Ministry of the Environment
199 Larch St, Suite 1201
Sudbury, ON P3E 5P9

Ministère de l'Environement
199, rue Larch, Bureau 1201
Sudbury, ON P3E 5P9

Ontario

Phone: (705) 564-7171
Fax: (705) 564-4180

September 17, 2007

To: Bruce Cave
Senior Environmental Officer, Sault Ste. Marie

Rod Stewart
Supervisor, Sault Ste. Marie

Cc: Brian Cameron
District Manager, Sudbury

Ed Cartier
Air Environmental Officer, Sault Ste. Marie

Kathy McDonald
APEP Supervisor, Sudbury

Lou-Ann Cornacchio
Technical Support Manager, Sudbury

From: Sandra Ausma
Air Quality Analyst, Sudbury

Re: Report on Sault Ste. Marie 2006 Particulate Monitoring Special Study

---

Background

The Algoma Steel Inc. (ASI) facility in Sault Ste. Marie (SSM), ON manufactures steel products. The facility is located on the north shore of the St. Marys River with residential neighbourhoods located to the north and east (Fig. 1). In 2006, ASI produced 2.198 million tonnes of steel. The facility operates 24-hrs/day 7 days/week.

Until December 2004, the ministry operated two comprehensive air monitoring stations in the vicinity of ASI. In December 2004, responsibility for the operation of these stations and samplers was transferred to ASI as part of the Source Emissions Monitoring (SEM) initiative which resulted in the transfer of responsibility for in-community air monitoring from the ministry to emitters. Table 1 summarizes the on-going routine air quality monitoring that is conducted in Sault Ste. Marie.

Table 1: Summary of parameters monitored in Sault Ste. Marie, ON in the vicinity of ASI on a routine basis.

	Continuous Monitoring			Discrete Sampling				
Station	TRS	SO2	Particulate	PAH	VOC	TSP	PM10	dustfall
71015								x
71042	x		x	x	x	x	x	x
71043								x
71045								x
71068	x	x		x	x	x		

In 2004, there were several days of poor air quality in the Bayview neighbourhood of Sault Ste. Marie due to high airborne particulate levels. This resulted in media coverage and Algoma Public Health approaching the ministry due to public complaints. The ministry's local District Office met with Algoma Public Health, residents from the Bayview neighbourhood and the local Member of Parliament (MP) to discuss more comprehensive particulate monitoring by the ministry in the Bayview area.

ASI is a schedule 4 company with respect to Ontario Regulation (O. Reg.) 419/05 and applicable standards, Point of Impingement (POI) and Ambient Air Quality Criteria (AAQC) guidelines. As such schedule 1 standards apply to ASI until 01 Feb 2010 when schedule 3 standards will be phased in. In the case where schedule 1 standards are unavailable or there is no ability to calculate 0.5-hr averages for comparison to schedule 1 standards, direction has been given from the ministry's Standards Development Branch (SDB) that schedule 3 standards may be used as AAQC until they are phased in. Examples of compounds where this would be the case includes hi-volume (hi-vol) total suspended particulate (TSP), metals and dustfall. Table 2 summarizes the standards and AAQC applicable to the monitoring conducted for this study.

Table 2: Summary of standards and AAQC used to compare to data collected during this study.

Contaminant	Schedule 1	Schedule 3		AAQC	Limiting Effect
	0.5-hr	24-hr	Other	24-hr	
Suspended Particulate Matter[1]	100 µg m^{-3}	120 µg m^{-3}			Visibility
PM_{10}[2]				50 µg m^{-3}	
Dustfall			7 g m^{-2} 30$days^{-1}$		Soiling
Benzo-a-pyrene				0.0011 µg m^{-3}	Health

[1] – < 44 µm in diameter
[2] – PM_{10} – particulate matter 10 µm in diameter and smaller in size: Interim AAQC

This report presents the results of continuous monitoring and discrete particulate sampling conducted in 2006 at 6 locations within Sault Ste. Marie around the ASI facility (Fig. 1). The objectives of this study were to further quantify and characterize airborne particulate in the neighbourhoods around ASI, focusing on the Bayview neighbourhood and to further quantify airborne PAH levels in the Bayview neighbourhood to complement soil and vegetation PAH sampling that was conducted by the ministry's Environmental Monitoring and Reporting Branch (EMRB) in 2005.

Methodology

A combination of real-time particulate monitoring, dustfall sampling and particulate filter sampling was conducted during the study period of March through October 2006 at the 6 locations identified in Table 3 and Fig. 1. Appendix 1 contains photos and satellite images of the stations. Three of the sites were in the Bayview neighbourhood: 71042 Bonney St., 71102 Peter J. Manzo Pool, and 71103 Mike Zuke Memorial Park. All six of the stations were secure, either due to the secure nature of the location (e.g., enclosed within fenced municipal property) or through the installation of portable fencing around the instrumentation.

Figure 1: Satellite image overview of study area. Particulate sources: 1- Algoma Steel Inc, 2 – Flakeboard (SSM) Co. Ltd., 3 – Algoma Tubes Inc., 4 – St. Marys Paper, 5 – Praxair, 6 – Algoma Central Railway. Sources within ASI: 1a – coal piles, 1b – lime plant, 1c – coke oven stacks, 1d – dekish area, and 1e – blast furnace vents. Map from Google.

Table 3: Summary of stations and sampling instrumentation.

Station #	Station Name	Aerocet	PQ100 or PQ 200	Dustfall	PAH
71042	Bonney St.	✓	✓	✓	✓
71100	West End Sewage Treatment Plant (WESTP)	✓	✓	✓	
71101	Second Line West Pump House	✓	✓	✓	
71102	Peter Manzo Pool	✓	✓	✓	
71103	Mike Zuke Park	✓	✓	✓	
71104	Cathcart	✓	✓	✓	

Hydro was readily available at 5 of the 6 sites. At the 71104 Cathcart St. location, the cost of installing hydro would have been prohibitive: an off-grid solar system was installed at this location.

Continuous particulate monitoring was performed using MetOne Aerocet Model 7350 continuous particulate monitors fitted with wind speed and direction instrumentation all locations (Fig. 2). TSP results from this instrument will be discussed within this report. The ministry's suspended particulate schedule 1 0.5-hr standard is 100 µg m^{-3} and the schedule 3 24-hr standard is 120 µg m^{-3}.

The Aerocet uses light scattered from suspended particulate to provide a continuous real-time measurement of airborne particulate. An internal visible laser diode is collimated and directed through sample air. Sample air is drawn into the Aerocet by an internal pump at 1.0 L min^{-1}. The Aerocet can provide 15-min to 24-hr averages: for this study, 15-minute particulate averages were collected and downloaded on a weekly basis.

Figure 2: Aerocet 7350 continuous particulate monitor.

At 71042 Bonney St. a MetOne Instruments BAM-1020 Particulate Monitor (BAM) continuous sampler was collocated with the Aerocet for part of the study to confirm particulate concentrations measured by the Aerocet. The BAM uses beta ray attenuation to provide a determination of mass concentration. A ^{14}C element emits a source of beta particles which are detected by a scintillation counter. A pump draws a measured amount of air through filter tape which is placed between the source and the detector. The filter tape collects the particulate in the air sample causing attenuation in the beta-particle signal: the degree of attenuation of the beta-particle signal is used to determine the mass concentration of particulate matter on the filter tape and hence the volumetric concentration of particulate in the ambient air sample. The BAM provides hourly averages of PM_{10} concentration.

Discrete particulate sampling was performed at all locations using either PQ 100 or PQ 200 samplers (Fig. 3) with 47 mm Teflon filters on a 24-hr 3-day sampling schedule. The PQ 100 samplers are portable samplers which draw ambient air at 16.7 L min^{-1}. For this study, the PM_{10} (particulate matter 10 µm in diameter and smaller) sampling head was used: the ministry's 24-hr interim PM_{10} standard is 50 µg m^{-3}. The PM_{10} results can also be compared to the schedule 3 24-hr suspended particulate (particulate less than 44 µm) standard. Filters were analyzed for a suite of metals by the ministry's Laboratory Services Branch (LaSB). Table 8 summarizes the analysed metals and the ministry standard, where available.

Figure 3: PQ 100 sampler.

Figure 4: Dustfall

Dustfall jars were installed at all 6 locations (Fig. 4). Dustfall comprises the largest fraction of particulate, generally in the 25 to100 µm range and larger more visible particulate matter which settle out from the atmosphere by gravity into dustfall jars. Jars are left in place for a period of 1 month. In combination with the identification of particles by optical microscopy, this method can serve as a useful indicator of the types and possible sources of particulate matter in areas

with dusting issues resulting from heavy soiling. Particles in this size range are not considered as having health-related effects. They are mostly associated with nuisance complaints due to local deposition (soiling) and visibility effects. The ministry's schedule 3 dustfall standard is 7 g m^{-2} $30days^{-1}$.

All of the dustfall samples were optically characterized to aid in source identification: optical characterization is semi-quantitative, but is able to indicate the relative abundance and/or presence of classes of particulate matter. The routine ministry laboratory scan comprises the following particle types: coal, coke, graphite, kish, coal soot, oil soot, fly ash, iron oxide and iron, silicates, slag, moulding sand, wood fibers, wood char, carbonates, biological material, polymers, aluminum metal, vegetation/plant chips, vegetation fibers, and paint chips.

24 hour polycyclic aromatic hydrocarbon (PAH) samples were collected using hi-vol samplers (Fig. 5) on a 12-day schedule at the Bonney St. location. Filters were analyzed for a suite of PAHs. Only Benzo-a-pyrene (BaP) will be discussed within this report since the ministry has an Ambient Air Quality Criteria (AAQC) for only this PAH.

Figure 5: PAH hi-vol sampler

Results and Discussion

Continuous Particulate Sampling

The sampling start and stop dates along with percent valid data for the Aerocet continuous particulate data are presented in Table 4. Sampling start dates were staggered between 22 March 2006 and 01 June 2006 depending on the amount of site preparation required, for example, installation of fencing, hydro, and/or solar power. Monitoring at the Bonney St. location ended a month earlier than at the other stations as the site became unavailable as a monitoring location. Additionally, construction activities on Bonney St. began in late June. The percent valid data reflects the amount of time the Aerocets were functional and collecting data during the sampling period.

Table 4: Summary of stations and sampling information for continuous particulate monitoring. % valid data based on 15-min averaging intervals.

Station #	Station Name	Start date	End date	Days	% Valid data	% Calm winds
71042	Bonney St.	2006/03/22	2006/09/07	168.84	84	33
71100	WESTP	2006/03/22	2006/10/18	209.94	90	33
71101	Second Line West Pump House	2006/03/22	2006/10/18	209.73	91	25
71102	Peter Manzo Pool	2006/04/24	2006/10/18	176.79	68	34
71103	Mike Zuke Park	2006/04/12	2006/10/18	188.88	87	32
71104	Cathcart	2006/06/01	2006/10/18	138.81	88	26

Problems were noted with the 71042 Bonney St. Aerocet dataset part way through the study period (significant drops in particulate concentrations). The available hourly BAM PM_{10} data for June, August and September 2006 was used to replace the Aerocet TSP data for these months. In the case of the BAM data, hourly PM_{10} data is presented and compared to the 0.5-hr schedule 1 suspended particulate standard and averaged to compare to the 24-hr schedule 3 suspended

particulate standard. The suspended particulate standards includes particulate 44 µm in diameter and smaller.

Fig 6 presents wind roses, generated from the 15-min Aerocet data, for each of the 6 monitoring locations. Wind directions associated with wind speeds less than 3 km hr^{-1} have been excluded since they are unreliable at these speeds. The predominant wind directions at most of the locations tend to be from the south east and north west. Some locations are impacted by local topography (e.g., buildings, trees, etc.)

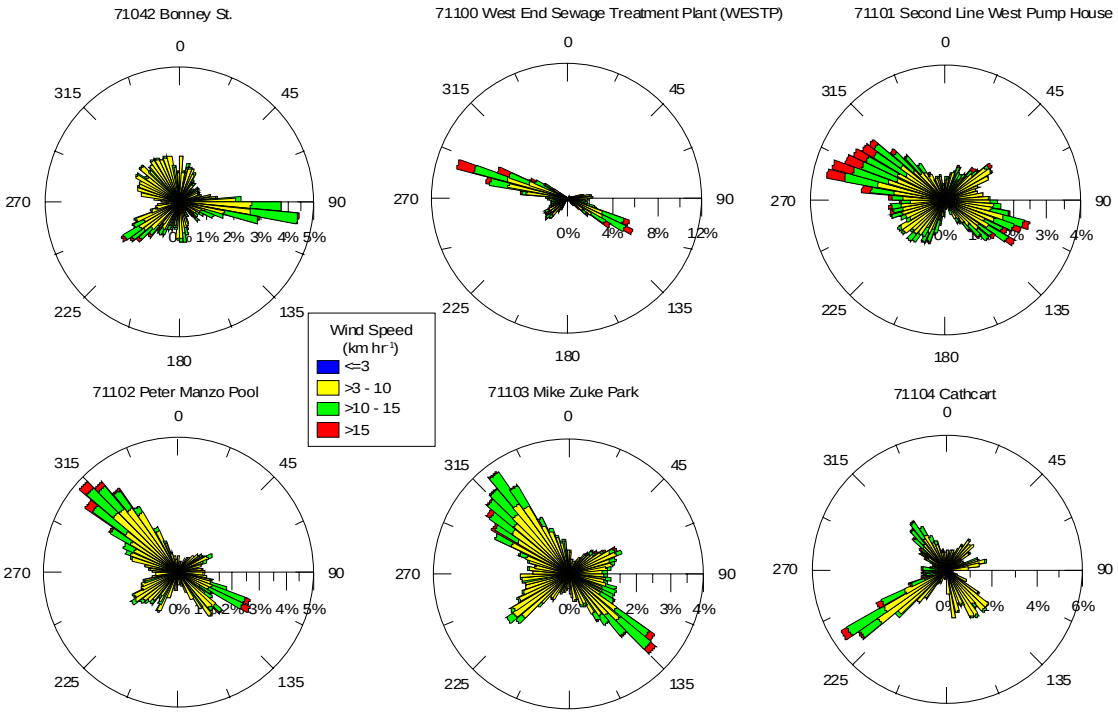


Figure 6: Wind roses for each of the 6 monitoring locations. Generated from the 15-min Aerocet data.

Appendix 2 graphically presents all the 0.5-hr and 24-hr averaged data for the study period in time series format. Light scattering particulate monitors are limited when temperatures are close to the dew point as particulate concentrations can rise to unrealistic levels. The Aerocets do not have ambient relative humidity sensors, therefore dew point temperatures could not be calculated, although there were occasions when particulate concentrations rose to very high levels. An examination of particulate and wind speed showed that most high particulate concentrations occurred at calm wind speeds (< 3 km hr^{-1}). For these reasons, values of TSP greater than 1000 µg m^{-3} were excluded from the analysis and not used in the discussions below.

Table 5 summarizes the 0.5-hr and 24-hr statistics for the full data set as described in Table 4. A minimum of 75 % valid data was required before calculating the 0.5-hr and 24-hr averages using the 15 minute raw data. Fig. 7 presents the monthly statistics for the 0.5-hr data and Fig. 8 presents the monthly statistics for the 24-hr data.

Exceedances of the suspended particulate schedule 1 0.5-hr standard of 100 µg m^{-3} occurred at all monitoring locations: the highest average concentration and largest exceedance rate occurred at 71042 Bonney St. and the lowest average concentration and smallest exceedance rate occurred

at 71100 WESTP and 71104 Cathcart, respectively. With the 24-hr averages, only two locations experienced exceedances of the schedule 3 standard of 120 µg m^{-3}: 71042 Bonney St. with 33 exceedances and 71101 Second Line West Pump House with 4 exceedances. These data show that TSP concentrations and number of 0.5-hr and 24-hr exceedances quickly drop in value as one moves away from the Algoma Steel Inc. property line: particulate concentrations within Bayview that are not adjacent to the ASI property line (i.e., 71102 Peter Manzo Pool, 71103 Mike Zuke Park) are comparable to those found at the other monitoring locations which are further away from ASI.

Table 5: Summary of 0.5-hr and 24-hr TSP statistics for the entire study period at each of the monitoring locations. All concentrations are in µg m^{-3}.

Station	0.5 hr averages (Schedule 1 suspended particulate 0.5-hr limit 100 µg m^{-3})				24-hr averages (Schedule 3 suspended particulate 24-hr limit 120 µg m^{-3})			
	max	average	exceedances	% exceedances	max	average	exceedances	% exceedances
71042	983	89	1803	27	248	83	33	25
71100	908	28	242	3	112	28	0	0
71101	699	40	584	6	180	40	4	2
71102	445	38	329	7	96	38	0	0
71103	586	31	231	3	93	32	0	0
71104	733	41	225	4	104	42	0	0

Stations within Bayview neighbourhood are highlighted

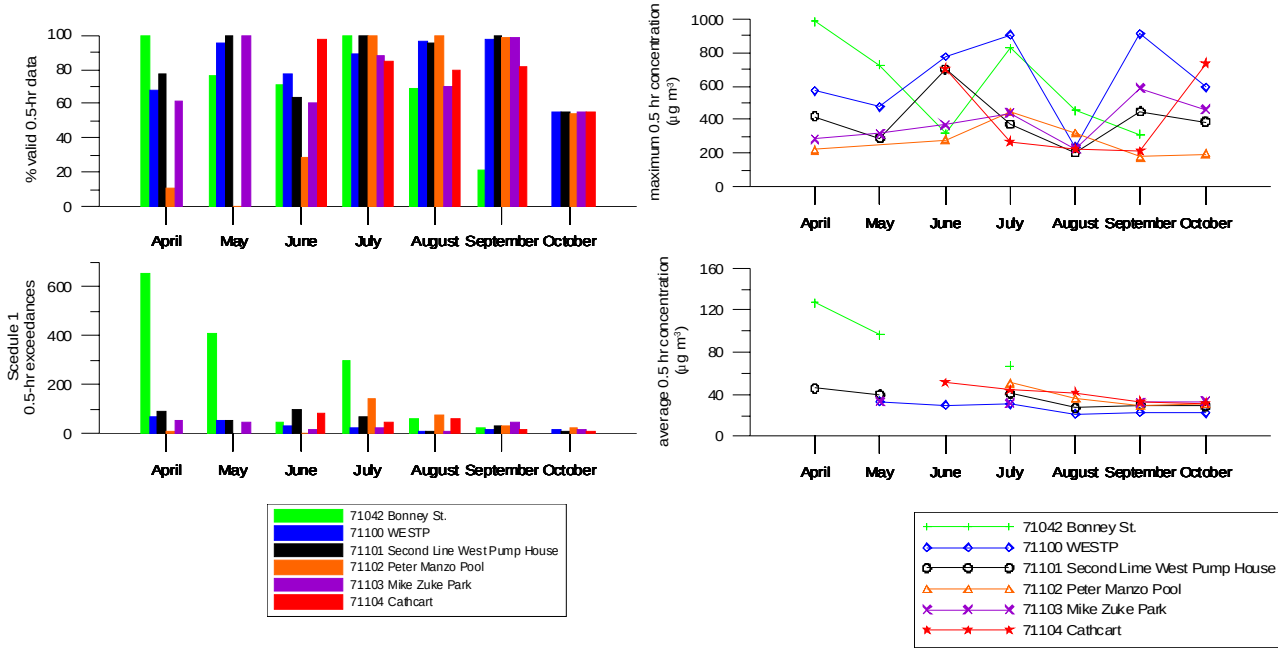


Figure 7: 0.5-hr TSP statistics for the 6 monitoring stations presented by month.

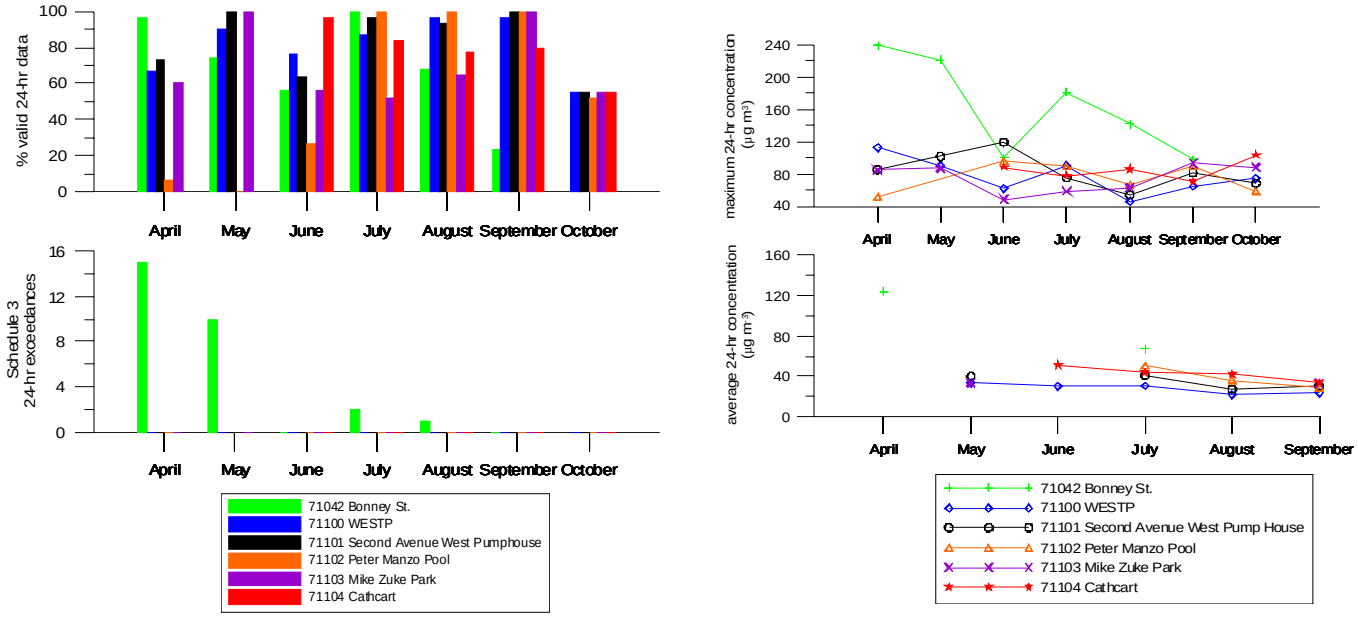


Figure 8: 24-hr TSP average statistics for the six monitoring locations presented by month

The availability of high resolution data is an advantage of using continuous monitoring. The collected data can be correlated by time to industrial processes or other emission activities and by wind direction to assist in attributing particulate to local sources. Fig. 9 presents time averaged 0.5-hr TSP concentrations for the entire study period. Standard deviations were large; error bars were excluded to enable viewing of diurnal trends. Diurnal variability is obvious in the data from all the sites except possibly 71042 Bonney St. Peak TSP concentrations occurred around 08:00 at 5 of the 6 sites. These maximum are likely due to a combination of morning rush hour vehicle traffic, initiation of daily industrial activity and the increased atmospheric

turbulence that occurs at dawn. Two daily TSP minimums can be identified and typically occurred before dawn between midnight and 04:00 and again around 17:00.

Not all airborne particulate in the vicinity of Algoma Steel Inc. is a result of activities at the facility. Other sources include additional industries in the area (e.g., Algoma Tubes Inc., Praxair, Flakeboard), vehicular traffic, heating exhaust, burning, road dust, and construction activities (e.g., Bonney St. construction ongoing for most of summer). Wind direction analysis of the continuous particulate data can help identify sources around the monitoring locations. Table 6 summarizes the approximate distances and wind directions from the stations to the various sources: sources within 1.5 km were the primary focus. Fig. 10 presents all 15-min concentrations greater than 100 µg m^{-3} correlated with wind direction. Calm winds less than 3 km hr^{-1} were filtered out since wind direction measurements are not reliable under calm conditions. Monthly breakdowns of the particulate versus wind direction are located in Appendix 3.

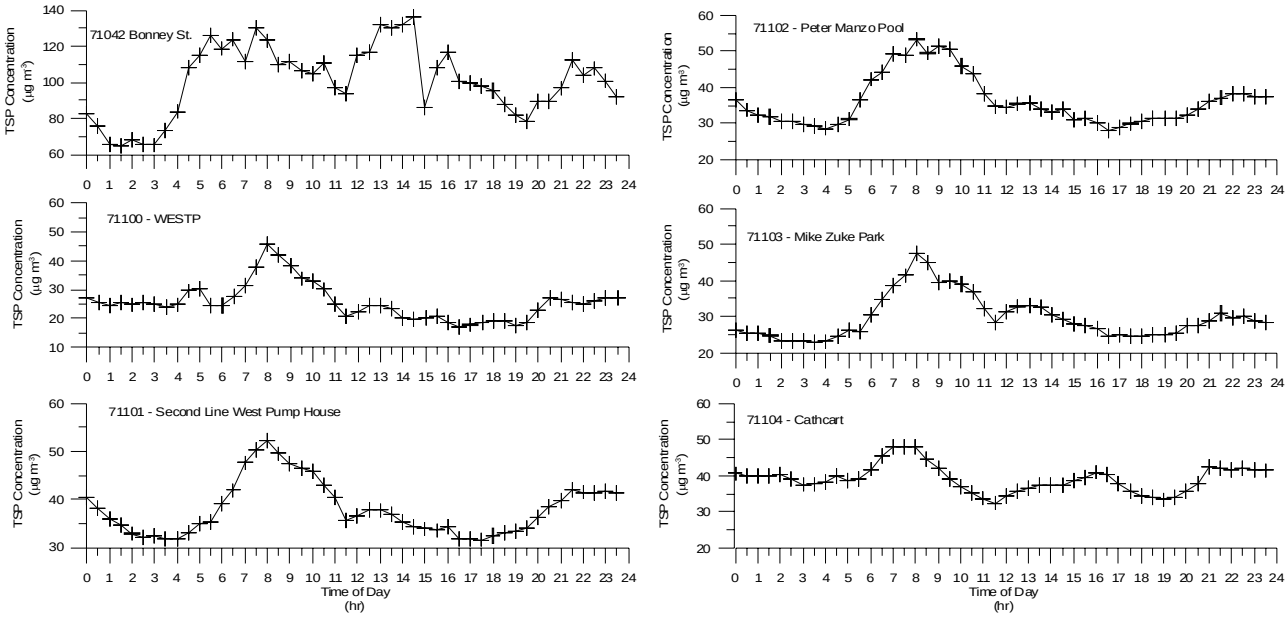


Figure 9: Diurnal variability in 0.5-hr averaged data. Error bars were large and have been excluded for easier viewing.

Table 6: Approximate wind direction (º) and distance (km) from study monitoring stations to various industrial particulate sources

Station	ASI			ASI Coal piles			ASI Lime piles		
	Distance (km)	> (º)	< (º)	Distance (km)	> (º)	< (º)	Distance (km)	> (º)	< (º)
71042	0.90	78	147	0.67	167	243	0.65	167	185
71100	2.84	87	113	1.80	105	127	2.16	108	114
71101	1.69	148	203	2.38	204	220	2.23	197	204
71102	0.96	96	191	1.20	192	225	1.17	185	195
71103	1.33	97	159	1.14	167	210	1.23	162	172
71104	0.82	232	360	2.08	250	255	1.73	250	255
Station	Algoma Tubes			St Marys			Flakeboard		
	Distance (km)	> (º)	< (º)	Distance (km)	> (º)	< (º)	Distance (km)	> (º)	< (º)
71042	0.92	37	63	2.42	70	74	2.73	252	260
71100	2.77	78	86	3.92	102	104	1.08	213	231
71101	1.00	163	206	2.77	142	150	4.08	236	241
71102	0.57	60	111	2.65	123	127	3.12	245	252
71103	1.00	86	105	2.85	117	121	2.71	244	250
71104	1.12	295	325	0.82	131	153	4.38	260	264

> < angles between which the industrial source lies with respect to the station

One needs to be cautious when attributing particulate levels to sources since there is a variety of sources in the vicinity of the monitoring locations and extensive areas of unpaved parking lots and industrial storage yards. At some of the stations industrial sources have a clear impact on particulate concentrations. At 71042 Bonney St., ASI, the associated coal and lime storage piles, and other upwind areas (e.g., unpaved parking lots) are the most significant source of particulate (Fig. 10). The wind directions associated with the storage piles provides a larger number of particulate concentrations greater than 100 µg m^{-3} and higher TSP concentrations in general.

At 71100 WESTP, ASI lies upwind of the monitoring location and appears to be contributing to elevated TSP concentrations; however, there are light industrial areas and extensive unpaved areas located between the monitoring location and ASI. Flakeboard, which is southwest of WESTP, also appears to be contributing to elevated particulate at this location. At 71101 Second Line West Pump House there were elevated particulate measured at this location which may have originated from ASI and associated storage piles. At 71102 Peter Manzo Pool, ASI and Algoma Tubes Inc. both have an impact on elevated TSP levels, but not to the extent observed at 71042 Bonney St. At 71103 Mike Zuke Park, TSP concentrations were similar to 71102 Peter Manzo Pool. At 71104 Cathcart, the contribution of ASI on elevated particulate is minimal compared to 71042 Bonney St. which is the same distance from ASI, but on the opposite side of the facility. St. Marys Paper may have also had an impact on particulate levels at 71104 Cathcart.

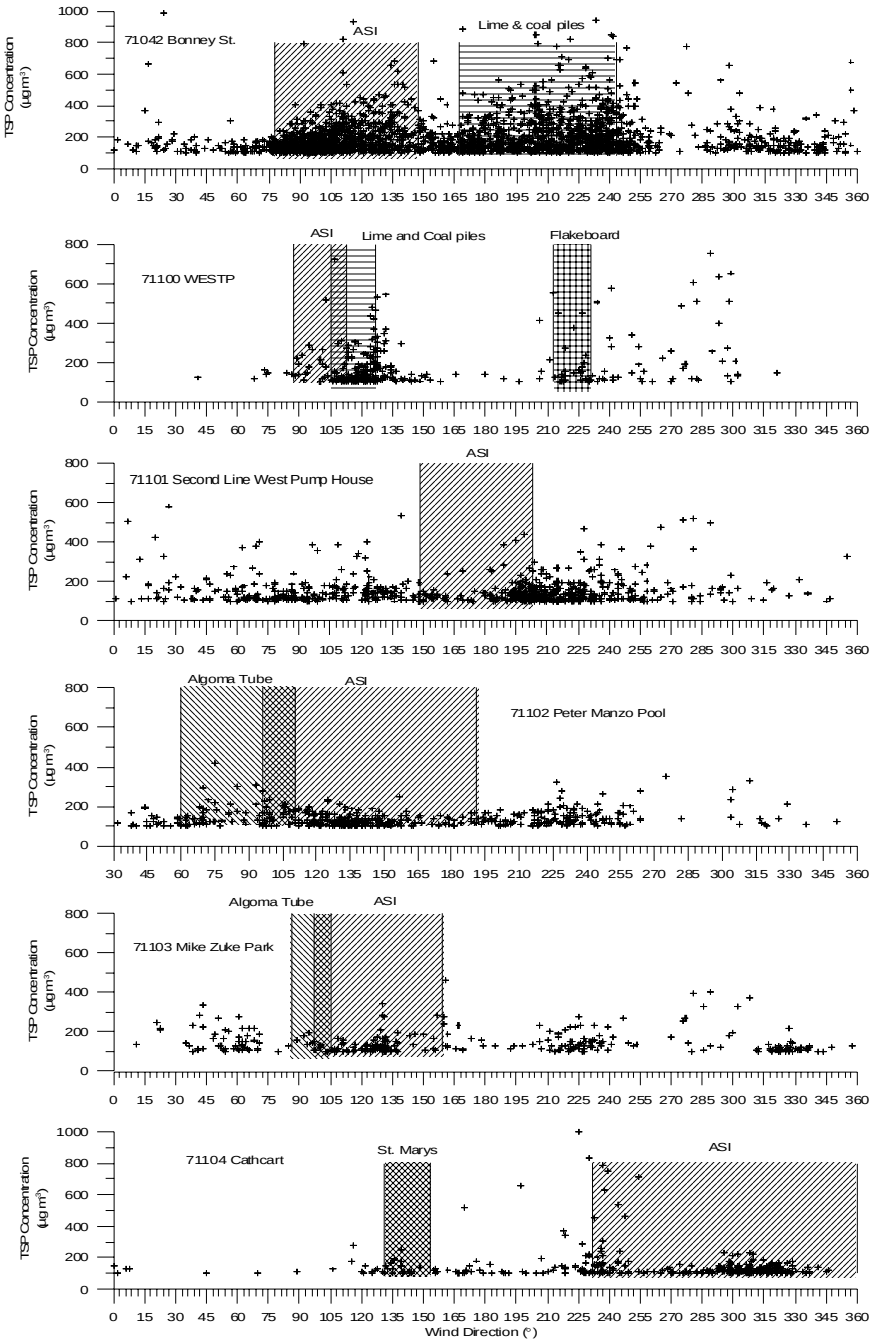


Figure 10: Wind direction analysis of 15 min average TSP data. Various industrial particulate sources are identified. Only TSP values greater than 100 µg m^{-3} have been included. Wind directions associated with wind speeds less than 3 km hr^{-1} have been excluded since wind direction becomes unreliable at low wind speeds

Non-continuous Sampling - 47mm Filter

PQ 100/200 sampling was initiated on 26 April 2006 at 5 of the 6 sites. Sampling at 71104 Cathcart was initiated on 01 June 2006 once the off-grid solar system was installed. Sampling ended 1 month early at 71042 Bonney St. as the site became unavailable for monitoring use. Sampling was conducted at a 3-day interval based on the NAPS schedule. Table 7 summarizes

the start and stop dates along with sample statistics for PM_{10}. Invalid data is primarily the result of missed sampling dates on weekends. Averages are provided in Table 7 for data sets with less than 75% valid data.

Table 7: PM_{10} statistics for PQ 100/200 24-hr samples. All concentrations in µg m^{-3}. Valid data based upon number of sampling dates available during study period. Averages are provided for data sets with less than 75% valid data.

Station	Start Date	End Date	Valid Samples	%valid (µg m^{-3})	Average (µg m^{-3})	Max (µg m^{-3})	exceedances	%exceed	%<mdl
71042	26-Apr-06	8-Sep-06	30	65.22	46.4	120	12	40.0	0.0
71100	26-Apr-06	14-Oct-06	42	72.41	18.1	43	0	0.0	0.0
71101	26-Apr-06	14-Oct-06	43	74.14	19.0	45	0	0.0	1.7
71102	26-Apr-06	14-Oct-06	44	75.86	30.5	87	8	18.2	0.0
71103	26-Apr-06	14-Oct-06	45	77.59	23.4	69	4	8.9	0.0
71104	1-Jun-06	14-Oct-06	34	75.56	28.1	55	1	2.9	0.0

Stations within Bayview neighbourhood are highlighted

Figure 11 presents all the PM_{10} particulate data for the study period in time series format. 71042 Bonney St. recorded the highest concentrations and the most exceedances of the 24-hr PM_{10} interim AAQC (Table 7). Exceedances were also recorded at the other two stations within the Bayview neighbourhood. Exceedances were not measured at 71100 WESTP or 71101 Second Line West Pump House. There were no exceedances of the ministry's schedule 3 24-hr suspended particulate standard.

Elements analyzed by XRF within the PM_{10} samples are listed in Table 8 along with the method detection limit (MDL) of the element and the ambient air quality criteria (AAQC) or schedule 3 24-hr standard, where available. Additionally, an overall summary is provided about the number of samples with detectable levels of the analyzed elements: in general, concentrations of metals were low as reflected by many of the samples containing concentrations less than the MDL and the number of samples in which all of the samples contained metals at concentrations less than 10% of the schedule 3 standard or AAQC.

Table 9 summarizes the statistics for elements which are of interest or for which there were potential exceedances. In general, 71042 Bonney St. samples had higher average and maximum concentrations, typically by a factor of 2 to 3, for silicon, iron, manganese, calcium, copper and aluminum. A number of exceedances occurred at 2 or more locations on the same date: 60% of the dates of exceedances at 71102 Peter Manzo Pool corresponded to dates of exceedances at 71042 Bonney St., 75% of the dates of exceedances at 71103 Mike Zuke Park corresponded to dates of exceedances at 71102 Peter Manzo Pool and on one date, 01 July, exceedances occurred at 71042 Bonney St., 71102, Peter Manzo Pool and Mike Zuke Park.

The stations closest to ASI, 71042 Bonney St., 71102 Peter Manzo Pool, 71103 Mike Zuke Park and 71104 Cathcart all had samples in which the iron (Fe) concentrations were higher than the ministry's schedule 3 24-hr standard of 4 µg m^{-3} for metallic iron. However, XRF analysis quantifies total elemental concentration and hence total iron within a sample (i.e., iron within iron salts such as iron oxide, iron sulphate, etc. would also be included in analysis) and exceedances of the iron schedule 3 limit cannot be confirmed. The data does, however, provide evidence of an impact by ASI at these locations.

Another compound which may have exceeded its guideline is silica. 71042 Bonney St. and 71102 Peter Manzo Pool both had silicon concentrations above the ministry's 24-hr silica AAQC of 5 µg m^{-3} for 3 forms of respirable silica (silicon dioxide): cristabolite, quartz and tridymite. Exceedances of the silica AAQCs cannot be confirmed since the form of silicon within the samples is unknown. Crystallographic analysis of the samples may allow verification of the crystal formation; however, the ministry's laboratory services branch currently does not perform this analysis. The presence of high levels of silicon within the samples suggests significant contribution to particulate loadings from roads and unpaved areas.

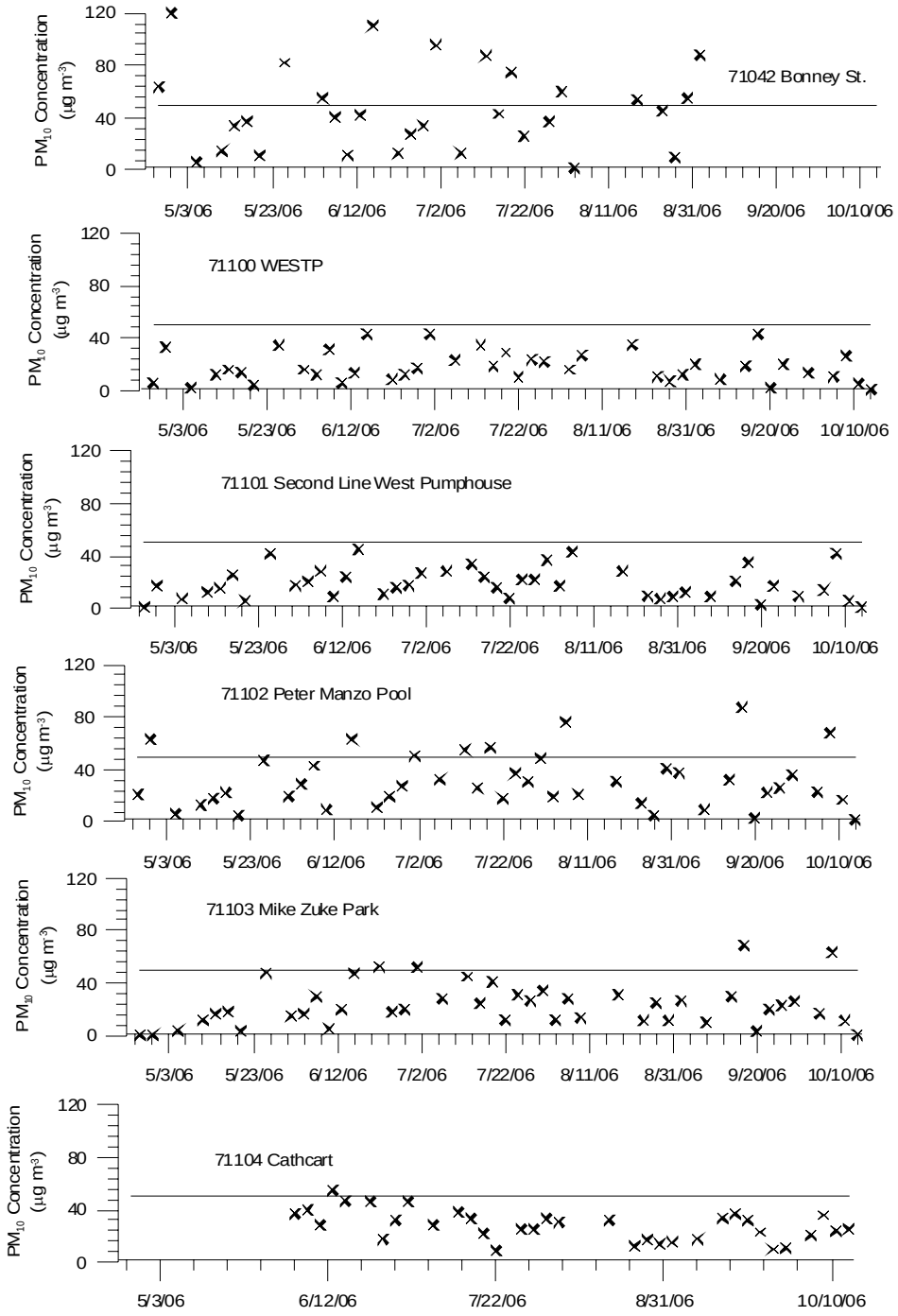


Figure 11: Time series presentation of PM_{10} 24-hr sampling results

Table 8: Overall summary of elements measured by XRF on 47 mm PQ 100/200 samples collected at study stations.

	Al	Si	P	S	Cl	Ca	Ti	V	Cr
MDL (µg m^{-3})	0.046	0.02	0.004	0.003	0.002	0.004	0.001	0.001	0.001
AAQC or Schedule 3 24-hr standard (µg m^{-3})	n/a	5[1]	n/a	n/a	10	n/a	120	2	1.5[1]
> 25% samples < MDL at all sampling locations			x						
All samples < 10% of standard					x		x	x	x

	Mn	Fe	Ni	Cu	Zn	Se	Br	Mo	Cd	Pb
MDL (µg m^{-3})	0.003	0.003	0.001	0.001	0.001	0.001	0.002	0.011	0.005	0.004
AAQC or Schedule 3 24-hr standard (µg m^{-3})	2.5[1]	4	2	50	120	10[1]	20	120[1]	2	2
> 25% samples < MDL at all sampling locations						x	x	x	x	
All samples < 10% of standard			x	x	x	x	x	x	x	x

[1] - AAQC

Table 9: Statistics summary for metals of interest including Si, Fe, Mn, Cd. Pb, S, Ca, Zn, Cu, and Al. Most samples contained metals at levels less than detection limits: if more than 25% of samples were less than MDL, averages were invalidated.

	Si mdl=0.02			Fe mdl=0.003			Mn mdl=0.003		Cd mdl=0.005	
location	avg	max	Exceed*	avg	max	Exceed**	avg	max	avg	max
71042	3.494	11	9	4.716	30	8	0.157	0.480	INV	0.007
71100	1.090	2.9	0	0.653	3.5	0	0.038	0.120	INV	0.003
71101	1.388	3.3	0	0.733	2.9	0	0.031	0.098	INV	0.006
71102	2.048	7.5	3	1.638	7.3	3	0.076	0.330	INV	0.005
71103	1.319	3.4	0	1.536	9.7	3	0.046	0.210	INV	0.009
71104	1.737	4.6	0	1.989	8.2	3	0.068	0.220	INV	0.003

	Pb mdl=0.004		S Mdl=0.003		Ca mdl=0.004		Zn mdl=0.001		Cu mdl=0.001		Al mdl=0.001	
location	avg	max	Avg	max	avg	max	avg	max	avg	max	avg	max
71042	0.015	0.063	1.145	3.4	3.135	9.0	0.053	0.240	0.007	0.042	0.382	1.10
71100	INV	0.017	0.765	3.1	0.910	3.3	0.015	0.053	INV	0.008	INV	0.38
71101	INV	0.012	0.881	3.2	0.745	2.2	0.026	0.110	0.003	0.007	0.161	0.37
71102	0.013	0.068	1.288	5.9	1.613	5.0	0.059	0.500	0.005	0.023	0.237	0.37
71103	INV	0.028	1.164	5.0	1.031	5.0	0.034	0.230	0.004	0.012	0.173	0.39
71104	0.018	0.130	1.347	3.6	1.035	4.0	0.101	0.430	0.010	0.033	0.213	0.54

* XRF analysis quantifies all silicon, including that silicon bound in salts. Ministry has AAQC for 3 forms of silica (silicon dioxide). These exceedances cannot be confirmed as exceedances of the Si AAQC.

** XRF analysis quantifies all iron, including that Fe bound in salts, e.g., ferric oxide. Ministry standard is for metallic iron only. These exceedances cannot be confirmed as exceedances of the Fe schedule 3 standard.

Wind direction data is available for most of the dates on which 24-hr particulate samples were collected. Wind roses were generated for dates on which exceedances occurred and are presented in Appendix 4. From this information exceedances may be attributed. This information is presented in Table 10. Several exceedances could not have an industrial source attributed and may be due to road dust. Some unattributed exceedances also contained high levels of iron, an indicator that local road dust may contain high levels of iron.

Table 10: Summary of 24-hr sampling exceedances, associated wind direction and likely source of exceedance (based on wind directions with concentrations of particulate > 50 µg m^{-3} and/or predominant wind direction).

Station	Date of 2006 exceedance	Type of exceedance			Predominant wind directions	Likely source
		PM_{10}	Fe*	Si*		
71042	26 April	X	X	X	SW NW	coal piles, unpaved areas
	29 April	X	X		SE N	ASI, ?
	26 May	X		X	E SW NW N	unpaved areas, coal piles
	04 June	X			SW NW	unpaved areas, coal piles
	16 June	X	X	X	SW	unpaved areas, coal piles
	01 July	X	X		E SE SW NW N	ASI, unpaved areas, road construction
	13 July	X	X	X	SW	coal storage, unpaved areas
	16 July		X		SW	coal storage, unpaved areas
	19 July	X		X	SE	coal & lime storage, unpaved areas
	31 July	X	X		SW	coal & lime storage, unpaved areas
	18 Aug	X		X	N	road construction
	24 Aug			X	N NE	road construction
	30 Aug	X		X	NE	road construction
	02 Sept	X	X	X	N SE	ASI, road construction
71102	29 Apr	X		X	SE	ASI
	7 Jun			X	n/a	?
	16 Jun	X			n/a	?
	1 July	X			SE NW	ASI, ?
	13 July	X			SW W NW	coal & lime storage, unpaved areas, ?
	19 July	X			SE	ASI
	06 Aug	X	X		NW	?
	30 Aug			X	SW W NW N	coal piles, unpaved areas, ?
	17 Sept	X	X		NW N	?
	8 Oct	X	X		SW NW N	?
71103	22 June	X	X		NW	?
	1 Jul	X			n/a	?
	17 Sep	X	X		NW NE	?
	8 Oct	X	X		NW NE	?
71104	13 Jun	X	X		SW	ASI
	22 June		X		NW	ASI
	20 Sept		X		NW NE	ASI

** XRF analysis quantifies all iron, including that Fe bound in salts, e.g., ferric oxide. Ministry schedule 3 Fe standard is for metallic iron only.

* XRF analysis quantifies all silicon, including that silicon bound in salts. Ministry has AAQC for 3 forms of silica (silicon dioxide). These exceedances cannot be confirmed as exceedances of the Si AAQC.

Non-continuous Sampling - Dustfall

Dustfall sampling was initiated in May 2006 and was terminated at the end of October 2006. Monthly dustfall results are presented in Figure 12 and statistics are presented in Table 11. Samples which exceeded the monthly dustfall schedule 3 standard and which were identified during optical microscopy as having algae present are identified on Figure 12 with turquoise diamonds. Algae contribute to the loading in the dustfall jars and are included in the dustfall value, however, during optical microscopy algae is not quantified so its contribution to the loading cannot be evaluated. For this reason, exceedance samples which contained algae are not included in the final exceedance count (Table 11).

Table 11: Summary of dustfall statistics May through October 2006.

Statistics	Average ($g\ m^{-2}\ 30days^{-1}$)	Maximum ($g\ m^{-2}\ 30days^{-1}$)	Exceedances	Exceedances with Algae present	Exceedances minus Exceedances with algae
71042 Bonney St.	16.4	29.2	6	3	3
71100 WESTP	4.1	8	1	1	0
71101 Second Line West Pump House	6.0	13.4	3	3	0
71102 Peter Manzo Pool	7.7	9.8	5	1	4
71103 Mike Zuke Park	5.7	12.7	2	1	1
71104 Cathcart	8.3	20.7	3	3	0

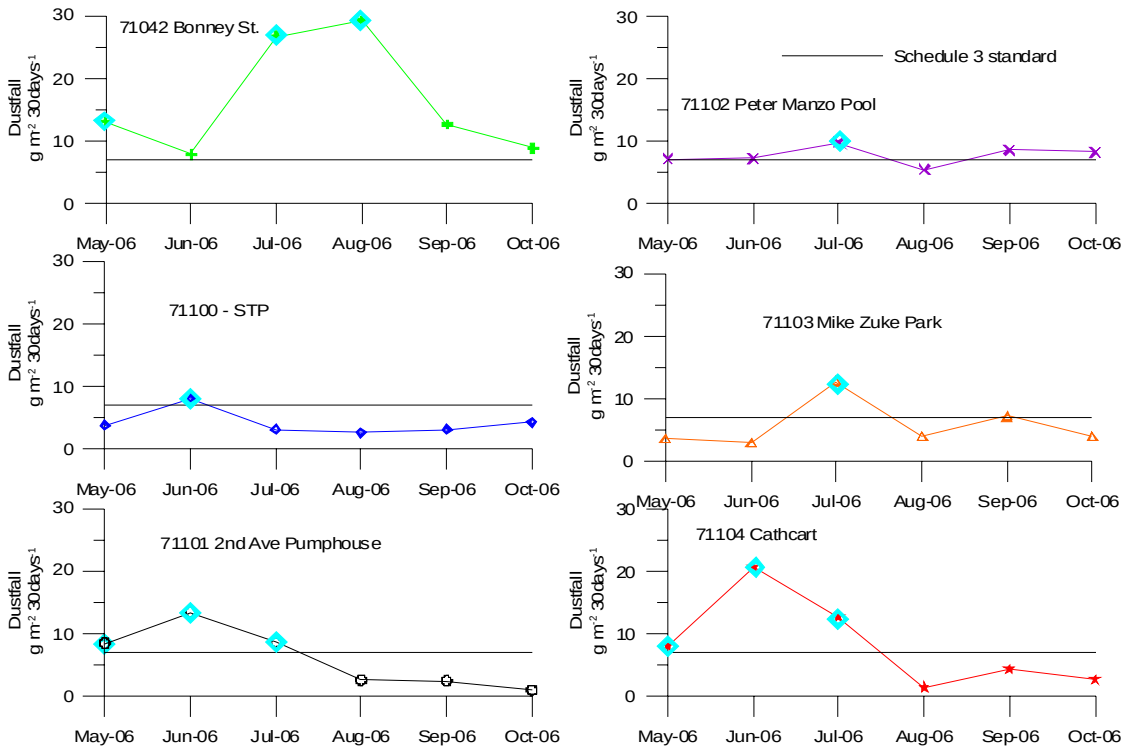


Figure 12: Summary of dustfall results May through October 2006 at the 6 sampling sites. The turquoise diamonds highlight samples in which algae was identified

Stations within the Bayview area were the only locations in which exceedances of the schedule 3 standard occurred. Optical characterisation was performed on all samples and provided insight into the sources of the particulate captured in the jars. Figure 13 presents the results of the optical characterisation: only non-trace level particle types are included. Within many of the samples, biological material and silicates contributed significantly to the dustfall. Biological material is primarily insect parts while silicates are primarily road dust from local streets or nearby unpaved areas. Table 12 lists the non-algae containing samples, the major particle types and the likely source.

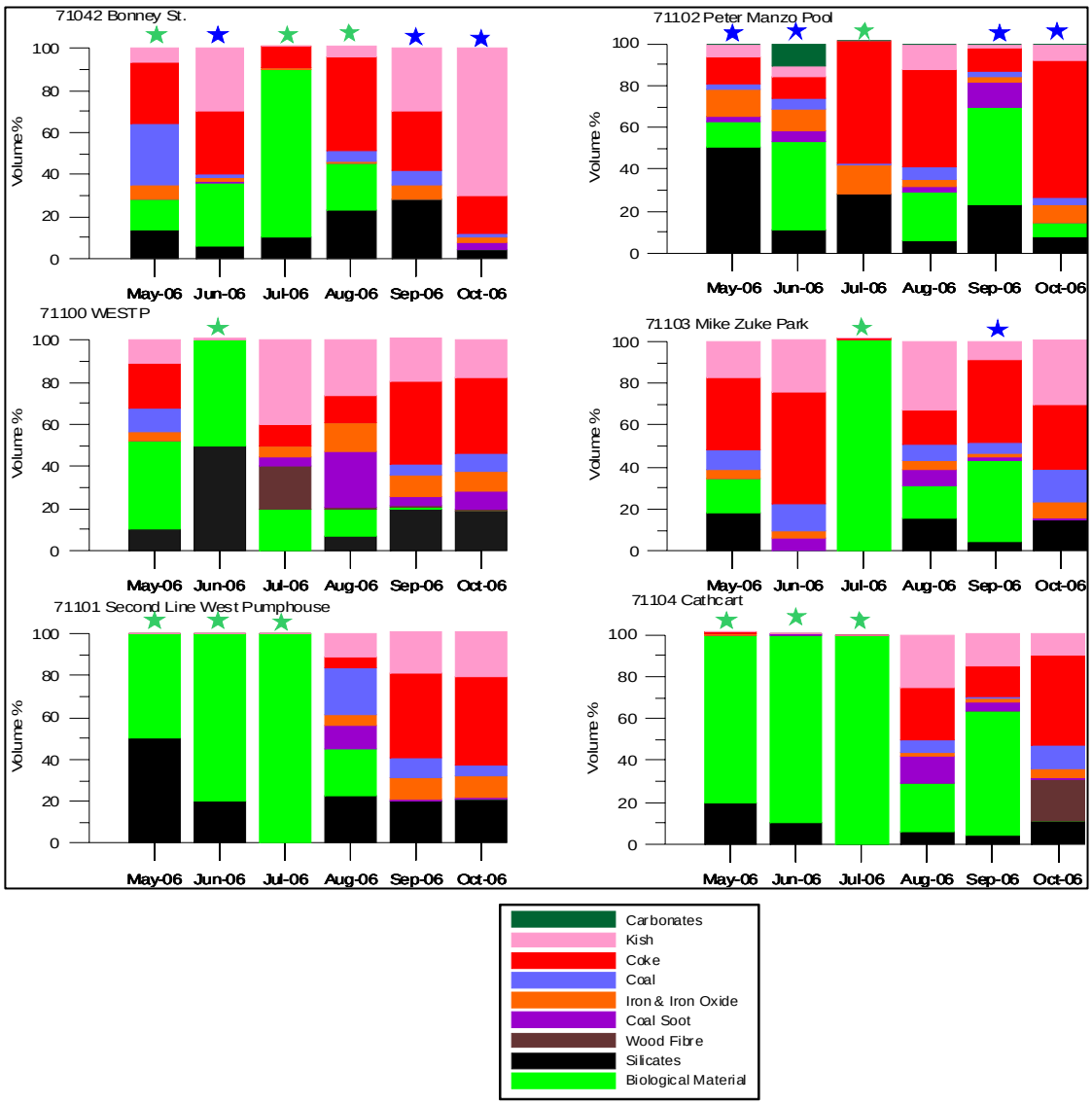


Figure 13: Optical characterisation results of dustfall samples collected at the 6 sampling locations. Blue stars identify exceedance samples. Green stars identify exceedance samples which contained algae.

Table 12: Summary of dustfall exceedance samples which did not contain algae and likely particle sources. Major particles must sum to more than 50% of identified particles. Information extracted from Fig. 13.

Station	Month	Major particles	Likely source
71042	June	coke, kish	ASI
	Sept	kish, coke, coal, iron & iron oxide	ASI
	Oct	kish, coke	ASI
71102	May	silicates, biological debris	Local environment, unpaved areas
	June	biological debris, silicates, carbonates	Local environment, unpaved areas, dust suppression
	Sept	biological debris, silicates	Local environment, unpaved areas
	Oct	coke, kish	ASI
71103	Sept	coke, kish, coal	ASI

All of the exceedances measured at 71042 Bonney St. can be attributed to activities at ASI. Conversely, most of the exceedances measured at 71102 Peter Manzo Pool can be attributed to the local environment and unpaved areas, with a single exceedance attributable to ASI. The single exceedance at 71103 can be attributed to activities at ASI.

A general conclusion from the dustfall optical characterisation is that particulate released from ASI is ubiquitous within the sampling area: 78% of the samples collected contained particulate originating from ASI, that is, coke, coal, kish, iron and iron oxide and/or coal soot.

Evidence of other industrial activities was also identified within the samples. The source of wood fibres in the July sample collected at 71100 WESTP was likely Flakeboard (Figure 13). Two additional samples collected at 71100 WESTP contained trace amounts of wood fibre, these trace amounts are not shown in Fig. 13. The source of wood fibres collected in the October sample at 71104 Cathcart was likely St. Marys Paper. Carbonates identified in the June sample collected at 71102 Peter Manzo Pool were the result of the spreading of calcium carbonate for dust control on the parking lots at Algoma Tubes Inc.

Non-continuous Sampling - PAH

Fig 14 presents the Benzo-a-pyrene results BaP obtained between 11 May 2006 and 08 Sept 2006 at 71042 Bonney St. Table 13 presents a summary of statistics for the various PAHs that were quantified. Benzo-a-pyrene is the only PAH for which the ministry has an AAQC (1.1 ng m^{-3}). Only 1 exceedance of the 24-hr BaP AAQC was measured during the sampling period.

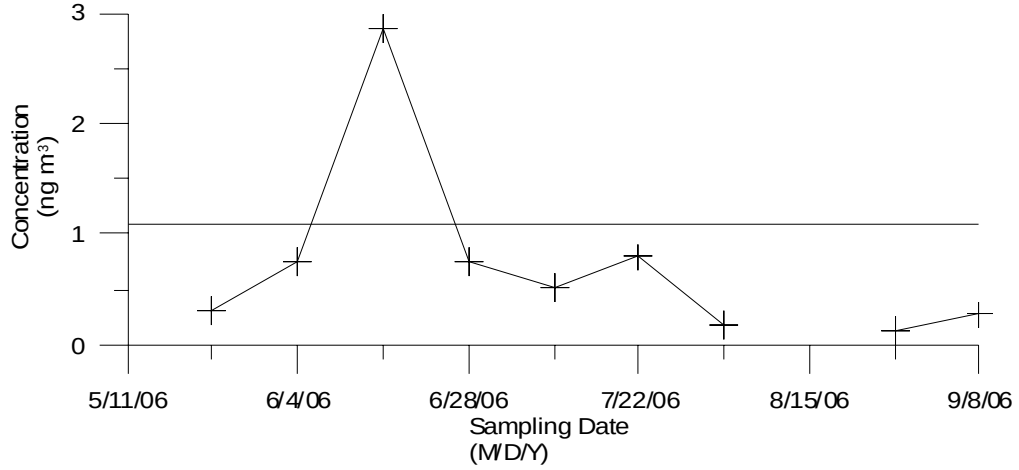


Figure 13: Benzo-a-pyrene sampling results for 71042 Bonney St. 11 May 2006 to 08 Sept 2006

Table 13: Summary of statistics for all PAHs in samples collected between 11 May 2006 and 08 Sept 2006. Sampling conducted on 12-day NAPS schedule using hi-vol sampling methods. Units of concentration are ng m^{-3}. All sample concentrations were above detection limits.

PAH	AAQC	# of samples	% valid data	Minimum	Average	Maximum	# above AAQC
Benzo(a)anthracene		9	82	0.11	0.76	3.26	
Chrysene		9	82	0.19	1.14	4.66	
Benzo(b)fluoranthene		9	82	0.24	1.56	7.03	
Benzo(k)fluoranthene		9	82	0.09	0.67	2.91	
Benzo(a)pyrene (corrected)	1.1	9	82	0.12	0.73	2.86	1
Indeno(1,2.3-c,d)pyrene		9	82	0.14	0.89	3.94	
Dibenzo(a,h)anthracene		9	82	0.04	0.23	1.03	
Benzo(g,h,i)perylene		9	82	0.16	0.86	3.42	

Conclusions

Particulate monitoring and sampling was conducted May through October 2006 at six locations in the vicinity of Algoma Steel Inc. in Sault Ste. Marie. Continuous particulate monitoring provided 0.5-hr and 24-hr TSP averages which could be compared to ministry schedule 1 and schedule 3 visibility based suspended particulate standards. This data was analysed by wind direction and for diurnal trends. The continuous data was complemented by 24-hr PM_{10} particulate samples collected on filters and dustfall sampling at all locations, and PAH sampling at one location.

ASI is a schedule 4 company and as such, schedule 1 standards apply until 01 February 2010 at which time schedule 3 standards will be phased in.

The continuous particulate monitoring illustrated that TSP concentrations quickly decline as one moves away from the ASI property line. The majority of exceedances of the schedule 1 0.5-hr suspended particulate standard and the highest TSP concentrations were measured at the 71042 Bonney St. location which is on the fence-line of ASI. The 71042 Bonney St. data also showed that storage piles and unpaved areas associated with ASI are the most significant contributor to TSP concentrations at this location.

There were over 1000 exceedances measured of the schedule 1 0.5-hr standard at 71042 Bonney St. The other two sites within the Bayview area (71102 Peter Manzo Pool and 71103 Mike Zuke Park) had approximately 6 to 8 times fewer 0.5-hr suspended particulate exceedances: the number of exceedances at these locations was comparable to those measured at locations outside the Bayview area (i.e., 71100 WESTP, 71101 Second Line West Pump House, 71104 Cathcart).

Through averages calculated from the continuous data, 71042 Bonney St. also recorded the highest number of exceedances of the schedule 3 24-hr suspended particulate standard with 33. The only other location at which the 24-hr standard was exceeded was 71101 Second Line West Pump House. 24-hr TSP averages were highest at Bonney St.: averages at the other Bayview monitoring stations were comparable to those outside Bayview.

Wind direction analysis of the continuous data showed that ASI had an impact on all the sampling locations. Other industrial activities and unpaved areas also impacted the monitoring results. Flakeboard impacted monitoring at 71100 WESTP and St. Marys Paper impacted monitoring at 71104 Cathcart.

Time averaging of the data showed TSP concentrations peaked around 08:00 at most monitoring locations as a result of a combination of rush hour traffic, start-up of industrial activities and increased atmospheric turbulence at dawn. Concentration minimums occurred pre-dawn between 00:00 and 04:00 and again around 17:00.

Discrete 24-hr PM_{10} particulate filter samples were collected on a 3-day sampling schedule. Samples were analyzed gravimetrically to determine PM_{10} concentrations and analyzed by XRF to determine metals concentrations. 71042 Bonney St. had the highest numbers of exceedances of the ministry's interim PM_{10} standard, with 12 exceedances. Exceedances were also measured at the other Bayview monitoring locations with 8 at 71102 Peter Manzo Pool and 4 at 71103 Mike Zuke Park. One exceedance was measured at 71104 Cathcart. No exceedances were measured at 71100 WESTP or 71101 Second Line West Pump House.

Average PM_{10} concentrations within the discrete 24-hr filter samples were the highest at 71042 Bonney St. and lowest at the more distant sampling locations of 71100 WESTP and 71101 Second Line West Pump House.

With respect to the XRF elemental analysis on the 24-hr filter samples, samples at 71042 Bonney St., 71102 Peter Manzo Pool, 71103 Mike Zuke Park and 71104 Cathcart all contained iron levels above the ministry's schedule 3 metallic iron standard. However, XRF determines the total iron in a sample; as a result, these may not be actual exceedances of the standard. They are indicators of the impact of ASI activities at the various monitoring locations closest to the facility.

Silicon levels were also above the 3 ministry schedule 3 silica (silicon dioxide) standards at 71042 Bonney St. and 71102 Peter Manzo Pool. XRF analysis determines the total silicon in the samples and does not differentiate between different salts of silicon. These high values are indicators of the high levels of road and unpaved parking lot debris in the vicinity of these sites.

Wind direction analysis on the sampling dates of the 24-hr filter samples when exceedances occurred showed that a number of the exceedances at 71042 Bonney St. and 71102 Peter Manzo Pool can be attributed to ASI. All of the exceedances at 71104 Cathcart can be attributed to ASI.

Eight dustfall exceedances occurred. Through optical characterisation of the dustfall samples, 5 of the exceedances could be attributed to ASI: greater than 50% of particulate from ASI. These included all 3 exceedances at 71042 Bonney St., one of the four exceedances at 71102 Peter Manzo Pool and the only exceedance at 71103 Mike Zuke Park. Significant particulate within the remaining 3 exceedances at 71102 Peter Manzo Pool were silicates (dust from roads and other unpaved surfaces) and biological debris (primarily insect parts). The use of dust suppression material at Algoma Tubes Inc. was also noted in one of the samples collected at 71102 Peter Manzo Pool.

Optical characterisation of all the dustfall samples highlighted the influence of ASI on particulate levels at all the sampling locations. At least 50% of samples collected at each location contained particulate released from ASI and 78% of all samples collectively contained particulate that were released from ASI (coke, coal, iron & iron oxide, coal soot, and/or kish).

Particulate from other industries were also observed within the samples although they did not contribute to exceedances. Wood fibres, likely from Flakeboard, comprised 20% of one sample collected at 71100 WESTP. Wood fibres likely from St. Marys paper comprised 20% of one sample collected at 71104 Cathcart.

PAH sampling was conducted only at the 71042 Bonney St. sampling location. 9 samples were collected on a 12-day schedule. One exceedance of the benzo-a-pyrene 24-hr AAQC was noted. The data has not been compared to the soil and vegetation sampling conducted by EMRB.

In summary, the data demonstrate that ASI and its associated material storage areas and unpaved surfaces are the primary contributors to high particulate levels in the area immediately surrounding the facility. The data also illustrate that emissions from ASI impact a significant area with particulate emissions identified in samples collected almost 3 km from the facility. Exceedances of several particulate based ministry schedule 3 limits were noted at all locations near ASI. Elemental analysis on 24-hr filter samples and optical characterisation of dustfall samples identified particulate released from ASI within samples which exceeded ministry limits.

Appendix 1: Satellite images and photos of monitoring locations.

Figure A1: Overview of Bayview neighbourhood showing location of 3 monitoring locations.

Figure A2: 71042 – Bonney St. station

Figure A3: 71103 – Mike Zuke Memorial Park

Figure A4: Overview of neighbourhood north of Algoma Steel Inc. showing location of Second Line West Pump House station

Figure A5: 71101 – Second Line West Pump House

Figure A6: Overview of neighbourhood to east of Algoma Steel Inc. showing location of Cathcart monitoring site

Figure A7: 71104 – Cathcart monitoring station with off-grid solar system

Figure A8: Overview of area to west of Algoma Steel Inc. showing location of West End Sewage Treatment Plant site.

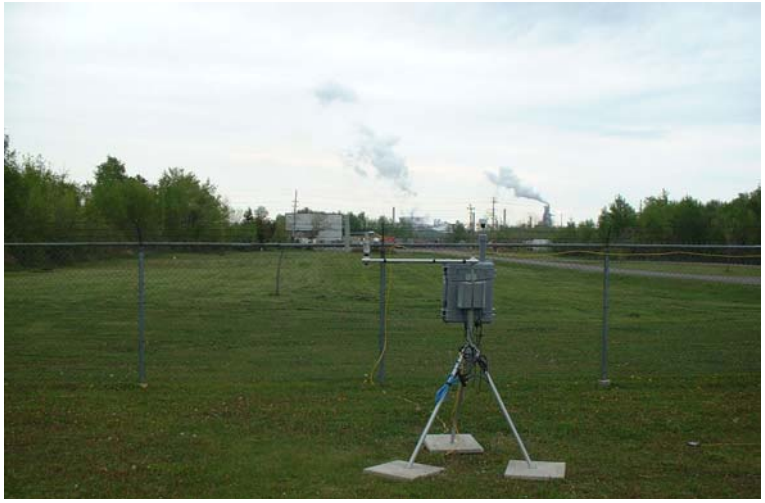
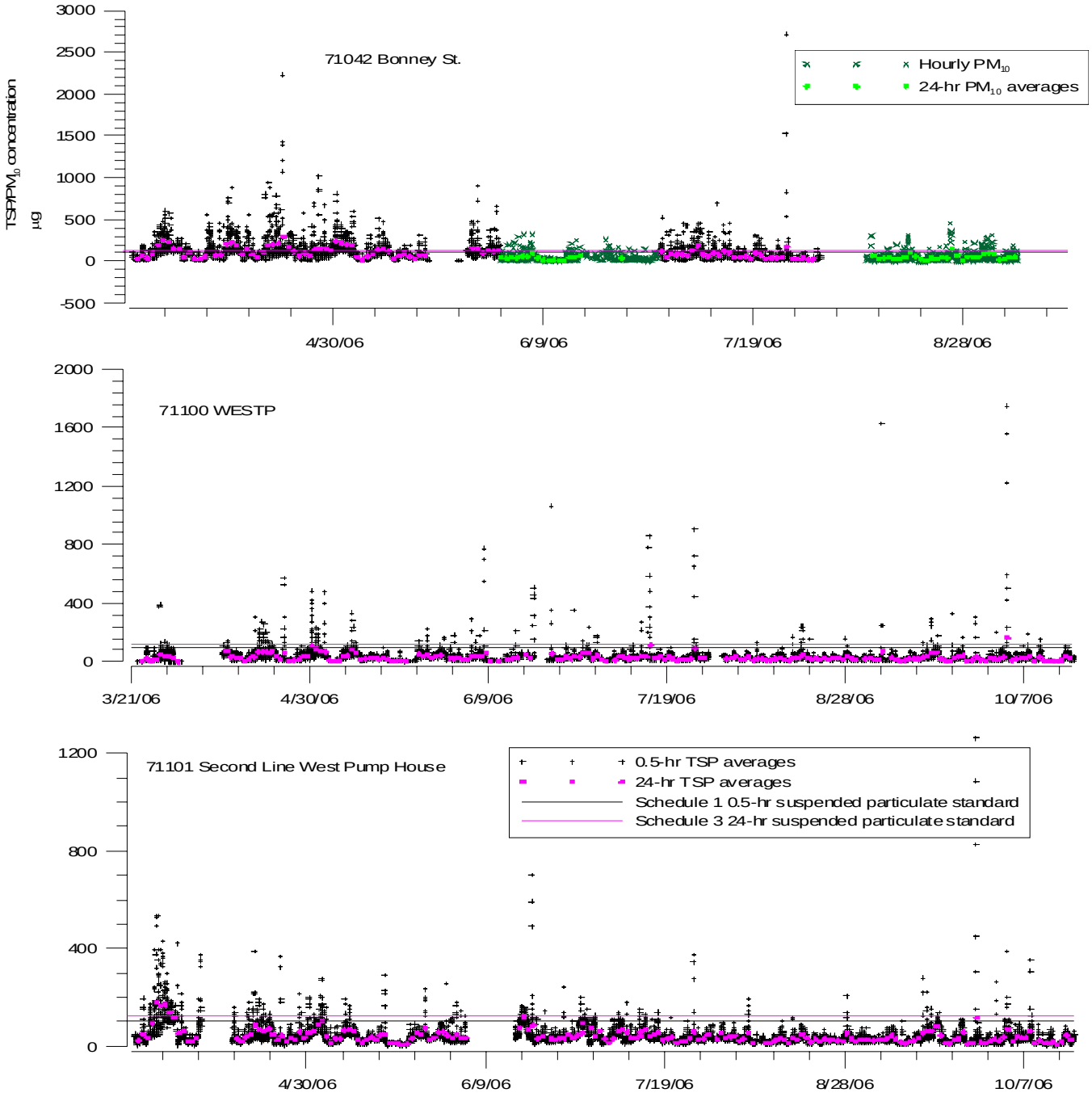
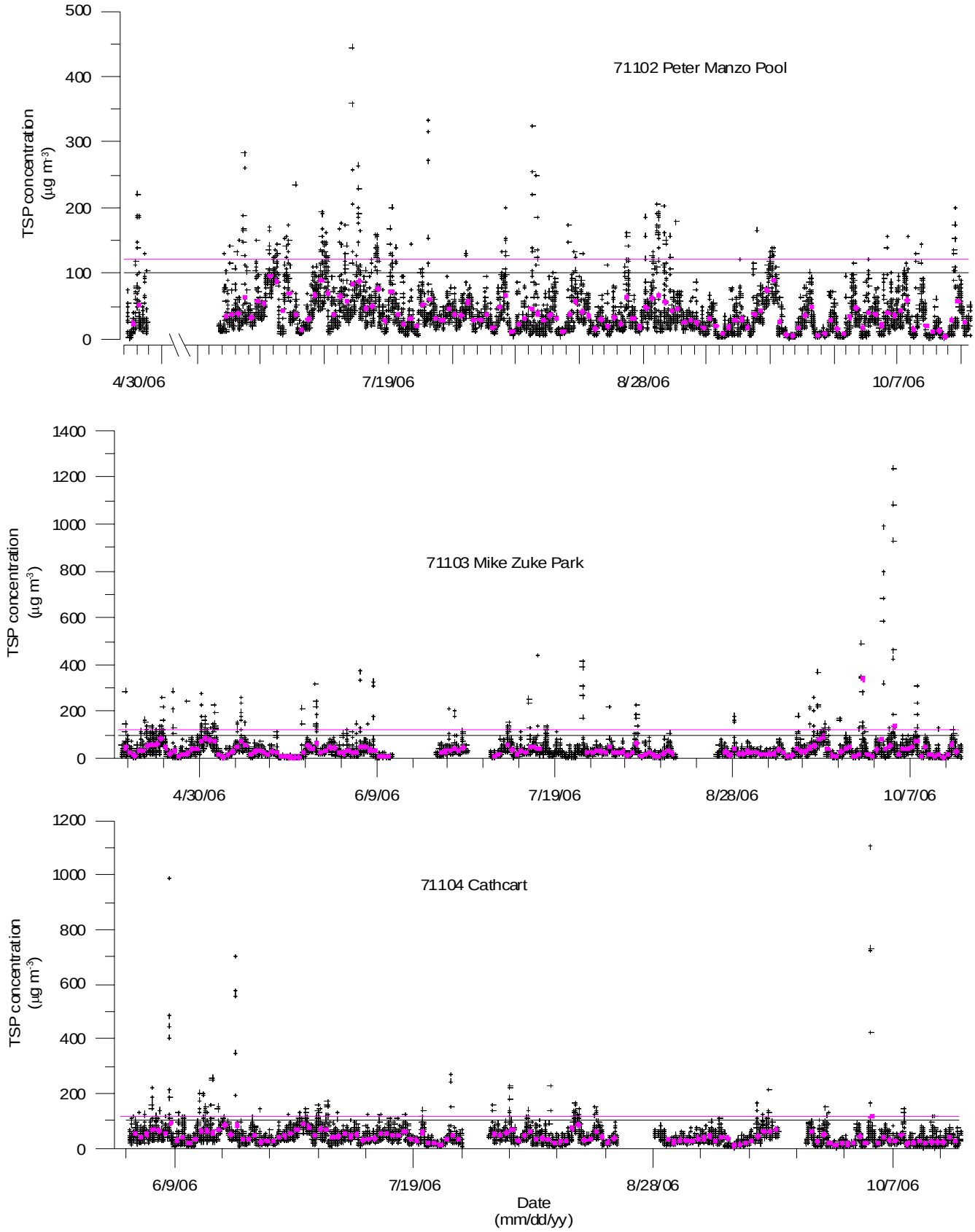


Figure A9: 71100 – West End Sewage Treatment Plant

Appendix 2: Time series of 15-min and 24-hr average data collected from continuous particulate monitors

note different ranges of vertical axis on graphs

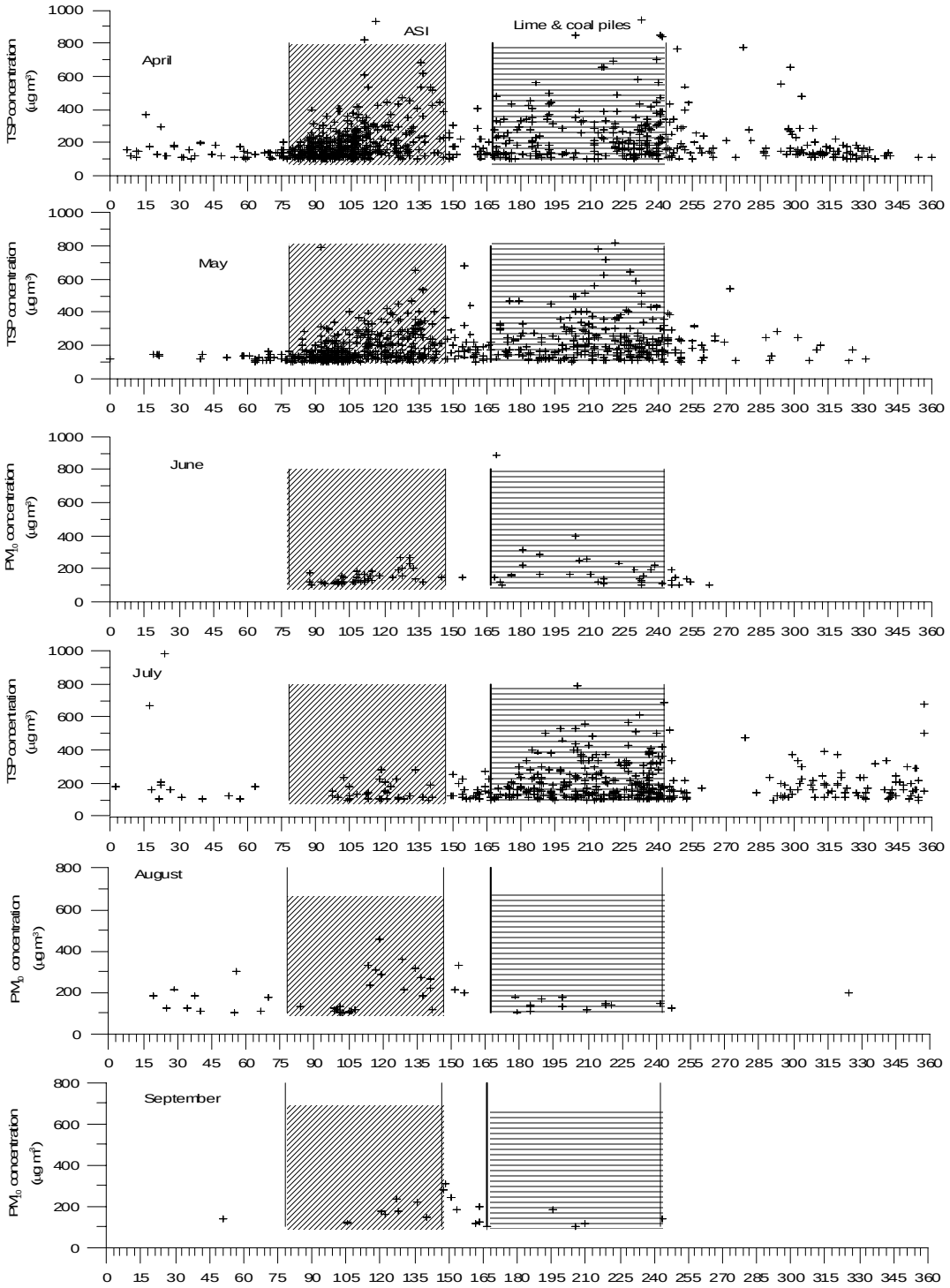


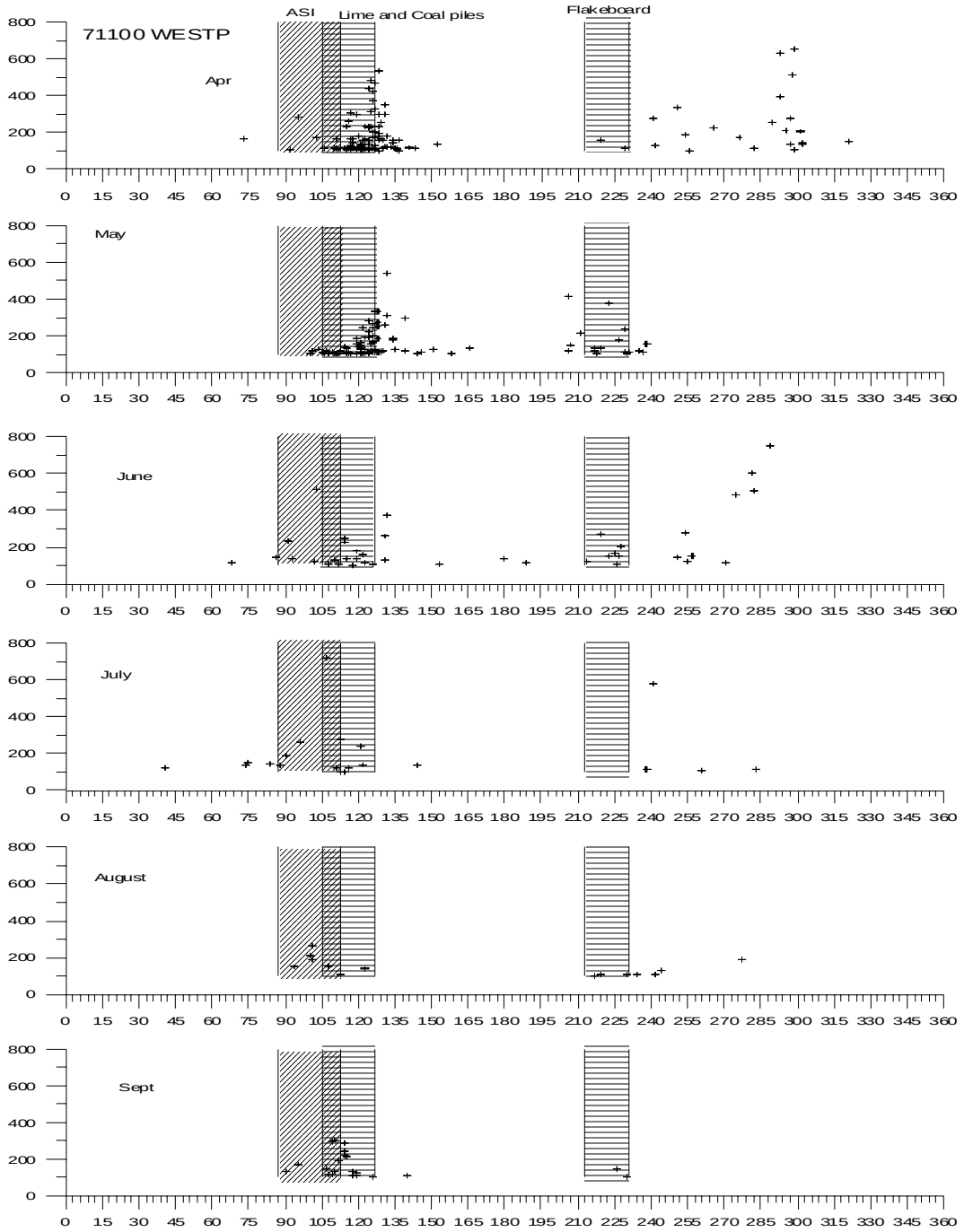

71102 Peter Manzo Pool
TSP concentration (µg m-3)
500
400
300
200
100
0
4/30/06
7/19/06
8/28/06
10/7/06
71103 Mike Zuke Park
TSP concentration (µg m-3)
1400
1200
1000
800
600
400
200
0
4/30/06
6/9/06
7/19/06
8/28/06
10/7/06
71104 Cathcart
TSP concentration (µg m-3)
1200
1000
800
600
400
200
0
6/9/06
7/19/06
8/28/06
10/7/06
Date (mm/dd/yy)

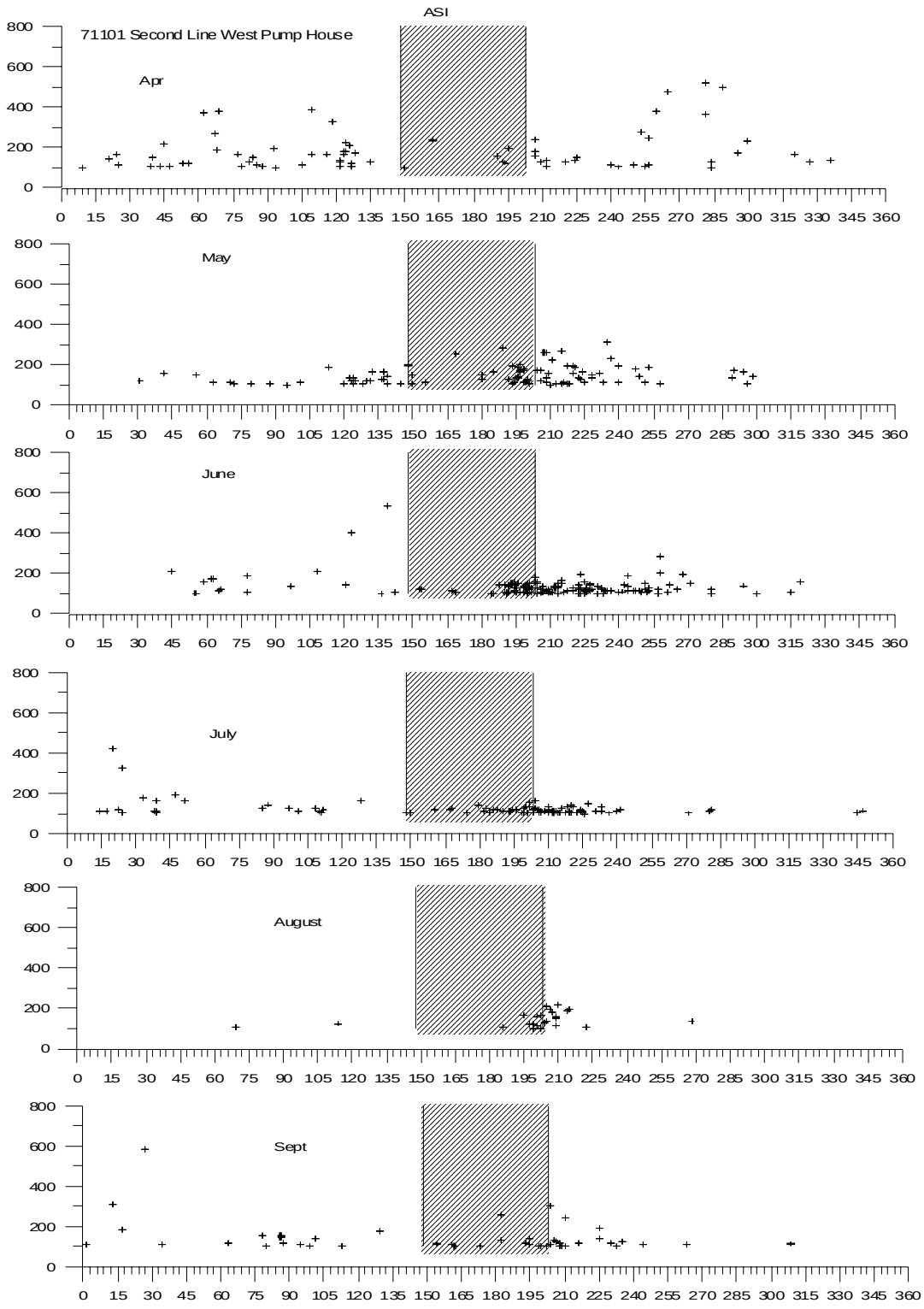
Appendix 3: Continuous particulate data (15-min) correlated by wind direction by month

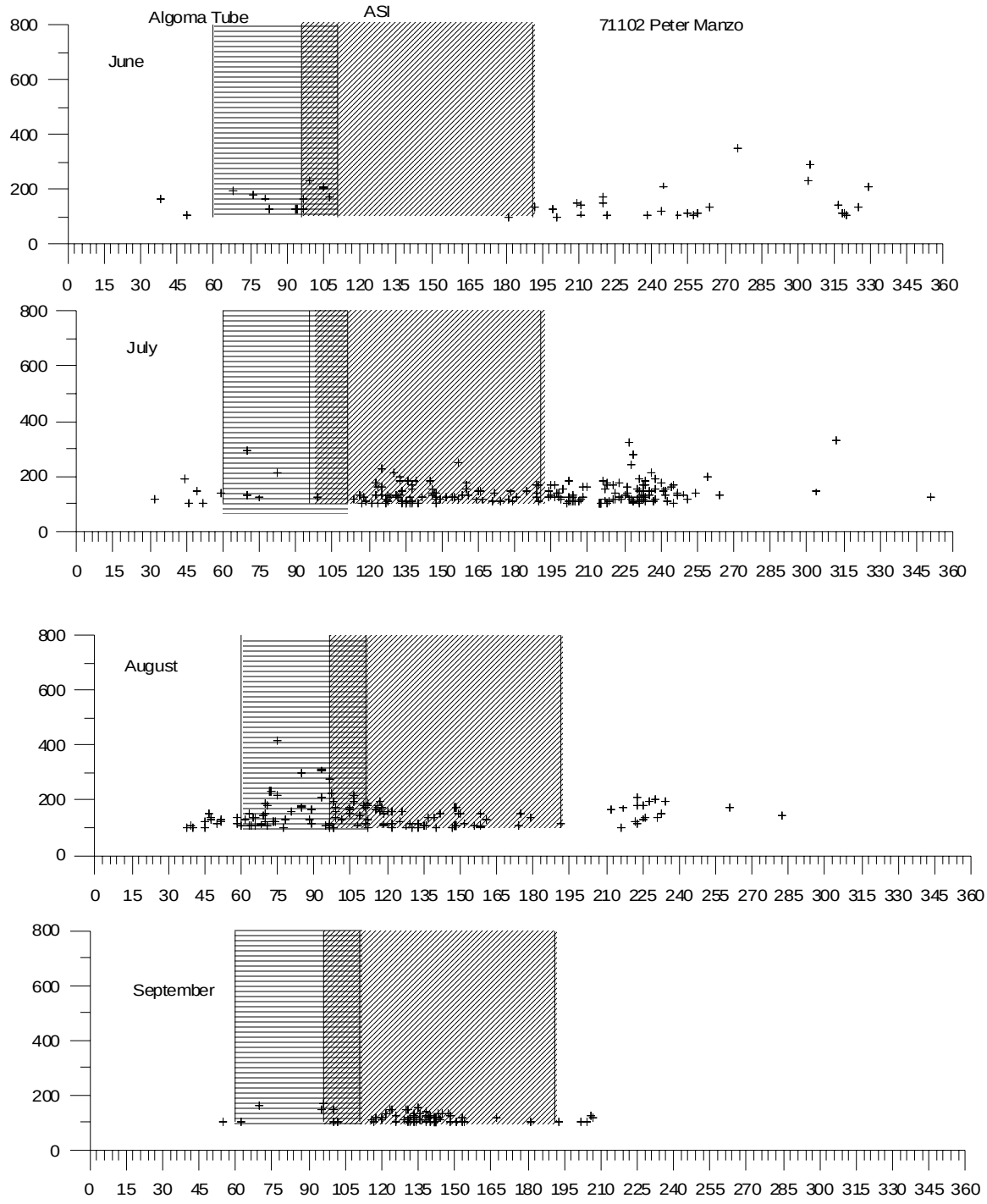
71042

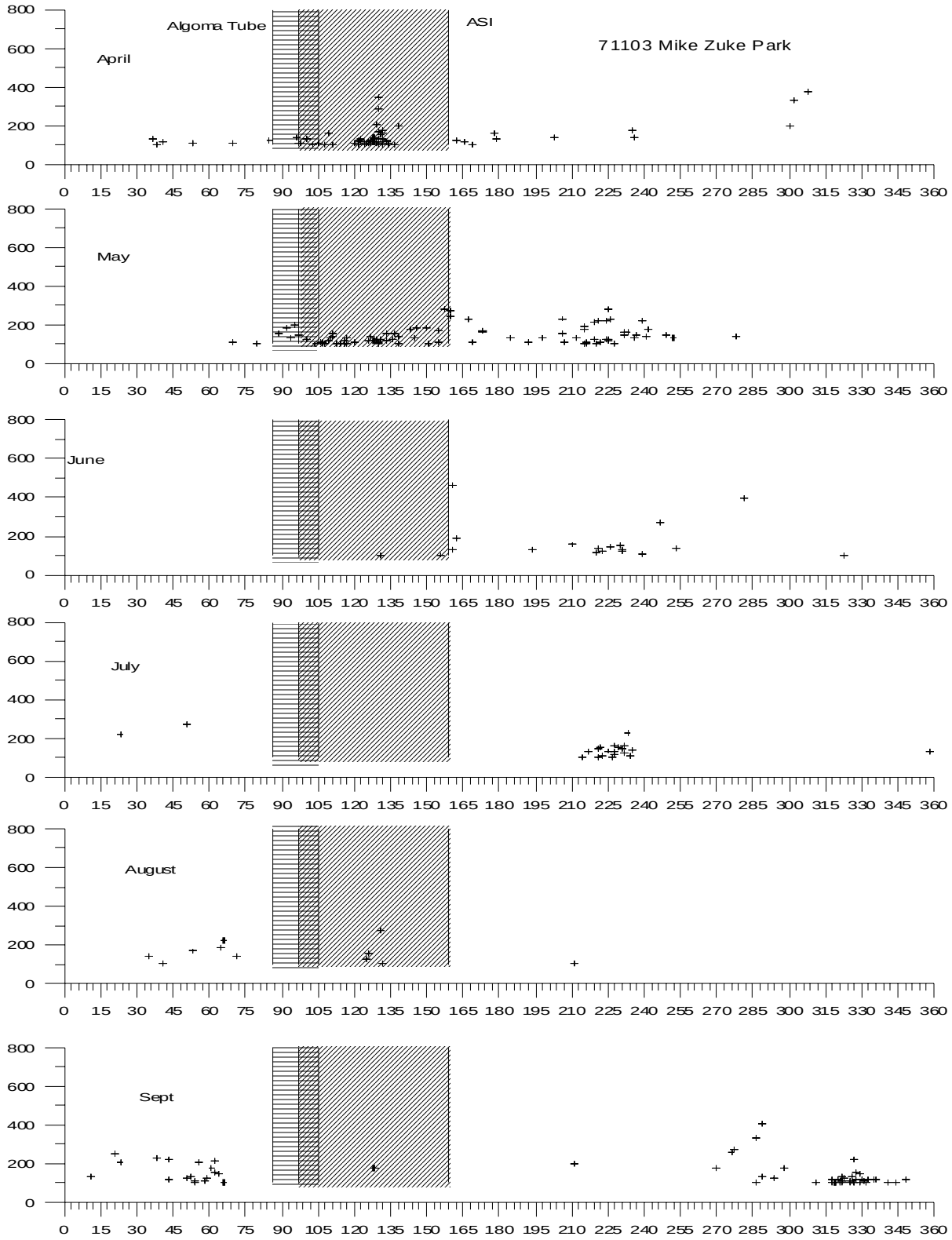
Note: June, August & September data are hourly PM_{10} BAM values

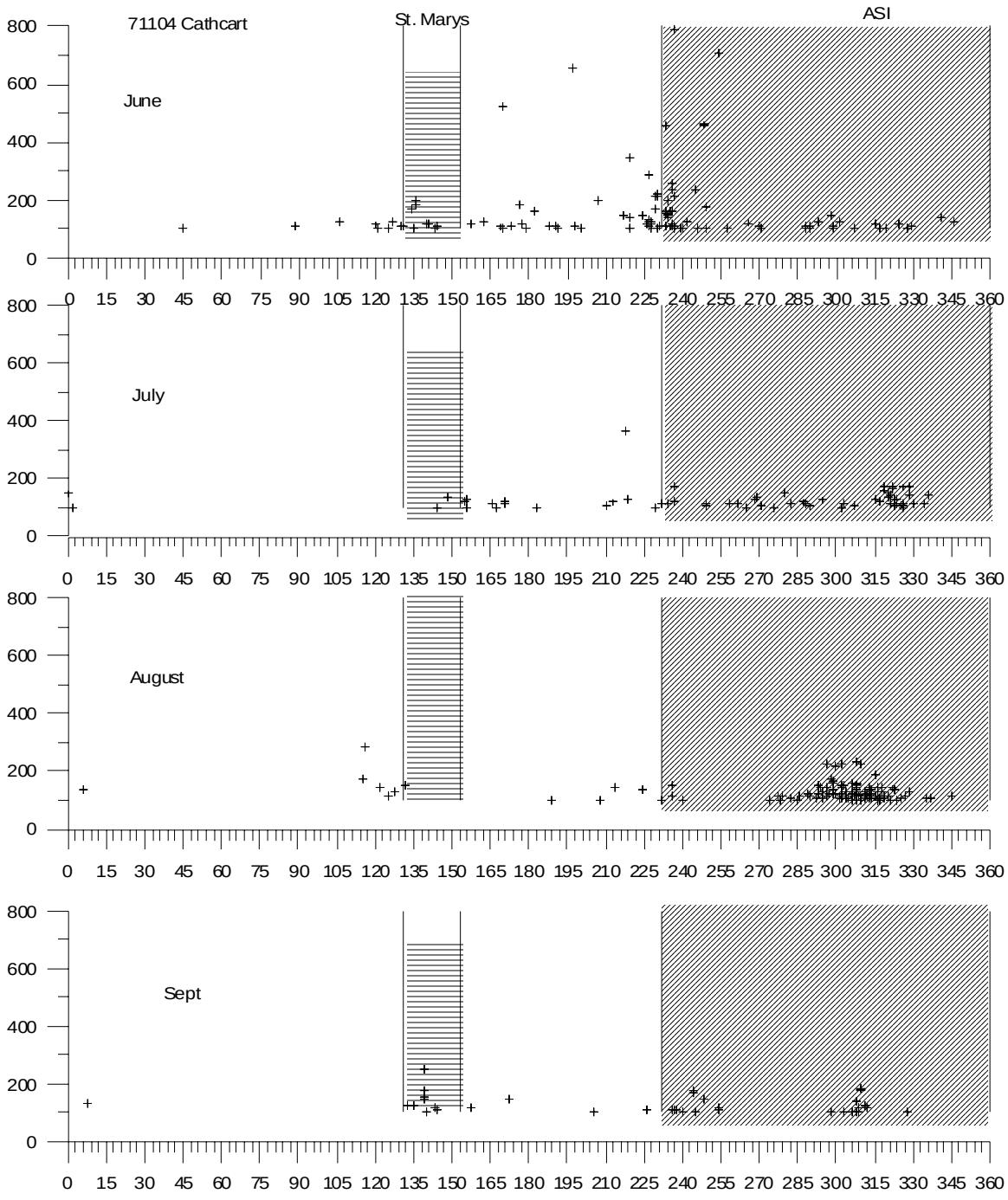



71100 WESTP
ASI
Lime and Coal piles
Flakeboard
Apr
May
June
July
August
Sept
0
200
400
600
800
0 15 30 45 60 75 90 105 120 135 150 165 180 195 210 225 240 255 270 285 300 315 330 345 360


ASI
71101 Second Line West Pump House
Apr
May
June
July
August
Sept
0
200
400
600
800
0 15 30 45 60 75 90 105 120 135 150 165 180 195 210 225 240 255 270 285 300 315 330 345 360


Algoma Tube
ASI
71102 Peter Manzo
June
July
August
September
800
600
400
200
0
0 15 30 45 60 75 90 105 120 135 150 165 180 195 210 225 240 255 270 285 300 315 330 345 360

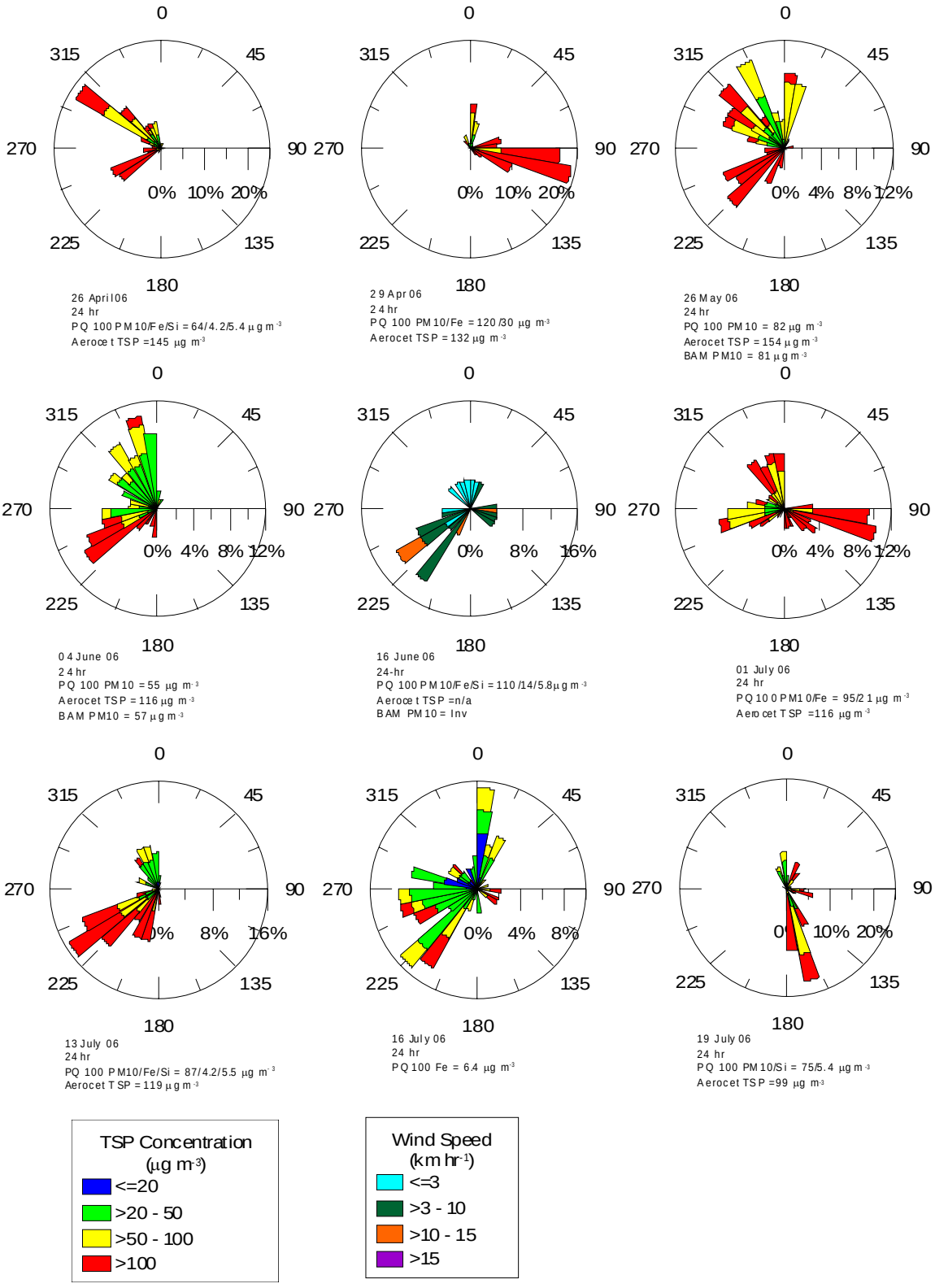

Algoma Tube
ASI
71103 Mike Zuke Park
April
May
June
July
August
Sept
800
600
400
200
0
0 15 30 45 60 75 90 105 120 135 150 165 180 195 210 225 240 255 270 285 300 315 330 345 360


71104 Cathcart
St. Marys
ASI
June
July
August
Sept
0
200
400
600
800
0 15 30 45 60 75 90 105 120 135 150 165 180 195 210 225 240 255 270 285 300 315 330 345 360

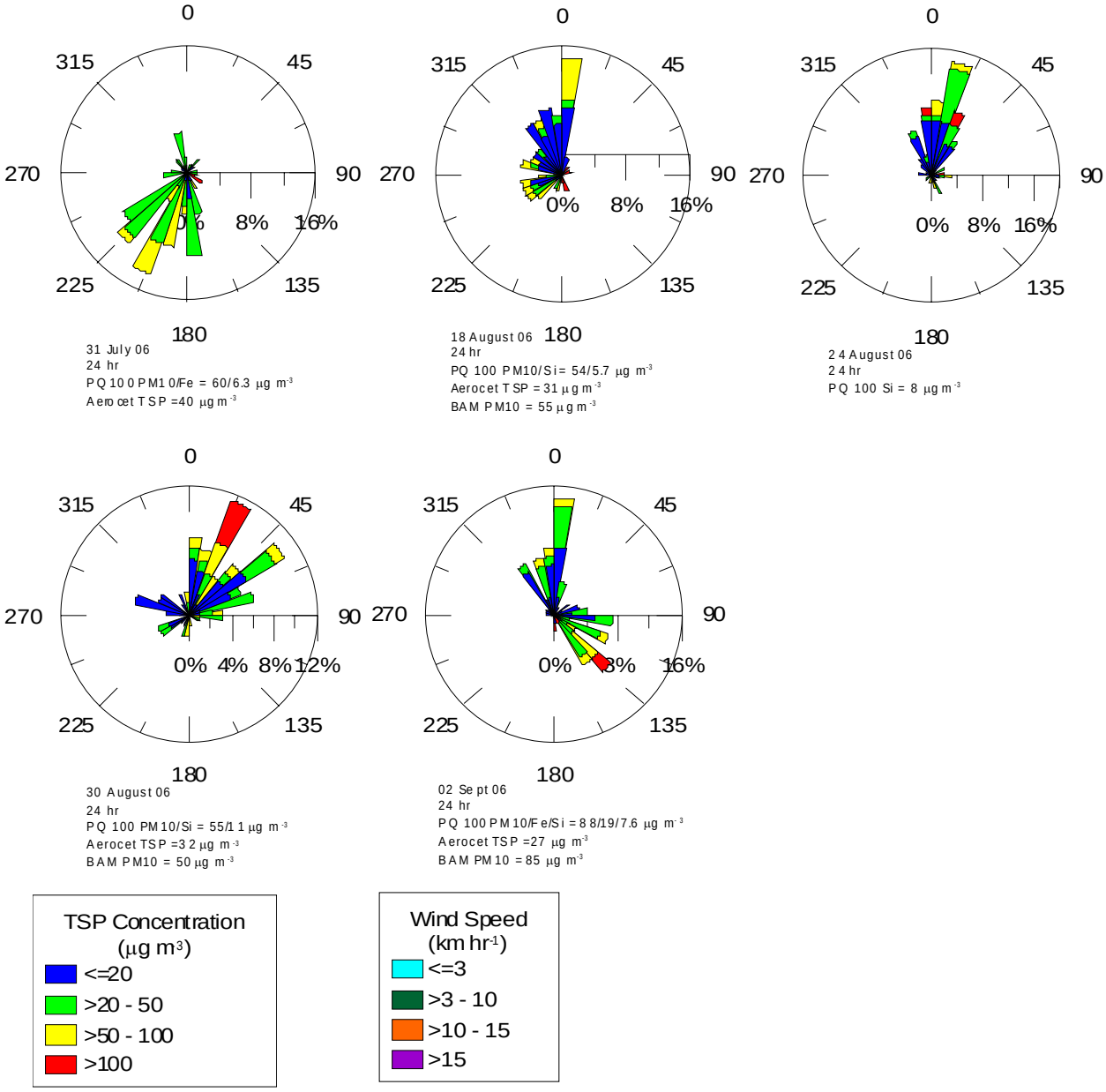
Appendix 4

Particulate/Wind Roses for dates on which there were PQ 100 PM_{10}, iron and/or Silica exceedances.

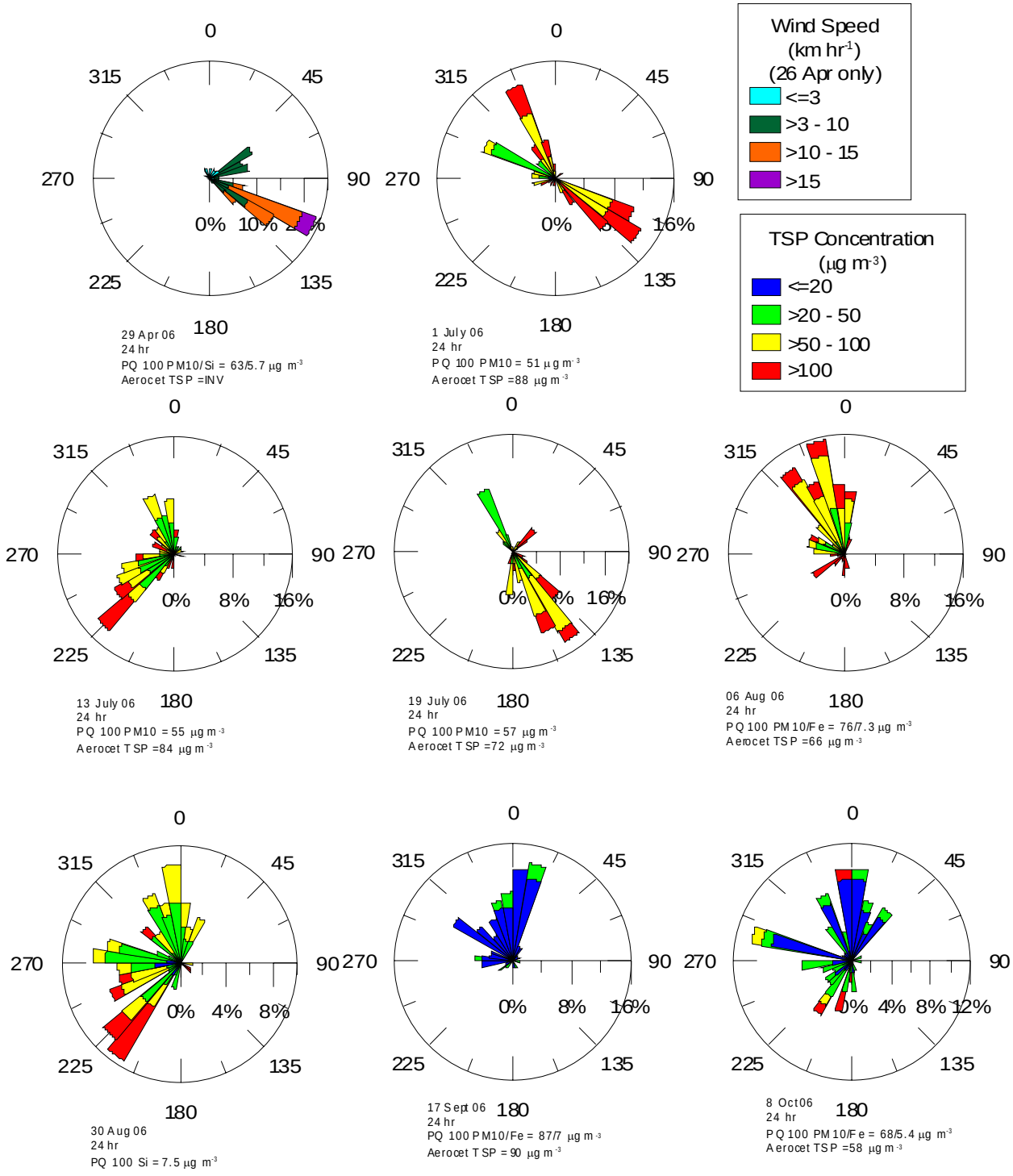
71042 Bonney St.: All roses are particulate roses, except 16 June, which is a wind rose.



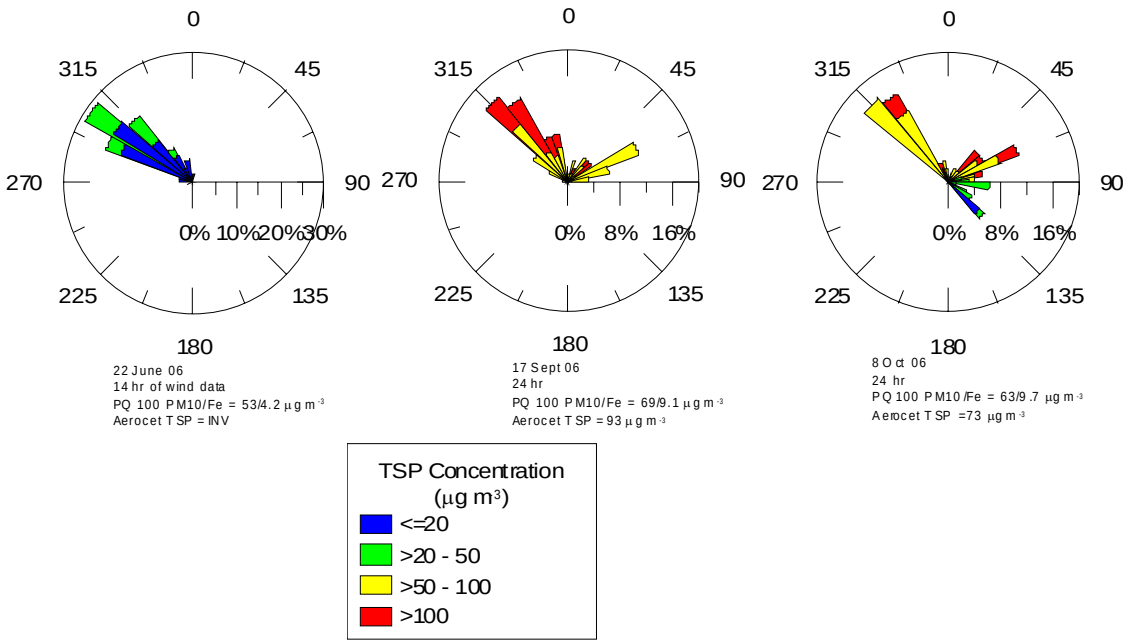
71042 Bonney St. continued:



71102 Peter Manzo Pool: All roses are particulate roses, except 29 April, which is a wind rose. Continuous particulate/wind data is not available for 07 June, 16 June or 30 August.



71103 Mike Zuke Park. Continuous particulate/wind data not available for 01 July.



71104 Cathcart: