



SENE Consultants Limited

Specialists in Energy, Nuclear and Environmental Sciences

**AIR QUALITY MONITORING
AT GIANT MINE SITE – YELLOWKNIFE
A BASELINE STUDY
(Volume 6 – 2009)**

Prepared for:

Indian and Northern Affairs Canada

Giant Mine Remediation Project
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March 2010

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Indian and Northern Affairs Canada

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1.0 INTRODUCTION

As a part of the Giant Mine Remediation Project (GMRP), and establishment of baseline conditions, the sixth round of air quality monitoring was carried out during the summer of 2009. Similar to the annual summer monitoring programs dating back to 2004, the purpose of the 2009 summer monitoring was to establish a baseline for the fugitive particulate emissions pertaining to the tailings areas and other on-site sources such as disturbed areas and travelled routes. The 2009 sampling program consisted of ambient air monitoring of TSP at the nearest residential location in the Giant Mine Town Site, and both TSP and PM₁₀ at four locations within the boundary of the Giant Mine site. Similar to all previous monitoring campaigns, the 2009 program consisted of 24-hour sampling on every 6th-day at all five sampling locations. The sampling program was undertaken to determine total and inhalable particulate loading, as well as their inorganic trace element (metal) content.

This report provides details of the monitoring program, the results and discussion of the findings, comparisons between 2009 data and data from the previous monitoring programs, as well as conclusions and recommendations. Reference should be made to the reports entitled “*Air Quality Monitoring at Giant Mine Site – Yellowknife, A Baseline Study Volume 1* through to *Volume 5* for details on the monitoring programs from 2004 through to 2008, respectively.

1.1 OVERVIEW OF THE GIANT MINE REMEDIATION PROJECT

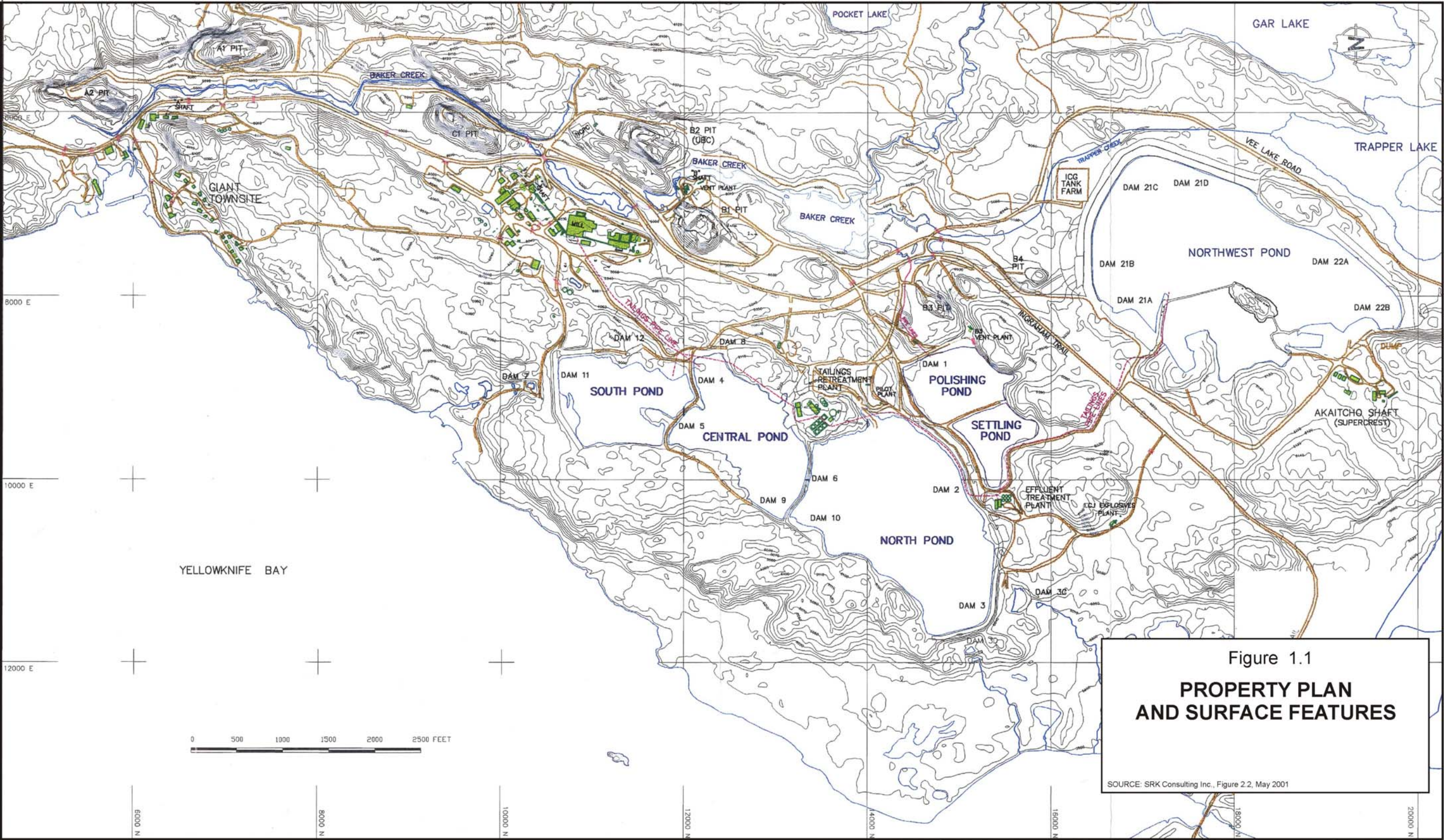
The Giant Mine, consisting of a mine, mill and roasting operation located within the city limits of Yellowknife on the west shore of Yellowknife Bay on Great Slave Lake, operated between 1948 and 1999. Prior to 1999, ore extracted from an extensive network of underground mine workings and open pits was processed through the mill and roaster facility for gold recovery. The surface facilities at the site are shown on Figure 1.1. They include the South, Central, North and Northwest Tailings Ponds which were developed to contain tailings (gangue material left after recovery of the gold) produced in the mill. Other surface features on the Giant Mine site include the settling and polishing ponds, which continue to be used to remove chemical precipitates produced in the mine water treatment plant, several pits (A1, A2, B1, B2, B3, B4 and C1) and numerous surface structures. Arsenic trioxide, a by-product of the roaster operation, was disposed in shallow vaults and chambers developed in the underground mine workings.

In 1999, Royal Oak Mines, the owner/operator at the time, was forced into receivership. A court appointed interim receiver transferred Giant Mine to the federal Department of Indian Affairs and Northern Development (DIAND). Immediately following this transfer, the mine was sold to Miramar Giant Mine Ltd. (MGML). MGML resumed mining at the site in 2000 and continued to do so until June 2004. All ore extracted from the mine during this period was processed at MGML parent company's Con operation located on the southern edge of the City of

Yellowknife. Under a separate agreement with MGML, as the agreement concluded June 2005, DIAND funds the ongoing care and maintenance necessary to protect public health and safety as well as to maintain environmental compliance at the mine.

DIAND and the government of the Northwest Territories signed a cooperation agreement respecting the Giant Mine Remediation Project in March 2005. Under this agreement, both parties agree to finalize a site wide Remediation Plan and be co-proponents through the regulatory process for the Plan. Both parties will cooperate and share costs for the implementation of the Remediation Plan. In the interim, the two governments also agreed to share costs for the ongoing care and maintenance of the site until such time that the Remediation Plan is implemented.

Figure 1.1 – Property Plan and Surface Features



1.2 OVERVIEW OF THE STUDY

SENES was retained by DIAND to design and set-up an air quality-monitoring program before the start of the remediation activities at the Giant Mine site. The monitoring program was developed to meet the following objectives:

- (1) To establish a baseline for the ambient particulate matter loading and inorganic trace element concentrations (specifically arsenic) at and around the Giant Mine site. These data are intended to augment the database on off-site measurements of particulate matter concentrations, which were historically collected at the community of Ndilo and continue to be collected in the City of Yellowknife. In addition, the on-site data are intended to provide base information for comparison to the effects of future planned remediation activities at the Giant Mine site.
- (2) To collect simultaneous samples of particulate matter of less than 10 micron in size (PM_{10}) as well as Total Suspended Particulates (TSP), in order to determine the ratio of concentrations of the two particulate size fractions (i.e., PM_{10} : TSP) and to ensure that sufficient sample is collected for inorganic trace element analysis (PM_{10} sample may not accumulate sufficient mass for trace element analysis). The ratio will be used as a guide to establish the monitoring protocol that is to be implemented during the remediation activities at the Giant Mine site.

The air quality monitoring program was implemented from July through September of each year since 2004. Simultaneous sampling of TSP and PM_{10} began in 2004 at one location only. The 2004 results indicated that 75% of the arsenic appeared to be associated with the coarse particles in TSP. In light of the health-related importance of the PM_{10} (inhalable) fraction, it was recommended that the monitoring program be modified to conduct simultaneous monitoring of TSP and PM_{10} at all of the on-site monitoring locations. This was implemented during the 2005 sampling program and has continued through all of the monitoring programs since.

This summary report for the 2009 monitoring program is organized into five sections. Section 2 presents applicable ambient air quality criteria for the subject pollutants. Section 3 provides an overview of the methodology, sampling equipment and implementation of the monitoring program. Section 4 includes a discussion of 2009 results. Section 5 provides a comparison analysis between the current and historical results, while Section 6 provides the conclusions and recommendations.

2.0 APPLICABLE AIR QUALITY CRITERIA

For the purpose of this study, the ambient air quality criteria set by the Northwest Territories (NWT) Environmental Protection Act (EPA) were used. For pollutants not addressed by the NWT's EPA, criteria from other jurisdictions, such as the Ontario Ministry of the Environment (MOE), were used.

2.1 PARTICULATE MATTER

The term 'particulate matter' describes all airborne solid and liquid particles of microscopic size, with the exception of pure water. The suspended portion of particulate matter generally consists of particles less than 40 to 50 microns (μm) in diameter. These particles can include a broad range of chemical species, such as elemental and organic carbon compounds, sulphates, nitrates and trace metals. Particle diameter (and shape) is reflective of the origin of particulate matter; larger suspended particles often originate from crustal material and smaller particles are largely derived from combustion processes.

Ambient air quality objectives for Canada (and other countries) were initially based on total suspended particulate matter (TSP). In Canada, TSP is a general term which applies to a wide variety of solid or liquid particles of a size and configuration such that they tend to remain suspended in the air and can thus be drawn into the respiratory passages. Other measures of particulate matter are inclusive of a larger range of sizes (for example, Environment Canada uses the term total particulate matter which includes all particles with diameters below 100 microns).

PM_{10} consists of particles that are less than or equal to 10 microns in aerodynamic diameter. The PM_{10} fraction poses a health concern because it can accumulate in the respiratory system. Many studies over the past few years have indicated that PM_{10} in the air is associated with various adverse health effects in people who already have compromised respiratory systems due to asthma, chronic pneumonia and cardiovascular problems.

The NWT 24-hour ambient air quality objective for TSP is $120 \mu\text{g}/\text{m}^3$. For PM_{10} , neither the NWT nor the Canada-Wide Standard (CWS) setting process has defined an acceptable limit. Consequently, the interim 24-hour PM_{10} objective/standard adopted by the British Columbia Ministry of Water, Land and Air Protection (WLAP), the Ministry of Environment and Conservation in Newfoundland and Labrador, and the Ontario Ministry of the Environment (MOE) was used for the purpose of this study (see Table 2.1).

Table 2.1 – Ambient Air Quality Criteria for TSP and PM₁₀

Pollutant	Averaging Period	Guideline Level	Ambient Air Quality Criterion
TSP	24-Hours	NWT	120 µg/m ³
PM ₁₀	24-Hours	B.C., Newfoundland and Labrador, and Ontario	50 µg/m ³

2.2 INORGANIC TRACE ELEMENTS

Suspended particulate matter, and specifically PM₁₀, is a mixture of chemically and physically diverse dusts and droplets, and some of these components may be important in determining the effects of PM₁₀ on health. Therefore, with the knowledge of Giant Mine's historic precious metal recovery operation and the presence of some potentially toxic inorganic trace elements (e.g., arsenic) at the site (especially in tailings ponds), it was determined that trace element analysis on the particulate matter samples collected during the three-month monitoring program was appropriate.

In assessing the health risk associated with the inorganic trace element constituents of the suspended particulate matter, the concentrations are compared against regulatory ambient air quality criteria, which in the case of trace elements, are primarily based on health impact. Since no guidelines/objectives were defined by the NWT's EPA or Alberta Environment for 24-hour ambient air inorganic trace element concentrations, the MOE's ambient air quality criteria, as defined in the MOE's Ambient Air Quality Criteria (AAQCs) document (see Table 2.2), were used as the criteria for determining the relative significance of trace element concentrations in the particulate matter samples from the Giant Mine sampling program.

Table 2.2 – Ambient Air Quality Criteria for Inorganic Trace Elements (24-hour)

Elements	AAQC ⁽¹⁾ (µg/m ³)
Aluminium	n/a
Antimony	25 (incl. compounds)
Arsenic	0.3 (incl. compounds)
Barium	10 (total water soluble)
Beryllium	0.01 (incl. compounds)
Boron	120
Cadmium	0.025 (incl. compounds)
Calcium	n/a
Chromium	1.5 (di and trivalent forms)
Cobalt	0.1
Copper	50
Iron	4 (metallic)
Lead	0.5 (and lead compounds)
Manganese	2.5 (compounds, including permanganates)
Molybdenum	120
Nickel	2
Potassium	n/a
Selenium	10
Silver	1
Strontium	120
Tellurium	10
Tin	10
Vanadium	2
Zinc	120

(1) Ontario Ministry of the Environment's Ambient Air Quality Criteria

3.0 EQUIPMENT AND METHODOLOGY

3.1 EQUIPMENT

For the 2009 monitoring program, eight (8) AirMetrics Mini-Vols and one (1) Tisch Environmental Hi-Vol sampler were deployed.

The Mini-Vol sampler is a portable sampling device that can be used to sample Total Suspended Particulates (TSP), PM₁₀ and particulate matter less than 2.5 µm in diameter (PM_{2.5}). The samplers use a small diaphragm pump to draw air through a 47 mm filter with pore size of 0.8 µm at a rate of approximately 5 L/min. The sampler can be powered using DC power from rechargeable batteries supplied with the unit, or from AC power, by plugging the charger into an AC source (at the Giant Mine DC power from rechargeable batteries is employed). On several occasions in 2008 the batteries failed to keep charge resulting in sample durations less than the desired period of 24-hours. The government of the Northwest Territories states that a sample must run within 25% of the desired sample duration in order to be valid. Out of a total of 136 attempted samples, a total of 44 samples (32%) were found to be invalid and therefore not considered appropriate for inclusion in the analysis. Performance has deteriorated compared to 2008, in which 22% of attempted samples were found to be invalid. It is recommended that batteries be replaced annually if DC power from rechargeable batteries is used. Details of the Mini-Vol samplers and sampling methodology are provided in Appendix A.

The High Volume (Hi-Vol) TSP sampler used for this monitoring program was a Volumetric Flow Controlled (VFC) type, equipped with a vacuum motor to pull air through an 8" X 10" filter supported on a wire-mesh at a flow rate of 42 to 45 cfm (~1,200 L/min). The unit was calibrated using a 30" water manometer. The same criterion for exclusion of samples that did not run for an acceptable duration ($\pm 25\%$ of the desired duration) also applies to the hi-vol samples. The sampling efficiency in 2009 was very low at 24%, which is half that of 2008 in which only 50% of attempted samples were valid. Details of sampling procedure are provided in Appendix B.

3.2 METHODOLOGY

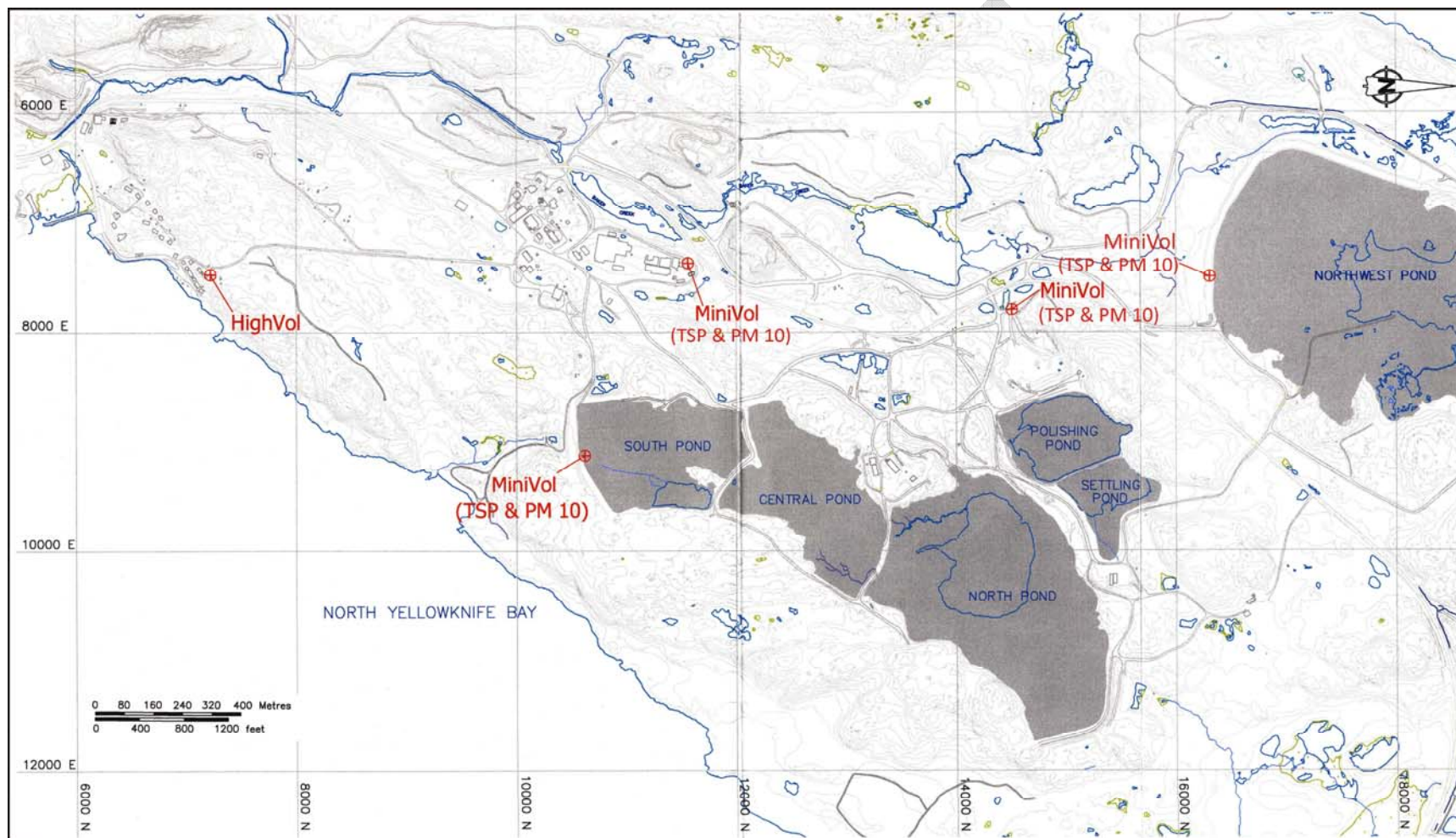
3.2.1 Monitoring Locations

Monitoring locations were established at the outset of the monitoring initiative and have remained constant over the course of the various summer monitoring campaigns. The locations were established based on a review of the average observed wind data over a five-year period at the Yellowknife Airport. The predominant winds are from the east as will be discussed in

Section 4.1 (see Figure 4.1). The locations chosen for the five monitors are shown on Figure 3.1, followed by descriptions and photographs of each.

DRAFT

Figure 3.1 – Location of Air Quality Sampling Sites



SOURCE: Adapted From SRK Consulting Inc., Figure 4.7-1, October 2005

Monitoring Location #1 (Giant Mine Townsite): The Hi-Vol TSP monitor was located in the Town south of the mill/roaster complex. The primary objective for this monitor was to determine ambient levels of total suspended particulate matter and arsenic at the nearest residences to the mine (see Figure 3.2).

Figure 3.2 – Monitoring Location #1 (Giant Mine Townsite)



Monitoring Location #2 (South end of South Tailings Pond): Two Mini-Vols were located at the south end of the tailings pond to monitor both TSP and PM₁₀ emissions from the tailings (see Figure 3.3), as well as to provide a measure of particulate matter and arsenic concentrations that might be transported towards the residential areas on Latham Island. Two Mini-Vols were used to determine the relationship between PM₁₀ and TSP, as per Section 1.2.

Figure 3.3 – Monitoring Location #2 (South End of South Tailings Pond)



Note: One monitor is shown as the photograph was taken in 2004 when there was only one monitor at this location. There are now two monitors (TSP and PM₁₀).

Monitoring Location #3 (Mill/Roaster Complex): Two Mini-Vols were located at the north end of the mill/roaster complex, in close proximity to the road (see Figure 3.4), to monitor both TSP and PM₁₀ emissions. At this location, the monitors are directly downwind of the prevailing easterly winds from the South Pond and east-northeasterly winds from the Central Pond, as well as downwind of south-southeasterly winds from the mill/roaster complex.

Figure 3.4 – Monitoring Location #3 (Mill/Roaster Complex)



Note: One monitor is shown as the photograph was taken in 2004 when there was only one monitor at this location. There are now two monitors (TSP and PM₁₀).

Monitoring Location #4 (Junction of Vee Lake Road and Ingraham Trail, B3-Pit): Two Mini-Vols were located in the vicinity of this road to monitor both TSP and PM₁₀ emissions. At this location, the monitors are downwind of the prevailing easterly winds from the Polishing Pond, the Settling Pond and the North Pond. As well, it is a suitable location to monitor emissions from the nearby roads (see Figure 3.5).

Figure 3.5 – Monitoring Location #4 (B3 Pit)



Note: One monitor is shown as the photograph was taken in 2004 when there was only one monitor at this location. There are now two monitors (TSP and PM₁₀).

Monitoring Location #5 (South of Northwest Pond): A pair of Mini-Vols were located on the south side of the Northwest Pond to monitor both TSP and PM₁₀ emissions. This monitoring location was added as per SENES' recommendation in the 2005 monitoring report, for the purpose of better distinguishing between emissions that may originate from the Northwest Pond and those that are emitted from the nearby roads (see Figure 3.6).

Figure 3.6 – Monitoring Location #5 (South of Northwest Pond)



3.2.2 Monitoring Frequency and Duration

A total of 92 valid Mini-Vol samples and 4 valid Hi-Vol samples were collected during the three months (June to September 2009) of monitoring. The 24-hour sampling was carried out on a 6-day cycle at all the sampling locations (both Hi-Vols and Mini-Vols). The sampling was completed on the same 6-day schedule as the Government of Northwest Territories' (GNWT) to allow subsequent comparison of the results, if deemed appropriate. The GNWT sampling is performed on the same schedule as Environment Canada's National Air Pollution Surveillance (NAPS) Network sampling program.

3.2.3 Analysis

The 47 mm Mini-Vol Quartz filters and the 8" x 10" Hi-Vol Quartz filters were conditioned and pre-weighed inside a humidity-controlled chamber in order to reduce errors due to variation in the humidity that may be adsorbed by the filters. For post-weighing, the filters were placed inside the same humidity controlled chamber as used in the pre-weighing, until stabilized. The gravimetric results were reported as the difference between the pre-weight and post-weight of the filters.

After the gravimetric analysis, the filters were analyzed for trace elements using acid digestion followed by Inductively Coupled Plasma – Mass Spectroscopy (ICP-MS), in accordance with the U.S. Environmental Protection Agency's (EPA) method SW-6020.

All analyses were conducted at Maxxam Analytics Inc. in Mississauga, Ontario.

3.2.4 QA/QC

The Quality Assurance/Quality Control (QA/QC) program for the sampling study consisted of detailed chain of custody. Analytical QA/QC procedures were also carried out by Maxxam Analytics.

INAC to provide additional details on QA/QC protocols/practices that are in place and followed by field staff.

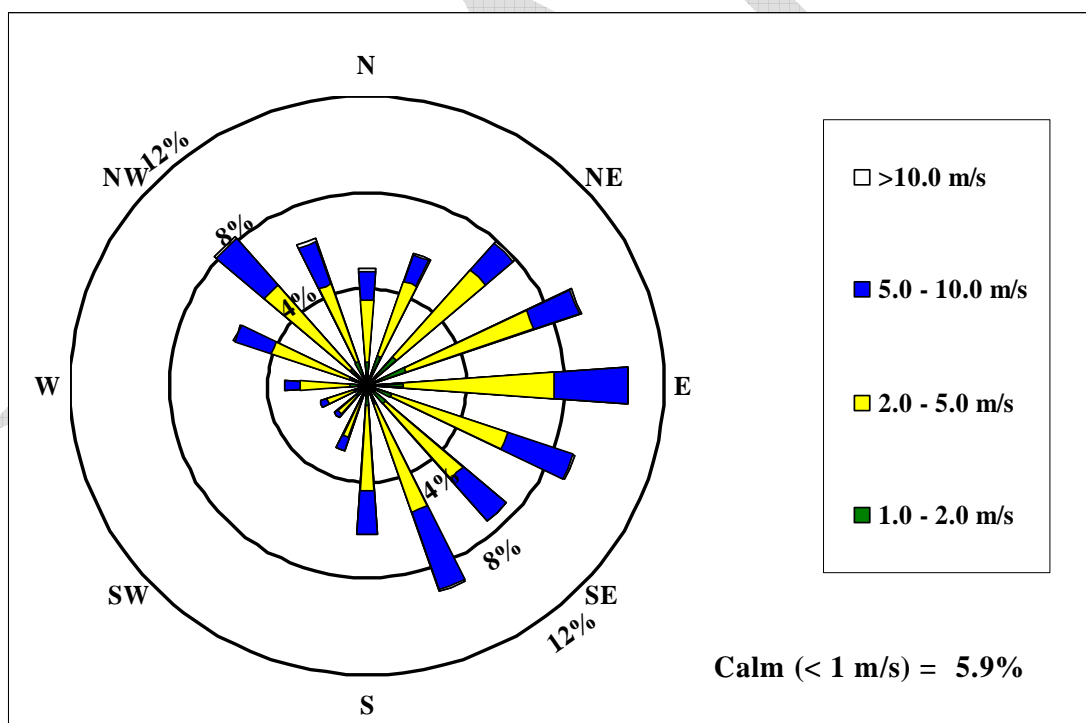
4.0 RESULTS AND DISCUSSION

4.1 METEOROLOGICAL CONSIDERATIONS

In analyzing the impact of the Giant Mine site on the local suspended particulate matter levels, and to determine which of the on-site source(s) (e.g., tailings ponds) have the greatest contribution to the ambient air suspended particulate levels, it should be recognized that meteorological conditions play an important role in the generation and dispersion of fugitive dust. Wind contributes to the levels of particulate matter in three ways. First, if sufficiently strong, wind can re-suspend dust. Second, wind disperses any particulate matter already suspended in the air. Third, wind enhances evaporation, leading to surface drying and a subsequent increase in the potential for the release of dust particles.

Figure 4.1 illustrates the 5-year (1996 to 2000) average wind speeds and percent frequencies by direction for Yellowknife Airport Meteorological Station.

Figure 4.1 – Windrose for Yellowknife Airport (1996 to 2000)



As shown in Figure 4.1, the predominant wind direction has a strong easterly (from the east) component. Winds out of the northwest and south-southeast occur at a relatively lower frequency, but with a slightly higher speed than the predominant easterly winds.

Temperature near the surface controls the buoyant component of turbulence (vertical motion). Heat from the earth's surface warms the air near the ground causing it to rise, reaching a maximum in the early afternoon and a minimum near sunrise. The near-surface temperature also controls how fast the surface dries. If the temperature is low, the moisture on the surface of the ground may remain or freeze, effectively sealing the surface from wind erosion and thereby reducing re-suspension of surface dust.

Precipitation also affects suspended particulate matter and dustfall levels. Most rainfall events are of limited duration, but their effectiveness as dust suppressors lasts considerably longer than the rainfall events themselves. Rain can also wash particulate matter and dust out of the air.

The monthly averages of daily temperature and precipitation for the Yellowknife Airport Meteorological Station, for the months of June, July, August and September 2009 are provided in Table 4.1.

Table 4.1 – Average Temperature and Precipitation Data at Yellowknife Airport (2009)

Temperature:	June	July	August	September
Daily Average (°C)	12.2	15.8	14.8	10.4
Daily Maximum (°C)	16.8	19.8	18.6	13.8
Daily Minimum (°C)	7.6	11.8	11.1	7.0
Precipitation:				
Rainfall (mm)	48.8	35.0	38.2	77.2
Snowfall (cm)	0	0	0	0
Precipitation (mm)	48.8	35.0	38.2	77.2
Average Snow Depth (cm)	0	0	0	0
Median Snow Depth (cm)	0	0	0	0
Snow Depth at Month-end (cm)	0	0	0	0

4.2 TSP AND PM₁₀ RESULTS

Gravimetric results for the TSP and PM₁₀ fractions are summarized in Table 4.2. Exceedances of ambient air quality criteria are indicated in bold in this table. This table illustrates that the 24-hour criteria values for TSP and PM₁₀ in ambient air were exceeded consistently throughout the monitoring program, and exceedances were noted at all of the on-site monitoring locations.

Table 4.2 also includes a summary of various statistical parameters calculated using the measured data at each location. As expected, the monitoring results from the off-site location at

the nearest residential receptor (i.e., Giant Mine Town Site) were significantly lower than those at the on-site monitoring locations. In previous years the highest average TSP and PM₁₀ concentrations were in most cases detected at the Northwest Pond site. Last year (2008), the highest average TSP concentration was noted at the B3 Pit. In 2009, the highest TSP concentration was noted at the Northwest Pond, while the highest PM₁₀ concentration was noted at the Mill location.

Note that in Table 4.2, 95th and 98th percentile values have been carried forward for consistency with historical reports. These parameters are not typically calculated on small datasets and should therefore be used with caution.

Figure 4.2 depicts the variability in TSP concentrations between the five sampling locations, while Figure 4.3 illustrates the variability in PM₁₀ concentrations among the on-site monitoring locations (PM₁₀ was not measured at the off-site location).

Table 4.2 – Results of TSP and PM₁₀ Measurements

Sampling Date	Giant Mine Town Site	South Pond		B3 Pit		Mill		NW Pond	
		TSP	PM ₁₀	TSP	PM ₁₀	TSP	PM ₁₀	TSP	PM ₁₀
6-Jun-09	NI	NS-INS	ND	NS-INS	41.7	ND	NS-INS	NS-INS	ND
12-Jun-09	NS-INS	111.1	55.6	166.7	69.4	41.7	ND	NS-INS	ND
18-Jun-09	NS-INS	69.4	69.4	69.4	83.3	NS-INS	123.5	NS-INS	55.6
24-Jun-09	NS-INS	NS-INS	69.4	69.4	69.4	111.1	NS-INS	NS-INS	41.7
30-Jun-09	NS-INS	125.0	NS-INS	69.4	69.4	69.4	NS-INS	83.3	55.6
6-Jul-09	NS-INS	83.3	55.6	83.3	83.3	55.6	NS-INS	NS-INS	69.4
12-Jul-09	NS-INS	83.3	83.3	83.3	55.6	83.3	NS-INS	NS-INS	NS-INS
18-Jul-09	7.8	NS-INS	83.3	125.0	69.4	83.3	85.0	NS-INS	83.3
24-Jul-09	12.3	111.1	NS-INS	NS-INS	111.1	111.1	NS-INS	NS-INS	69.4
30-Jul-09	12.3	57.7	NS-INS	111.1	NS-INS	NS-INS	NS-INS	NS-INS	111.1
5-Aug-09	NS-INS	139.5	97.2	111.1	69.4	97.2	NS-INS	111.1	111.1
11-Aug-09	11.2	NS-INS	83.3	97.2	41.7	110.7	NS-INS	125.0	69.4
17-Aug-09	NS-INS	NI	NI	NI	NI	NI	NI	NI	NI
23-Aug-09	NS-INS	111.1	111.1	97.2	69.4	83.3	NS-INS	111.1	111.1
29-Aug-09	NS-INS	97.2	83.3	83.3	96.8	69.4	NS-INS	263.9	69.4
4-Sep-09	NS-INS	69.4	55.6	55.6	ND	ND	NS-INS	111.1	ND
10-Sep-09	NS-INS	83.3	NS-INS	69.4	69.4	69.4	NS-INS	69.4	41.7
Maximum	12.3	139.5	111.1	166.7	111.1	111.1	123.5	263.9	111.1
98th Percentile	12.3	136.3	108.3	155.8	107.4	111.1	122.7	247.2	111.1
95th Percentile	12.3	131.5	104.2	139.6	101.8	111.1	121.5	222.2	111.1
Arithmetic Mean	10.9	95.1	77.0	92.3	71.4	82.1	104.2	125.0	74.1
Geometric Mean	10.7	92.1	75.1	88.5	69.1	79.1	102.5	114.7	70.2
Median	11.8	90.3	83.3	83.3	69.4	83.3	104.2	111.1	69.4

Notes:

All the samples exceeding the AAQC of 120 µg/m³ for TSP or 50 µg/m³ for PM₁₀ are shown in **bold** in the table.

ND – Not Detectable (i.e., below the laboratory detection limit)

NI – No Information (i.e., filter was not submitted to the laboratory)

NS-INS – No Sample due to Insufficient Data (i.e., sample excluded due to unacceptable sample duration)

ND data were not included in calculation of statistics

Figure 4.2 - Variability in TSP Concentrations at All Locations (June – September 2009)

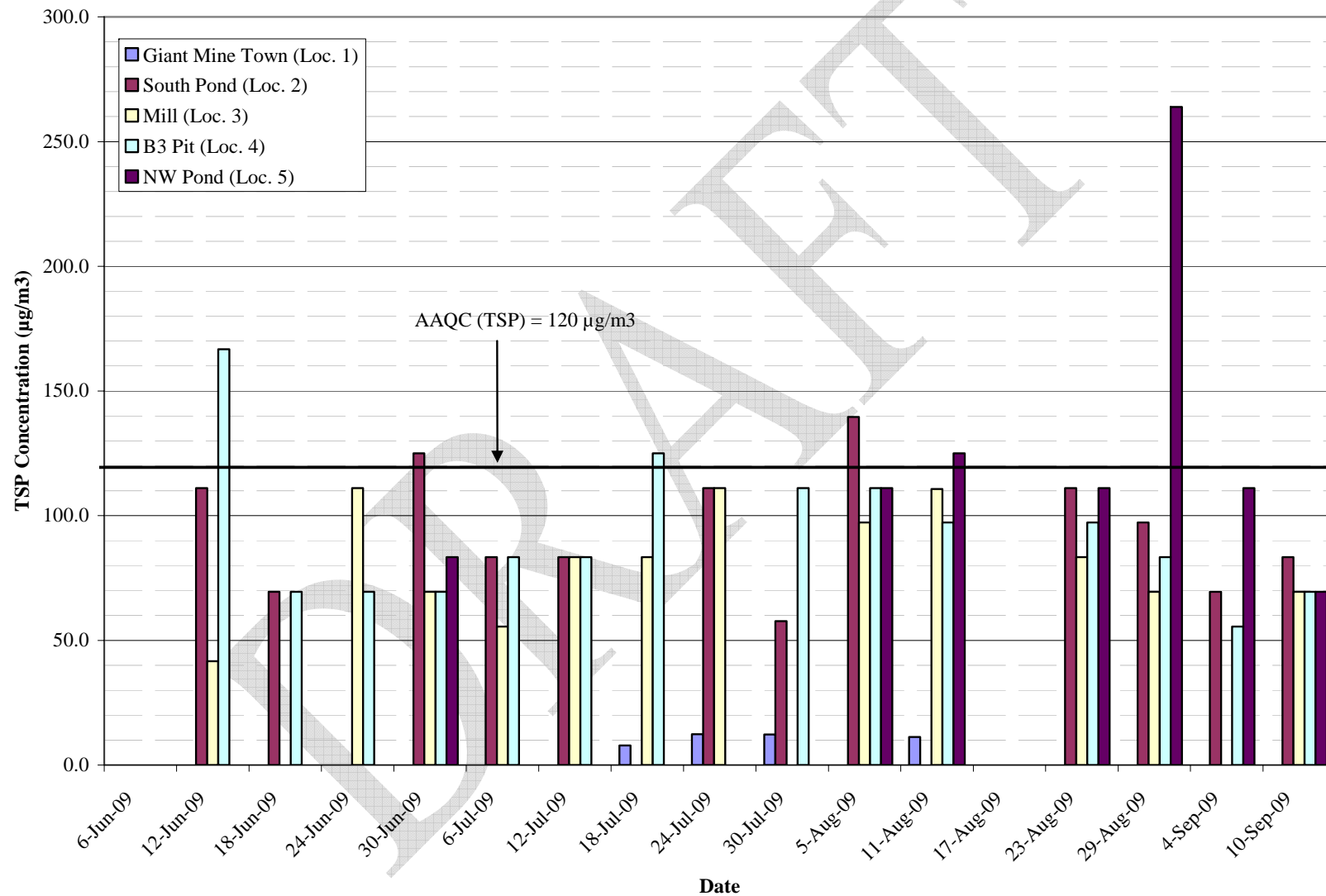


Figure 4.3 - Variability in PM₁₀ concentrations at Locations 2 – 5 (June to September 2009)

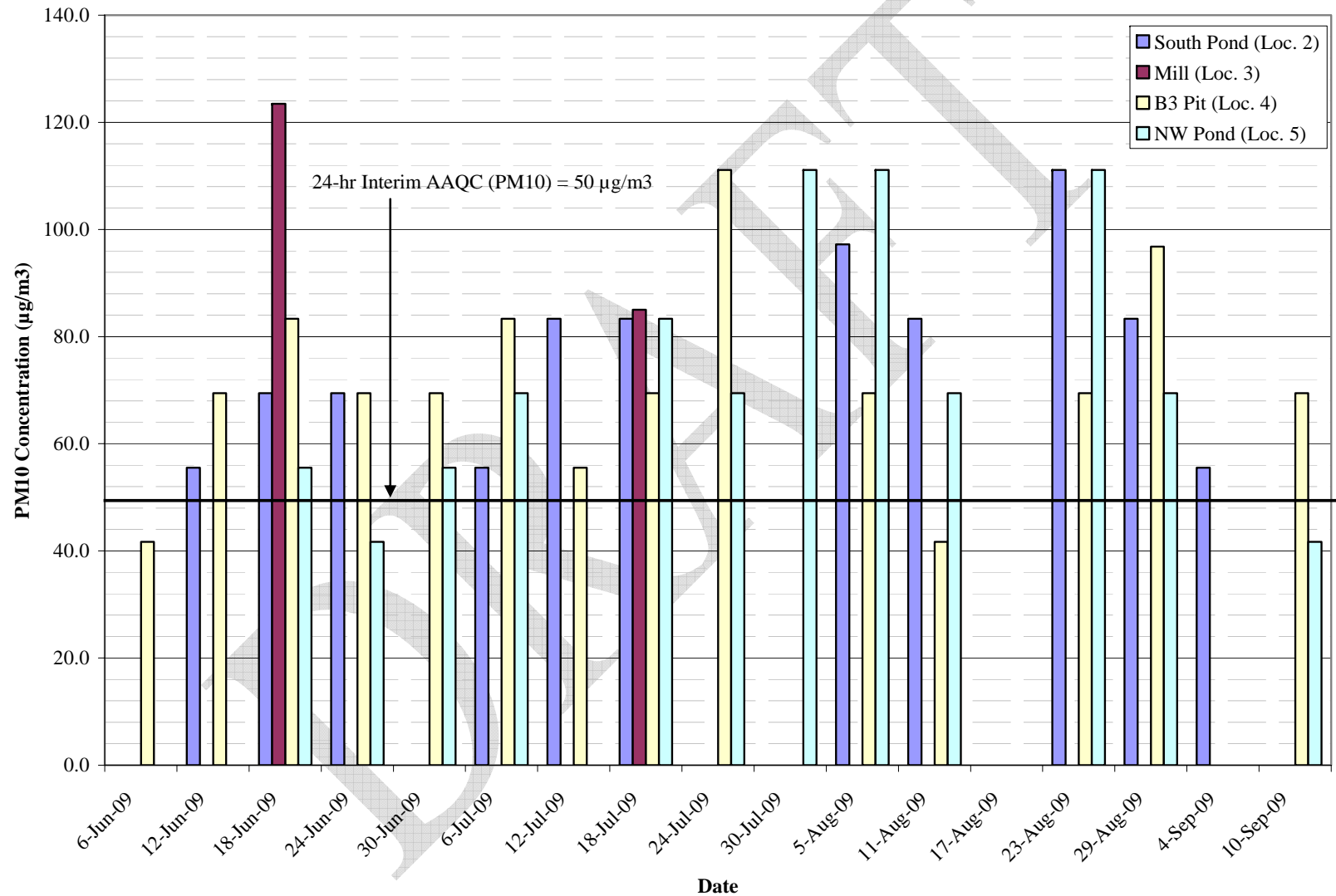


Figure 4.2 indicates that TSP concentrations exceeding the ambient air quality objective of $120 \mu\text{g}/\text{m}^3$ were recorded at several locations throughout the monitoring program. In this span of time there were two exceedances each at the South Pond, B3 Pit, and Northwest Pond locations, and none at the Mill. Figure 4.3 indicates that all but four measurable PM_{10} concentrations exceeded the standard of $50 \mu\text{g}/\text{m}^3$ (based on MOE's AAQC) during the 2009 air monitoring. Note that valid samples that resulted in non-detectable loadings are not represented on the above figures.

4.3 INORGANIC TRACE ELEMENTS

As discussed in Section 3, the particulate samples (both TSP and PM_{10}) were analyzed for inorganic trace element concentrations. The concentrations were given in weight per filter, which were converted into ambient concentrations in $\mu\text{g}/\text{m}^3$, based on the calibrated flow rate of the sampling equipment. The trace element concentrations for all of the Mini-Vol filters and hi-vol filters that were run for an acceptable duration ($\pm 25\%$ of 24 hours) are presented in Table 4.9 and Table 4.10, respectively (included at the end of this section). The results indicate that, with isolated exceptions for iron and arsenic, all other metal concentrations were below their applicable AAQC.

One of the main concerns with respect to the particulate matter emissions from the tailings areas at the Giant Mine site is the trace element content, specifically arsenic, of the suspended particulate matter. Table 4.3 summarizes the arsenic concentrations reported at all five sites during the 2009 monitoring program. The results indicate that arsenic levels exceeded the health-based ambient air quality criterion for arsenic (AAQCs = $0.3 \mu\text{g}/\text{m}^3$) only once, at the Northwest Pond location on August 29th, 2009.

The data in Table 4.3 indicate that the arsenic levels in TSP were noticeably higher at the Northwest Pond than at any of the other three on-site sampling locations. Arsenic in the PM_{10} fraction is similar between the sites; however, there is less valid data available to draw conclusions from for this size fraction. The Giant Mine Town Site mean and median arsenic concentrations were about an order of magnitude or more lower than all of the on-site locations.

Figure 4.4 through Figure 4.9 show the trends and correlations in arsenic levels in both TSP and PM_{10} at locations 2 through 5. At the South Pond (Location 2), arsenic was not present at detectable levels for many of the PM_{10} samples collected, and therefore there is little opportunity to correlate with concentrations of arsenic in TSP at this location. Similarly, correlation at the Mill (Location 3) was limited due to the number of invalid samples. The figures for Locations 4 and 5 show that arsenic levels in the two particulate matter size fractions (i.e., TSP & PM_{10}) tracked each other quite well where data are available. Overall, peak arsenic concentrations in PM_{10} generally corresponded with peak arsenic concentrations in TSP. The figures indicate that

at most of the monitoring locations the arsenic was present in the large particles (TSP), which are less likely to be of concern for human health. This agrees with the conclusions of the previous monitoring programs.

Concentrations of iron exceeded the AAQC of $4 \mu\text{g}/\text{m}^3$ at the B3 Pit on June 12th, 2009; the South Pond location on June 30th, 2009; and the Northwest Pond on August 29th and September 4th, 2009.

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Table 4.3 – Arsenic Concentration in Particulate Matter

Sampling Date	Giant Mine Town Site	South Pond		B3 Pit		Mill		NW Pond	
		As in TSP	As in PM ₁₀	As in TSP	As in PM ₁₀	As in TSP	As in PM ₁₀	As in TSP	As in PM ₁₀
6-Jun-09	NI	NS-INS	ND	NS-INS	ND	1.13E-02	NS-INS	NS-INS	ND
12-Jun-09	NS-INS	3.33E-02	ND	1.53E-02	ND	2.50E-02	1.09E-02	NS-INS	1.53E-02
18-Jun-09	NS-INS	3.33E-02	ND	7.64E-03	ND	NS-INS	ND	NS-INS	9.17E-03
24-Jun-09	NS-INS	NS-INS	ND	ND	ND	ND	NS-INS	NS-INS	ND
30-Jun-09	NS-INS	2.08E-01	NS-INS	8.33E-02	2.50E-02	6.81E-02	NS-INS	4.72E-02	1.67E-02
6-Jul-09	NS-INS	1.94E-02	ND	1.22E-02	ND	ND	NS-INS	NS-INS	ND
12-Jul-09	NS-INS	1.35E-02	ND	1.14E-02	ND	1.53E-02	NS-INS	NS-INS	NS-INS
18-Jul-09	ND	NS-INS	ND	1.53E-02	ND	1.94E-02	ND	NS-INS	ND
24-Jul-09	4.74E-03	4.86E-02	NS-INS	NS-INS	ND	1.32E-02	NS-INS	NS-INS	3.89E-02
30-Jul-09	ND	9.67E-03	NS-INS	1.26E-02	NS-INS	NS-INS	NS-INS	NS-INS	ND
5-Aug-09	NS-INS	ND	ND	1.21E-02	ND	1.15E-02	NS-INS	4.03E-02	1.11E-02
11-Aug-09	ND	NS-INS	1.81E-02	8.75E-02	1.67E-02	5.81E-02	NS-INS	6.11E-02	1.00E-02
17-Aug-09	NS-INS	NI	NI	NI	NI	NI	NI	NI	NI
23-Aug-09	NS-INS	1.81E-02	ND	1.81E-02	1.01E-02	2.22E-02	NS-INS	7.64E-03	ND
29-Aug-09	NS-INS	6.81E-02	ND	ND	8.44E-03	1.24E-02	NS-INS	8.75E-01	1.94E-02
4-Sep-09	NS-INS	1.21E-01	ND	3.06E-02	ND	1.67E-02	NS-INS	2.50E-01	7.64E-03
10-Sep-09	NS-INS	8.33E-03	NS-INS	2.08E-02	ND	ND	NS-INS	4.44E-02	ND
Maximum	4.74E-03	2.08E-01	1.81E-02	8.75E-02	2.50E-02	6.81E-02	1.09E-02	8.75E-01	3.89E-02
98th Percentile	4.74E-03	1.91E-01	1.81E-02	8.66E-02	2.45E-02	6.61E-02	1.09E-02	8.00E-01	3.62E-02
95th Percentile	4.74E-03	1.65E-01	1.81E-02	8.52E-02	2.38E-02	6.31E-02	1.09E-02	6.88E-01	3.21E-02
Arithmetic Mean	4.74E-03	5.29E-02	1.81E-02	2.72E-02	1.51E-02	2.48E-02	1.09E-02	1.89E-01	1.60E-02
Median	4.74E-03	3.33E-02	1.81E-02	1.53E-02	1.34E-02	1.67E-02	1.09E-02	4.72E-02	1.32E-02

Note:

All samples exceeding the AAQC of 0.3 µg/m³ are shown in **bold**.

ND – Non Detectable (i.e., below the laboratory detection limit)

NI – No Information (i.e., filter was not submitted to the laboratory)

NS-INS – No Sample due to Insufficient Data (i.e., sample excluded due to unacceptable sample duration)

ND data were not included in calculation of statistics

Figure 4.4 - Variability in Arsenic Concentrations at All TSP Sampling Locations

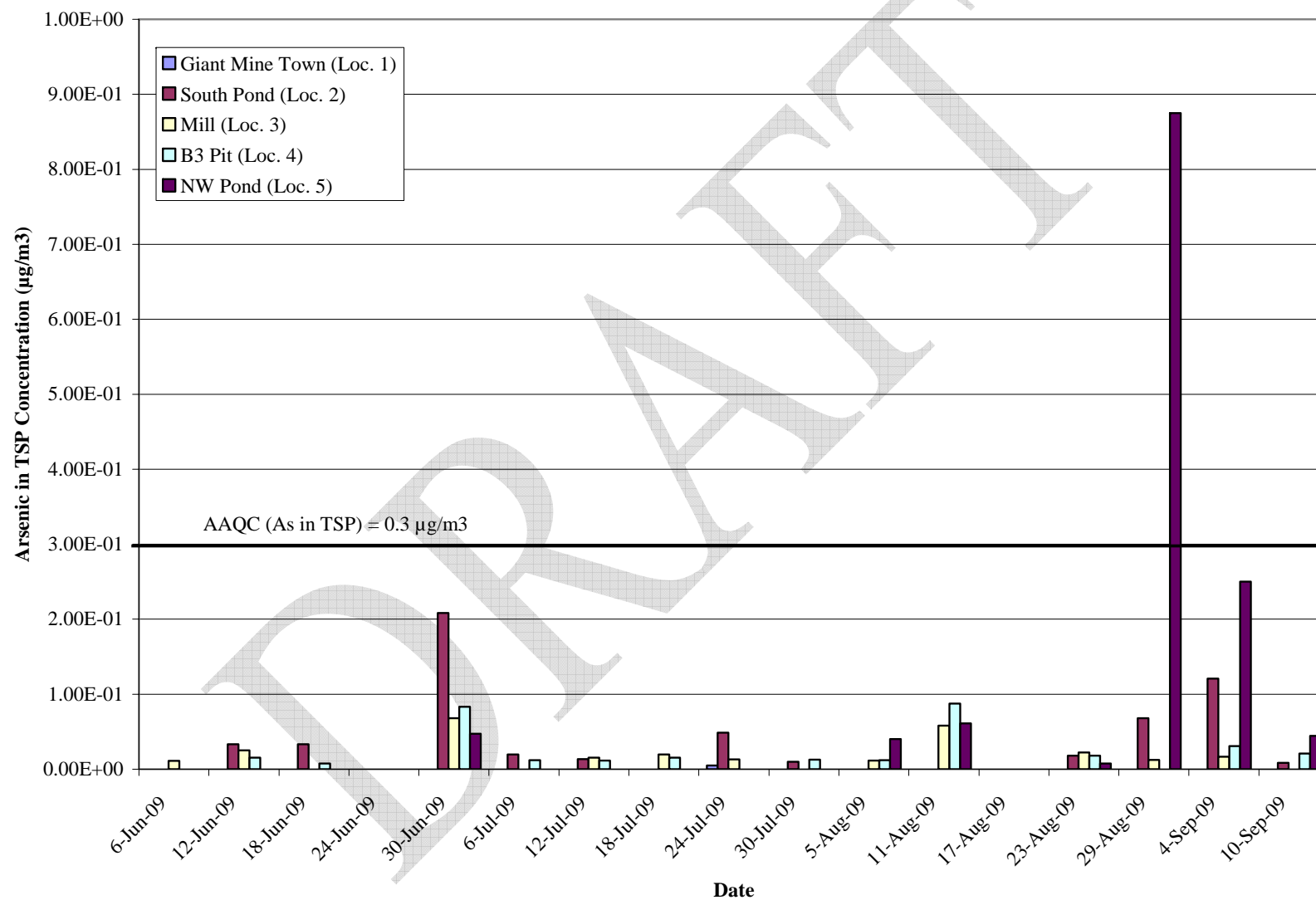


Figure 4.5 - Variability in Arsenic Concentrations at PM₁₀ Sampling Locations

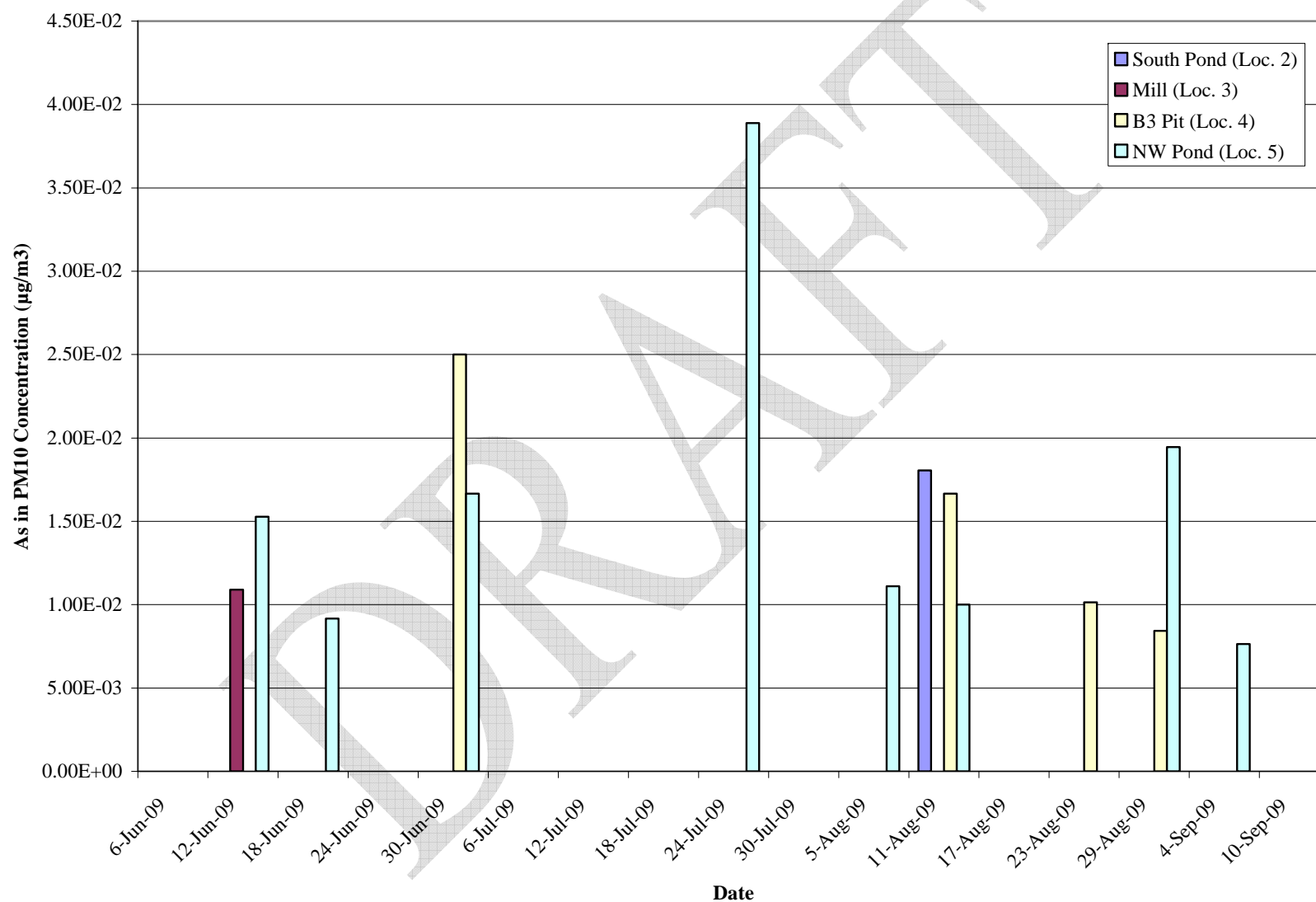


Figure 4.6 - Variability in Arsenic Concentrations in TSP/ PM₁₀ Samples Collected at the South Pond (Location 2)

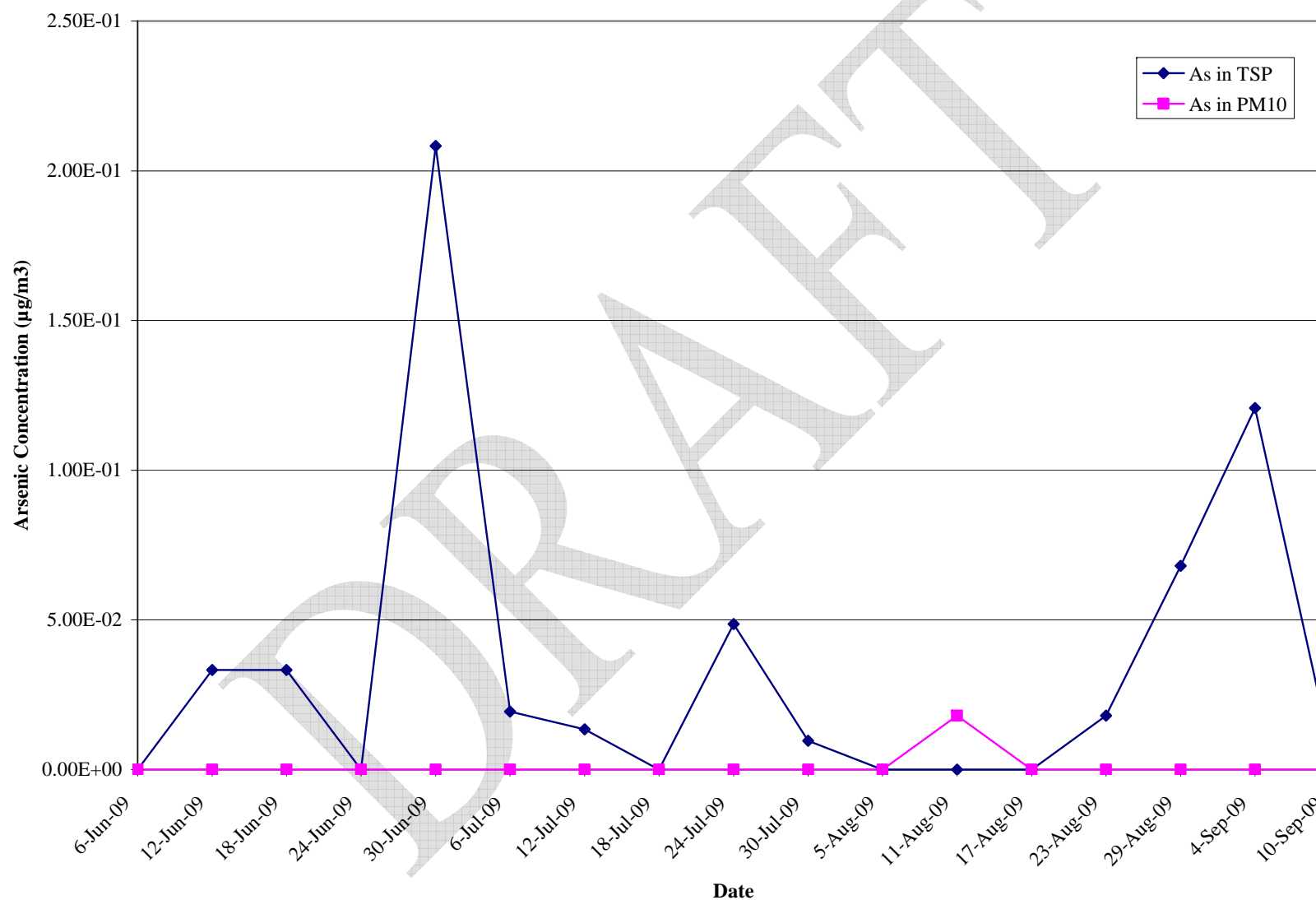


Figure 4.7 - Variability in Arsenic Concentrations in TSP/PM₁₀ Samples Collected at the Mill (Location 3)

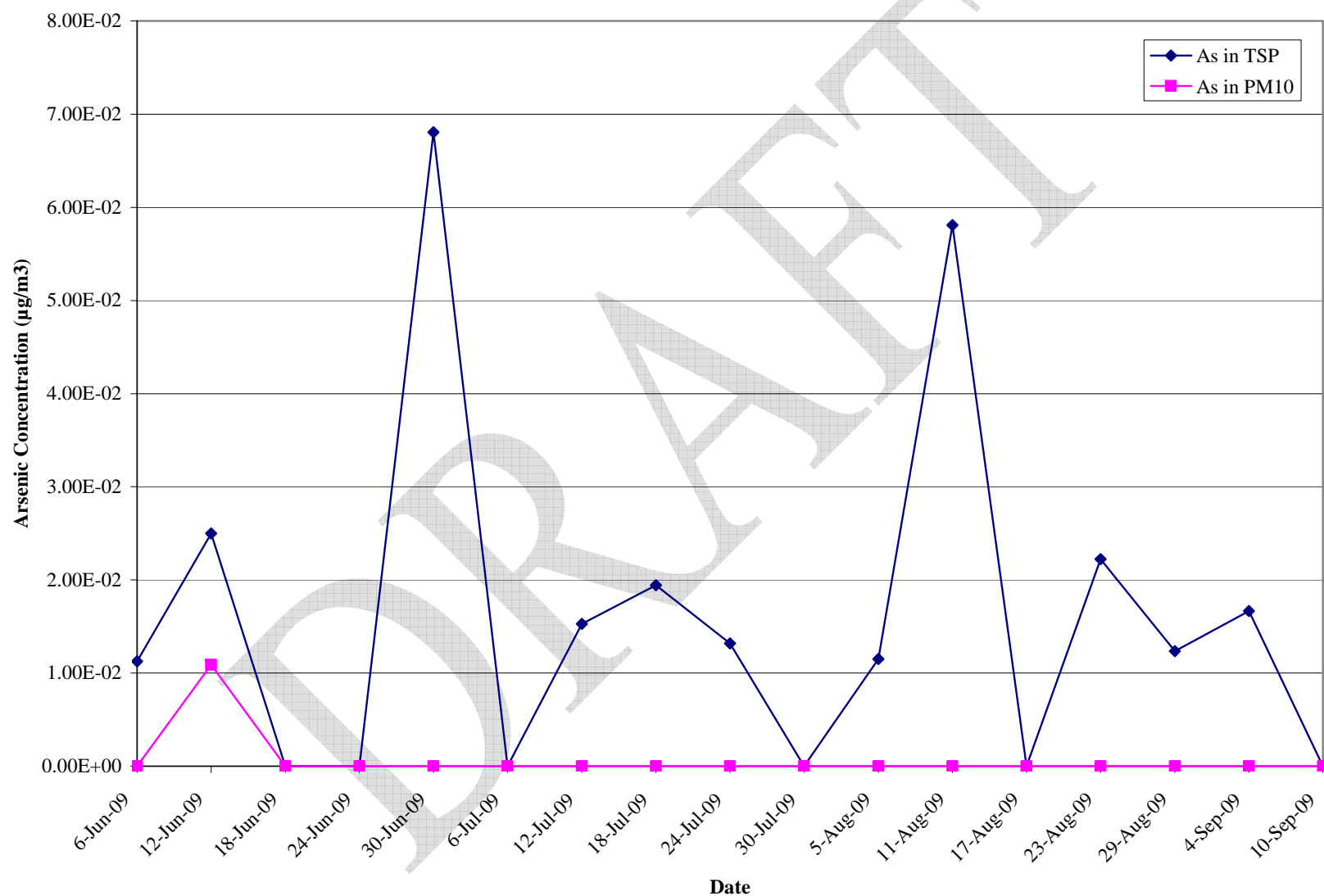


Figure 4.8 - Variability in Arsenic Concentrations in TSP/PM₁₀ Samples Collected at the B3 Pit (Location 4)

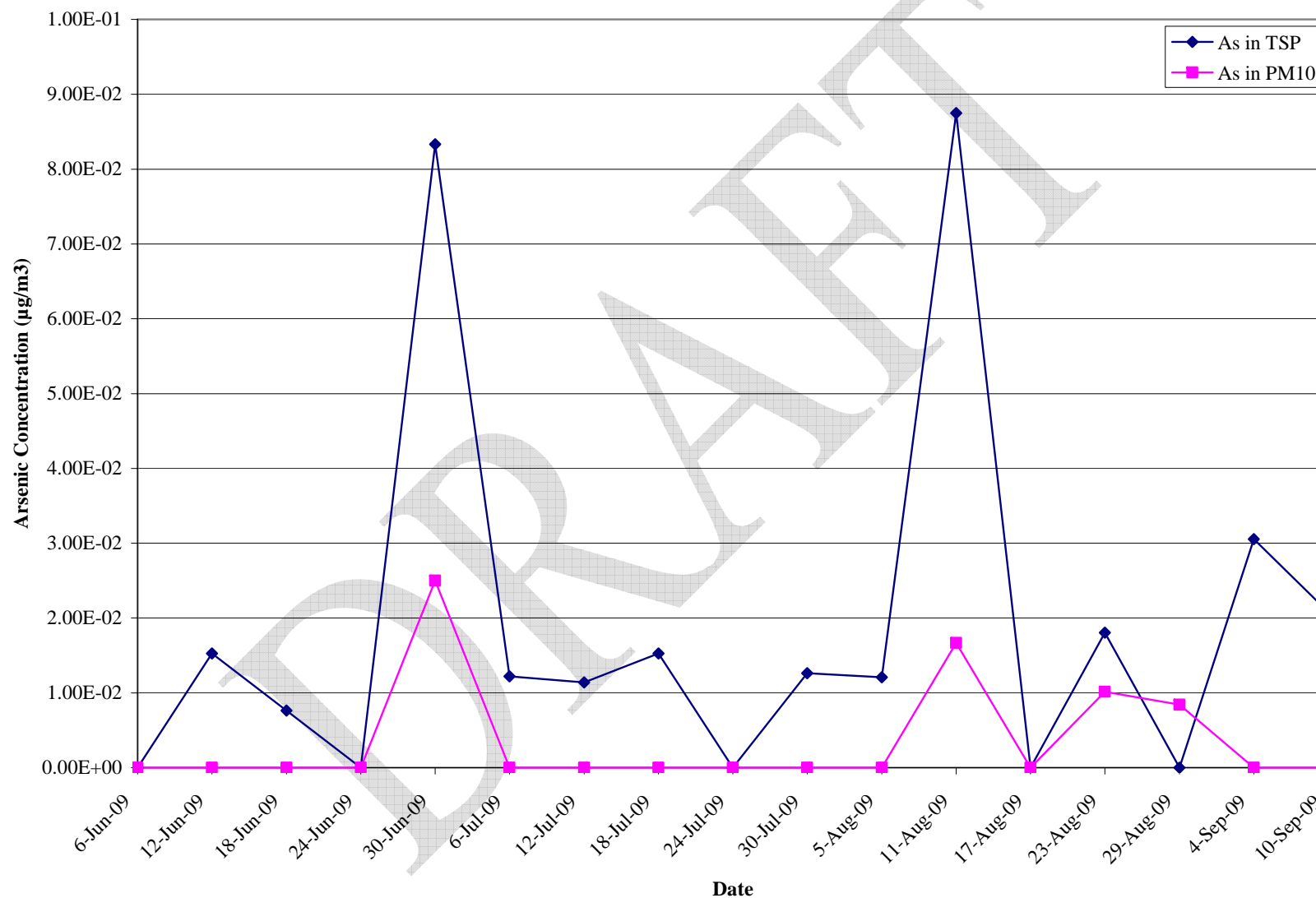
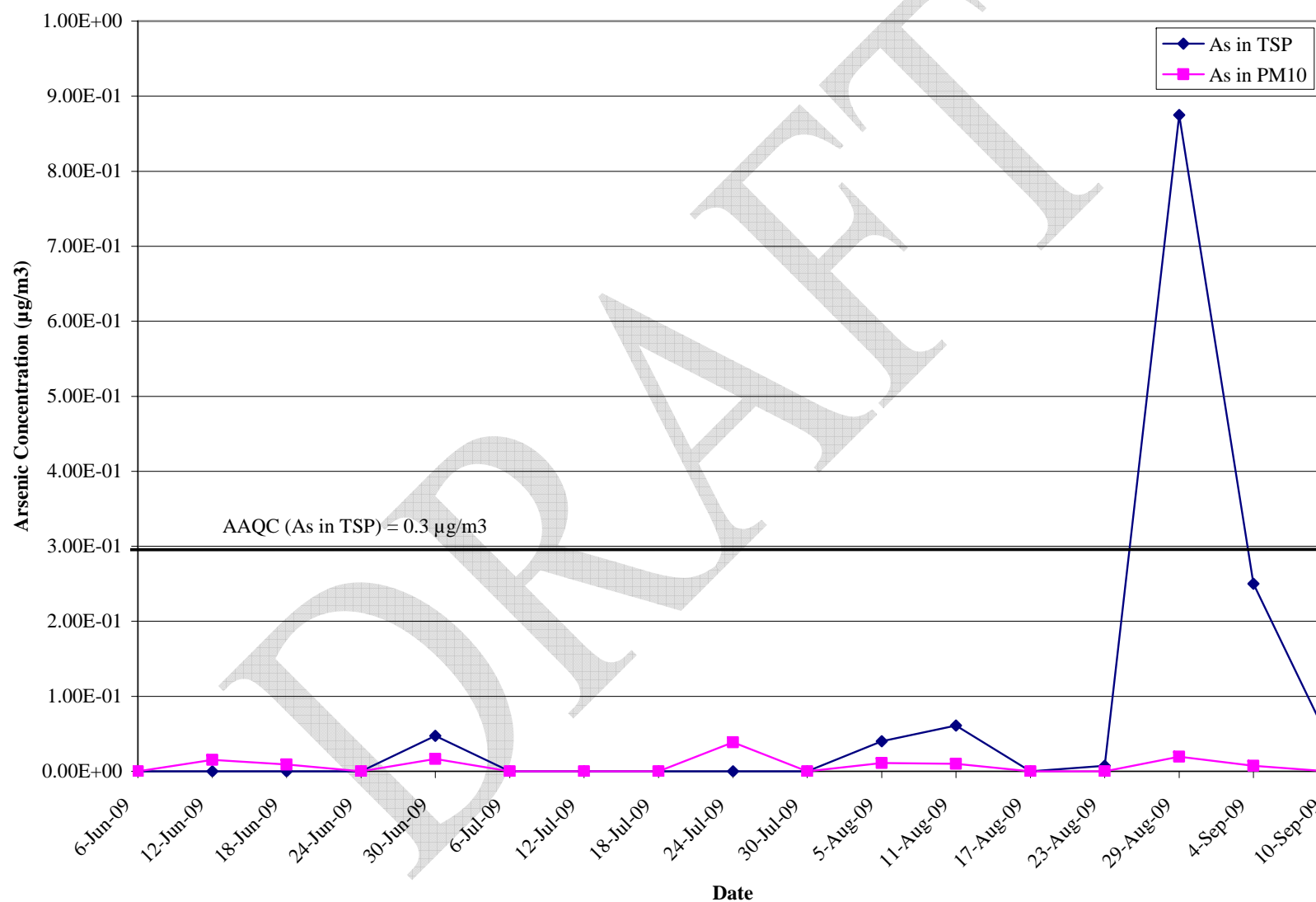


Figure 4.9 - Variability in Arsenic Concentrations in TSP/PM₁₀ Samples Collected at the Northwest Pond (Location 5)



4.4 INTERPRETATION OF RESULTS

Table 4.4 summarizes the days on which the particulate matter (TSP and PM₁₀), arsenic and iron concentrations were reported to be above their respective AAQC. The table shows that four of the five exceedances of the trace metals (arsenic and iron) occurred on days in which TSP was also exceeding its AAQC, with the exception being the iron exceedance on September 4th at the Northwest Pond. The TSP concentration was at approximately 93% of the AAQC on September 4th at this location.

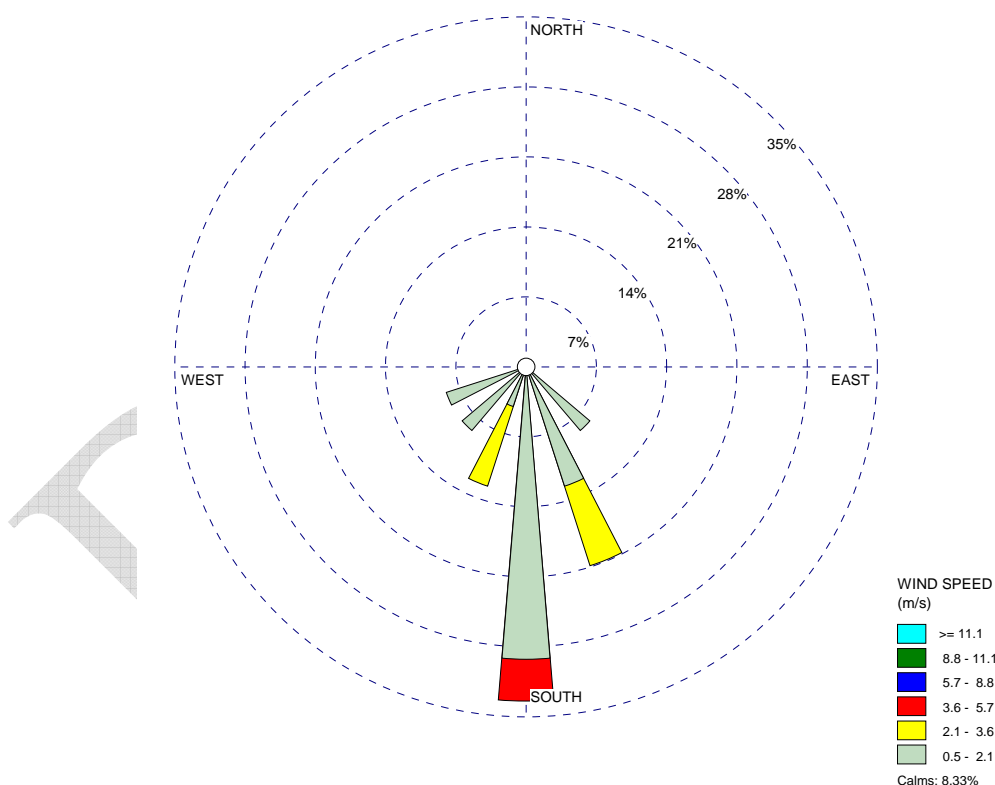
Table 4.4 – Summary of Exceedance Dates

Parameter (µg/m3)	TSP				PM10				Arsenic in TSP				Arsenic in PM10				Iron in TSP				Iron in PM10			
Location	2	3	4	5	2	3	4	5	2	3	4	5	2	3	4	5	2	3	4	5	2	3	4	5
6-Jun-09																								
12-Jun-09			x		x		x												x					
18-Jun-09					x	x	x	x																
24-Jun-09					x		x																	
30-Jun-09	x						x	x									x							
6-Jul-09					x		x	x																
12-Jul-09					x		x																	
18-Jul-09			x		x	x	x	x																
24-Jul-09							x	x																
30-Jul-09								x																
5-Aug-09	x				x		x	x																
11-Aug-09				x	x			x																
17-Aug-09																								
23-Aug-09					x		x	x																
29-Aug-09				x	x		x	x				x								x				
4-Sep-09					x															x				
10-Sep-09							x																	

Note: Location #1 (Giant Mine Town Site) was not included because there were no exceedances reported at this location.

Arsenic exceeded the AAQC at the Northwest Pond location on August 20th, 2009 ($0.88 \mu\text{g}/\text{m}^3$). The windrose for this date is presented in Figure 4.10, and temperatures on this date were mild (12°C to 25°C) with no precipitation. It would be expected that arsenic exceedances at this location would be associated with northerly winds due to the location of the monitor on the south side of the Northwest Pond. The windrose illustrates that the wind on this date was primarily from the south. In this instance, the wind would not be expected to have transported any material from the pond towards the monitor. Transport may have occurred from the B3 Pit, however on this date the arsenic in the B3 Pit sample was non-detectable. As such, there does not appear to be a correlation between arsenic concentrations and wind direction at this location. It should be noted that there were road grading activities, as well as pump removal from the Northwest Pond occurring on this date. The elevated arsenic concentration on this date may have been influenced by this local activity.

Figure 4.10 – Windrose for Arsenic Exceedance (August 29th, 2009)



The AAQCs for TSP and/or PM_{10} were exceeded at at least one location on fifteen out of the seventeen sampling days. Windroses for each of these days are presented below in Figure 4.11 (exclusive of August 29th, 2009, shown above).

Figure 4.11 – Windroses for PM Exceedance Days

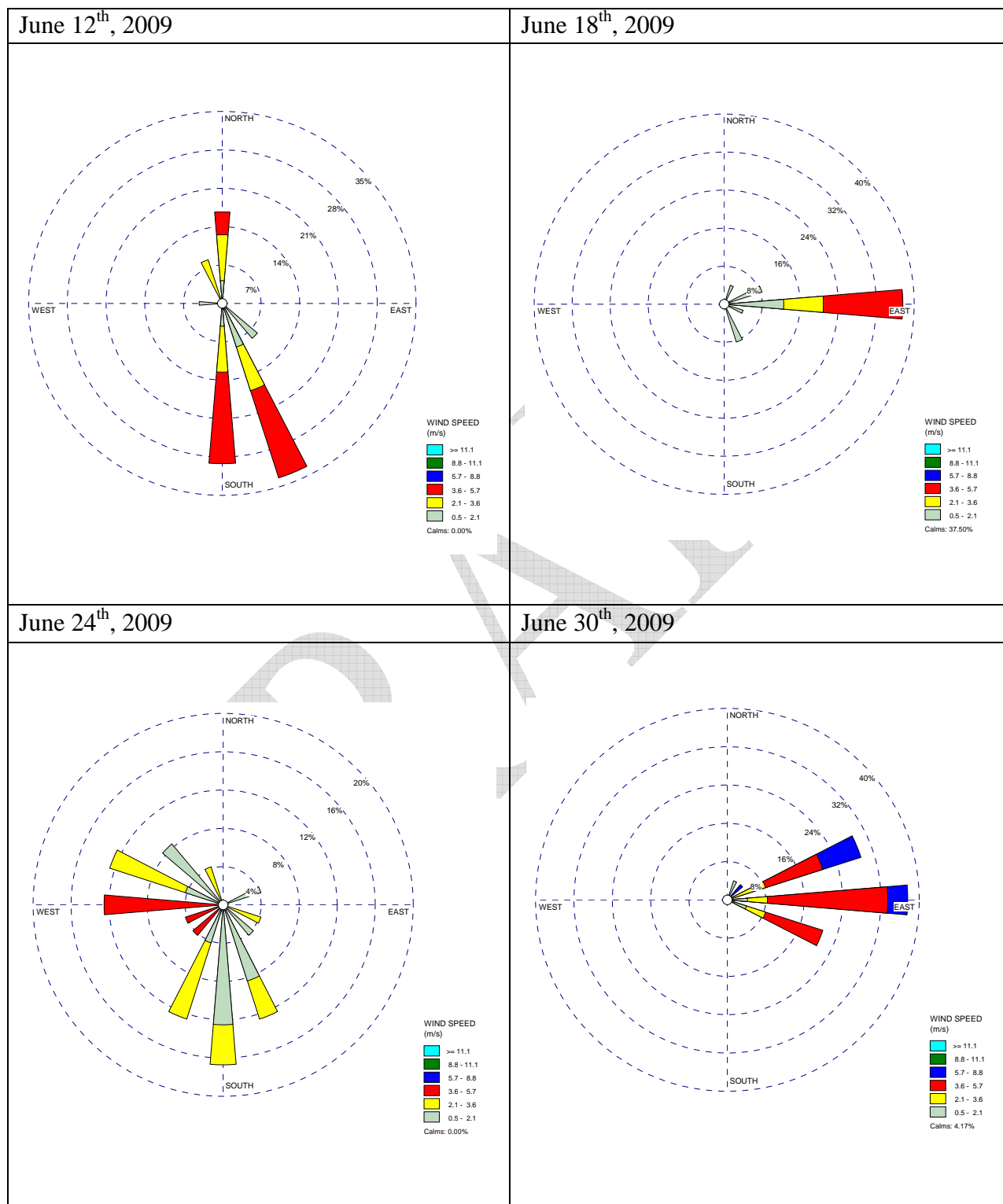


Figure 4.11 (Cont'd) - Windroses for PM Exceedance Days

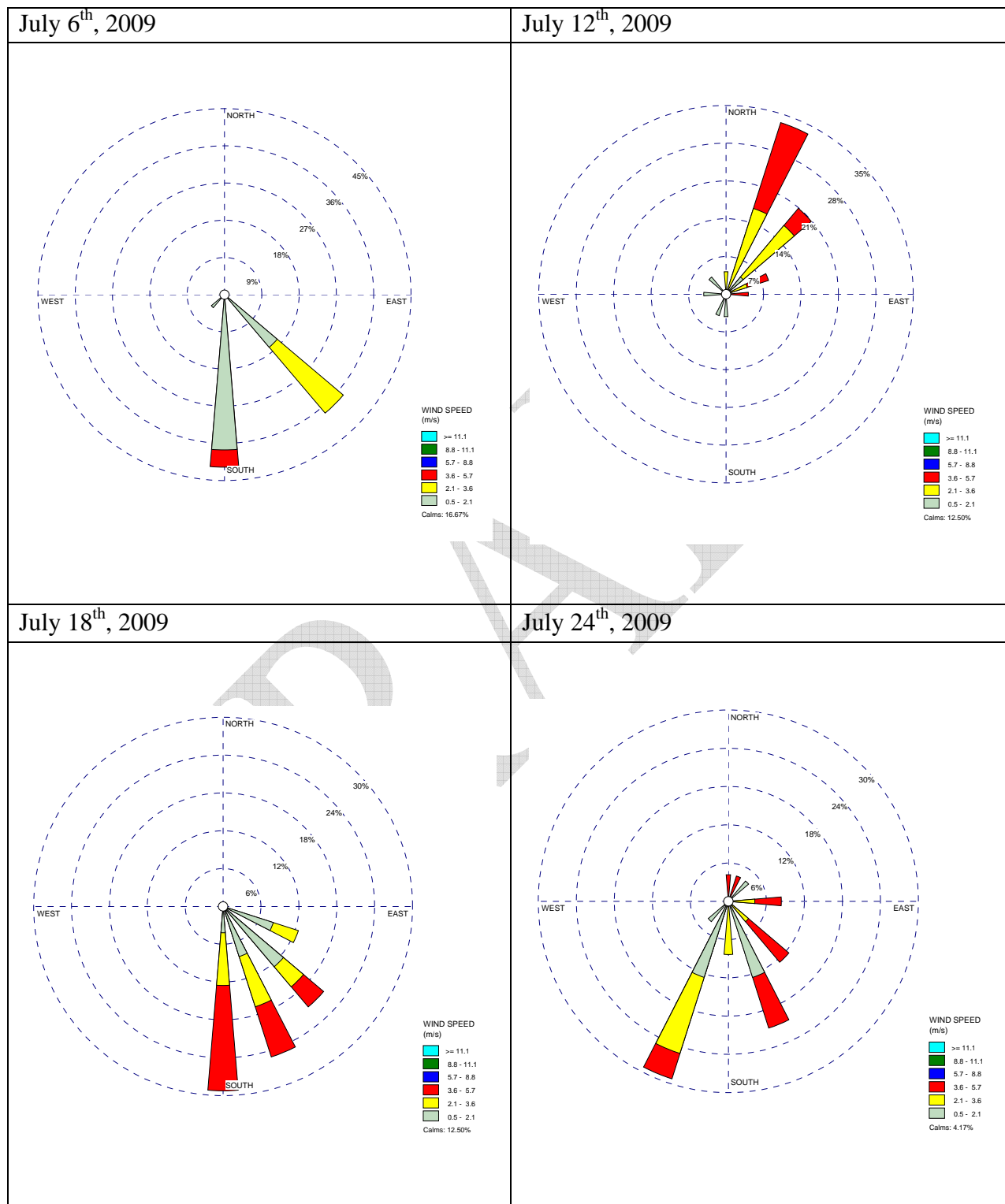


Figure 4.11 (Cont'd) - Windroses for PM Exceedance Days

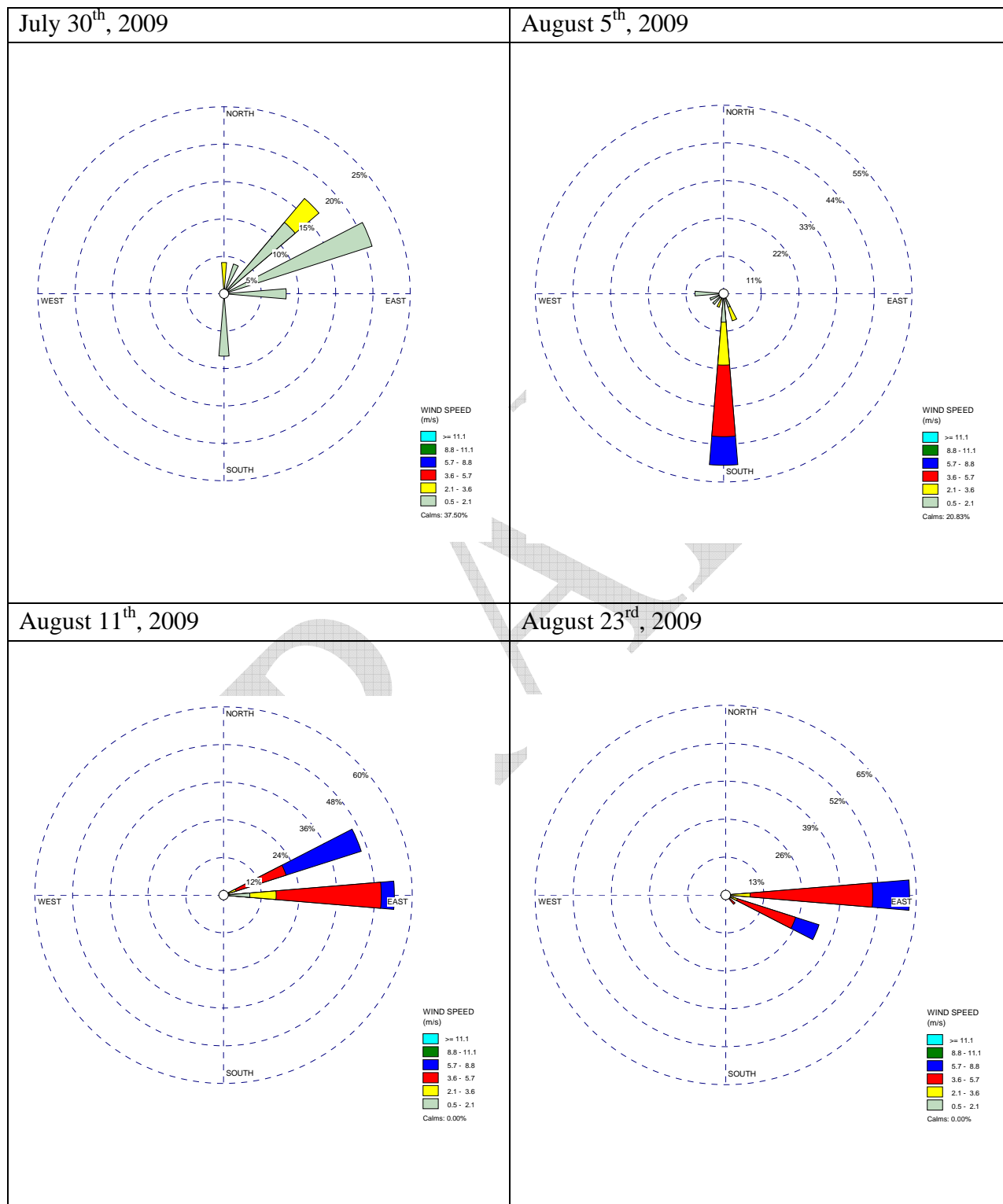
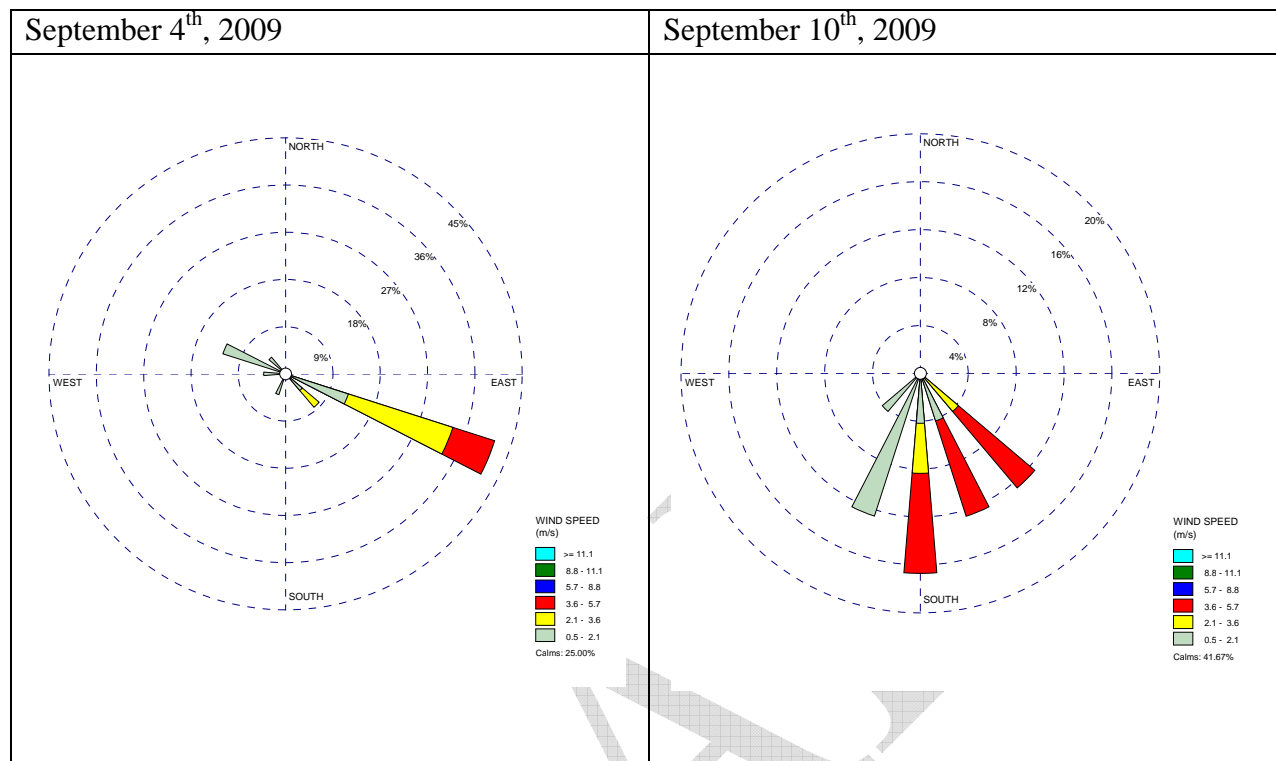


Figure 4.11 (Cont'd) - Windroses for PM Exceedance Days



The above figures illustrate that the monitors were collecting samples under a wide range of meteorological conditions. Exceedances of particulate matter were observed at the various stations under various meteorological conditions and therefore a clear correlation between exceedances of particulate matter and wind direction does not appear to exist.

To further explore the potential causes of these exceedances, site activities on the days for which the particulate matter (TSP), arsenic and/or iron criteria were exceeded were reviewed, as summarized in Table 4.6. Road grading activities which could result in generally elevated dust levels around the property were noted on 4 of the 6 exceedance days. For the other days, while dust generating activities occurred at FOS, the location of activities, wind direction and location of monitoring stations recording the exceedance show no clear pattern. A similar analysis was not complete for PM₁₀ as the PM₁₀ criterion was exceeded at at least one location on most sample days.

Table 4.5 – Wind Directions for PM Exceedance Dates

Sample Date	Location(s) with Exceedance	Dominant Wind Direction
12 June 2009	TSP: B3 Pit PM₁₀: South Pond, B3 Pit	S, SE
18 June 2009	TSP: None PM₁₀: All Locations	E
24 June 2009	TSP: None PM₁₀: South Pond, B3 Pit	W, S
30 June 2009	TSP: South Pond PM₁₀: B3 Pit, NW Pond	E
6 July 2009	TSP: None PM₁₀: South Pond, B3 Pit, NW Pond	S, SE
12 July 2009	TSP: None PM₁₀: South Pond, B3 Pit	NE
18 July 2009	TSP: B3 Pit PM₁₀: All Locations	S, SE
24 July 2008	TSP: None PM₁₀: B3 Pit, NW Pond	SW
30 July 2009	TSP: None PM₁₀: NW Pond	NE
5 August 2009	TSP: South Pond PM₁₀: South Pond, B3 Pit, NW Pond	S
11 August 2009	TSP: NW Pond PM₁₀: South Pond, NW Pond	E
23 August 2009	TSP: None PM₁₀: South Pond, B3 Pit, NW Pond	E
29 August 2009	TSP: NW Pond PM₁₀: South Pond, B3 Pit, NW Pond	S
4 September 2009	TSP: None PM₁₀: South Pond	SE
10 September 2009	TSP: None PM₁₀: B3 Pit	S, SE

Table 4.6 – Summary of Activities on Exceedance Dates

Parameter ($\mu\text{g}/\text{m}^3$)	TSP				PM10				Site Activities
Location	2	3	4	5	2	3	4	5	
6-Jun-09									
12-Jun-09			x		x		x		Excavation on FOS project, soil cement application
18-Jun-09					x	x	x	x	
24-Jun-09					x		x		
30-Jun-09	x						x	x	Road grading
6-Jul-09					x		x	x	
12-Jul-09					x		x		
18-Jul-09			x		x	x	x	x	Backfilling FOS, soil cement application Northwest pond, push garbage at dump
24-Jul-09							x	x	
30-Jul-09								x	
5-Aug-09	x				x		x	x	Road grading, water roads ETP, ditch construction
11-Aug-09				x	x			x	Road grading, push tailings piles at Akaitcho hazmat area
17-Aug-09									
23-Aug-09					x		x	x	
29-Aug-09				x	x		x	x	Road grading, remove pumps Northwest pond & polishing pond
4-Sep-09					x				
10-Sep-09							x		

4.5 COMPARISON OF CURRENT AND HISTORICAL MONITORING RESULTS

4.5.1 Sample Collection Efficiency

The 2009 monitoring program was similar in design to the previous programs in that samples of TSP and PM₁₀ were collected at all of the same locations since 2005. There was a decline in sample collection efficiency for both Mini-vol samplers and the hi-vol sampler compared to 2008. Sample collection efficiencies for all years are summarized in Table 4.7. The table includes 2005 and forward as the Northwest Pond location was not part of the program before 2005, and PM₁₀ samples were only collected at the South Pond location before 2005.

Table 4.7 – Summary of Historical Sample Collection Efficiency

Year	% Valid On-Site TSP/PM₁₀ Samples	% Valid Off-Site TSP Samples
2005 ¹	80%	100%
2006 ²	68%	95%
2007 ³	72%	87%
2008 ³	78%	50%
2009 ³	68%	24%

1 – Note that no screening criteria were employed to eliminate samples based on a sample duration that was too short. Missed samples were therefore the result of the monitors not operating.

2 – A screening criteria of $\pm 10\%$ of the desired sample time was implemented to eliminate non-representative samples.

3 – A screening criteria of $\pm 25\%$ of the desired sample duration, which is acceptable to the government of the Northwest Territories, was applied to eliminate non-representative samples

4.5.2 Particulate Matter Results

There was a marked improvement in average PM₁₀ concentrations at each on-site monitoring location compared to 2008. Similar to previous years, many of the PM₁₀ concentrations still exceeded the AAQC of 50 $\mu\text{g}/\text{m}^3$. While 2008 saw a significant decrease in the percentage of valid PM₁₀ samples that exceeded the AAQC compared to previous years (see Table 4.8), this trend did not continue in 2009. So while the average concentrations of PM₁₀ decreased, the levels in most cases were still above the AAQC.

Similar to PM₁₀, there was a noted improvement in average TSP concentrations at each on-site monitoring location compared to 2008. In this case however, the improvement is also apparent in the number of samples that exceeded the AAQC, with only 13% of valid samples exceeding the AACQ in 2009 versus 40% in 2008.

Table 4.8 summarizes the number of samples that exceeded the particulate matter AAQCs during the 2008 monitoring season and the previous years. Note this pertains only to the on-site monitoring (i.e., this summary does not include the off-site location as it has never exceeded the AAQC for TSP).

Table 4.8 – Summary of Historical PM Exceedances

Year	TSP		PM ₁₀	
	No. of Valid Samples	% Exceeding AAQC (120 µg/m ³)	No. of Valid Samples	% Exceeding AAQC (50 µg/m ³)
2005	54	19%	50	12%
2006	62	26%	54	80%
2007	44	73%	42	93%
2008	45	40%	55	60%
2009	47	13%	45	78%

4.5.3 Trace Elements Results

Trace element results are presented in Table 4.9 and Table 4.10. During the 2009 monitoring program, there was only one exceedance of the AAQC for arsenic. This was detected at the Northwest Pond location. In 2008 there was one exceedance, and in each of 2006 and 2007 there were three exceedances, and they were all detected at the Northwest Pond location. In 2005 there were a total of eight exceedances of arsenic, four of which were at the Northwest Pond. Of the remaining four, three were at the South Pond location and one was at the B3 Pit. One of the exceedances at the South Pond was found in the inhalable size fraction (PM₁₀). It is therefore noted that there is a decreasing trend with regard to arsenic concentrations at the Giant Mine site. There has not been an arsenic concentration above the AAQC in the PM₁₀ size fraction since 2005.

Similar to previous years, the only other trace element that exceeded its respective AAQC was iron. There were four exceedances in 2009, compared to three exceedances in 2008, and five in 2007. It should be noted however that in 2008 one of the values above the AAQC was associated with the inhalable size fraction (PM₁₀), whereas none were detected in this size fraction in 2009. In 2006, there were sixteen exceedances of the iron AAQC, with three of them occurring in PM₁₀ samples. In 2005 there were nineteen exceedances of the iron AAQC, with six occurring in the PM₁₀ samples. While exceedances have notably decreased from 2005 and 2006, results for 2007 to 2009 are improved over the previous period, but have more or less remained constant over the last three years.

4.5.4 Arsenic in Coarse Particles

In 2004, only one location had paired TSP and PM₁₀ samplers (the South Pond location). This data was used to estimate the amount of arsenic that is contained in the coarse particles and how much is in the inhalable size fraction. This initial data suggested that 75% of the ambient arsenic is contained within the coarse particles, and only 25% on average is present in the inhalable PM₁₀ fraction. As paired samplers were adopted into the program starting in 2005, this figure has been tracked in the subsequent years. The years 2006 and 2007 show very similar results, indicating that an average of 63% of the measured arsenic is in the coarse size fraction. The 2005 arsenic concentrations in TSP and PM₁₀ were highly variable, however, on average indicated that more than half of the measured ambient arsenic concentration was contained within the coarse particles. In 2008, an average of all the stations for which there was a valid sample for both TSP and PM₁₀ samplers revealed that approximately 58% of the total arsenic is in the coarse size fraction. In the samples for the Northwest Pond location only (i.e., where most of the exceedances have occurred historically), it was found that approximately 70% of the arsenic is entrained in the coarse size fraction.

With the decrease in sampling efficiency in 2009, there were only 9 sampling days in which both a TSP and PM₁₀ sample were collected at any given location. Averaging the arsenic levels in the inhalable size fraction versus the total particulate indicates that approximately 74% of the arsenic is entrained in the coarse size fraction.

Table 4.9 – Ambient Air Metal Concentrations at the On-site Monitoring Locations

Start Date	Location	Al (µg/m3)	Sb (µg/m3)	As (µg/m3)	Ba (µg/m3)	Be (µg/m3)	B (µg/m3)	Cd (µg/m3)	Ca (µg/m3)	Cr (µg/m3)	Co (µg/m3)	Cu (µg/m3)	Fe (µg/m3)	Pb (µg/m3)	Mn (µg/m3)	Mo (µg/m3)	Ni (µg/m3)	K (µg/m3)	Se (µg/m3)	Ag (µg/m3)	Sr (µg/m3)	Tl (µg/m3)	Sn (µg/m3)	Ti (µg/m3)	V (µg/m3)	Zn (µg/m3)	
6-Jun-09	South Pond - PM10	ND	ND	ND	ND	ND	ND	ND	1.01E+00	7.50E-03	ND	1.81E-02	ND	ND	1.94E-02	ND	1.14E-02	7.36E-01	ND	ND	ND	ND	3.06E-02	NI	ND	2.22E-01	
6-Jun-09	South Pond - TSP	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS
6-Jun-09	B3 Pit -PM10	1.24E+00	ND	ND	1.53E-02	ND	ND	ND	1.11E+00	1.19E-02	ND	1.07E-02	2.08E+00	ND	3.61E-02	ND	1.15E-02	1.08E+00	ND	ND	ND	ND	1.21E-02	NI	5.56E-03	1.29E-01	
6-Jun-09	B3 Pit -TSP	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS
6-Jun-09	Mill-PM10	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS
6-Jun-09	Mill-TSP	4.03E-01	ND	1.13E-02	ND	ND	ND	ND	1.13E+00	7.22E-03	ND	6.67E-03	9.03E-01	ND	1.67E-02	ND	9.31E-03	ND	ND	ND	ND	ND	ND	5.14E-03	NI	ND	7.92E-02
6-Jun-09	NW Pond-PM10	ND	ND	ND	ND	ND	ND	ND	ND	1.67E-02	ND	7.92E-03	ND	ND	1.67E-02	ND	1.19E-02	ND	ND	ND	ND	ND	ND	1.29E-02	NI	ND	ND
6-Jun-09	NW Pond-TSP	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS
12-Jun-09	South Pond - PM10	ND	ND	ND	ND	ND	ND	ND	NI	ND	ND	5.28E-03	ND	ND	8.19E-03	ND	1.24E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	ND
12-Jun-09	South Pond - TSP	5.83E-01	ND	3.33E-02	ND	ND	ND	ND	NI	7.08E-03	ND	8.89E-03	1.39E+00	ND	2.50E-02	ND	1.06E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	1.81E-01
12-Jun-09	B3 Pit -PM10	1.13E+00	ND	ND	1.53E-02	ND	ND	ND	NI	1.00E-02	ND	7.08E-03	1.81E+00	ND	2.22E-02	ND	9.58E-03	NI	ND	ND	ND	ND	ND	ND	6.11E-02	5.69E-03	ND
12-Jun-09	B3 Pit -TSP	4.17E+00	ND	1.53E-02	6.11E-02	ND	ND	ND	NI	2.92E-02	ND	1.81E-02	6.81E+00	1.00E-02	7.08E-02	ND	2.22E-02	NI	ND	ND	7.92E-03	ND	ND	2.50E-01	1.67E-02	2.92E-01	
12-Jun-09	Mill-PM10	ND	ND	1.09E-02	ND	ND	ND	ND	NI	ND	ND	ND	ND	ND	9.48E-03	ND	1.04E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	ND
12-Jun-09	Mill-TSP	5.56E-01	ND	2.50E-02	ND	ND	ND	ND	NI	7.36E-03	ND	7.08E-03	1.33E+00	ND	2.08E-02	ND	7.78E-03	NI	ND	ND	ND	ND	ND	ND	2.22E-02	ND	ND
12-Jun-09	NW Pond-PM10	3.33E-01	ND	1.53E-02	ND	ND	ND	ND	NI	7.92E-03	ND	7.64E-03	7.64E-01	ND	1.33E-02	ND	ND	NI	ND	ND	ND	ND	ND	ND	ND	ND	ND
12-Jun-09	NW Pond-TSP	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
18-Jun-09	South Pond - PM10	ND	ND	ND	ND	ND	ND	ND	NI	7.36E-03	ND	ND	ND	ND	7.50E-03	ND	ND	NI	ND	ND	ND	ND	ND	ND	ND	ND	ND
18-Jun-09	South Pond - TSP	ND	ND	3.33E-02	ND	ND	ND	ND	NI	9.31E-03	ND	9.17E-03	1.11E+00	ND	1.94E-02	ND	1.00E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	ND
18-Jun-09	B3 Pit -PM10	ND	ND	ND	ND	ND	ND	ND	NI	7.36E-03	ND	5.83E-03	ND	ND	8.89E-03	ND	7.92E-03	NI	ND	ND	ND	ND	ND	ND	ND	ND	ND
18-Jun-09	B3 Pit -TSP	3.47E-01	ND	7.64E-03	ND	ND	ND	ND	NI	9.44E-03	ND	4.72E-03	8.61E-01	ND	1.29E-02	ND	8.61E-03	NI	ND	ND	ND	ND	ND	ND	1.67E-02	ND	ND
18-Jun-09	Mill-PM10	ND	ND	ND	ND	ND	ND	ND	NI	ND	ND	1.11E-02	ND	ND	1.06E-02	ND	ND	NI	ND	ND	ND	ND	ND	ND	ND	ND	ND
18-Jun-09	Mill-TSP	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
18-Jun-09	NW Pond-PM10	ND	ND	9.17E-03	ND	ND	ND	ND	NI	9.86E-03	ND	5.83E-03	ND	ND	8.19E-03	ND	7.92E-03	NI	ND	ND	ND	ND	ND	ND	ND	ND	ND
18-Jun-09	NW Pond-TSP	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
24-Jun-09	South Pond - PM10	ND	ND	ND	7.08E-03	ND	ND	ND	NI	1.24E-02	ND	1.39E-02	ND	ND	1.39E-02	ND	1.53E-02	NI	ND	ND	ND	ND	ND	6.67E-03	ND	ND	ND
24-Jun-09	South Pond - TSP	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
24-Jun-09	B3 Pit -PM10	ND	ND	ND	ND	ND	ND	ND	NI	1.25E-02	ND	5.42E-03	ND	ND	9.31E-03	ND	1.35E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	ND
24-Jun-09	B3 Pit -TSP	ND	ND	ND	ND	ND	ND	ND	NI	1.31E-02	ND	ND	ND	ND	1.10E-02	ND	1.53E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	ND
24-Jun-09	Mill-PM10	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
24-Jun-09	Mill-TSP	ND	ND	ND	ND	ND	ND	ND	NI	1.39E-02	ND	4.86E-03	ND	ND	8.47E-03	ND	1.25E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	ND
24-Jun-09	NW Pond-PM10	ND	ND	ND	ND	ND	ND	ND	NI	1.17E-02	ND	ND	ND	ND	8.19E-03	ND	1.11E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	ND
24-Jun-09	NW Pond-TSP	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
30-Jun-09	South Pond - PM10	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
30-Jun-09	South Pond - TSP	8.33E-01	3.47E-02	2.08E-01	8.33E-03	ND	ND	ND	NI	1.18E-02	ND	1.25E-02	5.28E+00	1.94E-02	6.94E-02	ND	2.08E-02	NI	ND	ND	ND	ND	ND	ND	1.53E-02	4.86E-03	ND
30-Jun-09	B3 Pit -PM10	ND	ND	2.50E-02	ND	ND	ND	ND	NI	8.33E-03	ND	6.11E-03	7.50E-01	ND	9.03E-03	ND	1.00E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	ND
30-Jun-09	B3 Pit -TSP	3.33E-01	ND	8.33E-02	ND	ND	ND	ND	NI	1.21E-02	ND	7.92E-03	1.94E+00	5.42E-03	2.08E-02	ND	1.53E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	ND
30-Jun-09	Mill-PM10	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
30-Jun-09	Mill-TSP	ND	ND	6.81E-02	ND	ND	ND	ND	NI	8.19E-03	ND	4.44E-03	1.53E+00	5.14E-03	1.67E-02	ND	1.24E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	ND
30-Jun-09	NW Pond-PM10	ND	ND	1.67E-02	1.06E-02	ND	ND	ND	NI	7.92E-03	ND	5.00E-03	ND	ND	1.24E-02	ND	1.67E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	ND
30-Jun-09	NW Pond-TSP	ND	ND	4.72E-02	ND	ND	ND	ND	NI	9.17E-03	ND	ND	1.04E+00	5.97E-03	1.81E-02	ND	1.10E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	ND
6-Jul-09	South Pond - PM10	ND	ND	ND	ND	ND	ND	ND	NI	9.72E-03	ND	ND	ND	ND	ND	ND	3.19E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	ND
6-Jul-09	South Pond - TSP	ND	ND	1.94E-02	ND	ND	ND	ND	NI	7.36E-03	ND	4.72E-03	6.94E-01	ND	1.67E-02	ND	1.18E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	ND
6-Jul-09	B3 Pit -PM10	ND	ND	ND	ND	ND	ND	ND	NI	7.92E-03	ND	ND	ND	ND	ND	ND	1.15E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	ND

Air Quality Monitoring at Giant Mine Site, Yellowknife, NWT – 2009 Program

Start Date	Location	Al (µg/m3)	Sb (µg/m3)	As (µg/m3)	Ba (µg/m3)	Be (µg/m3)	B (µg/m3)	Cd (µg/m3)	Ca (µg/m3)	Cr (µg/m3)	Co (µg/m3)	Cu (µg/m3)	Fe (µg/m3)	Pb (µg/m3)	Mn (µg/m3)	Mo (µg/m3)	Ni (µg/m3)	K (µg/m3)	Se (µg/m3)	Ag (µg/m3)	Sr (µg/m3)	Tl (µg/m3)	Sn (µg/m3)	Ti (µg/m3)	V (µg/m3)	Zn (µg/m3)
6-Jul-09	B3 Pit -TSP	ND	ND	1.22E-02	ND	ND	ND	ND	NI	8.47E-03	ND	4.44E-03	ND	ND	1.17E-02	ND	1.10E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND
6-Jul-09	Mill-PM10	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
6-Jul-09	Mill-TSP	ND	ND	ND	ND	ND	ND	ND	NI	9.17E-03	ND	ND	ND	ND	8.47E-03	ND	1.26E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND
6-Jul-09	NW Pond-PM10	ND	ND	ND	ND	ND	ND	ND	NI	1.53E-02	ND	4.86E-03	ND	ND	9.17E-03	ND	1.81E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND
6-Jul-09	NW Pond-TSP	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
12-Jul-09	South Pond - PM10	ND	ND	ND	ND	ND	ND	ND	NI	ND	ND	4.17E-03	ND	ND	7.78E-03	ND	3.47E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND
12-Jul-09	South Pond - TSP	ND	ND	1.35E-02	ND	ND	ND	ND	NI	ND	ND	ND	ND	ND	1.13E-02	ND	7.92E-03	NI	ND	ND	ND	ND	ND	ND	ND	ND
12-Jul-09	B3 Pit -PM10	ND	ND	ND	ND	ND	ND	ND	NI	ND	ND	4.31E-03	ND	ND	8.19E-03	ND	1.04E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND
12-Jul-09	B3 Pit -TSP	4.31E-01	ND	1.14E-02	1.08E-02	ND	ND	ND	NI	1.03E-02	ND	5.97E-03	ND	ND	1.53E-02	ND	4.72E-02	NI	ND	ND	ND	ND	ND	ND	1.94E-02	ND
12-Jul-09	Mill-PM10	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
12-Jul-09	Mill-TSP	3.89E-01	ND	1.53E-02	ND	ND	ND	ND	NI	ND	ND	9.72E-03	ND	ND	1.35E-02	ND	3.61E-02	NI	ND	ND	ND	ND	ND	ND	1.53E-02	ND
12-Jul-09	NW Pond-PM10	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
12-Jul-09	NW Pond-TSP	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
18-Jul-09	South Pond - PM10	ND	ND	ND	ND	ND	ND	ND	NI	ND	ND	4.44E-03	ND	ND	8.19E-03	ND	5.83E-02	NI	ND	ND	ND	ND	ND	4.72E-03	ND	ND
18-Jul-09	South Pond - TSP	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
18-Jul-09	B3 Pit -PM10	ND	ND	ND	ND	ND	ND	ND	NI	1.03E-02	ND	1.01E-02	ND	ND	1.28E-02	ND	3.61E-02	NI	ND	ND	ND	ND	ND	1.21E-02	ND	ND
18-Jul-09	B3 Pit -TSP	6.39E-01	ND	1.53E-02	ND	ND	ND	ND	NI	1.18E-02	ND	7.36E-03	1.11E+00	7.08E-03	2.50E-02	ND	1.15E-02	NI	ND	ND	ND	ND	ND	5.00E-03	2.78E-02	ND
18-Jul-09	Mill-PM10	ND	ND	ND	ND	ND	ND	ND	NI	9.18E-03	ND	2.72E-02	ND	ND	2.04E-02	ND	2.38E-02	NI	ND	ND	ND	ND	ND	1.62E-02	ND	ND
18-Jul-09	Mill-TSP	3.47E-01	ND	1.94E-02	ND	ND	ND	ND	NI	7.22E-03	ND	7.08E-03	ND	ND	1.67E-02	ND	1.01E-02	NI	ND	ND	ND	ND	ND	ND	1.53E-02	ND
18-Jul-09	NW Pond-PM10	ND	ND	ND	ND	ND	ND	ND	NI	1.14E-02	ND	6.81E-03	ND	ND	1.53E-02	ND	1.67E-02	NI	ND	ND	ND	ND	ND	6.67E-03	ND	ND
18-Jul-09	NW Pond-TSP	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
24-Jul-09	South Pond - PM10	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
24-Jul-09	South Pond - TSP	4.17E-01	9.03E-03	4.86E-02	ND	ND	ND	ND	NI	ND	ND	5.28E-03	1.28E+00	5.97E-03	3.06E-02	ND	7.78E-03	NI	ND	ND	ND	ND	ND	ND	ND	ND
24-Jul-09	B3 Pit -PM10	ND	ND	ND	ND	ND	ND	ND	NI	8.75E-03	ND	5.56E-03	ND	ND	1.10E-02	ND	2.36E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND
24-Jul-09	B3 Pit -TSP	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
24-Jul-09	Mill-PM10	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
24-Jul-09	Mill-TSP	ND	ND	1.32E-02	ND	ND	ND	ND	NI	1.29E-02	ND	4.17E-02	ND	ND	1.33E-02	ND	8.33E-03	NI	ND	ND	ND	ND	ND	ND	ND	ND
24-Jul-09	NW Pond-PM10	4.31E-01	ND	3.89E-02	ND	ND	ND	ND	NI	8.61E-03	ND	7.50E-03	8.06E-01	5.00E-03	2.08E-02	ND	1.03E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND
24-Jul-09	NW Pond-TSP	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
30-Jul-09	South Pond - PM10	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
30-Jul-09	South Pond - TSP	ND	ND	9.67E-03	ND	ND	ND	ND	NI	ND	ND	4.76E-03	ND	ND	1.04E-02	ND	1.17E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND
30-Jul-09	B3 Pit -PM10	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
30-Jul-09	B3 Pit -TSP	3.75E-01	ND	1.26E-02	ND	ND	ND	ND	NI	2.08E-02	ND	5.00E-03	ND	ND	1.38E-02	ND	1.94E-02	NI	ND	ND	ND	ND	ND	ND	1.53E-02	ND
30-Jul-09	Mill-PM10	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
30-Jul-09	Mill-TSP	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
30-Jul-09	NW Pond-PM10	ND	ND	ND	ND	ND	ND	ND	NI	8.33E-03	ND	6.11E-03	ND	ND	7.78E-03	ND	8.61E-03	NI	ND	ND	ND	ND	ND	ND	ND	ND
30-Jul-09	NW Pond-TSP	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
5-Aug-09	South Pond - PM10	ND	ND	ND	ND	ND	ND	ND	NI	ND	ND	5.42E-03	ND	ND	7.36E-03	ND	8.89E-03	NI	ND	ND	ND	ND	ND	ND	ND	ND
5-Aug-09	South Pond - TSP	ND	ND	ND	ND	ND	ND	ND	NI	ND	ND	5.27E-03	ND	ND	1.29E-02	ND	9.15E-03	NI	ND	ND	ND	ND	ND	ND	ND	ND
5-Aug-09	B3 Pit -PM10	ND	ND	ND	ND	ND	ND	ND	NI	1.39E-02	ND	ND	ND	ND	1.03E-02	ND	1.81E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND
5-Aug-09	B3 Pit -TSP	4.86E-01	ND	1.21E-02	ND	ND	ND	ND	NI	4.58E-02	ND	6.53E-03	9.31E-01	ND	2.22E-02	ND	3.61E-02	NI	ND	ND	ND	ND	ND	ND	1.81E-02	ND
5-Aug-09	Mill-PM10	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
5-Aug-09	Mill-TSP	4.31E-01	ND	1.15E-02	ND	ND	ND	ND	NI	1.19E-02	ND	4.58E-03	7.22E-01	ND	1.67E-02	ND	2.22E-01	NI	ND	ND	ND	ND	ND	ND	1.94E-02	ND
5-Aug-09	NW Pond-PM10	ND	ND	1.11E-02	ND	ND	ND	ND	NI	1.39E-02	ND	ND	ND	ND	1.39E-02	ND	2.08E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND
5-Aug-09	NW Pond-TSP	5.14E-01	ND	4.03E-02	ND	ND	ND	ND	NI	9.58E-03	ND	9.72E-03	9.44E-01	ND	2.50E-02	ND	1.38E-02	NI	ND	ND	ND	ND	ND	4.72E-03	2.36E-02	ND

Air Quality Monitoring at Giant Mine Site, Yellowknife, NWT – 2009 Program

Start Date	Location	Al (µg/m3)	Sb (µg/m3)	As (µg/m3)	Ba (µg/m3)	Be (µg/m3)	B (µg/m3)	Cd (µg/m3)	Ca (µg/m3)	Cr (µg/m3)	Co (µg/m3)	Cu (µg/m3)	Fe (µg/m3)	Pb (µg/m3)	Mn (µg/m3)	Mo (µg/m3)	Ni (µg/m3)	K (µg/m3)	Se (µg/m3)	Ag (µg/m3)	Sr (µg/m3)	Tl (µg/m3)	Sn (µg/m3)	Ti (µg/m3)	V (µg/m3)	Zn (µg/m3)	
11-Aug-09	South Pond - PM10	ND	ND	1.81E-02	ND	ND	ND	ND	NI	ND	ND	5.83E-03	ND	ND	8.33E-03	ND	2.22E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	
11-Aug-09	South Pond - TSP	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	
11-Aug-09	B3 Pit -PM10	ND	ND	1.67E-02	ND	ND	ND	ND	NI	ND	ND	ND	ND	ND	7.22E-03	ND	2.08E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	
11-Aug-09	B3 Pit -TSP	3.47E-01	ND	8.75E-02	ND	ND	ND	ND	NI	9.86E-03	ND	1.03E-02	2.08E+00	6.67E-03	1.94E-02	ND	3.75E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	
11-Aug-09	Mill-PM10	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	
11-Aug-09	Mill-TSP	5.26E-01	8.85E-03	5.81E-02	ND	ND	ND	ND	NI	ND	ND	1.12E-02	1.52E+00	7.19E-03	3.46E-02	ND	1.12E-02	NI	ND	ND	ND	ND	ND	ND	2.21E-02	ND	ND
11-Aug-09	NW Pond-PM10	ND	ND	1.00E-02	ND	ND	ND	ND	NI	ND	ND	4.58E-03	ND	ND	9.44E-03	ND	1.53E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	
11-Aug-09	NW Pond-TSP	3.61E-01	ND	6.11E-02	ND	ND	ND	ND	NI	ND	ND	8.06E-03	1.21E+00	4.58E-03	2.36E-02	ND	1.18E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	
17-Aug-09	South Pond - PM10	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	
17-Aug-09	South Pond - TSP	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	
17-Aug-09	B3 Pit -PM10	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	
17-Aug-09	B3 Pit -TSP	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	
17-Aug-09	Mill-PM10	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	
17-Aug-09	Mill-TSP	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	
17-Aug-09	NW Pond-PM10	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	
17-Aug-09	NW Pond-TSP	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	
23-Aug-09	South Pond - PM10	ND	ND	ND	ND	ND	ND	ND	NI	ND	ND	4.86E-03	ND	ND	1.03E-02	ND	1.38E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	
23-Aug-09	South Pond - TSP	ND	ND	1.81E-02	7.36E-03	ND	ND	ND	NI	ND	ND	6.81E-03	ND	ND	1.22E-02	ND	1.18E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	
23-Aug-09	B3 Pit -PM10	ND	ND	1.01E-02	ND	ND	ND	ND	NI	1.14E-02	ND	5.00E-03	ND	ND	9.86E-03	ND	2.08E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	
23-Aug-09	B3 Pit -TSP	ND	ND	1.81E-02	ND	ND	ND	ND	NI	8.75E-03	ND	4.58E-03	8.47E-01	ND	1.39E-02	ND	1.67E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	
23-Aug-09	Mill-PM10	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	
23-Aug-09	Mill-TSP	ND	ND	2.22E-02	8.61E-03	ND	ND	ND	NI	1.36E-02	ND	2.08E-02	ND	ND	1.39E-02	ND	1.15E-02	NI	ND	6.53E-03	ND	ND	ND	ND	ND	ND	
23-Aug-09	NW Pond-PM10	ND	ND	ND	ND	ND	ND	ND	NI	ND	ND	5.69E-03	ND	ND	7.36E-03	ND	3.89E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	
23-Aug-09	NW Pond-TSP	ND	ND	7.64E-03	ND	ND	ND	ND	NI	ND	ND	4.86E-03	ND	ND	1.00E-02	ND	2.08E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	
29-Aug-09	South Pond - PM10	ND	ND	ND	ND	ND	ND	ND	NI	ND	ND	8.19E-03	ND	ND	1.33E-02	ND	3.19E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	
29-Aug-09	South Pond - TSP	4.31E-01	1.67E-02	6.81E-02	ND	ND	ND	ND	NI	ND	ND	8.06E-03	1.67E+00	9.72E-03	1.39E-01	ND	8.61E-03	NI	ND	ND	ND	ND	ND	ND	ND	ND	
29-Aug-09	B3 Pit -PM10	2.77E-01	ND	8.44E-03	ND	ND	ND	ND	NI	1.13E-02	ND	2.35E-02	ND	ND	1.34E-02	ND	1.52E-02	NI	ND	ND	ND	ND	ND	6.09E-03	ND	ND	
29-Aug-09	B3 Pit -TSP	3.47E-01	ND	ND	ND	ND	ND	ND	NI	8.61E-03	ND	7.36E-03	ND	ND	1.53E-02	ND	1.11E-02	NI	ND	ND	ND	ND	ND	ND	1.53E-02	ND	ND
29-Aug-09	Mill-PM10	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	
29-Aug-09	Mill-TSP	2.78E-01	ND	1.24E-02	ND	ND	ND	ND	NI	8.33E-03	ND	6.94E-03	ND	ND	1.53E-02	ND	1.07E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	
29-Aug-09	NW Pond-PM10	ND	ND	1.94E-02	ND	ND	ND	ND	NI	ND	ND	5.42E-03	ND	ND	1.36E-02	ND	1.39E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	
29-Aug-09	NW Pond-TSP	1.94E+00	1.39E-01	8.75E-01	ND	ND	ND	ND	NI	8.61E-03	1.33E-02	3.19E-02	1.53E+01	1.21E-01	2.22E-01	ND	2.92E-02	NI	ND	ND	1.35E-02	ND	ND	2.78E-02	7.50E-03	1.35E-01	
4-Sep-09	South Pond - PM10	ND	ND	ND	ND	ND	ND	ND	NI	ND	ND	ND	ND	ND	9.31E-03	ND	ND	NI	ND	ND	ND	ND	ND	ND	ND	ND	
4-Sep-09	South Pond - TSP	3.33E-01	2.22E-02	1.21E-01	ND	ND	ND	ND	NI	ND	ND	1.11E-02	2.78E+00	1.25E-02	3.33E-02	ND	7.78E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	
4-Sep-09	B3 Pit -PM10	ND	ND	ND	ND	ND	ND	ND	NI	ND	ND	ND	ND	ND	9.58E-03	ND	ND	NI	ND	ND	ND	ND	ND	ND	ND	ND	
4-Sep-09	B3 Pit -TSP	7.64E-01	ND	3.06E-02	ND	ND	ND	ND	NI	8.61E-03	ND	9.58E-03	1.67E+00	ND	2.78E-02	ND	9.58E-03	NI	ND	ND	ND	ND	ND	ND	3.33E-02	ND	ND
4-Sep-09	Mill-PM10	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	
4-Sep-09	Mill-TSP	ND	ND	1.67E-02	ND	ND	ND	ND	NI	ND	ND	ND	ND	ND	1.38E-02	ND	7.08E-03	NI	ND	ND	ND	ND	ND	ND	ND	ND	
4-Sep-09	NW Pond-PM10	ND	ND	7.64E-03	ND	ND	ND	ND	NI	ND	ND	6.94E-03	ND	ND	9.44E-03	ND	ND	NI	ND	ND	ND	ND	ND	ND	ND	ND	
4-Sep-09	NW Pond-TSP	6.81E-01	4.72E-02	2.50E-01	ND	ND	ND	ND	NI	7.08E-03	ND	1.39E-02	4.86E+00	3.61E-02	7.08E-02	ND	1.39E-02	NI	ND	ND	ND	ND	ND	5.97E-03	ND	ND	ND
10-Sep-09	South Pond - PM10	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	
10-Sep-09	South Pond - TSP	ND	ND	8.33E-03	ND	ND	ND	ND	NI	7.08E-03	ND	7.08E-03	ND	ND	1.17E-02	ND	1.94E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	
10-Sep-09	B3 Pit -PM10	ND	ND	ND	ND	ND	ND	ND	NI	1.14E-02	ND	ND	ND	ND	1.03E-02	ND	1.11E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	
10-Sep-09	B3 Pit -TSP	5.83E-01	ND	2.08E-02	ND	ND	ND	ND	NI	1.01E-02	ND	4.72E-03	1.18E+00	ND	2.92E-02	ND	1.10E-02	NI	ND	ND	ND	ND	ND	7.36E-03	1.94E-02	ND	ND
10-Sep-09	Mill-PM10	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	

Start Date	Location	Al (µg/m3)	Sb (µg/m3)	As (µg/m3)	Ba (µg/m3)	Be (µg/m3)	B (µg/m3)	Cd (µg/m3)	Ca (µg/m3)	Cr (µg/m3)	Co (µg/m3)	Cu (µg/m3)	Fe (µg/m3)	Pb (µg/m3)	Mn (µg/m3)	Mo (µg/m3)	Ni (µg/m3)	K (µg/m3)	Se (µg/m3)	Ag (µg/m3)	Sr (µg/m3)	Tl (µg/m3)	Sn (µg/m3)	Ti (µg/m3)	V (µg/m3)	Zn (µg/m3)	
10-Sep-09	Mill-TSP	ND	ND	ND	ND	ND	ND	ND	NI	7.78E-03	ND	ND	ND	ND	9.72E-03	ND	1.25E-02	NI	ND	ND	ND	ND	ND	ND	ND	ND	
10-Sep-09	NW Pond-PM10	ND	ND	ND	ND	ND	ND	ND	NI	ND	ND	1.31E-02	ND	ND	1.01E-02	ND	8.06E-03	NI	ND	ND	ND	ND	ND	ND	ND	ND	
10-Sep-09	NW Pond-TSP	4.86E-01	ND	4.44E-02	ND	ND	ND	ND	NI	7.78E-03	ND	5.97E-03	1.53E+00	5.42E-03	2.64E-02	ND	8.06E-03	NI	ND	1.39E-03	ND	ND	ND	ND	1.53E-02	ND	ND

Table 4.10 – Ambient Air Metal Concentrations at the Giant Mine Townsite

	Sample Date																
	6-Jun-09	12-Jun-09	18-Jun-09	24-Jun-09	30-Jun-09	6-Jul-09	12-Jul-09	18-Jul-09	24-Jul-09	30-Jul-09	5-Aug-09	11-Aug-09	17-Aug-09	23-Aug-09	29-Aug-09	4-Sep-09	10-Sep-09
Al	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	6.36E-02	7.90E-02	7.68E-02	NS-INS	NR	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
Sb	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	ND	ND	ND	NS-INS	NR	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
As	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	ND	4.74E-03	ND	NS-INS	ND	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
Ba	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	1.48E-03	1.58E-03	1.38E-03	NS-INS	NR	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
Be	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	ND	ND	ND	NS-INS	NR	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
B	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	ND	ND	ND	NS-INS	NR	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
Cd	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	ND	ND	ND	NS-INS	ND	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
Cr	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	1.42E-03	ND	1.64E-03	NS-INS	2.47E-03	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
Co	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	ND	ND	ND	NS-INS	ND	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
Cu	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	1.14E-01	1.14E-01	1.40E-01	NS-INS	1.46E-01	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
Fe	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	1.66E-01	1.66E-01	2.18E-01	NS-INS	1.35E-01	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
Pb	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	ND	ND	ND	NS-INS	ND	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
Mn	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	2.78E-03	3.16E-03	2.83E-03	NS-INS	2.78E-03	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
Mo	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	ND	ND	ND	NS-INS	NR	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
Ni	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	2.08E-02	3.16E-03	1.98E-02	NS-INS	ND	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
P	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	1.98E-02	3.47E-02	2.27E-02	NS-INS	NR	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
Se	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	ND	ND	ND	NS-INS	ND	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
Si	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	3.68E-01	3.81E-01	4.14E-01	NS-INS	NR	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
Ag	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	6.79E-04	ND	ND	NS-INS	NR	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
Sr	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	ND	ND	ND	NS-INS	NR	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
S	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	1.15E-01	1.19E-01	3.08E-01	NS-INS	1.29E-01	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
Tl	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	ND	ND	ND	NS-INS	NR	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
Sn	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	ND	ND	ND	NS-INS	NR	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
Ti	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	2.72E-03	3.28E-03	4.09E-03	NS-INS	NR	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
V	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	ND	ND	ND	NS-INS	ND	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
Zn	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	1.11E-02	6.25E-03	8.75E-03	NS-INS	7.84E-03	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
Zr	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	ND	ND	ND	NS-INS	NR	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
SO4	NI	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	3.45E-01	3.56E-01	9.25E-01	NS-INS	3.86E-01	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

As a part of the Giant Mine Remediation Project (GMRP), an air quality-monitoring program was devised and carried out during each summer since 2004 to establish a baseline for the fugitive emissions from the tailings areas and other disturbed areas at the mine site.

The 2009 program was carried out from June through to mid September and consisted of ambient air monitoring of TSP at the nearest residential location in the Giant Mine Town Site and simultaneous ambient air monitoring of TSP and PM₁₀ at four other locations within the property boundary of the Giant Mine site. The sampling was done to determine total and inhalable particulate loading, as well as the concentrations of their inorganic trace element constituents, such as arsenic.

The 2009 suspended particulate monitoring results indicate that the concentrations at the five sampling locations vary considerably with respect to average TSP and PM₁₀ concentrations. As expected, the Giant Mine Town Site results were low in comparison to the onsite monitoring locations. The highest TSP concentration was detected at the Northwest Pond location, which also had the highest average of all of the TSP monitoring stations. The maximum PM₁₀ concentration was logged at the Mill location, which also had the highest average however it should be noted that it also had the lowest sample collection efficiency.

The analyses of inorganic elements indicated that, with the exception of arsenic and iron all other concentrations were below their applicable AAQC. There were four exceedances of the AAQC for iron, and one exceedance of the AAQC for arsenic. This is very similar to the 2008 program in which there were three exceedances of iron and one exceedance of arsenic. Similar to previous monitoring years, the arsenic exceedance in 2008 was detected at the Northwest Pond location. Two of the iron exceedances were also at the Northwest Pond, with the others occurring at the B3 Pit and South Pond.

Overall, there was a decrease in average TSP and PM₁₀ concentrations in 2009 as compared to 2008. For TSP, this trend was accompanied by a significant decrease in the relative number of exceedances of the AAQCs. However, for PM₁₀ the relative number of exceedances increased. Therefore, while PM₁₀ concentrations on the whole decreased, the concentrations were still at levels above the AAQC.

A comparison of the amount of arsenic in the total particulate samples versus that in the inhalable size fraction revealed that on average, 74% of the arsenic is entrained in the coarse particles, however it should be noted that low sampling efficiency resulted in there only being 9

days for which a comparison was possible. This result is in line with previous monitoring programs which concluded that more than half of the total arsenic is entrained in the coarse particles as opposed to the inhalable particles. Arsenic contained in the coarse particles is less likely to have an impact on human health.

5.2 RECOMMENDATIONS

The results of the monitoring program do not strongly correlate when broad comparisons are made to meteorological data for exceedance days. Elevated concentrations are, however, generally associated with on-site activities. For purposes of comparison to historical data and as a measure of general site air quality, it is recommended that the same monitoring program be continued for the period during the remediation activities at the Giant Mine site.

The 2009 program had a large number of failed samplings. For the Mini-vol sampling, this was attributable to equipment battery malfunction (data for 44 of 136 samples were not appropriate for inclusion in the analysis because of unacceptable variations in the sample duration of greater than $\pm 25\%$ of 24 hours). Under separate cover, SENES has made a number of recommendations to INAC to improve both data collection efficiency and data quality.

6.0 REFERENCES

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APPENDIX A
MINI-VOL AIR SAMPLING PROCEDURE

APPENDIX A MINI-VOL AIR SAMPLING PROCEDURE

The AirMetrics Mini-Vol is a portable sampling device that can be used to sample Total Suspended Particulates (TSP), Particulate Matter less than 10 µm (PM₁₀, also known as inhalable particulates) and Particulate Matter less than 2.5 µm (PM_{2.5}, also known as respirable particulates). The sampler can be powered using DC power from the rechargeable batteries supplied with the unit, or AC power, by plugging the charger into an AC source.

The pieces of equipment required are:

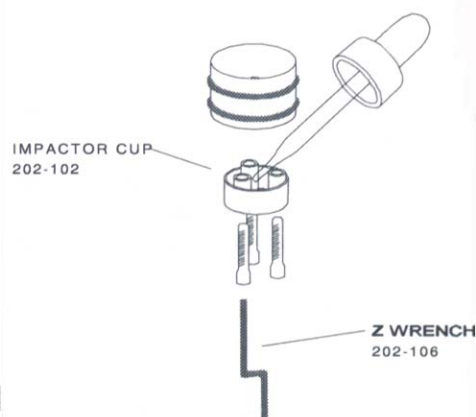
- 1 Mini-Vol pump module
- 2 battery packs
- 1 battery charger/transformer
- 1 tube of impactor grease
- hexane solvent
- 47 mm filters
- 1 field calibration kit including calibration orifice and flow measurement device (magnahelic or manometer)
- 1 tripod (for indoor or sampling in a protected area)
- 2 filter holder assemblies
- 2 PM₁₀ impactor assemblies
- 2 PM_{2.5} impactor assemblies
- 2 multi-impactor adaptors
- 2 rain hats
- 1 mounting cradle
- 1 mounting bracket and hoisting pole assembly (for mounting unit on high poles)

In order to successfully implement a sampling programme, the following steps should be followed:

1. Purchase 47 mm filters. The filter media chosen depends on the type of post-sampling analyses to be completed. For example, if only the particulate concentrations are required, choose glass fibre filters. If particulate sulphate concentrations or metals components are required, quartz, Teflon membrane or Teflon-coated glass fibre filters are more appropriate.
2. Send the filters to an accredited laboratory for numbering, conditioning and pre-weighing, OR
 - Label each filter with a unique identification number, place them in a desiccator and allow it to equilibrate for a minimum of 24 hours. After desiccation, immediately weigh the filters on a scale accurate to 1 µg and record the weight. Place the filters in a storage case (e.g. petri-slides). Filters should be handled with forceps to prevent contamination.
3. Charge the battery (ies) for a minimum of 18 hours prior to sampling. Check to ensure that the pump and programmer/timer work prior to transport to the field.

4. Prepare the sampler for initial use. Ensure that the filter holder assemblies, impactor discs and rain hats are free of dust and debris. Clean all parts with hexane to remove any grease and/or debris. Make up a suspension of 1" of impactor grease to 100 mL of hexane. Shake well until all grease is dissolved and a uniform suspension results. Use a dropper to thoroughly coat the impactor discs (both PM₁₀ and PM_{2.5} assemblies) with a small amount of the suspension as shown in Figure 1.

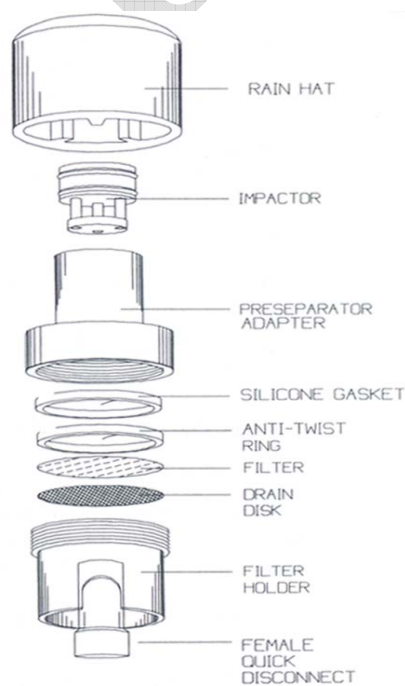
Figure 1
REGREASING PM_{2.5} IMPACTOR



5. Allow the hexane to evaporate, leaving a fine film of impactor grease on the discs. All actions involving solvent use should be completed in a fume hood or a well-ventilated area. The PM₁₀ and PM_{2.5} impactor assemblies and discs should be cleaned with hexane solvent and recoated with impactation grease solution after every seventh use, or sooner if noticeable build-up of particulate occurs.

6. Assemble the filter holder and impactor assemblies. Unscrew the filter holder assembly and remove the drain disc filter support screen assembly. Use a narrow, flat edge (such as a flat head screwdriver) to pop the filter support ring off, and place a preweighed, numbered filter on the support screen rough side up. Place the support ring back on, taking care not to twist or damage the filter. Place the support assembly back into the bottom portion of the filter holder.

Figure 2
PM₁₀ PRESEPARATOR AND FILTER HOLDER ASSEMBLY



- If TSP sampling is desired, screw the filter holder assembly together and place a rain hat over the top of the assembly.
- If PM₁₀ sampling is desired, slide the PM₁₀ impactor assembly (the one with the larger funnel hole) into the top portion of the filter holder assembly, such that the top of the

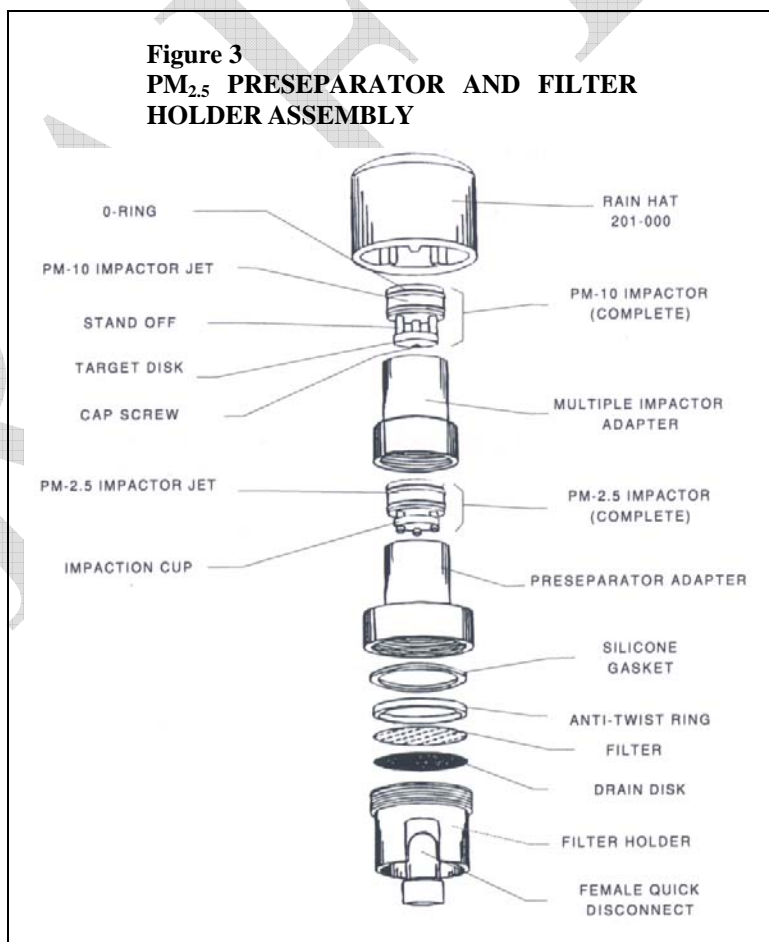
impactor is flush with the top of the holder assembly. This impactor causes all particles greater than 10 μm to impact on and stick to the disc at the bottom. Only particle 10 μm and less flow through to the filter. Screw the holder assembly together and place a rain hat over the top of the filter holder assembly. See Figure 2 for further detail.

- If $\text{PM}_{2.5}$ sampling is desired, slide the $\text{PM}_{2.5}$ impactor assembly (the one with the smaller funnel hole) into the top portion of the filter holder assembly, such that the top of the impactor is flush with the top of the holder assembly. This impactor causes all particles greater than 2.5 μm to impact on and stick to the disc at the bottom. Screw the holder assembly together. Next, slide the PM_{10} impactor assembly into the second impactor holder (i.e. the one that does not have a filter holder). Ensure that the impactor assembly is flush with the top of the impactor holder. Slide the bottom of this holder over the top of the filter holder assembly, containing the $\text{PM}_{2.5}$ impactor assembly. Place a rain hat over the top of the holder containing the PM_{10} impactor assembly. This configuration works by first removing particles greater than 10 μm (i.e. they impact and stick to the PM_{10} impactor disc). Only particles 10 μm and less flow through to the second impactor assembly, where particles greater than 2.5 μm impact and stick to the $\text{PM}_{2.5}$ impactor disc. Only particles 2.5 μm and less flow through to the filter. See Figure 3 for details.

- Flow meter reading from the centre of the ball. Record the displayed flow and the corresponding pressure drop reading on the magnahelic, manometer, etc.

- Adjust the flow knob to decrease the flow slightly.

Record the corresponding indicated flow on the flow meter and pressure drop on the magnahelic. Continue to do this for a minimum of five calibration points such that flows between approximately 4 and 7 L/min are sampled.



- Measure and record the ambient temperature and atmospheric pressure using a thermometer and a barometer (not included with the calibration kit). (NOTE: ambient pressure and temperature may be obtained from a nearby weather office if a measuring device is unavailable).
 - For each calibration point, use the equation provided with the calibration orifice to calculate the actual flow rate from the indicated flow rate, magnahelic pressure drop, ambient temperature and pressure. Plot a graph of indicated flow rate versus actual flow rate and draw a line of best fit. From the graph, determine the indicated flow that corresponds to an actual flow of 5 L/min. Re-set the flow meter to the indicated flow that provides an actual flow of 5 L/min. (NOTE: THIS IS EXTREMELY IMPORTANT WHEN SAMPLING FOR PM₁₀ OR PM_{2.5} AS THE IMPACTOR DISCS ARE DESIGNED TO PROVIDE THE CORRECT SIZE CUTPOINT AT PRECISELY 5 L/MIN).
 - Record the indicated flow rate. Turn the unit off and remove the calibration orifice and blank filter holder assembly.
7. Remove the pre-prepared filter holder assembly containing the pre-weighed filter from the protective plastic bag and attach it to the Mini-Vol using the Quick Connect fitting attached to the unit.
 8. Program the timer to turn the unit on at the appropriate time as described on Page 8 of the Users Manual, or manually turn the unit on to begin sampling. Slide the pump and timer assembly back into the casing, and re-attach the carrying handle.
 9. Record the filter number, battery number, sampler ID (if using more than one) and elapsed time meter reading.
 10. Place the sampler in the monitoring location. The unit should be upright, in an unobstructed area at least 30 cm away from any obstacle to air flow. For ambient monitoring, place the sampler away from interferences such as buildings, chimneys, trees, etc. Equipment security should also be taken into consideration when locating sampling sites to prevent theft or vandalism.
 11. Allow the unit to remain in the sampling location undisturbed for the appropriate duration. A sample duration of 24-hours is appropriate for ambient samples.
 12. If an additional sample is desired, repeat Steps 3 – 7 above with the second filter holder assembly and spare battery included with the Mini-Vol.
 13. After sampling has been completed, return to the site and retrieve the unit from the sampling location. Place the unit on a firm level surface. (NOTE: THE FILTERS SHOULD BE REMOVED FROM THE UNIT SHORTLY AFTER SAMPLING TO PREVENT CONTAMINATION AND/OR LOSS OF VOLATILES, ETC.)

14. Remove the carrying handle and lift the pump and timer assembly out of the casing, taking care not to pull any tubing or wires loose.
15. Check the sampler faceplate for any errors such as low battery or low flow, which causes the power to shut off and terminates sampling. Record the elapsed time.
16. Turn the unit on and record the ending flow rate. Stop the pump.
17. Remove the filter holder assembly and place into a protective plastic baggie. If another sample is required, remove the fresh filter holder assembly prepared in Step 13 above from the plastic bag and place it on the sampler. Turn the unit on briefly and record the initial flow rate. (NOTE: IF THE TEMPERATURE AND/OR PRESSURE HAS CHANGED DRAMATICALLY SINCE CALIBRATION THE UNIT SHOULD BE RE-CALIBRATED TO ENSURE THAT THE SAMPLE FLOWRATE IS SET AT 5 L/MIN)
18. Transport the used filter holder assembly to an indoor location. Remove the filter from the holder and place in a petri slide for protection prior to and during transport to the lab.
19. Continue to repeat Steps 9 through 19 for the duration of the sampling programme. Re-calibrate the unit at the end of the sampling programme. [REMEMBER TO CLEAN AND GREASE IMPACTOR DISCS EVERY 7 SAMPLES] When approximately 12 samples have been collected, send the samples back to the laboratory for post-weighing and any subsequent analyses. To prevent erroneous results due to scale errors, it is important that post-weighing be done on the same scale as the pre-weighing.
20. For each sample, calculate the average indicated flow rate from the initial and final flow readings. Use the calibration curve to convert indicated flow to actual flow. For each sample, determine the total elapsed time in minutes by subtracting the final reading on the elapsed time indicator from the initial reading. Convert to minutes. Multiply the average actual flow rate by the total elapsed time to obtain the total volume of air sampled. When the lab results are available, divide the total mass of particulate collected on the filter by the total volume of air sampled to determine the ambient particulate concentration ($\mu\text{g}/\text{m}^3$).

APPENDIX B

HI-VOL AIR SAMPLING PROCEDURE

APPENDIX B HI-VOL AIR SAMPLING PROCEDURE

High Volume (Hi-Vol) sampling is a regulatory method for determining the concentration of air particulate (dust) in an area. A Hi-Vol is essentially a giant vacuum cleaner that sucks air into it and through a pre-weighed filter. The units generally run for 24 hours. The filters are then removed and sent to a lab for post-weighing.

Sampler operation consists of the following steps:

1. After performing calibration procedure (as in the following section) , remove filter holder frame by loosening the four wing nuts allowing the brass bolts and washers to swing down out of the way. Shift frame to one side and remove.
2. Carefully center a new filter, rougher side up, on the supporting screen. Properly align the filter on the screen so that when the frame is in position the gasket will form an airtight seal on the outer edges of the filter.
3. Secure the filter with the frame, brass bolts, and washers with sufficient pressure to avoid air leakage at the edges (make sure that the plastic washers are on top of the frame).
4. Wipe any dirt accumulation from around the filter holder with a clean cloth.
5. Close shelter lid carefully and secure with the "S" hook.
6. Make sure all cords are plugged into their appropriate receptacles and the rubber tubing between the blower motor pressure tap and the TE-5009 continuous flow recorder (or TE-5008 manometer) is connected (be careful not to pinch tubing when closing door).
7. Prepare TE-5009 continuous flow recorder as follows:
 - a) Clean any excess ink and moisture on the inside of recorder by wiping with a clean cloth.
 - b) Depress pen arm lifter to raise pen point and carefully insert a fresh chart.
 - c) Carefully align the tab of the chart to the drive hub of the recorder and press gently with thumb to lower chart center onto hub. Make sure chart is placed under the chart guide clip and the time index clip so it will rotate freely without binding. Set time by rotating the drive hub clock-wise until the correct time on chart is aligned with time index pointer.
 - d) Make sure the TE-160 pen point rests on the chart with sufficient pressure to make a visible trace.
8. Prepare the Timer as instructed on the following page
9. At the end of the sampling period, remove the frame to expose the filter. Carefully remove the exposed filter from the supporting screen by holding it gently at the ends (not at the corners). Fold the filter lengthwise so that sample touches sample.

10. It is always a good idea to contact the lab you are dealing with to see how they may suggest you collect the filter and any other information that they may need.

To set up the digital timer:

1. Start with the Sampler Switch (Timed – Off – On) Switch #1, in the Off position. If you need to test or adjust the blower motor turn the Sampler switch to On. When done with adjusting, turn it back to Off.
2. Place the rotary switches in the desired positions. If today is Friday and you want the first sample time on Sunday, turn the “Sample After Days” switch to position 2. If you want to run the sampler every Sunday after that, turn the “Sample Every Days” switch to position 7, (for six day sampling use position 6). Turn “Sample for Hours” to desired number of running hours.
3. Next put the Display switch, Switch #4, in the Start Time position. Then using the Set switch, Switch #3, enter the start time, hours and minutes.
4. Next put the Display switch, Switch #4, in the Time of Day position. Then using the Set switch, Switch #3, enter the current time, hours and minutes.
5. Now press and release the Reset switch, Switch #2, toward Timer. A small triangle on the display will start blinking. This indicates the timer is running.
6. If you need to, reset the Hour Meter to zero. Press and release the reset switch, Switch #2, twice, toward Hour Meter.
7. Last thing to do is place the Sampler switch, Switch #1, (Timed – Off – On) in the Timed position.

Hi-Vol Calibration Procedure

Any instrument or mechanical device is subject to errors and/or inaccuracies in their readings. Therefore, in order to use the flow chart recorder on the Hi-Vol to determine the flow rate, the recorder must be calibrated to ensure that the actual flow rate is known (versus what is read on the charts).

The following is a step-by-step process of the calibration of a TE-5170-DV Volumetric Flow Controlled TSP Particulate Sampling System. The air flow through these types of sampling systems is controlled by a Volumetric Flow Controller (VFC) or dimensional venturi device.

This calibration differs from that of a mass flow controlled TSP sampler in that a slope and intercept does not have to be calculated to determine air flows. Also, the calibrator orifice Qactual slope and intercept from the orifice certification worksheet can be used here, unlike a

mass flow controlled TSP where Qstandard slope and intercept are used. The flows are converted from actual to standard conditions when the particulate concentrations are calculated.

With a Volumetric Flow Controlled (VFC) sampler, the calibration flow rates are provided in a Flow Look Up Table that accompanies each sampler.

Proceed with the following steps to begin the calibration:

Step one: Mount the calibrator orifice and top loading adapter plate to the sampler. A sampling filter is generally not used during this procedure. Tighten the top loading adapter hold down nuts securely for this procedure to assure that no air leaks are present.

Step two: Turn on the sampler and allow it to warm up to its normal operating temperature.

Step three: Conduct a leak test by covering the holes on top of the orifice and pressure tap on the orifice with your hands. Listen for a high-pitched squealing sound made by escaping air. If this sound is heard, a leak is present and the top loading adapter hold-down nuts need to be re-tightened.

Note: Avoid running the sampler for longer than 30 seconds at a time with the orifice blocked. This will reduce the chance of the motor overheating. Also, never try this leak test procedure with a manometer connected to the pressure tap on the calibration orifice or the pressure tap on the side of the sampler. Liquid from either manometer could be drawn into the system and cause motor damage.

Step four: Connect one side of a water manometer or other type of flow measurement device to the pressure tap on the side of the orifice with a rubber vacuum tube. Leave the opposite side of the manometer open to the atmosphere.

Step five: Connect a water manometer to the quick disconnect located on the side of the aluminum outdoor shelter (this quick disconnect is connected to the pressure tap on the side of the filter holder). If using the TE-5025A (a fixed orifice that uses load plates) orifice a longer manometer is used here as there is a possibility of great pressure difference from this port.

Step six: Make sure the TE-5028A orifice is all the way open (turn the black knob counter clockwise). Record both manometer readings the one from the orifice and the other from the side of the sampler. To read a manometer one side goes up and the other side goes down you add both sides, this is your inches of water. Repeat this process for the other four points by adjusting the knob on the variable orifice (just a slight turn) to four different positions and taking four different readings. You should have five sets of numbers, ten numbers in all.

Step seven: Remove the variable orifice and the top loading adapter and install a clean filter. Record the manometer reading from the side tap on the side of the sampler. This is used to calculate the operational flow rate of the sampler.

Step eight: Record the ambient air temperature, the ambient barometric pressure, the sampler serial number, the orifice serial number, the orifice Qactual slope and intercept with date last certified, today's date, site location and the operators initials.

The first step is to convert the orifice readings to the amount of actual air flow they represent using the following equation:

$$Qa = 1/m[Sqrt((H_2O)(Ta/Pa))-b]$$

where:

- Qa = actual flow rate as indicated by the calibrator orifice, m³/min
- H₂O = orifice manometer reading during calibration, in. H₂O
- Ta = ambient temperature during calibration, K (K = 273 + °C)
- Pa = ambient barometric pressure during calibration, mm Hg
- m = Qstandard slope of orifice calibration relationship
- b = Qstandard intercept of orifice calibration relationship

Once these standard flow rates have been determined for each of the run points, they are recorded in the column titled Qa, and are represented in cubic meters per minute. EPA guidelines state that at least three of these calibrator flow rates should be between 1.1 to 1.7 m³/min (39 to 60 CFM). This is the acceptable operating flow rate range of the sampler. If this condition is not met, the sampler should be recalibrated. An air leak in the calibration system may be the source of this problem. In some cases, a filter may have to be in place during the calibration to meet this condition.

The sampler H₂O readings need to be converted to mm Hg and recorded in the column titled Pf. This is done using the following equation:

$$Pf = 25.4 (in. H_2O/13.6)$$

where:

Pf is recorded in mm Hg

in. H₂O = sampler side pressure reading during calibration.

Po/Pa is calculated next. This is used to locate the sampler calibration air flows found in the Look Up Table. This is done using the following equation:

$$P_o/P_a = 1 - P_f/P_a$$

where:

P_a = ambient barometric pressure during calibration, mm Hg.

Using P_o/P_a and the ambient temperature during the calibration, consult the Look-Up Table to find the actual flow rate. Record these flows in the column titled Look Up.

Calculate the percent difference between the calibrator flow rates and the sampler flow rates using the following equation:

$$\% \text{ Diff.} = (\text{Look Up Flow} - Q_a)/Q_a * 100$$

where:

Look Up Flow = Flow found in Look Up Table, m³/min

Q_a = orifice flow during calibration, m³/min.

The EPA guidelines state that the percent difference should be within + or - 3 or 4%. If they are greater than this, a leak may have been present during calibration and the sampler should be recalibrated. The line on the worksheet labelled Operational Flow Rate is where the side tap reading is recorded which is taken with no resistance plates under the calibration orifice. With this side tap reading, P_f and P_o/P_a are calculated with the same equations listed above. This completes the calibration of this sampler.