- CAT diesel generator (construction generator). When available, anticipated 18-24 mo, 3 natural gas generators will be installed for baseload power. 2 NG generators run for prime power 1 NG generator for emergency Construction generator decommissioned. An electric power line will be constructed to provide power to the facility, anticipated to be in place 3 or more years after initial construction. With the power line in place, supplemental power will be needed from the NG generators. To identify the maximum emissions for each pollutant, the power supply scenarios were evaluated. The maximum emissions are presented to evaluate facility emissions (MTE, PTE) and TAC emissions. Air Quality Impact Analysis is based on maximum emission rates for all pollutants, regardless of operating scenario.
Underground Activities	100% ore extracted by drill/blast.	Production rates revised slightly 56% ore extracted by roadheader; 44% ore extracted by drill/blast Added mucking and roadheader road emissions Ef for CO emissions upon blasting was revised to an updated reference.
Surface Infrastructure		A diesel fire water pump has been added (emergency use only). A lime silo has been added.

Client:	Copperwood Resources, Inc.	Project ID.:	0023H001.00
Project:	Air Permit Application Emissions Calculations		
Prepared by:	MMD	Date:	05/10/23
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Facility and Operational Basis for Emissions Calculations

1. Thruput and Production Rates for Mine Excavation/Ore Production

Actual thruput / process rates:	6,800	Mtpd Design production rate
	1.1	convert to English units (1 Mt = 1.1 ton)
	7,480	tons per day actual production rate
	350	day/year actual operations
	2,618,000	tons/year normal production rate
	374	tons per hour
Ore moisture content:	**5**	%
Daily and Hourly Rates:	**20**	hours/day operations: 2 @ 10 hour shifts
	2	hours/day for each blasting operation: 2 @ 10 hour shifts
	350	day/year actual operations
	7000	hours / year actual operations
	700	individual hours / year actual blasting operations
Maximum thruput / process rates:	10%	additional daily rate representing maximum
	8,228	tons per day maximum production rate
	365	day/year maximum operations
	3,003,220	tons/year maximum ore production rate
	411.4	tons per hour
Daily and Hourly Rates:	**20**	hours/day operations: 2 @ 10 hour shifts
	2	hours/day for each blasting operation: 2 @ 10 hour shifts
	365	day/year maximum operations
	7,300	hours / year maximum operations
	730	individual hours / year maximum blasting operations

2. Thruput and Production Rates for Concentrate Production

Actual Concentrate Production Rate:	15	Mt/hr, as stated in 2023 FS report
	1.1	convert to English units (1 Mt = 1.1 ton)
	16.61	tons/hour wet concentrate, normal production rate
	7,992	hr/yr normal/actual: 24 hours/day x 333 days per year
	132,747	tons/year concentrate normal production rate
	8%	moisture content of concentrate
Maximum Concentrate Production Rate:	15%	additional rate representing maximum
	19.1	tons/hour concentrate maximum production rate
	8,760	hr/year maximum operations: 24 hours/day x 365 days/year
	167,329	tons/year concentrate maximum production rate

3. Particle Size Distribution for Particulate Matter Emissions

AP-42 Appendix B,2, Table B.2.2, page B.2-13 Mechanically Generated Aggregate, Unprocessed Ores, September, 1990.

% cumulative size			Proportion to PMtot		
PM-2.5 =	15.0	%	PMtot =	100	%
PM-10 =	51.0	%	PM-10 =	51	%
Ratio PM-2.5 / PM-10 =	0.29		PM-2.5 =	15.0	%

4. Ventilation Exhaust Volume

Year	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Maximum	Minimum
Portal Exhaust (cubic feet per minute)	85,000	255,000	180,000	180,000	180,000	180,000	180,000	180,000	180,000	180,000	180,000			255,000	85,000
North Exhaust Vent Raise (cubic feet per minute)			415,000	670,000	585,000	415,000	330,000	160,000	75,000	75,000	75,000			670,000	75,000
South Exhaust Vent Raise (cubic feet per minute)						170,000	340,000	425,000	425,000	425,000	595,000	595,000	425,000	595,000	170,000
Air Intake (cubic feet per minute)	85,000	255,000	595,000	850,000	765,000	765,000	850,000	765,000	680,000	680,000	850,000	595,000	425,000	850,000	85,000

6. Ore Stockpile Metrics

Capacity	620,000	Metric tons
	682,000	tons
Area of footprint	13	Acres
Fill Rate	6,800	Mtpd Design production rate
	7,480	tons per day fill rate

7. Tailings Facility Metrics

Tailings Footprint Area	316	acres
Tailings Area for wind exposure	230	acres
Dry Beach Area	9	acres
Slurry solids content:	50%	

8. The Power Generation Provisions

	CAT Diesel 1		CAT NG 1		CAT NG 2		CAT NG 3 (at portal)	
	Load %	hr/yr	Load %	hr/yr	Load %	hr/yr	Load %	hr/yr
Construction Diesel Generator [1]	100	4550						
Before powerline installation: 2 @ prime power; 1 emergency			100	8760	100	8760	100	500[2]
Supplemental Power after powerline installation 3			100	8760	100	880	100	880

1. Anticipated actual emissions: 7 day/week, 10 hr/day, 52 week/year; 25% contingency
2. Emergency generator designation require 500 hour limited operation.
3. Client provided operation data.

Evaluation of Maximum Emissions for Natural Gas Generator Operating Scenarios

Scenario 1

Prior to utility line installation: 2 generators operate @ 100% load, 8760 hr/yr; 1 generator operates @ 100% load as emergency back up, 500 hr/yr.

Scenario 2

After utility line installation for supplemental power: 1 generator operates @ 100% load, 8760 hr/yr; 2 generators operate @ 100% load for 900 hr/yr each

Results:

Hourly basis: Scenario 1 has a maximum of 2 generators operating at one time as the third is used as back up. Therefore, Scenario 2, with periods of 3 generators operating at one time is the basis of maximum hourly emissions.

Annual basis: based on generating hours per year, Scenario 1 (8760+8760+500) exceeds Scenario 2 for generator-hr/year (8760+900+900). Therefore, maximum annual emissions will be based on

Client:	Copperwood Resources, Inc.	Project ID.:	0023H001.00
Project:	Air Permit Application Emissions Calculations		
Prepared by:	MMD	Date:	05/10/23
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Maximum Facility Emissions for Criteria Pollutants[1]

Stack	Emission Source	NOx	SO2	CO	VOC	Lead	PM	PM10	PM2.5
		Criteria Pollutant Emissions in ton/year							
Stack Emissions									
SV-001	West Mine Exhaust Vent	13.26	9.26	25.37	1.00	8.56E-05	7.79	2.23	0.56
SV-002	East Mine Exhaust Vent	13.66	9.54	26.13	1.03	8.82E-05	8.03	2.30	0.58
SV-003	Portal Mine Exhaust Vent	7.23	5.05	13.84	0.55	4.67E-05	4.25	1.22	0.31
SV-004	Construction Generator (725 kW) [8]	24.38	0.052	1.03	0.28		0.70	0.70	0.70
SV-005	Natural Gas Power Generator (2 MW base load) [8]	5.17	0.02	7.33	7.14		1.44	1.44	1.44
SV-006	Natural Gas Power Generator (2 MW base load) [8]	5.17	0.02	7.33	7.14		1.44	1.44	1.44
SV-007	Emergency Power Generator Natural Gas (2MW)	0.30	0.00	0.42	0.41		0.08	0.07	0.07
SV-008	Fire Pump	1.57	0.10	0.34	0.13		0.11	0.11	0.11
SV-009	Lime Silo Vent						0.0040	0.0014	0.0005
	Total Stack Emissions *	60.09	24.00	80.76	17.40	2.20E-04	23.15	8.81	4.52
	Fugitive Emissions								
Surface Ore Transfer									
F001 - Ore Transfer from Portal to First Transfer Point						4.24E-06	0.39	0.15	0.02
F002 - Surplus Ore Transfer to Ore Stockpile						1.17E-05	1.02	0.47	0.07
F003 - Transfer Points at Ore Bins/Reclaim Area						9.49E-06	0.86	0.32	0.05
F004 - Management of Ore within Ore Stockpile Area						2.62E-05	2.38	1.13	0.17
F005 - Transfer Points at SAG Mill						5.42E-07	0.05	0.02	0.003
F006 - Concentrate Handling Operations						1.41E-08	0.04	0.02	0.00
Other Fugitive Emission Sources									
F007 - Wind Erosion at Ore Stockpile						5.50E-05	5.00	1.00	0.25
F008 - Wind Erosion at TDF						4.32E-05	3.40	1.77	0.90
F009 - Reagent Mixing Area					1.91E-02		6.56E-04	2.41E-04	2.41E-04
HR-01 - Vehicle Travel on Ore Stockpile [5]						2.10E-04	19.14	4.10	0.41
HR-02 - Conct Truck Travel on Access Road [5]						1.84E-05	1.20	0.26	0.03
HR-03 - Water Truck Travel on Access Road [5]						4.69E-05	3.05	0.65	0.07
HR-04 - Reagents/Grinding Media Truck Travel on Access Road [5]						3.55E-06	0.23	0.05	0.005
HR-05 - Explosives Truck Travel on Access Road [5]						4.14E-07	0.03	0.01	0.001
HR-06 - Natural Gas Delivery Truck Travel on Access Road [5]						5.09E-06	0.33	0.07	0.01
HR-07 - Diesel Fuel Delivery Truck Travel on Access Road [5]						2.09E-07	0.01	0.0029	0.0003
	Total Fugitive Emissions	0.00	0.00	0.00	0.02	4.35E-04	37.15	10.00	1.98
	Maximum Controlled Facility Emissions [1]	60.09	24.00	80.76	17.42	6.56E-04	60.30	18.81	6.49
	Potential to Emit [2, 3, 4]	60.09	24.00	80.76	17.40	2.20E-04	23.15	8.81	4.52

Normal/Actual Facility Emissions for Criteria Pollutants[1]

Stack	Emission Source	NOx	SO2	CO	VOC	Lead [6]	PM	PM10	PM2.5
		Criteria Pollutant Emissions in ton/year							
Stack Emissions									
SV-001	West Mine Exhaust Vent	6.14	4.66	18.99	0.46	8.56E-05	6.76	2.03	0.35
SV-002	East Mine Exhaust Vent	6.33	4.80	19.56	0.47	8.82E-05	6.96	2.09	0.36
SV-003	Portal Mine Exhaust Vent	3.35	2.54	10.36	0.25	4.67E-05	3.68	1.11	0.19
SV-004	Construction Generator (725 kW) 8	6.33	0.013	0.27	0.073		0.183	0.183	0.183
SV-005	Natural Gas Power Generator (2 MW base load) 8	5.17	0.02	7.33	7.14		1.44	1.44	1.44
SV-006	Natural Gas Power Generator (2 MW base load) 8	5.17	0.02	7.33	7.14		1.44	1.44	1.44
SV-007	Emergency Power Generator Natural Gas (2MW)	0.02	0.00	0.03	0.02		0.00	0.00	0.00
SV-008	Fire Pump	0.22	0.010	0.03	0.01		0.005	0.004	0.004
SV-009	Lime Silo Vent						0.000	0.000	0.000
	Total Stack Emissions	32.73	12.07	63.90	15.57	2.20E-04	20.48	8.31	3.98
	Fugitive Emissions								
Surface Ore Transfer									
F001 - Ore Transfer from Portal to First Transfer Point						4.24E-06	0.37	0.14	0.02
F002 - Surplus Ore Transfer to Ore Stockpile						1.17E-05	1.02	0.47	0.07
F003 - Transfer Points at Ore Bins/Reclaim Area						9.49E-06	0.86	0.32	0.05
F004 - Management of Ore within Ore Stockpile Area						2.62E-05	2.08	0.98	0.15
F005 - Transfer Points at SAG Mill						5.42E-07	0.05	0.02	0.003
F006 - Concentrate Handling Operations						1.41E-08	0.04	0.02	0.002
Other Fugitive Emission Sources									
F007 - Wind Erosion at Ore Stockpile						5.50E-05	5.00	1.00	0.25
F008 - Wind Erosion at TDF						4.32E-05	3.40	1.77	0.90
F009 - Reagent Mixing Area									
HR-01 - Vehicle Travel on Ore Stockpile						2.10E-04	16.69	3.57	0.36
HR-02 - Vehicle Travel on Access Road						1.84E-05	0.95	0.20	0.02
HR-03 - Water Truck Travel on Access Road [5]						4.69E-05	2.79	0.60	0.06
HR-04 - Reagents/Grinding Media Truck Travel on Access Road [5]						3.55E-06	0.20	0.04	0.004
HR-05 - Explosives Truck Travel on Access Road [5]						4.14E-07	0.02	0.005	0.0005
HR-06 - Natural Gas Delivery Truck Travel on Access Road 5						5.09E-06	0.33	0.07	0.01
HR-07 - Diesel Fuel Delivery Truck Travel on Access Road 5						2.09E-07	0.01	0.0029	0.0003
	Total Fugitive Emissions	0.00	0.00	0.00	0.00	4.35E-04	33.82	9.20	1.89

Greenhouse Gas Summary

Emergency Generators	26,511	tons/year CO2e
Mine Heaters	12,689	tons/year CO2e
Blasting	522	tons/year CO2e
Total	39,722	tons/year CO2e

Notes:

1. Maximum controlled facility emissions are all site emissions (including fugitive emissions) after applying collection and control efficiencies on maximum operating schedule. Normal/actual emissions are based on the normal/actual operating schedule and basis.
2. Potential to Emit (PTE) for criteria pollutants at this facility is the stack emissions with no fugitives. While underground material handling and transfer points would normally be considered to be fugitive emission sources, emissions are directed through mine vents, which serve as stacks and point sources of emissions.
3. New Source Performance Standards (NSPS), 40 CFR 60 Subpart LL (NSPS) for metallic minerals processing is applicable to this facility. This NSPS (metallic mining) was developed after 1980 and since this facility is not subject to federal Maximum Achievable Control Technology (MACT) standards, fugitive dust is not part of PTE.
4. PTE is based on controlled emissions since operation of emission control equipment will be a legally enforceable requirement of the operation. PTE for hazardous air pollutants (HAPs) is based on both stack and fugitive emissions per R 336.1116 (m).
5. On-Site Road emissions include fugitive emissions from surface roadway travel, no tailpipe emissions. It includes emissions from loaders moving ore at the Ore Stockpile and trucks moving produced concentrate along the access road from the concentrate storage area to the main gate. All on-site vehicle travel will be on unpaved roads.
6. Note that maximum controlled emissions for lead have not been adjusted or recalculated for normal/actual conditions in that emissions are very low. Therefore, normal/actual emissions for lead are the same as maximum controlled emissions.
7. not used.
8. The diesel Construction Generator will operate until the natural gas generators are opearational. For MCE and PTE, the yellow highlighted emissions are counted as between the two operating scenarios, these are the highest for that pollutant.

Foth

Client: Copperwood Resources, Inc. Project ID.: 0023H001.00
Project: Air Permit Application Emissions Calculations
Prepared by: MMD Date: 05/10/23
Checked by: AKM Date: 08/17/23

Ore
Concentrate
Native Soil
Tailings

Maximum Facility Emissions for Hazardous Air Pollutants/Michigan Air Toxics (Metals)[1, 10]

Source	PM	PM10	PM2.5	Units	Material	Antimony Sb	Arsenic As	Barium Ba	Beryllium Be	Cadmium Cd	Chromium Cr	Cobalt Co	Copper Cu	Lead Pb	Magnesium Mg	Manganese [9] Mn	Mercury Hg	Molybdenum Mo	Nickel Ni	Phosphorus P	Selenium Se	Silver Ag	Sulfur S	Tin Sn	Units
					Ore [2]	4.75E-05	1.80E-04	0.07559	2.60E-04	1.75E-04	0.011	0.003	1.460	1.10E-03	0.00	0.17	1.04E-05	5.06E-05	0.007	0.00	1.413E-04	4.387E-04	0.61	0.0003	
					Concentrate [3]	0.00003	0.00003	0.00021	0.00000	0.00000	0.00640	0.00003	28.10000	0.00003	2.11645	0.11620	8.00E-07	0.00003	0.00022	0.00073	0.00003	0.00007	7.32000	0.00003	
					Native Soil [4]	2.10E-05	0.0003	0.0188	0.0001	0.00005	0.004	0.0016	0.002	1.54E-03	0.45	0.22	8.90E-06	9.10E-05	0.002	0.07	1.10E-04	1.68E-05	0.04	0.0001	
					Tailings [5]	0.00005	0.0006	0.0535	0.0002	0.00003	0.0284	0.0036	0.4675	0.001	0.00	0.16	1.70E-06	2.70E-03	0.02	0.00	1.00E-04	2.20E-04	0.23	2.50E-04	
Underground Mine Emissions (Point) (EUMINEVENT) [7]																									
SV-001 (West Mine Exhaust Vent)	2.64	0.87	0.15	lb/hr	Ore	1.25E-06	4.75E-06	1.99E-03	6.86E-06	4.62E-06	2.86E-04	8.78E-05	3.85E-02	2.90E-05	0.00E+00	1.45E-03	2.74E-07	1.34E-06	1.73E-04	0.00E+00	3.73E-06	1.16E-05	1.62E-02	7.59E-06	lb/hr
	7.79	2.23	0.56	ton/yr		3.70E-06	1.40E-05	5.89E-03	2.03E-05	1.36E-05	8.45E-04	2.59E-04	1.14E-01	8.56E-05	0.00E+00	3.74E-03	8.10E-07	3.94E-06	5.10E-04	0.00E+00	1.10E-05	3.42E-05	4.78E-02	2.24E-05	ton/yr
SV-002 (East Mine Exhaust Vent)	2.72	0.89	0.16	lb/hr	Ore	1.29E-06	4.89E-06	2.06E-03	7.07E-06	4.76E-06	2.95E-04	9.05E-05	3.97E-02	2.99E-05	0.00E+00	1.49E-03	2.83E-07	1.38E-06	1.78E-04	0.00E+00	3.84E-06	1.19E-05	1.67E-02	7.82E-06	lb/hr
	8.03	2.30	0.58	ton/yr		3.81E-06	1.44E-05	6.07E-03	2.09E-05	1.40E-05	8.71E-04	2.67E-04	1.17E-01	8.82E-05	0.00E+00	3.85E-03	8.35E-07	4.06E-06	5.25E-04	0.00E+00	1.13E-05	3.52E-05	4.93E-02	2.31E-05	ton/yr
SV-003 (Portal Exhaust Vent)	1.44	0.47	0.08	lb/hr	Ore	6.84E-07	2.59E-06	1.09E-03	3.74E-06	2.52E-06	1.56E-04	4.79E-05	2.10E-02	1.58E-05	0.00E+00	7.91E-04	1.50E-07	7.28E-07	9.42E-05	0.00E+00	2.03E-06	6.31E-06	8.83E-03	4.14E-06	lb/hr
	4.25	1.22	0.31	ton/yr		2.02E-06	7.65E-06	3.21E-03	1.10E-05	7.44E-06	4.61E-04	1.41E-04	6.20E-02	4.67E-05	0.00E+00	2.04E-03	4.42E-07	2.15E-06	2.78E-04	0.00E+00	6.01E-06	1.86E-05	2.61E-02	1.22E-05	ton/yr
Total Underground Mine Emissions (Point)	6.80	2.23	0.40	lb/hr	Ore	3.23E-06	1.22E-05	5.14E-03	1.77E-05	1.19E-05	7.37E-04	2.26E-04	9.92E-02	7.47E-05	0.00E+00	3.74E-03	7.07E-07	3.44E-06	4.45E-04	0.00E+00	9.60E-06	2.98E-05	4.17E-02	1.95E-05	lb/hr
	20.07	5.75	1.45	ton/yr		9.53E-06	3.61E-05	1.52E-02	5.22E-05	3.51E-05	2.18E-03	6.68E-04	2.93E-01	2.20E-04	0.00E+00	9.63E-03	2.09E-06	1.02E-05	1.31E-03	0.00E+00	2.84E-05	8.80E-05	1.23E-01	5.77E-05	ton/yr
					lb per year toxics	0.019	0.072	30.340	0.104	0.070	4.355	1.335	586.007	0.441	0.000	19.26	0.00	0.020	2.63	0.00	0.057	0.176	246.34	0.115	
Haul Road Fugitive Emissions (Volume Source Fugitives) [6]																									
HR-01 Haul Road on Ore Stockpile (EUHAULROADS)	5.24	1.12	0.112	lb/hr	Ore	2.49E-06	9.44E-06	3.96E-03	1.36E-05	9.18E-06	5.69E-04	1.74E-04	7.66E-02	5.76E-05	0.00E+00	1.88E-03	5.45E-07	2.65E-06	3.43E-04	0.00E+00	7.41E-06	2.30E-05	3.22E-02	1.51E-05	lb/hr
	19.14	4.10	0.41	ton/yr		9.09E-06	3.45E-05	1.45E-02	4.98E-05	3.35E-05	2.08E-03	6.37E-04	2.80E-01	2.10E-04	0.00E+00	6.86E-03	1.99E-06	9.69E-06	1.25E-03	0.00E+00	2.71E-05	8.40E-05	1.17E-01	5.50E-05	ton/yr
HR-02 Concentrate Transfer Along On-Site Access Road (EUHAULROADS)	2.22	0.47	0.047	lb/hr	Native Soil	4.66E-07	7.10E-06	4.17E-04	2.35E-06	1.02E-06	8.15E-05	3.53E-05	4.37E-05	3.41E-05	9.99E-03	1.06E-03	1.98E-07	2.02E-06	5.31E-05	1.58E-03	2.44E-06	3.73E-07	8.88E-04	2.66E-06	lb/hr
	1.20	0.26	0.03	ton/yr		2.51E-07	3.83E-06	2.25E-04	1.27E-06	5.51E-07	4.39E-05	1.90E-05	2.36E-05	1.84E-05	5.39E-03	5.71E-04	1.07E-07	1.09E-06	2.86E-05	8.50E-04	1.32E-06	2.01E-07	4.79E-04	1.44E-06	ton/yr
HR-03 - Water Truck Transport Along On-Site Access Road (EUHAULROADS)	2.19	0.47	0.05	lb/hr	Native Soil	4.60E-07	7.01E-06	4.12E-04	2.32E-06	1.01E-06	8.04E-05	3.48E-05	4.32E-05	3.36E-05	9.86E-03	1.04E-03	1.95E-07	1.99E-06	5.24E-05	1.56E-03	2.41E-06	3.68E-07	8.76E-04	2.63E-06	lb/hr
	3.05	0.65	0.07	ton/yr		6.41E-07	9.77E-06	5.74E-04	3.24E-06	1.40E-06	1.12E-04	4.85E-05	6.01E-05	4.69E-05	1.37E-02	1.46E-03	2.72E-07	2.78E-06	7.30E-05	2.17E-03	3.36E-06	5.13E-07	1.22E-03	3.66E-06	ton/yr
HR-04 - Reagent/Grind Media Truck Transport Along On-Site Access Road (EUHAULROADS)	1.78	0.38	0.04	lb/hr	Native Soil	3.74E-07	5.70E-06	3.35E-04	1.89E-06	8.20E-07	6.54E-05	2.83E-05	3.51E-05	2.74E-05	8.02E-03	8.50E-04	1.59E-07	1.62E-06	4.26E-05	1.27E-03	1.96E-06	2.99E-07	7.13E-04	2.14E-06	lb/hr
	0.23	0.05	0.005	ton/yr		4.86E-08	7.41E-07	4.35E-05	2.45E-07	1.06E-07	8.50E-06	3.68E-06	4.56E-06	3.55E-06	1.04E-03	1.10E-04	2.06E-08	2.11E-07	5.53E-06	1.64E-04	2.55E-07	3.89E-08	9.26E-05	2.78E-07	ton/yr
HR-05 - Explosives Truck Transport Along On-Site Access Road (EUHAULROADS)	1.77	0.38	0.04	lb/hr	Native Soil	3.71E-07	5.65E-06	3.32E-04	1.87E-06	8.13E-07	6.48E-05	2.81E-05	3.48E-05	2.71E-05	7.95E-03	8.43E-04	1.57E-07	1.61E-06	4.22E-05	1.25E-03	1.94E-06	2.97E-07	7.07E-04	2.12E-06	lb/hr
	0.03	0.01	0.001	ton/yr		5.66E-09	8.63E-08	5.07E-06	2.86E-08	1.24E-08	9.90E-07	4.29E-07	5.31E-07	4.14E-07	1.21E-04	1.29E-05	2.40E-09	2.45E-08	6.44E-07	1.91E-05	2.97E-08	4.53E-09	1.08E-05	3.24E-08	ton/yr
HR-06 - Natural Gas Delivery Truck Transport Along On-Site Access Road (EUHAULROADS)	1.78	0.38	0.04	lb/hr	Native Soil	3.73E-07	5.69E-06	3.34E-04	1.88E-06	8.17E-07	6.52E-05	2.82E-05	3.50E-05	2.73E-05	8.00E-03	3.96E-03	1.58E-07	1.62E-06	4.25E-05	1.26E-03	1.95E-06	2.98E-07	7.11E-04	2.13E-06	lb/hr
	0.33	0.07	0.007	ton/yr		6.97E-08	1.06E-06	6.24E-05	3.52E-07	1.53E-07	1.22E-05	5.27E-06	6.54E-06	5.09E-06	1.49E-03	7.40E-04	2.95E-08	3.02E-07	7.93E-06	2.36E-04	3.65E-07	5.57E-08	1.33E-04	3.98E-07	ton/yr
HR-07 - Diesel Fuel Delivery Truck Transport Along On-Site Access Road (EUHAULROADS)	2.01	0.43	0.04	lb/hr	Native Soil	4.22E-07	6.43E-06	3.78E-04	2.13E-06	9.24E-07	7.37E-05	3.19E-05	3.96E-05	3.08E-05	9.04E-03	4.48E-03	1.79E-07	1.83E-06	4.80E-05	1.43E-03	2.21E-06	3.37E-07	8.04E-04	2.41E-06	lb/hr
	0.01	0.00	0.000	ton/yr		2.86E-09	4.35E-08	2.56E-06	1.44E-08	6.26E-09	4.99E-07	2.16E-07	2.68E-07	2.09E-07	6.12E-05	3.03E-05	1.21E-09	1.24E-08	3.25E-07	9.66E-06	1.50E-08	2.29E-09	5.44E-06	1.63E-08	ton/yr
Total Haul Road Fugitive Emissions	16.99	3.63	0.36	lb/hr		4.96E-06	4.70E-05	6.17E-03	2.61E-05	1.46E-05	1.00E-03	3.61E-04	7.68E-02	2.38E-04	5.28E-02	1.41E-02	1.59E-06	1.33E-05	6.24E-04	8.34E-03	2.03E-05	2.50E-05	3.69E-02	2.92E-05	lb/hr
	24.00	5.13	0.51	ton/yr		1.01E-05	5.00E-05	1.54E-02	5.49E-05	3.57E-05	2.26E-03	7.14E-04	2.80E-01	2.85E-04	2.18E-02	9.78E-03	2.42E-06	1.41E-05	1.37E-03	3.45E-03	3.24E-05	8.48E-05	1.19E-01	6.09E-05	ton/yr
					lb per year toxics	0.0202	0.1000	30.7666	0.1098	0.0715	4.5105	1.4282	559.1918	0.5697	43.6821	19.5668	0.0048	0.0282	2.7375	6.8921	0.0648	0.1696	238.8737	0.1217	
Surface Ore Transfer & Handling (Volume Source Fugitive) (EUFUGITIVES)																									
F001 - Portal to Transfer Tower	0.11	0.04	0.006	lb/hr	Ore	5.02E-08	1.90E-07	7.98E-05	2.75E-07	1.85E-07	1.15E-05	3.51E-06	1.54E-03	1.16E-06	0.00E+00	6.72E-05	1.10E-08	5.34E-08	6.91E-06	0.00E+00	1.49E-07	4.63E-07	6.48E-04	3.04E-07	lb/hr
	0.39	0.15	0.02	ton/yr		1.83E-07	6.94E-07	2.91E-04	1.00E-06	6.75E-07	4.18E-05	1.28E-05	5.63E-03	4.24E-06	0.00E+00	2.45E-04	4.01E-08	1.95E-07	2.52E-05	0.00E+00	5.45E-07	1.69E-06	2.37E-03	1.11E-06	ton/yr
F002 - Surplus Ore Transfer at Ore Stockpile	0.29	0.135	0.020	lb/hr	Ore	1.39E-07	5.25E-07	2.21E-04	7.59E-07	5.11E-07	3.17E-05	9.71E-06	4.26E-03	3.21E-06	0.00E+00	2.26E-04	3.04E-08	1.48E-07	1.91E-05	0.00E+00	4.12E-07	1.28E-06	1.79E-03	8.39E-07	lb/hr
	1.07	0.49	0.07	ton/yr		5.06E-07	1.92E-06	8.05E-04	2.77E-06	1.86E-06	1.16E-04	3.54E-05	1.56E-02	1.17E-05	0.00E+00	8.24E-04	1.11E-07	5.39E-07	6.97E-05	0.00E+00	1.51E-06	4.67E-06	6.54E-03	3.06E-06	ton/yr
F003 - Transfer Point at Ore Bins/Reclaim Area	0.25	0.09	0.01	lb/hr	Ore	1.17E-07	4.44E-07	1.87E-04	6.42E-07	4.32E-07	2.68E-05	8.21E-06	3.60E-03	2.71E-06	0.00E+00	1.52E-04	2.57E-08	1.25E-07	1.62E-05	0.00E+00	3.49E-07	1.08E-06	1.51E-03	7.10E-07	lb/hr
	0.9	0.3	0.0	ton/yr		4.10E-07	1.56E-06	6.53E-04	2.25E-06	1.51E-06	9.37E-05	2.87E-05	1.26E-02	9.49E-06	0.00E+00	5.31E-04	8.98E-08	4.37E-07	5.65E-05	0.00E+00	1.22E-06	3.79E-06	5.30E-03	2.48E-06	ton/yr
F004 - Management of Ore within Ore Stockpile	0.65	0.31	0.05	lb/hr	Ore	3.10E-07	1.17E-06	4.93E-04	1.70E-06	1.14E-06	7.08E-05	2.17E-05	9.53E-03	7.17E-06	0.00E+00	5.17E-04	6.79E-08	3.30E-07	4.27E-05	0.00E+00	9.22E-07	2.86E-06	4.00E-03	1.88E-06	lb/hr
	2.38	1.1	0.2	ton/yr		1.13E-06	4.29E-06	1.80E-03	6.19E-06	4.17E-06	2.58E-04	7.92E-05	3.48E-02	2.62E-05	0.00E+00	1.89E-03	2.48E-07	1.21E-06	1.56E-04	0.00E+00	3.37E-06	1.04E-05	1.46E-02	6.85E-06	ton/yr
F005 - Transfer Points at SAG Mill	0.012	0.0045	0.0007	lb/hr	Ore	5.86E-09	2.22E-08	9.33E-06	3.21E-08	2.16E-08	1.34E-06	4.11E-07	1.80E-04	1.36E-07	0.00E+00	7.58E-06	1.28E-09	6.25E-09	8.08E-07	0.00E+00	1.74E-08	5.41E-08	7.57E-05	3.55E-08	lb/hr
	0.05	0.02	0.00	ton/hr		2.34E-08	8.88E-08	3.73E-05	1.28E-07	8.63E-08	5.35E-06	1.64E-06	7.20E-04	5.42E-07	0.00E+00	3.03E-05	5.13E-09	2.50E-08	3.23E-06	0.00E+00	6.97E-08	2.16E-07	3.03E-04	1.42E-07	ton/yr
F006 - Concentrate Packaging Operations	0.011	0.004	0.0006	lb/hr	Concentrate	3.22E-09	3.22E-09	2.27E-08	1.86E-10	2.15E-10	6.88E-07	3.55E-09	3.02E-03	3.22E-09	2.27E-04	4.58E-06	8.60E-11	3.22E-09	2.41E-08	7.82E-08	3.22E-09	7.24E-09	7.87E-04	3.22E-09	lb/hr
	0.05	0.02	0.00	ton/yr		1.41E-08	1.41E-08	9.93E-08	8.14E-10	9.41E-10	3.01E-06	1.55E-08	1.32E-02	1.41E-08	9.96E-04	2.01E-05	3.76E-10	1.41E-08	1.05E-07	3.43E-07	1.41E-08	3.17E-08	3.44E-03	1.41E-08	ton/yr
Total fugitive emissions associated with Surface Ore Handling and Handling	1.32	0.58	0.09	lb/hr		6.25E-07	2.36E-06	9.90E-04	3.40E-06	2.29E-06	1.43E-04	4.36E-05	2.21E-02	1.44E-05	2.27E-04	9.74E-04	1.36E-07	6.66E-07	8.57E-05	7.82E-08	1.85E-06	5.75E-06	8.82E-03	3.77E-06	lb/hr
	4.8	2.1	0.3	ton/yr		2.27E-06	8.56E-06	3.59E-03	1.23E-05	8.31E-06	5.18E-04	1.58E-04	8.25E-02	5.22E-05	9.96E-04	3.54E-03	4.94E-07	2.42E-06	3.11E-04	3.43E-07	6.72E-06	2.09E-05	3.26E-02	1.37E-05	ton/yr
					lb per year toxics	4.54E-03	1.71E-02	7.17E+00	2.47E-02	1.66E-02	1.04E+00	3.16E-01	1.65E+02	1.04E-01	1.99E+00	7.08E+00	9.88E-04	4.83E-03	6.21E-01	6.85E-04	1.34E-02	4.17E-02	6.51E+01	2.73E-02	
Wind Erosion Stockpiles (Area Source Fugitives) (EUWINDEROSION)																									
F007 - Ore Stockpile (EUFUGITIVES)	1.14	0.23	0.06	lb/hr	Ore	5.43E-07	2.06E-06	8.64E-04	2.97E-06	2.00E-06	1.24E-04	3.80E-05	1.67E-02	1.26E-05	0.00E+00	3.83E-04	1.19E-07	5.78E-07	7.48E-05	0.00E+00	1.61E-06	5.01E-06	7.01E-03	3.29E-06	lb/hr
	5.00	1.00	0.25	ton/yr		2.38E-06	9.01E-06	3.78E-03	1.30E-05	8.76E-06	5.43E-04	1.67E-04	7.31E-02	5.50E-05	0.00E+00	1.68E-03	5.20E-07	2.53E-06	3.28E-04	0.00E+00	7.07E-06	2.20E-05	3.07E-02	1.44E-05	ton/yr
					lb per year toxics	4.75E-03	1.80E-02	7.57E+00	2.60E-02	1.75E-02	1.09E+00	3.33E-01	1.46E+02	1.10E-01	0.00E+00	3.35E+00	1.04E-03	5.06E-03	6.55E-01	0.00E+00	1.41E-02	4.39E-02	6.14E+01	2.88E-02	
F008 - Tailings Disposal Facility (EUFUGITIVES)	0.78	0.40	0.21	lb/hr	Tailings	3.88E-07	4.66E-06	4.15E-04	1.55E-06	2.33E-07	2.21E-04	2.80E-05	3.63E-03	9.86E-06	0.00E+00	6.49E-04	1.32E-08	2.10E-05	1.45E-04	0.00E+00	7.76E-07	1.71E-06	1.75E-03	1.94E-06	lb/hr
	3.40	1.77	0.90	ton/yr		1.70E-06	2.04E-05	1.82E-03	6.80E-06	1.02E-06	9.66E-04	1.22E-04	1.59E-02	4.32E-05	0.00E+00	2.84E-03	5.78E-08	9.18E-05	6.36E-04	0.00E+00	3.40E-06	7.48E-06	7.65E-03	8.50E-06	ton/yr
					lb per year toxics	3.40E-03	4.08E-02	3.64E+00	1.36E-02	2.04E-03	1.93E+00	2.45E-01	3.18E+01	8.64E-02	0.00E+00	5.69E+00	1.16E-04	1.84E-01	1.27E+00	0.00E+00	6.80E-03	1.50E-02	1.53E+01	1.70E-02	

Client: Copperwood Resources, Inc. Project ID.: 0023H001.00
Project: Air Permit Application Emissions Calculations
Prepared by: MMD Date: 05/10/23
Checked by: AKM Date: 08/17/23

Ore
Concentrate
Native Soil
Tailings

Maximum Facility Emissions for Hazardous Air Pollutants/Michigan Air Toxics (Metals)[1, 10]

Totals for all Emissions Sources

		Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Phosphorus	Selenium	Silver	Sulfur	Tin
Metallic TAC sourced	total lb/hr	9.74E-06	6.83E-05	1.36E-02	5.17E-05	3.10E-05	2.22E-03	6.97E-04	2.18E-01	3.49E-04	5.31E-02	1.99E-02	2.57E-06	3.90E-05	1.37E-03	8.34E-03	3.42E-05	6.73E-05	9.62E-02	5.77E-05
from PM emissions	decimal format lb/hr	0.00001	0.0001	0.014	0.00005	0.00003	0.002	0.0007	0.218	0.0003	0.0531	0.020	0.000003	0.000039	0.0014	0.008	0.00003	0.00007	0.096	0.00006
Metallic TAC sourced from NG Mine Heater combustion	lb/hr		0.00001	0.00022	0.00000	0.00005	0.00007	0.00000	0.00004			0.00002	0.00001	0.00005	0.00010		0.00000			
	Facility wide TAC lb/hr	0.00001	0.00008	0.01379	0.00005	0.00008	0.00229	0.00070	0.21853	0.00035	0.05307	0.01988	0.00002	0.00009	0.00148	0.00834	0.00004	0.00007	0.09619	0.00006
	lb/yr	0.05	0.25	79.49	0.28	0.18	12.92	3.66	1488.16	1.31	45.67	54.94	0.01	0.24	7.91	6.89	0.16	0.45	627.10	0.31
		TAC	TAC	TAC	TAC	TAC	TAC	TAC	TAC	TAC	TAC	TAC	TAC	TAC	TAC	TAC	TAC	TAC		TAC
Federal HAPS: marked as HAP		HAP	HAP		HAP	HAP	HAP	HAP		HAP		HAP	HAP		HAP		HAP			
		Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead	Magnesium	Manganese 9	Mercury	Molybdenum	Nickel	Phosphorus	Selenium	Silver	Sulfur	Tin

Total TACs=	
0.3	lb/hr
1,708	lb/year
0.9	ton/year

Summary of PM PTE Emissions with no metal HAPs

	PM	PM10	PM2.5	
SV-004 Construction Generator (725 kW)	0.16	0.16	0.16	lb/hr
PTE	0.37	0.70	0.37	ton/yr
SV-005 Natural Gas Power Generator (2 MW base load)	0.33	0.26	0.26	lb/hr
PTE	1.44	1.15	1.15	ton/yr
SV-006 Natural Gas Power Generator (2 MW base load)	0.33	0.26	0.26	lb/hr
PTE	1.44	1.15	1.15	ton/yr
SV-007 Emergency Power Generator Natural Gas (2MW)	0.33	0.26	0.26	lb/hr
PTE	0.08	0.07	0.07	ton/yr
SV-008 Fire Pump	0.44	0.44	0.44	lb/hr
PTE	0.11	0.11	0.11	ton/yr
SV-009 Lime Silo Vent	0.00	0.00	0.00	lb/hr
PTE	0.00	0.00	0.00	ton/yr
Reagent mixing area (F009)	0.00	0.00	0.00	lb/hr
PTE	0.00	0.00	0.00	ton/yr
Facility PM Stack Emissions (PTE)and Maximum Controlled Emissions	1.59	1.39	1.39	lb/hr
	3.45	3.18	2.84	ton/yr

Notes:

1. The hazardsous air pollutants on this sheet focus on metals in various fugitive sources. The other category of hazardous air pollutants are organic sources from combustion. These are tabulated on the Organic HAP Summary tab.
2. Ore data are the maximum average from sampled parting shales. Copper and silver concentrations are from Orvana Minerals, Corp. Feasibility Study Results Announcement, 02/07/2012.
3. Concentrate data are from *Orvana Minerals Corporation, Copperwood Technical Project, NI 43-01-0 Technical Report, April 30, 2010, Table 16-3 for Mg, Mn, and Cr. The remaining elemental concentrations are the maximum concentrations from Feasibility Study Update, Copperwood Project, April 20,2023, Table 19.3: Concentrate Specifications, page 19-4.*
4. Native soil data is the greatest maximum value from *Orvana EIA, Table 202.2.2-5, Summary of Soil Chemistry*.
5. Talings data are the maximum values from sampled composite talings. Derived from Orvana EIA, Table 203.3.4-5, Bulk Chemical Composition Composite Tailings from metalllurgical testing compared to unprocessed copper bearing sequence.
6. Roadway emissions only include fugitive emissions from surface roadway travel.
7. Potential to Emit (PTE) for this facility is the stack emissions with no fugitives. The New Source Performance Standards (NSPS) for metallic minerals processing is applicable to this facility
This NSPS (metallic mining) was developed after 1980 and since this facility is not subject to federal Maximum Achievable Control Technology (MACT) standards, fugitive dust is not part of PTE.
PTE is based on controlled emissions since operation of emission control equipment will be a legally enforceable requirement of the operation. PTE for hazardous air pollutants (HAPs)
is based on both stack and fugitive emissions per R 336.1116 (m).
8. Toxics from combustion appear on sheets for these emissions units and are summarized on the Organic HAP Summary tab.
9. Calculation of manganese TAC emissions is based on Note 29 in the MDEQ Table 2 List of Screening Levels. Note 29 states that the ITSL for manganese is most appropriately applied to PM10-Mn rather than TSP-Mn data. Therefore, all TAC calculations for Mn were based on PM-10 data.
10. Maximum facility emissions are all site emissions (including fugitive emissions) after applying collection and control efficiencies.

Concentrate composition has been updated according to Table 13.33 in the 2023 Feasibility Study

	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Phosphorus	Selenium	Silver	Sulfur	Tin
	Sb	As	Ba	Be	Cd	Cr	Co	Cu	Pb	Mg	Mn	Hg	Mo	Ni	P	Se	Ag	S	Sn
concentrate g/	30	30	211	1.73	2	x	33		30			0.8	30	224	728	30	67.4		30
%								28.1		2.11645161	0.116197183							7.32	
%w	0.00003	0.00003	0.000211	1.73E-06	0.000002	0.0064	0.000033	28.1	0.00003	2.11645161	0.116197183	0.0000008	0.00003	0.000224	0.000728	0.00003	0.0000674	7.32	0.00003

Notes
1. Chromium was not listed in Table 13.33, therefore the value from the 2018 permit application was used.
2. Magnesium and manganese are shown in Table 13.33 as MgO and MnO respectively. The elemental value used is based on the molecular weight ratio to the oxide weight.

	facility wide emission rates lb/hr	
antimony	0.000010	0.000010
arsenic	0.00008	0.00008
barium and soluble barium compounds	0.01379	0.01379
beryllium	0.00005	0.00005
cadmium	0.00008	0.00008
chromium	0.00229	0.00229
cobalt and cobalt compounds that release cobalt ions	0.00070	0.00070
copper	0.21853	0.21853
magnesium	0.05307	0.05307
manganese and manganese compounds	0.01988	0.01988
mercury and mercury compounds	0.00002	0.00002
molybdenum	0.00009	0.00009
nickel	0.00148	0.00148
phosphorus	0.00834	0.00834
selenium and inorganic selenium compounds	0.00004	0.00004
silver - soluble	0.00007	0.00007
sulfur (elemental)	0.09619	0.09619
tin	0.00006	0.00006

Client: Copperwood Resources, Inc.	Project ID.: 0023H001.00
Project: Air Permit Application Emissions Calculations	
Prepared by: MMD	Date: 05/10/23
Checked by: AKM	Date: 08/17/23

Underground Emissions (Point Sources) SV-001, SV-002, SV-003)
EUMINEVENT

SV-001 = West Mine Exhaust Vent
SV-002 = East Mine Exhaust Vent
SV-003 = Portal Exhaust Vent

Underground emissions are comprised from the following activities:

1 Drill
2 Blast
3 Material Handling (muck pile, rock breaker, and conveyor transfer points)
4 Mine heaters

Underground PM emissions are reduced by 50% due to settling. This reduction is based on the Eagle Mine calculations and performance.

1 Drilling

Additional particle size ratios are based on AP-42 Appendix B.2 Generalized Particle Size Distributions

	Drilling Emissions PM	PM-10	PM-2.5	
E factor		0.00008		lb/ton processed AP-42 11.19.2-2 E factor
	1	0.51	0.15	Particle size proportion[1]
	0.00016	0.00008	2.35E-05	Adjusted E Factor - lb/ton processed
				Maximum Emissions
	8,228	8,228	8,228	tons ore through put per day[2, 3]
	1.29	0.66	0.19	lb/day
	0.65	0.33	0.10	lb/day accounting for PM settling efficiency at 50%
	0.03	0.02	0.00	lb/hr based on 20 hrs/day[3]
	236	120	35	lb/year at 365 days per year[3]
	0.118	0.060	0.018	ton/year maximum emissions
				Actual Emisssions
	3,291	3,291	3,291	tons ore through put per day[2]
	0.52	0.26	0.08	lb/day
	0.26	0.13	0.04	lb/day accounting for PM settling efficiency at 50%
	0.01	0.01	0.00	lb/hr based on 20 hrs/day[4]
	90	46	14	lb/year at 350 days per year[4]
	0.05	0.02	0.01	ton/year actual emissions

1. See Facility Basis sheet, item 3.
2. See Facility Basis sheet, item 1.
3. Maximum emissions are based on all ore extracted by drill/blast; actual emissions are based on 44 % of ore extraction by drill/blast and use of road header account for 56%.
4. Maximum and Actual operational hours are shown on Facility Basis sheet, item 1.

2 Blasting PM Emissions

Based on AP-42, Chapter 11.9 Western Surface Coal Mining
(Best fit for this estimate)

$$\boxed{E = 0.000014(A)^{1.5}}$$

Emission factor equation from Table 11.9-1
for Blasting lb PM/blast

Drill hole depth: 10 feet
Wet Bulk Density Ore: 128 lb/ft3

Source: PFS Design Criteria, Document KD Engineering, No. KDE Q431-03-010

$$\boxed{E_{PM10} = (0.52)(0.000014)(A)^{1.5}}$$

0.52 = PM10 factor Table 11.9-1

$$\boxed{E_{PM2.5} = (0.03)(0.000014)(A)^{1.5}}$$

0.03 = PM2.5 factor Table 11.9-1

Where: E is emissions factor Area A is estimated by the volume of ore.

Area Calculation
Area is estimated from blasted volume per day divided by the drill hole depth (10 ft)

From mine plan:	tons/year	lb/ft3	lb/ton	ft3/yr
Maximum Ore Production Rate:	3,003,220	128	2000	46,925,313

44 Percent of ore extraction by blasting
2,064,714 ft2 Area blasted per year
10 ft depth of blast
5,657 ft2 area for 365 day/year
A= 5,657 ft2 daily blast area

Using formulae above, Emission factors E:

Emissions PM	Emissions PM-10	Emissions PM-2.5	
6.0	3.1	0.2	lb/blast per day
2	2	2	hr/day maximum
3.0	1.5	0.09	lb/hr maximum
1.49	0.77	0.045	lb/hr (50% Control as Settling Emission Factor for PM)
0.54	0.28	0.016	ton/yr maximum production
0.52	0.27	0.016	ton/yr normal production

A=	5,657	ft2 daily blast area
Maximum Operating days per year:	365	
Normal Operating days per year:	350	
Assumed Settling Emission Factor:	50%	Assume portion of PM will settle underground and not be vented to surface[1]
Max. Individual Blasting hours per year:	**730**	hr/yr
Normal Individual Blasting hours per year:	**700**	hr/yr

Emulsion maximum emissions - Based on maximum production rate

Maximum daily production rate:	8,228	ton/day
Maximum operating days/year	365	day/yr
Average annual blasting rate:	3,003,220	ton/yr blasted rock
Emulsion Powder Factor	1.80	lb emulsion/ton rock blasted
Annual emulsion usage	5,405,796	lb emulsion/yr
	2703	ton emulsion /yr

	NOx	SO_2	CO
lb emissions/ton explosive[1]	0.4	2	34
Emissions (lb/yr)	1081	5406	91899
Emissions (lb/hr)	1.5	7.4	125.9
Annualized Hourly Emissions (lb/hr)[2]	0.1		
Emissions (tpy)	0.5	2.7	45.9

Emulsion normal emissions - Based on normal production rate

Normal production rate:	7480	ton/day
Normal operating days/year:	350	days/yr
Average annual blasting rate:	2,618,000	ton/yr blasted rock
Emulsion Powder Factor:	1.80	lb. emulsion/ton rock blasted
Annual emulstion usage:	4,712,400	lb. emulsion/yr
	2356.2	ton emulsion /yr

NOx	SO_2	CO	
0.4	2	34	lb emissions/ton explosive[1]
942	4712	80111	Emissions (lb/yr)
1.3	6.7	114.4	Emissions (lb/hr)
0.1			Annualized Hourly Emissions (lb/hr)[2]
0.5	2.4	40.1	Emissions (tpy)

1. According to HCC, underground blasting operations will use a water-based emulsion. Given USEPA AP-42 does not have emission factors for water-based emulsion explosives, Foth relied on data from the *National Pollutant Inventory Emission Estimation Technique Manual for Explosives detonation and firing ranges Version 3.1 (August 2016)* prepared by the Australian Department of Environment and Energy. Appendix C, Table 7: Emission Factors for Category 1 and 2a substances provides emission factors for nitrogen oxides and carbon monoxide for a variety of explosives. The water-based emulsion emission factor for carbon monoxide varies based on diameter of drill hole. Conservatively, the carbon monoxide emission factor for less than 150 mm will be used. In that Appendix C does not provide emission factors for sulfur dioxide, the emission factor from Table 13.3-1 of USEPA AP-42 for ANFO will be used.

2. Based on verbal guidance provided by MDEQ, hourly emission rates for intermittent activities such as blasting can be annualized for NOx by multiplying the maximum calculated hourly rate for blasting by the maximum number of operation hours. For PTE, the maximum number of operation hours would be 7300. For normal operations, the maximum number of operation hours would be 7000.

3 Material Handling
Emissions Calculations:

	Process thru-put ton/hr	E factor PM lb/ton	E factor PM-10 lb/ton	E-Factor PM-2.5[1] lb/ton	Efficiency capture	Efficiency % note 2a PC equip	Efficiency % note Enclosure	Emissions PM lb/hr	Emissions PM-10 lb/hr	Emissions PM-2.5 (lb/hr)	Efactor Reference
Road Header Continuous Miner Excavation[3]	230	0.0054	0.0024	0.00036		90%		0.124	0.055	0.0083	11.19-2 Tertiary Crushing (Uncontrolled)
Remove Broken Ore from Muck Pile	411	0.003	0.0011	0.000165				1.234	0.453	0.0679	11.19-2 Conveyor Transfer Point (Uncontrolled)
Use Rolls/Rock Breaker to Reduce Ore Size	411	0.0054	0.0024	0.00036		90%		0.222	0.099	0.0148	11.19-2 Tertiary Crushing (Uncontrolled)
Transfer Ore to Feed Hopper	411	0.003	0.0011	0.000165		90%		0.123	0.045	0.0068	11.19-2 Conveyor Transfer Point (Uncontrolled)
Feed Hopper to Side Conveyor	411	0.003	0.0011	0.000165		90%		0.123	0.045	0.0068	11.19-2 Conveyor Transfer Point (Uncontrolled)
Side Conveyor to Main Conveyor	411	0.003	0.0011	0.000165		90%		0.123	0.045	0.0068	11.19-2 Conveyor Transfer Point (Uncontrolled)
LHD travel to transport ore to conveyor transfer point (see below)											

	PM	PM-10	PM-2.5	
Fugitive Emissions from Underground Material Handling	1.827	0.687	0.103	lb/hr
	0.913	0.344	0.052	lb/hr accounting for PM settling efficiency at 50%
maximum hours based on:	7300	7300	7300	hr/yr maximum
	6667	2508	376	lb/yr maximum
	3.3	1.3	0.2	ton/yr maximum
	7000	7000	7000	hr/yr actual
	6393	2405	361	lb/yr actual
	3.2	1.2	0.2	ton/yr actual

1. Particle size distribution is provided on Facility Basis sheet, item 3.
2. Capture & control efficiencies applied:
   (b) Emission source has a wet spray. Efficiency applied is: 90%
3. Road headers extract 56% of total process thruput.

Client: Copperwood Resources, Inc. Project ID.: 0023H001.00
Project: Air Permit Application Emissions Calculations
Prepared by: MMD Date: 05/10/23
Checked by: AKM Date: 08/17/23

LHD and Roadheader Travel

The FS describes the underground ore extraction process. A roadheader (Appendix A-5) extracts 56% of the ore. The LHD fleet (Appendix A-3) transports all the mined ore from the stope to a conveyor transfer point. The FS states the loading points will be < 250 m (0.16 miles) maximum from the mine headings. Therefore, the average roundtrip of the LHD is estimated at 0.16 miles. The roadheader will travel less than the LHD as it works the mine face, therefore, the estimate for roadheader travel is 25% the LHD travel.

Emission Factor E from AP-42 Chapter 13.2.2 Unaved Roads 11/06

$E = [k\ (s/12) \quad (\quad /3)\ ]$ lb/VMT Equation (1a)

$E = \mathrm{E}\ [(365 - \mathrm{P})/365]$ (dimensionless) Equation (2) Underground: P=0, therefore this adjustment =1

Where:
E= size specific emissions factor calculated for each vehicle (lb/VMT)
k= empirical constant selected from Table 13.2.2-2 (for industrial roads) (lb/VMT)
a & b= empirical constants selected from Table 13.2.2-2 (for industrial roads)

Constant	PM*	PM-10	PM-2.5
k (lb/VMT)	4.9	1.5	0.15
a	0.7	0.9	0.9
b	0.45	0.45	0.45

*Assumes PM is represented by PM-30

surface silt content s= 2 % silt content of stope bottom will be relatively low due from the aftermath of blasting and the efficiency and short timeframe needed to remove ore from the stope.

LHD Travel Emissions

Empty vehicle weight= 33.25 ton
payload weight= 10 ton/ load
Average round trip (RT) weight W= 38.25 ton
VMT calculation 0.16 VMT/ RT
LHD bucket capacity 10 ton/RT
Maximum Ore Production: 411.4 ton/hr
Maximum basis VMT: 6.58 VMT/hr

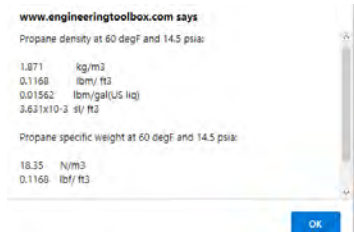
Actual Ore Production: 374 ton/hr
Actual basis VMT: 5.98 VMT/hr

Roadheader Travel Emissions

The roadheader travel is estimated to be25% the LHD travel:
maximum basis 1.6 VMT/hr
actual basis 1.5 VMT/hr
Vehicle weight W = 120,000 kg
W= 132 ton

Maximum operations underground 7,300 hr/yr
actual operations underground 7,000 hr/yr

1 kg = 2.2 lb
2000 lb= 1 ton



Emission Factors

	PM	PM-10	PM-2.5	
LDH	4.40	0.94	0.09	lb/VMT
Roadheader	7.67	1.64	0.16	lb/VMT
				Control Effiency
	50%	50%	50%	Settling factor [1]
	80%	80%	80%	Naturally damp conditions [2]

		Emissions [1]				
		VMT/hr	PM	PM-10	PM-2.5	
LDH	Maximum	6.6	2.89	0.62	0.06	lb/hr
			21119	4518	452	lb/yr
			10.56	2.26	0.23	ton/yr
	actual	6.0	2.63	0.56	0.06	lb/hr
			18410	3938	394	lb/yr
			9.21	1.97	0.20	ton/yr
Roadheader	Maximum	1.6	1.26	0.27	0.03	lb/hr
			9219	1972	197	lb/yr
			4.61	0.99	0.10	ton/yr
	actual	1.5	1.15	0.25	0.02	lb/hr
			8037	1719	172	lb/yr
			4.02	0.86	0.09	ton/yr

Total LHD and Roadheader Travel Emissions

	Emissions [1]			
	PM	PM-10	PM-2.5	
Maximum	4.2	0.9	0.1	lb/hr
	15.2	3.2	0.3	ton/yr
Actual	3.8	0.8	0.1	lb/hr
	13.2	2.8	0.3	ton/yr

1 Emissions have been reduced by 50% to account for settling in the underground mine.
2 The mine is expected to be damp overall and wet in many locations. This is supported by the groundwater model, showing minewater inflow will need removal and damp/wet conditions in the old White Pine Mine and other similar underground mines including Eagle Mine.

4 Mine Heaters

Mine heaters will be positioned at the mine ventilation intake with natural gas combustion emissions exhausted through the three mine exhaust vents. 150 day/yr Based on data from National Weather Service Forecast Offic http://www.crh.noaa.gov/mqt/index.php?page=climate/normals/marquette

The FS table 16.8 notes a 15 MBTU preproduction propane heater will be installed. Upon delivery, a 50 MBTU natural gas heater will be installed, replacing the propane heater. 3600 hr/yr there are 148 days/year with average temperature less than 32 F.

The PTI will be based on the maximum emissions between the natural gas and propane heaters shown below. The propane heater emits more emissions for all pollutants calcuated, therefore, the propane heater will be carried through the summary and modeling pages. The transition to natural gas heater will be described in the permit, acknowledging that the emissions will remain under the 4000 hr/yr

Natural Gas Heater - 50 MBTU natural gas heater

Heating value of natural gas: 1020 Btu/scf AP-42 Chapter 1.4
Heater capacity: 50 MBTU/hr
Natural gas usage: 0.049 10^6 scf/hr

Normal/Actual Emissions, taking permit limit to operate in cold months: 4000 hr/yr

With Permit Limit	NOx	CO	VOC	PM [1]	SO_2
Emissions (lb/hr)	4.90	4.12	0.27	0.19	0.03
Emissions (lb/yr)	19,608	16,471	1,078	745	118
Emissions (tpy)	9.8	8.2	0.5	0.4	0.1

Emission Factors - Natural Gas

AP-42 Table 1.4-1 Emission Factors for Nox and CO from Natural Gas Combustion and Table 1.4-2 Emission Factors for Criteria Pollutants and Greenhouse Gases from Natural Gas Combustion (Updated 07/98)

Pollutant	Emission Factor - lb/$10^{6\ scf}$	
NOx	100	
CO	84	
VOC	5.5	
PM	7.6	(Assume all PM10)
SO2	0.6	Assumes sulfur content of natural gas is 2,000 grains/10^6 scf

Days/year requiring mine heat: 150 day/yr
Operating time: 3600 hr/yr
Permit limit proposed: 4000 hr/yr

S Calculation for Propane
Sulfur content of Propane: 100 mg S / kg propane *
1 kg= 2.2 lbm
1 mg= 0.0154 grain
100 ft3 propane = 116.8 lbm/100-ft3
1 lbm= 453592 mg
S= 81.78 grain/100 ft3 propane

* Reference: https://www.tshrbv.nl/industries/petrochemical/total-sulfur-analysis/total-sulfur-analysis-in-liquefied-petroleum-gas-in-accordance-with-astm-d6667/#:~:text=The%20Total%20Sulfur%20analysis%20of,1.0%20to%20100%20mg%2Fkg.

Potential to Emit - Traditional Approach, uncontrolled running all year round: 8760 hr/yr

Uncontrolled	NOx	CO	VOC	PM [1]	SO_2
Emissions (lb/hr)	4.90	4.12	0.27	0.19	0.03
Emissions (lb/yr)	42,941	36,071	2,362	1,632	258
Emissions (tpy)	21.5	18.0	1.2	0.8	0.1

Propane Heater - 15 MBTU heater prior to installing Natural gas heater

No. heaters: 1
No. burners/heater: 6 ACI-CANEFCO - The heater will use 6 Maxon APX burners rated at 9 mmBTU/hour.
Load per burner: 9 mmBtu/hr
1000 gal LPG= 91.5 mmBtu AP-42 Chapter 1.5
Total burner fuel usage= 0.590 10^3 gal/hr

Emission Factors - Propane

AP-42 Table 1.5-1 Emission Factors for LPG Combustion (07/08)

Pollutant	Emission Factor - lb/10^3 gal	
NOx	13	
CO	7.5	
VOC	1.0	
PM	0.7	(Assume all PM10)
SO2	8.2	0.10S where S- sulfur content of propane in grain/100 ft3 gas vapor (assumed standard TP).

Potential to Emit - Traditional Approach, uncontrolled running all year round: 8760 hr/yr

Uncontrolled	NOx	CO	VOC	PM [1,2]	SO_2
Emissions (lb/hr)	7.67	4.43	0.59	0.21	4.8
Emissions (lb/yr)	67,208	38,774	5,170	1,809	42,281
Emissions (tpy)	33.6	19.4	2.6	0.9	21.1

Normal/Actual Emissions, taking permit limit to operate in cold months: 4000 hr/yr

With Permit Limit	NOx	CO	VOC	PM [1,2]	SO_2
Emissions (lb/hr)	7.67	4.43	0.59	0.21	4.83
Emissions (lb/yr)	30,689	17,705	2,361	826	19,306
Emissions (tpy)	15.3	8.9	1.2	0.4	9.7

1 PM value has accounted for a 50% settling efficiency
2 PM value shown will be used to represent PM10 and PM 2.5 in the summary calculations and table below.

Allocation of Emissions to Ventilation System:

Ventilation Summary is shown on Facility Basis sheet, item 4.
Use Maximum Ventilation Rates to Estimate Allocation of Emissions (Mine Year 2025), using the propane heater emissions.

	CFM	Allocation
SV-001 (West Mine Exhaust Vent)	330,000	0.388
SV-002 (East Mine Exhaust Vent)	340,000	0.400
SV-003 (Portal Mine Exhaust Vent)	180,000	0.21
	850,000	1.000

	Maximum Underground Emissions:							Normal Underground Emissions:							
	NOx	SOx	CO	PM	PM-10	PM-2.5	VOC	NOx	SOx	CO	PM	PM-10	PM-2.5	VOC	
Total lb/hr	7.8	12.2	130.3	6.80	2.23	0.40	0.59	7.8	11.6	118.9	6.40	2.14	0.39	0.59	
Total ton/yr	34.1	23.8	65.3	20.07	5.75	1.45	2.6	15.8	12.0	48.9	17.40	5.23	0.90	1.2	
Ventilation Raise Allocated Maximum Emissions								Ventilation Raise Allocated Normal Emissions							
SV-001 (West Mine Exhaust Vent)	3.04	4.75	50.59	2.64	0.87	0.154	0.229	3.03	4.49	46.15	2.48	0.83	0.150	0.229	lb/hr
	13.26	9.26	25.37	7.79	2.23	0.56	1.00	6.14	4.66	18.99	6.76	2.03	0.35	0.46	ton/yr
SV-002 (East	3.13	4.89	52.13	2.72	0.89	0.159	0.236	3.12	4.62	47.55	2.56	0.86	0.154	0.236	lb/hr
	13.66	9.54	26.13	8.03	2.30	0.58	1.03	6.33	4.80	19.56	6.96	2.09	0.36	0.47	ton/yr
SV-003	1.66	2.59	27.60	1.44	0.47	0.084	0.125	1.65	2.45	25.17	1.36	0.45	0.082	0.125	lb/hr
	7.23	5.05	13.84	4.25	1.22	0.31	0.55	3.35	2.54	10.36	3.68	1.11	0.19	0.25	ton/yr

Client:	Copperwood Resources, Inc.	Project ID.:	0023H001.00
Project:	Air Permit Application Emissions Calculations		
Prepared by:	MMD	Date:	05/10/23
Checked by:	AKM	Date:	08/17/23

Mine Heater: Organic and Metal Compounds from Natural Gas Combustion
AP-42 Ch. 1.4, Table 1.4-3 Emission factors entered for applicable parameters.

Trace Organic Pollutants	Emission Factor	Maximum Emissions (8760 hr/yr)		Actual Emissions (4000 hr/yr)	
	(lb/10^6 scf)	(lb/hr)	(lb/yr)	(lb/hr)	(lb/yr)
1,1,2,2-Tetrachloroethane					
1,1,2-Trichloroethane					
1,1-Dichloroethane					
1,2,3-Trimethylbenzene					
1,2,4-Trimethylbenzene					
1,2-Dichloroethane					
1,2-Dichloropropane					
1,3,5-Trimethyl benzene					
1,3-Butadiene					
1,3-Dichloropropene					
2-Methylnaphthalene	2.40E-05	1.18E-06	0.010305882	1.18E-06	0.004705882
3-Methylcholathrene	1.80E-06	8.82E-08	0.000772941	8.82E-08	0.000352941
2,2,4-Trimethly pentane					
Anthracene	1.80E-06	8.82E-08	0.000772941	8.82E-08	0.000352941
Acenaphthene	1.80E-06	8.82E-08	0.000772941	8.82E-08	0.000352941
Acenaphthylene	2.40E-06	1.18E-07	0.001030588	1.18E-07	0.000470588
Acetaldehyde					
Acrolein					
Benzene	2.10E-03	1.03E-04	0.901764706	1.03E-04	0.411764706
Benzo(a)anthracene	1.80E-06	8.82E-08	0.000772941	8.82E-08	0.000352941
Benzo(a)pyrene	1.20E-06	5.88E-08	0.000515294	5.88E-08	0.000235294
Benzo(b)fluoranthene	1.80E-06	8.82E-08	0.000772941	8.82E-08	0.000352941
Benzo(k)fluoranthene	1.80E-06	8.82E-08	0.000772941	8.82E-08	0.000352941
Benzo(g,h,i)perylene	1.20E-06	5.88E-08	0.000515294	5.88E-08	0.000235294
Biphenyl					
Butane	2.1	1.03E-01	901.7647059	1.03E-01	411.7647059
Butry/Isobutyraldehyde					
Carbon Tetrachloride					
Chlorobenzene					
Chloroethane					
Chloroform					
Chrysene	1.80E-06	8.82E-08	0.000772941	8.82E-08	0.000352941
Cyclopentane					
Dibenz(a,h)anthracene	1.20E-06	5.88E-08	0.000515294	5.88E-08	0.000235294
7,12-dimethylbenz(a)anthracene	1.60E-05	7.84E-07	0.006870588	7.84E-07	0.003137255
Dichlorobenzene	1.20E-03	5.88E-05	0.515294118	5.88E-05	0.235294118
Ethane	3.1	1.52E-01	1331.176471	1.52E-01	607.8431373
Ethylbenzene					
Ethylene Dibromide					
Fluorene	2.80E-06	1.37E-07	0.001202353	1.37E-07	0.00054902
Fluoroanthene	3.00E-06	1.47E-07	0.001288235	1.47E-07	0.000588235
Formaldehyde	7.50E-02	3.68E-03	32.20588235	3.68E-03	14.70588235
Indeno(1,2,3-cd)pyrene	1.80E-06	8.82E-08	0.000772941	8.82E-08	0.000352941
Methanol					
Methylcyclohexane					
Methylene Chloride					
Naphthalene	6.40E-04	3.14E-05	0.274823529	3.14E-05	0.125490196
n-Hexane	1.8	8.82E-02	772.9411765	8.82E-02	352.9411765
n-Nonane					
n-Octane					
n-Pentane	2.6	1.27E-01	1116.470588	1.27E-01	509.8039216
PAH					
Phenanthrene	1.70E-05	8.33E-07	0.0073	8.33E-07	0.003333333
Phenol					
Propane	1.6	7.84E-02	687.0588235	7.84E-02	313.7254902
Propylene					
Pyrene	5.00E-06	2.45E-07	0.002147059	2.45E-07	0.000980392
Styrene					
Tetrachloroethane					
Toluene	3.40E-03	1.67E-04	1.46	1.67E-04	0.666666667
Vinyl Chloride					
Xylene					

Natural Gas Mine Heater: Summary of Metals and TACs to model
AP-42 Ch. 1.4, Table 1.4-4

TraceMetal Pollutants	Emission Factor	Maximum Emissions		Actual Emissions (4000 hr/yr)		Allocation 0.388 SV001 West Vent	0.400 SV002 East Vent	0.21 SV003 Portal Vent
	(lb/10^6 scf)	(lb/hr)	(lb/yr)	(lb/hr)	(lb/yr)	(lb/hr)	(lb/hr)	(lb/hr)
Arsenic	2.00E-04	9.80E-06	0.086	9.80E-06	0.039	3.80623E-06	3.92157E-06	2.07612E-06
Barium	4.40E-03	2.16E-04	1.889	2.16E-04	0.863	8.3737E-05	8.62745E-05	4.56747E-05
Beryllium	1.20E-05	5.88E-07	0.005	5.88E-07	0.002	2.28374E-07	2.35294E-07	1.24567E-07
Cadmium	1.10E-03	5.39E-05	0.472	5.39E-05	0.216	2.09343E-05	2.15686E-05	1.14187E-05
Chromium	1.40E-03	6.86E-05	0.601	6.86E-05	0.275			
Cobalt	8.40E-05	4.12E-06	0.036	4.12E-06	0.016	1.59862E-06	1.64706E-06	8.71972E-07
Copper	8.50E-04	4.17E-05	0.365	4.17E-05	0.167	1.61765E-05	1.66667E-05	8.82353E-06
Manganese	3.80E-04	1.86E-05	0.163	1.86E-05	0.075	7.23183E-06	7.45098E-06	3.94464E-06
Mercury	2.60E-04	1.27E-05	0.112	1.27E-05	0.051			
Molybdenum	1.10E-03	5.39E-05	0.472	5.39E-05	0.216			
Nickel	2.10E-03	1.03E-04	0.902	1.03E-04	0.412	3.99654E-05	4.11765E-05	2.17993E-05
Selenium	2.40E-05	1.18E-06	0.010	1.18E-06	0.005			
Vanadium	2.30E-03	1.13E-04	0.988	1.13E-04	0.451			
Zinc	2.90E-02	1.42E-03	12.453	1.42E-03	5.686			
Acetaldehyde		0.00E+00	0	0.00E+00	0	0	0	0
Acrolein		0.00E+00				0	0	0
Formaldehyde		3.68E-03				0.001427336	0.001470588	0.000778547
Benzene		1.03E-04				3.99654E-05	4.11765E-05	2.17993E-05

Foth

Client:	Copperwood Resources, Inc.	Project ID.:	0023H001.00
Project:	Air Permit Application Emissions Calculations		
Prepared by:	MMD	Date:	05/10/23
Checked by:	AKM	Date:	08/17/23

Ore handling and processing emissions are comprised from the following fugitive emissions that are characterized as Volume Sources:
1. Ore Transfer from Portal to First Transfer Point (fugitive)
2. Surplus Ore Transfer at Ore Stockpile for Temporary Storage (fugitive)
3 Transfer Points at Ore Bins/Reclaim Area (fugitive)
4 Transfer Points at SAG Mill (fugitive)
5 Concentrate Handling Operations (fugitive)

Surface Ore Handling and Processing

EUOREHANDLING

1. Ore Transfer from Portal to First Transfer Point (fugitive)

Process F001	Process thru-put ton/hr [1]	E factor PM lb/ton	E factor PM-10 lb/ton	E-Factor PM-2.5 [4] lb/ton	Capture Efficiency % note 3a	Control Efficiency % note 3b PC equip	Control Efficiency % note 3a Enclosure	Emissions PM lb/hr	Emissions PM-10 lb/hr	Emissions PM-2.5 (lb/hr)	Efactor Reference	
Feed Ore Transfer Conveyor (No. 1) to Ore Transfer Conveyor (No. 2)	411	0.003	0.0011	0.000165			95%	0.062	0.023	0.0034	11.19-2 Conveyor Transfer Point (Uncontrolled)	
Feed Ore Transfer Conveyor (No. 1) to Surplus Ore Feed Conveyor (No. 4) (to Ore Stockpile)	206	0.003	0.0011	0.000165			95%	0.031	0.011	0.0017	11.19-2 Conveyor Transfer Point (Uncontrolled)	
Surplus Ore Feed Transfer (using FE) to Feed Ore Conveyor (No.1) (Return from Ore Stockpile)	206	0.0013	0.0006	0.0001			95%	0.013	0.006	0.0009	13.2.4 Equation (1), see Calc 1	
							Fugitive Emissions from F001	0.106	0.040	0.006	lb/hr	
							Maximum:	7300	7300	7300	hr/yr maximum	(see Note No. 5)
								771	293	44	lb/yr maximum	
								0.39	0.15	0.02	ton/yr maximum	
							Actual:	7000	7000	7000	hr/yr actual	(see Note No. 5)
								739	281	42	lb/yr actual	
								0.37	0.14	0.02	ton/yr actual	

2. Surplus Ore Transfer at Ore Stockpile for Temporary Storage (fugitive)

Process F002	Process thru-put ton/hr [1]	E factor PM lb/ton	E factor PM-10 lb/ton	E-Factor PM-2.5 [4] lb/ton	Capture Efficiency % note 3a	Control Efficiency % note 3b PC equip	Control Efficiency % note 3a Enclosure	Emissions PM lb/hr	Emissions PM-10 lb/hr	Emissions PM-2.5 (lb/hr)	Efactor Reference	
Ore Transfer Conveyor (No. 4) Transfer to Drop Point (within Ore Stockpile)	206	0.003	0.0011	0.000165			95%	0.031	0.011	0.002	11.19-2 Conveyor Transfer Point (Uncontrolled)	
FEL removes material from Conveyor No. 4 drop point for transfer to staging area within Ore Stockpile footprint. (handling/maintaining piles) (See Note 2)	206	0.0013	0.0006	0.0001				0.261	0.123	0.019	13.2.4 Equation (1), see Calc 1	
							Fugitive Emissions from F002	0.292	0.135	0.020	lb/hr	
							Maximum:	7300	7300	7300	hr/yr maximum	(see Note No. 5)
								2131	984	149	lb/yr maximum	
								1.07	0.49	0.07	ton/yr maximum	
							Actual:	7000	7000	7000	hr/yr actual	(see Note No. 5)
								2043	943	143	lb/yr actual	
								1.02	0.47	0.07	ton/yr actual	

3 Transfer Points at Ore Bins/Reclaim Area (fugitive)

Process F003	Process thru-put ton/hr [1]	E factor PM lb/ton	E factor PM-10 lb/ton	E-Factor PM-2.5 [4] lb/ton	Capture Efficiency % note 3a	Control Efficiency % note 3b PC equip	Control Efficiency % note 3a Enclosure	Emissions PM lb/hr	Emissions PM-10 lb/hr	Emissions PM-2.5 (lb/hr)	Efactor Reference	
Ore Transfer Conveyor No. 2 to Ore Bin Conveyor	411	0.003	0.0011	0.000165			95%	0.062	0.0226	0.0034	11.19-2 Conveyor Transfer Point (Uncontrolled)	
Ore Bin Conveyor Transfer to Ore Bins No. 1 to No. 4	411	0.003	0.0011	0.000165			95%	0.062	0.0226	0.0034	11.19-2 Conveyor Transfer Point (Uncontrolled)	
Ore Bins No. 1 to No. 4 Transfer to Ore Bin Feeders No. 1 to No. 4	411	0.003	0.0011	0.000165			95%	0.062	0.023	0.0034	11.19-2 Conveyor Transfer Point (Uncontrolled)	
Ore Bin Feeders No. 1 to No. 4 Transfer to SAG Mill Feed Conveyor No. 3	411	0.003	0.0011	0.000165			95%	0.062	0.023	0.0034	11.19-2 Conveyor Transfer Point (Uncontrolled)	
							Fugitive Emissions from F003	0.247	0.091	0.014	lb/hr	
							Maximum:	7300	7300	7300	hr/yr maximum	(see Note No. 5)
								1802	661	99	lb/yr maximum	
								0.90	0.33	0.05	ton/yr maximum	
							Actual:	7000	7000	7000	hr/yr actual	(see Note No. 5)
								1728	634	95	lb/yr actual	
								0.86	0.32	0.05	ton/yr actual	

Client:	Copperwood Resources, Inc.	Project ID.:	0023H001.00
Project:	Air Permit Application Emissions Calculations		
Prepared by:	MMD	Date:	05/10/23
Checked by:	AKM	Date:	08/17/23

4 Transfer Points at SAG Mill (fugitive)

Process F005	Process thru-put [1] ton/hr	E factor PM [4] lb/ton	E factor PM-10 [4] lb/ton	E-Factor PM-2.5 [4] lb/ton	Control Efficiency % note 3c PC equip	Control Efficiency % note 3a enclosure	Emissions PM lb/hr	Emissions PM-10 lb/hr	Emissions PM-2.5 (lb/hr)	Efactor Reference	
SAG Mill Feed Conveyor No. 3 Transfer to SAG Mill Hopper	411	0.003	0.0011	0.000165	90.0%	95%	0.0062	0.00226	0.00034	11.19-2 Conveyor Transfer Point (Uncontrolled)	
SAG Mill Hopper to SAG Mill	411	0.003	0.0011	0.000165	90.0%	95%	0.0062	0.00226	0.00034	11.19-2 Conveyor Transfer Point (Uncontrolled)	
						Fugitive Emissions from F005	0.012	0.005	0.001	lb/hr	
						Maximum:	8760	8760	8760	hr/yr maximum	(see Note No. 5)
							108	40	6	lb/yr maximum	
							0.05	0.02	0.00	ton/yr maximum	
						Actual:	7992	7992	7992	hr/yr actual	(see Note No. 5)
							99	36	5	lb/yr actual	
							0.05	0.02	0.00	ton/yr actual	

EUCONCENTRATE
5 Concentrate Handling Operations (fugitive)

Process F006	Process thru-put [1] ton/hr	E factor PM [4] lb/ton	E factor PM-10 [4] lb/ton	E-Factor PM-2.5 [4] lb/ton	Control Efficiency % note 3c PC equip	Control Efficiency % note 3a enclosure	Emissions PM lb/hr	Emissions PM-10 lb/hr	Emissions PM-2.5 (lb/hr)	Efactor Reference	
Copper Concentrate Filter Press to Copper Concentrate Stockpile	19.1	0.003	0.0011	0.000165	25.0%	95%	0.002	0.00079	0.00012	11.19-2 Conveyor Transfer Point (Uncontrolled)	
Copper Concentrate Stockpile to Concentrate Loadout Hopper	19.1	0.003	0.0011	0.000165	25.0%	95%	0.002	0.00079	0.00012	11.19-2 Conveyor Transfer Point (Uncontrolled)	
Concentrate Loadout Hopper to Concentrate Feeder	19.1	0.003	0.0011	0.000165	25.0%	95%	0.002	0.00079	0.00012	11.19-2 Conveyor Transfer Point (Uncontrolled)	
Concentrate Feeder to Truck Loading Conveyor	19.1	0.003	0.0011	0.000165	25.0%	95%	0.002	0.00079	0.00012	11.19-2 Conveyor Transfer Point (Uncontrolled)	
Truck Loading Conveyor to Concentrate Truck	19.1	0.003	0.0011	0.000165	25.0%	95%	0.002	0.00079	0.00012	11.19-2 Conveyor Transfer Point (Uncontrolled)	
						Fugitive Emissions from F006	0.011	0.004	0.001	lb/hr	
						Maximum:	8760	8760	8760	hr/yr maximum	(see Note No. 5)
							94	35	5	lb/yr maximum	
							0.05	0.02	0.00	ton/yr maximum	
						Actual:	7992	7992	7992	hr/yr actual	(see Note No. 5)
							86	31	5	lb/yr actual	
							0.04	0.02	0.00	ton/yr actual	

Notes:

1. Thruput and hours of operation are described on the Facility Basis sheet.

2. Most ore transfer will flow directly from mine portal to the process plant through the ore bins/reclaim area. However, it is assumed that approximately 50% of the ore will be transferred to the ore stockpile for intermediate storage. The intent is to keep the mine operations underway during times the process plant will be down for maintenance. Therefore, the tons/hour process rate for the ore stockpile is 411 tph * 0.50 = 206 tph.

3. Capture & control efficiencies applied:

(a) Emission source is indoors in an enclosed building or enclosed by cover. Efficiency applied is:	95%
(b) Emission source has a wet spray. Efficiency applied is:	90%
(c) Concentrate is 9% moisture. Additional Control Efficiency applied is:	25%

4. Particle size distribution is provided on Facility Basis sheet, item 3.

5. Mine operation basis, see Facility Basis Sheet:

	Normal/ Actual	Maximum
Mine operation hours/year:	7,000	7,300
thruput tons/hr:	374	411.4
ore production rate tons/year:	2,618,000	3,003,220
concentrate production hours/year:	7,992	8,760
Concentrate production tons/hr:	16.6	19.1
concentrate production rate tons/year:	132,747	167,329

Calc 1

Transfer to ore pile & handling mat'l pile - AP-42 13.2.4 Eq. (1)

$$E = k(0.0032)\left(\frac{U}{5}\right)^{1.3} / \left(\frac{M}{2}\right)^{1.4} (lb/ton)$$

E= emission factor
k=particle size multiplier (dimensionless)

U= mean wind speed (mph) U= 8.3 mph (Avg wind speed using meteorological data from Ironwood, MI for 2012-2016)
M= material moisture content ore (%) M= 5.0 % for the ore

Copper Ore

E PM lb/ton	E PM-10 lb/ton	E PM-2.5 lb/ton	k PM * unitless	k PM-10 unitless	k PM-2.5 unitless	U miles/hr	M %
0.0013	0.0006	0.0001	0.74	0.35	0.053	8.3	5.0

*Assumes k factor for PM is represented by PM-30

Client:	Copperwood Resources, Inc.	Project ID.:	0023H001.00
Project:	Air Permit Application Emissions Calculations		
Prepared by:	MMD	Date:	05/10/23
Checked by:	AKM	Date:	08/17/23

Ore Stockpile Material Handling - EUORESTOCKPILE

Ore Stockpile material handling emissions are comprised from the following activities
1. material handling
2. vehicle travel

1. Material Handling Activites

Process F004 (Fugitive Volume Source)	Process thru-put ton/hr	E factor PM lb/ton	E factor PM-10 lb/ton	E factor PM-2.5 lb/ton	Control Efficiency % note 2	Emissions PM lb/hr	Emissions PM-10 lb/hr	Emissions PM-2.5 lb/hr	E factor reference
Management of Ore at Staging Area within Ore Stockpile									
Surplus ore from mine operations is transferred to Ore Stockpile. FEL transfers to working area within footprint of Ore Stockpile area.	206	0.0013	0.0006	0.0001		0.261	1.23E-01	1.87E-02	13.2.4 Equation (1), see Calc 1
FEL manages piles within Ore Stockpile area (at 50% of pile mass) [1]	103	0.0013	0.0006	0.0001		0.130	6.17E-02	9.35E-03	13.2.4 Equation (1), see Calc 1
FEL transfers material from staging area within Ore Stockpile footprint for return to Conveyor No. 4. (handling/maintaining piles) (See Note 1)	206	0.0013	0.0006	0.0001		0.261	1.23E-01	1.87E-02	13.2.4 Equation (1), see Calc 1
Material handling emissions within Ore Stockpile						0.65	0.31	0.05	lb/hr
						7,300	7,300	7,300	hr/yr [2]
Process F004 Material Handling emissions:						4,763	2,253	341	lb/yr
						2.4	1.1	0.2	ton/yr

Notes:
1. Maximum controlled emissions for material handling within Ore Stockpile assumes that 50% of transferred ore will be managed further within Ore Stockpile.
2. Maximum and Actual Basis

		Maximum	Actual
From Facility Basis Sheet:	Operating hours/year	**7,300**	**7,000**
	Mine Thruput Rate tons/day	**8,228**	**7,480**

Calc 1

Transfer to ore pile & handling mat'l pile - AP-42 13.2.4 Eq. (1)

E= emission factor

$$E = k(0.0032)\left(\frac{U}{5}\right)^{1.3} / \left(\frac{M}{2}\right)^{1.4} (lb/ton)$$

k=particle size multiplier (dimensionless)

U= mean wind speed (mph) U= 8.3 mph (Avg wind speed using meteorological data from Ironwood, MI for 2012-2016)

M= material moisture content ore (%) M= 5.0 % for the ore (Information from the Prefeasibility Study for the project prepared by KD Engineering in July 2011 indicates that the ore moisture content was expected to be 6.5%. Therefore, 5% moisture will be used to be conservative.)

Copper Ore

E PM lb/ton	E PM-10 lb/ton	E PM-2.5 lb/ton	k PM * unitless	k PM-10 unitless	k PM-2.5 unitless	U miles/hr	M %
0.0013	0.0006	0.0001	0.74	0.35	0.053	8.3	5.0

*Assumes k factor for PM is represented by PM-30

F004 Ore Material Handling

PM	PM-10	PM-2.5	
0.7	0.3	0.05	lb/hr maximum
2.4	1.1	0.17	ton/yr maximum
2.1	1.0	0.15	ton/yr actual

2. Vehicle Travel on Ore Stockpile - HR01 (Fugitive Volume Source)

Unpaved roadway maximum emissions and potential to emit are based on the maximum overall production rate of the facility and the number of vehicles and trips required to handle this capacity. Based on AP-42 13.2.2 Unpaved Roads (11/06), it is used to estimate unpaved road PM, PM10, and PM2.5 emissions. The precipitation factor (factorprecip) is applied to vehicle emissions to account for the inherent control provided by the natural mitigation of rainfall and other precipitation. Additional controls are added to account for the road watering program and limitations on truck speeds.

Front End Loader CAT 988K $E = k\left(\frac{s}{12}\right)^{a} \times \left(\frac{W}{3}\right)^{b}$ lb/VMT Equation (1a) - for industrial roads

$Factor_{precip} = [(365 - P)/365]$ (dimensionless) Equation (2)

Where:
- E= emissions factor calculated for each vehicle in lb/VMT
- k= particle size multiplier selected from Table 13.2.2-2 for industrial roads, in lb/VMT
- a & b = empirical constants selected from Table 13.2.2-2 for industrial roads.
- s= surface material silt content (%) 2 % (Based on grain size distribution graph provided by Copperwood)
- W= mean weight of vehicle (tons) = 56 tons (vehicle weight empty); 16 tons (weight of payload); 64 tons (Average weight of vehicle including travel to Ore Stockpile and return empty to Conveyor No. 4)
- P= number of days/year with 0.01 in precipitation, selected from AP-42 Figure 13.2.2-1
- P= 150 days

Precipitation Factor = 0.59 Based on equation (2) and P = 150

Control from CE = 50% from limiting truck speed to 15 mph

HR-01 (Haul Road)

	Emission Factor for the CAT 988K wheel loader						Estimated Distance						Maximum	Actual
	E lb/VMT [1]	k lb/VMT	s %	W ton	a	b	Circuit [2] feet	Payload [3] ton	Material ton/hr	Circuits per hr [4]	VMT per hr	Emissions lb/hr	Emissions ton/yr	Emissions ton/yr
PM total *	1.63	4.9	2	64.0	0.7	0.45	1200	16.0	206	14	3.2	**5.24**	**19.14**	**18.4**
PM 10	0.35	1.5	2	64.0	0.9	0.45	1200	16.0	206	14	3.2	**1.12**	**4.10**	**3.9**
PM2.5	0.035	0.15	2	64.0	0.9	0.45	1200	16.0	206	14	3.2	**0.112**	**0.41**	**0.4**

*Assumes k factor for PM is represented by PM-30

Notes:
1. The emission factor has been adjusted to account for additional controls associated with limitations on vehicle speed to 15 mph.
2. One circuit is the distance from Ore Stockpile to incline at Transfer Tower, return to stockpile. Movement will be to various locations within the stockpile. To calculate emissions, it will be assumed that the estimated distance is about 600 feet from the transfer tower ramp to center of Ore Stockpile. Therefore the circuit will be 1,200 feet round-trip.
3. Payload is based on transporting rated payload.
4. Based on daily perspective

HR-01

Emissions PM	Emissions PM-10	Emissions PM-2.5	
5.2	1.1	0.1	lb/hr maximum
19.1	4.1	0.4	ton/yr maximum
16.7	3.6	0.36	ton/yr actual

Total Ore Handling at Ore Stockpile Summary

Emissions PM	Emissions PM-10	Emissions PM-2.5	
7.3	2.1	0.3	lb/hr maximum
21.5	5.2	0.6	ton/yr maximum
18.8	4.6	0.5	ton/yr actual

Client:	Copperwood Resources, Inc.	Project ID.:	0023H001.00
Project:	Air Permit Application Emissions Calculations		
Prepared by:	MMD	Date:	05/10/23
Checked by:	AKM	Date:	08/17/23

On-Site Roadway Fugitive Dust Emissions due to Vehicle Travel, Access Road - HR-02 and HR-07 - EUHAULROADS

Roadway dust emissions ar comprised from the following sources:	Distance (feet) [1]	Distance (miles) [1]	Description
1. Concentrate Trucks - Unpaved Road (HR-02)	13525	2.6	This estimate addresses product haul truck travel between the concentrate load-out area and the main gate access point to the mine.
2 Truck Transport of Water to Site (HR-03)	10800	2.0	This estimate addresses truck transport of water from the main gate to Off-loading Station at TDF.
3. Truck Transport of Reagents & Grinding Media (HR-04)	14135	2.7	This estimate addresses truck transport of mill reagents and grinding media from the main gate to the process plant.
4. Truck Transport of Explosives (HR-05)	11625	2.2	This estimate addresses truck transport of explosives from the main gate to the explosives magazine.
5. Truck Transport of Natural Gas Delivery (HR-06)	13505	2.6	This estimate addresses truck transport of bulk compressed natural gas from the main gate to the generators.
6. Truck Transport of Diesel Fuel Delivery (HR-07)	14500	2.7	This estimate addresses truck transport of bulk diesel fuel from the main gate to the diesel fuel storage tanks.

1 Distances measured from Figures 3-1 and 3-2. Roundtrips are double the distance.

Unpaved road emissions are based on AP-42 Chapter 13.2.2 (11/06).
The precipitation factor is applied to roadway emissions to account for the inherent control provided by the natural mitigation of rainfall and other precipitation.

Unpaved Road Emission Factor Calculations
AP-42 Chapter 13.2.2 Unaved Roads 11/06

$$\boxed{E = [k\ (s/12) \quad (\quad /3)\ ]}$$ lb/VMT Equation (1a)

$$\boxed{E = \mathrm{E}\ [(365 - \mathrm{P})/365]}$$ (dimensionless) Equation (2)

Where: E= size specific emissions factor calculated for each vehicle (lb/VMT)
k= empirical constant selected from Table 13.2.2-2 (for industrial roads) (lb/VMT)
a & b= empirical constants selected from Table 13.2.2-2 (for industrial roads)

Constant	PM*	PM-10	PM-2.5
k (lb/VMT)	4.9	1.5	0.15
a	0.7	0.9	0.9
b	0.45	0.45	0.45

*Assumes PM is represented by PM-30

s= surface material silt content (%)
s= 2 % silt content of aggregate mat'l used for on-site access road (Assumes regular road maintenance such as grading & replacing with fresh mat'l.)

Concentrate Truck Movement Along Access Road (HR-02)

5.12 miles per round trip
0.342 hours/trip (assume 15 mph speed limit)
Maximum hours per year for truck travel = 1,079 hours/year for truck travel

W= "fleet" average weight of vehicle (tons) - varies for each vehicle "fleet"
FS notes concentrate trucks are max gross wt of 75 ton (p. 18-14, 11 axle)
25 tons (vehicle weight empty)
W Concentrate truck= 53 tons (max weight of payload - in Michigan only)
52 empty)
P= number of days/year with 0.01 in precipitation, selected from AP-42 Figure 13.2.2-1
P= 150
VMT= vehicle miles traveled per year, (see below)
Precipitation factor= 0.59 Based on equation (2) and P=150

	PM	PM-10	PM-2.5	
E conc truck traffic=	2.96	0.63	0.06	lb/VMT

Water Transport Truck Movement Along Access Road (HR-03)

4.09 miles per round trip
0.273 hours/trip (assume 15 mph speed limit)
Maximum hours per year for truck travel = 2,787 hours/year for truck travel

W= "fleet" average weight of vehicle (tons) - varies for each vehicle "fleet"
23.5 tons (vehicle weight empty)
53 tons (max weight of payload - in Michigan only)
50 tons (Average weight of vehicle including travel from main gate to off-load location at TDF
P= number of days/year with 0.01 in precipitation, selected from AP-42 Figure 13.2.2-1
P= 150
VMT= vehicle miles traveled per year, (see below)
Precipitation factor= 0.59 Based on equation (2) and P=150

	PM	PM-10	PM-2.5	
E water truck traffic=	2.92	0.62	0.06	lb/VMT

Vehicle Miles Traveled (VMT)

VMT 5.1 miles (round trip distance on unpaved road between concentrate load-out area and main gate)
167,329 tons/year maximum concentrate production rate
53 ton/truck
3,158 truck trips/year
VMT con truck = 16,179 miles/yr unpaved
speed check 15 miles/hr

VMT 4.1 miles (round trip distance on unpaved road between water off-load area and main gate)
28 trucks per day (B. Stimac, 1/30/18)
365 days per year
10,220 truck trips per year
VMT water truck = 41,809 miles/yr unpaved
speed check 15.0 miles/hr

$$\boxed{Emissions = (E)(VMT)(1 - CE\%)}$$

Concentrate Product Haul Trucks Unpaved Road

Unpaved vehicle miles traveled, VMT 16,179 VMT/yr
15.00 VMT/hr
CE= 90% from roadway watering program
CE= 50% from limiting truck speed to 15 mph

	PM	PM-10	PM-2.5	
Unpaved Road Emission Factor EF	2.96	0.63	0.06	lb/VMT
Emissions	2.22	0.47	0.047	lb/hr
Emissions	2,394	512	51	lb/yr maximum
Emissions	1.2	0.3	0.03	ton/yr maximum
Emissions	0.9	0.2	0.02	ton/yr actual

$$\boxed{Emissions = (E)(VMT)(1 - CE\%)}$$

Water Transport Trucks Unpaved Road

Unpaved vehicle miles traveled, VMT 41,809 VMT/yr
15.0 VMT/hr
CE= 90% from roadway watering program
CE= 50% from limiting truck speed to 15 mph

	PM	PM-10	PM-2.5	
Unpaved Road Emission Factor EF	2.92	0.62	0.06	lb/VMT
Emissions	2.19	0.47	0.05	lb/hr
Emissions	6,105	1,306	131	lb/yr maximum
Emissions	3.1	0.7	0.07	ton/yr maximum
Emissions	2.8	0.6	0.1	ton/yr actual

Client: Copperwood Resources, Inc.	Project ID.: 0023H001.00
Project: Air Permit Application Emissions Calculations	
Prepared by: MMD	Date: 05/10/23
Checked by: AKM	Date: 08/17/23

Reagent & Grinding Media Truck Movement Along Access Road (HR-04)

5.35 miles per round trip
0.357 hours/trip (assume 15 mph speed limit)
Maximum hours per year for truck travel = 260 hours/year for truck travel
W= "fleet" average weight of vehicle (tons) - varies for each vehicle "fleet"
20 tons (vehicle weight empty)
Weight Delivery truck= 23.2 tons (weight of payload)
32 tons (Average weight of vehicle including delivering full and return empty)
P= number of days/year with 0.01 in precipitation, selected from AP-42 Figure 13.2.2-1
P= 150
VMT= vehicle miles traveled per year, calculated separately for each vehicle fleet (see below)
Precipitation factor= 0.59 Based on equation (2) and P=150

	PM	PM-10	PM-2.5	
E reagent truck traffic=	2.38	0.51	0.05	lb/VMT

VMT 5.4 miles round trip
14 trucks per week (Gmining 6/19/18)
52 weeks/year
728 truck trips/year
VMT = 3,898 miles/yr unpaved
speed check 15 miles/hr

$$\boxed{Emissions = (E)(VMT)(1 - CE\%)}$$

Unpaved vehicle miles traveled, VMT 3,898 VMT/yr
15.0 VMT/hr
CE= 90% from roadway watering program
CE= 50% from limiting truck speed to 15 mph

	PM	PM-10	PM-2.5	
Unpaved Road Emission Factor EF	2.38	0.51	0.05	lb/VMT
Emissions	1.78	0.38	0.038	lb/hr maximum
Emissions	463	99	10	lb/yr maximum
Emissions	0.2	0.05	0.005	ton/yr maximum
Emissions	0.2	0.04	0.004	ton/yr actual

Explosives Truck Movement Along Access Road (HR-05)

4.40 miles per round trip
0.294 hours/trip (assume 15 mph speed limit)
Maximum hours per year for truck travel = 31 hours/year for truck travel
W= "fleet" average weight of vehicle (tons) - varies for each vehicle "fleet"
20 tons (vehicle weight empty)
22 tons (weight of payload)
31 tons (Average weight of vehicle including delivering full and return empty)
P= number of days/year with 0.01 in precipitation, selected from AP-42 Figure
P= 150
VMT= vehicle miles traveled per year, calculated separately for each vehicle fleet (see below)
Precipitation factor= 0.59 Based on equation (2) and P=150

	PM	PM-10	PM-2.5	
E explosives delivery truck traffic=	2.36	0.50	0.05	lb/VMT

VMT 4.4 miles round trip
2 trucks per week (GMining, 6/19/18)
52 weeks per year
104 truck trips per year
VMT = 458 miles/yr unpaved
speed check 15 miles/hr

$$\boxed{Emissions = (E)(VMT)(1 - CE\%)}$$

Unpaved vehicle miles traveled, VMT 458 VMT/yr
15.0 VMT/hr
CE= 90% from roadway watering program
CE= 50% from limiting truck speed to 15 mph

	PM	PM-10	PM-2.5	
Unpaved Road Emission Factor EF	2.36	0.50	0.05	lb/VMT
Emissions	1.77	0.38	0.04	lb/hr maximum
Emissions	54	12	1	lb/yr maximum
Emissions	0.03	0.01	0.001	ton/yr maximum
Emissions	0.02	0.005	0.0005	ton/yr actual

HR-06 - Natural Gas Delivery Trucks

5.12 miles per round trip
0.341 hours/trip (assume 15 mph speed limit)
Maximum hours per year for truck travel = 373 hours/year for truck travel
W= "fleet" average weight of vehicle (tons) - varies for each vehicle "fleet"
20 tons (vehicle weight empty)
Weight Delivery truck= 22.8 tons (weight of payload) [1]
31 tons (Average weight of vehicle to CNG equipment full and return empty)
P= number of days/year with 0.01 in precipitation, selected from AP-42 Figure 13.2.2-1
P= 150
VMT= vehicle miles traveled per year, calculated separately for each vehicle fleet (see below)
Precipitation factor= 0.59 Based on equation (2) and P=150

	PM	PM-10	PM-2.5	
E delivery truck traffic=	2.37	0.51	0.05	lb/VMT

VMT 5.12 miles round trip
3 trucks per day (Gmining 4/2023)
365 days/year
1,095 truck trips/year
VMT Natural Gas delivery truck = 5,602 miles/yr unpaved
speed check 15 miles/hr

$$\boxed{Emissions = (E)(VMT)(1 - CE\%)}$$

Unpaved vehicle miles traveled, VMT 5,602 VMT/yr
15.00 VMT/hr
CE= 90% from roadway watering program
CE= 50% from limiting truck speed to 15 mph

	Emissions PM	Emissions PM-10	Emissions PM-2.5	
Unpaved Road Emission Factor EF	2.37	0.51	0.05	lb/VMT
Emissions	1.78	0.38	0.038	lb/hr maximum
Emissions	663	142	14	lb/yr maximum
Emissions	0.3	0.07	0.007	ton/yr maximum
Emissions	0.3	0.06	0.006	ton/yr actual

HR-07 - Diesel Fuel Delivery Haul Trucks

5.49 miles per round trip
0.366 hours/trip (assume 15 mph speed limit)
Maximum hours per year for truck travel = 14 hours/year for truck travel
W= "fleet" average weight of vehicle (tons) - varies for each vehicle "fleet"
17 tons (vehicle weight empty)
48.5 tons (assumes payload of 9,000 gal @7 lb/gal)
41.25 AST)
P= number of days/year with 0.01 in precipitation, selected from AP-42 Figure
P= 150
VMT= vehicle miles traveled per year, calculated separately for each vehicle fleet
Precipitation factor= 0.59 Based on equation (2) and P=150

	PM	PM-10	PM-2.5	
E delivery truck traffic=	2.68	0.57	0.06	lb/VMT

VMT 5 miles round trip
184,920 gallons, annual quantity delivered (GMining, 4/2023)
5,000 gallons per delivery
37 truck trips per year
VMT diesel delivery truck = 203 miles/yr unpaved
speed check 15 miles/hr

$$\boxed{Emissions = (E)(VMT)(1 - CE\%)}$$

Unpaved vehicle miles traveled, VMT 203 VMT/yr
15.0 VMT/hr
CE= 90% from roadway watering program
CE= 50% from limiting truck speed to 15 mph

	Emissions PM	Emissions PM-10	Emissions PM-2.5	
Unpaved Road Emission Factor EF	2.68	0.57	0.06	lb/VMT
Emissions	2.01	0.43	0.04	lb/hr maximum
Emissions	27	6	1	lb/yr maximum
Emissions	0.01	0.00	0.000	ton/yr maximum
Emissions	0.01	0.003	0.0003	ton/yr actual

1 Weight is calculated based on maximum annual natural gas usage of 149,762 decatherms or 149,726,250 cubic feet, 24.1 cf/lb, and three trucks per day.

Client:	Copperwood Resources, Inc.	Project ID.:	0023H001.00
Project:	Air Permit Application Emissions Calculations		
Prepared by:	MMD	Date:	05/10/23
Checked by:	AKM	Date:	08/17/23

Fugitive emissions due to wind erosion are estimate for the following two areas:
1 Ore Stockpile (F007)
2 Tailings Disposal Facility (TDF) (F008)

Wind Erosion - Ore Stockpile
EUORESTOCKPILE

1. Ore Stockpile Wind Erosion Emissions (F007) (Area Source Fugitives)
Ore stockpile dimensions and surface area based on base maps of the mine facility as provided by Copperwood

Ore Stockpile Surface Area (m^2) 51,790
Ore Stockpile Surface Area (ft^2) 557,460 — 1 square meter = 10.764 square feet
Acres 13 — 1 acre = 43,560 ft2

Particle Size Ratios: Provided by GMining - Grain Size Distributions for Ore Stockpile

	% passing		Ratio to TSP*
TSP =	1	Assume to be TSP	1
< 10 μm =	0.20		0.20
< 2.5 μm =	0.050		0.050

*Assume TSP represents PMtotal (PM)

Emissions Calculation:

$$Emissions = 1.7kA\left(\frac{365-P}{235}\right)\left(\frac{s}{1.5}\right)\left(\frac{f}{15}\right)$$ lb/day

EPA-450/3-88-008 Control of Open Fugitive Dust Sources, Equation (4-9)

A - acreage tailings for Ore Stockpile = 12.8

	PM	PM-10	PM-2.5	
k - particle size multiplier [1] =	1	0.20	0.050	(see particle size ratios for Ore Stockpile)

D - number of days/year in storage pile= 365
s - silt content %= 2 — Based on grain size distribution graphs provided by GMining for the Ore Stockpile.
P - days/year with >0.01" precipitation= 150 — Based on precipitation map in AP-42, Section 13.2.2, Unpaved Roads, Figure 13.2.2-1. Interpolate days of precipitation from contours.
f - % time wind is >12 mph at mean pile height= 15.5 — Based on wind frequency distribution count for five years of wind speed data provided by the Michigan Department of Environmental Quality from Ironwood, MI for the period 2012 through 2016.

8760 Hours of operation per year

Wind Erosion Emissions - Ore Stockpile

Emissions PM	Emissions PM-10	Emissions PM-2.5	
27.42	5.48	1.37	lb/day maximum and actual
1.14	0.229	0.057	lb/hr maximum and actual
5.00	1.00	0.250	ton/yr maximum and actual

Wind Erosion - Tailings Disposal Facility
EUTDF

2. TDF Wind Erosion Emissions (F008) (Area Source Fugitives)
Tailings will be deposited in slurry form at the Tailings Disposal Facility (TDF) on the east side of the facility (Figure 2). The TDF will be constructed in lifts. The berm for the tailings impoundment portion will be constructed of coarse tailings from the mill. Tailings will be pumped from the mill in a water-saturated state (approximately 80% solids) and the tailings will be generally covered with water in the TDF. Drying may occur in inactive sections of the tailings impoundment, which may form a dryer erodible tailings beach area. Based on information from GMining, the maximum exposed erodible beach area will be approximately 9.2 acres, with the overall maximum tailing footprint being 230 acres.

Tailings Surface Area	930,769	m2	1 square meter = 10.764 square feet
Tailings Surface Area	10,018,800	ft2	This information was provided by Copperwood on the TDF tailings surface area.
Tailings Surface Area	230	acres	1 acre = 43,560 ft2
Wet Beach Area (75% of Exposed Beach Area) (Acres)	25.25	acres	Information from GMining, tailings surface area over the life of the mine. The wet beach and dry beach surface areas are based on the maximum surface near the end of the project.
Dry Beach Area (25% of Exposed Beach Area)	409,883	ft2	A graph provided by Copperwood shows the total square feet of dry beach area at maximum TDF size.
Dry Beach Area (25% of Exposed Beach Area)	9.4	acres	
Dry Beach Area (25% of Exposed Beach Area)	38,079	m2	

Particle Size Ratios: Provided by GMining - Grain Size Distributions for TDF

	% passing		Ratio to TSP*
TSP =	1	Assume to be TSP	1
< 10 μm =	0.52		0.52
< 2.5 μm =	0.26		0.26

*Assume TSP represents PMtotal (PM). Note that distribution for 10 and 2.5 um particle sizes are based on a weighted average of distribution graphs for rougher and first cleaner scavenger tails.

VMT conct truck = $$Emissions = 1.7kA\left(\frac{365-P}{235}\right)\left(\frac{s}{1.5}\right)\left(\frac{f}{15}\right)$$ lb/day

EPA-450/3-88-008 Control of Open Fugitive Dust Sources, Equation (4-9)

A - acreage tailings for TDF= 9.4 acres

	PM	PM-10	PM-2.5	
k - particle size multiplier =	1	0.52	0.26	(see particle size ratios for TDF)

D - number of days/year in storage pile= 365
s - silt content %= 92.42 — Based on Particle Size Distribution graphs for rougher and first cleaner scavenger tails. Rougher tails are shown to be 88.14% silt content while the first cleaner scavenger tails are shown to be 99.72% silt. Copperwood indicates that 61% of the tailings will be rougher tails and 39% will be first cleaner scavenger tails. A weighted average percent silt content was calculated from this information.
P - days/year with >0.01" precipitation= 150 — Based on precipitation map in AP-42, Section 13.2.2, Unpaved Roads, Figure 13.2.2-1. Interpolate days of precipitation from contours.
f - % time wind is >12 mph at mean pile height= 15.5 — Based on wind frequency distribution count for five years of wind speed data provided by the Michigan Department of Environmental Quality from Ironwood, MI for the period 2012 through 2016.
Control efficiency to reflect crust layer formation on tailings: 98% — Assume 98% control due to formation of crust layer on exposed tailings area and remaining moisture in material. Exposure to wind erosion is also reduced by placing tailings in layers between waste rock layers and is below surface of a berm formed by waste rock materials.
8760 hours per year

Wind Erosion Emissions - TDF

Emissions PM	Emissions PM-10	Emissions PM-2.5	
18.64	9.68	4.9	lb/day maximum and actual
0.78	0.40	0.205	lb/hr maximum and actual
3.40	1.77	0.90	ton/yr maximum and actual

Client:	Copperwood Resources, Inc.	Project ID.:	0023H001.00
Project:	Air Permit Application Emissions Calculations		
Prepared by:	MMD	Date:	05/10/23
Checked by:	AKM	Date:	08/17/23

Reagent Emission Summary EUREAGENTMIX

1 Hazardous air polutant emissions
2 Particulate emissions from handling dry materials
3 VOC emissions from material handling
4 Reagent Lime Silo Emissions

1. Hazardous Air Pollutant Emissions

SDS Name Common name - form	Hazardous Component & CAS Number	Compoistion % weight	HAP Emissions		
Flomin C-3430 (SIBX) - supersac dry	Sodium isobutyl xanthate 25306-75-6	90%	0.1	lb/year	
MIBC - liquid	Methyl isobutyl carbinol 108-11-2	100%	6	lb/year	See section 3 below
Carboxymethyl Cellulose Sodium - granular	Carboxymethyl Cellulose Sodium 9004-32-4	100%	2.7E-02	lb/year	

Note : Balance of material composition is non-hazardous.
*MIBC and sodium sulfite are listed toxic air contaminants under Michigan's air pollution regulations.
*MIBC emissions calculations are provided in Section 3 on this sheet.

Reagent	Consumption [1]		Form	Packaging	Reagent Function
Sodium Hydrosulfinde (NaHS)	2,886	ton/yr	liquid	drum or IBC	Conditioner
Sodium Isobutyl Xantante (C-3430)	839	ton/yr	granular	sack	Collector
Methyl Isobutyl Carbinol (MIBC)	87	ton/yr	liquid	drum or IBC	Frother
Dowfroth 250 (D-250)	198	ton/yr	liquid	drum or IBC	Frother
Alkylaryl Dithiophosphate (A249)	887	ton/yr	liquid	drum or IBC	Conditioner
n-Dodecyl Mercaptan (NDM)	237	ton/yr	liquid	drum or IBC	Conditioner
Sodium Silicates	261	ton/yr	liquid	drum or IBC	Conditioner
Carboxymethyl Cellulose Sodium	365	ton/yr	granular	sack	Conditioner
Hydrated Lime	8008	ton/yr	granular	bulk	Conditioner
Flocculant (To be determined)	1.1	ton/yr	liquid	drum or IBC	Particle Attraction
Anti-Scalant (To be determined)	6,182	gal/yr	liquid	drum or IBC	Scale inhibitor

1 Feasiblity Study (GMining, 2023) Table 21.21 adding 10% contingency

2 PM Emissions for Handling Dry Materials

Emissions are calculated for granular material handling, which will generate PM. There will be one transfer point accounted to address the material being added to the receiving tank. Once the dry material is mixed in the tank, no further PM will be generated.
(activity inside mill building, contributes to fugitive volume source)

	Max. Annual thruput ton/yr [1]	E factor PM lb/ton	E factor PM-10 lb/ton	E factor PM-2.5 lb/ton	Control Efficiency [2] %	Emissions PM lb/yr	Emissions PM-10 lb/yr	Emissions PM-2.5 lb/yr	E factor reference
SIBX	559.9	0.003	0.0011	0.0011	95%	0.1	0.03	0.03	11.19-2 Conveyor Transfer Point (Uncontrolled)
Carboxymethyl Cellulose Sodium	180.4	0.003	0.0011	0.0011	95%	0.03	0.01	0.010	11.19-2 Conveyor Transfer Point (Uncontrolled)
Hydrated Lime (received in bulk)	8008.0	0.003	0.0011	0.0011	95%	1.20	0.44	0.44	11.19-2 Conveyor Transfer Point (Uncontrolled)

	Emissions PM	Emissions PM-10	Emissions PM-2.5	
Totals =	1.50E-04	5.49E-05	5.49E-05	lb/hr [3]
	1	0.5	0.5	lb/yr
	0.0007	0.0002	0.0002	tons/yr

1. Maximum annual throughputs were provided by Copperwood for reagent use in the process plant.
2. This emission source is indoors or enclosed. Efficiency applied is: 95%
3. The maximum operating hours for the mill in hours per year is: 8,760

3 MIBC Emissions from Volatilization from MIBC reagent storage tank

(activity inside reagent building) (exempt source)
Working Loss Equation from Section 7.1 of AP-42 for Liquid Storage Tanks:

$L_W = 0.0010 \times M_V \times P_{VA} \times Q \times K_N \times K_P$

Where:

M_V = Vapor Molecular Weight, lb/lb-mole =	102.2
P_{VA} = Vapor pressure at daily average liquid surface temperature, psia[1] =	9.67E-02
Q = Annual net throughput, bbl/year (1 bbl = 31.5 gal) =	618
K_N = Turnover factor, dimensionless =	1
K_P = Working loss product factor for most organic liquids, dimensionless =	1

S.G. = 0.802 @ 25 °C, density of H_2O = 1000 kg/m^3, thus, density of MIBC = 802 kg/m3 (6.7 lb/gal)

Annual Usage	87	tons/year
	25940	gal/year
Q=	618	bbl/year

$L_W = 0.0010 \times M_V \times P_{VA} \times Q \times K_N \times K_P$

L_W = **6** lb/year MIBC Emissions

0.00070 lb/hr MIBC emissions in 7300 hr/yr

MIBC has several different names. For TAC emissionevaluation, mthyl amyl alcohol (cas# 108-11-2) is used.

Notes:

1. This is the vapor pressure for MIBC at 20 °C as reported by the manufacturer. The vapor pressure is listed as 5 mmHg, the conversion is 5 X 0.019336 psia/mmHg = 0.0716 = 7.16E-02 psia.
2. The vapor pressure for NDM at 20 °C as reported by the manufacturer is < 0.1 psia.

4 n-Dodecyl Mercaptan (NDM) Emissions from Volatilization from NDM reagent storage tank

(activity inside reagent building) (exempt source)
Working Loss Equation from Section 7.1 of AP-42 for Liquid Storage Tanks:

$L_W = 0.0010 \times M_V \times P_{VA} \times Q \times K_N \times K_P$

Where:

M_V = Vapor Molecular Weight, lb/lb-mole =	202.41
P_{VA} = Vapor pressure at daily average liquid surface temperature, psia[2] =	0.1
Q = Annual net throughput, bbl/year (1 bbl = 31.5 gal) =	1586
K_N = Turnover factor, dimensionless =	1
K_P = Working loss product factor for most organic liquids, dimensionless =	1

S.G. = 0.845 @ 20 °C, density of H_2O = 1000 kg/m^3, thus, density of MIBC = 845 kg/m3 (7.1 lb/gal)

Annual Usage	237	tons/year
	66620	gal/year
Q=	1586	bbl/year

$L_W = 0.0010 \times M_V \times P_{VA} \times Q \times K_N \times K_P$

L_W = **32** lb/year NDM Emissions

0.00367 lb/hr NDM emissions in 7300 hr/yr

Total Reagent VOC Emission Summary	
38	lb/year VOC Emissions
0.0044	lb/hr VOC Emissions in 7300 hr/yr

Client:	Copperwood Resources, Inc.	Project ID.:	0023H001.00
Project:	Air Permit Application Emissions Calculations		
Prepared by:	MMD	Date:	05/10/23
Checked by:	AKM	Date:	08/17/23

4 Reagent Silo Emissions SV-009

The lime silo is equipped with a bin vent which filters air released as the silo is filled from a bulk delivery truck. The silo fill process is intermittent and takes less than one hour.

Activity	Process thru-put[1] ton/year	E factor PM lb/ton [2]	E factor PM-10 lb/ton [2]	E factor PM-2.5 lb/ton [2]	Emissions PM lb/yr	Emissions PM-10 lb/yr	Emissions PM-2.5 lb/yr	E factor reference
Lime Silo Emissions								
pneumatic unloading from truck to silo	8,008	0.00099	0.00034	0.0001	7.9	2.7	1.0	11.12-2 Cement unloading to elevated storage silo (pneumatic) (controlled E.F.)
				Total emissions Lime Silo	7.93	2.72	0.96	lb/yr maximum Emissions
					0.0009	0.0003	0.0001	lb/hr Maximum Controlled Emissions[3]
					0.004	0.001	0.0005	tons/yr maximum Emissions

Notes:

1. The capacity of the lime of silo is 70 tonnes or 77 short tons. Highland Copper will install the the lime for water pH correction on an as needed basis. The updated feasibility study does not allocate money in the capital budget for lime reagent use. The current operations do not call for lime use, therefore the maximum emissions are estimated using a bi-weekly delivery of the maximum capacity of the silo.

2. Chapter 11.24 of AP-42 does not contain emission factors to account for controlled bin vent emissions occurring from the loading of storage silos pneumatically.
Thus, emission factors for the Chapter 11.12 Concrete Batching for loading cement into elevated silos have been used as a surrogate.

Assume PM-2.5 is approximately 35% of PM-10 per AP-42, as calculated below. See Appendix B-2, Category 4, S

% cumulative size		
PM-2.5 =	30	%
PM-10 =	85	%
Ratio PM-2.5 / PM-10 =	0.35	

3. Hourly emissions have been estimated by dividing the annual emissions by 8760 hours/year.

Normal/Actual Reagent Silo Emissions

Activity	Process thru-put[1] ton/year	E factor PM lb/ton [2]	E factor PM-10 lb/ton [2]	E factor PM-2.5 lb/ton [2]	Emissions PM lb/yr	Emissions PM-10 lb/yr	Emissions PM-2.5 lb/yr	E factor reference
Lime Silo Emissions								
pneumatic unloading from truck to silo	0	0.00099	0.00034	0.0001	0.0	0.0	0.0	11.12-2 Cement unloading to elevated storage silo (pneumatic) (controlled E.F.)
				Total emissions Lime Silo	0	0	0	lb/yr maximum Emissions
					0.000	0.000	0.000	lb/hr Maximum Controlled Emissions[3]
					0.000	0.000	0.0000	tons/yr actual Emissions

Notes:

1. The updated feasibility study does not allocate money in the capital budget for lime reagent use, therefore actual emissions are estimated at zero.

2. Chapter 11.24 of AP-42 does not contain emission factors to account for controlled bin vent emissions occurring from the loading of storage silos pneumatically.
Thus, emission factors for the Chapter 11.12 Concrete Batching for loading cement into elevated silos have been used as a surrogate.

Assume PM-2.5 is approximately 35% of PM-10 per AP-42, as calculated below. See Appendix B-2, Category 4, September 1990.

% cumulative size		
PM-2.5 =	30	%
PM-10 =	85	%
Ratio PM-2.5 / PM-10 =	0.35	

3. Hourly emissions have been estimated by dividing the annual emissions by 8760 hours/year.

Client:	Copperwood Resources, Inc.	Project ID.:	0023H001.00
Project:	Air Permit Application Emissions Calculations		
Prepared by:	MMD	Date:	05/10/23
Checked by:	AKM	Date:	08/17/23

Construction Generator - EUCONGENERATOR (Diesel Generator)
SV-004

Caterpillar Prime C27 Generator (725 kw) will operate during construction to support facility operations only during construction. Once the natural gas generators are installed, this generator will be decommissioned.

Emissions Factors from CAT Data:

Pollutant	Emission Factors for CAT Prime C27 725kw g/hp-hr	lb/hp-hr	gal/hr
NOx [1]	2.6	0.0057	
CO [1]	0.11	0.0002	
THC (VOC) [1]	0.03	0.00007	
PM [1]	0.075	0.00017	
SO2 AP-42 Table 3.4-1, where S=%sulfur in fuel		0.00809S	
SO2 at S=0.0015		0.000012	
Fuel Consumption @ 100% load			53.5

AT Specification sheet, Appendix A-2; 60 Hz prime

For one generator:

Fuel Consumption @ 100% load:	53.5	Total gph, Diesel
Heating value of diesel:	137,000	Btu/gal
Maximum Heat Input:	7.33	mmBTU/hr

PTE calculations will be based on rated power output of the equipment.

Number of Generators:	1			
Power generated per Unit:	725 kW		Conversion: kilowatt =	1.3405 hp
Power generated per Unit:	972 hp			
Total Power generated:	972 hp			
PTE Operating Time [1]:	8760 hr/year			
Actual Operating Time [2]:	4550 hr/year	7 d/week, 10 hr/day, 25% contingency		

SV-004 (Construction Generator)
Potential to Emit (750 kW Unit)

	NOx	SOx	PM10	CO	VOC
lb/hp-hr (power output)	0.0057		0.00017	0.0002	0.00007
AP-42 E factor lb/hp-hr		0.000012			
Hourly Emission Rate (lb/hr)	5.6	0.01	0.16	0.2	0.06
Annualized Hourly Emission Rate (lb/hr) [3]	0.3				
PTE Annual Emission Rate (lb/yr)	48755.8	103.3	1406.4	2062.7	562.6
PTE Annual Emission Rate (ton/yr)	24.4	0.052	0.703	1.031	0.281
Actual Annual Emission Rate (ton/yr)	12.7	0.03	0.37	0.5	0.1

Organic Pollutants	Emission Factor (lb/mmBtu)	Maximum Emissions (lb/hr)	(lb/yr)	Relative Potency Factor [3]	Relative Maximum Hourly Emission Rate (lb/hr) [3]
Benzene	7.76E-04	0.01	49.8		
Toluene	2.81E-04	0.002	18.0		
Xylenes	1.93E-04	0.001	12.4		
Propylene	2.79E-03	0.02	179.1		
1,3-Butadiene	3.91E-05	0.0003	2.5		
Formaldehyde	7.89E-05	0.001	5.1		
Acetaldehyde	2.52E-05	0.0002	1.6		
Acrolein	7.88E-06	5.78E-05	0.5		
Polycyclic aromatic hydrocarbons (PAH)					
Naphthalene	1.30E-04	9.53E-04	8.35		
Acenaphthylene	9.23E-06	6.77E-05	0.59		
Acenaphthene	4.68E-06	3.43E-05	0.30		
Fluorene	1.28E-05	9.38E-05	0.82		
Phenanthrene	4.08E-05	2.99E-04	2.62		
Anthracene	1.23E-06	9.02E-06	0.08		
Fluoranthene	4.03E-06	2.95E-05	0.26		
Pyrene	3.71E-06	2.72E-05	0.24		
Benzo(a)anthracene *	6.22E-07	4.56E-06	0.040	0.1	4.56E-07
Chrysene *	1.53E-06	1.12E-05	0.10	0.01	1.12E-07
Benzo(b)fluoranthene *	1.11E-06	8.14E-06	0.071	0.1	8.14E-07
Benzo(k)fluoranthene *	2.18E-07	1.60E-06	0.014	0.1	1.60E-07
Benzo(a)pyrene *	2.57E-07	1.88E-06	0.017	1	1.88E-06
Indeno(1,2,3-cd)pyrene *	4.14E-07	3.03E-06	0.027	0.1	3.03E-07
Dibenz(a,h)anthracene *	3.46E-07	2.54E-06	0.022	1.1	2.79E-06
Benzo(g,h,l)perylene	5.56E-07	4.08E-06	0.036		
Total PAH	2.12E-04	1.55E-03	13.58		

Source of emission factors: AP-42, Tables 3.4-3 & 3.4-4 (October 1996 update)
* Items with an asterisk are listed PAH carcinogens.

Notes:
(1) PTE is based on EPA guidance on the maximum number of hours for an emergency generator (EPA Memorandum dated September 6, 1995).
(2) Actual operating hours based on estimated power needs during construction, 7 d/wk; 10 hr/day, add 25% contingency.
(3) Pursuant to the MDEQ PAH guidance, *Screening Levels for Polycyclic Aromatic Hydrocarbon* s, dated February 7, 2017, emissions in lb/hr have been adjusted using the Relative Potency Factors (RPF) to allow for screening using the Allowable Emission Rate Methodology under Rule 227 (1) (a).

Client:	Copperwood Resources, Inc.	Project ID.:	0023H001.00
Project:	Air Permit Application Emissions Calculations		
Prepared by:	MMD	Date:	05/10/23
Checked by:	AKM	Date:	08/17/23

Generators - EUNGGENERATORS (Natural Gas Generators)

SV-005, SV-006, SV-007 for prime / emergency power generation (prior to utility line installation); supplemental power after utility line installation.

There are two scenarios for the three generators:

Prior to utility line installation: 2 generators operate @ 100% load, 8760 hr/yr; 1 generator operates @ 100% load as emergency back up, 500 hr/yr.

After utility line installation for supplemental pow 1 generator operates @ 100% load, 8760 hr/yr; 2 generators operate @ 100% load for 900 hr/yr each

Two units will be located at the main power substation. A third unit is located at the portal.

total hours for 3 generators= 18020 generator-hr/yr

total hours for 3 generators= 10560 generator-hr/yr

Manufacturer's data provides Efactors for NOx, CO, and VOCs. AP-42 Ch. 3.2 is used for SOx

1 kW= 0.00341214 mmbtu/hr

1 kW= 1.341 hp

2000	kW	(100% load) for one engine
4000	kW	(100% load) for 2 engines
13.65	mmBtu/hr	(100% load) for 2 engines
8760	hr/year	maximum and actual hours of operation

Emission Facotrs	g/bkW-hr [1]	lb/kw-hr	Emissions Reduction [2]	lb/Mmbtu [3]
NOx	1.34	0.0030	80%	
CO	1.9	0.0042	80%	
HC (VOC)	0.37	0.0008		
SOx				5.88E-04
PMtotal [4]				4.83E-02
PM10				3.84E-02
PM2.5				3.84E-02

Maximum and Actual Emissions (2 units)	NOx [2]	CO	SOx	VOC	PMtotal [4]	PM10	PM2.5	
Emission Rate (For 2 units operating at same time)	2.4	3.3	0.008	3.3	0.659	0.524	0.524	lb/hr
Maximum and Actual Annual Emission Rate	20684	29329	70	28557	5776	4591	4591	lb/yr
Maximum and Actual Annual Emission Rate	10.3	14.7	0.0	14.3	2.9	2.3	2.3	ton/yr

1 Based on technical emission sheet, Appendix A-1

2 Miratech SCR emission control applies 80% reduction to emissions, Appendix A-1

3 AP-42 Ch. 3.2

4 estimated by adding emission factors for PM10 + PM condensible

Trace Organic Pollutants	Emission Factor	Maximum Emissions		Relative Potency Factor 1	Maximum Hourly Emissions 1
	(lb/mmBtu)	(lb/hr)	(lb/yr)		(lb/hr)
1,1,2,2-Tetrachloroethane *	4.00E-05	5.46E-04	4.8		
1,1,2-Trichloroethane *	3.18E-05	4.34E-04	3.8		
1,1-Dichloroethane	2.36E-05	3.22E-04	2.8		
1,2,3-Trimethylbenzene	2.30E-05	3.14E-04	2.7		
1,2,4-Trimethylbenzene	1.43E-05	1.95E-04	1.7		
1,2-Dichloroethane	2.36E-05	3.22E-04	2.8		
1,2-Dichloropropane	2.69E-05	3.67E-04	3.2		
1,3,5-Trimethlybenzene	3.38E-05	4.61E-04	4.0		
1,3-Butadiene *	2.67E-04	3.64E-03	31.9		
1,3-Dichloropropene *	2.64E-05	3.60E-04	3.2		
2-Methylnaphthalene *	3.32E-05	4.53E-04	4.0		
2,2-4-Trimethlypentane *	2.50E-04	3.41E-03	29.9		
Acenaphthene *	1.25E-05	1.71E-04	1.5		
Acenaphthylene *	5.53E-06	7.55E-05	0.7		
Acetaldehyde *	8.36E-03	1.14E-01	999.5		
Acrolein *	5.14E-03	7.02E-02	614.5		
Benzene *	4.40E-04	6.01E-03	52.6		
Benzo(b)fluoranthene *	1.66E-07	2.27E-06	1.98E-02	0.1	2.27E-07
Benzo(a)pyrene *	4.50E-07	6.14E-06	5.38E-02	1	6.14E-06
Benzo(g,h,l)perylene *	4.14E-07	5.65E-06	0.0		
Biphenyl *	2.12E-04	2.89E-03	25.3		
Butane	5.41E-04	7.38E-03	64.7		
Butry/Isobutyraldehyde	1.01E-04	1.38E-03	12.1		
Carbon Tetrachloride *	3.67E-05	5.01E-04	4.4		
Chlorobenzene *	3.04E-05	4.15E-04	3.6		
Chloroethane	1.87E-06	2.55E-05	0.2		
Chloroform *	2.85E-05	3.89E-04	3.4		
Chrysene *	6.93E-07	9.46E-06	8.29E-02	0.01	9.46E-08
Cyclopentane	2.27E-04	3.10E-03	27.1		
Ethane	1.05E-01	1.43E+00	12553.9		
Ethylbenzene *	3.97E-05	5.42E-04	4.7		
Ethylene Dibromide *	4.43E-05	6.05E-04	5.3		
Fluoroanthene *	1.11E-06	1.51E-05	0.1		
Fluorene *	5.67E-06	7.74E-05	0.7		
Formaldehyde *	5.28E-02	7.21E-01	6312.8		
Methanol *	2.50E-03	3.41E-02	298.9		
Methylcyclohexane	1.23E-03	1.68E-02	147.1		
Methylene Chloride *	2.00E-05	2.73E-04	2.4		
n-Hexane *	1.11E-03	1.51E-02	132.7		
n-Nonane	1.10E-04	1.50E-03	13.2		
n-Octane	3.51E-04	4.79E-03	42.0		
n-Pentane	2.60E-03	3.55E-02	310.9		
Naphthalene *	7.44E-05	1.02E-03	8.9		
PAH *	2.69E-05	3.67E-04	3.2		
Phenanthrene *	1.04E-05	1.42E-04	1.2		
Phenol *	2.40E-05	3.28E-04	2.9		
Propane	4.19E-02	5.72E-01	5009.6		
Pyrene *	1.36E-06	1.86E-05	0.2		
Styrene *	2.36E-05	3.22E-04	2.8		
Tetrachloroethane *	2.48E-06	3.38E-05	0.3		
Toluene	4.08E-04	5.57E-03	48.8		
Vinyl Chloride	1.49E-05	2.03E-04	1.8		
Xylene	1.84E-04	2.51E-03	22.0		

Source of emission factors: AP-42, Table 3.2-2 (July 2000 update)

1. Pursuant to the MDEQ PAH guidance document *Screening Levels for Polycyclic Aromatic Hydrocarbon* s, Feb. 7, 2017, emissions have been adjusted on applicable constituents using the Relative Potency Factors (RPF) to allow for screening using the Allowable Emission Rate Methodology under Rule 227 (1) (a).

* Items with an asterisk are listed federal Hazardous Air Pollutants by Section 112(b) of the Clean Air Act.

Client:	Copperwood Resources, Inc.	Project ID.:	0023H001.00
Project:	Air Permit Application Emissions Calculations		
Prepared by:	MMD	Date:	05/10/23
Checked by:	AKM	Date:	08/17/23

Generator - EUEMERGENERATOR (Natural Gas Generator)
SV-007 for emergency power. It is located at the portal.

The supplemental generator will be CAT Model G3520 EPA certified unit, rated at 2,000 kilowatts (kW) at 100% load, located at the portal.
Manufacturer's data provides Efactors for NOx, CO, and VOCs. AP-42 Ch. 3.2 is used for SOx, PM10.

2000	kW	(100% load) for one engine	1 kW=	0.00341214 mmbtu/hr
1	generator		1 kW=	1.341 hp
2000	kW	(100% load)		
6.82	mmBtu/hr	(100% load) for 1 engine		
500	hr/year	maximum hours PTE		
30	hr/year	actual hours per year based on 2.5 hr/mo testing and maintenance.		

Emission Facotrs	g/bkW-hr [1]	lb/kw-hr	Emissions Reduction [2]	lb/Mmbtu [3]
NOx	1.34	0.0030	80%	
CO	1.9	0.0042	80%	
HC (VOC)	0.37	0.0008		
SOx				5.88E-04
PMtotal [4]				4.83E-02
PM10				3.84E-02
PM2.5				3.84E-02

Maximum Emissions	NOx [2]	CO	SOx	VOC	PMtotal [4]	PM10	PM2.5	
Emission Rate	1.2	1.7	0.004	1.6	0.330	0.262	0.262	lb/hr
Maximum Annual Emission Rate	590	837	2	815	165	131	131	lb/yr
Maximum Annual Emission Rate	0.3	0.4	0.0	0.4	0.1	0.1	0.1	ton/yr

Actual Emissions	NOx [2]	CO	SOx	VOC	PMtotal [4]	PM10	PM2.5	
Emission Rate	1.2	1.7	0.004	1.6	0.330	0.262	0.262	lb/hr
Actual Annual Emission Rate	35	50	0.1	49	10	8	8	lb/yr
Actual Annual Emission Rate	0.018	0.025	0.000	0.024	0.005	0.004	0.004	ton/yr

1 Based on technical emission sheet, Appendix A-1
2 Miratech SCR emission control applies 80% reduction to emissions, Appendix A-1
3 AP-42 Ch. 3.2
4 estimated by adding emission factors for PM10 + PM condensible

Trace Organic Pollutants	**Emission Factor**	**Maximum Emissions**		**Relative Potency Factor 3**	**Relative Maximum Hourly Emissions 3**
	(lb/mmBtu)	**(lb/hr)**	**(lb/yr)**		(lb/hr)
1,1,2,2-Tetrachloroethane *	4.00E-05	2.73E-04	0.1		
1,1,2-Trichloroethane *	3.18E-05	2.17E-04	0.1		
1,1-Dichloroethane	2.36E-05	1.61E-04	0.1		
1,2,3-Trimethylbenzene	2.30E-05	1.57E-04	0.1		
1,2,4-Trimethylbenzene	1.43E-05	9.76E-05	0.0		
1,2-Dichloroethane	2.36E-05	1.61E-04	0.1		
1,2-Dichloropropane	2.69E-05	1.84E-04	0.1		
1,3,5-Trimethlybenzene	3.38E-05	2.31E-04	0.1		
1,3-Butadiene *	2.67E-04	1.82E-03	0.9		
1,3-Dichloropropene *	2.64E-05	1.80E-04	0.1		
2-Methylnaphthalene *	3.32E-05	2.27E-04	0.1		
2,2-4-Trimethlypentane *	2.50E-04	1.71E-03	0.9		
Acenaphthene *	1.25E-05	8.53E-05	0.0		
Acenaphthylene *	5.53E-06	3.77E-05	0.0		
Acetaldehyde *	8.36E-03	5.71E-02	28.5		
Acrolein *	5.14E-03	3.51E-02	17.5		
Benzene *	4.40E-04	3.00E-03	1.5		
Benzo(b)fluoranthene *	1.66E-07	1.13E-06	5.66E-04	0.1	1.13E-07
Benzo(a)pyrene *	4.50E-07	3.07E-06	1.54E-03	1	3.07E-06
Benzo(g,h,l)perylene *	4.14E-07	2.83E-06	0.0		
Biphenyl *	2.12E-04	1.45E-03	0.7		
Butane	5.41E-04	3.69E-03	1.8		
Butry/Isobutyraldehyde	1.01E-04	6.89E-04	0.3		
Carbon Tetrachloride *	3.67E-05	2.50E-04	0.1		
Chlorobenzene *	3.04E-05	2.07E-04	0.1		
Chloroethane	1.87E-06	1.28E-05	0.0		
Chloroform *	2.85E-05	1.94E-04	0.1		
Chrysene *	6.93E-07	4.73E-06	2.36E-03	0.01	4.73E-08
Cyclopentane	2.27E-04	1.55E-03	0.8		
Ethane	1.05E-01	7.17E-01	358.3		
Ethylbenzene *	3.97E-05	2.71E-04	0.1		
Ethylene Dibromide *	4.43E-05	3.02E-04	0.2		
Fluoroanthene *	1.11E-06	7.57E-06	0.0		
Fluorene *	5.67E-06	3.87E-05	0.0		
Formaldehyde *	5.28E-02	3.60E-01	180.2		
Methanol *	2.50E-03	1.71E-02	8.5		
Methylcyclohexane	1.23E-03	8.39E-03	4.2		
Methylene Chloride *	2.00E-05	1.36E-04	0.1		
n-Hexane *	1.11E-03	7.57E-03	3.8		
n-Nonane	1.10E-04	7.51E-04	0.4		
n-Octane	3.51E-04	2.40E-03	1.2		
n-Pentane	2.60E-03	1.77E-02	8.9		
Naphthalene *	7.44E-05	5.08E-04	0.3		
PAH *	2.69E-05	1.84E-04	0.1		
Phenanthrene *	1.04E-05	7.10E-05	0.0		
Phenol *	2.40E-05	1.64E-04	0.1		
Propane	4.19E-02	2.86E-01	143.0		
Pyrene *	1.36E-06	9.28E-06	0.0		
Styrene *	2.36E-05	1.61E-04	0.1		
Tetrachloroethane *	2.48E-06	1.69E-05	0.0		
Toluene	4.08E-04	2.78E-03	1.4		
Vinyl Chloride	1.49E-05	1.02E-04	0.1		
Xylene	1.84E-04	1.26E-03	0.6		

Source of emission factors: AP-42, Table 3.2-2 (July 2000 update)
1. PTE is based on EPA guidance on the maximum number of hours for an emergency generator (EPA Memorandum dated September 6, 1995).
2. Actual operating hours based on estimated power needs.
3. Pursuant to the MDEQ PAH guidance document *Screening Levels for Polycyclic Aromatic Hydrocarbon* s, Feb. 7, 2017, emissions have been adjusted on applicable constituents using the Relative Potency Factors (RPF) to allow for screening using the Allowable Emission Rate
* Items with an asterisk are listed federal Hazardous Air Pollutants by Section 112(b) of the Clean Air Act.

Foth	Client: Copperwood Resources, Inc.	Project ID.: 0023H001.00
	Project: Air Permit Application Emissions Calculations	
	Prepared by: MMD	Date: 05/10/23
	Checked by: AKM	Date: 08/17/23

Emergency Fire Pump Engine (exempt source)
EUFIREPUMP SV-008

The fire pump engine will only operate during an emergency situation if a fire should occur at the facility. The engine would pump water from the fire water tank to support fire-fighting operations.
Fire pump engine is a Clarke Fire Protection Products, Inc. fire pump driver Model JU6H-UFADX8 (250HP @1750rpm)

Engine Data:

Fuel Consumption @ 100% load:	10.4	gph, Diesel (info from Clarke engineering data sheet)
Heating value of diesel:	137,000	Btu/gal
Engine Rating	305	bhp
PTE hours of operation per year [1]:	500	hours
Actual hours of operation per year [1]:	50	hours

Criteria Pollutants	Emission Factor (lb/MMBtu)	Maximum Emissions (lb/hr)	Maximum Emissions (tpy)	Actual Emissions (tpy)
NOx	4.41	6.28	1.57	0.224
NOx [2]	4.41	0.36		
CO	0.95	1.35	0.34	0.03
SO_x	0.29	0.41	0.10	0.01
PM_{10}	0.31	0.44	0.11	0.01
Aldehydes	0.07	0.100	0.02	0.00
TOC				
Exhaust	0.35	0.50	0.12	0.01
Evaporative	0.00	0.000	0.00	0.00
Crankcase	0.01	0.0142	0.004	0.000
Refueling	0.00	0.00	0.00	0.00
Total TOC (assumed to represent VOC)		0.513	0.128	0.013

Organic Pollutants	Emission Factor (lb/MMBtu)	Maximum Emissions (lb/hr) [2]	Maximum Emissions (lb/year)
Benzene	9.33E-04	7.59E-05	6.65E-01
Toluene	4.09E-04	3.33E-05	2.91E-01
Xylenes	2.85E-04	2.32E-05	2.03E-01
Propylene	2.58E-03	2.10E-04	1.84E+00
1,3-Butadiene	3.91E-05	3.18E-06	2.79E-02
Formaldehyde	1.18E-03	9.60E-05	8.41E-01
Acetaldehyde	7.67E-04	6.24E-05	5.46E-01
Acrolein	9.25E-05	7.52E-06	6.59E-02
Polycyclic aromatic hydrocarbons (PAH)			
Naphthalene	8.48E-05	6.90E-06	6.04E-02
Acenaphthylene	5.06E-06	4.12E-07	3.60E-03
Acenaphthene	1.42E-06	1.15E-07	1.01E-03
Fluorene	2.92E-05	2.37E-06	2.08E-02
Phenanthrene	2.94E-05	2.39E-06	2.09E-02
Anthracene	1.87E-06	1.52E-07	1.33E-03
Fluoranthene	7.61E-06	6.19E-07	5.42E-03
Pyrene	4.78E-06	3.89E-07	3.41E-03
Benzo(a)anthracene *	1.68E-06	1.37E-07	1.20E-03
Chrysene *	3.53E-07	2.87E-08	2.51E-04
Benzo(b)fluoranthene *	9.91E-08	8.06E-09	7.06E-05
Benzo(k)fluoranthene *	1.55E-07	1.26E-08	1.10E-04
Benzo(a)pyrene *	1.88E-07	1.53E-08	1.34E-04
Indeno(1,2,3-cd)pyrene *	3.75E-07	3.05E-08	2.67E-04
Dibenz(a,h)anthracene *	5.83E-07	4.74E-08	4.15E-04
Benzo(g,h,l)perylene	4.89E-07	3.98E-08	3.48E-04
Total PAH	1.68E-04	1.37E-05	1.20E-01

Source of emission factors: AP-42, Tables 3.3-1 & 3.3-2 (October 1996 update)
* Items with an asterisk are listed PAH carcinogens.
(1) Number of operating hours based on those presented in EPA memo dated Sept. 6, 1995 regarding the calculation of PTE from emergency generators.
(2) Based on verbal guidance provided by MDEQ, hourly emission rates for emergency and intermittent equipment can be annualized for NOx by multiplying the actual calculated hourly rate by annual hours / 8760 hours. For PTE, the adjustment would be 500 / 8760.

Foth

Client:	Copperwood Resources, Inc.	Project ID.:	0023H001.00
Project:	Air Permit Application Emissions Calculations		
Prepared by:	MMD	Date:	05/10/23
Checked by:	AKM	Date:	08/17/23

Facility Stacks

Michigan Rule 336.1331 PM Limits Evaluation

	West Mine Exhaust Vent	East Mine Exhaust Vent	Portal Mine Exhaust Vent	Construction Generator (725 kW)	Natural Gas Power Generator (2 MW)	Natural Gas Power Generator (2 MW)	Emergency Power Generator Natural Gas (2 MW)	Fire Pump	Lime Silo Vent
	SV-001	SV-002	SV-003	SV-004	SV-005	SV-006	SV-007	SV-008	SV-009
Limit in lb PM per 1000 lb exhaust gas	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Stack exhaust rate - cfm	330000	340000	180000	1845	6030	6030	6030	1100	300
scfm	330000	340000	180000	727	2338	2338	2338	392	300
Calculate pounds gas:									
Stack temperature in °F	60	60	60	860	881	881	881	1000	60
pressure - atm	1	1	1	1	1	1	1	1	1
density - lb/cf	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075
Ventilation exhaust rate - lb/min	24750	25500	13500	138	452	452	452	83	23
lb/hr	1485000	1530000	810000	8304	27135	27135	27135	4950	1350
Hourly rate - 1000 lb exhaust gas	1485.0	1530.0	810.0	8.3	27.1	27.1	27.1	5.0	1.4
PM Emission Sources:									
Stack Emissions[1]- lb PM/hr	2.64	2.72	1.439	0.16	0.33	0.33	0.33	0.44	0.0009
PM rate (lb PM per 1000 lb gas)=	0.00178	0.00178	0.00178	0.019	0.012	0.012	0.012	0.089	0.001
Does stack meet Table 31 Limit?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
New Source Performance Standards:									
40 CFR 60.382 Standard for Particulate Matter									
Limits listed in (a)(1) - gram/dry std cubic meter	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Stack Emissions (see summary)- lb PM/hr	2.64	2.72	1.439	0.161	0.330	0.330	0.330	0.442	0.001
convert to g/hr	0.0058	0.0060	0.00317	0.00035	0.00073	0.00073	0.00073	0.00097	0.00000
Stack exhaust rate - scfm	330000	340000	180000	727	2338	2338	2338	392	300
convert to m3/hr	561000	578000	306000	1236	3975	3975	3975	666	510
PM concentration - g PM/m3	1.04E-08	1.04E-08	1.04E-08	2.86E-07	1.83E-07	1.83E-07	1.83E-07	1.46E-06	3.91E-09
Does stack meet the NSPS limit?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

1 m3/second =	2119	cfm (conversion factor from m3/sec to cfm)
1 cfm =	1.70	m3/hour (conversion factor from cfm to m3/hour)
1 cfm =	0.00047	m3/second (conversion factor from cfm to m3/second)

Emission Source	Stack Diameter (m)	stack area m2	Stack Exit Velocity (m/s)	flow m3/s	flow[1] scfm	Stack Gas Temp (°K)	Stack Gas Temp (°F)	
SV-001 - West Mine Exhaust Vent	2	3.14	49.4	155.10	330000	333	60	FS
SV-002 - East Mine Exhaust Vent	2	3.14	50.9	159.80	340000	333	60	FS
SV-003 - Portal Mine Exhaust Vent	4.77	17.87	4.7	84.60	180000	333	60	FS
SV-004 - Construction Generator	0.15	0.02	47.6	0.87	1845	1133	860	
SV-005 - Natural Gas Generator	0.38	0.11	24.9	2.83	6030	1154	881	
SV-006 - Natural Gas Generator	0.38	0.11	24.9	2.83	6030	1154	881	
SV-007 - Natural Gas Generator	0.38	0.11	24.9	2.83	6030	1154	881	
SV-008 Fire Pump	0.15	0.02	28.3	0.52	1100	1273	1000	
SV-009 Lime Silo Vent	0.20	0.03	4.3	0.14	300	333	60	

1 Values from manufacturer's literature.

Emergency Generators

TABLE 31
Particulate matter emission schedule

Process or process equipment	Capacity rating for each unit	Maximum allowable emission at operating conditions[1] (lbs. Particulate/1,000 lbs. gas except as noted)	Applicable reference test method
A. Fuel burning equipment			
1. Pulverized coal (includes cyclone furnaces)	0-1,000,000 lbs. steam per hour.	See figure 31 for maximum emission limit.	5B or 5C

Michigan Rule 336.1402 Emissions of sulfur dioxide from fuel-burning sources other than power plants

Limit	1.7	lb SO2 per mm BTU fuel input
Fuel usage at 100% load=	53.5	gal/hr
Fuel density=	7.1	lb/gal
Fuel heat rating=	19300	Btu/lb for diesel
Heat Input=	7331105	Btu/hr
Unit conversion =	1000000	Btu/mm Btu
Heat Input=	7.33	mm Btu/hr
Ultra Low Sulfur Diesel Fuel	15	ppm sulfur
Sulfur emissions		
Fuel usage at 100% load=	53.5	gal/hr
Fuel density=	7.1	lb/gal
Fuel usage at 100% load=	379.9	lb/hr
Emission rate of S at 15 ppm=	0.00570	lb/hr S
	0.5	lb S per lb SO2
Emission rate of SO2 =	0.0114	lb SO2/hr
Comparative Value =	0.0016	lb SO2/mm Btu fuel input
Does generator meet SO2 limit?	**Yes**	

molecular weight
S = 32
SO2 = 64

https://ars.apps.lara.state.mi.us/AdminCode/DownloadAdminCodeFile?FileName=1148_2012-

Part 3. Emission Limitations and Prohibitions - Particulate Matter R 336.1331, table 31

Note: Although the hourly SO2 emissions for this generator are presented on page 17 per AP-42, Ch. 3.3 Gasoline and Diesel Industrial Engines, a mass balance approach is taken here to calculate emissions to compare to Michigan limits. Since that chapter of AP-42 was published in 1996, diesel fuel is now mandated as ultra-low sulfur diesel, formulated to contain a maximum of 15 ppm sulfur.

Process or process equipment	Gas flow rate (SCFM)	Maximum allowable emission at operating conditions[1] (lbs. Particulate/1,000 lbs. gas except as noted)	Applicable reference test method
H. Iron ore pelletizing Grate kilns and traveling grates	Over 600,000	Apply to department for specific emission limit.	
	300,000-600,000	0.10	5B or 5C
	100,000-300,000	0.15	5B or 5C
	0-100,000	0.20	5B or 5C
I. Fertilizer plants (including ammoniator, granulator, reactor, dryer, cooler blender and all other processes Compliance shall be achieved as expeditiously as practical, but not later than January 1, 1981.		0.10	5B or 5C
J. Exhaust systems serving material handling equipment not otherwise listed in table 31 Compliance shall be achieved as expeditiously as practical, but not later than July 1, 1981.		0.10	5B or 5C

Client:	Copperwood Resources, Inc.
Project ID.:	0023H001.00
Project:	Air Permit Application Emissions Calculations
Prepared by:	MMD
Date:	05/10/23
Checked by:	AKM
Date:	08/17/23

Copperwood Air Dispersion Model Input Data - Emission Rates of Criteria Pollutants

Point Sources [1]

Emission Source		Stack Height (Above Ground) (m) [1]	Stack Diameter (m) [1]	Stack Exit Velocity (m/s)	Stack Gas Temp (°K)	PM10 (lb/hr)	PM10 (g/sec)	PM2.5 (lb/hr)	PM2.5 (g/sec)	NO2 (lb/hr)	NO2 (g/sec)	SO2 (lb/hr)	SO2 (g/sec)	CO (lb/hr)	CO (g/sec)
SV-001	West Mine Exhaust Vent	9	2	49.4	333	0.866	**0.109**	0.154	**0.0194**	3.04	**0.383**	4.75	**0.598**	50.59	**6.375**
SV-002	East Mine Exhaust Vent	9	2	50.9	333	0.89	**0.112**	0.159	**0.0200**	3.13	**0.394**	4.89	**0.616**	52.13	**6.568**
SV-003	Portal Mine Exhaust Vent	1	4.77	4.7	333	0.47	**0.059**	0.084	**0.0106**	1.66	**0.209**	2.59	**0.326**	27.60	**3.477**
SV-004	Construction Generator (725 kW) 8	4.5	0.1524	47.6	1133	0.161	**0.0202**	0.161	**0.0202**	5.57	**0.701**	0.012	**0.0015**	0.24	**0.030**
SV-005	Natural Gas Power Generator (2 MW base load) 8	4.5	0.381	24.9	1154	0.262	**0.0330**	0.262	**0.0330**	1.18	**0.149**	0.004	**0.0005**	1.67	**0.211**
SV-006	Natural Gas Power Generator (2 MW base load) 8	4.5	0.381	24.9	1154	0.262	**0.0330**	0.262	**0.0330**	1.18	**0.149**	0.004	**0.0005**	1.67	**0.211**
SV-007	Natural Gas Power Generator (2 MW base load) 8	4.5	0.381	24.9	1154	0.262	**0.0330**	0.262	**0.0330**	1.18	**0.149**	0.004	**0.0005**	1.67	**0.211**
SV-008	Fire Pump	4.5	0.1524	28.3	1273	0.442	**0.0557**	0.442	**0.0557**	0.36	**0.045**	0.413	**0.0521**	1.35	**0.171**
SV-009	Lime Silo Vent	4.6	0.2032	4.3	333	0.0003	**0.00004**	0.0003	**0.00004**		**0.000**		**0.0000**		**0.000**

Volume Sources [3]

Emission Source		Volume Height (m)	Volume Width (m)	Release Height (m)	Adjusted Road Width	Initial Horizontal Dimension (m)	Initial Vertical Dimension (m)	PM10 Emissions (lb/hr)	PM10 Emissions (g/sec)	No. of Volume Source Segments	PM10 Rate per Volume (g/sec)	PM2.5 Emissions (lb/hr)	PM2.5 Emissions (g/sec)	PM2.5 Rate per Volume (g/sec)	NO2 Emissions (lb/hr)	NO2 Emissions (g/sec)	NO2 per Volume (g/sec)	SO2 Emissions (lb/hr)	SO2 Emissions (g/sec)	SO2 per Volume (g/sec)	CO Emissions (lb/hr)	CO Emissions (g/sec)	CO per Volume (g/sec)
F001	Ore Transfer from Portal to First Transfer Point (Transfer Tower) [4]	N/A	N/A	0.75		0.21	0.21	0.040	**0.0051**	1		**0.0060**	**0.0008**										
F002	Surplus Ore Transfer to Ore Stockpile [5]	N/A	N/A	5		0.21	0.21	0.135	**0.0170**	1		**0.0204**	**0.0026**										
F003A/B	Transfer Points at Ore Bins/Reclaim Area [6]	N/A	N/A	11.0		7.27	10.2	0.091	**0.011**	2	**5.70E-03**	**0.0136**	**0.0017**	**8.55E-04**									
F004	Management of Ore within Ore Stockpile Area [7]	NA	N/A	16.2		0.81	3.8	0.309	**0.039**	1		**0.0467**	**0.0059**										
F005	Transfer Points at SAG Mill [8]	N/A	N/A	13		7.90	12.00	0.005	**0.0006**	1		0.001	**8.55E-05**										
F006A/B	Concentrate Handling Operations [9]	N/A	N/A	6		8.72	5.60	0.004	**0.0005**	2	**2.48E-04**	0.0006	**7.45E-05**	**3.72E-05**									
F009A/B	Reagent Mixing and Management [10]	N/A	N/A	6.5		7.27	6.10	5.49E-05	**6.92E-06**	2	**3.46E-06**	5.49E-05	**6.92E-06**	**3.46E-06**									
HR-01	Vehicle Travel on Ore Stockpile [11]	10.2	10.1	5.1	10.1	4.7	4.7	1.122	0.1414	13	**1.09E-02**	0.112	0.014	**1.09E-03**									
HR-02	Conct Truck Travel on Access Road [12]	10	8.5	5.0	8.5	7.9	4.7	0.47	0.0598	233	**2.57E-04**	0.047	0.006	**2.57E-05**									
HR-03	Water Transport Truck on Access Road [13]	8.6	8.4	4.3	8.4	7.8	4.0	0.47	0.0590	234	**2.52E-04**	0.047	0.006	**2.52E-05**									
HR-04	Reagent/Grinding Media Truck on Access Road [14]	10	8.5	5.0	8.5	7.9	4.7	0.38	0.0480	240	**2.00E-04**	0.038	0.005	**2.00E-05**									
HR-05	Explosives Truck Travel on Access Road [15]	10	8.5	5.0	8.5	7.9	4.7	0.38	0.0476	206	**2.31E-04**	0.038	0.005	**2.31E-05**									
HR-06	Natural Gas Delivery Truck Travel on Access Road [16]	10	8.5	5.0	8.5	7.9	4.7	0.38	0.0479	235	**2.04E-04**	0.038	0.005	**2.04E-05**									
HR-07	Diesel Fuel Delivery Truck Travel on Access Road [17]	10	8.5	5.0	8.5	7.9	4.7	0.43	0.0541	245	**2.21E-04**	0.043	0.005	**2.21E-05**									

Area Sources

Emission Source	X-Axis Length (m)	Y-Axis Length (m)	Release Height (m)	Initial Vertical (m)	Area (m2)	PM10 Emissions (lb/hr)	PM10 Emissions (g/sec)	PM10 Emissions (g/m^2-sec)	PM2.5 Emissions (lb/hr)	PM2.5 Emissions (g/sec)	PM2.5 Emissions (g/m^2-sec)
F007 - Wind Erosion at Ore Stockpile			15	7.0	51,790	0.23	0.03	**5.56E-07**	0.057	0.007	**1.39E-07**
F008 - Wind Erosion at TDF			30	14.0	38,079	0.4	0.05	**1.33E-06**	0.205	0.026	**6.79E-07**

Building Dimensions [18]

Building Name	X-Axis Bldg/Structure Length (m)	Y-Axis Bldg/Structure Width (m)	Bldg/ Structure Height (m)	Area (m2)	UTM Coordinates Easting (m)	UTM Coordinates Northing (m)
Process Plant and Support Facility	108.4	37.8	26	4,098	270405	5172284
Concentrate Processing Area	43	34	12	1,462	270366	5172261
Reagent Building	31.6	14	4.8	442	270397	5172325
Ore Bins/Reclaim Area	32	18.8	22	602	270564	5172416
Warehouse	37.7	37.5	6	1,414	270446	5172436
Truck Shop/Mine Services Area	18.6	46.3	6	861	270472	5172467
Dry	37.5	25	3	938	270423	5172467

Notes:

by Copperwood.

(2) The emergency generator will operate as needed a maximum of 500 hours per year.

(3) All volume sources were calculated based on the MDEQ guidance document entitled *Air Dispersion Modeling Guidance Document* dated September 2009.

(4) This represents particulate emissions vented from conveyor No. 1 transfer tower at F001. The transfer conveyor is assumed to be 1.5 meters above ground, with the release height being 1.5 / 2 = 0.75. The initial horizontal dimension is the width of the conveyor = 3 feet = 0.91 meters / 4.3 = 0.21 meters. The initial vertical dimension is the drop distance = 3 feet = 0.91 meters / 4.3 = 0.21 meters.

(5) To estimate this volume source at F002, the release height was the height of the drop point at the ore stockpile = 10 / 2 = 5 meters. The initial horizontal dimension is the width of the conveyor = 3 feet = 0.91 meters / 4.3 = 0.21 meters. The initial vertical dimension is the drop distance = 3 feet = 0.91 meters / 4.3 = 0.21 meters.

(6) To estimate emissions from the ore bins/reclaim area (F003), it will be assumed the emissions will be released within the footprint of the structure. Therefore, the release height for the structure is the height of the bins = 22 meters / 2 = 11 meters. There will be two volume sources. The initial horizontal dimension for each volume source = 31.25 / 4.3 = 7.27 meters (which is half the length of one side of the structure), while the initial vertical dimension = 22 / 2.15 = 10.2 meters.

(7) For F004, to estimate emissions from a FE loader at a pile, it was assumed the release height for the FE loader bucket will be at about 4 feet in height or 1.2 meters. Given the height of the Ore Stockpile will be 15 meters above ground level, the adjusted loader height will be 1.2 + 15 = 16.2 meters. The initial horizontal dimension is the width of the bucket = 3.5 meters / 4.3 = 0.81 meters. The initial vertical dimension is the height of the drop = 16.2 / 4.3 = 3.8 meters.

(8) F005 will be a drop point just inside the process plant building. To estimate emissions from inside the process plant, the release height will be the height of the building = 26 meters / 2 = 13 meters. The initial horizontal dimension will be the width of the building = 34 / 4.3 = 7.9 meters. The initial vertical dimension will be 26 / 2.15 = 12 meters.

(9) Emissions from the concentrate load-out area at F006 include management of concentrate inside the building. This emission source is minimal due to enclosure of the drop point and the fact the material is 9% moisture. It is nonetheless included in air dispersion modeling to be conservative. For purposes of modeling, it is assumed it would be a volume source that includes just the southwest end of the building. The volume is one source that includes release of the emissions from the roof of the building. The release height is the midpoint of the building height = 12 / 2 = 6 meters. There will be two volume sources. The initital horizontal dimension is one-half of the building width = 37.5 / 4.3 = 8.72 meters. The initial vertical dimension is the building height = 12 / 2.15 = 5.6 meters.

(10) Emissions from the reagent building include particulate emissions from mixing of reagents. While these sources are exempt sources, they are being included in air dispersion modeling to be conservative. Modeling for TACs associated with reagent mixing was not required. For purposes of modeling, it is assumed emissions would come from the entire building. Therefore, the building was divided into two volume sources using MDEQ guidance for setting up volume sources associated with release of emissions from building roofs/vents. The release height is the midpoint of the building height = 13 / 2 = 6.5 meters. The initial horizontal dimension of each volume source is 31.25 / 4.3 = 7.27 meters. The initial vertical dimension of each volume source is 13 / 2.15 = 6.1 meters.

(11) For HR-01, this included estimation of vehicle height, volume width, release height, initial lateral dimension and initial vertical dimension. Based on use of a CAT 990H FE loader, the height is 5.1 meters, the width is 4.1 meters and length 12.8 meters. Given this information, the volume height is 5.1 * 2 = 10.2 meters, with the volume width being the loader width + 6 meters = 4.1 + 6 = 10.1 meters. The release height = volume height / 2 = 10.2 / 2 = 5.1 meters. The initial horizontal dimension = the volume width / 2.15 = / 2.15 = 4.7 meters, with the initial vertical dimension = height of the volume / 2.15 or 10.2 / 2.15 = 4.7 meters.

(12) For HR-02, this included estimation of vehicle height, volume width, release height, initial lateral dimension and initial vertical dimension. Based on use of bulk product haul truck, the height is 16 feet (including trailer + distance from ground) or 5 meters. The width is 8.3 feet or 2.5 meters. The overall length (including trailer and cab) is 53 feet or 16 meters. Given this information, the volume height is 5 * 2 = 10 meters, with the volume width being the truck width + 6 meters = 8.5 meters. The release height = volume height / 2 = 10 / 2 = 5 meters. For alternating volume sources, the initial horizontal dimension = 2 X the adjusted road width / 2.15 = 17 / 2.15 = 7.9 meters, with the initial vertical dimension = height of the volume / 2.15 or 10 / 2.15

(13) For HR-03, this included estimation of vehicle height, volume width, release height, initial lateral dimension and initial vertical dimension. Based on use of water transport truck, the height is 14 feet (including trailer + distance from ground) or 4.3 meters. The width is 8 feet or 2.4 meters. The overall length (including trailer and cab) is 65 feet or 19.8 meters. Given this information, the volume height is 4.3 * 2 = 8.6 meters, with the volume width being the truck width + 6 meters = 8.4 meters. The release height = volume height / 2 = 8.6 / 2 = 4.3 meters. For alternating volume sources, the initial horizontal dimension = 2 X the adjusted road width / 2.15 = 16.8 / 2.15 = 7.8 meters, with the initial vertical dimension = height of the volume / 2.15 or 8.6 /

(14) For HR-04, this included estimation of vehicle height, volume width, release height, initial lateral dimension and initial vertical dimension. Based on use of bulk product delivery truck, the height is 16 feet (including trailer + distance from ground) or 5 meters. The width is 8.3 feet or 2.5 meters. The overall length (including trailer and cab) is 53 feet or 16 meters. Given this information, the volume height is 5 * 2 = 10 meters, with the volume width being the truck width + 6 meters = 8.5 meters. The release height = volume height / 2 = 10 / 2 = 5 meters. For alternating volume sources, the initial horizontal dimension = 2 X the adjusted road width / 2.15 = 17 / 2.15 = 7.9 meters, with the initial vertical dimension = height of the volume / 2.15 or 10 / 2.15 = 4.7 meters.

(15) For HR-05, this included estimation of vehicle height, volume width, release height, initial lateral dimension and initial vertical dimension. Based on use of bulk product delivery truck, the height is 16 feet (including trailer + distance from ground) or 5 meters. The width is 8.3 feet or 2.5 meters. The overall length (including trailer and cab) is 53 feet or 16 meters. Given this information, the volume height is 5 * 2 = 10 meters, with the volume width being the truck width + 6 meters = 8.5 meters. The release height = volume height / 2 = 10 / 2 = 5 meters. For alternating volume sources, the initial horizontal dimension = 2 X the adjusted road width / 2.15 = 17 / 2.15 = 7.9 meters, with the initial vertical dimension = height of the volume / 2.15 or 10 / 2.15 = 4.7 meters.

(16) For HR-06, this included estimation of vehicle height, volume width, release height, initial lateral dimension and initial vertical dimension. Based on use of bulk product delivery truck, the height is 16 feet (including trailer + distance from ground) or 5 meters. The width is 8.3 feet or 2.5 meters. The overall length (including trailer and cab) is 53 feet or 16 meters. Given this information, the volume height is 5 * 2 = 10 meters, with the volume width being the truck width + 6 meters = 8.5 meters. The release height = volume height / 2 = 10 / 2 = 5 meters. For alternating volume sources, the initial horizontal dimension = 2 X the adjusted road width / 2.15 = 17 / 2.15 = 7.9 meters, with the initial vertical dimension = height of the volume / 2.15 or 10 / 2.15 = 4.7 meters.

(17) For HR-07, this included estimation of vehicle height, volume width, release height, initial lateral dimension and initial vertical dimension. Based on use of bulk product delivery truck, the height is 16 feet (including trailer + distance from ground) or 5 meters. The width is 8.3 feet or 2.5 meters. The overall length (including trailer and cab) is 53 feet or 16 meters. Given this information, the volume height is 5 * 2 = 10 meters, with the volume width being the truck width + 6 meters = 8.5 meters. The release height = volume height / 2 = 10 / 2 = 5 meters. For alternating volume sources, the initial horizontal dimension = 2 X the adjusted road width / 2.15 = 17 / 2.15 = 7.9 meters, with the initial vertical dimension = height of the volume / 2.15 or 10 / 2.15 = 4.7 meters.

(18) Dimensions are provided for buildings on-site that are adjacent identified emission sources. These additional buildings are included in the dispersion model even though these structures do not release emissions. This is because these structures could have some impact on downwash and/or cavity effects at the site. Dimensions for buildings were provided by Lycopodium.

Copperwood Air Dispersion Model Input Data - Emission Rates of Toxic Air Contaminants

	Metals									
	% Aresenic [2]	% Copper [2]	% Lead [2]	% Barium [2]	% Cobalt [2]	% Manganese[4]	% Barium[2]	% Beryllium[2]	% Cadmium[2]	% Nickel[2]
Ore	1.80E-04	1.460	1.10E-03	0.07559	3.33E-03	8.77E-04	7.56E-02	2.60E-04	1.75E-04	6.54E-03
Concentrate	3.00E-05	28.100	3.00E-05	0.01860	3.30E-05	1.16E-01	2.11E-04	1.73E-06	2.00E-06	2.24E-04
Native Soils	3.20E-04	0.00197	1.54E-03	0.0188	1.59E-03	2.23E-01	1.88E-02	1.06E-04	4.60E-05	2.39E-03
Tailings	6.00E-04	0.4675	1.27E-03	0.0535	3.60E-03	1.61E-01	5.35E-02	2.00E-04	3.00E-05	1.87E-02

Point Sources

Emission Source		Aresenic	Copper	Lead	Barium	Cobalt	Manganese	Barium	Beryllium	Cadmium	Nickel
SV-001 - West Mine Exhaust Vent		1.08E-06	4.86E-03	3.65E-06	2.51E-04	1.13E-05	1.84E-04	2.62E-04	8.93E-07	3.22E-06	2.68E-05
SV-002 - East Mine Exhaust Vent		1.11E-06	5.00E-03	3.76E-06	2.59E-04	1.16E-05	1.89E-04	2.70E-04	9.20E-07	3.32E-06	2.76E-05
SV-003 - Portal Mine Exhaust Vent		5.88E-07	2.65E-03	1.99E-06	1.37E-04	6.14E-06	1.00E-04	1.43E-04	4.87E-07	1.76E-06	1.46E-05
SV-004 - Construction Generator											
SV-005 - Natural Gas Generator											
SV-006 - Natural Gas Generator											
SV-007 - Natural Gas Generator											
SV-008 Fire Pump											
SV-009 Lime Silo Vent											

Emission Source	acetaldehyde	benzene	1,3-Butadiene	Benzo(a)pyrene	Ethylene Dibromide [5]	acrolein	formaldehyde	Units
SV-001 - West Mine Exhaust Vent		5.03564E-06					0.000179844	g/sec
SV-002 - East Mine Exhaust Vent		5.18824E-06					0.000185294	g/sec
SV-003 - Portal Mine Exhaust Vent		2.74671E-06					9.80969E-05	g/sec
SV-004 - Construction Generator	2.32726E-05	0.0007	3.61095E-05	1.46E-07		7.28E-06	7.28655E-05	g/sec
SV-005 - Natural Gas Generator	0.007188424	3.78E-04	0.000229582	3.86937E-07	3.80918E-05	0.004419677	0.04540057	g/sec
SV-006 - Natural Gas Generator	0.007188424	3.78E-04	0.000229582	3.86937E-07	3.80918E-05	0.004419677	0.04540057	g/sec
SV-007 - Natural Gas Generator	0.007188424	3.78E-04	2.30E-04	3.87E-07	3.81E-05	0.004419677	0.04540057	g/sec
SV-008 Fire Pump	7.85933E-06	9.56E-06	4.01E-07	1.93E-09		9.47834E-07	1.20913E-05	g/sec
SV-009 Lime Silo Vent								

Volume Sources

Emission Source	Number of Volume Source Segments	Aresenic	Copper	Lead	Barium	Cobalt	Manganese	Barium	Beryllium	Cadmium	Nickel	Units
F001 - Ore Transfer at Transfer Tower	1	8.71E-07	1.94E-04	1.46E-07	1.01E-05	4.43E-07	8.47E-06	1.01E-05	3.46E-08	2.33E-08	8.71E-07	g/sec
F002 - Surplus Ore Transfer to Ore Stockpile	1	6.62E-08	5.37E-04	4.04E-07	2.78E-05	1.22E-06	2.85E-05	2.78E-05	9.56E-08	6.44E-08	2.41E-06	g/sec
F003A&B - Transfer Points at Ore Bins/Reclaim Area [1]	2	2.80E-08	9.25E-11	1.71E-07	1.18E-05	5.17E-07	9.55E-06	1.18E-05	4.04E-08	2.72E-08	1.02E-06	g/sec
F004 - Management of Ore at Ore Stockpile	1	1.48E-07	1.20E-03	9.03E-07	6.21E-05	2.74E-06	6.52E-05	6.21E-05	2.14E-07	1.44E-07	5.38E-06	g/sec
F005 - Transfer Points at SAG Mill	1	2.80E-09	2.27E-05	1.71E-08	1.18E-06	5.17E-08	9.55E-07	1.18E-06	4.04E-09	2.72E-09	1.02E-07	g/sec
F006A&B - Concentrate Handling Operations [1]	2	2.03E-10	1.90E-04	2.03E-10	1.43E-09	2.23E-10	2.88E-07	1.43E-09	1.17E-11	1.35E-11	1.52E-09	g/sec
HR-01 - Vehicle Travel on Ore Stockpile [1]	13	9.15E-08	7.42E-04	5.59E-07	3.84E-05	1.69E-06	1.82E-05	3.84E-05	1.32E-07	8.90E-08	3.33E-06	g/sec
HR-02 - Concentrate Truck Travel on Access Road [1, 3]	233	3.82E-09	2.35E-08	1.83E-08	2.26E-07	1.90E-08	5.70E-07	2.25E-07	1.27E-09	5.50E-10	2.86E-08	g/sec
HR-03 - Water Truck Travel on Access Road [1, 3]	234	3.77E-09	2.32E-08	1.81E-08	2.22E-07	1.88E-08	5.63E-07	2.22E-07	1.25E-09	5.43E-10	2.82E-08	g/sec
HR-04 - Reagent/Grinding Media Truck on Access Road [1,3]	240	2.99E-09	1.84E-08	1.44E-08	1.76E-07	1.49E-08	4.46E-07	1.76E-07	9.92E-10	4.30E-10	2.24E-08	g/sec
HR-05 - Explosives Truck Travel on Access Road [1,3]	206	3.46E-09	2.13E-08	1.66E-08	2.03E-07	1.72E-08	5.15E-07	2.03E-07	1.15E-09	4.97E-10	2.58E-08	g/sec
HR-06 Natural Gas Delivery Truck Travel on Access Road	235	3.05E-09	1.88E-08	1.46E-08		1.51E-08	2.12E-06	1.79E-07	1.01E-09	4.38E-10	2.28E-08	g/sec
HR-07 Diesel Fuel Delivery Truck Travel on Access Road	245	3.31E-09	2.04E-08	1.59E-08		1.64E-08	2.30E-06	3.46E-08	1.10E-09	4.75E-10	2.47E-08	g/sec

Area Sources

Emission Source	Area	Aresenic	Copper	Lead	Barium	Cobalt	Manganese	Barium	Beryllium	Cadmium	Nickel	Units
F007 - Wind Erosion at Ore Stockpile	51,790	1.10E-09	4.06E-08	3.05E-11	2.10E-09	9.25E-11	9.32E-10	2.10E-09	7.23E-12	4.86E-12	1.82E-10	g/m2-sec
F008 - Wind Erosion at TDF	38,079	2.50E-09	1.20E-08	3.26E-11	1.37E-09	9.25E-11	2.15E-09	1.37E-09	5.14E-12	7.71E-13	4.80E-10	g/m2-sec

Notes:

1. Each TAC concentration is for each volume source segment. Lead is included here although it is regulated as a federal criteria pollutant.
2. Lead and most TAC emission rates for ore materials are based on PM emission composition.
3. For vehicle travel on the access road (HR-02, HR-03, HR-04, and HR-05), all emission calculations were calculated based on the percentage of TACs in native soils. Note that the access road will be dressed with clean aggregate material, such that trucks are not in direct contact with native soils over the route.
4. Calculation of manganese TAC emissions is based on Note 29 in the MDEQ Table 2 List of Screening Levels. Note 29 states that the ITSL for manganese is most appropriately applied to PM10-Mn rather than TSP-Mn data. Therefore, all TAC calculations for Mn were based on PM-10 data.
5. Ethylene dibromide is the same as 1,2-dibromoethane, CAS # 106934

Client:	Copperwood Resources, Inc.	Project ID.:	0023H001.00
Project:	Air Permit Application Emissions Calculations		
Prepared by:	MMD	Date:	05/10/23
Checked by:	AKM	Date:	08/17/23

TACs are generated by the following equipment that do not run at the same time:
3 NG generators
1 diesel generator (construction)
1 NG mine heater (exhaust through ventilation raises)
1 diesel fire pump
From the perspective of hourly TAC emission rates, the maximum emissions are generated when the 3 NG generators operate to supplement line power + the firewater pump + NG mine heater. Because the diesel construction generator emissions include several TACs not present in NG generator, the scenario with the diesel generator operating was considered for the TACs unique to that equipment. This results in a comprehensive list of TACs.

Scenario 1: 3 NG generators runing simultaneously in the supplemental power scenario + the diesel fire water pump+ the NG mine heater
Scenario 2: 1 Construction diesel generator runing + diesel fire water pump + NG mine heater.

For simplicity, a combination of the two scenarios selecting the highest emissions for each parameter was the basis of the TAC evaluation.

1 Diesel Generator (construction)

Organic Pollutants	Maximum Emissions (lb/hr)	Maximum Hourly Emission Rate (lb/hr) [3]
1,3-Butadiene	0.000286583	
Acenaphthene	3.43021E-05	
Acenaphthylene	6.76513E-05	
Acetaldehyde	0.000184703	
Acrolein	5.77565E-05	
Anthracene	9.01529E-06	
Benzene	0.005687692	
Benzo(a)anthracene *	4.55895E-06	4.55895E-07
Benzo(a)pyrene *	1.88368E-06	1.88368E-06
Benzo(b)fluoranthene *	8.13575E-06	8.13575E-07
Benzo(g,h,l)perylene	4.0752E-06	
Benzo(k)fluoranthene *	1.59783E-06	1.59783E-07
Chrysene *	1.12141E-05	1.12141E-07
Dibenz(a,h)anthracene *	2.53601E-06	2.78961E-06
Fluoranthene	2.95379E-05	
Fluorene	9.38176E-05	
Formaldehyde	0.000578298	
Indeno(1,2,3-cd)pyrene *	3.03441E-06	3.03441E-07
Naphthalene	0.000952835	
Phenanthrene	0.000299044	
Polycyclic aromatic hydrocarbons (PAH)		
Propylene	0.020449305	
Pyrene	2.71924E-05	
Toluene	0.00205959	
Total PAH	0.001550431	
Xylenes	0.001414594	

Fire Water Pump - Diesel

	Maximum Emissions (lb/hr) [2]
1,3-Butadiene	3.1798E-06
Acenaphthene	1.1548E-07
Acenaphthylene	4.115E-07
Acetaldehyde	6.2376E-05
Acrolein	7.5225E-06
Anthracene	1.5208E-07
Benzene	7.5875E-05
Benzo(a)anthracene *	1.3662E-07
Benzo(a)pyrene *	1.5289E-08
Benzo(b)fluoranthene	8.0592E-09
Benzo(g,h,l)perylene	3.9768E-08
Benzo(k)fluoranthene	1.2605E-08
Chrysene *	2.8707E-08
Dibenz(a,h)anthracene	4.7412E-08
Fluoranthene	6.1888E-07
Fluorene	2.3747E-06
Formaldehyde	9.5963E-05
Indeno(1,2,3-cd)pyren	3.0497E-08
Naphthalene	6.8963E-06
Phenanthrene	2.3909E-06
Polycyclic aromatic hydrocarbons (PAH)	
Propylene	0.00020982
Pyrene	3.8873E-07
Toluene	3.3262E-05
Total PAH	1.3668E-05
Xylenes	2.3177E-05

Exhausting thru ventilation raises
1 NG mine heater

Organic Pollutants	Maximum Emissions (lb/hr)
2-Methylnaphthalene	1.18E-06
3-Methylcholathrene	8.82E-08
Acenaphthene	8.82E-08
Acenaphthylene	1.18E-07
Anthracene	8.82E-08
Benzo(a)anthracene	8.82E-08
Benzene	1.03E-04
Benzo(b)fluoranthene	8.82E-08
Benzo(a)pyrene	5.88E-08
Benzo(g,h,i)perylene	5.88E-08
Benzo(k)fluoranthene	8.82E-08
Butane	1.03E-01
7,12-dimethylbenz(a)	7.84E-07
Dichlorobenzene	5.88E-05
Chrysene	8.82E-08
Ethane	1.52E-01
Dibenz(a,h)anthracer	5.88E-08
Fluoroanthene	1.47E-07
Fluorene	1.37E-07
Formaldehyde	3.68E-03
Indeno(1,2,3-cd)pyre	8.82E-08
n-Hexane	8.82E-02
n-Pentane	1.27E-01
Naphthalene	3.14E-05
Phenanthrene	8.33E-07
Propane	7.84E-02
Pyrene	2.45E-07
Toluene	1.67E-04

2 NG Geneerators - prime pwer

Trace Organic Pollutant	Maximum Emissions (lb/hr)	Maximum Hourly Emission Rate (lb/hr) [3]
1,1,2,2-Tetrachloroethane	0.000545942	
1,1,2-Trichloroethane *	0.000434024	
1,1-Dichloroethane	0.000322106	
1,2,3-Trimethylbenzene	0.000313917	
1,2,4-Trimethylbenzene	0.000195174	
1,2-Dichloroethane	0.000322106	
1,2-Dichloropropane	0.000367146	
1,3,5-Trimethylbenzene	0.000461321	
1,3-Butadiene *	0.003644166	
1,3-Dichloropropene *	0.000360322	
2-Methylnaphthalene *	0.000453132	
2,2-4-Trimethylpentane *	0.00341214	
Acenaphthene *	0.000170607	
Acenaphthylene *	7.54765E-05	
Acetaldehyde *	0.114101962	
Acrolein *	0.070153598	
Benzene *	0.006005366	
Benzo(b)fluoranthene *	2.26566E-06	2.26566E-07
Benzo(a)pyrene *	6.14185E-06	6.14185E-06
Benzo(g,h,l)perylene *	5.6505E-06	
Biphenyl *	0.002893495	
Butane	0.007383871	
Butry/Isobutyraldehyde	0.001378505	
Carbon Tetrachloride *	0.000500902	
Chlorobenzene *	0.000414916	
Chloroethane	2.55228E-05	
Chloroform *	0.000388984	
Chrysene *	9.45845E-06	9.45845E-08
Cyclopentane	0.003098223	
Ethane	1.4330988	
Ethylbenzene *	0.000541848	
Ethylene Dibromide *	0.000604631	
Fluoroanthene *	1.51499E-05	
Fluorene *	7.73873E-05	
Formaldehyde *	0.720643968	
Methanol *	0.0341214	
Methylcyclohexane	0.016787729	
Methylene Chloride *	0.000272971	
n-Hexane *	0.015149902	
n-Nonane	0.001501342	
n-Octane	0.004790645	
n-Pentane	0.035486256	
Naphthalene *	0.001015453	
PAH *	0.000367146	
Phenanthrene *	0.000141945	
Phenol *	0.000327565	
Propane	0.571874664	
Pyrene *	1.8562E-05	
Styrene *	0.000322106	
Tetrachloroethane *	3.38484E-05	
Toluene	0.005568612	
Vinyl Chloride	0.000203364	
Xylene	0.002511335	

Emerg NG generator - 1

Trace Organic Pollutan	Maximum Emission (lb/hr)	Relative Maximum Hourly Emission Rate (lb/hr) [3]
1,1,2,2-Tetrachloroethane	0.00027	
1,1,2-Trichloroethane *	0.00022	
1,1-Dichloroethane	0.00016	
1,2,3-Trimethylbenzene	0.00016	
1,2,4-Trimethylbenzene	9.8E-05	
1,2-Dichloroethane	0.00016	
1,2-Dichloropropane	0.00018	
1,3,5-Trimethylbenzene	0.00023	
1,3-Butadiene *	0.00182	
1,3-Dichloropropene *	0.00018	
2-Methylnaphthalene *	0.00023	
2,2-4-Trimethylpentane *	0.00171	
Acenaphthene *	8.5E-05	
Acenaphthylene *	3.8E-05	
Acetaldehyde *	0.05705	
Acrolein *	0.03508	
Benzene *	0.003	
Benzo(b)fluoranthene *	1.1E-06	1.13283E-07
Benzo(a)pyrene *	3.1E-06	3.07093E-06
Benzo(g,h,l)perylene *	2.8E-06	
Biphenyl *	0.00145	
Butane	0.00369	
Butry/Isobutyraldehyde	0.00069	
Carbon Tetrachloride *	0.00025	
Chlorobenzene *	0.00021	
Chloroethane	1.3E-05	
Chloroform *	0.00019	
Chrysene *	4.7E-06	4.72923E-08
Cyclopentane	0.00155	
Ethane	0.71655	
Ethylbenzene *	0.00027	
Ethylene Dibromide *	0.0003	
Fluoroanthene *	7.6E-06	
Fluorene *	3.9E-05	
Formaldehyde *	0.36032	
Methanol *	0.01706	
Methylcyclohexane	0.00839	
Methylene Chloride *	0.00014	
n-Hexane *	0.00757	
n-Nonane	0.00075	
n-Octane	0.0024	
n-Pentane	0.01774	
Naphthalene *	0.00051	
PAH *	0.00018	
Phenanthrene *	7.1E-05	
Phenol *	0.00016	
Propane	0.28594	
Pyrene *	9.3E-06	
Styrene *	0.00016	
Tetrachloroethane *	1.7E-05	
Toluene	0.00278	
Vinyl Chloride	0.0001	
Xylene	0.00126	

Fire Water Pump - Diesel

1,3-Butadiene	3.1798E-06
Acenaphthene	1.1548E-07
Acenaphthylene	4.115E-07
Acetaldehyde	6.2376E-05
Acrolein	7.5225E-06
Anthracene	1.5208E-07
Benzene	7.5875E-05
Benzo(a)anthracene *	1.3662E-07
Benzo(a)pyrene *	1.5289E-08
Benzo(b)fluoranthene	8.0592E-09
Benzo(g,h,l)perylene	3.9768E-08
Benzo(k)fluoranthene	1.2605E-08
Chrysene *	2.8707E-08
Dibenz(a,h)anthracen	4.7412E-08
Fluoranthene	6.1888E-07
Fluorene	2.3747E-06
Formaldehyde	9.5963E-05
Indeno(1,2,3-cd)pyren	3.0497E-08
Naphthalene	6.8963E-06
Phenanthrene	2.3909E-06
Polycyclic aromatic hydrocarbons (PAH)	
Propylene	0.00020982
Pyrene	3.8873E-07
Toluene	3.3262E-05
Total PAH	1.3668E-05
Xylenes	2.3177E-05

Source of emission factors: AP-42, Table 3.2-2 (July 2000 update)
1. Pursuant to the MDEQ PAH guidance document Screening Levels for Polycyclic Aromatic Hydrocarbons, Feb. 7, 2017, emissions have been adjusted on applicable constituents using the Relative Potency Factors (RPF) to allow for screening using the Allowable Emission Rate Methodology under Rule 227 (1) (a).
* Items with an asterisk are listed federal Hazardous Air Pollutants by Section 112(b) of the Clean Air Act.

Client: Copperwood Resources, Inc. Project ID.: 0023H001.00
Project: Air Permit Application Emissions Calculations
Prepared by: MMD Date: 05/10/23
Checked by: AKM Date: 08/17/23

From various equipment, assemble two senarios to compare and select worse case emissions on a pollutant by pollutant basis.

diesel HAPs	NG HAPs	Scenario 1: 3 NG generators + NG mine heater +firewater pump	Scenario 2: 1 diesel generator + NG mine heater + firewater pump		worst case between scenarios 1 and 2; lb/hr	CAS No
	1,1,2,2-Tetrachloroethane *	0.000818914		1,1,2,2-Tetrachloroethan	0.000818914	79345
	1,1,2-Trichloroethane *	0.000651036		1,1,2-Trichloroethane *	0.000651036	79005
	1,1-Dichloroethane	0.000483159		1,1-Dichloroethane	0.000483159	75343
	1,2,3-Trimethylbenzene	0.000470875		1,2,3-Trimethylbenzene	0.000470875	526738
	1,2,4-Trimethylbenzene	0.000292762		1,2,4-Trimethylbenzene	0.000292762	95636
	1,2-Dichloroethane	0.000483159		1,2-Dichloroethane	0.000483159	107062
	1,2-Dichloropropane	0.000550719		1,2-Dichloropropane	0.000550719	78875
	1,3,5-Trimethlybenzene	0.000691982		1,3,5-Trimethlybenzene	0.000691982	108678
1,3-Butadiene	1,3-Butadiene *	0.005469428	0.000289763	1,3-Butadiene *	0.005469428	106990
	1,3-Dichloropropene *	0.000550719		1,3-Dichloropropene *	0.000550719	542756
	2-Methylnaphthalene *	6.81E-04	1.18E-06	2-Methylnaphthalene *	0.000680875	91576
	2,2-4-Trimethlypentane *	0.00511821		2,2-4-Trimethlypentane *	0.00511821	540841
Anthracene		2.40E-07	9.26E-06	Anthracene	9.2556E-06	120127
Acenaphthene	Acenaphthene *	2.56E-04	3.45E-05	Acenaphthene	0.000256114	83329
Acenaphthylene	Acenaphthylene *	1.14E-04	6.82E-05	Acenaphthylene	0.000113744	208968
Acetaldehyde	Acetaldehyde *	0.171215318	0.000247079	Acetaldehyde	0.171215318	75070
Acrolein	Acrolein *	0.10523792	6.52789E-05	Acrolein	0.10523792	107028
Benzene	Benzene *	9.19E-03	5.87E-03	Benzene	0.009186866	71432
Benzo(a)anthracene *		2.25E-07	4.78E-06	Benzo(a)anthracene *	4.78381E-06	56553
Benzo(a)pyrene *	Benzo(a)pyrene *	9.29E-06	1.96E-06	Benzo(a)pyrene *	9.28689E-06	50328
Benzo(b)fluoranthene *	Benzo(b)fluoranthene *	4.36E-07	8.23E-06	Benzo(b)fluoranthene *	8.23204E-06	205992
Benzo(k)fluoranthene *		1.01E-07	1.70E-06	Benzo(k)fluoranthene *	1.69867E-06	207089
Benzo(g,h,l)perylene	Benzo(g,h,l)perylene *	8.57E-06	4.17E-06	Benzo(g,h,l)perylene	8.57435E-06	191242
	Biphenyl *	0.004340242		Biphenyl *	0.004340242	92524
	Butane	1.14E-01	1.03E-01	Butane	0.114016983	106978
	Butry/Isobutyraldehyde	0.002067757		Butry/Isobutyraldehyde	0.002067757	78842
	Carbon Tetrachloride *	0.000751353		Carbon Tetrachloride *	0.000751353	56235
	Chlorobenzene *	0.000622374		Chlorobenzene *	0.000622374	108907
	Chloroethane	3.82842E-05		Chloroethane	3.82842E-05	75003
	Chloroform *	0.000583476		Chloroform *	0.000583476	67663
Chrysene *	Chrysene *	2.59E-07	1.13E-05	Chrysene *	1.13311E-05	218019
	Cyclopentane	0.004647335		Cyclopentane	0.004647335	287923
Dibenz(a,h)anthracene *		1.06E-07	2.64E-06	Dibenz(a,h)anthracene *	2.64224E-06	53703
	Ethane	2.30E+00	1.52E-01	Ethylbenzene *	0.000812772	100414
	Ethylbenzene *	0.000812772		Ethylene Dibromide *	0.000906947	106934
	Ethylene Dibromide *	0.000906947		Fluorene *	0.000118593	86737
Fluorene	Fluorene *	1.19E-04	9.63E-05	Fluoroanthene *	3.03038E-05	206440
Fluoranthene	Fluoroanthene *	2.35E-05	3.03E-05	Formaldehyde *	1.084738385	50000
Formaldehyde	Formaldehyde *	1.08E+00	4.35E-03	Indeno(1,2,3-cd)pyrene *	3.15314E-06	193395
Indeno(1,2,3-cd)pyrene *		1.19E-07	3.15E-06	Methanol *	0.0511821	67561
	Methanol *	0.0511821		Methylcyclohexane	0.025181593	108872
	Methylcyclohexane	0.025181593		Methylene Chloride *	0.000409457	75092
	Methylene Chloride *	0.000409457		Naphthalene *	0.001561448	91203
Naphthalene	Naphthalene *	1.56E-03	9.91E-04	n-Hexane *	0.110960147	110543
	n-Hexane *	1.11E-01	8.82E-02	n-Nonane	0.002252012	111842
	n-Nonane	0.002252012		n-Pentane	0.180680364	109660
	n-Octane	0.007185967		PAH *	0.001564099	#N/A
	n-Pentane	1.81E-01	1.27E-01	Phenanthrene *	0.000302268	85018
Total PAH	PAH *	0.000564387	0.001564099	Phenol *	0.000491348	108952
Phenanthrene	Phenanthrene *	2.16E-04	3.02E-04	Propylene	0.020659121	115071
	Phenol *	0.000491348		Pyrene *	2.84769E-05	129000
	Propane	9.36E-01	7.84E-02	Styrene *	0.000483159	100425
Propylene		0.000209816	0.020659121	Tetrachloroethane *	5.07726E-05	79345
Pyrene	Pyrene *	2.85E-05	2.78E-05	Toluene	0.008552847	108883
	Styrene *	0.000483159		Vinyl Chloride	0.000305045	75014
	Tetrachloroethane *	5.07726E-05		Xylene	0.00379018	1330207
Toluene	Toluene	8.55E-03	2.26E-03	3-Methylcholathrene	8.82353E-08	56495
	Vinyl Chloride	0.000305045		7,12-dimethylbenz(a)anth	7.84314E-07	57976
Xylenes	Xylene	0.00379018	0.001437771	Dichlorobenzene	5.88235E-05	25321226

TAC from both NG and diesel combustion
TAC only from diesel combution

Facility Name:		Facility Address:

Chemical Name	CAS No.	Screening Level: 1st ITSL µg/m³	Screening Level: 1st ITSL Avg Time	Screening Level: 2nd ITSL µg/m³	Screening Level: 2nd ITSL Avg Time	Screening Level: IRSL / SRSL µg/m³ (annual Avg)	AQD	Footnote(s)	AER 1st ITSL: Max lbs per hour	AER 1st ITSL: lbs per month, 24-hr, 8-hr or 1-hr	AER 2nd ITSL: Max lbs per hour	AER 2nd ITSL: lbs per month, 24-hr, 8-hr or 1-hr	AER IRSL / SRSL: Max lbs per hour	AER IRSL / SRSL: lbs per month	ER: Max Hourly ER lbs/hour	ER: Rate (1st ITSL)	ER: 1st ITSL Rate Units	ER: Rate (2nd ITSL)	ER: 2nd ITSL Rate Units	ER: Rate (IRSL)	ER: IRSL / SRSL Rate Units	Less than AER?: 1st ITSL Max Hourly Rate	Less than AER?: 1st ITSL ER	Less than AER?: 2nd ITSL Max Hourly Rate	Less than AER?: 2nd ITSL ER	Less than AER?: IRSL Max Hourly Rate	Less than AER?: IRSL ER	Action	% of AER: 1st ITSL Max Hourly Rate	% of AER: 1st ITSL ER	% of AER: 2nd ITSL Max Hourly Rate	% of AER: 2nd ITSL ER	% of AER: IRSL Max Hourly Rate	% of AER: IRSL ER
antimony	7440360	0.2	annual						0.108	8					0.000010	0.01285	lbs/month					yes	yes						0.0%	0.2%				
arsenic	7440382					0.0002							0.0001	0.008	0.00008					0.05704	lbs/month					yes	no	model					72.3%	713.0%
barium and soluble barium compou	7440393	5	8 hr					35	0.1	0.1					0.01379	0.21089	lbs/8-hr					yes	no					model	13.8%	210.9%				
beryllium	7440417	0.02	24 hr			0.0004			0.001	0.0024			0.0002	0.016	0.00005	0.00229	lbs/24-hr			0.03816	lbs/month	yes	yes			yes	no	model	5.2%	95.5%			24.2%	238.5%
cadmium	7440439					0.0006							0.0003	0.024	0.00008					0.06199	lbs/month					yes	no	model					26.2%	258.3%
chromium	7440473							17							0.00229																			
cobalt and cobalt compounds that r	7440484	0.2	8 hr			0.0001		42	0.004	0.004			7E-05	0.0052	0.00070	0.01003	lbs/8-hr			0.51174	lbs/month	yes	no			no	no	model	17.5%	250.8%			998.6%	9841.1%
copper	7440508	2	8 hr						0.04	0.04					0.21853	3.68991	lbs/8-hr					no	no					model	546.3%	9224.8%				
magnesium	7439954	100	8 hr					38	2	2					0.05307	0.4246	lbs/8-hr					yes	yes						2.7%	21.2%				
manganese and manganese compo	7439965	0.3	annual					29	0.162	12					0.01988	18.8626	lbs/month					yes	no					model	12.3%	157.2%				
mercury and mercury compounds	7439976	0.3	annual	1	24 hr			7	0.162	12	0.05	0.12			0.00002	0.01244	lbs/month	0.00041	lbs/24-			yes	yes	yes	yes				0.0%	0.1%	0.0%	0.3%		
molybdenum	7439987	30	8 hr						0.6	0.6					0.00009	0.00081	lbs/8-hr					yes	yes						0.0%	0.1%				
nickel	7440020					0.006							0.0032	0.24	0.00148					1.07845	lbs/month					yes	no	model					45.6%	449.4%
phosphorus	7723140	20	24 hr					32	1	2.4					0.00834	0.20012	lbs/24-hr					yes	yes						0.8%	8.3%				
selenium and inorganic selenium co	7782492	2	8 hr					34	0.04	0.04					0.00004	0.00047	lbs/8-hr					yes	yes						0.1%	1.2%				
silver - soluble	7440224	0.1	8 hr						0.002	0.002					0.00007	0.00112	lbs/8-hr					yes	yes						3.4%	56.1%				
sulfur (elemental)	7704349							26							0.09619																			
tin	7440315	20	8 hr						0.4	0.4					0.00006	0.00084	lbs/8-hr					yes	yes						0.0%	0.2%				

% of AER — Turn values red if they are greater than: 100%

yellow columns = must enter information

Links:
Toxics Screening Level Query Footnotes

Hg 7. Besides the assessment of mercury ambient air impacts in comparison to the ITSLs, larger individual sources of mercury emissions undergoing permit review (e.g., greater than 5 to 10 lbs/yr) may be evaluated on a case-by-case basis to address concerns for deposition and bioaccumulation, taking into account site-specific factors such as the presence of nearby recreational fisheries and realistic exposure scenarios.

Cr 17. See specific trivalent and hexavalent chromium compounds.

S 26. This toxic air contaminant (TAC) is reasonably anticipated to exist as a particle in the ambient air. A toxicological review has determined that, in lieu of setting a screening level, the primary NAAQS for particulate matter (PM2.5, PM10) are reasonable and appropriate health protective levels for the particulate. The ***combined*** ambient impact of

all particulate TAC emissions from the process must be below the applicable PM primary NAAQS (PM2.5, PM10). The PM primary NAAQS for particulate matter may be used in permit to install exemption determinations for this TAC under Rule 290(2)(a)(iii) or Rule 291.

Co 42. The ***combined*** ambient impact of cobalt and cobalt compounds that release cobalt ions with the CAS No. 71-48-7, 136-52-7, 513-79-1, 814-89-1, 1002-88-6, 1307-96-6, 1308-06-1, 1317-42-6, 1560-69-6, 7440-48-4, 7646-79-9, 10026-24-1, 10141-05-6, 21041-93-0, and 61789-51-3 cannot exceed the ITSL of 0.2 µg/m³ (8-hour averaging time) and the IRSL of 0.00013 µg Co/m³ or SRSL of 0.0013 µg Co/m³ (annual averaging time).

Mn 29. The ITSL for manganese is 0.3 µg/m³ with an annual averaging time. This ITSL is most appropriately applied to PM_{10}-Mn or $PM_{2.5}$-Mn data rather than TSP-Mn data. This ITSL applies to "manganese and manganese compounds," therefore emissions of multiple forms of manganese must be accounted for additively to ensure that the combined ambient air impact does not exceed the manganese ITSL. This ITSL applies to ambient air impacts of the manganese atom, therefore the emissions and modeled impacts of various manganese compounds may be molecular weight-adjusted to the equivalent emission rate and ambient air impact of the manganese alone. Please note that potassium permanganate (CAS# 7722-64-7) also has a short-term ITSL = 0.6 µg/m³ (8 hour averaging time).

P 32. The Chemical Abstract Service number (CAS#) has been changed to 12185-10-3. Since the original number 7723-14-0, is still used by many organizations, it is listed as the primary CAS#.

Se 34. The ***combined*** ambient impact of all selenium and inorganic selenium compounds with the CAS# 7446-08-4, 7446-34-6, 7488-56-4, 7783-00-8, 10102-18-8, and 13410-01-0 cannot exceed 2 µg/m³ (8-hour averaging time).

Ba 35. The ***combined*** ambient impact of all barium and soluble barium compounds with the CAS# 543-80-6, 1304-28-5, 10022-31-8, 10361-37-2, 10553-31-8, 13477-00-4, 13718-50-8, 17194-00-2, and 21109-95-5 cannot exceed 5 µg/m³ (8-hour averaging time).

Mg 38. The ***combined*** ambient impact of magnesium (CAS No. 7439-95-4) and magnesium compounds, magnesium hydroxide, magnesium oxide, and magnesium nitrate (CAS Nos. 1309-42-8, 1309-48-4, and 10377-60-3, respectively), cannot exceed the ITSL of 100 µg/m³ (8-hour average).

Facility Name: Copperwood Mine | **Facility Address:**

Chemical Name	CAS No.	Screening Level: 1st ITSL µg/m³	1st ITSL Avg Time	2nd ITSL µg/m³	2nd ITSL Avg Time	IRSL / SRSL µg/m³ (annual Avg)	AQD Footnote(s)	Allowable Emission Rate (AER): 1st ITSL Max lbs per hour	1st ITSL lbs per month, 24-hr, 8-hr or 1-hr	2nd ITSL Max lbs per hour	2nd ITSL lbs per month, 24-hr, 8-hr or 1-hr	IRSL / SRSL Max lbs per hour	IRSL / SRSL lbs per month	Proposed Emission Rate (ER): Max Hourly ER lbs/hour	Rate (1st ITSL)	1st ITSL Rate Units	Rate (2nd ITSL)	2nd ITSL Rate Units	Rate (IRSL)	IRSL / SRSL Rate Units
1,1,2,2-tetrachloroethane	79345					0.02						0.0108	0.8	0.000819					0.59781	lbs/month
1,1,2-trichloroethane	79005	11	annual	160	24 hr	0.063		5.94	440	8	19.2	0.034	2.52	0.000651	0.47526	lbs/month	0.015625	lbs/24-	0.47526	lbs/month
1,1-dichloroethane	75343	500	annual					270	20000					0.000483	0.35271	lbs/month				
1,2,3-trimethylbenzene	526738	185	annual	1200	8 hr		14	99.9	7400	24	24			0.000471	0.34374	lbs/month	0.003767	lbs/8-h		
1,2,4-trimethylbenzene	95636	185	annual	1200	8 hr		14	99.9	7400	24	24			0.000293	0.21372	lbs/month	0.002342	lbs/8-h		
1,2-dichloroethane	107062					0.04						0.0216	1.6	0.000483					0.35271	lbs/month
propylene dichloride	78875	4	annual			0.2		2.16	160			0.108	8	0.000551	0.40203	lbs/month			0.40203	lbs/month
1,3,5-trimethyl benzene	108678	185	annual	1200	8 hr		14	99.9	7400	24	24			0.000692	0.50515	lbs/month	0.005536	lbs/8-h		
1,3-butadiene	106990	33	annual			0.03		17.82	1320			0.0162	1.2	0.005466	3.99036	lbs/month			3.99036	lbs/month
1,3-dichloropropene	542756	20	annual			0.2		10.8	800			0.108	8	0.00054	0.39455	lbs/month			0.39455	lbs/month
2-methylnaphthalene	91576	10	annual					5.4	400					0.00068	0.49618	lbs/month				
2,2,4-Trimethyl Pentane	540841	3500	8 hr				1	70	70					0.005118	0.04095	lbs/8-hr				
anthracene	120127	1000	annual					540	40000					1.82E-05	0.01327	lbs/month				
acenaphthene	83329	210	annual					113.4	8400					0.000256	0.18693	lbs/month				
acenaphthylene	208968	35	annual					18.9	1400					0.000136	0.09907	lbs/month				
acetaldehyde	75070	9	annual			0.5		4.86	360			0.27	20	0.171215	124.987	lbs/month			124.987	lbs/month
acrolein	107028	0.4	annual	5	1 hr		13	0.216	16	0.005	0.005			0.105238	76.8237	lbs/month	0.105238	lbs/hr		
benzene	71432	30	annual	30	24 hr	0.1		16.2	1200	1.5	3.6	0.054	4	0.011451	8.35942	lbs/month	0.27483	lbs/24-	8.35942	lbs/month
benz(a)anthracene	56553						5							9.25E-06						
benzo(a)pyrene	50328	0.002	24 hr			0.001	5	0.0001	0.0002			0.0005	0.04	9.23E-06	0.00022	lbs/24-hr			0.00674	lbs/month
Benzo(b)fluoranthene	205992						5							1.63E-05						
Benzo(k)fluoranthene	207089						5							3.21E-06						
benzo(g,h,i)perylene	191242	13	annual					7.02	520					8.52E-06	0.00622	lbs/month				
biphenyl	92524	13	8 hr			0.43		0.26	0.26			0.2322	17.2	0.00434	0.03472	lbs/8-hr			3.16838	lbs/month
butane	106978	23800	8 hr				22	476	476					0.011076	0.08861	lbs/8-hr				
isobutyraldehyde	78842	160	annual					86.4	6400					0.002068	1.50946	lbs/month				
carbon tetrachloride	56235	480	annual			0.17		259.2	19200			0.0918	6.8	0.000751	0.54849	lbs/month			0.54849	lbs/month
chlorobenzene	108907	50	annual	4400	8 hr			27	2000	88	88			0.000622	0.45433	lbs/month	0.004979	lbs/8-h		
ethyl chloride	75003	10000	24 hr					500	1200					3.83E-05	0.00092	lbs/24-hr				
chloroform	67663					0.4						0.216	16	0.000583					0.42594	lbs/month
chrysene	218019						5							2.25E-05						
cyclopentane	287923	17200	8 hr					344	344					0.004647	0.03718	lbs/8-hr				
dibenz(a,h)anthracene	53703						5							5.12E-06						
ethylbenzene	100414	1000	24 hr			0.4		50	120			0.216	16	0.000813	0.01951	lbs/24-hr			0.59332	lbs/month
1,2-dibromoethane	106934	9	annual			0.002		4.86	360			0.0011	0.08	0.000907	0.66207	lbs/month			0.66207	lbs/month
fluorene	86737	140	annual					75.6	5600					0.00019	0.13871	lbs/month				
fluoranthene	206440	140	annual					75.6	5600					5.97E-05	0.04358	lbs/month				
formaldehyde	50000	30	24 hr			0.08		1.5	3.6			0.0432	3.2	1.081062	25.9455	lbs/24-hr			789.175	lbs/month
Indeno(1,2,3-cd)pyrene	193395						5							6.1E-06						
methanol	67561	20000	24 hr	28000	1 hr			1000	2400	28	28			0.051182	1.22837	lbs/24-hr	0.051182	lbs/hr		
methylcyclohexane	108872	16000	8 hr					320	320					0.025182	0.20145	lbs/8-hr				
methylene chloride	75092	2000	annual	14000	1 hr	60	13	1080	80000	14	14	32.4	2400	0.000409	0.2989	lbs/month	0.000409	lbs/hr	0.2989	lbs/month
naphthalene	91203	3	annual	520	8 hr	0.08		1.62	120	10.4	10.4	0.0432	3.2	0.001913	1.39617	lbs/month	0.015301	lbs/8-h	1.39617	lbs/month
n-hexane	110543	700	annual					378	28000					0.022725	16.5891	lbs/month				
n-nonane	111842	550	annual					297	22000					0.002252	1.64397	lbs/month				
pentane	109660	17700	8 hr					354	354					0.053229	0.42584	lbs/8-hr				
PAH (benzo(a)pyrene)	50328	0.002	24 hr			0.001	5	0.0001	0.0002			0.0005	0.04	1.41E-05	0.00034	lbs/24-hr			0.01029	lbs/month
phenanthrene	85018	0.1	annual					0.054	4					0.0006	0.43835	lbs/month				
phenol	108952	190	8 hr					3.8	3.8					0.000491	0.00393	lbs/8-hr				
propylene	115071	8600	8 hr					172	172					0.041108	0.32887	lbs/8-hr				
pyrene	129000	100	annual					54	4000					5.48E-05	0.03998	lbs/month				
styrene	100425	1000	annual			2		540	40000			1.08	80	0.000483	0.35271	lbs/month			0.35271	lbs/month
1,1,2,2-tetrachloroethane	79345					0.02						0.0108	0.8	5.08E-05					0.03706	lbs/month
toluene	108883	5000	24 hr					250	600					0.008386	0.20127	lbs/24-hr				
vinyl chloride	75014	100	annual			0.11		54	4000			0.0594	4.4	0.000305	0.22268	lbs/month			0.22268	lbs/month
mixed xylenes	1330207	390	annual				2	210.6	15600					0.00379	2.76683	lbs/month				
methyl amyl alcohol	108112	1000	8 hr					20	20					0.000697	0.00557	lbs/8-hr				
n-dodecyl mercaptan	112-55-0	8	8 hr					0.16	0.16					0.003665	0.02932	lbs/8-hr				

Chemical Name	Is Proposed Emission Rate less than AER?: 1st ITSL Max Hourly Rate	1st ITSL ER	2nd ITSL Max Hourly Rate	2nd ITSL ER	IRSL Max Hourly Rate	IRSL ER		% of AER (Turn values red if they are greater than: 100%): 1st ITSL Max Hourly Rate	1st ITSL ER	2nd ITSL Max Hourly Rate	2nd ITSL ER	IRSL Max Hourly Rate	IRSL ER
1,1,2,2-tetrachloroethane					yes	yes						7.6%	74.7%
1,1,2-trichloroethane	yes	yes	yes	yes	yes	yes		0.0%	0.1%	0.0%	0.1%	1.9%	18.9%
1,1-dichloroethane	yes	yes						0.0%	0.0%				
1,2,3-trimethylbenzene	yes	yes	yes	yes				0.0%	0.0%	0.0%	0.0%		
1,2,4-trimethylbenzene	yes	yes	yes	yes				0.0%	0.0%	0.0%	0.0%		
1,2-dichloroethane					yes	yes						2.2%	22.0%
propylene dichloride	yes	yes			yes	yes		0.0%	0.3%			0.5%	5.0%
1,3,5-trimethyl benzene	yes	yes	yes	yes				0.0%	0.0%	0.0%	0.0%		
1,3-butadiene	yes	yes			yes	no	model	0.0%	0.3%			33.7%	332.5%
1,3-dichloropropene	yes	yes			yes	yes		0.0%	0.0%			0.5%	4.9%
2-methylnaphthalene	yes	yes						0.0%	0.1%				
2,2,4-Trimethyl Pentane	yes	yes						0.0%	0.1%				
anthracene	yes	yes						0.0%	0.0%				
acenaphthene	yes	yes						0.0%	0.0%				
acenaphthylene	yes	yes						0.0%	0.0%				
acetaldehyde	yes	yes			yes	no	model	3.5%	34.7%			63.4%	624.9%
acrolein	yes	no	no	no			model	48.7%	480.1%	2104.8%	2104.8%		
benzene	yes	yes	yes	yes	yes	no	model	0.1%	0.7%	0.8%	7.6%	21.2%	209.0%
benz(a)anthracene													
benzo(a)pyrene	yes	yes			yes	yes		9.2%	92.3%			1.7%	16.8%
Benzo(b)fluoranthene													
Benzo(k)fluoranthene													
benzo(g,h,i)perylene	yes	yes						0.0%	0.0%				
biphenyl	yes	yes			yes	yes		1.7%	13.4%			1.9%	18.4%
butane	yes	yes						0.0%	0.0%				
isobutyraldehyde	yes	yes						0.0%	0.0%				
carbon tetrachloride	yes	yes			yes	yes		0.0%	0.0%			0.8%	8.1%
chlorobenzene	yes	yes	yes	yes				0.0%	0.0%	0.0%	0.0%		
ethyl chloride	yes	yes						0.0%	0.0%				
chloroform					yes	yes						0.3%	2.7%
chrysene													
cyclopentane	yes	yes						0.0%	0.0%				
dibenz(a,h)anthracene													
ethylbenzene	yes	yes			yes	yes		0.0%	0.0%			0.4%	3.7%
1,2-dibromoethane	yes	yes			yes	no	model	0.0%	0.2%			84.0%	827.6%
fluorene	yes	yes						0.0%	0.0%				
fluoranthene	yes	yes						0.0%	0.0%				
formaldehyde	yes	no			no	no	model	72.1%	720.7%			2502.5%	24661.7%
Indeno(1,2,3-cd)pyrene													
methanol	yes	yes	yes	yes				0.0%	0.1%	0.2%	0.2%		
methylcyclohexane	yes	yes						0.0%	0.1%				
methylene chloride	yes	yes	yes	yes	yes	yes		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
naphthalene	yes	yes	yes	yes	yes	yes		0.1%	1.2%	0.0%	0.1%	4.4%	43.6%
n-hexane	yes	yes						0.0%	0.1%				
n-nonane	yes	yes						0.0%	0.0%				
pentane	yes	yes						0.0%	0.1%				
PAH (benzo(a)pyrene)	yes	no			yes	yes	model	14.1%	140.9%			2.6%	25.7%
phenanthrene	yes	yes						1.1%	11.0%				
phenol	yes	yes						0.0%	0.1%				
propylene	yes	yes						0.0%	0.2%				
pyrene	yes	yes						0.0%	0.0%				
styrene	yes	yes			yes	yes		0.0%	0.0%			0.0%	0.4%
1,1,2,2-tetrachloroethane					yes	yes						0.5%	4.6%
toluene	yes	yes						0.0%	0.0%				
vinyl chloride	yes	yes			yes	yes		0.0%	0.0%			0.5%	5.1%
mixed xylenes	yes	yes						0.0%	0.0%				
methyl amyl alcohol	yes	yes						0.0%	0.0%				
n-dodecyl mercaptan	yes	yes						2.3%	18.3%				

yellow columns = must enter information
methyl amyl alcohol is MIBC.
Links:
[Toxics Screening Level Query Footnotes]
[Procedure for the Carcinogenic PAHs of Footnote No. 5 - See PAHs worksheet]

Potency Factors for TACs with AQD Footnote 5.

Table 1. PAH Potency Equivalency Factors (PEFs)

CHEMICAL NAME	CAS NO.	PEF	Emission Rate (lb/hr)
Dibenz(a,h)anthracene	53-70-3	1.1	2.64E-06
3-Methylcholanthrene	56-49-5	5.7	
7,12-Dimethylbenz(a)anthracene	57-97-6	65	
Chrysene	218-01-9	0.01	1.13E-05
Indeno(1,2,3-cd)pyrene	193-39-5	0.1	3.15E-06
Benzo(a)anthracene	56-55-3	0.1	4.78E-06
Benzo(b)fluoranthene	205-99-2	0.1	8.23E-06
Benzo(k)fluoranthene	207-08-9	0.1	1.70E-06
Benzo(j)fluoranthene	205-82-3	0.1	
5-Methylchrysene	3697-24-3	1	
Benzo(a)pyrene	50-32-8	1	9.29E-06
Dibenzo(a,e)pyrene	192-65-4	1	
Dibenzo(a,h)pyrene	189-64-0	10	
Dibenzo(a,i)pyrene	189-55-9	10	
Dibenzo(a,l)pyrene	191-30-0	10	
Equivalent Emission Rate of benzo(a)pyrene (lb/hr)			1.41E-05

yellow columns = must enter information

Instructions: In the table for Rule 227(1)(a) enter in CAS Numbers and emission rates for each PAH that is emitted. The table above will calculate the "equivalent emission rate of benzo(a)pyrene." Next, you need to compare this to the IRSL (or SRSL) for benzo(a)pyrene.

In the table for Rule 227(1)(a), (b), or (c), enter the CAS No. for benzo(a)pyrene (50-32-8) into Column B, **and change the Chemical Name in Column A from "benzo(a)pyrene" to "PAHs as benzo(a)pyrene."** Changing the name will prevent the table above from double-counting the benzo(a)pyrene emissions. Then enter the equivalent emission rate of benzo(a)pyrene into the appropriate column.

Additionally, in the table for Rule 227(1)(a),(b), or (c), **remove the entries for the ITSL in Column D**

Client:	Copperwood Resources, Inc.	Project ID:	0023H001.00
Project:	Air Permit Application Emissions Calculations		
Prepared by:	MMD	Date:	05/10/23
Checked by:	AKM	Date:	08/17/23

Version e-GGRT RY2013.R.01
Date: 7/4/2023

Equation C-1:

$$CO_2 = 1x10^{-3} * Fuel * HHV * EF$$

$$CH_4 \; or \; N_2O = 1 \; x \; 10^{-3} * Fuel * HHV * EF$$

Facility Name:	Copperwood Resources, Inc.
Reporter Name:	
Unit or Group Name/ ID:	EUGENERATOR - SV-004
Configuration Type:	
Fuel/ Fuel Type:	Distillate Fuel Oil No. 2 (Diesel)
Reporting Period:	NA - PTE Calculations
Comments:	Source data should be consistent with Emergency Generators sheet.
Unit Type:	General Stationary Fuel Combustion

Fuel Input Data

[Fuel] = Mass or volume of fuel combusted per year, from company records as defined in §98.6 (express mass in short tons for solid fuel, volume in standard cubic feet for gaseous fuel, and volume in gallons for liquid fuel)	826,944.	Gallons Distillate Fuel Oil No. 2 (Diesel) based on 2 generators at a combined 94.4gallons/hour fuel usage at peak capacity and 8760 hours/year maximum operation.
[HHV] = Default High heat value of the fuel, from Table C-1 (mmBtu/mass or mmBtu/volume)	0.138	

Constants

[1 x 10^{-3}] = Conversion Factor from kg to metric tons (constant)	0.001

Annual CO_2 Mass Emissions For the Specific Fuel Type (metric tons) from Equation C-1

Emission Factor, from Table C-1 (kg CO_2/mmBtu)	73.96
combustion of the specified fuel (metric tons)	**8440**

Enter this value in e-GGRT

Annual CH_4 Mass Emissions For the Specific Fuel Type (metric tons) from Equation C-8

[EF] = Fuel-Specific Default Emission Factor for CH_4, from Table C-2 (kg CH_4/mmBtu)	0.003
combustion of the specified fuel (metric tons)	**0.34**

VMT conct truck =

Enter this value in e-GGRT

Annual N_2O Mass Emissions For the Specific Fuel Type (metric tons) from Equation C-8

[EF] = Fuel-Specific Default Emission Factor for N_2O, from Table C-2 (kg N_2O/mmBtu)	0.0006
combustion of the specified fuel (metric tons)	**0.068**

Enter this value in e-GGRT

INFORMATION ONLY: Annual CH_4 Mass Emissions For the Specific Fuel Type Converted to Carbon Dioxide Equivalent (metric tons CO_2e)

[GWP_{CH4}] = Global Warming Potential for CH_4	25
[CH_4] = Annual CH_4 emissions from combustion of the specified fuel (metric tons CO_2e)	8.56

INFORMATION ONLY: Annual N_2O Mass Emissions For the Specific Fuel Type Converted to Carbon Dioxide Equivalent (metric tons CO_2e)

[GWP_{N2O}] = Global Warming Potential for N_2O	298
[N_2O] = Annual N_2O emissions from combustion of the specified fuel (metric tons CO_2e)	20.40

Total CO2e emissions	EUCONGENERATORS	8469	metric tons CO2e
		9316	**short tons CO2e**

Version e-GGRT RY2013.R.01
Date: 7/4/2023

Equation C-1:

$$CO_2 = 1x10^{-3} * Fuel * HHV * EF$$

$$CH_4 \; or \; N_2O = 1 \; x \; 10^{-3} * Fuel * HHV * EF$$

Facility Name:	Copperwood Resources, Inc.
Reporter Name:	
Unit or Group Name/ ID:	EUNGGENERATORS - SV-005 - SV-006
Configuration Type:	
Fuel/ Fuel Type:	Natural Gas
Reporting Period:	NA - PTE Calculations
Comments:	Source data should be consistent with Emergency Generators sheet.
Unit Type:	General Stationary Fuel Combustion

Fuel Input Data

[Fuel] = Mass or volume of fuel combusted per year, from company records as defined in §98.6 (express mass in short tons for solid fuel, volume in standard cubic feet for gaseous fuel, and volume in gallons for liquid fuel)	316,516,320.	single generator fuel consmption =9268 btu/ekW-hr, gen set rating=2000 kW generator, HHV Nat. Gas= 1026 Btu/scf, nat gas used 18,066 scf/hr per generator
[HHV] = Default High heat value of the fuel, from Table C-1 (mmBtu/mass or mmBtu/volume)	0.001026	

Constants

[1 x 10^{-3}] = Conversion Factor from kg to metric tons (constant)	0.001

Annual CO_2 Mass Emissions For the Specific Fuel Type (metric tons) from Equation C-1

Emission Factor, from Table C-1 (kg CO_2/mmBtu)	73.96
combustion of the specified fuel (metric tons)	**24018**

Enter this value in e-GGRT

Annual CH_4 Mass Emissions For the Specific Fuel Type (metric tons) from Equation C-8

[EF] = Fuel-Specific Default Emission Factor for CH_4, from Table C-2 (kg CH_4/mmBtu)	0.003
combustion of the specified fuel (metric tons)	**0.97**

VMT conct truck =

Enter this value in e-GGRT

Annual N_2O Mass Emissions For the Specific Fuel Type (metric tons) from Equation C-8

[EF] = Fuel-Specific Default Emission Factor for N_2O, from Table C-2 (kg N_2O/mmBtu)	0.0006
combustion of the specified fuel (metric tons)	**0.195**

Enter this value in e-GGRT

INFORMATION ONLY: Annual CH_4 Mass Emissions For the Specific Fuel Type Converted to Carbon Dioxide Equivalent (metric tons CO_2e)

[GWP_{CH4}] = Global Warming Potential for CH_4	25
[CH_4] = Annual CH_4 emissions from combustion of the specified fuel (metric tons CO_2e)	24.36

INFORMATION ONLY: Annual N_2O Mass Emissions For the Specific Fuel Type Converted to Carbon Dioxide Equivalent (metric tons CO_2e)

[GWP_{N2O}] = Global Warming Potential for N_2O	298
[N_2O] = Annual N_2O emissions from combustion of the specified fuel (metric tons CO_2e)	58.06

Total CO2e emissions	EUGENERATORS	24101	metric tons CO2e
		26511	**short tons CO2e**

Client:	Copperwood Resources, Inc.	Project ID.:	0023H001.00
Project:	Air Permit Application Emissions Calculations		
Prepared by:	MMD	Date:	05/10/23
Checked by:	AKM	Date:	08/17/23

Version e-GGRT RY2013.R.01
Date: 3/19/2018

Equation C-1:

$$CO_2 = 1x\,10^{-3} * Fuel * HHV * EF$$

$$CH_4 \ or \ N_2O = 1 \ x \ 10^{-3} * Fuel * HHV * EF$$

Facility Name:	Copperwood Resources, Inc.
Reporter Name:	
Unit or Group Name/ ID:	EUEMERGENERATOR - SV-007
Configuration Type:	
Fuel/ Fuel Type:	Natural Gas
Reporting Period:	NA - PTE Calculations
Comments:	Source data should be consistent with Emergency Generator sheet.
Unit Type:	General Stationary Fuel Combustion

Fuel Input Data

[Fuel] = Mass or volume of fuel combusted per year, from company records as defined in §98.6 (express mass in short tons for solid fuel, volume in standard cubic feet for gaseous fuel, and volume in gallons for liquid fuel)	9,033,000.	single generator fuel consmption =9268 btu/ekW-hr, gen set rating=2000 kW generator, HHV Nat. Gas= 1026 Btu/scf, nat gas used 18,066 scf/hr per generator
[HHV] = Default High heat value of the fuel, from Table C-1 (mmBtu/mass or mmBtu/volume)	0.001026	

Constants

[1 x 10^{-3}] = Conversion Factor from kg to metric tons (constant)	0.001

Annual CO_2 Mass Emissions For the Specific Fuel Type (metric tons) from Equation C-1

Emission Factor, from Table C-1 (kg CO_2/mmBtu)	73.96
combustion of the specified fuel (metric tons)	**685**

Enter this value in e-GGRT

Annual CH_4 Mass Emissions For the Specific Fuel Type (metric tons) from Equation C-8

[EF] = Fuel-Specific Default Emission Factor for CH_4, from Table C-2 (kg CH_4/mmBtu)	0.003
combustion of the specified fuel (metric tons)	**0.03**

VMT conct truck =

Enter this value in e-GGRT

Annual N_2O Mass Emissions For the Specific Fuel Type (metric tons) from Equation C-8

[EF] = Fuel-Specific Default Emission Factor for N_2O, from Table C-2 (kg N_2O/mmBtu)	0.0006
combustion of the specified fuel (metric tons)	**0.006**

Enter this value in e-GGRT

INFORMATION ONLY: Annual CH_4 Mass Emissions For the Specific Fuel Type Converted to Carbon Dioxide Equivalent (metric tons CO_2e)

[GWP_{CH4}] = Global Warming Potential for CH_4	25
[CH_4] = Annual CH_4 emissions from combustion of the specified fuel (metric tons CO_2e)	0.70

INFORMATION ONLY: Annual N_2O Mass Emissions For the Specific Fuel Type Converted to Carbon Dioxide Equivalent (metric tons CO_2e)

[GWP_{N2O}] = Global Warming Potential for N_2O	298
[N_2O] = Annual N_2O emissions from combustion of the specified fuel (metric tons CO_2e)	1.66

Total CO2e emissions	EUGENERATORS	688 metric tons CO2e
		757 short tons CO2e

Client:	Copperwood Resources, Inc.	Project ID.:	0023H001.00
Project:	Air Permit Application Emissions Calculations		
Prepared by:	MMD	Date:	05/10/23
Checked by:	AKM	Date:	08/17/23

Version e-GGRT RY2013.R.01
Date: 3/19/2018

Equation C-1:

$$CO_2 = 1x\,10^{-3} * Fuel * HHV * EF$$

$$CH_4 \; or \; N_2O = 1 \; x \; 10^{-3} * Fuel * HHV * EF$$

Facility Name:	Copperwood Resources, Inc.
Reporter Name:	
Unit or Group Name/ ID:	EUFIREPUMP SV-008
Configuration Type:	
Fuel/ Fuel Type:	Distillate Fuel Oil No. 2 (Diesel)
Reporting Period:	NA - PTE Calculations
Comments:	Source data should be consistent with spec sheet. Clarke Fire Protection Products, Inc. fire pump driver Model JU6H-UFADX8 (250HP @1750rpm)
Unit Type:	General Stationary Fuel Combustion

Fuel Input Data

[Fuel] = Mass or volume of fuel combusted per year, from company records as defined in §98.6 (express mass in short tons for solid fuel, volume in standard cubic feet for gaseous fuel, and volume in gallons for liquid fuel)	5,200.	Gallons Distillate Fuel Oil No. 2 (Diesel) at 10.4 gallons/hour fuel usage at peak capacity and 500 hours/year maximum operation.
[HHV] = Default High heat value of the fuel, from Table C-1 (mmBtu/mass or mmBtu/volume)	0.138	

Constants

[1 x 10^{-3}] = Conversion Factor from kg to metric tons (constant)	0.001

Annual CO_2 Mass Emissions For the Specific Fuel Type (metric tons) from Equation C-1

Emission Factor, from Table C-1 (kg CO_2/mmBtu)	73.96
combustion of the specified fuel (metric tons)	**53**

Enter this value in e-GGRT

Annual CH_4 Mass Emissions For the Specific Fuel Type (metric tons) from Equation C-8

[EF] = Fuel-Specific Default Emission Factor for CH_4, from Table C-2 (kg CH_4/mmBtu)	0.003
combustion of the specified fuel (metric tons)	**0.00**

VMT conct truck =

Enter this value in e-GGRT

Annual N_2O Mass Emissions For the Specific Fuel Type (metric tons) from Equation C-8

[EF] = Fuel-Specific Default Emission Factor for N_2O, from Table C-2 (kg N_2O/mmBtu)	0.0006
combustion of the specified fuel (metric tons)	**0.000**

Enter this value in e-GGRT

INFORMATION ONLY: Annual CH_4 Mass Emissions For the Specific Fuel Type Converted to Carbon Dioxide Equivalent (metric tons CO_2e)

[GWP_{CH4}] = Global Warming Potential for CH_4	25
[CH_4] = Annual CH_4 emissions from combustion of the specified fuel (metric tons CO_2e)	0.05

INFORMATION ONLY: Annual N_2O Mass Emissions For the Specific Fuel Type Converted to Carbon Dioxide Equivalent (metric tons CO_2e)

[GWP_{N2O}] = Global Warming Potential for N_2O	298
[N_2O] = Annual N_2O emissions from combustion of the specified fuel (metric tons CO_2e)	0.13

Total CO2e emissions	EUGENERATORS	53	metric tons CO2e
		59	**short tons CO2e**

Client: Copperwood Resources, Inc.	Project ID.: 0023H001.00
Project: Air Permit Application Emissions Calculations	
Prepared by: MMD	Date: 05/10/23
Checked by: AKM	Date: 08/17/23

Blasting will be conducted using an emulsion. To account for greenhouse gases, ANFO will be used as a surrogate.

	EUFUGITIVES-blast
Version	e-GGRT RY2013.R.01
Today's date	8/18/2023

Pounds ANFO (emulsion) used per year: 5,405,796

Equation C-1:

$$CO_2 = 1x\,10^{-3} * Fuel * HHV * EF$$

$$CH_4 \; or \; N_2O = 1 \; x \; 10^{-3} * Fuel * HHV * EF$$

Facility Name:	Copperwood Resources, Inc.
Reporter Name:	
Unit or Group Name/ ID:	EUFUGITIVES-blast
Configuration Type:	
Fuel/ Fuel Type:	Distillate Fuel Oil No. 2 (Diesel) - 6% of ANFO/emulsion
Reporting Period:	NA - PTE Calculations
Comments:	Source data should be consistent with Underground sheet.
Unit Type:	General Stationary Fuel Combustion

Fuel Input Data

[Fuel] = Mass or volume of fuel combusted per year, from company records as defined in §98.6 (express mass in short tons for solid fuel, volume in standard cubic feet for gaseous fuel, and volume in gallons for liquid fuel)	46,335	Gallons Distillate Fuel Oil No. 2 (Diesel) based on estimated annual ANFO usage at 6% Distillate Fuel Oil No. 2 and 7 pounds/gallon
[HHV] = Default High heat value of the fuel, from Table C-1 (mmBtu/mass or mmBtu/volume)	0.138	

Constants

[1 x 10^{-3}] = Conversion Factor from kg to metric tons (constant)	0.001

Annual CO_2 Mass Emissions For the Specific Fuel Type (metric tons) from Equation C-1

[EF] = Fuel-Specific Default CO_2 Emission Factor, from Table C-1 (kg CO_2/mmBtu)	73.96
combustion of the specified fuel (metric tons)	**473**

Enter this value in e-GGRT

Annual CH_4 Mass Emissions For the Specific Fuel Type (metric tons) from Equation C-8

[EF] = Fuel-Specific Default Emission Factor for CH_4, from Table C-2 (kg CH_4/mmBtu)	0.003
combustion of the specified fuel (metric tons)	**0.019**

VMT conct truck =

Enter this value in e-GGRT

Annual N_2O Mass Emissions For the Specific Fuel Type (metric tons) from Equation C-8

[EF] = Fuel-Specific Default Emission Factor for N_2O, from Table C-2 (kg N_2O/mmBtu)	0.0006
combustion of the specified fuel (metric tons)	**0.004**

Enter this value in e-GGRT

INFORMATION ONLY: Annual CH_4 Mass Emissions For the Specific Fuel Type Converted to Carbon Dioxide Equivalent (metric tons CO_2e)

[GWP_{CH4}] = Global Warming Potential for CH_4	25
[CH_4] = Annual CH_4 emissions from combustion of the specified fuel (metric tons CO_2e)	0.48

INFORMATION ONLY: Annual N_2O Mass Emissions For the Specific Fuel Type Converted to Carbon Dioxide Equivalent (metric tons CO_2e)

[GWP_{N2O}] = Global Warming Potential for N_2O	298
[N_2O] = Annual N_2O emissions from combustion of the specified fuel (metric tons CO_2e)	1.1

Total CO2e emissions	EUFUGITIVES-blast	475 metric tons CO2e
		522 short tons CO2e

Client: Copperwood Resources, Inc.		Project ID.:	0023H001.00
Project: Air Permit Application Emissions Calculations			
Prepared by: MMD		Date:	05/10/23
Checked by: AKM		Date:	08/17/23

Mine Heaters - SV-001, SV-002, SV-003
Version e-GGRT RY2013.R.01
Date: 7/4/2023

Equation C-1: $CO_2 = 1x\,10^{-3} * Fuel * HHV * EF$

$CH_4\ or\ N_2O = 1\ x\ 10^{-3} * Fuel * HHV * EF$

Facility Name:	Copperwood Resources, Inc.
Reporter Name:	
Unit or Group Name/ ID:	Mine Heaters - SV-001, SV-002, SV-003
Configuration Type:	
Fuel/ Fuel Type:	Propane Combustion
Reporting Period:	NA - PTE Calculations
Comments:	Source data should be consistent with Mine Heaters sheet.
Unit Type:	General Stationary Fuel Combustion

Fuel Input Data

[Fuel] = Mass or volume of fuel combusted per year, from company records as defined in §98.6 (express mass in short tons for solid fuel, volume in standard cubic feet for gaseous fuel, and volume in gallons for liquid fuel)	2,360,656	gallons per year propane based on permitted 4000 hours per year operation.
[HHV] = Default High heat value of the fuel, from Table C-1 (mmBtu/mass or mmBtu/volume)	0.092	

Constants

[1 x 10^{-3}] = Conversion Factor from kg to metric tons (constant)	0.001

Annual CO_2 Mass Emissions For the Specific Fuel Type (metric tons) from Equation C-1

[EF] = Fuel-Specific Default CO_2 Emission Factor, from Table C-1 (kg CO_2/mmBtu)	53.06
combustion of the specified fuel (metric tons)	**11524**

Enter this value in e-GGRT

Annual CH_4 Mass Emissions For the Specific Fuel Type (metric tons) from Equation C-8

[EF] = Fuel-Specific Default Emission Factor for CH_4, from Table C-2 (kg CH_4/mmBtu)	0.001
combustion of the specified fuel (metric tons)	**0.22**

VMT conct truck =

Enter this value in e-GGRT

Annual N_2O Mass Emissions For the Specific Fuel Type (metric tons) from Equation C-8

[EF] = Fuel-Specific Default Emission Factor for N_2O, from Table C-2 (kg N_2O/mmBtu)	0.0001
combustion of the specified fuel (metric tons)	**0.022**

Enter this value in e-GGRT

INFORMATION ONLY: Annual CH_4 Mass Emissions For the Specific Fuel Type Converted to Carbon Dioxide Equivalent (metric tons CO_2e)

[GWP_{CH4}] = Global Warming Potential for CH_4	25
[CH_4] = Annual CH_4 emissions from combustion of the specified fuel (metric tons CO_2e)	5.43

INFORMATION ONLY: Annual N_2O Mass Emissions For the Specific Fuel Type Converted to Carbon Dioxide Equivalent (metric tons CO_2e)

[GWP_{N2O}] = Global Warming Potential for N_2O	298
[N_2O] = Annual N_2O emissions from combustion of the specified fuel (metric tons CO_2e)	6.47

Total CO2e emissions	Mine Heaters	11535	metric tons CO2e
		12689	**short tons CO2e**

Table C-1 to Subpart C - Default CO_2 Emission Factors and High Heat Values for Various Types of Fuel

Fuel Type	Default High Heat Value	Default CO_2 Emission Factor
Coal and Coke	**mmBtu/short ton**	**kg CO_2 /mmBtu**
Anthracite	25.09	103.69
Bituminous	24.93	93.28
Subbituminous	17.25	97.17
Lignite	14.21	97.72
Coal Coke	24.80	113.67
Mixed (Commercial sector)	21.39	94.27
Mixed (Industrial coking)	26.28	93.90
Mixed (Industrial sector)	22.35	94.67
Mixed (Electric Power sector)	19.73	95.52
Natural Gas	**mmBtu/scf**	**kg CO_2 /mmBtu**
(Weighted U.S. Average)	1.026E-03	53.06
Petroleum Products	**mmBtu/gallon**	**kg CO_2 /mmBtu**
Distillate Fuel Oil No. 1	0.139	73.25
Distillate Fuel Oil No. 2	0.138	73.96
Distillate Fuel Oil No. 4	0.146	75.04
Residual Fuel Oil No. 5	0.140	72.93
Residual Fuel Oil No. 6	0.150	75.10
Used Oil	0.138	74.00
Kerosene	0.135	75.20
Liquefied petroleum gases (LPG)[1]	0.092	61.71
Propane[1]	0.091	62.87
Propylene[1]	0.091	67.77
Ethane[1]	0.068	59.60
Ethanol	0.084	68.44
Ethylene[2]	0.058	65.96
Isobutane[1]	0.099	64.94
Isobutylene[1]	0.103	68.86
Butane[1]	0.103	64.77
Butylene[1]	0.105	68.72
Naphtha (<401 deg F)	0.125	68.02
Natural Gasoline	0.110	66.88
Other Oil (>401 deg F)	0.139	76.22
Pentanes Plus	0.110	70.02
Petrochemical Feedstocks	0.125	71.02
Petroleum Coke	0.143	102.41
Special Naphtha	0.125	72.34
Unfinished Oils	0.139	74.54
Heavy Gas Oils	0.148	74.92
Lubricants	0.144	74.27
Motor Gasoline	0.125	70.22
Aviation Gasoline	0.120	69.25
Kerosene-Type Jet Fuel	0.135	72.22
Asphalt and Road Oil	0.158	75.36
Crude Oil	0.138	74.54
Other Fuels (Solid)	**mmBtu/short ton**	**kg CO_2 /mmBtu**
Municipal Solid Waste	9.95 [3]	90.70
Tires	28.00	85.97
Plastics	38.00	75.00
Petroleum Coke	30.00	102.41
Other Fuels (Gaseous)	**mmBtu/scf**	**kg CO_2 /mmBtu**
Blast Furnace Gas	9.20E-05	274.32
Coke Oven Gas	5.99E-04	46.85
Propane Gas	2.52E-03	61.46

Table C-1 to Subpart C - Default CO_2 Emission Factors and High Heat Values for Various Types of Fuel

Fuel Type	Default High Heat Value	Default CO_2 Emission Factor
Fuel Gas [4]	1.39E-03	59.00
Biomass Fuels - Solid	**mmBtu/short ton**	**kg CO_2 /mmBtu**
Wood and Wood Residuals (dry [5]	17.48	93.80
Agricultural Byproducts	8.25	118.17
Peat	8.00	111.84
Solid Byproducts	10.39	105.51
Biomass Fuels - Gaseous	**mmBtu/scf**	**kg CO_2 /mmBtu**
Landfill Gas	4.85E-04	52.07
Other Biomass Gases	6.55E-04	52.07
Biomass Fuels - Liquid	**mmBtu/gallon**	**kg CO_2 /mmBtu**
Ethanol	0.084	68.44
Biodiesel	0.128	73.84
Rendered Animal Fat	0.125	71.06
Vegetable Oil	0.120	81.55

[1] The HHV for components of LPG determined at 60ºF and saturation pressure with the exception of ethylene.

[2] Ethylene HHV determined at 41ºF (5ºC) and saturation pressure.

3 Use of this default HHV is allowed only for: (a) units that combust MSW, do not generate steam, and are allowed to use Tier 1; (b) units that derive no more than 10 percent of their annual heat input from MSW and/or tires; and (c) small batch incinerators that combust no more than 1,000 tons of MSW per year.

4 Reporters subject to subpart X of this part that are complying with §98.243(d) or subpart Y of this part may only use the default HHV and the default CO_2 emission factor for fuel gas combustion under the conditions prescribed in §98.243(d)(2)(i) and (d)(2)(ii) and §98.252(a)(1) and (a)(2), respectively. Otherwise, reporters subject to subpart X or subpart Y shall use either Tier 3 (Equation C–5) or Tier 4.

[5] Use the following formula to calculate a wet basis HHV for use in Equation C-1: HHVw=((100-M)/100)*HHVd where HHVw = wet basis HHV, M = moisture content(percent) and HHVd=dry basis HHV from Table C-1.

Table C-2 to Subpart C - Default CH_4 and N_2O Emission Factors for Various Types of Fuel

Fuel Type	Default CH_4 Emission Factor (kg CH_4/mmBtu)	Default N_2O Emission Factor (kg N_2O/mmBtu)
Coal and Coke (All fuel types in Table C-1	1.1E-02	1.6E-03
Natural Gas	1.0E-03	1.0E-04
Petroleum (All fuel types in Table C-1)	3.0E-03	6.0E-04
Fuel Gas	3.0E-03	6.0E-04
Municipal Solid Waste	3.2E-02	4.2E-03
Tires	3.2E-02	4.2E-03
Blast Furnace Gas	2.2E-05	1.0E-04
Coke Oven Gas	4.8E-04	1.0E-04
Biomass Fuels - Solid (All fuel types in Table C-1, except wood and wood residuals)	3.2E-02	4.2E-03
Wood and wood residuals	7.2E-03	3.6E-03
Biomass Fuels - Gaseous (All fuel types in Table C-1)	3.2E-03	6.3E-04
Biomass Fuels – Liquid (All fuel types in Table C-1)	1.1E-03	1.1E-04

Note: Those employing this table are assumed to fall under the IPCC definitions of the “Energy Industry” or “Manufacturing Industries and Construction”. In all fuels except for coal the values for these two categories are identical. For coal combustion, those who fall within the IPCC “Energy Industry” category may employ a value of 1 g of CH4/mmBtu.

Appendix D

Fugitive Dust Control Plan

Fugitive Dust Control Plan

Copperwood Resources Inc.
Gogebic County, Michigan

August 2023

Project I.D.: 23H001

Solving our clients' toughest science and engineering challenges.

Fugitive Dust Control Plan

Project ID: 23H001

Prepared for

Copperwood Resources Inc.

Gogebic County, Michigan

Prepared by

Foth Infrastructure & Environment, LLC

August 2023

2121 Innovation Court • De Pere, WI 54115 • (920) 497-2500

foth.com

Fugitive Dust Control Plan

Table of Contents

Page

Figure

(Figure located after Figures tab)

Appendices

List of Abbreviations, Acronyms, and Symbols

CRI	Copperwood Resources Inc.
Foth	Foth Infrastructure & Environment, LLC
NAICS	North American Industry Classification System
Project	Copperwood Project
PTI	Permit to Install Application
SAG	Semi-Autogenous Grinding
TDF	Tailings Disposal Facility

1. Introduction

This Fugitive Dust Control Plan has been prepared by Foth Infrastructure & Environment, LLC (Foth) on behalf of Copperwood Resources Inc. (CRI) as part of the 2023 Air Permit to Install Application (PTI) for the proposed mining and ore processing operations. The Copperwood Project (Project) site is located in Ironwood and Wakefield Townships, Gogebic County, Michigan, approximately 10 miles north of Wakefield, Michigan. Figure 1-1 shows the mining area plan, including locations of potential fugitive dust sources. This plan addresses information on best management practices and controls to minimize fugitive dust from the sources at this facility.

Pursuant to R336.1371 of Part 3, Emission Limitations and Prohibitions – Particulate Matter, a Fugitive Dust Control Plan may be required for any fugitive dust source involved in processing, storing, transporting, and conveying bulk materials such as metal ores. The Project will mine and process a copper bearing ore body. The facility will operate under North American Industry Classification System (NAICS) Code 212234. The major requirements for dust control under this regulation are the following:

- A written Fugitive Dust Control Program.
- Maintenance of records consistent with activities to be implemented under the program.
- Identification of control technologies and methods that will be implemented as part of the program. Control methods must be selected for activities listed in R 336.1372.

Ore will be excavated underground through use of drill, blast, continuous mining, and mechanized room and pillar methods. Once fragmented, ore will be transported to belt conveyors for transport to the main mine conveyor. The main transfer belt conveyor will bring ore to the surface. At surface, the ore will be routed to either the Bins/Reclaim Area or the Ore Stockpile. Milling and processing will be completed in the Process Plant. The Process Plant will produce the saleable concentrate and generate a tailings slurry that will be pumped to the Tailing Disposal Facility (TDF). Haul and delivery traffic supports the operations. All roads at the facility will be unpaved.

Emissions from these operations are characterized and quantified in the air permit application. For fugitive sources, control measures will be followed to reduce dust generation during these activities. Potential sources of fugitive dust include:

- Underground mining operations.
- Outdoor material management, feed conveyors, and conveyor transfer points.
- Wind erosion from material storage:
  - Ore stockpiles
  - TDF
  - Topsoil stockpile
- Vehicle traffic.

2. Underground Mining Operations

Underground mining activities generating dust emissions include drilling, blasting, continuous mining, ore transfer, feed hoppers and rolls/rock breakers, and conveyor transfer from the ore management areas to the surface. A portion of the underground dust generated will settle, however, airborne dust will be carried out of the mine in the ventilation. The mine will be ventilated by drawing in air through a mine ventilation intake, located northwest of the mine site. Exhaust exits through three ventilation raises labeled on Figure 1-1: the Mine Vent Exhaust; West, Mine Vent Exhaust; East, and Portal Exhaust Vent. Control of fugitive dust emissions from these processes will be implemented as mine development advances into full production.

Fugitive emission controls in the underground mine will be a combination of dust suppression and prevention activity. Fresh water will be used for dust control in the active mining and haulage areas. Water sprays will be used to dampen dust generated from transfer points or activities.

Work procedures will be developed as mine construction advances to production that will address specific fugitive emission control activities required for the different mining job tasks.

3. Surface Material Storage and Handling

3.1 Outdoor Transfer Tower, Feed Conveyors and Transfer Points

Particulate fugitive emissions will be generated by movement of ore to various surface locations on the site. These fugitive emission sources include the following ore transfer emission sources:

- Ore transfer from underground mine to the surface.
- Ore transfer to the Ore Bins/Reclaim Area and Ore Stockpile.
- Ore transfer points at the Semi-Autogenous Grinding (SAG) Mill (Process Plant) prior to the material becoming a slurry.

Throughout the ore transfer systems, emissions will be controlled through use of belt conveyors with enclosures at the transfer points.

3.2 Ore Stockpile

Ore transferred to the Ore Stockpile will discharge material through an enclosed chute to the stockpile. Fugitive emissions may occur during management and handling of ore, including movement from the discharge conveyor drop point, moving ore from the stockpile into transfer hoppers using a front-end loader and due to wind erosion.

Particulate emissions will be controlled through enclosure of the discharge chute, and through work practices such as minimizing drop heights of the front-end loader bucket. In addition, the particle size distribution for material in the stockpile shows the silt content to be a low value of 2%, which should aid in minimizing particulate emissions.

3.3 Tailings Disposal Facility

The TDF footprint will cover approximately 316 acres (over the approximately 12-year life of mine). This footprint includes the tailings area and the embankments. A decant pond will cover the majority of the top tailings surface (approximately 230 acres). Of the “beach” area not covered by the pond, approximately 75% remain wet beach area and approximately 25% will become exposed dry tailings. The dry beach area has been addressed for potential fugitive dust generation.

Tailings slurry will be pumped to the TDF and distributed through a tailings distribution system. The slurry will be approximately 50% solids. Once deposited, drying will take place over time in unsubmerged areas. This material will form a crust that acts to reduce fugitive dust emissions. The formation of a crust layer in combination with deposition of the material in a wet state are anticipated to significantly reduce the fugitive dust potential. The preferred method of tailings emission control will be to keep as much of the tailings deposit submerged in the operational water pond of the impoundment as practical. During the winter months, snow cover and freezing conditions will naturally dampen dust generation. If additional dust control is necessary, either water spraying or chemical sealants may be applied to beach areas that are not moist.

3.4 Topsoil Storage Area

Any long-term topsoil storage area accumulated during site construction will have vegetative covers established to control erosion from precipitation and wind-blown fugitive dust emissions. Temporary control measures will include water or dust suppressant application until vegetation is established. Once vegetation is established, minimal fugitive dust is expected from topsoil storage. This helps maintain slope stability, structural integrity, and erosion control as well as dust emissions.

4. Unpaved Haul Roads

Haul roads at the facility will include the main access road from the front gate to the Process Plant, the explosives storage area, and the Water Truck Offload Area; and haulage roads at the Ore Stockpile. Location of the access roads and Ore Stockpile are shown on Figure 1-1. All haul roads will be unpaved.

A front-end loader will be utilized at the Ore Stockpile. A concentrate product truck will transport product along the access road within the facility from the concentrate loadout area at the Process Plant to the main gate. A haulage truck may also transport water for use in the process to the offload area on the west side of the TDF. In addition, water trucks and various other service vehicles will transport reagents and supplies to the Process Plant. Other service vehicles will include fuel and reagent transport trucks and trucks hauling emulsion products to the explosives magazine.

4.1 Dust Suppression Techniques

During drier and warmer times of the year and when freezing conditions are not occurring, the access road will be watered periodically throughout the day to maintain it in a relatively wet condition. As needed, an on-site water truck will be used to distribute water evenly across roadway segments to maintain surfaces in a moist state during traffic periods. The watering program will be in effect along the access road segments shown on Figure 1-1 (HR-02, HR-03, HR-04, and HR-05).

During winter months and colder times of the year (October to April), roadways may be under snow cover. However, it is not uncommon for “freeze-dry” conditions to occur. Freeze-drying occurs when no snow cover is present, and a very thin layer becomes desiccated. In low temperatures, it is not practical to use water to prevent freeze-drying. Approved chemical dust suppressants may be applied to unpaved roadways on an as-needed basis.

In addition to watering and use of chemical dust suppressants, unpaved haul roads will be dressed with coarse aggregate materials to maintain lower silt content and the fugitive dust potential of the roadway surfaces. As roadway aggregate materials are worn down, they will be replaced with new coarse aggregate materials. The facility will also establish a speed limit of 15 miles per hour for on-site roads. This low speed will reduce the potential for dust generation from unpaved roadway surfaces.

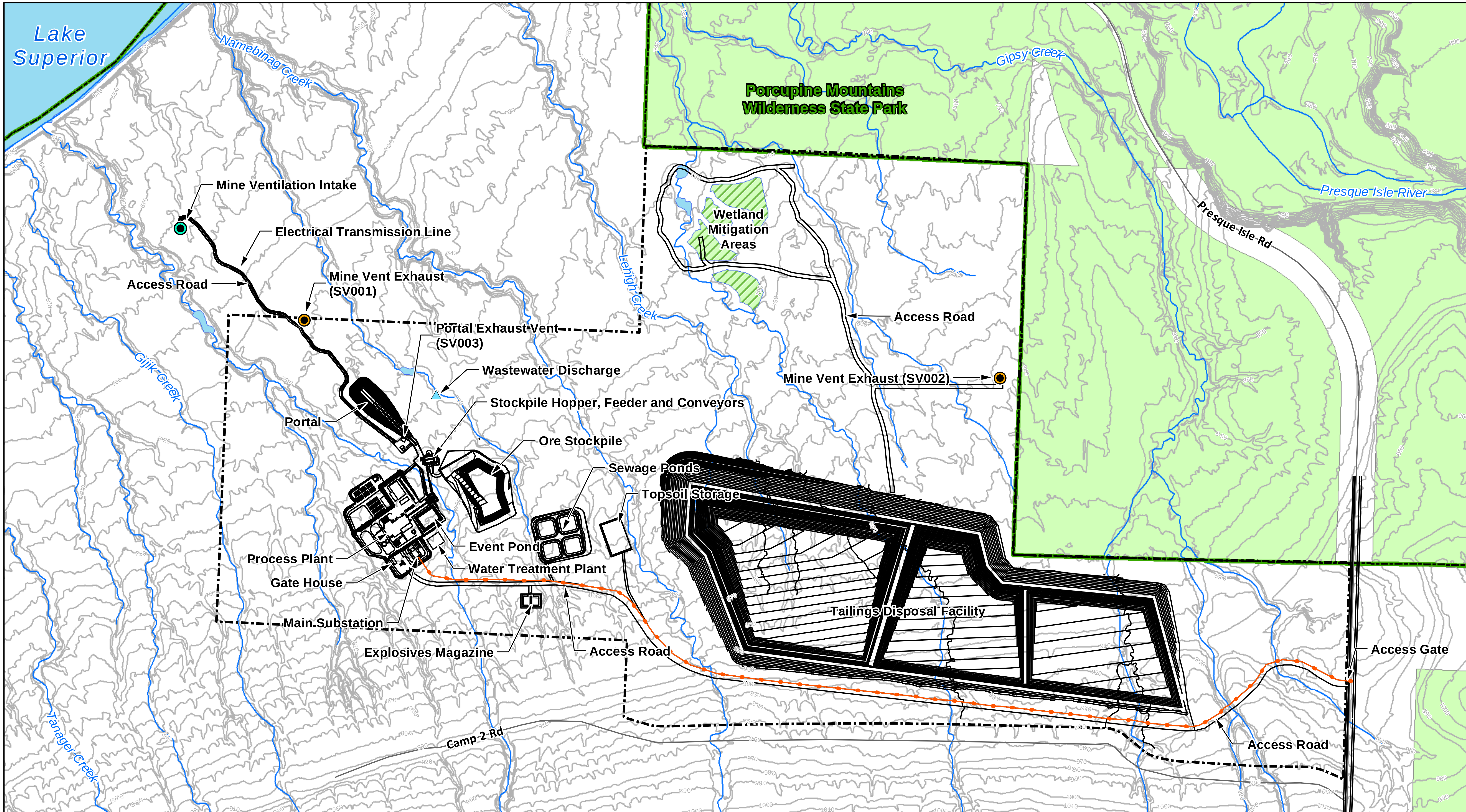
4.2 Haul Road Segments

Documentation of dust suppression activities for haul roads will be done using a form similar to the On-Site Haul Road Watering Documentation Form in Appendix A. The form will be used by field supervision to assess the effectiveness of roadway dust suppression techniques and document corrective actions. The form will be completed daily during operations. For ease in identifying potential problem areas, roadways within the facility have been assigned roadway segment identification numbers, marked on the Watering Documentation Forms. Identification numbers will be as follows:

Haul Road Segment Description	Identification Number
Main Gate to Fuel Storage, Reagent Area, Concentrate Load Out Dock	Segment 1
Access Road to Water Truck Offload Area	Segment 2
Ore Stockpile Haulage Route	Segment 3
Access Road to Explosives Magazine	Segment 4

Records of the haul road dust suppression program will be maintained over the life of the mine operations. The form or a similar-type form provided in Appendix A will be completed daily to document the status of water used for dust suppression on identified haul road segments. Information on chemical dust suppressants used can also be added to the form.

Figure



NOTES:

1. Horizontal coordinate system is NAD1983 UTM Zone 16N, units in meters.
2. Hydrographic data from the USGS.
3. Road and boundary data from Michigan GIS Open Data and the USFS.
4. Contour data generated from USGS 1-meter digital elevation model (DEM).

LEGEND

- Exhaust Raise
- Intake Raise
- Wastewater Discharge
- Mine Site Feature
- Electrical Transmission Line
- 10' Topographic Contour
- Minor Road
- River/Stream
- Lake/Pond
- Property Boundary
- Ottawa National Forest Boundary
- Porcupine Mountains Wilderness State Park

SV = Stack Vent

This drawing is neither a legally recorded map nor a survey and is not intended to be used as one. This drawing is a compilation of records, information and data used for reference purposes only.

HIGHLAND Copper Company Inc.

Foth

N

0 600 1,200 Feet

HIGHLAND COPPER

FIGURE 1-1

MINE AREA PLAN
FUGITIVE DUST CONTROL PLAN
COPPERWOOD PROJECT, GOGEBIC COUNTY, MI

Date: AUGUST 2023	Revision Date:	
Drawn By: BJW1	Checked By: AKM	Project: 23H001

Path: Q:\Highland Copper\23H001\GIS\mxd\Fugitive Dust Control Plan\Figure 1-1 Mine Area.mxd Date: 8/18/2023

Appendix A

On-Site Haul Road Watering Documentation Form

On-Site Haul Road Watering Documentation Form
Segment Haul Truck Routes

Date: ________ Name of Inspector: ________________________

1. Weather conditions: ____

2. Was watering applied to haul roads on this day? Yes ___ No ___

2. If yes, what was the watering schedule?

First Shift ______________________

Second Shift ______________________

3. What was the approximate volume of water used?

Segment 1 – Process Plant to Main Gate	Gallons	_______
Segment 2 – Access Road to Water Truck Offload Area	Gallons	_______
Segment 3 – Ore Stockpile Haulage Route	Gallons	_______
Segment 4 – Main Gate to Explosives Magazine	Gallons	_______

4. If water was not used, identify the reason:

Precipitation

____

Snow Pack or Freezing Conditions

____

No traffic during the entire period

____

5. Identify Chemical Dust Suppressants Used and Segment Numbers:

____

Comments:____

____

____

This form has a minimum of information to be documented. It may be re-formatted and enhanced in the course of operations.

Appendix E

Air Quality Impact Analysis

Report

Air Quality Impact Analysis

HIGHLAND Copper Company Inc.

Copperwood Resources Inc.
Gogebic County, Michigan

August 2023

Project I.D.: 23H001

Solving our clients' toughest science and engineering challenges.

Air Quality Impact Analysis

Project ID: 23H001

Prepared for

Copperwood Resources Inc.

Gogebic County, Michigan

Prepared by

Foth Infrastructure & Environment, LLC

August 2023

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foth.com

Air Quality Impact Analysis

Table of Contents

Page

Tables

(Tables located after Tables tab)

Table of Contents (continued)

Figures

(Figures located after Figures tab)

Appendices

List of Abbreviations, Acronyms, and Symbols

AER	Allowable Emission Rate
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
AQCR	Air Quality Control Region
ARM	Ambient Ratio Method
BACT	Best Available Control Technology
CO	carbon monoxide
CRI	Copperwood Resources Inc.
DEM	Digital Elevation Model
EGLE	Michigan Department of Environment, Great Lakes, and Energy
g/s	grams per second
$g/s\text{-}m^2$	grams per second per square meter
Foth	Foth Infrastructure & Environment, LLC
H	height
IRSL	Initial Risk Screening Level
ITSL	Initial Threshold Screening Level
L	width
lb	pound
lb/hr	pound per hour
IWD	Iron County Airport
m	meter
MDEQ	Michigan Department of Environmental Quality
NAAQS	National Ambient Air Quality Standards
NAD	North American Datum
NO_2	nitrogen dioxide
NWS	National Weather Service
PFL	profile
PM	particulate matter
$PM_{2.5}$	particulate matter 2.5 microns or less
PM_{10}	particulate matter 10 microns or less
Project	Copperwood Project
PSD	Prevention of Significant Deterioration
PTE	Potential to Emit
RfC	Reference Concentration for Chronic Inhalation Exposure
SFC	surface
SHP	Shapefile
SIL	Significant Impact Level
SO_2	sulfur dioxide
SRSL	Secondary Risk Screening Level
TAC	Toxic Air Contaminants
TDF	Tailings Disposal Facility
USEPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator

1. Introduction

This Air Quality Impact Analysis has been prepared by Foth Infrastructure & Environment, LLC (Foth) on behalf of Copperwood Resources Inc. (CRI) for the Michigan Air Use Permit - Permit to Install for mining and ore processing operations at the Copperwood Project (Project) located in Gogebic County. Permit application requirements include dispersion modeling for criteria pollutants. Additionally, estimated emissions and evaluation of pollutant impacts indicate that several toxic air contaminants (TAC) exceed screening levels established by Michigan Department of Environment, Great Lakes, and Energy (EGLE). A comprehensive emission inventory is provided in the Michigan Air Use Permit to Install Application, which is the basis of the modeling effort documented in this report. Dispersion modeling addressing both criteria pollutants and the selected TACs demonstrate compliance with Michigan and federal health standards.

CRI plans to construct the facility to mine, extract, and process a nonferrous ore body. Ore will be transported from an underground mine to a Process Plant where it will be processed through a series of size reduction steps and then directed to a flotation operation to recover the target metals. The final product, a copper-silver concentrate, will be transferred off site for refining.

This facility will be located in an attainment area for all pollutants. It will not be a major source for New Source Review; therefore it will not be subject to the Prevention of Significant Deterioration (PSD) regulations. Nonetheless, predicted emissions from the site will need to comply with the National Ambient Air Quality Standards (NAAQS), PSD increments for particulate matter 10 microns or less (PM_{10}), particulate matter 2.5 microns or less ($PM_{2.5}$), nitrogen dioxide (NO_2) and sulfur dioxide (SO_2). Class II PSD increments were used for the review.

The overall layout of the facility is shown on Figure 1-1 which shows the locations of important features of the operation, including location of mine ventilation stacks, the Ore Stockpile and Tailings Disposal Facility (TDF), and access roads. Figure 1-2 provides more detail and shows the location of stacks in the Process Plant and adjacent areas.

Criteria Pollutants

Pollutants regulated by the NAAQS and requiring inclusion in an air impact analysis are the following:

- PM_{10}
- $PM_{2.5}$
- SO_2
- NO_2
- Carbon monoxide (CO)
- Lead

Particulate matter (PM) is emitted during material handling, vehicle traffic, underground drilling, blasting, continuous mining activities, and fuel combustion. Sources of SO_2, NO_2, and CO will be from fuel combustion used for one diesel construction generator, three natural gas power generators, one emergency fire pump, use of blasting emulsions underground, and mine heaters. The natural gas generators will be operated in several services: prime power supply, supplemental power, and emergency power. All generator emissions are considered in NAAQS and PSD increment evaluation.

Toxic Air Contaminants

Besides lead (a federal criteria pollutant), certain additional Michigan TACs have been identified in various emission sources at the facility. There are two categories of TACs: metals in process materials and organic pollutants emitted during combustion of fuels. Allowable Emission Rates for all identified TACs were first screened using the method at R 2336.1227 (1) (a). Those TACs not passing screening were further evaluated for compliance through air dispersion modeling. These contaminants are included in the air impact analysis. More details on this analysis are discussed in Section 5.

Air Dispersion Modeling Protocol

Prior to conducting the air quality impact analysis, an Air Dispersion Modeling Protocol letter was sent to EGLE on April 7, 2023, for the agency's review and approval. The letter outlined Foth's approach to conducting air dispersion modeling for the Project. An e-mail from EGLE dated April 11, 2023, provided approval of the modeling protocol and also provided a couple of comments that were resolved in further communications with EGLE.

Summary of Modeling

This analysis was performed based on information provided in the *MDEQ – Air Quality Division Guidelines for Air Dispersion Modeling* (MDEQ, 2008). Air dispersion modeling included the following input parameters:

- Use of the United States Environmental Protection Agency (USEPA) American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) air dispersion model. This model was approved by the USEPA on November 9, 2005, and was adopted as the preferred model by MDEQ as of January 2006. For analyses included in this report, the latest version of the AERMOD executable Version No. 22112 was used.

- Five years of surface meteorological data from Gogebic – Iron County Airport (IWD) near Ironwood, Michigan. As available on the EGLE website, data for the years 2018 through 2022 were used in the dispersion model for all modeling iterations. The data set includes use of upper air meteorological data from Green Bay, Wisconsin. The station elevation is 375 meters (m) above sea level. Foth chose to use the U-Star meteorological data, which provides improved estimates of airborne concentrations at low wind speeds.

- A model receptor grid was placed over the site. The grid was spaced at 50 m apart and extended to approximately 2,500 m from the property line in all four directions.

- Use of the Maximum Controlled Emissions calculations as developed for the Michigan Air Use Permit - Permit to Install to estimate emissions from specific sources of emissions, including stack emissions, various fugitive sources of emissions from material handling areas, the Ore Stockpile, the TDF, buildings, and roads. Fugitive sources of emissions from the Ore Stockpile and the TDF were characterized as area sources, whereas material handling areas, buildings, and roads were depicted as volume sources for purposes of the air dispersion model.

- Exempt emission sources are addressed in the evaluation of NAAQS and PSD increments. Exempt sources include the emergency fire pump and reagent handling activities.

- Specific dimensions for structures were used, as scaled from site maps for the Project. Figure 1-1 is a general layout map that shows the footprint of the facility in relation to the surrounding area. A detailed site map is provided on Figure 1-2 and shows the location of stacks, haul roads on the property, and an ambient air boundary that will surround the entire facility.

This report describes the methodology and results used to complete this assessment of the facility maximum air emissions with regard to compliance with applicable regulations governing allowable air quality impacts.

2. Emission Sources

The ambient air quality analysis was based on the sources listed in Tables 2-1, 2-2, and 2-3. Table 2-1 includes all identified point sources (stacks), along with information on stack height, stack diameter, flow rate, stack exit gas temperature, stack orientation and obstructions and stack location in Universal Transverse Mercator (UTM) coordinates. In general, the grams per second (g/s) source emission rates used in AERMOD were based on pound per hour (lb/hr) Potential to Emit (PTE) for the emission sources. Emission rates for each pollutant are itemized in the detailed spreadsheet provided in Appendix A.

To assist with demonstration of compliance with the 1-hour NO_2 NAAQS, the emission rate for one source that will be operating intermittently (fire pump) was adjusted to provide an annualized NO_2 average hourly rate by applying the following adjustment: lb/hr (annualized) = lb/hr (PTE) * Annual Hour Limitation/8,760 hours per year. For such equipment the annual hour limitation is 500 hours per year, in accordance with a USEPA memorandum dated September 6, 1995 (USEPA, 1995).

Table 2-2 provides information on area sources included for PM modeling. Information includes the x-axis, y-axis, and total area of the source. The location of the area source in UTM coordinates is also provided with respect to the southwest corner of each area source. For area sources, the emission rate in AERMOD was expressed in units of grams per second per square meter ($g/s\text{-}m^2$).

Table 2-3 includes input information for all volume sources that were modeled, including data for initial horizontal dimension, initial vertical dimension, center for volume source location (UTM coordinates) and release height. Volume source emission rates are also expressed in terms of grams per second. Additional details for each volume source are included in Appendix A.

In addition to the sources listed in the above referenced tables, the impact analysis must consider use of significant "nearby" air pollution sources in the dispersion model. The Air Dispersion Modeling Protocol letter of April 7, 2023, assumed that significant sources of air pollution are not located near the facility. While EGLE initially indicated that one nearby source may need to be included in modeling, it was later stated that the source was not close enough to the site to be significant. This was confirmed by EGLE in the e-mail response of April 20, 2023. Therefore, no nearby sources are included in modeling.

3. Emission Rates

All emission rates were estimated from the Maximum Controlled Emissions calculations that were prepared for the Permit to Install Application. Most emission rates were based on emission factors published in the USEPA Compilation of Air Pollutant Emission Factors, AP-42. Based on the referenced emission rates, modeling iterations were developed for all criteria pollutants that will be emitted as part of the operations. Criteria pollutants included in the modeling analyses were NO_2, SO_2, CO, PM_{10}, $PM_{2.5}$, and lead. As specified by EGLE, total PM emission rates for all point sources were used in determining compliance with R 336.1331. Fugitive emission sources were evaluated using hourly emission rates for PM_{10} and $PM_{2.5}$.

A review was conducted on the list of Michigan TACs to determine if the Maximum Controlled Emission rates for the facility will meet health-based screening levels for each identified contaminant. Emission rates for metals associated with the mining and ore processing operations were derived from the total PM emission factors. These metal emission factors were developed by reviewing data gathered by CRI for ore, tailings, waste rock, concentrate, and natural soils in the area. Factors were calculated using these data and use of total suspended PM rather than PM_{10} or $PM_{2.5}$ emissions. The one exception was for manganese, for which PM_{10} data were used in accordance with EGLE guidance. More details on metals concentrations used in permit calculations are provided in the emissions calculations for the Permit to Install Application.

Acceptable TAC screening levels are published and updated periodically on the EGLE website (EGLE, 2023a, 2023b). To assess compliance with health-based screening levels, the proposed maximum controlled emission rates were compared to the Allowable Emission Rate (AER) outlined in R 336.1227(a)(1). EGLE provides a spreadsheet on their website to assist in identifying TACs not passing very conservative thresholds. TACs not passing the AER screening need modeling to demonstrate compliance with health-based levels.

Metal TACs present in PM emitted from mining and ore processing operations were evaluated along with incidental trace metals present in combustion sources. Of the 19 identified metal TACs, 10 were in compliance with the AER based on the methodology outlined in R 336.1227 (a) (1). A copy of the spreadsheet that supports this conclusion is provided in Appendix B. Air dispersion modeling for the remaining eight chemicals was conducted to demonstrate compliance with the stated screening levels.

Several organic TACs were identified that are associated with combustion of natural gas in the three power generators and diesel fuel in the construction generators and emergency fire pump. All but seven identified pollutant emissions were in compliance with the AER screening methodology. A copy of the spreadsheet that supports this conclusion is provided in Appendix B. Air dispersion modeling for the seven organic constituents was performed to demonstrate that these chemicals were in compliance with EGLE air toxics screening levels.

4. Components of Modeling Analysis

Air quality dispersion modeling requires the incorporation of several components of information in order to develop an acceptable technical analysis. Air quality dispersion models use emission rates from various sources, as determined by an emission inventory, along with appropriate meteorological data to calculate concentrations at designated receptors located around a facility. The following sections describe the procedures that were followed for the modeling analysis.

4.1 Model Selection

The selected dispersion model was implemented to evaluate off-site ground level impacts from emission sources at the Project. The model selected for this effort was the USEPA approved AERMOD, for refined modeling analysis. AERMOD allows calculation of impacts in both simple and complex terrain and is approved by the USEPA for use in evaluating the effects of aerodynamic downwash. Screening techniques (i.e., USEPA's AERSCREEN model) were bypassed in favor of a refined air quality analysis, as refined analysis is characteristic of more realistic ambient ground level concentrations.

AERMOD has general acceptability within the EGLE Air Quality Division and the USEPA and allows use of EGLE-sanctioned meteorological data to be loaded directly into the software. While the USEPA has made this model available publicly for general use, for ease of operation a Windows-based version of this software was chosen for this exercise, as developed by Breeze Software®. The Breeze software is Version 11.0, released in June 2022. This version includes the latest updates to the AERMOD model as prepared by the USEPA. Currently, the software uses AERMOD Version 22112.

AERMOD can account for settling and dry deposition of particulates, downwash, area and volume sources, plume rise as a function of downwind distance, separation of point sources, and terrain adjustment. AERMOD uses the input of true source and building locations in the UTM grid system or a local coordinate system scaled from a site map so that sources and structures are positioned relative to each other in the model.

4.2 Model Inventory

Among the information for model input were data that describe source characteristics. Input data requirements include point, volume, and area source locations with respect to the specified origin of the coordinate system, emission rates, point and volume source height above ground level, etc. Details regarding input parameters to the model, including emission rates for the selected pollutants are provided in Appendix A.

4.3 Source of Meteorological Data

Hourly surface meteorological data are required as input to the AERMOD model. Besides wind speed and wind direction, AERMOD requires several additional parameters to be incorporated into the data set. Raw meteorological files generally need to be preprocessed in order to be used in the model. EGLE has already processed data sets for a number of National Weather Service (NWS) stations in the state and are available on the EGLE website for use in AERMOD. The weather station identified as the Iron County Airport – IWD near Ironwood, Michigan, was chosen as the off-site source of surface meteorological data for this investigation based on proximity to the facility. Surface (SFC) and profile (PFL) files were downloaded from the EGLE website for use in performing modeling runs. The "U-Star" version of the meteorological files were chosen for this analysis due to better accuracy in assessing concentrations at low wind speeds.

Mixing height data (the distance above the ground within which relatively free vertical mixing occurs in the atmosphere) are available for selected sites across the United States for yearly time periods. The upper air observation site located at Green Bay, Wisconsin, was the closest station that can provide twice-daily upper air observations for the modeling of the site. Mixing height information is incorporated into the data set from EGLE.

Although five years of meteorological data are generally used in major source air permitting, EGLE policy allows a source that does not trigger PSD review to use one year of meteorological data in its modeling exercise. However, it is recognized that this permitting process may receive additional public scrutiny. For this reason, five years of meteorological data were used for modeling all criteria pollutants except lead. Years covered were from 2018 to 2022. Given only one-year meteorological files were available from the EGLE website, five-year files were created for the years 2018 to 2022 using Microsoft NotePad®. The five-year meteorological file was used for modeling compliance with the 1-hour NO_2, 1-hour SO_2, and $PM_{2.5}$ standards.

Given the NAAQS for lead is expressed as a three-month rolling average over three years, EGLE guidance (MDEQ, 2008) allows one to conservatively estimate compliance by reporting the maximum monthly concentration over one year. For this exercise, lead was modeled using meteorological data from the year 2019. This year was selected because it resulted in the highest ambient air impact for PM_{10}. For Michigan air toxics associated with materials processing that require dispersion modeling, modeling was also conducted using year 2019 meteorological data. For other Michigan air toxics associated with combustion that required air dispersion modeling, the most recent year of 2022 was used.

4.4 Ambient Air Boundary

The ambient air boundary for this Project is the property boundary depicted on Figure 1-1. As shown on the figure, public access to the property will be limited through a variety of measures, including fencing and gates, physical barriers, warning signage, manned guard shacks, and periodic security patrols.

The Project is adjacent to the Porcupine Mountains Wilderness State Park on a far western extent of the park. The entire region is sparsely populated and in a densely forested part of the Upper Peninsula of Michigan. Forest cover and significant snowfall impede much traffic adjacent to the site. This provides the Project a natural barrier around most of the site to restrict public access. This natural barrier along with some additional security measures will allow the facility to control public access as required by state and federal rules. These security measures are explained below.

Gate and Fencing – An access gate and adjacent fencing will be constructed next to Presque Isle Road (Route 519) to preclude unauthorized access from the public. This is the area that is most exposed to public travel, as this public road is used to access the facilities some distance north in the Park. Figure 1-1 shows more detail.

Physical Barriers – At various locations surrounding the property, hiking, logging, and potentially deer paths lead to the property. A thorough survey of these locations and conditions will indicate an appropriate physical barrier with warning signs. These barriers may include logs, earthen berms, stones or rocks, or other options.

Warning Signage – In addition to natural physical barriers around the property boundary, warning signage will be installed along other sections of the property boundary to advise that the area is off-limits to the public, including hikers and hunters/trappers that may be in the area.

Implementing these measures will ensure that the public does not enter the site along the property boundary and will establish this delineation as the ambient air boundary for the Project. Only receptors along and outside the property boundary will be assessed during air dispersion modeling.

4.5 Receptor Grid Design

For this investigation, one receptor grid was used to represent ground level impacts from the Project outside of the ambient air boundary line and on adjacent public roads. Consistent with EGLE guidance, a 50-m spacing interval was used for the receptor grid. The receptor grid was extended to approximately 5,000 m across the facility. This grid was judged to be adequate to assess compliance with air quality impacts in the vicinity. Receptors within the ambient air boundary were not included in the analysis. Discrete receptors were placed along the ambient air boundary at 25-m intervals.

A uniform Cartesian grid was used for this modeling analysis with each receptor being designated by its applicable UTM grid coordinate. The UTM grid coordinate system was laid out in the North American Datum (NAD) 1983, Zone 16. UTM coordinates for the facility were determined from a Shapefile (SHP) site map for the area. Locations of structures and emission points were scaled from the site map.

4.6 Topography

The grade elevation of the Project is about 787 feet (240 m) above mean sea level. The terrain elevation varies within the area surrounding the facility. To account for terrain, a one-third arc second Digital Elevation Model (DEM) terrain data file was imported into the model for the local area to simulate regional terrain. DEM data sets are in conformance with NAD 1983. Receptor heights were interpolated from the terrain data using the AERMAP tool incorporated into AERMOD.

4.7 Building Wake Effects

In the AERMOD model, USEPA regulatory default options were used to consider the aerodynamic effects of nearby structure(s) on plume dispersion from point sources of emissions. AERMOD does not use building wake effects for non-point sources. A structure is considered "nearby" or sufficiently close to an emission source to cause wake effects when the distance between the stack and the nearest part of the structure is less than or equal to five times the lesser of the height (H) or the projected width (L) of the structure.

The AERMOD model uses two different sets of building dimension parameters to consider wake effects. The two sets of parameters were used in two different sets of calculations that the model selects, depending on the ratio of stack height to building height. In AERMOD, the influence of building wakes on plume transport and dispersion is evaluated by the Schulman and Scire Method for physical stack heights less than hb + 0.5 pound (lb). The variable hb is the building height and the variable lb is the lesser of the building height or width. Another method employed in AERMOD is the Huber and Snyder Method for stack heights greater than hb + 0.5 lb and less than hb + 1.5 lb and no downwash effects for stack heights greater than hb + 1.5 lb. AERMOD performs an additional check using the gradual plume rise due to momentum alone at a distance of two structure heights downwind. If the plume height is given by the sum of the physical stack height and momentum rise is greater than the structure height plus the lesser of the height or width (hb + 1.5 lb), the plume is assumed to be unaffected by the building wake. Otherwise, the plume is affected by the building wake. AERMOD uses building dimension inputs and stack heights to calculate these effects through a Building Profile Input Program that is incorporated into the software.

4.8 Ambient Background Concentrations

The NAAQS analysis must include appropriate background concentrations of criteria pollutants in the Project vicinity. EGLE provided ambient background concentrations for each criteria pollutant and applicable averaging time in a table that was attached at the bottom of an e-mail on approval of the air dispersion modeling protocol. The table is located in Appendix C. Given EGLE did not update background concentrations for the annual and 24-hour average SO_2 concentrations, the background concentrations for these averaging times from the 2018 air permit application (Foth, 2018) were used.

5. Maximum Air Quality Impact Determination

The AERMOD model was run using meteorological data from the years 2018 through 2022 for criteria pollutant evaluations, including PM (PM_{10}, $PM_{2.5}$), NO_2, SO_2, and CO using the input data previously described to predict the source pollutant impacts at each of the receptor points. Results of the model runs were analyzed to determine the concentrations for each applicable averaging period. The criteria pollutant lead was assessed using meteorological data from 2018, as this year produced the highest PM_{10} concentration. Note the current lead NAAQS is expressed in terms of a three-month rolling average. Michigan guidance (MDEQ, 2008) allows one assess compliance with the lead NAAQS by conservatively evaluating compliance against maximum monthly average concentrations. This approach was performed using meteorology from 2018.

5.1 Maximum Impacts and Significant Impact Level Analysis

A preliminary dispersion modeling assessment was performed to determine if criteria pollutant emissions would have a significant impact on ambient air quality. The ambient air impacts from facility-wide emissions for $PM_{2.5}$, PM_{10}, NO_2, SO_2, and CO were compared against the respective established Significant Impact Levels (SIL). Table 5-1 shows the maximum concentrations for each criteria pollutant and compares them against SILs. Except for CO, the 3-hour, 24-hour, and the annual SO_2 standard, SILs were exceeded for all pollutants. As a result of this analysis, dispersion modeling results were compared to the NAAQS for all criteria pollutants.

5.2 NAAQS Predicted Impact Analysis

Table 5-2 shows the predicted impact analysis for criteria pollutants for each averaging period with respect to the NAAQS. Also provided is the meteorological year associated with each concentration. Given the form of the NAAQS standards for $PM_{2.5}$, SO_2, and NO_2, modeling for these pollutants was performed across the entire five-year data set. These air quality impacts are the result of using emission rates determined from the PTE calculations used to support the Permit to Install Application. As discussed in Section 5.1, the preliminary modeling assessment indicated that certain pollutants would be below the applicable SIL for several averaging periods. However, modeling results for all applicable averaging periods are provided in the table.

USEPA guidance as stated in a March 1, 2011, memorandum from the agency indicates that one can evaluate emissions of NO_2 using one of three tiered methods (USEPA, 2011). Tier 1 assumes full conversion of NO to NO_2, while the Tier 2 allows an Ambient Ratio Method (ARM) to assume a portion of the NO is converted to NO_2. The current version of AERMOD incorporates ARM2 as an option. ARM2 uses default upper and lower limits on the ambient ratio applied to modeled NO_2 concentration at 0.9 and 0.5, respectively. Given all NO_2 modeling was performed using the ARM2 approach, Table 5-2 shows NO_2 results using this method.

5.3 Predicted Impact Analysis for PSD Increment

The mining and mill processing facility will be located in an attainment area for all criteria pollutants and will not be subject to PSD review. However, it is located in an Air Quality Control Region (AQCR) where the PSD minor source baseline has been established for PM_{10}, $PM_{2.5}$, NO_2, and SO_2. While minor source baselines for most pollutants were established in the 1980s, the minor source baseline for $PM_{2.5}$ was set on March 30, 2016. This is AQCR 126, which includes the entire Upper Peninsula of Michigan. These baseline dates are provided in Michigan guidance on PSD Baseline Dates in Appendix D. In accordance with USEPA guidance, Table 5-3 compares the second highest of the predicted source impact concentrations to the PSD increment levels. For all model runs, the source impact is less than the PSD Increment, showing compliance with those criteria.

5.4 Maximum Impacts for Toxic Air Contaminants in Comparison to Michigan Screening Levels

After application of Best Available Control Technology (BACT), a new or modified facility may not emit identified TACs at a level that would cause a predicted ambient impact in excess of a contaminant specific health-based screening level. There are three types of screening levels: the Initial Threshold Screening Level (ITSL), the Initial Risk Screening Level (IRSL), and the Secondary Risk Screening Level (SRSL). The list of screening levels is updated periodically by EGLE and is posted on its website. For this analysis, the most recent List of Screening Levels dated July 24, 2023, was used (EGLE, 2023a).

To determine compliance with these screening levels, a spreadsheet was obtained from the EGLE website and used to screen contaminants pursuant to the method outlined in R 336.1227(1) (a) (EGLE, 2023b). Facility-wide Maximum Controlled Emission rates developed for the Permit to Install were used as Emission Rates to assess compliance for each ITSL, IRSL or SRSL. Of the 19 TACs identified in materials that will be processed on site, ten were determined to be in compliance with R 336.1225 based on this approach. The results of the screening analysis are provided in Appendix B. Eight metals were evaluated using the AERMOD air dispersion model, pursuant to the approach outlined under R 336.1227 (1) (c). Results show the remaining metals to be in compliance with the screening level.

In addition, organic TACs associated with combustion of natural gas and diesel in on-site generators and other combustion sources were screened for compliance with threshold level concentrations. All except for seven chemicals passed screening using this approach. These seven organic TACs were modeled and compared to the appropriate screening level. Results presented on Table 5-4 show the Maximum Predicted Ambient Impact to be less than the Screening Level in all cases. Given this evaluation is being performed for facility-wide emissions, modeled annual concentrations were compared against the SRSL in accordance with R 336.1225(2). The results of these analyses show compliance with the applicable standards.

6. Conclusion

Based on this air dispersion analysis of emission sources at the Project, the site air emissions comply with the NAAQS and Class II PSD increments for criteria pollutants and all screening levels for identified Michigan TACs.

7. References

Foth Infrastructure & Environment, LLC, 2018. Michigan Air Use Permit – Permit to Install Application. March 2018.

Michigan Department of Environment, Great Lakes, and Energy – Air Quality Division, 2023a. Toxic Air Contaminants – Demonstrating Compliance with Rule 225. Undated. Accessed on EGLE website August 2, 2023: [Toxic Air Contaminants - Demonstrating Compliance with Rule 225 (michigan.gov)]

Michigan Department of Environment, Great Lakes, and Energy – Air Quality Division, 2023b. Demonstrating Compliance with Rule 225 – Rule 227 Spreadsheet. Accessed on EGLE website on July 15, 2023: [Toxics (michigan.gov)] (link source).

Michigan Department of Environmental Quality, 2008. *Air Quality Division Guidelines for Air Dispersion Modeling* (revised November 2008).

United States Environmental Protection Agency, 1995. Memorandum, *Calculating Potential to Emit (PTE) for Emergency Generators*, September 6, 1995.

United States Environmental Protection Agency, 2011. Memorandum, *Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 NAAQS*, March 1, 2011.

Tables

Table 2-1
Point Sources of Emissions

Stack ID	Emission Point Description	UTM Coordinates		Stack Height Above Ground Level (m)[1]	Stack Diameter (m)	Stack Exit Velocity (m/sec)	Stack Gas Temperature (°K)
		X Coordinate	Y Coordinate				
SV-001	West Mine Exhaust Vent	270062.8	5173139.5	9	2	49.4	333
SV-002	East Mine Exhaust Vent	272795.9	5172909.3	9	2	50.9	333
SV-003	Portal Mine Exhuase Vent	270320.2	5172836.2	1	4.8	4.7	333
SV-004	Construction Generator (725 kW)	270265	5172431	4.5	0.1524	47.6	1133
SV-005	Natural Gas Generator (2 mW)	270435.2	5172262.7	4.5	0.381	24.9	1154
SV-006	Natural Gas Generator (2 mW)	270435.2	5172269.5	4.5	0.381	24.9	1154
SV-007	Natural Gas Generator (2 mW)	270483.9	5172648.6	4.5	0.381	24.9	1154
SV-008	Fire Pump	270490.5	5172308.2	4.5	0.1524	28.3	1273
SV-009	Lime Silo Vent	270405.2	5172370.2	4.6	0.2032	4.3	333

Notes:
[1] All stacks are measured from the base of the building or structure. Stacks are vertical and unobstructed.
°K = degrees Kelvin
kW = kilowatt
m = meters
m/sec = meters per second
mW = megawatt
UTM = Universal Transverse Mercator

Prepared by: CED1
Checked by: AKM

Table 2-2
Input Data for Area Emission Sources

Area Source	UTM Coordinates (m)		Release Height	Initial Vertical	Total Area
	X Coordinate	Y Coordinate	(m)	(m)	(m)
F007 - Wind Erosion at Ore Stockpile	270739.4	5172310.7	15	7	51,790
F008 - Wind Erosion at TDF	271840.7	5171804.5	30	14	38,079

Notes:
m = meters
TDF = Tailings Disposal Facility
UTM = Universal Transverse Mercator

Prepared by: CED1
Checked by: AKM

Table 2-3
Input Data for Volume Emission Sources

Volume Source	UTM Coordinates (m)		Initial Horizontal Dimension	Initial Vertical Dimension	Release Height
	X Coordinate	Y Coordinate	(m)	(m)	(m)
F001 - Ore Transfer from Portal to Transfer Tower	270545.2	5172590.1	0.21	0.21	0.75
F002 - Surplus Ore Transfer to Ore Stockpile	270636.7	5172542.9	0.21	0.21	5
F003A - Transfer Points at Ore Bins/Reclaim Area	270562.5	5172438.9	7.3	10.2	11
F003B - Transfer Points at Ore Bins/Reclaim Area	270551.9	5172431.9	7.3	10.2	11
F004 - Management of Ore at Ore Stockpile	270733.5	5172527.6	0.81	3.8	16.2
F005 - Transfer Points at SAG Mill	270478	5172368.9	7.9	12	13
F006A - Concentrate Handling Operations	270384.2	5172293.4	8.72	5.6	6
F006B - Concentrate Handling Operations	270368.2	5172283.3	8.72	5.6	6
F009A- Reagent Mixing and Management	270411.9	5172343.5	6.5	7.27	6.1
F009B - Reagent Mixing and Management	270399.5	5172336.4	6.5	7.27	6.1
HR-01 Vehicle Travel on Ore Stockpile	Various		4.7	4.7	5.1
HR-02 - Concentrate Truck Travel on Access Road	Various		7.9	4.7	5
HR-03 - Water Transport Truck on Access Road	Various		7.8	4	4.3
HR-04 - Reagent Grinding Media Truck on Access Road	Various		7.9	4.7	5
HR-05 - Explosives Truck Travel on Access Road	Various		7.9	4.7	5
HR-06 - Natural Gas Delivery Truck on Access Road	Various		7.9	4.7	5
HR-07 - Diesel Delivery Truck on Access Road	Various		7.9	4.7	5

Notes:
m = meters
UTM = Universal Transverse Mercator

Prepared by: CED1
Checked by: AKM

Table 5-1
Significant Impact Analysis
Maximum Concentrations from the Modeling Study

Pollutant	Averaging Period	Year	First Highest Value (µg/m3)	SIL (µg/m3)	Less Than SIL
$PM_{2.5}$	Annual	2018-2022	0.31	0.3	No
$PM_{2.5}$	24-Hr Avg	2018-2022	2.9	1.2	No
PM_{10}	24-Hr Avg	2020	13.4	5	No
SO_2	Annual	2021	0.24	1	Yes
SO_2	24-Hr Avg	2022	3.5	5	Yes
SO_2	3-Hr Avg	2018	10.3	25	Yes
SO_2	1-Hr Avg	2018 - 2022	16.0	8	No
NO_2 (Tier 2)	Annual	2018 - 2022	1.4	1	No
NO_2 (Tier 2)	1-Hr Avg	2018 - 2022	66.5	7.5	No
CO	8-Hr Avg	2020	59.8	500	Yes
CO	1-Hr Avg	2022	171	2,000	Yes

Prepared by: CED1
Checked by: AKM

Notes:
Each value is the first highest concentration across five years of meteorological data: 2018 through 2022.
Note that NO_2 was modeled using the Ambient Ratio Method 2 (AMR2). This regulatory approach assumes that a portion of the NO_X is converted to NO_2. For the default setting in ARM2, upper and lower limits applied to modeling are set at 0.9 and 0.5, respectively.
Avg = average
CO = carbon monoxide
Hr = hour
NO_2 = nitrogen dioxide
PM_{10} = particulate matter less than 10 microns
$PM_{2.5}$ = particulate matter less than 2.5 microns
SIL = Significant Impact Level
SO_2 = sulfur dioxide
$\mu g/m^3$ = micrograms per cubic meter

Table 5-2
Comparison of Predicted Ambient Impacts to NAAQS Concentrations

Criteria Pollutant	Averaging Period	Year	Predicted Ambient Impact ($\mu g/m^3$)	Background Concentration[1] ($\mu g/m^3$)	Total Impact ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)
$PM_{2.5}$	Annual [4]	2018-2022	0.31	5.6	5.91	12
$PM2_{.5}$	24-Hr Avg [2]	2018-2022	1.8	15.6	17.4	35
PM_{10}	24-Hr Avg [3]	2019	8.4	66	74.4	150
SO_2	Annual [4]	2021	0.24	6.5	6.74	80
SO_2	24-Hr Avg [5]	2021	2.6	21.2	23.8	365
SO_2	3-Hr Avg [5]	2022	7.6	10.5	18.1	1,300
SO_2	1-Hr Avg [6]	2018-2022	12.2	3.6	15.8	196
NO_2 (ARM2)	Annual [4]	2018-2022	1.4	2.4	3.8	100
NO_2 (ARM2)	1-Hr Avg [7]	2018-2022	54.5	13.3	67.8	188
CO	8-Hr Avg [5]	2021	59.3	580	639	10,000
CO	1-Hr Avg [5]	2018	142.7	1,114	1,256	40,000
Lead	3-Month Average [8]	2018	0.00029	---	0.00029	0.15

Prepared by: CED1
Checked by: AKM

Notes:

[1] Background concentrations were obtained from EGLE in a table included in Appendix C. Given EGLE did not provide updated background concentrations for the Annual and 24-Hr Avg SO_2, background concentrations from the 2018 air permit application were used.

[2] The $PM_{2.5}$ 24-hour concentration is the maximum eighth highest concentration over five years of meteorological data.

[3] The PM_{10} 24-hour concentration is the highest sixth highest concentration over five year of meteorological data.

[4] The $PM_{2.5}$, SO_2, and NO_2 annual values are the highest annual average concentrations over five years of meteorological data. The highest value is used for comparison against the annual NAAQS limit.

[5] The SO_2 24-hour and 3-hour values and CO 1-hour and 8-hour values are highest second-high concentrations over 5 years of meteorological data. These values are used for assessing compliance with the NAAQS.

[6] The SO_2 1-hour value is the five-year average of the fourth-highest daily maximum 1-hour concentrations. This is representative of the 99th percentile of the daily maximum 1-hour concentrations.

[7] The NO_2 1-hour value is the five-year average of the eighth-highest daily maximum 1-hour concentrations. This is representative of the 98th percentile of the daily maximum 1-hour concentrations. Note that NO_2 was modeled using the Tier 2 Ambient Ratio Method (AMR) that has been updated in AERMOD to ARM2. This regulatory approach assumes that default upper and lower limits on the ambient ratio are 0.9 and 0.5, respectively.

[8] The current NAAQS for lead is expressed as a three-month rolling average. Compliance is met when the maximum arithmetic 3-month average concentration is equal or below 0.15 $\mu g/m^3$. Given the complications assosciated with modeling due to the form of the standard, compliance has been conservatively assessed by evaluating compliance with the maximum monthly average concentration over meteorological year of 2018. The year 2018 was chosen because it corresponds to the year in which the highest PM_{10} concentration was

Avg = average
CO = carbon monoxide
Hr = hour
NAAQS = National Ambient Air Quality Standards
NO_2 = nitrogen dioxide
PM_{10} = particulate matter less than 10 microns
$PM_{2.5}$ = particulate matter less than 2.5 microns
SO_2 = sulfur dioxide
$\mu g/m^3$ = micrograms per cubic meter

Table 5-3
Comparison of Source Impacts to PSD Increment Concentrations

Criteria Pollutant	Averaging Period	Year	Source Impact ($\mu g/m^3$)	PSD Increment Class II ($\mu g/m^3$)
$PM_{2.5}$ (2)	Annual (3)	2018-2022	0.31	4
$PM_{2.5}$ (1), (2)	24-Hr Avg	2018-2022	2.5	9
PM_{10} (2)	Annual (3)	2019	2.6	17
PM_{10} (1)	24-Hr Avg	2019	9.7	30
SO_2	Annual (3)	2021	0.24	20
SO_2 (1)	24-Hr Avg	2021	2.6	91
SO_2 (1)	3-Hr Avg	2022	7.6	325
NO_2 (Tier2) (4)	Annual (3)	2018-2022	1.4	25

Prepared by: CED1
Checked by: AKM

Notes:

(1) All short term values (non-annual) are the highest 2nd high concentrations for the referenced year over five years of meteorological data: 2018 through 2022.

(2) It should be noted the minor source baseline date for $PM_{2.5}$ has was triggered in AQCR 126 in Michigan on March 31, 2016. Therefore, non-major sources such as Copperwood will need to comply with the $PM_{2.5}$ PSD

(3) Annual results are the highest annual average concentration for the referenced year over five years of meteorological data: 2018 through 2022.

(4) The NO_2 Tier 2 approach is ARM2, which uses default upper and lower limits of 0.9 and 0.5, respectively, on the ambient ratio applied to modeled NO_2.

AQCR = Air Quality Control Region
Avg = average
Hr = hour
NO_2 = nitrogen dioxide
NO_x = nitrogen oxides
PM_{10} = particulate matter less than 10 microns
$PM_{2.5}$ = particulate matter less than 2.5 microns
PSD = Prevention of Significant Deterioration
SO_2 = sulfur dioxide
$\mu g/m^3$ = micrograms per cubic meter

Table 5-4
Comparison of Maximum Source Impacts for Michigan TAC to Appropriate ITSL, IRSL, SRSL, or RfC Screening Levels

Listed TAC[1]	Screening Level (µg/m³)	Screening Level Averaging Time	Type of Screening Level	Maximum Predicted Ambient Impact (µg/m³)
Copper	2	8-Hr Avg	ITSL	0.93
Arsenic	0.002	Annual	SRSL	0.00013
Cobalt	0.2	8-Hr Avg	ITSL	0.0021
Cobalt	0.0013	Annual	SRSL	0.0002
Manganese	0.3	Annual	ITSL	0.012
Barium	5	8-Hr Avg	ITSL	0.048
Beryllium	0.02	24-Hr Avg	ITSL	8.00E-05
Beryllium	0.004	Annual	SRSL	1.00E-05
Cadmium	0.006	Annual	SRSL	1.00E-05
Nickel	0.06	Annual	SRSL	2.50E-04
Benzene	30	24-Hr Avg	ITSL	0.026
Benzene	30	Annual	ITSL	0.002
Benzene	1.0	Annual	SRSL	0.002
1,3-Butadiene	33	Annual	ITSL	0.0086
1,3-Butadiene	0.3	Annual	SRSL	0.0086
Benzo(a)pyrene	0.002	24-Hr Avg	ITSL	2.30E-05
Benzo(a)pyrene	0.01	Annual	SRSL	1.50E-06
1,2-Dibromoethane	9	Annual	ITSL	0.00014
1,2-Dibromoethane	0.02	Annual	SRSL	0.00014

Table 5-4 (continued)

Listed TAC[1]	Screening Level (µg/m³)	Screening Level Averaging Time	Type of Screening Level	Maximum Predicted Ambient Impact (µg/m³)
Acetaldehyde	9	Annual	ITSL	0.01
Acetaldehyde	5	Annual	SRSL	0.01
Acrolein	5	1-Hr Avg	ITSL	1.1
Acrolein	0.4	Annual	ITSL	0.016
Formaldehyde	30	24-Hr Avg	ITSL	2.6
Formaldehyde	0.8	Annual	SRSL	0.16

Prepared by: CED1
Checked by: AKM

Notes:

[1] Remaining identified TACs are in compliance with all screening levels using the screening tool provided under R 336.1227 (a) See spreadsheet in Appendix C.

Avg = average

Hr = hour

IRSL = Initial Risk Screening Level

ITSL = Initial Threshold Screening Level

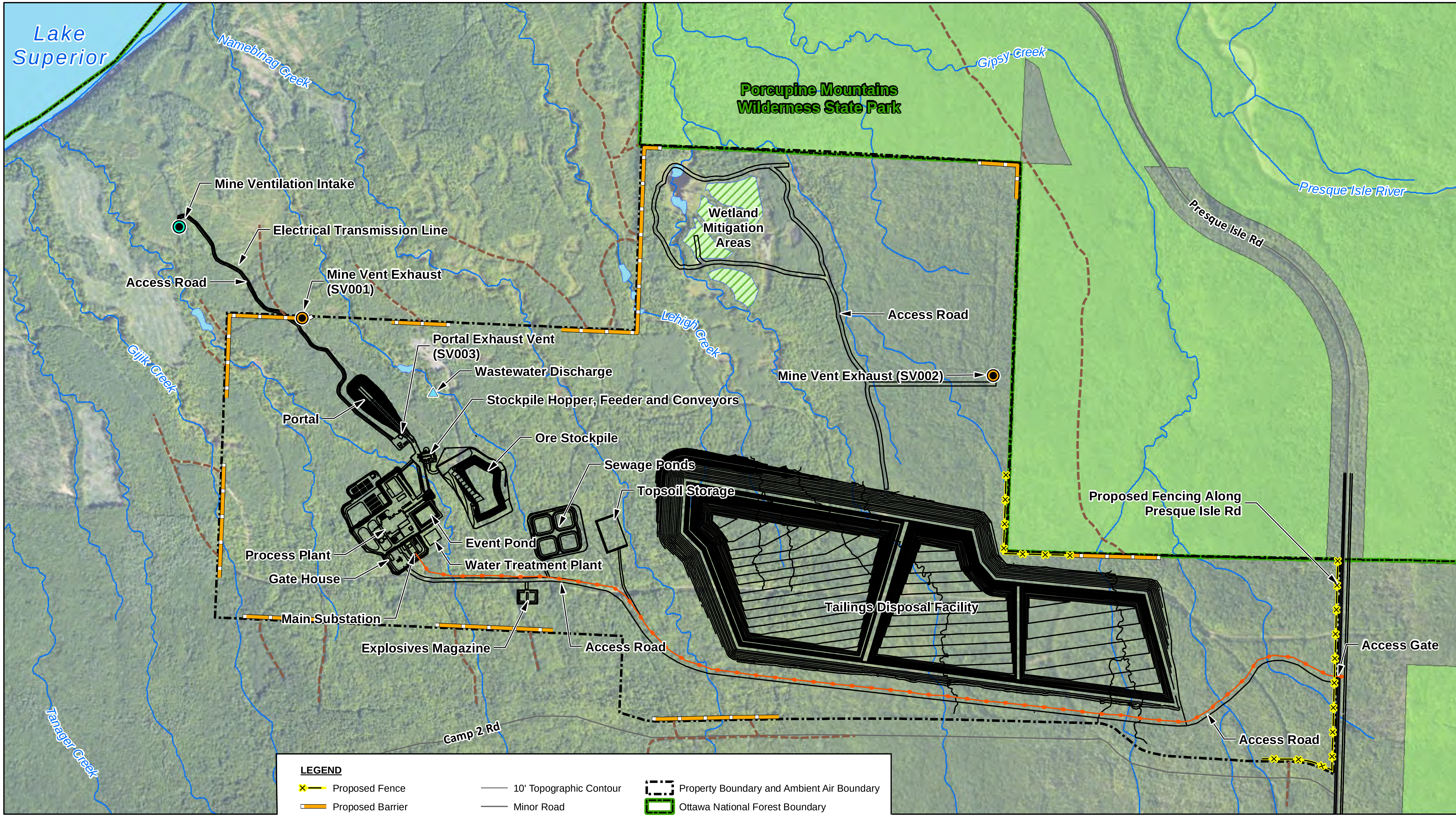
RfC = Reference Concentration for Chronic Inhalation Exposure

SRSL = Secondary Risk Screening Level

TAC = toxic air contaminant

$\mu g/m^3$ = micrograms per cubic meter

Figures



NOTES:
1. Base air photo from the USDA
2. Horizontal coordinate system is NAD1983 UTM Zone 16N, units in meters.
3. Hydrographic data from the USGS.
4. Road and boundary data from Michigan GIS Open Data and the USFS.
5. Contour data generated from USGS 1-meter digital elevation model (DEM).
6. Trail segments digitized from USDA NAIP 2022 air photo and have not been field verified.

This drawing is neither a legally recorded map nor a survey and is not intended to be used as one. This drawing is a compilation of records, information and data used for reference purposes only.

HIGHLAND Copper Company Inc.

Foth

N

0 600 1,200 Feet

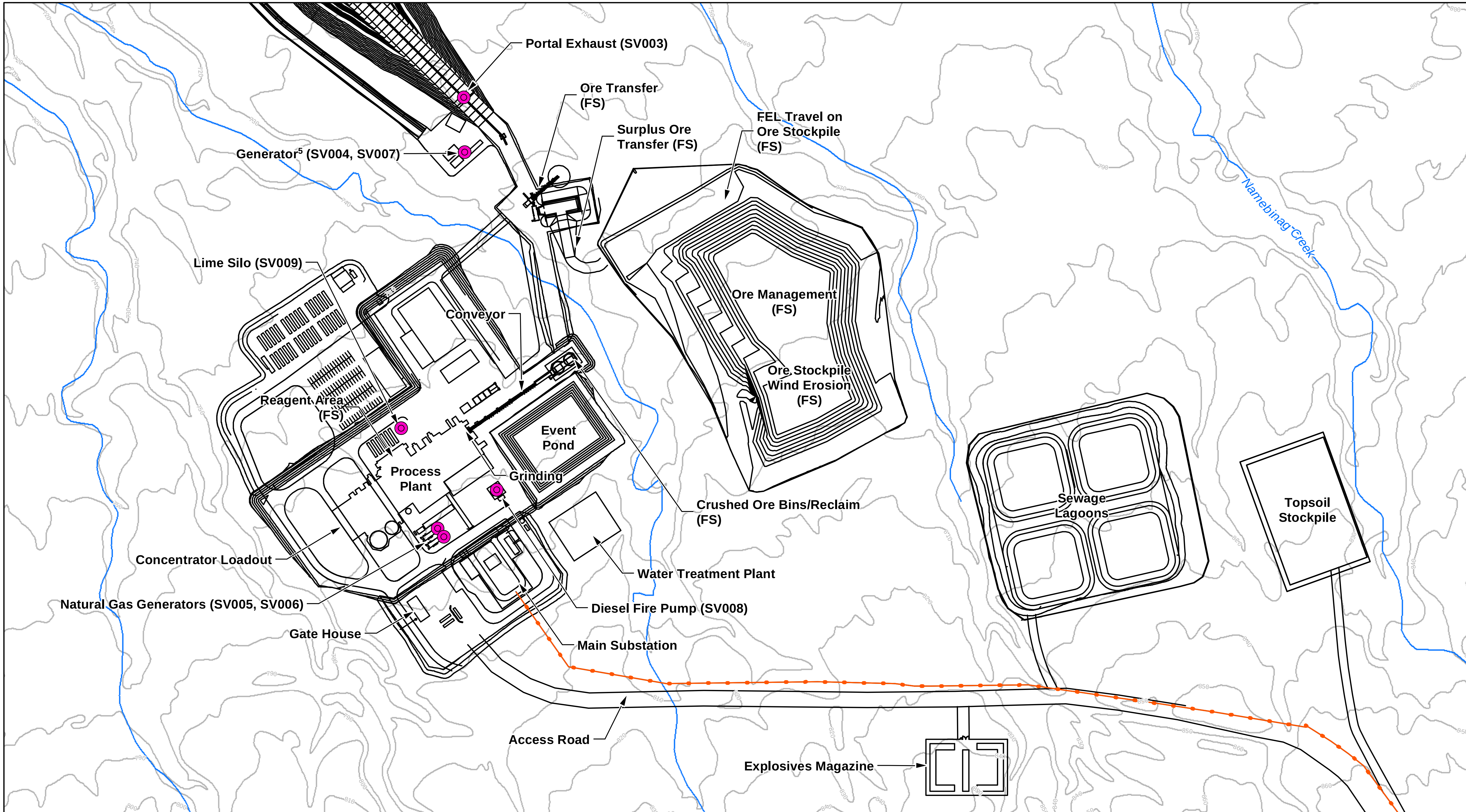
HIGHLAND COPPER

FIGURE 1-1

MINE AREA PLAN
AIR QUALITY IMPACT ANALYSIS
COPPERWOOD PROJECT, GOGEBIC COUNTY, MI

Date: AUGUST 2023		Revision Date:
Drawn By: BJW1	Checked By: AKM	Project: 23H001

Path: Q:\Highland Copper\23H001\GIS\mxd\Air Quality Impact Analysis\Figure 1-1 Mine Area.mxd Date: 8/18/2023



NOTES:

1. Horizontal coordinate system is NAD1983 UTM Zone16N, units in meters.
2. Hydrographic data from the USGS.
3. Road and boundary data from Michigan GIS Open Data and the USFS.
4. Contour data generated from USGS 1-meter digital elevation model (DEM).
5. SV004 is the diesel generator used during initial construction. It will be replaced with a natural gas generator when available at same location.

LEGEND

- Stack Location
- Mine Site Feature
- Electrical Transmission Line
- 10' Topographic Contour
- River/Stream
- Property Boundary

SV = Stack Vent
FS = Fugitive Source
Note: Not all fugitive dust sources are shown.

This drawing is neither a legally recorded map nor a survey and is not intended to be used as one. This drawing is a compilation of records, information and data used for reference purposes only.

HIGHLAND Copper Company Inc.

Foth

0 150 300 Feet

N

HIGHLAND COPPER

FIGURE 1-2

PROCESS PLANT AREA
AIR QUALITY IMPACT ANALYSIS
COPPERWOOD PROJECT, GOGEBIC COUNTY, MI

Date: AUGUST 2023	Revision Date:	
Drawn By: BJW1	Checked By: AKM	Project: 23H001

Path: Q:\Highland Copper\23H001\GIS\mxd\Air Quality Impact Analysis\Figure 1-2 Process Plant Area.mxd Date: 8/18/2023

Appendix A

Input Parameters for Air Dispersion Modeling Analysis

Client: Copperwood Resources, Inc. Project ID.: 0023H001.00
Project: Air Permit Application Emissions Calculations
Prepared by: MMD Date: 05/10/23
Checked by: AKM Date: 08/17/23

Copperwood Air Dispersion Model Input Data - Emission Rates of Criteria Pollutants

Point Sources [1]

Emission Source		Stack Height (Above Ground) (m) [1]	Stack Diameter (m) [1]	Stack Exit Velocity (m/s)	Stack Gas Temp (°K)	PM10 (lb/hr)	PM10 (g/sec)	PM2.5 (lb/hr)	PM2.5 (g/sec)	NO2 (lb/hr)	NO2 (g/sec)	SO2 (lb/hr)	SO2 (g/sec)	CO (lb/hr)	CO (g/sec)
SV-001	West Mine Exhaust Vent	9	2	49.4	333	0.866	**0.109**	0.154	**0.0194**	3.04	**0.383**	4.75	**0.598**	50.59	**6.375**
SV-002	East Mine Exhaust Vent	9	2	50.9	333	0.89	**0.112**	0.159	**0.0200**	3.13	**0.394**	4.89	**0.616**	52.13	**6.568**
SV-003	Portal Mine Exhaust Vent	1	4.77	4.7	333	0.47	**0.059**	0.084	**0.0106**	1.66	**0.209**	2.59	**0.326**	27.60	**3.477**
SV-004	Construction Generator (725 kW) 8	4.5	0.1524	47.6	1133	0.161	**0.0202**	0.161	**0.0202**	5.57	**0.701**	0.012	**0.0015**	0.24	**0.030**
SV-005	Natural Gas Power Generator (2 MW base load) 8	4.5	0.381	24.9	1154	0.262	**0.0330**	0.262	**0.0330**	1.18	**0.149**	0.004	**0.0005**	1.67	**0.211**
SV-006	Natural Gas Power Generator (2 MW base load) 8	4.5	0.381	24.9	1154	0.262	**0.0330**	0.262	**0.0330**	1.18	**0.149**	0.004	**0.0005**	1.67	**0.211**
SV-007	Natural Gas Power Generator (2 MW base load) 8	4.5	0.381	24.9	1154	0.262	**0.0330**	0.262	**0.0330**	1.18	**0.149**	0.004	**0.0005**	1.67	**0.211**
SV-008	Fire Pump	4.5	0.1524	28.3	1273	0.442	**0.0557**	0.442	**0.0557**	0.36	**0.045**	0.413	**0.0521**	1.35	**0.171**
SV-009	Lime Silo Vent	4.6	0.2032	4.3	333	0.0003	**0.00004**	0.0003	**0.00004**		**0.000**		**0.0000**		**0.000**

Volume Sources [3]

Emission Source		Volume Height (m)	Volume Width (m)	Release Height (m)	Adjusted Road Width	Initial Horizontal Dimension (m)	Initial Vertical Dimension (m)	PM10 Emissions (lb/hr)	PM10 Emissions (g/sec)	No. of Volume Source Segments	PM10 Rate per Volume (g/sec)	PM2.5 Emissions (lb/hr)	PM2.5 Emissions (g/sec)	PM2.5 Rate per Volume (g/sec)	NO2 Emissions (lb/hr)	NO2 Emissions (g/sec)	NO2 per Volume (g/sec)	SO2 Emissions (lb/hr)	SO2 Emissions (g/sec)	SO2 per Volume (g/sec)	CO Emissions (lb/hr)	CO Emissions (g/sec)	CO per Volume (g/sec)
F001	Ore Transfer from Portal to First Transfer Point (Transfer Tower) [4]	N/A	N/A	0.75		0.21	0.21	0.040	**0.0051**	1		**0.0060**	**0.0008**										
F002	Surplus Ore Transfer to Ore Stockpile [5]	N/A	N/A	5		0.21	0.21	0.135	**0.0170**	1		**0.0204**	**0.0026**										
F003A/B	Transfer Points at Ore Bins/Reclaim Area [6]	N/A	N/A	11.0		7.27	10.2	0.091	**0.011**	2	**5.70E-03**	**0.0136**	**0.0017**	**8.55E-04**									
F004	Management of Ore within Ore Stockpile Area [7]	NA	N/A	16.2		0.81	3.8	0.309	**0.039**	1		**0.0467**	**0.0059**										
F005	Transfer Points at SAG Mill [8]	N/A	N/A	13		7.90	12.00	0.005	**0.0006**	1		0.001	**8.55E-05**										
F006A/B	Concentrate Handling Operations [9]	N/A	N/A	6		8.72	5.60	0.004	**0.0005**	2	**2.48E-04**	0.0006	**7.45E-05**	**3.72E-05**									
F009A/B	Reagent Mixing and Management [10]	N/A	N/A	6.5		7.27	6.10	5.49E-05	**6.92E-06**	2	**3.46E-06**	5.49E-05	**6.92E-06**	**3.46E-06**									
HR-01	Vehicle Travel on Ore Stockpile [11]	10.2	10.1	5.1	10.1	4.7	4.7	1.122	0.1414	13	**1.09E-02**	0.112	0.014	**1.09E-03**									
HR-02	Conct Truck Travel on Access Road [12]	10	8.5	5.0	8.5	7.9	4.7	0.47	0.0598	233	**2.57E-04**	0.047	0.006	**2.57E-05**									
HR-03	Water Transport Truck on Access Road [13]	8.6	8.4	4.3	8.4	7.8	4.0	0.47	0.0590	234	**2.52E-04**	0.047	0.006	**2.52E-05**									
HR-04	Reagent/Grinding Media Truck on Access Road [14]	10	8.5	5.0	8.5	7.9	4.7	0.38	0.0480	240	**2.00E-04**	0.038	0.005	**2.00E-05**									
HR-05	Explosives Truck Travel on Access Road [15]	10	8.5	5.0	8.5	7.9	4.7	0.38	0.0476	206	**2.31E-04**	0.038	0.005	**2.31E-05**									
HR-06	Natural Gas Delivery Truck Travel on Access Road [16]	10	8.5	5.0	8.5	7.9	4.7	0.38	0.0479	235	**2.04E-04**	0.038	0.005	**2.04E-05**									
HR-07	Diesel Fuel Delivery Truck Travel on Access Road [17]	10	8.5	5.0	8.5	7.9	4.7	0.43	0.0541	245	**2.21E-04**	0.043	0.005	**2.21E-05**									

Area Sources

Emission Source	X-Axis Length (m)	Y-Axis Length (m)	Release Height (m)	Initial Vertical (m)	Area (m2)	PM10 Emissions (lb/hr)	PM10 Emissions (g/sec)	PM10 Emissions (g/m^2-sec)	PM2.5 Emissions (lb/hr)	PM2.5 Emissions (g/sec)	PM2.5 Emissions (g/m^2-sec)
F007 - Wind Erosion at Ore Stockpile			15	7.0	51,790	0.23	0.03	**5.56E-07**	0.057	0.007	**1.39E-07**
F008 - Wind Erosion at TDF			30	14.0	38,079	0.4	0.05	**1.33E-06**	0.205	0.026	**6.79E-07**

Building Dimensions [18]

Building Name	X-Axis Bldg/Structure Length (m)	Y-Axis Bldg/Structure Width (m)	Bldg/ Structure Height (m)	Area (m2)	UTM Coordinates Easting (m)	UTM Coordinates Northing (m)
Process Plant and Support Facility	108.4	37.8	26	4,098	270405	5172284
Concentrate Processing Area	43	34	12	1,462	270366	5172261
Reagent Building	31.6	14	4.8	442	270397	5172325
Ore Bins/Reclaim Area	32	18.8	22	602	270564	5172416
Warehouse	37.7	37.5	6	1,414	270446	5172436
Truck Shop/Mine Services Area	18.6	46.3	6	861	270472	5172467
Dry	37.5	25	3	938	270423	5172467

Notes:

by Copperwood.

(2) The emergency generator will operate as needed a maximum of 500 hours per year.

(3) All volume sources were calculated based on the MDEQ guidance document entitled *Air Dispersion Modeling Guidance Document* dated September 2009.

(4) This represents particulate emissions vented from conveyor No. 1 transfer tower at F001. The transfer conveyor is assumed to be 1.5 meters above ground, with the release height being 1.5 / 2 = 0.75. The initial horizontal dimension is the width of the conveyor = 3 feet = 0.91 meters / 4.3 = 0.21 meters. The initial vertical dimension is the drop distance = 3 feet = 0.91 meters / 4.3 = 0.21 meters.

(5) To estimate this volume source at F002, the release height was the height of the drop point at the ore stockpile = 10 / 2 = 5 meters. The initial horizontal dimension is the width of the conveyor = 3 feet = 0.91 meters / 4.3 = 0.21 meters. The initial vertical dimension is the drop distance = 3 feet = 0.91 meters / 4.3 = 0.21 meters.

(6) To estimate emissions from the ore bins/reclaim area (F003), it will be assumed the emissions will be released within the footprint of the structure. Therefore, the release height for the structure is the height of the bins = 22 meters / 2 = 11 meters. There will be two volume sources. The initial horizontal dimension for each volume source = 31.25 / 4.3 = 7.27 meters (which is half the length of one side of the structure), while the initial vertical dimension = 22 / 2.15 = 10.2 meters.

(7) For F004, to estimate emissions from a FE loader at a pile, it was assumed the release height for the FE loader bucket will be at about 4 feet in height or 1.2 meters. Given the height of the Ore Stockpile will be 15 meters above ground level, the adjusted loader height will be 1.2 + 15 = 16.2 meters. The initial horizontal dimension is the width of the bucket = 3.5 meters / 4.3 = 0.81 meters. The initial vertical dimension is the height of the drop = 16.2 / 4.3 = 3.8 meters.

(8) F005 will be a drop point just inside the process plant building. To estimate emissions from inside the process plant, the release height will be the height of the building = 26 meters / 2 = 13 meters. The initial horizontal dimension will be the width of the building = 34 / 4.3 = 7.9 meters. The initial vertical dimension will be 26 / 2.15 = 12 meters.

(9) Emissions from the concentrate load-out area at F006 include management of concentrate inside the building. This emission source is minimal due to enclosure of the drop point and the fact the material is 9% moisture. It is nonetheless included in air dispersion modeling to be conservative. For purposes of modeling, it is assumed it would be a volume source that includes just the southwest end of the building. The volume is one source that includes release of the emissions from the roof of the building. The release height is the midpoint of the building height = 12 / 2 = 6 meters. There will be two volume sources. The initital horizontal dimension is one-half of the building width = 37.5 / 4.3 = 8.72 meters. The initial vertical dimension is the building height = 12 / 2.15 = 5.6 meters.

(10) Emissions from the reagent building include particulate emissions from mixing of reagents. While these sources are exempt sources, they are being included in air dispersion modeling to be conservative. Modeling for TACs associated with reagent mixing was not required. For purposes of modeling, it is assumed emissions would come from the entire building. Therefore, the building was divided into two volume sources using MDEQ guidance for setting up volume sources associated with release of emissions from building roofs/vents. The release height is the midpoint of the building height = 13 / 2 = 6.5 meters. The initial horizontal dimension of each volume source is 31.25 / 4.3 = 7.27 meters. The initial vertical dimension of each volume source is 13 / 2.15 = 6.1 meters.

(11) For HR-01, this included estimation of vehicle height, volume width, release height, initial lateral dimension and initial vertical dimension. Based on use of a CAT 990H FE loader, the height is 5.1 meters, the width is 4.1 meters and length 12.8 meters. Given this information, the volume height is 5.1 * 2 = 10.2 meters, with the volume width being the loader width + 6 meters = 4.1 + 6 = 10.1 meters. The release height = volume height / 2 = 10.2 / 2 = 5.1 meters. The initial horizontal dimension = the volume width / 2.15 = / 2.15 = 4.7 meters, with the initial vertical dimension = height of the volume / 2.15 or 10.2 / 2.15 = 4.7 meters.

(12) For HR-02, this included estimation of vehicle height, volume width, release height, initial lateral dimension and initial vertical dimension. Based on use of bulk product haul truck, the height is 16 feet (including trailer + distance from ground) or 5 meters. The width is 8.3 feet or 2.5 meters. The overall length (including trailer and cab) is 53 feet or 16 meters. Given this information, the volume height is 5 * 2 = 10 meters, with the volume width being the truck width + 6 meters = 8.5 meters. The release height = volume height / 2 = 10 / 2 = 5 meters. For alternating volume sources, the initial horizontal dimension = 2 X the adjusted road width / 2.15 = 17 / 2.15 = 7.9 meters, with the initial vertical dimension = height of the volume / 2.15 or 10 / 2.15

(13) For HR-03, this included estimation of vehicle height, volume width, release height, initial lateral dimension and initial vertical dimension. Based on use of water transport truck, the height is 14 feet (including trailer + distance from ground) or 4.3 meters. The width is 8 feet or 2.4 meters. The overall length (including trailer and cab) is 65 feet or 19.8 meters. Given this information, the volume height is 4.3 * 2 = 8.6 meters, with the volume width being the truck width + 6 meters = 8.4 meters. The release height = volume height / 2 = 8.6 / 2 = 4.3 meters. For alternating volume sources, the initial horizontal dimension = 2 X the adjusted road width / 2.15 = 16.8 / 2.15 = 7.8 meters, with the initial vertical dimension = height of the volume / 2.15 or 8.6 /

(14) For HR-04, this included estimation of vehicle height, volume width, release height, initial lateral dimension and initial vertical dimension. Based on use of bulk product delivery truck, the height is 16 feet (including trailer + distance from ground) or 5 meters. The width is 8.3 feet or 2.5 meters. The overall length (including trailer and cab) is 53 feet or 16 meters. Given this information, the volume height is 5 * 2 = 10 meters, with the volume width being the truck width + 6 meters = 8.5 meters. The release height = volume height / 2 = 10 / 2 = 5 meters. For alternating volume sources, the initial horizontal dimension = 2 X the adjusted road width / 2.15 = 17 / 2.15 = 7.9 meters, with the initial vertical dimension = height of the volume / 2.15 or 10 / 2.15 = 4.7 meters.

(15) For HR-05, this included estimation of vehicle height, volume width, release height, initial lateral dimension and initial vertical dimension. Based on use of bulk product delivery truck, the height is 16 feet (including trailer + distance from ground) or 5 meters. The width is 8.3 feet or 2.5 meters. The overall length (including trailer and cab) is 53 feet or 16 meters. Given this information, the volume height is 5 * 2 = 10 meters, with the volume width being the truck width + 6 meters = 8.5 meters. The release height = volume height / 2 = 10 / 2 = 5 meters. For alternating volume sources, the initial horizontal dimension = 2 X the adjusted road width / 2.15 = 17 / 2.15 = 7.9 meters, with the initial vertical dimension = height of the volume / 2.15 or 10 / 2.15 = 4.7 meters.

(16) For HR-06, this included estimation of vehicle height, volume width, release height, initial lateral dimension and initial vertical dimension. Based on use of bulk product delivery truck, the height is 16 feet (including trailer + distance from ground) or 5 meters. The width is 8.3 feet or 2.5 meters. The overall length (including trailer and cab) is 53 feet or 16 meters. Given this information, the volume height is 5 * 2 = 10 meters, with the volume width being the truck width + 6 meters = 8.5 meters. The release height = volume height / 2 = 10 / 2 = 5 meters. For alternating volume sources, the initial horizontal dimension = 2 X the adjusted road width / 2.15 = 17 / 2.15 = 7.9 meters, with the initial vertical dimension = height of the volume / 2.15 or 10 / 2.15 = 4.7 meters.

(17) For HR-07, this included estimation of vehicle height, volume width, release height, initial lateral dimension and initial vertical dimension. Based on use of bulk product delivery truck, the height is 16 feet (including trailer + distance from ground) or 5 meters. The width is 8.3 feet or 2.5 meters. The overall length (including trailer and cab) is 53 feet or 16 meters. Given this information, the volume height is 5 * 2 = 10 meters, with the volume width being the truck width + 6 meters = 8.5 meters. The release height = volume height / 2 = 10 / 2 = 5 meters. For alternating volume sources, the initial horizontal dimension = 2 X the adjusted road width / 2.15 = 17 / 2.15 = 7.9 meters, with the initial vertical dimension = height of the volume / 2.15 or 10 / 2.15 = 4.7 meters.

(18) Dimensions are provided for buildings on-site that are adjacent identified emission sources. These additional buildings are included in the dispersion model even though these structures do not release emissions. This is because these structures could have some impact on downwash and/or cavity effects at the site. Dimensions for buildings were provided by Lycopodium.

Client:	Copperwood Resources, Inc.	Project ID.:	0023H001.00
Project:	Air Permit Application Emissions Calculations		
Prepared by:	MMD	Date:	05/10/23
Checked by:	AKM	Date:	08/17/23

Copperwood Air Dispersion Model Input Data - Emission Rates of Toxic Air Contaminants

	Metals									
	% Aresenic [2]	% Copper [2]	% Lead [2]	% Barium [2]	% Cobalt [2]	% Manganese[4]	% Barium[2]	% Beryllium[2]	% Cadmium[2]	% Nickel[2]
Ore	1.80E-04	1.460	1.10E-03	0.07559	3.33E-03	8.77E-04	7.56E-02	2.60E-04	1.75E-04	6.54E-03
Concentrate	3.00E-05	28.100	3.00E-05	0.01860	3.30E-05	1.16E-01	2.11E-04	1.73E-06	2.00E-06	2.24E-04
Native Soils	3.20E-04	0.00197	1.54E-03	0.0188	1.59E-03	2.23E-01	1.88E-02	1.06E-04	4.60E-05	2.39E-03
Tailings	6.00E-04	0.4675	1.27E-03	0.0535	3.60E-03	1.61E-01	5.35E-02	2.00E-04	3.00E-05	1.87E-02

Point Sources

Emission Source		Aresenic	Copper	Lead	Barium	Cobalt	Manganese	Barium	Beryllium	Cadmium	Nickel	acetaldehyde	benzene	1,3-Butadiene	Benzo(a)pyrene	Ethylene Dibromide [5]	acrolein	formaldehyde	Units
SV-001 - West Mine Exhaust Vent		1.08E-06	4.86E-03	3.65E-06	2.51E-04	1.13E-05	1.84E-04	2.62E-04	8.93E-07	3.22E-06	2.68E-05		5.03564E-06					0.000179844	g/sec
SV-002 - East Mine Exhaust Vent		1.11E-06	5.00E-03	3.76E-06	2.59E-04	1.16E-05	1.89E-04	2.70E-04	9.20E-07	3.32E-06	2.76E-05		5.18824E-06					0.000185294	g/sec
SV-003 - Portal Mine Exhaust Vent		5.88E-07	2.65E-03	1.99E-06	1.37E-04	6.14E-06	1.00E-04	1.43E-04	4.87E-07	1.76E-06	1.46E-05		2.74671E-06					9.80969E-05	g/sec
SV-004 - Construction Generator												2.32726E-05	0.0007	3.61095E-05	1.46E-07		7.28E-06	7.28655E-05	g/sec
SV-005 - Natural Gas Generator												0.007188424	3.78E-04	0.000229582	3.86937E-07	3.80918E-05	0.004419677	0.04540057	g/sec
SV-006 - Natural Gas Generator												0.007188424	3.78E-04	0.000229582	3.86937E-07	3.80918E-05	0.004419677	0.04540057	g/sec
SV-007 - Natural Gas Generator												0.007188424	3.78E-04	2.30E-04	3.87E-07	3.81E-05	0.004419677	0.04540057	g/sec
SV-008 Fire Pump												7.85933E-06	9.56E-06	4.01E-07	1.93E-09		9.47834E-07	1.20913E-05	g/sec
SV-009 Lime Silo Vent																			

Volume Sources

Emission Source	Number of Volume Source Segments	Aresenic	Copper	Lead	Barium	Cobalt	Manganese	Barium	Beryllium	Cadmium	Nickel	Units
F001 - Ore Transfer at Transfer Tower	1	8.71E-07	1.94E-04	1.46E-07	1.01E-05	4.43E-07	8.47E-06	1.01E-05	3.46E-08	2.33E-08	8.71E-07	g/sec
F002 - Surplus Ore Transfer to Ore Stockpile	1	6.62E-08	5.37E-04	4.04E-07	2.78E-05	1.22E-06	2.85E-05	2.78E-05	9.56E-08	6.44E-08	2.41E-06	g/sec
F003A&B - Transfer Points at Ore Bins/Reclaim Area [1]	2	2.80E-08	9.25E-11	1.71E-07	1.18E-05	5.17E-07	9.55E-06	1.18E-05	4.04E-08	2.72E-08	1.02E-06	g/sec
F004 - Management of Ore at Ore Stockpile	1	1.48E-07	1.20E-03	9.03E-07	6.21E-05	2.74E-06	6.52E-05	6.21E-05	2.14E-07	1.44E-07	5.38E-06	g/sec
F005 - Transfer Points at SAG Mill	1	2.80E-09	2.27E-05	1.71E-08	1.18E-06	5.17E-08	9.55E-07	1.18E-06	4.04E-09	2.72E-09	1.02E-07	g/sec
F006A&B - Concentrate Handling Operations [1]	2	2.03E-10	1.90E-04	2.03E-10	1.43E-09	2.23E-10	2.88E-07	1.43E-09	1.17E-11	1.35E-11	1.52E-09	g/sec
HR-01 - Vehicle Travel on Ore Stockpile [1]	13	9.15E-08	7.42E-04	5.59E-07	3.84E-05	1.69E-06	1.82E-05	3.84E-05	1.32E-07	8.90E-08	3.33E-06	g/sec
HR-02 - Concentrate Truck Travel on Access Road [1, 3]	233	3.82E-09	2.35E-08	1.83E-08	2.26E-07	1.90E-08	5.70E-07	2.25E-07	1.27E-09	5.50E-10	2.86E-08	g/sec
HR-03 - Water Truck Travel on Access Road [1, 3]	234	3.77E-09	2.32E-08	1.81E-08	2.22E-07	1.88E-08	5.63E-07	2.22E-07	1.25E-09	5.43E-10	2.82E-08	g/sec
HR-04 - Reagent/Grinding Media Truck on Access Road [1,3]	240	2.99E-09	1.84E-08	1.44E-08	1.76E-07	1.49E-08	4.46E-07	1.76E-07	9.92E-10	4.30E-10	2.24E-08	g/sec
HR-05 - Explosives Truck Travel on Access Road [1,3]	206	3.46E-09	2.13E-08	1.66E-08	2.03E-07	1.72E-08	5.15E-07	2.03E-07	1.15E-09	4.97E-10	2.58E-08	g/sec
HR-06 Natural Gas Delivery Truck Travel on Access Road	235	3.05E-09	1.88E-08	1.46E-08		1.51E-08	2.12E-06	1.79E-07	1.01E-09	4.38E-10	2.28E-08	g/sec
HR-07 Diesel Fuel Delivery Truck Travel on Access Road	245	3.31E-09	2.04E-08	1.59E-08		1.64E-08	2.30E-06	3.46E-08	1.10E-09	4.75E-10	2.47E-08	g/sec

Area Sources

Emission Source	Area	Aresenic	Copper	Lead	Barium	Cobalt	Manganese	Barium	Beryllium	Cadmium	Nickel	Units
F007 - Wind Erosion at Ore Stockpile	51,790	1.10E-09	4.06E-08	3.05E-11	2.10E-09	9.25E-11	9.32E-10	2.10E-09	7.23E-12	4.86E-12	1.82E-10	g/m2-sec
F008 - Wind Erosion at TDF	38,079	2.50E-09	1.20E-08	3.26E-11	1.37E-09	9.25E-11	2.15E-09	1.37E-09	5.14E-12	7.71E-13	4.80E-10	g/m2-sec

Notes:

1. Each TAC concentration is for each volume source segment. Lead is included here although it is regulated as a federal criteria pollutant.
2. Lead and most TAC emission rates for ore materials are based on PM emission composition.
3. For vehicle travel on the access road (HR-02, HR-03, HR-04, and HR-05), all emission calculations were calculated based on the percentage of TACs in native soils. Note that the access road will be dressed with clean aggregate material, such that trucks are not in direct contact with native soils over the route.
4. Calculation of manganese TAC emissions is based on Note 29 in the MDEQ Table 2 List of Screening Levels. Note 29 states that the ITSL for manganese is most appropriately applied to PM10-Mn rather than TSP-Mn data. Therefore, all TAC calculations for Mn were based on PM-10 data.
5. Ethylene dibromide is the same as 1,2-dibromoethane, CAS # 106934

Appendix B

Screening Analysis for Michigan TAC

Facility Name:								Facility Address:																			
		Screening Level						Allowable Emission Rate (AER)						Proposed Emission Rate (ER)							Is Proposed Emission Rate less than AER?						
								1st ITSL		2nd ITSL		IRSL / SRSL															
Chemical Name	CAS No.	1st ITSL µg/m³	1st ITSL Avg Time	2nd ITSL µg/m³	2nd ITSL Avg Time	IRSL / SRSL µg/m³ (annual Avg)	AQD Footnote(s)	Max lbs per hour	lbs per month, 24-hr, 8-hr or 1-hr	Max lbs per hour	lbs per month, 24-hr, 8-hr or 1-hr	Max lbs per hour	lbs per month	Max Hourly ER lbs/hour	Rate (1st ITSL)	1st ITSL Rate Units	Rate (2nd ITSL)	2nd ITSL Rate Units	Rate (IRSL)	IRSL / SRSL Rate Units	1st ITSL Max Hourly Rate	1st ITSL ER	2nd ITSL Max Hourly Rate	2nd ITSL ER	IRSL Max Hourly Rate	IRSL ER	Action
antimony	7440360	0.2	annual					0.108	8					0.000010	0.01285	lbs/month					yes	yes					
arsenic	7440382					0.0002						0.0001	0.008	0.00008					0.05704	lbs/month					yes	no	model
barium and soluble barium compou	7440393	5	8 hr				35	0.1	0.1					0.01379	0.21089	lbs/8-hr					yes	no					model
beryllium	7440417	0.02	24 hr			0.0004		0.001	0.0024			0.0002	0.016	0.00005	0.00229	lbs/24-hr			0.03816	lbs/month	yes	yes			yes	no	model
cadmium	7440439					0.0006						0.0003	0.024	0.00008					0.06199	lbs/month					yes	no	model
chromium	7440473						17							0.00229													
cobalt and cobalt compounds that	7440484	0.2	8 hr			0.0001	42	0.004	0.004			7E-05	0.0052	0.00070	0.01003	lbs/8-hr			0.51174	lbs/month	yes	no			no	no	model
copper	7440508	2	8 hr					0.04	0.04					0.21853	3.68991	lbs/8-hr					no	no					model
magnesium	7439954	100	8 hr				38	2	2					0.05307	0.4246	lbs/8-hr					yes	yes					
manganese and manganese compo	7439965	0.3	annual				29	0.162	12					0.01988	18.8626	lbs/month					yes	no					model
mercury and mercury compounds	7439976	0.3	annual	1	24 hr		7	0.162	12	0.05	0.12			0.00002	0.01244	lbs/month	0.00041	lbs/24-			yes	yes	yes	yes			
molybdenum	7439987	30	8 hr					0.6	0.6					0.00009	0.00081	lbs/8-hr					yes	yes					
nickel	7440020					0.006						0.0032	0.24	0.00148					1.07845	lbs/month					yes	no	model
phosphorus	7723140	20	24 hr				32	1	2.4					0.00834	0.20012	lbs/24-hr					yes	yes					
selenium and inorganic selenium co	7782492	2	8 hr				34	0.04	0.04					0.00004	0.00047	lbs/8-hr					yes	yes					
silver - soluble	7440224	0.1	8 hr					0.002	0.002					0.00007	0.00112	lbs/8-hr					yes	yes					
sulfur (elemental)	7704349						26							0.09619													
tin	7440315	20	8 hr					0.4	0.4					0.00006	0.00084	lbs/8-hr					yes	yes					

Chemical Name	% of AER: 1st ITSL Max Hourly Rate	1st ITSL ER	2nd ITSL Max Hourly Rate	2nd ITSL ER	IRSL Max Hourly Rate	IRSL ER
Turn values red if they are greater than:					100%	
antimony	0.0%	0.2%				
arsenic					72.3%	713.0%
barium and soluble barium compou	13.8%	210.9%				
beryllium	5.2%	95.5%			24.2%	238.5%
cadmium					26.2%	258.5%
chromium						
cobalt and cobalt compounds that	17.5%	250.8%			998.6%	9841.1%
copper	546.3%	9224.8%				
magnesium	2.7%	21.2%				
manganese and manganese compo	12.3%	157.2%				
mercury and mercury compounds	0.0%	0.1%	0.0%	0.3%		
molybdenum	0.0%	0.1%				
nickel					45.6%	449.4%
phosphorus	0.8%	8.3%				
selenium and inorganic selenium co	0.1%	1.2%				
silver - soluble	3.4%	56.1%				
sulfur (elemental)						
tin	0.0%	0.2%				

yellow columns = must enter information

Links:
Toxics Screening Level Query Footnotes

Hg 7. Besides the assessment of mercury ambient air impacts in comparison to the ITSLs, larger individual sources of mercury emissions undergoing permit review (e.g., greater than 5 to 10 lbs/yr) may be evaluated on a case-by-case basis to address concerns for deposition and bioaccumulation, taking into account site-specific factors such as the presence of nearby recreational fisheries and realistic exposure scenarios.

Cr 17. See specific trivalent and hexavalent chromium compounds.

S 26. This toxic air contaminant (TAC) is reasonably anticipated to exist as a particle in the ambient air. A toxicological review has determined that, in lieu of setting a screening level, the primary NAAQS for particulate matter (PM2.5, PM10) are reasonable and appropriate health protective levels for the particulate. The ***combined*** ambient impact of

all particulate TAC emissions from the process must be below the applicable PM primary NAAQS (PM2.5, PM10). The PM primary NAAQS for particulate matter may be used in permit to install exemption determinations for this TAC under Rule 290(2)(a)(iii) or Rule 291.

Co 42. The ***combined*** ambient impact of cobalt and cobalt compounds that release cobalt ions with the CAS No. 71-48-7, 136-52-7, 513-79-1, 814-89-1, 1002-88-6, 1307-96-6, 1308-06-1, 1317-42-6, 1560-69-6, 7440-48-4, 7646-79-9, 10026-24-1, 10141-05-6, 21041-93-0, and 61789-51-3 cannot exceed the ITSL of 0.2 µg/m³ (8-hour averaging time) and the IRSL of 0.00013 µg Co/m³ or SRSL of 0.0013 µg Co/m³ (annual averaging time).

Mn 29. The ITSL for manganese is 0.3 µg/m³ with an annual averaging time. This ITSL is most appropriately applied to PM_{10}-Mn or $PM_{2.5}$-Mn data rather than TSP-Mn data. This ITSL applies to "manganese and manganese compounds," therefore emissions of multiple forms of manganese must be accounted for additively to ensure that the combined ambient air impact does not exceed the manganese ITSL. This ITSL applies to ambient air impacts of the manganese atom, therefore the emissions and modeled impacts of various manganese compounds may be molecular weight-adjusted to the equivalent emission rate and ambient air impact of the manganese alone. Please note that potassium permanganate (CAS# 7722-64-7) also has a short-term ITSL = 0.6 µg/m³ (8 hour averaging time)

P 32. The Chemical Abstract Service number (CAS#) has been changed to 12185-10-3. Since the original number 7723-14-0, is still used by many organizations, it is listed as the primary CAS#.

Se 34. The ***combined*** ambient impact of all selenium and inorganic selenium compounds with the CAS# 7446-08-4, 7446-34-6, 7488-56-4, 7783-00-8, 10102-18-8, and 13410-01-0 cannot exceed 2 µg/m³ (8-hour averaging time).

Ba 35. The ***combined*** ambient impact of all barium and soluble barium compounds with the CAS# 543-80-6, 1304-28-5, 10022-31-8, 10361-37-2, 10553-31-8, 13477-00-4, 13718-50-8, 17194-00-2, and 21109-95-5 cannot exceed 5 µg/m³ (8-hour averaging time).

Mg 38. The ***combined*** ambient impact of magnesium (CAS No. 7439-95-4) and magnesium compounds, magnesium hydroxide, magnesium oxide, and magnesium nitrate (CAS Nos. 1309-42-8, 1309-48-4, and 10377-60-3, respectively), cannot exceed the ITSL of 100 µg/m³ (8-hour average).

Facility Name: Copperwood Mine **Facility Address:**

Chemical Name	CAS No.	Screening Level: 1st ITSL µg/m³	1st ITSL Avg Time	2nd ITSL µg/m³	2nd ITSL Avg Time	IRSL / SRSL µg/m³ (annual Avg)	AQD Footnote(s)	Allowable Emission Rate (AER): 1st ITSL Max lbs per hour	1st ITSL lbs per month, 24-hr, 8-hr or 1-hr	2nd ITSL Max lbs per hour	2nd ITSL lbs per month, 24-hr, 8-hr or 1-hr	IRSL / SRSL Max lbs per hour	IRSL / SRSL lbs per month	Max Hourly ER lbs/hour
1,1,2,2-tetrachloroethane	79345					0.02						0.0108	0.8	0.000819
1,1,2-trichloroethane	79005	11	annual	160	24 hr	0.063		5.94	440	8	19.2	0.034	2.52	0.000651
1,1-dichloroethane	75343	500	annual					270	20000					0.000483
1,2,3-trimethylbenzene	526738	185	annual	1200	8 hr		14	99.9	7400	24	24			0.000471
1,2,4-trimethylbenzene	95636	185	annual	1200	8 hr		14	99.9	7400	24	24			0.000293
1,2-dichloroethane	107062					0.04						0.0216	1.6	0.000483
propylene dichloride	78875	4	annual			0.2		2.16	160			0.108	8	0.000551
1,3,5-trimethyl benzene	108678	185	annual	1200	8 hr		14	99.9	7400	24	24			0.000692
1,3-butadiene	106990	33	annual			0.03		17.82	1320			0.0162	1.2	0.005466
1,3-dichloropropene	542756	20	annual			0.2		10.8	800			0.108	8	0.00054
2-methylnaphthalene	91576	10	annual					5.4	400					0.00068
2,2,4-Trimethyl Pentane	540841	3500	8 hr				1	70	70					0.005118
anthracene	120127	1000	annual					540	40000					1.82E-05
acenaphthene	83329	210	annual					113.4	8400					0.000256
acenaphthylene	208968	35	annual					18.9	1400					0.000136
acetaldehyde	75070	9	annual			0.5		4.86	360			0.27	20	0.171215
acrolein	107028	0.4	annual	5	1 hr		13	0.216	16	0.005	0.005			0.105238
benzene	71432	30	annual	30	24 hr	0.1		16.2	1200	1.5	3.6	0.054	4	0.011451
benz(a)anthracene	56553						5							9.25E-06
benzo(a)pyrene	50328	0.002	24 hr			0.001	5	0.0001	0.0002			0.0005	0.04	9.23E-06
Benzo(b)fluoranthene	205992						5							1.63E-05
Benzo(k)fluoranthene	207089						5							3.21E-06
benzo(g,h,i)perylene	191242	13	annual					7.02	520					8.52E-06
biphenyl	92524	13	8 hr			0.43		0.26	0.26			0.2322	17.2	0.00434
butane	106978	23800	8 hr				22	476	476					0.011076
isobutyraldehyde	78842	160	annual					86.4	6400					0.002068
carbon tetrachloride	56235	480	annual			0.17		259.2	19200			0.0918	6.8	0.000751
chlorobenzene	108907	50	annual	4400	8 hr			27	2000	88	88			0.000622
ethyl chloride	75003	10000	24 hr					500	1200					3.83E-05
chloroform	67663					0.4						0.216	16	0.000583
chrysene	218019						5							2.25E-05
cyclopentane	287923	17200	8 hr					344	344					0.004647
dibenz(a,h)anthracene	53703						5							5.12E-06
ethylbenzene	100414	1000	24 hr			0.4		50	120			0.216	16	0.000813
1,2-dibromoethane	106934	9	annual			0.002		4.86	360			0.0011	0.08	0.000907
fluorene	86737	140	annual					75.6	5600					0.00019
fluoranthene	206440	140	annual					75.6	5600					5.97E-05
formaldehyde	50000	30	24 hr			0.08		1.5	3.6			0.0432	3.2	1.081062
Indeno(1,2,3-cd)pyrene	193395						5							6.1E-06
methanol	67561	20000	24 hr	28000	1 hr			1000	2400	28	28			0.051182
methylcyclohexane	108872	16000	8 hr					320	320					0.025182
methylene chloride	75092	2000	annual	14000	1 hr	60	13	1080	80000	14	14	32.4	2400	0.000409
naphthalene	91203	3	annual	520	8 hr	0.08		1.62	120	10.4	10.4	0.0432	3.2	0.001913
n-hexane	110543	700	annual					378	28000					0.022725
n-nonane	111842	550	annual					297	22000					0.002252
pentane	109660	17700	8 hr					354	354					0.053229
PAH (benzo(a)pyrene)	50328	0.002	24 hr			0.001	5	0.0001	0.0002			0.0005	0.04	1.41E-05
phenanthrene	85018	0.1	annual					0.054	4					0.0006
phenol	108952	190	8 hr					3.8	3.8					0.000491
propylene	115071	8600	8 hr					172	172					0.041108
pyrene	129000	100	annual					54	4000					5.48E-05
styrene	100425	1000	annual			2		540	40000			1.08	80	0.000483
1,1,2,2-tetrachloroethane	79345					0.02						0.0108	0.8	5.08E-05
toluene	108883	5000	24 hr					250	600					0.008386
vinyl chloride	75014	100	annual			0.11		54	4000			0.0594	4.4	0.000305
mixed xylenes	1330207	390	annual				2	210.6	15600					0.00379
methyl amyl alcohol	108112	1000	8 hr					20	20					0.000697
n-dodecyl mercaptan	112-55-0	8	8 hr					0.16	0.16					0.003665

Chemical Name	Proposed Emission Rate (ER): Rate (1st ITSL)	1st ITSL Rate Units	Rate (2nd ITSL)	2nd ITSL Rate Units	Rate (IRSL)	IRSL / SRSL Rate Units	Is Proposed Emission Rate less than AER?: 1st ITSL Max Hourly Rate	1st ITSL ER	2nd ITSL Max Hourly Rate	2nd ITSL ER	IRSL Max Hourly Rate	IRSL ER	
1,1,2,2-tetrachloroethane					0.59781	lbs/month					yes	yes	
1,1,2-trichloroethane	0.47526	lbs/month	0.015625	lbs/24-	0.47526	lbs/month	yes	yes	yes	yes	yes	yes	
1,1-dichloroethane	0.35271	lbs/month					yes	yes					
1,2,3-trimethylbenzene	0.34374	lbs/month	0.003767	lbs/8-h			yes	yes	yes	yes			
1,2,4-trimethylbenzene	0.21372	lbs/month	0.002342	lbs/8-h			yes	yes	yes	yes			
1,2-dichloroethane					0.35271	lbs/month					yes	yes	
propylene dichloride	0.40203	lbs/month			0.40203	lbs/month	yes	yes			yes	yes	
1,3,5-trimethyl benzene	0.50515	lbs/month	0.005536	lbs/8-h			yes	yes	yes	yes			
1,3-butadiene	3.99036	lbs/month			3.99036	lbs/month	yes	yes			yes	no	model
1,3-dichloropropene	0.39455	lbs/month			0.39455	lbs/month	yes	yes			yes	yes	
2-methylnaphthalene	0.49618	lbs/month					yes	yes					
2,2,4-Trimethyl Pentane	0.04095	lbs/8-hr					yes	yes					
anthracene	0.01327	lbs/month					yes	yes					
acenaphthene	0.18693	lbs/month					yes	yes					
acenaphthylene	0.09907	lbs/month					yes	yes					
acetaldehyde	124.987	lbs/month			124.987	lbs/month	yes	yes			yes	no	model
acrolein	76.8237	lbs/month	0.105238	lbs/hr			yes	no	no	no			model
benzene	8.35942	lbs/month	0.27483	lbs/24-	8.35942	lbs/month	yes	yes	yes	yes	yes	no	model
benz(a)anthracene													
benzo(a)pyrene	0.00022	lbs/24-hr			0.00674	lbs/month	yes	yes			yes	yes	
Benzo(b)fluoranthene													
Benzo(k)fluoranthene													
benzo(g,h,i)perylene	0.00622	lbs/month					yes	yes					
biphenyl	0.03472	lbs/8-hr			3.16838	lbs/month	yes	yes			yes	yes	
butane	0.08861	lbs/8-hr					yes	yes					
isobutyraldehyde	1.50946	lbs/month					yes	yes					
carbon tetrachloride	0.54849	lbs/month			0.54849	lbs/month	yes	yes			yes	yes	
chlorobenzene	0.45433	lbs/month	0.004979	lbs/8-h			yes	yes	yes	yes			
ethyl chloride	0.00092	lbs/24-hr					yes	yes					
chloroform					0.42594	lbs/month					yes	yes	
chrysene													
cyclopentane	0.03718	lbs/8-hr					yes	yes					
dibenz(a,h)anthracene													
ethylbenzene	0.01951	lbs/24-hr			0.59332	lbs/month	yes	yes			yes	yes	
1,2-dibromoethane	0.66207	lbs/month			0.66207	lbs/month	yes	yes			yes	no	model
fluorene	0.13871	lbs/month					yes	yes					
fluoranthene	0.04358	lbs/month					yes	yes					
formaldehyde	25.9455	lbs/24-hr			789.175	lbs/month	yes	no			no	no	model
Indeno(1,2,3-cd)pyrene													
methanol	1.22837	lbs/24-hr	0.051182	lbs/hr			yes	yes	yes	yes			
methylcyclohexane	0.20145	lbs/8-hr					yes	yes					
methylene chloride	0.2989	lbs/month	0.000409	lbs/hr	0.2989	lbs/month	yes	yes	yes	yes	yes	yes	
naphthalene	1.39617	lbs/month	0.015301	lbs/8-h	1.39617	lbs/month	yes	yes	yes	yes	yes	yes	
n-hexane	16.5891	lbs/month					yes	yes					
n-nonane	1.64397	lbs/month					yes	yes					
pentane	0.42584	lbs/8-hr					yes	yes					
PAH (benzo(a)pyrene)	0.00034	lbs/24-hr			0.01029	lbs/month	yes	no			yes	yes	model
phenanthrene	0.43835	lbs/month					yes	yes					
phenol	0.00393	lbs/8-hr					yes	yes					
propylene	0.32887	lbs/8-hr					yes	yes					
pyrene	0.03998	lbs/month					yes	yes					
styrene	0.35271	lbs/month			0.35271	lbs/month	yes	yes			yes	yes	
1,1,2,2-tetrachloroethane					0.03706	lbs/month					yes	yes	
toluene	0.20127	lbs/24-hr					yes	yes					
vinyl chloride	0.22268	lbs/month			0.22268	lbs/month	yes	yes			yes	yes	
mixed xylenes	2.76683	lbs/month					yes	yes					
methyl amyl alcohol	0.00557	lbs/8-hr					yes	yes					
n-dodecyl mercaptan	0.02932	lbs/8-hr					yes	yes					

% of AER — Turn values red if they are greater than: 100%

Chemical Name	1st ITSL Max Hourly Rate	1st ITSL ER	2nd ITSL Max Hourly Rate	2nd ITSL ER	IRSL Max Hourly Rate	IRSL ER
1,1,2,2-tetrachloroethane					7.6%	74.7%
1,1,2-trichloroethane	0.0%	0.1%	0.0%	0.1%	1.9%	18.9%
1,1-dichloroethane	0.0%	0.0%				
1,2,3-trimethylbenzene	0.0%	0.0%	0.0%	0.0%		
1,2,4-trimethylbenzene	0.0%	0.0%	0.0%	0.0%		
1,2-dichloroethane					2.2%	22.0%
propylene dichloride	0.0%	0.3%			0.5%	5.0%
1,3,5-trimethyl benzene	0.0%	0.0%	0.0%	0.0%		
1,3-butadiene	0.0%	0.3%			33.7%	332.5%
1,3-dichloropropene	0.0%	0.0%			0.5%	4.9%
2-methylnaphthalene	0.0%	0.1%				
2,2,4-Trimethyl Pentane	0.0%	0.1%				
anthracene	0.0%	0.0%				
acenaphthene	0.0%	0.0%				
acenaphthylene	0.0%	0.0%				
acetaldehyde	3.5%	34.7%			63.4%	624.9%
acrolein	48.7%	480.1%	2104.8%	2104.8%		
benzene	0.1%	0.7%	0.8%	7.6%	21.2%	209.0%
benz(a)anthracene						
benzo(a)pyrene	9.2%	92.3%			1.7%	16.8%
Benzo(b)fluoranthene						
Benzo(k)fluoranthene						
benzo(g,h,i)perylene	0.0%	0.0%				
biphenyl	1.7%	13.4%			1.9%	18.4%
butane	0.0%	0.0%				
isobutyraldehyde	0.0%	0.0%				
carbon tetrachloride	0.0%	0.0%			0.8%	8.1%
chlorobenzene	0.0%	0.0%	0.0%	0.0%		
ethyl chloride	0.0%	0.0%				
chloroform					0.3%	2.7%
chrysene						
cyclopentane	0.0%	0.0%				
dibenz(a,h)anthracene						
ethylbenzene	0.0%	0.0%			0.4%	3.7%
1,2-dibromoethane	0.0%	0.2%			84.0%	827.6%
fluorene	0.0%	0.0%				
fluoranthene	0.0%	0.0%				
formaldehyde	72.1%	720.7%			2502.5%	24661.7%
Indeno(1,2,3-cd)pyrene						
methanol	0.0%	0.1%	0.2%	0.2%		
methylcyclohexane	0.0%	0.1%				
methylene chloride	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
naphthalene	0.1%	1.2%	0.0%	0.1%	4.4%	43.6%
n-hexane	0.0%	0.1%				
n-nonane	0.0%	0.0%				
pentane	0.0%	0.1%				
PAH (benzo(a)pyrene)	14.1%	140.9%			2.6%	25.7%
phenanthrene	1.1%	11.0%				
phenol	0.0%	0.1%				
propylene	0.0%	0.2%				
pyrene	0.0%	0.0%				
styrene	0.0%	0.0%			0.0%	0.4%
1,1,2,2-tetrachloroethane					0.5%	4.6%
toluene	0.0%	0.0%				
vinyl chloride	0.0%	0.0%			0.5%	5.1%
mixed xylenes	0.0%	0.0%				
methyl amyl alcohol	0.0%	0.0%				
n-dodecyl mercaptan	2.3%	18.3%				

yellow columns = must enter information
methyl amyl alcohol is MIBC.
Links:
Toxics Screening Level Query Footnotes
Procedure for the Carcinogenic PAHs of Footnote No. 5 - See PAHs worksheet

Potency Factors for TACs with AQD Footnote 5.

Table 1. PAH Potency Equivalency Factors (PEFs)

CHEMICAL NAME	CAS NO.	PEF	Emission Rate (lb/hr)
Dibenz(a,h)anthracene	53-70-3	1.1	2.64E-06
3-Methylcholanthrene	56-49-5	5.7	
7,12-Dimethylbenz(a)anthracene	57-97-6	65	
Chrysene	218-01-9	0.01	1.13E-05
Indeno(1,2,3-cd)pyrene	193-39-5	0.1	3.15E-06
Benzo(a)anthracene	56-55-3	0.1	4.78E-06
Benzo(b)fluoranthene	205-99-2	0.1	8.23E-06
Benzo(k)fluoranthene	207-08-9	0.1	1.70E-06
Benzo(j)fluoranthene	205-82-3	0.1	
5-Methylchrysene	3697-24-3	1	
Benzo(a)pyrene	50-32-8	1	9.29E-06
Dibenzo(a,e)pyrene	192-65-4	1	
Dibenzo(a,h)pyrene	189-64-0	10	
Dibenzo(a,i)pyrene	189-55-9	10	
Dibenzo(a,l)pyrene	191-30-0	10	
Equivalent Emission Rate of benzo(a)pyrene (lb/hr)			1.41E-05

yellow columns = must enter information

Instructions: In the table for Rule 227(1)(a) enter in CAS Numbers and emission rates for each PAH that is emitted. The table above will calculate the "equivalent emission rate of benzo(a)pyrene." Next, you need to compare this to the IRSL (or SRSL) for benzo(a)pyrene.

In the table for Rule 227(1)(a), (b), or (c), enter the CAS No. for benzo(a)pyrene (50-32-8) into Column B, **and change the Chemical Name in Column A from "benzo(a)pyrene" to "PAHs as benzo(a)pyrene."** Changing the name will prevent the table above from double-counting the benzo(a)pyrene emissions. Then enter the equivalent emission rate of benzo(a)pyrene into the appropriate column.

Additionally, in the table for Rule 227(1)(a),(b), or (c), **remove the entries for the ITSL in Column D**

Appendix C

Criteria Air Pollutant Background Concentrations

(Provided by EGLE)

	NO2		CO		SO2		PM-2.5		PM-10
	Houghton Lake		Horicon Wildlife Area (Beaver Dam), WI		Forest County, WI		Bad River Tribal School (Aslhand Co, WI)		Duluth, MN
	1-hr 98th pctl	Annual Avg	1-hr Max	8-hr Max	1-hr 99th pctl	3-hr Max	24-hr 98th pctl	Annual Avg	24-hr Max
2020	6.4	1.0	0.4	0.3	1.5	4.0	12.8	5.2	107
2021	7.3	1.0	0.6	0.5	1.3	1.5	20.6	6.7	61
2022	7.5	1.3	1.0	0.5	1.3	1.1	13.5	4.9	72
	7.1	**1.3**	**1.0**	**0.5**	**1.4**	**4.0**	**15.6**	**5.6**	
	ppb	ppb	ppm	ppm	ppb	ppb	ug/m3	ug/m3	

PM10			
Year	Max Highs	Year	Highs
2020	107	2020	107
2020	74	2020	74
2020	66	2022	72
2020	61	**2020**	**66**
2021	61		
2021	58		
2021	58		
2021	58		
2022	72		
2022	62		
2022	57		
2022	55		

NO2		CO		SO2		PM-2.5		PM-10
13.3	**2.4**	**1,113.6**	**580.0**	**3.6**	**10.5**	**15.6**	**5.6**	**66**
ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3
								3-yr 4th high

Red numbers to be used in modeling

Data and calculations prepared by Alec Kownacki - EGLE AQD

20-Apr-23

Appendix D

EGLE Guidance on PSD Baseline Dates

Prevention o i ni i ant Deterioration Baseline Dates

Major our e

NO_x	T P / PM10	O_2	PM2.
February 8, 1988	January 6, 1975	January 6, 1975	October 20, 2010

Minor our e

(Revised June 7, 2018)

AQCR #	NO_x	T P / PM10	O_2	PM2.
122	**Mar h 28, 1988** PTI No. 943-87 Ada Cogeneration Ada	**January 31, 1980** PTI No. 541-79 Grand Haven Board of Light & Power Grand Haven	**January 31, 1980** PTI No. 541-79 Grand Haven Board of Light & Power Grand Haven	**July 12, 2012** PTI No. 103-12 Midland Cogeneration Venture Midland
123	**De ember 28, 1989** PTI No. 1144-89 Oakland County Incinerator Auburn Hills	**June 24, 1978** Permit No. EPA-5-A-79-10 Marblehead Lime Detroit	**June 24, 1978** Permit No. EPA-5-A-79-10 Marblehead Lime Detroit	**eptember 14, 2012** PTI No. 21-09A Hoosier Energy Van Buren Township
123*		**July 21, 1999** PTI No. 269-99 Detroit Edison River Rouge River Rouge		
124	**January 19, 199** PTI Nos. 28-95 & 29-95 North Star Steel / BHP Dundee	**February 1, 1978** Permit No. EPA-5-A-79-5 North Star Steel Monroe	**February 1, 1978** Permit No. EPA-5-A-79-5 North Star Steel Monroe	**May 1, 2018** Permit No. 75-18 Gerdau Macsteel Monroe
125	**Mar h 4, 1988** PTI No. 748-87 Michigan State University East Lansing	**April 24, 1979** Permit No. EPA-5-A-79-20 GM, Hydramatic Division Three Rivers	**April 2, 1979** Permit No. EPA-5-A-79-16 Upjohn Corporation Kalamazoo	**June 29, 2017** PTI No. 26-15B Knauf Insulation, Inc. Albion
126	**May 13, 1988** PTI No. 519-87A Tondu Energy Systems Filer City	**February 8, 1980** PTI No. 6-80 Mead Paper Company Escanaba	**February 8, 1980** PTI No. 6-80 Mead Paper Company Escanaba	**Mar h 31, 2016** PTI No. 59-16 Flakeboard America Limited, dba Arauco North America Grayling
82	**De ember 27, 1994** PTI No. 489-94 North Star Steel Benton Harbor	**De ember 27, 1994** PTI No. 489-94 North Star Steel Benton Harbor	**De ember 27, 1994** PTI No. 489-94 North Star Steel Benton Harbor	**May 10, 2016** PTI No. 75-16 Indeck Niles

*Note that there is a separate area within AQCR 123 for which PM10 has an alternate baseline date.
PTI refers to an Air Quality Division Permit to Install application.

Appendix F

RACT/BACT/LAER Clearinghouse Information

Pollutant n o at on

Cl ck on the P ocess n o at on button to see o e n o at on about the p ocess assoc ated w th th s pollutant.
O cl ck on the P ocess L st button to etu n to the l st o p ocesses.

RBLC Home | New Search | Search Results | Facility Information | Process List | Process Information | Pollutant Information

Help
F NAL

RBLC : LA-0209
Co po ate/Co pany: BIG RIVER INDUSTRIES, INC.
Fac l ty Na e: GRAVELITE DIVISION
P ocess: CONVEYOR SYSTEMS AND STOCKPILES

Pollutant: Particulate matter, filterable < 10 µ (FPM10)
CAS Number: PM

Pollutant Group(s): Particulate Matter (PM),
Substance Registry System: Particulate matter, filterable < 10 µ (FPM10)

Pollution Prevention/**A**dd-on Control Equipment/**B**oth/**N**o Controls Feasible: P
P2/Add-on Description: WATER SPRAYS AND/OR PARTIAL ENCLOSURE

Test Method: Unspecified
EPA/OAR Methods | All Other Methods

Percent Efficiency: 90.000
Compliance Verified: Unknown
EMISSION LIMITS:
Case-by-Case Basis: BACT-PSD
Other Applicable Requirements: OPERATING PERMIT
Other Factors Influence Decision: Unknown
Emission Limit 1: 0.1000 LB/H HOURLY MAXIMUM
Emission Limit 2: 0.4300 T/YR ANNUAL MAXIMUM
Standard Emission Limit: 0
COST DATA:
Cost Verified? No
Dollar Year Used in Cost Estimates:
Cost Effectiveness: 0 $/ton
Incremental Cost Effectiveness: 0 $/ton
Pollutant Notes:

Pollutant n o   at on

Cl ck on the P ocess n o   at on button to see   o e n o   at on about the p ocess assoc ated w th th s pollutant.
O   cl ck on the P ocess L st button to etu n to the l st o p ocesses.

RBLC Home | New Search | Search Results | Facility Information | Process List | Process Information

Pollutant Information

Help

F NAL

RBLC   : LA-0209
Co po ate/Co   pany: BIG RIVER INDUSTRIES, INC.
Fac l ty Na   e: GRAVELITE DIVISION
P ocess: LOADOUT, TRUCK AND RAIL, EAST & WEST

Pollutant: Particulate matter, filterable < 10 µ (FPM10)

CAS Number: PM

Pollutant Group(s): Particulate Matter (PM),

Substance Registry System: Particulate matter, filterable < 10 µ (FPM10)

Pollution Prevention/**A**dd-on Control Equipment/**B**oth/**N**o Controls Feasible: P

P2/Add-on Description: WATER SPRAYS AND/OR PARTIAL ENCLOSURE

Test Method: Unspecified

EPA/OAR Methods | All Other Methods

Percent Efficiency: 90.000
Compliance Verified: Unknown
EMISSION LIMITS:
- **Case-by-Case Basis:** BACT-PSD
- **Other Applicable Requirements:** OPERATING PERMIT
- **Other Factors Influence Decision:** Unknown
- **Emission Limit 1:** 0.0100 LB/H HOURLY MAXIMUM
- **Emission Limit 2:** 0.0500 T/YR ANNUAL MAXIMUM
- **Standard Emission Limit:** 0

COST DATA:
- **Cost Verified?** No
- **Dollar Year Used in Cost Estimates:**
- **Cost Effectiveness:** 0 $/ton
- **Incremental Cost Effectiveness:** 0 $/ton
- **Pollutant Notes:**

Technology Transfer Network
Clean Air Technology Center - RACT/BACT/LAER Clearinghouse

Pollutant n o at on

Cl ck on the P ocess n o at on button to see o e n o at on about the p ocess assoc ated w th th s pollutant.
O cl ck on the P ocess L st button to etu n to the l st o p ocesses.

RBLC Home | New Search | Search Results | Facility Information | Process List | Process Information | Pollutant Information

Help
F NAL

RBLC : VA-0292
Co po ate/Co pany: ISLAND CREEK COAL
Fac l ty Na e: ISLAND CREEK COAL - VP #8 GARDEN PLANT
P ocess: COAL HANDLING AND TRANSFER OPERATIONS

Pollutant: Particulate matter, filterable < 10 µ (FPM10)
CAS Number: PM

Pollutant Group(s): Particulate Matter (PM),
Substance Registry System: Particulate matter, filterable < 10 µ (FPM10)

Pollution Prevention/**A**dd-on Control Equipment/**B**oth/**N**o Controls Feasible: P
P2/Add-on Description: WET SUPPRESSION

Test Method: Unspecified

EPA/OAR Methods | All Other Methods

Percent Efficiency: 90.000
Compliance Verified: Unknown
EMISSION LIMITS:
- **Case-by-Case Basis:** BACT-PSD
- **Other Applicable Requirements:** NSPS
- **Other Factors Influence Decision:** Unknown
- **Emission Limit 1:** 3.3500 T/YR
- **Emission Limit 2:** 0
- **Standard Emission Limit:** 0 NOT AVAILABLE

COST DATA:
- **Cost Verified?** No
- **Dollar Year Used in Cost Estimates:** 2005
- **Cost Effectiveness:** 0 $/ton
- **Incremental Cost Effectiveness:** 0 $/ton
- **Pollutant Notes:**

Pollutant n o at on

F NAL

RBLC : AR-0074
Co po ate/Co pany: PLUM POINT ASSOCIATES, LLC
Fac l ty Na e: PLUM POINT ENERGY
P ocess: MATERIAL HANDLING, COAL, PARTIALLY INCLOSED

Pollutant: Particulate matter, filterable < 10 µ (FPM10)

CAS Number: PM

Pollutant Group(s): Particulate Matter (PM),

Substance Registry System: Particulate matter, filterable < 10 µ (FPM10)

Pollution Prevention/**A**dd-on Control Equipment/**B**oth/**N**o Controls Feasible: A

P2/Add-on Description: PARTIAL ENCLOSURES

Test Method: Unspecified

EPA/OAR Methods | All Other Methods

Percent Efficiency: 0
Compliance Verified:
EMISSION LIMITS:
- **Case-by-Case Basis:** BACT-PSD
- **Other Applicable Requirements:**
- **Other Factors Influence Decision:**
- **Emission Limit 1:** 0.1000 LB/H
- **Emission Limit 2:** 0.4000 LB/H
- **Standard Emission Limit:** 0

COST DATA:
- **Cost Verified?** No
- **Dollar Year Used in Cost Estimates:**
- **Cost Effectiveness:** 0 $/ton
- **Incremental Cost Effectiveness:** 0 $/ton
- **Pollutant Notes:** Stackput conveyors 1& 3, barge unloading,reclaim conveyors 1& 2, reclaim transfer - limit is 0.1 lb/h. Stackout conveyor 2 - limit is 0.4 lb/h. stackout transfer - limit is 0.2 lb/h

Pollutant n o at on

Cl ck on the P ocess n o at on button to see o e n o at on about the p ocess assoc ated w th th s pollutant.
O cl ck on the P ocess L st button to etu n to the l st o p ocesses.

RBLC Home | New Search | Search Results | Facility Information | Process List | Process Information | Pollutant Information

Help
F NAL

RBLC : OR-0046
Co po ate/Co pany: CALPINE
Fac l ty Na e: TURNER ENERGY CENTER, LLC
P ocess: ELECTRICAL POWER GENERATION

Pollutant: Nitrogen Oxides (NOx) **CAS Number:** 10102

Pollutant Group(s): InOrganic Compounds, Oxides of Nitrogen (NOx), Particulate Matter (PM),

Substance Registry System: Nitrogen Oxides (NOx)

Pollution Prevention/**A**dd-on Control Equipment/**B**oth/**N**o Controls Feasible: A

P2/Add-on Description: SELECTIVE CATALYTIC REDUCTION

Test Method: Unspecified

EPA/OAR Methods | All Other Methods

Percent Efficiency: 92.000
Compliance Verified: Unknown
EMISSION LIMITS:
- **Case-by-Case Basis:** BACT-PSD
- **Other Applicable Requirements:** NSPS
- **Other Factors Influence Decision:** No
- **Emission Limit 1:** 2.0000 PPMVD 1-H BLOCK
- **Emission Limit 2:** 0
- **Standard Emission Limit:** 0 NOT AVAILABLE

COST DATA:
- **Cost Verified?** No
- **Dollar Year Used in Cost Estimates:** 2006
- **Cost Effectiveness:** 0 $/ton
- **Incremental Cost Effectiveness:** 0 $/ton
- **Pollutant Notes:** LIMIT APPLIES TO COMBINED TURBINE/HRSG EXHAUST.

Pollutant n o   at on

Cl ck on the P ocess n o   at on button to see o e n o   at on about the p ocess assoc ated w th th s pollutant.
O cl ck on the P ocess L st button to etu n to the l st o p ocesses.

RBLC Home | New Search | Search Results | Facility Information | Process List | Process Information | Pollutant Information

Help
F NAL

RBLC   : OR-0046
Co po ate/Co pany: CALPINE
Fac l ty Na e: TURNER ENERGY CENTER, LLC
P ocess: ELECTRICAL POWER GENERATION

Pollutant: Carbon Monoxide **CAS Number:** 630-08-0

Pollutant Group(s): InOrganic Compounds, **Substance Registry System:** Carbon Monoxide

Pollution Prevention/**A**dd-on Control Equipment/**B**oth/**N**o Controls Feasible: A
P2/Add-on Description: OXIDATION CATALYST

Test Method: Unspecified

EPA/OAR Methods | All Other Methods

Percent Efficiency:	92.000
Compliance Verified:	Unknown
EMISSION LIMITS:	
Case-by-Case Basis:	BACT-PSD
Other Applicable Requirements:	
Other Factors Influence Decision:	Unknown
Emission Limit 1:	2.0000 PPMVD 3-H ROLLING/@>70% CAPACITY
Emission Limit 2:	3.0000 PPMVD 3-HR ROLLING/@<70% CAPACITY
Standard Emission Limit:	0 NOT AVAILABLE
COST DATA:	
Cost Verified?	No
Dollar Year Used in Cost Estimates:	2006
Cost Effectiveness:	0 $/ton
Incremental Cost Effectiveness:	0 $/ton
Pollutant Notes:	LIMITS APPLY TO COMBINED TURBINE/HRSG EXHAUST.

Pollutant n o at on

Cl ck on the P ocess n o at on button to see o e n o at on about the p ocess assoc ated w th th s pollutant.
O cl ck on the P ocess L st button to etu n to the l st o p ocesses.

RBLC Home | New Search | Search Results | Facility Information | Process List | Process Information

Pollutant Information

Help

F NAL

RBLC : UT-0060
Co po ate/Co pany: DESERET GENERATION AND TRANSMISSION CO.
Fac l ty Na e: DESERET GENERATION AND TRANSMISSION CO.
P ocess: ROADS (UNPAVED)

Pollutant: Particulate Matter (PM) **CAS Number:** PM

Pollutant Group(s): Particulate Matter (PM), **Substance Registry System:** Particulate Matter (PM)

Pollution Prevention/**A**dd-on Control Equipment/**B**oth/**N**o Controls Feasible: P

P2/Add-on Description: WATER SPRAYED AND/OR CHEMICALLY TREATED. NO EMISSION RATE LIMITS

Test Method: Unspecified

EPA/OAR Methods | All Other Methods

Percent Efficiency:	0
Compliance Verified:	
EMISSION LIMITS:	
Case-by-Case Basis:	BACT-PSD
Other Applicable Requirements:	
Other Factors Influence Decision:	
Emission Limit 1:	0
Emission Limit 2:	0
Standard Emission Limit:	0
COST DATA:	
Cost Verified?	No
Dollar Year Used in Cost Estimates:	
Cost Effectiveness:	0 $/ton
Incremental Cost Effectiveness:	0 $/ton
Pollutant Notes:	

Technology Transfer Network
Clean Air Technology Center - RACT/BACT/LAER Clearinghouse

Pollutant n o at on

Cl ck on the P ocess n o at on button to see o e n o at on about the p ocess assoc ated w th th s pollutant.
O cl ck on the P ocess L st button to etu n to the l st o p ocesses.

RBLC Home | New Search | Search Results | Facility Information | Process List | Process Information | Pollutant Information

Help

F NAL

RBLC : UT-0061
Co po ate/Co pany: NUCOR STEEL CORPORATION
Fac l ty Na e: NUCOR STEEL CORPORATION
P ocess: ROADS (UNPAVED)

Pollutant: Visible Emissions (VE) **CAS Number:** VE

Pollutant Group(s): **Substance Registry System:** Visible Emissions (VE)

Pollution Prevention/**A**dd-on Control Equipment/**B**oth/**N**o Controls Feasible: P
P2/Add-on Description: WATER SPRAYED OR CHEMICALLY TREATED

Test Method: Unspecified

EPA/OAR Methods | All Other Methods

Percent Efficiency: 0
Compliance Verified:
EMISSION LIMITS:
Case-by-Case Basis: Other Case-by-Case
Other Applicable Requirements:
Other Factors Influence Decision:
Emission Limit 1: 20.0000 % OPACITY
Emission Limit 2: 0
Standard Emission Limit: 0
COST DATA:
Cost Verified? No
Dollar Year Used in Cost Estimates:
Cost Effectiveness: 0 $/ton
Incremental Cost Effectiveness: 0 $/ton
Pollutant Notes:

Pollutant n o at on

Cl ck on the P ocess n o at on button to see o e n o at on about the p ocess assoc ated w th th s pollutant.
O cl ck on the P ocess L st button to etu n to the l st o p ocesses.

RBLC Home | New Search | Search Results | Facility Information | Process List | Process Information | Pollutant Information

Help
F NAL

RBLC : AR-0124
Co po ate/Co pany: UNION COUNTY LUMBER COMPANY
Fac l ty Na e: EL DORADO SAWMILL
P ocess: HAUL ROADS SN-09

Pollutant: Particulate matter, total (TPM)
CAS Number: PM

Pollutant Group(s): Particulate Matter (PM),
Substance Registry System: Particulate matter, total (TPM)

Pollution Prevention/**A**dd-on Control Equipment/**B**oth/**N**o Controls Feasible: P
P2/Add-on Description: ROAD WATERING PLAN + 0% OFF-SITE OPACITY

Test Method: Unspecified
EPA/OAR Methods | All Other Methods

Percent Efficiency: 90.000
Compliance Verified: No
EMISSION LIMITS:
Case-by-Case Basis: BACT-PSD
Other Applicable Requirements: OPERATING PERMIT
Other Factors Influence Decision: No
Emission Limit 1: 12.7000 LB/H
Emission Limit 2: 0
Standard Emission Limit: 0
COST DATA:
Cost Verified? No
Dollar Year Used in Cost Estimates:
Cost Effectiveness: 0 $/ton
Incremental Cost Effectiveness: 0 $/ton
Pollutant Notes:

Technology Transfer Network
Clean Air Technology Center - RACT/BACT/LAER Clearinghouse

Pollutant n o at on

Cl ck on the P ocess n o at on button to see o e n o at on about the p ocess assoc ated w th th s pollutant.
O cl ck on the P ocess L st button to etu n to the l st o p ocesses.

RBLC Home | New Search | Search Results | Facility Information | Process List | Process Information

Pollutant Information

Help
F NAL

RBLC : LA-0209
Co po ate/Co pany: BIG RIVER INDUSTRIES, INC.
Fac l ty Na e: GRAVELITE DIVISION
P ocess: UNPAVED ROADS

Pollutant: Particulate matter, filterable < 10 µ (FPM10)

CAS Number: PM

Pollutant Group(s): Particulate Matter (PM),

Substance Registry System: Particulate matter, filterable < 10 µ (FPM10)

Pollution Prevention/**A**dd-on Control Equipment/**B**oth/**N**o Controls Feasible: P
P2/Add-on Description: WATERING AND REDUCED SPEED LIMIT

Test Method: Unspecified

EPA/OAR Methods | All Other Methods

Percent Efficiency: 95.500
Compliance Verified: Unknown
EMISSION LIMITS:
Case-by-Case Basis: BACT-PSD
Other Applicable Requirements: OPERATING PERMIT
Other Factors Influence Decision: Unknown
Emission Limit 1: 0.7000 LB/H HOURLY MAXIMUM
Emission Limit 2: 3.0500 T/YR ANNUAL MAXIMUM
Standard Emission Limit: 0
COST DATA:
Cost Verified? No
Dollar Year Used in Cost Estimates:
Cost Effectiveness: 0 $/ton
Incremental Cost Effectiveness: 0 $/ton
Pollutant Notes:

Appendix G

Proposed Compliance Monitoring and Reporting Plan

Compliance Monitoring and Reporting for Permit to Install

Copperwood Resources, Inc. (CRI) understands the following permit conditions may apply upon approval of the Permit to Install for the Project:

General Permit Conditions

Equipment will not be constructed unless a Permit to Install authorizing action is issued and valid.

Installation and construction must commence within 18 months of issuance of the Permit to Install. Interruptions in construction of longer than 18 months will cause the Permit to Install to become void unless otherwise authorized by the EGLE. CRI shall notify EGLE if construction of the Project has not been pursued.

CRI understands an approved Permit to Install may be revoked if emitting equipment is not performing in accordance with terms and conditions of the permit or is violating Michigan air use rules or the Federal Clean Air Act.

CRI understands the Permit to Install, once issued, applies to any person or legal entity that then or thereafter owns or operates the facility. Should CRI desire a change of ownership, a request shall be made to the EGLE in a timely manner.

In accordance with the approved Permit to Install, CRI shall provide notice to EGLE of abnormal conditions, start-up, shutdown or malfunction resulting in emissions of a hazardous or toxic air pollutant which continues for more than one hour in excess of any applicable standard or limitation or emissions of any air contaminant continuing for more than two hours in excess of an applicable standard or limitation as required in R 336.1912. The notice shall be provided within two business days after the abnormal start-up or shutdown or discovery of abnormal condition or malfunction. Written reports, if required, must be filed with EGLE within 10 days after abnormal start-up or shutdown occurring, within 10 days after abnormal conditions or malfunction has been corrected, or within 30 days of discovery of abnormal condition or malfunction, whichever is first. Written reports shall include all information specified in R 336.1912(5).

CRI acknowledges Permit to Install approval does not exempt it from complying with future applicable requirements which may be promulgated under Part 55 of 1994 PA Act 451, as amended, and the rules promulgated hereunder.

CRI shall not cause or permit to be discharged into the air from a process or process equipment a visible emission of density greater than the permitted limit.

Collected air contaminants shall be removed as necessary and as outlined in the control equipment procedures approved by the EGLE. The collection and disposal of the contaminants shall be performed to minimize the escape of contaminants in accordance with Michigan rules and industry practice.

CRI understands the EGLE may require performance tests at CRI expense in accordance with R 336.2001 and R 336.2003, under any conditions listed in R 336.2001.

Special Conditions

Process/Operational Limits

CRI shall not operate processes identified as emitting fugitive dust (EUOREHANDLING, and EUHAULROADS) unless a program for continuous control is implemented and maintained. This program is outlined in the *Fugitive Dust Control Plan,* Appendix D.

Where indicated, CRI shall operate certain emission points associated with EUOREHANDLING at the Ore Transfer from Portal to First Transfer Point (F001), Surplus Ore Transfer to Ore Stockpile (F002), Ore Bins/Reclaim Area (F003), and transfer at the SAG Mill (F005) such that they are equipped with enclosures and/or conveyor covers. This will include drop points between conveyors and to the stockpiles.

Management of ore within the Ore Stockpile (F004) shall be conducted to minimize dust generation, including minimizing drop heights of the FEL bucket and use of water on travel routes for the FEL.

Fugitive dust emissions from use of haul roads associated with EUHAULROADS (HR-01 through HR-07) will be minimized through use of certain work practices, including use of aggregate on the access road leading from the main gate to the concentrate loadout area and use of a water truck for wet suppression of this haul route. Vehicle speeds will also be maintained at 15 mph. Wet suppression will also be used at the Ore Stockpile (HR-01) to reduce fugitive dust along the transfer route for the FEL that transfers ore from the stockpile to the Ore Transfer from Portal.

Combustion Equipment

Considering the combustion equipment, the following combinations are evaluated in this air permit application:

When the construction diesel generator is operating (low sulfur fuel only), the following equipment may be operating:

- The emergency firewater pump can operate, no time limit.
- The propane or natural gas mine heater can operate up to 4,000 hours per year.
- There will be no additional generators operating.

When the three natural gas generators are on site, they can operate the following way:

Pre-power line installation:

- 2 natural gas generators can operate 24/7/365 (8,760 hours per year) at 100% load.
- The 3rd natural gas generator is on emergency standby and can operate up to 500 hours per year at 100% load
- The propane or natural gas mine heater can operate up to 4,000 hours per year
- The emergency firewater pump can operate, no time limit

Post-power line installation:

- 1 natural gas generator can operate 24/7/365 at 100% load
- 2 natural gas generators can each operate up to 4,000 hours per year[1], however, anticipated to be needed for 900 hours per year each at 100% load
- The propane or natural gas mine heater can operate up to 4,000 hours per year
- The emergency firewater pump can operate, no time limit

[1] 4,000 operating hours per year maintains the annual PTE.

To achieve low emissions, each natural gas generator will be equipped with both a SCR and Oxidation Catalyst system for reducing emissions of NO_2, CO to levels that will comply with NAAQS and Michigan TAC standards. The control equipment will be operated and maintained with a *Malfunction and Abatement Plan* that will be prepared and submitted to the EGLE for approval in accordance with air permit conditions and prior to operation of the generators.

The facility will conduct maintenance on the equipment to meet requirements of 40 CFR 60, Subpart IIII.

Testing

Stack testing, if required by the EGLE, will be performed for specified emission rates as required by the EGLE in the approved Permit to Install at CRI expense.

Evaluation of visible emissions, if required by the EGLE, will be performed at CRI expense.

Monitoring

Monitoring for specified rates as required EGLE in the approved Permit to Install shall be performed by CRI at the specified time and frequency.

Recordkeeping/Reporting/Notification

CRI shall maintain records of SCR/Oxidation Catalyst inspections and maintenance in a satisfactory manner and in accordance with manufacturers' requirements. All records shall be kept on file for a period of five years and made available to the EGLE upon request.

CRI shall perform recordkeeping requirements for visible emission limits and stacks in accordance with approved Permit to Install requirements.

Emissions Reporting

CRI shall submit the annual Michigan Air Emission Reporting System (MAERS) report by March 15 of each year, covering emissions generated the previous calendar year (January 1 through December 31). The report shall be prepared in accordance with EGLE instructions, MAERS Workbook, and Calculating Air Emissions for MAERS guidebook, published by the EGLE.