Appendix B.6:
Air Quality Technical Memorandum

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Air Quality Analysis Technical Memorandum

Zavoral Property Mine and Reclamation Project

AECOM

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Technical Memorandum
Stationary Source Air Emissions and Dust

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Executive Summary

The Tiller Corporation, Inc. (Tiller) proposes to operate a sand and gravel mine on the site of a dormant, unreclaimed gravel mine in the City of Scandia, Washington County, Minnesota. The 114-acre site (Zavoral Site or Site) is located along St. Croix Trail North (State Trunk Highway [TH] 95) near its intersection with TH 97. Tiller proposes to mine and reclaim 64 acres of the 114-acre Site, predominately on portions of the Site that were previously disturbed by mining. An 8-acre area that has not been previously mined is included in the proposed mining area. Tiller is also proposing to restore approximately 4 acres of the previously mined area located within the St. Croix National Scenic Riverway and USA Scenic Easement Area.

This technical memorandum presents the evaluations completed for Task 15 - Stationary Source Air Emissions and Dust. It identifies potential environmental impacts related to the Project alternatives and identifies measures that could avoid, minimize, or mitigate for these potential impacts. This work was conducted as part of the Environmental Impact Statement (EIS) process to be completed under Minn. R. 4410.

The Project scope incorporates the proposed Zavoral Site operation and includes the following EIS alternatives:

- Alternative 1 – Tiller's Preferred Alternative. Mining and reclamation would occur over a 5 to 10-year period.
- Alternative 2 – No-Build Alternative.
- Alternative 3 – Reduced Timeframe. Mining and reclamation would occur over an up to 5-year period.

The following goals are included under Task 15 - Stationary Source Air Emissions

- Prepare potential to emit (PTE) calculations for both fugitive emission sources for particulate matter (PM), inhalable particulate matter (PM_{10}), and fine particulate matter ($PM_{2.5}$) PM, PM_{10}, and $PM_{2.5}$ using maximum production rate information and worst case emission assumptions;,
- Complete a project ambient air quality analysis using the PTE calculations, actual meteorological data, and the USEPA computer model AERMOD to calculate ambient concentrations of PM, PM_{10}, and $PM_{2.5}$
- Compare the results from the computer model against the National Ambient Air Quality Standards (NAAQS);
- Complete a deposition analysis of PM to the land, St. Croix River and three creeks near the site.
- Compare the results of the computer model to appropriate standards for potential siliotic effects from ambient exposures to fugitive dust from the proposed operations.

The air quality analysis included calculating the maximum emissions of PM, PM_{10}, and $PM_{2.5}$ from the proposed operations at the Project Site (Site) for hourly, daily, and annual averaging periods.

The maximum emission rates were calculated for each of three mining phases using the maximum mine excavation rate, the maximum number of trucks that would travel on on-Site roads, and the longest on-Site road lengths for paved and unpaved roads for each proposed phase. Although Alternative #1 and Alternative #3 have two different timeframes for overall operation the maximum production rate for both alternatives is the same on a daily and annual basis. Since the ambient air quality impacts are based on daily and annual timeframes, the maximum daily and annual impacts are the same for Alternative #1 and Alternative #3.

These maximum emission rates were then used in a computer based ambient air quality modeling analysis to estimate the maximum concentrations of PM, PM_{10}, and $PM_{2.5}$. The computer model calculates the maximum concentration PM_{10} which could occur no more than 6 days in any one year. For $PM_{2.5}$, the maximum concentration could occur no more that 1 day per year. The maximum concentrations occur at the northern property boundary of the Site and decreases as the distance from the site increases. The ambient air quality model was also used to estimate the deposition of PM on local vegetation, into the St. Croix River and into the Zavoral Creek, Middle Creek, and South Creek.

The results of the air quality analysis have indicated that under the maximum mining rates, without the use of mitigation methods for fugitive dust, the proposed Project would be likely to cause excessive fugitive dust in the ambient air. The area that may be impacted is irregular in shape and extends from approximately 0.5 miles to the west, 1.2 miles to the north, 0.9 miles to the east, and up to 1.4 miles to the south. This excess fugitive dust might adversely affect human health and the local vegetation in that irregularly shaped area extending outward from the Site boundary. The fugitive dust is not likely to adversely affect the water quality in the St. Croix River or any of the Creeks.

Mitigation techniques (such as spraying water on roads) to reduce fugitive dust are well known and readily available and are listed in this technical memorandum. Routine application of a combination of these mitigation techniques has the potential to reduce fugitive dust to a level that would not have a significant effect on human health or the environment.

Tiller has developed a mitigation plan, that if implemented, would reduce PM, PM_{10} and $PM_{2.5}$ emissions to levels that are below the National Ambient Air Quality Standards (NAAQS), nuisance dust levels, and health based silica concentration levels.

This plan and its associated monitoring and recordkeeping could be incorporated as a requirement of a future Conditional Use Permit.

1.0 Project Background

AECOM is completing tasks to analyze the potential for environmental impacts, and identify measures to mitigate potential impacts for the identified alternatives related to the Zavoral Property Mining and Reclamation Project. This is part of the EIS process to be completed under Minn. R. 4410. This technical memorandum presents the analysis and evaluation completed for Task 7.15 Stationary Source Air Emissions and Dust.

The alternatives to be addressed in the EIS are summarized below. This Stationary Source Air Emissions and Dust Technical Memorandum addresses the three alternatives (focusing on the "build alternatives").

1.1 Alternative 1: Applicant's Preferred Alternative – 5 to 10-Year Operation

1.1.1 Zavoral Site Activities

The mining and reclamation would be conducted in phases, with a Project duration of up to 10 years under this alternative.

In general, reclamation of the Site would proceed in increments as areas of mining are completed. The reclamation plan proposes that perimeter areas be sloped and interior areas backfilled and graded to reclamation grades. Topsoil or other organic material would be applied to these areas and vegetation established to reduce erosion. The Environmental Assessment Worksheet (EAW), prepared earlier for the Project, proposed that the previously mined area within the St. Croix Riverway be restored during the final phase of mining operations at the Site. Tiller's letter to the City (April 7, 2009) proposed revising the reclamation and phasing plan to include reclamation of the area within the St. Croix Riverway and scenic easement areas during the first years of operation. This technical memorandum, therefore, evaluates the Project scenario that includes reclamation of the St. Croix Riverway and scenic easement areas during the first 5 years of mining operations on the Site.

1.1.2 Scandia Mine Activities

Raw aggregate material mined at the Site would primarily be transported to the Scandia Mine. The Scandia Mine currently uses or processes aggregate material from the Scandia Mine and materials that are transported to the Scandia Mine from various locations, most recently Chisago, Minnesota, and Polk counties, Wisconsin. Tiller has indicated that the materials transported from the Zavoral Site would replace materials hauled to the Scandia Mine from Chisago County and Polk County. The following activities would occur at the Scandia Mine:

- Aggregate material brought in from the Zavoral Site (add-rock) would be blended with aggregate material mined at the Scandia Mine for use in the production of hot mix asphalt.
- A portion of the aggregate material transported to the Scandia Mine may be processed as needed through a series of crushers, screens, conveyors, wash decks, and classifiers to produce commercial grade construction aggregates.
- The finished construction aggregate products would be stockpiled at the Scandia Mine until they are hauled off-site by trucks to various construction sites.

The Scandia Mine operates under a Conditional Use Permit (CUP) and an Annual Operating Permit (AOP) approved by the City of Scandia. The processing activities listed above are included in the activities authorized by these permits.

1.2 Alternative 2: No-Build Alternative

The No-Build alternative is based on the existing use continuing at the Site. It would remain as an unreclaimed open space. Allowable future uses of the Zavoral Site are agricultural and rural residential.

1.3 Alternative 3: Reduced Time Period - Up to 5-Year Operation

This alternative focuses on the impacts of the proposed activities if the overall time frame for mining at the Zavoral Site is up to 5 years rather than up to 10 years, as proposed in the Preferred Alternative. This would result in more mining occurring for more weeks each year and more material being mined per year.

Tiller is proposing the following activities at the Zavoral Site with either of the "build alternatives" (Alternatives 1 and 3):

- Clearing and grubbing the Site of vegetation, as necessary.
- Removing overburden from areas to be mined, and stockpiling the material on the Site for potential future use in reclamation.
- Excavating raw aggregate materials.
- Using water from the existing well for dust suppression.
- Storing fuel and related materials, such as oil, anti-freeze, grease, and hydraulic fluid, on the Site.
- Reclaiming the Site through grading, placing topsoil or other organic material, and seeding.

Mining operations would typically be conducted on a seasonal basis from April through mid-November.

Mined aggregate material (pit-run and/or add-rock) would primarily be hauled to Tiller's Scandia Mine near Manning Avenue and 225th Street for use in material produced at that Site.

2.0 Stationary Source Air Emissions and Dust Study Goals

The study goals for this task are presented below.

2.1 Zavoral Site

This technical memorandum addresses the following for the Zavoral Site:

- Potential to emit (PTE) calculations for emission sources for PM, PM_{10}, and $PM_{2.5}$. Normally, potential environmental impacts from point sources and fugitive emissions (dust) are interrelated. However, for this Project Tiller is not proposing to install any point sources of emissions. All emission sources are considered to be fugitive dust sources. These activities, excavating and loading aggregate, hauling gravel on unpaved and paved roads, would generate airborne concentrations of fugitive dust, and to a much lesser degree, particulate from internal combustion engines that could be transported off site and deposited onto nearby land, vegetation, rivers and lakes.

  Tiller provided estimates of the maximum hourly, daily, and annual excavation of aggregate and number of haul trucks. PTE calculations were prepared for three (3) mining phases described as Phase 1 Mining, Phase 2 Mining, and Phase 3 Mining. The PTE calculations for each mining phase represent the worst case emissions while the facility is operating at maximum capacity. Since the ambient air quality analyses are based on annual and daily emissions, which do not vary between Alternate 1 and Alternative 3, only one set of PTE calculations were completed for the three mining phases. Normal operations would likely generate less fugitive dust.

  Tiller provided a fugitive dust mitigation plan that provides details on the practices and procedures Tiller would use to reduce fugitive dust. AECOM reviewed the plan and determined that it was consistent with good operating practices and, if implemented, would reduce fugitive dust emissions from work activities at the proposed Site.

  Based on the information in the fugitive Dust Control Plan, AECOM prepared a set of mitigated emission calculations and

- The atmospheric transport processes (dispersion and deposition) used to determine ambient concentrations of PM_{10} and $PM_{2.5}$ using the US Environmental Protection Agency (USEPA) Guideline model AERMOD. AERMOD uses five years of actual meteorological data, including wind speed, wind direction, temperature, humidity, etc., acquired from the Minnesota Pollution Control Agency (MPCA) to more accurately predict the ambient concentrations.

- The results of the deposition modeling analysis of dust to the earth's land, St. Croix River, Zavoral Creek, Middle Creek, and South Creek. This includes dry deposition due to gravitational settling and surface impaction due to turbulent air flow near surface elements as well as wet deposition due to wash-out by precipitation. Modeling was conducted according to approved USEPA methodologies presented in the Guideline on Air Quality Models (40 CFR Part 51 Appendix W), and in accordance with MPCA Modeling Guidance posted at http://www.pca.state.mn.us/air/modeling.html#guidance.

- The results of the 24-hour and annual average NAAQS modeling analysis for total PM, PM_{10}, and $PM_{2.5}$ emissions from the aggregate operations and reclamation activities. Modeling was performed for three different phases of mining and reclamation proposed by Tiller for Alternative 1. Since an ambient modeling analysis is based on annual and daily emissions, which do not vary between Alternate 1 and Alternative 3, separate analyses were not completed for Alternate 3.
- The results of the modeling analysis along with appropriate citations from referenced literature to address the siliotic effects from ambient exposures to fugitive dust from the proposed operations. The severity of the health effects are directly proportional to the fraction of crystalline silica in the particulate. The major concern regarding silica exposure has been the issue of silicosis, a disease of the lungs caused by chronic exposure to relatively high airborne concentrations of crystalline silica.

USEPA screening techniques were used to evaluate the potential for ecosystem impacts in downwind areas, especially in the St. Croix Riverway and scenic easement areas.

2.2 Scandia Mine

Tiller has stated that no new or modified equipment would be required or used to process or handle the materials brought in from the Zavoral Site. Therefore, no change in the emission rates or impacts are expected compared to current operations.

3.0 Methodology

3.1 Goal 1 – Potential to Emit Calculations

3.1.1 Uncontrolled Emissions

Uncontrolled potential to emit (PTE) calculations represent the maximum emissions expected to occur from a facility on an hourly, daily, and/or annual basis. The PTE calculations for this analysis were prepared using standard techniques in accordance with guidance from the USEPA and the MPCA. In order to calculate the PTE, the equations used the maximum amount of aggregate that will be mined, the maximum number of trucks that will travel on on-site roads, and the longest road distance on-site for each phase of operation. Other conservative assumptions were used including the maximum silt content listed in the USEPA published documents for paved and unpaved roads (an important factor to estimate road dust). No mitigating factors were applied to the calculations such as road watering or other dust control practices.

PTE calculations were prepared for the following fugitive emission sources:

- Haul truck traffic on paved entry roads using the equation and emission factors published by the USEPA in the AP 42, Fifth Edition, Volume I,Chapter 13: Miscellaneous Sources, Section 13.2.1 Paved Roads. January 2011.
- Haul truck traffic on unpaved haul roads on the mine property for three phases of mine activity using the equation and emission factors from AP-42 Section 13.2.2, Unpaved Roads. November 2006.
- Mining and loading aggregate into haul trucks using the equation and emission factor for the Source Classification Code 30502503 for Mineral Products Manufacturing and Processing, Sand and Gravel – Construction, Material Transfer and Conveying.

Data provided by Tiller included the number of haul trucks, quantity of aggregate mined, and proposed location of haul roads for each of the three mining scenarios. The data included:

1. Maximum number of haul trucks per day = 280
2. Maximum hourly aggregate excavation and loading = 670 tons
3. Maximum daily aggregate excavation and loading = 6,720 tons
4. Maximum annual aggregate excavation and loading = 500,000 tons

Haul road distances were calculated for each mining scenario using Figures C1, C2 and C3 for each phase of the mining plan (attached) provided by Tiller showing the haul road locations. Where the maps show more than one loop, the longest loop was used for all truck traffic to provide a maximum estimate of emissions.

3.1.2 Mitigated (Controlled) Emission Calculations

Tiller has prepared a fugitive dust control plan (Zavoral Mine Dust Control Plan, September 2011) to define the mitigation methods that would be used to reduce emissions of fugitive dust from the

Site. A copy of the Zavoral Mine Dust Control Plan is in **Appendix A**. The mitigation methods selected include:

- Paved Roads – Sweeping and washing to remove dirt
- Unpaved Roads – Placing asphalt fines on the roads, watering, and chemical dust suppression
- Excavation Areas – Watering
- Reclamation material stockpiles - Watering during construction, seeding for long-term mitigation
- Based on published information from the USEPA, these mitigation techniques can effectively reduce fugitive dust emissions. The effect of the proposed mitigation techniques would be:
- Paved Roads – 90% for sweeping and washing
- Unpaved Roads – 90% for watering, silt load reduced from 25.5 grams per square meter (g/m2) to 6 g/m2 for application of asphalt fines
- Excavation Areas – 90% for water application
- Reclamation material stockpiles – 90% for watering, 100% for seeding

Emission calculations for the mitigated PTE were completed using the same assumptions on mining activity as were used for the uncontrolled PTE calculations.

3.2 Goal 2 – Ambient Air Quality Analysis

Air dispersion modeling was performed to access the impacts to ambient air and deposition from gravel mine operations on the Zavoral Property. The property is located on the western bank of the St. Croix River, near the City of Scandia, in Washington County, Minnesota. The property is approximately 45 kilometers (28 miles) northeast of downtown Minneapolis. An Air Quality Impact Analysis (AQIA) was conducted to access the ambient air quality impact due to the emissions generated by the haul roads and excavations associated with the mining operations, which consists of three phases. Refined dispersion modeling was used to access compliance with the National Ambient Air Quality Standards (NAAQSs) for $PM_{2.5}$ and PM_{10}, and to access the impacts from PM deposition on land vegetation and on the St. Croix River.

Guidance provided in the following documents was used throughout this AQIA:

- MPCA Air Dispersion Modeling Guidance for Minnesota Title V Modeling Requirements and Federal Prevention of Significant Deterioration (PSD) Requirements, Minnesota Pollution Control Agency, Version 2.2, October 20, 2004.
- *Guideline on Air Quality Models* (40 CFR Part 51 – Appendix W), November 9, 2005.
- User's Guide for the AMS/EPA Regulatory Model – AERMOD, U.S. EPA, EPA-454/B-03-001, September 2004.

- Addendum: User's Guide for the AMS/EPA Regulatory Model – AERMOD (EPA-454/B-03-001, September 2004), U.S. EPA, March 2011.

3.2.1 Model Selection

The air quality dispersion model used for this analysis was AERMOD (version 11103).

3.2.2 Dispersion Options

Regulatory default dispersion options, as identified in Appendix W to 40 CFR Part 51-Guideline on Air Quality Models, were selected for this analysis. Only concentration values were calculated for the NAAQS portion of the analysis. Concentration and deposition values were calculated for the deposition portion of the analysis. Dry and wet deposition depletion (removal) from the emission plume was not considered for either the NAAQS or deposition analyses. Because the facility is located in a rural setting, the rural dispersion option was selected.

3.2.3 Coordinate System

The Universal Transverse Mercator (UTM) coordinate system North America Datum (NAD) 83, Zone 15 was used to extract coordinates for all locations associated with the modeling analysis.

3.2.4 Terrain Modeling

The elevated terrain option was selected in the AERMOD model. The flagpole receptor option was not selected. Digital terrain data files were downloaded from the USGS National Elevation Dataset (NED) website and processed using AERMAP (version 09040) to directly provide receptor elevations. A uniform ground-level elevation derived from Site drawings (840 feet (256.03 meters) above mean sea level) was attributed to the facility emission sources.

3.2.5 Facility Emission Sources

The proposed emission source modeled emission rates (gram per second (g/s)) for PM, PM_{10}, and $PM_{2.5}$ were based on pound per hour (lb/hr) potential to emit (PTE) over a 24-hour averaging period. These rates were used for comparison with the NAAQS for all 24-hour and annual averaging periods.

Haul roads were identified in the model as strings of volume sources. The emission rate for each haul road segment was equal to the total emissions for the haul road divided by the number of segments that made up the haul road.

The excavation emission sources were identified as individual volume sources in the model. Emission source parameters and emission rates are provided in the attachments.

3.2.6 Source Groups

There were three separate phases of the mining Project: Phase 1 Reclamation, Phase 2 Mining, and Phase 3 Mining. Three separate source groups were established in the model to account for the emission sources associated with each phase.

3.2.7 External Emission Sources

No external (non-facility) emission sources were included in the analyses.

3.2.8 Building Downwash

No buildings were identified and included in the model, thus building wake effect inputs were not incorporated into the model. Also, no point sources were identified as emission sources for the facility and AERMOD does not use building downwash for non-point sources.

3.2.9 Good Engineering Practice Stack Height

Since no processing would be conducted at the Site and no asphalt or concrete plant would be present, no point sources were identified as emission sources for the facility, thus no stacks were included in the model. Thus, "Good Engineering Practice" (GEP) stack height modeling guidance was not applicable.

3.2.10 Receptor Grids

For the NAAQS analysis, receptors were positioned along the property boundary line and off-property out to a distance of 1,000 meters from the approximate center of the property. Receptors were spaced no more than 50 meters apart along the property line. Receptors were spaced 100 meters apart off-property.

For the deposition analysis to land, receptors were positioned were spaced no more than 50 meters apart along the property boundary line.

For deposition to the St. Croix River receptors were also placed along the shore and within a representative portion of the St. Croix River. Receptors were spaced no more than 100 meters apart along the shore and 100 meters apart within the perimeter of the St. Croix River.

3.2.11 Meteorology

Five years (2004 through 2008 are the most recent available data set) of preprocessed AERMOD surface and profile meteorological data were acquired from the MPCA for use in the model. This includes actual data on wind speed, wind direction, temperature, and humidity. Surface meteorological data from Minneapolis/St. Paul International Airport and upper air data from Chanhassen, Minnesota for years 2004 through 2008 were used in the analyses. The files had been generated by MPCA with AERMET (06341).

3.2.12 Ambient Background Concentrations

Ambient background concentrations for PM_{10} and $PM_{2.5}$ were obtained from the MPCA's Standardized Air Modeling (SAM) Spreadsheet (version 09293) and are summarized in Table 3.

3.3 Goal 3 – Deposition Analysis

The results of the AQIA described above were used to generate the deposition analysis. The model receptors placed around the facility on land were used to evaluate land deposition. Because of their location, the results of the analysis of deposition to land was used in the evaluation of deposition to Zavoral Creek, Middle Creek, and South Creek. Receptors were placed along the St.

Croix River to allow quantification of the deposition to water. The maximum daily and annual concentrations were compared to the secondary NAAQS to evaluate potential impacts to vegetation. A grid was established over the St. Croix River and the maximum average daily and annual deposition were calculated for a distance of 2,200 meters upstream and downstream to evaluate potential additional silt loading into the St. Croix.

4.0 Findings

4.1 Goal 1 – Potential to Emit Calculations

4.1.1 Uncontrolled Emissions

The following tables summarize the uncontrolled PTE for the proposed Project. No mitigation techniques were considered as part of the uncontrolled PTE calculations.

The excavation and loading calculations (Table 1) do not change based on the mining phase. The maximum mining quantities were used for this calculation.

Table 1 – Uncontrolled Potential to Emit from Excavation and Loading Operations

		Hourly		**Daily**		**Annual**	
Excavation Rate		**670 tons/hr**		**6,720 tons/day**		**500,000 tons/yr**	
		Emission Rate	**lb/hr**	**Emission Rate**	**lb/day**	**Emission Rate**	**lb/year**
PM		19.4	lb/hr	195	lb/day	14,500	lb/year
PM_{10}		4.3	lb/hr	43	lb/day	3,200	lb/year
$PM_{2.5}$ (17% of PM_{10})		0.7	lb/hr	7	lb/day	544	lb/year

The paved and unpaved road calculations were completed for each mining phase (Table 2). Again, all PTE calculations are for uncontrolled emissions. No mitigation techniques were considered.

Table 2 – Summary of Uncontrolled Potential Emissions from Haul Roads

Phase 1	**Paved Entry Road**		**Unpaved Mine Roads**	
	Lb/day	Lb/year	Lb/day	Lb/year
PM	677	46,590	1,467	76,299
PM_{10}	135	9,318	521	27,093
$PM_{2.5}$	33.2	2,287	52.1	2,709
Phase 2	**Paved Entry Road**		**Unpaved Mine Roads**	
	Lb/day	Lb/year	Lb/day	Lb/year
PM	841	57,875	3,204	166,568
PM_{10}	168	11,575	1,137	59,146
$PM_{2.5}$	41.3	2,841	114	5,915

Phase 3	Paved Entry Road		Unpaved Mine Roads	
	Lb/day	Lb/year	Lb/day	Lb/year
PM	841	57,875	2,188	113,729
PM_{10}	168	11,575	777	40,384
$PM_{2.5}$	41.3	2,841	78	4,038

4.1.2 Mitigated (Controlled) Emissions

The following tables summarize the mitigated PTE for the proposed Project. The mitigation techniques listed in Section 3.1.2 were considered in calculating the mitigated PTE.

The excavation and loading calculations (Table 3) do not change based on the mining phase. The maximum mining quantities were used for this calculation

Table 3: Potential to Emit from Excavation and Loading Operations

Excavation Rate	Hourly		Daily		Annual	
	670 tons/hr		6,720 tons/day		500,000 tons/year	
	Emission Rate	lb/hr	Emission Rate	lb/day	Emission Rate	lb/year
PM	1.9	lb/hr	19.5	lb/day	1,450	lb/year
PM_{10}	0.4	lb/hr	4.3	lb/day	320	lb/year
$PM_{2.5}$ (17% of PM_{10})	0.1	lb/hr	0.7	lb/day	544	lb/year

The mitigated paved and unpaved road calculations are summarized in **Table 4** for each mining phase.

Table 4: Summary of Potential Emissions from Haul Roads

Phase 1	Paved Entry Road		Unpaved Mine Roads	
	lb/day	lb/year	lb/day	lb/year
PM	87.3	6005	53.8	2794
PM_{10}	17.5	1201	14.3	745
$PM_{2.5}$	4.3	295	1.43	74.5
Phase 2	**Paved Entry Road**		**Unpaved Mine Roads**	
	lb/day	lb/year	lb/day	lb/year
PM	108.4	7460	117	6100

PM_{10}	21.7	1492	31.3	1626
$PM_{2.5}$	5.3	366	3.1	163
Phase 3	**Paved Entry Road**		**Unpaved Mine Roads**	
	lb/day	lb/year	lb/day	lb/year
PM	108.4	7460	80	4165
PM_{10}	21.7	1492	21.4	1110
$PM_{2.5}$	5.3	366	2.1	111

4.2 Goal 2 – Ambient Air Quality Analysis

4.2.1 Ambient Air Quality Analysis for Uncontrolled Emission

Dispersion modeling was conducted to access the impact on ambient air quality from uncontrolled facility sources of PM_{10} and $PM_{2.5}$ emissions, and compare those impacts with applicable NAAQSs. The model predicted that the uncontrolled impacts from facility sources plus the addition of appropriate background concentrations would result in exceedances of the NAAQSs for PM_{10} and $PM_{2.5}$. The NAAQS results are summarized in Table 5.

Table 5 - Summary of Ambient Air Quality Modeling Analysis

Mining Phase	Pollutant	Avg. Period	Maximum Concentration ug/m^3	Ambient Background ug/m^3	Worst-case + Ambient Background ug/m^3	NAAQS ug/m^3	% of NAAQS
Phase 1	$PM_{2.5}$	24-Hr	108.4	24	132.4	35	378%
		Annual	11.2	8.0	19.2	15	128%
	PM_{10}	24-Hr	755.9	43	798.9	150	533%
Phase 2	$PM_{2.5}$	24-Hr	101.2	24	125.2	35	358%
		Annual	14.3	8.0	22.3	15	149%
	PM_{10}	24-Hr	829.4	43	872.4	150	582%
Phase 3	$PM_{2.5}$	24-Hr	137.4	24	161.4	35	461%
		Annual	15.1	8.0	23.1	15	154%
	PM_{10}	24-Hr	1013.4	43	1056.4	150	704%

Table Notes:
$PM_{2.5}$ 24-hour result is the multiyear average of the H1H values. The average H1H value and the monitored ambient background value are summed and compared to the standard.
$PM_{2.5}$ annual result is multiyear annual average concentration over all analysis years. The multiyear average value and the monitored background value are summed and compared to the standard.
PM_{10} 24-hour result is H6H concentration over all analysis years. The H6H value and the monitored ambient background value are summed and compared to the standard.
Ambient Background Concentrations provided MPCA Standardized Air Modeling (SAM) Spreadsheet [Version 09293].
No external sources of emissions were included in this analysis.

Figures 1 through 3 show the area where the $PM_{2.5}$ concentrations are predicted to be above the NAAQS for each of the three proposed mining phases. Figures 4 through 6 show the area where the PM_{10} concentrations are predicted to be above the NAAQS for each of the three proposed mining phases. For both $PM_{2.5}$ and PM_{10}, the largest area of high concentrations would occur during Phase 2 due to longer haul roads on-site. As shown, the areas are very irregular in shape. The approximate maximum distances to the location where the NAAQS would be met are summarized in Table 6.

Table 6 – Approximate Maximum Distances to NAAQS Boundary

	PM_{10} Miles	$PM_{2.5}$ Miles
North	0.9	1.2
South	1.2	1.4
East	0.9	0.9
West	0.5	0.5

4.2.2 Ambient Air Quality Analysis for Mitigated Emissions

Dispersion modeling was conducted to access the impact on ambient air quality from mitigated facility sources of PM_{10} and $PM_{2.5}$ emissions and compare those impacts with applicable NAAQSs. The model predicted that the mitigated impacts from facility sources plus the addition of appropriate background concentrations would not result in exceedances of the NAAQSs for PM_{10} or $PM_{2.5}$ at any off-site location. The NAAQS results are summarized in Table 7.

Table 7: Summary of Ambient Air Quality Modeling Analysis for Mitigated Emissions

Mining Phase	Pollutant	Avg. Period	Source Contribution ug/m³	Ambient Background[4] ug/m³	Worst-case (or Average) + Ambient Background ug/m3	NAAQS ug/m3	% of NAAQS
Phase 1	PM2.5[1, 2]	24-Hr	6.38	24	30.4	35	87%
		Annual	1.00	8.0	9.0	15	60%
	PM10[3]	24-Hr	6.34	43	49.3	150	33%
Phase 2	PM2.5[1, 2]	24-Hr	5.00	24	29.0	35	83%
		Annual	0.97	8.0	9.0	15	60%
	PM10[3]	24-Hr	8.92	43	51.9	150	35%
Phase 3	PM2.5[1, 2]	24-Hr	6.44	24	30.4	35	87%
		Annual	0.95	8.0	9.0	15	60%
	PM10[3]	24-Hr	6.77	43	49.8	150	33%

Table Notes:

1. PM2.5 24-hour result is the multiyear average of the H1H values. The average H1H value and the monitored ambient background value are summed and compared to the standard.

2. PM2.5 annual result is multiyear annual average concentration over all analysis years. The multiyear average value and the monitored background value are summed and compared to the standard.

3. PM10 24-hour result is H6H concentration over all analysis years. The H6H value and the monitored ambient background value are summed and compared to the standard.

4. Ambient Background Concentrations provided MPCA Standardized Air Modeling (SAM) Spreadsheet [Version 09293].

4.2.3 Silica Analysis

Silica is the main component in sand and in rocks like sandstone and granite. As such, silica is expected to be present in the aggregate extracted from the Project Site. Prolonged inhalation exposure to fine silica dust, which is known to occur in some workplace environments involving mining and construction trades can result in a specific adverse health effect known as silicosis. The types of work places for which the risk of silicosis is most prevalent include tunneling and excavation, road building, demolition work and explosive blasting work, as well as slate, granite cutting and glass manufacturing industries, brickmaking and some manufacturing processes involving crystalline silica. Although standards for workplace exposure have been established to prevent silicosis for workers in industrial settings, at least one state agency has also developed ambient guidelines for silica to prevent "environmental silicosis", in the absence of workplace exposure.

Silica exposure to residents or workers in the area around the Project could potentially occur as a result of breathing fugitive dust from the mining and aggregate hauling operations. Neither the U.S. EPA nor MPCA have developed health based ambient concentration limits for silica.

The Occupational Health and Safety Administration (OSHA) has assigned a maximum exposure limit (MEL) of 300 $\mu g/m^3$ to silica expressed as an 8-hour time weighted average (TWA) for workers. The American Conference of Industrial Hygienists (ACGIH) has recommended a Threshold Limit Value - Time-Weighted Average Limit (TLV -TWA) of between 50 $\mu g/m^3$ and 100 $\mu g/m^3$ for the respirable fraction of the dust depending on the type of silica that is present. The ACGIH standard is also intended for workplace applications.

The above exposure limits are for daily exposure to workers to silica over a typical 8-hour work day. Since the highest 24-hour ambient air quality concentrations for $PM_{2.5}$ shown in Table 5 represents total respirable dust and not just silica, a direct comparison cannot be made. However, the data indicates that the maximum uncontrolled concentration will be below the OSHA but above ACGIH worker standards. Tiller has conducted workplace monitoring of employees for respirable dust at similar aggregate facilities. The data collected from those tests indicates that the total respirable dust was below the OSHA TWA. Therefore, the silica content was also below the OSHA TWA. (Tiller, 2010).

The state of California has developed ambient guidelines for annual average concentrations to protect against chronic non-cancer health effects for the general public, including those in the general population that are most sensitive. These are referred to as Reference Exposure Levels (RELs). California has developed an REL for respirable (i.e., $PM_{2.5}$) silica of 3 $\mu g/m^3$.

- Tiller has collected a sample of fine aggregate, particles that will pass through a 200 mesh screen, and analyzed this sample for crystalline silica. The fine aggregate was used because it represents the material that has the potential to become airborne during mining or haul truck operation. The analysis showed that the fine aggregate at the Site is 25% crystalline silica.

- Since the California REL is an annual standard, this limit can be compared to the annual ambient air quality concentrations from the Site emissions for $PM_{2.5}$ shown in Tables 5 and 6 after they have been adjusted for the percentage of crystalline silica contained in the Zavoral aggregate. AECOM assumed that the existing ambient concentration of silica is zero.

Based on the results of the NAAQS modeling analysis, the uncontrolled emissions of dust would result in a maximum annual ambient air concentration of silica of 3.8 $\mu g/m^3$. The mitigated emissions would result in a maximum annual ambient air concentration of silica of 0.26 $\mu g/m^3$, which is well below the California silica guideline.

4.3 Goal 3 – Deposition Analysis

Deposition modeling was conducted for PM emissions to assess the impact of particulate deposition from the proposed action. The concentration of particulate decreases with distance, and since the modeling analysis uses historic actual meteorological data, these values represent the highest concentration likely to occur during any one day.

The deposition analysis results showing the highest concentration of particulate matter resulting from uncontrolled emissions at the proposed Zavoral Site are summarized in **Table 8.**

Table 8: Deposition Analysis Results for the Site and the St. Croix River for Uncontrolled Emissions

Deposition to:	Mining Phase	Avg. Period	2004 g/m²	2005 g/m2	2006 g/m2	2007 g/m2	2008 g/m2	Multiyear Worst-Case g/m²
St. Croix River	Phase 1	24-Hr	0.26	0.25	0.22	0.20	0.23	0.26
		Annual	6.74	7.02	7.59	8.46	8.44	8.46
	Phase 2	24-Hr	0.26	0.27	0.28	0.29	0.31	0.31
		Annual	12.44	13.62	13.82	15.07	15.32	15.32
	Phase 3	24-Hr	0.50	0.50	0.46	0.31	0.32	0.50
		Annual	12.76	14.64	14.23	15.37	15.52	15.52
Land	Phase 1	24-Hr	3.40	3.53	3.40	3.05	3.45	3.53
		Annual	270.7	287.7	263.1	248.9	269.0	287.7
	Phase 2	24-Hr	3.26	3.52	3.55	3.13	3.54	3.55
		Annual	236.5	255.1	232.1	218.8	236.2	255.1
	Phase 3	24-Hr	3.10	3.27	3.34	3.04	3.38	3.38
		Annual	236.3	253.9	232.1	219.1	235.6	253.9

Table Notes:
24-hour results are H1H deposition rate of PM for each year.
Annual results are the highest annual average deposition for each year.

The deposition analysis results showing the highest concentration of particulate matter resulting from mitigated emissions at the proposed Zavoral Site are summarized in **Table 9.**

Table 9: Deposition Analysis Results for the Site and the St. Croix River for Mitigated Emissions

Deposition to:	Mining Phase	Avg. Period	2004 g/m^2	2005 g/m^2	2006 g/m^2	2007 g/m^2	2008 g/m^2	Multiyear Worst-Case
St. Croix River	Phase 1	24-Hr	0.03	0.03	0.03	0.02	0.03	0.03
		Annual	0.74	0.78	0.83	0.94	0.93	0.94
	Phase 2	24-Hr	0.04	0.04	0.04	0.04	0.05	0.05
		Annual	1.7	1.9	2.0	2.2	2.2	2.2
	Phase 3	24-Hr	0.06	0.06	0.06	0.04	0.04	0.06
		Annual	1.65	1.86	1.83	1.99	2.00	2.00
Land	Phase 1	24-Hr	3.80	3.40	3.40	3.50	3.70	3.80
		Annual	20.5	21.7	21.5	18.7	20.3	21.7
	Phase 2	24-Hr	0.23	0.25	0.24	0.21	0.22	0.25
		Annual	26.6	26.4	31.0	24.3	25.5	31.0
	Phase 3	24-Hr	0.34	0.30	0.34	0.25	0.22	0.34
		Annual	15.6	16.7	25.6	14.4	15.5	25.6

Table Notes:

24-hour results are H1H deposition rate of PM for each year.

Annual results are the highest annual average deposition for each year.

5.0 Impact Analysis

5.1 Goal 2 – Ambient Air Quality Analysis

5.1.1 National Ambient Air Quality and Minnesota Air Quality Standards

The Clean Air Act (CAA) required the USEPA to set NAAQS for pollutants considered harmful to public health and the environment. NAAQS include two types of air quality standards: primary and secondary. Minnesota has adopted the NAAQS for PM_{10} and $PM_{2.5}$.

Primary standards protect public health, including the health of sensitive populations such as asthmatics, children and the elderly. Secondary standards protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings (USEPA, 2009a).

As shown on Table 3 and Figures 1 through 6, the uncontrolled emissions from the proposed mining operation, would exceed the NAAQS for all mining phases. Exceedance of the NAAQS is not allowed under Minnesota air quality regulations. Refer to Section 7.0 for potential mitigation measures to help reduce PM emissions.

5.1.2 Silica Impacts

As discussed above, the lowest short-term exposure limit to crystalline silica recommended for worker exposure over an 8-hour day is 50 $\mu g/m^3$. Based on the results of the NAAQS modeling analysis, the uncontrolled emissions of dust would result in a maximum annual ambient air concentration of silica of 3.8 $\mu g/m^3$. The mitigated emissions would result in a maximum annual ambient air concentration of silica of 0.26 $\mu g/m^3$, which is well below the California silica guideline.

5.2 Goal 3 – Deposition Analysis

5.2.1 Land and Vegetation

5.2.2 Deposition to Land

The deposition analysis was completed for potential impacts to local vegetation. Dust deposits can have significant effects on plant life, though mainly at high dust loadings. This can include:

- Reduced photosynthesis due to reduced light penetration through the leaves. This can cause reduced growth rates and plant vigor. It can be especially important for horticultural crops, through reductions in fruit setting, fruit size, and sugar levels.

- Increased incidence of plant pests and diseases. Dust deposits can act as a medium for the growth of fungal diseases. In addition, it appears that sucking and chewing insects are not affected by dust deposits to any great extent, whereas their natural predators are affected.

Under normal conditions, only PM_{10} remains in the atmosphere long enough to be considered atmospheric particulates. This is reflected in the actions of the USEPA, which eliminated the NAAQS for PM. The PM NAAQS was superseded by the PM_{10} NAAQS on July 1, 1987. Therefore, use of PM_{10} for deposition analysis is appropriate for impacts to land and plants.

Since the uncontrolled predicted concentrations of PM_{10} are above the NAAQS primary and secondary standards, in the absence of mitigation techniques, the concentrations may be high enough to adversely impact local vegetation within the areas shown in Figures 1 through 3.

As noted above, the largest area would occur during mining Phase 2 due to longer haul road lengths.

Following implementation of mitigation techniques, the concentrations of PM_{10} are below the primary and secondary standards. As noted above, the secondary NAAQS were established to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings. Since the deposition analysis shows the highest predicted concentration on any day, all other days would be predicted to have lower impacts. Therefore, it is unlikely that deposition would have an adverse impact on the surrounding land.

Neither the USEPA nor the MPCA has a standard for nuisance dust. Several countries have established nuisance dust standards that can be used for reference in evaluating PM concentrations related to the proposed action. **Table 10** summarizes nuisance dust standards for several countries.

Table 10: Summary of Nuisance Dust Standards

Nuisance: mass deposition measurements				
UK "unofficial" nuisance dust deposition rate[75]	All particulates	**200 $mg/m^2/day$**	Annual mean	Serious nuisance
West Australia Nuisance Standard	All particulates	**133 $mg/m^2/day$**	Monthly mean	First loss of amenity
		333 $mg/m^2/day$		Unacceptable reduction in air quality
West Germany Nuisance Standard	All particulates	**350 $mg/m^2/day$**	Monthly mean	Possible nuisance
	All particulates	**650 $mg/m^2/day$**		Very likely nuisance
Malaysia Air Quality Standard	All particulates	**133 $mg/m^2/day$**		Nuisance dust deposition
Israel Air Quality Standard	All particulates	**2 * 10^5 $kg/km^2/month$**		Nuisance dust deposition

Source: http://www.goodquarry.com/article.aspx?id=58&navid=2

The results of the modeling analysis indicate that the uncontrolled PM emissions from the Zavoral Site would be above the nuisance dust levels. The mitigated dust levels would be less than the above standards.

5.2.3 Deposition to the St. Croix

The deposition analysis was completed for potential impacts to the St. Croix River. The primary concern would be a significant increase in the amount of sediment in the river. To determine if a significant impact occurred, the current amount of sediment (sediment loading) in the St. Croix River near Scandia was obtained from the USGS and compared to the amount that would be added under the worst-case and mitigated conditions from the operations at the Site.

The USGS has been collecting water flow data from the St. Croix River at St. Croix Falls since 1902. Additionally, the USGS collected sediment data in 1981 and 1982 from the same location at St. Croix Falls.

The water flow data shows that flow rates vary substantially over time. Based on the published data, the highest monthly average flow rate in the St. Croix River at St. Croix Falls was 29,600 cubic feet per second (cfs) which occurred in April 2001. The lowest monthly average flow rate in the St. Croix River at St. Croix Falls was 839 cfs, which occurred in August 1934.

The sediment loading data collected by the USGS in 1981 and 1982 showed that the sediment loading in the river ranged from 12.5 tons/day in January to 1,293 tons/day in April.

Extrapolating the sediment data to estimate the minimum and maximum sediment loading at the historic high and low flow rates shows that the minimum sediment loading in the St. Croix would be approximately 4.8 tons/day and the maximum sediment loading would be 2,225 tons/day without any contribution from operation at the proposed Zavoral Site.

The maximum deposition of PM into the St. Croix River from the Project was determined by modeling the amount of PM that would be deposited into the river for a distance of 2,200 meters upstream and downstream from the Site under the maximum emission and deposition conditions. The worst-case uncontrolled 24-hour average deposition rate based on an average from the receptors in the above area is 0.231 $g/m^2/day$. The worst-case annual average deposition rate based on an average from the receptors in the basin is 10.03 $g/m^2/year$.

Since the amount of PM that would deposited in the river is a function of the width of the river, the width of the river was estimated at low and high flow rates. The river would be at its widest when the flow rate is highest and at its narrowest when the river is at its lowest flow conditions. Table 11 shows the results of the deposition analysis.

Table 11: Summary of Sediment Loading in the St. Croix with Uncontrolled Emissions from the Site

Flow Rate Cfs	Current Sediment Loading Tons/day	Contribution from Zavoral Tons/day	% Increase in Sediment Loading
839	4.8	0.2	3.7
29,600	2,225	1.3	0.1

The worst-case mitigated 24-hour average deposition rate based on an average from the receptors in the above area is 0.016 $g/m^2/day$. The worst-case annual average deposition rate based on an average from the receptors in the basin is 0.7 $g/m^2/year$.

Table 12 shows the results of the deposition analysis with the mitigated emissions from the proposed Zavoral Site.

Table 12: Summary of Sediment Loading in the St. Croix with Mitigated Emissions from the Site

Flow Rate cfs	Current Sediment Loading Tons/day	Contribution from Zavoral Tons/day	% Increase in Sediment Loading
839	4.8	0.2	0.2%
29,600	2,225	0.09	0.01%

It is unlikely that fugitive dust would adversely affect the water quality in the St. Croix River under either uncontrolled or mitigated conditions given:

- The existing high degree of variability in the sediment loading in the St. Croix River,
- The fact that maximum deposition conditions would only occur when:
  - Mining activities are at the maximum rate
  - Mining activities are taking place on the northern boundary of the proposed Site
  - Weather conditions are consistent with those that yielded the predicted maximum impact. Such weather conditions only occurred for one day out of the five years of actual meteorological data used in the modeling analysis

Also, the proposed mining plan does not include mining activity in the winter, which is when low flow conditions occur.

5.2.4 Deposition to Creeks

A deposition analysis was completed for Zavoral Creek, Middle Creek, and South Creek. The length and approximate width of each creek was determined from aerial photographs and on-site visual observations to derive the approximate area of each creek from the headwaters to the St. Croix River. The locations and lengths of the creeks are shown on Figure 7. For the purposes of this analysis, it was assumed that dust would be deposited along the entire creek at the maximum rate for land deposition shown on Table 9 for each mining phase. This assumption results in a substantial overestimate of the actual deposition of dust into the creek because:

- The maximum deposition rate occurs at the north property line for the proposed Site.
- The three creeks are located away from the point of maximum deposition.
- Deposition rates decrease with distance from the source. For example, as shown on Table 28, the maximum 24-hour deposition to land is 0.36 g/m^2 where the maximum deposition rate at the St. Croix River is 0.05 g/m^2.

Table 13 shows the results of the deposition analysis for Zavoral Creek, Middle Creek, and South Creek.

Table 13 –Maximum Deposition of Particulate Matter to Zavoral Creek, Middle Creek, and South Creek

Phase 1	Total Length	Assumed Average Width	Area	Maximum Daily Deposition Rate	Maximum Daily Deposition	Maximum Daily Deposition	Maximum Annual Deposition Rate	Maximum Annual Deposition	Maximum Annual Deposition
	meters	meters	m^2	g/m^2	g/day	lb/day	g/m^2	g/year	lb/year
Zavoral Creek	2098	1	2098	0.36	755	1.7	28.8	60429	133.2
Middle Creek	752	1	752	0.36	271	0.6	28.8	21656	47.7
South Creek	1468	1	1468	0.36	528	1.2	28.8	42276	93.2
Phase 2									
Zavoral Creek	2098.2	1	2098	0.36	755	1.7	25.5	53505	118.0
Middle Creek	751.9	1	752	0.36	271	0.6	25.5	19175	42.3
South Creek	1467.9	1	1468	0.36	528	1.2	25.5	37432	82.5
Phase 3									
Zavoral Creek	2098	1	2098	0.34	755	1.7	25.4	53295	117.5
Middle Creek	752	1	752	0.34	271	0.6	25.4	19099	42.1
South Creek	1468	1	1468	0.34	528	1.2	25.4	37285	82.2

As shown on Table 13, the maximum daily deposition rate would be:

- 1.7 lbs particulate matter/day over the entire length of Zavoral Creek. For perspective, this is the equivalent of approximately one handful of dust distributed across over approximately 1.3 miles of creek length.
- 0.6 lbs particulate matter/day over the entire length (~0.5 miles) of Middle Creek.
- 1.2 lbs particulate matter/day over the entire length (~0.9 miles) of South Creek.

No data were found on the existing amount of silt in the three creeks. Therefore, an analysis of the percent increase in silt loading is not included.

6.0 Potential Mitigation

Potential mitigation actions to reduce emissions of PM from the mining operation and haul roads may include:

- Application of water to unpaved roads to maintain a high moisture content.
- Routine sweeping of paved roads to reduce the silt loading on the pavement.
- Application of dust control chemicals, such as calcium chloride, lignosulfonate or other dust control chemical, to reduce fugitive dust emissions from unpaved roads.
- Application of water to the excavation area to maintain a high moisture content of excavated material.
- Reduction in the daily mining rate and number of trucks traveling to and from the Site.
- Installation and maintenance of a wheel wash system at the transition from unpaved to paved roads.
- Covering truck beds with tarps to reduce wind-blown dust.
- Application of dust control chemicals to reduce wind blown dust emissions from inactive areas prior to reclamation.

A combination of the above mitigation techniques, applied routinely during facility operations, has the potential to reduce the impacts from fugitive dust emissions to a level that would meet the NAAQS, MAAQS and reduce the potential impacts described above.

Tiller provided a fugitive dust mitigation plan that provides details on the practices and procedures Tiller would use to reduce fugitive dust. AECOM reviewed the plan and determined that it is consistent with good operating practices and, if implemented, would reduce fugitive dust emissions from work activities at the proposed Site.

7.0 References

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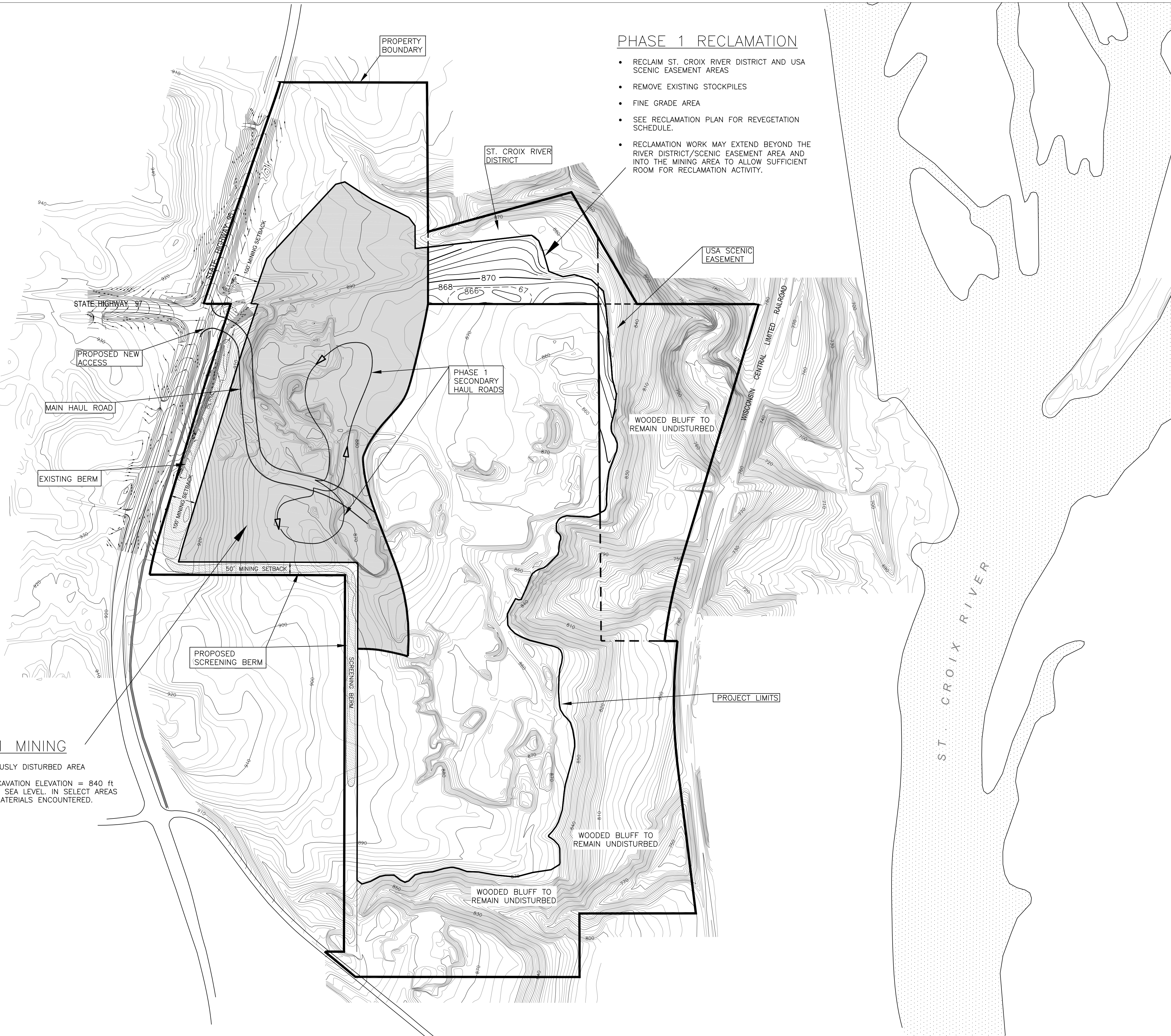
AECOM

Figures



PHASE 1 RECLAMATION

- RECLAIM ST. CROIX RIVER DISTRICT AND USA SCENIC EASEMENT AREAS
- REMOVE EXISTING STOCKPILES
- FINE GRADE AREA
- SEE RECLAMATION PLAN FOR REVEGETATION SCHEDULE.
- RECLAMATION WORK MAY EXTEND BEYOND THE RIVER DISTRICT/SCENIC EASEMENT AREA AND INTO THE MINING AREA TO ALLOW SUFFICIENT ROOM FOR RECLAMATION ACTIVITY.

PHASE 1 MINING

- MINE PREVIOUSLY DISTURBED AREA
- MINIMUM EXCAVATION ELEVATION = 840 ft ABOVE MEAN SEA LEVEL. IN SELECT AREAS BASED ON MATERIALS ENCOUNTERED.

NOTES:

1. TOPOGRAPHY FROM WASHINGTON COUNTY. AERIAL PHOTOGRAPHY FROM APRIL 2000.
2. GRADES REPRESENT PROPOSED MINIMUM RESTORATION GRADES.
3. SETBACKS ARE AS FOLLOWS:
   50' FROM PROPERTY LINE
   100' FROM ROAD RIGHT-OF-WAY.
   MINING AND RECLAMATION GRADING MAY OCCUR WITHIN 50' OF THE ROAD RIGHT-OF-WAY IF COMPLETED WITHIN ONE MINING SEASON.
4. MINING ACTIVITY WILL FOLLOW THE GENERAL PROGRESSION INDICATED ON THIS SERIES OF PLANS.
5. DEPTH OF MINING TO VARY THROUGHOUT THE SITE AND WILL DEPEND UPON THE QUALITY OF MATERIAL ENCOUNTERED. MAXIMUM EXCAVATION DEPTH WILL BE TO A MINIMUM ELEVATION OF 840 FEET ABOVE MEAN SEA LEVEL
6. THE MINING AREA WILL BE RECLAIMED TO APPROXIMATE GRADES ILLUSTRATED ON THIS PLAN. GRADES ILLUSTRATED REPRESENT A MINIMUM RECLAMATION ELEVATION. SLOPES WILL BE GRADED TO A MAXIMUM OF 4:1. SPECIFICS OF THE PLANTING AND REVEGETATION PLAN ARE DETAILED IN THE RECLAMATION PLAN.
7. SEQUENCING:
   1) CONSTRUCT HAUL ROAD.
   2) REMOVE EXISTING TREES
   3) CONSTRUCT NEW SCREENING BERMS AS INDICATED ON PLANS.
   4) BEGIN PHASE 1 RECLAMATION
   5) PROCEED WITH MINING, PHASES 1-3.

N

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SCALE IN FEET

Sunde Engineering, PLLC.

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TILLER CORPORATION

ZAVORAL MINING AND RECLAMATION PROJECT

SCANDIA, MINNESOTA

DATE	REVISION

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

Kirsten Pauly

DATE: 12/22/10 REG. NO.: 21842

INFORMATION:

PROJECT NO.:	02-626
DRAWN BY:	NM
CHECKED BY:	KP
APPROVED BY:	KP
SCALE:	Graphic
DATE:	12/22/10

DESCRIPTION:

MINING AND RECLAMATION PHASING

SHEET NO:

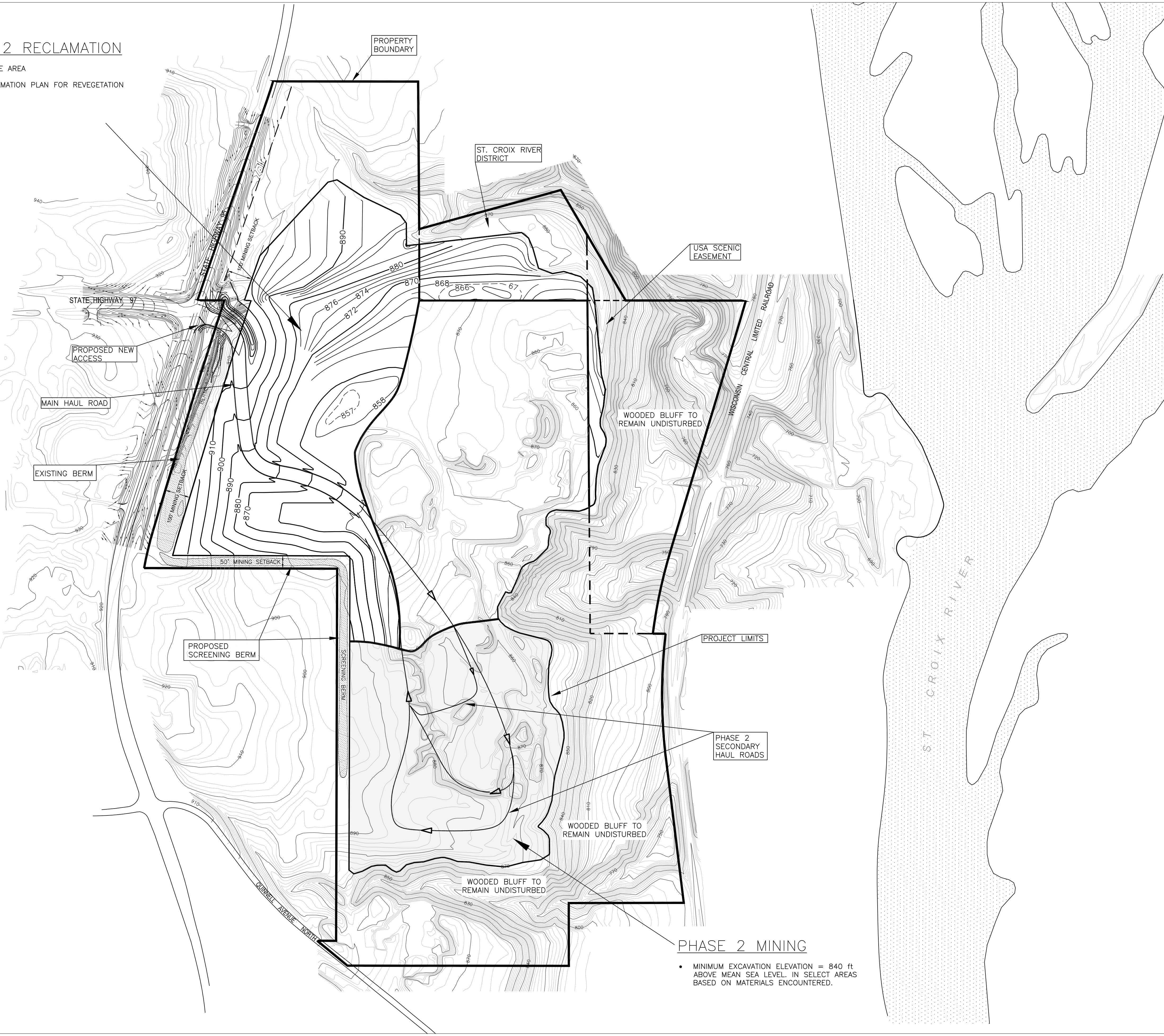
C1

of

#02-626 T.32 , R.19 , S.18 DRAWING: \\Kirstenspc\dwgs\Tiller - All\Tiller Zavoral\2010 mining and phasing plans\2010-12-01\Phase 1 Mining Plan.dwg LAYOUT: Phase 1 Mining Plan

PHASE 2 RECLAMATION

- FINE GRADE AREA
- SEE RECLAMATION PLAN FOR REVEGETATION SCHEDULE.



PHASE 2 MINING

- MINIMUM EXCAVATION ELEVATION = 840 ft ABOVE MEAN SEA LEVEL. IN SELECT AREAS BASED ON MATERIALS ENCOUNTERED.

NOTES:

1. TOPOGRAPHY FROM WASHINGTON COUNTY. AERIAL PHOTOGRAPHY FROM APRIL 2000.
2. GRADES REPRESENT PROPOSED MINIMUM RESTORATION GRADES.
3. SETBACKS ARE AS FOLLOWS:
   50' FROM PROPERTY LINE
   100' FROM ROAD RIGHT-OF-WAY.
   MINING AND RECLAMATION GRADING MAY OCCUR WITHIN 50' OF THE ROAD RIGHT-OF-WAY IF COMPLETED WITHIN ONE MINING SEASON.
4. MINING ACTIVITY WILL FOLLOW THE GENERAL PROGRESSION INDICATED ON THIS SERIES OF PLANS.
5. DEPTH OF MINING TO VARY THROUGHOUT THE SITE AND WILL DEPEND UPON THE QUALITY OF MATERIAL ENCOUNTERED. MAXIMUM EXCAVATION DEPTH WILL BE TO A MINIMUM ELEVATION OF 840 FEET ABOVE MEAN SEA LEVEL
6. THE MINING AREA WILL BE RECLAIMED TO APPROXIMATE GRADES ILLUSTRATED ON THIS PLAN. GRADES ILLUSTRATED REPRESENT A MINIMUM RECLAMATION ELEVATION. SLOPES WILL BE GRADED TO A MAXIMUM OF 4:1. SPECIFICS OF THE PLANTING AND REVEGETATION PLAN ARE DETAILED IN THE RECLAMATION PLAN.
7. SEQUENCING:
   1) CONSTRUCT HAUL ROAD.
   2) REMOVE EXISTING TREES
   3) CONSTRUCT NEW SCREENING BERMS AS INDICATED ON PLANS.
   4) BEGIN PHASE 1 RECLAMATION
   5) PROCEED WITH MINING, PHASES 1–3.

Sunde Engineering, PLLC.
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TILLER CORPORATION

ZAVORAL MINING AND RECLAMATION PROJECT

SCANDIA, MINNESOTA

DATE	REVISION
1/17/11	Phase 2 Reclamation Notes

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

Kirsten Pauly

DATE: 12/22/2010 REG. NO.: 21842

INFORMATION:

PROJECT NO.:	02-626
DRAWN BY:	NM
CHECKED BY:	KP
APPROVED BY:	KP
SCALE:	Graphic
DATE:	12/22/10

DESCRIPTION:

MINING AND RECLAMATION PHASING

SHEET NO:

C2

of

#02-626 T.32 , R.19 , S.18 DRAWING: \\Kirstenspc\dwgs\Tiller - All\Tiller Zavoral\2010 mining and phasing plans\2010-12-01 submited to share site\Phase 2 Mining Plan C2 - Revised 1-17-11.dwg LAYOUT: Phase 2 Mining Plan

NOTES:

1. TOPOGRAPHY FROM WASHINGTON COUNTY. AERIAL PHOTOGRAPHY FROM APRIL 2000.
2. GRADES REPRESENT PROPOSED MINIMUM RESTORATION GRADES.
3. SETBACKS ARE AS FOLLOWS:
   50' FROM PROPERTY LINE
   100' FROM ROAD RIGHT-OF-WAY.
   MINING AND RECLAMATION GRADING MAY OCCUR WITHIN 50' OF THE ROAD RIGHT-OF-WAY IF COMPLETED WITHIN ONE MINING SEASON.
4. MINING ACTIVITY WILL FOLLOW THE GENERAL PROGRESSION INDICATED ON THIS SERIES OF PLANS.
5. DEPTH OF MINING TO VARY THROUGHOUT THE SITE AND WILL DEPEND UPON THE QUALITY OF MATERIAL ENCOUNTERED. MAXIMUM EXCAVATION DEPTH WILL BE TO A MINIMUM ELEVATION OF 840 FEET ABOVE MEAN SEA LEVEL
6. THE MINING AREA WILL BE RECLAIMED TO APPROXIMATE GRADES ILLUSTRATED ON THIS PLAN. GRADES ILLUSTRATED REPRESENT A MINIMUM RECLAMATION ELEVATION. SLOPES WILL BE GRADED TO A MAXIMUM OF 4:1. SPECIFICS OF THE PLANTING AND REVEGETATION PLAN ARE DETAILED IN THE RECLAMATION PLAN.
7. SEQUENCING:
   1) CONSTRUCT HAUL ROAD.
   2) REMOVE EXISTING TREES.
   3) CONSTRUCT NEW SCREENING BERMS AS INDICATED ON PLANS.
   4) BEGIN PHASE 1 RECLAMATION
   5) PROCEED WITH MINING, PHASES 1-3.

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ZAVORAL MINING AND RECLAMATION PROJECT

SCANDIA, MINNESOTA

DATE	REVISION

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Kirsten Pauly

DATE: 12/22/10 REG. NO.: 21842

INFORMATION:

PROJECT NO.:	02-626
DRAWN BY:	NM
CHECKED BY:	KP
APPROVED BY:	KP
SCALE:	Graphic
DATE:	12/22/2010

DESCRIPTION:

MINING AND RECLAMATION PHASING

SHEET NO:

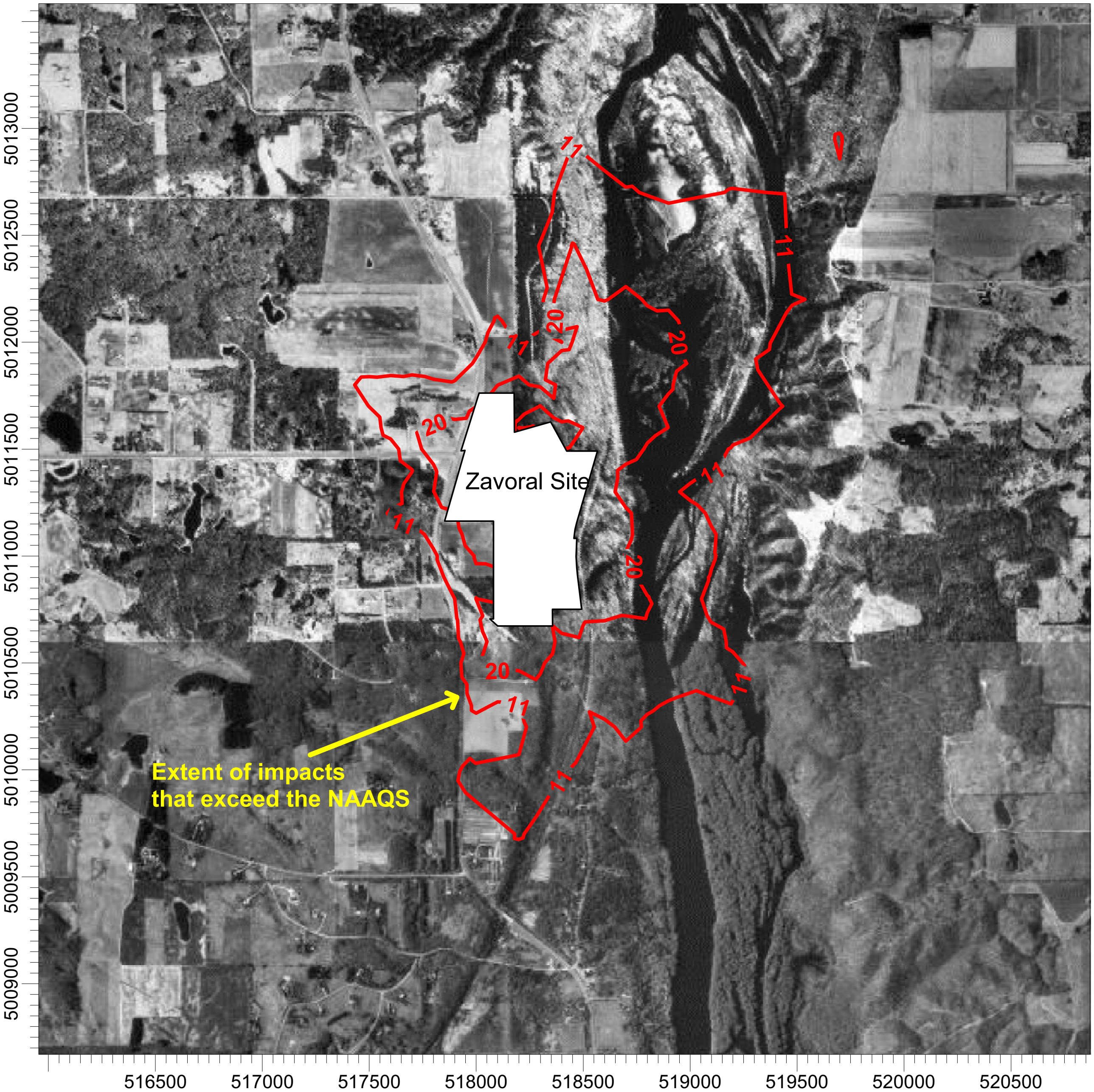
C3

of

#02-626 T.32 , R.19 , S.18 DRAWING: \\Kirstenspc\dwgs\Tiller - All\Tiller Zavoral\2010 mining and phasing plans\2010-12-01\Phase 3 Mining Plan.dwg LAYOUT: Phase 3 Mining Plan

PROJECT TITLE:

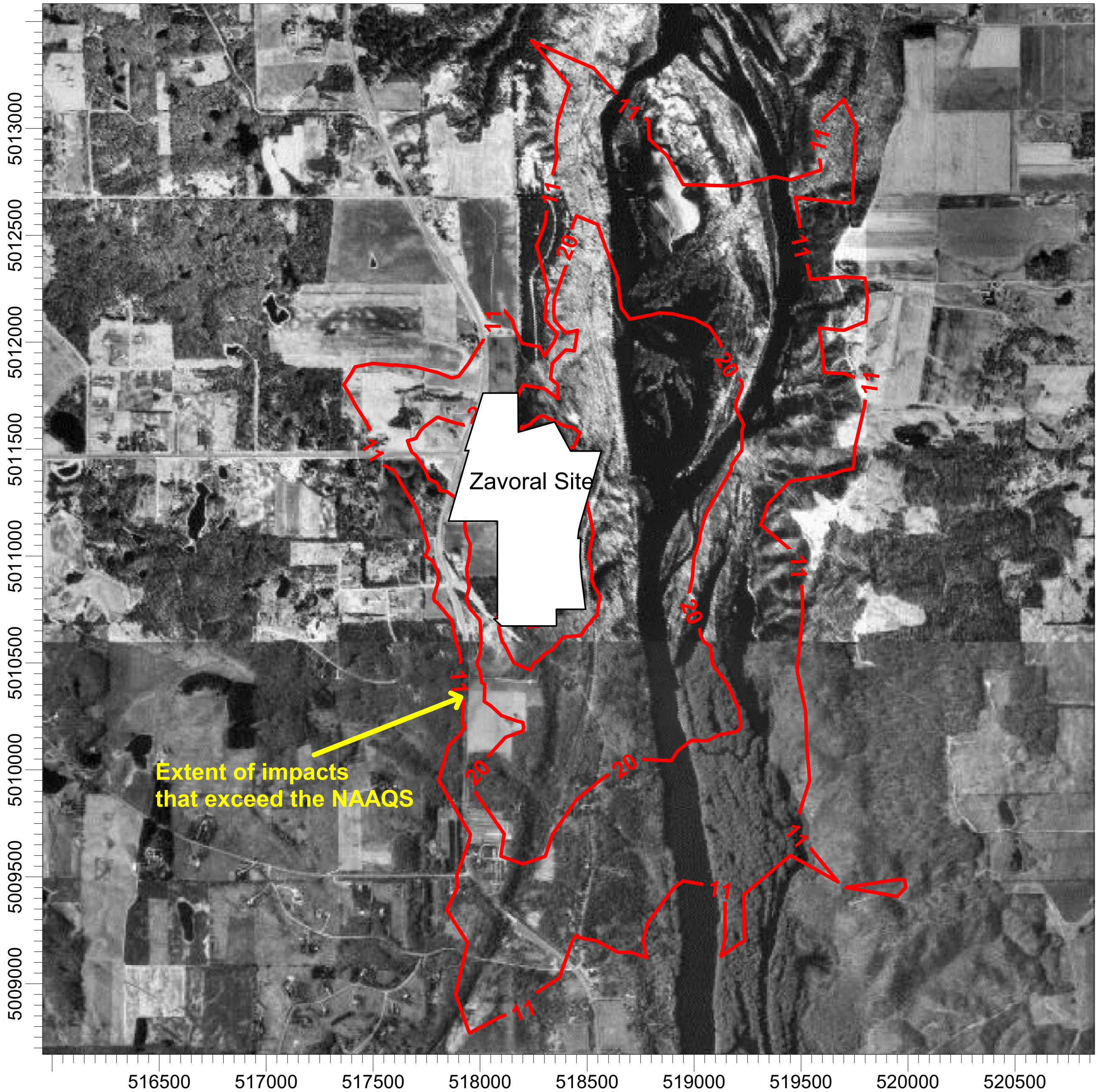
Zavoral Mining and Reclamation Project - Phase 1
PM2.5 24-Hour NAAQS Modeling Results



COMMENTS: Maximum facility impact that would demonstrate compliance with NAAQS is 11 ug/m3. Phase 1 unmitigated PM2.5 concentration contours.	NO. OF SOURCES: **410**		
	NO. OF RECEPTORS **2698**		
	OUTPUT: **Concentration**	SCALE: 1:30,000 0 — 1 km	
	MAX. CONC.: **108.38202 ug/m^3**	DATE: **8/16/2011**	FIGURE NO.: **Figure 1**

PROJECT TITLE:

Zavoral Mining and Reclamation Project - Phase 2
PM2.5 24-Hour NAAQS Modeling Results

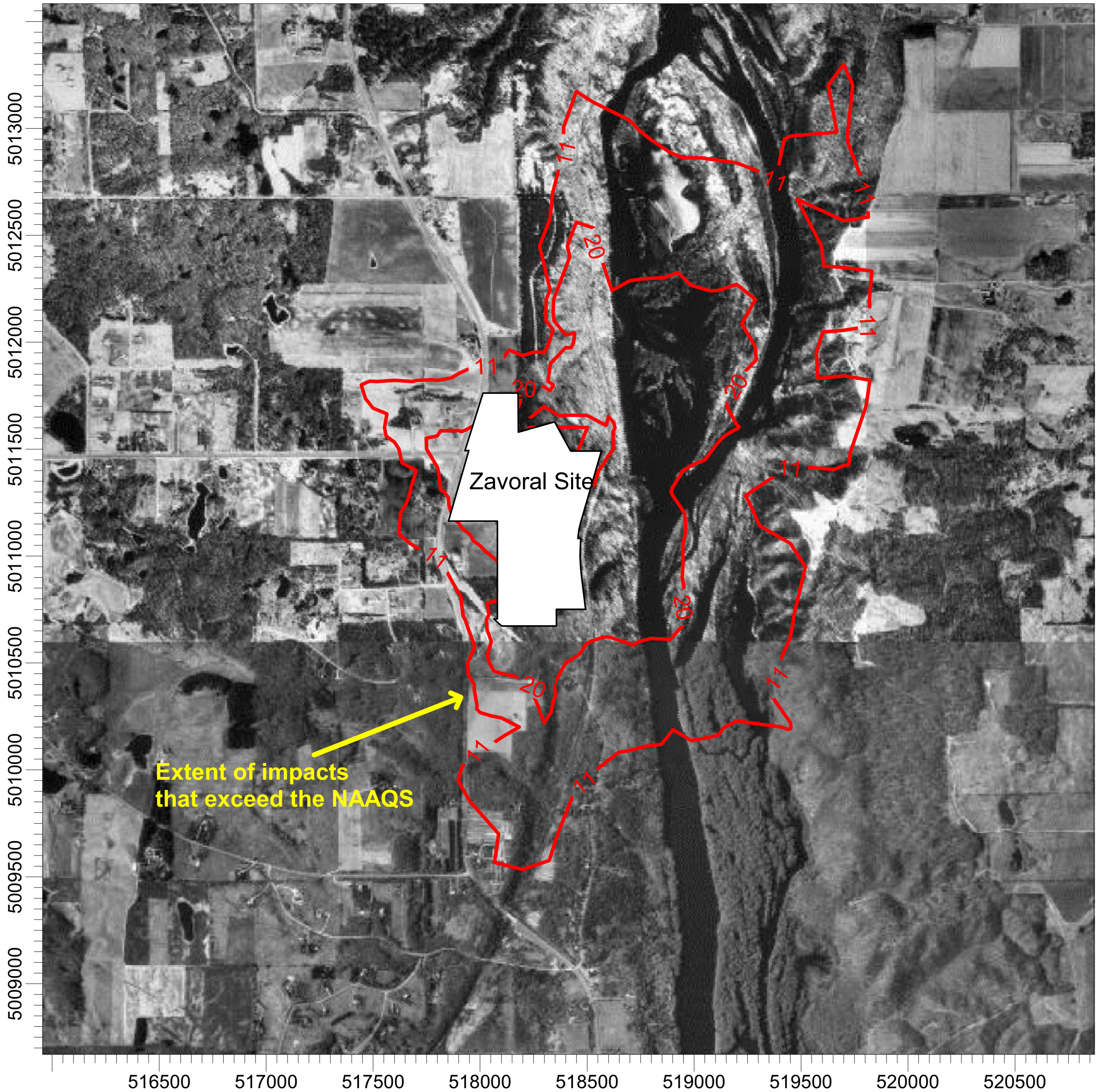


COMMENTS:	NO. OF SOURCES:		
Maximum facility impact that would demonstrate compliance with NAAQS is 11 ug/m3. Phase 2 unmitigated PM2.5 concentration contours.	**410**		
	NO. OF RECEPTORS **2698**		
	OUTPUT: **Concentration**	SCALE: 1:30,000 (0 — 1 km)	
	MAX. CONC.: **101.18476 ug/m^3**	DATE: **8/16/2011**	FIGURE NO.: **Figure 2**

ISC-AERMOD View - Lakes Environmental Software

PROJECT TITLE:

Zavoral Mining and Reclamation Project - Phase 3
PM2.5 24-Hour NAAQS Modeling Results

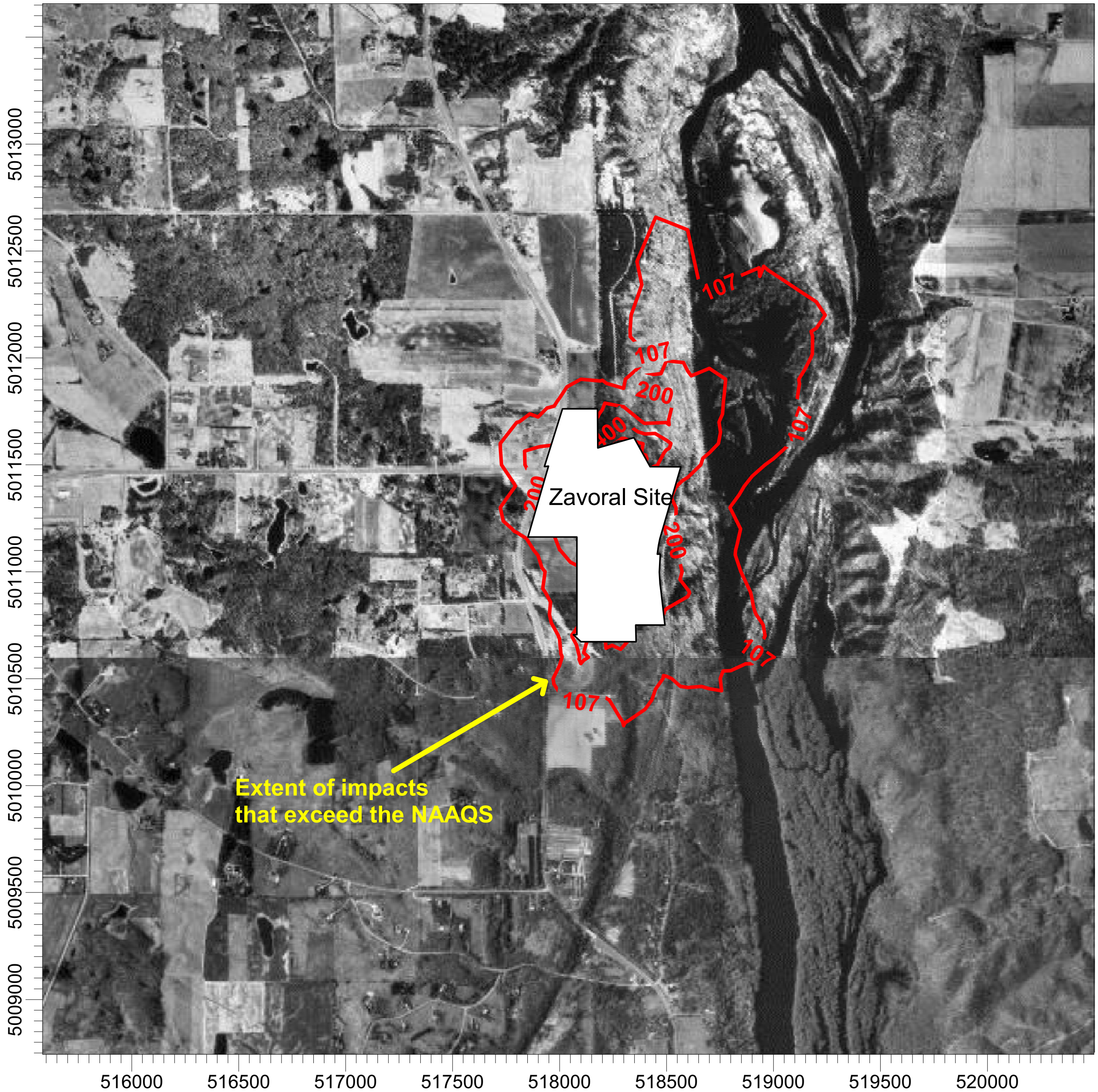


COMMENTS:	NO. OF SOURCES:		
Maximum facility impact that would demonstrate compliance with NAAQS is 11 ug/m3. Phase 3 unmitigated PM2.5 concentration contours.	**410**		
	NO. OF RECEPTORS **2698**		
	OUTPUT: **Concentration**	SCALE: 1:30,000 (0 — 1 km)	
	MAX. CONC.: **137.35002 ug/m^3**	DATE: **8/16/2011**	FIGURE NO.: **Figure 3**

ISC-AERMOD View - Lakes Environmental Software

PROJECT TITLE:

Zavoral Mining and Reclamation Project - Phase 1
PM10 24-Hour NAAQS Modeling Results



COMMENTS: Maximum facility impact that would demonstrate compliance with NAAQS is 107 ug/m3. Phase 1 unmitigated PM10 concentration contours.	NO. OF SOURCES: **410**		
	NO. OF RECEPTORS **2698**		
	OUTPUT: **Concentration**	SCALE: 1:30,000 0 — 1 km	
	MAX. CONC.: **755.92778 ug/m^3**	DATE: **8/16/2011**	FIGURE NO.: **Figure 4**

ISC-AERMOD View - Lakes Environmental Software

PROJECT TITLE:

Zavoral Mining and Reclamation Project - Phase 2
PM10 24-Hour NAAQS Modeling Results

COMMENTS: Maximum facility impact that would demonstrate compliance with NAAQS is 107 ug/m3. Phase 2 unmitigated PM10 concentration contours.	NO. OF SOURCES: **410**		
	NO. OF RECEPTORS **2698**		
	OUTPUT: **Concentration**	SCALE: 1:30,000 (0 – 1 km)	
	MAX. CONC.: **829.44109 ug/m^3**	DATE: **8/16/2011**	FIGURE NO.: **Figure 5**

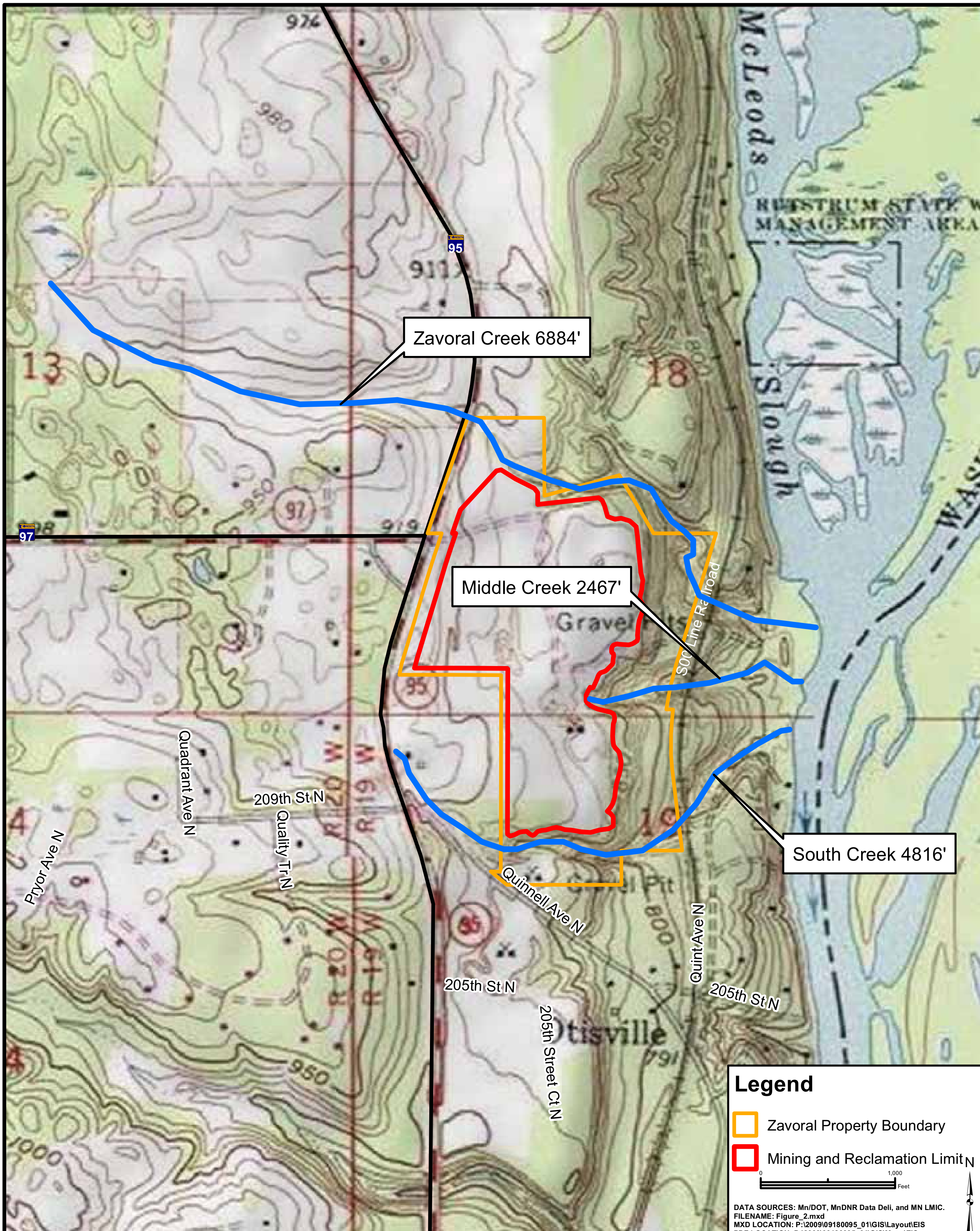
ISC-AERMOD View - Lakes Environmental Software

PROJECT TITLE:

Zavoral Mining and Reclamation Project - Phase 3
PM10 24-Hour NAAQS Modeling Results

COMMENTS:	NO. OF SOURCES:		
Maximum facility impact that would demonstrate compliance with NAAQS is 107 ug/m3.	**410**		
Phase 3 unmitigated PM10 concentration contours.	NO. OF RECEPTORS **2698**		
	OUTPUT: **Concentration**	SCALE: 1:30,000 0 ——— 1 km	
	MAX. CONC.: **1013.38668 ug/m^3**	DATE: **8/16/2011**	FIGURE NO.: **Figure 6**

ISC-AERMOD View - Lakes Environmental Software



Prepared By:

AECOM

Prepared For:

SCANDIA

FIGURE 7
ZAVORAL STREAMS

ZAVORAL MINING AND RECLAMATION PROJECT
SCANDIA, MINNESOTA

OCT. 2011

60210154

Appendix A

Tiller Fugitive Dust Control Plan

Tiller Corporation
Zavoral Mine Dust Control Plan

Scandia, MN

09/19/11

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I. Dust Control Plan

Introduction

The following dust control plan for the Zavoral Mining and Reclamation Plan has been prepared to address potential impacts to air quality resulting from fugitive dust associated with the proposed Project. The Plan identifies several mitigation measures which will be implemented at the Site to eliminate or reduce fugitive dust emissions. Stripping operations, extraction, aggregate loading and hauling on unpaved haul roads are the largest sources of dust creation during the project operation. The following measures will be taken to limit and reduce the amount of dust created during operations.

1. Stripping Operations and Reclamation Grading Operations:

Elevated fugitive dust emissions can occur during stripping operations. Topsoil and over burden have already been removed from the majority of the Site during previous mining operations. In the areas that remain to be stripped, stripping operations will be performed in a sequence of phases, which minimizes the amount of exposed open areas. Topsoils that are not immediately used for reclamation activities will be stockpiled or shaped into berms and seeded within 14 days to establish vegetation. Berms will be inspected periodically and areas reseeded as necessary to ensure establishment of vegetation. Existing berms as well as new screening berms located along the perimeter of the Site further act to reduce emissions by trapping/containing a portion of the fugitive dust emissions within the Site.

Reclamation activity will proceed as timely as possible as areas of mining are completed (exception is Phase 1 Reclamation which is not proposed to be mined). Perimeter areas will be sloped and the interior areas backfilled and graded to reclamation grades. Topsoil application, seeding and mulching of the graded area will be performed in accordance with the approved Reclamation Plan. The approved Reclamation Plan will contain specifications and schedules for these activities. The schedule will be developed with the intent of reducing the exposure of the applied topsoils, thereby reducing the potential for fugitive dust emissions. Seeded areas will be inspected to assure establishment of vegetation and reseeded as necessary.

2. Active Mining Area:

A. Main Haul Road

1. *Paving*: The main haul road will be paved with asphalt for the first 300 feet into the site.

2. *Millings:* Asphalt millings will be applied to the main haul road, starting from the end

of the paved portion of the main haul road down to the base of the mine or approximately 660 feet. Once asphalt millings are applied and graded, truck traffic will compact the material so that after approximately two to five days the millings surface may be swept and washed.

3. *Calcium chloride:* Calcium chloride will be applied to the internal haul roads from the edge of the milled portion of the haul road throughout the unpaved haul roads within any given active phase.

4. *Watering:* Water application to the unpaved haul roads will be conducted as needed between applications of calcium chloride. Any secondary haul roads that are in use will be watered on a daily basis (unless there has been precipitation in the last 24 hours). Water trucks will be available onsite whenever there is a hauling event or reclamation activity.

5. *Washing:* The paved and milled portion of the main haul road will be washed with a high pressure low volume wash twice a day during haul events. This reduces the accumulation of silts on the road surface significantly reducing fugitive dust emissions.

6. *Sweeping:* The Site entrance and the paved portion of the haul road, including that portion surfaced with asphalt millings will be swept one to two times per week to remove accumulated sediments. (Washing the paved sections of the haul road twice a day during haul events will reduce the frequency of sweeping needed.)

B. Excavation Area:

The sand and gravel deposit naturally contains some moisture which helps control fugitive dust emissions associated with the excavation and loading activities. However, during extended dry periods, this may not be sufficient to adequately control fugitive dust. In the event of an extended dry period, water will be applied to the area in the immediate vicinity of the excavation area.

C. Hauling Operations:

Haul trucks hauling from the Site during haul events will be covered with tarps to reduce wind-blown dust. In addition, haul trucks traveling throughout the Site are required to limit their speed to 15 mph or less which contributes to the reduction of fugitive dust emissions.