Memorandum

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April 30, 2019

TO: Dave Anderson, Aquila Resources Inc.

CC: Matt Schowengerdt, Foth Infrastructure & Environment, LLC
Steve Donohue, Foth Infrastructure & Environment, LLC
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FR: Andrea Martin, Foth Infrastructure & Environment, LLC
Jason Martin, Foth Infrastructure & Environment, LLC

RE: Back Forty Project – Revision to Air Deposition and Water Quality and Soil Impact Analysis for the Mining Permit Amendment Application and Environmental Impact Assessment Amendment

Purpose

In November 2018, Aquila Resources Inc. (Aquila) provided a deposition evaluation to the Michigan Department of Environmental Quality (MDEQ) to complete the Environmental Impact Assessment Amendment (EIAA) (Foth, 2018a) for the Back Forty Project (Project). Foth Infrastructure & Environment, LLC (Foth) prepared the deposition memorandum (Foth, 2018b), which was based on air emissions tabulated in the Michigan Air Use Permit – Permit to Install Modification (Foth, 2018c). As MDEQ reviewed the modification application, the MDEQ Air Quality Division communicated a number of comments and questions on the emissions calculations that resulted in air emissions inventory revisions. These revisions and the results of updated dispersion modeling were provided to MDEQ in a series of communications summarized in Martin (2019). The purpose of this memorandum is to present a revised deposition evaluation (re-evaluation) for the Project.

Deposition Re-evaluation Summary

The deposition re-evaluation addresses three issues addressed in Foth (2018b) and one additional issue in response to MDEQ comments:

- Water quality impact evaluation on two local water bodies:
  - Menominee River segment adjacent to the Project.
  - Spring Lake south of the facility.

- Soil impact evaluation at ten locations on the Project Boundary.

- Sulfate deposition rate comparison with a protective standard.

- Evaluation of one receptor (Receptor A) north of the facility boundary.

Figure 1 illustrates the receptor grid within the watersheds draining to the two local water bodies, the receptor locations of the soil evaluation, and Receptor A location. Receptor A is located in an upland area, therefore, evaluation of deposition will be limited to a soil evaluation.

The following basis of evaluation is discussed in more detail in the deposition memorandum Foth (2018b) which continues to apply to this re-evaluation.

Parameter Selection

Parameters evaluated for deposition inputs are copper (Cu), lead (Pb), mercury (Hg), sulfur (S) - sulfate SO4, zinc (Zn).

Deposition Modeling

Modeling assumptions and basis follow the discussion provided in Foth (2018b). Model inputs have been revised, with the emissions revisions summarized in Martin (2019). Attachment 1 provides the revised emission rates and model inputs. The receptor grid is identical as Foth (2018b). Deposition rates for the receptors and parameters of interest are provided in Attachment 2.

Evaluating Deposition Modeling Results

Figure 2 illustrates deposition loads are more concentrated close to the facility and emission sources, and diminish with distance. Figure 2 shows modeled potential copper deposition rates and provides an example of all constituent modeling results, albeit with respective rates. Deposition model results are tabulated in Attachment 2. Numerical evaluation of deposition rates are provided below.

Potential Impacts to Water Quality

Important water bodies close to the facility that may potentially be affected by deposition are the Menominee River and Spring Lake, the closest lake to the south of the facility. Deposition both directly on the water body as well as deposition onto the drainage basin are considered. The analysis for the metal constituents considers the following:

- Deposition loads were calculated by multiplying a selected area (a typical unit is square meters [m^2]) by the average deposition rate within the selected area, expressed in mass per area per time (i.e., mg/m^2/year). Deposition loads in an area are expressed in mass per time (mg/year).

- The two water bodies of interest with their associated drainage basins are shown on Figure 1:
  - Menominee River: with drainage areas in the Project Area; Wisconsin Watershed; and Menominee River
  - Spring Lake: Shakey Lakes Watershed

The water bodies of interest are listed below with their respective drainage areas, illustrated on Figure 1.

- Menominee River segment – 139,948 m^2.
- Project Watershed (draining to Menominee River segment) – 424,319 m^2 without the contact water area.
- Wisconsin Watershed (draining to Menominee River segment) – 2,424,503 m^2.
- Spring Lake – 11,306 m^2.
- Spring Lake Watershed – 924,139 m^2.

The Project Watershed is partitioned into two areas shown on Figure 1: the area that drains to the Menominee River; and the area where contact water is collected and treated prior to discharge. The contact water area is close to facility activities and therefore has the highest values of deposition. These deposition values were included in the Project Watershed average deposition rate (providing a conservative approach), however, the contact area was not included in the drainage to the Menominee River. Over a year, the deposition load was considered as entering the water body of interest. The volume of water considered affected is the annual flow through the water body. Flow data were derived from the Project environmental baseline study (ERM, 2011) and one quarter of available recent baseline data.

A concentration increment due to deposition was estimated by dividing the deposition load per year by the affected water volume per year, resulting in a mass per volume value or concentration.

A baseline concentration of the constituents was developed conservatively, represented by the mean of baseline data plus two standard deviations. Adding the concentration increment due to deposition to the baseline concentration results in a Highest Predicted Concentration. The Highest Predicted Concentration can be compared to a water quality standard to evaluate the effect of deposition on the environment. Michigan Rule 57 Water Quality Standards are shown in the calculations.

The baseline concentrations of mercury in both Menominee River and Spring Lake are above the applicable water quality standard. Therefore, the resulting Highest Predicted Concentration for mercury for both water bodies is also above the applicable water quality standard. Although the protective criteria of the water quality standard cannot be met, considering the increment compared to the baseline concentration gives a sense of the additive potential of the deposition.

Sulfur, the only non-metal constituent, is modeled as described above. The evaluation of sulfur is done by two approaches:

- Sulfur is converted to sulfate by considering 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 0.333 to 1.

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

- A water quality evaluation for sulfate can be done in fashion similar to mercury. Sulfate does not have a water quality standard; however, consideration of how large the increment ratio is in comparison to the baseline concentration provides a perspective on the potential measure of the deposition impact.

Potential water quality impacts for the Menominee River and Spring Lake are presented in Attachment 3 and summarized on Table 1.

Potential Impacts to Soils

Deposition of a particular constituent on soil is evaluated by assuming the constituent incorporates into a top inch of soil and estimating an impacted constituent concentration, then comparing the result to available protective criteria. From baseline data, native soil composition data are available. Ten locations surrounding the facility are marked on Figure 1. They are located in close proximity to the fence line. The evaluation is presented in Attachment 4 and summarized on Table 2.

Receptor A was also evaluated for potential impacts to soils. With this receptor being further distant to the facility, the deposition rates for all constituents are less than those listed at the closest location evaluated at the Project boundary, Receptor 3. Attachment 4 provides the numerical evaluation and summarized on Table 2.

Sulfate Deposition Rate Comparison

Although the geochemical reaction does not take place in the atmosphere, the stoichiometric conversion of sulfur to sulfate enables a comparison of a representative 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. The sulfate deposition rate comparison is presented in Attachment 5 and summarized on Table 3.

Results and Conclusions

The re-evaluation of potential deposition shows that the change in emissions estimates has not significantly changed the deposition evaluation conducted in support of the EIAA (Foth 2018b, a).

Results of the deposition analysis demonstrate that potential metal and sulfur emissions targeted for this study are not anticipated to have impacts exceeding protective standards on surface waters, soils, and environment, where baseline concentrations do not already exceed standards. The water quality evaluation for two surface water bodies closest to the Project were considered. This included the segment of the Menominee River adjacent the Project Area and Spring Lake, the closest lake to the Project. Water bodies closest to Project emissions will incur deposition effects to a greater degree than water bodies farther away. An analysis of closer water bodies implies the characterized effects will be less impactful on more distant water bodies.

Water Quality Evaluation Results

Water quality impact evaluation is summarized on Table 1. Water quality standard comparisons were made for copper, lead, zinc, and mercury. For copper, lead, and zinc, the comparison shows that water quality remains within protective water quality standards for the Highest Predicted Concentration, a conservative estimate of the potential water quality arising from deposition from the Project.

Mercury is a constituent typically present in water bodies throughout the state and region at levels higher than the water quality standard. Mercury concentrations for the Menominee River and Spring Lake show baseline exceedances. The evaluation for the Project can be performed by considering the increment ratio. The increment has been estimated as a fraction of baseline concentration. For both the Menominee River and Spring Lake, the deposition increment for mercury is a fraction of baseline, indicating negligible effect on the environment from mercury from the Project.

Sulfur was evaluated as the sulfate ion for water quality impact. Although no water quality standard is available, the deposition increment estimated was a fraction of 1% of baseline for both water bodies, indicating negligible potential water quality impacts from sulfur related to Project emissions.

Soil Impact Evaluation

Soil impacts and the sulfate deposition rate evaluation were based on deposition potentially occurring adjacent to the facility. An additional receptor (Receptor A) was evaluated for compliance with protective soil criteria. Soil impact evaluation results are summarized in Table 2. Potential soil impacts have been quantified and have been found compliant with the most stringent standard identified. Evaluations of both annual deposition and deposition over the seven-year life of the mine shows no standard exceedance is anticipated for either scenario. Receptor A evaluation has been included in the table and shows that potential deposition rates will not result in exceedances in local soils.

Sulfate Deposition Rate

Sulfate deposition rate evaluation results are summarized in Table 3. A theoretical wet sulfate deposition rate evaluation was performed. Michigan has no specific deposition standards so the Minnesota protective wet sulfate deposition standard was used for the analysis. Although repealed, the Minnesota standard is the only science-based standard available for sulfate deposition effects. The comparison shows that the highest

comparative sulfate deposition rate estimated for the Project complies with the environmentally protective Minnesota standard.

Attachments

References

Environmental Resources Management (ERM), 2011. *Hydrogeology Report Environmental Baseline Studies*. September 2011.

Foth Infrastructure & Environment, LLC, 2018a. *Environmental Impact Assessment Amendment*. November 2018.

Foth Infrastructure & Environment, LLC, 2018b. Memorandum to Dave Anderson: *Back Forty Project – Air Deposition and Water Quality and Soil Impact Analysis for the Mining Permit Amendment Application and Environmental Impact Assessment Amendment.* November 21, 2018.

Foth Infrastructure & Environment, LLC, 2018c. *Michigan Air Use Permit – Permit to Install Modification*. November 2018.

Martin, Jason, Foth Infrastructure & Environment, LLC, 2019. *Aquila Air Emission Calculation and Dispersion Model Tables*. Email to Andrew Drury, Jim Haywood (Michigan Department of Environmental Quality), April 26, 2019.

Tables

Table 1
Deposition Water Quality Impact Evaluation

Constituent	Baseline concentration Meets WQS	Highest Predicted Concentration Meets WQS	Ratio of Increment to Baseline (%)
Menominee River			
Copper	yes	yes	0.1
Lead	yes	yes	0.4
Mercury	no	no	0.25
Sulfate	NA	NA	0.0005
Zinc	yes	yes	0.05
Spring Lake			
Copper	yes	yes	7
Lead	yes	yes	26
Mercury	no	no	21
Sulfate	NA	NA	0.04
Zinc	yes	yes	4

Abbreviations:
% = percent
NA = not applicable
WQS = water quality standard

Prepared by: AKM
Checked by: CED1

Table 2
Summary of Soil Evaluation

Standard and Estimated Value	Copper mg/kg (ppm)	Lead mg/kg (ppm)	Mercury mg/kg (ppm)	Sulfate[1] mg/kg (ppm)	Zinc mg/kg (ppm)
Drinking Water Protection Criteria and Risk Based Screening Level				5000	
Groundwater Surface Water Interface Protection Criteria and Risk Based Screening Level			0.05		
Risk Management Criteria for Metals at BLM Mining Sites	7	6			43

One Year Maximum Value Soil Calculated Concentration:

Soil Evaluation Location	Copper mg/kg (ppm)	Lead mg/kg (ppm)	Mercury mg/kg (ppm)	Sulfate [1] mg/kg (ppm)	Zinc mg/kg (ppm)
1	4.53	3.85	0.010	140	19.2
2	4.53	3.85	0.010	139	19.1
3	4.52	3.79	0.009	137	18.8
4	4.51	3.77	0.009	136	18.7
5	4.52	3.80	0.009	137	18.8
6	4.50	3.71	0.009	134	18.3
7	4.54	3.91	0.010	139	19.3
8	4.52	3.81	0.009	137	18.9
9	4.51	3.74	0.009	135	18.5
10	4.51	3.76	0.009	136	18.6
Receptor A	4.51	3.75	0.009	134	18.6
Do any concentrations exceed standards:	No	No	No	No	No

Seven Year Maximum Value Soil Calculated Concentration:

Soil Evaluation Location	Copper mg/kg (ppm)	Lead mg/kg (ppm)	Mercury mg/kg (ppm)	Sulfate [1] mg/kg (ppm)	Zinc mg/kg (ppm)
1	4.74	4.78	0.014	177	24.7
2	4.72	4.76	0.014	172	24.1
3	4.63	4.31	0.012	155	21.6
4	4.59	4.16	0.011	148	20.8
5	4.64	4.38	0.012	156	22.1
6	4.51	3.76	0.009	135	18.6
7	4.77	5.16	0.015	172	25.6
8	4.66	4.45	0.012	158	22.4
9	4.56	4.00	0.010	144	20.0
10	4.59	4.11	0.011	149	20.6
Receptor A	4.57	4.05	0.011	146	20.2
Do any concentrations exceed standards:	No	No	No	No	No

Note:

[1] Sulfate is converted stoichiometrically from sulfur

Abbreviations:

BLM = Bureau of Land Management
mg/kg = milligram per kilogram
ppm = parts per million

Prepared by: AKM
Checked by: CED1

Table 3
Deposition Rate Comparison for Sulfate

Wet Sulfate Deposition	Kilograms per hectare per year	Reference
Background Rate	4.5	National Atmospheric Deposition Program data
Highest Comparative Rate Associated with the Facility	2.6	Calculated
Theoretical Potential Deposition Rate for the Project	7.1	Calculated: Background + Highest Comparative Rate
Comparative Standard	11	Minnesota Rule, 7021.0030 Acid Deposition Standard[1]

Notes:

[1] This chapter of the Minnesota Rules was repealed by the state in 2013 in that it was no longer needed for enforcement or environmental protection purposes. However, the acceptable concentration can still be used as a benchmark for this evaluation.

Prepared by: AKM
Checked by: CED1

Figures

Wisconsin Watershed
2,424,503 m ^{2}

Menominee River Segment
139,948 m ^{2}

Project Watershed Drainage
to Menominee River
424,319 m ^{2}

Receptor A

Project Watershed
(Contact Water Area)
537,688 m ^{2}

Spring Lake Basin
924,139 m ^{2}

Spring Lake
11,306 m ^{2}

NOTES

1. Topographic basemap from Esri and its data suppliers. Topographic contours shown in feet above mean sea level.
2. Horizontal datum based on NAD 1983. Horizontal coordinates based on UTM Zone 16 North.
3. Updated site layout and pit design supplied by Aquila in September 2018.

LEGEND

- Receptor A
- Deposition Grid Locations
- Soil Evaluation Locations
- Evaluation Location
- Evaluation Location Watersheds
- Evaluation Location Watersheds Disturbed Areas
- Contact Water Management Areas
- Mine Pit Perimeter
- Project Boundary

Aquila Resources Inc.

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Foth Infrastructure & Environment, LLC			
REVISED	DATE	BY	DESCRIPTION

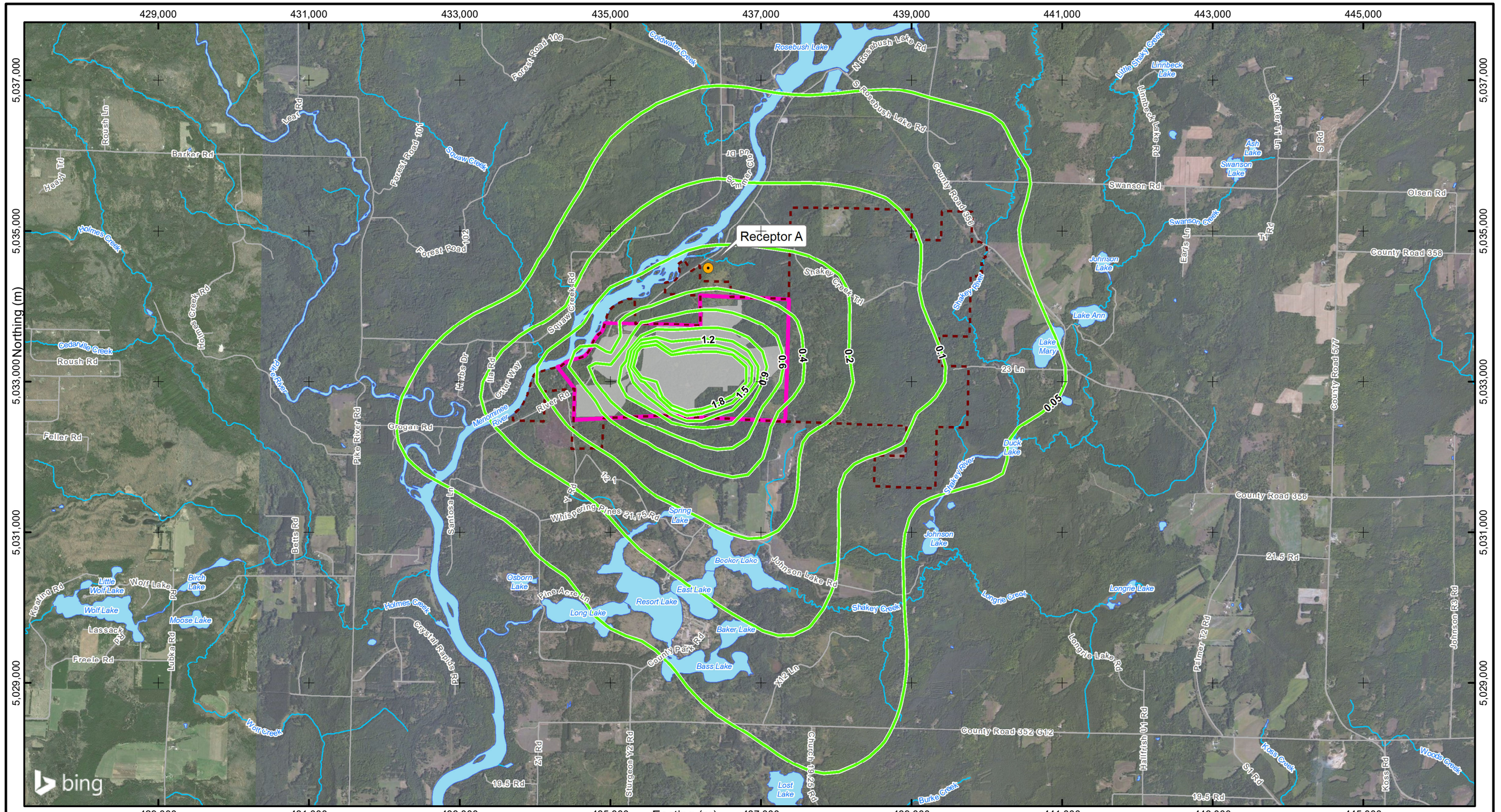
BACK FORTY PROJECT

FIGURE 1
DEPOSITION ANALYSIS
DEPOSITION EVALUATION
LOCATIONS AND WATERSHEDS
STEPHENSON, MICHIGAN

PREPARED BY:	AKM	DATE: APR. '19	
REVIEWED BY:	FJM1	DATE: APR. '19	Scale: 0 1,100 2,200 Feet
APPROVED BY:	CED1	DATE: APR. '19	Drafted by: DAT

Date: APRIL 2019
Project No: 17A021

Path: X:\GB\IE\2014\14A021-00\GIS\mxd\EIA Amendment\Deposition Analysis Response\Figure 1 Deposition Grid within Watersheds.mxd Date: 4/24/2019



NOTES

1. Aerial supplied by Esri and its data suppliers.
2. Horizontal datum based on NAD 1983.
   Horizontal coordinates based on UTM Zone 16 North.
3. Updated site layout and pit design supplied by Aquila in September 2018.
4. Deposition modeling was performed by Foth using AERMOD based on maximum calculated emission rates. Annual deposition rates were determined by including data on particle density, particle diameter and mass fraction. Preprocessed meteorology data from the Menominee-Marinette station for 2017 were used in the analysis.

LEGEND

- Receptor A
- Copper Depositon Contours (milligrams/square meter/year)
- Major Road
- Minor Road
- Streams
- Lakes/Rivers
- Contact Water Management Areas
- Mineral Property Boundary
- Project Boundary

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Foth Infrastructure & Environment, LLC			
REVISED	DATE	BY	DESCRIPTION

PREPARED BY:	AKM	DATE:	APR. '19
REVIEWED BY:	FJM1	DATE:	APR. '19
APPROVED BY:	CED1	DATE:	APR. '19

BACK FORTY PROJECT

FIGURE 2

DEPOSITION ANALYSIS
COPPER DEPOSITION MODELING RESULTS - 2019
STEPHENSON, MICHIGAN

Scale: 0 2,000 4,000 Feet

Date: APRIL 2019

Drafted by: DAT

Project No: 17A021

Path: X:\GB\IE\2014\14A021-00\GIS\mxd\EIA Amendment\Deposition Analysis Response\Figure 2 Copper Deposition Modeling Results - 2018.mxd Date: 4/24/2019

Attachment 1

Deposition Inputs

Client:	Aquila Resources, Inc.	Project ID.:	17A021	
Project:	Back 40 Project - Menominee County, Michigan			
Prepared by:	CED1	Date:	02/26/19	
Checked by:	AKM	Date:	04/22/19	

Air Deposition Model Input Data - Emission Rates of Selected Air Contaminants for Deposition Modeling

	Mercury %	Copper %	Sulfur %	Lead %	Zinc %
Ore	0.0153	0.664	28.76	2.95	17.93
Waste Rock	0.0001	0.008	2.32	0.02	0.13
Tails	0.0001	0.785	39.10	0.06	0.34
Cu Concentrate	0.0053	30.2	29.90	3.35	2.53
Zn Concentrate	0.0370	0.617	24.60	0.27	56.10
Pb Concentrate	0.0370	10	29.90	38.70	4.86
Native Soils	8.90E-07	0.00045	0.004	0.00037	0.00183

Point Sources

Emission Source	Mercury	Copper	Sulfur	Lead	Zinc	Units
SV01A Crushing Plant	3.471E-07	1.505E-05	6.519E-04	6.679E-05	4.064E-04	**g/sec**
SV01B Crushing Plant	1.007E-07	4.364E-06	1.890E-04	1.937E-05	1.179E-04	**g/sec**
SV02A Crushing Plant	5.932E-08	2.572E-06	1.114E-04	1.141E-05	6.946E-05	**g/sec**
SV02B Crushing Plant	1.047E-06	4.539E-05	1.966E-03	2.015E-04	1.226E-03	**g/sec**
SV02C Crushing Plant	2.035E-08	8.823E-07	3.822E-05	3.916E-06	2.383E-05	**g/sec**
SV03 Mercury Retort	8.983E-06					**g/sec**

Volume Sources

Emission Source	No. of Volume Source Segments	Mercury	Copper	Sulfur	Lead	Zinc	Units
ROM	**1**	3.617E-06	1.568E-04	6.793E-03	6.960E-04	4.236E-03	**g/sec**
FLOTPC	**3**	2.171E-07	9.413E-06	4.078E-04	4.178E-05	2.543E-04	**g/sec**
FLOTMILL	**1**	2.335E-07	1.012E-05	4.385E-04	4.493E-05	2.734E-04	**g/sec**
FLOTSAG	**1**	2.123E-08	9.203E-07	3.987E-05	4.085E-06	2.486E-05	**g/sec**
OXIDEPC	**1**	1.282E-07	5.556E-06	2.407E-04	2.466E-05	1.501E-04	**g/sec**
OXIDESEC	**1**	2.110E-07	9.148E-06	3.963E-04	4.060E-05	2.471E-04	**g/sec**
OXIDEMILL	**1**	4.670E-08	2.025E-06	8.771E-05	8.986E-06	5.469E-05	**g/sec**
OXIDEBALLMILL	**1**	2.165E-07	9.387E-06	4.066E-04	4.166E-05	2.535E-04	**g/sec**
CONCT	**1**	1.827E-07	1.667E-05	1.330E-04	7.826E-06	2.679E-04	**g/sec**

Area Sources

Emission Source	Area	Mercury	Copper	Sulfur	Lead	Zinc	Units
Open Pit	**315,000**	3.453E-11	1.552E-09	9.360E-08	6.637E-09	4.047E-08	**g/m2-sec**
TMF_WIND	**112,625**	4.549E-12	3.383E-10	9.911E-08	8.391E-10	5.398E-09	**g/m2-sec**
EOP - WIND	**53,416**	5.931E-10	2.571E-08	1.114E-06	1.141E-07	6.944E-07	**g/m2-sec**
WOP - WIND	**12,982**	6.488E-10	2.813E-08	1.218E-06	1.248E-07	7.597E-07	**g/m2-sec**
NWRF_WRM	**471,717**	5.810E-13	4.321E-11	1.266E-08	1.072E-10	6.894E-10	**g/m2-sec**
SWRF_WRM	**209,587**	6.135E-13	4.563E-11	1.337E-08	1.132E-10	7.280E-10	**g/m2-sec**
TMF_WRM	**433,541**	2.529E-13	1.881E-11	5.510E-09	4.665E-11	3.001E-10	**g/m2-sec**

Notes:

[1] Each constituent concentration is for each volume source segment. Lead is included here although it is regulated as a federal criteria pollutant

[2] Lead and TAC emission rates are based on PM emission composition.

Client:	Aquila Resources, Inc.	Project ID.:	17A021
Project:	Back 40 Project - Menominee County, Michigan		
Prepared by:	CED1	Date:	02/26/19
Checked by:	AKM	Date:	04/22/19

Particle Density, Particle Size Diameters, and Associated Mass Fractions

Ore Density [1] =	2.62	g/cm^3
Waste Rock Density =	2.08	g/cm3
Tailings Dry Density =	2.30	g/cm3
Conc't Density [1] =	1.9	g/cm^3
Native Soils Density =	1.3	g/cm3

Mean Particle Size Range Calculations [2]

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 [3]

SV01 Crushing Plant
SV02 Crushing Plant

Ore Material Density = 2.62 g/cm^3
Controlled with Baghouse

Particle Size Range (μm)	Cum Size (%)	Cum Wt. (g/cm^3)	Mass (g/cm^3)	Uncontrolled Mass Fraction	Control (%)	Controlled Mass (g/cm^3)	Controlled Mass Fraction		
1	4	0.10	0.10	0.04	99	0.0010	0.072	2.62	0.630
2	11	0.29	0.18	0.07	99	0.0018	0.126	2.62	1.554
2.5	15	0.39	0.10	0.04	99.5	0.0005	0.036	2.62	2.259
3	18	0.47	0.08	0.03	99.5	0.0004	0.027	2.62	2.758
4	25	0.65	0.18	0.07	99.5	0.0009	0.063	2.62	3.524
5	30	0.79	0.13	0.05	99.5	0.0007	0.045	2.62	4.518
6	34	0.89	0.10	0.04	99.5	0.0005	0.036	2.62	5.515
10	51	1.34	0.45	0.17	99.5	0.0022	0.153	2.62	8.163
15	100	2.62	1.28	0.49	99.5	0.0064	0.441	2.62	12.664
Totals			2.62	1.0		0.015	1.0		

Client:	Aquila Resources, Inc.	Project ID.:	17A021
Project:	Back 40 Project - Menominee County, Michigan		
Prepared by:	CED1	Date:	02/26/19
Checked by:	AKM	Date:	04/22/19

Volume Sources [3]

UNLOAD
FELOAD
CB 1 to 3
TRTOWER
DROP1, TRANS1, FLOTCHTE
DROP2, TRANS2, OXCHUTE
FELHOP

Ore Material Density = 2.62 g/cm^3
No Control Devices Added to Mechanically Change Particle Size

Particle Size Range (µm)	Cum Size (%)	Cum Wt. (g/cm^3)	Mass (g/cm^3)	Mass Fraction		
1	4	0.10	0.10	0.04	2.62	0.630
2	11	0.29	0.18	0.07	2.62	1.554
2.5	15	0.39	0.10	0.04	2.62	2.259
3	18	0.47	0.08	0.03	2.62	2.758
4	25	0.65	0.18	0.07	2.62	3.524
5	30	0.79	0.13	0.05	2.62	4.518
6	34	0.89	0.10	0.04	2.62	5.515
10	51	1.34	0.45	0.17	2.62	8.163
15	100	2.62	1.28	0.49	2.62	12.664
Totals			2.62	1.0		

HRROM
HRFTMFWRF

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

Client:	Aquila Resources, Inc.	Project ID.:	17A021
Project:	Back 40 Project - Menominee County, Michigan		
Prepared by:	CED1	Date:	02/26/19
Checked by:	AKM	Date:	04/22/19

Area Sources [3]

Open Pit — Waste Rock Density = 2.08 g/cm^3
WR Travel and Place — No Control Devices Added to Mechanically Change 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	2.08	0.630
2	11	0.23	0.15	0.07	2.08	1.554
2.5	15	0.31	0.08	0.04	2.08	2.259
3	18	0.37	0.06	0.03	2.08	2.758
4	25	0.52	0.15	0.07	2.08	3.524
5	30	0.62	0.10	0.05	2.08	4.518
6	34	0.71	0.08	0.04	2.08	5.515
10	51	1.06	0.35	0.17	2.08	8.163
15	100	2.08	1.02	0.49	2.08	12.664
Totals			2.08	1.0		

TMF and WRF Wind Erosion — Tailings Density = 2.3 g/cm^3
No Control Devices Added to Mechanically Change Particle Size

Particle Size Range (µm)	Cum Size (%)	Cum Wt. (g/cm^3)	Mass (g/cm^3)	Mass Fraction
1	4	0.09	0.09	0.04
2	11	0.25	0.16	0.07
2.5	15	0.35	0.09	0.04
3	18	0.41	0.07	0.03
4	25	0.58	0.16	0.07
5	30	0.69	0.12	0.05
6	34	0.78	0.09	0.04
10	51	1.17	0.39	0.17
15	100	2.30	1.13	0.49
Totals			2.30	1.0

Client:	Aquila Resources, Inc.	Project ID.:	17A021
Project:	Back 40 Project - Menominee County, Michigan		
Prepared by:	CED1	Date:	02/26/19
Checked by:	AKM	Date:	04/22/19

Concentrate Load-Out Bldg

Concentrate Material Density = 1.9 g/cm^3

No Control Devices Added to Mechanically Change Particle Size

Particle Size Range (μm)	Cum Size (%)	Cum Wt. (g/cm^3)	Mass (g/cm^3)	Mass Fraction
1	4	0.0760	0.0760	0.04
2	11	0.2090	0.1330	0.07
2.5	15	0.2850	0.0760	0.04
3	18	0.3420	0.0570	0.03
4	25	0.4750	0.1330	0.07
5	30	0.5700	0.0950	0.05
6	34	0.6460	0.0760	0.04
10	51	0.9690	0.3230	0.17
15	100	1.9000	0.9310	0.49
Totals			1.90	1.0

Notes:

1. Material densities were taken directly from the *Data Table completed for air emission calculations* for the Aquila Resources, Inc. site.

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

3. 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 Rates for Receptors of Interest

Client:	Aquila Resources		Project ID.:	17A021
Project:	Back Forty Project - Menominee County, Michigan			
Prepared by:	AKM		Date:	04/29/19
Checked by:	CED1		Date:	04/30/19

Water Quality Evaluation for Menominee River and Spring Lake **Page**

Copper Deposition Modeling Results: mg/m^2/year

Client:	Aquila Resources	Project ID.:	17A021
Project:	Back Forty Project - Menominee County, Michigan		
Prepared by:	AKM	Date:	04/29/19
Checked by:	CED1	Date:	04/30/19

ID	X	Y	Copper deposition mg/m2/yr	Drainage Area SqMeters	
Project Watershed	435,907.60	5,033,090	6.376	962,007	
Project Watershed	436,107.60	5,033,090	6.164	962,007	
Project Watershed	435,507.60	5,033,290	5.403	962,007	
Project Watershed	435,707.60	5,033,290	1.517	962,007	
Project Watershed	435,907.60	5,033,290	1.842	962,007	
Project Watershed	436,107.60	5,033,290	2.232	962,007	
Project Watershed	436,307.60	5,033,290	2.393	962,007	
Project Watershed	435,307.60	5,033,490	0.540	962,007	
Project Watershed	435,507.60	5,033,490	1.690	962,007	
Project Watershed	435,707.60	5,033,490	1.378	962,007	
Project Watershed	435,907.60	5,033,490	1.270	962,007	
Project Watershed	436,107.60	5,033,490	1.303	962,007	
Project Watershed	436,307.60	5,033,490	1.350	962,007	
Project Watershed	435,107.60	5,033,690	0.209	962,007	
Project Watershed	435,307.60	5,033,690	0.683	962,007	
Project Watershed	435,507.60	5,033,690	0.780	962,007	
Project Watershed	435,707.60	5,033,690	0.818	962,007	
Project Watershed	435,907.60	5,033,690	0.859	962,007	
Project Watershed	436,107.60	5,033,690	0.873	962,007	
Project Watershed	435,107.60	5,033,890	0.416	962,007	
Project Watershed	435,307.60	5,033,890	0.430	962,007	
Project Watershed	435,507.60	5,033,890	0.487	962,007	
Project Watershed	435,707.60	5,033,890	0.527	962,007	
Project Watershed	435,907.60	5,033,890	0.596	962,007	
Project Watershed	436,107.60	5,033,890	0.637	962,007	
Project Watershed	435,307.60	5,034,090	0.289	962,007	
		Average:	1.58	424,319	See Note
			mg/m2/yr	m2	

Note: Project Watershed area is adjusted to account for contact water area of 537,688 m2 which will not drain to the Menominee River.

Deposition Loading on Basin	
670,099	mg/yr

Client: Aquila Resources Project ID.: 17A021
Project: Back Forty Project - Menominee County, Michigan
Prepared by: AKM Date: 04/29/19
Checked by: CED1 Date: 04/30/19

ID	X	Y	Copper deposition mg/m2/yr	Drainage Area SqMeters
Shakey Lakes Watershed	435,907.60	5,031,090	0.163	924,139
Shakey Lakes Watershed	436,107.60	5,031,090	0.177	924,139
Shakey Lakes Watershed	435,707.60	5,031,290	0.174	924,139
Shakey Lakes Watershed	435,907.60	5,031,290	0.189	924,139
Shakey Lakes Watershed	436,107.60	5,031,290	0.205	924,139
Shakey Lakes Watershed	436,307.60	5,031,290	0.227	924,139
Shakey Lakes Watershed	435,707.60	5,031,490	0.212	924,139
Shakey Lakes Watershed	435,907.60	5,031,490	0.232	924,139
Shakey Lakes Watershed	436,107.60	5,031,490	0.250	924,139
Shakey Lakes Watershed	436,307.60	5,031,490	0.275	924,139
Shakey Lakes Watershed	436,507.60	5,031,490	0.299	924,139
Shakey Lakes Watershed	436,707.60	5,031,490	0.320	924,139
Shakey Lakes Watershed	435,707.60	5,031,690	0.261	924,139
Shakey Lakes Watershed	435,907.60	5,031,690	0.289	924,139
Shakey Lakes Watershed	436,107.60	5,031,690	0.315	924,139
Shakey Lakes Watershed	436,307.60	5,031,690	0.346	924,139
Shakey Lakes Watershed	436,507.60	5,031,690	0.365	924,139
Shakey Lakes Watershed	436,707.60	5,031,690	0.387	924,139
Shakey Lakes Watershed	436,307.60	5,031,890	0.442	924,139
Shakey Lakes Watershed	436,507.60	5,031,890	0.462	924,139
Shakey Lakes Watershed	436,707.60	5,031,890	0.463	924,139
Shakey Lakes Watershed	436,907.60	5,032,090	0.501	924,139
		Average:	0.30	924,139
			mg/m2/yr	m2

Deposition Loading on Basin	
275,312	mg/yr

Wisconsin Watershed	434,707.60	5,034,090	0.147	2,424,503
Wisconsin Watershed	434,707.60	5,034,290	0.124	2,424,503
Wisconsin Watershed	434,907.60	5,034,290	0.174	2,424,503
Wisconsin Watershed	435,107.60	5,034,290	0.200	2,424,503
Wisconsin Watershed	434,707.60	5,034,490	0.107	2,424,503
Wisconsin Watershed	434,907.60	5,034,490	0.137	2,424,503
Wisconsin Watershed	435,107.60	5,034,490	0.160	2,424,503
Wisconsin Watershed	435,307.60	5,034,490	0.173	2,424,503
Wisconsin Watershed	434,707.60	5,034,690	0.092	2,424,503
Wisconsin Watershed	434,907.60	5,034,690	0.112	2,424,503
Wisconsin Watershed	435,107.60	5,034,690	0.131	2,424,503
Wisconsin Watershed	434,707.60	5,034,890	0.079	2,424,503
Wisconsin Watershed	434,907.60	5,034,890	0.095	2,424,503
Wisconsin Watershed	435,107.60	5,034,890	0.111	2,424,503
Wisconsin Watershed	434,707.60	5,035,090	0.069	2,424,503
Wisconsin Watershed	434,907.60	5,035,090	0.083	2,424,503
Wisconsin Watershed	435,107.60	5,035,090	0.096	2,424,503
Wisconsin Watershed	435,307.60	5,035,090	0.109	2,424,503
Wisconsin Watershed	434,307.60	5,035,290	0.044	2,424,503
Wisconsin Watershed	434,507.60	5,035,290	0.053	2,424,503
Wisconsin Watershed	434,707.60	5,035,290	0.061	2,424,503

Copper Deposition Modeling Results: mg/m^2/year

Client: Aquila Resources Project ID.: 17A021
Project: Back Forty Project - Menominee County, Michigan
Prepared by: AKM Date: 04/29/19
Checked by: CED1 Date: 04/30/19

ID	X	Y	Copper deposition mg/m2/yr	Drainage Area SqMeters
Wisconsin Watershed	434,907.60	5,035,290	0.074	2,424,503
Wisconsin Watershed	435,107.60	5,035,290	0.085	2,424,503
Wisconsin Watershed	435,307.60	5,035,290	0.095	2,424,503
Wisconsin Watershed	435,507.60	5,035,290	0.105	2,424,503
Wisconsin Watershed	434,107.60	5,035,490	0.034	2,424,503
Wisconsin Watershed	434,307.60	5,035,490	0.040	2,424,503
Wisconsin Watershed	434,507.60	5,035,490	0.048	2,424,503
Wisconsin Watershed	434,707.60	5,035,490	0.055	2,424,503
Wisconsin Watershed	434,907.60	5,035,490	0.067	2,424,503
Wisconsin Watershed	435,107.60	5,035,490	0.076	2,424,503
Wisconsin Watershed	435,307.60	5,035,490	0.085	2,424,503
Wisconsin Watershed	435,507.60	5,035,490	0.093	2,424,503
Wisconsin Watershed	434,107.60	5,035,690	0.031	2,424,503
Wisconsin Watershed	434,307.60	5,035,690	0.037	2,424,503
Wisconsin Watershed	434,507.60	5,035,690	0.043	2,424,503
Wisconsin Watershed	434,707.60	5,035,690	0.050	2,424,503
Wisconsin Watershed	434,907.60	5,035,690	0.061	2,424,503
Wisconsin Watershed	435,107.60	5,035,690	0.069	2,424,503
Wisconsin Watershed	435,307.60	5,035,690	0.076	2,424,503
Wisconsin Watershed	435,507.60	5,035,690	0.083	2,424,503
Wisconsin Watershed	435,707.60	5,035,690	0.087	2,424,503
Wisconsin Watershed	434,307.60	5,035,890	0.035	2,424,503
Wisconsin Watershed	434,507.60	5,035,890	0.040	2,424,503
Wisconsin Watershed	434,707.60	5,035,890	0.046	2,424,503
Wisconsin Watershed	434,907.60	5,035,890	0.056	2,424,503
Wisconsin Watershed	435,107.60	5,035,890	0.062	2,424,503
Wisconsin Watershed	435,307.60	5,035,890	0.068	2,424,503
Wisconsin Watershed	435,507.60	5,035,890	0.074	2,424,503
Wisconsin Watershed	435,707.60	5,035,890	0.078	2,424,503
Wisconsin Watershed	434,507.60	5,036,090	0.037	2,424,503
Wisconsin Watershed	434,707.60	5,036,090	0.042	2,424,503
Wisconsin Watershed	434,907.60	5,036,090	0.051	2,424,503
Wisconsin Watershed	435,107.60	5,036,090	0.056	2,424,503
Wisconsin Watershed	435,307.60	5,036,090	0.062	2,424,503
Wisconsin Watershed	435,507.60	5,036,090	0.067	2,424,503
Wisconsin Watershed	435,707.60	5,036,090	0.070	2,424,503
Wisconsin Watershed	434,507.60	5,036,290	0.034	2,424,503
Wisconsin Watershed	434,707.60	5,036,290	0.039	2,424,503
		Average:	0.08	2,424,503
			mg/m2/yr	m2

Deposition Loading on Basin	
191,886	mg/yr

Copper Deposition Modeling Results: mg/m^2/year

Client:	Aquila Resources	Project ID.:	17A021
Project:	Back Forty Project - Menominee County, Michigan		
Prepared by:	AKM	Date:	04/29/19
Checked by:	CED1	Date:	04/30/19

ID	X	Y	Copper deposition mg/m2/yr	Drainage Area SqMeters
Menominee River	434,907.60	5,033,890	0.308	139,948
Menominee River	434,907.60	5,034,090	0.224	139,948
Menominee River	435,107.60	5,034,090	0.269	139,948
		Average:	0.27	139,948
			mg/m2/yr	m2

Deposition Loading on River	
37,333	mg/yr

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Client: Aquila Resources Project ID.: 17A021
Project: Back Forty Project - Menominee County, Michigan
Prepared by: AKM Date: 04/29/19
Checked by: CED1 Date: 04/30/19

ID	X	Y	Lead deposition mg/m2/yr	Drainage Area SqMeters
Project Watershed	435,907.60	5,033,090	37.813	962,007
Project Watershed	436,107.60	5,033,090	38.037	962,007
Project Watershed	435,507.60	5,033,290	24.260	962,007
Project Watershed	435,707.60	5,033,290	7.400	962,007
Project Watershed	435,907.60	5,033,290	10.336	962,007
Project Watershed	436,107.60	5,033,290	12.431	962,007
Project Watershed	436,307.60	5,033,290	12.671	962,007
Project Watershed	435,307.60	5,033,490	2.549	962,007
Project Watershed	435,507.60	5,033,490	7.610	962,007
Project Watershed	435,707.60	5,033,490	6.435	962,007
Project Watershed	435,907.60	5,033,490	6.314	962,007
Project Watershed	436,107.60	5,033,490	6.436	962,007
Project Watershed	436,307.60	5,033,490	6.848	962,007
Project Watershed	435,107.60	5,033,690	1.015	962,007
Project Watershed	435,307.60	5,033,690	3.091	962,007
Project Watershed	435,507.60	5,033,690	3.570	962,007
Project Watershed	435,707.60	5,033,690	3.896	962,007
Project Watershed	435,907.60	5,033,690	4.225	962,007
Project Watershed	436,107.60	5,033,690	4.242	962,007
Project Watershed	435,107.60	5,033,890	1.873	962,007
Project Watershed	435,307.60	5,033,890	1.964	962,007
Project Watershed	435,507.60	5,033,890	2.272	962,007
Project Watershed	435,707.60	5,033,890	2.537	962,007
Project Watershed	435,907.60	5,033,890	2.910	962,007
Project Watershed	436,107.60	5,033,890	3.068	962,007
Project Watershed	435,307.60	5,034,090	1.336	962,007
		Average:	8.27	424,319 See Note
			mg/m2/yr	m2

Note: Project Watershed area is adjusted to account for contact water area of 537,688 m2 which will not drain to the Menominee River.

Deposition Loading on Basin	
3,511,103	mg/yr

Note: Project Watershed is area adjusted to account for contact water area.

Foth

Client: Aquila Resources Project ID.: 17A021
Project: Back Forty Project - Menominee County, Michigan
Prepared by: AKM Date: 04/29/19
Checked by: CED1 Date: 04/30/19

ID	X	Y	Lead deposition mg/m2/yr	Drainage Area SqMeters
Shakey Lakes Watershed	435,907.60	5,031,090	0.792	924,139
Shakey Lakes Watershed	436,107.60	5,031,090	0.868	924,139
Shakey Lakes Watershed	435,707.60	5,031,290	0.838	924,139
Shakey Lakes Watershed	435,907.60	5,031,290	0.925	924,139
Shakey Lakes Watershed	436,107.60	5,031,290	1.011	924,139
Shakey Lakes Watershed	436,307.60	5,031,290	1.141	924,139
Shakey Lakes Watershed	435,707.60	5,031,490	1.028	924,139
Shakey Lakes Watershed	435,907.60	5,031,490	1.139	924,139
Shakey Lakes Watershed	436,107.60	5,031,490	1.241	924,139
Shakey Lakes Watershed	436,307.60	5,031,490	1.396	924,139
Shakey Lakes Watershed	436,507.60	5,031,490	1.515	924,139
Shakey Lakes Watershed	436,707.60	5,031,490	1.593	924,139
Shakey Lakes Watershed	435,707.60	5,031,690	1.271	924,139
Shakey Lakes Watershed	435,907.60	5,031,690	1.431	924,139
Shakey Lakes Watershed	436,107.60	5,031,690	1.580	924,139
Shakey Lakes Watershed	436,307.60	5,031,690	1.782	924,139
Shakey Lakes Watershed	436,507.60	5,031,690	1.862	924,139
Shakey Lakes Watershed	436,707.60	5,031,690	1.918	924,139
Shakey Lakes Watershed	436,307.60	5,031,890	2.301	924,139
Shakey Lakes Watershed	436,507.60	5,031,890	2.366	924,139
Shakey Lakes Watershed	436,707.60	5,031,890	2.279	924,139
Shakey Lakes Watershed	436,907.60	5,032,090	2.364	924,139
		Average:	1.48	924,139
			mg/m2/yr	m2

Deposition Loading on Basin	
1,371,086	mg/yr

Wisconsin Watershed	434,707.60	5,034,090	0.681	2,424,503
Wisconsin Watershed	434,707.60	5,034,290	0.577	2,424,503
Wisconsin Watershed	434,907.60	5,034,290	0.793	2,424,503
Wisconsin Watershed	435,107.60	5,034,290	0.920	2,424,503
Wisconsin Watershed	434,707.60	5,034,490	0.495	2,424,503
Wisconsin Watershed	434,907.60	5,034,490	0.631	2,424,503
Wisconsin Watershed	435,107.60	5,034,490	0.745	2,424,503
Wisconsin Watershed	435,307.60	5,034,490	0.821	2,424,503
Wisconsin Watershed	434,707.60	5,034,690	0.426	2,424,503
Wisconsin Watershed	434,907.60	5,034,690	0.522	2,424,503
Wisconsin Watershed	435,107.60	5,034,690	0.616	2,424,503
Wisconsin Watershed	434,707.60	5,034,890	0.367	2,424,503
Wisconsin Watershed	434,907.60	5,034,890	0.446	2,424,503
Wisconsin Watershed	435,107.60	5,034,890	0.527	2,424,503
Wisconsin Watershed	434,707.60	5,035,090	0.321	2,424,503
Wisconsin Watershed	434,907.60	5,035,090	0.391	2,424,503
Wisconsin Watershed	435,107.60	5,035,090	0.459	2,424,503
Wisconsin Watershed	435,307.60	5,035,090	0.520	2,424,503
Wisconsin Watershed	434,307.60	5,035,290	0.208	2,424,503
Wisconsin Watershed	434,507.60	5,035,290	0.248	2,424,503

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Client: Aquila Resources Project ID.: 17A021
Project: Back Forty Project - Menominee County, Michigan
Prepared by: AKM Date: 04/29/19
Checked by: CED1 Date: 04/30/19

ID	X	Y	Lead deposition mg/m2/yr	Drainage Area SqMeters
Wisconsin Watershed	434,707.60	5,035,290	0.287	2,424,503
Wisconsin Watershed	434,907.60	5,035,290	0.349	2,424,503
Wisconsin Watershed	435,107.60	5,035,290	0.406	2,424,503
Wisconsin Watershed	435,307.60	5,035,290	0.458	2,424,503
Wisconsin Watershed	435,507.60	5,035,290	0.506	2,424,503
Wisconsin Watershed	434,107.60	5,035,490	0.158	2,424,503
Wisconsin Watershed	434,307.60	5,035,490	0.188	2,424,503
Wisconsin Watershed	434,507.60	5,035,490	0.224	2,424,503
Wisconsin Watershed	434,707.60	5,035,490	0.260	2,424,503
Wisconsin Watershed	434,907.60	5,035,490	0.317	2,424,503
Wisconsin Watershed	435,107.60	5,035,490	0.364	2,424,503
Wisconsin Watershed	435,307.60	5,035,490	0.406	2,424,503
Wisconsin Watershed	435,507.60	5,035,490	0.446	2,424,503
Wisconsin Watershed	434,107.60	5,035,690	0.147	2,424,503
Wisconsin Watershed	434,307.60	5,035,690	0.176	2,424,503
Wisconsin Watershed	434,507.60	5,035,690	0.205	2,424,503
Wisconsin Watershed	434,707.60	5,035,690	0.238	2,424,503
Wisconsin Watershed	434,907.60	5,035,690	0.289	2,424,503
Wisconsin Watershed	435,107.60	5,035,690	0.328	2,424,503
Wisconsin Watershed	435,307.60	5,035,690	0.363	2,424,503
Wisconsin Watershed	435,507.60	5,035,690	0.395	2,424,503
Wisconsin Watershed	435,707.60	5,035,690	0.421	2,424,503
Wisconsin Watershed	434,307.60	5,035,890	0.167	2,424,503
Wisconsin Watershed	434,507.60	5,035,890	0.191	2,424,503
Wisconsin Watershed	434,707.60	5,035,890	0.221	2,424,503
Wisconsin Watershed	434,907.60	5,035,890	0.266	2,424,503
Wisconsin Watershed	435,107.60	5,035,890	0.298	2,424,503
Wisconsin Watershed	435,307.60	5,035,890	0.326	2,424,503
Wisconsin Watershed	435,507.60	5,035,890	0.353	2,424,503
Wisconsin Watershed	435,707.60	5,035,890	0.375	2,424,503
Wisconsin Watershed	434,507.60	5,036,090	0.175	2,424,503
Wisconsin Watershed	434,707.60	5,036,090	0.202	2,424,503
Wisconsin Watershed	434,907.60	5,036,090	0.242	2,424,503
Wisconsin Watershed	435,107.60	5,036,090	0.267	2,424,503
Wisconsin Watershed	435,307.60	5,036,090	0.294	2,424,503
Wisconsin Watershed	435,507.60	5,036,090	0.318	2,424,503
Wisconsin Watershed	435,707.60	5,036,090	0.334	2,424,503
Wisconsin Watershed	434,507.60	5,036,290	0.162	2,424,503
Wisconsin Watershed	434,707.60	5,036,290	0.187	2,424,503
		Average:	0.37	2,424,503
			mg/m2/yr	m2

Deposition Loading on Basin	
905,008	mg/yr

Lead Deposition Modeling Results: mg/m^2/year

Client:	Aquila Resources	Project ID.:	17A021
Project:	Back Forty Project - Menominee County, Michigan		
Prepared by:	AKM	Date:	04/29/19
Checked by:	CED1	Date:	04/30/19

ID	X	Y	Lead deposition mg/m2/yr	Drainage Area SqMeters
Menominee River	434,907.60	5,033,890	1.392	139,948
Menominee River	434,907.60	5,034,090	1.019	139,948
Menominee River	435,107.60	5,034,090	1.222	139,948
		Average:	1.21	139,948
			mg/m2/yr	m2

Deposition Loading on River	
169,488	mg/yr

Client: Aquila Resources Project ID.: 17A021
Project: Back Forty Project - Menominee County, Michigan
Prepared by: AKM Date: 04/29/19
Checked by: CED1 Date: 04/30/19

ID	X	Y	Mercury deposition ng/m2/yr	Drainage Area SqMeters
Project Watershed	435,907.60	5,033,090.00	154047.6	962,007
Project Watershed	436,107.60	5,033,090.00	147291.9	962,007
Project Watershed	435,507.60	5,033,290.00	125435.7	962,007
Project Watershed	435,707.60	5,033,290.00	36901.7	962,007
Project Watershed	435,907.60	5,033,290.00	44807.1	962,007
Project Watershed	436,107.60	5,033,290.00	53336.2	962,007
Project Watershed	436,307.60	5,033,290.00	57857.8	962,007
Project Watershed	435,307.60	5,033,490.00	13110.8	962,007
Project Watershed	435,507.60	5,033,490.00	39449.7	962,007
Project Watershed	435,707.60	5,033,490.00	32902.2	962,007
Project Watershed	435,907.60	5,033,490.00	30145.4	962,007
Project Watershed	436,107.60	5,033,490.00	30703.3	962,007
Project Watershed	436,307.60	5,033,490.00	32510.2	962,007
Project Watershed	435,107.60	5,033,690.00	5237.0	962,007
Project Watershed	435,307.60	5,033,690.00	16113.8	962,007
Project Watershed	435,507.60	5,033,690.00	18705.5	962,007
Project Watershed	435,707.60	5,033,690.00	19923.7	962,007
Project Watershed	435,907.60	5,033,690.00	21021.3	962,007
Project Watershed	436,107.60	5,033,690.00	21227.6	962,007
Project Watershed	435,107.60	5,033,890.00	9767.8	962,007
Project Watershed	435,307.60	5,033,890.00	10352.9	962,007
Project Watershed	435,507.60	5,033,890.00	11921.9	962,007
Project Watershed	435,707.60	5,033,890.00	13045.4	962,007
Project Watershed	435,907.60	5,033,890.00	14781.7	962,007
Project Watershed	436,107.60	5,033,890.00	15667.6	962,007
Project Watershed	435,307.60	5,034,090.00	7093.5	962,007
		Average:	37,822	424,319 See Note
			ng/m2/yr	m2

Note: Project Watershed area is adjusted to account for contact water area of 537,688 m2 which will not drain to the Menominee River.

Deposition Loading on Basin

16,048,381,287	ng/yr
16048	mg/yr

Foth

Client:	Aquila Resources	Project ID.:	17A021
Project:	Back Forty Project - Menominee County, Michigan		
Prepared by:	AKM	Date:	04/29/19
Checked by:	CED1	Date:	04/30/19

ID	X	Y	Mercury deposition ng/m2/yr	Drainage Area SqMeters
Shakey Lakes Watershed	435,907.60	5,031,090.00	4688	924,139
Shakey Lakes Watershed	436,107.60	5,031,090.00	5241	924,139
Shakey Lakes Watershed	435,707.60	5,031,290.00	4954	924,139
Shakey Lakes Watershed	435,907.60	5,031,290.00	5497	924,139
Shakey Lakes Watershed	436,107.60	5,031,290.00	6216	924,139
Shakey Lakes Watershed	436,307.60	5,031,290.00	7224	924,139
Shakey Lakes Watershed	435,707.60	5,031,490.00	6156	924,139
Shakey Lakes Watershed	435,907.60	5,031,490.00	6845	924,139
Shakey Lakes Watershed	436,107.60	5,031,490.00	7864	924,139
Shakey Lakes Watershed	436,307.60	5,031,490.00	8914	924,139
Shakey Lakes Watershed	436,507.60	5,031,490.00	9243	924,139
Shakey Lakes Watershed	436,707.60	5,031,490.00	9249	924,139
Shakey Lakes Watershed	435,707.60	5,031,690.00	7775	924,139
Shakey Lakes Watershed	435,907.60	5,031,690.00	8735	924,139
Shakey Lakes Watershed	436,107.60	5,031,690.00	10395	924,139
Shakey Lakes Watershed	436,307.60	5,031,690.00	11434	924,139
Shakey Lakes Watershed	436,507.60	5,031,690.00	11312	924,139
Shakey Lakes Watershed	436,707.60	5,031,690.00	10706	924,139
Shakey Lakes Watershed	436,307.60	5,031,890.00	14659	924,139
Shakey Lakes Watershed	436,507.60	5,031,890.00	13494	924,139
Shakey Lakes Watershed	436,707.60	5,031,890.00	12415	924,139
Shakey Lakes Watershed	436,907.60	5,032,090.00	13124	924,139
		Average:	8,915	924,139
			ng/m2/yr	m2

Deposition Loading on Basin	
8,239,133,068	ng/yr
8239.1	mg/yr

ID	X	Y	Deposition Value	SqMeters
Wisconsin Watershed	434,707.60	5,034,090.00	3557	2,424,503
Wisconsin Watershed	434,707.60	5,034,290.00	3023	2,424,503
Wisconsin Watershed	434,907.60	5,034,290.00	4189	2,424,503
Wisconsin Watershed	435,107.60	5,034,290.00	4888	2,424,503
Wisconsin Watershed	434,707.60	5,034,490.00	2620	2,424,503
Wisconsin Watershed	434,907.60	5,034,490.00	3362	2,424,503
Wisconsin Watershed	435,107.60	5,034,490.00	3981	2,424,503
Wisconsin Watershed	435,307.60	5,034,490.00	4354	2,424,503
Wisconsin Watershed	434,707.60	5,034,690.00	2273	2,424,503
Wisconsin Watershed	434,907.60	5,034,690.00	2795	2,424,503
Wisconsin Watershed	435,107.60	5,034,690.00	3299	2,424,503
Wisconsin Watershed	434,707.60	5,034,890.00	1976	2,424,503
Wisconsin Watershed	434,907.60	5,034,890.00	2399	2,424,503
Wisconsin Watershed	435,107.60	5,034,890.00	2821	2,424,503
Wisconsin Watershed	434,707.60	5,035,090.00	1734	2,424,503
Wisconsin Watershed	434,907.60	5,035,090.00	2110	2,424,503
Wisconsin Watershed	435,107.60	5,035,090.00	2455	2,424,503
Wisconsin Watershed	435,307.60	5,035,090.00	2769	2,424,503
Wisconsin Watershed	434,307.60	5,035,290.00	1117	2,424,503

Foth

Client:	Aquila Resources	Project ID.:	17A021
Project:	Back Forty Project - Menominee County, Michigan		
Prepared by:	AKM	Date:	04/29/19
Checked by:	CED1	Date:	04/30/19

ID	X	Y	Mercury deposition ng/m2/yr	Drainage Area SqMeters
Wisconsin Watershed	434,507.60	5,035,290.00	1338	2,424,503
Wisconsin Watershed	434,707.60	5,035,290.00	1550	2,424,503
Wisconsin Watershed	434,907.60	5,035,290.00	1881	2,424,503
Wisconsin Watershed	435,107.60	5,035,290.00	2176	2,424,503
Wisconsin Watershed	435,307.60	5,035,290.00	2439	2,424,503
Wisconsin Watershed	435,507.60	5,035,290.00	2691	2,424,503
Wisconsin Watershed	434,107.60	5,035,490.00	850	2,424,503
Wisconsin Watershed	434,307.60	5,035,490.00	1016	2,424,503
Wisconsin Watershed	434,507.60	5,035,490.00	1209	2,424,503
Wisconsin Watershed	434,707.60	5,035,490.00	1409	2,424,503
Wisconsin Watershed	434,907.60	5,035,490.00	1706	2,424,503
Wisconsin Watershed	435,107.60	5,035,490.00	1952	2,424,503
Wisconsin Watershed	435,307.60	5,035,490.00	2169	2,424,503
Wisconsin Watershed	435,507.60	5,035,490.00	2378	2,424,503
Wisconsin Watershed	434,107.60	5,035,690.00	794	2,424,503
Wisconsin Watershed	434,307.60	5,035,690.00	952	2,424,503
Wisconsin Watershed	434,507.60	5,035,690.00	1111	2,424,503
Wisconsin Watershed	434,707.60	5,035,690.00	1285	2,424,503
Wisconsin Watershed	434,907.60	5,035,690.00	1555	2,424,503
Wisconsin Watershed	435,107.60	5,035,690.00	1758	2,424,503
Wisconsin Watershed	435,307.60	5,035,690.00	1939	2,424,503
Wisconsin Watershed	435,507.60	5,035,690.00	2110	2,424,503
Wisconsin Watershed	435,707.60	5,035,690.00	2249	2,424,503
Wisconsin Watershed	434,307.60	5,035,890.00	903	2,424,503
Wisconsin Watershed	434,507.60	5,035,890.00	1033	2,424,503
Wisconsin Watershed	434,707.60	5,035,890.00	1196	2,424,503
Wisconsin Watershed	434,907.60	5,035,890.00	1430	2,424,503
Wisconsin Watershed	435,107.60	5,035,890.00	1596	2,424,503
Wisconsin Watershed	435,307.60	5,035,890.00	1747	2,424,503
Wisconsin Watershed	435,507.60	5,035,890.00	1890	2,424,503
Wisconsin Watershed	435,707.60	5,035,890.00	2006	2,424,503
Wisconsin Watershed	434,507.60	5,036,090.00	952	2,424,503
Wisconsin Watershed	434,707.60	5,036,090.00	1092	2,424,503
Wisconsin Watershed	434,907.60	5,036,090.00	1302	2,424,503
Wisconsin Watershed	435,107.60	5,036,090.00	1432	2,424,503
Wisconsin Watershed	435,307.60	5,036,090.00	1576	2,424,503
Wisconsin Watershed	435,507.60	5,036,090.00	1702	2,424,503
Wisconsin Watershed	435,707.60	5,036,090.00	1790	2,424,503
Wisconsin Watershed	434,507.60	5,036,290.00	880	2,424,503
Wisconsin Watershed	434,707.60	5,036,290.00	1009	2,424,503
		Average:	1,996	2,424,503
			ng/m2/yr	m2

Deposition Loading on Basin

4,839,728,043	ng/yr
4839.7	mg/yr

Mercury Deposition Modeling Results: ng/m^2/year

Client:	Aquila Resources	Project ID.:	17A021
Project:	Back Forty Project - Menominee County, Michigan		
Prepared by:	AKM	Date:	04/29/19
Checked by:	CED1	Date:	04/30/19

ID	X	Y	Mercury deposition ng/m2/yr	Drainage Area SqMeters
Menominee River	434,907.60	5,033,890.00	7239	139,948
Menominee River	434,907.60	5,034,090.00	5320	139,948
Menominee River	435,107.60	5,034,090.00	6445	139,948
		Average:	6,334	139,948
			ng/m2/yr	m2

Deposition Loading on River

886,479,101	ng/yr
886.5	mg/yr

Client: Aquila Resources Project ID.: 17A021
Project: Back Forty Project - Menominee County, Michigan
Prepared by: AKM Date: 04/29/19
Checked by: CED1 Date: 04/30/19

ID	X	Y	Sulfur deposition ug/m2/yr	Drainage Area SqMeters
Project Watershed	435,907.60	5,033,090.00	290343	962,007
Project Watershed	436,107.60	5,033,090.00	282228	962,007
Project Watershed	435,507.60	5,033,290.00	250914	962,007
Project Watershed	435,707.60	5,033,290.00	89394	962,007
Project Watershed	435,907.60	5,033,290.00	123178	962,007
Project Watershed	436,107.60	5,033,290.00	136925	962,007
Project Watershed	436,307.60	5,033,290.00	122792	962,007
Project Watershed	435,307.60	5,033,490.00	28908	962,007
Project Watershed	435,507.60	5,033,490.00	92923	962,007
Project Watershed	435,707.60	5,033,490.00	84069	962,007
Project Watershed	435,907.60	5,033,490.00	101721	962,007
Project Watershed	436,107.60	5,033,490.00	103780	962,007
Project Watershed	436,307.60	5,033,490.00	82790	962,007
Project Watershed	435,107.60	5,033,690.00	11674	962,007
Project Watershed	435,307.60	5,033,690.00	38990	962,007
Project Watershed	435,507.60	5,033,690.00	43666	962,007
Project Watershed	435,707.60	5,033,690.00	47942	962,007
Project Watershed	435,907.60	5,033,690.00	54746	962,007
Project Watershed	436,107.60	5,033,690.00	57790	962,007
Project Watershed	435,107.60	5,033,890.00	24249	962,007
Project Watershed	435,307.60	5,033,890.00	24233	962,007
Project Watershed	435,507.60	5,033,890.00	27164	962,007
Project Watershed	435,707.60	5,033,890.00	30355	962,007
Project Watershed	435,907.60	5,033,890.00	35760	962,007
Project Watershed	436,107.60	5,033,890.00	39330	962,007
Project Watershed	435,307.60	5,034,090.00	16164	962,007
		Average:	86,232	424,319 See Note
			ug/m2/yr	m2

Deposition Loading on Basin

36,589,770,255	ug/yr Sulfur
36,589,770	mg/yr sulfur
109,879,189,954	ug/yr Sulfate
109,879,190	mg/yr sulfate

Notes:
1. Project Watershed area is adjusted to account for contact water area of 537,688 m2 which will not drain to the Menominee River.
2. Conversion of sulfur deposition to sulfate ion deposition was done stoichiometrically: molecular weight (MW) of S=32; MW of SO4 = 96
Ratio of S:SO4 = 0.333:1
3. The Project Watershed has the highest sulfur deposition rate (and therefore highest theoretical sulfate deposition rate) of all areas evaluated. To perform a sulfate deposition rate evaluation, the highest theoretical sulfate deposition rate is calculated.

Sulfate Deposition Rate within Project Watershed

Sulfur deposition rate for Project Watershed	86,232	ug/m2/yr
Sulfate deposition rate (Note 2)	258,954	ug/m2/yr

Client:	Aquila Resources	Project ID.:	17A021
Project:	Back Forty Project - Menominee County, Michigan		
Prepared by:	AKM	Date:	04/29/19
Checked by:	CED1	Date:	04/30/19

ID	X	Y	Sulfur deposition ug/m2/yr	Drainage Area SqMeters
Shakey Lakes Watershed	435,907.60	5,031,090.00	8582	924,139
Shakey Lakes Watershed	436,107.60	5,031,090.00	9226	924,139
Shakey Lakes Watershed	435,707.60	5,031,290.00	9223	924,139
Shakey Lakes Watershed	435,907.60	5,031,290.00	9901	924,139
Shakey Lakes Watershed	436,107.60	5,031,290.00	10598	924,139
Shakey Lakes Watershed	436,307.60	5,031,290.00	11576	924,139
Shakey Lakes Watershed	435,707.60	5,031,490.00	11196	924,139
Shakey Lakes Watershed	435,907.60	5,031,490.00	12009	924,139
Shakey Lakes Watershed	436,107.60	5,031,490.00	12764	924,139
Shakey Lakes Watershed	436,307.60	5,031,490.00	13841	924,139
Shakey Lakes Watershed	436,507.60	5,031,490.00	14932	924,139
Shakey Lakes Watershed	436,707.60	5,031,490.00	15880	924,139
Shakey Lakes Watershed	435,707.60	5,031,690.00	13619	924,139
Shakey Lakes Watershed	435,907.60	5,031,690.00	14751	924,139
Shakey Lakes Watershed	436,107.60	5,031,690.00	15813	924,139
Shakey Lakes Watershed	436,307.60	5,031,690.00	17186	924,139
Shakey Lakes Watershed	436,507.60	5,031,690.00	18083	924,139
Shakey Lakes Watershed	436,707.60	5,031,690.00	19085	924,139
Shakey Lakes Watershed	436,307.60	5,031,890.00	21587	924,139
Shakey Lakes Watershed	436,507.60	5,031,890.00	22710	924,139
Shakey Lakes Watershed	436,707.60	5,031,890.00	22790	924,139
Shakey Lakes Watershed	436,907.60	5,032,090.00	24513	924,139
		Average:	14,994	924,139
			ug/m2/yr	m2

Notes:

1. Conversion of sulfur deposition to sulfate ion deposition was done stoichiometrically: molecular weight (MW) of S=32; MW of SO4 = 96
Ratio of S:SO4 = 0.333:1

Deposition Loading on Basin	
13,856,476,736	ug/yr Sulfur
13,856,477	mg/yr sulfur
41,611,041,251	ug/yr Sulfate
41,611,041	mg/yr sulfate

ID	X	Y	Deposition Value	SqMeters
Wisconsin Watershed	434,707.60	5,034,090.00	8440	2,424,503
Wisconsin Watershed	434,707.60	5,034,290.00	7143	2,424,503
Wisconsin Watershed	434,907.60	5,034,290.00	9999	2,424,503
Wisconsin Watershed	435,107.60	5,034,290.00	11349	2,424,503
Wisconsin Watershed	434,707.60	5,034,490.00	6126	2,424,503
Wisconsin Watershed	434,907.60	5,034,490.00	7812	2,424,503
Wisconsin Watershed	435,107.60	5,034,490.00	9002	2,424,503
Wisconsin Watershed	435,307.60	5,034,490.00	9579	2,424,503
Wisconsin Watershed	434,707.60	5,034,690.00	5223	2,424,503
Wisconsin Watershed	434,907.60	5,034,690.00	6339	2,424,503
Wisconsin Watershed	435,107.60	5,034,690.00	7321	2,424,503
Wisconsin Watershed	434,707.60	5,034,890.00	4442	2,424,503
Wisconsin Watershed	434,907.60	5,034,890.00	5332	2,424,503
Wisconsin Watershed	435,107.60	5,034,890.00	6192	2,424,503
Wisconsin Watershed	434,707.60	5,035,090.00	3837	2,424,503
Wisconsin Watershed	434,907.60	5,035,090.00	4622	2,424,503
Wisconsin Watershed	435,107.60	5,035,090.00	5348	2,424,503
Wisconsin Watershed	435,307.60	5,035,090.00	5972	2,424,503

Client: Aquila Resources Project ID.: 17A021
Project: Back Forty Project - Menominee County, Michigan
Prepared by: AKM Date: 04/29/19
Checked by: CED1 Date: 04/30/19

ID	X	Y	Sulfur deposition ug/m2/yr	Drainage Area SqMeters
Wisconsin Watershed	434,307.60	5,035,290.00	2486	2,424,503
Wisconsin Watershed	434,507.60	5,035,290.00	2968	2,424,503
Wisconsin Watershed	434,707.60	5,035,290.00	3380	2,424,503
Wisconsin Watershed	434,907.60	5,035,290.00	4091	2,424,503
Wisconsin Watershed	435,107.60	5,035,290.00	4707	2,424,503
Wisconsin Watershed	435,307.60	5,035,290.00	5241	2,424,503
Wisconsin Watershed	435,507.60	5,035,290.00	5773	2,424,503
Wisconsin Watershed	434,107.60	5,035,490.00	1874	2,424,503
Wisconsin Watershed	434,307.60	5,035,490.00	2239	2,424,503
Wisconsin Watershed	434,507.60	5,035,490.00	2638	2,424,503
Wisconsin Watershed	434,707.60	5,035,490.00	3034	2,424,503
Wisconsin Watershed	434,907.60	5,035,490.00	3688	2,424,503
Wisconsin Watershed	435,107.60	5,035,490.00	4201	2,424,503
Wisconsin Watershed	435,307.60	5,035,490.00	4645	2,424,503
Wisconsin Watershed	435,507.60	5,035,490.00	5091	2,424,503
Wisconsin Watershed	434,107.60	5,035,690.00	1738	2,424,503
Wisconsin Watershed	434,307.60	5,035,690.00	2081	2,424,503
Wisconsin Watershed	434,507.60	5,035,690.00	2397	2,424,503
Wisconsin Watershed	434,707.60	5,035,690.00	2741	2,424,503
Wisconsin Watershed	434,907.60	5,035,690.00	3344	2,424,503
Wisconsin Watershed	435,107.60	5,035,690.00	3774	2,424,503
Wisconsin Watershed	435,307.60	5,035,690.00	4145	2,424,503
Wisconsin Watershed	435,507.60	5,035,690.00	4511	2,424,503
Wisconsin Watershed	435,707.60	5,035,690.00	4795	2,424,503
Wisconsin Watershed	434,307.60	5,035,890.00	1957	2,424,503
Wisconsin Watershed	434,507.60	5,035,890.00	2207	2,424,503
Wisconsin Watershed	434,707.60	5,035,890.00	2537	2,424,503
Wisconsin Watershed	434,907.60	5,035,890.00	3066	2,424,503
Wisconsin Watershed	435,107.60	5,035,890.00	3420	2,424,503
Wisconsin Watershed	435,307.60	5,035,890.00	3728	2,424,503
Wisconsin Watershed	435,507.60	5,035,890.00	4036	2,424,503
Wisconsin Watershed	435,707.60	5,035,890.00	4270	2,424,503
Wisconsin Watershed	434,507.60	5,036,090.00	2013	2,424,503
Wisconsin Watershed	434,707.60	5,036,090.00	2304	2,424,503
Wisconsin Watershed	434,907.60	5,036,090.00	2790	2,424,503
Wisconsin Watershed	435,107.60	5,036,090.00	3063	2,424,503
Wisconsin Watershed	435,307.60	5,036,090.00	3360	2,424,503
Wisconsin Watershed	435,507.60	5,036,090.00	3629	2,424,503
Wisconsin Watershed	435,707.60	5,036,090.00	3809	2,424,503
Wisconsin Watershed	434,507.60	5,036,290.00	1839	2,424,503
Wisconsin Watershed	434,707.60	5,036,290.00	2113	2,424,503
		Average:	4,403	2,424,503
			ug/m2/yr	m2

Notes:
1. Conversion of sulfur deposition to sulfate ion deposition was done stoichiometrically: molecular weight (MW) of S=32; MW of SO4 = 96
Ratio of S:SO4 = 0.333:1

Deposition Loading on Basin

10,675,991,213	ug/yr Sulfur
10,675,991	mg/yr sulfur
32,060,033,673	ug/yr Sulfate
32,060,034	mg/yr sulfate

Client:	Aquila Resources	Project ID.:	17A021
Project:	Back Forty Project - Menominee County, Michigan		
Prepared by:	AKM	Date:	04/29/19
Checked by:	CED1	Date:	04/30/19

ID	X	Y	Sulfur deposition ug/m2/yr	Drainage Area SqMeters
Menominee River	434,907.60	5,033,890.00	18041	139,948
Menominee River	434,907.60	5,034,090.00	13012	139,948
Menominee River	435,107.60	5,034,090.00	15416	139,948
		Average:	15,489	139,948
			ug/m2/yr	m2

Notes:
1. Conversion of sulfur deposition to sulfate ion deposition was done stoichiometrically: molecular weight (MW) of S=32; MW of SO4 = 96
Ratio of S:SO4 = 0.333:1

Deposition Loading on River

2,167,708,685	ug/yr Sulfur
2,167,709	mg/yr sulfur
6,509,635,691	ug/yr Sulfate
6,509,636	mg/yr sulfate

Client: Aquila Resources Project ID.: 17A021
Project: Back Forty Project - Menominee County, Michigan
Prepared by: AKM Date: 04/29/19
Checked by: CED1 Date: 04/30/19

ID	X	Y	Zinc deposition mg/m2/yr	Drainage Area SqMeters
Project Watershed	435,907.60	5,033,090.00	171.4	962,007
Project Watershed	436,107.60	5,033,090.00	165.6	962,007
Project Watershed	435,507.60	5,033,290.00	145.1	962,007
Project Watershed	435,707.60	5,033,290.00	39.8	962,007
Project Watershed	435,907.60	5,033,290.00	47.7	962,007
Project Watershed	436,107.60	5,033,290.00	58.4	962,007
Project Watershed	436,307.60	5,033,290.00	63.7	962,007
Project Watershed	435,307.60	5,033,490.00	14.3	962,007
Project Watershed	435,507.60	5,033,490.00	44.6	962,007
Project Watershed	435,707.60	5,033,490.00	36.0	962,007
Project Watershed	435,907.60	5,033,490.00	32.1	962,007
Project Watershed	436,107.60	5,033,490.00	33.0	962,007
Project Watershed	436,307.60	5,033,490.00	35.3	962,007
Project Watershed	435,107.60	5,033,690.00	5.5	962,007
Project Watershed	435,307.60	5,033,690.00	18.0	962,007
Project Watershed	435,507.60	5,033,690.00	20.6	962,007
Project Watershed	435,707.60	5,033,690.00	21.5	962,007
Project Watershed	435,907.60	5,033,690.00	22.3	962,007
Project Watershed	435,107.60	5,033,890.00	22.6	962,007
Project Watershed	435,107.60	5,033,890.00	10.9	962,007
Project Watershed	435,307.60	5,033,890.00	11.3	962,007
Project Watershed	435,507.60	5,033,890.00	12.8	962,007
Project Watershed	435,707.60	5,033,890.00	13.8	962,007
Project Watershed	435,907.60	5,033,890.00	15.6	962,007
Project Watershed	436,107.60	5,033,890.00	16.6	962,007
Project Watershed	435,307.60	5,034,090.00	7.6	962,007
		Average:	41.78	424,319
			mg/m2/yr	m2

Note: Project Watershed area is adjusted to account for contact water area of 537,688 m2 which will not drain to the Menominee River.

Deposition Loading on Basin
17,729,321 mg/yr

Client:	Aquila Resources	Project ID.:	17A021
Project:	Back Forty Project - Menominee County, Michigan		
Prepared by:	AKM	Date:	04/29/19
Checked by:	CED1	Date:	04/30/19

ID	X	Y	Zinc deposition mg/m2/yr	Drainage Area SqMeters
Shakey Lakes Watershed	435,907.60	5,031,090.00	4.3	924,139
Shakey Lakes Watershed	436,107.60	5,031,090.00	4.7	924,139
Shakey Lakes Watershed	435,707.60	5,031,290.00	4.6	924,139
Shakey Lakes Watershed	435,907.60	5,031,290.00	5.0	924,139
Shakey Lakes Watershed	436,107.60	5,031,290.00	5.4	924,139
Shakey Lakes Watershed	436,307.60	5,031,290.00	6.0	924,139
Shakey Lakes Watershed	435,707.60	5,031,490.00	5.6	924,139
Shakey Lakes Watershed	435,907.60	5,031,490.00	6.1	924,139
Shakey Lakes Watershed	436,107.60	5,031,490.00	6.6	924,139
Shakey Lakes Watershed	436,307.60	5,031,490.00	7.3	924,139
Shakey Lakes Watershed	436,507.60	5,031,490.00	7.9	924,139
Shakey Lakes Watershed	436,707.60	5,031,490.00	8.5	924,139
Shakey Lakes Watershed	435,707.60	5,031,690.00	6.9	924,139
Shakey Lakes Watershed	435,907.60	5,031,690.00	7.6	924,139
Shakey Lakes Watershed	436,107.60	5,031,690.00	8.3	924,139
Shakey Lakes Watershed	436,307.60	5,031,690.00	9.2	924,139
Shakey Lakes Watershed	436,507.60	5,031,690.00	9.7	924,139
Shakey Lakes Watershed	436,707.60	5,031,690.00	10.3	924,139
Shakey Lakes Watershed	436,307.60	5,031,890.00	11.7	924,139
Shakey Lakes Watershed	436,507.60	5,031,890.00	12.3	924,139
Shakey Lakes Watershed	436,707.60	5,031,890.00	12.3	924,139
Shakey Lakes Watershed	436,907.60	5,032,090.00	13.4	924,139
		Average:	7.90	924,139
			mg/m2/yr	m2

Deposition Loading on Basin	
7301875	mg/yr

ID	X	Y	Deposition Value	SqMeters
Wisconsin Watershed	434,707.60	5,034,090.00	3.8	2,424,503
Wisconsin Watershed	434,707.60	5,034,290.00	3.3	2,424,503
Wisconsin Watershed	434,907.60	5,034,290.00	4.6	2,424,503
Wisconsin Watershed	435,107.60	5,034,290.00	5.3	2,424,503
Wisconsin Watershed	434,707.60	5,034,490.00	2.8	2,424,503
Wisconsin Watershed	434,907.60	5,034,490.00	3.6	2,424,503
Wisconsin Watershed	435,107.60	5,034,490.00	4.2	2,424,503
Wisconsin Watershed	435,307.60	5,034,490.00	4.6	2,424,503
Wisconsin Watershed	434,707.60	5,034,690.00	2.4	2,424,503
Wisconsin Watershed	434,907.60	5,034,690.00	3.0	2,424,503
Wisconsin Watershed	435,107.60	5,034,690.00	3.5	2,424,503
Wisconsin Watershed	434,707.60	5,034,890.00	2.1	2,424,503
Wisconsin Watershed	434,907.60	5,034,890.00	2.5	2,424,503
Wisconsin Watershed	435,107.60	5,034,890.00	2.9	2,424,503
Wisconsin Watershed	434,707.60	5,035,090.00	1.8	2,424,503
Wisconsin Watershed	434,907.60	5,035,090.00	2.2	2,424,503
Wisconsin Watershed	435,107.60	5,035,090.00	2.5	2,424,503
Wisconsin Watershed	435,307.60	5,035,090.00	2.9	2,424,503
Wisconsin Watershed	434,307.60	5,035,290.00	1.2	2,424,503
Wisconsin Watershed	434,507.60	5,035,290.00	1.4	2,424,503

Client: Aquila Resources Project ID.: 17A021
Project: Back Forty Project - Menominee County, Michigan
Prepared by: AKM Date: 04/29/19
Checked by: CED1 Date: 04/30/19

ID	X	Y	Zinc deposition mg/m2/yr	Drainage Area SqMeters
Wisconsin Watershed	434,707.60	5,035,290.00	1.6	2,424,503
Wisconsin Watershed	434,907.60	5,035,290.00	1.9	2,424,503
Wisconsin Watershed	435,107.60	5,035,290.00	2.2	2,424,503
Wisconsin Watershed	435,307.60	5,035,290.00	2.5	2,424,503
Wisconsin Watershed	435,507.60	5,035,290.00	2.8	2,424,503
Wisconsin Watershed	434,107.60	5,035,490.00	0.9	2,424,503
Wisconsin Watershed	434,307.60	5,035,490.00	1.1	2,424,503
Wisconsin Watershed	434,507.60	5,035,490.00	1.3	2,424,503
Wisconsin Watershed	434,707.60	5,035,490.00	1.4	2,424,503
Wisconsin Watershed	434,907.60	5,035,490.00	1.8	2,424,503
Wisconsin Watershed	435,107.60	5,035,490.00	2.0	2,424,503
Wisconsin Watershed	435,307.60	5,035,490.00	2.2	2,424,503
Wisconsin Watershed	435,507.60	5,035,490.00	2.5	2,424,503
Wisconsin Watershed	434,107.60	5,035,690.00	0.8	2,424,503
Wisconsin Watershed	434,307.60	5,035,690.00	1.0	2,424,503
Wisconsin Watershed	434,507.60	5,035,690.00	1.1	2,424,503
Wisconsin Watershed	434,707.60	5,035,690.00	1.3	2,424,503
Wisconsin Watershed	434,907.60	5,035,690.00	1.6	2,424,503
Wisconsin Watershed	435,107.60	5,035,690.00	1.8	2,424,503
Wisconsin Watershed	435,307.60	5,035,690.00	2.0	2,424,503
Wisconsin Watershed	435,507.60	5,035,690.00	2.2	2,424,503
Wisconsin Watershed	435,707.60	5,035,690.00	2.3	2,424,503
Wisconsin Watershed	434,307.60	5,035,890.00	0.9	2,424,503
Wisconsin Watershed	434,507.60	5,035,890.00	1.1	2,424,503
Wisconsin Watershed	434,707.60	5,035,890.00	1.2	2,424,503
Wisconsin Watershed	434,907.60	5,035,890.00	1.5	2,424,503
Wisconsin Watershed	435,107.60	5,035,890.00	1.6	2,424,503
Wisconsin Watershed	435,307.60	5,035,890.00	1.8	2,424,503
Wisconsin Watershed	435,507.60	5,035,890.00	2.0	2,424,503
Wisconsin Watershed	435,707.60	5,035,890.00	2.1	2,424,503
Wisconsin Watershed	434,507.60	5,036,090.00	1.0	2,424,503
Wisconsin Watershed	434,707.60	5,036,090.00	1.1	2,424,503
Wisconsin Watershed	434,907.60	5,036,090.00	1.3	2,424,503
Wisconsin Watershed	435,107.60	5,036,090.00	1.5	2,424,503
Wisconsin Watershed	435,307.60	5,036,090.00	1.6	2,424,503
Wisconsin Watershed	435,507.60	5,036,090.00	1.8	2,424,503
Wisconsin Watershed	435,707.60	5,036,090.00	1.8	2,424,503
Wisconsin Watershed	434,507.60	5,036,290.00	0.9	2,424,503
Wisconsin Watershed	434,707.60	5,036,290.00	1.0	2,424,503
		Average:	2.09	2,424,503
			mg/m2/yr	m2

Deposition Loading on Basin	
5056452	mg/yr

Zinc Deposition Modeling Results: mg/m^2/year

Client: Aquila Resources Project ID.: 17A021
Project: Back Forty Project - Menominee County, Michigan
Prepared by: AKM Date: 04/29/19
Checked by: CED1 Date: 04/30/19

ID	X	Y	Zinc deposition mg/m2/yr	Drainage Area SqMeters
Menominee River	434,907.60	5,033,890.00	8.1	139948
Menominee River	434,907.60	5,034,090.00	5.9	139948
Menominee River	435,107.60	5,034,090.00	7.1	139948
		Average:	7.00	139948
			mg/m2/yr	m2

Deposition Loading on River	
979014	mg/yr

Attachment 3

Water Quality Evaluation

Client:	Aquila Resources	Project ID.:	17A021
Project:	Back Forty Project - Menominee County, Michigan		
Prepared by:	AKM	Date:	04/29/19
Checked by:	CED1	Date:	04/30/19

Menominee River Deposition Increment Calculations

Menominee River Flow Basis:		
Low flow discharge (MDEQ, 2015)		
cubic feet per second	1,050	
conversion factor: cfs to m3/hr	101.94	
cubic meter per hour	107,038	
hours per year	8,760	
cubic meters per year	937,650,091	
Liters per year	9.4E+11	L/year

Deposition results: pages 5-24	Copper Deposition	Lead Deposition	Zinc Deposition	Mercury Deposition	Sulfate Deposition (converted from sulfur deposition)
Wisconsin Watershed	191,886 mg/yr	905,008 mg/yr	5,056,452 mg/yr	4,840 mg/yr	32,060,034 mg/yr
Project Watershed	670,099 mg/yr	3,511,103 mg/yr	17,729,321 mg/yr	16,048 mg/yr	109,879,190 mg/yr
Menominee River - direct	37,333 mg/yr	169,488 mg/yr	979,014 mg/yr	886 mg/yr	6,509,636 mg/yr
Total deposition from all contributors	899,318 mg/yr	4,585,599 mg/yr	23,764,788 mg/yr	21,775 mg/yr	148,448,859 mg/yr
Annual River flow - L/year	9.4E+11 L/yr	9.4E+11 L/yr	9.4E+11 L/yr	9.4E+11 L/yr	9.4E+11 L/yr
increment concentration from deposition	9.6E-07 mg/L	4.9E-06 mg/L	2.5E-05 mg/L	2.3E-08 mg/L	1.6E-04 mg/L
increment concentration from deposition	9.6E-04 ug/L	4.9E-03 ug/L	2.5E-02 ug/L	2.3E-05 ug/L	1.6E-01 ug/L

Spring Lake Deposition Increment Calculations

Spring Lake annual flow is estimated based as a percentage of Shakey River flow.
To be conservative, the estimate is based on 10% of a mid-range flow value stated in ERM (2011).

Shakey River - Mid-range Flow Rate	27	cubic feet per second: low flow value from ERM (2011)
	2.8E+06	L per hour - unit conversion
	2.4E+10	L per year - unit conversion
Spring Lake estimated flow rate (15%)	3,616,652,155	L per year

Deposition results: pages 5-24	Copper Deposition	Lead Deposition	Zinc Deposition	Mercury Deposition	Sulfate Deposition (converted from sulfur deposition)
Shakey Lakes Watershed	275312 mg/yr	1371086 mg/yr	7301875 mg/yr	8239 mg/yr	41611041 mg/yr
Volume L	3,616,652,155 L per yr	3,616,652,155 L per yr	3,616,652,155 L per yr	3,616,652,155 L per yr	3,616,652,155 L per yr
increment concentration from deposition	0.00008 mg/L	0.00038 mg/L	0.0020 mg/L	0.0000023 mg/L	0.012 mg/L
increment concentration from deposition	0.1 ug/L	0.4 ug/L	2 ug/L	0.002 ug/L	12 ug/L

Reference:
Environmental Resources Management. September 2011. *Hydrogeology Report Environmental Baseline Studies* , Appendix E-1

Foth

Client: Aquila Resources Project ID.: 17A021
Project: Back Forty Project - Menominee County, Michigan
Prepared by: AKM Date: 04/29/19
Checked by: CED1 Date: 04/30/19

Menominee River Water Quality Impact Evaluation

Sampling Station:			Menominee River Station MSG-13															
Sample Date:			9/20/2007	12/11/2007	12/11/2007	3/31/2008	7/2/2008	7/2/2008	9/23/2008	9/23/2008	12/9/2008	12/9/2008	3/24/2009	3/24/2009	6/22/2009	9/1/2010	12/7/2010	3/30/2011	7/31/2018
Parameter	Total or Dissolved	Units																	
Copper	T	ug/L	1.0	1.0	1.0	1.0	1.0	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	NM	NM	NM	1.1
Lead	T	ug/L	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	NM	NM	NM	0.2
Hardness	T	ug/L	120000	120000	120000	120000	95000	94000	110000	120000	130000	130000	120000	120000	99000	NM	NM	NM	NM
Mercury, Low Level	T	ug/L	0.0106	0.00364	0.00343	0.00338	0.00755	0.00577	0.00528	0.00539	0.00382	0.0035	0.00586	0.00514	0.00232	NM	NM	NM	0.00153
Zinc	T	ug/L	10	50	50	10	10	10	10	44	10	10	10	10	10	NM	NM	NM	4.8
Sulfate	T	ug/L	34000	26000	26000	21000	16000	16000	29000	29000	29000	29000	17000	20000	23000	17000	13000	17000	13800

Baseline Data from: Environmental Resources Management. September 2011. *Hydrogeology Report Environmental Baseline Studies* , Appendix E-1
NM = No Measurement

Data Statistical Analysis and Water Quality Comparison

Parameter	Mean	Maximum	Minimum	Standard Deviation	Representative Background Concentration Mean + 2 Std Deviations	Maximum Increment Due to Deposition	Highest Predicted Concentration	Rule 57 WQ Standard[1]	Does Background Meet WQ std?	Does Highest Predicted Concentration Meet WQ std?	Ratio of Increment to Background (%)
	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L			
Copper	1.014	1.10	1.000	0.036	1.087	0.0010	1.088	10.1	yes	yes	0.09
Lead	0.943	1.00	0.200	0.214	1.370	0.0049	1.375	23.3	yes	yes	0.36
Hardness	115231										
Mercury, Low Level	0.005	0.01	0.002	0.002	0.009	0.00002	0.009	0.0013	no	no	0.247
Zinc	17.77	50	4.80	16.50	50.76	0.03	50.789	133.2	yes	yes	0.05
Sulfate	22106	34000	13000	6486	35077	0.16	35077.639	NA	NA	NA	0.0005

1 The standard chosen for this evaluation is the Final Chronic Value (FCV) for copper, lead, zinc; and the Wildlife standard for mercury. Water quality standards are calculated on pages 24 and 25.

Spring Lake Water Quality Impact Evaluation

		Sampling Station:	Shakey River Station MSG 1										
		Sample Date:	9/20/2007	12/12/2007	3/31/2008	6/25/2008	9/25/2008	12/9/2008	3/24/2009	6/26/2009	9/1/2010	12/7/2010	3/30/2011	7/31/2018
Parameter	Total or Dissolved	Units												
Copper	T	ug/L	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	NM	NM	NM	1.1
Lead	T	ug/L	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	NM	NM	NM	0.2
Hardness	T	ug/L	150000	190000	210000	170000	160000	180000	200000	190000	NM	NM	NM	NM
Mercury, Low Level	T	ug/L	0.0102	0.00388	0.00291	0.00731	0.00545	0.00392	0.00432	0.000563	NM	NM	NM	0.00142
Zinc	T	ug/L	10	50	10	25	44	10	10	10	NM	NM	NM	4.6
Sulfate	T	ug/L	5000	17000	28000	16000	13000	13000	14000	20000	4500	7000	9500	2300

		Sampling Station:	Shakey River Station MSG 3										
		Sample Date:	9/20/2007	12/12/2007	3/31/2008	6/25/2008	9/25/2008	12/9/2008	3/24/2009	6/26/2009	9/1/2010	12/7/2010	3/30/2011	7/31/2018
Parameter	Total or Dissolved	Units												
Copper	T	ug/L	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	NM	NM	NM	1.1
Lead	T	ug/L	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	NM	NM	NM	0.2
Hardness	T	ug/L	210000	250000	130000	200000	200000	240000	200000	200000	NM	NM	NM	NM
Mercury, Low Level	T	ug/L	0.00811	0.00235	0.0115	0.0111	0.00361	0.00111	0.00844	0.00063	NM	NM	NM	0.00115
Zinc	T	ug/L	10	50	10	10	10	10	10	10	NM	NM	NM	8.4
Sulfate	T	ug/L	16000	33000	25000	14000	14000	20000	32000	16000	7500	6900	9300	4900

Baseline Data from: Environmental Resources Management. September 2011. *Hydrogeology Report Environmental Baseline Studies* , Appendix E-1 and recent sampling performed at the Project Site.
Spring Lake sampling station did not include analytical data collection. Analytical data from two adjacent sampling stations, MSG-1 and MSG-3, were averaged to represent surrogate data at Spring Lake.
NM = No Measurement

Data Statistical Analysis and Water Quality Comparison

Parameter	Mean	Maximum	Minimum	Standard Deviation	Representative Background Concentration Mean + 2 Std Deviations	Maximum Increment Due to Deposition	Highest Predicted Concentration	Rule 57 WQ Standard[1]	Does Background Meet WQ std?	Does Highest Predicted Concentration Meet WQ std?	Ratio of Increment to Background (%)
	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L			
Copper	1.01	1.1	1	0.03	1.08	0.08	1.2	15.7	yes	yes	7
Lead	0.91	1	0.2	0.27	1.44	0.38	1.8	34.9	yes	yes	26
Hardness	192500										
Mercury, Low Level	0.0049	0.01	0.00056	0.00295	0.011	0.002	0.013	0.0013	no	no	21
Zinc	16.8	50	4.6	16.71	50.2	2.0	52.2	205.8	yes	yes	4
Sulfate	14496	33000	2300	7356	29208	12	29219.7	NA	NA	NA	0.04

1 The standard chosen for this evaluation is the FCV for copper, lead, zinc; and the Wildlife standard for mercury. Water quality standards are calculated on pages 24 and 25.
NA - not applicable

Client:	Aquila Resources Inc.	Scope ID: 14A021
Project:	Back Forty - Rule 57 Water Quality Values	
Prepared by:	MCC2	Date: 10-27-15
Checked by:	ASH1	Date: 10-27-15

Michigan DEQ Rule 57 Water Quality Values

The purpose of this analysis is to calculate the MDEQ Rule 57 water quality values for copper, lead, and zinc. The Final Chronic Value (FCV), Aquatic Maximum Value (AMV), and Final Acute Value (FAV) water quality values for these parameters are calculated using equations that are provided by the MDEQ. The hardness of the surface water body being evaluated for compliance with Rule 57 standards is used as an input to these equations. Hardness has units of milligrams per liter (mg/L). The values that result from the execution of the water quality equations are in units of micrograms per liter (ug/L). CFc is the acute and chronic conversion factor for lead, defined below.

Location: Menominee River Station MSG-13

Hardness (H) in units of mg/L

$H := 115.2$

Copper (units of ug/L)

$$FCV_{copper} := \left(e^{(0.8545 \cdot \ln(H) - 1.702)}\right) \cdot 0.96$$

$$AMV_{copper} := \left(e^{(0.9422 \cdot \ln(H) - 1.7)}\right) \cdot 0.96$$

$$FAV_{copper} := \left(e^{(0.9422 \cdot \ln(H) - 1.7)}\right) \cdot 0.96 \cdot 2$$

$FCV_{copper} = 10.1$ $AMV_{copper} = 15.4$ $FAV_{copper} = 30.7$

Lead (units of ug/L)

$$CFc := 1.46203 - (\ln(H) \cdot 0.14571)$$

$$FCV_{lead} := \left(e^{(0.9859 \cdot \ln(H) - 1.270)}\right) \cdot CFc$$

$$AMV_{lead} := \left(e^{(0.9859 \cdot \ln(H) + 0.2972)}\right) \cdot CFc$$

$$FAV_{lead} := \left(e^{(0.9859 \cdot \ln(H) + 0.9904)}\right) \cdot CFc \cdot 2$$

$FCV_{lead} = 23.3$ $AMV_{lead} = 111.7$ $FAV_{lead} = 446.9$

Zinc (units of ug/L)

$$FCV_{zinc} := \left(e^{(0.8473 \cdot \ln(H) + 0.884)}\right) \cdot 0.986$$

$$AMV_{zinc} := \left(e^{(0.8473 \cdot \ln(H) + 0.884)}\right) \cdot 0.978$$

$$FAV_{zinc} := \left(e^{(0.8473 \cdot \ln(H) + 0.884)}\right) \cdot 0.978 \cdot 2$$

$FCV_{zinc} = 133.2$ $AMV_{zinc} = 132.1$ $FAV_{zinc} = 264.2$

Client:	Aquila Resources Inc.		Scope ID: 14A021
Project:	Back Forty - Rule 57 Water Quality Values		
Prepared by:	MCC2		Date: 10-27-15
Checked by:	ASH1		Date: 10-27-15

Michigan DEQ Rule 57 Water Quality Values

The purpose of this analysis is to calculate the MDEQ Rule 57 water quality values for copper, lead, and zinc. The Final Chronic Value (FCV), Aquatic Maximum Value (AMV), and Final Acute Value (FAV) water quality values for these parameters are calculated using equations that are provided by the MDEQ. The hardness of the surface water body being evaluated for compliance with Rule 57 standards is used as an input to these equations. Hardness has units of milligrams per liter (mg/L). The values that result from the execution of the water quality equations are in units of micrograms per liter (ug/L). CFc is the acute and chronic conversion factor for lead, defined below.

Location: Spring Lake, represented by the average of MSG-1 and MSG-3

Hardness (H) in units of mg/L

$H := 192.5$

Copper (units of ug/L)

$$FCV_{copper} := \left(e^{(0.8545 \cdot \ln(H) - 1.702)}\right) \cdot 0.96$$

$$AMV_{copper} := \left(e^{(0.9422 \cdot \ln(H) - 1.7)}\right) \cdot 0.96$$

$$FAV_{copper} := \left(e^{(0.9422 \cdot \ln(H) - 1.7)}\right) \cdot 0.96 \cdot 2$$

$FCV_{copper} = 15.7$ $AMV_{copper} = 24.9$ $FAV_{copper} = 49.8$

Lead (units of ug/L)

$$CFc := 1.46203 - (\ln(H) \cdot 0.14571)$$

$$FCV_{lead} := \left(e^{(0.9859 \cdot \ln(H) - 1.270)}\right) \cdot CFc$$

$$AMV_{lead} := \left(e^{(0.9859 \cdot \ln(H) + 0.2972)}\right) \cdot CFc$$

$$FAV_{lead} := \left(e^{(0.9859 \cdot \ln(H) + 0.9904)}\right) \cdot CFc \cdot 2$$

$FCV_{lead} = 34.9$ $AMV_{lead} = 167.4$ $FAV_{lead} = 669.5$

Zinc (units of ug/L)

$$FCV_{zinc} := \left(e^{(0.8473 \cdot \ln(H) + 0.884)}\right) \cdot 0.986$$

$$AMV_{zinc} := \left(e^{(0.8473 \cdot \ln(H) + 0.884)}\right) \cdot 0.978$$

$$FAV_{zinc} := \left(e^{(0.8473 \cdot \ln(H) + 0.884)}\right) \cdot 0.978 \cdot 2$$

$FCV_{zinc} = 205.8$ $AMV_{zinc} = 204.1$ $FAV_{zinc} = 408.2$

Attachment 4

Soil Evaluation

Client: Aquila Resources Project ID.: 17A021
Project: Back Forty Project - Menominee County, Michigan
Prepared by: AKM Date: 04/29/19
Checked by: CED1 Date: 04/30/19

I Comparative Criteria for Soils

	Copper mg/kg (ppm)	Lead mg/kg (ppm)	Mercury mg/kg (ppm)	Sulfur mg/kg (ppm)	Sulfate [1] mg/kg (ppm)	Zinc mg/kg (ppm)
Direct Contact Criteria and Risk Based Screening Level [2]	20000	400	160	n.a.	n.a.	170000
Drinking Water Protection Criteria and Risk Based Screening Level [2]	5800	700	1.7	n.a.	**5000**	2400
Groundwater Surface Water Interface Protection Criteria and Risk Based Screening Level [2]	100	6900	**0.05**	n.a.	n.a.	200
Risk Management Criteria for Metals at BLM Mining Sites [3]	**7**	**6**	1	n.a.	n.a.	**43**

Most stringent value for each parameter is in bold.

II Selected Deposition Receptors and Deposition Rate

		Deposition Rate	Copper	Lead	Mercury	Sulfur	Sulfate [1]	Zinc
Location	X Coordinate	Y Coordinate	mg/m2/year	mg/m2/year	mg/m2/year	mg/m2/year	mg/m2/year	mg/m2/year
1	435107.6	5033690	0.93	4.1	0.021	54.7	164.1	24.3
2	435707.6	5033690	0.84	4.0	0.019	48.3	144.9	22.2
3	436307.6	5034090	0.48	2.3	0.011	27.8	83.4	12.7
4	437307.6	5034090	0.36	1.7	0.008	18.9	56.7	9.5
5	437307.6	5033490	0.55	2.6	0.012	28.8	86.3	14.6
6	437307.6	5032490	0.04	0.2	0.001	2.3	6.8	1.2
7	436307.6	5032490	1.04	5.5	0.023	48.8	146.4	27.6
8	435307.6	5032490	0.59	2.8	0.013	31.6	94.8	15.7
9	434507.6	5032490	0.24	1.2	0.005	13.2	39.7	6.3
10	434507.6	5032890	0.33	1.6	0.007	19.1	57.2	8.7
Receptor A	436303	5034506	0.28	1.3	0.007	15.6	46.9	7.3

III Soil Characteristics of Native Soils

	Copper mg/kg (ppm)	Lead mg/kg (ppm)	Mercury mg/kg (ppm)	Sulfur mg/kg (ppm)	Sulfate [1] mg/kg (ppm)	Zinc mg/kg (ppm)
Soil Composition [4]	4.5	3.7	0.0089	44.5	133.5	18.3
Specific Gravity of Soil [5]	1.33					

IV Potential Soil Impacts

If one year of deposition mixed with the top 2 centimeter (cm) of soil, the soil characteristics could potentially be:
Mass of soil:
volume = 1 m x 1 m x 2 cm = 0.02 m^3 mass of soil per m^2 by 2 cm deep = 26.6 kg per m^2
Estimating the potential concentration after 1 year of deposition:
Potential concentration = native soil composition mg/kg + (one year deposition mg/m^2/26.6 m^2/kg)

Location	Copper mg/kg (ppm)	Lead mg/kg (ppm)	Mercury mg/kg (ppm)	Sulfur mg/kg (ppm)	Sulfate [1] mg/kg (ppm)	Zinc mg/kg (ppm)
1	4.53	3.85	0.0097	n.a.	139.67	19.21
2	4.53	3.85	0.0096	n.a.	138.95	19.13
3	4.52	3.79	0.0093	n.a.	136.64	18.78
4	4.51	3.77	0.0092	n.a.	135.63	18.66
5	4.52	3.80	0.0094	n.a.	136.74	18.85
6	4.50	3.71	0.0089	n.a.	133.76	18.34
7	4.54	3.91	0.0098	n.a.	139.00	19.34
8	4.52	3.81	0.0094	n.a.	137.06	18.89
9	4.51	3.74	0.0091	n.a.	134.99	18.54
10	4.51	3.76	0.0092	n.a.	135.65	18.63
Receptor A	4.51	3.75	0.0092	n.a.	133.77	18.57

No exceedance of applicable standards are identified.

Client:	Aquila Resources	Project ID.:	17A021
Project:	Back Forty Project - Menominee County, Michigan		
Prepared by:	AKM	Date:	04/29/19
Checked by:	CED1	Date:	04/30/19

If 7 years of deposition is mixed with the top 2 cm of soil, the soil characteristics could potentially be:

Location	Copper mg/kg (ppm)	Lead mg/kg (ppm)	Mercury mg/kg (ppm)	Sulfur mg/kg (ppm)	Sulfate [1] mg/kg (ppm)	Zinc mg/kg (ppm)
1	4.74	4.78	0.014	n.a.	176.7	24.7
2	4.72	4.76	0.014	n.a.	171.6	24.1
3	4.63	4.31	0.012	n.a.	155.5	21.6
4	4.59	4.16	0.011	n.a.	148.4	20.8
5	4.64	4.38	0.012	n.a.	156.2	22.1
6	4.51	3.76	0.009	n.a.	135.3	18.6
7	4.77	5.16	0.015	n.a.	172.0	25.6
8	4.66	4.45	0.012	n.a.	158.4	22.4
9	4.56	4.00	0.010	n.a.	144.0	20.0
10	4.59	4.11	0.011	n.a.	148.5	20.6
Receptor A	4.57	4.05	0.011	n.a.	145.9	20.2

No exceedance of applicable standards are identified.

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] Foth, 2015. Memorandum: Waste Rock, Tailings, and Soil Metal Concentrations Measured During Static Testing. August 19, 2015.

[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.

Abbreviations:

BLM = Bureau of Land Management

cm = centimeter

m = meter

m^2/kg = square meters per kilogram

m^3 = cubic meter

mg/kg = milligrams per kilograms

mg/m^2 = milligrams per square meter

n.a. = not applicable

ppm = parts per million

Attachment 5

Sulfate Deposition Rate Evaluation

Client:	Aquila Resources	Project ID.:	17A021
Project:	Back Forty Project - Menominee County, Michigan		
Prepared by:	AKM	Date:	04/29/19
Checked by:	CED1	Date:	04/30/19

Sulfate Deposition Rate Analysis

Michigan has no specific deposition standards. A comparason is made of a theoretical wet sulfate deposition rate for the Project to Minnesota Rules, chapter 7021 Acid Deposition Standard, an environmentally protective standard for sulfate deposition.

Minnesota Rules 7021.0030 Acid Deposition Standard
11 kilograms of wet sulfate deposition per hectare per year

Evaluate the comparable theoretical sulfate deposition rate from the Project against the standard
Highest potential sulfate deposition rate = background rate + Project Rate

Background Rate:	4.5 kilograms per hectare per year	Reference 1	
Project Sulfate Rate:	258,954 ug/m2/yr	Reference 2	
	2.6 kilograms per hectare per year	unit conversion of Project Area deposition rate	
Highest potential rate:	7.1 kilograms per hectare per year		

References:
1. National Atmospheric Deposition Program, National Trends Network (NTN) map provided below. Visual Interpolation of values adjacent to the project
2. Project Area deposition rate shown is the average theoretical sulfate deposition rate encompassed Project Watershed. This area is selected because it includes the Project area and will have the highest rates.

Conclusion : The highest predicted sulfate deposition rate for the Project is 7.1 kg per ha per year. This rate is less than the Minnesota standard of 11 kg per ha per year. Therefore, the Project will not produce detrimental sulfate deposition impacts.