January 14, 2014

Ms. Kristina Handt
City of Scandia
14727 209th St N
Scandia, MN 55073

Re: Dust Emissions Monitoring – Zavoral Mine
Project #4055-002

INTRODUCTION:

This report presents the results of the recent air monitoring for potential fugitive dust and diesel exhaust emissions conducted by Indoor Environment Group, Inc. (IEG) in regard to mining operations at the Zavoral Mine in Scandia, Minnesota. Sampling was conducted on December 15 & 17, 2013.

The scope of our monitoring service was limited to the collection of respirable silica samples, nitrogen dioxide samples, diesel particulate matter samples and real time dust level monitoring from multiple locations adjacent to the mine and along the haul route. Services were performed in order to assess airborne emissions and potential environmental release related to the loading and hauling operations.

EXECUTIVE SUMMARY:

Monitoring activities assessed the levels of two categories of airborne particulates; respirable dust and $PM_{2.5}$ as well as two potential aerosol emissions; nitrogen dioxide and diesel particulate matter.

The Environmental Protection Agency currently sets standards based on two categories of particulate matter (PM), "PM_{10}" and "$PM_{2.5}$." PM10 is matter 10 micrometers in diameter or less and is defined as inhalable course particles. The EPA defines PM2.5 as fine particle pollution and includes any particle that is 2.5 micrometers in diameter or smaller.

The Occupational Health and Safety Administration (OSHA) rules, as well as current guidelines from the National Institute for Occupational Safety and Health (NIOSH) focus on "respirable dust" levels. Respirable dust is considered any airborne particulate less than 4.0µ in diameter.

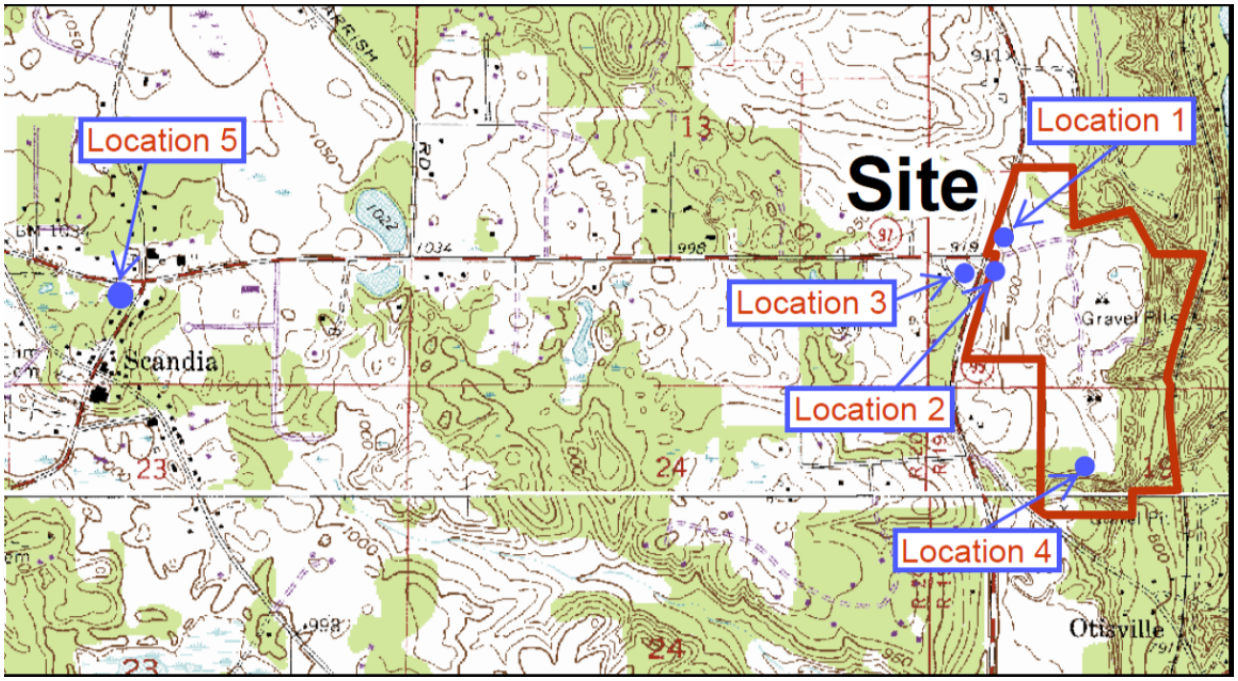
Our monitoring activities were designed to evaluate the dust levels within two of these categories. The air monitoring strategy employed utilized real-time monitors for $PM_{2.5}$ (2.5µ) particulate and standard laboratory based exposure monitoring procedures to evaluate the respirable dust (4µ) levels. Dust sampling procedures were also designed to evaluate airborne crystalline silica levels.

Exhaust emissions monitoring was performed to determine the impact of loading and hauling equipment. Specifically, nitrogen dioxide and diesel particulate matter were selected as they are the most likely compounds released in a measurable quantity during these operations.

Monitoring activities were conducted at 5 locations including one upwind location for comparison purposes. All air sampling was conducted at a uniform vertical height of 5 feet using a tripod or existing structures. Day 1 (December 15, 2013) sampling was performed on a day with no mine activity while Day 2 (December 17, 2013) was performed during normal mining activities.

Sampling was performed at five locations. Locations were selected based on prevailing wind direction at the site. The sample locations are identified as follows:

Location #1: Upwind edge of the mine
Location #2: Downwind edge of mine entrance
Location #3: Downwind of first acceleration zone on haul route
Location #4: Downwind edge of mine site
Location #5: Downwind at intersection of Highway 97 and Highway 3



Maps of the sampling locations are also provided in the attachments.

Findings:

Sample results for the current monitoring event can be summarized as follows:

- Respirable Dust: Below detectable levels
- Respirable Silica: Below detectable levels
- Particulate Monitoring (PM 2.5): Below EPA standards
- Diesel Particulate Matter: Below detectable levels
- Nitrogen Dioxide: Below detectable levels

Based on all sampling performed at the site, the best available research and current regulatory

guidelines and recommendations, it is our opinion that these operations currently pose no threat to public health or the environment. Additional information regarding the sample procedures, results and findings can be found in the following sections of this report.

METHODOLOGY:

Respirable Dust Sampling

The respirable silica samples were collected using portable sampling pumps and SKC aluminum cyclones fitted with 37mm filter cassettes loaded with PVC filters. The cyclones are designed to isolate respirable aerosols and provide a particle cut-off at 4 µm. This is specified as a 50 percent cut-off at 4 µm. After collection the cassettes were sealed and submitted to Galson Laboratories of East Syracuse, New York for analysis.

Samples were analyzed according to NIOSH method 0600/7500; mod OSHA ID-142. The limit for detection for respirable dust was 0.10 mg. The qualitative level of detection for crystalline silica was 0.010 mg. All quality control results associated with the samples were within established control limits.

Dust Monitoring – PM 2.5

Real-time dust monitoring was performed using four TSI DustTrak 8520 Aerosol Monitors with environmental enclosures. At each location the monitors were fitted with a PM 2.5 impactor.

Monitors were zero calibrated at the beginning of each sampling period. Sampling periods corresponded with the respirable dust sampling activities. Monitors were set to collect data every 30 seconds. All data was downloaded at the completion of daily monitoring.

Diesel Particulates

The monitoring for Diesel Exhaust (elemental carbon) was conducted using open-faced 37mm quartz fiber filter cassettes. The filter cassette is connected to a portable sampling pump with flexible vacuum tubing. The recommended flow rate is 2-4 liters per minute with a sample volume between 140 and 19,000 liters. After collection the filter cassette is capped and submitted to the laboratory for analysis. Laboratory analysis was performed by Galson Laboratories.

The analysis method for diesel exhaust is based on the new American Conference of Governmental Industrial Hygienists (ACGIH) proposed Threshold Limit Value (TLV®) for diesel particulates, which under the new method are measured as elemental carbon. The elemental carbon samples collected on the quartz filters are analyzed according to NIOSH Method 5040.

Nitrogen Dioxide

The monitoring for Nitrogen Dioxide was conducted using UMEX 200 Passive Samplers (SKC 500-200). The monitors clip to the sampling stand and the media is exposed for the duration of the sampling period. After collection the sampler is closed and contained in an airtight transport container and submitted to the Galson Laboratories for ion chromotography analysis.

RESULTS:

Sample results for all monitoring activities are summarized in the following tables. A complete copy of the laboratory report prepared by Galson Laboratories is provided in Appendix A.

TABLE 1
RESPIRABLE DUST SAMPLE RESULTS

Sample #	Location	Date	Sample Type	OSHA PEL/ ACGIH TLV*	Result
RD1-01	Site 1	12/17/13	Respirable Dust	5.0 mg/m^3 3.0 mg/m^3	<0.047 mg/m^3
RD2-01	Site 2	12/17/13	Respirable Dust	5.0 mg/m^3 3.0 mg/m^3	<0.047 mg/m^3
RD3-01	Site 3	12/17/13	Respirable Dust	5.0 mg/m^3 3.0 mg/m^3	<0.048 mg/m^3
RD4-01	Site 4	12/17/13	Respirable Dust	5.0 mg/m^3 3.0 mg/m^3	<0.047 mg/m^3
RD5-01	Site 5	12/17/13	Respirable Dust	5.0 mg/m^3 3.0 mg/m^3	<0.048 mg/m^3

mg/m^3 = micrograms per cubic meter
< = use of the "less than" sign followed by a number (e.g. 0.020) indicates that result of the laboratory analysis was less than the Method Detection Limit.
OSHA PEL = Occupational Safety and Health Administrations current Permissible Exposure Limit
ACGIH TLV = American Conference of Governmental Industrial Hygienists threshold limit value

TABLE 2
RESPIRABLE SILICA SAMPLE RESULTS

Sample #	Location	Date	Sample Type	OSHA PEL/ ACGIH TLV	Result
RD1-01	Site 1	12/17/13	Respirable Silica Crystalline Quartz	0.098 mg/m^3 0.025 mg/m^3	<0.0093 mg/m^3 (none detected)
RD2-01	Site 2	12/17/13	Respirable Silica Crystalline Quartz	0.098 mg/m^3 0.025 mg/m^3	<0.0094 mg/m^3 (none detected)
RD3-01	Site 3	12/17/13	Respirable Silica Crystalline Quartz	0.098 mg/m^3 0.025 mg/m^3	<0.0096 mg/m^3 (none detected)
RD4-01	Site 4	12/17/13	Respirable Silica Crystalline Quartz	0.098 mg/m^3 0.025 mg/m^3	<0.048 mg/m^3 (none detected)
RD5-01	Site 5	12/17/13	Respirable Silica Crystalline Quartz	0.098 mg/m^3 0.025 mg/m^3	<0.047 mg/m^3 (none detected)

mg/m^3 = micrograms per cubic meter
< = use of the "less than" sign followed by a number (e.g. 0.020) indicates that result of the laboratory analysis was less than the Method Detection Limit.
OSHA PEL = Occupational Safety and Health Administrations current Permissible Exposure Limit
ACGIH TLV = American Conference of Governmental Industrial Hygienists threshold limit value

TABLE 3
DIESEL PARTICULATE MATTER SAMPLES

Sample #	Location	Exposure Limit*	Results	Notes
DP1-01	Site 1	20.0 µg/m^3	<3 µg/m^3 elemental 18 µg/m^3 total	Below ACGHI recommendations
DP2-01	Site 2	20.0 µg/m^3	<3 µg/m^3 elemental 17 µg/m^3 total	Below ACGHI recommendations
DP3-01	Site 3	20.0 µg/m^3	<3 µg/m^3 elemental 14 µg/m^3 total	Below ACGHI recommendations
DP4-01	Site 4	20.0 µg/m^3	<3 µg/m^3 elemental 16 µg/m^3 total	Below ACGHI recommendations
DP5-01	Site 5	20.0 µg/m^3	<3 µg/m^3 elemental 15 µg/m^3 total	Below ACGHI recommendations

* Proposed ACGIH Threshold Limit Value (TLV®) for diesel particulates measured as elemental carbon

TABLE 4
NITROGEN DIOXIDE SAMPLES

Sample #	Location	OSHA PEL/ ACGIH TLV	Results	Notes
NO1-01	Site 1	5 ppm 0.2 ppm	<0.03 ppm	-
NO2-01	Site 2	5 ppm 0.2 ppm	<0.03 ppm	-
NO3-01	Site 3	5 ppm 0.2 ppm	-	Sampler malfunction
NO4-01	Site 4	5 ppm 0.2 ppm	<0.03 ppm	-
N5-01	Site 5	5 ppm 0.2 ppm	<0.03 ppm	-

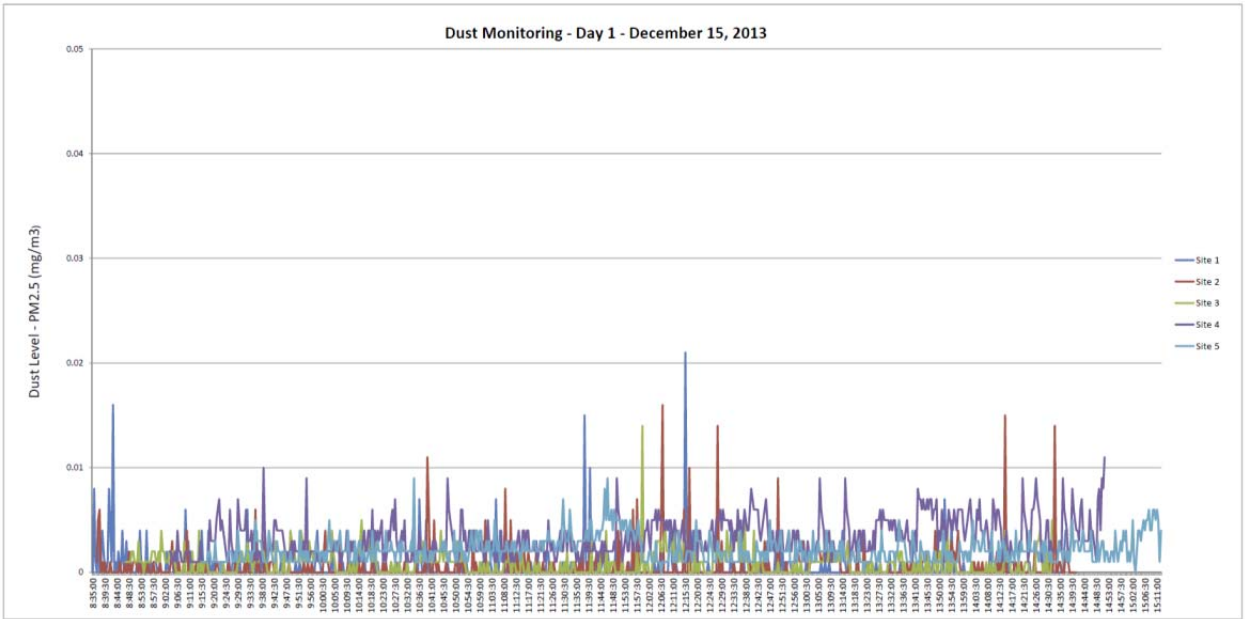
OSHA PEL = Occupational Safety and Health Administrations current Permissible Exposure Limit
ACGIH TLV = American Conference of Governmental Industrial Hygienists threshold limit value

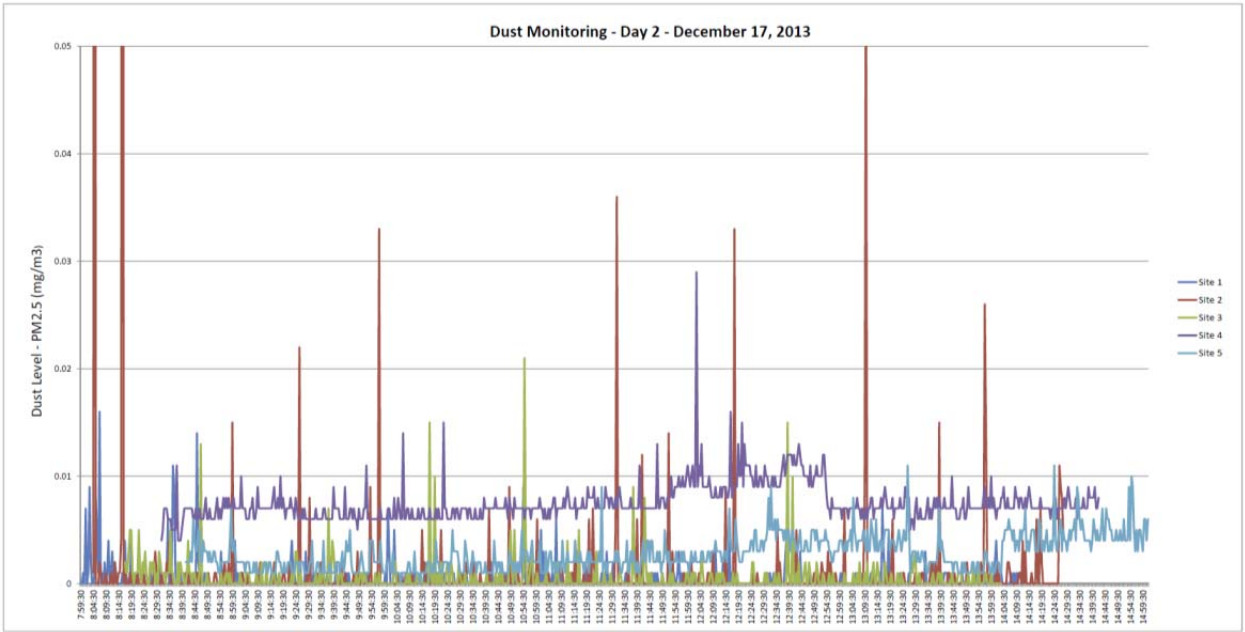
TABLE 5
PARTICULATE TESTING RESULTS

Date	Particle Size	Location	Low	High	Average	EPA Standard*
Day 1 12/15/13	2.5 µ	Site 1	0.000 mg/m^3	0.021 mg/m^3	0.001 mg/m^3	0.012 mg/m^3 0.035 mg/m^3
		Site 2	0.000 mg/m^3	0.016 mg/m^3	0.001 mg/m^3	0.012 mg/m^3 0.035 mg/m^3
		Site 3	0.000 mg/m^3	0.014 mg/m^3	0.001 mg/m^3	0.012 mg/m^3 0.035 mg/m^3
		Site 4	0.001 mg/m^3	0.011 mg/m^3	0.003 mg/m^3	0.012 mg/m^3 0.035 mg/m^3
		Site 5	0.000 mg/m^3	0.009 mg/m^3	0.002 mg/m^3	0.012 mg/m^3 0.035 mg/m^3
Day 2 12/17/13	2.5 µ	Site 1	0.000 mg/m^3	0.016 mg/m^3	0.001 mg/m^3	0.012 mg/m^3 0.035 mg/m^3
		Site 2	0.000 mg/m^3	0.231 mg/m^3	0.001 mg/m^3	0.012 mg/m^3 0.035 mg/m^3
		Site 3	0.000 mg/m^3	0.021 mg/m^3	0.001 mg/m^3	0.012 mg/m^3 0.035 mg/m^3
		Site 4	0.000 mg/m^3	0.029 mg/m^3	0.006 mg/m^3	0.012 mg/m^3 0.035 mg/m^3
		Site 5	0.000 mg/m^3	0.011 mg/m^3	0.001 mg/m^3	0.012 mg/m^3 0.035 mg/m^3

*The EPA standard for $PM_{2.5}$ of 0.012 mg/m^3 is the primary standard and is an annual mean averaged over three years. The daily (24 hour) standard 0.035 mg/m^3.

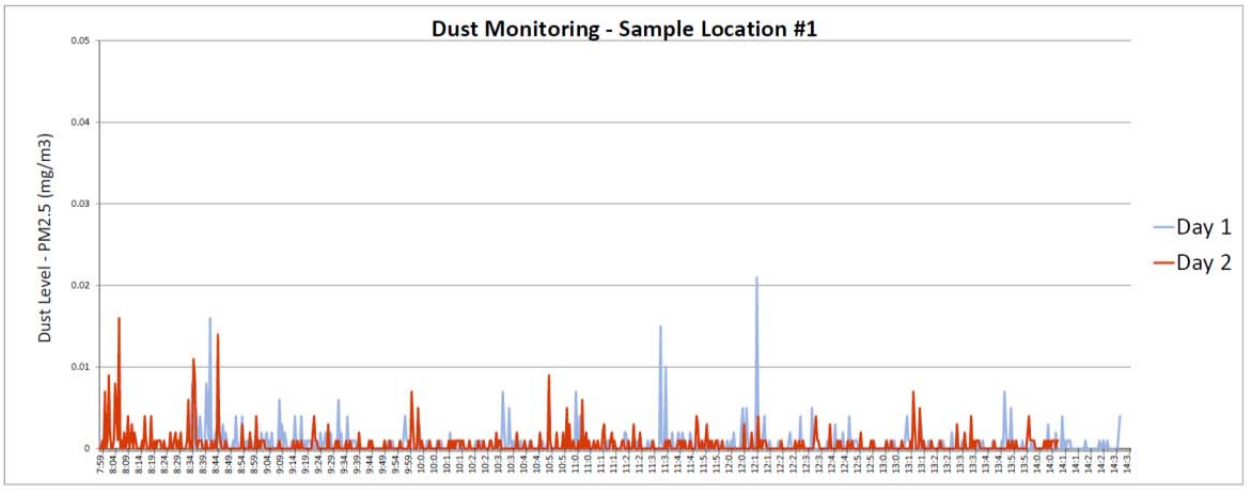
Particulate Monitoring Summary by day:

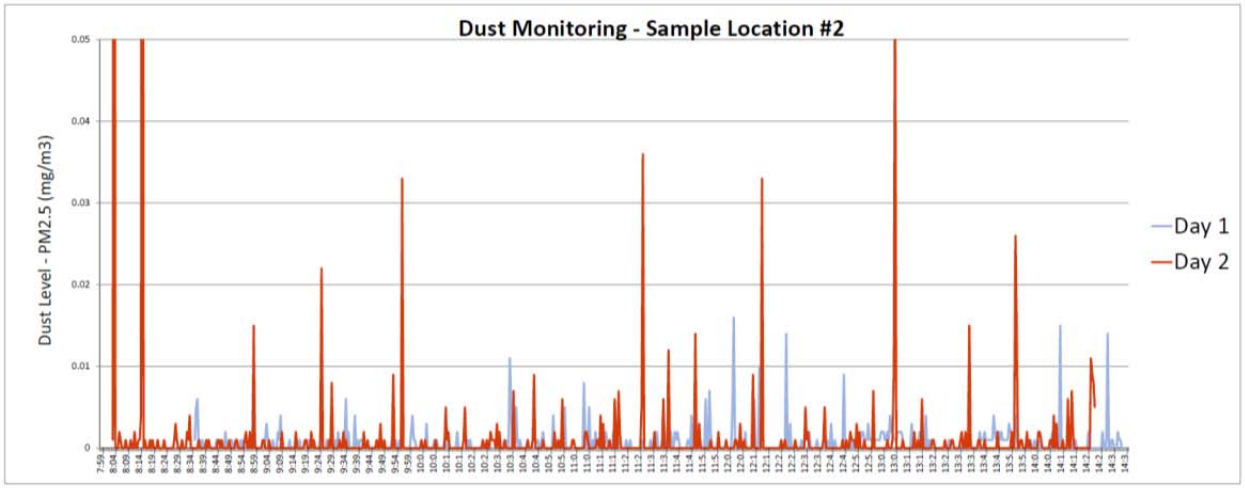


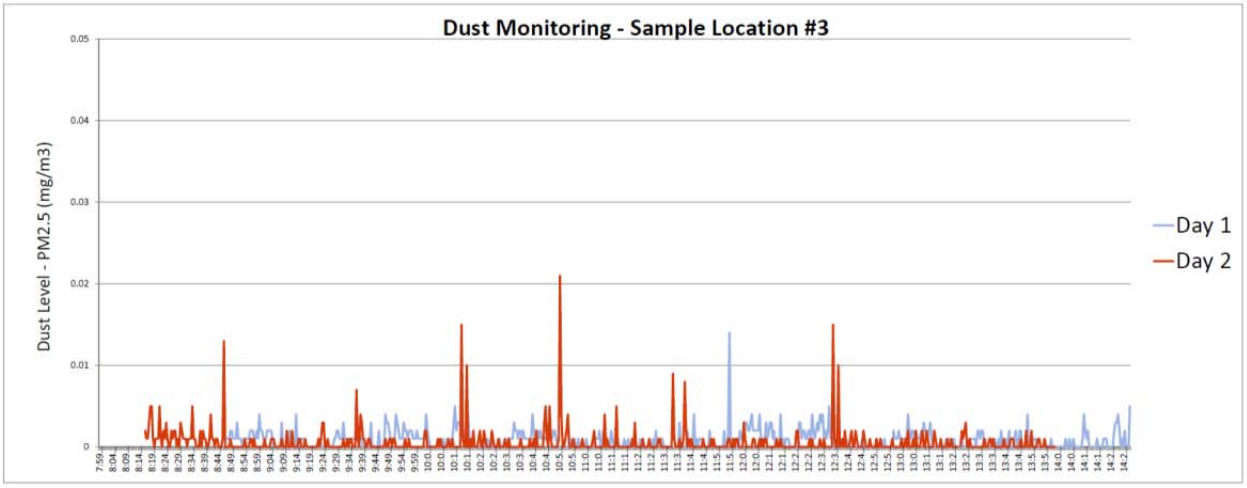


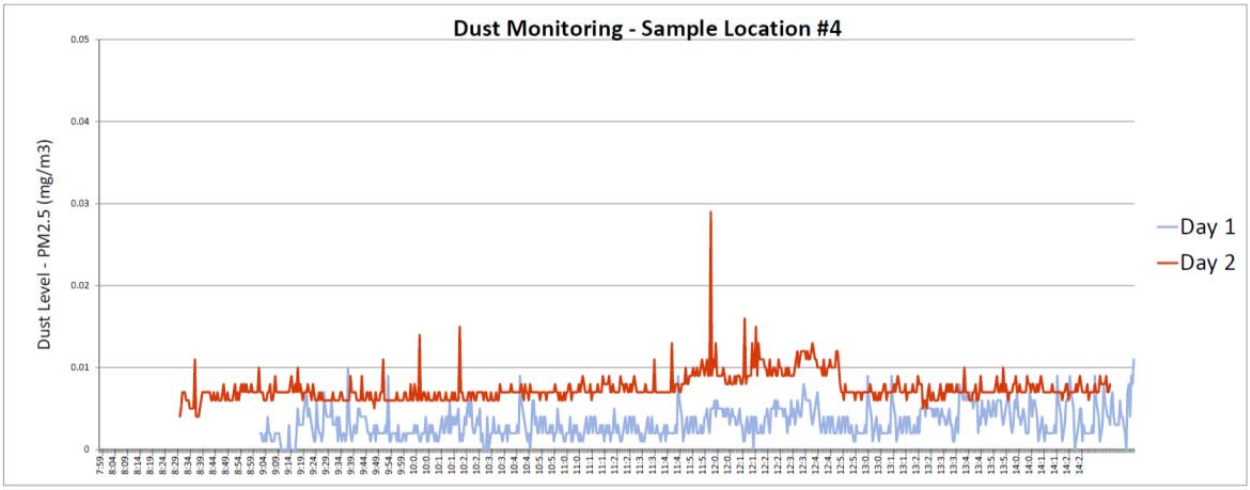
Full sized tables have been included as attachments.

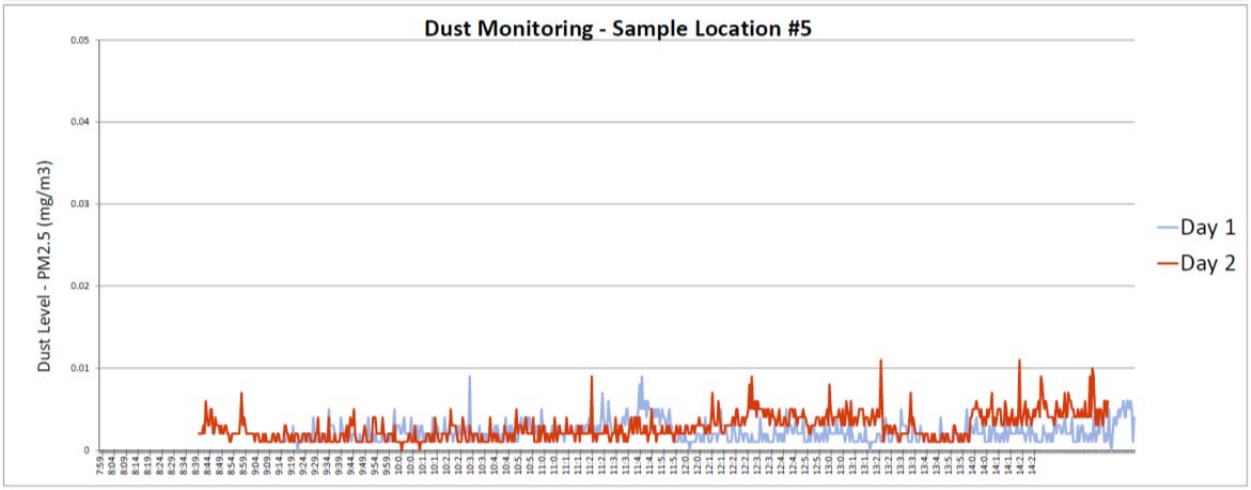
Particulate Monitoring Summaries by Site:











Full sized tables have been included as attachments.

DISCUSSION:

Respirable dust, respirable quartz silica, airborne particulate levels, nitrogen dioxide and diesel particulate matter were tested on two non-consecutive days in areas at or adjacent to the Zavoral Mine in Scandia, Minnesota to evaluate fugitive dust emissions and air quality impact.

Sampling stations were established at five locations based on the wind direction at the time of sampling. One station was located upwind of the mine and the remaining four were located at likely dust release locations on or near the mine or along the haul route.

Sampling was performed on two days; Day 1 (12/15/13) was a day with no activity at the mine and Day 2 (12/17/13) was during normal mining, loading and hauling activities.

Activities witnessed on both days included mining, stockpiling and loading activities within the mine as well as transportation of the material to a processing facility. Based on discussions with mine personnel, the activities performed were very consistent with the normal operations at the site on weekdays.

Respirable Dust

A total of 5 respirable dust samples were collected on Day 2 during mining operations. All respirable dust samples were found to be below the OSHA PEL of 5 mg/m^3, the current ACGIH threshold limit value of 3 mg/m^3 and the NIOSH REL of 0.05 mg/m^3 at the time of testing.

Respirable Quartz Silica

Each respirable dust sample was submitted for additional analysis to determine the level of respirable silica.

No detectable levels of crystalline quartz silica were found on any of the respirable silica dust samples. Accordingly, all respirable silica samples were found to be below the OSHA PEL of 0.098 mg/m^3 (assuming 100% silica), the NIOSH recommended exposure limit of 0.05 mg/m^3 the current ACGIH threshold limit value of 0.025 mg/m^3 at the time of testing.

The actual OSHA PEL for these samples would be 5 mg/m^3 since no silica was detected during the qualitative analysis.

Airborne Particulates

Particulate levels were determined using five TSI DustTrak 8520 Aerosol Monitors with environmental enclosures. One monitor was place immediately upwind of the loading operations and other four monitors located at downwind sites. At each location the monitor was fitted with a PM 2.5 impactor.

$PM_{2.5}$ levels ranged from 0.000 mg/cm^2 to 0.231 mg/cm^2 over the two days of sampling. In general, downwind samples showed only a slight increase as compared to the upwind sample. A few spikes were detected on the downwind sample at the mine entrance and may have coincided with road cleaning operations.

Averages at each location on the active mining day were all well below the EPA National Ambient Air Quality Standards and were only marginally higher than the averages on Day 1 (non active day). The average $PM_{2.5}$ levels were between 0.0006 mg/m^3 and 0.0033 mg/m^3 during no activity and between 0.0005 mg/m^3 and 0.0075 mg/m^3 during mining operations.

The highest sustained dust levels were detected downwind from the mine site, on the southern edge of operations. Levels detected at that location on Day 2 (active mining) ranged from 0.004 mg/m^3 and 0.029 mg/m^3 with an average level of 0.0075 mg/m^3. The average level on Day 1 was 0.0033 mg/m^3. The slightly higher ambient level at this site was likely due to the location which was subject to more wind than the other locations and immediately adjacent to recently opened ground.

For daily monitoring such as was performed during this sampling activity we normally compare the results to the EPA's National Ambient Air Quality Standards, specifically those levels regarding daily averages. Current EPA daily average standard for $PM_{2.5}$ is 0.035 mg/m^3 (35 µg/m^3). Airborne levels detected at the site were significantly below this standard.

Diesel Particulate Matter

Diesel particulate matter (DPM) samples were collected at each location to determine if hauling activities were significantly impacting air quality levels along the haul route. The results at each location were found to be well below ACGIH recommendations indicating that hauling activities were having little impact on the quality of air at the time of sampling. Total carbon levels ranged from 14 $\mu g/m^3$ to 18 $\mu g/m^3$ while the more important Elemental Carbon levels were all below the level of detection (<3 $\mu g/m^3$).

There are no legal exposure limits for diesel particulate matter (DPM) in general occupational settings in the USA. The first DPM exposure limit of 0.15 mg/m^3 was proposed by ACGIH in its 1995-1996 NIC. It was later lowered to 0.05 mg/m^3 (as total diesel particulate matter). In its 2001 NIC, the ACGIH replaced it with a practically equivalent TLV of 0.02 mg/m^3 as elemental carbon (the EC fraction typically constitutes about 40% of the total diesel particulate mass), but the DPM listing was withdrawn in 2003. The current recommendations range from 0.02 mg/m^3 to 0.1 mg/m^3 from various organizations. We have listed the most recent ACGIH proposal of 0.02 mg/m^3 (20 µg/m3) as the exposure limit for the results table as this is the most stringent. However, very little health data is available to support this lower threshold.

Nitrogen Dioxide

Nitrogen dioxide is another indicator contaminant found in conjunction with diesel exhaust and was, for the reason, sampled at each location to detect any impact on local air quality. All samples were found to be below the level of detection (<3 $\mu g/m^3$).

SUMMARY:

The sampling performed during this monitoring session confirmed that current mining and hauling operations are having little or no impact on local air quality levels. Based on our findings we feel that the current Dust Control Plan is effectively keeping dust and exhaust emissions to a minimum.

This sampling activity was performed in December so environmental conditions are dramatically different than those that will be present in the summer months. For that reason, compliance with the Dust Control Plan should monitored on a continual basis and additional sampling should be performed during a hot, dry period to identify the worst case levels.

RECOMMENDATIONS:

Based on the findings of this sampling activity, Indoor Environment Group, Inc. recommends the following activities:

1. Complete another dust sampling activity during the summer months

2. Continue monthly dust control site review (AOP Item 12)

3. Maintain compliance with the current Dust Control Plan

We did not find any reason to recommend any changes to the current Dust Control Plan at this time. However, given that exhaust emissions monitoring results were undetectable and that is unlikely that these levels would be higher in the summer months we would recommend removing diesel particulate matter and nitrogen dioxide monitoring from future sampling activities.

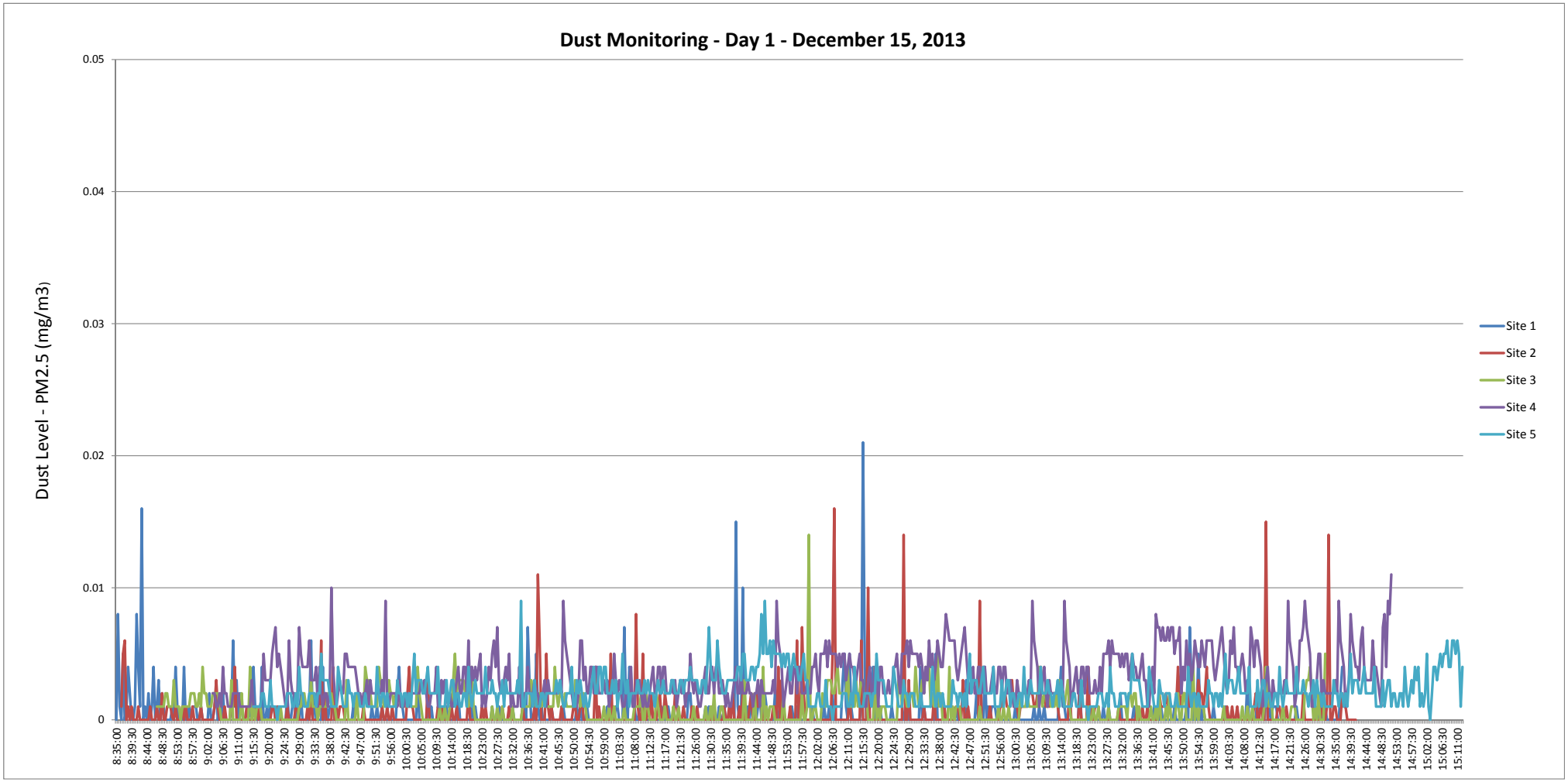
REMARKS:

The environmental services provided by Indoor Environment Group's industrial hygienists, technicians, analysts and project managers for this project have been conducted in a manner consistent with the degree of care and technical skill exercised by environmental professionals currently practicing in this area under similar budget and time constraints.

Recommendations contained in this report represent our professional judgment at the time the project was performed.

This concludes our report. Any questions regarding the fieldwork, sample results or presented findings should be directed to Indoor Environment Group, Inc.

Dave Gutterud
Director of Operations


Dust Monitoring - Day 1 - December 15, 2013
Dust Level - PM2.5 (mg/m3)
0.05
0.04
0.03
0.02
0.01
0
Site 1
Site 2
Site 3
Site 4
Site 5
8:35:00
8:39:30
8:44:00
8:48:30
8:53:00
8:57:30
9:02:00
9:06:30
9:11:00
9:15:30
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9:29:00
9:33:30
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14:17:00
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14:26:00
14:30:30
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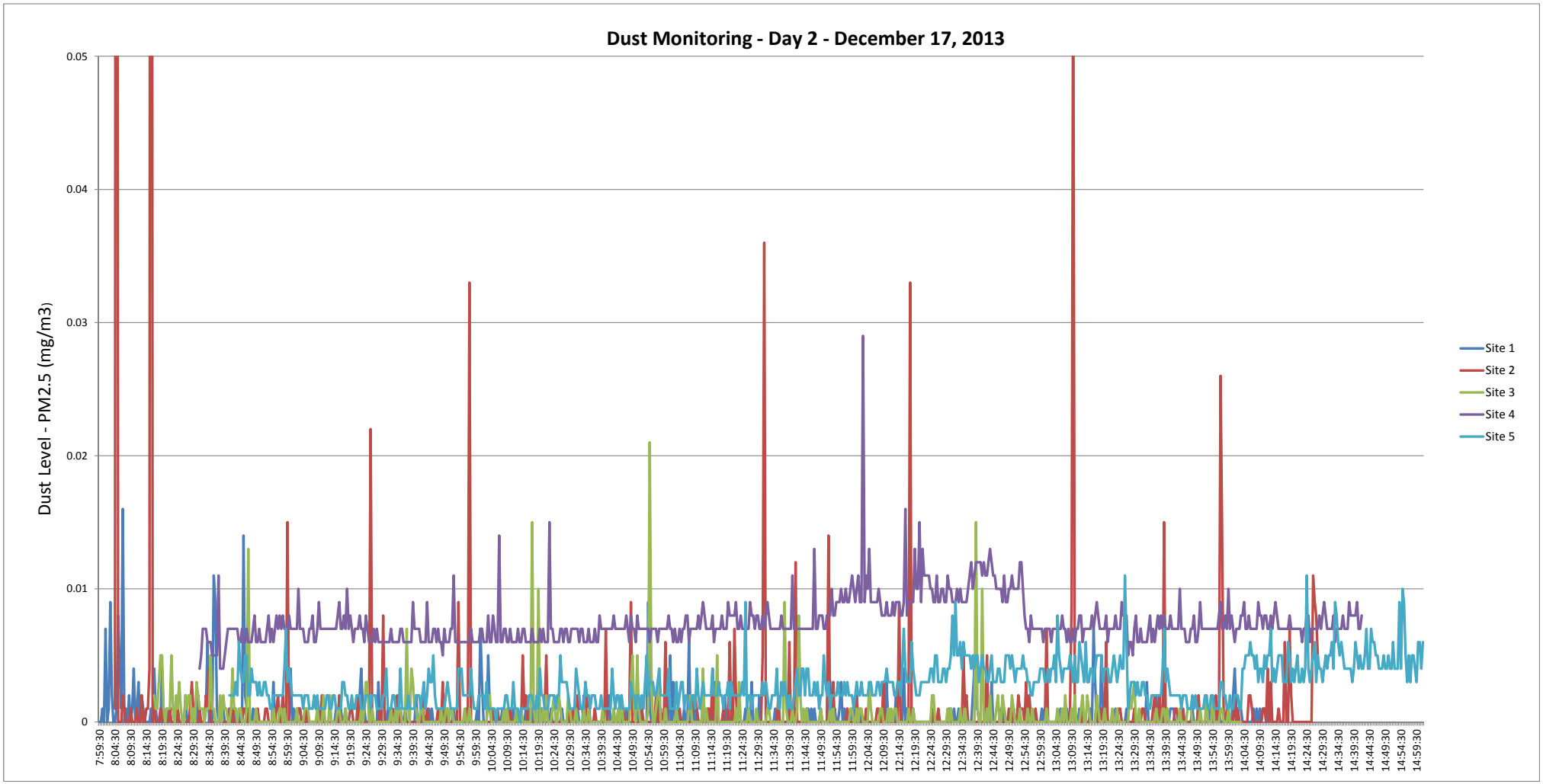
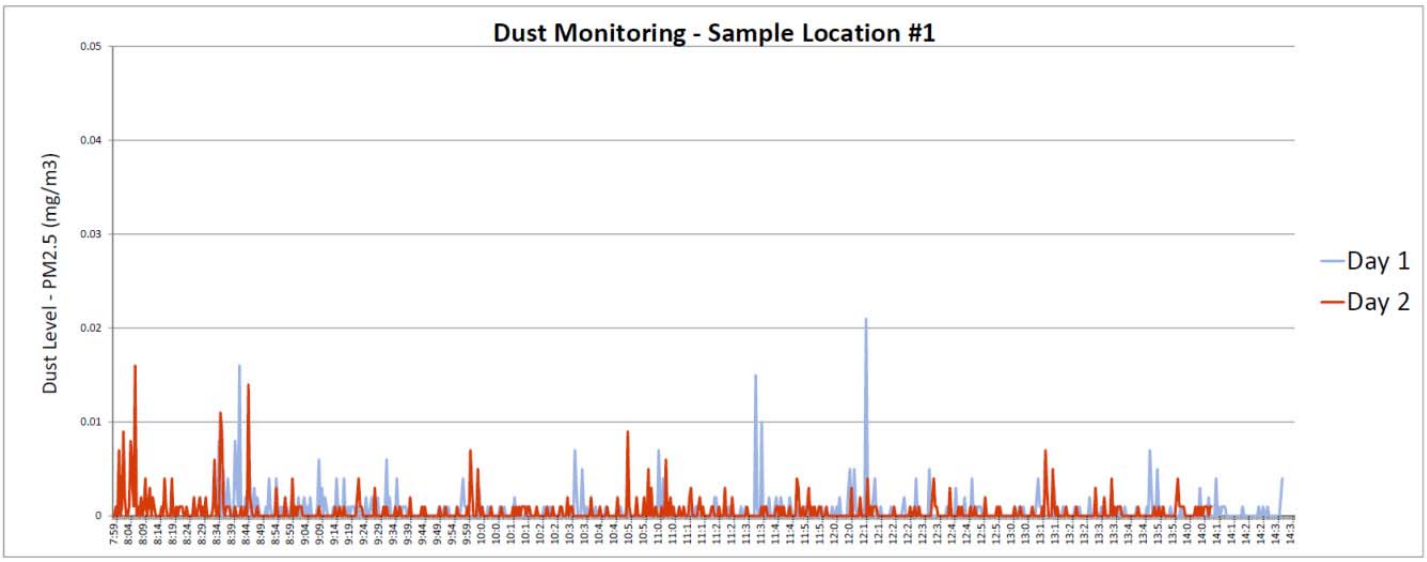
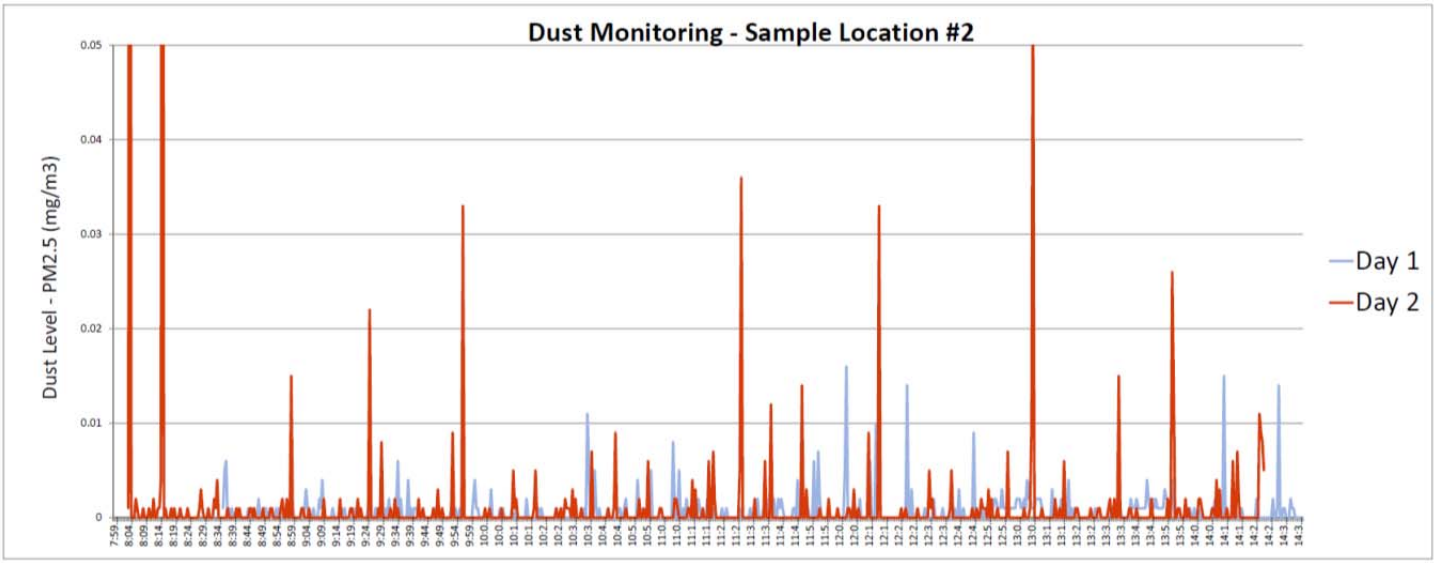
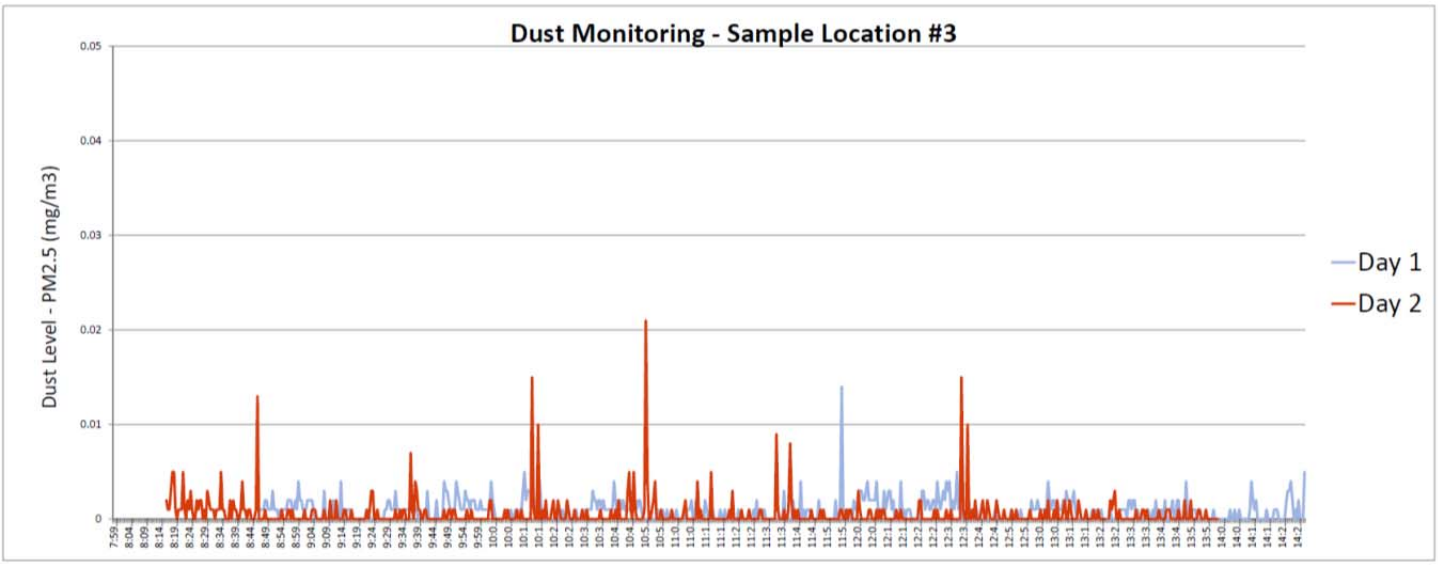
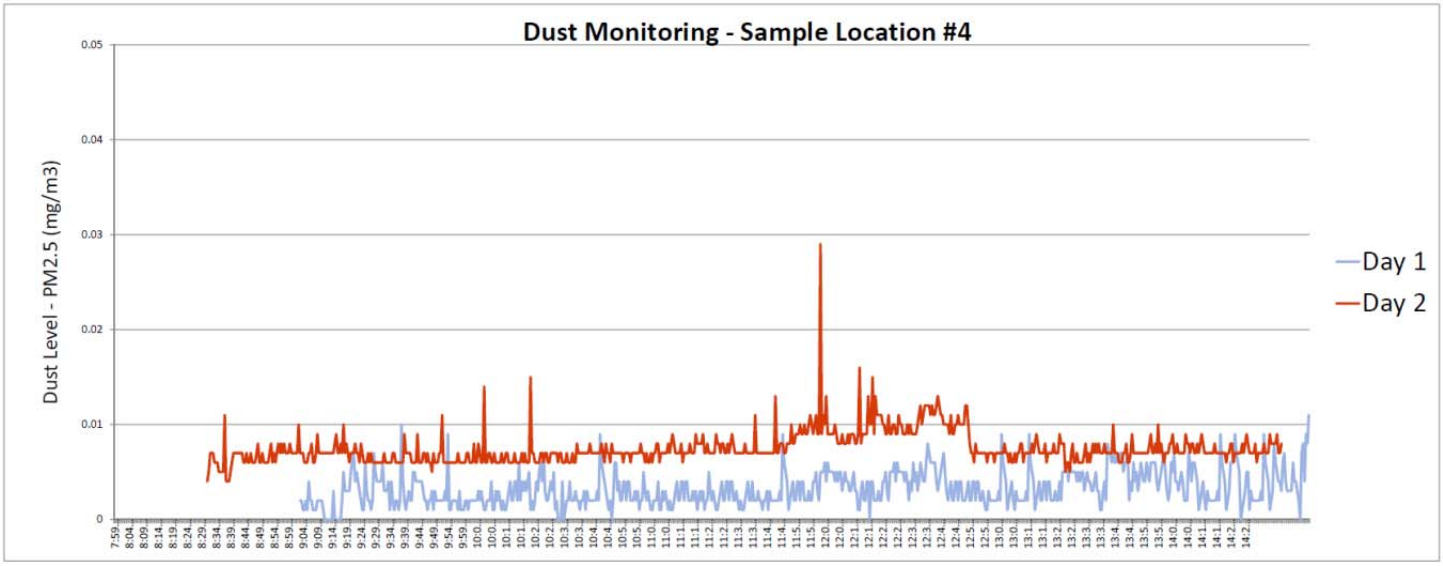
15:11:00

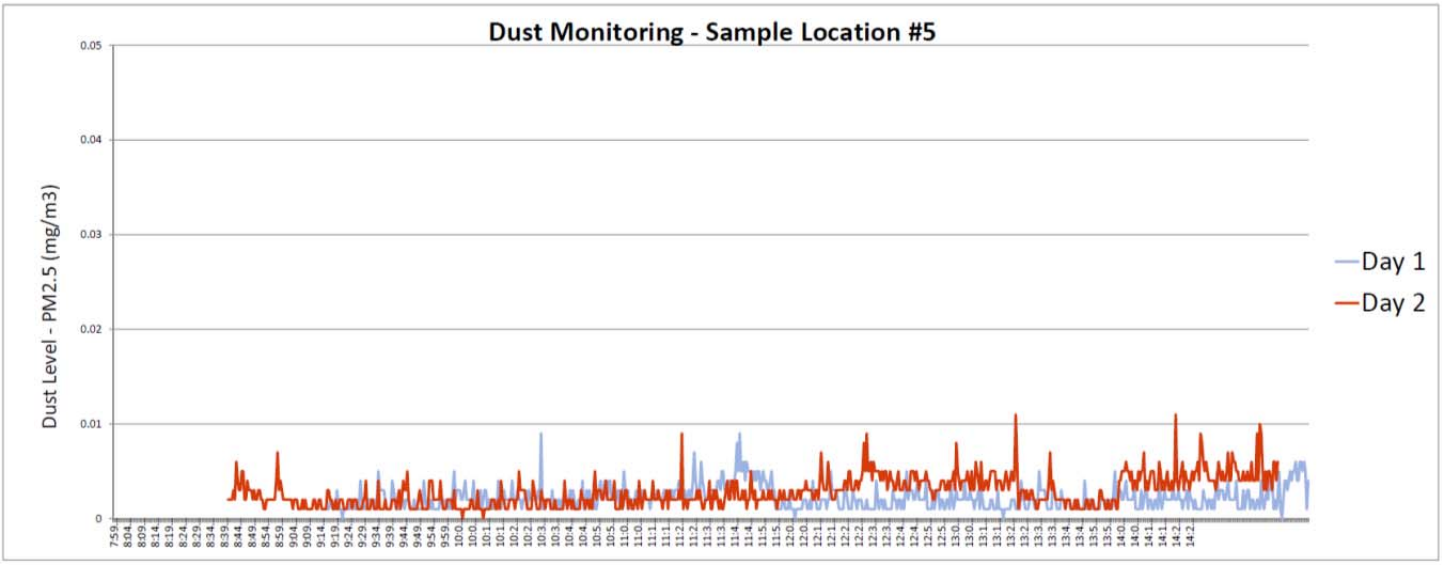

Dust Monitoring - Day 2 - December 17, 2013
Dust Level - PM2.5 (mg/m3)
0.05
0.04
0.03
0.02
0.01
0
Site 1
Site 2
Site 3
Site 4
Site 5


Dust Monitoring - Sample Location #1
Dust Level - PM2.5 (mg/m3)
Day 1
Day 2


Dust Monitoring - Sample Location #2
Dust Level - PM2.5 (mg/m3)
Day 1
Day 2

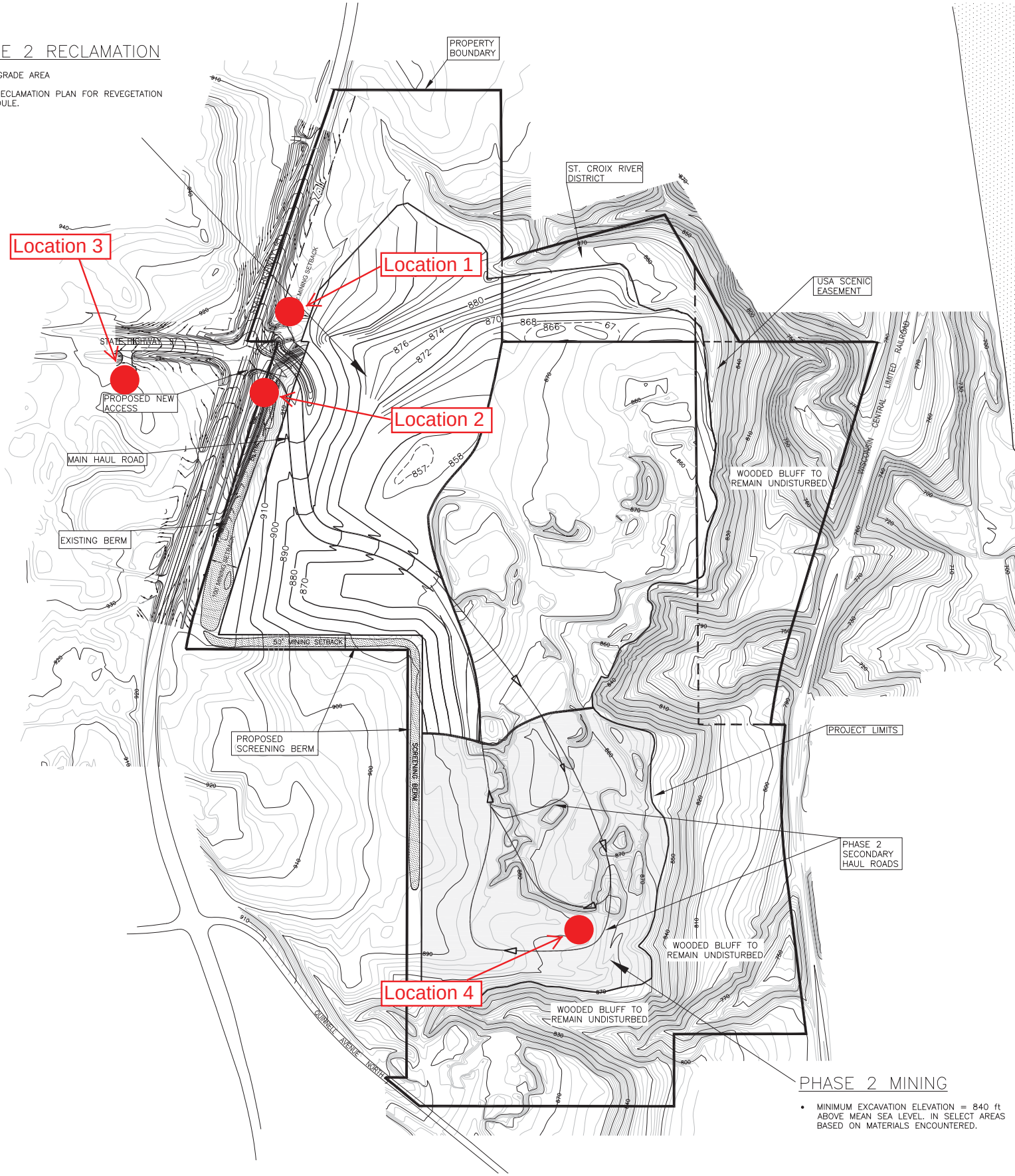

Dust Monitoring - Sample Location #3
Dust Level - PM2.5 (mg/m3)
Day 1
Day 2


Dust Monitoring - Sample Location #4
Dust Level - PM2.5 (mg/m3)
0.05
0.04
0.03
0.02
0.01
0
Day 1
Day 2


Dust Monitoring - Sample Location #5
Dust Level - PM2.5 (mg/m3)
0.05
0.04
0.03
0.02
0.01
0
Day 1
Day 2

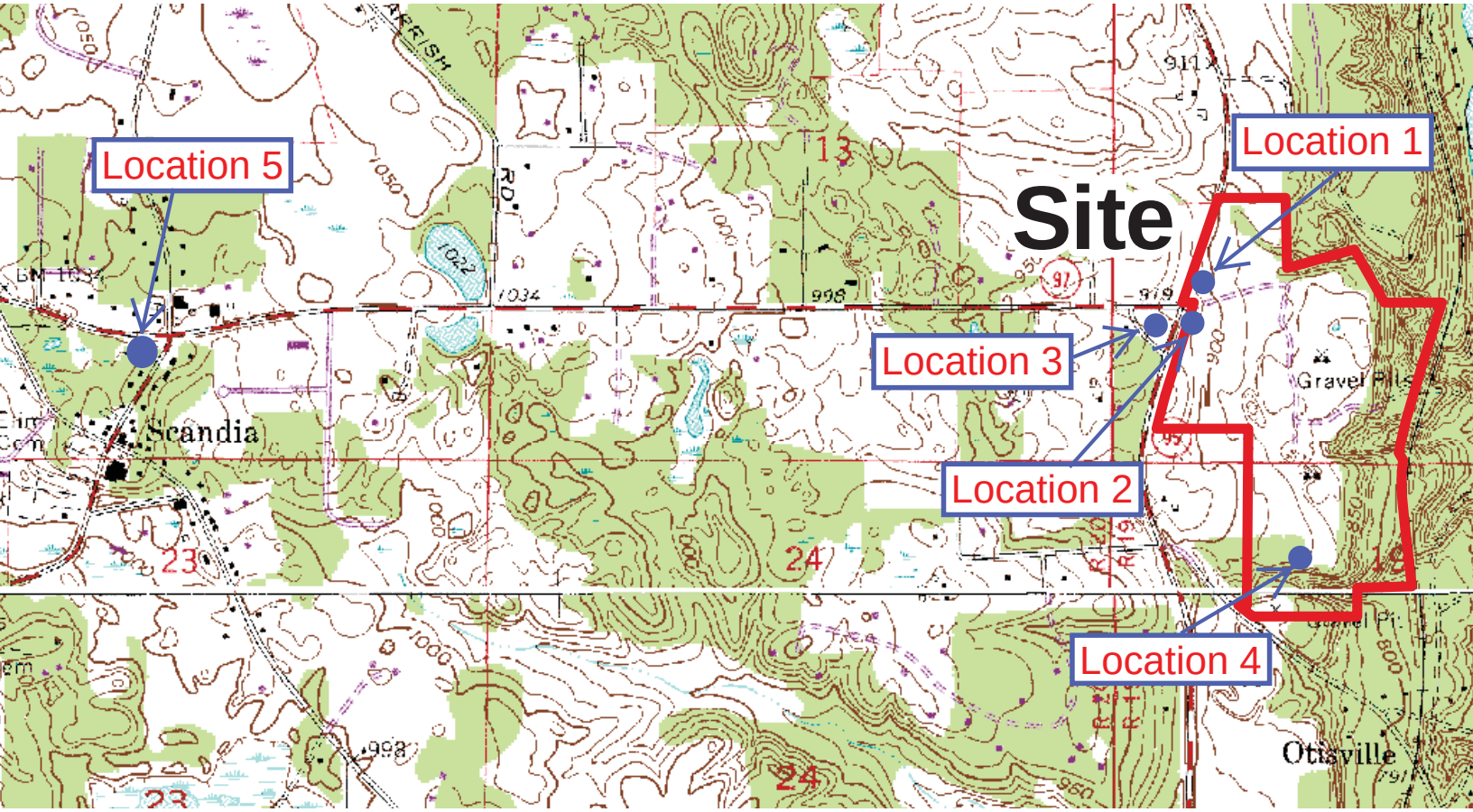
PHASE 2 RECLAMATION

- 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.


Location 5
Site
Location 1
Location 3
Location 2
Location 4
Scandia
Gravel Pits
Otisville
13
23
24
19