# Memorandum

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May 8, 2018

TO: Tom Repaal, Copperwood Resources, Inc.

CC: Kris Baran, Foth Infrastructure & Environment, LLC
Steve Donohue, Foth Infrastructure & Environment, LLC

FR: Andrea Martin, Foth Infrastructure & Environment, LLC
Curt Dungey, Foth Infrastructure & Environment, LLC

RE: Copperwood Project – Air Deposition Analysis

## Purpose

This memorandum has been prepared by Foth Infrastructure & Environment, LLC (Foth) for Copperwood Resources, Inc. (Copperwood). The purpose of this memorandum is to analyze potential air quality deposition impacts that may result from activities at the proposed Copperwood Project (Project) nonferrous mining and ore processing operations. The air deposition analysis was performed to address R425.202 (b) of Michigan's Natural Resources Environmental Protection Act (NREPA) Part 632, Nonferrous Metallic Mining Regulations in support of requirements of the Environmental Impact Assessment Amendment (Foth, 2018a). R425.202 requires the applicant perform an analysis of the potential cumulative impacts on the mining and affected area from all proposed mining activities.

This memorandum analyzes potential air deposition impacts to soils. The analysis considers two constituents of concern: copper and sulfur. Copper is the target metal of the mine and therefore is anticipated to be a constituent of the particulate matter emissions from operations. Sulfur is commonly present in the ore and other materials and is evaluated as sulfate through stoichiometric conversion. The sulfate ion is more reactive in the environment than sulfur, and by assuming the complete conversion of sulfur to sulfate, the evaluation is extremely conservative regarding potential effects of this parameter.

For this analysis, it is assumed that constituents are retained in the soil at the location where they were deposited. This assumption simplifies the analysis, however, in reality, deposited material will undergo numerous chemical and physical reactions in the environment and will not remain entirely in place. The receptor grid used for deposition modeling extends approximately 3 kilometers beyond the site in all directions. Figure 1 shows the Project location, the location of specific operations, and the Project boundary. Ten receptors immediately outside the Project boundary are evaluated for deposition impacts, also shown on Figure 1. Being close to the Project boundary, these locations will likely experience the maximum deposition from the operations.

## Background Information

The Project is located in Ironwood and Wakefield Townships, Gogebic County, Michigan at approximately 90° 0.5′ West and 46° 40.75′ North, as shown on Figure 1. Copperwood proposes to operate an underground nonferrous mine and ore processing facility at this location. Potential sources of air emissions are discussed more fully in the *Michigan Air Use Permit – Permit to Install Application* (Foth, 2018b). Activities associated with potential air emissions will include blasting, excavating, material handling, management of storage piles, and material transfer activities. With the exception of roadway emissions from vehicle travel, all emissions sources identified in Foth (2018b) were included in the air deposition analysis. Given the access roads will be dressed with either aggregate or native soils that contain minimal metals or other chemicals of concern, they are not significant sources of copper and sulfur and therefore were not included in this analysis.

The evaluation began with air deposition modeling. Based on modeling results, impacts on soil are then considered and compared against selected criteria. The comparison assists in understanding the deposition impact from the facility and the likelihood operations will have significant impact to the soil. The following discussion provides details.

## Air Deposition Modeling

Modeling air deposition rates for selected constituents are based on facility emissions estimates. Hourly emission rates for copper and sulfur were first estimated from air emission calculations that were completed for the air permit application (Foth, 2018b). Constituent emissions were estimated from total particulate matter emissions in conjunction with the weight percent of each constituent in materials being emitted, also documented in Foth (2018b). While constituents are bound to a specific process material as part of its lithology, the weight percent of the constituent was used in each calculation. To be conservative, the estimates were based on total particulate emissions rather than emissions based on a size fraction, such as particulate matter less than 10 microns ($PM_{10}$). Additionally, the facility Maximum Controlled Emissions (MCE) were used as a basis. This represents an upper bound of permitted emissions. Routinely the facility will operate below the MCE, with only occasional durations at the MCE. Emission sources included a mix of both point sources (stacks) and fugitive air emissions. Point sources included the three ventilation exhaust points for the underground mining operations. Fugitive air emissions included sources such as material transfer and handling activities and wind erosion from material storage areas. Hourly emission rates and other input parameters used in the deposition model are provided in Attachment 1.

Constituent air emission rates were entered into a model that can simulate deposition of the constituents over the surrounding area. During preparation of the air permit application, dispersion of air emissions was estimated to determine airborne concentrations of contaminants at receptors established within a receptor grid across the site. The purpose of the air dispersion modeling was to assess compliance with applicable ambient air quality standards. The air model used for this process was AERMOD, a regulatory air quality model that is sanctioned by the United States Environmental Protection Agency (USEPA) and is the preferred model for conducting air quality analyses by state regulatory agencies, including the Michigan Department of Environmental Quality (MDEQ).

This same air quality model can be used to estimate deposition of air contaminants across a region. However, to estimate deposition impacts, additional information needs to be provided in the air quality model set-up. Additional information includes data on particle density, particle size, and associated mass fractions for each emission source and process material. Particle density and size data for air emission sources used in the deposition model are documented in Attachment 1 to this memorandum.

Execution of modeling runs included use of MDEQ – sanctioned meteorological data from Gogebic – Iron County Airport (IWD) near Ironwood, Michigan that is available on the MDEQ website. These meteorological data sets included information on wind speed and wind direction, as well as rainfall data, the latter of which are a required element in deposition modeling. While the air dispersion model used a 50-meter receptor grid across an area that was approximately 2,500 meters in any direction from the site, the deposition model used a 100-meter grid with a receptor grid that extended about 3,000 meters in each direction from the Property boundary.

The most recent year of meteorological data (2017) was used in this analysis. Using AERMOD over the 1-year period, annual deposition rates of the constituents of interest were predicted across all receptor points in the modeling domain. Deposition rates were expressed in grams per square meter per year ($g/m^2$/year) for copper and sulfur. Figures 2 and 3, respectively, provide depictions of copper and sulfur deposition modeling results over the regional area. Deposition contours indicate deposition loads diminish with distance from the Project site. Upon completion of air deposition modeling, deposition rates for each receptor were tabulated. Attachment 2 provides the deposition rates for selected receptors and a sample of all receptor data for copper and sulfur. The full set of receptor data is not provided in the report as it is approximately 90 pages long.

## Soil Impact Evaluation

The soil impact evaluation is presented in the calculations located in Attachment 3 and is comprised of five parts described below.

I Comparative Soil Criteria

NREPA Part 201 Environmental Remediation contains criteria by which to compare soil characteristics: *Table 2. Soil: Residential and Commercial I Part 201 Generic Soil Clean up Criteria*, RRD Operational Memorandum No. 1 (MDEQ, 2006). The following criteria were selected:

- Direct Contact Criteria and Risk Based Screening Levels.

- Drinking Water Protection Criteria and Risk Based Screening Levels.

- Groundwater Surface Water Interface Protection Criteria and Risk Based Screening Levels.

The Groundwater Surface Water (GSI) Interface Protection Criteria provides a hardness-based criteria for copper. The hardness value of 379 milligrams/liter (mg/L) from the original Mining Permit Application (Orvana, 2011) for Shallow Glacial Overburden Groundwater (Table 202.2.7-2) was selected. These calculations are provided in Attachment 4.

Additionally, the *Risk Management Criteria for Metals at BLM Mining Sites* (United States Department of Interior, 2004) (Bureau of Land Management [BLM] criteria) provides additional criteria for copper. Criteria are presented as constituent levels that avoid adverse toxic effects on wildlife and livestock for a variety of mammals and birds. The selected value used in this evaluation is the most stringent wildlife value. As can be seen in Section I of the calculations, the metal screening levels are one or more orders of magnitude lower than the Part 201 cleanup standards. In fact, the natural soils in the area currently exceed the criteria. Thus, the evaluation of deposition impacts from the Project will be considered by reviewing the percentage increase that deposition contributes to the current soil composition. Without the ability to meet the BLM criteria, the comparison becomes somewhat qualitative.

<u>II Selected Receptors Deposition Rates</u>

The selected receptors at the Project Boundary were identified in the deposition model output data set. Locations and coordinates are shown on Figure 1 and are listed in Section II of the calculations with the deposition rates of the selected constituents. These receptors are selected as those closest and external to the Property boundary, which are anticipated to experience the highest deposition rates external to the Property boundary.

<u>III Native Soil Characteristics</u>

Native soil characteristics for selected constituents along with a specific gravity are shown in Section III of the calculations.

<u>IV Potential Soil Impacts</u>

Potential soil impacts are calculated on the basis of 1 year and 14 years (duration of operations) of deposition. Considering one square meter of soil 1 centimeter thick, the estimate applies the deposition to that mass of soil. For each constituent, the units are converted so that addition is performed on a consistent unit basis.

Although the proposed facility will not emit sulfate ion ($SO_4^{-2}$), the evaluation of sulfur is done by assuming sulfur is converted to sulfate via the chemical reaction shown in Equation (1). The geochemical reaction is one of several that take place over time as a mineral weathers. The molecular weights of sulfur and oxygen are 32 and 16, respectively. The ratio of sulfur to sulfate on a mass basis is 0.32 to 1.

Equation (1) $S + 2\ O_2 \longrightarrow SO_4^{2-}$

The evaluation of potential soil impacts shows that with deposition added for 1 year and 14 years of operation, Michigan protective criteria will continue to be met immediately outside the Property boundary. Native soil exceeds the BLM criteria for copper. Deposition at the selected receptors could potentially increase the copper composition from 0.1 to 2.5% annually. Over 14 years, the increase in copper concentrations may approach 33%, without accounting for natural attenuation and mineral adsorption. As shown on Figures 2 and 3, deposition rates diminish with distance from the facility, therefore, the selected receptors represent a worst case.

V Sulfur Deposition Rate

Although the geochemical reaction does not take place in the atmosphere, the stoichiometric conversion of sulfur to sulfate enables a comparison of the largest theoretical sulfate deposition rate of the Project to a sulfate deposition standard. Michigan does not maintain a sulfate deposition standard; however, Minnesota developed an environmentally protective standard that will be used for this analysis. Although Minnesota Rule, chapter 7021, Acid Deposition Standard was repealed in 2013, the environmentally acceptable deposition rate can still be used as a benchmark for this evaluation. The standard is 11 kilograms of wet sulfate deposition per hectare per year (kg/ha/yr), which can also be expressed as 1,100 milligrams per square meter per year ($mg/m^2/yr$).

To evaluate the contribution rate from the facility, the current deposition rate is identified. Nationwide sulfate ion deposition rates are tracked and available from the National Atmospheric Deposition Program (NADP) National Trends Network (NTN). The Project is between the NTN site WI 36 in Trout Lake, Wisconsin and MI99 in Chassel Michigan. The location and the sulfate ion deposition trend graph are shown in Attachment 5. For the last 5 years of available data, the background deposition rate at this location is estimated at 6 kg/ha/yr (600 $mg/m^2/yr$). The rate evaluation considers the background rate plus the additional calculated sulfate rate generated at the Project. As can be seen in Section V of the calculations, the highest predicted sulfate deposition rate will continue to be below the Minnesota acid deposition standard.

## Conclusions

Results of the conservatively-estimated deposition analysis demonstrate that potential copper and sulfur/sulfate deposition are not anticipated to have significant impacts on soils in the analysis. Four criteria were identified: three Michigan criteria and one sourced from a BLM document. The analysis shows that for both 1 year and after 14 years of operations at maximum emissions, a conservative potential deposition rate will not raise the copper or sulfate compositions of the soils above the Michigan protective criteria. The comparison to the Risk Management Criteria from the BLM showed that native soils exceed the criteria. The addition of deposition to the soil for 1-year and 14-year duration increased the theoretical constituent compositions at the 10 selected receptors as shown below.

## Range of Theoretical Increase in Constituent Composition at 10 Selected Receptors

| Constituent | 1-Year Duration | 14-Year Duration |
|---|---|---|
| Copper | 0.1 to 2.4% | 2 to 33% |
| Sulfate | 0 to 0.05% | 0.03 to 0.71% |

## References

Foth Infrastructure & Environment, LLC, 2018a. *Mining Permit Application Amendment, Copperwood, Volume II, Environmental Impact Assessment Amendment*. March 2018.

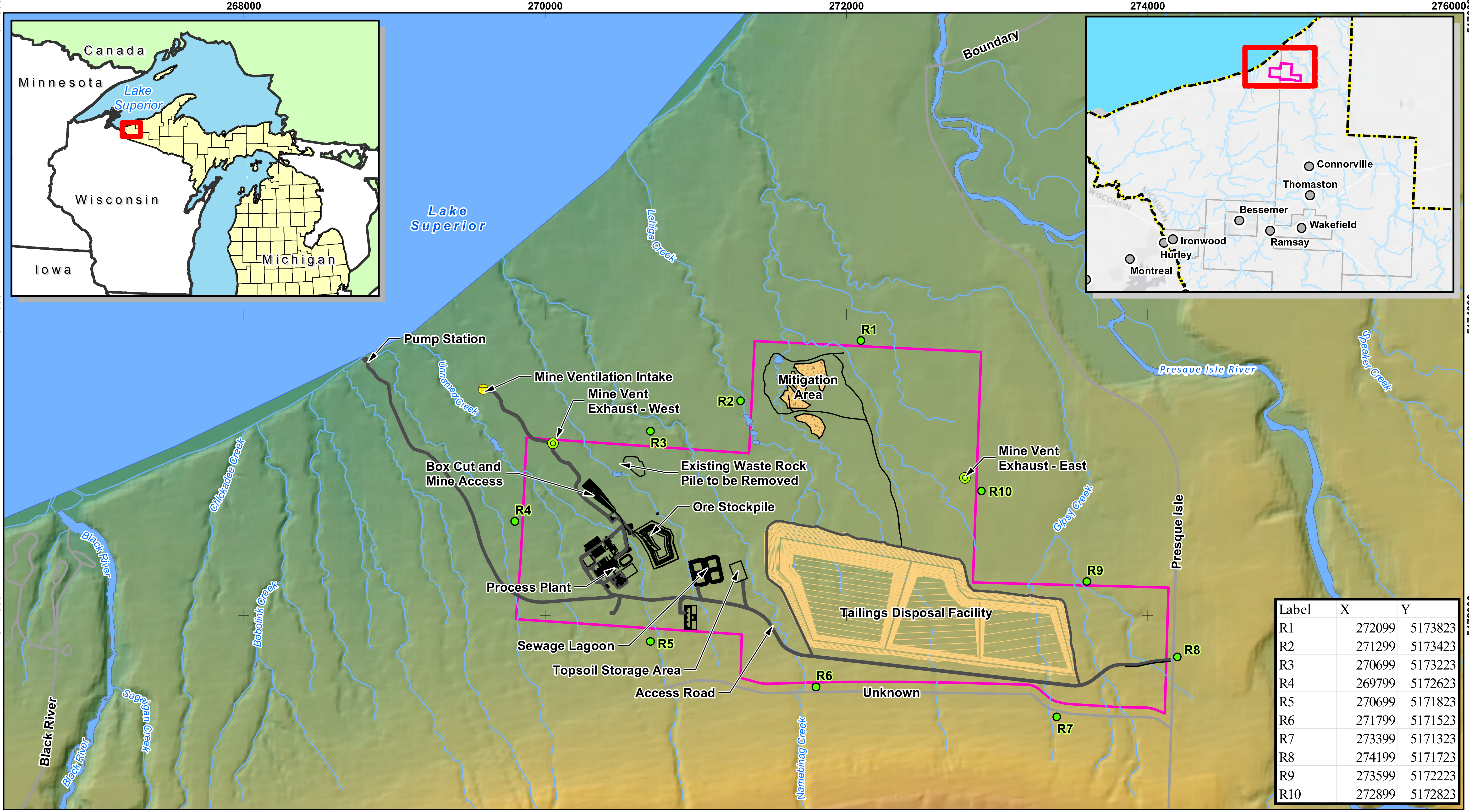
Foth Infrastructure & Environment, LLC, 2018b. *Michigan Air Use Permit - Permit to Install*. March 2018.

Michigan Department of Environmental Quality, 2006. *MDEQ RRD Operational Memoradum No. 1, Part 201 Cleanup Criteria, Part 213 Risk-Based Screening Levels, Attachment 1 Table 2. Soil: Residntial and Industrial-Commercial I Part 201 Generic Cleanup Criteria and Screening Levls: Part 213 Tier I Risk-Based Screening Levels (RBSLs*). January 23, 2006.

Orvana Resources US Corp, 2011. *Copperwood Mine - Mining Permit Application*. September 2011.

United States Department of the Interior, 2004. *Risk Management Criteria of Metals at BLM Sites*. Karl L. Ford. Buereau of Land Mangement, National Science and Techology Center, Denver CO. Table 4. Wildlife and Livestock Risk management Criteria for Metals in Soils. (Technical Note 390, rev. October 2004).

# Figures




| Label | X | Y |
|---|---|---|
| R1 | 272099 | 5173823 |
| R2 | 271299 | 5173423 |
| R3 | 270699 | 5173223 |
| R4 | 269799 | 5172623 |
| R5 | 270699 | 5171823 |
| R6 | 271799 | 5171523 |
| R7 | 273399 | 5171323 |
| R8 | 274199 | 5171723 |
| R9 | 273599 | 5172223 |
| R10 | 272899 | 5172823 |

**NOTES:**

1. Coordinate System: NAD 1983 UTM Zone 16N
2. Facility supplied by Lycopodium in December 2017.

**LEGEND**

- Selected Receptors
- Roads
- Plant and Facility
- Tailing Disposal Facility
- Access Road
- Lakes and Rivers
- Property Boundary

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Foth

| Foth Infrastructure & Environment, LLC | | | |
|---|---|---|---|
| REVISED | DATE | BY | DESCRIPTION |
| | | | |
| | | | |
| | | | |

PREPARED BY: AKM DATE: MAY '18

REVIEWED BY: CED1 DATE: MAY '18

APPROVED BY: KKB DATE: MAY '18

COPPERWOOD RESOURCES

**FIGURE 1**
AIR DEPOSITION ANALYSIS
SELECTED RECEPTORS
NEAR PROPERTY BOUNDARY
GOGEBIC COUNTY, MICHIGAN

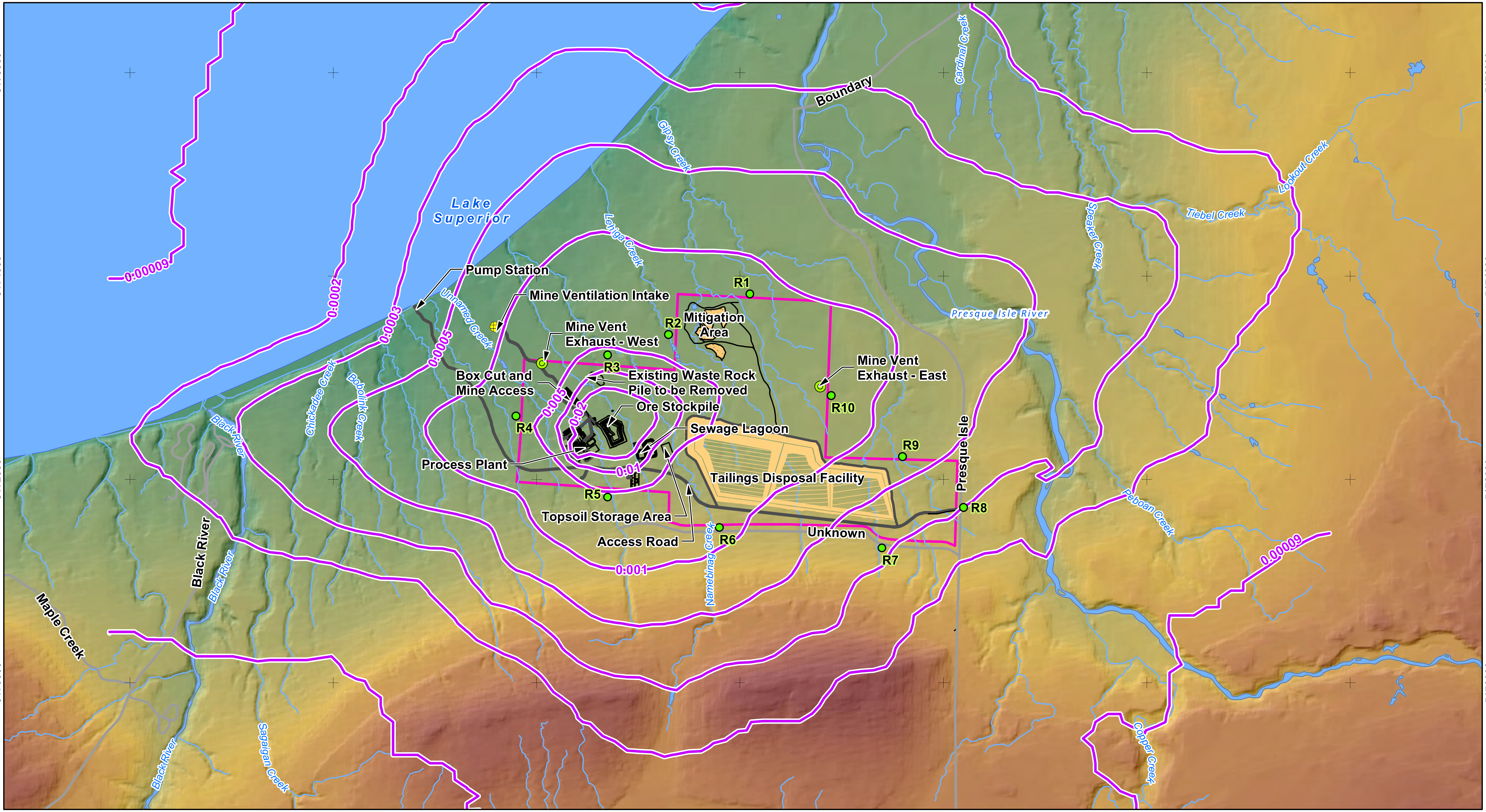
Scale: 0 1,000 2,000 Feet

Date: MAY 2018

Drafted by: DAT

Project: 17C050

Path: Q:\Copperwood Resources\17C050\GIS\mxd\ADA\Figure 1 Deposition Grid.mxd Date: 5/2/2018




**NOTES:**
1. Coordinate System: NAD 1983 UTM Zone 16N
2. Facility supplied by Lycopodium in December 2017.

**LEGEND**

- Selected Receptors
- Copper Deposition Contour (grams/square meter/year)
- Plant and Facility
- Tailing Disposal Facility
- Access Road
- Roads
- Lakes and Rivers
- Property Boundary

HIGHLAND Copper Company Inc.

Foth

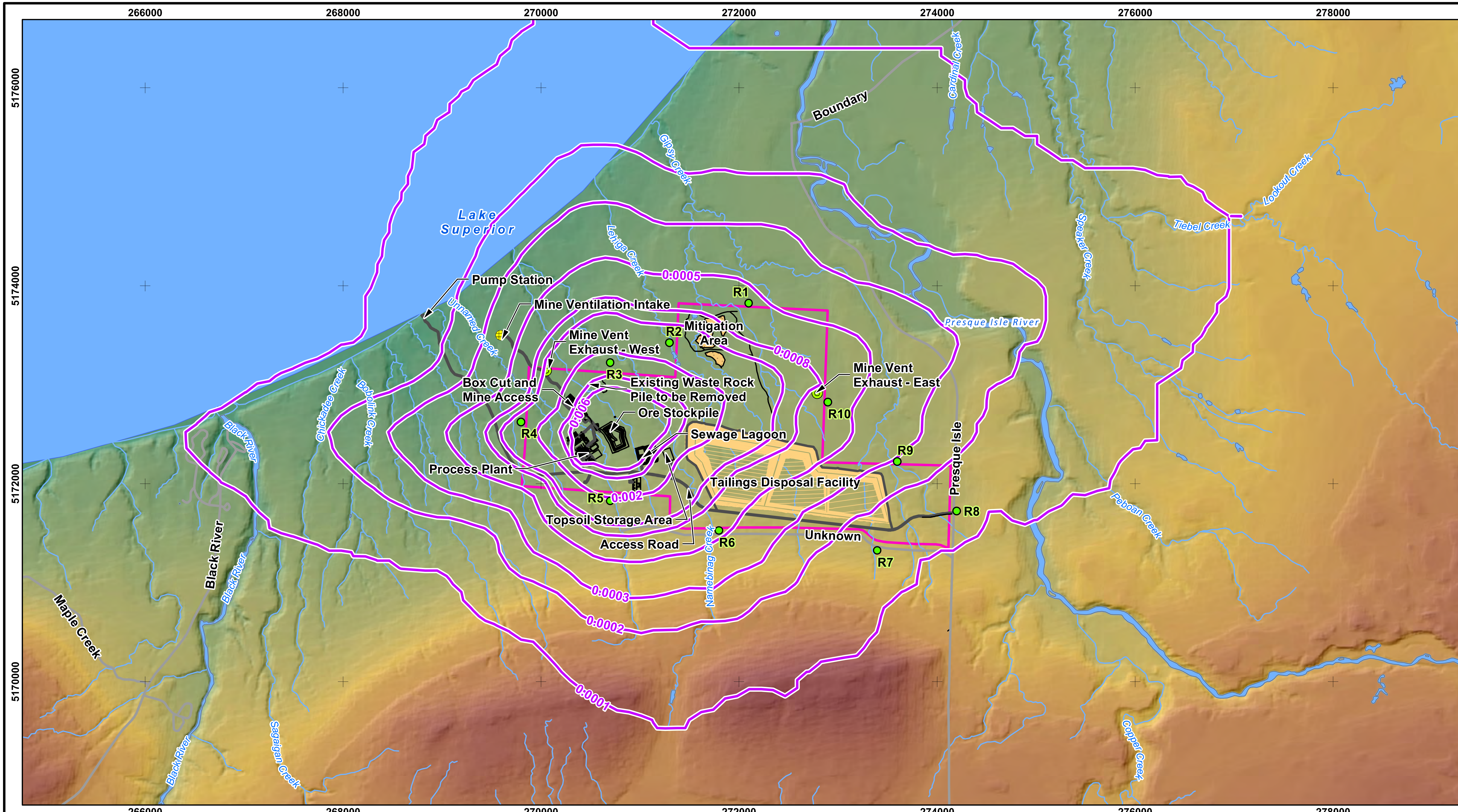
| Foth Infrastructure & Environment, LLC | | | |
|---|---|---|---|
| REVISED | DATE | BY | DESCRIPTION |
| PREPARED BY: AKM | | | DATE: MAY '18 |
| REVIEWED BY: CED1 | | | DATE: MAY '18 |
| APPROVED BY: KKB | | | DATE: MAY '18 |

COPPERWOOD RESOURCES

**FIGURE 2**
AIR DEPOSITION ANALYSIS
COPPER DEPOSTION CONTOURS
GOGEBIC COUNTY, MICHIGAN

Scale: 0 1,500 3,000 Feet
Date: MAY 2018
Drafted by: DAT
Project: 17C050

Path: Q:\Copperwood Resources\17C050\GIS\mxd\ADA\Figure 2 Copper Deposition Contours.mxd Date: 5/2/2018




**NOTES:**
1. Coordinate System: NAD 1983 UTM Zone 16N
2. Facility supplied by Lycopodium in December 2017.

**LEGEND**

- Selected Receptors
- Sulfur Deposition Contour (grams/square meter/year)
- Plant and Facility
- Tailing Disposal Facility
- Access Road
- Roads
- Lakes and Rivers
- Property Boundary

HIGHLAND Copper Company Inc.

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**Foth Infrastructure & Environment, LLC**

| REVISED | DATE | BY | DESCRIPTION |
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|---|---|
| PREPARED BY: AKM | DATE: MAY '18 |
| REVIEWED BY: CED1 | DATE: MAY '18 |
| APPROVED BY: KKB | DATE: MAY '18 |

COPPERWOOD RESOURCES

**FIGURE 3**
AIR DEPOSITION ANALYSIS
SULFUR DEPOSTION CONTOURS
GOGEBIC COUNTY, MICHIGAN

| | |
|---|---|
| Scale: 0 1,500 3,000 Feet | Date: MAY 2018 |
| Drafted by: DAT | Project: 17C050 |

Path: Q:\Copperwood Resources\17C050\GIS\mxd\ADA\Figure 3 Sulfur Deposition Contours.mxd Date: 5/2/2018

# Attachment 1

# Air Deposition Model Input Data

| Client: | Copperwood Resources, Inc. | Project ID.: | 17C050 |
|---|---|---|---|
| Project: | Air Permit Application Emissions Calculations | | |
| Prepared by: | CED1 | Date: | 04/09/18 |
| Checked by: | AKM | Date: | 04/13/18 |

## Copperwood Air Deposition Model Input Data - Emission Rates of Copper and Sulfur

| | % Copper [2] | % Sulfur [2] |
|---|---|---|
| Ore | 1.460 | 0.61 |
| Concentrate | 29.170 | 8.80 |
| Native Soils | 0.00197 | 0.04 |
| Tailings | 0.4675 | 0.23 |

| Emission Source | | Copper | Sulfur | Units |
|---|---|---|---|---|
| SV-001 West Mine Exhaust Vent | | 9.34E-05 | 3.93E-05 | g/sec |
| SV-002 East Mine Exhaust Vent | | 9.63E-05 | 4.05E-05 | g/sec |
| SV-003 Portal Mine Exhaust Vent | | 5.10E-05 | 2.14E-05 | g/sec |
| SV-004 - Power Plant Generator No. 1 | | | | g/sec |
| SV-005 - Power Plant Generator No. 2 | | | | g/sec |
| SV-006 - Power Plant Generator No. 3 | | | | g/sec |
| SV-007 - Power Plant Generator No. 4 | | | | g/sec |
| SV-008 - Power Plant Generator No. 5 | | | | g/sec |
| SV-009 - Emergency Generator No. 1 | | | | g/sec |
| SV-010 - Emergency Generator No. 2 | | | | g/sec |
| SV-011 - Emergency Generator No. 3 | | | | g/sec |

***Volume Sources***

| Emission Source | Number of Volume Source Segments | Copper | Sulfur | Units |
|---|---|---|---|---|
| F001 - Ore Transfer at Transfer Tower | 1 | 2.00E-04 | 8.42E-05 | g/sec |
| F002 - Surplus Ore Transfer to Ore Stockpile | 1 | 2.00E-04 | 8.42E-05 | g/sec |
| F003A&B - Transfer Points at Ore Bins/Reclaim Area [1] | 2 | 2.00E-04 | 8.42E-05 | g/sec |
| F004 - Management of Ore at Ore Stockpile | 1 | 1.06E-03 | 4.45E-04 | g/sec |
| F005 - Transfer Points at SAG Mill | 1 | 2.00E-05 | 8.42E-06 | g/sec |
| F006A&B - Concentrate Handling Operations [1] | 2 | 2.16E-04 | 6.52E-05 | g/sec |
| HR-01 - Vehicle Travel on Ore Stockpile [1] | 13 | 4.56E-04 | 1.92E-04 | g/sec |
| HR-02 - Concentrate Truck Travel on Access Road [1, 3] | 239 | 4.53E-06 | 1.90E-06 | g/sec |
| HR-03 - Water Truck Travel on Access Road [1, 3] | 167 | 1.10E-08 | 2.24E-07 | g/sec |

***Area Sources***

| Emission Source | Area ($m^2$) | Copper | Sulfur | Units |
|---|---|---|---|---|
| F007 - Wind Erosion at Ore Stockpile | 51,790 | 4.06E-08 | 1.71E-08 | g/m2-sec |
| F008 - Wind Erosion at TDF | 38,079 | 1.20E-08 | 5.78E-09 | g/m2-sec |

***Notes:***

1. Each copper and sulfur emission rate is for each volume source segment.

2. Copper and sulfur emission rates are based on PM emission composition.

3. For vehicle travel on the access road (HR-02 and HR-03), 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. Given the number of volume sources for HR-02 and HR-03 (total of 406) that would to be modified to include particle data for deposition modeling and low concentrations of copper and sulfur in the source materials (native soils/aggregate), these sources were not included in the deposition model.

| | | | |
|---|---|---|---|
| Client: Copperwood Resources, Inc. | | Project ID.: | 17C050 |
| Project: Air Permit Application Emissions Calculations | | | |
| Prepared by: CED1 | | Date: | 04/09/18 |
| Checked by: AKM | | Date: | 04/13/18 |

**Particle Density, Particle Size Diameters, and Associated Mass Fractions**

| | | |
|---|---|---|
| Ore Density [1] = | 1.60 | g/cm$^3$ |
| Tailings Dry Density [2] = | 1.31 | g/cm3 |
| Conc't Density [1] = | 1.92 | g/cm$^3$ |
| Native Soils Density [3] = | 1.33 | g/cm3 |

Mean Particle Size Range Calculations [4]

| Low Cut (μm) | High Cut (μm) | Mean Size (μm) |
|---|---|---|
| 0 | 1 | 0.63 |
| 1 | 2 | 1.55 |
| 2 | 2.5 | 2.26 |
| 2.5 | 3 | 2.76 |
| 3 | 4 | 3.52 |
| 4 | 5 | 4.52 |
| 5 | 6 | 5.52 |
| 6 | 10 | 8.16 |
| 10 | 15 | 12.66 |

## Point Sources [5]

SV-001 West Mine Exhaust Vent
SV-002 East Mine Exhaust Vent
SV-003 Portal Mine Exhaust Vent

Ore Material Density = 1.60 g/cm$^3$
No Control Devices Added to Mechanically Change Mean Particle Size

| Particle Size Range (μm) | Cum Size (%) | Cum Wt. (g/cm$^3$) | Mass (g/cm$^3$) | Mass Fraction |
|---|---|---|---|---|
| 1 | 4 | 0.06 | 0.06 | 0.04 |
| 2 | 11 | 0.18 | 0.11 | 0.07 |
| 2.5 | 15 | 0.24 | 0.06 | 0.04 |
| 3 | 18 | 0.29 | 0.05 | 0.03 |
| 4 | 25 | 0.40 | 0.11 | 0.07 |
| 5 | 30 | 0.48 | 0.08 | 0.05 |
| 6 | 34 | 0.54 | 0.06 | 0.04 |
| 10 | 51 | 0.82 | 0.27 | 0.17 |
| 15 | 100 | 1.60 | 0.78 | 0.49 |
| Totals | | | 1.60 | 1.0 |

| Client: | Copperwood Resources, Inc. | Project ID.: | 17C050 |
|---|---|---|---|
| Project: | Air Permit Application Emissions Calculations | | |
| Prepared by: | CBD1 | Date: | 04/09/18 |
| Checked by: | AKM | Date: | 04/13/18 |

## Volume Sources [5]

F001 - Ore Transfer Tower
F002 - Surplus Ore Transfer to Ore Stockpile
F003 - Transfer Points at Ore Bins/Reclaim Area
F004 - Management of Ore at Ore Stockpile
F005 - Transfer Points at SAG Mill
HR-01 - Vehicle Travel on Ore Stockpile

Ore Material Density = 1.60 $g/cm^3$
No Control Devices Added to Mechanically Change Mean Particle Size

| Particle Size Range (µm) | Cum Size (%) | Cum Wt. ($g/cm^3$) | Mass ($g/cm^3$) | Mass Fraction |
|---|---|---|---|---|
| 1 | 4 | 0.06 | 0.06 | 0.04 |
| 2 | 11 | 0.18 | 0.11 | 0.07 |
| 2.5 | 15 | 0.24 | 0.06 | 0.04 |
| 3 | 18 | 0.29 | 0.05 | 0.03 |
| 4 | 25 | 0.40 | 0.11 | 0.07 |
| 5 | 30 | 0.48 | 0.08 | 0.05 |
| 6 | 34 | 0.54 | 0.06 | 0.04 |
| 10 | 51 | 0.82 | 0.27 | 0.17 |
| 15 | 100 | 1.60 | 0.78 | 0.49 |
| Totals | | | 1.60 | 1.0 |

HR-02 - Concentrate Truck Travel on Access Road
HR-03 - Water Truck Travel on Access Road

Native Soils Density = 1.33 $g/cm^3$
No Control Devices Added to Mechanically Change Mean Particle Size

| Particle Size Range (µm) | Cum Size (%) | Cum Wt. ($g/cm^3$) | Mass ($g/cm^3$) | Mass Fraction |
|---|---|---|---|---|
| 1 | 4 | 0.05 | 0.05 | 0.04 |
| 2 | 11 | 0.15 | 0.09 | 0.07 |
| 2.5 | 15 | 0.20 | 0.05 | 0.04 |
| 3 | 18 | 0.24 | 0.04 | 0.03 |
| 4 | 25 | 0.33 | 0.09 | 0.07 |
| 5 | 30 | 0.40 | 0.07 | 0.05 |
| 6 | 34 | 0.45 | 0.05 | 0.04 |
| 10 | 51 | 0.68 | 0.23 | 0.17 |
| 15 | 100 | 1.33 | 0.65 | 0.49 |
| Totals | | | 1.33 | 1.0 |

F006 - Concentrate Handling Operations

Concentrate Material Density = 1.92 $g/cm^3$
No Control Devices Added to Mechanically Change Mean Particle Size

| Particle Size Range (µm) | Cum Size (%) | Cum Wt. ($g/cm^3$) | Mass ($g/cm^3$) | Mass Fraction |
|---|---|---|---|---|
| 1 | 4 | 0.08 | 0.08 | 0.04 |
| 2 | 11 | 0.21 | 0.13 | 0.07 |
| 2.5 | 15 | 0.29 | 0.08 | 0.04 |
| 3 | 18 | 0.35 | 0.06 | 0.03 |
| 4 | 25 | 0.48 | 0.13 | 0.07 |
| 5 | 30 | 0.58 | 0.10 | 0.05 |
| 6 | 34 | 0.65 | 0.08 | 0.04 |
| 10 | 51 | 0.98 | 0.33 | 0.17 |
| 15 | 100 | 1.92 | 0.94 | 0.49 |
| Totals | | | 1.92 | 1.0 |

| | | | |
|---|---|---|---|
| Client: Copperwood Resources, Inc. | | Project ID.: | 17C050 |
| Project: Air Permit Application Emissions Calculations | | | |
| Prepared by: CBD1 | | Date: | 04/09/18 |
| Checked by: AKM | | Date: | 04/13/18 |

## Area Sources [5]

F007 - Wind Erosion at Ore Stockpile — Ore Material Density = 1.60 g/cm$^3$

No Control Devices Added to Mechanically Change Mean Particle Size

| Particle Size Range (μm) | Cum Size (%) | Cum Wt. (g/cm$^3$) | Mass (g/cm$^3$) | Mass Fraction |
|---|---|---|---|---|
| 1 | 4 | 0.06 | 0.06 | 0.04 |
| 2 | 11 | 0.18 | 0.11 | 0.07 |
| 2.5 | 15 | 0.24 | 0.06 | 0.04 |
| 3 | 18 | 0.29 | 0.05 | 0.03 |
| 4 | 25 | 0.40 | 0.11 | 0.07 |
| 5 | 30 | 0.48 | 0.08 | 0.05 |
| 6 | 34 | 0.54 | 0.06 | 0.04 |
| 10 | 51 | 0.82 | 0.27 | 0.17 |
| 15 | 100 | 1.60 | 0.78 | 0.49 |
| Totals | | | 1.60 | 1.0 |

F008 - Wind Erosion at TDF — Tailings Density = 1.31 g/cm$^3$

No Control Devices Added to Mechanically Change Mean Particle Size

| Particle Size Range (μm) | Cum Size (%) | Cum Wt. (g/cm$^3$) | Mass (g/cm$^3$) | Mass Fraction |
|---|---|---|---|---|
| 1 | 4 | 0.05 | 0.05 | 0.04 |
| 2 | 11 | 0.14 | 0.09 | 0.07 |
| 2.5 | 15 | 0.20 | 0.05 | 0.04 |
| 3 | 18 | 0.24 | 0.04 | 0.03 |
| 4 | 25 | 0.33 | 0.09 | 0.07 |
| 5 | 30 | 0.39 | 0.07 | 0.05 |
| 6 | 34 | 0.45 | 0.05 | 0.04 |
| 10 | 51 | 0.67 | 0.22 | 0.17 |
| 15 | 100 | 1.31 | 0.64 | 0.49 |
| Totals | | | 1.31 | 1.0 |

***Notes:***

1. Material densities were taken directly from the *Preliminary Design Criteria that were prepared for the Prefeasibility Study of the Copperwood Project, Upper Peninsula, USA* completed by KD Engineering dated July 29, 2011.

2. Tailings density information was derived from the value provided for Stage 2 tailings density as stated in Table 5-1 in the *Mining Permit Application Amendment* as prepared by Foth Infrastructure & Environment, LLC dated March 2018.

3. U.S. Department of Agriculture Natural Resources Conservation Service, Soil Quality Indicators publication on typical bulk density of soils.

4. The methodology for determining the mean particle size range is taken from the *Human Health Risk Assessment Protocol for Hazaredous Waste Combustion Facilities*, Chapter 3, Air Dispersion and Deposition Modeling.

5. Certain assumptions were made regarding particle size and density for input files to the air deposition model. Particle diameters were taken from Appendix B.2, Table B.2.2 to AP-42, Generalized Particle Size Distributions. Table B.2.2 is for use with aggregate and unprocessed ores that are mechanically generated. This broad category includes emissions from milling, grinding and crushing of these types of materials.

# Attachment 2

# Deposition Results

Client: Copperwood Resources, Inc. Project ID.: 17C050
Project: Air Deposition Impact Analysis - Soil Impact Evaluation
Prepared by: AKM Date: 05/02/18
Checked by: CEDI Date: 05/02/18

-- Data are generated for 9,801 receptors. Only page 1 of 85 has been provided --

**Selected Receptors**

| ID | X coord. METER | Y coord. METER | Copper g/m**2 | Sulfur g/m**2 | Copper mg/m**2 | Sulfur mg/m**2 |
|---|---|---|---|---|---|---|
| R1 | 272099 | 5173823 | 0.0013 | 0.00056 | 1.3 | 0.56 |
| R2 | 271299 | 5173423 | 0.00318 | 0.00137 | 3.18 | 1.37 |
| R3 | 270699 | 5173223 | 0.00623 | 0.00269 | 6.23 | 2.69 |
| R4 | 269799 | 5172623 | 0.00299 | 0.00127 | 2.99 | 1.27 |
| R5 | 270699 | 5171823 | 0.0042 | 0.00178 | 4.2 | 1.78 |
| R6 | 271799 | 5171523 | 0.00127 | 0.00055 | 1.27 | 0.55 |
| R7 | 273399 | 5171323 | 0.00032 | 0.00014 | 0.32 | 0.14 |
| R8 | 274199 | 5171723 | 0.0003 | 0.00013 | 0.3 | 0.13 |
| R9 | 273599 | 5172223 | 0.00066 | 0.00029 | 0.66 | 0.29 |
| R10 | 272899 | 5172823 | 0.00147 | 0.00064 | 1.47 | 0.64 |

**All Receptor Data**

| ID | X coord. METER | Y coord. METER | Copper g/m**2 | Sulfur g/m**2 |
|---|---|---|---|---|
| 1 | 265799 | 5168723 | 0.00003 | 0.00001 |
| 2 | 265899 | 5168723 | 0.00003 | 0.00001 |
| 3 | 265999 | 5168723 | 0.00003 | 0.00002 |
| 4 | 266099 | 5168723 | 0.00004 | 0.00002 |
| 5 | 266199 | 5168723 | 0.00004 | 0.00002 |
| 6 | 266299 | 5168723 | 0.00004 | 0.00002 |
| 7 | 266399 | 5168723 | 0.00004 | 0.00002 |
| 8 | 266499 | 5168723 | 0.00004 | 0.00002 |
| 9 | 266599 | 5168723 | 0.00004 | 0.00002 |
| 10 | 266699 | 5168723 | 0.00004 | 0.00002 |
| 11 | 266799 | 5168723 | 0.00004 | 0.00002 |
| 12 | 266899 | 5168723 | 0.00005 | 0.00002 |
| 13 | 266999 | 5168723 | 0.00005 | 0.00002 |
| 14 | 267099 | 5168723 | 0.00005 | 0.00002 |
| 15 | 267199 | 5168723 | 0.00005 | 0.00002 |
| 16 | 267299 | 5168723 | 0.00005 | 0.00002 |
| 17 | 267399 | 5168723 | 0.00005 | 0.00002 |
| 18 | 267499 | 5168723 | 0.00005 | 0.00002 |
| 19 | 267599 | 5168723 | 0.00005 | 0.00002 |
| 20 | 267699 | 5168723 | 0.00006 | 0.00002 |
| 21 | 267799 | 5168723 | 0.00006 | 0.00003 |
| 22 | 267899 | 5168723 | 0.00006 | 0.00003 |
| 23 | 267999 | 5168723 | 0.00007 | 0.00003 |
| 24 | 268099 | 5168723 | 0.00007 | 0.00003 |
| 25 | 268199 | 5168723 | 0.00007 | 0.00003 |
| 26 | 268299 | 5168723 | 0.00007 | 0.00003 |
| 27 | 268399 | 5168723 | 0.00007 | 0.00003 |
| 28 | 268499 | 5168723 | 0.00007 | 0.00003 |
| 29 | 268599 | 5168723 | 0.00007 | 0.00003 |
| 30 | 268699 | 5168723 | 0.00008 | 0.00003 |
| 31 | 268799 | 5168723 | 0.00008 | 0.00003 |
| 32 | 268899 | 5168723 | 0.00008 | 0.00003 |
| 33 | 268999 | 5168723 | 0.00008 | 0.00003 |
| 34 | 269099 | 5168723 | 0.00008 | 0.00004 |
| 35 | 269199 | 5168723 | 0.00008 | 0.00004 |
| 36 | 269299 | 5168723 | 0.00009 | 0.00004 |
| 37 | 269399 | 5168723 | 0.00009 | 0.00004 |

| ID | X coord. METER | Y coord. METER | Copper g/m**2 | Sulfur g/m**2 |
|---|---|---|---|---|
| 4900 | 271699 | 5172723 | 0.00575 | 0.00249 |
| 4901 | 271799 | 5172723 | 0.00482 | 0.00209 |
| 4902 | 271899 | 5172723 | 0.0041 | 0.00178 |
| 4903 | 271999 | 5172723 | 0.00355 | 0.00154 |
| 4904 | 272099 | 5172723 | 0.0031 | 0.00135 |
| 4905 | 272199 | 5172723 | 0.00274 | 0.00119 |
| 4906 | 272299 | 5172723 | 0.00244 | 0.00106 |
| 4907 | 272399 | 5172723 | 0.00219 | 0.00095 |
| 4908 | 272499 | 5172723 | 0.00197 | 0.00086 |
| 4909 | 272599 | 5172723 | 0.00179 | 0.00078 |
| 4910 | 272699 | 5172723 | 0.00164 | 0.00072 |
| 4911 | 272799 | 5172723 | 0.00156 | 0.00068 |
| 4912 | 272899 | 5172723 | 0.00142 | 0.00062 |
| 4913 | 272999 | 5172723 | 0.00129 | 0.00056 |
| 4914 | 273099 | 5172723 | 0.00118 | 0.00051 |
| 4915 | 273199 | 5172723 | 0.00108 | 0.00047 |
| 4916 | 273299 | 5172723 | 0.001 | 0.00044 |
| 4917 | 273399 | 5172723 | 0.00093 | 0.00041 |
| 4918 | 273499 | 5172723 | 0.00087 | 0.00038 |
| 4919 | 273599 | 5172723 | 0.00081 | 0.00036 |
| 4920 | 273699 | 5172723 | 0.00076 | 0.00033 |
| 4921 | 273799 | 5172723 | 0.00072 | 0.00031 |
| 4922 | 273899 | 5172723 | 0.00067 | 0.00029 |
| 4923 | 273999 | 5172723 | 0.00063 | 0.00028 |
| 4924 | 274099 | 5172723 | 0.00059 | 0.00026 |
| 4925 | 274199 | 5172723 | 0.00056 | 0.00024 |
| 4926 | 274299 | 5172723 | 0.00051 | 0.00022 |
| 4927 | 274399 | 5172723 | 0.00048 | 0.00021 |
| 4928 | 274499 | 5172723 | 0.00045 | 0.0002 |
| 4929 | 274599 | 5172723 | 0.00043 | 0.00019 |
| 4930 | 274699 | 5172723 | 0.00041 | 0.00018 |
| 4931 | 274799 | 5172723 | 0.00041 | 0.00018 |
| 4932 | 274899 | 5172723 | 0.0004 | 0.00017 |
| 4933 | 274999 | 5172723 | 0.00038 | 0.00016 |
| 4934 | 275099 | 5172723 | 0.00036 | 0.00015 |
| 4935 | 275199 | 5172723 | 0.00035 | 0.00015 |
| 4936 | 275299 | 5172723 | 0.00033 | 0.00014 |

# Attachment 3

# Calculations

| | | | |
|---|---|---|---|
| Client: Copperwood Resources, Inc. | | Project ID.: | 17C050 |
| Project: Air Deposition Impact Analysis - Soil Impact Evaluation | | | |
| Prepared by: AKM | | Date: | 05/02/18 |
| Checked by: CED1 | | Date: | 05/02/18 |

### I Comparative Criteria for Soils

| | Copper mg/kg (ppm) | Sulfur mg/kg (ppm) | Sulfate [1] mg/kg (ppm) |
|---|---|---|---|
| Direct Contact Criteria and Risk Based Screening Level [2] | 20,000 | n.a. | n.a. |
| Drinking Water Protection Criteria and Risk Based Screening Level [2] | 5,800 | n.a. | 5,000 |
| Groundwater Surface Water Interface Protection Criteria and Risk Based Screening Level [2] | 160 | n.a. | n.a. |
| Risk Management Criteria for Metals at BLM Mining Sites [3] | 7 | n.a. | n.a. |

### II Selected Deposition Receptors and Deposition Rate

| | | Deposition Rate | Copper | Sulfur | Sulfate [1] |
|---|---|---|---|---|---|
| Location | X Coordinate | Y Coordinate | mg/m2/year | mg/m2/year | mg/m2/year |
| R1 | 272099 | 5173823 | 1.3 | 0.56 | 1.68 |
| R2 | 271299 | 5173423 | 3.18 | 1.37 | 4.11 |
| R3 | 270699 | 5173223 | 6.23 | 2.69 | 8.07 |
| R4 | 269799 | 5172623 | 2.99 | 1.27 | 3.81 |
| R5 | 270699 | 5171823 | 4.2 | 1.78 | 5.34 |
| R6 | 271799 | 5171523 | 1.27 | 0.55 | 1.65 |
| R7 | 273399 | 5171323 | 0.32 | 0.14 | 0.42 |
| R8 | 274199 | 5171723 | 0.3 | 0.13 | 0.39 |
| R9 | 273599 | 5172223 | 0.66 | 0.29 | 0.87 |
| R10 | 272899 | 5172823 | 1.47 | 0.64 | 1.92 |

### III Soil Characteristics of Native Soils

| | | Copper | Sulfur | Sulfate [1] |
|---|---|---|---|---|
| Soil Composition [4] | Weight % | 0.00197 | 0.04 | 0.12 |
| | mg/kg or ppm | 19.7 | 400 | 1200 |
| | specific gravity of soil [5]: | 1.33 | | |

### IV Potential Soil Impacts

If one year of deposition mixed with the top 1 centimeter (cm) of soil, the soil characteristics could potentially be:

Mass of soil:

volume = 1 m x 1 m x 1 cm = 0.01 m3 mass of soil per m2 by 1 cm deep = 13.3 kg per m2

Estimating the potential concentration after 1 year of deposition:

Potential concentration = native soil composition mg/kg + (one year deposition mg/m2/13.3 m2/kg)

For one year of operations:

| Location | Copper mg/kg (ppm) | % increase in soil composition | Sulfate [1] mg/kg (ppm) | % increase in soil composition |
|---|---|---|---|---|
| R1 | 19.8 | 0.5% | 1200.1 | 0.01% |
| R2 | 19.9 | 1.2% | 1200.3 | 0.03% |
| R3 | 20.2 | 2.4% | 1200.6 | 0.05% |
| R4 | 19.9 | 1.1% | 1200.3 | 0.02% |
| R5 | 20.0 | 1.6% | 1200.4 | 0.03% |
| R6 | 19.8 | 0.5% | 1200.1 | 0.01% |
| R7 | 19.7 | 0.1% | 1200.0 | 0.00% |
| R8 | 19.7 | 0.1% | 1200.0 | 0.00% |
| R9 | 19.7 | 0.3% | 1200.1 | 0.01% |
| R10 | 19.8 | 0.6% | 1200.1 | 0.01% |

For 14 year duration of operations:

| Location | Copper mg/kg (ppm) | % increase in soil composition | Sulfate [1] mg/kg (ppm) | % increase in soil composition |
|---|---|---|---|---|
| R1 | 21.1 | 7% | 1201.8 | 0.15% |
| R2 | 23.0 | 17% | 1204.3 | 0.36% |
| R3 | 26.3 | 33% | 1208.5 | 0.71% |
| R4 | 22.8 | 16% | 1204.0 | 0.33% |
| R5 | 24.1 | 22% | 1205.6 | 0.47% |
| R6 | 21.0 | 7% | 1201.7 | 0.14% |
| R7 | 20.0 | 2% | 1200.4 | 0.04% |
| R8 | 20.0 | 2% | 1200.4 | 0.03% |
| R9 | 20.4 | 4% | 1200.9 | 0.08% |
| R10 | 21.2 | 8% | 1202.0 | 0.17% |

Soil impacts: Of the four criteria identified in I, native soil exceeds the Risk Management Criteria for Metals at BLM Mining Sites for copper. Deposition could potentially increase the copper composition from 0.1 to 2.5% on an annual basis. Over a 14 year mine life, the increase in copper concentrations are higher, however, continue to meet the Michigan standard criteria. All other criteria are met for both copper and sulfate.

**V Evaluation of Sulfate Deposition Rate**

To compare the highest sulfate deposition rate of the project on the environment to the standard, convert the standard [6] for SO4 ion from kg/ha/yr to mg/m2/yr.

| | | | | | |
|---|---|---|---|---|---|
| 11 kg [6] / ha-year | 1000 g / kg | 1000 mg / g | ha / 10000 m2 | = | 1100 mg/m2/yr |

Background Sulfate Deposition Rate [7]:

| | | | | | |
|---|---|---|---|---|---|
| 6 kg / ha-year | 1000 g / kg | 1000 mg / g | ha / 10000 m2 | = | 600 mg/m2/yr |

| | |
|---|---|
| Highest sulfate deposition rate of the 10 locations: (Receptor Location 5) | 8 mg/m2/yr |
| Total highest predicted sulfate deposition rate: | 608 mg/m2/yr |
| Is the highest sulfate deposition rate compliant with the acid deposition standard? | Yes |

Notes

1 Sulfate is a calculated value. Sulfate is potentially present based on all sulfur converting to sulfate. Based on their respective molecular weights, there could be 3 times the mass of sulfate as sulfur.

2. Michigan Part 201 Generic Cleanup Criteria and Screening Levels/Part 213 Risk-Based Screening Levels, Table 2 Soil: Residential, rounded.

3. US Department of Interior - Bureau of Land Management, 2004. Risk Management Criteria for Metals at BLM Mining Sites, Technical Note 390 rev. October 2004. Values selected from Table 4 are the most stringent.

4. Native soil data is the greatest maximum value from Orvana EIA, Table 202.2.2-5, Summary of Soil Chemistry.

5. U.S. Department of Agriculture Natural Resources Conservation Service, *Soil Quality Indicators* publication on typical bulk density of soils.

6. Minnesota Rule 7021 Acid Deposition Control: 7021.0030 Acid Deposition Standard: 11 kg wet sulfate deposition per hectare per year. Although this rule is no longer in effect in Minnesota, the value provided is the only identified protective deposition standard for sulftate and is therefore informative in this analysis.

7. National Atmospheric Deposition Program, Average between NTN Sites WI36 in Trout Lake WI and MI99 in Chassell MI. High deposition value of 6 kg/ha-year, most recent 5 years of data.

# Attachment 4

# Calculations for the GSI Criteria

# Calculation of Generic Facility-Specific Part 201 Groundwater Surface Water Interface (GSI) Criteria for {G} Footnoted Hazardous Substances

**Directions for calculating generic facility-specific GSI criteria:**

1. Enter **"hardness"** (Column C) or **"pH"** (Column D). Click the green check mark to the left of the Excel formula bar or press the "Enter" key.
2. The GSI criteria for surface water **not** protected as a source of drinking water are the lower of the final chronic value (FCV), wildlife value (WV), and the surface water human non-drinking water value (HNDV). These criteria are presented in Column L.
3. The GSI criteria for surface water protected as a source of drinking water are the lower of the FCV, WV, and surface water human drinking water value (HDV). Surface water protected as a source of drinking water includes the Great Lakes and their connecting waters, and inland surface water in close proximity to a water supply intake. These criteria are presented in Column M. Refer to Part 201 Criteria Application Guidesheet #3 for further guidance on selecting the applicable GSI criterion.
4. The final acute values (FAV) protective of aquatic life are presented in column E. The calculation of the FAV is provided to allow the identification of any exceedance of an acute GSI criterion. Where an exceedance of an acute GSI criterion exists, an evaluation must be done to determine appropriate action in accordance with provisions of R 299.5716, R 299.5526(4) and RRD Operational Memorandum No. 5.

| Calculate GSI in ug/L (ppb) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Hazardous Substance** | **Chemical Abstract Service Number (CAS #)** | *** ENTER Hardness in mg CaCO3/L** | *** ENTER pH** | **Final Acute Value (FAV)** | **FAV Conversion Factor** | **Final Chronic Value (FCV)** | **FCV Conversion Factor** | **Wildlife Value (WV)** | **Surface Water Human Non-Drinking Water Value (HNDV)** | **Surface Water Human Drinking Water Value (HDV)** | **GSI Criteria for Surface Water Not Protected for Drinking Water Use** | **GSI Criteria for Surface Water Protected for Drinking Water Use** |
| Acetate | 71501 | NA | **pH** | Calculated | NA | Calculated | NA | NA | 1.3E+6 | 16,000 | Calculated | Calculated |
| Acetic acid | 64197 | NA | **pH** | Calculated | NA | Calculated | NA | NA | 1.3E+6 | 16,000 | Calculated | Calculated |
| Barium | 7440393 | **hardness** | NA | Calculated | NA | Calculated | NA | NA | 1.6E+5 | 1,900 | Calculated | Calculated |
| Beryllium | 7440417 | **hardness** | NA | Calculated | NA | Calculated | NA | NA | 1,200 | 160 | Calculated | Calculated |
| Cadmium | 7440439 | **hardness** | NA | Calculated | Calculated | Calculated | Calculated | NA | 130 | 3 | Calculated | Calculated |
| Chromium (III) | 16065831 | **hardness** | NA | Calculated | NA | Calculated | 0.86 | NA | 9,400 | 120 | Calculated | Calculated |
| Copper | 7440508 | **379** | NA | 94.31797613 | NA | 2.8E+1 | 0.96 | NA | 38,000 | 470 | 2.8E+1 | 2.8E+1 |
| Lead | 7439921 | **hardness** | NA | Calculated | Calculated | Calculated | Calculated | NA | 190 | 14 | Calculated | Calculated |
| Manganese | 7439965 | **hardness** | NA | Calculated | NA | Calculated | NA | NA | 59,000 | 1,300 | Calculated | Calculated |
| Nickel | 7440020 | **hardness** | NA | Calculated | NA | Calculated | 0.997 | NA | 2.1E+5 | 2,600 | Calculated | Calculated |
| Zinc | 7440666 | **hardness** | NA | Calculated | NA | Calculated | 0.986 | NA | 16,000 | 3,300 | Calculated | Calculated |
| Pentachlorophenol | 87865 | NA | **pH** | Calculated | NA | Calculated | NA | NA | 2.8 | 1.8 | Calculated | Calculated |

NA = Criterion or value is not available or not applicable.

* The formulas in this spreadsheet depend upon appropriate entries in these cells. Do not leave these cells blank. If numeric hardness or pH values are not available, enter the word "hardness" or "pH" in the appropriate cell.

To evaluate copper, lead, and zinc criteria, an average hardness value was developed considering

Hardness Value is the mean of all samples from the Shallow Glacial Overburden Groundwater.

See Orvana Mining Permit Application, Table 202.2.7-2.

Prepared by: AKM
Checked by CED1

# Calculation of Generic Facility-Specific
# Part 201 Soil GSI Protection Criteria (GSI PC)

**Directions for calculating a generic facility-specific soil GSI PC:**

1. Manually type in the **"GSI"** criterion calculated on the previous page, rounded to 2 significant figures. DO NOT CUT AND PASTE as this will enter the unrounded value and generate a different value. Click the green check mark to the left of the Excel formula bar or press the "Enter" key.
2. The GSI PC will calculate and appear in Column W. The GSI PC are the higher of the Soil-Water Partition Value for GSI (Column U) and the 20 X GSI value (Column V).

| Calculate Soil GSI PC in ug/Kg (ppb) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Hazardous Substance** | **Chemical Abstract Service Number (CAS #)** | *** ENTER GSI** | **Soil-Water Distribution Coefficients (Kd) L/Kg** | **Henry's Law Constant (HLC) atm-m3/mol** | **Soil Organic Carbon-Water Partition Coefficient (Koc) L/Kg** | **Soil-Water Partition Value for GSI ug/Kg** | **20 X GSI ug/Kg** | **Soil GSI PC ug/Kg** |
| Acetate | 71501 | **GSI** | NA | NA | NA | Calculated | Calculated | Calculated |
| Acetic acid | 64197 | **GSI** | NA | NA | NA | Calculated | Calculated | Calculated |
| Barium | 7440393 | **GSI** | 41 | NA | NA | Calculated | Calculated | Calculated |
| Beryllium | 7440417 | **GSI** | 790 | NA | NA | Calculated | Calculated | Calculated |
| Cadmium | 7440439 | **GSI** | 75 | NA | NA | Calculated | Calculated | Calculated |
| Chromium (III) | 16065831 | **GSI** | 1.8E+6 | NA | NA | Calculated | Calculated | Calculated |
| Copper | 7440508 | **2.8E+1** | 360 | NA | NA | 1.6E+5 | 5.6E+2 | 1.6E+5 |
| Lead | 7439921 | **GSI** | 11,000 | NA | NA | Calculated | Calculated | Calculated |
| Manganese | 7439965 | **GSI** | NA | NA | NA | Calculated | Calculated | Calculated |
| Nickel | 7440020 | **GSI** | 65 | NA | NA | Calculated | Calculated | Calculated |
| Zinc | 7440666 | **GSI** | 62 | NA | NA | Calculated | Calculated | Calculated |
| Pentachlorophenol | 87865 | **GSI** | NA | 2.44E-8 | 592 | Calculated | Calculated | Calculated |

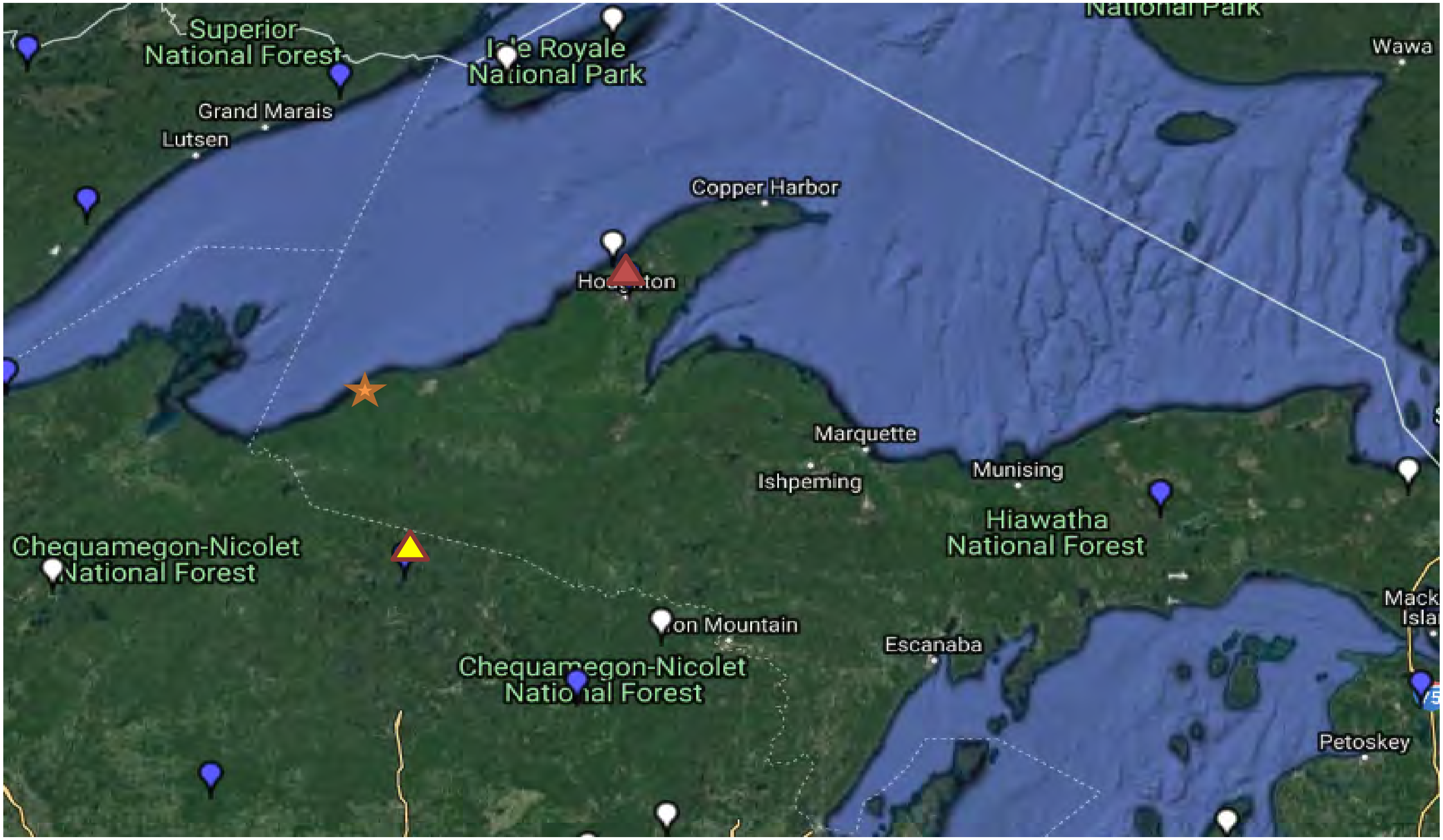
NA = Criterion or value is not available or not applicable.

* The formulas in this spreadsheet depend upon appropriate entries in these cells. Do not leave these cells blank. If numeric GSI values are not available, enter "GSI" in the appropriate cell.

Prepared by: AKM
Checked by: CED1

# Attachment 5

# Background Sulfate Deposition Rates

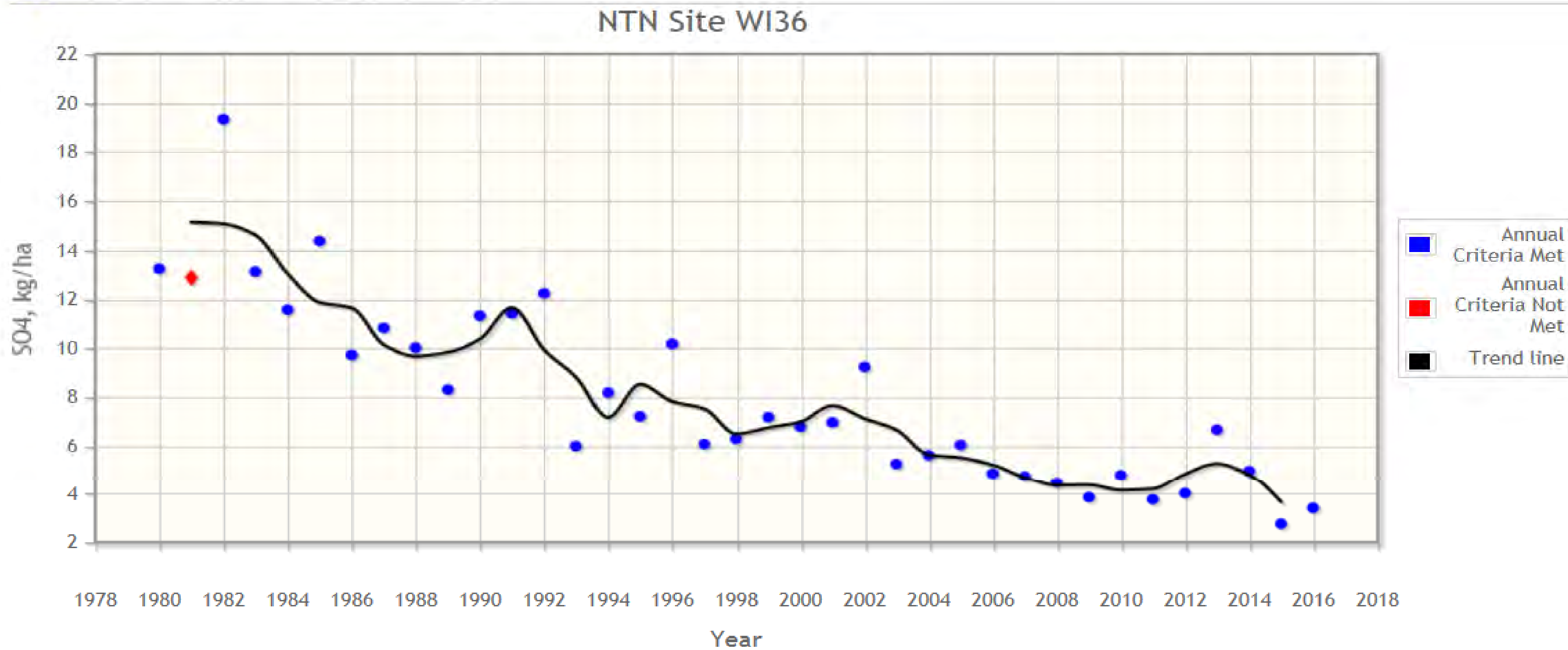



MI99 Copperwood Project

WI36

http://nadp.slh.wisc.edu/data/sites/list/?net=NTN

National Atmospheric Deposition Program




**What to Plot**

**Concentration**

pH | $SO_4$ | $NO_3$ | $NH_4$ | Ca | Mg | K | Na | Cl

**Equivelents**

H | $SO_4$ | $NO_3$ | $NH_4$ | Ca | Mg | K | Na | Cl

**Deposition**

H | $SO_4$ | $NO_3$ | $NH_4$ | Ca | Mg | K | Na | Cl | Total N

**Precipitation**

PPT

**More Information**

**Annual Criteria:**

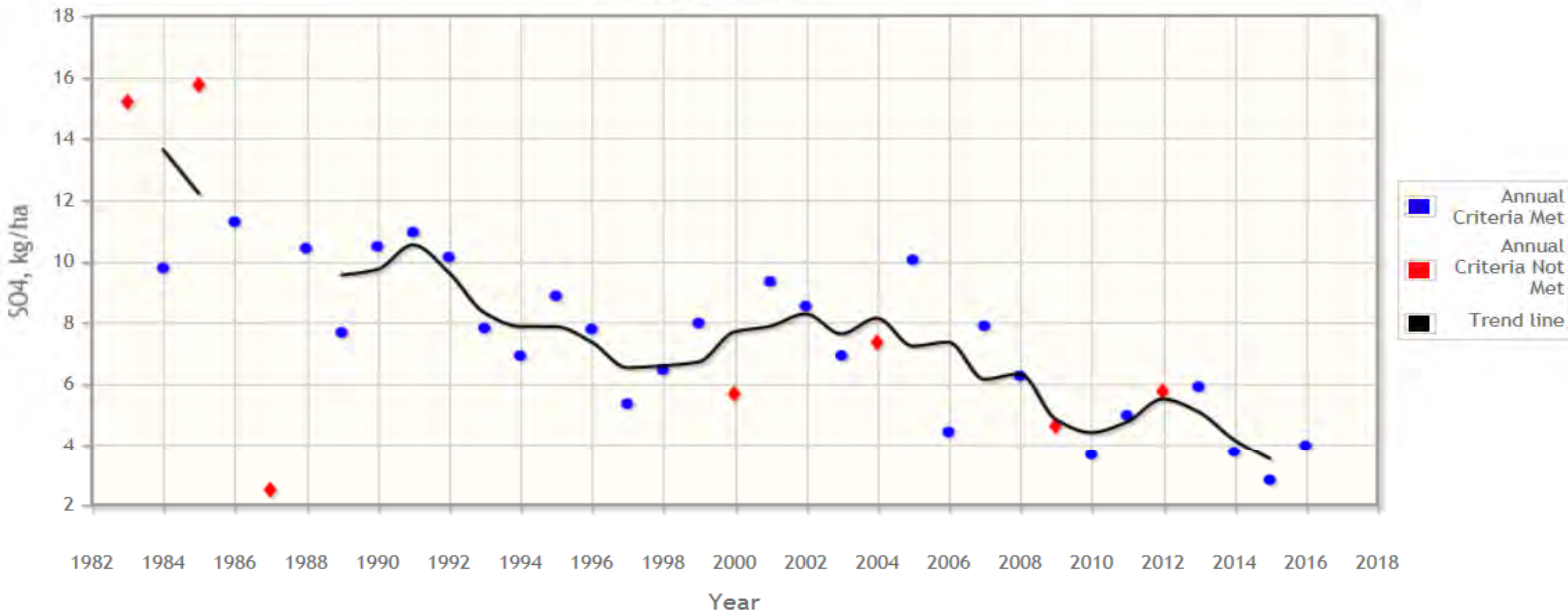
The annual weighted mean concentrations and depositions are characterized as meeting or not meeting the NADP's data completeness criteria for each 1-year period.

1. Valid samples for 75% of the time period
2. Valid samples for 90% of the precipitation amount
3. Precipitation amounts for 75% of the time period

Conservative Value for last 5 years of data: 5 kg/ha-year

National Atmospheric Deposition Program

## NTN Site MI99




**What to Plot**

**Concentration**

pH | $SO_4$ | $NO_3$ | $NH_4$ | Ca | Mg | K | Na | Cl

**Equivelents**

H | $SO_4$ | $NO_3$ | $NH_4$ | Ca | Mg | K | Na | Cl

**Deposition**

H | $SO_4$ | $NO_3$ | $NH_4$ | Ca | Mg | K | Na | Cl | Total N

**Precipitation**

PPT

**More Information**

**Annual Criteria:**

The annual weighted mean concentrations and depositions are characterized as meeting or not meeting the NADP's data completeness criteria for each 1-year period.

1. Valid samples for 75% of the time period
2. Valid samples for 90% of the precipitation amount
3. Precipitation amounts for 75% of the time period

http://nadp.slh.wisc.edu/data/ntn/plots/ntntrends.html?siteID=MI99

Conservative Value for last 5 years of data: 6 kg/ha-year