

**AIR QUALITY MONITORING  
AT GIANT MINE SITE – YELLOWKNIFE  
A BASELINE STUDY  
(Volume 3 – 2006)**

**Prepared for:**

**Indian and Northern Affairs Canada**

Giant Mine Remediation Project  
5<sup>th</sup> Floor, Precambrian Building  
P.O. Box 1500  
Yellowknife, NWT  
X1A 2R3

**Prepared by:**

**SENES Consultants Limited**

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L4B 3N4

February 2007

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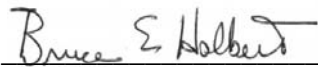
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## **EXECUTIVE SUMMARY**

As a part of the Giant Mine Remediation Project (GMRP), an air quality-monitoring program was devised and carried out during the summers of 2004, 2005 and 2006 to establish a baseline for the fugitive emissions from the tailings areas and other disturbed areas at the mine site. This report pertains to the sampling program carried out in 2006. (Please refer to *Air Quality Monitoring at Giant Mine Site – Yellowknife, A Baseline Study Volume 1* for details on the 2004 program and *Volume 2* for details on the 2005 program.) The 2006 program was carried out from June through to the beginning of October 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 PM<sub>10</sub> 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 2006 suspended particulate monitoring results indicate that the concentrations at the five sampling locations vary considerably with respect to average TSP and PM<sub>10</sub> concentrations. The Giant Mine Town Site results were low in comparison to the onsite monitoring locations. The Northwest Pond site had the highest TSP concentration of the five TSP monitoring locations, and the highest PM<sub>10</sub> concentrations of the four PM<sub>10</sub> monitoring locations.

The analyses of inorganic elements indicated that, with the exception of arsenic, beryllium, chromium, iron, and nickel all other concentrations were below their applicable AAQC. Beryllium exceeded the applicable AAQC standard on July 5<sup>th</sup>, 2006 at both TSP and PM<sub>10</sub> monitors in the South Pond location. Chromium exceeded the AAQC on two samples from the South Pond and one sample from the Northwest Pond monitoring locations. Iron concentrations were greater than the AAQC on a number of samples collected between June 16<sup>th</sup> and August 10<sup>th</sup>, 2006 at the onsite monitoring locations. The arsenic AAQC of 0.3 µg/m<sup>3</sup> was exceeded 3 times at the Northwest Pond, on July 16<sup>th</sup> and 22<sup>nd</sup>, and August 10<sup>th</sup>, 2006. In the 2005 study (Volume 2), there were exceedances of arsenic in the B3 Pit location, and elevated values in the South Pond location. There were no exceedances of arsenic at these locations during the 2006 study.

Overall, the 2006 results indicated noticeably higher ambient concentrations of TSP and PM<sub>10</sub>, however there was a decrease in the frequency of arsenic and iron exceedances when compared to the 2005 results. As with the 2005 results, it can be shown that more than half of the measured ambient arsenic concentration is contained within the coarse particles, and are therefore less likely to impact human health.

Activities that may have contributed to elevated concentrations of TSP and PM<sub>10</sub> in 2006 include heavier-than-normal truck traffic to and near 138 portal (B3 Pit), as well as the realignment of Baker Creek. The realignment project took place throughout the summer, and may have influenced the particulate concentrations at the B3 Pit location and the Northwest Pond location. Truck traffic resulting from the ongoing project passed the monitors at the Northwest Pond location on a regular basis.

Since arsenic in TSP provides a better measure of the day-to-day fluctuations in ambient arsenic concentrations, TSP sampling is more useful in determining from which source(s) the arsenic is likely to have originated. Since one of the objectives of the sampling program is to assess harmful levels of exposure to arsenic in ambient air, PM<sub>10</sub> sampling is a more appropriate measure of exposure, as the TSP sampling may overestimate exposure levels by a factor of at least 2, on average. Therefore, it is recommended that the simultaneous sampling of TSP and PM<sub>10</sub> at all on-site sampling locations be continued for subsequent monitoring at this site.

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## **1.0 INTRODUCTION**

As a part of the Giant Mine Remediation Project (GMRP), and establishment of baseline conditions, the third round of air quality monitoring was carried out during the summer of 2006. Similar to the 2004 and 2005 monitoring programs, the purpose of 2006 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 2006 sampling program consisted of ambient air monitoring of TSP and PM<sub>10</sub> at the nearest residential location in the Giant Mine Town Site and four other locations within the boundary of the Giant Mine site. Similar to 2004 and 2005, the program consisted of 24-hour sampling on every 6<sup>th</sup>-day at all five sampling locations. The sampling program was undertaken to determine total and inhalable particulate loading, as well as their inorganic trace elements (e.g. metals) content.

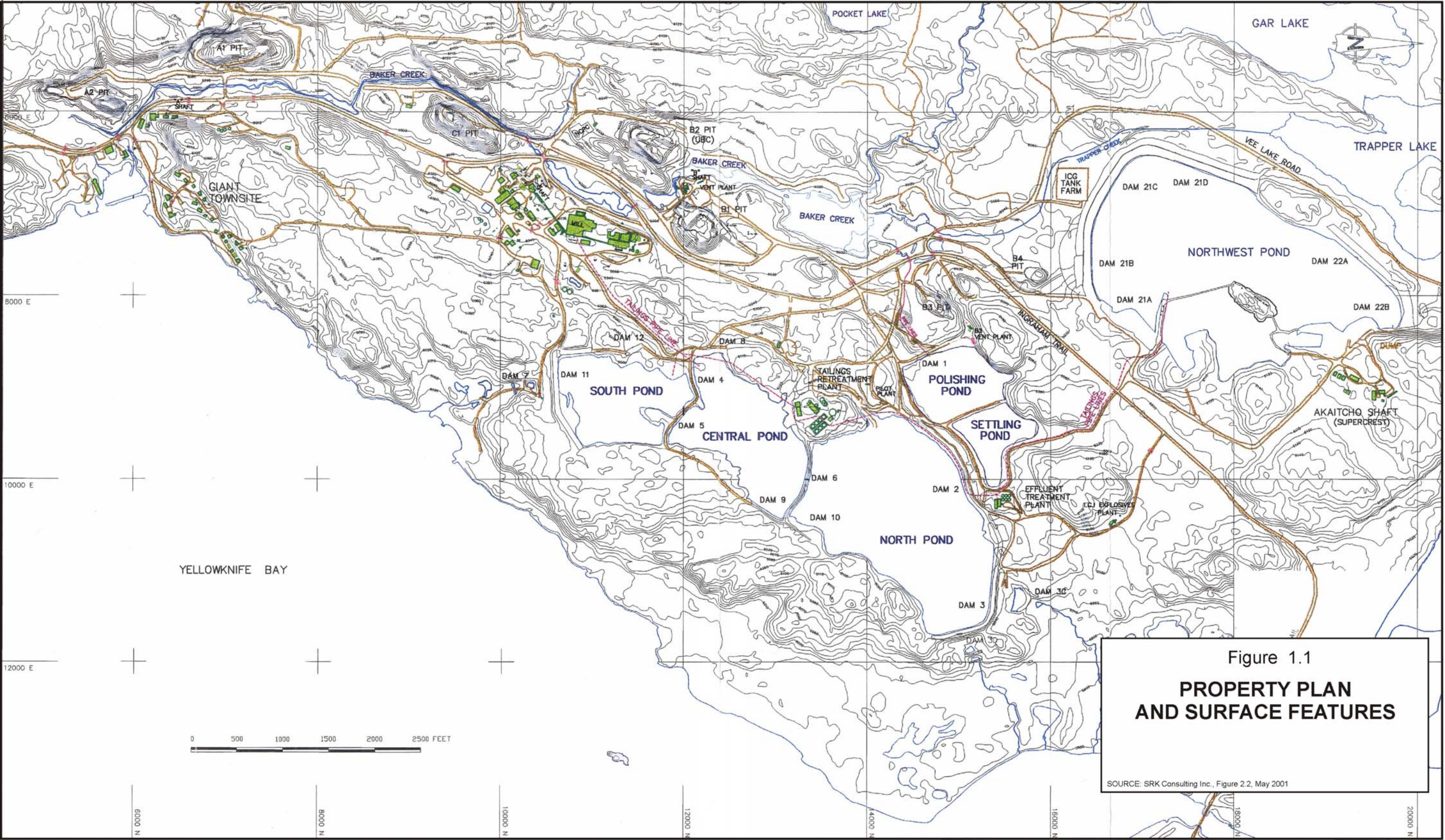
This report provides details of the monitoring program, the results and discussion of the findings, comparisons between 2006 data and data from the previous monitoring programs, as well as conclusions and recommendations. Reference should be made to the reports entitled “*Air Quality Monitoring at Giant Mine Site – Yellowknife, A Baseline Study Volume 1 and Volume 2*” for details on the 2004 and 2005 programs, 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 continued 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, concluding 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.

## **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 2004, June through September of 2005, and June through September of 2006. The second objective of the monitoring program, which was to establish the ratio of concentrations of the two particle size fractions, was attained from the 2004 monitoring data. The 2004 results indicated that 75% of the arsenic appears to be associated with the coarse particles in TSP and therefore, to better identify days with high emission levels from the mine site, arsenic concentrations in TSP samples are to be assessed. At the same time, in light of moderate correlation between the two

particulate size fractions (TSP and PM<sub>10</sub>) and the health-related importance of the PM<sub>10</sub> fraction, it was recommended that the monitoring program be modified to conduct simultaneous monitoring of PM<sub>10</sub> as well as TSP at all the on-site monitoring locations. This was implemented during the 2005 sampling program and continued during the 2006 monitoring program.

This report presents the 2006 results, and provides a comparison between the 2006 monitoring results and the results from the 2004 and 2005 programs.

This report 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 2006 results. Section 5 provides a comparison analysis between 2004, 2005 and 2006 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 ( $\mu\text{m}$ ) 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).

$\text{PM}_{10}$ , consists of particles less than or equal to 10 microns in aerodynamic diameter. The  $\text{PM}_{10}$  fraction poses a health concern because it can accumulate in the respiratory system. Many studies over the past few years have indicated that  $\text{PM}_{10}$  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  $\text{PM}_{10}$ , neither the NWT nor the Canada-Wide Standard (CWS) setting process has defined an acceptable limit. Consequently, the interim 24-hour  $\text{PM}_{10}$  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 (no longer listed in ON) (see Table 2.1).

**TABLE 2.1**  
**AMBIENT AIR QUALITY CRITERION FOR TSP AND PM<sub>10</sub>**

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

## **2.2 INORGANIC TRACE ELEMENTS**

Suspended particulate matter, and specifically PM<sub>10</sub>, is a mixture of chemically and physically diverse dusts and droplets, and some of these components may be important in determining the effects of PM<sub>10</sub> 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 criteria, as defined in the *Point of Impingement Standards and Ambient Air Quality Criteria (AAQCs) Guideline* (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 <sup>(1)</sup> (µg/m <sup>3</sup> )
Aluminium	100
Antimony	25 (incl. compounds)
Arsenic	0.3 (incl. compounds)
Barium	10 (total water soluble)
Beryllium	0.01 (incl. compounds)
Cadmium	2 (incl. compounds)
Calcium	n/a
Chromium	1.5 (di, tri and hexa)
Cobalt	0.1
Copper	50
Iron	4 (metallic)
Lead	2
Magnesium	n/a
Manganese	2.5 (compounds)
Mercury	2
Molybdenum	120
Nickel	2
Potassium	n/a
Selenium	10
Silver	1
Sodium	n/a
Strontium	120
Tin	10
Tungsten	n/a
Vanadium	2
Zinc	120
Zirconium	n/a

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

### **3.0 EQUIPMENT AND METHODOLOGY**

#### **3.1 EQUIPMENT**

For the 2006 monitoring program, eight (8) AirMetrics Mini-Vols and one Tisch Environmental Hi-Vol sampler were deployed.

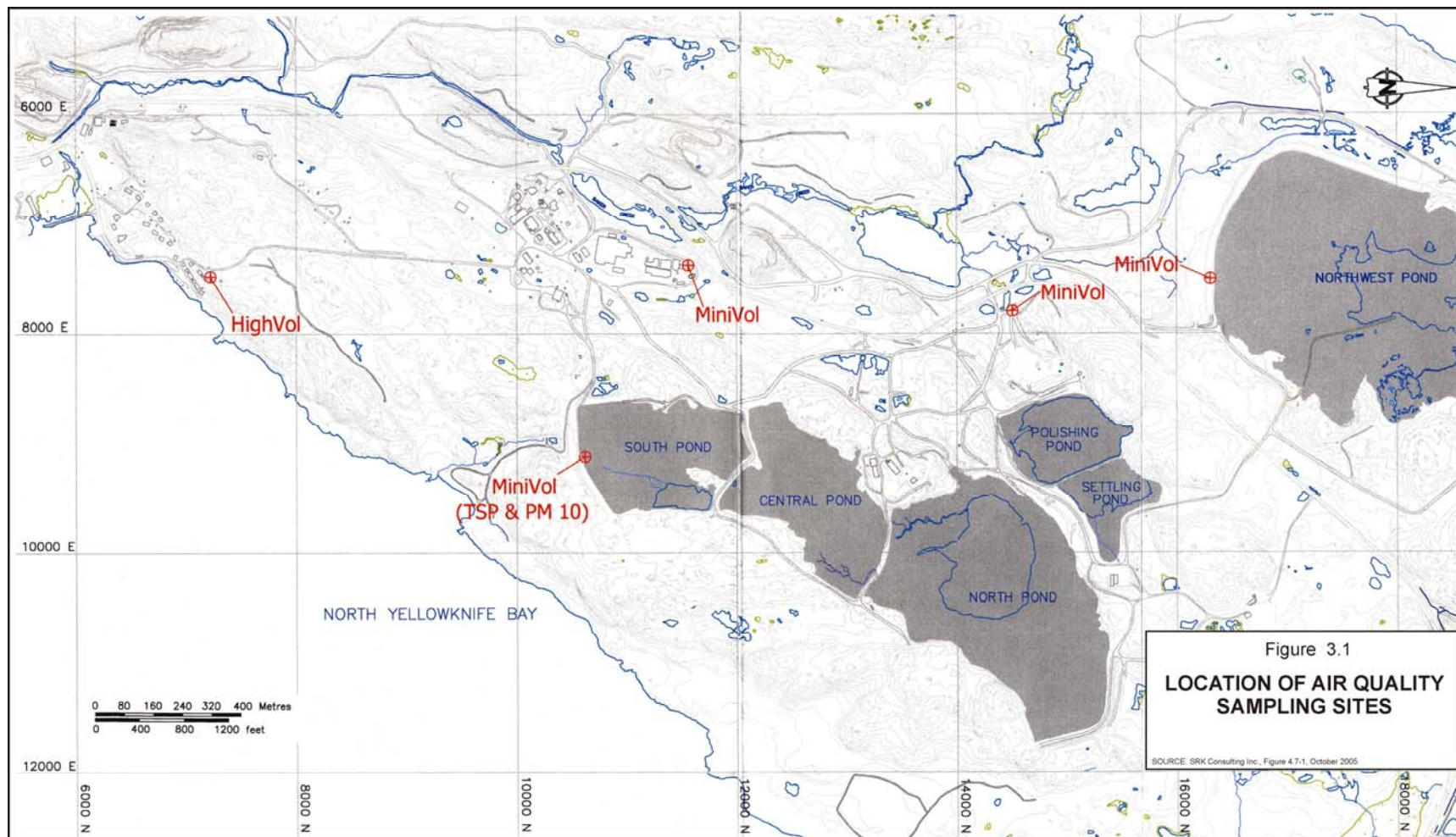
The Mini-Vol sampler is a portable sampling device that can be used to sample Total Suspended Particulates (TSP), PM<sub>10</sub> and Particulate Matter less than 2.5 µm in diameter (PM<sub>2.5</sub>). The samplers use a small diaphragm pump to draw air through a 47 mm filter with pore size of 0.8 µm 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. Details of the Mini-Vol samplers, sampling method 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. Details of sampling procedure are provided in Appendix B.

#### **3.2 METHODOLOGY**

##### **3.2.1 Monitoring Locations**

After reviewing the average observed wind data over a five-year period at the Yellowknife Airport, five locations were identified as suitable locations to set-up the samplers. The predominant winds are from the east as discussed in a subsequent section (see Figure 4.1). The locations chosen for the five monitors are shown on Figure 3.1 and are as follow:





- 1 Monitoring Location #1 (Giant Mine Townsite):* The Hi-Vol TSP monitor was located in the Townsite 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)**



- 2     *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 PM<sub>10</sub> 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 PM<sub>10</sub> and TSP, as per Section 1.2.

**FIGURE 3.3**  
**MONITORING LOCATION #2**  
**(SOUTH END OF SOUTH TAILINGS POND)**



- 3     *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 PM<sub>10</sub> 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)**





- 4 *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 PM<sub>10</sub> 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**  
**(JUNCTION OF VEE LAKE ROAD AND INGRAHAM TRAIL, B3-PIT)**



- 5 *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 PM<sub>10</sub> 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 152 Mini-Vol and 19 Hi-Vol samples were collected during the four months (June to September 2006) 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 done at the same time as the Government of Northwest Territories' (GNWT) 6-day ambient air monitoring schedule to allow subsequent comparison of the results, if deemed appropriate. The GNWT sampling is performed on the same day 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, as well as collection of travel blanks, for each batch of filters shipped to the laboratory for analysis. Analytical QA/QC procedures were also carried out by Maxxam Analytics.

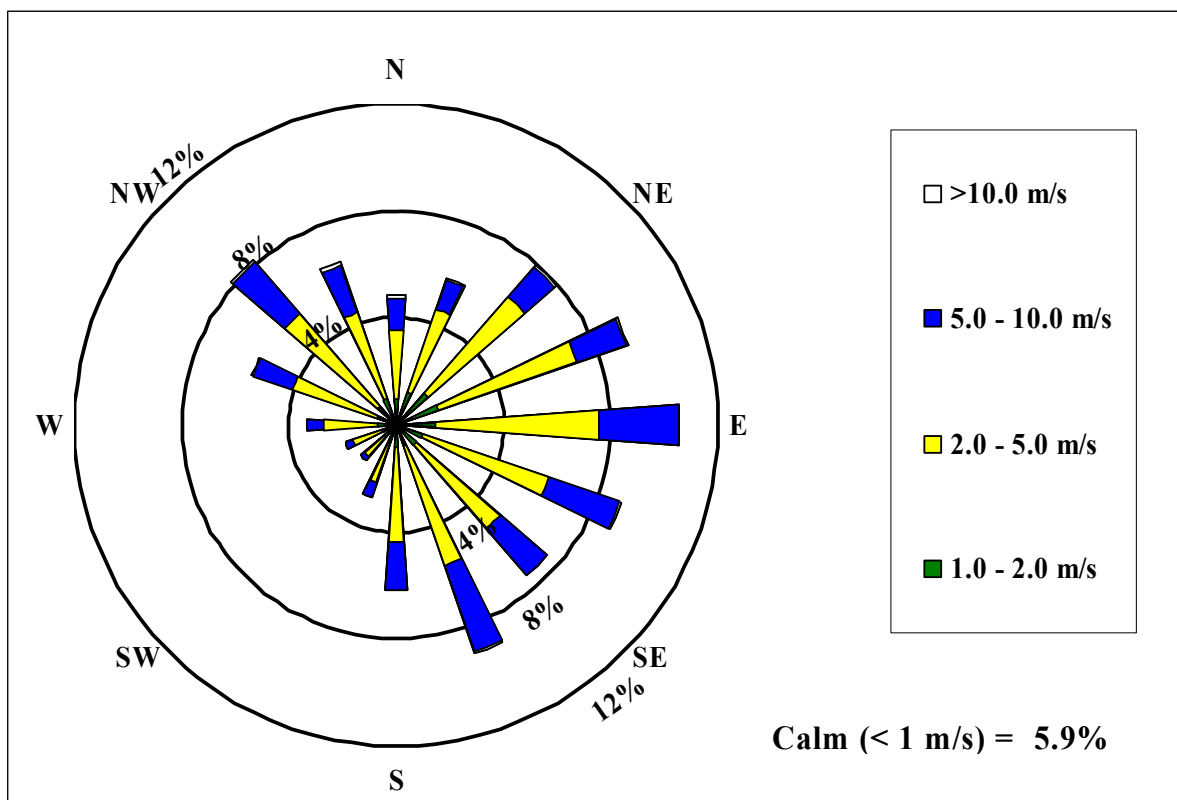
## 4.0 RESULTS AND DISCUSSION

### 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 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 an 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 winds (easterly).

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 2006 are provided in Table 4.1.

**TABLE 4.1**  
**AVERAGE TEMPERATURE AND PRECIPITATION DATA**  
**YELLOWKNIFE AIRPORT (2006)**

<b>Temperature:</b>	<b>June</b>	<b>July</b>	<b>August</b>	<b>September</b>
Daily Average (°C)	16.3	16.6	15.4	9.8
Daily Maximum (°C)	20.9	20.9	19.3	13.2
Daily Minimum (°C)	11.5	12.4	11.5	6.5
<b>Precipitation:</b>				
Rainfall (mm)	30.5	41.2	52.4	20.0
Snowfall (cm)	0	0	0	0
Precipitation (mm)	30.5	41.2	52.4	20.0
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 PM<sub>10</sub> RESULTS**

Gravimetric results for the TSP and PM<sub>10</sub> fractions are summarized in Table 4.2. The exceedances of ambient air quality criteria are indicated in bold. The 24-hour TSP criterion of 120 µg/m<sup>3</sup> (based on NWT's EPA) was exceeded frequently during the months of June and July,



at all the onsite monitoring locations (see Table 4.2). In addition, the Northwest Pond location exceeded the 24-hour TSP criterion on August 10<sup>th</sup> and 27<sup>th</sup>, 2006.

The 24-hour PM<sub>10</sub> standard of 50 µg/m<sup>3</sup> (based on MOE's interim AAQC) was exceeded throughout most of the monitoring program (June to September) at all the onsite monitoring locations (see Table 4.2). The PM<sub>10</sub> concentrations, especially during the months of June and July, were similar or at times higher than measured TSP concentrations at the same monitoring location.

**TABLE 4.2**  
**RESULTS OF TSP AND PM<sub>10</sub> MEASUREMENTS**

Location	Giant Mine Town Site	South Pond		Mill		B3 Pit		Northwest Pond	
Parameter (µg/m <sup>3</sup> )	TSP	TSP	PM <sub>10</sub>	TSP	PM <sub>10</sub>	TSP	PM <sub>10</sub>	TSP	PM <sub>10</sub>
Date (dd/mm/yy)	Location #1	Location #2		Location #3		Location #4		Location #5	
10/06/2006	21.7	104.6	<b>90.3</b>	104.2	<b>62.5</b>	111.1	<b>152.8</b>	NI	<b>138.9</b>
16/06/2006	21.4	<b>145.8</b>	<b>159.7</b>	83.3	<b>118.1</b>	<b>166.7</b>	<b>90.3</b>	<b>156.0</b>	<b>125.0</b>
22/06/2006	30.2	<b>138.9</b>	<b>125.0</b>	<b>138.9</b>	<b>111.1</b>	NI	NI	118.1	<b>138.9</b>
28/06/2006	28.2	76.4	<b>83.3</b>	NI	<b>111.1</b>	<b>180.6</b>	<b>131.9</b>	<b>201.4</b>	<b>159.7</b>
05/07/2006	16.1	<b>145.8</b>	<b>97.2</b>	69.4	<b>62.5</b>	83.3	<b>90.3</b>	48.6	<b>111.1</b>
10/07/2006	10.8	97.2	<b>90.3</b>	<b>125.0</b>	<b>111.1</b>	118.1	<b>62.5</b>	111.1	BDL
16/07/2006	26.7	104.2	<b>103.7</b>	<b>217.2</b>	<b>83.3</b>	<b>145.8</b>	<b>76.4</b>	<b>166.7</b>	<b>166.7</b>
22/07/2006	54.0	<b>187.5</b>	<b>145.8</b>	NI	<b>90.3</b>	<b>125.0</b>	<b>97.2</b>	<b>277.8</b>	<b>125.0</b>
28/07/2006	8.3	NI	NI	NI	NI	NI	NI	68.6	NI
10/08/2006	9.9	NI	<b>118.1</b>	NI	NI	76.4	NI	<b>131.9</b>	NI
15/08/2006	9.6	41.7	<b>62.5</b>	90.3	<b>62.5</b>	NI	NI	76.4	<b>76.4</b>
21/08/2006	9.6	62.5	<b>69.4</b>	90.3	<b>55.6</b>	41.7	NI	NI	BDL
27/08/2006	6.4	69.4	<b>90.3</b>	69.4	<b>55.6</b>	62.5	NI	<b>226.3</b>	<b>55.6</b>
02/09/2006	5.5	94.3	NI	48.6	<b>55.6</b>	62.5	<b>69.4</b>	NI	<b>69.4</b>
08/09/2006	13.8	61.7	NI	BDL	<b>97.2</b>	55.6	41.7	55.6	NI
14/09/2006	5.7	BDL	BDL	BDL	NI	BDL	NI	41.7	BDL
20/09/2006	6.9	BDL	BDL	BDL	NI	BDL	BDL	BDL	41.7
26/09/2006	7.8	BDL	BDL	97.2	NI	BDL	BDL	BDL	BDL
01/10/2006	BDL	BDL	NI	48.6	NI	BDL	NI	BDL	NI
AAQC Limits (µg/m <sup>3</sup> )	TSP = 120, PM <sub>10</sub> = 50								

Note: All the exceeding days are shown in bold in the table.

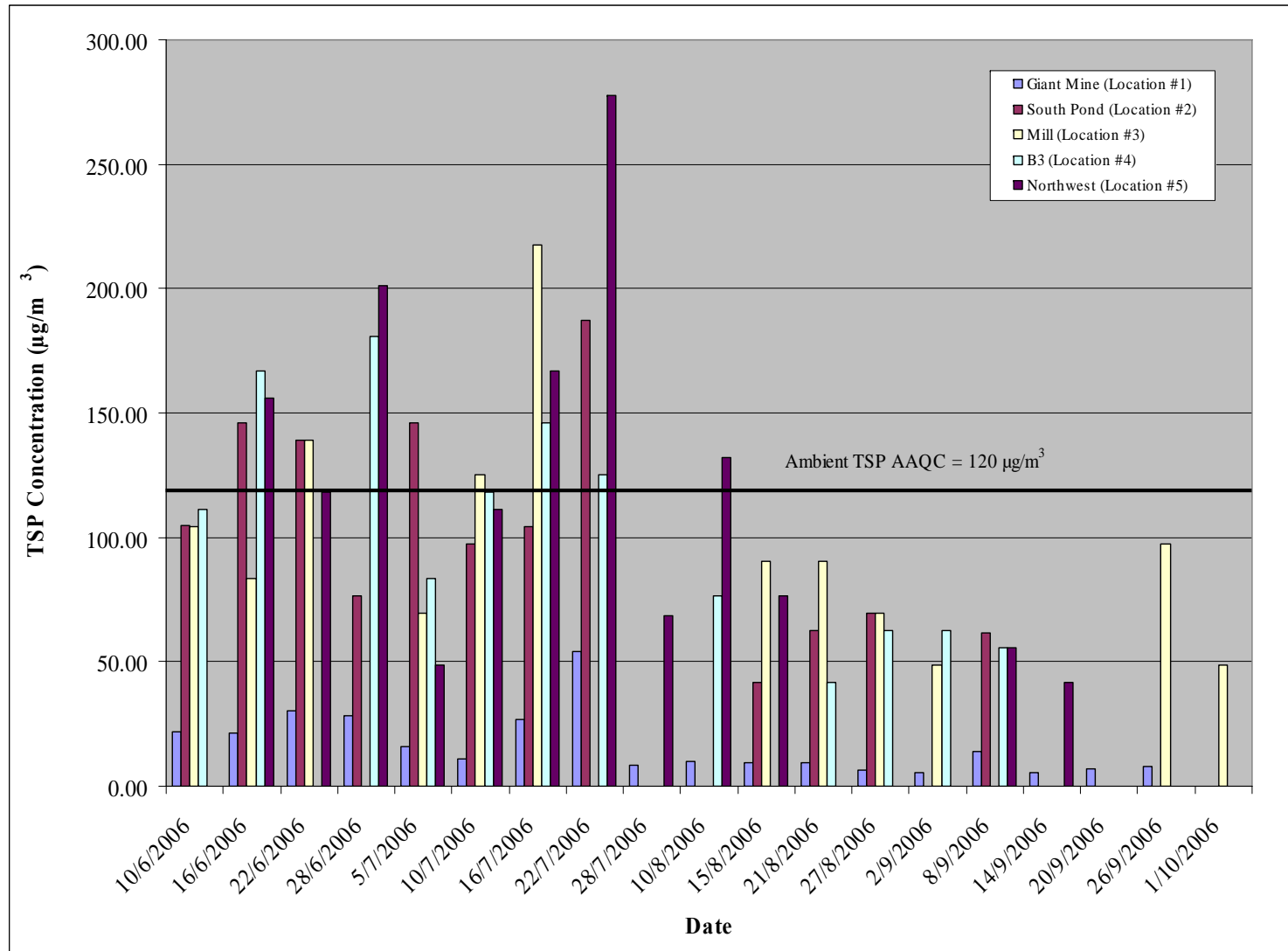
BDL – Below Detection Limit.

NI – Not Included due to unacceptable sampling duration (greater than +/- 10% of 24-hours).

AAQC – Ambient Air Quality Criteria (MOE).

Figure 4.2 depicts the variability in TSP concentrations between the five sampling locations, while Figure 4.3 shows the variability in PM<sub>10</sub> concentrations between sampling locations #2 though #5 (PM<sub>10</sub> was not measured at location #1).

**FIGURE 4.2**  
**VARIABILITY IN TSP CONCENTRATIONS AT ALL LOCATIONS**  
**GIANT MINE, NWT, JUNE TO SEPTEMBER 2006**



**FIGURE 4.3**  
**VARIABILITY IN PM<sub>10</sub> CONCENTRATIONS AT LOCATIONS 2, 3, 4 & 5**  
**GIANT MINE, NWT, JUNE TO SEPTEMBER 2006**

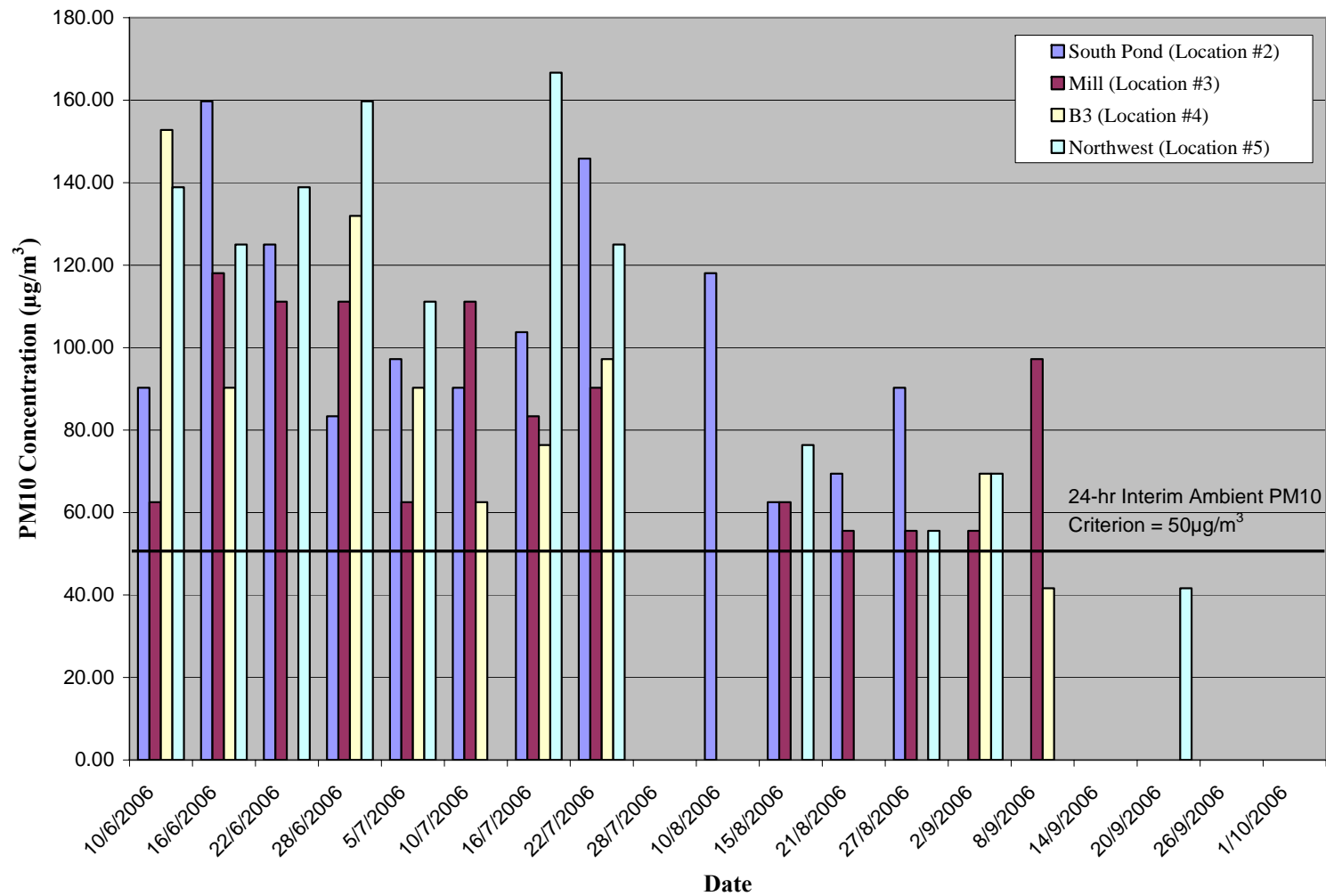


Figure 4.2 indicates that TSP concentrations exceeding the ambient air quality objective of  $120 \mu\text{g}/\text{m}^3$  were recorded consistently at several locations during the months of June and July. In this span of time there were four exceedances at the Northwest Pond, the South Pond and the B3 Pit monitoring locations, as well as three exceedances at the Mill location. Figure 4.3 indicates that all measurable  $\text{PM}_{10}$  concentrations exceeded the standard of  $50 \mu\text{g}/\text{m}^3$  (based on MOE's AAQC) at all locations until September 14<sup>th</sup>, where only the Mill location exceeded. After this point,  $\text{PM}_{10}$  concentrations were either within the standard or non-detectable.

Table 4.3 summarizes the statistical distribution of the measured TSP and  $\text{PM}_{10}$  concentrations at all five sites. Similar to 2005 data, the 2006 results indicate considerable variation with respect to average and maximum TSP and  $\text{PM}_{10}$  concentrations. 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. Again similar to 2005 results, the Northwest Pond site had the highest TSP concentrations of the five TSP monitoring locations and the highest  $\text{PM}_{10}$  concentrations of the four  $\text{PM}_{10}$  monitoring locations.

**TABLE 4.3**  
**SUMMARY OF STATISTICS FOR PARTICULATE MATTER**

Location	Giant Mine Town Site	South Pond		Mill		B3 Pit		Northwest Pond	
Parameter ( $\mu\text{g}/\text{m}^3$ )	TSP	TSP	$\text{PM}_{10}$	TSP	$\text{PM}_{10}$	TSP	$\text{PM}_{10}$	TSP	$\text{PM}_{10}$
Statistical Parameter	Location #1	Location #2		Location #3		Location #4		Location #5	
Maximum	54	188	160	218	118	181	153	278	167
98 <sup>th</sup> Percentile	46	178	157	200	116	178	149	263	165
95 <sup>th</sup> Percentile	34	165	152	174	114	173	144	240	163
Median	10	101	94	90	83	97	90	118	125
Mean	16	103	103	99	83	102	90	127	110

### 4.3 INORGANIC TRACE ELEMENTS

As discussed in Section 3, the particulate samples (both TSP and  $\text{PM}_{10}$ ) 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 that were run for an acceptable duration ( $\pm 10\%$  of 24 hours) and 22 of the Hi-Vol filters are

presented in Tables 4.6 and 4.7, respectively (included at the end of this section). The results indicate that, with the exception of beryllium, chromium, iron, nickel and arsenic all other metal concentrations were below their applicable AAQC. There were two beryllium exceedances on July 5<sup>th</sup>, 2006 – both at the South Pond location. Iron concentrations were greater than the AAQC on some of the on-site samples collected between June 16<sup>th</sup> and August 10<sup>th</sup>, 2006. Chromium exceeded its AAQC on June 22<sup>nd</sup>, July 5<sup>th</sup>, 2006 at the South Pond location, and August 10<sup>th</sup>, 2006 at the Northwest Pond location. Nickel was in exceedance of its AAQC standard on June 22<sup>nd</sup> and July 5<sup>th</sup>, 2006 – both at the South Pond location.

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 4.4 lists the arsenic concentrations reported at all five sites during the monitoring period of June to September 2006. The results indicate exceedances of the health-based ambient air quality criterion for arsenic ( $AAQC_{As} = 0.3 \mu\text{g}/\text{m}^3$ ) at the Northwest Pond location only, on July 16<sup>th</sup> and 22<sup>nd</sup>, and August 10<sup>th</sup>, 2006.

The data in Table 4.4 indicates that the arsenic levels were noticeably higher at the Northwest Pond than at the other three onsite sampling locations. The highest arsenic concentrations were reported for the Northwest Pond, however the South Pond and the B3 Pit each had arsenic concentrations that were close to the air quality standard, but did not exceed it. The arsenic concentrations measured at the Mill location were noticeably lower than reported at the other three locations, and the Giant Mine Town Site arsenic concentrations were an order of magnitude lower than the Mill location. This confirms the conclusion of 2005 results, which demonstrated that the arsenic concentrations varied significantly by sample location, and for certain locations by sample date.

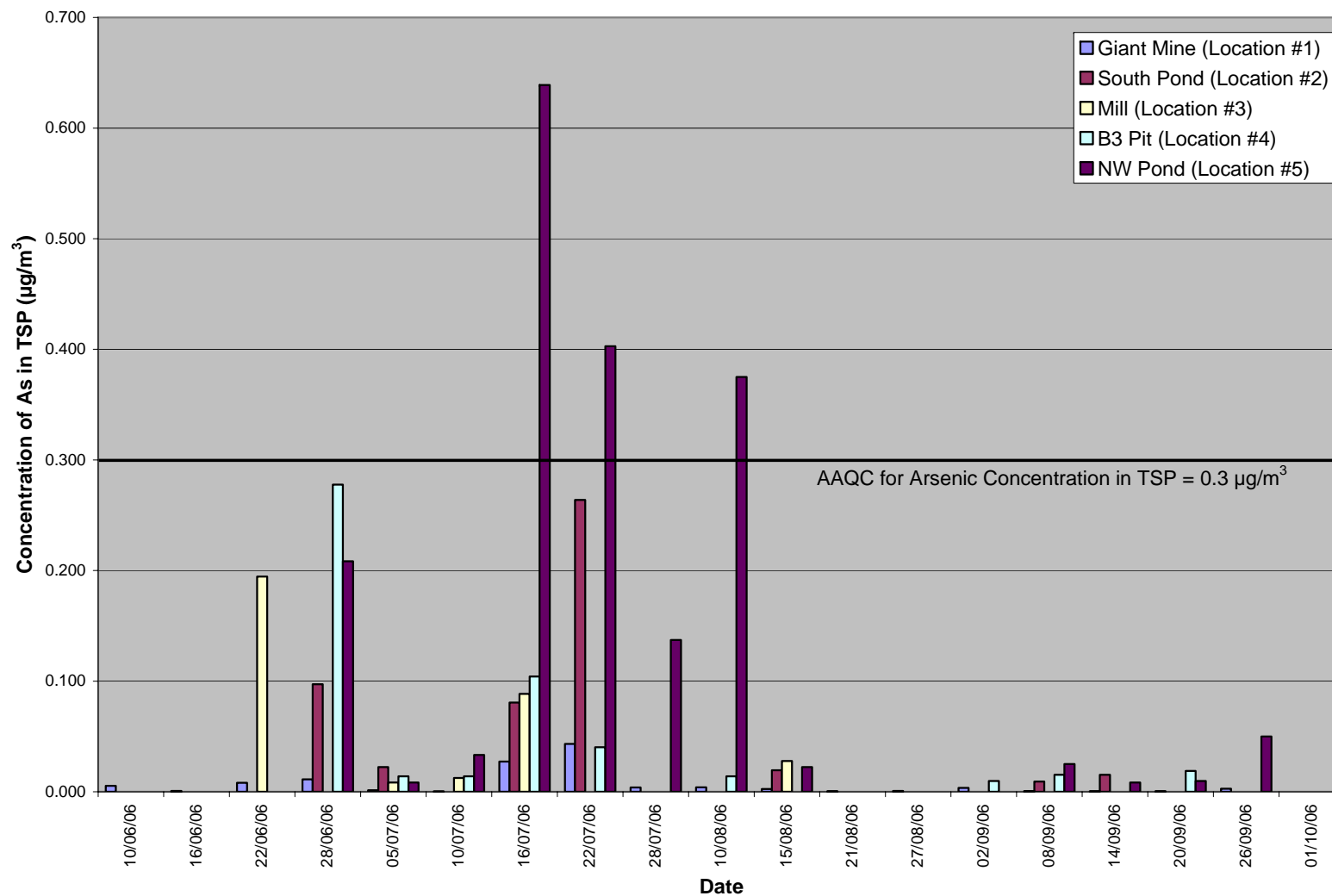
**TABLE 4.4**  
**ARSENIC CONCENTRATIONS IN PARTICULATE MATTER**

Location	Giant Mine Town Site	South Pond		Mill		B3 Pit		Northwest Pond	
Parameter (µg/m <sup>3</sup> )	AS in TSP	As in TSP	As in PM <sub>10</sub>	As in TSP	As in PM <sub>10</sub>	As in TSP	As in PM <sub>10</sub>	As in TSP	As in PM <sub>10</sub>
Date (dd/mm/yy)	Location #1	Location #2		Location #3		Location #4		Location #5	
10/06/2006	0.005	BDL	BDL	BDL	BDL	BDL	BDL	No data	BDL
16/06/2006	0.001	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
22/06/2006	0.008	BDL	BDL	0.194	0.069	No data	No data	BDL	BDL
28/06/2006	0.011	0.097	BDL	No data	BDL	0.278	BDL	0.208	BDL
05/07/2006	0.001	0.022	BDL	0.008	BDL	0.014	BDL	0.008	BDL
10/07/2006	0.0004	BDL	BDL	0.013	BDL	0.014	BDL	0.033	BDL
16/07/2006	0.027	0.081	0.032	0.089	0.008	0.104	0.021	<b>0.639</b>	0.264
22/07/2006	0.043	0.263	0.081	No data	0.010	0.040	0.017	<b>0.403</b>	0.153
28/07/2006	0.004	No data	No data	No data	No data	No data	No data	0.137	No data
10/08/2006	0.004	No data	0.043	No data	No data	0.014	No data	<b>0.375</b>	No data
15/08/2006	0.003	0.019	0.015	0.027	BDL	No data	No data	0.022	BDL
21/08/2006	0.0005	BDL	BDL	BDL	BDL	BDL	No data	No data	BDL
27/08/2006	0.001	BDL	BDL	BDL	BDL	BDL	No data	No data	BDL
02/09/2006	0.004	No data	No data	BDL	BDL	0.010	BDL	No data	BDL
08/09/2006	0.001	0.009	No data	BDL	BDL	0.015	BDL	0.025	No data
14/09/2006	0.0004	0.015	BDL	BDL	No data	BDL	No data	0.008	BDL
20/09/2006	0.001	BDL	BDL	BDL	No data	0.019	0.010	0.010	BDL
26/09/2006	0.003	BDL	BDL	BDL	No data	BDL	BDL	0.050	0.008
01/10/2006	No data	BDL	No data	BDL	No data	BDL	No data	BDL	No data
<b>Summary Statistics</b>									
<b>Maximum</b>	0.043	0.26	0.081	0.19	0.069	0.28	0.021	0.64	0.264
<b>98<sup>th</sup> Percentile</b>	0.038	0.24	0.078	0.19	0.067	0.25	0.021	0.59	0.259
<b>95<sup>th</sup> Percentile</b>	0.030	0.21	0.075	0.17	0.063	0.21	0.02	0.51	0.253
<b>Median</b>	0.003	0.02	0.037	0.03	0.01	0.015	0.017	0.04	0.15
<b>Mean</b>	0.007	0.07	0.043	0.07	0.03	0.06	0.016	0.16	0.14

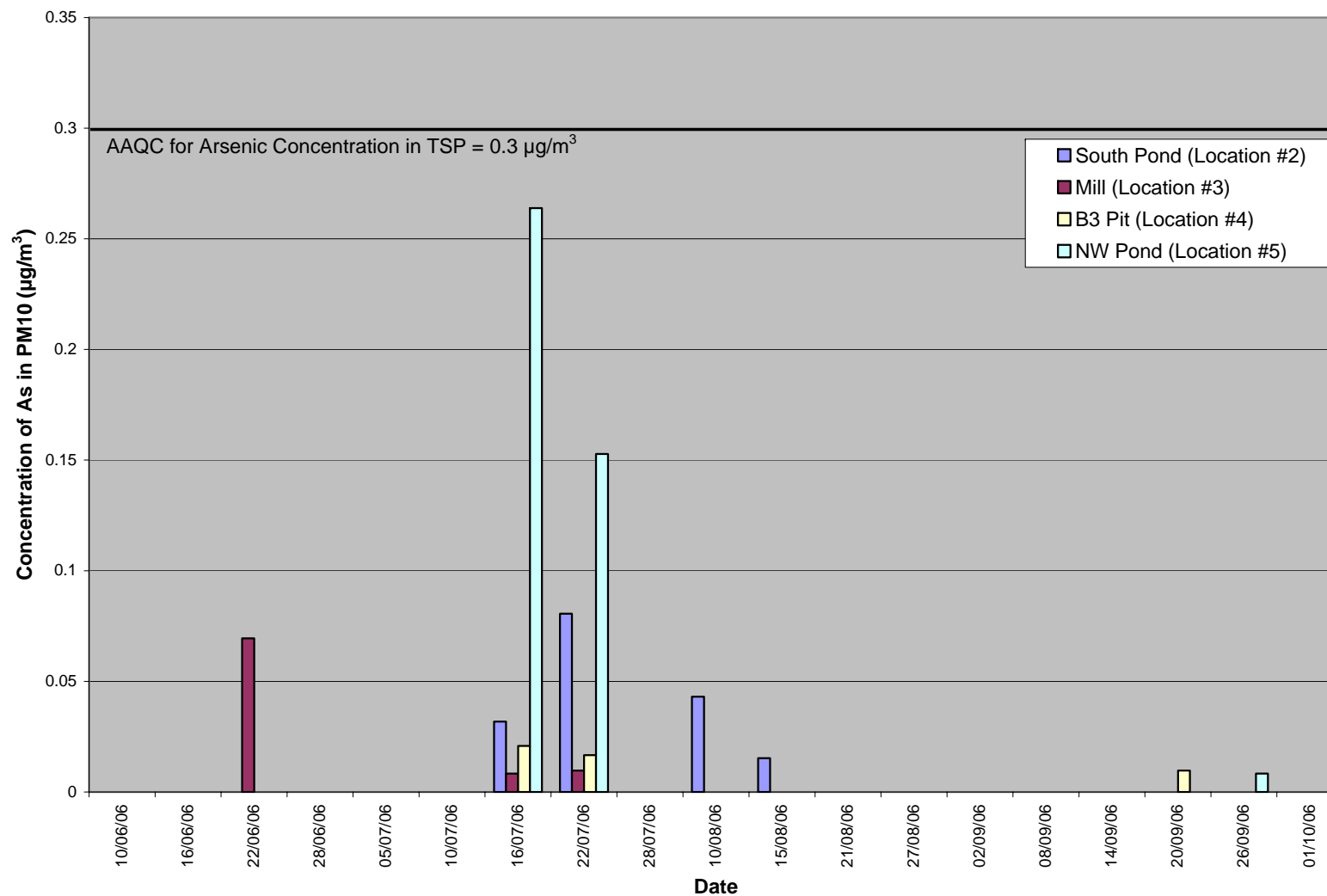
Note: exceedances are shown in Bold.

Figures 4.4 through 4.9 show the trends and correlations in arsenic levels in both TSP and PM<sub>10</sub> at locations 2 through 5. The figures show that arsenic levels in the two particulate matter size fractions (i.e., TSP & PM<sub>10</sub>) tracked each other quite well where data was available. Overall, peak arsenic concentrations in PM<sub>10</sub> generally corresponded with peak arsenic concentrations in TSP. The figures indicate that at most of the monitoring locations a significant portion of the arsenic was present in the large particles (TSP), which are less likely to be of concern for human health. This was also the case for 2005 monitoring results.

**FIGURE 4.4**  
**VARIABILITY IN ARSENIC CONCENTRATIONS AT ALL TSP SAMPLING LOCATIONS**

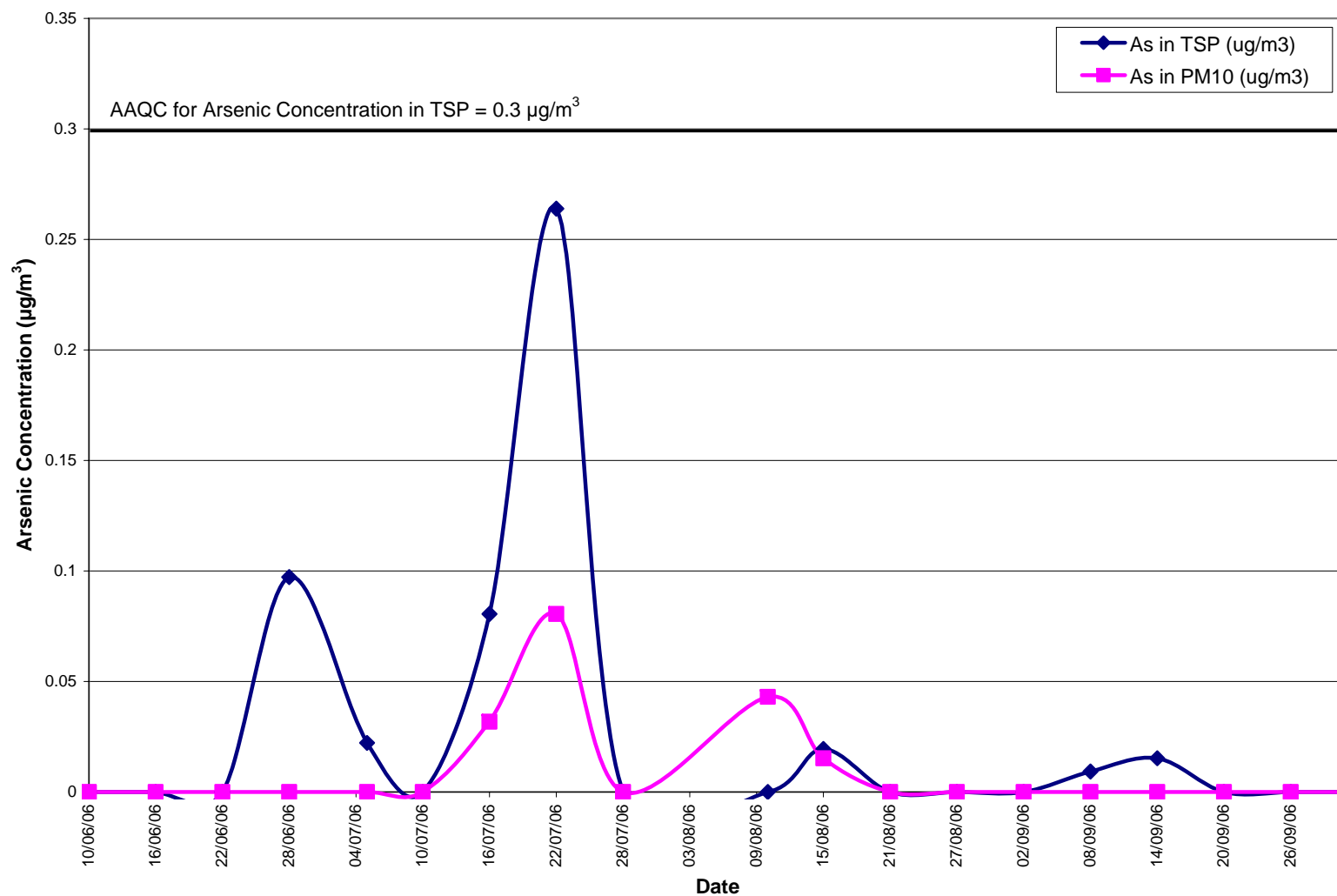


**FIGURE 4.5**  
**VARIABILITY IN ARSENIC CONCENTRATIONS AT PM<sub>10</sub> SAMPLING LOCATIONS**

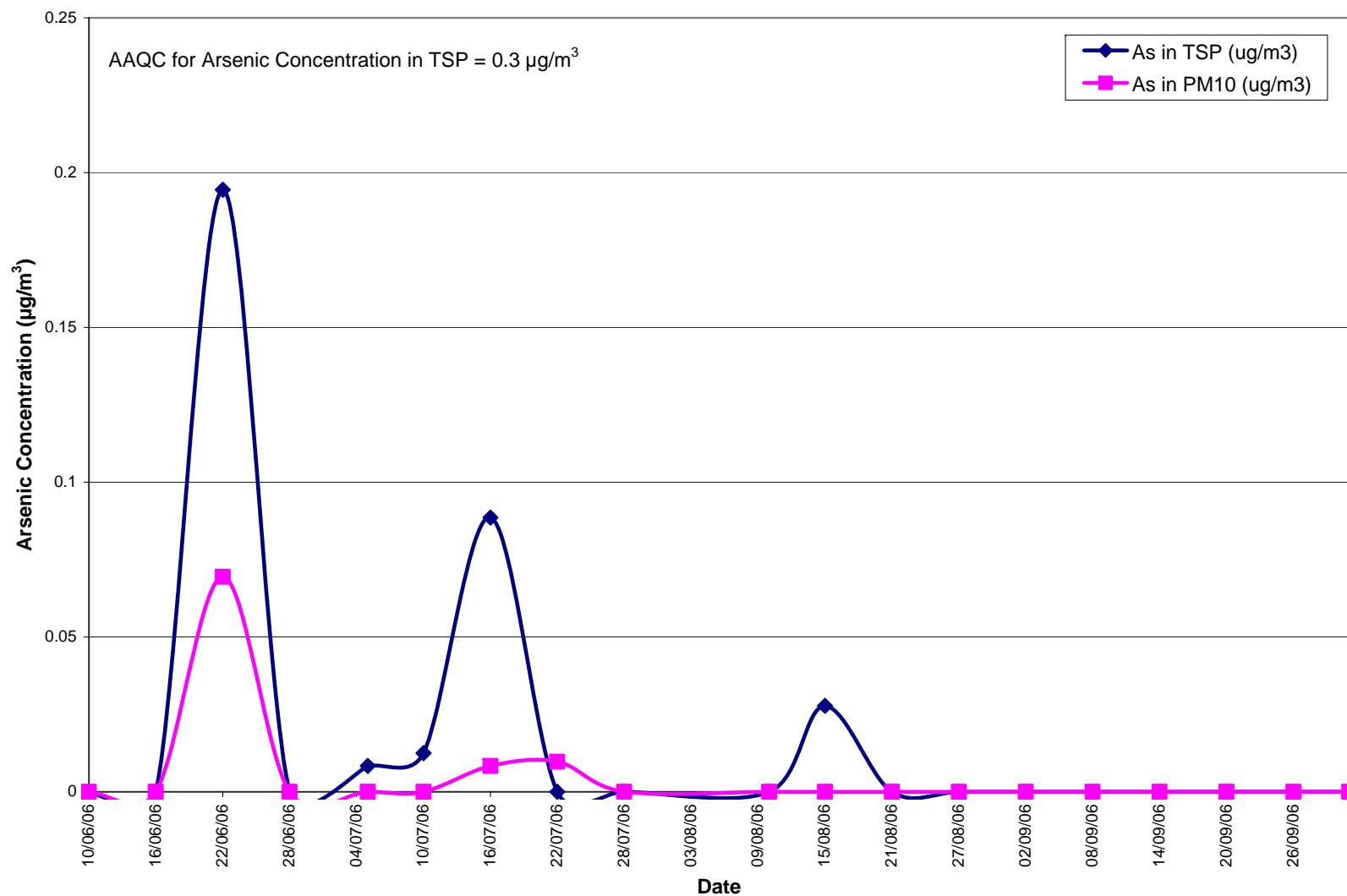




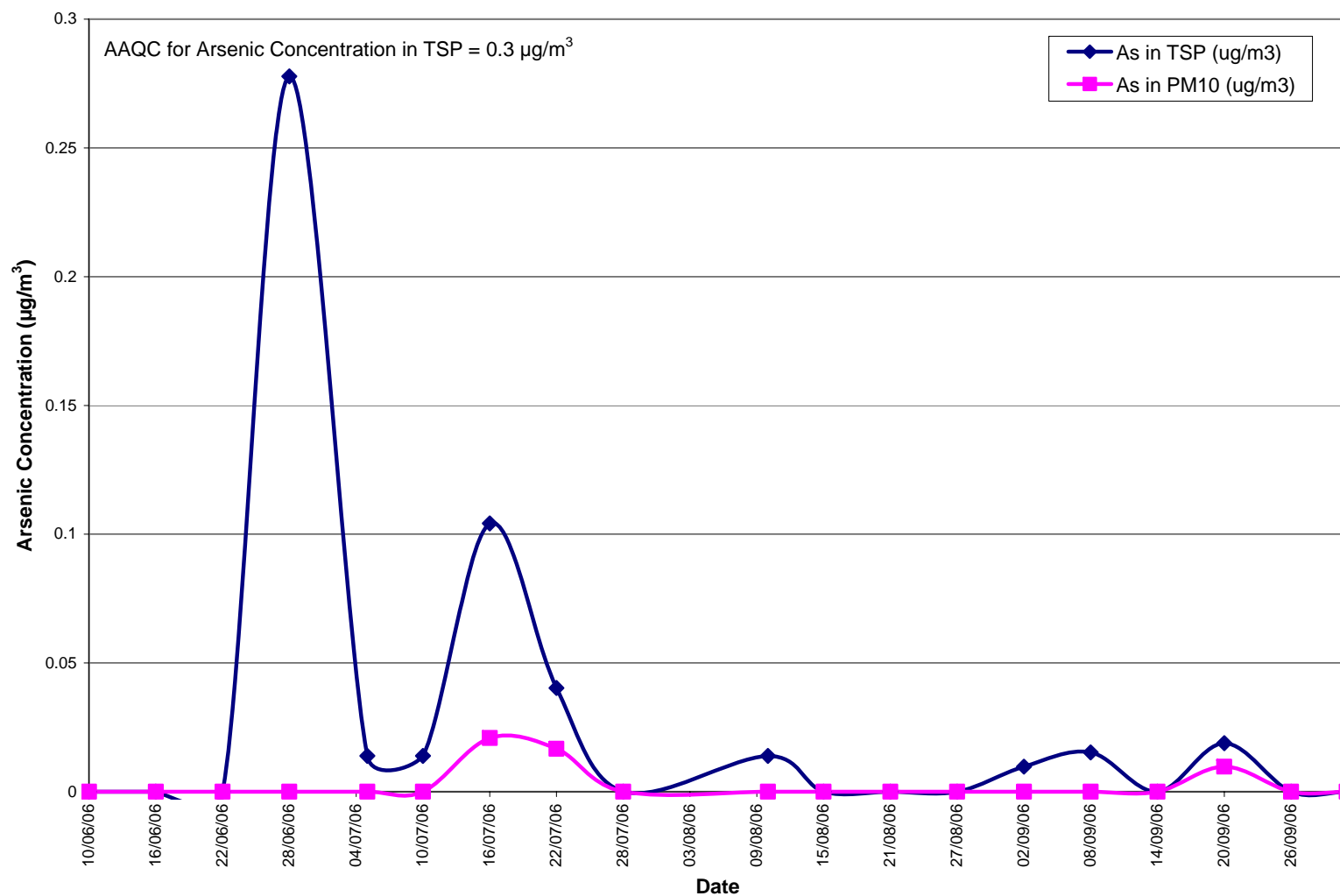
**FIGURE 4.6**  
**VARIABILITY IN ARSENIC CONCENTRATIONS AT SOUTH POND (LOCATION #2) FOR TSP/PM<sub>10</sub> SAMPLES**



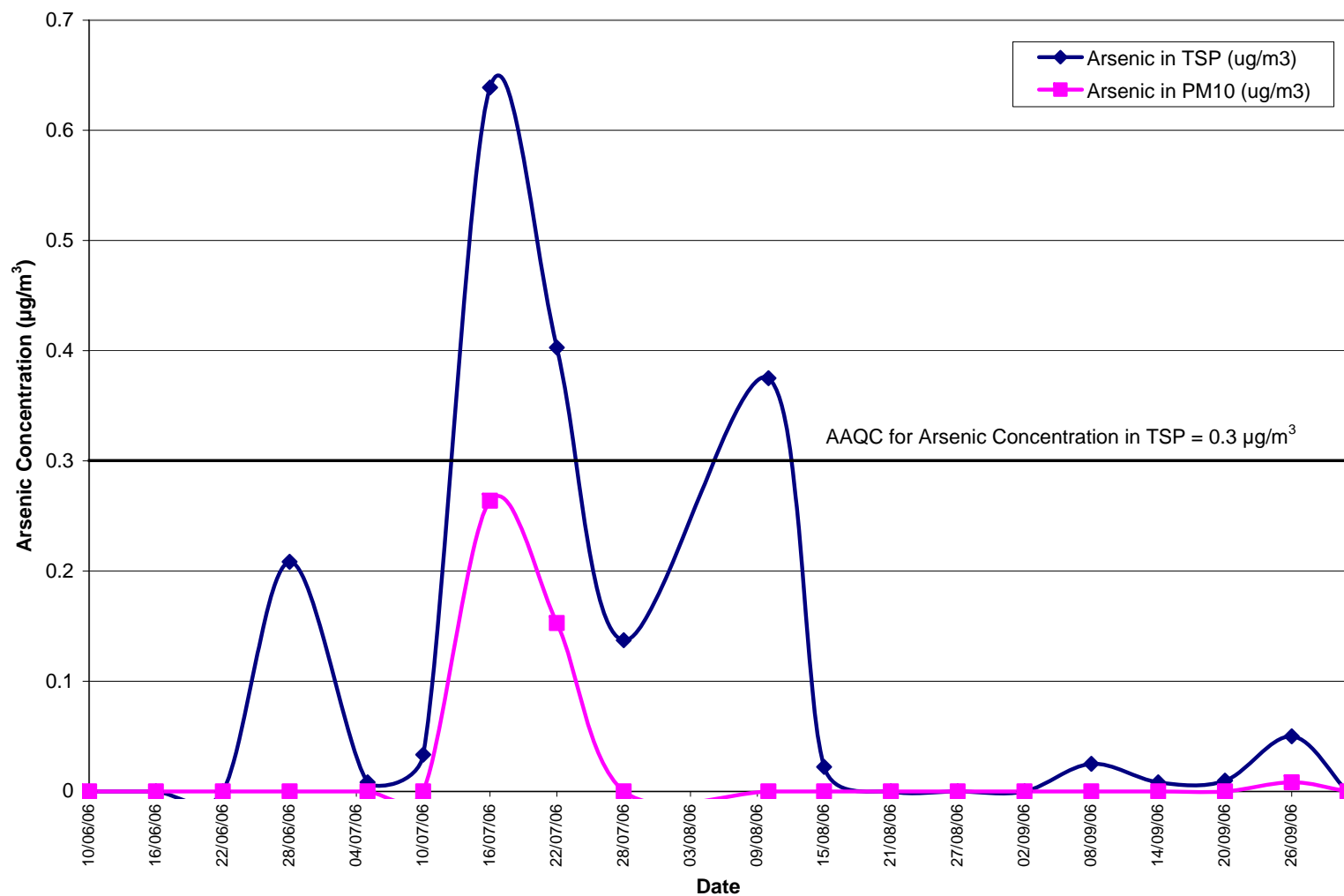
**FIGURE 4.7**  
**VARIABILITY IN ARSENIC CONCENTRATIONS AT MILL (LOCATION #3) FOR TSP/PM<sub>10</sub> SAMPLES**



**FIGURE 4.8**  
**VARIABILITY IN ARSENIC CONCENTRATIONS AT B3 Pit (LOCATION #4) FOR TSP/PM<sub>10</sub> SAMPLES**



**FIGURE 4.9**  
**VARIABILITY IN ARSENIC CONCENTRATIONS AT NORTHWEST POND (LOCATION #5) FOR TSP/PM<sub>10</sub> SAMPLES**



#### 4.4 INTERPRETATION OF RESULTS

Table 4.5 summarizes the days on which the particulate matter (TSP and PM<sub>10</sub>) and/or arsenic and/or iron concentrations were reported to be above their respective AAQC. The table clearly shows that all arsenic exceedances, both in TSP and PM<sub>10</sub>, corresponded with days that the concentrations of TSP and/or PM<sub>10</sub> were also exceeding their respective AAQC.

In general, for most of the monitoring stations, there was a good correlation observed between the iron and TSP exceedances as well as iron and PM<sub>10</sub> exceedances. There were more exceedances of iron in the TSP, however, suggesting that similar to arsenic, iron is associated mainly with larger suspended particulate fractions. There was only one instance (at the Mill) where there was an exceedance in iron concentration but no exceedances of TSP or PM<sub>10</sub>.

All arsenic and iron exceedances were reported between June 16<sup>th</sup> and August 10<sup>th</sup>, 2006 indicating that perhaps the high concentrations of arsenic and iron could be attributed to a specific onsite activity that occurred during this time period.

**TABLE 4.5  
SUMMARY OF SIGNIFICANT DATES FOR ELEVATED OR EXCEEDED  
PM<sub>10</sub> AND ARSENIC CONCENTRATIONS**

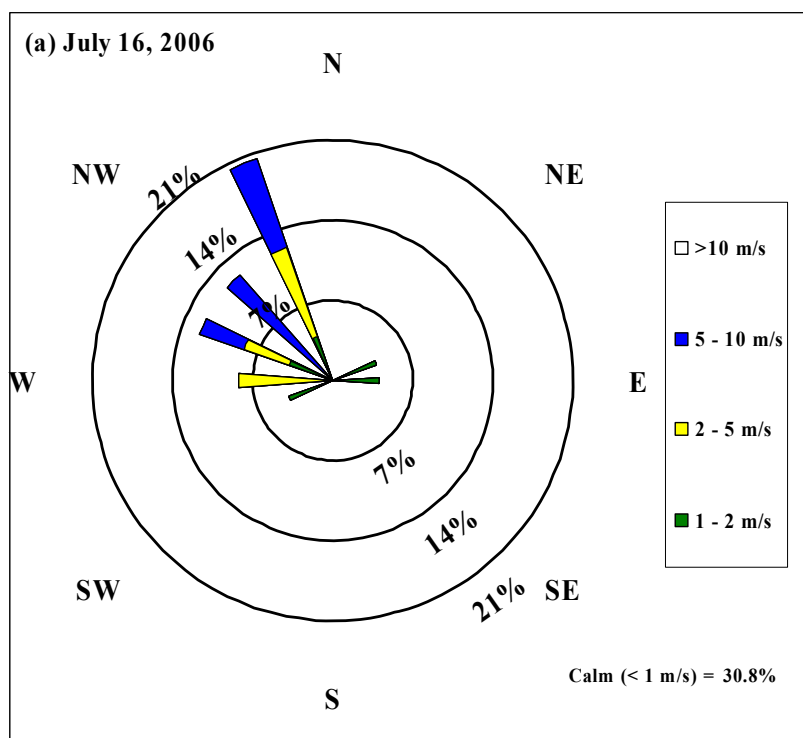
Parameter (µg/m <sup>3</sup> )	TSP				PM <sub>10</sub>				Arsenic in TSP				Arsenic in PM <sub>10</sub>				Iron in TSP				Iron in PM <sub>10</sub>			
Location	2	3	4	5	2	3	4	5	2	3	4	5	2	3	4	5	2	3	4	5	2	3	4	5
10/06/2006					x	x	x	x																
16/06/2006	x		x	x	x	x	x	x										x		x				x
22/06/2006	x	x			x	x		x									x	x						
28/06/2006			x	x	x	x	x	x											x	x				
05/07/2006	x				x	x	x	x									x				x			
10/07/2006		x			x	x	x																	
16/07/2006		x	x	x	x	x	x	x				x						x	x	x				x
22/07/2006	x		x	x	x	x	x	x				x					x			x				
10/08/2006				x	x							x								x				
15/08/2006					x	x		x																
21/08/2006					x	x																		
27/08/2006					x	x		x																
02/09/2006						x	x	x																
08/09/2006						x																		

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

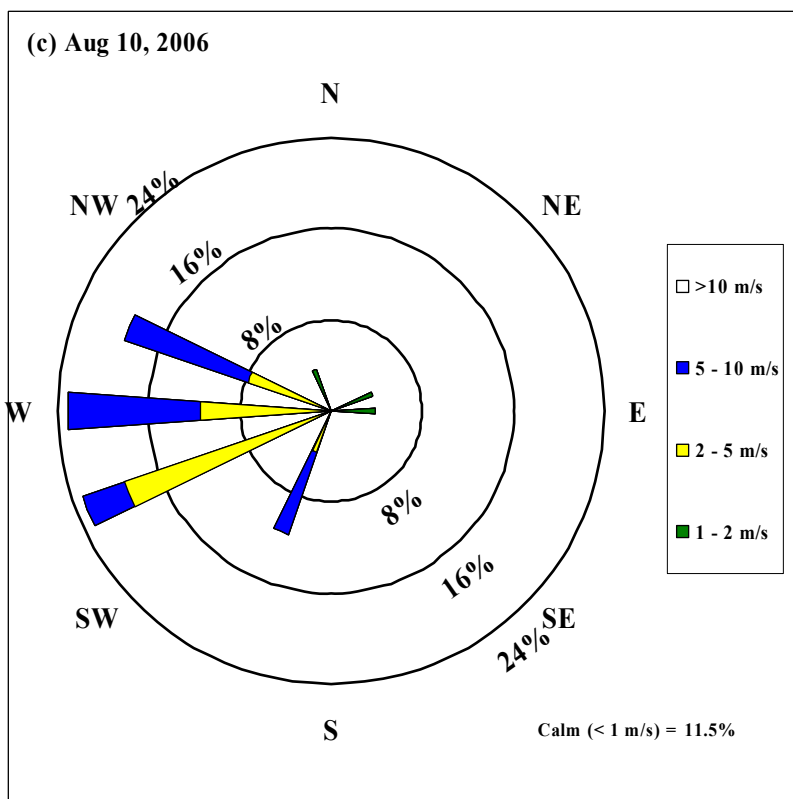
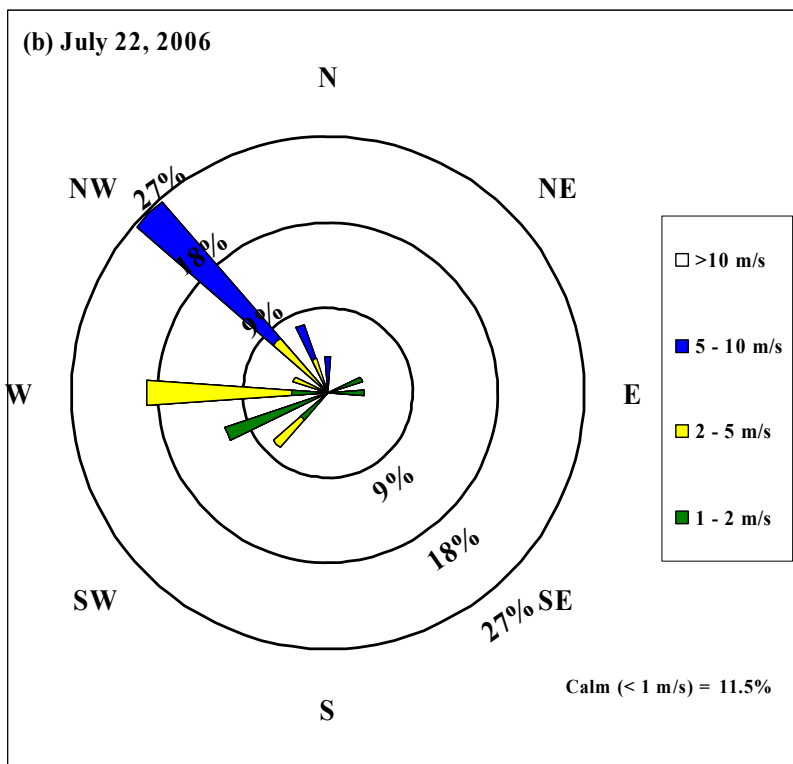
The above table demonstrates that TSP and PM<sub>10</sub> were in exceedance of their respective AAQC standards for much of the 2006 summer period. It was noted by site personnel that a realignment of the nearby Baker Creek was taking place throughout the summer, and may therefore be considered a potentially significant source of particulate emission.

Arsenic exceeded the AAQC criteria at the Northwest Pond location a total of three times, on three separate monitoring days – July 16<sup>th</sup> and 22<sup>nd</sup>, and August 10<sup>th</sup>, 2006. The windroses for each of these days are presented in Figures 4.10 (a) through (c). These figures illustrate that on the arsenic exceedance days, the wind direction was predominantly from the north-northwest to westerly. The three days were also characterized by mild temperatures (10°C to 27°C), and periods of rain showers.

**FIGURE 4.10**  
**WINDROSES FOR THE DAYS WITH EXCEEDED ARSENIC CONCENTRATIONS**

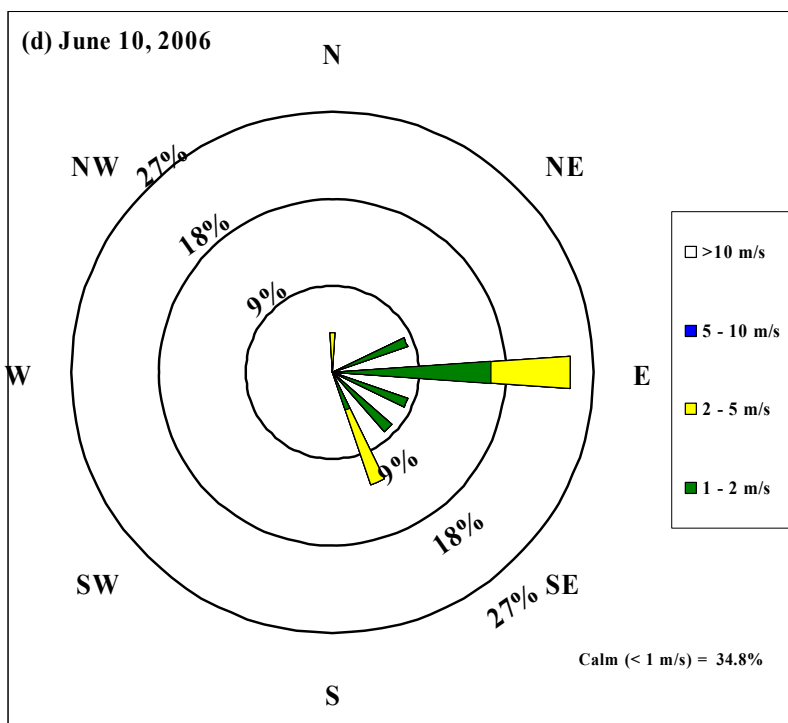


**FIGURE 4.10 (cont'd)**  
**WINDROSES FOR THE DAYS WITH EXCEEDED ARSENIC CONCENTRATIONS**



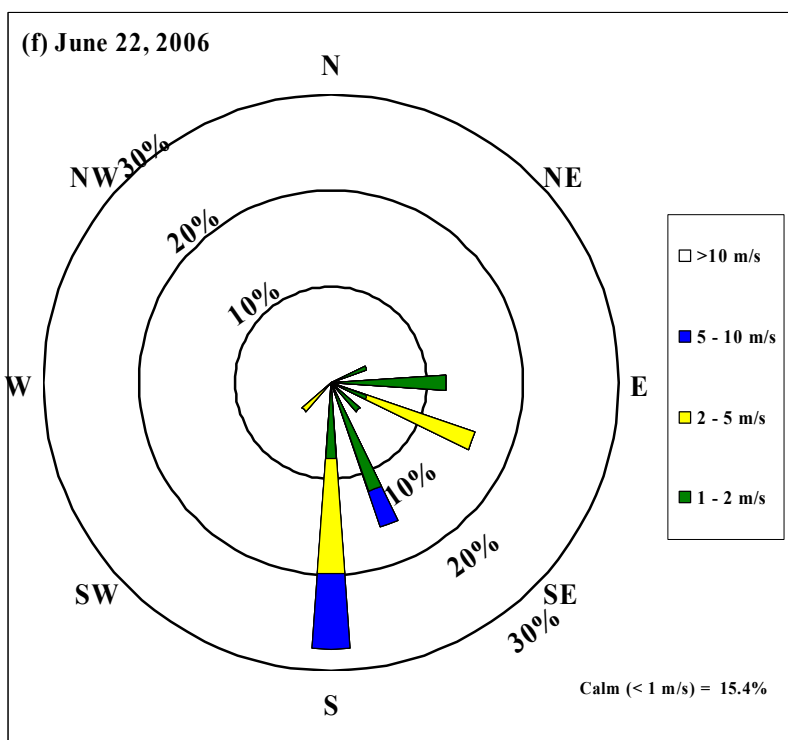
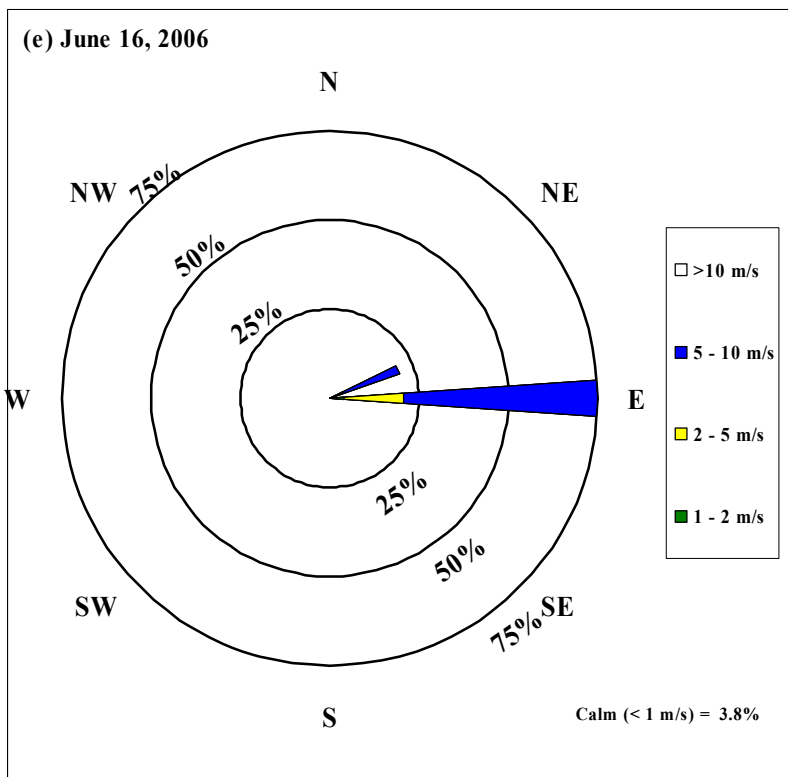
Out of the 19 sampling days included in the 2006 monitoring program, there were 14 days with exceedances of TSP and/or PM<sub>10</sub>. Windroses for each of these days are presented below in Figures 4.10 (d) through (n). Exceedances of TSP and PM<sub>10</sub> also occurred on the days for which the windroses have been provided above as Figures 4.10 (a) through (c), for which the arsenic concentrations exceeded the applicable AAQC criterion. Exceedances of the AAQC criteria for TSP and PM<sub>10</sub> occurred consistently over the course of the monitoring program, from June 10<sup>th</sup>, 2006 until September 14<sup>th</sup>, 2006. After September 14<sup>th</sup>, 2006 there were no exceedances of TSP or PM<sub>10</sub>.

**FIGURE 4.10**  
**WINDROSES FOR THE DAYS WITH EXCEEDED PM<sub>10</sub> CONCENTRATIONS**

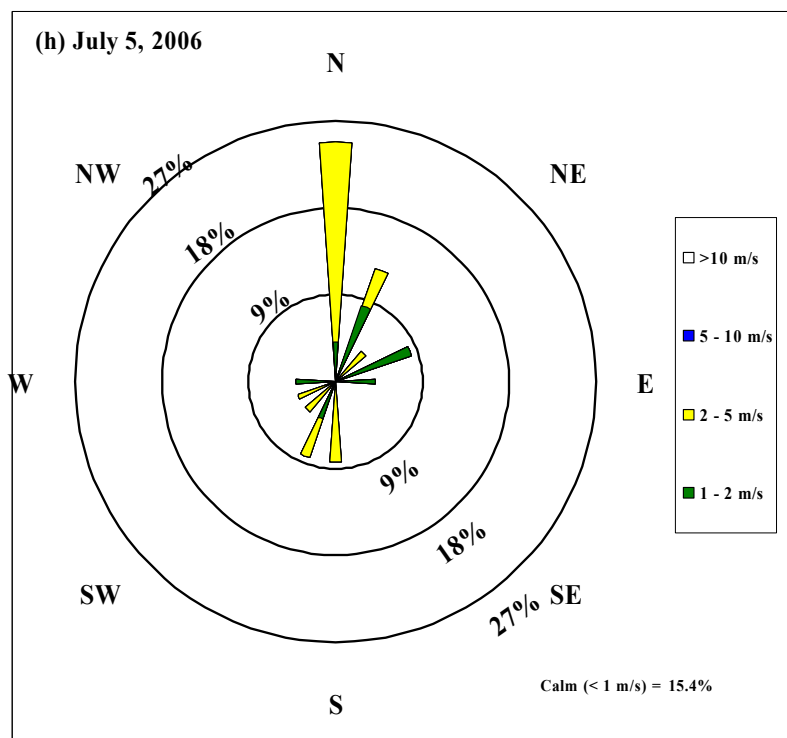
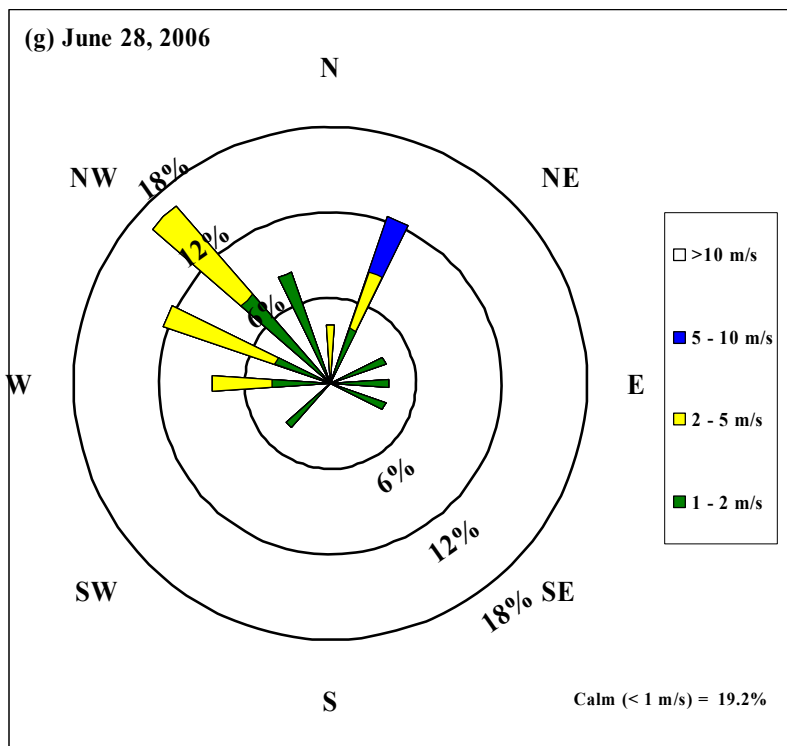




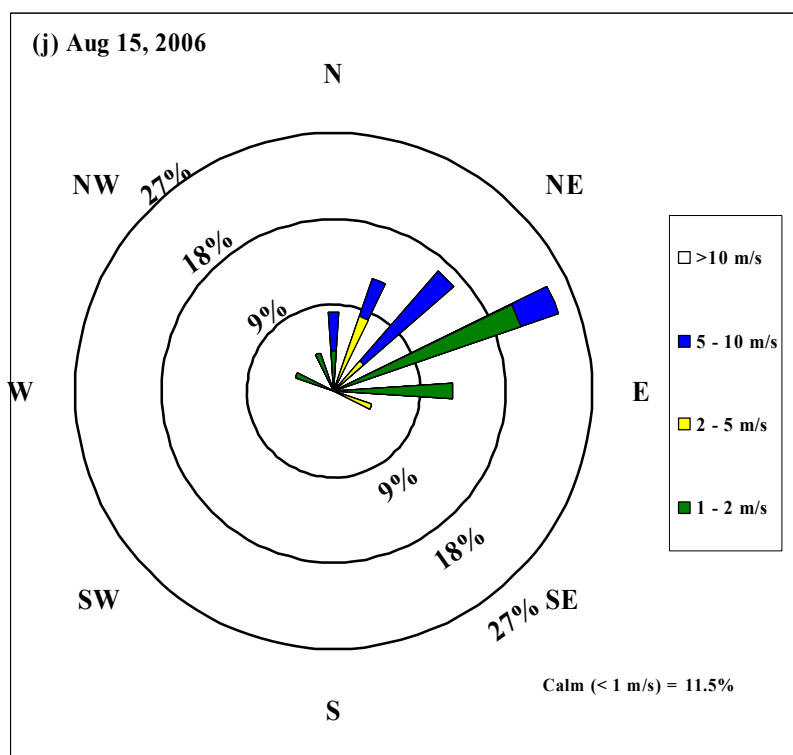
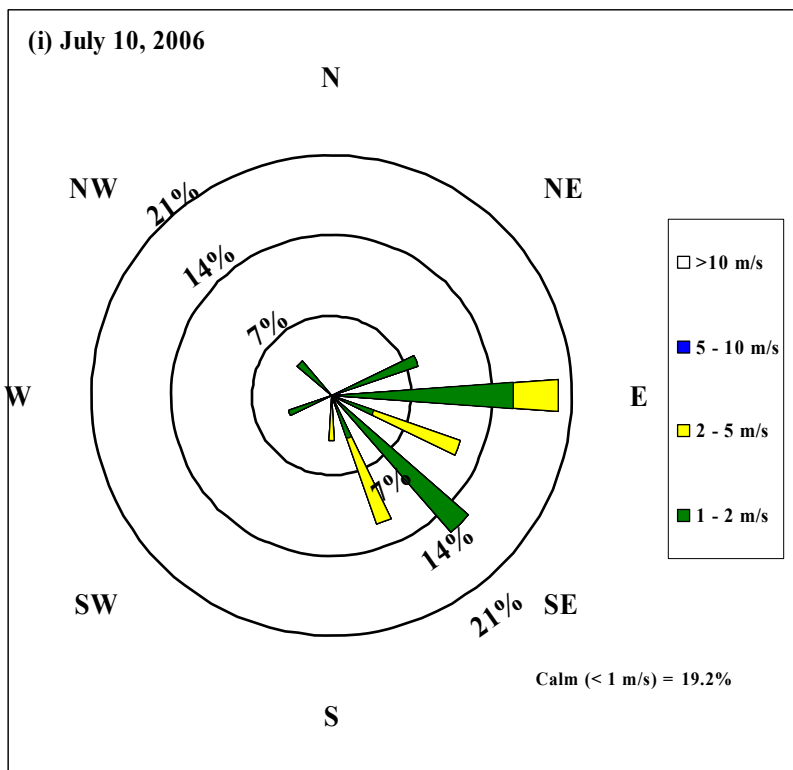
**FIGURE 4.10 (cont'd)**  
**WINDROSES FOR THE DAYS WITH EXCEEDED PM<sub>10</sub> CONCENTRATIONS**



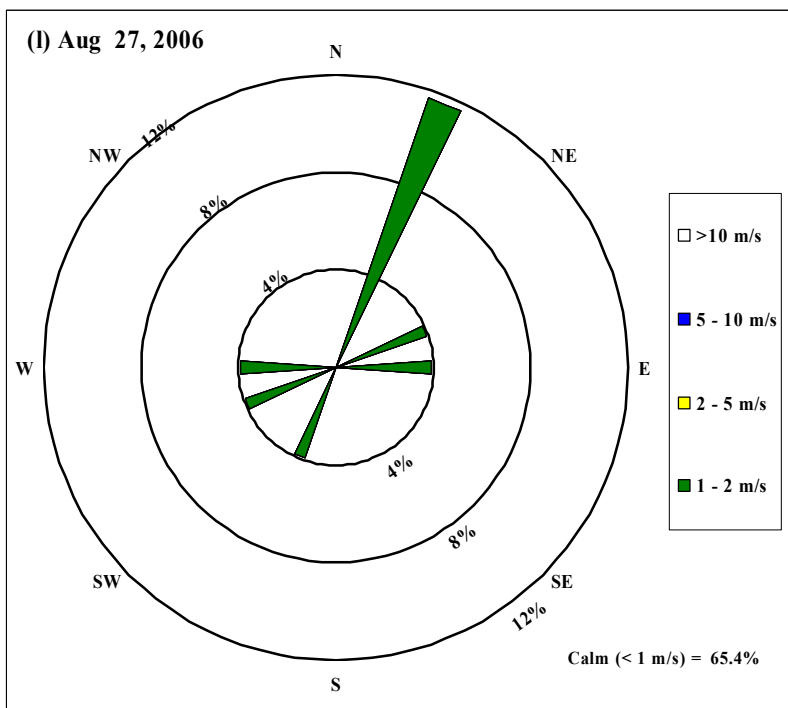
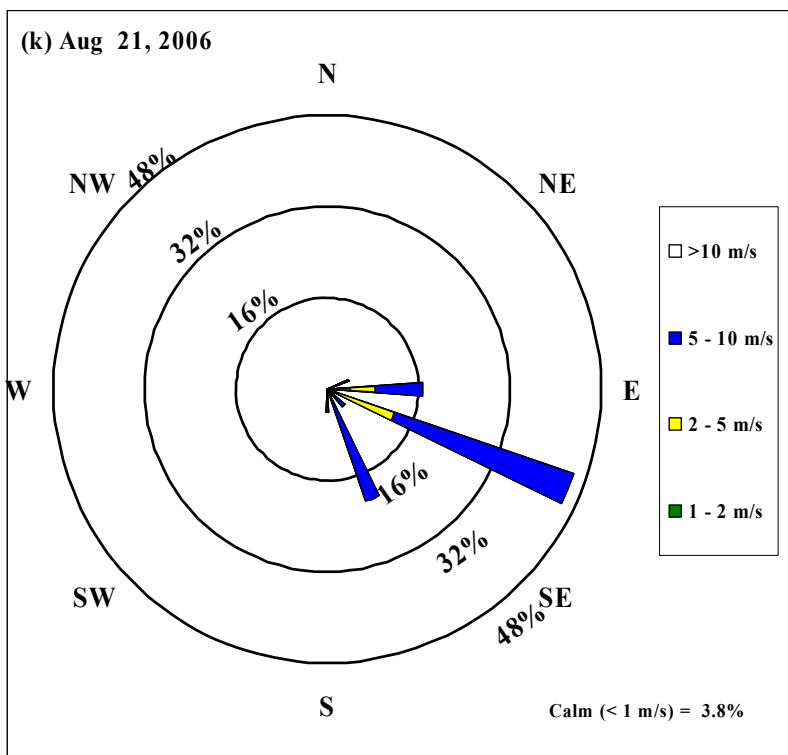
**FIGURE 4.10 (cont'd)**  
**WINDROSES FOR THE DAYS WITH EXCEEDED PM<sub>10</sub> CONCENTRATIONS**



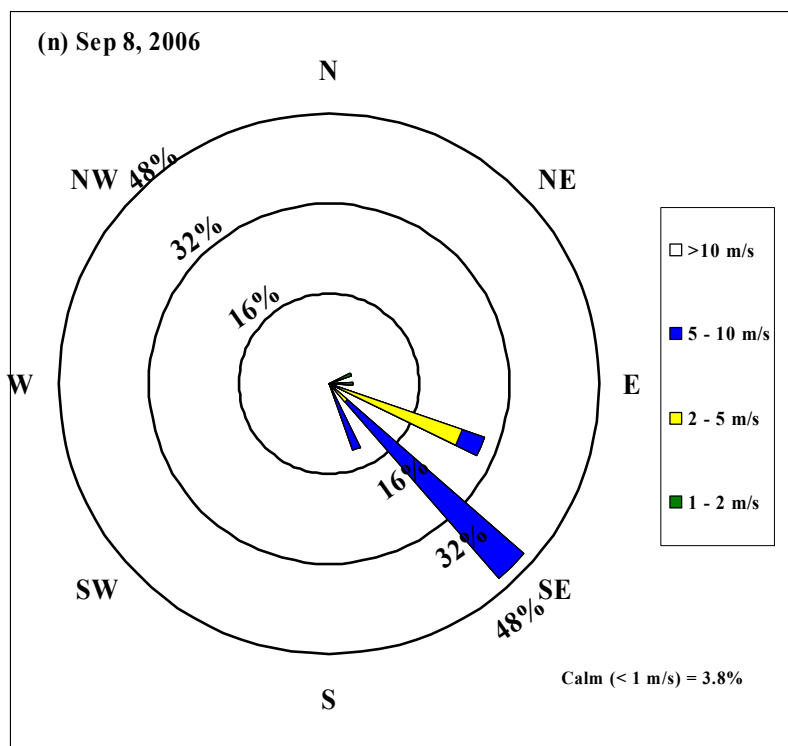
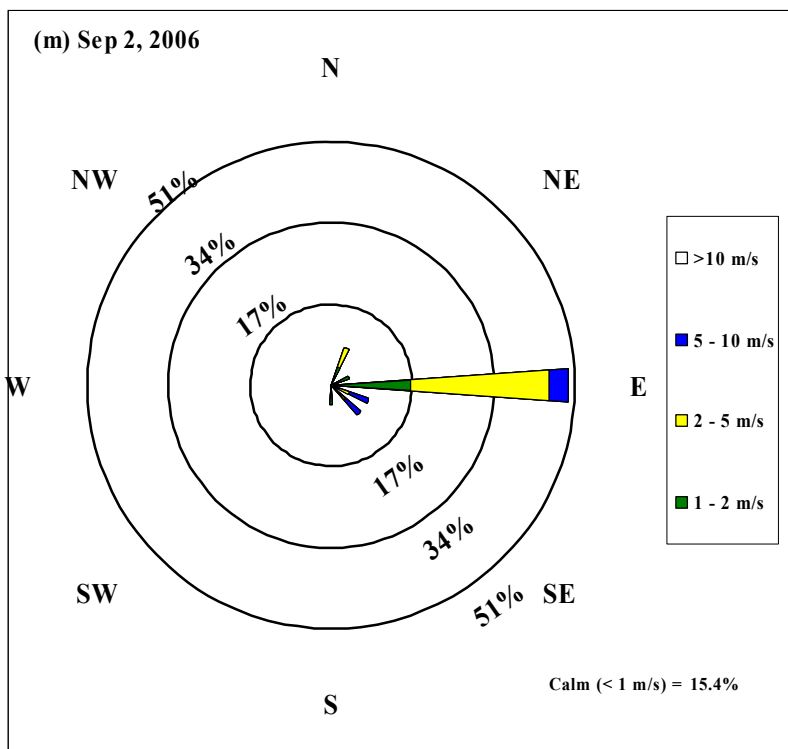
**FIGURE 4.10 (cont'd)**  
**WINDROSES FOR THE DAYS WITH EXCEEDED PM<sub>10</sub> CONCENTRATIONS**



**FIGURE 4.10 (cont'd)**  
**WINDROSES FOR THE DAYS WITH EXCEEDED PM<sub>10</sub> CONCENTRATIONS**



**FIGURE 4.10 (cont'd)**  
**WINDROSES FOR THE DAYS WITH EXCEEDED PM<sub>10</sub> CONCENTRATIONS**



The above figures illustrate that the monitors were collecting samples under a wide range of meteorological conditions. When a comparison is made to the sampling results, however, a clear correlation between exceedances of particulate matter and wind direction does not appear to exist. For the South Pond location, concentrations of particulate matter may be attributed to activities in the South Tailings Pond, as well as the movement of vehicles travelling on a nearby on-site roadway. Concentrations at the Mill location may be attributed to nearby roadways. According to site personnel, there was heavy haul truck traffic in the vicinity of the B3 Pit location which likely influenced the TSP and PM<sub>10</sub> results, and there was also an ongoing realignment of Baker Creek which lasted throughout the summer and may have impacted the particulate concentrations at the B3 Pit and the Northwest Pond locations. There was an increase in truck traffic near the Northwest Pond location due to the realignment project.

#### **4.5 COMPARISON OF 2004, 2005 AND 2006 MONITORING RESULTS**

The 2006 monitoring program was similar to the 2005 program in that samples of TSP and PM<sub>10</sub> were collected at all of the same locations as 2005. There was a slight increase in the number of sampling days in 2006 as compared to 2005. In 2004, the Northwest Pond location was not part of the program, and PM<sub>10</sub> samples were only collected at the South Pond location.

Overall the 2006 results indicate noticeably higher ambient concentrations of TSP and PM<sub>10</sub>, with more consistent exceedances of the AAQC when compared to the 2004 and 2005 monitoring results. There were however fewer exceedances of arsenic than in 2005, and all exceedances were limited to the Northwest Pond locations, whereas in 2005 elevated arsenic levels were detected at the South Pond the B3 Pit locations. There were also fewer instances of elevated or exceeding iron concentrations in 2006 as compared to 2005. There continued to be variability in the locations of the exceeding iron levels. In 2004, with the exception of iron content in one of the onsite PM<sub>10</sub> samples, all other measured concentrations of trace inorganic elements in the ambient air were below the health-based ambient air quality criteria, as defined by the Ontario Ministry of the Environment. Also in 2004, there was only one day in which the measured TSP concentrations at the sampling locations exceeded 120 µg/m<sup>3</sup> and two days in which the PM<sub>10</sub> levels exceeded 50 µg/m<sup>3</sup>. In 2005, there were numerous exceedances of TSP, PM<sub>10</sub>, arsenic and iron. Tables 4.2, 4.4 and 4.5 provide summaries of the exceedances of TSP, PM<sub>10</sub>, arsenic and iron in 2006. All arsenic exceedances were at monitoring location 5, suggesting possible contribution from the Northwest Tailings Pond.

The 2004 monitoring data at location #2 suggested that 75% of the ambient arsenic is contained within the coarse particles, and only 25% on average is present in the inhalable PM<sub>10</sub> fraction. The 2005 arsenic concentrations in TSP and PM<sub>10</sub> (measured at all onsite monitoring locations) were highly variant, however, on average indicated that more than half of the measured ambient arsenic concentration was contained within the coarse particles. This is confirmed by the 2006

monitoring data, which demonstrates that on average, 63% (with a maximum of 91%) of the measured ambient arsenic concentrations may be entrained in the coarse particles (see Table 4.4).

The higher concentrations reported in 2006 may in large part be attributed to off-site activities. It was noted by site personnel that a realignment of Baker Creek (located near the Northwest Pond) was taking place throughout the summer. In addition to the particulate generated by the realignment, there was also a noted increase in truck traffic in the area as a result of this project. Heavier-than-normal traffic was also noted in the area of the B3 pit.

From the perspective of the monitoring program and detecting arsenic emissions from the Giant Mine site, the 2006 data supports the conclusions of the 2004 and 2005 monitoring programs, in that:

- TSP provides a better measure of peaks in fugitive dust emissions from the mine site because more arsenic is present in the TSP than in the PM<sub>10</sub> samples; and,
- PM<sub>10</sub> samples provide a better measure of arsenic exposure for health protection.

Since arsenic in TSP provides a better measure of the day-to-day fluctuations in ambient arsenic concentrations, TSP sampling is more useful in determining from which sources the arsenic is likely to have originated. Since one of the objectives of the sampling program is also to assess harmful levels of exposure to arsenic in ambient air, PM<sub>10</sub> sampling is a more appropriate measure of exposure, as the TSP sampling may overestimate exposure levels by a factor of at least 2, on average.

TABLE 4.6  
AMBIENT AIR METAL CONCENTRATIONS AT THE ON-SITE MONITORING LOCATIONS (Mini-Vol Samplers)

Filter ID	Start Date	Location	Ag	Al	As	Ba	Be	Cd	Co	Cr	Cu	Fe	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	V	Zn
2006 - 60110	10/6/2006	South Pond - PM10	ND	ND	ND	ND	ND	ND	ND	0.083	0.056	ND	0.097	ND	0.111	ND	ND	ND	ND	ND	ND	ND
2006 - 51707	10/6/2006	South Pond - TSP	ND	ND	ND	ND	ND	ND	ND	0.181	ND	0.976	ND	ND	0.139	ND	ND	ND	ND	ND	ND	ND
2006 - 51723	10/6/2006	B3 Pit - PM10	ND	ND	ND	ND	ND	ND	ND	0.097	ND	ND	ND	ND	0.069	ND	ND	ND	ND	ND	ND	ND
2006 - 60108	10/6/2006	B3 Pit - TSP	ND	51.39	ND	ND	ND	ND	ND	0.264	ND	1.528	0.194	ND	0.139	ND	ND	ND	ND	ND	ND	ND
2006 - 51706	10/6/2006	Mill - PM10	ND	ND	ND	ND	ND	ND	ND	0.389	0.042	2.361	0.083	ND	0.278	ND	ND	ND	ND	ND	ND	ND
2006 - 51719	10/6/2006	Mill - TSP	ND	ND	ND	ND	ND	ND	ND	0.083	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006 - 51701	10/6/2006	NW Pond - PM10	ND	ND	ND	ND	ND	ND	ND	0.153	ND	0.833	ND	ND	0.097	ND	ND	ND	ND	ND	ND	ND
2006-051702	16/6/2006	South Pond - PM10	ND	ND	ND	ND	ND	ND	ND	0.375	ND	2.639	0.069	ND	0.292	ND	ND	ND	ND	ND	ND	ND
2006-051703	16/6/2006	South Pond - TSP	ND	ND	ND	ND	ND	ND	ND	0.403	ND	2.917	0.083	ND	0.319	ND	ND	ND	ND	ND	ND	0.694
2006-051704	16/6/2006	B3 Pit - PM10	ND	ND	ND	ND	ND	ND	ND	0.083	ND	0.833	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006-051705	16/6/2006	B3 Pit - TSP	ND	1.81	ND	0.083	ND	ND	ND	0.903	0.083	<b>8.611</b>	0.153	ND	0.653	ND	ND	ND	ND	ND	ND	ND
2006-051708	16/6/2006	Mill - PM10	ND	ND	ND	ND	ND	ND	ND	0.556	ND	3.750	0.097	ND	0.375	ND	ND	ND	ND	ND	ND	ND
2006-051709	16/6/2006	Mill - TSP	ND	2.22	ND	ND	ND	ND	ND	0.069	ND	1.250	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006-051710	16/6/2006	NW Pond - PM10	ND	ND	ND	ND	ND	ND	ND	0.556	0.056	<b>4.583</b>	0.097	ND	0.375	ND	ND	ND	ND	ND	ND	ND
2006-051711	16/6/2006	NW Pond - TSP	ND	2.13	ND	ND	ND	ND	ND	0.270	0.426	<b>4.823</b>	0.099	ND	0.142	ND	ND	ND	ND	ND	ND	ND
2006-051714	22/6/2006	South Pond - PM10	ND	ND	ND	ND	ND	ND	ND	0.667	ND	3.611	0.097	ND	0.375	ND	ND	ND	ND	ND	ND	ND
2006-051716	22/6/2006	South Pond - TSP	ND	1.94	ND	0.389	ND	ND	0.056	<b>8.056</b>	0.083	<b>41.667</b>	1.097	0.001	<b>3.611</b>	ND	ND	ND	ND	ND	ND	ND
2006-051720	22/6/2006	Mill - PM10	ND	1.53	0.069	ND	ND	ND	ND	0.097	ND	1.806	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006-051721	22/6/2006	Mill - TSP	ND	2.64	0.194	ND	ND	ND	ND	0.181	ND	<b>4.583</b>	0.097	ND	0.097	ND	ND	ND	ND	ND	ND	ND
2006-051724	22/6/2006	NW Pond - PM10	ND	ND	ND	ND	ND	ND	ND	0.264	0.042	1.250	0.083	ND	0.153	ND	ND	ND	ND	ND	ND	ND
2006-051725	22/6/2006	NW Pond - TSP	ND	ND	ND	ND	ND	ND	ND	0.153	ND	1.111	ND	ND	0.069	ND	ND	ND	ND	ND	ND	ND
2006-060101	28/6/2006	South Pond - PM10	ND	ND	ND	ND	ND	ND	ND	0.181	ND	ND	ND	ND	0.097	ND	ND	ND	ND	ND	ND	ND
2006-060102	28/6/2006	South Pond - TSP	ND	ND	0.097	ND	ND	ND	ND	0.125	0.069	1.667	ND	ND	0.069	ND	ND	ND	ND	ND	ND	ND
2006-060105	28/6/2006	B3 Pit - PM10	ND	ND	ND	ND	ND	ND	ND	0.111	ND	ND	ND	ND	0.069	ND	ND	ND	ND	ND	ND	ND
2006-060106	28/6/2006	B3 Pit - TSP	ND	2.08	0.278	ND	ND	ND	ND	0.111	ND	<b>6.250</b>	0.111	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006-060104	28/6/2006	Mill - PM10	ND	ND	ND	ND	ND	ND	ND	0.111	ND	0.833	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006-060109	28/6/2006	NW Pond - PM10	ND	ND	ND	ND	ND	ND	ND	0.069	0.042	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006-060111	28/6/2006	NW Pond - TSP	ND	ND	0.208	ND	ND	ND	ND	0.083	ND	<b>4.583</b>	0.097	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006-062901	5/7/2006	South Pond - PM10	ND	0.28	ND	0.035	<b>0.083</b>	ND	0.011	1.000	0.022	<b>5.556</b>	0.121	0.000	0.625	ND	ND	ND	ND	ND	ND	ND
2006-062902	5/7/2006	South Pond - TSP	ND	0.42	0.022	0.050	<b>0.111</b>	ND	0.036	<b>4.444</b>	0.040	<b>19.444</b>	0.514	0.000	<b>2.222</b>	ND	ND	ND	ND	ND	ND	ND
2006-062903	5/7/2006	B3 Pit - PM10	ND	0.14	ND	0.010	ND	ND	ND	0.181	0.043	1.528	0.025	ND	0.208	ND	ND	ND	ND	ND	ND	0.083
2006-062904	5/7/2006	B3 Pit - TSP	ND	0.28	0.014	0.010	ND	ND	0.004	0.194	0.029	1.806	0.031	ND	0.236	ND	ND	ND	ND	ND	ND	ND
2006-062905	5/7/2006	Mill - PM10	ND	0.14	ND	0.014	ND	ND	0.006	0.264	0.017	2.083	0.035	ND	0.319	ND	ND	ND	ND	ND	ND	ND
2006-062906	5/7/2006	Mill - TSP	ND	0.42	0.008	0.014	ND	ND	0.006	0.264	0.018	2.361	0.039	ND	0.306	ND	ND	ND	0.014	ND	ND	ND
2006-062907	5/7/2006	NW Pond - PM10	ND	0.14	ND	0.018	ND	ND	0.007	0.347	0.021	2.639	0.042	0.000	0.375	ND	ND	ND	ND	ND	ND	ND
2006-062908	5/7/2006	NW Pond - TSP	ND	0.28	0.008	0.007	ND	ND	ND	0.194	0.010	1.806	0.029	ND	0.222	ND	ND	ND	ND	ND	ND	ND



TABLE 4.6 (Cont'd)  
AMBIENT AIR METAL CONCENTRATIONS AT THE ON-SITE MONITORING LOCATIONS (Mini-Vol Samplers)

Filter ID	Start Date	Location	Ag	Al	As	Ba	Be	Cd	Co	Cr	Cu	Fe	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	V	Zn
2006-062909	10/7/2006	South Pond - PM10	ND	0.28	ND	ND	ND	ND	ND	0.194	0.015	1.667	0.024	ND	0.236	ND	ND	ND	ND	ND	ND	ND
2006-062910	10/7/2006	South Pond - TSP	ND	0.28	ND	ND	ND	ND	ND	0.131	0.014	1.208	0.021	ND	0.139	ND	ND	ND	0.004	ND	ND	ND
2006-062911	10/7/2006	B3 Pit - PM10	ND	0.28	ND	0.013	ND	ND	0.007	0.278	0.021	2.639	0.038	ND	0.319	ND	ND	ND	0.007	ND	ND	ND
2006-062912	10/7/2006	B3 Pit - TSP	ND	1.11	0.014	0.014	ND	ND	0.006	0.292	0.065	2.917	0.047	ND	0.278	ND	ND	ND	0.006	ND	ND	0.097
2006-062913	10/7/2006	Mill - PM10	ND	0.28	ND	ND	ND	ND	ND	0.058	0.015	0.653	0.013	ND	0.060	ND	ND	ND	ND	ND	ND	ND
2006-062914	10/7/2006	Mill - TSP	ND	0.42	0.013	ND	ND	ND	ND	0.050	0.014	1.056	0.021	ND	0.064	ND	ND	ND	ND	ND	ND	ND
2006-062915	10/7/2006	NW Pond - PM10	ND	0.14	ND	0.007	ND	ND	ND	0.153	0.017	1.306	0.029	ND	0.167	ND	ND	ND	ND	ND	ND	ND
2006-062916	10/7/2006	NW Pond - TSP	ND	0.42	0.033	0.007	ND	ND	ND	0.106	0.015	1.667	0.028	ND	0.103	ND	ND	ND	ND	ND	ND	ND
2006-062917	16/7/2006	South Pond - PM10	ND	0.41	0.032	0.008	ND	ND	ND	0.112	0.018	1.660	0.025	ND	0.122	0.007	0.010	ND	ND	ND	ND	ND
2006-062918	16/7/2006	South Pond - TSP	ND	0.56	0.081	0.008	ND	ND	ND	0.110	0.015	2.778	0.044	ND	0.093	0.011	0.019	ND	ND	ND	ND	ND
2006-062919	16/7/2006	B3 Pit - PM10	ND	0.42	0.021	ND	ND	ND	0.004	0.375	0.007	2.639	0.075	0.000	0.264	ND	ND	ND	ND	ND	ND	ND
2006-062920	16/7/2006	B3 Pit - TSP	ND	2.22	0.104	0.017	ND	ND	0.010	0.542	0.031	8.056	0.153	0.000	0.361	0.021	0.021	ND	0.006	0.008	ND	ND
2006-062921	16/7/2006	Mill - PM10	ND	0.42	0.008	0.010	ND	ND	ND	0.065	0.014	0.833	0.018	ND	0.053	ND	ND	ND	ND	ND	ND	ND
2006-062922	16/7/2006	Mill - TSP	ND	3.00	0.089	0.023	ND	ND	ND	0.054	0.020	5.255	0.077	ND	0.044	0.008	ND	ND	0.012	0.009	ND	ND
2006-062923	16/7/2006	NW Pond - PM10	ND	1.39	0.264	0.010	ND	ND	0.004	0.054	0.038	5.000	0.056	ND	0.053	0.047	0.042	ND	ND	ND	0.006	ND
2006-062924	16/7/2006	NW Pond - TSP	ND	2.36	0.639	0.014	ND	ND	0.011	0.068	0.044	11.667	0.153	ND	0.063	0.092	0.099	ND	ND	0.008	0.008	0.111
2006-062925	22/7/2006	South Pond - PM10	ND	0.69	0.081	0.018	ND	ND	ND	0.014	0.013	2.083	0.026	ND	0.018	0.015	0.022	ND	0.007	ND	ND	0.083
2006-062926	22/7/2006	South Pond - TSP	ND	2.22	0.264	0.010	ND	ND	0.006	0.019	0.025	7.361	0.103	ND	0.026	0.042	0.074	ND	ND	ND	0.008	0.069
2006-062929	22/7/2006	B3 Pit - PM10	ND	1.11	0.017	ND	ND	ND	ND	0.011	0.017	1.333	0.025	ND	0.010	ND	ND	ND	ND	ND	ND	ND
2006-062930	22/7/2006	B3 Pit - TSP	ND	1.81	0.040	0.014	ND	ND	ND	0.018	0.010	3.194	0.049	ND	0.011	0.006	ND	ND	ND	ND	0.007	ND
2006-062927	22/7/2006	Mill - PM10	ND	0.42	0.010	ND	ND	ND	ND	0.013	0.008	0.569	0.011	ND	0.010	ND	ND	ND	ND	ND	ND	ND
2006-070713	22/7/2006	NW Pond - PM10	ND	0.69	0.153	0.008	ND	ND	ND	0.029	0.015	2.917	0.038	ND	0.031	0.028	0.025	ND	ND	ND	ND	ND
2006-070714	22/7/2006	NW Pond - TSP	ND	1.39	0.403	0.008	ND	ND	0.007	0.051	0.022	8.056	0.104	ND	0.047	0.061	0.065	ND	ND	ND	0.006	0.097
2006-070723	28/7/2006	NW Pond - TSP	ND	0.41	0.137	ND	ND	ND	ND	0.008	0.010	2.332	0.027	ND	ND	0.019	0.025	ND	ND	ND	ND	ND
2006-070725	10/8/2006	South Pond - PM10	ND	0.42	0.043	0.007	ND	ND	ND	0.026	0.010	1.236	0.017	ND	0.019	0.008	0.011	ND	ND	ND	ND	ND
2006-070728	10/8/2006	B3 Pit - TSP	ND	0.28	0.014	ND	ND	ND	ND	0.013	0.013	0.625	0.011	ND	0.013	0.006	ND	ND	0.010	ND	ND	ND
2006-070727	10/8/2006	NW Pond - TSP	ND	1.39	0.375	0.008	ND	ND	0.015	3.333	0.036	15.278	0.472	0.000	0.722	0.065	0.064	ND	ND	ND	ND	0.083
2006-070734	15/8/2006	South Pond - PM10	ND	0.69	0.015	ND	ND	ND	ND	0.014	0.010	0.597	0.017	0.000	0.008	ND	0.013	ND	0.004	ND	ND	ND
2006-070735	15/8/2006	South Pond - TSP	ND	ND	0.019	ND	ND	ND	ND	0.008	0.008	0.500	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006-070738	15/8/2006	Mill - PM10	ND	0.28	ND	ND	ND	ND	ND	0.010	0.008	0.361	0.007	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006-070739	15/8/2006	Mill - TSP	ND	1.25	0.028	0.010	ND	ND	ND	0.010	0.008	1.944	0.028	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006-070740	15/8/2006	NW Pond - PM10	ND	ND	ND	ND	ND	ND	ND	0.010	0.010	0.208	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006-070741	15/8/2006	NW Pond - TSP	ND	0.28	0.022	ND	ND	ND	ND	0.008	0.006	0.625	0.013	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006-070744	21/8/2006	South Pond - PM10	ND	0.28	ND	0.007	ND	ND	ND	0.013	0.038	0.417	0.008	ND	0.007	ND	ND	ND	ND	ND	ND	ND
2006-070745	21/8/2006	South Pond - TSP	ND	ND	ND	ND	ND	ND	ND	0.011	ND	0.153	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006-070747	21/8/2006	B3 Pit - TSP	ND	0.14	ND	ND	ND	ND	ND	ND	ND	0.222	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006-070743	21/8/2006	Mill - PM10	ND	ND	ND	ND	ND	ND	ND	0.024	0.006	0.125	ND	ND	0.010	ND	ND	ND	ND	ND	ND	ND
2006-070748	21/8/2006	Mill - TSP	ND	ND	ND	ND	ND	ND	ND	0.007	0.018	0.153	ND	ND	0.010	ND	ND	ND	ND	ND	ND	ND
2006-070749	21/8/2006	NW Pond - PM10	ND	ND	ND	ND	ND	ND	ND	0.010	ND	0.125	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

**TABLE 4.6 (Cont'd)**  
**AMBIENT AIR METAL CONCENTRATIONS AT THE ON-SITE MONITORING LOCATIONS (Mini-Vol samplers)**

Filter ID	Start Date	Location	Ag	Al	As	Ba	Be	Cd	Co	Cr	Cu	Fe	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	V	Zn
2006-071001	27/8/2006	South Pond - PM10	ND	ND	ND	ND	ND	ND	ND	0.010	0.007	0.111	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006-071002	27/8/2006	South Pond - TSP	ND	ND	ND	ND	ND	ND	ND	0.008	0.006	0.097	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006-071004	27/8/2006	B3 Pit - TSP	ND	0.42	ND	ND	ND	ND	ND	0.024	0.010	1.375	0.019	ND	0.011	ND	ND	ND	0.004	ND	ND	ND
2006-071005	27/8/2006	Mill - PM10	ND	ND	ND	ND	ND	ND	ND	0.010	0.006	0.347	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006-071006	27/8/2006	Mill - TSP	ND	0.14	ND	ND	ND	ND	ND	0.010	0.008	0.319	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006-071007	27/8/2006	NW Pond - PM10	ND	ND	ND	ND	ND	ND	ND	0.011	0.007	0.153	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006-071013	2/9/2006	B3 Pit - PM10	ND	ND	ND	ND	ND	ND	ND	0.015	0.007	0.194	ND	ND	0.007	ND	ND	ND	ND	ND	ND	ND
2006-071014	2/9/2006	B3 Pit - TSP	ND	0.28	0.010	0.007	ND	ND	ND	0.022	0.008	0.500	0.008	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006-071015	2/9/2006	Mill - PM10	ND	ND	ND	ND	ND	ND	ND	0.015	0.008	0.181	ND	ND	0.007	ND	ND	ND	ND	ND	ND	ND
2006-071016	2/9/2006	Mill - TSP	ND	0.14	ND	ND	ND	ND	ND	0.010	0.006	0.264	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006-071017	2/9/2006	NW Pond - PM10	ND	ND	ND	ND	ND	ND	ND	0.011	0.013	0.222	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006-071021	8/9/2006	South Pond - TSP	ND	0.15	0.009	ND	ND	ND	ND	0.009	0.006	0.509	0.009	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006-071022	8/9/2006	B3 Pit - PM10	ND	ND	ND	ND	ND	ND	ND	0.008	0.010	0.181	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006-071023	8/9/2006	B3 Pit - TSP	ND	0.28	0.015	ND	ND	ND	ND	0.013	0.010	0.625	0.010	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006-071024	8/9/2006	Mill - PM10	ND	ND	ND	0.007	ND	ND	ND	0.025	0.011	0.222	ND	ND	ND	ND	ND	ND	0.004	ND	ND	ND
2006-071025	8/9/2006	Mill - TSP	ND	ND	ND	ND	ND	ND	ND	0.008	ND	0.222	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006-071026	8/9/2006	NW Pond - TSP	ND	0.14	0.025	ND	ND	ND	ND	0.008	0.006	0.667	0.011	ND	ND	0.008	ND	ND	ND	ND	ND	ND
2006-071030	14/9/2006	South Pond - PM10	0.001	0.28	ND	ND	ND	ND	ND	0.014	0.014	0.625	0.011	ND	0.008	ND	ND	ND	0.006	ND	ND	ND
2006-071031	14/9/2006	South Pond - TSP	ND	ND	0.015	ND	ND	ND	ND	0.019	0.010	0.236	ND	ND	0.007	ND	ND	ND	ND	ND	ND	ND
2006-071033	14/9/2006	B3 Pit - TSP	ND	ND	ND	0.010	ND	ND	ND	0.007	0.007	0.153	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006-071035	14/9/2006	Mill - TSP	ND	0.14	ND	ND	ND	ND	ND	0.008	0.015	0.236	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006-071036	14/9/2006	NW Pond - PM10	ND	ND	ND	0.007	ND	ND	ND	0.026	0.011	0.181	0.008	ND	0.010	ND	ND	ND	ND	ND	ND	ND
2006-071037	14/9/2006	NW Pond - TSP	ND	ND	0.008	ND	ND	ND	ND	0.007	0.008	0.306	0.007	ND	0.007	ND	ND	ND	ND	ND	ND	ND
2006-071039	20/9/2006	South Pond - PM10	ND	ND	ND	ND	ND	ND	ND	ND	0.018	0.083	ND	ND	0.015	ND	ND	ND	ND	ND	ND	ND
2006-071038	20/9/2006	South Pond - TSP	ND	ND	ND	ND	ND	ND	ND	0.011	0.014	0.097	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006-071041	20/9/2006	B3 Pit - PM10	ND	0.28	0.010	ND	ND	ND	ND	0.015	0.014	0.597	0.014	ND	0.011	0.004	ND	ND	ND	ND	ND	ND
2006-071042	20/9/2006	B3 Pit - TSP	ND	0.43	0.019	ND	ND	ND	ND	0.009	0.013	0.870	0.016	ND	0.010	0.004	ND	ND	ND	ND	ND	ND
2006-082129	20/9/2006	Mill - TSP	ND	0.14	ND	ND	ND	ND	ND	0.010	0.006	0.375	0.008	ND	0.008	ND	ND	ND	ND	ND	ND	ND
2006-082130	20/9/2006	NW Pond - PM10	ND	0.14	ND	0.008	ND	ND	ND	0.007	0.007	0.222	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006-082131	20/9/2006	NW Pond - TSP	ND	0.28	0.010	ND	ND	ND	ND	ND	0.006	0.514	0.010	ND	ND	ND	ND	ND	0.004	ND	ND	ND
2006-082450	26/9/2006	South Pond - PM10	ND	ND	ND	ND	ND	ND	ND	0.008	0.010	0.139	0.010	ND	ND	ND	ND	ND	ND	ND	ND	ND
2006-082451	26/9/2006	South Pond - TSP	ND	0.14	ND	ND	ND	ND	ND	0.008	0.007	0.292	ND	ND	ND	ND	ND	ND	0.014	ND	ND	ND
2006-082452	26/9/2006	B3 Pit - PM10	ND	0.28	ND	ND	ND	ND	ND	0.008	0.008	0.389	0.008	ND	0.008	ND	ND	ND	0.011	ND	ND	ND
2006-082453	26/9/2006	B3 Pit - TSP	ND	0.42	ND	ND	ND	ND	ND	0.029	0.011	0.806	0.017	ND	0.018	ND	ND	ND	ND	ND	ND	ND
2006-082455	26/9/2006	Mill - TSP	ND	2.08	ND	0.015	ND	ND	ND	0.014	0.017	3.333	0.056	ND	0.013	0.004	ND	ND	ND	ND	0.007	ND
2006-082456	26/9/2006	NW Pond - PM10	ND	ND	0.008	ND	ND	ND	ND	0.008	0.015	0.264	ND	ND	0.008	0.004	ND	ND	ND	ND	ND	ND
2006-082457	26/9/2006	NW Pond - TSP	ND	0.14	0.050	ND	ND	ND	ND	0.007	0.008	0.931	0.008	ND	0.008	0.008	0.013	ND	0.004	ND	ND	ND
2006-082436	01/10/2006	South Pond - TSP	ND	ND	ND	ND	ND	ND	ND	0.011	0.010	0.208	0.017	ND	0.010	ND	ND	ND	ND	ND	ND	ND
2006-082438	01/10/2006	B3 Pit - TSP	ND	0.28	ND	ND	ND	ND	0.010	0.011	0.011	0.389	0.010	ND	0.011	0.008	ND	ND	ND	ND	ND	ND
2006-082441	01/10/2006	Mill - TSP	ND	ND	ND	ND	ND	ND	ND	0.011	0.007	0.139	0.035	ND	0.008	ND	ND	ND	ND	ND	ND	ND
2006-082442	01/10/2006	NW Pond - TSP	ND	ND	ND	ND	ND	ND	ND	0.008	0.018	0.167	ND	ND	0.007	0.004	ND	ND	0.006	ND	ND	ND

TABLE 4.7  
AMBIENT AIR METAL CONCENTRATIONS FOR SAMPLES COLLECTED AT THE GIANT MINE TOWNSITE  
(Hi-Vol samplers)

Sample ID	50144	50145	50146	50147	50148	50150	2006-050901	2006-050902	2006-050903	2006-050910	2006-050923	2006-050922	2006-050921	2006-050920	2006-050919	2006-050918	2006-050917	2006-050916	2006-050911	Max	Limit
Sampling Start Date	10/6/2006	16/6/2006	22/6/2006	28/6/2006	5/7/2006	10/7/2006	16/7/2006	22/7/2006	28/7/2006	10/8/2006	15/8/2006	21/8/2006	27/8/2006	2/9/2006	8/9/2006	14/9/2006	20/9/2006	26/9/2006	1/10/2006		
Duration of Sampling (hrs)	21	23.75	23.89	23.61	23.56	23.73	23.73	23.83	23.91	23.83	24.12	23.58	23.81	24.24	23.94	23.71	23.74	23.59	0		
Ag	0.0004	0.0003	0.0002	0.0001	ND	ND	ND	ND	ND	0.0001	0.0001	0.0001	0.0001	0.0003	0.0001	ND	ND	ND	n/a	0.0004	1
Al	0.062	0.047	0.234	0.087	0.131	0.022	0.806	1.482	0.086	0.068	0.024	0.024	0.020	0.053	0.041	0.020	0.016	0.081	n/a	1.482	100
As	0.005	0.001	0.008	0.011	0.001	0.000	0.027	0.043	0.004	0.004	0.003	0.000	0.001	0.004	0.001	0.000	0.001	0.003	n/a	0.043	0.3
Ba	0.0036	0.0036	0.0041	0.0042	0.0044	0.0029	0.0021	0.0023	0.0006	0.0012	0.0005	0.0005	0.0004	0.0005	0.0007	0.0004	ND	0.0004	n/a	0.0044	10
Be	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	ND	0.01
Cd	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	ND	2
Co	ND	ND	ND	ND	ND	ND	0.0011	0.0019	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	0.0019	0.1
Cr	0.0009	0.0011	0.0019	0.0011	0.0009	ND	0.0031	0.0068	0.0026	0.0009	0.0005	0.0006	0.0004	0.0007	0.0006	0.0005	0.0001	0.0005	n/a	0.0068	1.5
Cu	0.056	0.053	0.052	0.118	0.062	0.008	0.051	0.031	0.005	0.023	0.024	0.026	0.047	0.036	0.049	0.019	0.016	0.025	n/a	0.118	50
Fe	0.105	0.118	0.443	0.150	0.212	0.032	1.550	2.717	0.172	0.117	0.043	0.038	0.027	0.097	0.074	0.030	0.019	0.150	n/a	2.717	4
Mn	0.003	0.002	0.008	0.004	0.004	0.001	0.025	0.046	0.003	0.002	0.001	0.001	0.001	0.002	0.002	0.001	0.001	0.003	n/a	0.046	120
Mo	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	ND	n/a
Ni	ND	0.0007	0.0010	ND	0.0012	0.0028	0.0025	0.0041	0.0006	0.0021	0.0021	0.0022	0.0008	0.0008	0.0007	0.0006	0.0006	0.0005	n/a	0.0041	2
Pb	0.0019	0.0005	0.0015	0.0009	0.0008	0.0003	0.0020	0.0028	0.0015	0.0014	0.0006	0.0005	0.0004	0.0042	0.0006	0.0004	ND	0.0005	n/a	0.0042	2
Sb	ND	ND	ND	ND	ND	ND	0.0015	0.0021	0.0004	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	0.0021	25
Se	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	ND	10
Sn	ND	ND	ND	ND	0.0002	ND	ND	ND	0.0005	0.0003	0.0003	0.0002	0.0002	0.0002	0.0002	0.0004	ND	ND	n/a	0.0005	10
Sr	ND	ND	ND	ND	0.0005	ND	0.0014	0.0019	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	0.0019	120
V	ND	ND	0.0005	ND	0.0005	ND	0.0033	0.0058	0.0003	0.0002	ND	ND	ND	ND	ND	ND	ND	0.0003	n/a	0.0058	2
Zn	0.011	ND	ND	0.008	0.004	ND	0.009	0.013	0.007	0.012	0.004	0.004	0.004	0.005	0.004	ND	ND	0.011	n/a	0.013	120

*Note:* All values are in µg/m<sup>3</sup>

## **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 the summers of 2004, 2005 and 2006 to establish a baseline for the fugitive emissions from the tailings areas and other disturbed areas at the mine site.

The 2006 program was carried out from June through to the beginning of October 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 PM<sub>10</sub> 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 2006 suspended particulate monitoring results indicate that the concentrations at the five sampling locations vary considerably with respect to average TSP and PM<sub>10</sub> concentrations. The Giant Mine Town Site results were low in comparison to the onsite monitoring locations. The Northwest Pond site had the highest TSP concentration of the five TSP monitoring locations, and the highest PM<sub>10</sub> concentrations of the four PM<sub>10</sub> monitoring locations.

The analyses of inorganic elements indicated that, with the exception of arsenic, beryllium, chromium, iron, and nickel all other concentrations were below their applicable AAQC. Beryllium exceeded the applicable AAQC standard on July 5<sup>th</sup>, 2006 at both TSP and PM<sub>10</sub> monitors in the South Pond location. Chromium exceeded the AAQC on two samples from the South Pond and one sample from the Northwest Pond monitoring locations. Iron concentrations were greater than the AAQC on a number of samples collected between June 16<sup>th</sup> and August 10<sup>th</sup>, 2006 at the onsite monitoring locations. The arsenic AAQC of 0.3 µg/m<sup>3</sup> was exceeded 3 times at the Northwest Pond, on July 16<sup>th</sup> and 22<sup>nd</sup>, and August 10<sup>th</sup>, 2006. In the 2005 study (Volume 2), there were exceedances of arsenic in the B3 Pit location, and elevated values in the South Pond location. There were no exceedances of arsenic at these locations during the 2006 study.

Overall, the 2006 results indicated noticeably higher ambient concentrations of TSP and PM<sub>10</sub>, however there was a decrease in the frequency of arsenic and iron exceedances of AAQC compared to the 2005 results. Similar to the 2005 monitoring results, the 2006 results also indicate that more than half of the measured ambient arsenic concentration is contained within the coarse particles, which are less likely to have an impact on human health.

Activities that may have contributed to elevated concentrations of TSP and PM<sub>10</sub> in 2006 include heavier-than-normal truck traffic to and near 138 portal (B3 Pit), as well as the realignment of Baker Creek. The realignment project took place throughout the summer, and may have influenced the particulate concentrations at the B3 Pit location as well as the Northwest Pond location. Truck traffic resulting from the ongoing project passed the monitors at the Northwest Pond location on a regular basis.

## **5.2 RECOMMENDATIONS**

The monitoring program has improved considerably by adding a fifth on-site station at the south side of Northwest Pond. The results of the monitoring program correlate well with activities on-site and in the vicinity of the Giant Mine site. Therefore, it is recommended that the same monitoring program be continued for the period prior to as well as during the remediation activities at the Giant Mine site.

Although much improved compared to the 2005 monitoring results, the 2006 results have had a few failed samplings, which were mainly attributed to equipment malfunction and/or operator mistake. More frequent maintenance of the sampling equipment and collection of filters as early as possible on the day after the sampling day is recommended.

## **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 (PM<sub>10</sub>, also known as inhalable particulates) and Particulate Matter less than 2.5 µm (PM<sub>2.5</sub>, 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 PM<sub>10</sub> impactor assemblies
- 2 PM<sub>2.5</sub> 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)

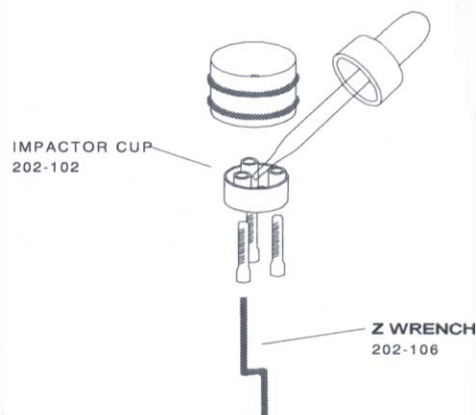
In order to successfully implement a sampling programme, the following steps should be followed:

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 PM<sub>10</sub> and PM<sub>2.5</sub> assemblies) with a small amount of the suspension as shown in Figure 1.

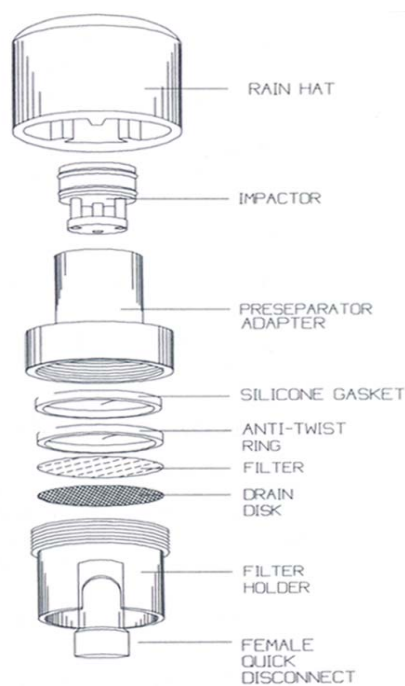
**Figure 1**  
**REGREASING PM<sub>2.5</sub> IMPACTOR**



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 PM<sub>10</sub> and PM<sub>2.5</sub> 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.

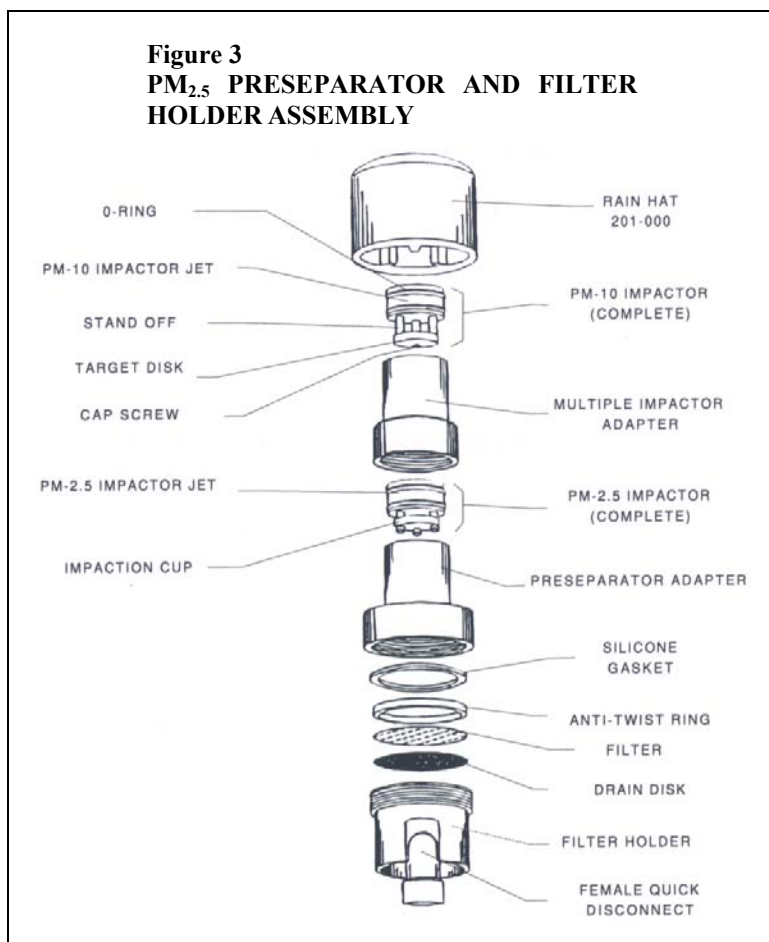
**Figure 2**  
**PM<sub>10</sub> PRESEPARATOR AND FILTER HOLDER ASSEMBLY**



- If TSP sampling is desired, screw the filter holder assembly together and place a rain hat over the top of the assembly.
- If PM<sub>10</sub> sampling is desired, slide the PM<sub>10</sub> 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  $\mu\text{m}$  to impact on and stick to the disc at the bottom. Only particle 10  $\mu\text{m}$  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  $\mu\text{m}$  to impact on and stick to the disc at the bottom. Screw the holder assembly together. Next, slide the  $\text{PM}_{10}$  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  $\text{PM}_{10}$  impactor assembly. This configuration works by first removing particles greater than 10  $\mu\text{m}$  (i.e. they impact and stick to the  $\text{PM}_{10}$  impactor disc). Only particles 10  $\mu\text{m}$  and less flow through to the second impactor assembly, where particles greater than 2.5  $\mu\text{m}$  impact and stick to the  $\text{PM}_{2.5}$  impactor disc. Only particles 2.5  $\mu\text{m}$  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 PM<sub>10</sub> OR PM<sub>2.5</sub> 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, m<sup>3</sup>/min
- H<sub>2</sub>O = orifice manometer reading during calibration, in. H<sub>2</sub>O
- 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 m<sup>3</sup>/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 H<sub>2</sub>O 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. H<sub>2</sub>O = 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, m<sup>3</sup>/min

$Q_a$  = orifice flow during calibration, m<sup>3</sup>/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.