Ministry of the Environment
Ministère de l'Environnement

Ontario

Report of a Provincial Officer

Air Quality Impacts of Unimin Ltd. on Kasshabog Lake near the Town of Havelock, Ontario

February 15, 2013

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Executive Summary

The Eastern Regional Air Quality Unit was tasked to study the air quality impacts of Unimin Ltd. Nephton and Blue Mountain operations upon the Kasshabog Lake area near Havelock, Ontario. The Peterborough District Office of the Ministry has received numerous complaints about soiling and visibility impacts which have been attributed to the facility operations. Equipment was deployed by the Regional Air Quality Unit (AQ) at the homes of two of the complainants. Continuous particulate readings were collected from May 24, 2012 until November 1, 2012. The original survey intent was to attempt to corroborate citizen complaints with analytical data in support of the Ministry's compliance activities. Elevated episodes of inhalable and respirable particulates were also found, and this prompted discussions with the local Medical Officer of Health. Ontario does not have scheduled standards for the smallest fractions of particles that have been observed. Discussions were undertaken with the Medical Officer of Health (MOH) and this data summary was prepared to assist public health officials in their assessment.

The air quality impacts of the Unimin facilities are being considered in context of the ***Environmental Protection Act of Ontario, RSO 1990 (EPA)*** general provisions and Ontario Regulation 419/05 (Local Air Quality], pursuant to the EPA, as amended from time to time. The Regulation will be referred to as O.Reg419.

Unimin is required by Ontario Regulation 419/05 (Local Air Quality) Section 20, schedule 3, to ensure that their suspended particulate emissions do not result in concentrations in excess of 120 micrograms per cubic meter in a 24 hour average period. Unimin undertook a voluntary monitoring program concurrently with this study. Those results demonstrated compliance with the Schedule 3 limit. Data collected by the Air Quality Unit also showed compliance with that limit based on rolling average computation of 1-minute data.

The one-minute data shows excursion values of particulate that approach values typically seen in occupational exposures. These excursion values may pose a hazard not fully contemplated in the schedules of Regulation 419, and may constitute a unique situation requiring the considerations of Section 14, ***Environmental Protection Act of Ontario, RSO 1990 (EPA).*** Part III, section 45 of Regulation 419/05 is also applicable in this situation.

The operations at Unimin are resulting in elevated levels of PM 10, PM 2.5, and PM 1.0 that approach or exceed levels of concern in several jurisdictions. The local Medical Officer of Health has expressed concern in this regard. A Medical Doctor has provided a letter outlining health concerns attributed to the air quality in the vicinity.

Elevated short-term suspended particulate levels are consistent with surface soiling events reported by local citizens. These excursion events rationalize and explain the deposition observed despite the 24-hour compliance that is demonstrated.

Visual observations, photographs, instrument readings, and microscopic analysis of dusts collected demonstrate consistent evidence that the operations at Unimin are adversely affecting the study area.

I conclude:

- Unimin is the source of contaminants that are being released to the atmosphere in an amount and manner that is causing the following adverse effects, contrary to the general provisions of the ***Environmental Protection Act of Ontario, RSO 1990*** (EPA) , Section 14:

    a) impairment of the quality of the natural environment for any use that can be made of it,

    (b) damage to property,

    (c) harm or material discomfort to any person,

    (d) loss of enjoyment of normal use of property.

- The facility operations are the source of contaminants whose observed deposition results in violations of the limits contained in schedule 2 of Ontario Regulation 419/05 (Local Air Quality) for Dustfall.
- Unimin is the source of contaminants that are being released to the atmosphere in an amount and manner that is in violation of Part III, section 45 of Ontario Regulation 419/05 (Local Air Quality)

Overview

Regional AQ staff interviewed the complainants who allowed instrumentation to be deployed on their properties. Accounts of soiling, visibility impairment, and loss of enjoyment of their homes were noted. Provincial Officer Paul Burt of the AQ section has commented upon his observations in his attached report (Appendix 1).

Complainants were requested to keep a logbook of their observations and experiences. Photographs and samples of dust were provided to Officer Burt. Several of these photographs will be excerpted and discussed in this report. Data summaries of noteworthy episodes will be presented and discussed.

Process Description

Unimin Ltd. owns and operates a mine and material processing facility in the survey area. The principal product is Nepheline Syenite, a specialty material used primarily in the production of glass. This facility has been in operation for more than 70 years, and the mine tailings are stored on the property.

Nepheline Syenite ore is quarried from open pit mines and trucked to either the Blue Mountain or Nephton processing buildings. The raw ore is crushed in a dry process until it reaches product specifications. The finished products are transported by truck in bulk or in bags. Process dust is collected by several baghouses which discharge to the atmosphere. Waste rock tailings are applied as slurry to storage areas.

Appendix 3 contains Material Safety Data Sheets (MSDS) for several of the products and materials produced and handled at the facilities. Those documents make reference to various particulate standards that are discussed later in this report.

Area Under Study

Maps of the vicinity are presented in Figures 1& 2. The survey area is rural with a mixture of full-time and seasonal cottages.

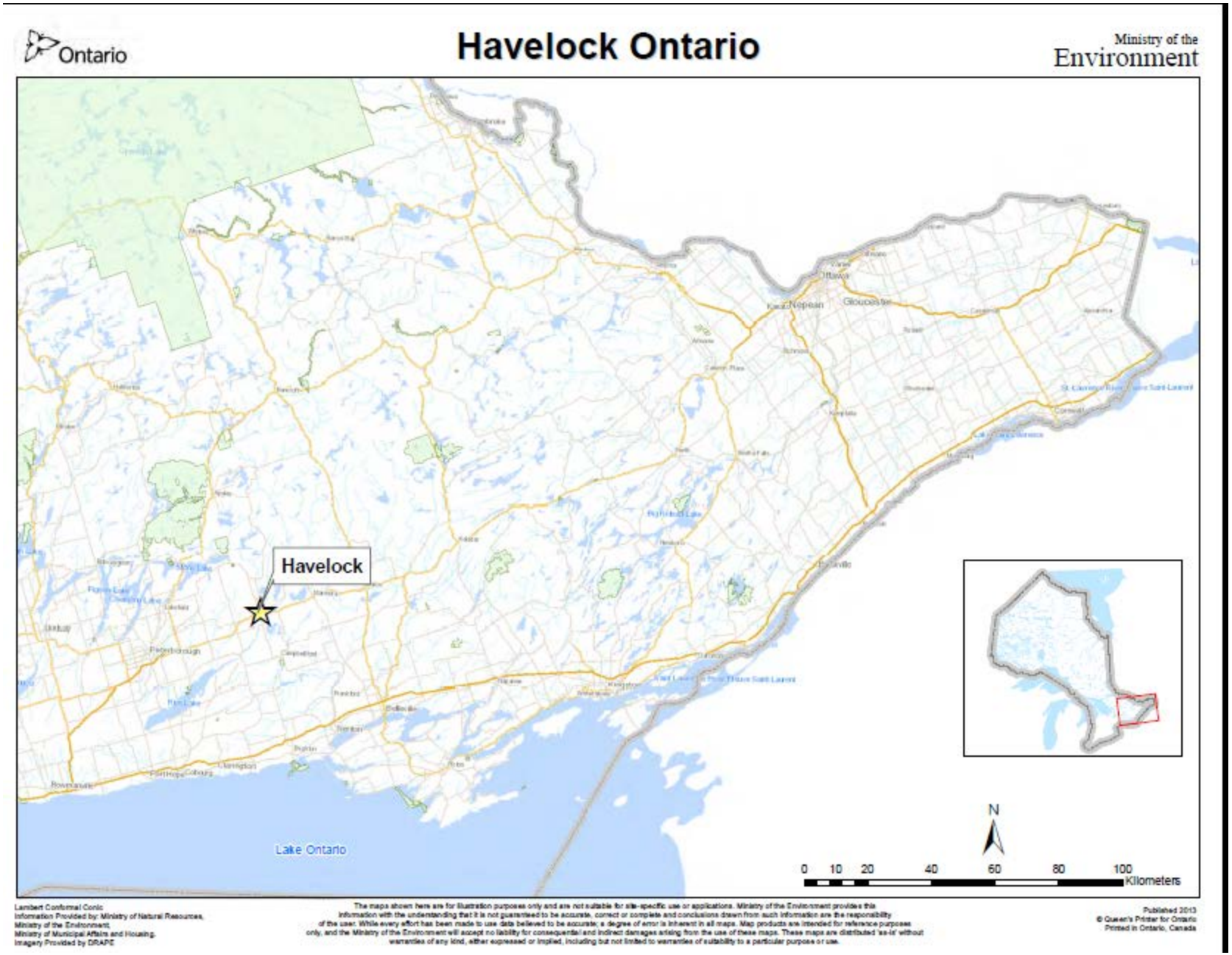


Figure 1: Survey Area Overview

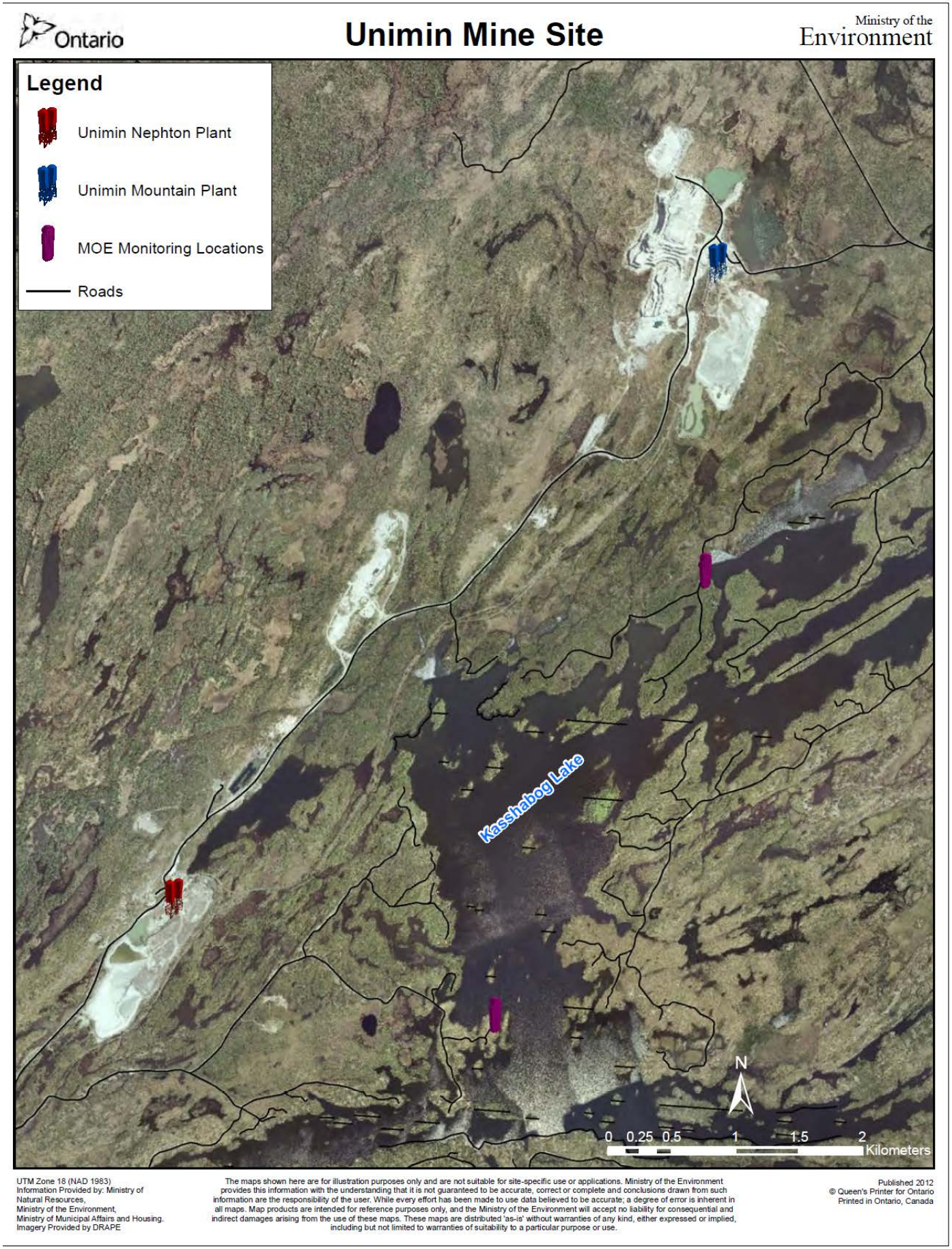


Figure 2: Survey Area - Satellite Imagery

The Blue Mountain component is to the north, the Nephton sites to the west. I will refer to subsets of the Nephton site as “Nephton North” and “Nephton South”.

Conceptual Site Model

A conceptual model was developed to explain the particulate impacts that are observed and reported to the Ministry of the Environment. The impacts are believed to be arising from turbulent wind action intersecting elevated areas of the Unimin operations that are rich in particulate materials from the processing and tailings areas. Site conditions in the last several years must have experienced some change in character in comparison to years past. The Regional Air Quality Unit is unaware of any substantial complaints prior to the current study.

The passage of winds from the west must travel around the elevated topography near the site. This causes the wind to accelerate and generates turbulence that is effective at lifting dusts and particulate. This has been observed by provincial officers.

Figure 3 is a photograph taken by a Provincial Officer during a site visit. Please note the localized character of the event. The material in tailing piles is being vigorously lifted and is available to be transported.

Figure 3: Particulate Vortex

Complainants have supplied numerous photographs of impacts relating to visibility reduction and soiling. There has also been **YOUTUBE** video postings of some of these events.

Those reading an electronic version of this report can follow this link if your access policies permit: http://www.youtube.com/watch?v=iLWx0waE280

Three-dimensional rendering of the survey area is presented in Figure 4, next page. A 5x vertical exaggeration has been applied to highlight the discussion.

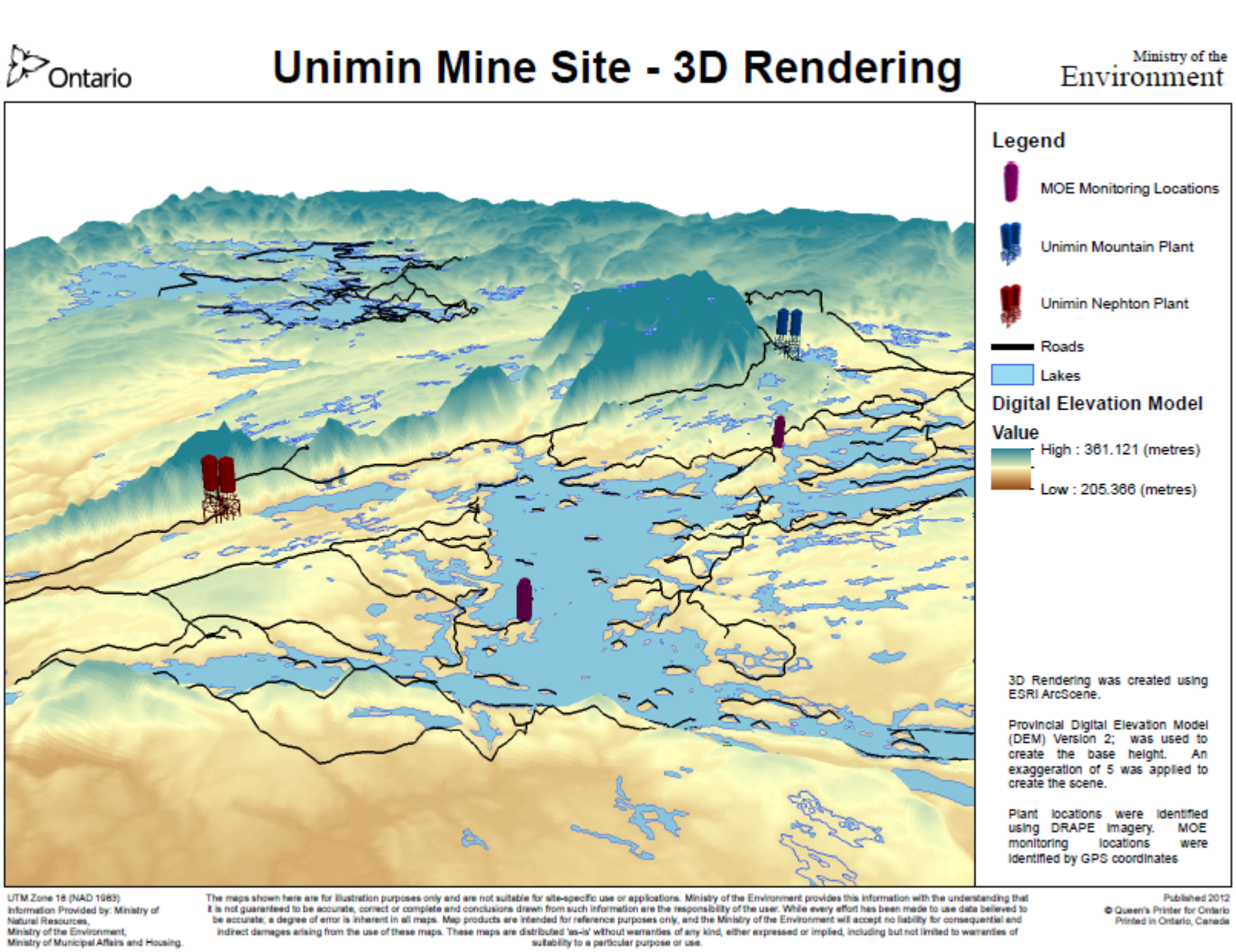


Figure 4: Three-Dimensional Site Model

Figure 5: Photograph of Particulate Vortices

Figure 6: Photograph of Particulate Vortex

Figure 7: Particulate Vortex - Tailings Area

Figure 8: Complainant Supplied Photograph of Visibility Impact

Figure 9: Complainant supplied photograph


Figure 10: Complainant supplied photograph.

Legislation

The ***Environmental Protection Act of Ontario, RSO 1990*** page 1, defines and describes "Adverse Effect". This definition is crucial to the application of the general provisions of the Act, and Regulations made under it. The Act can be located on the internet:
http://www.e-laws.gov.on.ca/html/regs/english/elaws_regs_050419_e.htm

From the Act:

Interpretation

1. (1) In this Act,

"adverse effect" means one or more of,

(a) impairment of the quality of the natural environment for any use that can be made of it,

(b) injury or damage to property or to plant or animal life,

(c) harm or material discomfort to any person,

(d) an adverse effect on the health of any person,

(e) impairment of the safety of any person,

(f) rendering any property or plant or animal life unfit for human use,

(g) loss of enjoyment of normal use of property, and

(h) interference with the normal conduct of business; ("conséquence préjudiciable")

"contaminant" means any solid, liquid, gas, odour, heat, sound, vibration, radiation or combination of any of them resulting directly or indirectly from human activities that causes or may cause an adverse effect; ("contaminant")

Sections (a), (b) (c) and (g) capture the essence of the complaints that have been registered with the Ministry and conveyed to the Medical Officer of Health for the area with specific concern regarding the possibility of (d), human health effects.

Section 14 of the EPA:

Prohibition, discharge of contaminant

14. (1) Subject to subsection (2) but despite any other provision of this Act or the regulations, a person shall not discharge a contaminant or cause or permit the discharge of a contaminant into the natural environment, if the discharge causes or may cause an adverse effect. 2005, c. 12, s. 1 (5).

Section 14 EPA is contemplated for use for contaminants or mixtures of them that pose immediate hazard by virtue of their physical properties and short time periods of exposure. A momentary episode of extremely high concentration may pose unique health or environmental effects while averaging out to a "419 compliant" result. This typically happens in chemical spill scenarios, but data collected during this survey demonstrates this issue. The Ministry has provided the Medical Officer of Health and Public Health Ontario with interim data and has discussed findings. The human health considerations in this regard have been left to the professional judgement of those agencies. The entire data set has been provided to them as an adjunct to this report. This report is intended to assist medical authorities by pointing out episodes of potential interest in that context. The Medical Officer of Health is expected to report under separate cover.

Ontario Regulation 419/05

Ontario Regulation 419/05 (Local Air Quality) sets scheduled limits for concentration values, but also addresses adverse effect. This is relevant in context of Ministerial response to contaminants not scheduled in the Regulation.

Part III , section 45 of O. Reg419 has an "adverse effect provision" similar to S. 14 of the EPA.

> **45.** No person shall cause or permit to be caused the emission of any air contaminant to such extent or degree as may,
>
> (a) cause discomfort to persons;
>
> (b) cause loss of enjoyment of normal use of property;
>
> (c) interfere with normal conduct of business; or
>
> (d) cause damage to property. O. Reg. 507/09, s. 32 (1).

Section 45 (a), (b), and (d) re-state the matters contemplated under Section 14 in context of the complaints received by the Ministry. Regulation 419 scheduled standards are average-based, such as *"100 micrograms per cubic meter of Contaminant X for a ½ hour period"*.

Ontario Regulation 419/05, Sections 19 & 20 contain scheduled limits for total suspended particulate matter, referred to as TSP. There are two limits for different averaging periods for it in Schedules 2 & 3. They reflect different averaging times. The scheduled value is set for TSP with the rationale to protect the environment from soiling effects.

Schedule 2: ½ hour concentration value of 100 micrograms per cubic meter
Schedule 3: 24 hour average concentration of 120 micrograms per cubic meter.

It has been noted that a regulatory "speed-up" has been granted for the Unimin facility operations, placing it in "Schedule 3" of Regulation 419 for suspended particulate. The shorter time-period schedule 2 is not legally applicable for this site. Schedule 2 considerations are relevant to both sites in order to explain observed soiling and reconcile Schedule 3 compliance that is generally observed. It is for this reason that Schedule 2 calculations have been undertaken and are presented.

Other Ministry Initiatives

Ontario operates a province-wide Air Quality Index (AQI) reporting telemetry system at various sites across the province. This system continuously measures and reports PM 2.5 particulate, a parameter of the survey under discussion. This system reports a 3 hour AQI "Alert Level" for PM 2.5 of 45 micrograms per cubic meter as a level of health concern. No such station is operating near the survey area. The data collected in this survey can be used for comparison to the AQI alert level, or any other relevant jurisdictional standard to examine possible impacts.

Parameters Under Study

The following contaminants were evaluated in this survey: Dustfall, Total Suspended Particulate (TSP), and three smaller size fractions of particulate matter (PM), referred to as PM 10, PM 2.5 and PM 1.0. The numerical designation denotes the aerodynamic diameter of those particles. The particulate was measured by a GRIMM analyzer.

Airbourne particulate is not spherical in shape. The term "aerodynamic diameter" is the equivalent size of a sphere with transport properties demonstrated by the particle under study. Particles of differing diameters show difference in settling out in the atmosphere, and also their ability to penetrate the human respiratory system. In

general the smaller a particle, the deeper it can penetrate into the lungs. The shape and structure of particles also affects their potential for damage. Particles substantially below 1 micron in diameter can cross into the human bloodstream from the lungs and can cause damage. Public concerns were expressed regarding the possibility of the emissions from Unimin being structurally similar to particles capable of causing silicosis. This was discounted based on microscopic examination conducted by MOE specialists.

Public Health Ontario has recently released a comprehensive study: ***A Review of Air Quality Index and Air Quality Health Index***. The study can be found at: http://www.oahpp.ca/resources/air-quality-indices.html

Portions of pages 17 & 18 of that report are excerpted on the following pages. That report has extensive references on health impacts of particulate.

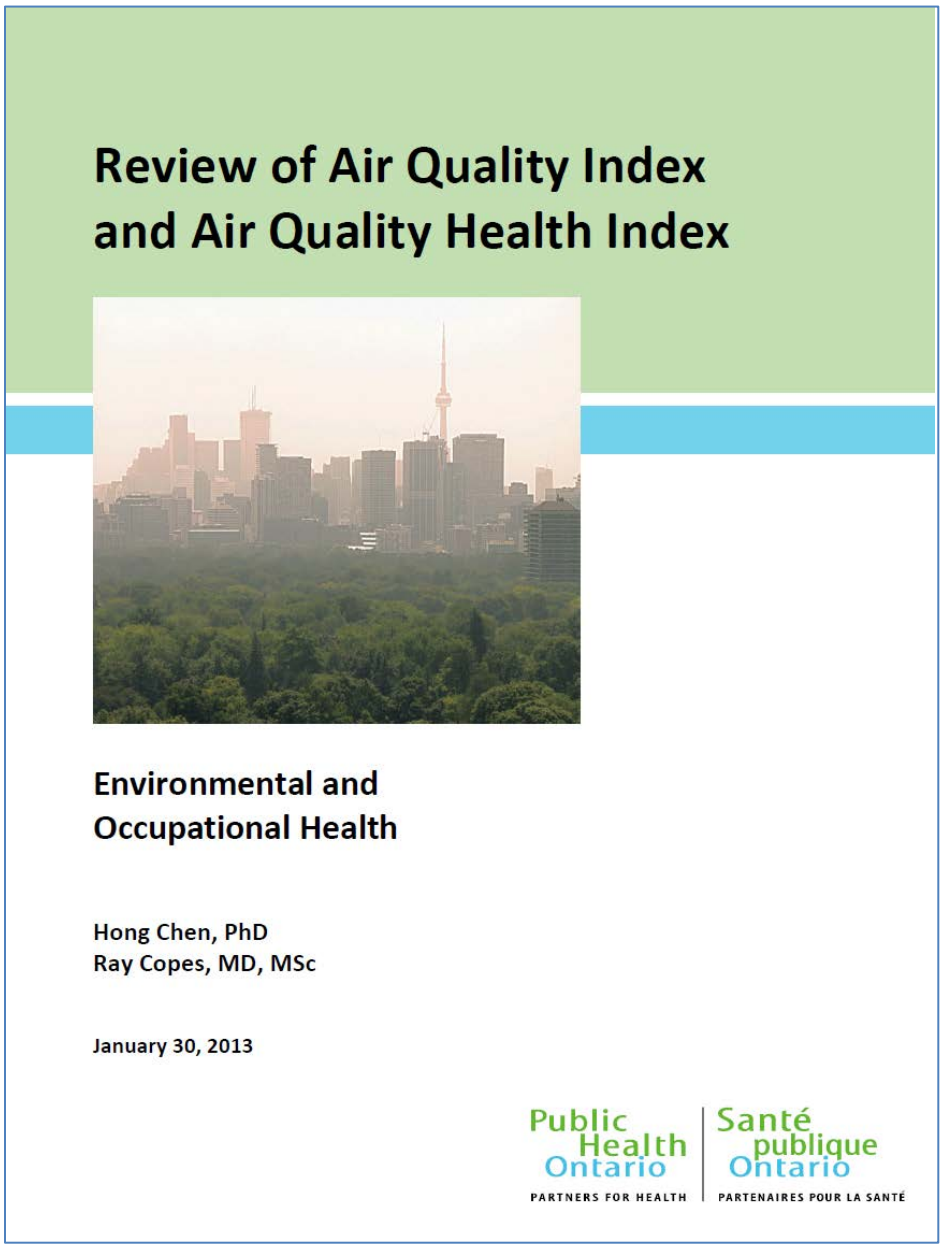


Figure 11: Public Health Ontario Report Cover Page

Current Canadian standards for $PM_{2.5}$. The derivation of the CWS built upon the Science Assessment Document results for the NAAQOS for PM (1998) (*http://www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/air/naaqo-onqaa/particulate_matter_matieres_particulaires/summary-sommaire/98ehd220.pdf*). The reference levels determined by the document refer to "several key epidemiological studies" that focused on mortality and hospitalization endpoints to establish an exposure-response relationship, but the specific studies used to establish that exposure-response relationship were not identified explicitly. The Science Assessment Document does reference one particular study that found a 1.5% increase in the overall mortality in six U.S. cities per 10 $\mu g/m^3$ increase in $PM_{2.5}$. In this study, the average exposure rates of $PM_{2.5}$ ranged between 11-30 $\mu g/m^3$. Although the Science Assessment Document recognized the lack of a demonstrated threshold for $PM_{2.5}$, a reference level was set at 15$\mu g/m^3$.

Canadian Council of Ministers of the Environment (CCME) released a document in 2004 to update the CWS based on emerging studies since 1997 (*http://www.ccme.ca/assets/pdf/prrvw_pm_fine_rvsd_es_e.pdf*). The CCME report reviewed 40 acute mortality studies, as well as long-term epidemiological, clinical and toxicological studies. Despite the well-recognized issue with Generalized Additive Models (GAMs) used in previous studies (including those cited by the 1998 Science Assessment Document), the previously reported positive associations between short-term $PM_{2.5}$ and health effects were generally consistent with the newer research. CCME concluded that the CWS of 30$\mu g/m^3$ was appropriate, after taking into account important factors including protecting human health, as well as achievability, feasibility and the costs of reducing pollutant levels. The CWS achievement is based on the 3-year moving average of the 98th percentile.

In comparison, the U.S. EPA conducted a comprehensive review of the literature pertaining to PM exposure and health effects in 2009 (*http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=216546*). They found that the risk estimates for all-cause mortality ranged from 0.29% to 1.21% per 10 $\mu g/m^3$ increase $PM_{2.5}$. A causal relationship may exist between $PM_{2.5}$ exposure and mortality, considering all epidemiological, clinical and toxicological evidence. The rationale behind the 24-hour exposure standard of 35$\mu g/m^3$ was not further elaborated, but achievement is based on the 3-year moving average of the 98th percentile.

On the other hand, the WHO air quality guideline in 2005 for $PM_{2.5}$ is set at 25$\mu g/m^3$ (*http://whqlibdoc.who.int/hq/2006/WHO_SDE_PHE_OEH_06.02_eng.pdf*). At the time of the report, the majority of studies examining short-term effects focused on PM_{10}. These published studies and related

meta-analyses showed mortality effects for PM_{10} ranging from 0.46% to 0.62% per 10 µg/m^3 increase. This is approximately equivalent to a 5% increase in mortality at a PM_{10} concentration of 150µg/m^3. With that, the guideline for PM_{10} was set at 50 µg/m^3 for a 24-hour average concentration, and the WHO halved that value to derive the 24-hour guideline for $PM_{2.5}$ at 25 µg/m^3. However, the WHO recommends that authorities achieve PM levels below the air quality guidelines because no thresholds for PM have been identified.

Figure 12: Public Health Ontario Particulate excerpt pages 17-18

The variety of standards is caused by the fact that particulate material does not have a “No Effect Level” (NOEL). Medical opinion is split worldwide regarding an appropriate protective concentration limit.

The following photographs depict the GRIMM samplers and their deployment. The original intent of this survey was to collect data to confirm and quantify particulate soiling complaints reported to the Ministry. The samplers were placed on complainants properties to assess their personal exposures to particulate. This required siting the devices in locations that do not meet the rigorous siting requirements of typical air quality studies. Consequently the data is treated more generally than normal in context of “source-receptor geometry”. The effects of terrain and turbulence will be discussed in subsequent sections.

Figure 13: B1 Station

Figure 14: B2 Station

Figure 15: GRIMM Instrument

Survey Description

Total Suspended Particulate

The GRIMM particle analyzer is described as an “Equivalent Method” for the determination of concentrations of PM 10. It has not been so designated for TSP. This means that the values reported may not be immediately suitable for use in context of Regulation 419, but support S. 14 EPA and S 45 O. Reg419 issues.

The GRIMM particle analyzer uses laser light scattering to determine the concentrations of particulate in various size fractions. Total Suspended Particulate is calculated in part from the partitions of the PM 10 through PM 1.0 groups. The particles above 10 microns can interact with the laser light in the sensor to over-report the

TSP concentration under certain conditions. Experience has shown that this effect is most likely to occur under high relative humidity, low temperatures and elevated particle concentrations. In high humidity and colder temperature the dew point / frost point of the atmosphere becomes relevant. A physical model to account for the effect was developed in earlier GRIMM studies conducted in Eastern Region. It is summarized below.

The dew point of air describes the condensation of water vapour into microscopic droplets. If air is chilled below the dew point, then moisture condenses out. Typically this occurs when a warm moist air mass comes in contact with cooler objects. Temperature fluctuations near the dew point were conjectured to have the potential to affect measurement of TSP.

The instrument has a limited capacity to dry the incoming air stream that is being sampled. Under most conditions this capacity is adequate, but is occasionally exceeded. Very humid sampling conditions are seen to exhibit unusual TSP readings upon occasion. High particle loadings in highly humid conditions near the dew point are one distinct set of conditions where the TSP reading may be affected. The values are high, but not as high as suggested by the instrument. A working theory of the cause was applied to the data validation and analysis.

For example: *The sampler is operating before sunrise on a cold morning. If there is a high relative humidity then temperature fluctuations may be enough to elicit the "dew point effect" if the instruments "drying capacity" is exceeded. If the sensor unit warms or cools differently than the sample air stream then it is possible for the sampler to produce internal conditions amenable for condensation of microscopic dew droplets. These droplets are capable of refracting, scattering and reflecting the laser light in the sensor, leading to the potential TSP over-reporting. The particles in the air can become condensation surfaces themselves, altering the assessment of them.*

Particulate data would typically be considered an "outlier" if affected in this manner and would be excluded. **Data collected in the latter half of October 2012 shows this effect and has been excluded from the analysis.** The particulate data was examined for particulate excursion events when ambient temperature changes might result in potential dew point issues. These data points were studied and if they were deemed suspicious they were given special consideration.

The GRIMM analyzer also monitors atmospheric pressure, humidity, wind speed and direction. It collects data minute-by minute which is collected in a computerized format for quality assurance and control. Provincial Officer Paul Burt of Eastern Region Technical Support Section conducted these steps and his observation report on this and other components of this study is appended. It will be referred to as 'Officer Burt's Report" in subsequent sections of this report.

The GRIMM analyzer has a medium resolution wind speed and direction sensor. It can report to the nearest degree, but the wind vane is subjected to some effects not normally encountered in ambient air quality monitoring.

Dustfall

Ontario Regulation 419/05 has a ½ hour standard for Dustfall in Schedule 2. Dustfall is considered to be settleable material that drops out of aerial suspension and rests on surfaces. The scheduled value is 8,000 micrograms per square meter ½ hour average. Samples of dust were collected from a variety of locations, and are described in Officer Burt's report, attached as Appendix 1.

Officer Burt collected samples of dust which accumulated on the sampling equipment housing upon several occasions. These samples were sent for microscopic examination and analysis. The photographs below were taken by Officer Burt, and are fully described in his report.

Detailed microscopic examinations of tailings dust and Unimin product were undertaken. Details of size fraction composition were produced. Those analytical reports are appended in Officer Burt's report. The MOE GRIMM sampling units will not detect these larger fractions, but their deposition effects can be noted.

Figure 5: GRIMM sampler- cleaned

Figure 6: GRIMM sampler - soiled by dust

Figure 7: GRIMM sampler - close-up of soiling

Complainants were requested to take photographs of dust impacts. Patio furniture was cleaned and photographed following dust exposure. These photographs were e-mailed to the Ministry on a daily basis. The complainants were requested to ***"write with their fingers"*** in the dust if possible. This is an important consideration and will be discussed later in this report. These photographs are appended on a DVD-ROM which has been produced to archive this survey.

It has been reported that the facility undertook extensive corrective actions in August of 2012. The effectiveness of this in context of GRIMM data will be discussed in subsequent sections of this report.

Complaints of soiling have been registered for virtually every day of September 2012. Photographs from these complaints show various levels of impact, some much more severe than others. It must be noted that the Schedule 2 dustfall standard is quite stringent. It can be violated with loadings that are difficult to see with the unaided eye. The question of adverse effect versus violation must be considered. It is possible to violate the standard and not cause an adverse effect. The violations described are of sufficient quantity, frequency, and extent that adverse effects are occurring. Visual observations such as those presented next demonstrate these violations.

A single grain of salt has a mass of approximately 80 micrograms. A 10 cm. diameter plastic Petrie dish is often used to collect dust samples. A deposition of 63 micrograms in such an area equals the regulatory limit. A single grain of salt in such a Petrie dish exceeds the standard by 30 percent. Please note the piles of material created at the ends of the "dust writings". These piles greatly exceed "1 grain of salt" in amount. When the area of the writing is considered it demonstrates clear violation of the standard, for a continuing period of time. More than one half-hour period of violation must have occurred. Examination of GRIMM data in the preceding 8-hours often shows elevated momentary values of particulate. This shows the potential for soiling despite long-period average compliance with scheduled standards. Microscopic analysis of tailings material shows content in the range of 50-100 microns. This material is rejected by the GRIMM analyzer but has soiling potential if transported off-site by the turbulent vortices observed.

Some of the soiling incidents are presented next page:

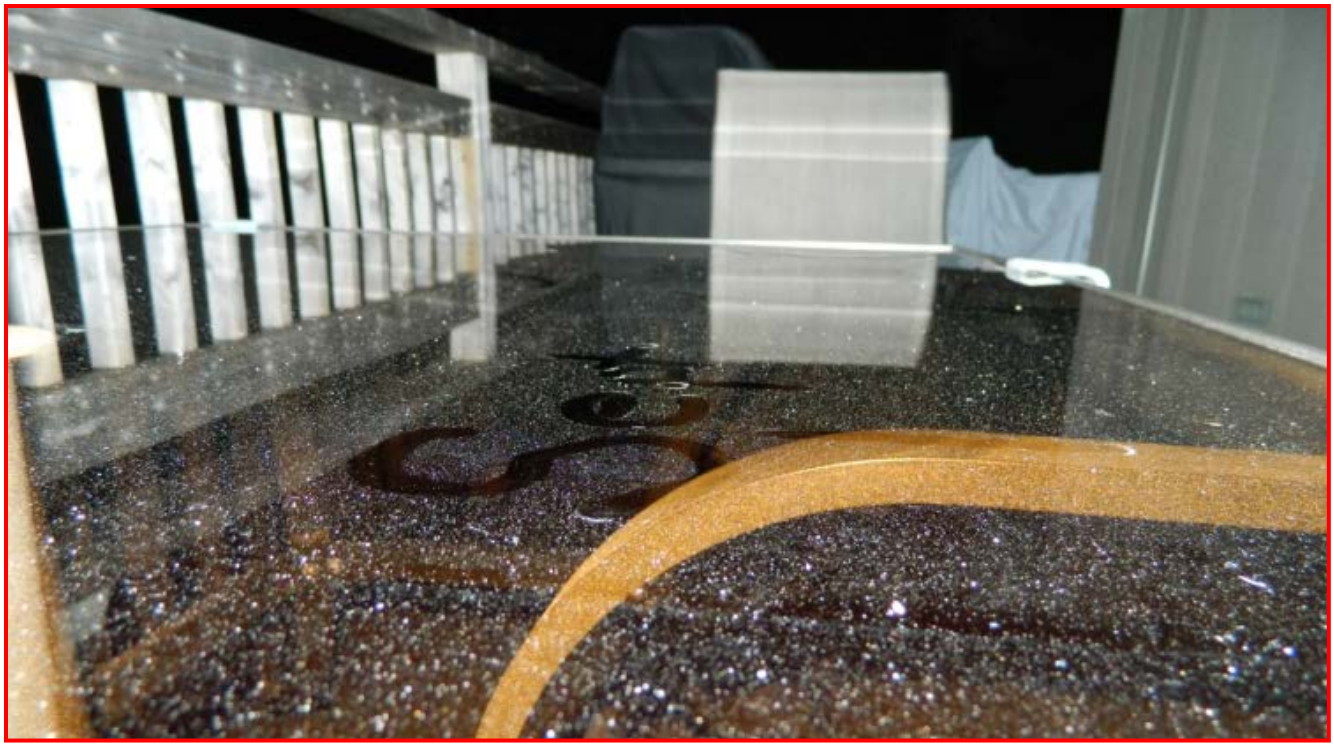


Figure 16: September 1 complaint photo

Figure 17: September 2 complaint photo

Figure 18: September 25 complaint photo

The Ministry operates a Litigation Unit that specializes in microscopic analysis of samples. Experts at the Unit produce reports detailing the size distribution of collected materials and make conclusions regarding possible sources. These reports are presented in Officer Burt's report. Detailed microscopic examinations of tailings dust and Unimin product were undertaken. Details of size fraction composition were produced. Those results show that the tailings material has substantial material that will deposit downwind if it is entrained by sufficient wind velocity and turbulence. The tailings material also contains approximately 8 percent material that would qualify as PM 2.5 and below. The tailings material contains 45 percent material that is larger than TSP. Unimin's product contains approximately 25 percent PM 2.5 or below. These findings suggest that loss of product could be a component of the respirable material that is observed, separate from any tailings-related emissions. The tailings material contains substantial settleable particulate that can be deposited if re-entrained by the wind turbulence previously mentioned. The MOE sampling units will not detect these larger fractions, but their deposition effects can be noted. The deposited material matches the composition of the source samples taken at Unimin.

Data Analysis

This survey collected data on 4 size fractions, on a 1-minute basis, for several months. This resulted in tens of thousands of individual observations per month. This data was provided regularly to the Medical Officer of Health as an interim measure, and is summarized in the following sections.

O. Reg 419 schedule 2-3 effects in context of soiling.

Unimin has conducted Hivol "Schedule 3" monitoring of TSP 24-hour levels at a site in the survey area. This monitoring showed Schedule 3 compliance. It is difficult to reconcile reported and observed dust impacts with TSP readings unless the shorter time periods are examined. Dust deposition is proportional to particulate concentrations in air. Different size fractions deposit at different rates. Atmospheric turbulence affects the ability of the material to remain suspended. The "vortex effect" previously described generates very short-term high concentration clouds that are observed to travel great distances. These short term events result in levels that are momentarily very high, with attendant deposition effects at great distance from the source. This is observed

at both MOE sampling sites. The short-period sampling explains the discrepancy between observed adverse effects and Schedule 3 compliance.

The short time period “excursions” that were consistently observed have a potential for human health effects not typically contemplated in ambient air sampling. Ambient air does not usually demonstrate large “Peak to Mean” variability unless it is affected by a substantial local source in a changing wind pattern. It is of some concern that Unimin is several kilometers away from the samplers and such high excursion values attributable to their operation are observed. The peak levels measured throughout the survey are levels that are more typically observed in occupational settings in a workplace, or possibly in the vicinity of a forest fire and not anticipated under ambient conditions in “cottage country”. These other types of high-particulate situations are usually consistently high, by their nature. The events recorded in this survey may represent some unusual health impact potential. The scheduled values in O.Reg419 for TSP have been set with intention to prevent soiling incidents, not to protect human health. The situation under study may represent a situation not contemplated in the rational for the TSP standards. Short term excursions of high levels of particulate may overwhelm a person’s ability to clear their lungs. It is for this reason that the survey data was supplied to the Medical Officer of Health for their expert consideration.

The Ministry is in possession of a letter from a Medical Doctor who has a patient in the study area. That letter describes serious adverse health effects. The MOH has been copied on that letter for their consideration. A redacted copy, to protect personal confidentiality, is appended to this report. That document is in Appendix 7. The local MOH has expressed concern regarding the particulate levels in the area, and has noted it upon the internet web page maintained by the Health Unit.

The survey data is summarized in graphical format on a monthly basis in the following pages. One format is a conventional presentation of the raw data; the other is a statistically smoothed version. The data demonstrates a clear directional influence in regards to elevated values. The operations at Unimin are considered to be the most likely source of these impacts. The “surface plots” are based upon tens of thousands of observations. Please note narrow ranges of wind speed and direction result in high PM 10 values. This is considered to be the result of the particulate being lifted off-site, as described in the Conceptual Site Model presented earlier.

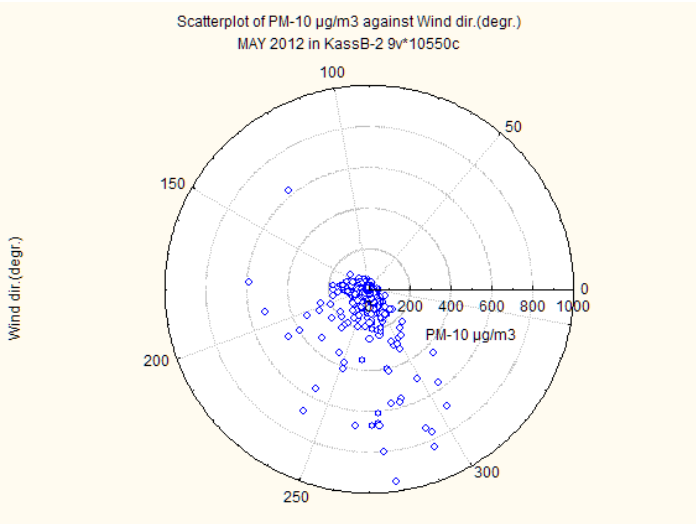


Figure 19: Standard Polar Scatterplot

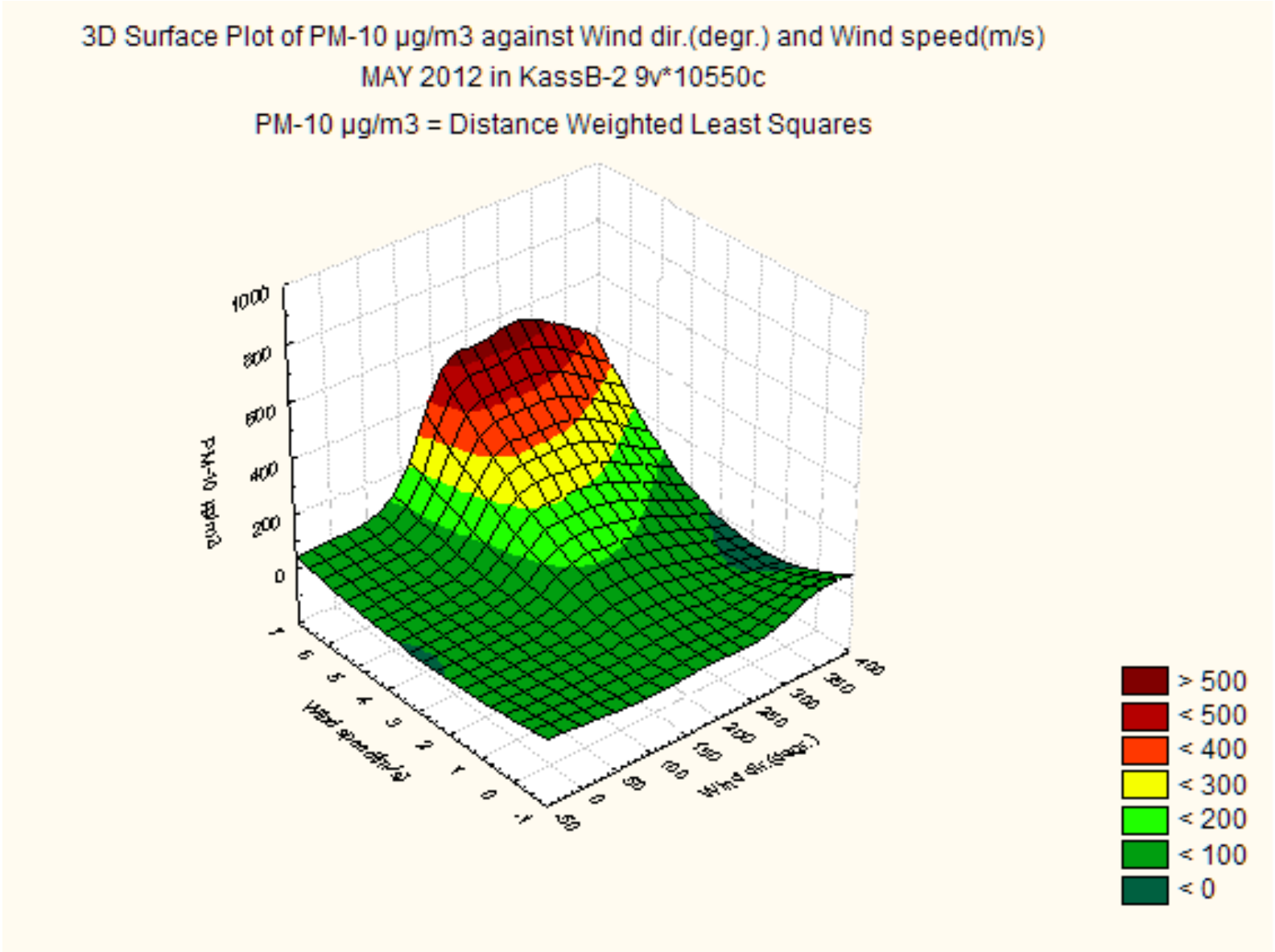


Figure 20: May PM-10 at station B-2

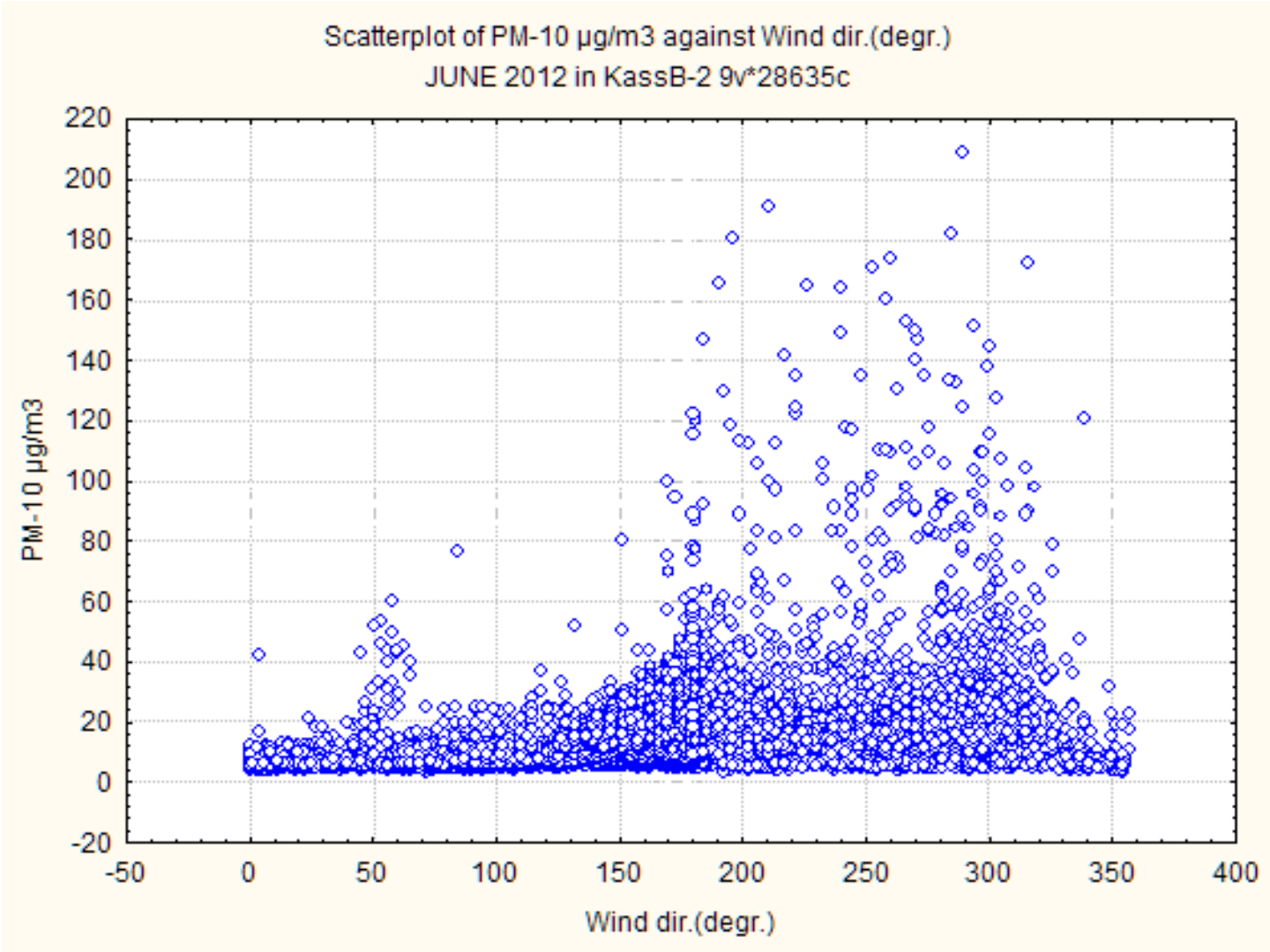


Figure 21: Cartesian Scatterplot of PM-10 at Station B-2

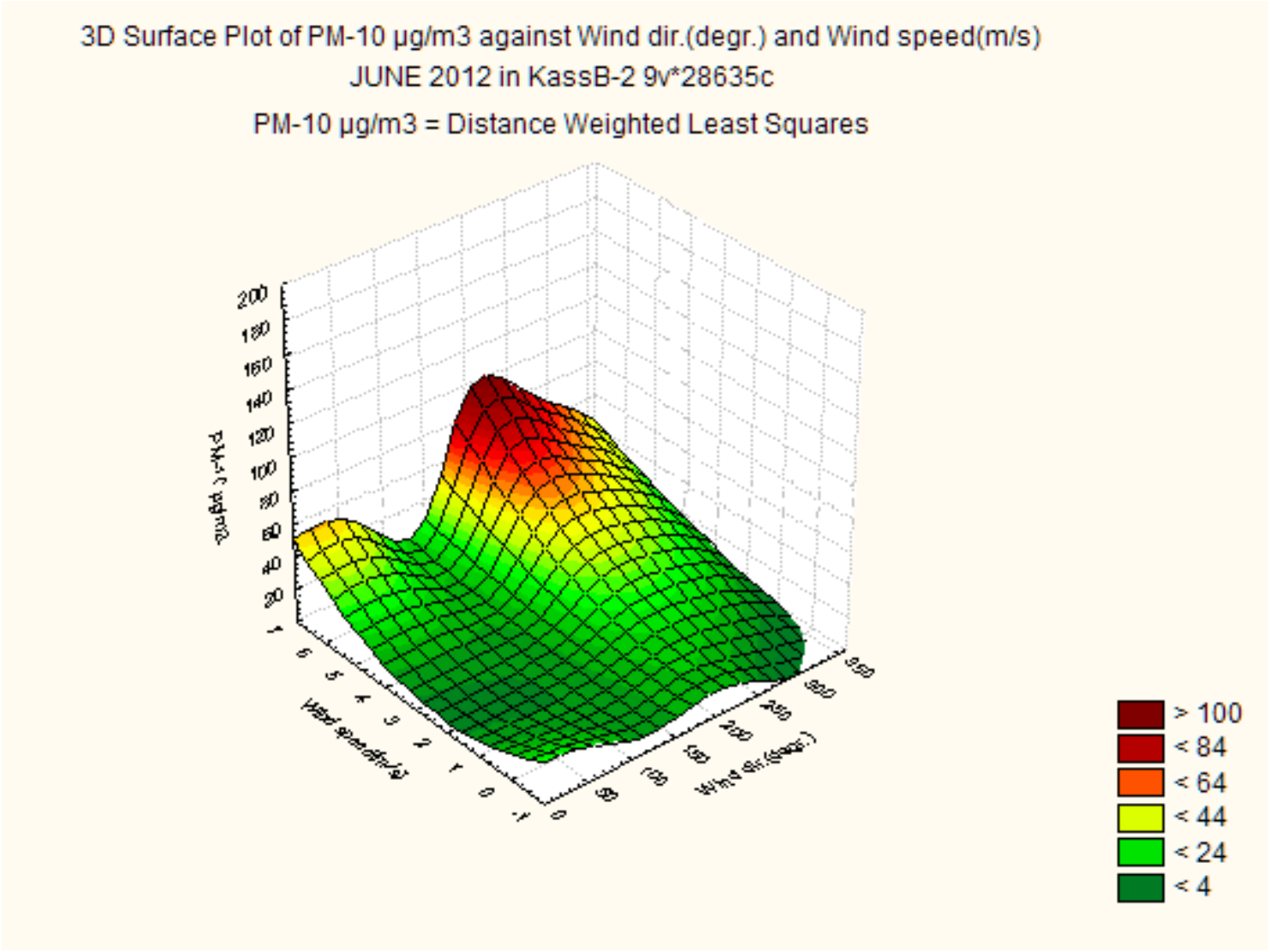


Figure 22: Statistical Response surface for July PM-10 at Station B-2

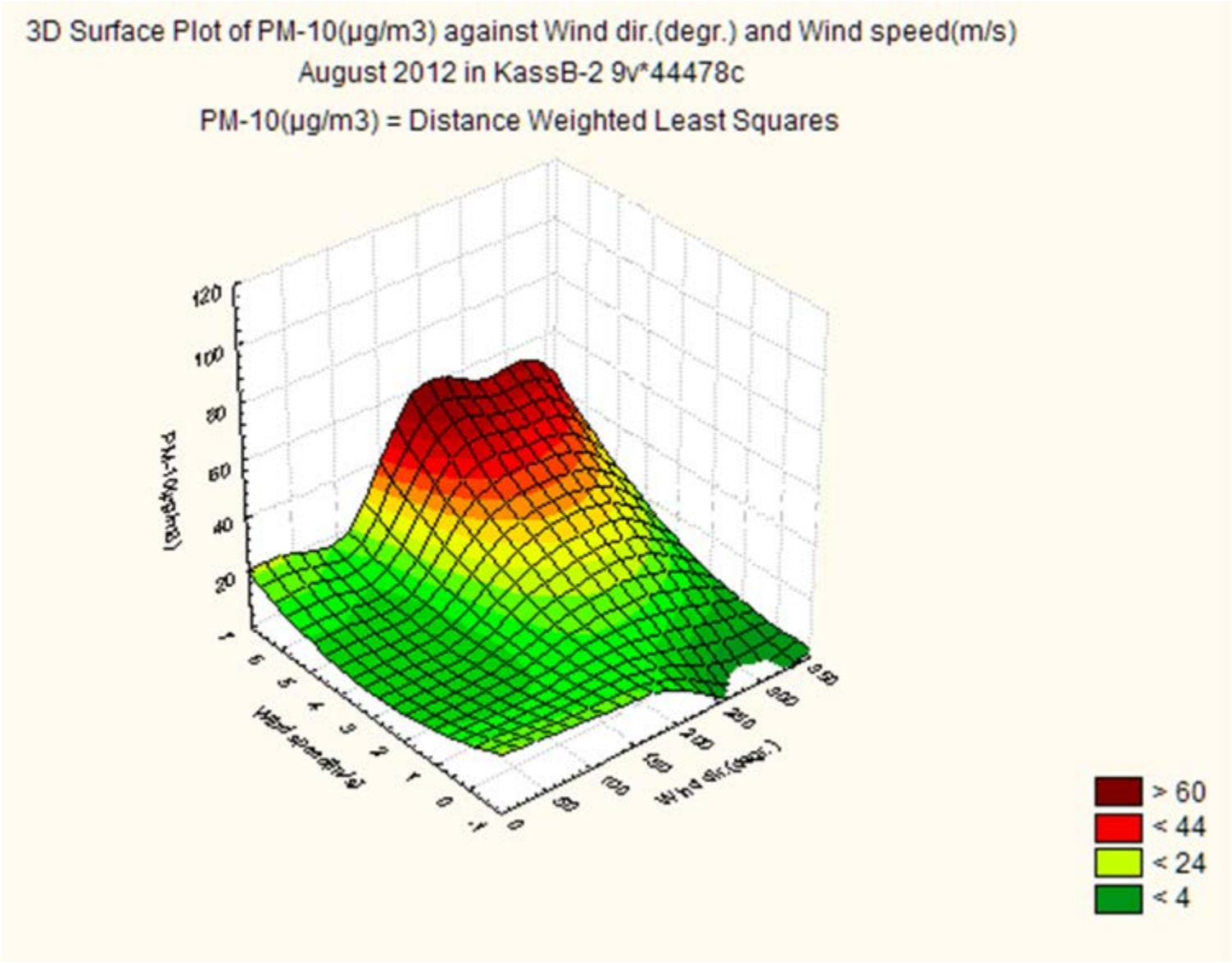


Figure 23: Station B2 August PM 10 response surface

This graphic demonstrates that a unique set of wind speed and direction at the receptor site results in significantly increased particulate levels. This surface is based on the analysis of more than 44,000 observations. It is similar in character to May, June, and July data.

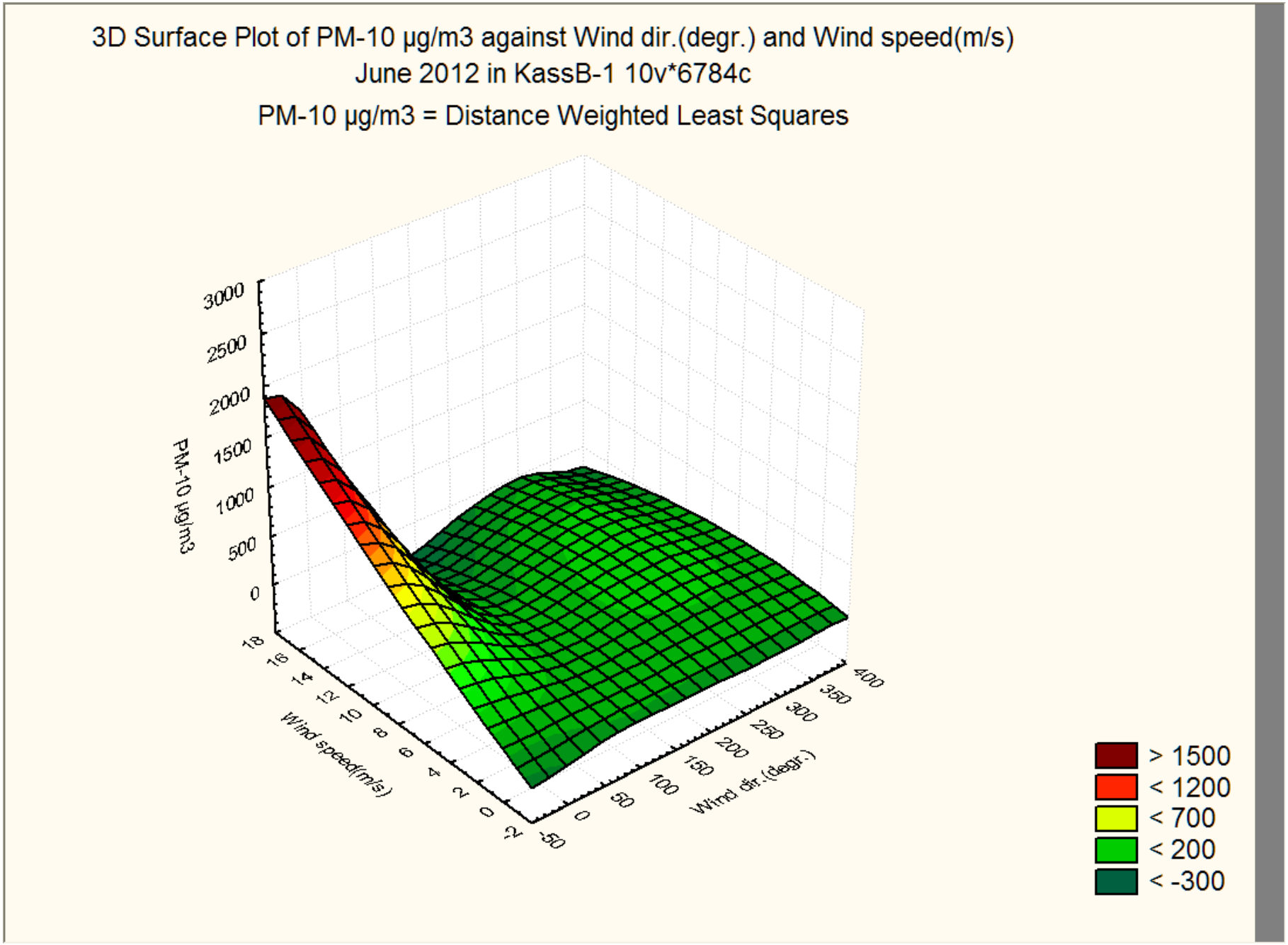


Figure 24: June PM-10 response surface for station B-1

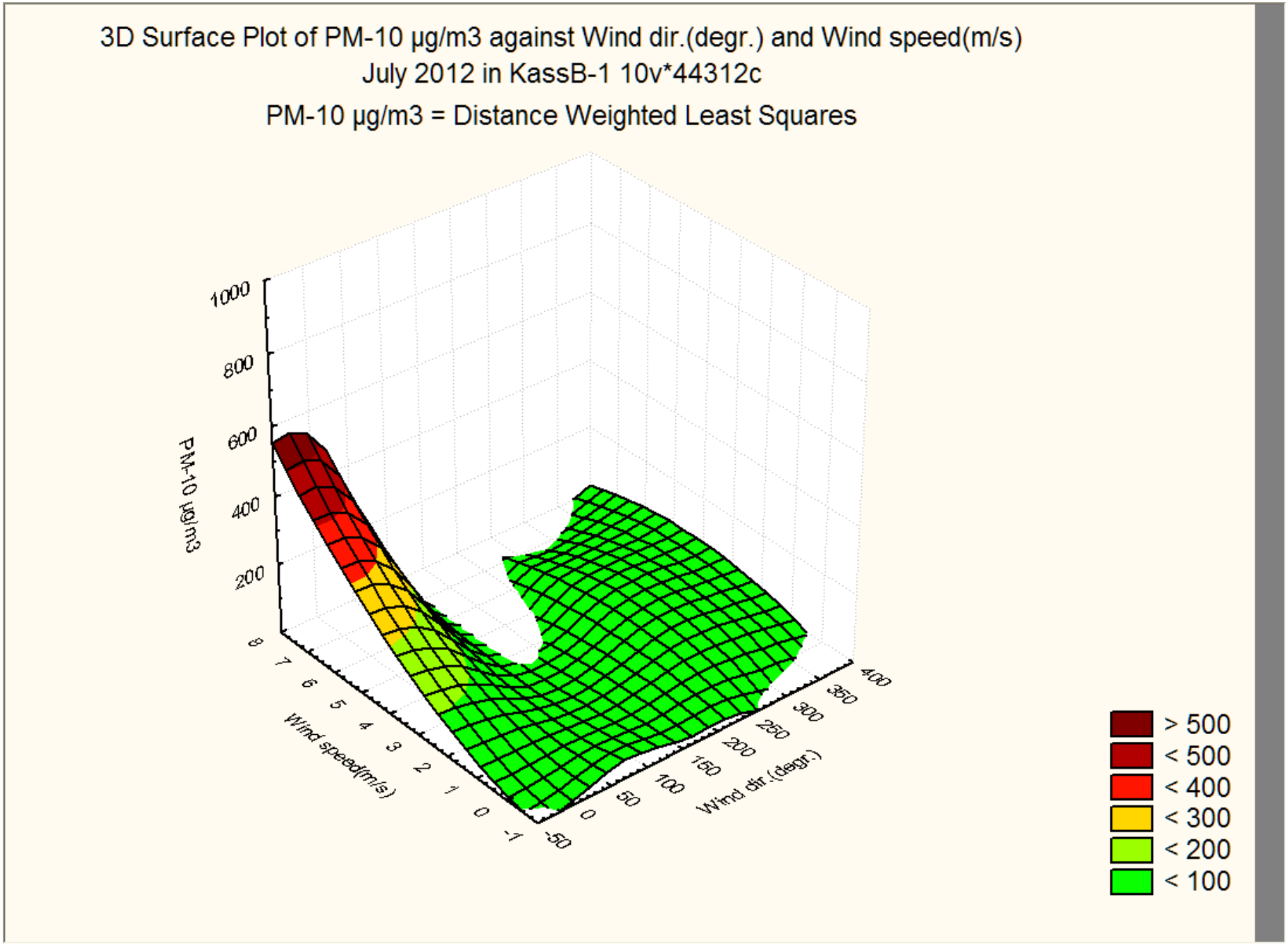


Figure 25: July PM-10 response surface at Station B-1

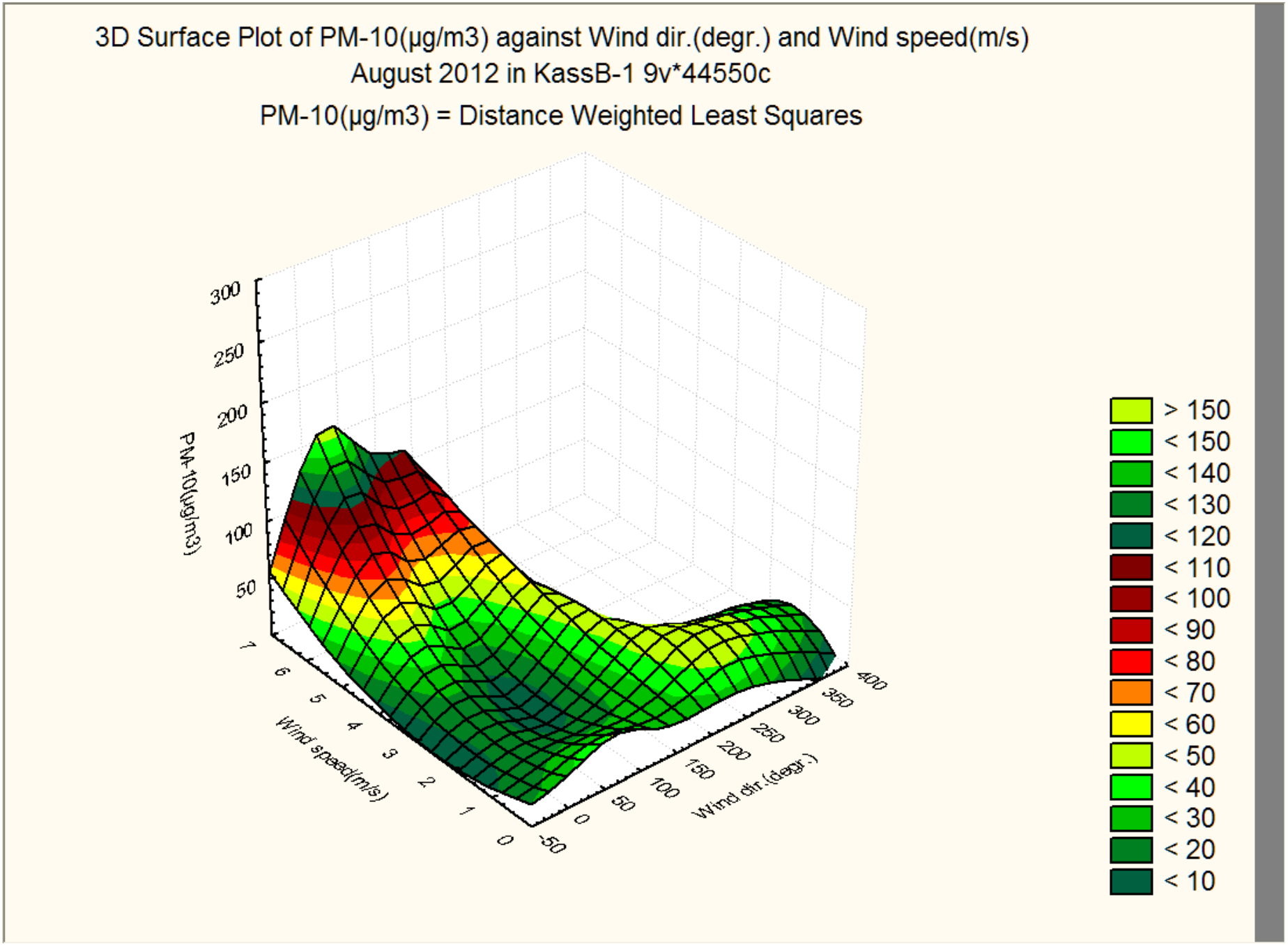


Figure 26: August PM-10 response surface for Station B-1

Figures 20 to 26 show a clear directional influence in regard to high momentary values of particulate. There is a characteristic combination of wind speeds and directions at each station that are associated with significantly elevated particulate levels. The GRIMM analyzer is not considered an equivalent method for the determination of TSP. The elevated values for that parameter are not enforceable for O. Reg. 419 purposes, but serve to substantiate the dustfall and soiling effects that have been observed. Measurements of 24-hour TSP concentrations have been recorded by UNIMIN and show compliance. Calculations of 24 hour levels from the GRIMM values support that claim, but the high peaks observed have been sufficient to elevate 24-hour averages to close to the scheduled standard. The momentary peak values substantiate and rationalize the observed soiling effects, despite Schedule 3 compliance.

The Ministry is compiling a Jurisdictional Standard Review to summarize particulate standards, regulations and guidelines in use by other regulatory agencies. That document is still in draft form. The data collected in this survey should be compared to the levels described in that document upon its release. The appended DVD-ROM is included in this report for that purpose. Appendices 2, 5, and 6 contain U.S. EPA, Environment Canada, and British Columbia's publications regarding their particulate regulatory position. PM 2.5 regulation is being examined by many jurisdiction and the published data shows a range of values set as levels of concern.

The Ontario Ministry of Labour enforces workplace standards for air quality in occupational settings. The literature describes this parameter as **Particulates not Otherwise Specified (PNOS**) or equivalently as **Particulates Not Otherwise Classified (PNOC).** Appendix 4 contains the rationale document**.** The document describes average values in the range of thousands of micrograms per cubic meter as a level of concern. The momentary values observed in this survey are within that range. This is noteworthy, considering that the survey sites are several kilometers from the UNIMIN site. The PNOS rationale document expresses concern that high momentary values of smaller sized particulate have the potential to harm human health. The "high excursion" peak values can overwhelm the lungs ability to clear these particles. It is for this reason that the data in this survey has been provided to the Medical Officer of Health for their review and comment. A portion of the rationale is in Figure 27.

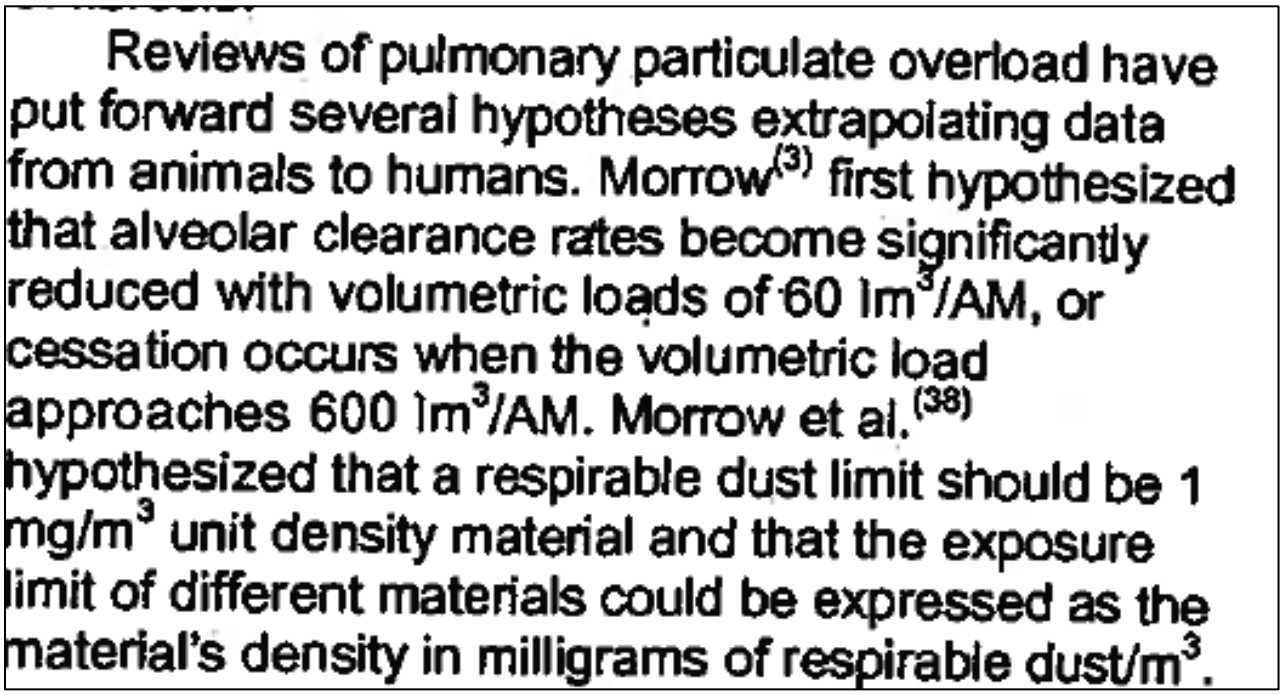

Reviews of pulmonary particulate overload have put forward several hypotheses extrapolating data from animals to humans. Morrow[3] first hypothesized that alveolar clearance rates become significantly reduced with volumetric loads of 60 lm^3/AM, or cessation occurs when the volumetric load approaches 600 lm^3/AM. Morrow et al.[38] hypothesized that a respirable dust limit should be 1 mg/m^3 unit density material and that the exposure limit of different materials could be expressed as the material's density in milligrams of respirable dust/m^3.

Figure 27: Overload considerations of PNOS

The following pages present are some graphics of noteworthy data periods. The vertical scale is logarithmic in some of them to allow visualization of the PM 2.5 and PM 1.0 fractions in comparison to TSP / PM 10.

Excerpted from UNIMIN's MSDS for Nepheline Syenite:

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

Exposure Limits

Definitions:
MSHA means Mine Safety and Health Administration.
NIOSH means National Institute for Occupational Safety and Health.
Ontario OEL means "Occupational Exposure Limit" established by the Ontario Ministry of Labour ("MOL")
OSHA means Occupational Safety and Health Administration.
PEL means OSHA Permissible Exposure Limit.
REL means the NIOSH Recommended Exposure Limit.
TLV means American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value.
TWA means time-weighted average.

Ontario OEL – 10 mg/ m^3 (total dust)
PEL - 5mg/m^3 TWA (respirable fraction) as Particulates not Otherwise Classified
TLV- None established (refer to ACGIH guidance for Particulates (insoluble or poorly soluble) Not Otherwise Specified)
MSHA – 10 mg/m^3 TWA (total dust) as Particulates not Otherwise Classified

Figure 28: Nepheline Syenite MSDS excerpt from Appendix 3
Note the occupational levels of concern of 10 mg/m^3 total dust and 5 mg/m^3 respirable particulate. 1 mg/m^3 equals 1000 µg/ m^3

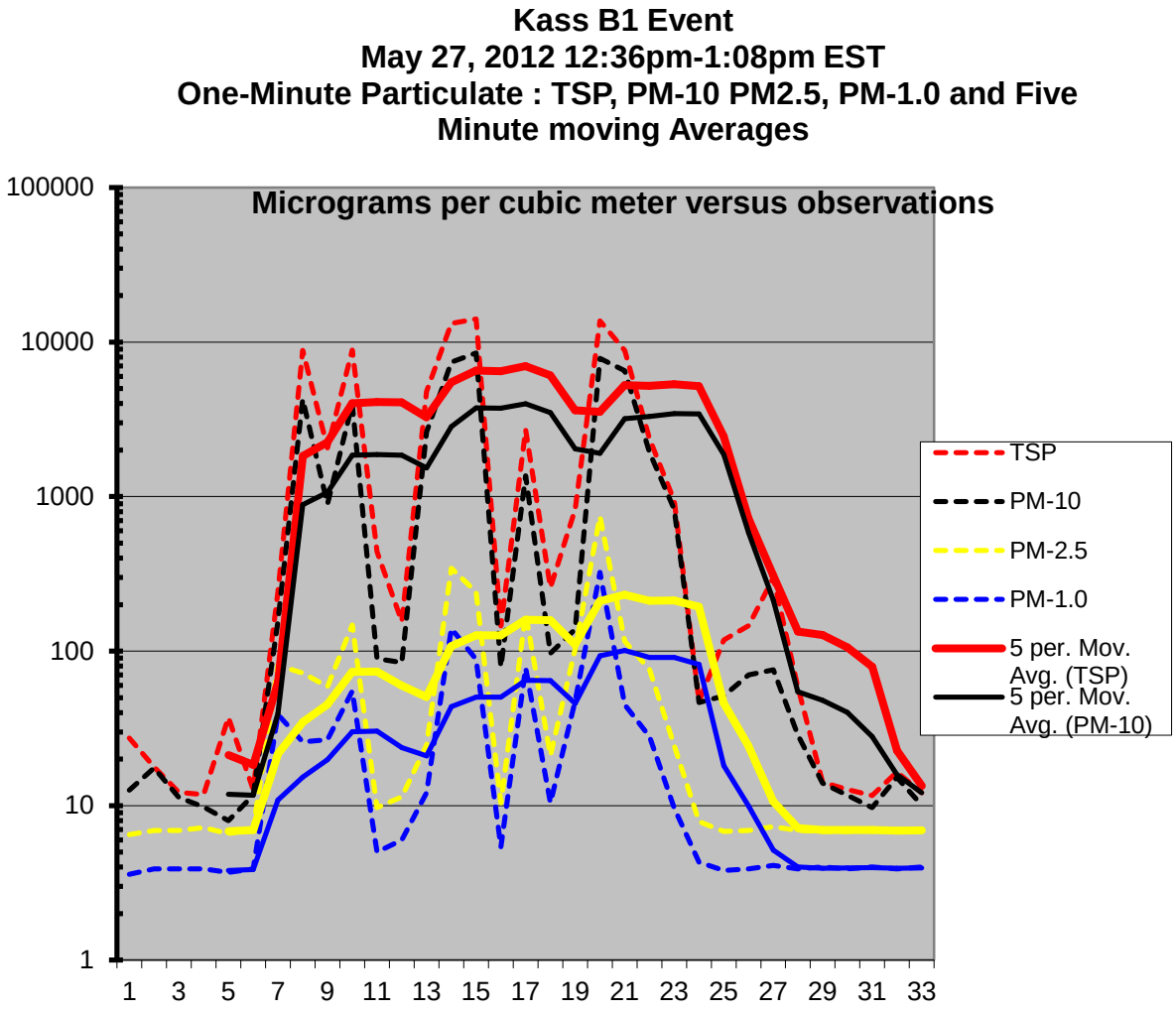


Figure 29: May 27 Event Analysis

The real-time data is displayed in dashed lines in Figure 29. The rolling 5 minute averages are presented in solid lines. The TSP peak demonstrates the soiling potential of high concentrations of particulate. The TSP values are

reaching occupational levels of concern. This episode shows values of PM 2.5 momentarily exceeding World Health Organization (WHO) health effects threshold of 25 micrograms per cubic meter PM 1.0 values are similarly elevated. This suggests the potential for adverse human health effects in context of Section 14, EPA general provisions.

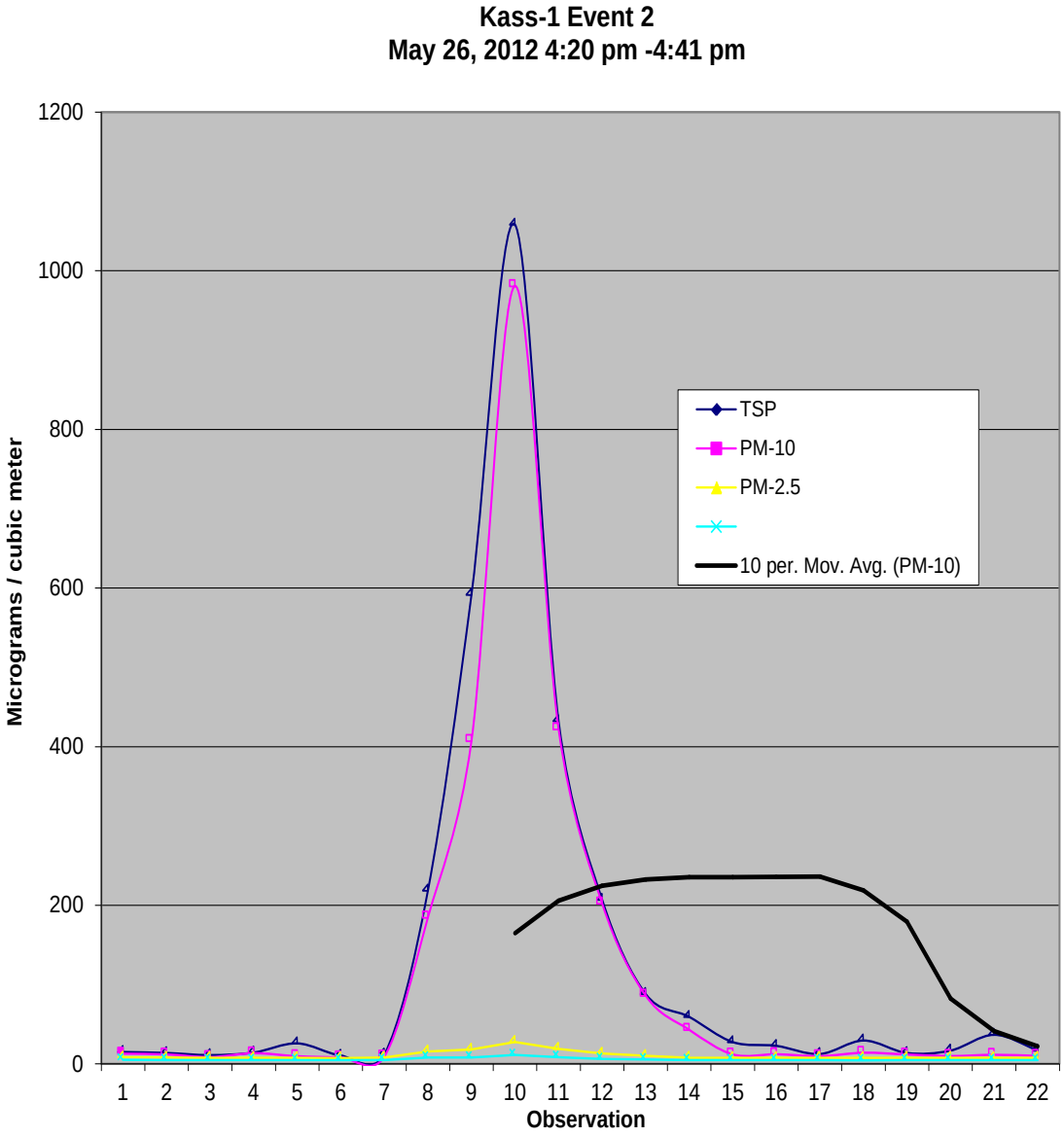


Figure 30: May 26 episode

Figure 30 demonstrates the impact that a momentary excursion can have in context of rolling averages. The black line shows the ten minute average PM 10 exposure to exceed 200 micrograms per cubic meter. Figure 31 demonstrates the effect on 30-minute averages. 30-minute TSP values are above 200 micrograms per cubic meter, and PM 10 above 100 micrograms per cubic meter.

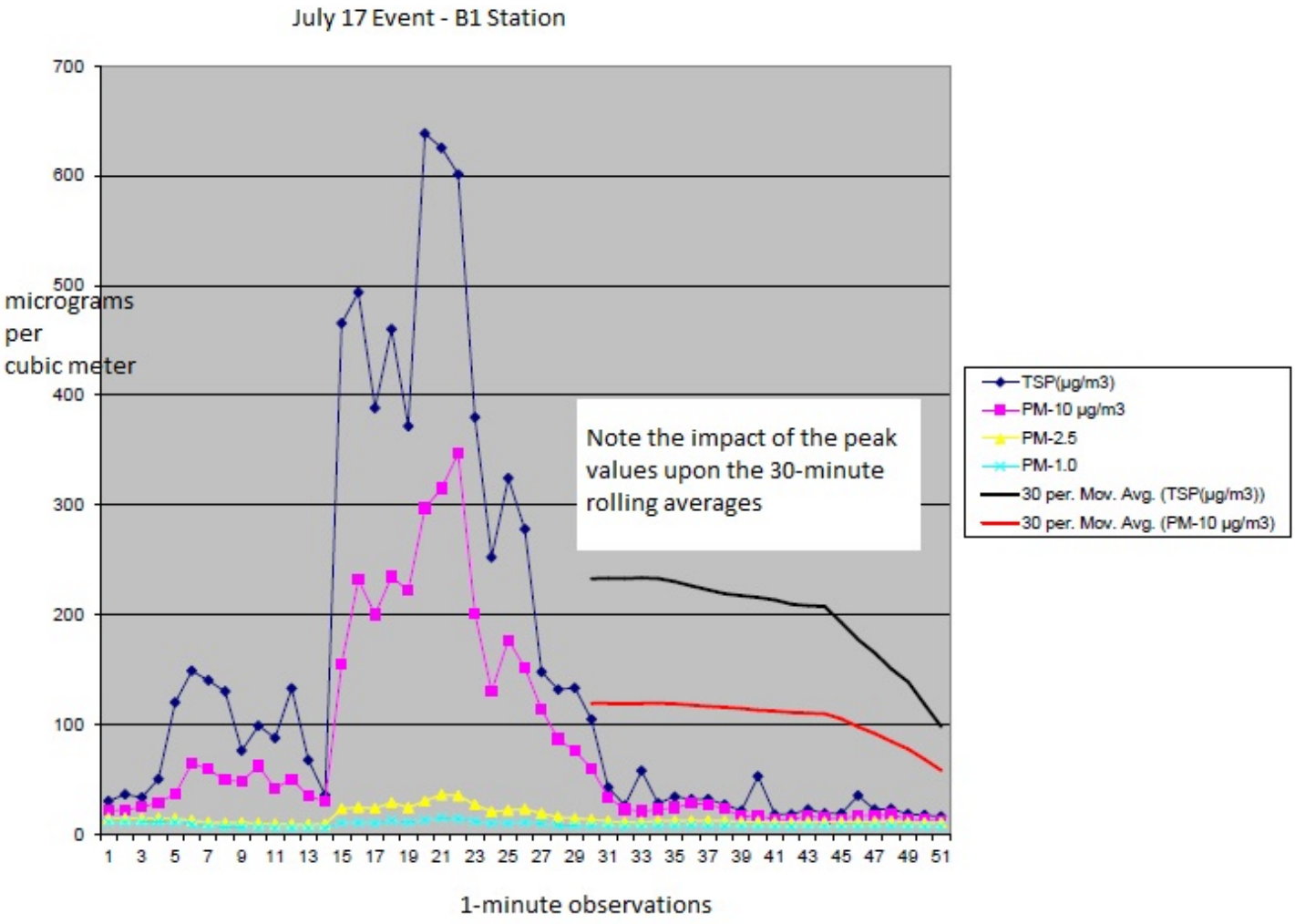


Figure 31: Peak to Mean Effects

The episode depicted in Figure 31 demonstrates a violation of the Schedule 2 standard for TSP. It is not actionable because the Unimin facility has been granted a “regulatory speed-up” which shifts their compliance target to Schedule 3.

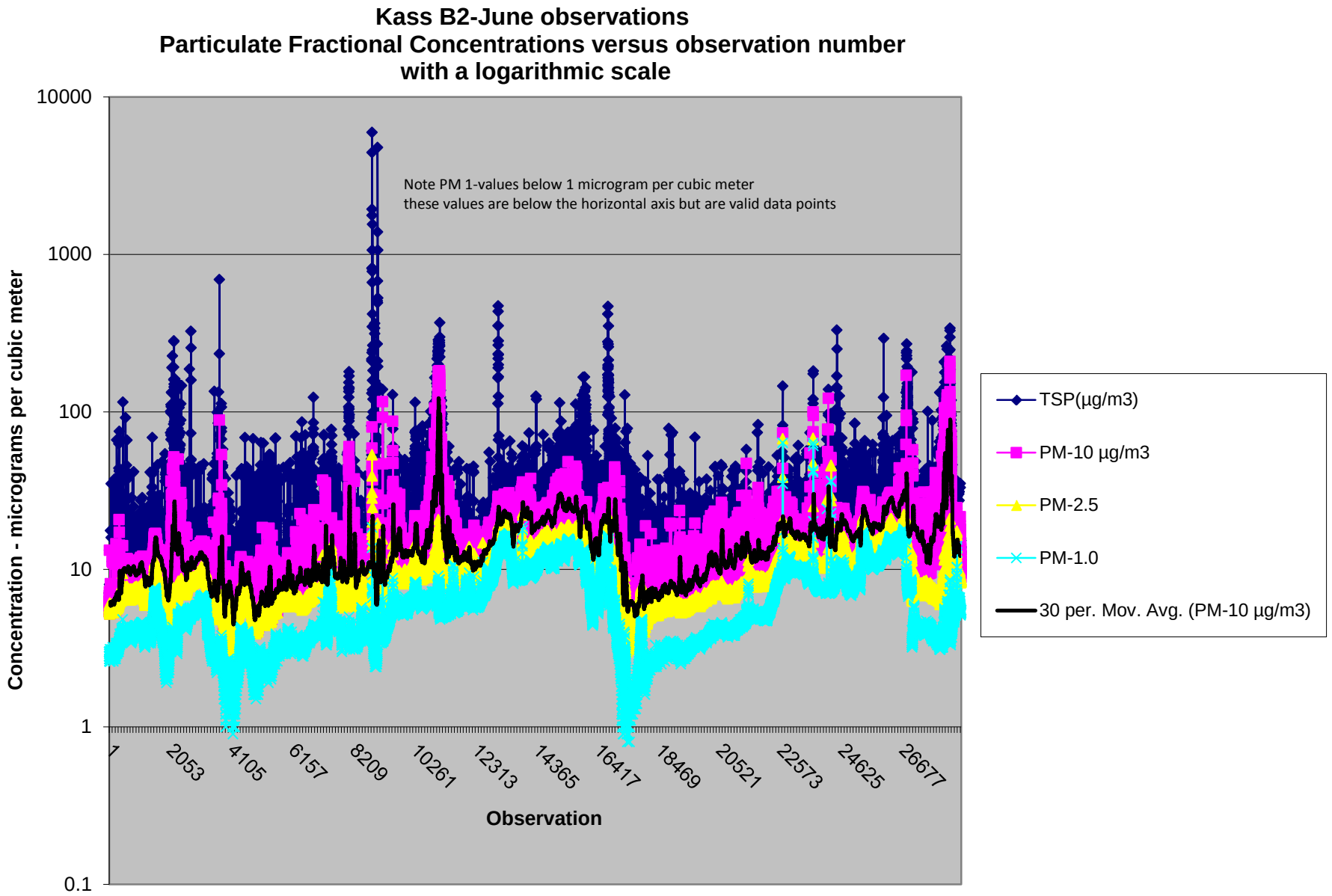


Figure 32: June Data at Station B-2

Unimin undertook extensive remediation in July and August of 2012. September data shows improvement in comparison to earlier readings, but complaints of soiling were registered throughout September.

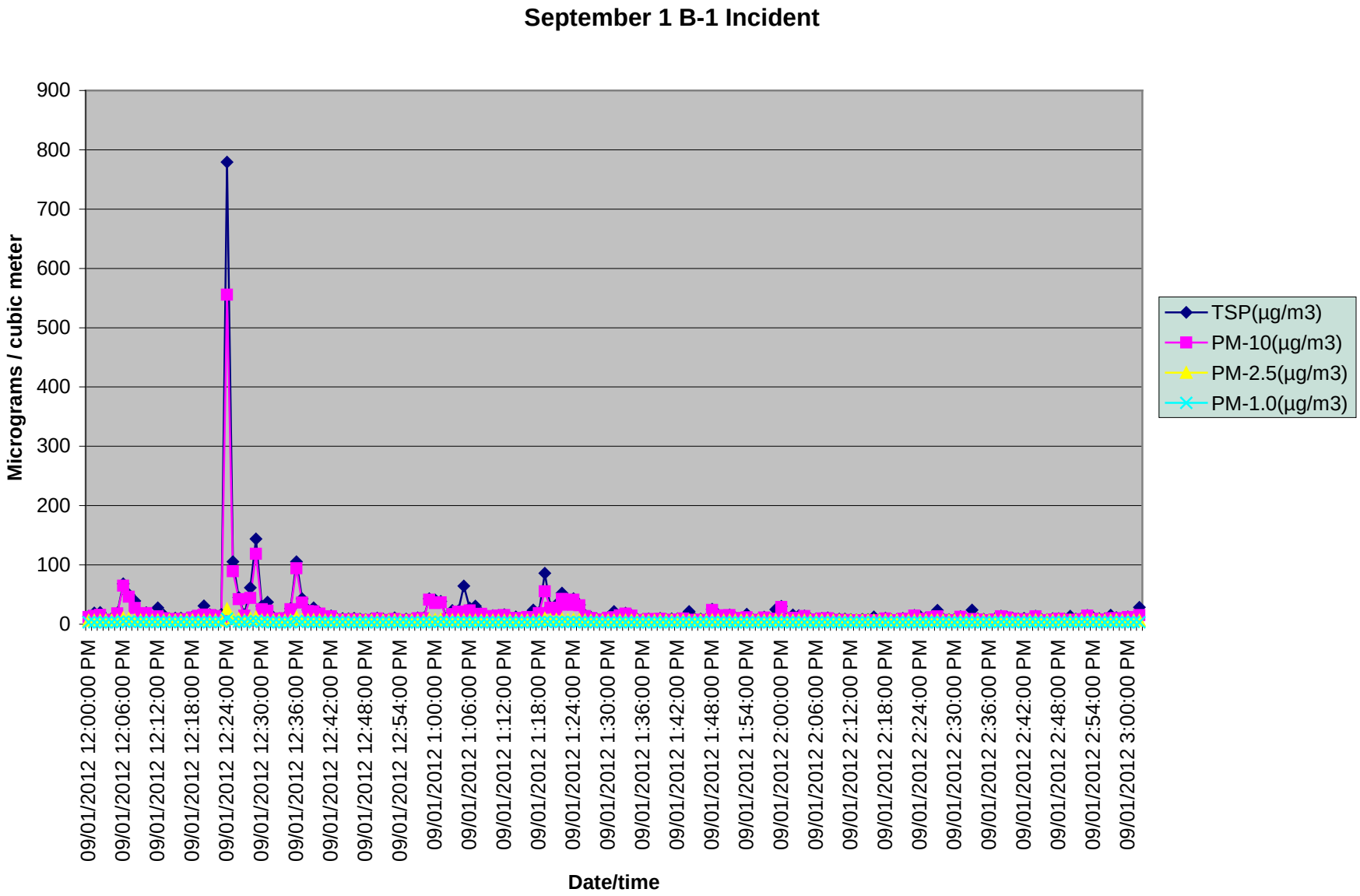


Figure 33: September 2012 incident at Station B-1

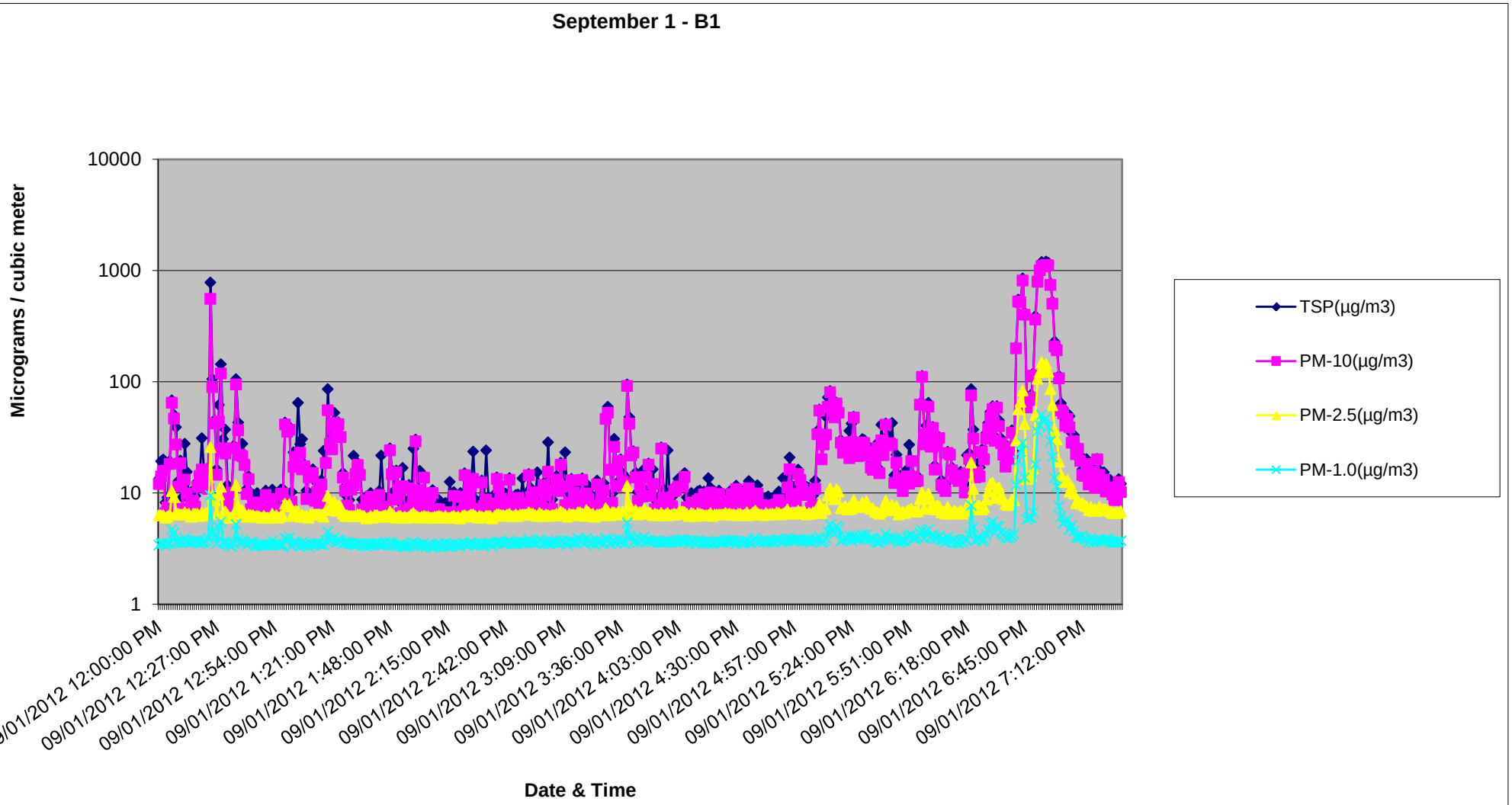


Figure 34: September 2012 Incident at Station B-1

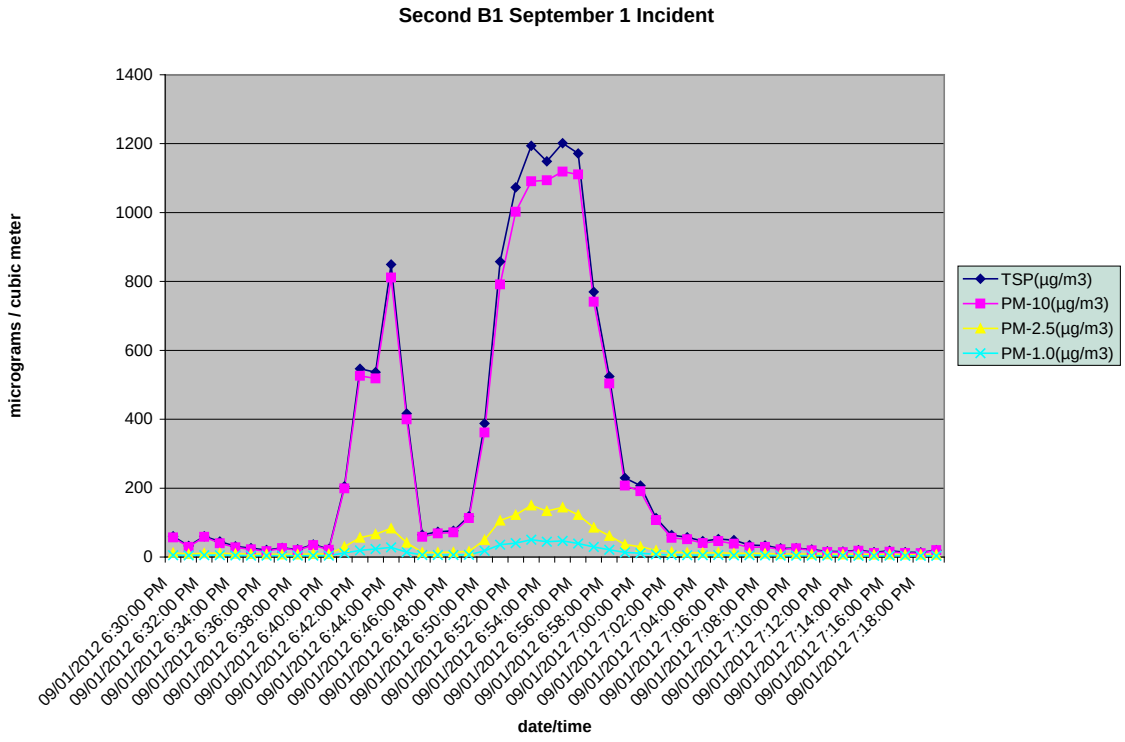


Figure 35: Second September 2012 Incident at Station B1

Please note the PM 1.0 values exceed momentary levels of 100 micrograms per cubic meter.

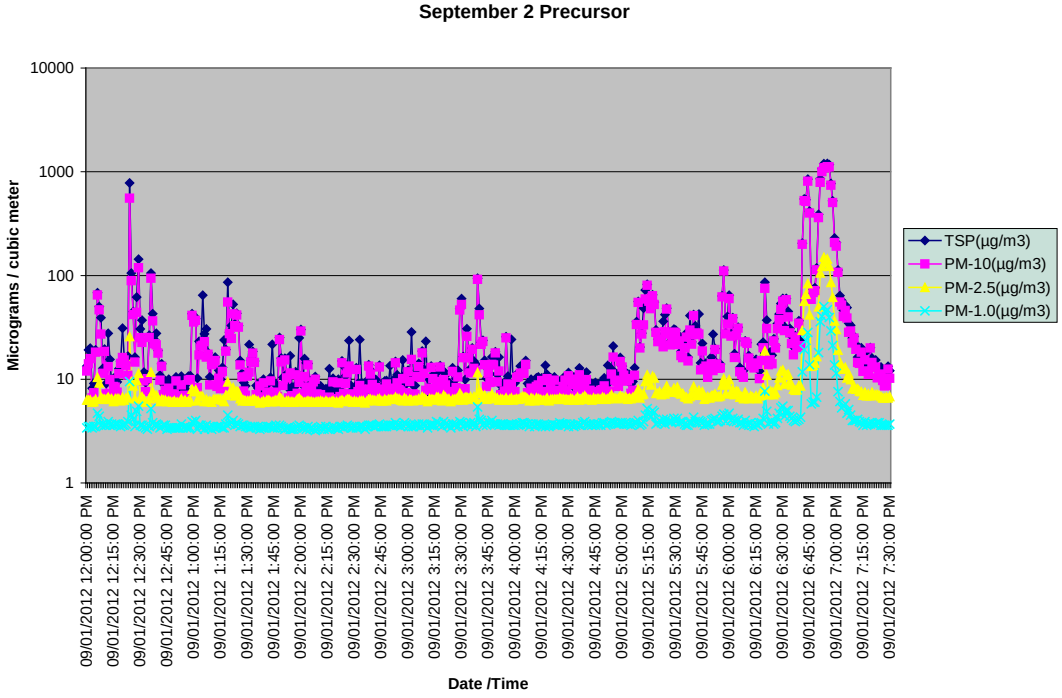


Figure 36: Station B1 September 2 event

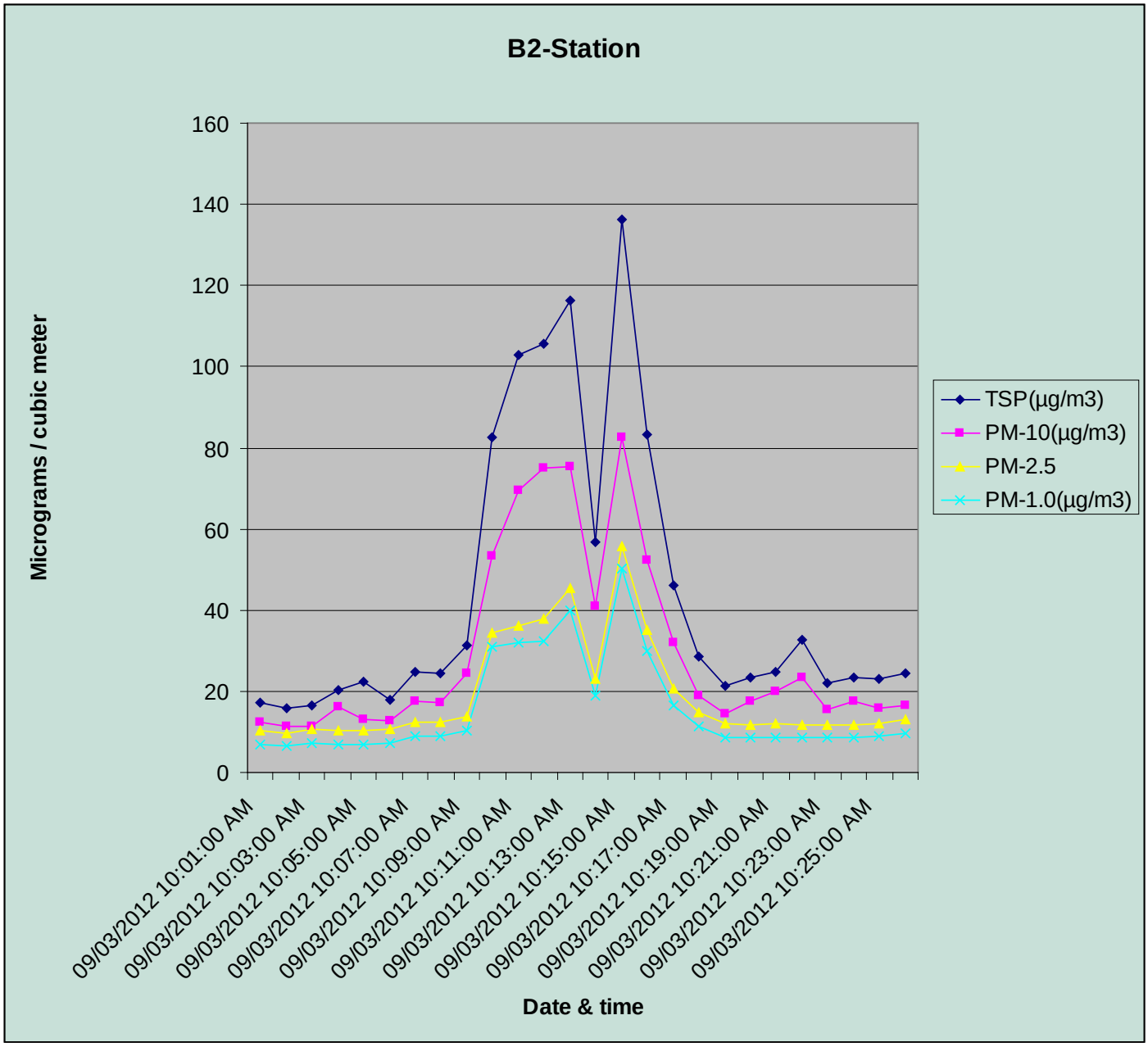


Figure 37: B2-Station demonstrating respirable particle impacts

Figure 37 shows an event in which the majority of the respirable PM 10 material is below PM 1.0. This event underscores the PNOC health concerns of sub-micron particulate.

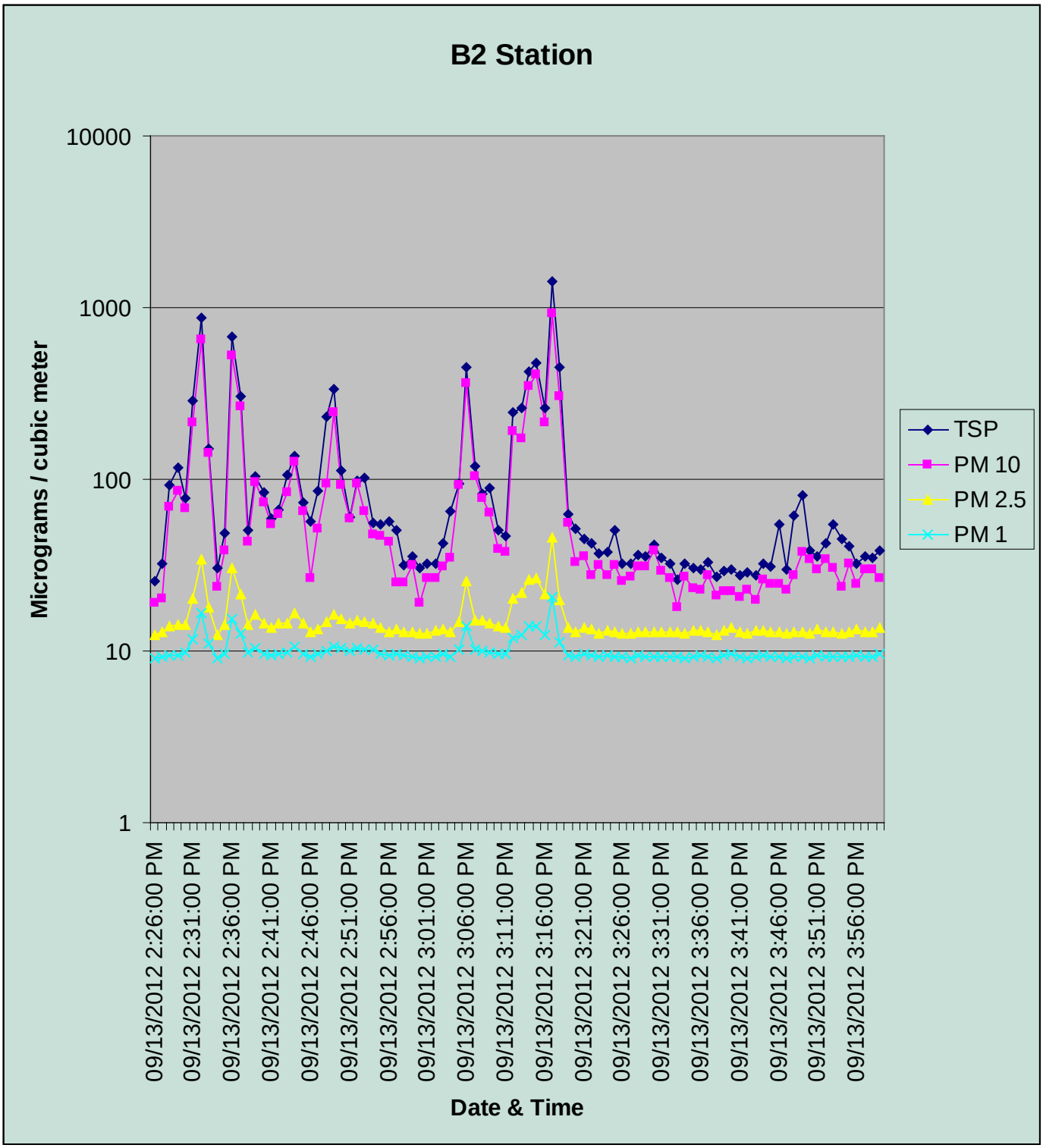


Figure 38: September 13 - Station B2

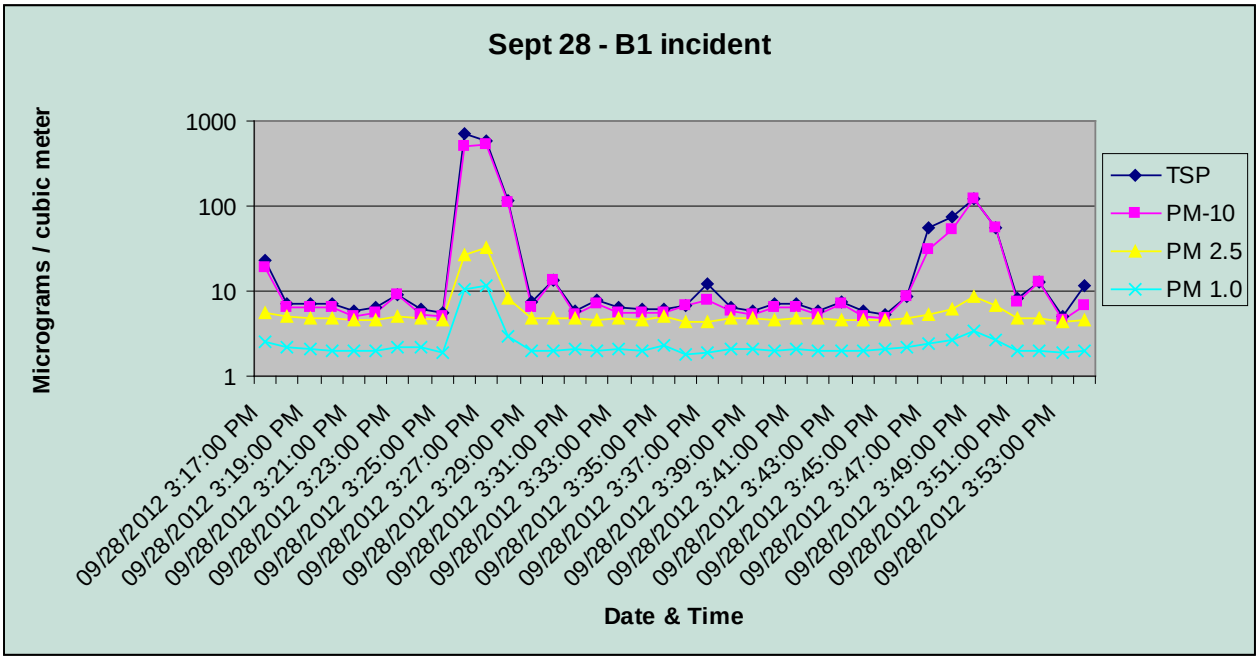


Figure 39: September 28 - B2 station

Figure 33 shows 2 elevated periods of particulate. Preliminary assessment suggests that the "Nephton North" site is the source for the first, the second period attributable to "Nephton South". The haul road may be the source of the first event. Note that TSP is mostly composed of PM 10 in figure 17(above).

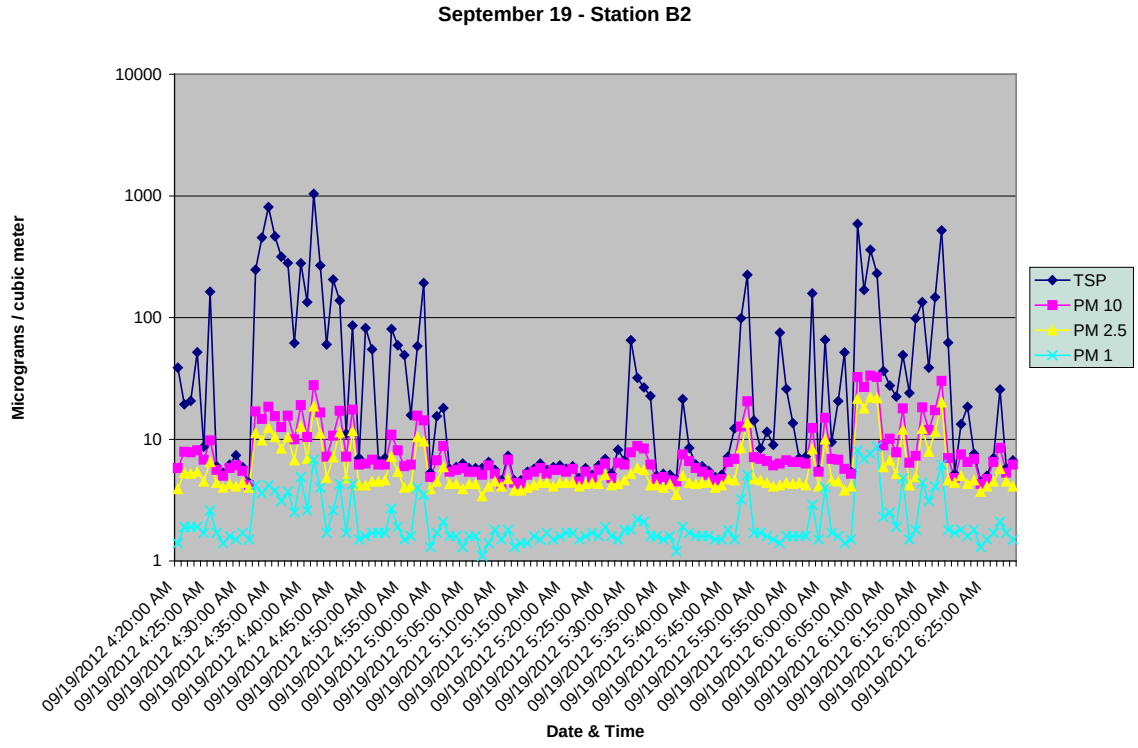


Figure 40: B2 station - September 19

The previous graphics demonstrate events of elevated respirable particle levels. In general the respirable particle levels are lower in the latter half of September. This suggests that remediation efforts have had some positive effect but have not resolved the situation.

Traffic Analysis

The suggestion that roadway dust was the source was examined. The unpaved roads in the vicinity have had local crushed rock of similar composition to materials processed by Unimin applied to them. Microscopic analysis confirms this material is still present. Officer Burt has made observations of the impact of vehicle passage and concludes that the effects are negligible in both amount and duration. A traffic study was undertaken to confirm these observations.

The County of Peterborough deployed traffic counting hardware and provided the data to the Air Quality Unit. That survey included the Labour Day weekend. A rendering of that data is below.

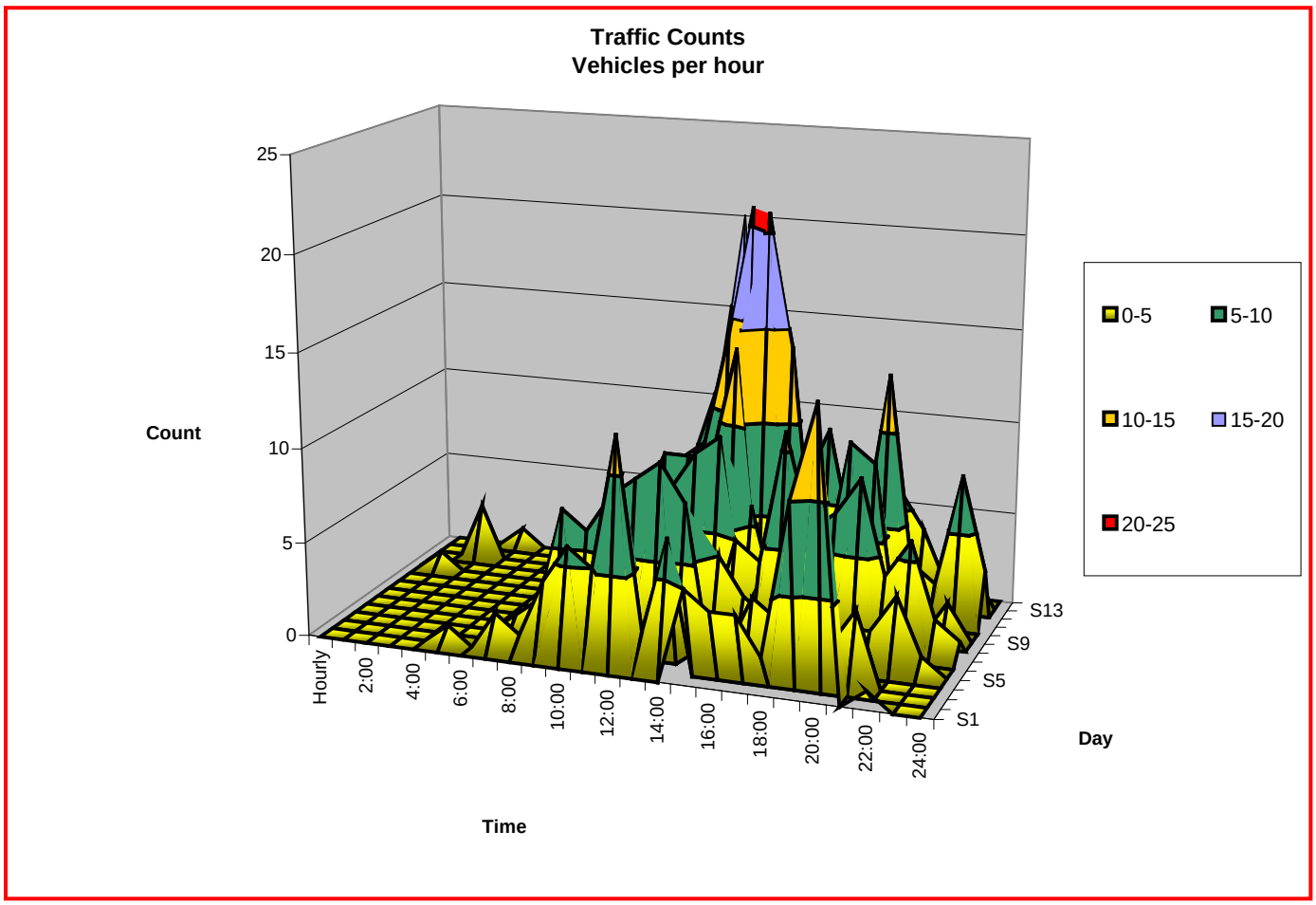


Figure 41: Traffic Counts – Labour Day Weekend 2012

Night-time traffic is essentially zero, and peak values of 20 vehicles per hour occur rarely. Officer Burt has not noted any substantial road dust impacts attributable to traffic in his personal observations.

Dustfall Analysis

Dustfall loadings on a ½ hour basis are still resulting in violations of scheduled standards in Ontario Regulation 419. These violations are severe enough to result in adverse effects and are in violation of s45, Part III, O.Reg 419/05. These dust impacts are of a sufficient character, severity, and frequency to support claims of adverse impact in context of S.14, EPA. Similar accumulations of dust have been found on MOE equipment that has been deployed. That material is visibly similar to Unimin products or tailings materials. The complainant-supplied photographs are consistent with the momentary excursion particulate values that have been observed.

The Investigations and Enforcement Branch of the Ministry (IEB) has conducted formal witness interviews with citizens residing in the study area. In general, they recount episodes of reduced visibility and particulate impacts consistent with the findings of this report.

Summary & Conclusions

- Multiple lines of evidence demonstrate that the operations at Unimin's Blue Mountain and Nephton sites have resulted in discharges of contaminants to the natural environment resulting in violations of the general provisions of the EPA and regulations made under it.
    - Discharges of particulate and dust that may cause adverse effect contrary to S14(1) of the EPA, including possible human health effects.
    - Discharges of particulate and dust that may cause adverse effect contrary to S45 of the Ontario Regulation 419/05.
    - Discharges of particulate and dust that result in a violation of the Schedule 2 standard for Dustfall contained in Ontario Regulation 419/05
    - The peak concentrations observed may pose an unusual health hazard not contemplated in the "soiling" rationale of the TSP schedules of Regulation 419/05
- High excursion values of particulates require assessment by medical professionals to determine potential health effects.
- These impacts are of an on-going nature despite mitigation attempts
- Justification exists for Ministry of the Environment intervention directed to the reduction of air quality impacts upon the study area.

Recommendations

- Advise the Regional Director of these findings
- Advise the Health Unit of these findings, and provide the MOH with copies of data and records for their consideration.

-Original Signed by -

Michael Ladouceur
Air Scientist, Provincial Officer 143
Eastern Region

Ministry of the Environment
Ministère de l'Environnement

Ontario

Report of a Provincial Officer

Air Quality Impacts of UNIMIN Ltd. on Kasshabog Lake near the Town of Havelock, Ontario

February 15, 2013

Appendix 1

Officer Paul Burt's Observation Report

Michael Ladouceur
Air Scientist
Provincial Officer 143
Air Pesticides Environmental Planning Unit
Technical Support Section
Eastern Region
Ministry of the Environment

Ministry of the Environment
Ministère de l'Environnement

February 11, 2013

UNIMIN CANADA LTD.
PARTICULATE SURVEY

Belmont, Havelock-Belmont-Methuen Township, Ontario

P.Burt
Air Quality Technician
APEP Unit
Technical Support Section
Eastern Region
Ministry of the Environment

Introduction

Chris Johnson, Provincial Officer from Peterborough District Office, requested a particulate survey in the vicinity of Unimin Canada Ltd. The Ministry has received numerous complaints of particulate drifting across Kasshabog Lake, see Figure 1. Unimin Canada owns and operates two mines in the area Nephton and Blue Mountain. Nepheline Syenite is processed at each mine site. IDS task number 2121-8UUHHR was assigned.

Method

Particulate collection would consist of real time monitoring by a GRIMM particulate analyzer. Particulate deposition will be collected by swab samples. The instrument provides particulate size fractions, PM-10, PM2.5 and PM 1.0. The instrument provides Total Suspended Particulate (TSP) concentration by software calculation. Wind speed and wind direction were monitored along with ambient conditions; temperature, humidity and barometric pressure. Two stations were setup on Kasshabog Lake where complaints had been received. One was located near the north end of the lake the other near the south end, see Figure 1. Particulates samples or swabs were collected from areas where visible particulate deposition was noted. Photographs were taken to document location and deposition. Reference material from the mine would be collected for comparison to collected material at complainant's homes. This would provide comparison of particulate samples taken by the complainant and the Provincial Officer. Samples were sent to the Ministry Laboratory for analysis by x-ray fraction, microscopy and particle size distribution.

A one week traffic study was undertaken during the survey.

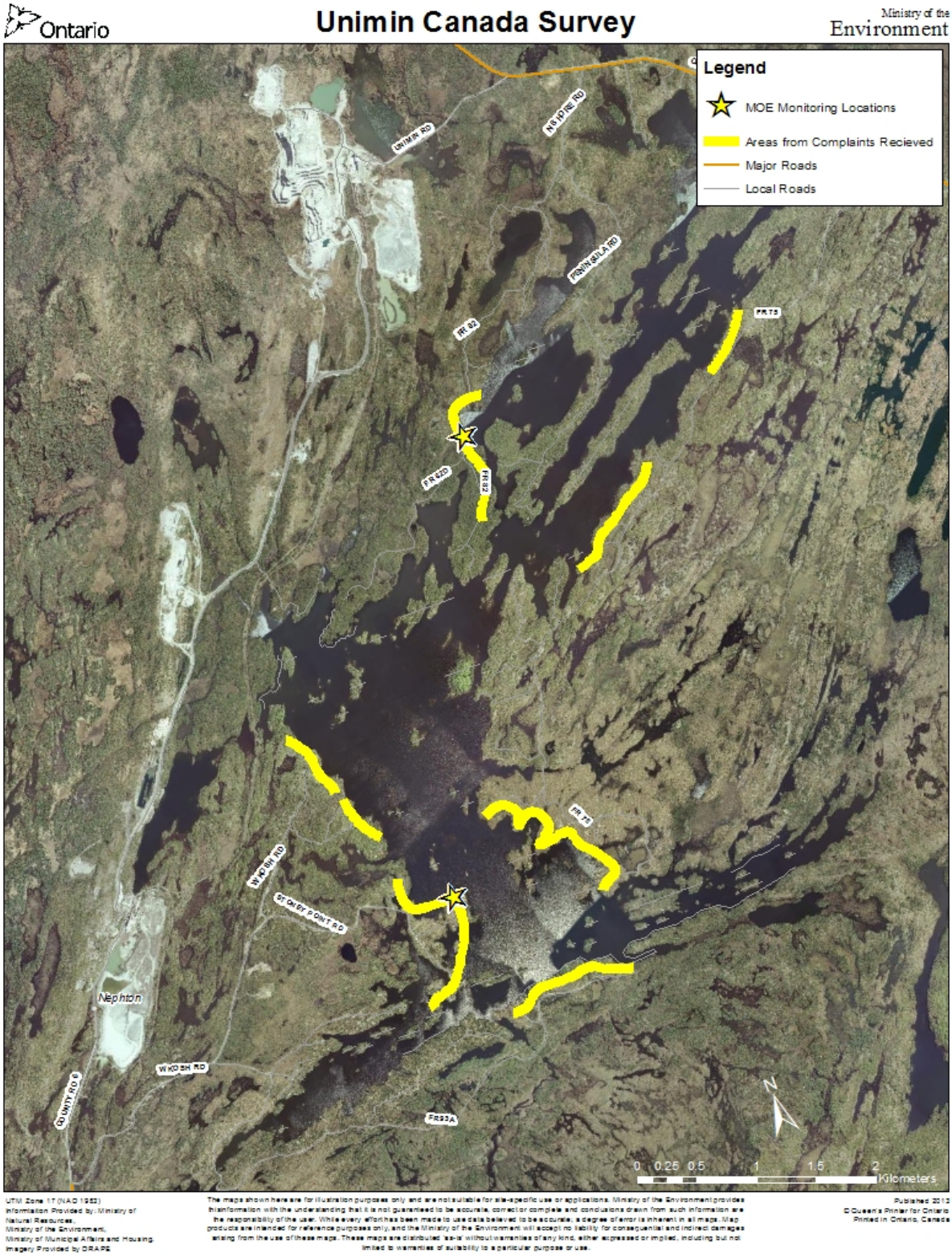


Figure 1 Unimin Canada Complainant Areas and Air Monitoring Sites

Results and Analysis

On April 26, 2012, Officer Johnson and I met with one of the complainants. We reviewed photographs taken by the home owner showing particulate on furniture both indoors and out. I walked around the property and collected particulate off the patio table and water craft.

On April 26th, Officer Johnson and I met with the Blue Mountain Plant Manager and Operation Manager. We discussed the issue of offsite particulate impacts. Abatement action was discussed on improvements to the tailings area and other related air quality improvements. Status update on progress to existing projects and planned future enhancements were discussed. Officer Johnson indicated the company should consider doing an air quality monitoring survey around Kasshabog Lake. A site visit to the two plants and tailings area was done. The company provided two of their final products they produce from Blue Mountain facility. The Nephton Mine produces similar products. Tailings samples from the Blue Mountain were taken.

On May 24, 2012, Officer Johnson and I observed particulate coming out from the side of the building at Blue Mountain Mine, Figure 2. Officer Johnson talked to Plant Manager to determine were the particulate was coming from. A transport truck was leaving around the same time with particulate plume coming off the truck, see Figure 3. Both incidents show best management practices are not being followed.

On May 24th, two GRIMM real time particulate monitors where set-up, One on Fire Route 82 the second on Fire Route 98, Figure 1. The survey concluded on November 1, 2012. Results of the data will be discussed and reported on separately by Mike Ladouceur, Regional Air Scientist.

Figure 2 Particulate Discharging from side of plant wall at Blue Mountain Mine

Figure 3 Transport truck with Product Spilt from Loading, Leaving Blue Mountain Mine

Results and Analysis continued

There were a total of 41 particulate deposition samples taken for this survey. The survey consisted of the following samples:

- 16 swabs taken by complainant
- 17 swabs by Provincial Officer
- 3 filters from the air monitoring equipment
- 3 of product and tailings for reference material and size fraction distribution
- 2 of other related material

The samples were collected from April 26, until November 1, 2012. The 16 taken by the complainant were collected from their patio table outside and from locations inside their home. The 17 samples collected by Provincial Officer were from surfaces around the complainant's homes and from the lip of the two GRIMM instruments. The GRIMM instrument has a teflon filter inside that air flows through which collects all the particulate before leaving the instrument. One filter from each monitoring station was submitted plus one filter from Fire Route 82, that was exposed for approximately one month in October. The reference samples from Unimin were Product 330 sand and MX4 Fine Product and tailing material from Blue Mountain Mine. The 2 other samples, one of white material seen on Highway 46 and the second, gravel material used on the road for Fire Route 82. Residents on Kasshabog Lake had concerns that the white material observed on Hwy 46 was caused by Unimin Mines.

The samples taken by the complainant and the Provincial Officer were sent to the Ministry of the Environment Laboratory for microscopic analysis. The Laboratory microscopic analysis results show the particle composition in percentage and provide a conclusion on possible sources. The Lab provided microscopic photographs of the three reference materials and one collected swab particulate sample. The photographs include measured particle size, see Appendix A.

The company's reference material was sent to the Ministry Lab for particle size distribution analysis. See Appendix B for laboratory analysis. The size distribution results will be further discussed in Mike Ladouceurs' report. The instrument filters were sent for microscopic analysis. The white material collected on Highway 46 was analyzed using microscopy and x-ray fraction analysis, see Figure 4. The gravel collected had just been spread on the road and had not yet been compacted by vehicles, see Figure 5. The results for all swab samples can be found in Appendix

C. A table was created to indicate the Sample Number, Collected By, Laboratory Submission Number, Date Collected and Location of Sample collected.

Figure 4 White Material on Highway 46

Figure 5 Road Material used on Fire Route 82

A complainant took 12 swab samples from their patio table and 4 swabs inside their home. The results showed: Fine ground crystals of feldspars and feldspathoids and Micas (biotite, phlogopite) in varying percentages along with a few other materials. This composition is also the same microscopic results as the reference material collected from the Blue Mountain Mine. From the samples I took, 12 samples were from the north end of the Lake and 5 were from the south end. The results showed: Fine ground crystals of feldspars and feldspathoids and Micas (biotite, phlogopite) in varying percentages along with a few other materials at both locations. This is identical to the reference material collected.

The filters from the GRIMM instrument showed identical results to the swabs collected but showed high pollen percentages on the filters that were exposed from the start of the survey to July 31, 2012. The pollen collected from the swab samples were low to trace levels but never the highest component. The filter that was exposed for approximately one month show only trace amounts of material, no conclusion could be drawn.

Photographs of the GRIMM instrument lip showed particulate deposits between site visits. See Figures 6 to 9 for examples. Figure 6 is from Fire Route 98, taken on July 31. This is 3 weeks of deposition for this site. A swab sample of particulate off the instrument shelter and inside the instrument case showed the same compositions as the reference material. The residents reported they had seen a dust cloud across Kasshabog Lake on July 17, 2012. Figures 7 to 9 were taken from Fire Route 82. Figure 7 is approximately 3 1/2 weeks exposure, figure 8, 2 1/2 weeks exposure and figure 9, 2 weeks of accumulate deposition. These photographs show the deposition occurring between three consecutive visits from August 21st to October 16, 2012. The swab sample results showed the same composition to the reference material. The deposition in Figure 8 was taken on October 2, 2012, it was the most particulate deposition I had observed since the start of the survey.

Figure 6 GRIMM located at Fire Route 98

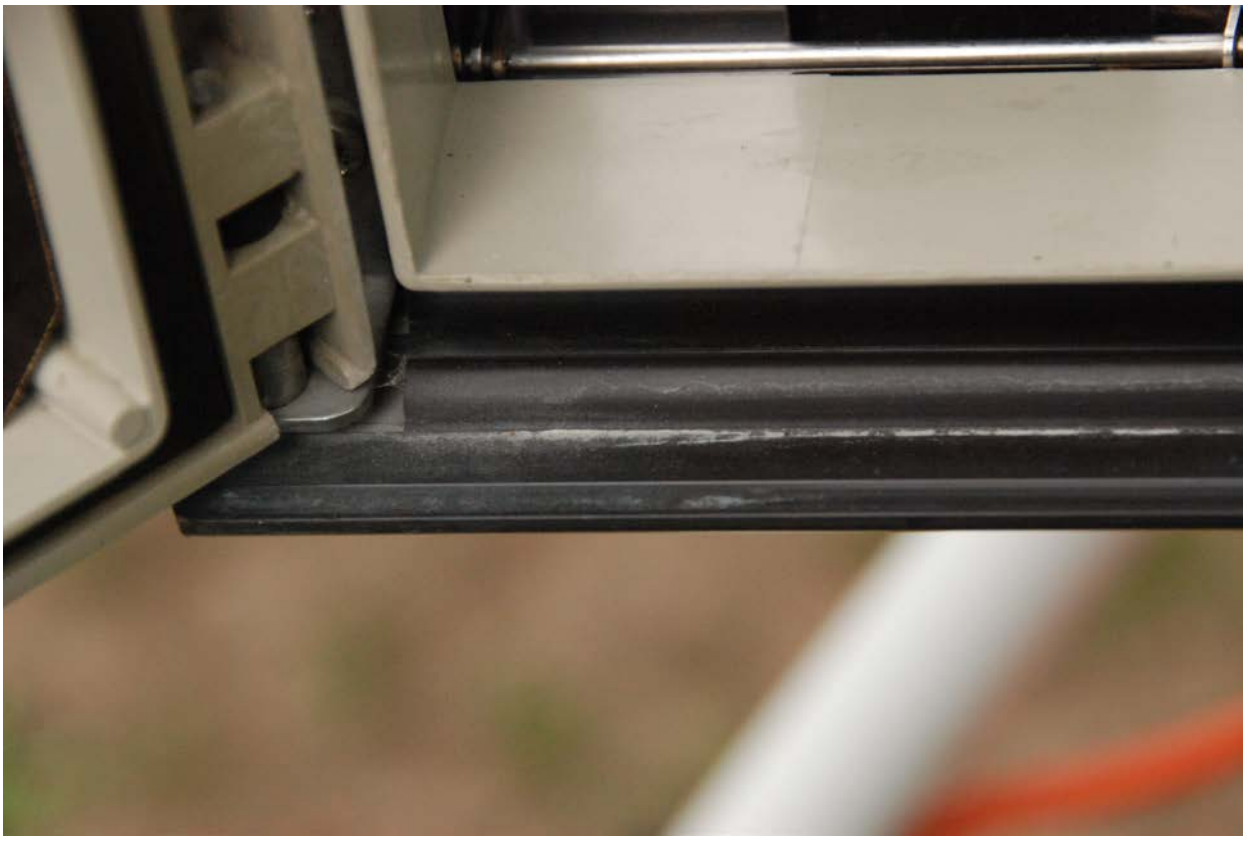


Figure 7 GRIMM located at Fire Route 82

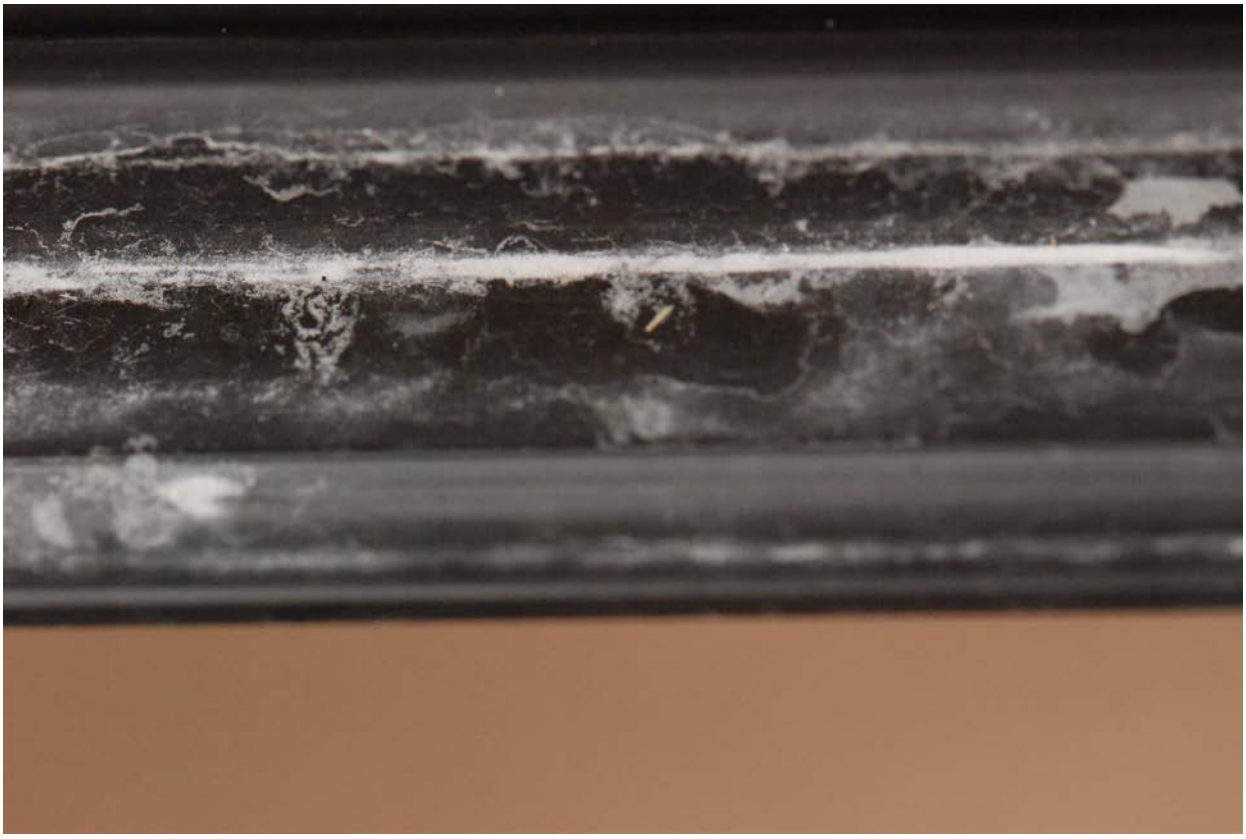


Figure 8 GRIMM located at Fire Route 82

Figure 9 GRIMM located at Fire Route 82

The sampled white road material collected from Hwy 46, results were inconclusive. The sample was analysed by microscopic and x-ray fraction. There was a presents of weathered concrete and mineral aggregates 90 % and salts 10%. The road material showed similar results to the reference material.

A road traffic survey was under taken by the County of Peterborough, at Fire Route 82 just south of Fire Route 82C. The survey started on August and was completed on September 3, 2012. See Appendix D for the results. During my visits to the site on Route 82, I observe cars passing by on August 21st and October 2, 2012. On the 21st the winds were calm 3 cars passed by one faster than the other two. The car going the fastest created a visible plume that lasted for approximately 15 seconds. The slower cars visible plume was less. On October 2nd, 4 cars passed by and no visible plume was created.

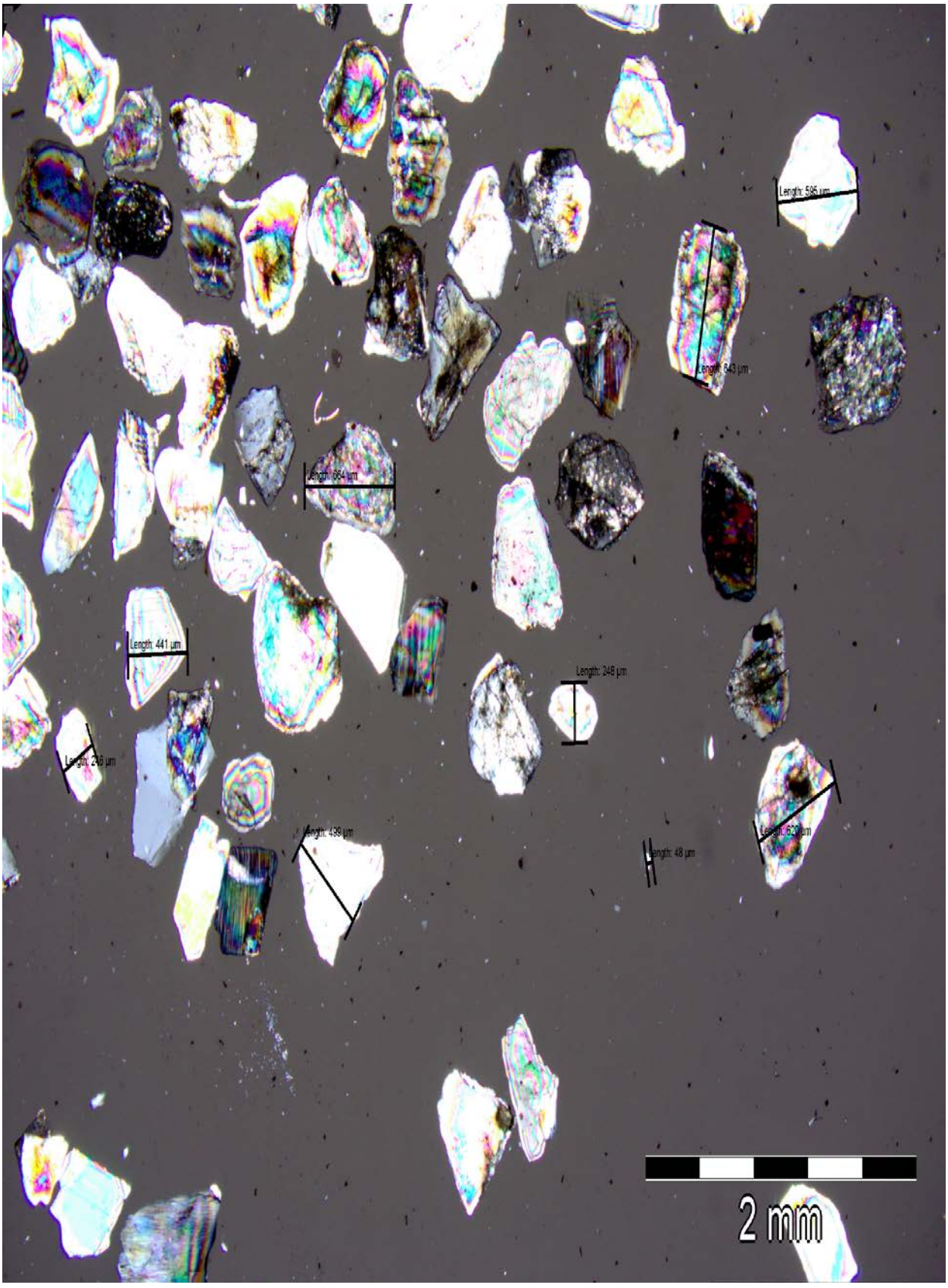
Summary and Conclusion

I had several discussions with the residents, where the air monitoring stations were located. The substance of the complaints was related to particulate residue landing on windows, outdoor furniture and getting inside their homes. The residents have expressed a health concern about the fine particulate powder. The residents observed on April 2, May 29, June 30 and July7, 2012 clouds of particulate drifting across Bottle and Kasshabog Lake. Residents of the lake emailed complaints to the Ministry regarding particulate causing itchy eyes, scratchy throats and concern about their health. I believe the residents' complaints are credible and truthful.

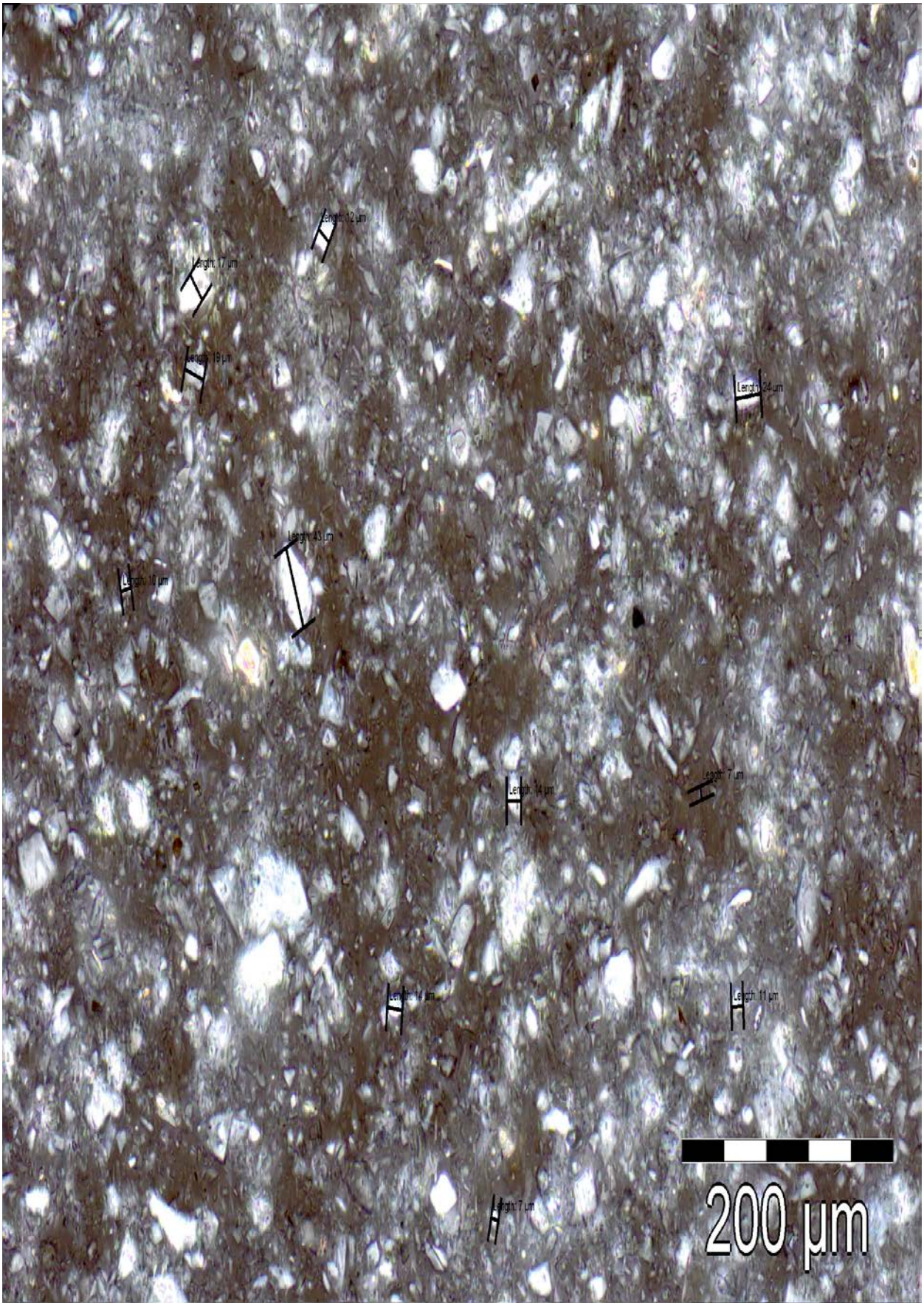
My observations and the sampling results provide evidence that off-site deposition of particulate is occurring. This evidence further supports the residents' complaints of adverse effects.

- **Original Signed By -**

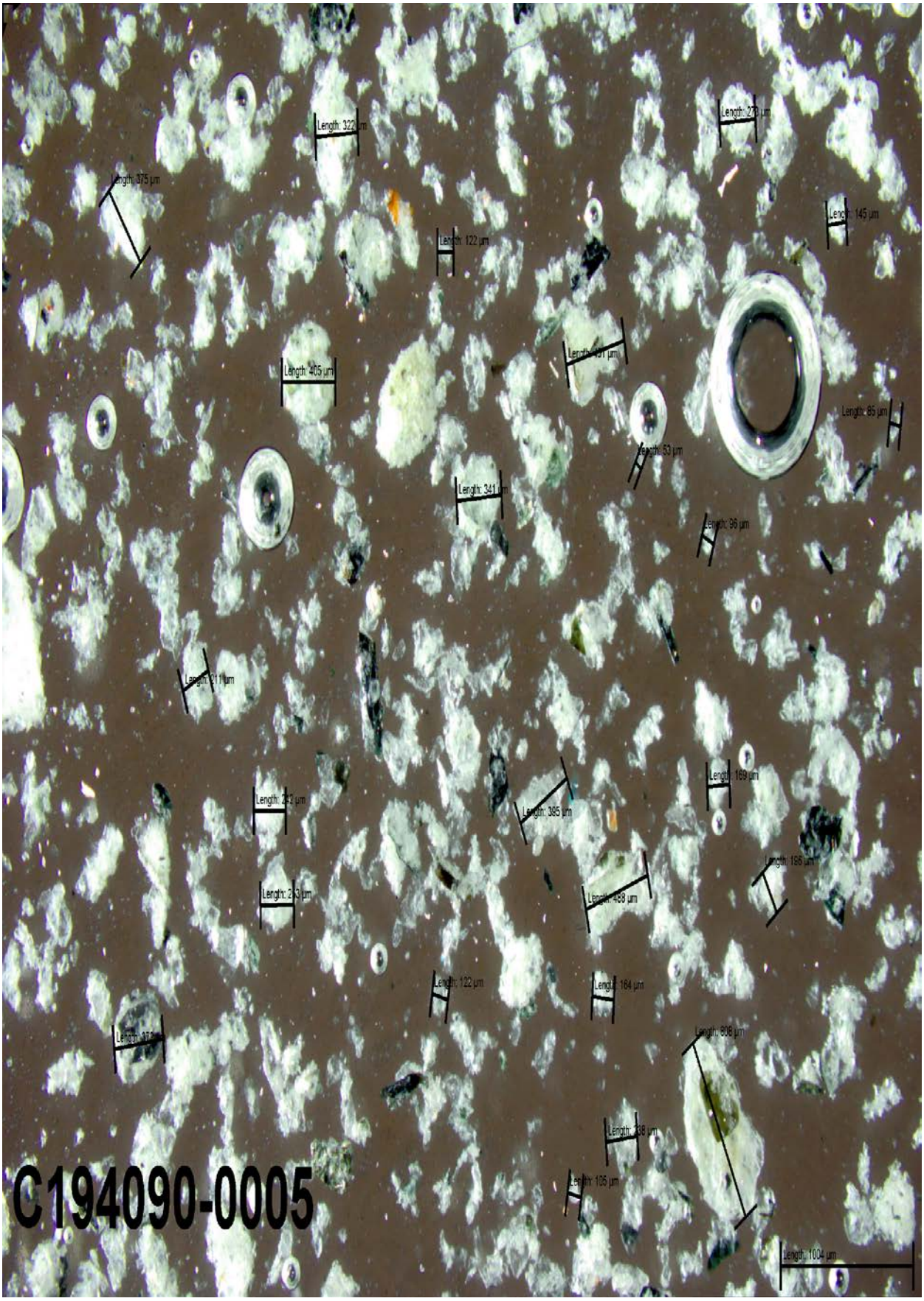
Paul Burt
Sr. Environmental Officer
APEP Unit, Technical Support
Regional file:



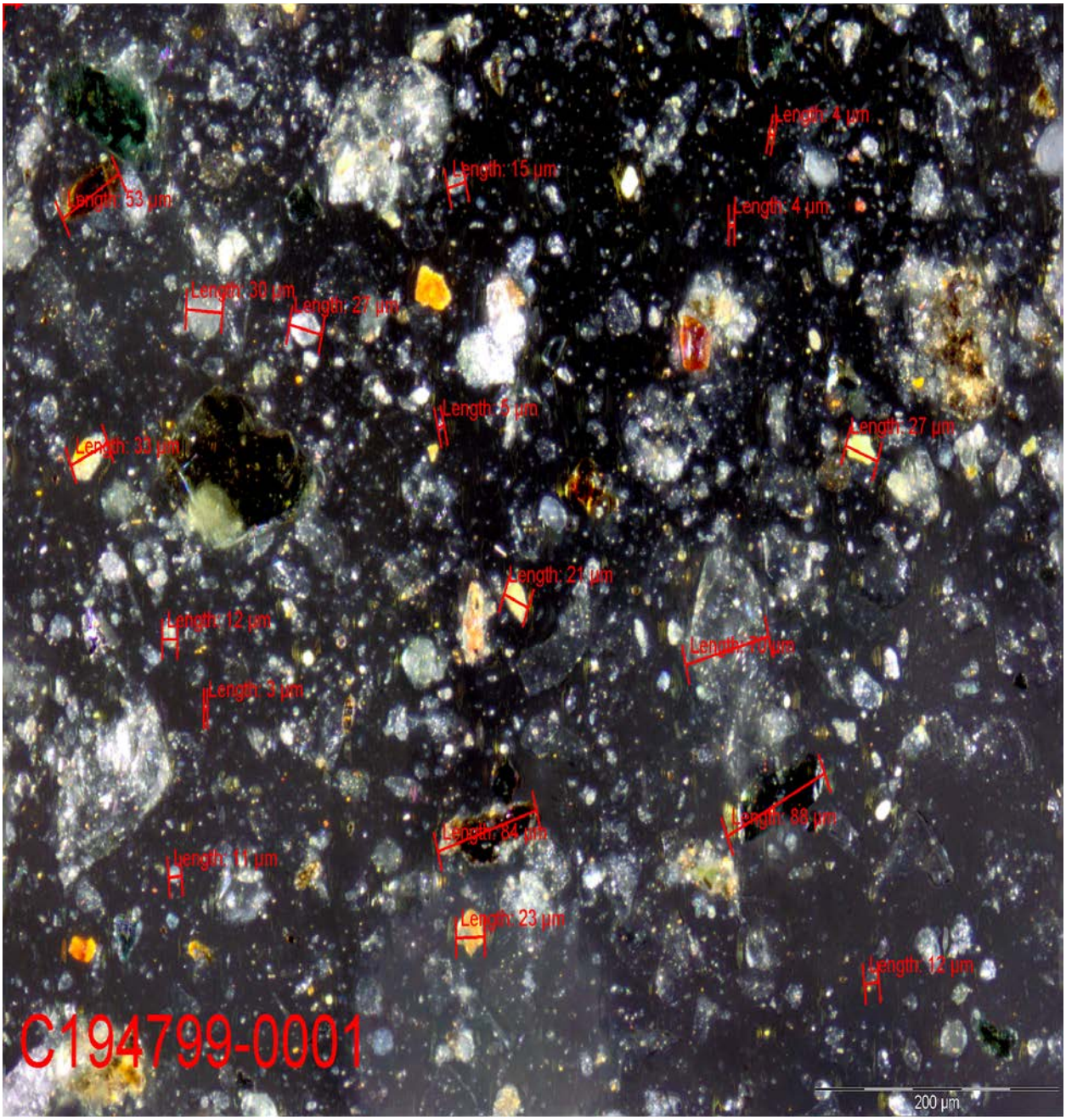
Product 330 Sand



Product Fine MX4



Tailings Blue Mountain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Length: 23 µm
Length: 12 µm
C194799-0001
200 µm

Swab Sample

APPENDIX B

Size Fraction Distrubtion

HAV-UNIM-26 Tailings Material from Blue Mountain

HAV-UNIM-27 Product 330 Sand

HAV-UNIM-28 Product MX4 Fine

fieldid	sdescription	Collectdate	Parameter Name	Test Code	Reportable Result	Units	Valqualifier
HAV-UNIM-26	BLUE MOUNTAIN TAILINGS	26-APR-2012	%Sand,very coarse(1000-2000um)	PSIZE1	0.5	%V	<=W
HAV-UNIM-26	BLUE MOUNTAIN TAILINGS	26-APR-2012	% <1000 um, >42.2 um	PSIZE4	44.5	%V	
HAV-UNIM-26	BLUE MOUNTAIN TAILINGS	26-APR-2012	% <42.2 um	PSIZE5	55.5	%V	
HAV-UNIM-26	BLUE MOUNTAIN TAILINGS	26-APR-2012	% <62 um, >42.2 um	PZ062	12.6	%V	
HAV-UNIM-26	BLUE MOUNTAIN TAILINGS	26-APR-2012	% <88 um, >62 um	PZ088	10.2	%V	
HAV-UNIM-26	BLUE MOUNTAIN TAILINGS	26-APR-2012	% <1000 um, >704 um	PZ1000	0.2	%V	<=W
HAV-UNIM-26	BLUE MOUNTAIN TAILINGS	26-APR-2012	% <10.5 um, >7.46 um	PZ10D5	5	%V	
HAV-UNIM-26	BLUE MOUNTAIN TAILINGS	26-APR-2012	% <125 um, >88 um	PZ125	8.8	%V	
HAV-UNIM-26	BLUE MOUNTAIN TAILINGS	26-APR-2012	% <14.9 um, >10.5 um	PZ14D9	6.6	%V	
HAV-UNIM-26	BLUE MOUNTAIN TAILINGS	26-APR-2012	% <176 um, >125 um	PZ176	6.6	%V	
HAV-UNIM-26	BLUE MOUNTAIN TAILINGS	26-APR-2012	% <1.01 um, >0.66 um	PZ1D01	1.4	%V	
HAV-UNIM-26	BLUE MOUNTAIN TAILINGS	26-APR-2012	% <1.69 um, >1.01 um	PZ1D69	2.4	%V	
HAV-UNIM-26	BLUE MOUNTAIN TAILINGS	26-APR-2012	% <21.1 um, >14.9 um	PZ21D1	8	%V	
HAV-UNIM-26	BLUE MOUNTAIN TAILINGS	26-APR-2012	% <250 um, >176 um	PZ250	3.6	%V	
HAV-UNIM-26	BLUE MOUNTAIN TAILINGS	26-APR-2012	% <29.8 um, >21.1 um	PZ29D8	9.2	%V	

HAV-UNIM-26	BLUE MOUNTAIN TAILINGS	26-APR-2012	% <2.63 um, >1.69 um	PZ2D63	2.4	%V	
HAV-UNIM-26	BLUE MOUNTAIN TAILINGS	26-APR-2012	% <352 um, >250 um	PZ352	1.6	%V	
HAV-UNIM-26	BLUE MOUNTAIN TAILINGS	26-APR-2012	% <3.73 um, >2.63 um	PZ3D73	2.4	%V	
HAV-UNIM-26	BLUE MOUNTAIN TAILINGS	26-APR-2012	% <42.2 um, >29.8 um	PZ42D2	10.4	%V	
HAV-UNIM-26	BLUE MOUNTAIN TAILINGS	26-APR-2012	% <500 um, >352 um	PZ500	1	%V	
HAV-UNIM-26	BLUE MOUNTAIN TAILINGS	26-APR-2012	% <5.27 um, >3.73 um	PZ5D27	3	%V	
HAV-UNIM-26	BLUE MOUNTAIN TAILINGS	26-APR-2012	% <704 um, >500 um	PZ704	0.2	%V	<=W
HAV-UNIM-26	BLUE MOUNTAIN TAILINGS	26-APR-2012	% <7.46 um, >5.27 um	PZ7D46	3.8	%V	
HAV-UNIM-26	BLUE MOUNTAIN TAILINGS	26-APR-2012	% <0.21 um, >0.10 um	PZD211	0.2	%V	<=W
HAV-UNIM-26	BLUE MOUNTAIN TAILINGS	26-APR-2012	% <0.34 um, >0.21 um	PZD34	0.2	%V	<=W
HAV-UNIM-26	BLUE MOUNTAIN TAILINGS	26-APR-2012	% <0.43 um, >0.34 um	PZD43	0.2	%V	<=W
HAV-UNIM-26	BLUE MOUNTAIN TAILINGS	26-APR-2012	% <0.66 um, >0.43 um	PZD66	0.6	%V	
HAV-UNIM-26	BLUE MOUNTAIN TAILINGS	26-APR-2012	% <62 um, >2.63 um, sum	SUM2	60.9	%V	
HAV-UNIM-26	BLUE MOUNTAIN TAILINGS	26-APR-2012	% <1000 um, >62 um, sum	SUM4	32.1	%V	
HAV-UNIM-26	BLUE MOUNTAIN TAILINGS	26-APR-2012	% <2.63 um, >0.10 um, sum	SUM5	7	%V	

HAV-UNIM-27	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	%Sand,very coarse(1000-2000um)	PSIZE1	2	%V	
HAV-UNIM-27	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <1000 um, >42.2 um	PSIZE4	97	%V	
HAV-UNIM-27	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <42.2 um	PSIZE5	1	%V	<T
HAV-UNIM-27	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <62 um, >42.2 um	PZ062	0.6	%V	
HAV-UNIM-27	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <88 um, >62 um	PZ088	1	%V	
HAV-UNIM-27	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <1000 um, >704 um	PZ1000	2.2	%V	
HAV-UNIM-27	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <10.5 um, >7.46 um	PZ10D5	0.2	%V	<=W
HAV-UNIM-27	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <125 um, >88 um	PZ125	2.8	%V	
HAV-UNIM-27	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <14.9 um, >10.5 um	PZ14D9	0.2	%V	<=W
HAV-UNIM-27	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <176 um, >125 um	PZ176	6.8	%V	
HAV-UNIM-27	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <1.01 um, >0.66 um	PZ1D01	0.2	%V	<=W
HAV-UNIM-27	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <1.69 um, >1.01 um	PZ1D69	0.2	%V	<=W
HAV-UNIM-27	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <21.1 um, >14.9 um	PZ21D1	0.2	%V	<=W
HAV-UNIM-27	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <250 um, >176 um	PZ250	14.2	%V	
HAV-UNIM-27	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <29.8 um, >21.1 um	PZ29D8	0.2	%V	<=W
HAV-UNIM-27	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <2.63 um, >1.69 um	PZ2D63	0.2	%V	<=W
HAV-UNIM-27	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <352 um, >250 um	PZ352	25	%V	

HAV-UNIM-27	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <3.73 um, >2.63 um	PZ3D73	0.2	%V	<=W
HAV-UNIM-27	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <42.2 um, >29.8 um	PZ42D2	0.2	%V	<=W
HAV-UNIM-27	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <500 um, >352 um	PZ500	30.4	%V	
HAV-UNIM-27	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <5.27 um, >3.73 um	PZ5D27	0.2	%V	<=W
HAV-UNIM-27	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <704 um, >500 um	PZ704	13.8	%V	
HAV-UNIM-27	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <7.46 um, >5.27 um	PZ7D46	0.2	%V	<=W
HAV-UNIM-27	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <0.21 um, >0.10 um	PZD211	0.2	%V	<=W
HAV-UNIM-27	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <0.34 um, >0.21 um	PZD34	0.2	%V	<=W
HAV-UNIM-27	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <0.43 um, >0.34 um	PZD43	0.2	%V	<=W
HAV-UNIM-27	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <0.66 um, >0.43 um	PZD66	0.2	%V	<=W
HAV-UNIM-27	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <62 um, >2.63 um, sum	SUM2	1.7	%V	
HAV-UNIM-27	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <1000 um, >62 um, sum	SUM4	96.2	%V	
HAV-UNIM-27	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <2.63 um, >0.10 um, sum	SUM5	0.1	%V	<=W

HAV-UNIM-28	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	%Sand,very coarse(1000-2000um)	PSIZE1	0.5	%V	<=W
HAV-UNIM-	ONE PRODUCT PRODUCED BY UNIMIN	26-APR-	% <1000 um, >42.2 um	PSIZE4	0.5	%V	<=W

28	MINE	2012					
HAV-UNIM-28	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <42.2 um	PSIZE5	100	%V	
HAV-UNIM-28	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <62 um, >42.2 um	PZ062	0.2	%V	<=W
HAV-UNIM-28	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <88 um, >62 um	PZ088	0.2	%V	<=W
HAV-UNIM-28	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <1000 um, >704 um	PZ1000	0.2	%V	<=W
HAV-UNIM-28	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <10.5 um, >7.46 um	PZ10D5	11.8	%V	
HAV-UNIM-28	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <125 um, >88 um	PZ125	0.2	%V	<=W
HAV-UNIM-28	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <14.9 um, >10.5 um	PZ14D9	13.2	%V	
HAV-UNIM-28	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <176 um, >125 um	PZ176	0.2	%V	<=W
HAV-UNIM-28	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <1.01 um, >0.66 um	PZ1D01	4.8	%V	
HAV-UNIM-28	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <1.69 um, >1.01 um	PZ1D69	8.2	%V	
HAV-UNIM-28	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <21.1 um, >14.9 um	PZ21D1	12.2	%V	
HAV-UNIM-28	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <250 um, >176 um	PZ250	0.2	%V	<=W
HAV-UNIM-28	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <29.8 um, >21.1 um	PZ29D8	6	%V	
HAV-UNIM-28	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <2.63 um, >1.69 um	PZ2D63	9.8	%V	
HAV-UNIM-28	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <352 um, >250 um	PZ352	0.2	%V	<=W
HAV-UNIM-28	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <3.73 um, >2.63 um	PZ3D73	7.6	%V	

HAV-UNIM-28	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <42.2 um, >29.8 um	PZ42D2	3	%V	
HAV-UNIM-28	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <500 um, >352 um	PZ500	0.2	%V	<=W
HAV-UNIM-28	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <5.27 um, >3.73 um	PZ5D27	9	%V	
HAV-UNIM-28	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <704 um, >500 um	PZ704	0.2	%V	<=W
HAV-UNIM-28	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <7.46 um, >5.27 um	PZ7D46	11	%V	
HAV-UNIM-28	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <0.21 um, >0.10 um	PZD211	0.2	%V	<=W
HAV-UNIM-28	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <0.34 um, >0.21 um	PZD34	0.2	%V	<=W
HAV-UNIM-28	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <0.43 um, >0.34 um	PZD43	0.2	%V	<=W
HAV-UNIM-28	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <0.66 um, >0.43 um	PZD66	3	%V	
HAV-UNIM-28	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <62 um, >2.63 um, sum	SUM2	73.9	%V	
HAV-UNIM-28	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <1000 um, >62 um, sum	SUM4	0.1	%V	<=W
HAV-UNIM-28	ONE PRODUCT PRODUCED BY UNIMIN MINE	26-APR-2012	% <2.63 um, >0.10 um, sum	SUM5	26.1	%V	

APPENDIX C

Sample Number	Collected By	Lab Submission No.	Date Collected	Location of Sample
Hav-unim-01	Provincial Officer	C194090-0001	April 26, 2012	Patio table
Hav-unim-02	Provincial Officer	-0002	April 26, 2012	Patio table
Hav-unim-03	Provincial Officer	-0003	April 26, 2012	Paddle Boat-inside
Hav-unim-04	Provincial Officer	-0004	April 26, 2012	Paddle Boat-outside
Hav-unim-05	Provincial Officer	-0005	April 26, 2012	Tailings
Hav-unim-06	Provincial Officer	-0006	April 26, 2012	Product 330 sand
Hav-unim-07	Provincial Officer	-0007	April 26, 2012	Mx4 fine grind
Hav-unim-08	Complainant	C194799-001	April 28, 2012	Patio table
Hav-unim-09	Complainant	-0002	April 30, 2012	Patio table
Hav-unim-10	Complainant	-0003	April 30, 2012	Inside
Hav-unim-11	Complainant	-0004	May 4, 2012	Patio table
Hav-unim-12	Complainant	-0005	May 4, 2012	Patio table
Hav-unim-13	Complainant	-0006	May 6, 2012	Patio table
Hav-unim-14	Provincial Officer	-0007	May 24, 2012	Highway 46
Hav-unim-15	Provincial Officer	-0008	May 31, 2012	Grimm lip
Hav-unim-16	Provincial Officer	C196238-0001	June 19, 2012	Window ledge-complainant
Hav-unim-17	Provincial Officer	-0002	June 19, 2012	Grimm lip
Hav-unim-18	Provincial Officer	-0003	July 10, 2012	Gravel
Hav-unim-19	Provincial Officer	-0004	July 10, 2012	Big goods
Hav-unim-20	Complainant	-0005	July 24, 2012	Patio table
Hav-unim-21	Complainant	-0006	July 26, 2012	Patio table
Hav-unim-22	Provincial Officer	-0007	May 24-July 31, 2012	Grimm filter
Hav-unim-23	Provincial Officer	-0008	July 31, 2012	Grimm lip
Hav-unim-24	Provincial Officer	-0009	July 31, 2012	Top of shelter-Grimm lip
Hav-unim-25	Provincial Officer	-0010	May 24-July 31, 2012	Grimm lip Bid good
Hav-unim-26	Provincial Officer	C197182-0001	April 26,2012	Particle size Tailing
Hav-unim-27	Provincial Officer	-0002	April 26, 2012	Particle size Product 330 sand

Hav-unim-28	Provincial Officer	-0003	April 26, 2012	Particle size MX4 fine grind
Hav-unim-29	Complainant	C199036-0001	August 17, 2012	Patio table
Hav-unim-30	Complainant	-0002	August 20, 2012	Inside
Hav-unim-31	Provincial Officer	-0003	August 21. 2021	Grimm Markham
Hav-unim-32	Provincial Officer	-0004	August 21, 2012	Grimm Bid Good
Hav-unim-33	Provincial Officer	-0005	August 21, 2012	Patio table @ Bid goods
Hav-unim-34	Complainant	-0006	September 5, 2012	Patio table
Hav-unim-35	Complainant	-0007	September 10. 2012	Inside
Hav-unim-36	Complainant	-0008	September 13, 2012	Patio table
Hav-unim-37	Provincial Officer	-0009	September 14, 2012	Behind hinge- lip of Grimm
Hav-unim-38	Provincial Officer	-0010	October 2, 2012	Grimm filter
Hav-unim-39	Provincial Officer	-0011	October 2, 2012	Grimm south
Hav-unim-40	Complainant	C199036-0001	September 25, 2012	Patio Table
Hav-unim-41	Complainant	-0002	September 27, 2012	Inside
Hav-unim-42	Complainant	-0003	October 4, 2012	Patio table
Hav-unim-43	Provincial Officer	-0004	October -16, 2012	Grimm North
Hav-unim-44	Provincial Officer	-0005	October 16-November 16, 2012	Grimm filter

Environmental Forensics Section

SUBMISSION: C194090
FIELD NO. SAMPLE:Hav-unim-01 to Hav-unim-07
LAB.NO.SAMPLE: C194090-0001 to 0007
AUTHORED BY: Eva Just-Przygodzka

Seven particulate material samples including three reference material samples were received from Kingston. The samples were taken at [redacted] Fine Road 82. from complainant's patio table, paddle boat. The reference material was collected from Blue Mountain tailings area and Unimin mine. Fallout of particulate material from Unimin Mine Blue Mountain was suspected.

The material was examined by means of stereoscopic and polarized microscopes.

Microscopical analyses indicated the presence of the following material:

SAMPLE NO. C194090-0001 (Hav-unim-01**)**

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Fine ground crystals of feldspars and feldspathoids	80%
2. Micas (biotite, phlogopite)	10%
3. Vegetation fibres and chips	5%
4. Pollen	5%

SAMPLE NO. C194090-0002 (Hav-unim-02**)**

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Fine ground crystals of feldspars and feldspathoids	90%
2. Micas (biotite, phlogopite)	5%
3. Vegetation fibres and chips	5%
4. Pollen	Traces

SAMPLE NO. C194090-0003 (Hav-unim-03**)**

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Fine ground crystals of feldspars and feldspathoids	90%
2. Micas (biotite, phlogopite)	5%
3. Vegetation fibres and chips	5%
4. Pollen	Traces

SAMPLE NO. C194090-0004 (Hav-unim-04**)**

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Fine ground crystals of feldspars and feldspathoids	90%
2. Micas (biotite, phlogopite)	5%

3. Vegetation fibres and chips	5%
4. Pollen	Traces

SAMPLE NO. C194090-0005 (Hav-unim-05**)**

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Fine ground crystals of feldspars and feldspathoids	90%
2. Micas (biotite, phlogopite)	10%

SAMPLE NO. C194090-0006 (Hav-unim-06**)**

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Fine ground crystals of feldspars and feldspathoids	100%

SAMPLE NO. C194090-0007 (Hav-unim-07**)**

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Powdered crystals of feldspars and feldspathoids	100%

CONCLUSIONS:

The complainant's samples contained particulate material which were similar to reference material. Therefore, the particles found on the complainant's property may have originated from Blue Mountain tailing area or Unimin mine
See micrographs with measurement of the particles in attachment.

Environmental Forensics Section

SUBMISSION: C194799
FIELD NO. SAMPLE:Hav-unim-08 to Hav-unim-15
LAB.NO.SAMPLE: C194799-0001 to 0008
AUTHORED BY: Eva Just-Przygodzka

Eight particulate material samples were received from Kingston. The samples were taken at [redacted] Fine Road 82. from complainant's property and at Hwy 46 north of Unim Road. Fallout of particulate material from Unimin Mine Blue Mountain was suspected.

The material was examined by means of stereoscopic and polarized microscopes. One sample # C194799-0007 was examined by means of an energy dispersive x-ray analyzer (EDXRA). Some micro chemical and physical tests were also done.

Microscopical, instrumental, micro chemical and physical analyses indicated the presence of the following material:

SAMPLE NO. C194799-0001 (Hav-unim-08**)**

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Fine ground crystals of feldspars and feldspathoids	80%
2. Micas (biotite, phlogopite)	10%
3. Vegetation fibres and chips	10%
4. Fabric fibres	Traces
5. Wood fibres	Traces

SAMPLE NO. C194799-0002 (Hav-unim-09**)**

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Fine ground crystals of feldspars and feldspathoids	80%
2. Micas (biotite, phlogopite)	10%
3. Vegetation fibres and chips	5%
4. Wood fibres	5%
5. Fabric fibres	Traces

SAMPLE NO. C194799-0003 (Hav-unim-10**)**

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Paper fibres	30%
2. Fabric fibres	30%

3. Vegetation fibres	20%
4. Wood fibres	10%
5. Fine ground crystals of feldspars and feldspathoids	10%
6. Micas (biotite, phlogopite)	Traces

SAMPLE NO. C194799-0004 (Hav-unim-11**)**

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Fine ground crystals of feldspars and feldspathoids	75%
2. Micas (biotite, phlogopite)	10%
3. Vegetation fibres and chips	10%
4. Fabric fibres	5%
5. Wood fibres	Traces
6. Rock debris	Traces

SAMPLE NO. C194799-0005 (Hav-unim-12)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Fine ground crystals of feldspars and feldspathoids	65%
2. Micas (biotite, phlogopite)	10%
3. Vegetation fibres	10%
4. Pollen	10%
5. Fabric fibres	5%
6. Potato starch	Traces

SAMPLE NO. C194799-0006 (Hav-unim-13**)**

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Fine ground crystals of feldspars and feldspathoids	75%

2. Micas (biotite, phlogopite)	10%
3. Pollen	10%
4. Vegetation fibres	5%
5. Potato starch	Traces

SAMPLE NO. C194799-0007 (Hav-unim-14**)**

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Weathered concrete with mineral aggregates (carbonates, micas, feldspars, feldspathoids, ferromagnesian minerals, magnetite)	90%
2. White scale of salt (NaCl)	10%

EDXRA showed the presence of the following elements:
white crystals: C, O, **Na**, Mg, Al, Si, S, **Cl**, K, Ca, Fe

SAMPLE NO. C194799-8 (Hav-unim-15**)**

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Pollen	50%
2. Fine ground crystals of feldspars, feldspathoids, micas and ferromagnesian minerals	30%
3. Mineral wool	10%
4. Vegetation fibres and chips	10%

CONCLUSIONS:

The complainant's samples contained mostly fine ground crystals of feldspars and feldspathoids that were similar to the provided reference material with sub#C194090.

Therefore, the particulate material found on the complainant's property may have originated from Blue Mountain tailing area or Unimin mine.
See micrographs with measurement of the particles in attachment.

Environmental Forensics Section

SUBMISSION: C196238
FIELD NO. SAMPLE: Hav-unim-16 to Hav-unim-25
LAB.NO.SAMPLE: C196238-0001 to 0010
AUTHORED BY: Eva Just-Przygodzka

Ten particulate material samples were received from Kingston. The samples were taken at 82 Fire Road, Lot[redacted] and [redacted] from the complainants' properties. Dust from nepheline syenite* mine – quarrying and processing facilities was suspected.

The material was examined by means of stereoscopic and polarized microscopes.

Microscopical analyses indicated the presence of the following material:

* nepheline syenite is an intrusive igneous rock, composed nepheline (feldspathoid), albite, microcline (feldspars), micas, ferromagnesian minerals.

SAMPLE NO. C196238-0001 (Hav-unim-16)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Ground minerals (feldspars, feldspathoids, micas, ferromagnesian minerals)	70%
2. Pollen	20%
3. Vegetation fibres and chips	10%

SAMPLE NO. C196238-0002 (Hav-unim-17)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Ground minerals (feldspars, feldspathoids, micas, ferromagnesian minerals)	70%
2. Pollen	20%
3. Vegetation fibres and chips	10%

SAMPLE NO. C196238-0003 (Hav-unim-18)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Gravel of nepheline syenite (feldspars, feldspathoids, micas, ferromagnesian minerals)	100%

SAMPLE NO. C196238-0004 (Hav-unim-19)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Ground minerals (feldspars, feldspathoids, micas, ferromagnesian minerals)	100%
2. Vegetation fibres	Traces

SAMPLE NO. C196238-0005 (Hav-unim-20)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Ground minerals (feldspars, feldspathoids, micas, ferromagnesian minerals)	90%
2. Biological material (insect parts)	5%
3. Vegetation fibres	5%

SAMPLE NO. C196238-0006 (Hav-unim-21)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Ground minerals (calcite, feldspars, feldspathoids, micas)	90%
2. Biological material (insect parts)	5%
3. Vegetation fibres and chips	5%

SAMPLE NO. C196238-0007 (Hav-unim-22)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)

1. Pollen	40%
2. Fine ground minerals (calcite, feldspars, feldspathoids, micas)	30%
3. Vegetation fibres and chips	30%

SAMPLE NO. C196238-0008 (Hav-unim-23)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Ground minerals (feldspars, feldspathoids, micas, ferromagnesian minerals)	100%
3. Vegetation fibres	Traces

SAMPLE NO. C196238-0009 (Hav-unim-24)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Ground minerals (feldspars, feldspathoids, micas, ferromagnesian minerals)	90%
3. Pollen	10%

SAMPLE NO. C196238-0010 (Hav-unim-25)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Pollen	50%
2. Ground minerals (calcite, feldspars, feldspathoids, micas)	30%
3. Vegetation fibres	20%

CONCLUSIONS:

The complainants' samples contained particulate material which may have originated from the following sources:

Nepheline syenite mine operations: ground minerals

Environment: pollen, vegetation fibres and chips, insect parts

Environmental Forensics Section

SUBMISSION: C197785
FIELD NO. SAMPLE:Hav-unim-29 to Hav-unim -39
LAB.NO.SAMPLE: C197785-0001 to 0011
AUTHORED BY: Eva Just-Przygodzka

Eleven particulate material samples were received from Kingston. The samples were taken from complainants' properties outside and inside of the houses. Dust from industry was suspected.

The material was examined by means of stereoscopic and polarized microscopes.

Microscopical analyses indicated the presence of the following material:

SAMPLE NO. C197785-0001 (Hav-unim-29**)**

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Fine ground minerals (feldspars, feldspathoids, micas, ferromagnesian minerals)	85%
2. Vegetation chips and fibres	10%
3. Recrystallized calcium carbonate powder	5%
4. Black, white paint droplets	Traces

SAMPLE NO. C197785-0002 (Hav-unim-30**)**

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Fine ground minerals (feldspars, feldspathoids, micas, ferromagnesian minerals)	90%
2. Vegetation chips and fibres	10%
3. Insect excrements	Traces

SAMPLE NO. C197785-0003 (Hav-unim-31**)**

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Fine ground minerals (feldspars, feldspathoids, micas, ferromagnesian minerals)	90%
2. Vegetation chips and fibres	10%
3. Mineral wool	Traces
4. Corn starch	Traces

SAMPLE NO. C197785-0004 (Hav-unim-32**)**

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Fine ground minerals (feldspars, feldspathoids, micas)	100%
2. Vegetation chips	Traces
3. Pollen	Traces

SAMPLE NO. C197785-0005 (Hav-unim-33**)**

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Fine ground minerals (feldspars, feldspathoids, micas)	70%
2. Vegetation chips	10%
3. Wood chips	10%
4. Biological material (insect parts)	5%
5. Recrystallized calcium carbonate powder	5%

SAMPLE NO. C197785-0006(Hav-unim-34**)**

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)

1. Fine ground minerals (feldspars, feldspathoids, micas, ferromagnesian minerals)	70%
2. Vegetation chips	10%
3. Wood chips and fibres	10%
4. Biological material (insect parts)	5%
5. Recrystallized calcium carbonate powder	5%
6. Fungus spores	Traces

SAMPLE NO. C197785-0007(Hav-unim-35**)**

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Fine ground minerals (feldspars, feldspathoids, micas, carbonates, ferromagnesian minerals)	70%
2. Vegetation chips	10%
3. Recrystallized calcium carbonate powder	10%
4. Fabric fibres	5%
5. Human hairs	5%

SAMPLE NO. C197785-0008(Hav-unim-36**)**

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Fine ground minerals (feldspars, feldspathoids, micas, carbonates, ferromagnesian minerals)	65%
2. Vegetation chips	10%
3. Fabric fibres	10%
4. Wood chips	10%
5. Recrystallized calcium carbonate powder	5%
6. Biological material (insect parts)	Traces
7. Aluminum metal debris	Traces

8. White plastic turnings	Traces
9. Corn starch	Traces

SAMPLE NO. C197785-0009 (Hav-unim-37**)**

QUALITATIVE ANALYSIS	Only a few particles
1. Very fine ground minerals (feldspars, feldspathoids, micas, ferromagnesian minerals)	Traces
2. Fabric fibres	Traces
3. Corn starch	Traces

SAMPLE NO. C197785-0010 (Hav-unim-38**)**

QUALITATIVE ANALYSIS	Only a few particles
1. Very fine ground minerals (feldspars, feldspathoids, micas, ferromagnesian minerals)	Traces
2. Mineral wool	Traces
3. Epithelial cells	Traces

SAMPLE NO. C197785-0011 (Hav-unim-39**)**

QUALITATIVE ANALYSIS	Only a few particles
1. Fine ground minerals (feldspars, feldspathoids, micas, ferromagnesian minerals)	Traces
2. Vegetation chips	Traces
3. Recrystallized calcium carbonate powder	Traces

CONCLUSIONS:

The complainants' samples contained particulate material which may have originated from the following sources:

Mineral grinding operation: fine and very fine ground minerals

Environment: vegetation chips and fibres, wood chips, insect parts, insect excrements, fungus spores, pollen

House: human hairs, fabric fibres, aluminum metal debris, paint droplets, corn starch,

plastic turnings, mineral wool, epithelial cells.

Construction site, house etc.: recrystallized calcium carbonate powder

Environmental Forensics Section

SUBMISSION: C199036
FIELD NO. SAMPLE: Hav-unim-40, Hav-unim-41, Hav-unim-42, Hav-unim-43, Hav-unim-44
LAB.NO.SAMPLE: C199036-0001 to 0005
AUTHORED BY: Eva Just-Przygodzka

Five particulate material samples were received from Kingston. The samples were taken at Fire Road 82, Lot [redacted] from complainant's property. Industrial particulate fallout was suspected.

The material was examined by means of stereoscopic and polarized microscopes.

Microscopical analyses indicated the presence of the following material:

SAMPLE NO. C199036-0001 (Hav-unim-40**)**

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Fine ground minerals (feldspars, feldspathoids, carbonates, micas, ferromagnesian minerals)	60%
2. Fungus spores	10%
3. Vegetation fibres and chips	10%
4. Wood chips	5%
5. Pollen	5%
6. Corn starch	5%
7. Biological material (insect parts)	5%
8. White paint droplets	Traces
9. Mineral wool	Traces
10. Aluminum metal debris	Traces
11. Calcium carbonate powder with calcite recrystallization	Traces

SAMPLE NO. C199036-0002 (Hav-unim-41**)**

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Fine ground minerals (feldspars, feldspathoids, carbonates, micas, ferromagnesian minerals)	45%
2. Vegetation fibres	10%
3. Fabric fibres	10%
4. Wheat, corn starch	10%
5. Epithelial cells	10%
6. Paper fibres	10%
7. Biological material (insect parts)	5%
8. Resinous like material	Traces

SAMPLE NO. C199036-0003 (Hav-unim-42**)**

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Fine ground minerals (feldspars, feldspathoids, carbonates, micas, ferromagnesian minerals)	70%
2. Vegetation chips and fibres	20%
4. Wheat, corn starch	10%

SAMPLE NO. C199036-0004 (Hav-unim-43**)**

QUALITATIVE ANALYSIS	Only a few particles
1. Very fine ground minerals (feldspars, feldspathoids, carbonates, micas, ferromagnesian minerals)	Traces
2. Vegetation chips and fibres	Traces
4. Corn starch	Traces
5. Epithelial cells	Traces

SAMPLE NO. C199036-0005 (Hav-unim-44)

QUALITATIVE ANALYSIS	Only a few particles
1. Mineral dust	Traces
2. Epithelial cells	Traces
3. Vegetation chips and fibres	Traces
4. Blue fabric fibres	Traces
5. Wood char	Traces

CONCLUSIONS:

The complainant's samples contained particulate material which may have originated from the following sources:

Grinding operation e.g. mine: fine ground minerals

Environment: fungus spores, pollen, vegetation chips and fibres, insect parts

House: white paint droplets, mineral wool, epithelial cells, wheat and corn starch, wood chips, wood char, fabric fibres, aluminum metal debris, resinous like material, calcium carbonate powder with calcite recrystallization, paper fibres

APPENDIX D

Provided by the County of Peterborough

Traffic Count 2012 Miscellaneous count August 28th 2012

Hourly	August 28th		August 29th		August 30th		August 31st		September 1st		September 2nd		September 3rd	
1:00		0		0		0		0		1		0		0
2:00		0		0		0		0		0		3		0
3:00		0		0		0		0		0		0		1
4:00		0		0		0		0		0		0		0
5:00		1		0		0		0		0		0		0
6:00		0		0		0		0		0		0		0
7:00		2		1		0		0		0		0		0
8:00		1		2		0		0		0		1		3
9:00		4		7		1		4		2		2		2
10:00		6		6		2		1		5		3		0
11:00		5		8		2		7		8		7		7
12:00		12		9		3		7		8		8		11
13:00		2		10		2		9		8		14		20
14:00		7		8		3		10		14		21		4
15:00	5		1		5		5		6		21		9	
16:00	4		1		3		4		1		14		6	
17:00	4		4		2		11		8		2		9	
18:00	2		3		6		6		3		3		3	
19:00	10		2		1		7		10		4		6	
20:00	15		2		2		9		9		13		6	
21:00	0		4		2		4		0		3		4	
22:00	1		0		4		6		0		2		1	
23:00	0		0		1		2		2		8		2	
24:00	0		0		0		1		0		3		0	
Total	**81**		**68**		**39**		**93**		**85**		**132**		**94**	

Start Date: August 28th

End Date: September 3rd

Counter # 10

Location Description: Located on FR 82 just south of FR 82c