Peace River Project Water Use Plan

Title: Williston Dust Control Monitoring

Reference GMSMON-18

Implementation Year 5

BC Hydro Williston Reservoir Air Monitoring 2012 Annual Report

Study Period: January 1, 2012– December 31, 2012.

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Table of Contents

BC Hydro Williston Reservoir Tillage Experiments and Regional Air Monitoring 2012 Annual Report

Executive Summary

The entrainment and transport of sand and fine grained particulates (dust) can be a major environmental issue at the Williston Reservoir, which is located in northern British Columbia. In order to assess the success of the mitigation measures designed to decrease dust emissions from beaches on the Williston Reservoir, and to provide on-going monitoring to quantify the 24-hour and annual average levels of particulate matter (PM_{10} and $PM_{2.5}$) in the atmosphere in relation to provincial and federal air quality standards, a long term regional air quality monitoring program surrounding the reservoir was implemented over the fall of 2011 and spring of 2012.

The monitoring network has two major components:

- hourly measurement of PM_{10} and $PM_{2.5}$ and associated meteorology each day, seven days a week, for the entire year in both Tsay Keh and Ft. Ware.
- measurement of 24 hour average PM_{10} and $PM_{2.5}$ concentrations and associated meteorology at key locations around the shoreline of the reservoir in the Finlay Reach area to characterize regional particulate matter levels for the entire snow free season.

The same instrumentation is used to monitor ambient levels of PM_{10}, $PM_{2.5}$, and environmental conditions (i.e., temperature, relative humidity, atmospheric pressure, wind speed, wind direction, precipitation) at Tsay Keh and Ft. Ware. At both sites the PM instrument and datalogging hardware are housed in a climate-controlled, custom-built steel building, with mains power and connectivity to the internet (Fig. 3.1)

PM_{10} and $PM_{2.5}$ were measured continuously at both Tsay Keh and Ft. Ware using Thermo Scientific Ambient Particulate Monitors (TEOM 1405D), which are US EPA, Federal Equivalent designated monitors and have been deployed in monitoring networks worldwide to measure particulate matter mass concentrations.

Monitoring of regional air quality (PM_{10} and $PM_{2.5}$) during the 2012 dust season was carried out around the Williston Reservoir at nine locations (Lafferty, Davis South, Chowika, Van Somer, Tsay Keh, Rat Lake, Ingenica, Stromquist and Pete Toy) using BGI Ltd, Model PQ200 samplers, which are a U.S. EPA Federal Reference Instruments that are widely used internationally and have proven to be very reliable, and robust (Figs. 3.1 and 3.2). An important consideration in the selection of this instrument was the fact that these samplers run on 12v unlike the

previously used Partisols samplers that required 120 V, making them logistically difficult to maintain.

Wind flow at the Williston Reservoir was very consistent and dominated by northerly and southerly winds throughout most of the year and largely results from topographic steering of the dominant westerly flows that are re-directed along the valley of the Peace River and the Rocky Mountain Trench. At Tsay Keh, the strongest and most consistent winds during 2012 were in February and were characterized by a strong southerly component. Relatively strong southerly winds also dominated from March through June. Wind flow at Fort Ware shows a similar pattern with northerly and southerly flows dominating, although NNW and SSE winds are more common in Fort Ware than in Tsay Keh and most likely reflects the localized topographic steering in this area. Winds at Fort Ware also tend to be somewhat more varied than at Tsay Keh and are distributed around the dominant NNW-SSE flow directions in most months.

TEOM measurements indicated that both PM_{10} and $PM_{2.5}$ concentrations were low during 2012 with $PM_{2.5}$ values ranging from near zero to a maximum of 25.5 and 36.4 µg m^{-3} at Tsay Keh and Fort Ware, respectively. As expected, PM_{10} values were higher, ranging from near zero to 37.9 µg m^{-3} at Tsay Keh because of its proximity to the reservoir. PM_{10} concentrations at Fort Ware were similar in magnitude and ranged from 0.1 to 91.8 µg m^{-3}. At both sites, the annual averages for both $PM_{2.5}$ and PM_{10} were less than approximately 10 µg m^{-3}.

There were no exceedances of Provincial or Federal $PM_{2.5}$ or PM_{10} standards at Tsay Keh during 2012 based on the TEOM data. In contrast, Fort Ware had two exceedances of $PM_{2.5}$ and five exceedances of PM_{10}, which may well have been associated with construction activity for the new Medical Centre located approximately 200 m to the west of the monitoring station.

Regional PM_{10} and $PM_{2.5}$ dust concentrations measured around the Reservoir using the BGI samplers showed very similar results to those obtained from the TEOMs. Overall average maximum 24-hr PM_{10} BGI concentrations in 2012 extended from a low of 7.1 µg m^{-3} (range 1.2 to 23.1 µg m^{-3}) at Ingenica to a maximum of 22.8 µg m^{-3} (range 2.7 to 48.6 µg m^{-3}) at Stromquist. The overall 24-hr maximum concentration at Tsay Keh was 29.9 µg m^{-3} with daily values ranging from 0.8 to 29.9 µg m^{-3}. The highest individual 24-hr concentrations were recorded for Rat Lake (165.7 µg m^{-3}) and Stromquist (48.6 µg m^{-3}).

In general, higher concentrations were associated with southerly wind flows. Minimum overall average 24-hr average PM_{10} values were very low, particularly during the late fall and winter months with many sites recording <1 µg m^{-3} with the largest minimum of 2.70 µg m^{-3} recorded at Stromquist.

Based on these data, there were very few exceedances above the 50 µg m^{-3} PM_{10} BC standard in 2012. In addition, there were no exceedances of the 30 µg m^{-3} $PM_{2.5}$ CWS or the new BC provincial standard for $PM_{2.5}$ of 25 µg m^{-3}. Overall, there were a total of eleven exceedances of the BC PM_{10} standard with the largest at Rat Lake (4 exceedances) followed by Lafferty and Pete Toy with two each, with one exceedance each at Davis, Stromquist and Van Somer There were no exceedances of the $PM_{2.5}$ or PM_{10} standards at Tsay Keh, Chowika or Ingenica.

The relatively low dust concentrations and lower number of exceedances of the PM_{10} and $PM_{2.5}$ standards likely reflects several factors. Of key importance were the high water levels, even at the beginning of the dust season in both 2011 and 2012, which reduced exposed beach areas, thereby reducing the potential source areas for dust entrainment and subsequent transport downwind. Also of importance were the meteorological conditions that mitigated against entrainment of sand and emission of dust. Wind speeds during 2011 and 2012 were similar in frequency, magnitude and direction and generally lower than those in 2010, with fewer intense storms with regional wind flow from the south (Figs. 4.3 and 4.4). In addition, both the 2011 and 2012 season had considerable precipitation amounts with approximately 250 mm of during the sampling period in 2011, as compared to 277 mm in 2012. These higher precipitation levels, on over 30% of the observation days in both 2011 and 2012, tended to keep the surface relatively moist, thereby increasing the entrainment threshold and decreasing potential dust emissions. As well, the generally high relative humidity throughout the monitoring periods, in conjunction with the low temperatures and wind speeds likely decreased evaporation keeping the surface relatively moist, thereby reducing dust emissions.

Despite the similarity in concentrations and water levels in 2011 and 2012, there was considerably less tillage carried out in 2012, raising the question as to the efficacy of tillage in reducing dust emissions. There is however, an enormous amount of literature spanning decades, covering many locations throughout the world that clearly demonstrates that tillage is a very effective method to reduce dust emissions. It would appear that in the case of the Williston Reservoir that during dust seasons with high water levels and moderate to high precipitation that dust emissions are naturally low because of the smaller areal extent of exposed beaches and their lower emissivity due to moisture effects. This observation clearly suggest that a tillage strategy needs to be developed that takes into account water levels and exposed surface area, meteorology and beach emissivity with some understanding of which areas of the reservoir should be protected most or at least first. Developing such a strategy is a very difficult task based solely on field measurements where individual variables vary greatly from year to year and from place to place. However as Fryrear et al. (2009 and 2010) emphasized, it is necessary to develop an informed strategy and appropriate logistical support to ensure tillage can be applied in a cost effective manner to reduce dust emissions in a timely manner. Gillies et al. (2013) have presented a numerical model for the Williston Reservoir that can, in part, be used to help build a tillage strategy using data that has been collected over the past few years as part of the tillage trials, the PI SWERL testing and the Regional Air Monitoring Program. Using this type of modelling, individual parameters can be changed and concentrations calculated for numerous locations around the reservoir for differing, atmospheric, surface and water level conditions allowing for a more complete understanding of the relationship between dust concentrations around the reservoir and the amount and location of surface tilled.

ACKNOWLEDGEMENTS

We would like to express our gratitude to Mike Tilson, Rob Brown and Mike Istchenko and to the Anthony Chalifoux, Cody Davis, Stephan Friesen and Mike Pierre of Chu Cho for their excellent contributions to this project that included the installation and maintenance of equipment, data collection and data reduction. Their dedication and contributions to the project, often under less than ideal field conditions are gratefully acknowledged.

Sincere gratitude are also extended to Aaron Flett and Harry Brownlow of BC Hydro and Johnny Pierre (Chu Cho Field Manager) and Dennis Izony (Chief, Tsay Keh Dene) for their assistance with the ongoing operation of the project and for helping resolve the many logistical problems that were encountered along the way. Special thanks are extended to Harry Brownlow for the numerous discussions and input that helped guide the research program,

We are also very grateful to Jordy McCauley (owner and operator) and the staff at Finlay River Outfitters, Fort Graham, BC, for the excellent hospitality that was extended to our entire crew throughout the 2011-2012 field season.

1.0 INTRODUCTION

The entrainment and transport of sand and fine grained particulate matter (dust) can be a major environmental issue at the Williston Reservoir, which is located in northern British Columbia. The reservoir is the largest body of fresh water in British Columbia with a surface area of 1775 km^2 and a shoreline of 1770 km and was created 1968 when BC Hydro constructed the Bennett Dam on the Peace River to generate hydroelectric power. During the late winter and early spring months the reservoir is typically at its lowest level (*low pool*), up to approximately 10,000 ha of beach area can be exposed. High winds (>20 km/h) during low water levels can result in large dust storms from the exposed beaches that impacts visibility and air quality throughout the valley. Importantly the village of Tsay Key, which is located at the northern tip of the reservoir in almost direct alignment with the dominant storm winds from the south, can be severely affected by dust entrained from downwind beaches along the length of the reservoir.

As a result of the environmental impacts associated with the dust storms and the potential health risks to inhabitants of the reservoir, a 3-year field research project was initiated in the spring of 2008, with funding from BC Hydro and co-operation with the Tsay Keh Dene Band to evaluate potential techniques to wind erosion on the exposed beaches. Based on the three years of testing, it was concluded that tillage would be an effective tool to reduce erosion and dust emissions on large areas of many beaches at the Williston Reservoir. It was noted however, that tillage is not effective on the deep sands where silt/clay rich clods cannot be brought to the surface. It is, therefore, important to identify areas of deep sands and to develop, through further research, cost effective methods to stabilize these locations.

An important part of the implementation of tillage to control wind erosion and dust emissions on the Williston beaches has been the development and installation of a dust monitoring network around the reservoir during the spring of 2008. The primary objective of the network is:

To conduct regional dust monitoring at selected sites surrounding Williston Reservoir to evaluate the ambient air quality ($PM_{2.5}$ *and* PM_{10}*) in the region and the effectiveness of the tillage operations in reducing regional dust concentrations.*

The initial air quality monitoring network was established in 2008 to measure 24-hr average $PM_{2.5}$ and PM_{10} dust concentrations. Because of the logistics involved and the development of a technically advanced system for the rugged conditions of the reservoir sites system, the 2008 and 2009 networks were only operational during May and June when water levels were relatively low and the tillage trials were operational. As a result of important on-going concerns that dust storms can occur well into the fall and with the increase in experience and infrastructure as well as important on-going concerns it was decided that monitoring should be extended in 2010 from spring to fall, informally expressed as "*from snow to snow*".

2.0 THE INITIAL DUST MONITORING PROGRAM (2010-2011)

In 2010 and 2011 PM_{10} and $PM_{2.5}$ were measured at seven locations around the Williston Reservoir using Dichotomous Partisol Monitors, which are a standard reference instrument commonly used for regulatory monitoring (Figs. 3.6 and 3.7). These samplers simultaneously collect fine and coarse PM on two 47 mm filters held in molded filter cassettes. The sampler exchanges and exposes each set of two filters according to a user-specified sampling schedule. Up to 16 filter cassettes (8 pairs) can be stored in the instrument at a given time allowing the instrument to remain unattended for several days at a time. Partisol samplers were located at Tsay Keh Beach, Stromquist Beach, Lafferty Beach, Ivor Creek Point, Davis Beach and Rat Lake.

In addition to the samplers, wind speed, wind direction, temperature, relative humidity and precipitation were recorded at 1 Hz, averaged at 15 min intervals and stored on a CR1000 datalogger (Fig. 2.1).

In that Partisols typically run on 120 v, it was necessary to provide a stable current supply. After considering numerous options, the samplers were powered by small diesel generators located 50-70 m away from the sampler, in the most advantageous location possible to avoid contaminating the filters with diesel exhaust (Fig. 2.1). In addition, exhaust was vented at an elevation of 10 m to promote diffusion. No noticeable trace of diesel particulates was noticed on the filter samples.

FIGURE 2.1. PHOTOGRAPH OF PARTISOL DICHOTOMOUS SAMPLER SET-UP AT LAFFERTY BEACH IN 2010.

Monitoring of PM_{10} and $PM_{2.5}$ was carried out each year from early spring until early fall. It should be noted that the length of data collection varied from site to site and year to year as a result of the weather, water levels and the logistical constraints associated with putting in and taking out the instrumentation

3.0 Regional Air Quality Monitoring Program, 2011-2012

In order to assess the success of the mitigation measures designed to decrease dust emissions from beaches on the Williston Reservoir, and to provide on-going monitoring to quantify the 24-hour and annual average levels of particulate matter (PM_{10} and $PM_{2.5}$) in the atmosphere in relation to provincial and federal air quality standards, a long term regional air quality monitoring program surrounding the reservoir was implemented over the fall of 2011 and spring of 2012.

The monitoring network has two major components:

- hourly measurement of PM_{10} and $PM_{2.5}$ and associated meteorology each day, seven days a week, for the entire year in both Tsay Keh and Ft. Ware.
- measurement of 24 hour average PM_{10} and $PM_{2.5}$ concentrations and associated meteorology at key locations around the shoreline of the reservoir in the Finlay Reach area to characterize regional particulate matter levels for the entire snow free season.

In both the above cases the measurements are taken specifically to evaluate the air quality in this region as it relates to both Federal and Provincial air quality guidelines and standards. In 2000, the Canadian Council of Ministers of the Environment (CCME) ratified new Canada Wide Standard (CWS) for airborne particulates based on a $PM_{2.5}$ concentration of 30 µg m^{-3} (24 hour averaging time) based on the 98^{th} percentile of annual measurements, averaged over three consecutive years, and was implemented in 2010. The CWS was adopted by British Columbia in 2000. However in 2009 a new, more stringent $PM_{2.5}$ ambient air quality criteria of 25 µg m^{-3} based on a 24 hour averaging time derived from the 98^{th} percentile of annual measurements was adopted by BC. It should be noted that the new provincial criteria for $PM_{2.5}$ are in addition to the existing provincial AQO of 50 µg m^{-3} (24-hour average) (http://www.bcairquality.ca/regulatory/pm25-objective.html) and both criteria must be met to be in compliance.

3.1 Continuous PM10 and PM2.5 Monitoring in Tsay Keh and Ft. Ware

An important part of this new sampling approach was the deployment of permanent air quality monitoring stations at Tsay Keh and Fort Ware that continuously measure and record PM_{10} and $PM_{2.5}$ levels using the Thermo Scientific Ambient Particulate Monitor, TEOM 1405D. In addition, standard meteorological data are collected continuously at the sites using the same instrumentation used at the remote sites around the reservoir.

In both Tsay Keh and Ft. Ware the same instrumentation is used to monitor ambient levels of PM_{10}, $PM_{2.5}$, and environmental conditions (i.e., temperature, relative humidity, atmospheric pressure, wind speed, wind direction, precipitation). At both sites the PM instrument and datalogging hardware are housed in a climate-controlled, custom-built steel building, with mains power and connectivity to the internet (Fig. 3.1)

PM_{10} and $PM_{2.5}$ at these sites are measured continuously with the TEOM 1405D (Fig. 3.2), which has US EPA, Federal Equivalent designation status and has been deployed in monitoring networks worldwide to measure particulate matter mass

FIGURE 3.1. THE ENVIRONMENTAL ENCLOSURE AT TSAY KEH THAT HOUSES THE TEOM, DATALOGGING INSTRUMENTS AND PROVIDES A PLATFORM FOR THE METEOROLOGICAL SENSORS AND THE TEOM INLET.

FIGURE 3.2. THE INTERIOR OF THE ENVIRONMENTAL ENCLOSURE SHOWING THE TEOM, DATALOGGING INSTRUMENTS, AND NETWORKING HARDWARE, TSAY KEH.

concentrations continuously. TEOMs have been used exclusively by the Great Basin Unified Air Pollution Control District, Bishop, CA, to monitor PM_{10} dust emissions at Owens Lake, CA, which historically has had the highest dust levels associated with fugitive emissions in North America (Ono 2006).

The instrument uses a patented tapered element oscillating microbalance that is a micro-weighing technology that provides true mass measurements and is not filter based. This version of the TEOM measures PM_{10} and $PM_{2.5}$ simultaneously. The 1405D provides a self-referencing, National Institute of Standards and Technology (NIST)-traceable true mass measurement. The system differentiates itself from other PM measurement methods by utilizing a direct mass measurement that is not subject to measurement uncertainties found in surrogate techniques such as beta attenuation, light scattering, or pressure drop. Specifications for the TEOM 1405D are given in Table 3.1.

Table 3.1 lists the specific model and manufacturer for the meteorological instruments used at Tsay Key and Ft. Ware as well at the remote sites surrounding the reservoir.

TABLE 3.1. TEOM MODEL 1450-D SPECIFICATIONS.

Measurement Method	**Tapered Element Oscillating Microbalance (TEOM) Technology**
Measurement Ranges	0 to 1,000,000 $\mu g/m^3$ ($1 g/m^3$)
Precision	$\pm 2.0 \mu g/m^3$ (one-hour average), $\pm 1.0 \mu g/m^3$ (24-hour average)
Accuracy	For Mass Measurement: ±0.75%
Resolution	$0.1 \mu g/m^3$
Flowrate	Main flow rate: Fine PM filter, 3.9L/min.; Coarse PM filter, 1.67L/min.
	Bypass flow rate: 12.0L/min.
Data Memory	Internal datalogging of user-specified variables; 5,00,000 record capacity
Input Output	Four averaged analog inputs (0 to 5VDC) with user-defined conversion to engineering units; 8 User-defined Analog Outputs (0-1 or 0-5VDC); 2 User-defined contact closure alarm circuits; Ethernet with embedded FTP server, US, RS-232, and RS-485; touchscreen with user interface, and ePort software to view and change system operation from PC
Data Output	Selectable from 10 sec. to 24 hour
Approvals	Designed to meet: CE EN 761326:1997 + A1:1998 + A2:2001 + A3:2003 and EN:61010-1; UL 61010-1:2004; CSA C22.2 No. 61010-1:2004; and FCC Part 15 Subpart B, Class B
Operating Limits: Temperature Range	Temperature of sampled air may vary between -40° and +60°C. TEOM sensor and control units must be weather protected within the range of 8° to 25°C.
Power Requirements	Pump: 12V, 60Hz 4.25A; 240V 50Hz 2.25A Instrument: 10-240V 440V 47-63Hz

TABLE 3.2. THE METEOROLOGICAL INSTRUMENTS DEPLOYED AT THE SAMPLING SITES.

Environmental Parameter	Instrument	Manufacturer, Make, Model
Temperature	Temperature Sensor	Rotronic Instrument Corp., HygroClip2, HC2-S3-L
Relative Humidity	Relative Humidity Sensor	Rotronic Instrument Corp., HygroClip2, HC2-S3-L
Atmospheric Pressure	Barometric Pressure Sensor	RM Young, 61302V
Wind Speed	Propeller-style anemometer	RM Young, RM Young Wind Monitor, 05103
Wind Direction	Wind vane	RM Young, RM Young Wind Monitor, 05103
Precipitation	Tipping bucket rain gauge	Texas Electronics, Tipping Bucket Rain Gauge, TE525M

To log and store the data from the TEOM 1405D and the meteorological instruments, a custom designed hardware and software interface was designed. The main design goal for the data acquisition program for the BC Hydro monitoring stations in Tsay Keh and Ft. Ware was good reliability and ability to save collected meteorological and PM data on multiple platforms.

The backbone of the data acquisition system is a Campbell Scientific datalogger Model CR1000. These dataloggers are highly reliable and require very little power to operate. The dataloggers are configured to run off 12 v batteries. The datalogger and computer batteries re-charge their power from large 12 v batteries connected to a battery charger that draws from mains power and solar power should the mains power be interrupted. This method insures that meteorological instruments will function and collect data even if mains power is interrupted or completely off. Unfortunately the solar power is not sufficient to power the TEOM instruments.

The meteorological instruments at the stations are interfaced to the CR1000 datalogger, which reads and records the data every second and computes one and ten minute averages and saves it to a 2GB CF memory card. In addition, the TEOM 1405D is interfaced to the CR1000 via serial port communication and specially developed software. The TEOM instrument is polled for new readings every 10 minutes, which are stored in the 10 minute data table together with the meteorological data. The datalogger is also interfaced to a stand-alone lap top computer via a second serial port providing secondary back-up. Fig. 3.3 illustrates schematically the interconnection of the instrumentation and the data logging system.

The incoming data stream requires more memory capacity than the datalogger is configured for. To overcome this limitation the one second data are stored on the computer in two locations: the internal hard drive and an external USB memory card.

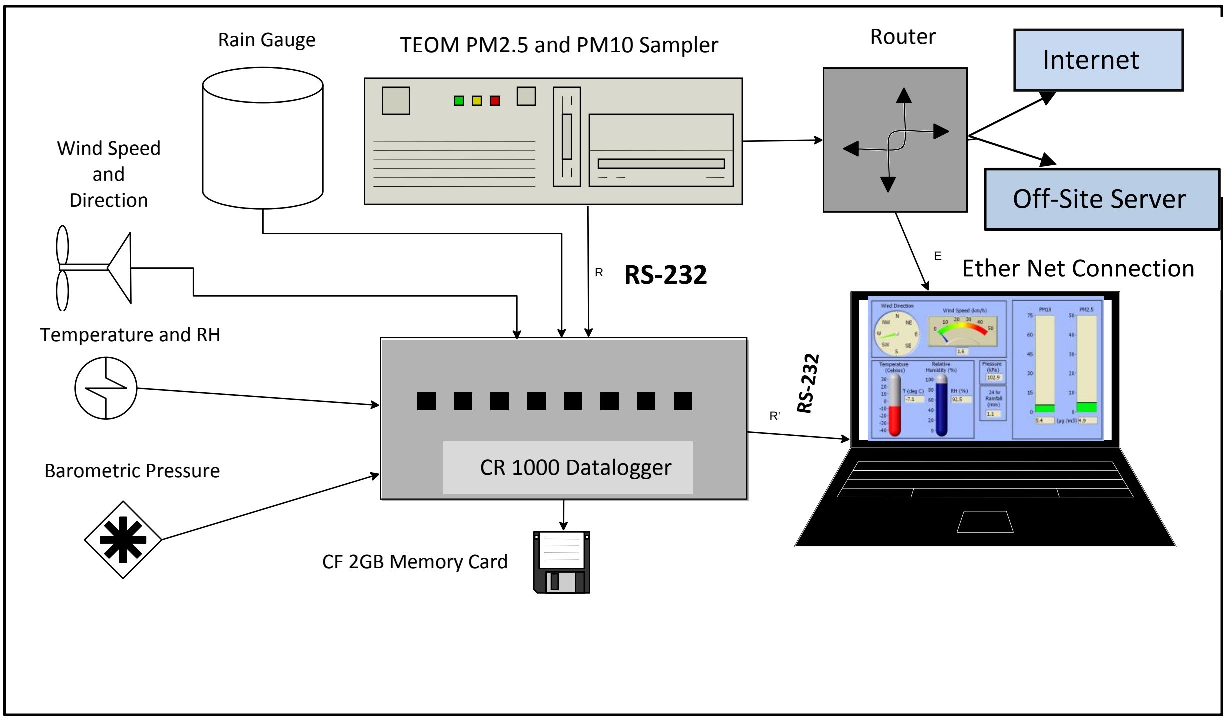


FIGURE 3.3. SCHEMATIC DIAGRAM OF THE INSTRUMENTATION AND DATALOGGING SYSTEM AT TSAY KEH AND FT. WARE.

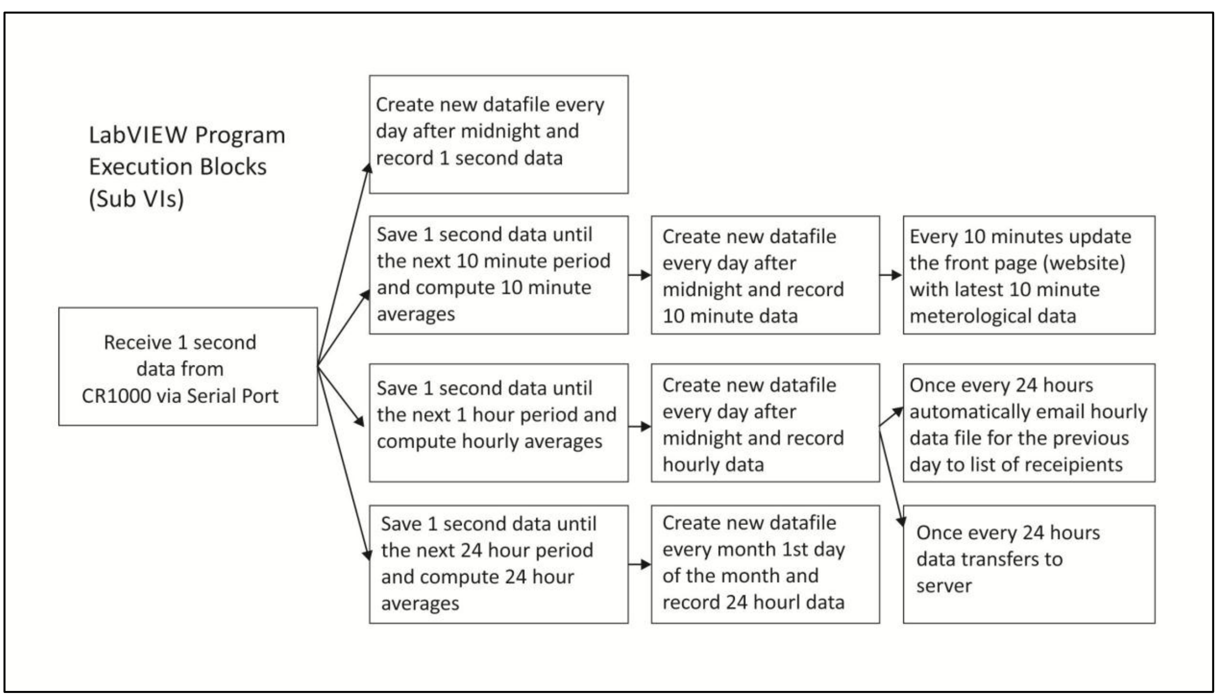
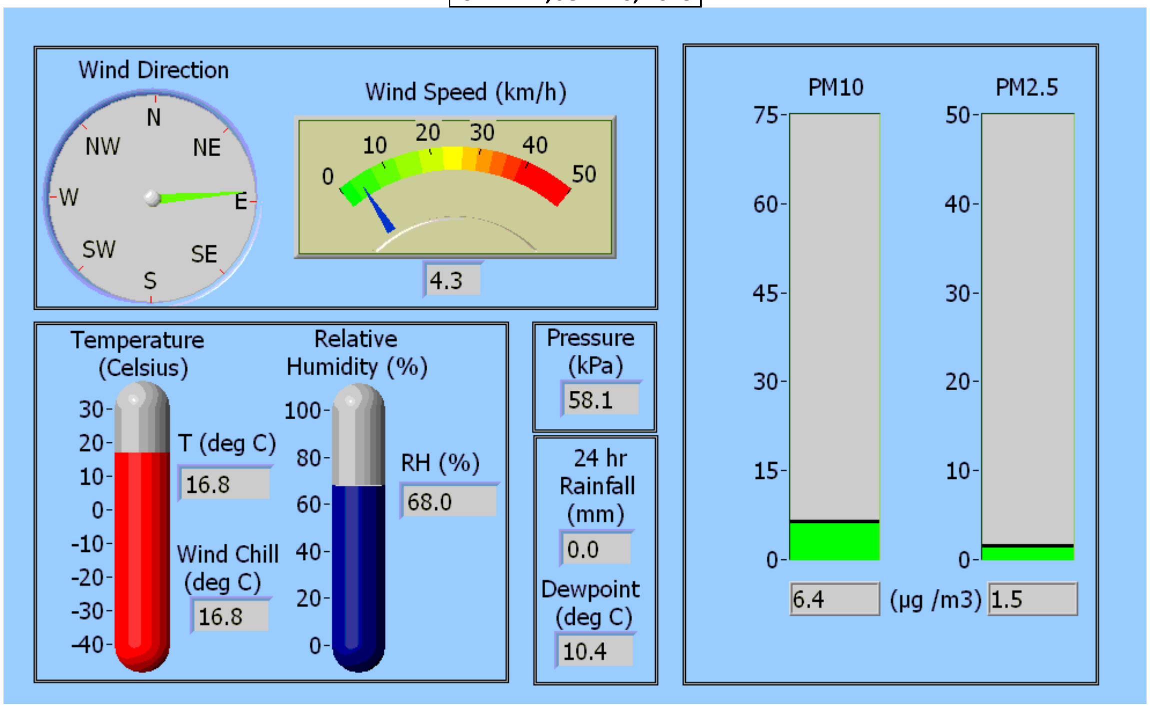


FIGURE 3.4. THE LOGIC OF DATA ACQUISITION AND STORAGE FOR THE BASE STATIONS IN TSAY KEY AND FT. WARE.

TSAY KEH, JULY 10, 2013.



FORT WARE, JULY 10, 2013.

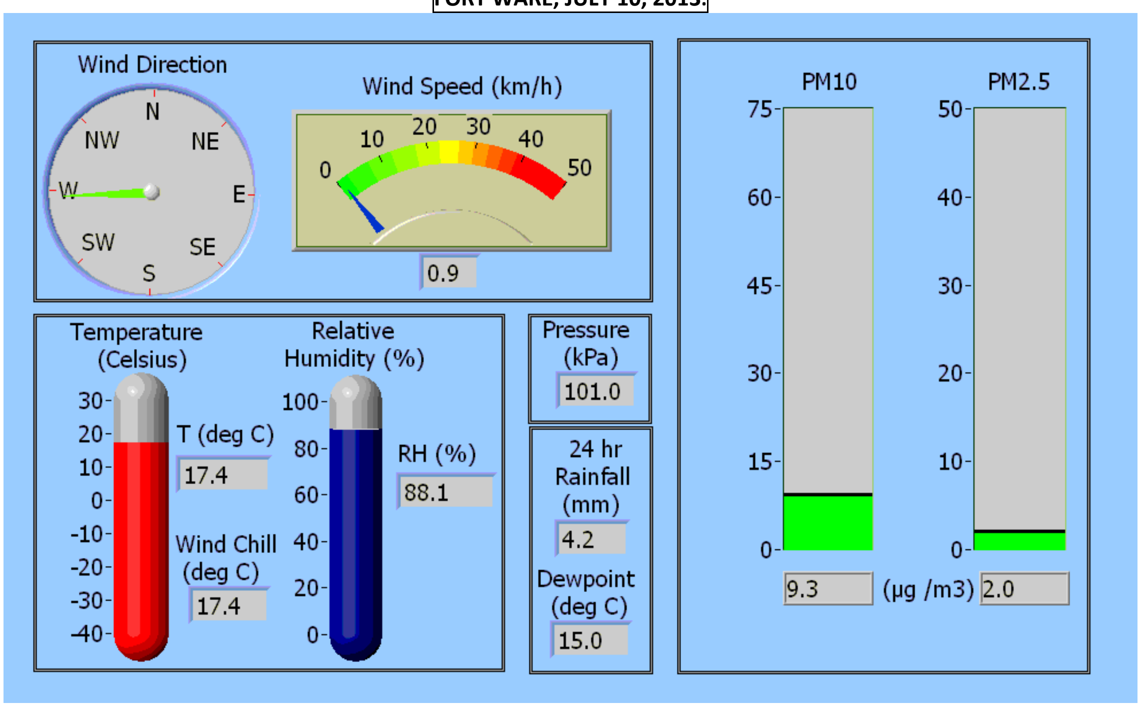


FIGURE 3.5. SCREEN SHOT OF DISPLAYS AT THE TSAY KEH BAND OFFICE AND FORT WARE SCHOOL SCREENS, 1500H, JULY 10, 2013. THE BARS DENOTING THE LEVELS OF THE PM_{10} AND $PM_{2.5}$ CHANGE FROM GREEN TO ORANGE TO RED AS CONCENTRATION LEVELS APPROACH AND THEN EXCEED THE 24 HOUR STANDARD.

The computer receives the one second data from the datalogger and uses a custom-developed LabVIEW program to process and display these data. In that the computer has significant data recording at both village sites, and in order to synchronize time at both sites, each computer is running a third party application that connects to the atomic time server in Canada and automatically synchronizes the computer clock every hour to the national time. The one second data from the datalogger are saved to appropriately named files that have the correct date in the name of each file. A new file is created every day one second after midnight. In a similar manner to the datalogger the LabView program running on the networked laptop computer stores data to its memory and then computes 10 minute, 1 hour, and 24 hour data averages and saves that processed data to an appropriately named data file (see Figs. 3.3 and 3.4). As well, all data are transmitted daily at midnight via the internet to a server located in the Nickling Environmental office in Cambridge ON, providing additional back-up of all PM and meteorological data from Tsay Keh and Fort Ware.

In addition to processing and recording the entire data set, the laptop computer in the instrument shed also acts as a web server for each station. The meteorological data are updated every 10 minutes and the PM data every hour. Figure 3.5 shows the appearance of the basic display that is updated every 10 minutes. The updated pages are displayed on large flat screen TV displays in the Tsay Keh Band Office and the Ft. Ware School lobby (Fig 3.5).

Tsay Keh: http://willistondust.zapto.org/TK%20Data.html

Fort Ware: http://willistondust.zapto.org/FW%20Data.html

It is hoped that in the near future additions to the websites will be made to include graphs and tables and photographs showing long term trends and yearly comparisons of air quality, beach conditions and reservoir levels.

During the past year ongoing internet problems in Tsay Keh limited access to the websites, this was primarily related to the fact that the village has a single IP address and a relatively small bandwidth. To overcome this issue, for both Tsay Keh and Fort Ware, updates every 10 minutes are sent to an external web host that can be accessed within both villages. Although cumbersome this solution did allow access to the monitor screens. It is hoped that plans to upgrade the internet services in Tsay Keh will be carried out in the near future.

3.2 PM10 and PM2.5 PM Monitoring at the Regional Sites

Prior to 2010 Partisol samplers, which require 120 V, at 20 amps, were used to collect both PM_{10} and $PM_{2.5}$ at the regional sites. Although these instruments provided excellent data in past years, the logistics of maintaining them became increasingly difficult, particularly with regard to supplying fuel for the generators late in the season when water levels were high. After detailed discussions and review of potential alternative instruments, it was decided to install BGI Ltd., Model PQ200 samplers, which are a U.S. EPA Federal Equivalent Reference Instrument that are widely used internationally and have proven to be very reliable, and robust

(Figs. 3.6 and 3.7). An important consideration in the selection of this instrument was the fact that these samplers run on 12 v and have a relatively low power draw that can be supplied by two heavy-duty batteries and solar panels that were already available from the tillage trials.

Despite their simplicity and reliability the BGI PQ200 can only take one sample at a time (PM_{10} or $PM_{2.5}$) depending on which size selective inlet is used with the instrument and must be manually loaded prior to each 24-hr sample run. As a result, two instruments are needed at each site for the collection of PM_{10} and $PM_{2.5}$. Importantly, unlike the Partisol, each BGI instrument must be reloaded with a new filter prioir to each sampling period. The BGI however, is fully programmable using its onboard computer and the instrument can be set to take a sample for a specified duration (typically 24 hrs). Overall, the robust nature of the BGI, its simplicity and its relatively low cost and the fact that it runs on 12 volts rather than mains power makes it an ideal sampler for the logistically difficult conditions at the Williston Reservoir.

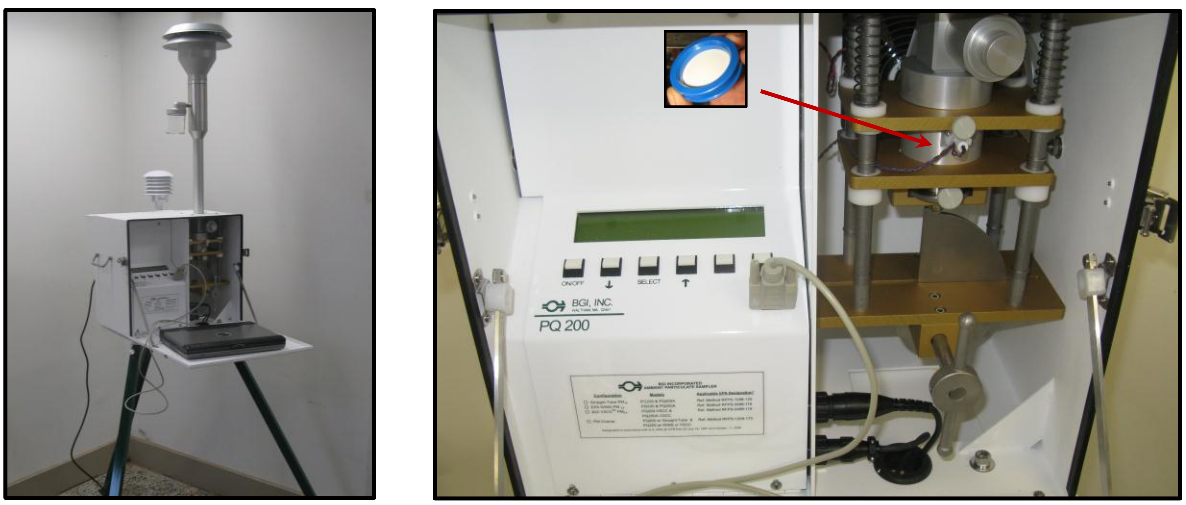


FIGURE 3.6. (A) BGI, MODEL PQ200 PM SAMPLER ON TRIPOD MOUNT, (B) CLOSE UP OF THE PROGRAMMABLE CONTROLLER UNIT (ON LEFT) AND THE INSTRUMENT FILTER CHAMBER (ON RIGHT) AS WELL AS A CLOSE UP OF A FILTER RING HOLDER AND A 47 MM FILTER.

FIGURE 3.7. DEPLOYMENT OF THE BGI PQ200 PM_{10} AND $PM_{2.5}$ SAMPLERS AS WELL AS THE ASSOCIATED METEOROLOGICAL INSTRUMENTATION AT CHOWIKA BEACH.

The air quality sampling network designed for the 2012 field season was intended to operate from early spring when the ice and snow first cleared (typically mid to late May), until the first snow in early Fall (typically late September to early October) following the filling of the reservoir to peak pool. In 2012 monitoring was halted in mid-October with the first snowfall.

3.2.1 Instrument Deployment

PM_{10} and $PM_{2.5}$ samplers were deployed at eight sites on the northern reach of the Williston Reservoir that were selected to be representative of the regional air quality (Fig. 3.8). Detailed co-ordinates for the sites are given in Table 3.3. As well, brief descriptions and photographs of each sampling site are given in Table 3.4.

In addition to the remote sites, PM_{10} and $PM_{2.5}$ samplers were also co-located with the TEOM at Tsay Keh sampling hut (Fig. 3.1). Power for the instruments and the datalogger at the remote sites was provided by two 12 V batteries connected in parallel and housed in a weatherproof container. The batteries were charged by a large solar panel previously used in the tillage trials.

TABLE 3.3. GPS CO-ORDINATES FOR BGI AND TEOM MONITORING SITES.

Site	Latitude	Longitude
Lafferty	56° 20.588'	124° 21.231'
Davis	56° 30.828'	124° 28.144'
Chowika	56° 44.629'	124° 21.231'
Van Somer	56° 50.242'	124° 53.131'
Tsay Keh	56° 53.497'	124° 57.832'
Rat Lake	56° 49.616'	124° 55.697'
Ingenica	56° 47.201'	124° 52.527'
Stromquist	56° 34.036'	124° 37.696'
Pete Toy	56° 29.699'	124° 33.262'

FIGURE 3.8. LOCATION OF THE TEOM AND BGI PARTICLE SAMPLERS AT THE WILLISTON RESERVOIR.

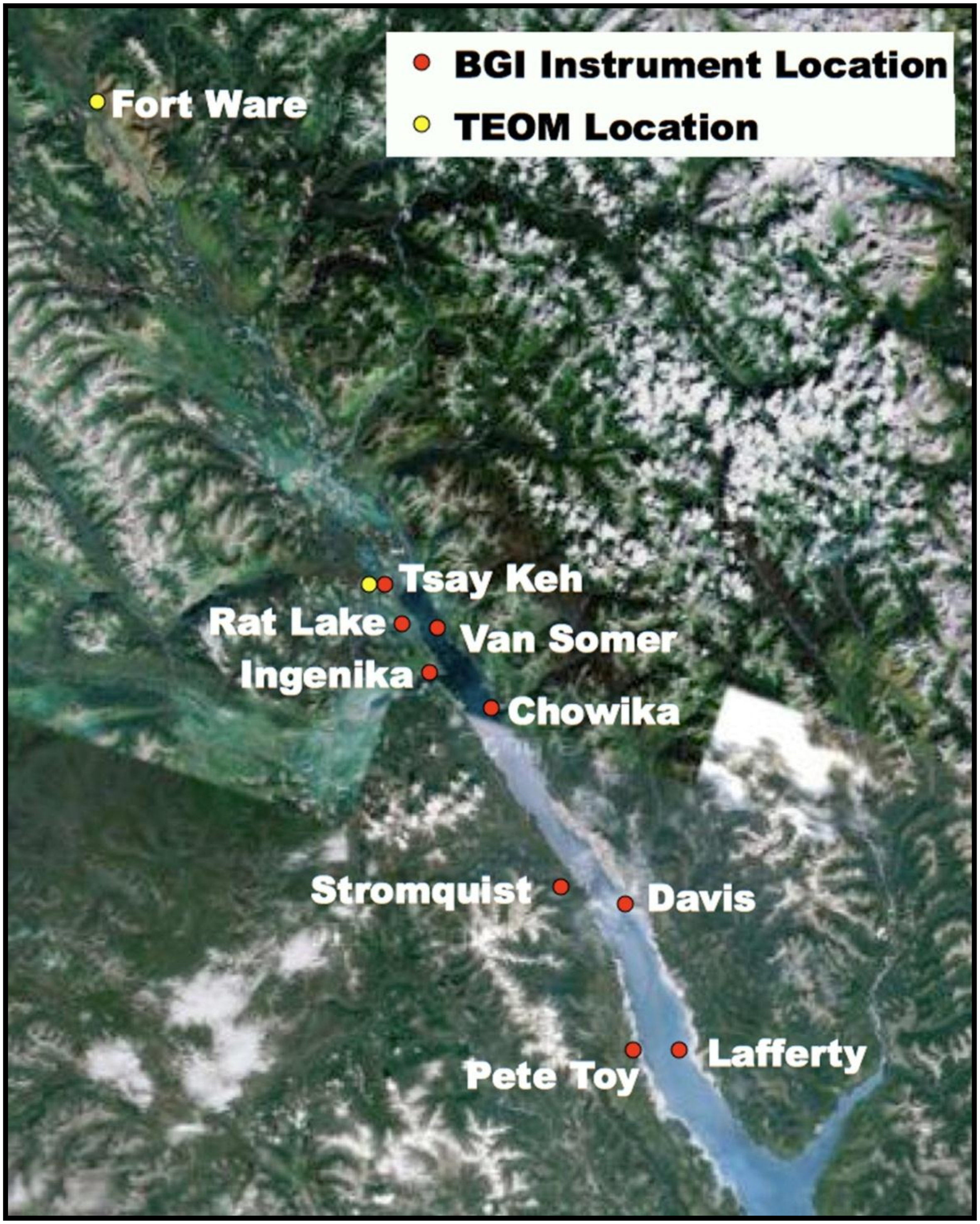
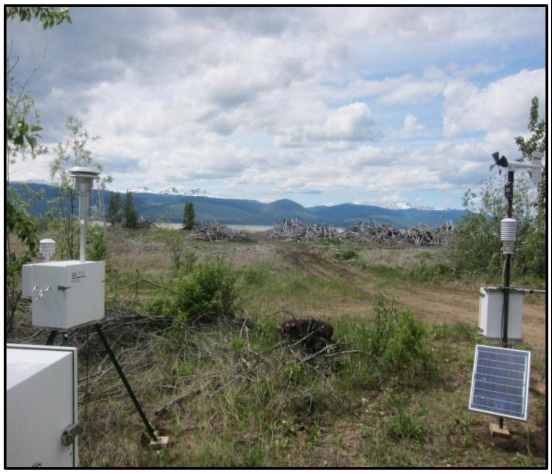


TABLE 3.4. SITE DESCRIPTIONS FOR THE BGI LOCATIONS

Pete Toy 	Pete Toy is located on an exposed beach adjacent to Ole Creek. The breach is comprised of mobile sand and there is no vegetation, stumps or logs to impede wind flow and sand transport at the site. The samplers are subject to regional dust emissions from adjacent beaches as well as emissions from surrounding beaches. This beach is visually dusty during storm periods.
Stromquist 	Stromquist is located on an exposed point that is subject to northerly and southerly winds. The samplers are located on a sandy beach that is a source for sand and dust transport during storm events. The site is exposed to regional dust emissions from upwind sources (north and south) sources and is strongly affected by south easterly flows. A small amount of vegetation and dead tree stumps are present that can affect sediment transport. This beach is visually dusty during storm periods.
Ingenica 	This site is located on a point that is exposed to southerly winds and to a lesser extent northerly winds that transport dust from the beaches on the west side of the reservoir. There is no adjacent beach to the BGI at this location. Importantly, this site is a good indicator of regional dust within the reservoir.

Rat Lake 	The samplers are located on top of an exposed bluff adjacent to a narrow beach along the western edge of the reservoir. The surface of the site is comprised of crusted sand with a sparse vegetation cover. No measurable amount of dust appears to be generated by the surface at this site and there are no adjacent beaches. This site is a very good indicator of regional dust conditions as plumes pass by from the south. There is no northerly exposure at this site but has limited directed exposure to more northerly winds.
Tsay Keh 	The BGI samplers at this site are located on top of the TEOM sampling shed in Tsay Keh, adjacent to the school and community center. This site provides a designed co-location sampling site with the TEOM. The site surface is covered with grasses and low shrubs. There is a nearby beach with a very long fetch, which is free of vegetation and comprised of mobile sediment. The location is subject to all winds and dust from the south during storm events.
Fort Ware 	The sampling shed at Fort Ware is located on a river terrace approximately 75 m west of the school and approximately 150 m east and 10 m above the roadway entering into the village. This instrument shed only houses a TEOM and the associated meteorological. As a result of the planned expansion of the school and ongoing issues with road dust, this site will likely need to be moved to a new location that better represents the regional air quality.

Van Somer 	Located on Van Somer beach, this site is comprised of highly erodible sandy silt. This location is often one of the worst emitting beaches in the valley. Intense dust emissions can often be seen from across the reservoir in Tsay Keh. Paradoxically, during extended low pool years, this beach may have extensive vegetation, limiting dust transport. The BGI is well exposed to both northerly and southerly winds.
Chowika 	The samplers at this site are exposed to both southerly and northerly winds. The surface at Chowika is comprised of large gravel cobbles with an abundance of large woody debris and as a result is not a source for localized transport of sand and dust. This site is an excellent indicator of regional dust transport from both the north and south.
Davis 	This site is characterized by over 320 degrees of exposure to southerly and northerly winds on a beach that is comprised of mixed gravel, sands and clays. The surface is covered with woody debris and a small amount of plant matter that may grow if given time before water inundation. This beach is a known dust emitter resulting from the diverse range of sediments that are present. Fine-grained, mobile sands, located south of Davis creek are a major factor for the ejection high dust from the extensive beach complex.

Lafferty 	This site has excellent north/south exposure and captures dust as it blows past other beaches. Lafferty itself (in the vicinity of the sampler) is not a strong emitter of dust, however, the adjacent beaches (Collins to the North and Ospika to the South) are considered major emitting beaches. The surface surrounding the sampler at Lafferty is primarily coarse sand and gravel. There is also a significant amount of woody debris present at this site.

3.2.2 Sampling Protocols at the Regional Sites

As discussed above, the BGI samplers, unlike the Partisol, can only be loaded with one sample filter at a time. As a result, all sites needed to be visited and filters installed prior the beginning of a given sampling period, typical air quality studies begin at midnight. A major on-going problem with regard to the sampling however, is the fact that the monitoring crews were housed at Fort Graham on the eastern side of the reservoir near Davis Beach. In order to satisfy the sampling protocol, each site had to be visited at least once every 3 days, which necessitated long days of driving particularly for the crew loading the west side samplers. To balance the driving, the crew alternated which side they covered. Over the field season each crew drove over 40,000 km frequently in inclement weather, on bad roads.

After detailed consideration of the logistics involved, timing of filter changes and safety concerns it was decided that the remote samplers would operate on a one-in-three day sampling period (start: May 24, 2012), which insures that each day of the week is captured through time. This sampling scheme is commonly used in air quality studies to reduce the operating costs (costs associated with personnel, filters, laboratory analyses, etc.). The sampling days were synchronized with the Provincial Air Quality Monitoring days, which also follow the US EPA schedule. Once the tillage operations were completed and the reservoir approached high pool, inundating most of the emissive particles, a one-in six day sampling protocol was adopted (June 14, 2012). This change reduced personnel need as well as driving distances and cost. During this period the crew was reduced to three individuals consisting of two Nickling Environmental employees and one Tsay Keh Band member.

During the study the following data were collected at each remote site during each 24-hr sampling period: 1) 24 hour average PM_{10} and $PM_{2.5}$, 2) wind speed, 3) wind direction, 4) temperature, 5) atmospheric pressure, and 6) precipitation. The instruments used are listed in

Table 3.2. The data from the environmental instruments were recorded by a CR1000 datalogger.

PM_{10} and $PM_{2.5}$ were measured with two BGI, PQ200 samplers. To insure comparability with the Tsay Keh base station PM measurements, two additional BGI samplers PQ200 samplers (one configured for PM_{10} and the other for $PM_{2.5}$) were co-located with the TEOM in Tsay Keh.

The operation of the satellite monitors around the reservoir was carried out by two teams of two individuals each consisting of a Nickling Environmental employee and Tsay Keh Band member both of whom had been trained in the sampling protocols. The sampling stations were divided into two groups, those on the west side of the reservoir (including Tsay Keh) and those on the east side

Once a crew arrived at a site a visual inspection was made of all instruments to ensure that there was no physical damage. If no obvious problems were noted the CR1000 datalogger was connected and a visual check of all the instrument output was made to ensure that all the instruments were recording and functioning properly. Following this the BGI was opened and the data associated with the sampler (barometric pressure, internal temperature, etc.) were downloaded. Following this, the filter cassette from the previous 24-hr sample was removed from the BGI, put in its transport container and logged on the chain of custody form (see Fig. 3.6b). Prior to the installation of a new filter a leak test and flow audit for the system was undertaken and the field data sheet completed indicating any operating issues with the BGI. If the system was in good operating condition the new filter cartridge was removed from its case, logged and placed into the instrument. The BGI was programmed to begin sampling on the next sampling day and the instrument closed up. If no issues were observed at the site the crew would move on to the next sampling location. If there was a problem, however, it would require that the crew complete servicing the other sites and if necessary make a return visit the following day with spare parts to affect repairs. It should be noted however, that this was a very rare case and only occurred after a bear incident and the erosion of the bank causing and instrument to fall into the water. In general once the system was set up operations at the remote sites ran very smoothly.

Despite how well the sample sites performed, it would be more efficient, less costly and safer if a crew trailer was located in Tsay Keh so that the crews could service the sites from a central northern point. It is hoped that this will be seen as a priority for the 2013 field season. As well serious consideration should also be given to returning a daily sampling program, at least during the main dust season. This however would require the purchase of additional instruments and at least two more crew members

3.2.3 SAMPLING PROTOCOL FOR THE TEOM SITES

Particle sampling with the TEOM was carried out automatically over 10 minute intervals and then averaged for 1 and 24 hr periods. Similarly, meteorological data were collected each second and averaged over 10 minute and 24 hr intervals corresponding to the TEOM data averaging intervals. The TEOMs require on-going scheduled maintenance that must be carried out at set time periods. First, the micro filters must be changed on a regular basis, the timing of which is stipulated by the TEOM output and is dependent on the concentration of the particulate matter in the air being sampled. A leak test and flow audit are also carried out when filters are exchanged, typically once a month. During any of the inspections, flow problems and instrument parts failures are identified and corrective measures taken as soon as possible to limit instrument down time. A total system audit and calibration is usually carried out annually, but in the case of the Williston monitors this has been done twice a year as a result of severe weather conditions.

4.0 Regional Dust Monitoring Results

4.1 Wind Flow at Tsay Keh and Fort Ware

The entrainment and transport of sand and finer grained particulates is a complex function of the surface characteristics and wind field of a given site. Sand sized particles are generally transported relatively short distances during a given storm but aid in the ejection of fine grained particulates through bombardment and abrasion processes. In contrast, finer particulates (dust: PM<100 µm) can be transported and diffused downwind great distances depending on the particle size, wind speed and the turbulent characteristics of the wind flow.

Wind flow at the Williston Reservoir is very consistent and is dominated by northerly and southerly winds throughout most of the year. Monthly wind speed and direction patterns (i.e., wind roses) for the 2012 study period for both Tsay Keh and Fort Ware are shown in Figs. 4.1A-B and 4.2A-B. This pattern, in large part, results from topographic steering of the dominantly western flows that are redirected along the valley of the Peace River and the Rocky Mountain Trench.

At Tsay Keh, the strongest and most consistent winds during 2012 were in February and were characterized by a strong southerly component. Relatively strong southerly winds also dominated from March through June. However, during this period a relatively strong north-north east to north component was also apparent. These strong southerly and northerly winds, coupled with the low water level in the reservoir (Fig. 4.6) exposing thousands of hectares of erodible sediments, are the primary reasons for the high dust storm potential at Williston during the spring and early summer months (Figs. 4.1 a and b).

Wind flow at Fort Ware (Fig. 4.2a and b) shows a similar pattern with northerly and southerly flows dominating, although NNW and SSE winds are more common in Fort Ware than in Tsay Keh and most likely reflects the localized topographic steering in this area. Winds at Fort Ware also tend to be somewhat more varied than at Tsay Keh and are distributed around the dominant NNW-SSE flow directions in most months. As well, wind speeds, particularly from the south, are generally higher in Tsay Keh reflecting the long open fetch along the reservoir to the south.

4.2 PM CONCENTRATIONS AT TSAY KEH AND FORT WARE

Scientific Ambient Particulate Monitors (TEOM Model 1405D) were deployed at both Tsay Keh and Fort Ware in climate controlled weather proof huts to continuously monitor average 24-hr $PM_{2.5}$ and PM_{10} throughout the year (Figs. 3.1 and 3.2). Two BGI PQ200 samplers were co-located with the TEOM in Tsay Keh as a cross reference for the Regional BGIs. It should be noted that both the BGI PQ200 and The TEOM 1405 are USA EPA approved equivalent methods (FEM) for the measurement of $PM_{2.5}$ and PM_{10} and are accepted samplers in Canada.

Figures 4.3 and 4.4 present PM_{10} and $PM_{2.5}$ concentration time series for the TEOM samplers in Tsay Keh and Fort Ware along with the associated meteorological data for the 2012 observation period. Tabular data associated with these plots are given in Appendix I and II. As a result of mechanical and electronic breakdown, required servicing of the TEOMs, and travel logistics, some data were not obtained by the Tsay Keh and Fort Ware TEOMS. In Appendix I this is indicated by "NaN". As well, during some periods, particularly during the winter months, the quantity of particles in the atmosphere was very low and below the detectable limit of the TEOMs. In Appendix I and II, as well as associated tables, this is indicated by an asterisk (*).

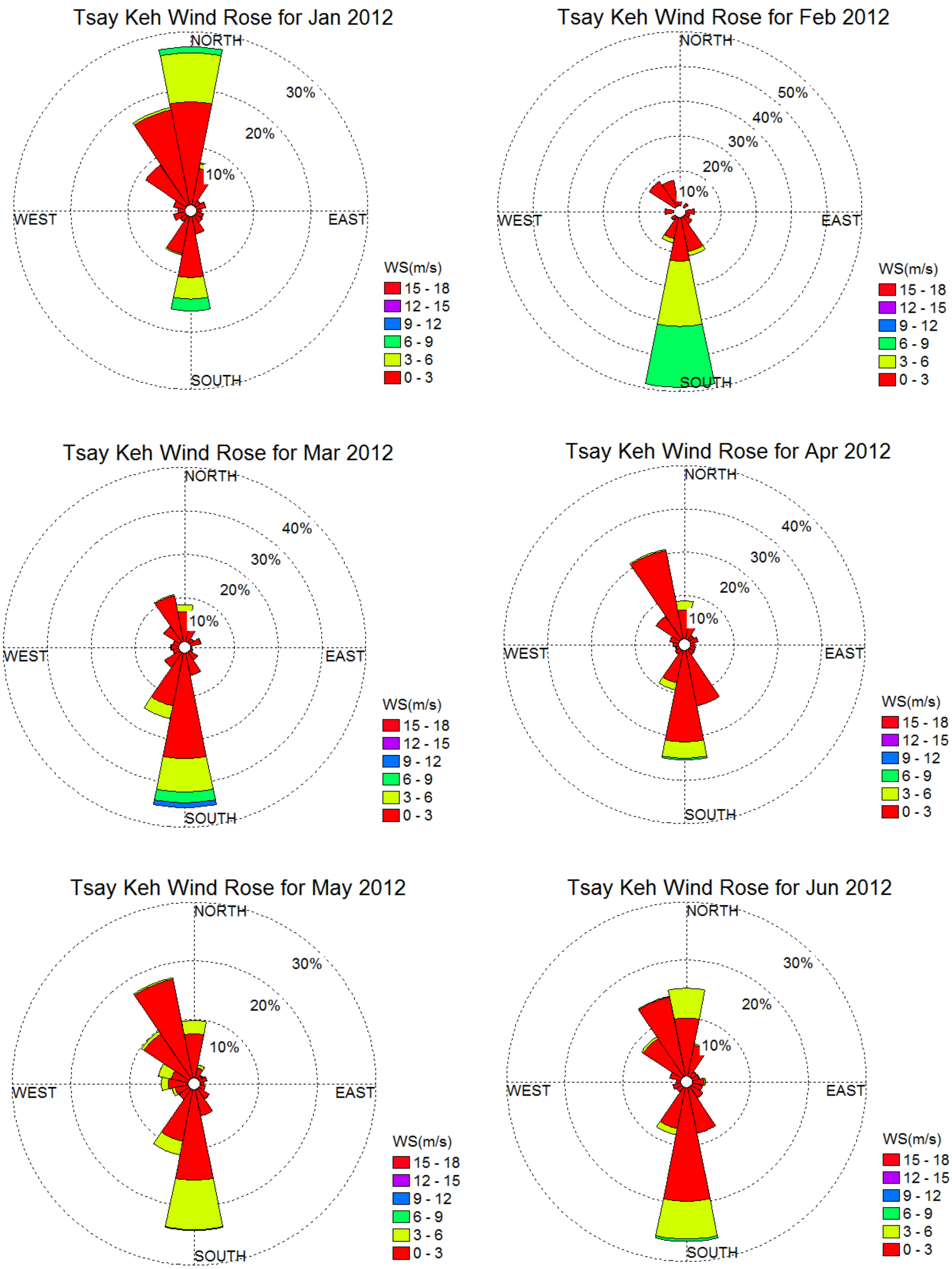


FIGURE 4.1A. MONTHLY WIND ROSES FOR TSAY KEH.

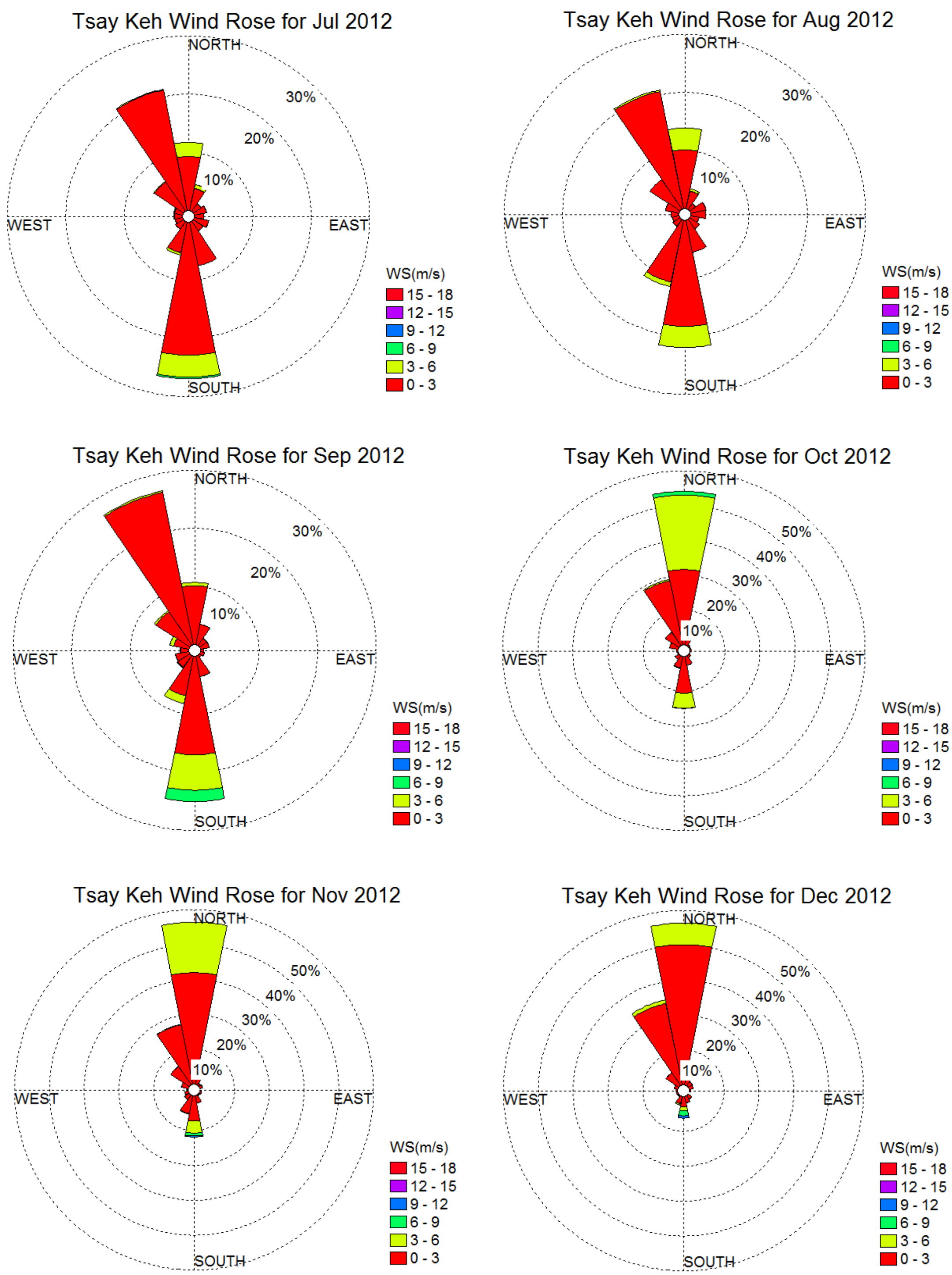


FIGURE 4.1B. MONTHLY WIND ROSES FOR TSAY KEH.

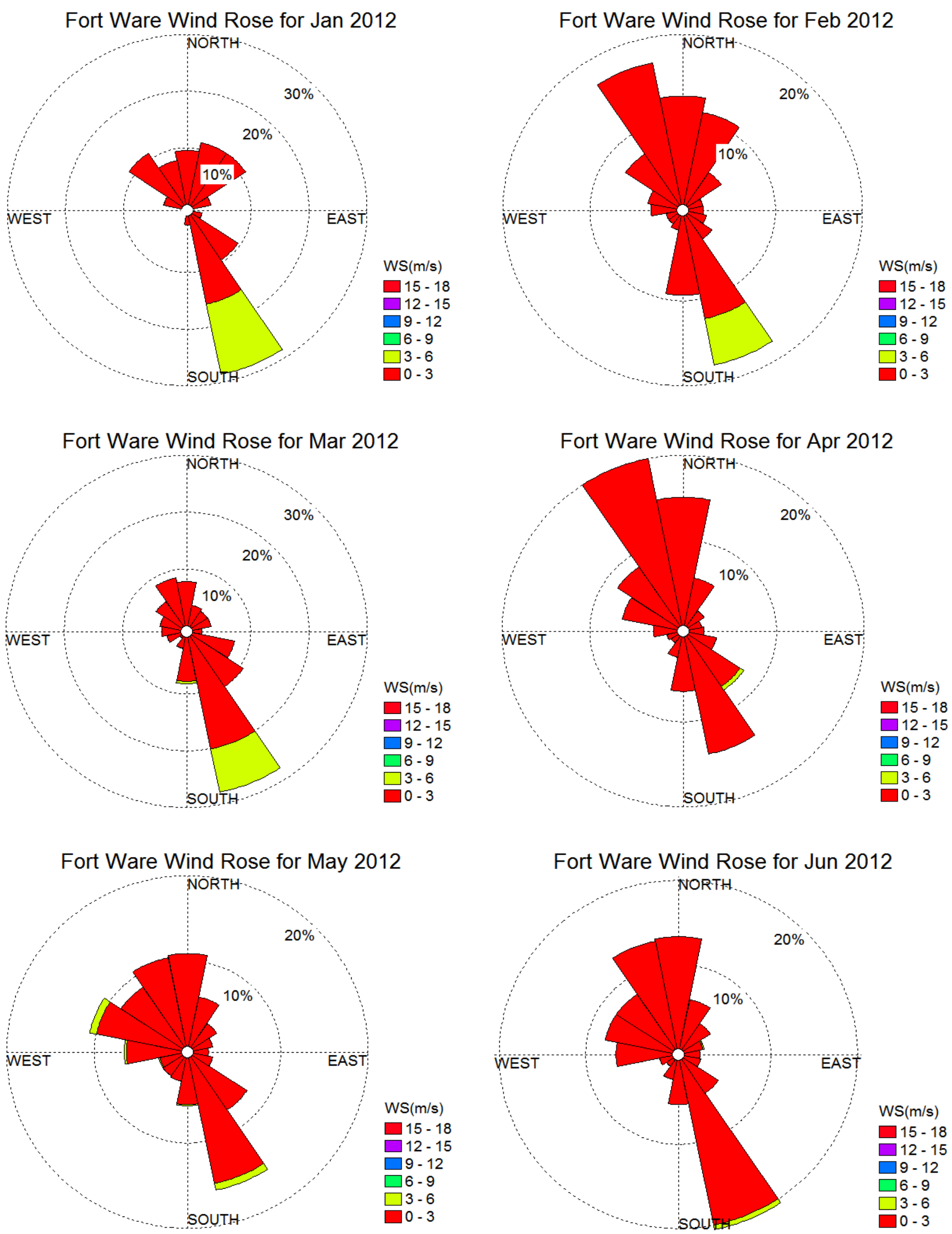


FIGURE 4.2A. MONTHLY WIND ROSES FOR FORT WARE.

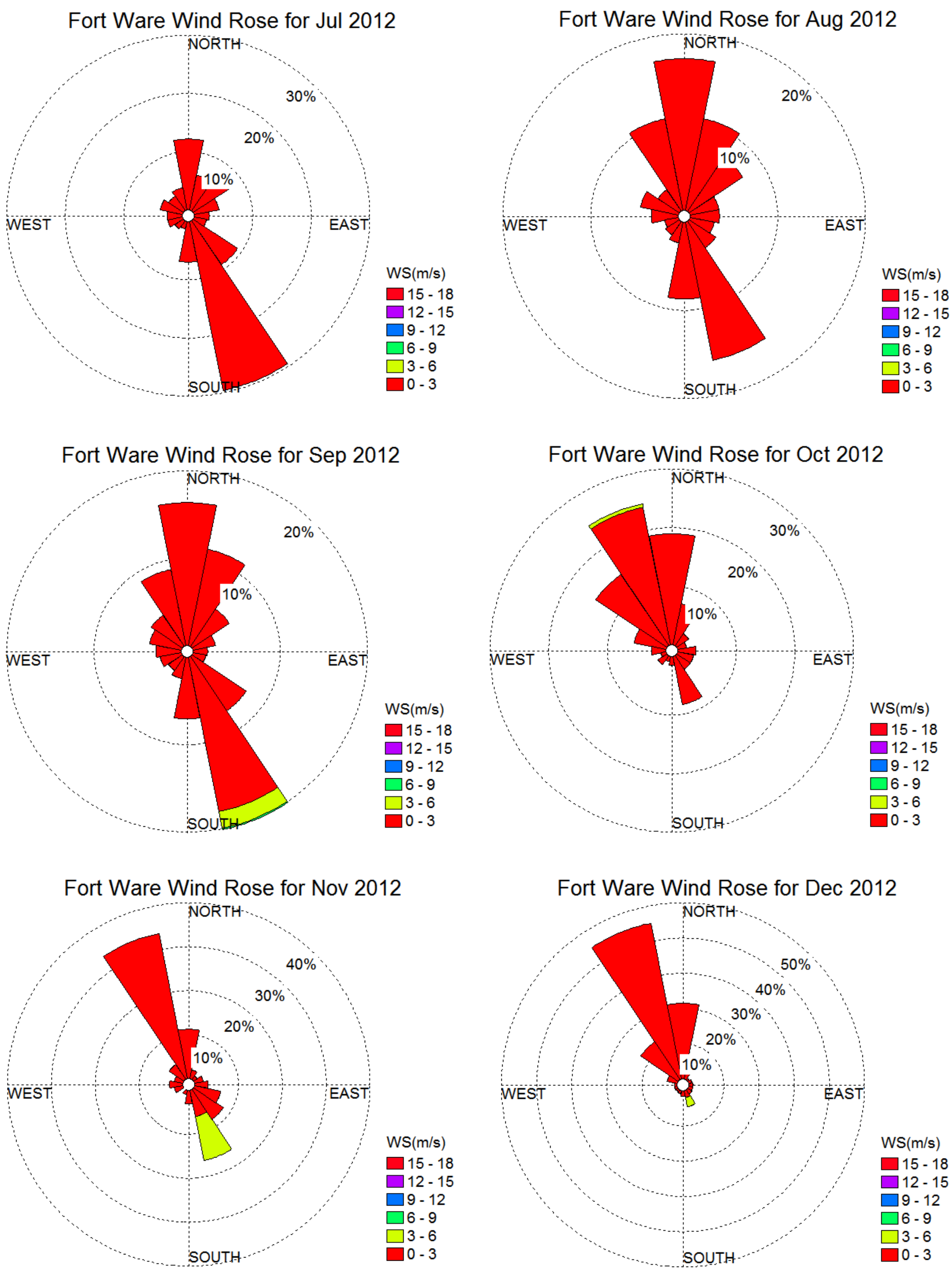


FIGURE 4.2B. MONTHLY WIND ROSES FOR FORT WARE.

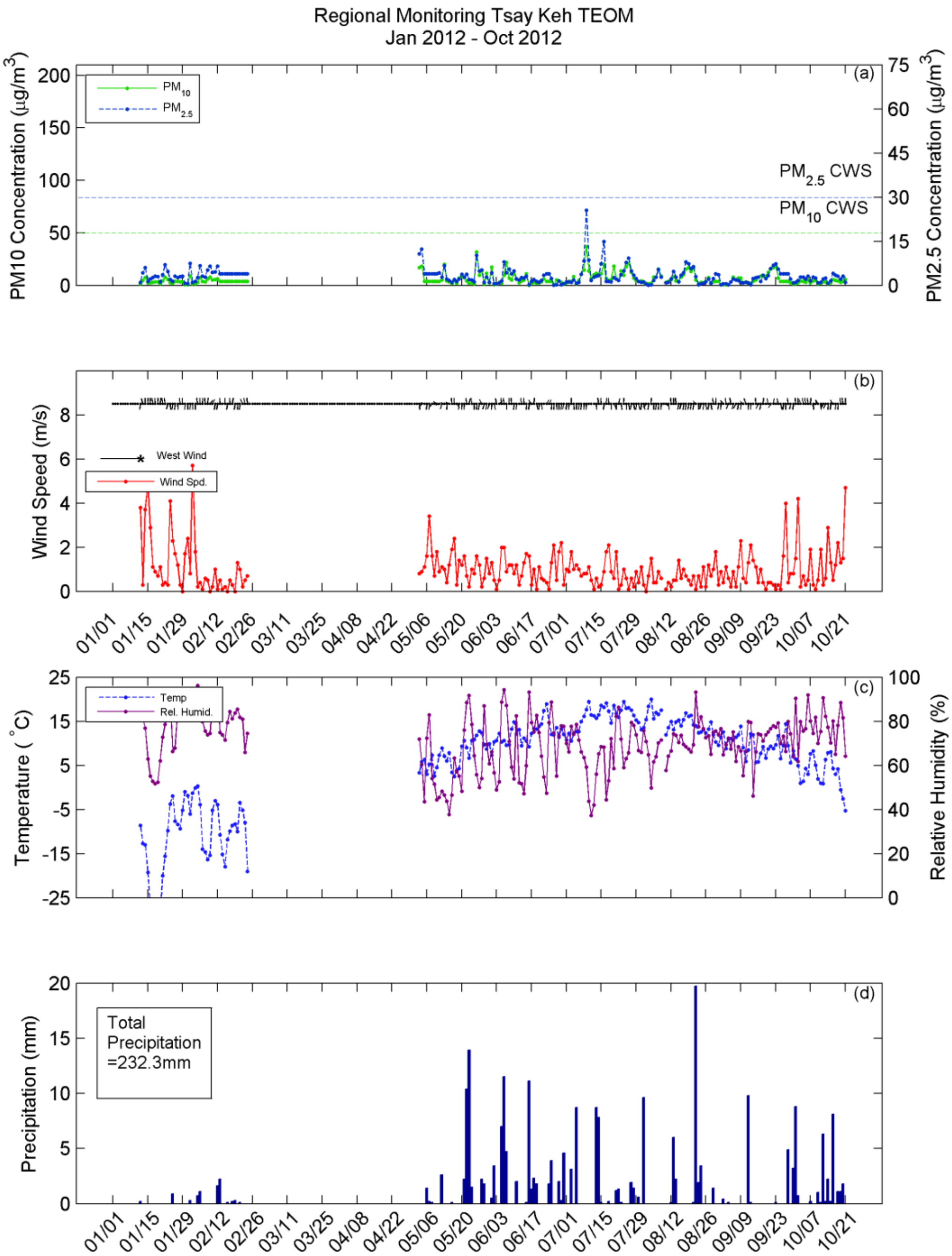


FIGURE 4.3. TIME SERIES OF 24-HR AVERAGE TEOM PM_{10} AND $PM_{2.5}$ CONCENTRATIONS SHOWING WIND SPEED AND DIRECTION, TEMPERATURE, RELATIVE HUMIDITY AND PRECIPITATION FOR TSAY KEH.

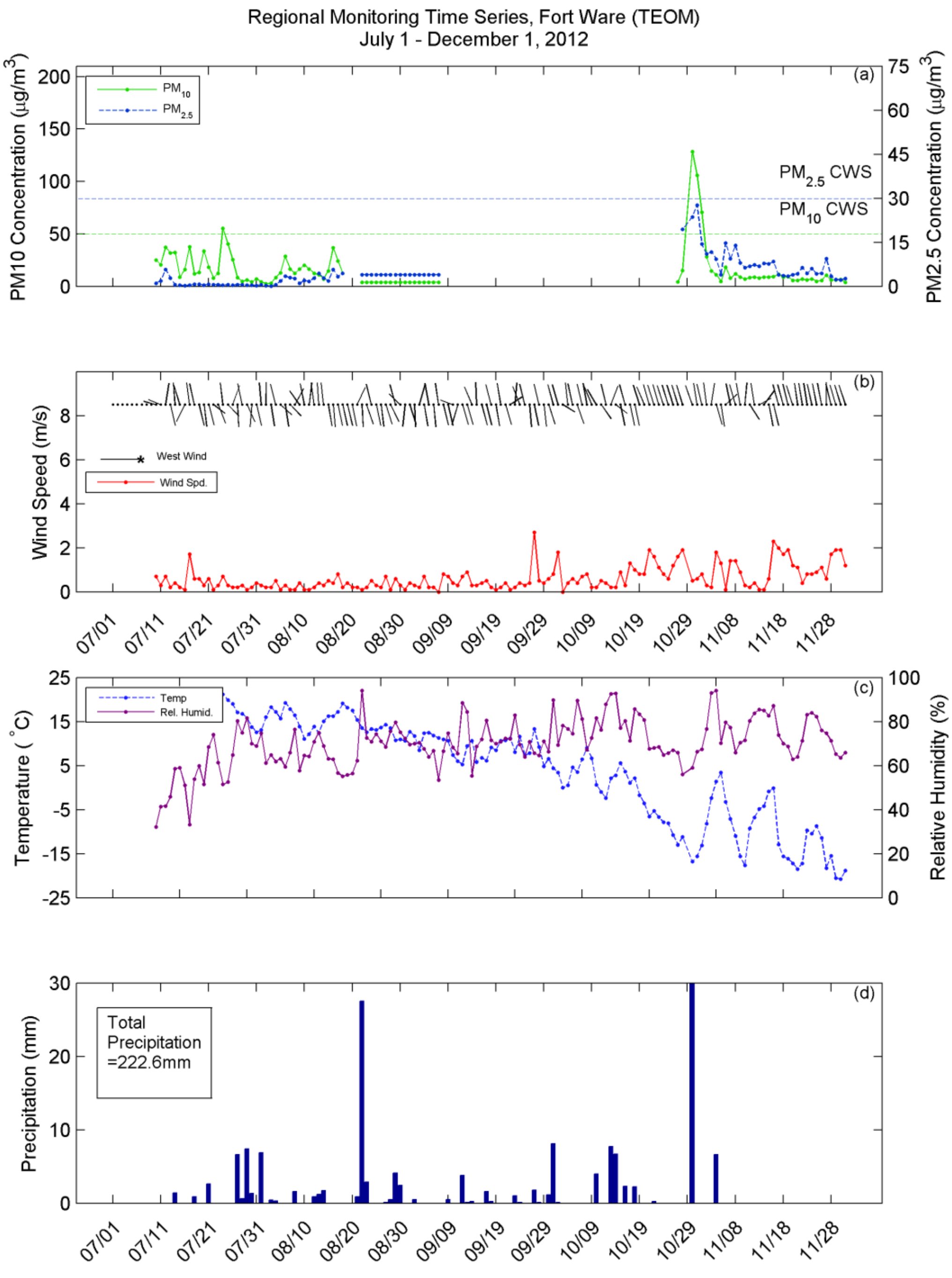


FIGURE 4.4. TIME SERIES OF 24-HR AVERAGE TEOM PM_{10} AND $PM_{2.5}$ CONCENTRATIONS SHOWING WIND SPEED AND DIRECTION, TEMPERATURE, RELATIVE HUMIDITY AND PRECIPITATION FOR FORT WARE.

TABLE 4.1. OVERAL MEAN 24-HR PM_{10} AND $PM_{2.5}$ CONCENTRATIONS AT THE 2012 TEOM SAMPLING SITES

2012	Tsay Keh		Fort Ware	
	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}
Average	3.6	6.9	4.2	7.0
Min	0.1	*	0.1	0.2
Max	25.5	37.9	36.4	91.8

*Below detectable Limit

As can be noted in Figs. 4.3 and 4.4, both PM_{10} and $PM_{2.5}$ concentrations were relatively low during 2012, with $PM_{2.5}$ values ranging from near zero to a maximum of 25.5 and 36.4 µg m^{-3} at Tsay Keh and Fort Ware, respectively (Table 4.1). As expected PM_{10} values were higher, ranging from near zero to 37.9 µg m^{-3} at Tsay Keh and 0.1 to 91.8 µg m^{-3} at Fort Ware (Table 4.1). At both sites, the annual averages for both $PM_{2.5}$ and PM_{10} were less than approximately 10 µg m^{-3}.As noted above, the relatively new Canada Wide Standard (CWS) for airborne particulate matter is based on a $PM_{2.5}$ concentration of 30 µg m^{-3} (24 hour averaging time) based on the 98th percentile of annual measurements, averaged over three consecutive years. In that three years of TEOM data are not yet available for Tsay Keh or Fort Ware, the numerical value of the CWS is used here as an approximation for the level of exceedances of $PM_{2.5}$ at these sites. Exceedance of PM_{10} for the two sites is based on British Columbia's existing AQO of 50 µg m^{-3} (24-hour average). Table 4.2 presents the dates and levels of PM_{10} and $PM_{2.5}$ exceedances at the TEOM sampling sites during the 2012 study period.

TABLE 4.2. PM_{10} AND $PM_{2.5}$ EXCEEDANCES AT THE TEOM SAMPLING SITES DURING THE 2012 STUDY PERIOD.

Date	Tsay Keh		Fort Ware	
2012	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}
9-Jul-12			36.4	91.8
24-Jul-12			55.1	59.2
30-Oct-12				89.6
31-Oct-12				76.7
1-Nov-12				72.9

Total Exceedances in 2012					
Size	**Tsay Keh**		**Fort Ware**		**Total**
PM_{10}	0	0	0	0	**1**
$PM_{2.5}$	0	0	2	5	**7**

There were no exceedances of $PM_{2.5}$ or PM_{10} at Tsay Keh during 2012 based on the TEOM data. In contrast, Fort Ware had two exceedances of $PM_{2.5}$ and five exceedances of PM_{10}. The exceedances on July 9 and 24 were associated with southerly winds that also resulted in fairly high dust concentrations at Tsay Keh. For example, on July 9, $PM_{2.5}$ and PM_{10} levels at Tsay Keh were 25.5 and 36.8 µg m^{-3}, respectively, which are high but below the CWS and BC AQO. Unfortunately further information on the regional extent of this event is not available in that the regionals samplers were not operating on this day as a result of the one-in-three day sampling protocol. The need for daily sampling at the regional sites needs to be revisited and is discussed in the conclusions.

On October and November 3, 2012 exceedances of PM_{10} but not $PM_{2.5}$ were observed at Fort Ware. This pattern suggests a relatively local source of coarse dust. During the Fall of 2012 construction of the new Health Care Facility and Band Office was underway. The location of the new facility is directly west of the TEOM site. As well the main, gravel access road to the Health Care Centre and the village is located between the TEOM and the construction site. As a result it is likely that these exceedances of PM_{10} are associated with dust being generated from the road and the construction site. From an anecdotal perspective, localized dust plumes were visible at the construction sites when the TEOM site was visited for regular maintenance during this period.

The TEOM filters show a clear difference between the characteristics of particulate matter in the atmosphere during different seasons of the year. Fig. 4.5 shows the 2.5 µm (fine) filters retrieved from the Tsay Keh TEOM at different times of the year. On the far left side is a new filter that has not been installed in the TEOM band is very white. The next filter is from the spring to mid-summer and is characterized by a light grey brown colour that is characteristic of mineral dust. As can be seen the next filter, which was collecting particles during the late summer and fall, is somewhat darker in colour and likely reflects the collection of wood smoke particles ≤2.5 µm most likely during the fall when wood is being burned in the village for home heating (Rau 1989). The winter filter is almost completely black and is indicative of the preponderance of fine (≤2.5 µm) wood smoke particles in the atmosphere that are dominant during the winter months.

IGURE. 4.5. REPRESENTATIVE FILTERS FROM THE TSAY KEY TEOM THAT WERE COLLECTING PARTICLES <2.5 µM FOR DIFFERENT PERIODS OF THE YEAR.

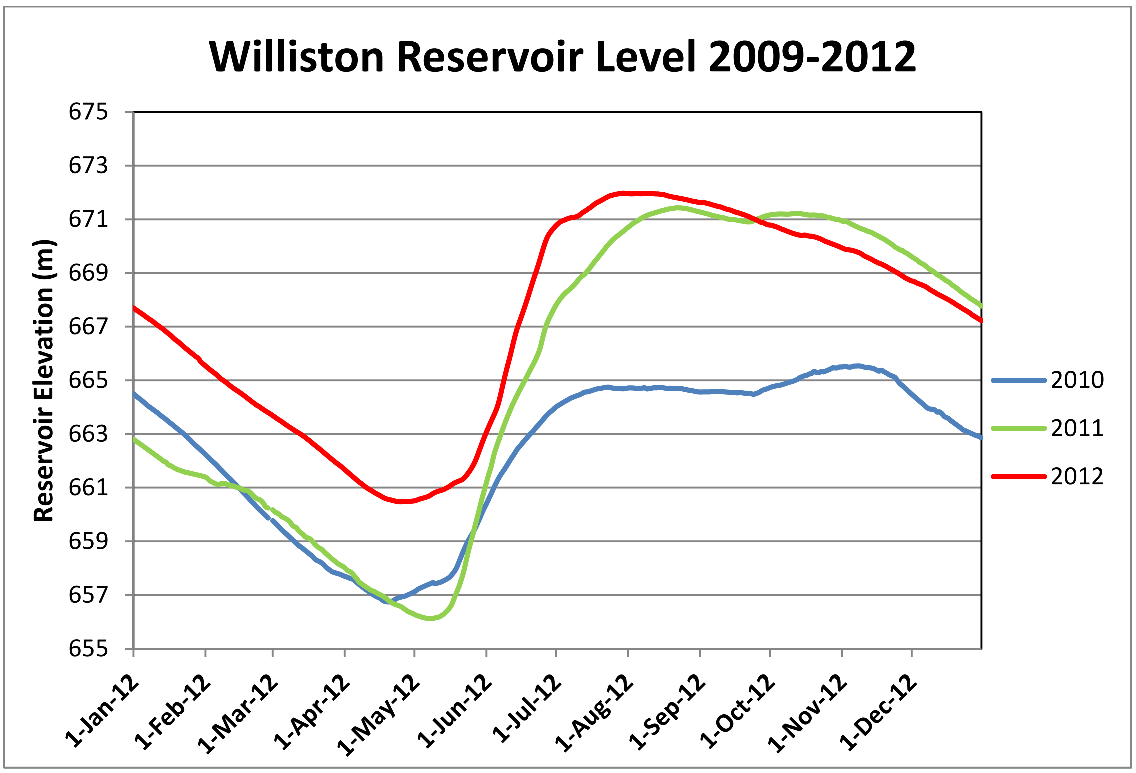


FIGURE 4.6. DAILY WATER LEVELS OF THE WILLISTON RESERVOIR FOR 2010, 2011 AND 2012.

4.3 PM CONCENTRATIONS AT THE BGI REGIONAL SITES

Average 24-hr $PM_{2.5}$ and PM_{10} concentrations as well as associated meteorological data for the 2012 snow free season measured using paired BGI PQ200 samplers for the measurement of $PM_{2.5}$ and PM_{10} located around the Williston Reservoir are given in Appendix II. These data represent samples collected using one-in-three (May 24 to June 14) and one-in-six day (June 14 – Oct 14) sampling protocols. Time series plots for the BGI sites (including the Tsay Keh collocated instrument) and meteorological data are shown in Figs. 4.10A-I. As well, Table 4.3 provides a summary of the average 24-hr $PM_{2.5}$ and PM_{10} for each site.

As can be noted in the time series and tabular data for the regional BGI samplers, both the PM_{10} and $PM_{2.5}$ dust concentrations were generally low during the 2012 sampling period and are comparable to the concentrations measured with the TEOMs at both Tsay Keh and Fort Ware (Figs. 4.10A, 4.10B). Overall, average maximum 24-hr PM_{10} BGI concentrations in 2012 extended from a low of 7.1 µg m^{-3} (hourly range 1.2 to 23.1 µg m^{-3}) at Ingenica (Fig. 4.10E) to a maximum of 22.8 µg m^{-3} (hourly range 2.7 to 48.6 µg m^{-3}) at Stromquist (Fig. 4.10I). The overall 24-hr maximum concentration at Tsay Keh was 29.9 µg m^{-3} with daily values ranging from 0.8 to 29.9 µg m^{-3}. The highest individual 24-hr concentrations were recorded for Rat Lake (165.7 µg m^{-3}) and Stromquist (48.6 µg m^{-3}).

In general, higher concentrations were associated with southerly wind flows. Minimum overall average 24-hr average PM_{10} values were very low, particularly during the late fall and winter months with many sites recording <1 µg m^{-3} with the largest minimum of 2.70 µg m^{-3} being recorded at Stromquist.

A striking feature of the 2012 Regional Air Monitoring data are the very low levels of $PM_{2.5,}$ which were typically well below 10 µg m^{-3} at all sites on most days (Figs. 4.10A-J) and Tables 4.3 and 4.4). Values ranged from lows of <1 µg m^{-3} at most sites to highs of 14.4 µg m^{-3} at Tsay Keh on June 8 and 13.7 µg m^{-3} at Stromquist on August 7. Average $PM_{2.5}$ and PM_{10} concentrations measured in 2012 were very similar to those measured in 2011, but considerably lower than those measured in 2010 (Table 4.5). The lower concentrations in both 2011 and 2012 are likely associated with the higher water levels (Fig. 4.11) and higher precipitation (Appendix I) in both years during the spring and summer. In contrast 2010 had considerably lower water levels (Fig. 4.6) and somewhat less precipitation and as a result much higher $PM_{2.5}$ and PM_{10} levels.

The $PM_{2.5}/PM_{10}$ ratio is a parameter that characterizes a given site in terms of the relative proportion of $PM_{2.5}$ and PM_{10}. In general, $PM_{2.5}$ is more typically associated with long distance transport as a result of deposition of the coarser particles during downwind transport. In contrast, particles between 2.5 and 10 µm are typically more closely associated with localized entrainment and emissions. In that PM_{10} contains the $\leq$2.5 µm particles, $PM_{2.5}$ never exceeds the value of PM_{10} so the ratio must be $\leq$1. Mean $PM_{2.5}/PM_{10}$ ratios for the nine sampling sites range from a low of 0.24 at Rat Lake to highs of 0.40 and 0.41 at Van Somer and Chowika, respectively (Table 4.6). In general, the ratios are somewhat more consistent and higher than those found at similar sites in 2011 but have a wide range of values for a given site when viewed on an annual basis.

Higher ratios can result from either an increased proportion of $PM_{2.5}$ particles or a lower proportion of PM_{10} particles. Based on a review of the 2011 and 2012 PM data it would appear that higher ratios in 2012 were associated with higher proportions of $PM_{2.5}$ particles at several of the sites. This suggests that transport in 2012 was in general dominated by the long distance transport of finer material rather than more local sources. This might be explained by the fact that 2012 was dominated by relatively infrequent and short duration storm events that would favour the prolonged suspension of finer material that can be transported downwind over time.

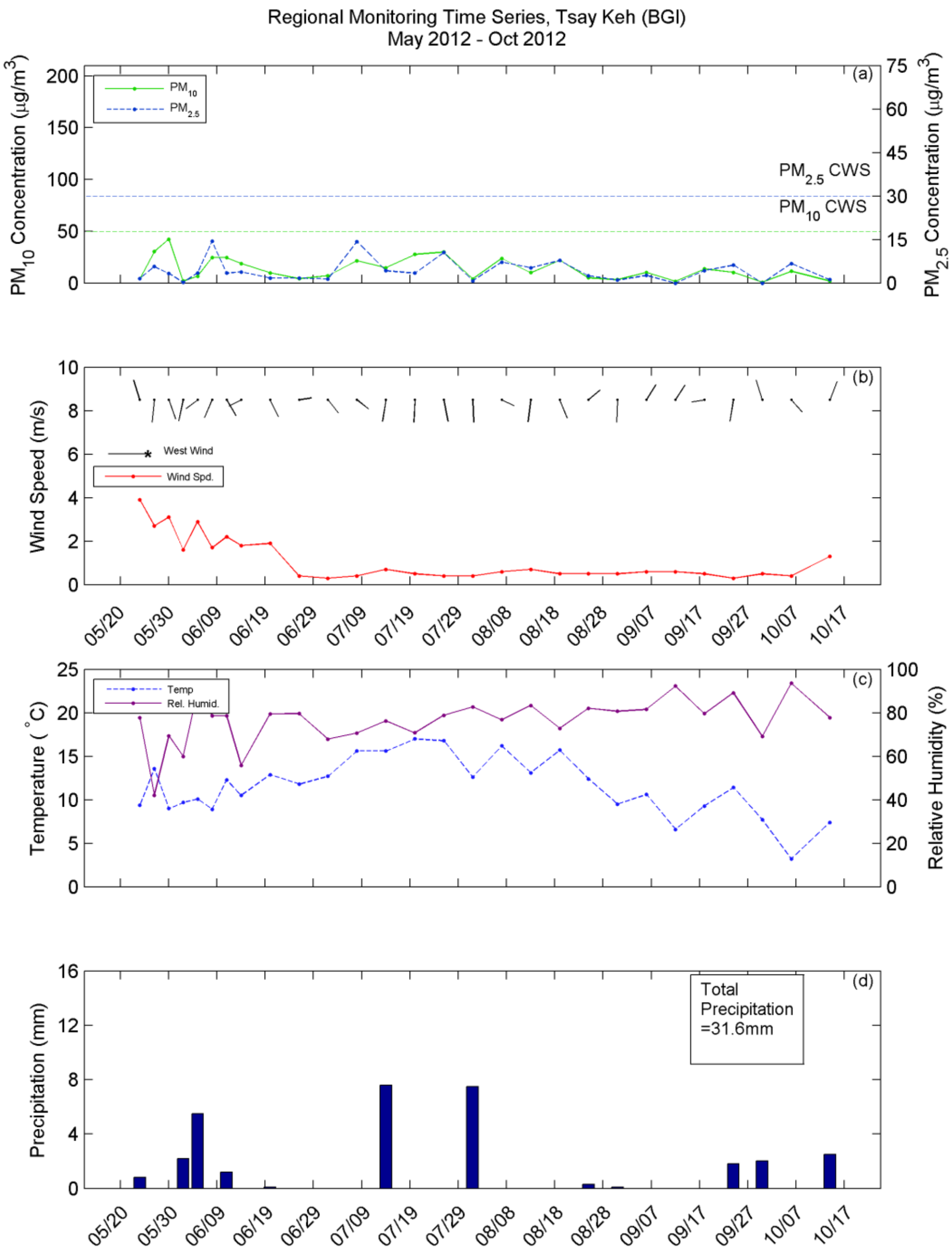


FIGURE 4.10A. TIME SERIES OF 24-HR AVERAGE COLOCATED BGI PM_{10} AND $PM_{2.5}$ CONCENTRATIONS SHOWING WIND SPEED AND DIRECTION, TEMPERATURE, RELATIVE HUMIDITY AND PRECIPITATION FOR TSAY KEH.

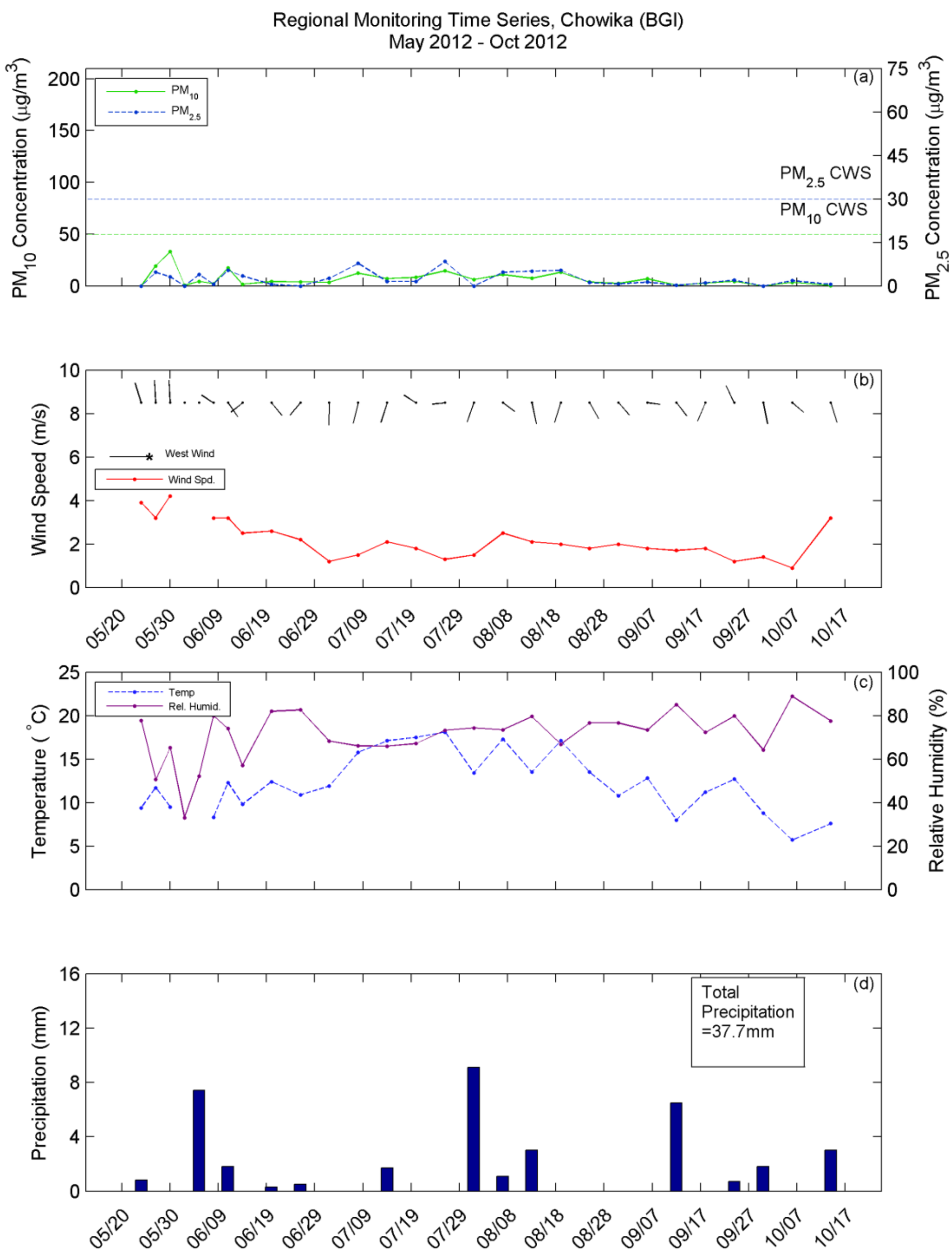


FIGURE 4.10B. TIME SERIES OF 24-HR AVERAGE BGI PM_{10} AND $PM_{2.5}$ CONCENTRATIONS SHOWING WIND SPEED AND DIRECTION, TEMPERATURE, RELATIVE HUMIDITY AND PRECIPITATION FOR CHOWIKA.

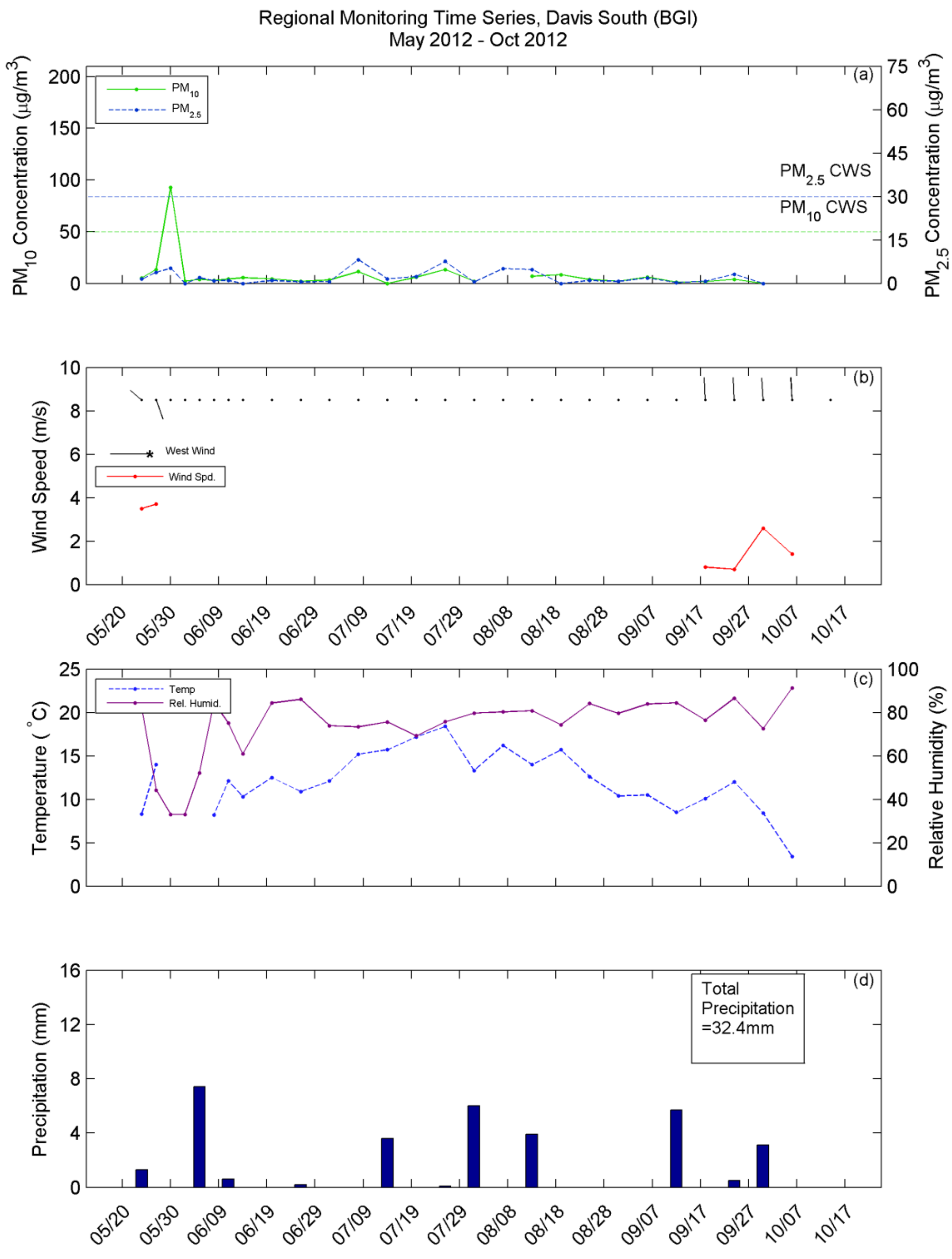


FIGURE 4.10C. TIME SERIES OF 24-HR AVERAGE BGI PM_{10} AND $PM_{2.5}$ CONCENTRATIONS SHOWING WIND SPEED AND DIRECTION, TEMPERATURE, RELATIVE HUMIDITY AND PRECIPITATION FOR DAVIS SOUTH.

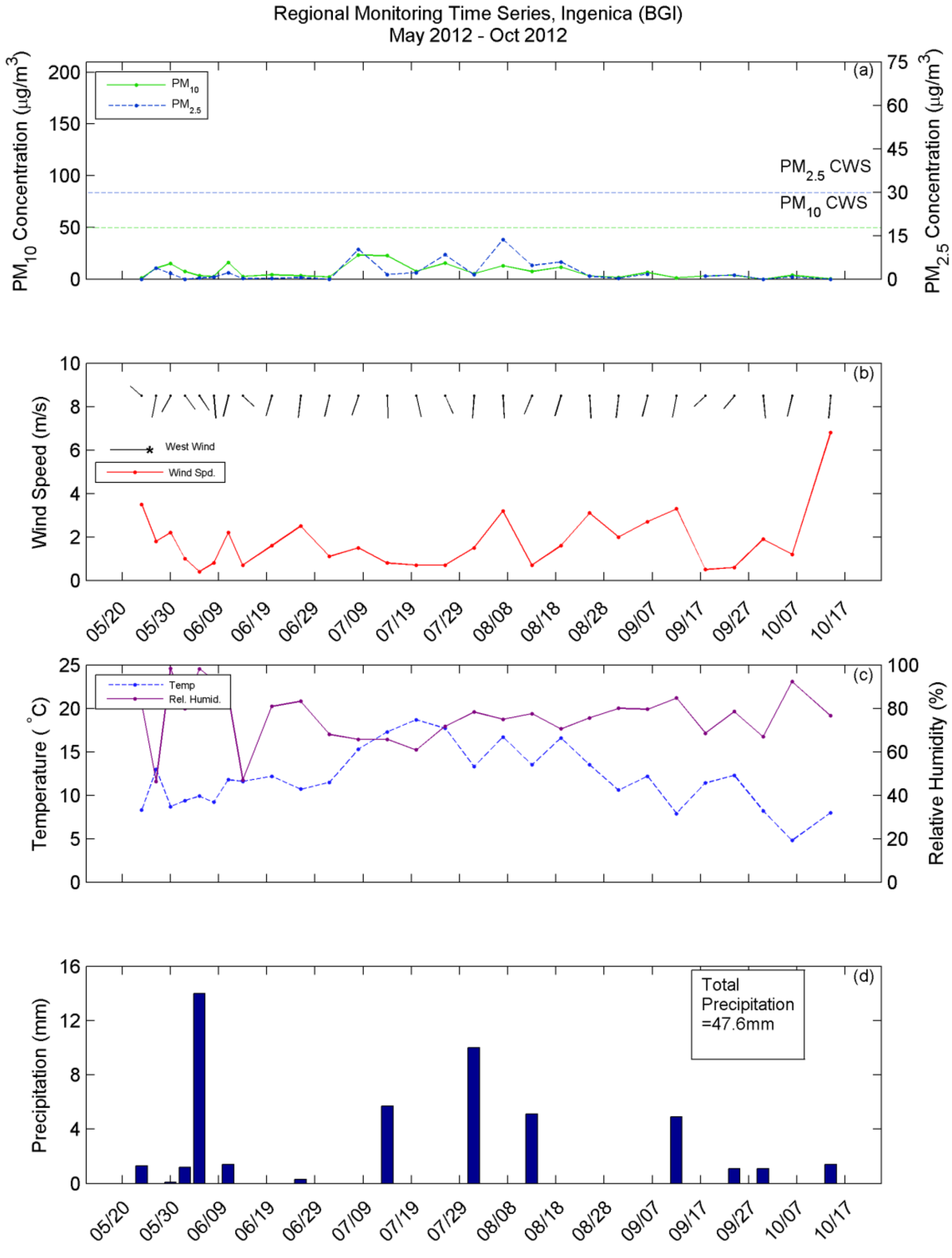


FIGURE 4.10D. TIME SERIES OF 24-HR AVERAGE BGI PM_{10} AND $PM_{2.5}$ CONCENTRATIONS SHOWING WIND SPEED AND DIRECTION, TEMPERATURE, RELATIVE HUMIDITY AND PRECIPITATION FOR INGENICA.

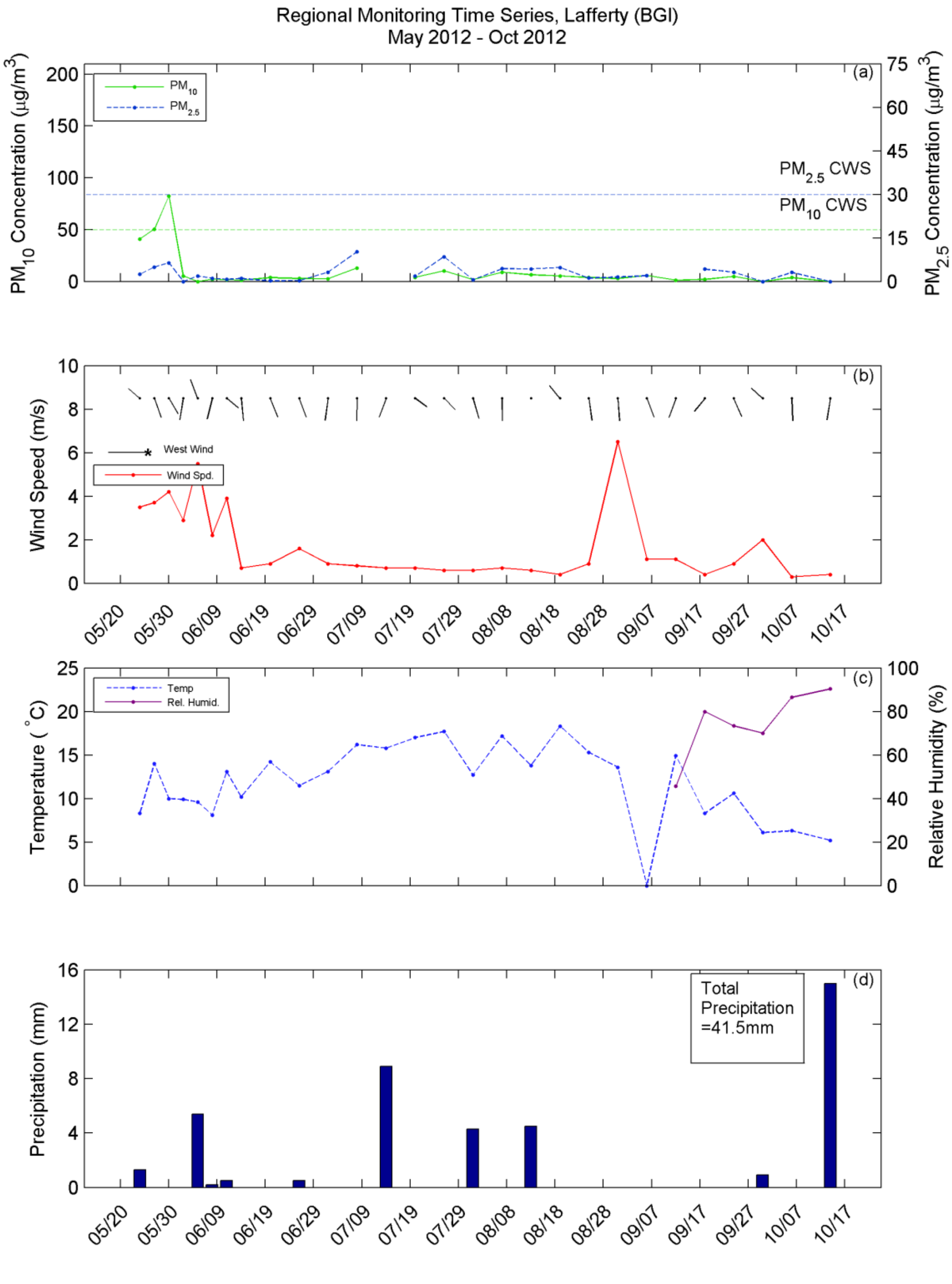


FIGURE 4.10E. TIME SERIES OF 24-HR AVERAGE BGI PM_{10} AND $PM_{2.5}$ CONCENTRATIONS SHOWING WIND SPEED AND DIRECTION, TEMPERATURE, RELATIVE HUMIDITY AND PRECIPITATION FOR LAFFERTY.

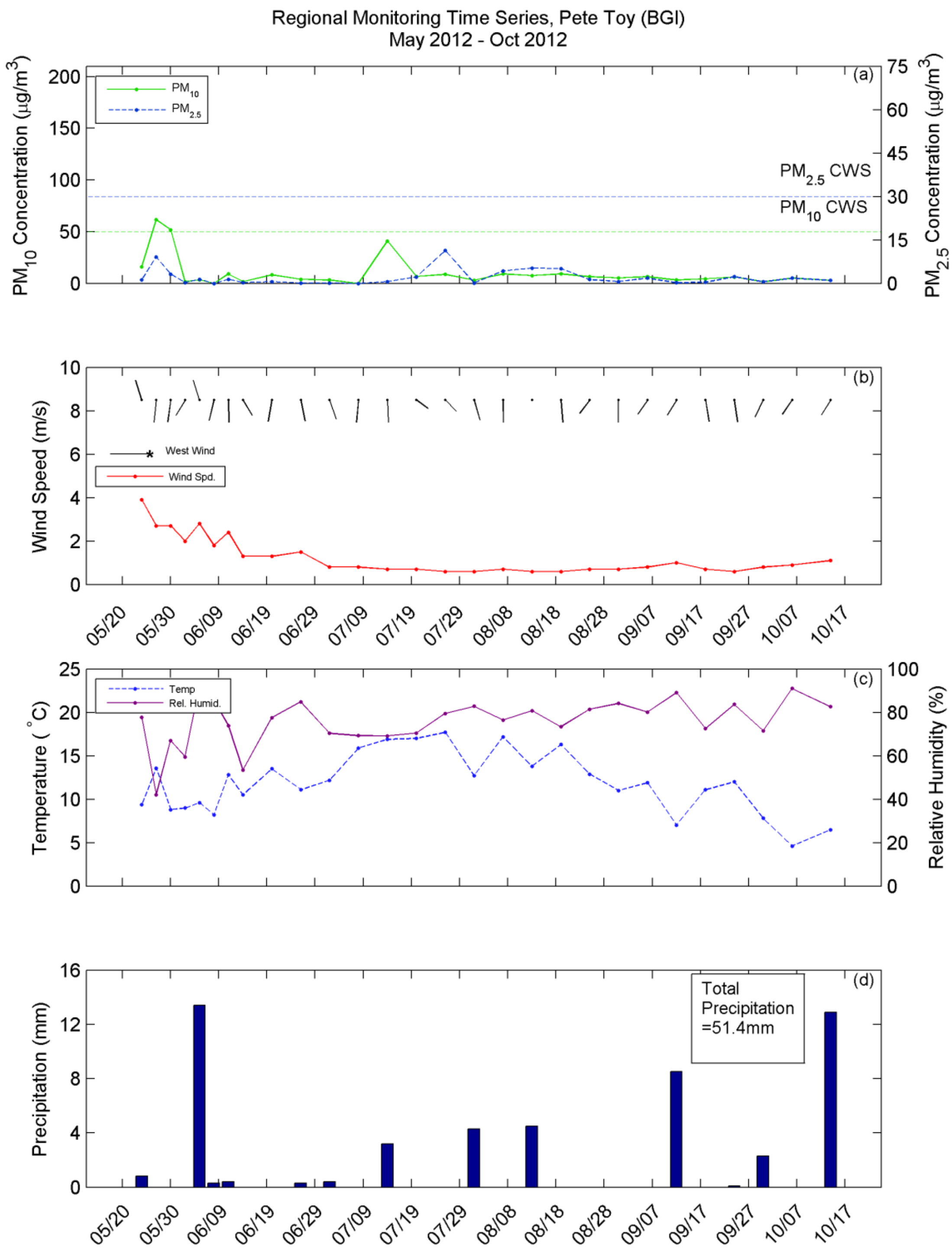


FIGURE 4.10F. TIME SERIES OF 24-HR AVERAGE BGI PM_{10} AND $PM_{2.5}$ CONCENTRATIONS SHOWING WIND SPEED AND DIRECTION, TEMPERATURE, RELATIVE HUMIDITY AND PRECIPITATION FOR PETE TOY.

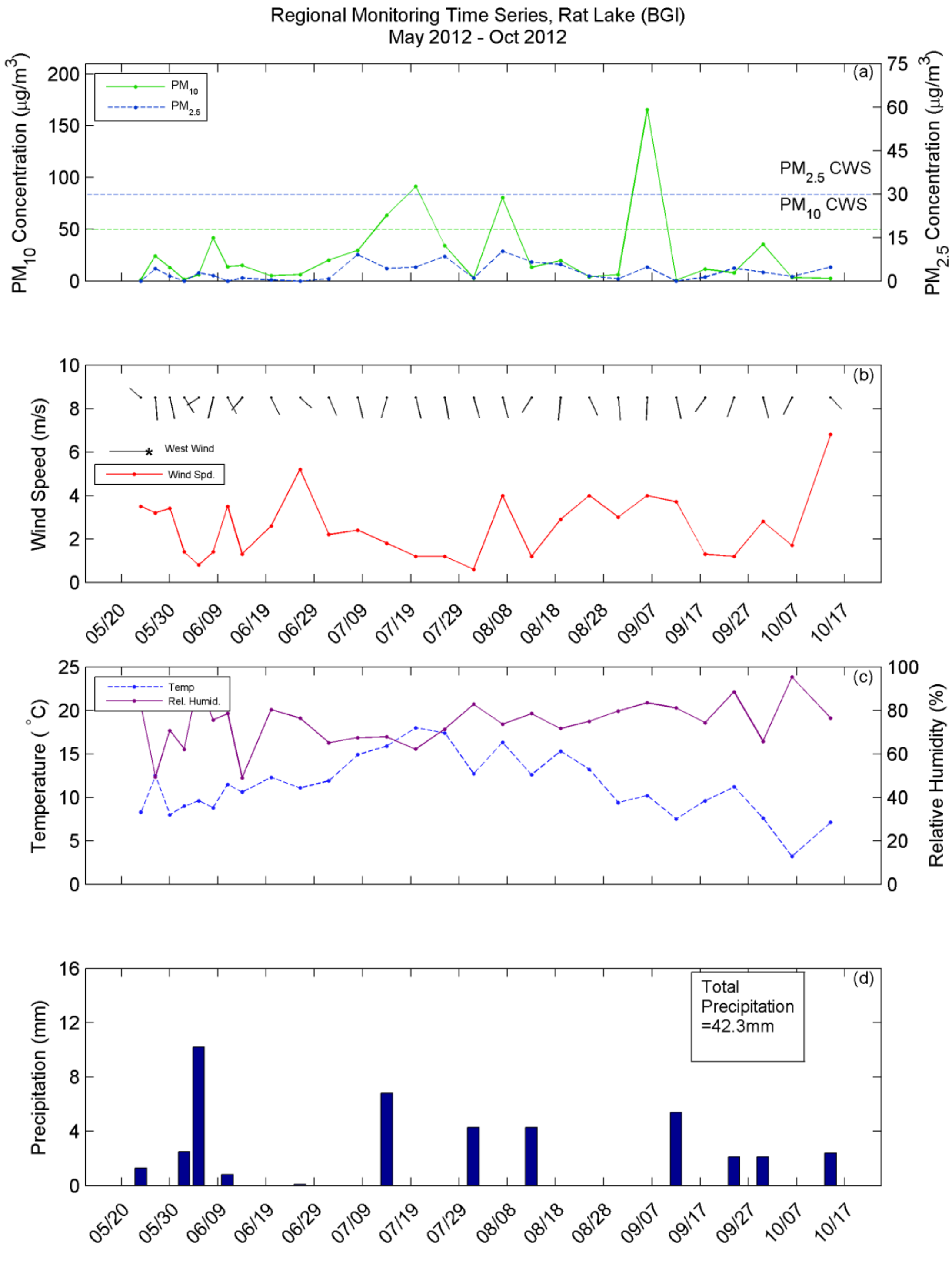


FIGURE 4.10G. TIME SERIES OF 24-HR AVERAGE BGI PM_{10} AND $PM_{2.5}$ CONCENTRATIONS SHOWING WIND SPEED AND DIRECTION, TEMPERATURE, RELATIVE HUMIDITY AND PRECIPITATION FOR RAT LAKE.

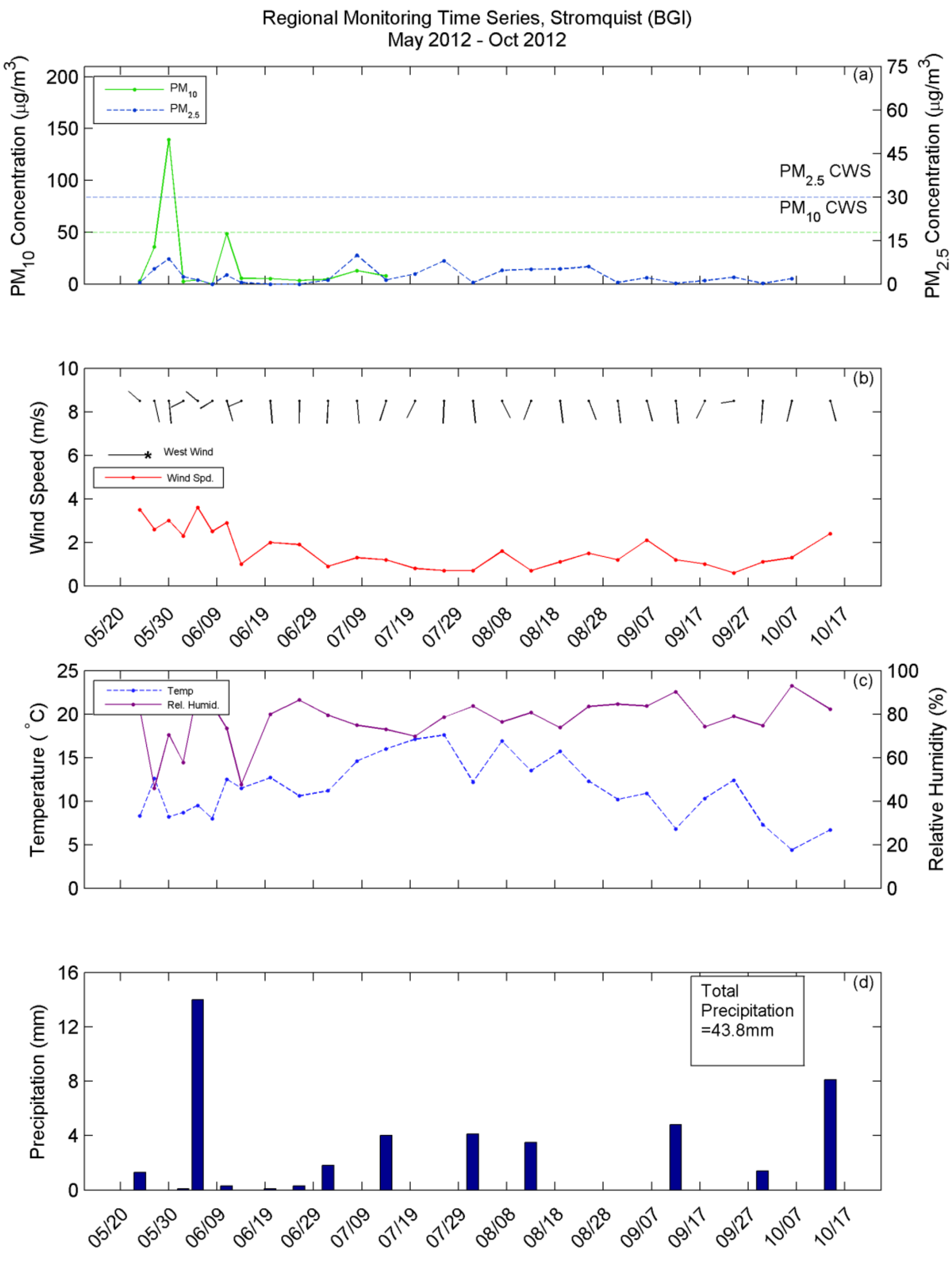


FIGURE 4.10H. TIME SERIES OF 24-HR AVERAGE BGI PM_{10} AND $PM_{2.5}$ CONCENTRATIONS SHOWING WIND SPEED AND DIRECTION, TEMPERATURE, RELATIVE HUMIDITY AND PRECIPITATION FOR STROMQUIST.

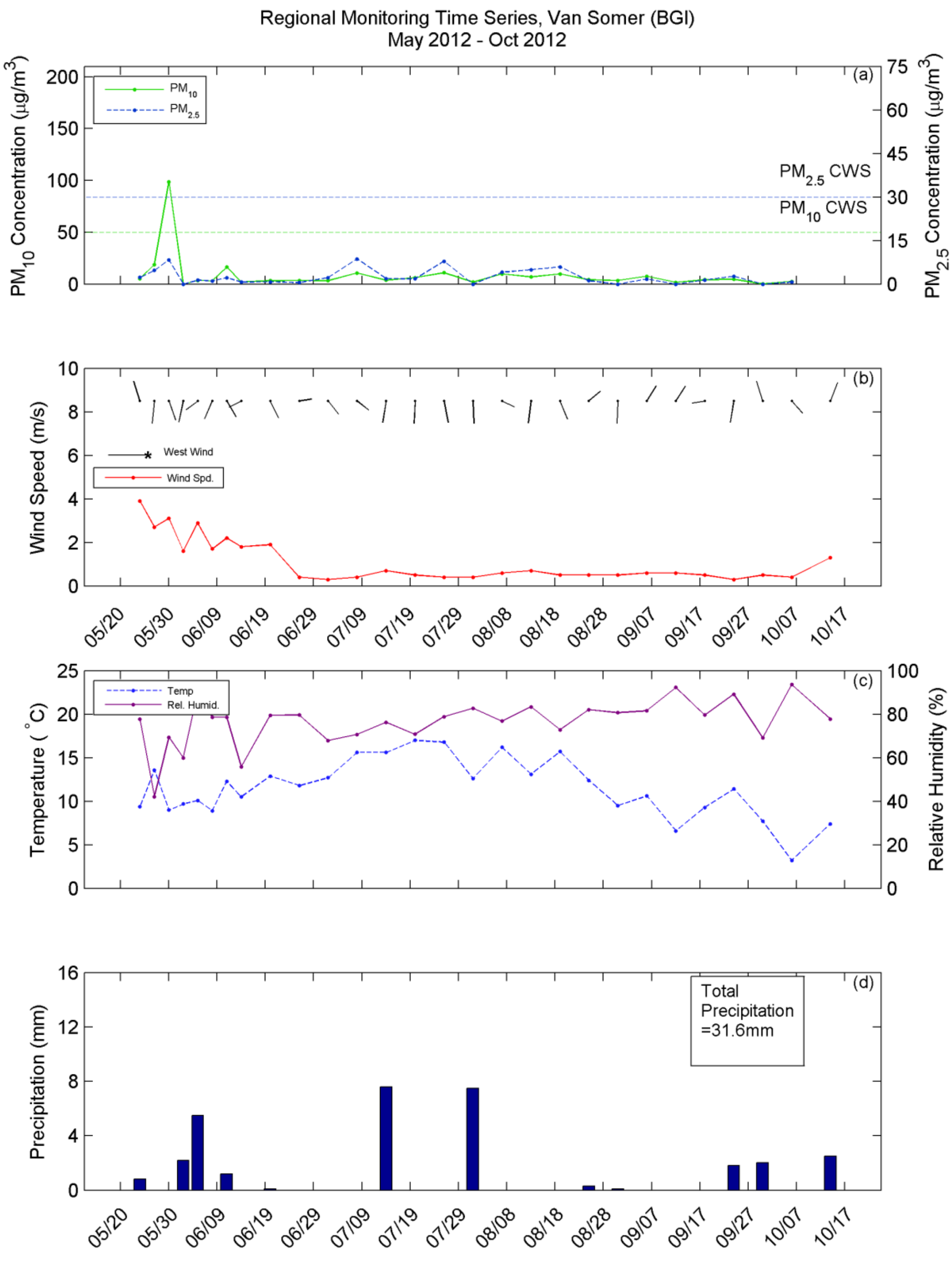


FIGURE 4.10I. TIME SERIES OF 24-HR AVERAGE BGI PM_{10} AND $PM_{2.5}$ CONCENTRATIONS SHOWING WIND SPEED AND DIRECTION, TEMPERATURE, RELATIVE HUMIDITY AND PRECIPITATION FOR VAN SOMER.

TABLE 4.3. 24-HR AVERAGE $PM_{2.5}$ AND PM_{10} CONCENTRATIONS MEASURED AT THE BGI SAMPLING SITES.

Date	Tsay Keh		South Davis		Van Somer		Stromquist		Rat Lake		Chowika		Lafferty		Pete Toy		Ingenica	
	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
	24-hr Average Concentration (µg/m^3)																	
24-May-12	4.1	1.6	NaN	NaN	5.3	1.5	1	*	40.9	2.5	16.2	1.2	1.3	*	3.1	0.5	5.1	2.3
27-May-12	30.4	5.7	19.4	4.7	13.5	3.8	10.5	3.8	50.4	5	61.6	9.1	24	4.2	35.8	5.2	18.7	4.7
30-May-12	42.4	3.3	33.1	3.1	92.6	5.2	15	2	82.4	6.4	51.9	3.2	13	1.7	139.4	8.7	98.8	8.3
02-Jun-12	2	0.2	0.6	*	2.2	*	7.4	*	5.2	*	1.4	0.3	1.5	*	2.7	2.5	NaN	NaN
05-Jun-12	6.6	3.5	4.4	3.9	3.9	2	3.2	0.4	*	*	3.5	1.4	6	2.8	3.9	1.4	3.6	1.3
08-Jun-12	24.5	14.4	2.1	0.6	2.8	0.9	2.5	0.7	2.2	1.1	NaN	NaN	41.6	1.9	NaN	NaN	3	1.1
11-Jun-12	24.5	3.4	17.3	5.4	4.2	1	16	2.2	1.7	0.8	9.2	1.4	13.9	*	48.6	3.1	16.3	2.2
14-Jun-12	18.9	3.8	1.7	3.4	5.6	*	2.7	0.2	1.3	1	1.8	0.3	15	1	5.5	0.5	2.1	0.7
20-Jun-12	9.8	1.7	4.2	0.5	4.4	1	4.2	0.3	3.7	0.2	8.3	0.6	5.1	0.4	5.2	*	3.3	0.8
26-Jun-12	4.2	1.7	3.9	*	2.1	0.5	3.2	0.5	2.8	0.3	3.9	0.1	6.1	*	3.6	*	3.4	0.5
02-Jul-12	7	1.4	3.6	2.6	3.2	0.6	2.2	*	2.7	3.2	3.2	0.1	20.1	0.8	4.7	1.4	3.3	2.2
08-Jul-12	21.5	14.3	12.3	7.8	11.4	8.2	23.1	10.3	12.9	10.2	NaN	NaN	29.6	9.1	12.9	9.9	10.8	8.7
14-Jul-12	14.9	4.2	7.1	1.5	*	*	22.7	1.6	NaN	NaN	41	0.6	63.5	4.3	7.7	1.4	3.8	1.9
20-Jul-12	27.6	3.4	8.2	1.5	5.9	2.4	7.5	2.2	4	1.8	6.6	2.2	91.3	4.8	NaN	3.5	6.2	1.8
26-Jul-12	29.9	10.5	14.6	8.4	13.4	7.6	15.5	8.4	10.2	8.5	8.8	11.3	33.9	8.5	NaN	8	11	7.9
01-Aug-12	3.9	0.8	6.1	*	2.2	0.5	5.4	1.5	1.8	0.6	3.1	0.1	2.6	1	NaN	0.5	2	*
07-Aug-12	23.7	7.2	11	4.7	*	5.1	13	13.7	8.9	4.4	9.1	4.3	80.4	10.3	NaN	4.7	9.8	4.1
13-Aug-12	10	5.3	7.4	5.1	6.8	4.8	7.4	4.7	6.4	4.3	7.6	5.3	13.3	6.6	NaN	5.1	6.8	5
19-Aug-12	21.9	7.8	13.3	5.4	8.5	*	11.6	5.9	5.3	4.8	9.1	5.1	19.7	5.7	NaN	5.2	9.9	5.9
25-Aug-12	5	2.5	3.7	1.2	3.7	1	3	1	3.7	1.2	6.4	1.3	4	1.7	NaN	6	4.2	1.2
31-Aug-12	3.3	1	2.3	0.7	2.2	0.7	1.7	0.3	2.8	1.5	5.4	0.6	6.3	0.8	NaN	0.5	3.4	*
06-Sep-12	10.2	2.6	6.9	1.3	6.3	1.9	6.4	1.7	5.7	2	6.5	1.8	165.7	4.8	NaN	2.2	7.6	1.7
12-Sep-12	1.6	*	0.7	0.2	1.2	0.3	1.2	*	1.2	*	3.3	0.2	0.9	*	NaN	0.3	1.7	*
18-Sep-12	13.6	4.3	2.6	1.1	1.6	0.8	3.1	1	2	4.2	4.3	0.4	11.4	1.3	NaN	1.2	4.2	1.4
24-Sep-12	10.2	6.2	4.3	2	3.9	3.2	3.7	1.4	4.8	3.2	6.2	2.3	7.9	4.4	NaN	2.4	4.6	2.7
30-Sep-12	0.8	*	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	1.5	0.5	35.4	3	NaN	0.2	NaN	NaN
06-Oct-12	11.4	6.7	3.4	1.8	NaN	NaN	3.7	0.8	3.8	3.1	5.1	1.8	3.2	1.6	NaN	1.9	2.6	0.7
14-Oct-12	2	1.2	0.3	0.5	NaN	NaN	NaN	NaN	NaN	NaN	3.1	1.0	2.6	4.8	NaN	NaN	NaN	NaN

NaN: instrument out of order or decommissioned * Below detectable limit

TABLE 4.4. OVERALL MEAN 24-HR PM_{10} AND $PM_{2.5}$ CONCENTRATIONS AT THE REGIONAL 2012 BGI SAMPLING SITES.

2012	Tsay Key		Chowika		Davis South		Ingenica		Lafferty		Pete Toy		Rat Lake		Stromquist		Van Somer	
	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Average	13.8	4.2	7.2	2.5	8.3	2.1	7.1	2.4	9.9	2.8	10.3	2.0	25.7	3.2	22.8	2.8	9.1	2.5
Min	0.8	*	0.3	*	*	*	1.2	*	*	*	1.4	0.1	0.9	*	2.7	*	1.7	*
Max	29.9	14.4	17.3	8.4	13.4	8.2	23.1	13.7	12.9	10.2	41.0	11.3	165.7	10.3	48.6	9.9	16.3	8.7

*Below detectable limit

TABLE 4.5. COMPARISON OF OVERALL AVERAGE ANNUAL PM_{10} AND $PM_{2.5}$ VALUES FOR SIMILAR SITES 2010 – 2012.

Location	Tsay Key		Davis South		Stromquist		Lafferty		Pete Toy		Rat Lake		Annual Average	
	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Year	Concentration ($\mu g\ m^{-3}$)													
Average 2012	14.0	4.0	7.0	2.1	23.0	3.0	10.0	3.0	10.0	2.0	26.0	3.0	12.7	2.4
Average 2011	10.0	1.0	5.0	1.0	22.0	2.0	15.0	3.0	14.0	5.0	8.0	3.0	10.6	2.1
Average 2010	155.0	5.0	435.0	7.0	232.0	9.0	326.0	11.0	235.0	19.0	na	na	197.6	7.3
													Avg. Ann. Diff. %	
Difference	Difference in Concentration Between Years (%)												PM_{10}	$PM_{2.5}$
2012 and 2011	4.0	3.0	3.0	1.0	-1.0	1.0	-5.0	0.0	-4.0	-3.0	18.0	0.0	2.4	0.3
2012 and 2010	-145.0	-4.0	-430.0	-6.0	-210.0	-7.0	-311.0	-8.0	-221.0	-14.0	na	na	-187.0	-5.1
2011 and 2010	-141.0	-1.0	-427.0	-5.0	-211.0	-6.0	-316.0	-8.0	-225.0	-17.0	na	na	-184.9	-4.9

As noted above, in 2000, the Canadian Council of Ministers of the Environment (CCME) ratified new Canada Wide Standard (CWS) for airborne particulates based on a $PM_{2.5}$ concentration of 30 µg m^{-3} (24 hour averaging time) based on the 98th percentile of annual measurements, averaged over three consecutive years, and was implemented in 2010. The CWS was adopted by British Columbia in 2000. However in 2009, a new and more stringent $PM_{2.5}$ ambient air quality criteria of 25 µg m^{-3} based on a 24 hour averaging time derived from the 98th percentile of annual measurements was adopted by BC. It should be noted that the new provincial criteria for $PM_{2.5}$ are in addition to the existing provincial AQO of 50 µg m^{-3} (24-hour average) (http://www.bcairquality.ca/regulatory/pm25-objective.html).

During 2011 there were very few exceedances above the 50 µg m^{-3} PM_{10} BC standard. In addition, there were no exceedances of the 30 µg m^{-3} $PM_{2.5}$ CWS or the new BC provincial standard for $PM_{2.5}$ of 25 µg m^{-3} (Table 4.7). Overall, there were a total of eleven exceedances of the BC PM_{10} standard with the largest at Rat Lake (four exceedances) followed by Lafferty and Pete Toy with two each, and one exceedance each at Davis, Stromquist and Van Somer. There were no exceedances of either the $PM_{2.5}$ or PM_{10} standards at Tsay Keh, Chowika or Ingenica.

The relatively low dust concentrations and lower number of exceedances of the PM_{10} and $PM_{2.5}$ standards likely reflects several factors. Of key importance were the high water levels, even at the beginning of the dust season in both 2011 and 2012, which reduced exposed beach areas thereby reducing the potential source areas for dust entrainment and subsequent transport downwind (Fig. 4.5). Also of importance were the meteorological conditions that worked against entrainment of sand and emission of dust. Wind speeds during 2011 and 2012 were similar in frequency, magnitude and direction and generally lower than those in 2010, with fewer intense storms with regional wind flow from the south (Fig. 4.1). In addition, both the 2011 and 2012 seasons were very wet with approximately 250 mm of precipitation during the sampling period in 2011 as compared to 277 mm in 2012 (Fig. 4.10A-J and Appendix III). These high precipitation levels, on over 30% of the observation days in both 2011 and 2012, tended to keep the surface relatively moist, thereby increasing the entrainment threshold and decreasing potential dust emissions. As well, the generally high relative humidity throughout the monitoring periods, in conjunction with the low temperatures and wind speeds likely decreased evaporation helping to retain moisture in the sediments thereby reducing dust emissions and dust emission potential.

One might expect that PM_{10} concentrations would tend to increase somewhat proportionally to the increase in wind speed. In 2010, maximum dust concentrations tended to lag up to several hours following the maximum wind speed. However, in 2012, and to some extent in 2011, there was little difference between peak wind speeds and maximum concentrations at most sites as can be seen during the largest recorded storm event of May 30, 2012. This is typified by the wind flow and concentration patterns at Davis, Lafferty, Pete Toy, Stromquist and Van Somer, all of which had exceedances of PM_{10} during this dust event (Figs. 4.10D, F, G, I, J and Appendix III). This decrease in lag time suggests that a large proportion of the dust being measured at a given site was likely derived relatively close to the sampling instruments, resulting in a very fast and relatively large increase in PM_{10} and $PM_{2.5}$ concentrations.

TABLE 4.6. $PM_{2.5}/PM_{10}$ RATIOS FOR THE BGI MONITORING SITES FOR THE 2012 MONITORING SEASON

2012	Tsay Keh	Chowika	Davis South	Ingenica	Lafferty	Pete Toy	Rat Lake	Stromquist	Van Somer	Overall
Average	0.35	0.41	0.38	0.31	0.48	0.25	0.24	0.31	0.40	0.35
Std Dev	0.18	0.21	0.21	0.21	0.28	0.21	0.19	0.30	0.21	0.22
Coef Var	0.52	0.51	0.54	0.69	0.58	0.86	0.78	0.99	0.52	0.67
Min	0.08	0.09	0.06	0.07	0.05	0.01	0.03	0.06	0.08	
Max	0.67	0.89	0.82	0.95	0.91	0.78	0.56	0.93	0.81	

TABLE 4.7. PM_{10} AND $PM_{2.5}$ EXCEEDANCES AT THE BGI SAMPLING SITES DURING THE 2011 STUDY PERIOD.

Date	**Tsay Keh**		**Davis**		**Van Somer**		**Stromquist**		**Rat Lake**		**Chowika**		**Lafferty**		**Pete Toy**		**Ingenica**	
2012	$PM_{2.5}$	PM_{10}	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
27-May-12													50.4		61.6			
30-May-12			92.6		99.6		139.4						82.4		51.9			
14-Jul-12									63.5				*	*				
20-Jul-12							*		91.3									
7-Aug-12			*				*		80.4									
6-Sep-12							*		166.2									

Total Exceedances in 2012

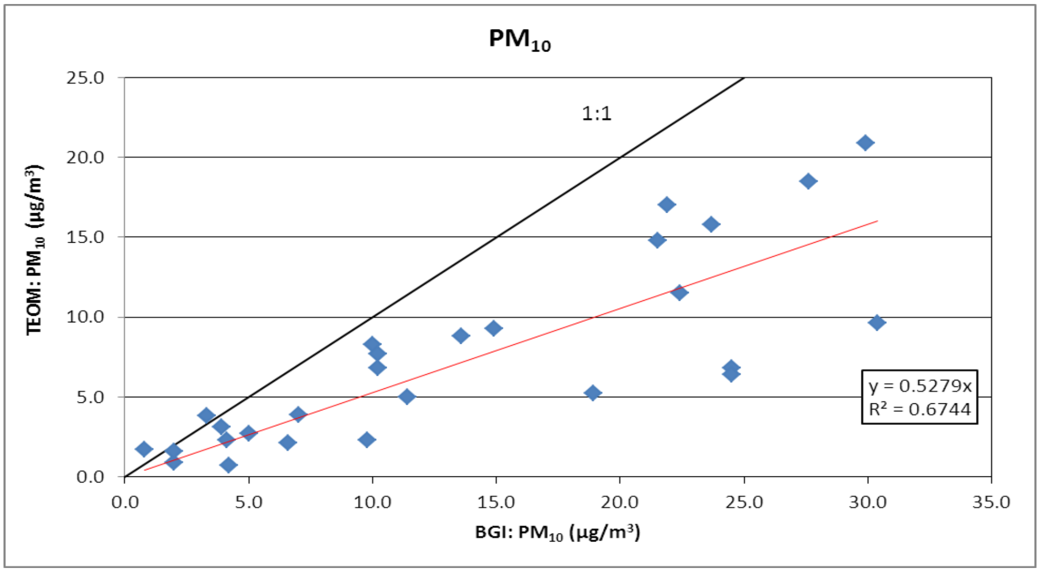
																			Total
PM_{10}	0		1		1		1		4		0		`		2		0		**11**
$PM_{2.5}$		0		0		0		0		0		0		0		0		0	**0**

It is also of note that in previous years the magnitude and timing of the dust concentrations in relation to wind speed was in many cases controlled by the proximity to available dust sources and associated topography. For example, the frequent exceedances at Rat Lake during southerly wind appears to be directly related to the flow and acceleration of air up the cliff face that is comprised of fine grained sediments that are easily entrained and transported when winds are from the south and somewhat perpendicular to the shoreline. Similarly, the extensive surface of fine-grained sediments at Pete Toy gives rise to somewhat higher average concentrations at this site. These patterns reflects the physical processes associated with the entrainment and subsequent transport, diffusion and ultimate deposition of dust in relation to the elevation and physical setting/location of a given sampling site. In general, higher concentrations and shorter lag times are associated with more exposed sites with long fetches and upwind supplies of entrainable sediment. Longer lag times and lower concentrations, often associated with lower wind speeds, are typically associated with less exposed or sites at higher elevations. It should be noted however that these general observations can be skewed as the result of local changes in surface conditions (e.g., moisture content, surface crusting due to precipitation events) and local topography).

4.4 Comparison of TEOM and BGI Measurements at Tsay Keh

Figure 4.12 shows a comparison of the $PM_{2.5}$ and PM_{10} measured with the TEOM and BGI instruments for similar days at Tsay Keh for the 2012 sampling period. As can be seen in this figure the TEOM measurements consistently underestimate the concentrations measured by BGI samplers for both $PM_{2.5}$ and PM_{10}. In general the $PM_{2.5}$ readings are closer to a 1:1 relationship between the two instruments (Fig. 4.12) both the $PM_{2.5}$ and PM_{10} measurements have reasonable linear correlations between the BGI and TEOM.

Differences between sampling instruments are not uncommon and small differences such as those shown below can be attributed to several factors. The very small quantities of $PM_{2.5}$ and PM_{10} can be measured more precisely with lower error on larger filters in a laboratory setting as is the case with the BGI instruments. Another possible error associated with the TEOM samples may be associated with the continuous heating of the filter over long periods of time to remove moisture effects that may result in the burning off/evaporation of volatile components in the particles that would not occur in the standard gravimetric analysis of the BGI filters. In that the differences between the two instruments were relatively small and concentrations very low for both $PM_{2.5}$ and PM_{10}, calibration corrections were not made to the TEOM concentrations based on the relationships shown in Fig 4.12.



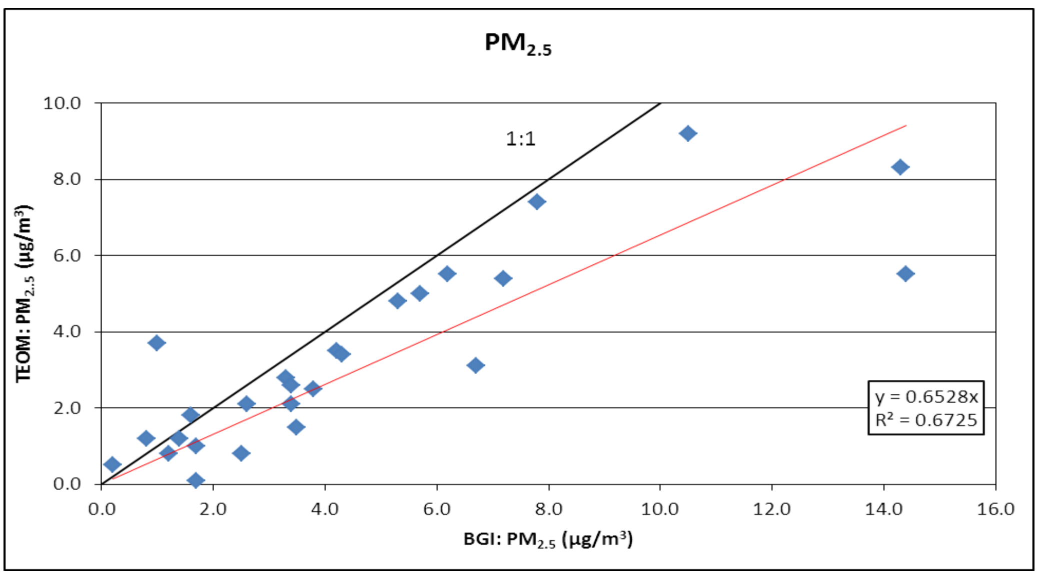


FIGURE 4.12. ANNUAL RELATIONSHIP BETWEEN 24-HR PM_{10} AND $PM_{2.5}$ CONCENTRATIONS AT TSAY KEH.

5.0 CONCLUSIONS

In general PM_{10} and $PM_{2.5}$ concentrations in 2012 were similar to those in 2011, and much lower than those in 2010 when considerably more beach areas were exposed. As a result there were fewer exceedances of Provincial and Federal standards in 2012 (11 total) as compared to 18 in 2011, and over 40 in 2010.

Despite the similarity in concentrations and water levels in 2011 and 2012 there was considerably less tillage carried out in 2012 as a result of several logistical problems, which raises the question of the efficacy of tillage in reducing dust emissions. There is however an enormous amount of literature from the dust bowl era to the present covering many locations throughout the world that clearly demonstrates tillage as a very effective method to reduce dust emissions. It would appear that in the case of the Williston Reservoir; during dust seasons with high water levels and moderate to high precipitation that dust emissions are naturally low because of the smaller areal extent of exposed beaches and their lower emissivity due to moisture effects. This observation clearly suggest that a tillage strategy needs to be developed that takes into account water levels and exposed surface area, meteorology and beach emissivity with some understanding of which areas of the reservoir should be protected most or at least first. Developing such a strategy is a very difficult task based solely on field measurements where individual variables vary greatly from year to year and from place to place. Gillies et al. (2013) describe one approach that involves the use of modeling to characterize the dust climatology of the Williston Reservoirand use this to evaluate the relative contributions of PM_{10} (and potentially $PM_{2.5}$) from different beaches by applying a Lagrangian Particle Dispersion Model. By identifying and ranking the importance or severity of each beach unit to a defined receptor site (e.g., Tsay Kay village), mitigation of the highest ranked beaches for impacting air quality can also be ranked in importance. This approach builds on the methods developed and the data obtained from the tillage trials, the PI SWERL testing and the Regional Air Monitoring Program. Using this type of modelling, individual parameters can be changed and concentrations calculated for numerous locations around the reservoir for differing, atmospheric, surface and water level conditions allowing for a more complete understanding of the relationship between dust concentrations around the reservoir and the amount and location of surface tilled. Acquiring additional PM_{10} and $PM_{2.5}$ data as well as regional meteorological data is still a critical component of the dust mitigation efforts at Williston Reservoir as this information will inform both the on-going risk associated with the PM levels, as well as inform developing management strategies.

6.0 Bibliography

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Appendix I

TEOM Particulate and Meteorological Data for Tsay Key (2012)

Tsay Keh PM and Meteorological Data (2012)									
Date	$PM_{2.5}$ (µg m^{-3})	PM_{10} (µg m^{-3})	PM Ratio	Wind Speed (ms^{-1})	Wind Direction (degrees)	Air Temp. (^{0}C)	RH (%)	Total Precip (mm)	Barometric Pressure (kPa)
1-Jan-12	2.7	3.9	0.69	3.5	180	-8.6	84.4	0	101.8
2-Jan-12	0.7	1.2	0.58	3.9	181	-2.5	92.8	0	100.3
3-Jan-12	2.6	2.9	0.90	1.3	184	-5.8	91.6	0	100.5
4-Jan-12	*	*	NaN	2.9	178	1.8	90	15.4	99.6
5-Jan-12	1.2	1.5	0.80	1.3	191	-0.8	82.1	0	100.6
6-Jan-12	3.4	4	0.85	0.6	340	-9.1	82.5	0	101.5
7-Jan-12	*	0.4	NaN	3.8	179	-4.9	89.3	0	100.9
8-Jan-12	1.8	2.2	0.82	1.9	183	-2.3	89.8	0.1	100.5
9-Jan-12	2.4	3	0.80	2.1	227	-1.3	88	1.5	100.6
10-Jan-12	3.3	4.2	0.79	0.6	346	-16.1	75.6	0	103.0
11-Jan-12	1.1	1.7	0.65	2.5	186	-12.4	81.8	0	102.9
12-Jan-12	*	0.7	NaN	3.9	192	-8.5	83.6	0.2	101.7
13-Jan-12	*	*	NaN	0.6	337	-12.7	81.2	0	101.5
14-Jan-12	5.3	6.7	0.79	3.7	1	-12.9	76.8	0	101.4
15-Jan-12	1.2	2.4	0.50	4.8	8	-19.3	62.7	0	102.6
16-Jan-12	2.2	2.7	0.81	3	2	-27	55.2	0	103.0
17-Jan-12	2.9	3.3	0.88	1.1	351	-34.9	52.8	0	102.6
18-Jan-12	2.9	3.3	0.88	0.9	354	-35.3	52	0	102.3
19-Jan-12	2.9	3.2	0.91	0.7	4	-35.5	52.3	0	101.5
20-Jan-12	1.1	1.5	0.73	1.1	11	-28.8	62.2	0	100.7
21-Jan-12	3.6	4.3	0.84	0.9	347	-20	72.9	0	99.0
22-Jan-12	6.9	7.9	0.87	0.6	343	-15.7	78.6	0	99.6
23-Jan-12	4.7	5.4	0.87	0.7	207	-9.8	84.7	0	99.6
24-Jan-12	0.6	1.1	0.55	4.2	177	-3.7	90.8	0	98.9
25-Jan-12	*	*	NaN	2.8	198	-2.3	66.9	0.9	99.5
26-Jan-12	3.2	4.3	0.74	2.2	195	-7.5	67.3	0	100.7
27-Jan-12	1.4	2.3	0.61	1.4	172	-8.4	83.8	0	101.3
28-Jan-12	2.7	3.2	0.84	0.5	348	-9.4	88	0	100.8
29-Jan-12	3.1	3.6	0.86	0	0	-5.2	88.2	0	99.4
30-Jan-12	0.5	0.6	0.83	1.8	189	-1	89.9	0	99.6
31-Jan-12	0.4	0.5	0.80	2.5	181	-1.8	89.5	0	100.2
1-Feb-12	2.9	3.4	0.85	1.1	186	-6	82.5	0.3	101.3

Tsay Keh PM and Meteorological Data (2012)									
Date	$PM_{2.5}$ (µg m^{-3})	PM_{10} (µg m^{-3})	PM Ratio	Wind Speed (ms^{-1})	Wind Direction (degrees)	Air Temp. (^0C)	RH (%)	Total Precip (mm)	Barometric Pressure (kPa)
2-Feb-12	1.1	1.5	0.73	5.7	179	-1.3	85.5	0	102.0
3-Feb-12	1.1	1.4	0.79	2	174	-0.1	88.8	0	102.1
4-Feb-12	2.6	3	0.87	0.5	346	0.3	96.3	0.7	102.4
5-Feb-12	6.3	7.2	0.88	0.7	0	-3.9	90.2	1.1	102.9
6-Feb-12	1.2	1.3	0.92	0.5	7	-14	79.8	0	102.8
7-Feb-12	1.5	1.9	0.79	0.7	358	-14.6	75.6	0	102.0
8-Feb-12	2.8	3.3	0.85	0.7	9	-16.3	73.8	0	102.1
9-Feb-12	6.2	7.5	0.83	0.6	27	-15.4	74.5	0	102.5
10-Feb-12	4.5	5.3	0.85	0.5	41	-5.2	88.6	0	102.1
11-Feb-12	4.7	5.7	0.82	1.2	198	-3	87.2	0	101.6
12-Feb-12	6	6.9	0.87	0.8	194	-3.9	89.9	1.6	100.9
13-Feb-12	3.6	4.3	0.84	0.7	356	-10.8	75	2.2	101.4
14-Feb-12	3.4	4.4	0.77	0.7	84	-15.1	73.9	0	101.5
15-Feb-12	8.2	10.4	0.79	0.6	1	-18	71.4	0	102.0
16-Feb-12	8.6	9.9	0.87	0.5	200	-11.8	79.4	0.1	101.8
17-Feb-12	6.1	7.8	0.78	0.8	358	-9.9	84.4	0	101.5
18-Feb-12	4.6	5.7	0.81	0.8	17	-8.6	81.1	0.2	100.7
19-Feb-12	4.6	5.1	0.90	0.6	188	-8.3	83.7	0.3	100.8
20-Feb-12	3.2	4.8	0.67	1.7	183	-10	85.6	0	100.5
21-Feb-12	3.9	4.7	0.83	1.3	191	-3.4	81.8	0.1	99.8
22-Feb-12	7.9	8.6	0.92	0.7	333	-5.2	81.1	0	100.4
23-Feb-12	5.8	6.6	0.88	0.8	346	-8	66.6	0	101.7
24-Feb-12	*	*	NaN	1	349	-14.4	71.9	0	101.3
25-Feb-12	NaN	NaN	NaN	1.3	356	-10.3	61.6	0	101.6
26-Feb-12	NaN	NaN	NaN	1.1	69	-15.3	65.1	0	102.3
27-Feb-12	NaN	NaN	NaN	2.2	182	-14.3	78.4	0	101.2
28-Feb-12	NaN	NaN	NaN	0.8	169	-8.4	82.2	0.1	100.5
29-Feb-12	NaN	NaN	NaN	0.8	1	-7.4	82.9	0	100.4
1-Mar-12	NaN	NaN	NaN	1.5	209	-8.9	71.3	0	101.2
2-Mar-12	NaN	NaN	NaN	1.5	183	-4.1	71.8	0	100.9
3-Mar-12	NaN	NaN	NaN	1.3	307	-3.8	63.8	2.2	100.7
4-Mar-12	NaN	NaN	NaN	1	203	-8.7	79.3	0	100.9
5-Mar-12	NaN	NaN	NaN	1.4	355	-14.4	63.9	0	101.1
6-Mar-12	NaN	NaN	NaN	2	202	-14.3	73	0	101.2
7-Mar-12	NaN	NaN	NaN	2.2	186	-2.3	75.8	0.2	101.1
8-Mar-12	NaN	NaN	NaN	4.7	178	1	85.4	1.7	101.0
9-Mar-12	NaN	NaN	NaN	3.2	186	1.7	68.6	0	100.0
10-Mar-12	NaN	NaN	NaN	1.4	180	-3.3	75.7	0	100.0
11-Mar-12	NaN	NaN	NaN	1.3	176	-0.7	88.9	0.3	99.2
12-Mar-12	2	14	0.14	1.3	189	-3.7	81.7	3.3	99.0

Tsay Keh PM and Meteorological Data (2012)									
Date	$PM_{2.5}$ (µg m^{-3})	PM_{10} (µg m^{-3})	PM Ratio	Wind Speed (ms^{-1})	Wind Direction (degrees)	Air Temp. (^{0}C)	RH (%)	Total Precip (mm)	Barometric Pressure (kPa)
13-Mar-12	2.7	3.7	0.73	1.6	0	-8.6	79.3	0	99.1
14-Mar-12	2.1	2.8	0.75	2.2	176	-6.8	80.5	0.1	99.9
15-Mar-12	0.2	0.7	0.29	1.6	175	-1.5	87.6	0	99.1
16-Mar-12	1	1.2	0.83	1.6	184	-1.3	90.2	0.1	99.4
17-Mar-12	2.4	3	0.80	0.7	132	-5.2	81.4	0	100.0
18-Mar-12	2.8	3.5	0.80	1.9	184	-4.8	74	0	100.2
19-Mar-12	2.4	3.1	0.77	1.3	197	-7.6	79.8	0.7	100.3
20-Mar-12	2.3	3	0.77	1.5	176	-8.1	76.5	0	99.4
21-Mar-12	1.7	2.3	0.74	1.5	191	-4.8	85.7	0.4	100.3
22-Mar-12	3.7	4.6	0.80	1.4	193	-3.9	67.8	0.1	101.3
23-Mar-12	5.2	6.3	0.83	0.9	172	-6.9	64.4	0	101.9
24-Mar-12	3.8	4.7	0.81	1	183	-6.3	72.9	0	101.6
25-Mar-12	4.3	5.5	0.78	1	203	-6.5	70	0	101.0
26-Mar-12	2.7	3.5	0.77	0.9	357	-6.9	61.6	0	100.9
27-Mar-12	2.5	3.7	0.68	1.4	195	-3.2	63.3	0	100.5
28-Mar-12	4.2	5.6	0.75	1.3	186	-1	78.6	0	99.8
29-Mar-12	1.2	1.7	0.71	2.2	185	-0.2	88.4	0.1	99.2
30-Mar-12	1.7	2.2	0.77	1	192	-0.6	77.4	0.8	99.4
31-Mar-12	2.4	2.9	0.83	1.1	186	-5.4	68.1	0	100.0
1-Apr-12	2.1	2.6	0.81	1	179	-4.8	57.1	0	100.5
2-Apr-12	1	2.3	0.43	3.2	187	-2.3	71.1	0	100.6
3-Apr-12	2	3.8	0.53	1.4	184	2.7	70.6	0	100.3
4-Apr-12	3	3.9	0.77	1.3	186	0.2	65.4	0	101.2
5-Apr-12	1.5	2.2	0.68	1.9	3	-0.3	55.6	0	101.8
6-Apr-12	2	2.8	0.71	1.1	12	-0.4	54.7	0	102.0
7-Apr-12	2.4	3.6	0.67	1.1	163	-1.7	66	0	102.4
8-Apr-12	1.8	3.2	0.56	1.1	193	-0.1	63	0	102.7
9-Apr-12	2.9	5.3	0.55	0.9	164	1	61.2	0	102.0
10-Apr-12	4	6.8	0.59	0.8	154	3.7	54.3	0	101.2
11-Apr-12	6.5	11.9	0.55	1.5	8	7.7	57.9	0	100.8
12-Apr-12	5.1	7.2	0.71	1.8	358	3.8	85.9	2.5	100.9
13-Apr-12	4	5.2	0.77	0.9	177	1.9	91.3	0.8	101.2
14-Apr-12	3.3	4.2	0.79	1.6	179	2	72.4	0	101.9
15-Apr-12	2.6	3.7	0.70	2	188	0.8	70.8	0	101.7
16-Apr-12	2.2	3.2	0.69	1.4	175	2.5	68.9	0	101.2
17-Apr-12	3.8	5.1	0.75	1.6	183	2	74.2	0	101.4
18-Apr-12	3.4	4.8	0.71	1.4	187	1.8	75.1	0	101.2
19-Apr-12	1.4	2.4	0.58	1.8	186	3.3	74.6	0	101.0
20-Apr-12	1.9	2.5	0.76	1.7	232	5.2	64.3	0.2	101.0
21-Apr-12	2	3.4	0.59	1.2	174	1.9	57.5	0	101.9

Tsay Keh PM and Meteorological Data (2012)									
Date	$PM_{2.5}$ (µg m^{-3})	PM_{10} (µg m^{-3})	PM Ratio	Wind Speed (ms^{-1})	Wind Direction (degrees)	Air Temp. (^{0}C)	RH (%)	Total Precip (mm)	Barometric Pressure (kPa)
22-Apr-12	2.8	5.5	0.51	1.3	182	1.9	56.8	0	101.6
23-Apr-12	3.5	6.1	0.57	1.3	195	2.6	76.6	1.7	101.1
24-Apr-12	3.2	5	0.64	1.3	8	2.6	68.8	0	100.9
25-Apr-12	1.6	2.2	0.73	1.1	193	4	77.6	1.5	100.7
26-Apr-12	0.1	0.3	0.33	0.9	184	2.7	95.8	9.4	100.4
27-Apr-12	1.6	2.1	0.76	1.9	226	4.9	69.4	2.3	101.0
28-Apr-12	*	0.1	NaN	1.7	187	3.3	79.6	0	101.4
29-Apr-12	2.1	3.2	0.66	1.7	185	4.4	75.8	0	101.2
30-Apr-12	1.4	3.6	0.39	1.2	153	5.8	61.6	0	100.1
1-May-12	3	4.9	0.61	1.3	191	4.5	89.5	4.8	100.3
2-May-12	1.6	2.3	0.70	1.7	192	4.4	72.1	0	100.9
3-May-12	1.6	4.4	0.36	1.3	174	3.5	71.7	0	100.7
4-May-12	1.7	3.4	0.50	1.8	244	5.9	58.3	0	100.9
5-May-12	2.6	4.9	0.53	1.6	283	6	45	0	102.0
6-May-12	5.1	23	0.22	2.1	189	3.2	72.8	1.4	102.3
7-May-12	2.7	31.5	0.09	3.4	186	5.4	82.9	0.2	101.7
8-May-12	1.6	5.8	0.28	2.6	240	7	53.2	0.1	100.9
9-May-12	2.1	5.6	0.38	1.6	270	2.7	51.2	0	100.9
10-May-12	3.3	9.2	0.36	2.1	297	4.5	44.6	0	101.5
11-May-12	2.2	4.3	0.51	1.6	262	7.5	44.9	0	101.9
12-May-12	3.1	5.2	0.60	1.7	212	8.8	48.6	0	101.9
13-May-12	6.5	19.7	0.33	2.1	286	7	46.5	0	102.0
14-May-12	1.5	3.9	0.38	1.4	184	6	44	0	102.1
15-May-12	1.6	3.5	0.46	2.1	290	7.9	37.1	0	101.5
16-May-12	0.6	1.8	0.33	2.2	358	3.1	47.4	0.1	101.5
17-May-12	1.6	4.4	0.36	2.7	357	2.6	64	0	101.4
18-May-12	0.7	1.5	0.47	1.9	162	4.2	55	0	101.7
19-May-12	1.9	6.6	0.29	1.8	197	4.6	55	0	101.8
20-May-12	3.8	8.9	0.43	2	182	9.7	48.1	0	101.3
21-May-12	2.5	7.4	0.34	1.6	187	10.6	77.4	2.8	100.7
22-May-12	2.4	2.9	0.83	1.6	351	8.9	88.6	11.1	100.4
23-May-12	0.9	1.1	0.82	0.8	19	6.7	91.8	12.6	101.0
24-May-12	1.8	2.3	0.78	1.7	352	10.7	78.3	1.5	101.8
25-May-12	1	1.7	0.59	1.3	183	10.9	63.8	0	101.8
26-May-12	10.2	32	0.32	2.1	183	11.8	55.9	0	100.9
27-May-12	5	9.6	0.52	2	193	12.8	49.6	0	101.0
28-May-12	5	13.3	0.38	1.6	339	12.5	55	2.2	101.2
29-May-12	0.7	1.2	0.58	1.3	208	9.5	87.1	1.8	101.2
30-May-12	2.7	11.5	0.23	2	194	8.9	68.2	0	101.3
31-May-12	0.4	2.4	0.17	1.7	216	9.9	60.3	0	101.1

Tsay Keh PM and Meteorological Data (2012)									
Date	$PM_{2.5}$ (µg m^{-3})	PM_{10} (µg m^{-3})	PM Ratio	Wind Speed (ms^{-1})	Wind Direction (degrees)	Air Temp. (^0C)	RH (%)	Total Precip (mm)	Barometric Pressure (kPa)
1-Jun-12	4.5	21.5	0.21	2	181	8.2	66	2.7	100.7
2-Jun-12	*	0.2	NaN	1	162	10.2	55.9	1.2	100.7
3-Jun-12	0.1	0.7	0.14	1.8	1	10.6	49.4	0	101.1
4-Jun-12	0.3	2.7	0.11	1.9	71	12.4	52.6	0.1	101.4
5-Jun-12	1.5	2.2	0.68	2.1	350	10.2	89.9	7	101.2
6-Jun-12	7.5	9.2	0.82	2.1	349	10.6	94.3	11.4	101.1
7-Jun-12	2.3	20.1	0.11	4	180	9.4	87.2	4.7	100.5
8-Jun-12	4.7	6	0.78	1.6	359	9.7	70.9	0	101.2
9-Jun-12	3.1	4.6	0.67	1.6	354	13.4	58.7	0	101.3
10-Jun-12	4.5	10.8	0.42	1.5	193	14.9	52.9	0	101.4
11-Jun-12	2	6.3	0.32	1.5	192	11.9	84.1	2	101.3
12-Jun-12	0.8	1.6	0.50	1.4	273	13	51	0	101.1
13-Jun-12	2.1	3.6	0.58	1.4	354	9.6	51.2	0	101.1
14-Jun-12	2.1	5	0.42	1.6	359	11.2	47.1	0	101.3
15-Jun-12	2.8	10.9	0.26	2	187	10.5	61	2.3	101.5
16-Jun-12	*	*	NaN	1.6	188	9.3	93.5	8.9	100.5
17-Jun-12	0.9	1.6	0.56	1.1	310	12.3	79.7	1.3	100.2
18-Jun-12	1.5	2.5	0.60	1.5	9	13.5	74.5	3.2	100.7
19-Jun-12	1	1.7	0.59	1.1	160	13.2	82.7	0.9	101.5
20-Jun-12	0.7	2.3	0.30	1.3	184	13.8	74.7	0	101.7
21-Jun-12	1.5	3.2	0.47	1.2	171	14.6	63.4	0	101.6
22-Jun-12	7.2	11.9	0.61	1.4	94	17.9	52.9	0	101.5
23-Jun-12	11.7	18.8	0.62	1.6	49	18.9	47.7	0	101.4
24-Jun-12	6.4	8.3	0.77	1.4	161	14.5	80.8	1.9	101.2
25-Jun-12	*	*	NaN	1.4	182	12	87.7	3.8	100.9
26-Jun-12	*	0.2	NaN	2.1	185	11.9	74.1	0	100.6
27-Jun-12	*	5.1	NaN	1.2	176	13.6	54.7	0	100.9
28-Jun-12	1.2	4.4	0.27	2.2	183	11.4	75.1	2	101.1
29-Jun-12	*	2.8	NaN	2.2	187	13.2	77.1	0.3	101.1
30-Jun-12	*	0.6	NaN	1.1	210	11.9	77.9	4.6	101.0
1-Jul-12	0.5	2.1	0.24	1.3	190	10.7	69.4	0	101.0
2-Jul-12	0.6	3.9	0.15	1.3	189	12.2	66.7	0	101.0
3-Jul-12	0.9	3.7	0.24	2	358	10.7	77.7	3.2	100.8
4-Jul-12	1.6	8.4	0.19	2.5	178	12.3	74	0	101.2
5-Jul-12	0.4	1.6	0.25	1.3	177	12.8	78	8.7	101.6
6-Jul-12	1	4.9	0.20	1.5	186	13	70.8	0	101.8
7-Jul-12	3.8	10.4	0.37	1.2	193	15	65.7	0	101.9
8-Jul-12	8.4	15	0.56	1.2	184	16.1	63.3	0	101.9
9-Jul-12	25.5	36.8	0.69	1.1	184	17.6	59.2	0	101.5
10-Jul-12	7.7	13.6	0.57	1.7	266	19.5	43.5	0	101.4

Tsay Keh PM and Meteorological Data (2012)									
Date	$PM_{2.5}$ (µg m^{-3})	PM_{10} (µg m^{-3})	PM Ratio	Wind Speed (ms^{-1})	Wind Direction (degrees)	Air Temp. (^{0}C)	RH (%)	Total Precip (mm)	Barometric Pressure (kPa)
11-Jul-12	1	6.3	0.16	1.5	269	16.6	37.1	0	101.6
12-Jul-12	2.6	10	0.26	1.3	90	16.2	42.2	0	101.7
13-Jul-12	2.9	11.5	0.25	1.4	178	15.9	55.5	0	101.8
14-Jul-12	3.2	9.3	0.34	1.3	345	16.3	65.4	7.8	101.6
15-Jul-12	7.1	11.2	0.63	1.4	356	18.6	68.5	0.1	101.9
16-Jul-12	14.9	20.2	0.74	1.3	188	18.4	67.7	0	101.2
17-Jul-12	0.8	6.3	0.13	2.4	7	19.1	44.4	0	100.8
18-Jul-12	0.8	4.7	0.17	2.8	355	17.3	52.8	0.2	101.0
19-Jul-12	1.1	5.1	0.22	1.4	182	14.6	71.9	0	101.7
20-Jul-12	2.5	18.7	0.13	1.1	138	18.7	58.5	0	101.5
21-Jul-12	2.1	5.8	0.36	2.2	182	16.8	82.3	1.2	101.4
22-Jul-12	1.7	4.7	0.36	0.8	26	15.9	86.2	1.3	101.7
23-Jul-12	3.7	13.8	0.27	1.1	166	17.5	72.1	0.1	101.7
24-Jul-12	4.9	9.9	0.49	1.5	5	19.5	58.9	0	101.5
25-Jul-12	7.8	17.8	0.44	1.3	177	18	63.1	0	101.8
26-Jul-12	9.2	21	0.44	1.3	167	18.2	65.3	0	101.6
27-Jul-12	4.9	12.1	0.40	1.4	202	17.5	79.3	1.9	101.3
28-Jul-12	3.4	6.7	0.51	1.5	165	16.3	78.3	1.4	101.5
29-Jul-12	2.3	4.9	0.47	1.4	187	15.3	73.8	0	101.6
30-Jul-12	0.4	3.1	0.13	1.1	165	14.6	67	0.6	101.5
31-Jul-12	0.7	4.2	0.17	1.7	188	13	66.1	0	101.6
1-Aug-12	0.7	2.8	0.25	1.1	158	13.5	76	9.6	101.5
2-Aug-12	*	1	NaN	1.1	195	15.5	70.5	0	101.8
3-Aug-12	*	1.2	NaN	1.4	195	18.4	65.1	0	101.7
4-Aug-12	*	2.2	NaN	2	5	20	49.9	0	101.5
5-Aug-12	1.7	7.7	0.22	1.1	182	15.4	61.9	0	101.5
6-Aug-12	2.8	7.9	0.35	1.3	194	17	64	0	101.7
7-Aug-12	5.4	15.8	0.34	1.5	186	16.6	70.2	0	101.7
8-Aug-12	2.6	8.8	0.30	1.4	185	17.5	71.6	0	101.5
9-Aug-12	*	2.6	NaN	1.6	288	15.5	50.3	0	101.8
10-Aug-12	0.8	2.9	0.28	1	127	12	57.8	0	101.9
11-Aug-12	0.8	3.7	0.22	1.3	175	13.1	64.8	0	102.1
12-Aug-12	2.2	5.6	0.39	1.7	356	15.1	66.6	0.1	101.8
13-Aug-12	4.9	8.3	0.59	1.2	4	13.2	74.6	6	101.4
14-Aug-12	2.6	4.3	0.60	2.4	351	14.8	73.3	2.2	102.1
15-Aug-12	1.2	3.8	0.32	1.7	201	15.3	70.5	0	102.1
16-Aug-12	3.6	8	0.45	1.3	207	14	73.6	0	101.7
17-Aug-12	4.1	9.8	0.42	1.5	188	15.3	69.5	0	101.6
18-Aug-12	8.1	15.9	0.51	1.2	193	16.9	68.4	0	101.3
19-Aug-12	7.3	16.8	0.43	1.3	192	16.1	67.4	0	101.4

Tsay Keh PM and Meteorological Data (2012)									
Date	$PM_{2.5}$ (µg m^{-3})	PM_{10} (µg m^{-3})	PM Ratio	Wind Speed (ms^{-1})	Wind Direction (degrees)	Air Temp. (^{0}C)	RH (%)	Total Precip (mm)	Barometric Pressure (kPa)
20-Aug-12	5.9	14	0.42	1.1	195	16.3	66.2	0	101.3
21-Aug-12	6.2	15.6	0.40	1.4	190	14.2	69.5	0.1	101.1
22-Aug-12	2.2	4.2	0.52	0.8	312	14.1	93.3	19.7	101.0
23-Aug-12	*	1.3	NaN	1.2	184	12.4	77.5	1.9	101.0
24-Aug-12	0.5	3	0.17	0.8	209	12.6	82	3.4	101.4
25-Aug-12	0.5	2.7	0.19	1.6	188	13.1	76.7	0	101.5
26-Aug-12	1	3.7	0.27	1	177	12.4	72.6	0	101.3
27-Aug-12	2.1	7.3	0.29	1.8	188	13.2	73.4	0	101.0
28-Aug-12	0.5	2.3	0.22	1.1	166	14.8	65	0	100.9
29-Aug-12	1	3.2	0.31	1.5	345	11.9	75.1	1.4	101.0
30-Aug-12	0.5	2.3	0.22	2.3	2	10.2	75.8	0	101.6
31-Aug-12	*	2.5	NaN	1.2	194	9.6	73.8	0	101.4
1-Sep-12	*	0.2	NaN	1.7	189	11.5	76.5	0	101.1
2-Sep-12	0.4	0.4	1.00	1.5	296	12.6	65.4	0.4	101.2
3-Sep-12	0.4	0.9	0.44	1.3	352	8.8	69.5	0	101.7
4-Sep-12	0	0.3	0.00	1.5	214	11	72.5	0.1	101.8
5-Sep-12	0.9	3.6	0.25	1.1	339	11	68	0	101.9
6-Sep-12	2.1	7.5	0.28	1.6	205	10.7	75	0	101.8
7-Sep-12	1.1	5.3	0.21	1.2	222	11.4	61.6	0	102.1
8-Sep-12	1.5	7	0.21	1.5	198	11.9	68.5	0	101.4
9-Sep-12	0.5	6.7	0.07	2.9	190	13.9	66.6	0	100.1
10-Sep-12	0.6	2.4	0.25	1.5	299	9	55.4	0	100.7
11-Sep-12	0.8	3.5	0.23	1.3	332	5.9	66.3	0	101.7
12-Sep-12	0.2	1.2	0.17	1.4	186	8.5	80.4	9.8	102.0
13-Sep-12	0	2.2	0.00	2.4	186	12	79.7	0.1	101.7
14-Sep-12	1.8	3.4	0.53	1.9	276	11.9	46.1	0	101.5
15-Sep-12	2.2	5.1	0.43	1.3	357	5.7	65.9	0	102.4
16-Sep-12	2.6	8	0.33	1.1	221	5.8	74.2	0	102.5
17-Sep-12	1	8.5	0.12	1.8	203	7.7	73.7	0	101.9
18-Sep-12	2.6	8.1	0.32	1	5	9.3	71.1	0	101.9
19-Sep-12	2.5	9.4	0.27	1.1	276	6.7	73.8	0	102.1
20-Sep-12	3.2	11.8	0.27	1.3	341	8.7	75.2	0	102.1
21-Sep-12	5.8	16	0.36	1.2	231	9.4	76.7	0	101.9
22-Sep-12	6.7	16.6	0.40	0.9	18	8.8	78	0	101.9
23-Sep-12	7.2	17.8	0.40	1.1	281	9.7	77.2	0.1	101.8
24-Sep-12	4.7	7.7	0.61	0.8	337	11.7	78.9	0.5	101.7
25-Sep-12	1.3	6.7	0.19	1.1	170	6.9	68.9	0	101.9
26-Sep-12	2.2	8.1	0.27	2.1	188	9.5	73	0	101.5
27-Sep-12	3.4	16.7	0.20	4.5	181	14.4	66.3	0	100.7
28-Sep-12	1.6	3.5	0.46	1	346	9.5	80	4.9	101.0

Tsay Keh PM and Meteorological Data (2012)									
Date	$PM_{2.5}$ (µg m^{-3})	PM_{10} (µg m^{-3})	PM Ratio	Wind Speed (ms^{-1})	Wind Direction (degrees)	Air Temp. (^{0}C)	RH (%)	Total Precip (mm)	Barometric Pressure (kPa)
29-Sep-12	0.4	1.9	0.21	1.3	204	5.5	74	0	101.6
30-Sep-12	0.2	0.8	0.25	1.1	188	8.3	64	3.2	101.9
1-Oct-12	0.3	1.1	0.27	2	356	6.5	90.4	8.8	100.9
2-Oct-12	1.6	2.4	0.67	4.3	358	5	61.7	0.7	102.7
3-Oct-12	2.4	3.7	0.65	0.8	326	1	79.8	0	103.1
4-Oct-12	2.6	3.6	0.72	0.8	351	1.4	75.5	0	103.0
5-Oct-12	2.1	3	0.70	1.1	348	4.3	76.5	0	102.8
6-Oct-12	3.1	5	0.62	0.8	347	3	92	0	102.5
7-Oct-12	1.4	2.5	0.56	2	7	7.6	80	0.2	102.0
8-Oct-12	2.4	4.1	0.59	0.9	171	8.3	74.6	0	101.8
9-Oct-12	2.5	5.1	0.49	0.8	252	5.3	81.6	0	101.4
10-Oct-12	0.3	0.8	0.38	1.4	314	1.9	70.1	1	102.2
11-Oct-12	1	2	0.50	2.3	174	1.1	75.4	0.1	101.3
12-Oct-12	2	3.3	0.61	2	225	0.9	90.6	6.3	100.2
13-Oct-12	2.4	3.2	0.75	1	226	6	83.3	0.2	100.5
14-Oct-12	*	0.7	NaN	2.9	182	7.5	77.9	2.2	99.6
15-Oct-12	1.1	1.9	0.58	1.6	185	8.1	70.5	0.2	99.7
16-Oct-12	4.2	5.8	0.72	0.9	309	4.3	80.1	8.1	99.5
17-Oct-12	2.9	4.1	0.71	1.6	184	3	65.2	0	101.4
18-Oct-12	2.9	3.6	0.81	2.6	184	4.2	78.2	1.1	100.7
19-Oct-12	2.1	2.9	0.72	1.3	351	-0.5	88.4	1.1	100.3
20-Oct-12	3.1	3.8	0.82	1.5	347	-2.6	81.5	1.8	101.0
21-Oct-12	0.9	5.5	0.16	4.8	2	-5.3	64.1	0	101.9
22-Oct-12	1.2	6.7	0.18	3.6	3	-4.4	64.9	0	101.9
23-Oct-12	0.9	5.1	0.18	2.7	359	-4.7	60.9	0	102.1
24-Oct-12	2.1	17	0.12	2.4	356	-6.2	61.3	0	102.5
25-Oct-12	2.7	17.9	0.15	1.7	355	-6.7	63.9	0	103.0
26-Oct-12	0.4	8.5	0.05	2.9	355	-7.9	62.7	0	102.4
27-Oct-12	0.3	13.7	0.02	4	358	-10.6	60.6	0	101.6
28-Oct-12	2	11.8	0.17	4.2	2	-10.1	53	0	101.3
29-Oct-12	1.8	15	0.12	4.4	359	-11.2	53.3	0	101.3
30-Oct-12	7.6	30.5	0.25	1.7	350	-14.5	59	0	101.8
31-Oct-12	20.3	37.9	0.54	1.6	358	-11.3	60.5	0	101.5
1-Nov-12	7	32.3	0.22	1.8	352	-9.7	60.3	0	101.3
2-Nov-12	4	12.6	0.32	1	0	-5.6	73.6	0	101.5
3-Nov-12	10.8	13.5	0.80	0.5	323	-1.3	92.1	1.5	100.8
4-Nov-12	2	2.7	0.74	3.1	178	1.3	89.5	1.1	100.5
5-Nov-12	1.2	1.7	0.71	1.5	211	5.1	58.5	0	101.2
6-Nov-12	2.4	3.4	0.71	0.5	329	-2.6	76.7	0	101.5
7-Nov-12	4.4	4.4	1.00	1.6	354	-5.2	85.1	0	101.7

Tsay Keh PM and Meteorological Data (2012)									
Date	$PM_{2.5}$ (µg m^{-3})	PM_{10} (µg m^{-3})	PM Ratio	Wind Speed (ms^{-1})	Wind Direction (degrees)	Air Temp. (^0C)	RH (%)	Total Precip (mm)	Barometric Pressure (kPa)
8-Nov-12	0.7	1	0.70	2.2	359	-9.8	68.8	0	102.5
9-Nov-12	0.7	*	NaN	1.8	352	-14	70.5	0	102.5
10-Nov-12	3.1	3.7	0.84	0.8	360	-17.3	72	0	101.9
11-Nov-12	5.3	7.5	0.71	2.1	197	-6.8	78.1	0	101.4
12-Nov-12	6.4	7.5	0.85	0.5	263	-4.9	83	0	101.3
13-Nov-12	5.8	7	0.83	0.7	241	-2.5	85.3	0	101.2
14-Nov-12	3	3.5	0.86	1.3	232	-2.2	84.6	0.2	101.1
15-Nov-12	0.9	2	0.45	0.8	175	1.6	83	2	100.9
16-Nov-12	10	12.1	0.83	4.1	178	1.5	85.2	0.4	100.4
17-Nov-12	2.9	12.6	0.23	3.4	357	-7.2	82.6	0	99.6
18-Nov-12	3.3	6.9	0.48	2.8	355	-12.5	78.4	0	99.8
19-Nov-12	2.5	4.8	0.52	3.1	357	-12.8	77.4	0	100.2
20-Nov-12	3	4.9	0.61	2.3	355	-15.9	69.9	0	101.0
21-Nov-12	NaN	NaN	NaN	1.5	352	-18.4	70.6	0	101.3
22-Nov-12	NaN	NaN	NaN	1.1	358	-16.7	75.9	0	102.2
23-Nov-12	NaN	NaN	NaN	0.9	4	-7.7	85.1	0	100.9
24-Nov-12	NaN	NaN	NaN	0.9	305	-5.6	89	0	101.3
25-Nov-12	NaN	NaN	NaN	0.9	347	-3.6	90.3	0	101.7
26-Nov-12	NaN	NaN	NaN	1.4	344	-7.9	86.9	0	102.0
27-Nov-12	NaN	NaN	NaN	1.2	348	-15.1	81.1	0	102.0
28-Nov-12	NaN	NaN	NaN	3.1	359	-12.6	78.3	0	101.5
29-Nov-12	NaN	NaN	NaN	3.5	357	-17.4	71.5	0	100.7
30-Nov-12	NaN	NaN	NaN	3.3	356	-18.2	68.7	0	100.6
1-Dec-12	NaN	NaN	NaN	1.7	355	-16.9	73	0	100.1
2-Dec-12	NaN	NaN	NaN	2.2	351	-16.3	73.2	0	99.6
3-Dec-12	NaN	NaN	NaN	1.1	356	-15.1	75.7	0	100.5
4-Dec-12	NaN	NaN	NaN	1.6	353	-12.5	80.9	0	99.6
5-Dec-12	NaN	NaN	NaN	2.5	351	-16.4	71.2	0	100.7
6-Dec-12	NaN	NaN	NaN	0.9	1	-14.4	80.3	0	101.2
7-Dec-12	NaN	NaN	NaN	1.4	354	-17.1	76.1	0	101.2
8-Dec-12	NaN	NaN	NaN	1.2	355	-23.2	66.8	0	102.2
9-Dec-12	NaN	NaN	NaN	0.8	5	-18.8	74.5	0	101.5
10-Dec-12	NaN	NaN	NaN	0.8	6	-13.6	82.2	0	100.9
11-Dec-12	NaN	NaN	NaN	2.6	360	-7.3	84.7	0	99.8
12-Dec-12	NaN	NaN	NaN	1	351	-12.3	78.8	0	100.7
13-Dec-12	NaN	NaN	NaN	1.8	196	-6.1	88.6	0	99.8
14-Dec-12	NaN	NaN	NaN	1.5	179	-9.8	85.4	0	100.2
15-Dec-12	NaN	NaN	NaN	6.3	179	-4	85.4	0	99.3
16-Dec-12	NaN	NaN	NaN	0.5	287	-8.6	85.1	0	99.3
17-Dec-12	NaN	NaN	NaN	0.4	354	-11.2	83.8	0	99.6

Tsay Keh PM and Meteorological Data (2012)									
Date	$PM_{2.5}$ (µg m^{-3})	PM_{10} (µg m^{-3})	PM Ratio	Wind Speed (ms^{-1})	Wind Direction (degrees)	Air Temp. (^{0}C)	RH (%)	Total Precip (mm)	Barometric Pressure (kPa)
18-Dec-12	NaN	NaN	NaN	1	356	-12.5	80.8	0	100.4
19-Dec-12	NaN	NaN	NaN	1.1	356	-12.2	81.2	0	100.2
20-Dec-12	NaN	NaN	NaN	3.7	360	-14.9	73.3	0	100.8
21-Dec-12	NaN	NaN	NaN	2.7	357	-18.4	68.4	0	101.9
22-Dec-12	NaN	NaN	NaN	0.7	346	-23.5	67.2	0	101.8
23-Dec-12	NaN	NaN	NaN	0.7	353	-21.7	69.6	0	101.7
24-Dec-12	NaN	NaN	NaN	1.9	351	-18.9	70.3	0	102.3
25-Dec-12	NaN	NaN	NaN	1.7	349	-22.9	63.8	0	102.0
26-Dec-12	NaN	NaN	NaN	1.3	352	-27.3	61.3	0	101.5
27-Dec-12	NaN	NaN	NaN	0.6	2	-29.3	62.8	0	101.8
28-Dec-12	NaN	NaN	NaN	1.1	359	-19.8	70.3	0	101.6
29-Dec-12	NaN	NaN	NaN	0.5	348	-23	67.4	0	102.0
30-Dec-12	NaN	NaN	NaN	0.4	9	-19.3	76.3	0	102.2
31-Dec-12	NaN	NaN	NaN	0.5	344	-11.9	84.6	0	102.0

APPENDIX II

TEOM PARTICULATE AND METEOROLOGICAL DATA FOR FORT WARE (2012)

Fort Ware PM and Meteorological Data (2012)									
Date	$PM_{2.5}$ (µg m^{-3})	PM_{10} (µg m^{-3})	PM Ratio	Wind Speed (ms^{-1})	Wind Direction (degrees)	Air Temp. (^{0}C)	RH (%)	Total Precip (mm)	Barometric Pressure (kPa)
1-Jan-12	*	*	*	1.33	160.62	-10.8	85.7	0.0	101.4
2-Jan-12	3.3	4.0	0.82	1.71	150.80	-3.4	93.2	0.0	99.9
3-Jan-12	4.5	5.3	0.85	0.13	34.01	-6.6	90.3	0.0	100.1
4-Jan-12	0.1	0.2	0.89	2.38	158.20	0.5	94.6	16.9	99.2
5-Jan-12	3.9	4.5	0.86	0.63	143.84	-2.0	88.1	0.7	100.3
6-Jan-12	10.3	12.2	0.85	0.28	3.70	-12.7	83.8	0.0	101.2
7-Jan-12	*	*	*	1.78	155.78	-6.6	87.7	0.0	100.4
8-Jan-12	9.7	11.4	0.85	0.62	116.69	-4.4	89.8	0.1	100.1
9-Jan-12	6.8	8.1	0.85	0.82	346.00	-5.3	81.0	0.1	100.4
10-Jan-12	18.9	22.4	0.85	0.23	8.32	-18.2	72.1	0.0	102.7
11-Jan-12	2.8	3.6	0.79	0.51	118.80	-13.7	80.9	0.0	102.5
12-Jan-12	*	0.3	*	1.63	151.36	-8.1	86.6	0.0	101.3
13-Jan-12	9.5	10.8	0.88	0.35	359.57	-13.1	81.2	0.0	101.1
14-Jan-12	2.1	2.9	0.74	1.94	343.19	-15.7	74.1	0.0	101.3
15-Jan-12	2.9	3.5	0.81	1.83	339.96	-22.0	63.9	0.0	102.4
16-Jan-12	5.0	5.9	0.84	1.22	339.58	-29.8	53.5	0.0	102.7
17-Jan-12	5.2	5.9	0.89	1.70	350.22	-36.5	51.1	0.0	102.2
18-Jan-12	5.9	6.8	0.88	0.94	341.54	-36.0	50.1	0.0	101.9
19-Jan-12	6.4	7.4	0.87	0.78	345.76	-35.6	50.1	0.0	101.1
20-Jan-12	1.2	1.4	0.84	0.84	347.55	-28.0	61.4	0.0	100.2
21-Jan-12	7.8	9.0	0.87	0.54	340.85	-20.3	72.3	0.0	98.7
22-Jan-12	2.1	2.4	0.87	0.60	338.22	-14.3	80.3	0.0	99.3
23-Jan-12	5.8	6.7	0.87	0.54	3.24	-10.0	84.8	0.0	99.3
24-Jan-12	*	0.3	*	2.29	155.71	-4.4	90.0	0.0	98.5
25-Jan-12	2.7	3.4	0.79	1.76	164.66	-3.5	79.0	0.9	99.2
26-Jan-12	6.5	7.8	0.84	1.56	159.56	-8.9	78.4	0.0	100.3
27-Jan-12	5.1	6.0	0.85	0.99	156.37	-8.3	82.7	0.1	100.9
28-Jan-12	1.3	1.5	0.85	0.09	343.05	-9.5	86.4	0.0	100.4
29-Jan-12	3.3	3.7	0.89	0.00	0.00	-5.5	90.9	0.0	99.1
30-Jan-12	1.8	2.1	0.85	1.06	169.77	-1.8	94.8	0.2	99.3
31-Jan-12	0.7	0.9	0.78	2.27	164.02	-0.6	94.9	0.0	99.9
1-Feb-12	5.8	6.6	0.87	0.76	159.40	-3.1	84.0	0.9	101.0
2-Feb-12	0.9	1.3	0.71	2.89	154.60	-0.8	83.9	0.9	101.6
3-Feb-12	1.8	2.3	0.79	1.80	150.21	0.1	89.1	1.3	101.7
4-Feb-12	3.5	4.0	0.87	0.71	357.42	-0.5	88.4	0.7	102.1
5-Feb-12	3.1	3.3	0.94	0.43	326.59	-2.1	80.5	3.0	102.6
6-Feb-12	6.9	8.0	0.86	0.25	174.95	-8.3	74.6	1.2	102.4
7-Feb-12	11.8	14.3	0.83	0.15	278.87	-12.8	73.4	0.0	101.7
8-Feb-12	6.5	7.9	0.83	0.33	323.68	-15.4	72.1	0.0	101.8
9-Feb-12	11.1	13.1	0.85	0.38	354.73	-12.7	71.2	0.0	102.1
10-Feb-12	4.3	4.9	0.89	0.30	348.91	-4.7	89.0	0.0	101.8
11-Feb-12	3.9	4.7	0.84	0.70	161.53	-2.4	88.9	0.1	101.2
12-Feb-12	10.6	12.4	0.86	0.50	159.70	-4.0	89.6	0.0	100.6
13-Feb-12	8.2	9.7	0.85	0.54	138.88	-10.1	74.7	1.3	101.1
14-Feb-12	4.6	5.7	0.80	0.43	348.99	-12.1	72.6	0.0	101.2

Fort Ware PM and Meteorological Data (2012)									
Date	$PM_{2.5}$ (µg m^{-3})	PM_{10} (µg m^{-3})	PM Ratio	Wind Speed (ms^{-1})	Wind Direction (degrees)	Air Temp. (^0C)	RH (%)	Total Precip (mm)	Barometric Pressure (kPa)
15-Feb-12	9.9	12.2	0.81	0.42	156.44	-13.4	68.9	0.0	101.6
16-Feb-12	9.4	11.0	0.85	0.33	168.90	-9.5	76.0	0.5	101.5
17-Feb-12	4.0	4.8	0.84	0.54	349.09	-8.9	85.8	0.0	101.2
18-Feb-12	4.8	5.5	0.86	0.76	0.41	-7.6	74.4	1.1	100.4
19-Feb-12	8.6	10.1	0.85	0.32	177.05	-7.4	74.0	1.9	100.5
20-Feb-12	5.2	6.2	0.83	0.72	135.22	-10.9	81.4	0.0	100.1
21-Feb-12	6.4	7.2	0.88	0.99	151.98	-3.4	85.3	1.4	99.5
22-Feb-12	11.0	12.6	0.88	0.55	329.41	-4.4	73.2	1.1	100.2
23-Feb-12	3.5	3.0	0.86	0.83	279.42	-5.5	59.5	1.2	101.4
24-Feb-12	6.5	8.5	0.77	0.67	354.06	-13.4	71.1	0.0	101.0
25-Feb-12	2.4	2.9	0.81	0.63	321.22	-9.6	59.2	0.0	101.4
26-Feb-12	6.9	8.0	0.86	0.73	350.07	-15.1	62.8	0.0	101.9
27-Feb-12	5.0	6.2	0.81	0.79	140.83	-12.8	76.9	0.0	100.8
28-Feb-12	7.4	8.8	0.84	0.56	146.80	-8.5	77.0	0.2	100.2
29-Feb-12	1.7	2.3	0.70	0.53	333.33	-7.4	81.5	0.0	100.1
1-Mar-12	2.6	3.8	0.69	0.85	151.62	-9.3	68.8	0.0	100.9
2-Mar-12	9.6	11.2	0.86	0.64	139.35	-4.9	74.9	1.0	100.5
3-Mar-12	7.6	8.9	0.86	0.71	255.72	-4.7	66.1	5.7	100.4
4-Mar-12	6.9	8.0	0.86	0.57	122.31	-8.1	70.0	0.1	100.6
5-Mar-12	6.1	7.1	0.86	0.98	342.25	-11.7	61.7	0.2	100.8
6-Mar-12	0.5	1.0	0.57	1.25	151.03	-12.5	71.6	0.0	100.7
7-Mar-12	6.3	7.5	0.84	0.57	146.93	-3.5	76.8	0.4	100.8
8-Mar-12	1.3	1.8	0.72	2.82	155.02	0.9	79.5	2.7	100.5
9-Mar-12	2.7	3.5	0.77	1.90	171.95	2.0	56.9	0.0	99.6
10-Mar-12	0.1	0.7	0.17	1.40	155.29	-1.4	60.9	0.0	99.6
11-Mar-12	2.8	3.5	0.79	0.55	286.73	-1.3	83.6	2.4	98.8
12-Mar-12	0.7	1.2	0.63	1.59	164.16	-2.9	76.8	4.2	98.6
13-Mar-12	6.6	8.0	0.83	1.16	338.68	-10.7	70.4	0.1	98.9
14-Mar-12	1.4	2.1	0.67	1.31	159.13	-6.3	70.3	0.1	99.5
15-Mar-12	1.1	1.5	0.74	1.02	164.29	-1.6	82.6	0.5	98.8
16-Mar-12	4.7	5.6	0.85	0.72	110.39	-0.8	74.6	0.0	99.1
17-Mar-12	4.2	4.9	0.84	0.60	315.69	-4.4	75.5	0.0	99.7
18-Mar-12	2.0	2.6	0.77	1.08	189.92	-4.7	72.4	1.4	99.9
19-Mar-12	6.6	7.8	0.84	0.80	356.94	-8.4	76.1	0.8	100.0
20-Mar-12	1.2	1.7	0.72	0.96	230.98	-6.2	66.8	0.0	99.1
21-Mar-12	2.9	3.6	0.80	0.73	325.76	-6.6	77.6	0.4	100.1
22-Mar-12	4.9	5.9	0.84	0.74	293.56	-4.6	61.3	0.8	101.0
23-Mar-12	11.4	13.2	0.86	0.54	155.42	-6.0	66.0	0.0	101.6
24-Mar-12	8.5	10.2	0.83	0.46	186.91	-5.4	58.8	0.0	101.3
25-Mar-12	11.7	13.7	0.85	0.56	323.95	-6.2	60.8	0.0	100.6
26-Mar-12	7.2	8.5	0.84	0.56	95.83	-6.0	57.4	0.0	100.6
27-Mar-12	5.9	7.4	0.80	0.81	157.66	-0.5	55.6	0.0	100.1
28-Mar-12	4.7	6.1	0.76	1.06	149.63	-0.5	75.0	0.2	99.5
29-Mar-12	0.9	1.5	0.62	1.43	148.83	1.5	78.8	0.0	98.8
30-Mar-12	2.5	3.0	0.82	1.31	217.89	1.8	57.8	0.0	99.0
31-Mar-12	1.4	1.8	0.78	1.06	250.34	-1.0	50.2	0.0	99.7
1-Apr-12	6.3	7.4	0.86	0.70	336.74	-2.1	50.0	0.0	100.2
2-Apr-12	3.9	5.3	0.74	1.15	140.16	-2.7	75.5	0.0	100.2
3-Apr-12	2.7	3.7	0.74	0.69	344.43	2.1	61.6	1.5	100.0
4-Apr-12	5.1	6.1	0.82	1.10	342.26	0.4	59.2	0.0	101.0
5-Apr-12	1.6	2.0	0.78	1.40	333.95	-0.3	55.7	0.0	101.6
6-Apr-12	1.1	1.6	0.67	1.25	343.54	0.8	49.5	0.0	101.7

Fort Ware PM and Meteorological Data (2012)									
Date	$PM_{2.5}$ (µg m^{-3})	PM_{10} (µg m^{-3})	PM Ratio	Wind Speed (ms^{-1})	Wind Direction (degrees)	Air Temp. (^{0}C)	RH (%)	Total Precip (mm)	Barometric Pressure (kPa)
7-Apr-12	5.6	7.3	0.77	0.66	275.61	2.3	52.8	0.0	102.0
8-Apr-12	5.1	6.7	0.75	0.64	156.22	2.3	57.5	0.0	102.3
9-Apr-12	7.1	10.1	0.71	0.69	164.31	3.0	56.8	0.0	101.6
10-Apr-12	7.3	10.2	0.71	0.51	145.70	5.5	53.2	0.0	100.9
11-Apr-12	6.5	9.6	0.68	0.66	313.85	5.6	68.0	0.0	100.6
12-Apr-12	5.9	8.3	0.71	0.43	352.06	3.4	89.2	5.5	100.7
13-Apr-12	2.3	3.6	0.63	0.91	312.23	2.4	79.0	0.9	100.9
14-Apr-12	NaN	NaN	NaN	0.98	158.85	3.5	54.1	0.0	101.5
15-Apr-12	NaN	NaN	NaN	1.34	151.12	4.3	55.8	0.0	101.3
16-Apr-12	NaN	NaN	NaN	0.83	119.74	4.5	60.9	0.0	100.9
17-Apr-12	NaN	NaN	NaN	0.62	150.23	3.3	65.7	0.0	101.1
18-Apr-12	NaN	NaN	NaN	1.23	142.99	4.7	59.6	0.0	100.8
19-Apr-12	NaN	NaN	NaN	1.44	151.01	6.2	56.8	0.0	100.6
20-Apr-12	NaN	NaN	NaN	1.08	199.24	4.9	63.4	2.0	100.7
21-Apr-12	NaN	NaN	NaN	1.18	285.36	4.5	42.9	0.0	101.6
22-Apr-12	NaN	NaN	NaN	0.66	232.48	3.7	51.7	0.0	101.3
23-Apr-12	NaN	NaN	NaN	0.54	239.04	2.7	76.4	1.9	100.8
24-Apr-12	NaN	NaN	NaN	0.75	170.63	5.5	60.1	0.0	100.6
25-Apr-12	NaN	NaN	NaN	0.68	126.55	4.6	72.2	0.5	100.4
26-Apr-12	NaN	NaN	NaN	0.41	319.06	3.9	91.1	9.4	100.1
27-Apr-12	NaN	NaN	NaN	1.53	186.34	5.0	66.1	0.5	100.6
28-Apr-12	NaN	NaN	NaN	1.36	194.41	6.5	57.1	0.0	101.0
29-Apr-12	NaN	NaN	NaN	0.92	236.37	6.9	58.9	0.0	100.8
30-Apr-12	NaN	NaN	NaN	0.94	60.59	7.7	52.1	0.0	99.8
1-May-12	NaN	NaN	NaN	0.81	166.03	5.1	87.2	5.9	100.0
2-May-12	NaN	NaN	NaN	1.25	161.45	5.9	65.4	0.0	100.5
3-May-12	NaN	NaN	NaN	0.85	314.30	5.2	67.7	0.0	100.4
4-May-12	NaN	NaN	NaN	1.14	282.14	5.6	57.4	0.0	100.6
5-May-12	NaN	NaN	NaN	1.11	273.01	4.8	48.9	0.0	101.6
6-May-12	NaN	NaN	NaN	1.74	151.70	5.4	61.4	0.0	101.9
7-May-12	NaN	NaN	NaN	2.49	152.91	8.5	68.8	0.0	101.2
8-May-12	NaN	NaN	NaN	1.59	251.20	6.5	48.5	0.0	100.6
9-May-12	NaN	NaN	NaN	1.25	338.49	2.4	47.9	0.0	100.5
10-May-12	NaN	NaN	NaN	2.21	303.24	6.0	33.7	0.0	101.1
11-May-12	NaN	NaN	NaN	1.10	292.93	7.3	42.9	0.0	101.6
12-May-12	NaN	NaN	NaN	0.95	262.00	9.1	46.7	0.0	101.6
13-May-12	NaN	NaN	NaN	1.45	271.40	7.3	46.4	0.0	101.7
14-May-12	NaN	NaN	NaN	1.03	146.95	8.4	37.1	0.0	101.8
15-May-12	NaN	NaN	NaN	1.28	287.91	6.7	38.6	0.0	101.2
16-May-12	NaN	NaN	NaN	1.66	316.16	3.7	41.0	0.0	101.2
17-May-12	NaN	NaN	NaN	1.68	319.79	2.7	64.8	0.0	101.1
18-May-12	NaN	NaN	NaN	0.98	297.92	4.7	45.4	0.0	101.4
19-May-12	NaN	NaN	NaN	1.04	158.53	6.1	43.9	0.0	101.5
20-May-12	NaN	NaN	NaN	1.24	155.14	10.4	42.1	0.0	101.0
21-May-12	NaN	NaN	NaN	1.38	152.75	12.1	61.4	0.7	100.4
22-May-12	NaN	NaN	NaN	0.98	330.80	8.6	86.8	14.4	100.2
23-May-12	NaN	NaN	NaN	0.82	135.48	7.6	90.0	12.0	100.7
24-May-12	NaN	NaN	NaN	1.02	286.85	11.1	72.0	0.8	101.5
25-May-12	NaN	NaN	NaN	0.83	182.87	12.0	54.8	0.0	101.5
26-May-12	NaN	NaN	NaN	1.14	166.83	13.4	49.1	0.0	100.6
27-May-12	NaN	NaN	NaN	0.90	222.28	12.8	47.0	0.0	100.7
28-May-12	NaN	NaN	NaN	1.26	324.61	11.3	58.0	3.2	100.9

Fort Ware PM and Meteorological Data (2012)									
Date	$PM_{2.5}$ (µg m^{-3})	PM_{10} (µg m^{-3})	PM Ratio	Wind Speed (ms^{-1})	Wind Direction (degrees)	Air Temp. (^0C)	RH (%)	Total Precip (mm)	Barometric Pressure (kPa)
29-May-12	NaN	NaN	NaN	0.76	43.68	9.2	87.2	4.9	100.9
30-May-12	NaN	NaN	NaN	1.03	191.85	9.8	61.2	0.0	100.9
31-May-12	NaN	NaN	NaN	0.97	291.81	10.3	55.0	0.0	100.8
1-Jun-12	NaN	NaN	NaN	1.57	158.73	9.7	55.3	0.0	100.3
2-Jun-12	NaN	NaN	NaN	1.23	278.88	10.5	44.4	0.0	100.4
3-Jun-12	NaN	NaN	NaN	1.11	325.29	10.0	56.7	0.0	100.9
4-Jun-12	NaN	NaN	NaN	1.17	13.73	11.3	58.2	1.3	101.2
5-Jun-12	NaN	NaN	NaN	0.81	347.13	9.8	90.9	5.9	101.0
6-Jun-12	NaN	NaN	NaN	0.72	342.87	10.4	92.9	13.5	100.8
7-Jun-12	NaN	NaN	NaN	1.45	153.68	9.9	86.9	10.0	100.2
8-Jun-12	1.6	3.7	0.44	0.71	314.97	10.6	66.6	0.0	101.0
9-Jun-12	*	6.5	*	1.05	330.91	14.8	52.0	0.0	101.1
10-Jun-12	*	6.4	*	1.05	318.32	18.0	40.3	0.0	101.0
11-Jun-12	*	2.8	*	1.10	164.77	13.7	68.6	1.2	101.0
12-Jun-12	*	9.3	*	0.71	286.37	11.9	51.3	0.0	100.7
13-Jun-12	0.3	10.7	0.03	0.93	313.49	10.0	47.6	0.0	100.9
14-Jun-12	0.1	7.2	0.01	0.77	330.92	9.5	49.2	0.0	101.1
15-Jun-12	0.3	13.9	0.02	0.88	153.88	11.6	53.5	0.8	101.1
16-Jun-12	0.5	1.0	0.51	1.14	158.77	10.0	86.7	4.9	100.1
17-Jun-12	0.3	2.3	0.12	0.88	328.31	13.5	65.2	0.9	99.9
18-Jun-12	0.7	3.6	0.20	1.11	329.52	14.7	63.2	1.5	100.5
19-Jun-12	0.8	2.8	0.29	0.54	151.25	13.8	74.7	0.9	101.2
20-Jun-12	0.6	6.1	0.09	0.65	224.80	14.9	68.6	0.0	101.4
21-Jun-12	1.2	9.0	0.13	1.07	79.44	15.8	61.3	0.0	101.3
22-Jun-12	2.3	16.0	0.14	1.07	39.97	18.7	49.5	0.0	101.3
23-Jun-12	6.2	25.1	0.25	0.86	148.30	19.5	45.3	0.0	101.2
24-Jun-12	3.6	10.5	0.34	0.71	162.11	14.6	77.9	1.5	100.9
25-Jun-12	*	1.3	*	1.24	162.79	11.8	90.1	1.3	100.4
26-Jun-12	*	3.4	*	1.27	210.12	13.6	61.9	0.0	100.3
27-Jun-12	0.4	10.2	0.04	0.90	301.71	14.0	47.4	0.0	100.6
28-Jun-12	1.1	10.6	0.10	1.09	154.13	13.0	63.7	0.2	100.7
29-Jun-12	0.0	4.7	0.01	1.00	179.35	14.8	63.1	0.6	100.7
30-Jun-12	0.4	4.0	0.09	0.84	155.01	11.0	75.7	1.5	100.7
1-Jul-12	1.4	9.4	0.15	0.55	233.42	10.8	60.0	0.0	100.7
2-Jul-12	7.7	17.0	0.46	0.62	115.10	12.2	59.8	0.0	100.7
3-Jul-12	*	0.6	*	0.90	353.01	11.1	73.4	1.4	100.6
4-Jul-12	1.8	9.7	0.18	1.18	250.71	14.7	60.7	0.0	100.9
5-Jul-12	1.7	16.5	0.11	0.91	161.23	12.8	73.8	0.1	101.2
6-Jul-12	4.5	37.2	0.12	0.74	153.42	15.6	57.5	0.0	101.5
7-Jul-12	7.4	30.9	0.24	0.65	166.64	16.3	56.0	0.0	101.6
8-Jul-12	15.6	52.1	0.30	0.66	152.61	18.7	57.3	0.0	101.5
9-Jul-12	36.4	91.8	0.40	0.63	155.25	20.3	51.3	0.0	101.2
10-Jul-12	11.8	42.3	0.28	0.83	275.26	17.7	45.6	0.0	101.1
11-Jul-12	1.0	18.6	0.05	0.78	284.91	15.8	41.5	0.0	101.3
12-Jul-12	6.0	42.4	0.14	0.91	14.93	16.2	42.3	0.0	101.4
13-Jul-12	*	24.8	*	0.71	150.91	18.6	44.8	0.0	101.5
14-Jul-12	*	29.7	*	1.12	354.73	17.2	60.3	1.4	101.3
15-Jul-12	*	9.4	*	1.04	323.46	19.7	58.8	0.0	101.6
16-Jul-12	*	16.9	*	0.72	246.68	20.9	49.0	0.0	100.9
17-Jul-12	*	36.8	*	1.78	344.35	20.0	33.8	0.0	100.6
18-Jul-12	0.5	11.4	0.05	0.93	336.61	16.4	56.0	0.9	100.8
19-Jul-12	0.5	13.5	0.04	0.76	156.41	16.4	59.5	0.0	101.3

Fort Ware PM and Meteorological Data (2012)									
Date	$PM_{2.5}$ (µg m^{-3})	PM_{10} (µg m^{-3})	PM Ratio	Wind Speed (ms^{-1})	Wind Direction (degrees)	Air Temp. (^{0}C)	RH (%)	Total Precip (mm)	Barometric Pressure (kPa)
20-Jul-12	*	35.2	*	0.54	158.33	20.0	50.5	0.0	101.2
21-Jul-12	0.7	16.5	0.04	1.07	150.83	16.9	69.9	2.6	101.1
22-Jul-12	0.5	8.1	0.06	0.64	126.94	18.2	74.1	0.0	101.3
23-Jul-12	0.2	12.3	0.01	0.97	140.84	20.4	60.7	0.0	101.4
24-Jul-12	0.1	59.2	0.00	0.89	344.49	21.1	51.3	0.0	101.2
25-Jul-12	0.2	36.4	0.00	0.84	117.54	20.0	52.6	0.0	101.4
26-Jul-12	*	25.3	*	0.87	34.97	19.0	64.9	0.0	101.2
27-Jul-12	0.4	8.3	0.05	0.65	175.35	17.0	81.2	6.6	101.0
28-Jul-12	0.3	4.6	0.07	0.65	341.63	17.3	72.5	0.6	101.2
29-Jul-12	0.1	6.2	0.02	0.55	145.82	15.6	82.3	7.4	101.3
30-Jul-12	*	3.9	*	0.67	187.80	13.8	69.6	1.3	101.2
31-Jul-12	*	7.4	*	0.63	157.21	12.7	68.9	0.0	101.3
1-Aug-12	0.3	3.7	0.09	0.55	346.69	13.1	74.8	6.9	101.2
2-Aug-12	*	1.5	*	0.84	0.18	16.2	60.4	0.2	101.5
3-Aug-12	*	3.0	*	0.61	169.55	18.4	64.6	0.2	101.3
4-Aug-12	0.0	10.0	0.00	0.72	336.53	17.2	60.4	0.3	101.3
5-Aug-12	1.7	13.2	0.13	0.60	113.91	15.8	63.6	0.0	101.2
6-Aug-12	3.5	31.5	0.11	0.58	163.09	19.3	59.2	0.0	101.4
7-Aug-12	2.8	13.3	0.21	0.67	122.38	17.9	66.2	0.0	101.4
8-Aug-12	2.2	11.1	0.20	0.63	44.08	16.3	76.3	1.6	101.2
9-Aug-12	0.8	17.0	0.05	0.69	308.56	13.8	56.9	0.0	101.5
10-Aug-12	2.2	22.2	0.10	0.69	342.31	11.1	65.0	0.0	101.6
11-Aug-12	1.4	16.6	0.08	0.47	12.04	12.7	62.8	0.0	101.8
12-Aug-12	2.6	9.9	0.26	0.57	347.67	13.8	71.5	0.9	101.5
13-Aug-12	4.5	11.1	0.40	0.79	353.42	12.4	75.0	1.6	101.2
14-Aug-12	2.8	7.0	0.39	0.75	346.65	15.1	68.6	1.3	101.8
15-Aug-12	2.1	17.4	0.12	0.67	160.62	16.1	63.3	0.0	101.7
16-Aug-12	5.6	36.5	0.15	0.56	169.60	16.2	62.7	0.0	101.4
17-Aug-12	3.2	22.7	0.14	0.90	156.98	17.4	55.7	0.0	101.3
18-Aug-12	14.6	28.1	0.52	0.58	154.51	19.1	55.0	0.0	101.0
19-Aug-12	14.0	25.9	0.54	0.91	155.83	18.2	56.1	0.0	101.1
20-Aug-12	17.5	39.8	0.44	0.57	159.28	17.4	56.4	0.0	101.0
21-Aug-12	19.6	35.5	0.55	1.09	42.71	15.5	62.8	1.0	100.8
22-Aug-12	5.9	8.3	0.71	0.33	160.00	13.4	94.1	28.2	100.7
23-Aug-12	0.7	1.6	0.42	0.67	152.77	12.6	72.5	2.1	100.7
24-Aug-12	3.9	6.0	0.64	0.93	334.89	13.4	70.7	0.0	101.1
25-Aug-12	5.8	15.7	0.37	0.54	159.79	13.1	73.9	0.0	101.1
26-Aug-12	7.7	23.1	0.33	0.59	169.01	13.6	71.2	0.0	101.0
27-Aug-12	4.1	36.6	0.11	0.89	149.53	14.5	68.2	0.1	100.7
28-Aug-12	1.4	4.1	0.35	0.52	140.60	13.3	75.8	0.5	100.5
29-Aug-12	0.9	1.8	0.49	0.87	334.04	10.8	79.0	4.1	100.8
30-Aug-12	0.5	1.1	0.47	0.47	285.43	10.8	75.8	2.4	101.3
31-Aug-12	4.5	6.8	0.67	0.53	189.64	10.7	72.2	0.0	101.0
1-Sep-12	6.4	11.5	0.55	0.77	149.25	12.8	69.5	0.0	100.8
2-Sep-12	2.0	4.9	0.40	1.06	172.61	11.3	70.2	0.5	101.0
3-Sep-12	3.4	9.3	0.37	0.68	20.65	8.6	70.8	0.0	101.5
4-Sep-12	1.6	6.7	0.24	1.20	162.76	12.4	67.1	0.0	101.5
5-Sep-12	4.7	18.3	0.26	0.74	338.90	12.3	64.8	0.0	101.6
6-Sep-12	7.8	30.9	0.25	0.65	167.76	11.8	66.5	0.0	101.4
7-Sep-12	5.0	19.7	0.26	0.80	346.89	11.1	54.2	0.0	101.8
8-Sep-12	NaN	NaN	NaN	0.96	154.64	11.3	66.1	0.0	101.0
9-Sep-12	NaN	NaN	NaN	1.19	159.06	10.5	75.0	0.5	99.7

Fort Ware PM and Meteorological Data (2012)									
Date	$PM_{2.5}$ (µg m^{-3})	PM_{10} (µg m^{-3})	PM Ratio	Wind Speed (ms^{-1})	Wind Direction (degrees)	Air Temp. (^{0}C)	RH (%)	Total Precip (mm)	Barometric Pressure (kPa)
10-Sep-12	NaN	NaN	NaN	0.87	288.66	7.3	67.6	0.0	100.4
11-Sep-12	NaN	NaN	NaN	0.81	209.59	6.1	65.2	0.0	101.3
12-Sep-12	NaN	NaN	NaN	0.99	151.05	5.4	89.2	3.8	101.6
13-Sep-12	NaN	NaN	NaN	1.29	154.63	9.7	83.8	0.1	101.2
14-Sep-12	NaN	NaN	NaN	0.84	323.50	10.2	55.9	0.2	101.1
15-Sep-12	NaN	NaN	NaN	0.58	351.29	5.8	68.5	0.0	102.1
16-Sep-12	NaN	NaN	NaN	0.61	154.55	6.7	72.1	0.0	102.2
17-Sep-12	NaN	NaN	NaN	0.84	153.90	6.3	80.8	1.6	101.6
18-Sep-12	NaN	NaN	NaN	0.57	335.75	8.8	71.8	0.2	101.6
19-Sep-12	NaN	NaN	NaN	0.53	159.45	8.6	69.9	0.0	101.8
20-Sep-12	NaN	NaN	NaN	0.45	342.03	10.7	71.0	0.0	101.8
21-Sep-12	NaN	NaN	NaN	0.56	151.13	10.8	72.1	0.0	101.6
22-Sep-12	NaN	NaN	NaN	0.69	70.42	11.1	72.2	0.0	101.6
23-Sep-12	NaN	NaN	NaN	0.36	8.12	8.3	82.8	1.0	101.5
24-Sep-12	NaN	NaN	NaN	0.68	327.45	11.4	68.9	0.1	101.4
25-Sep-12	NaN	NaN	NaN	1.09	334.48	7.4	63.6	0.0	101.6
26-Sep-12	NaN	NaN	NaN	0.87	170.17	8.1	70.7	0.0	101.2
27-Sep-12	NaN	NaN	NaN	2.99	159.21	13.3	66.4	1.8	100.3
28-Sep-12	NaN	NaN	NaN	0.91	334.33	9.0	63.4	0.1	100.7
29-Sep-12	NaN	NaN	NaN	0.58	168.23	5.0	70.7	0.0	101.2
30-Sep-12	NaN	NaN	NaN	0.77	146.73	6.6	67.6	2.4	101.5
1-Oct-12	NaN	NaN	NaN	0.94	329.47	4.1	89.2	6.2	100.6
2-Oct-12	NaN	NaN	NaN	1.74	332.55	3.1	69.6	0.0	102.6
3-Oct-12	NaN	NaN	NaN	0.47	20.85	0.1	77.9	0.0	102.8
4-Oct-12	NaN	NaN	NaN	0.49	351.42	0.5	77.1	0.0	102.7
5-Oct-12	NaN	NaN	NaN	0.62	335.52	5.0	74.8	0.0	102.5
6-Oct-12	NaN	NaN	NaN	0.59	149.38	3.4	89.6	0.0	102.2
7-Oct-12	NaN	NaN	NaN	0.86	336.53	6.8	78.9	0.0	101.7
8-Oct-12	NaN	NaN	NaN	0.88	342.99	8.8	67.7	0.0	101.5
9-Oct-12	NaN	NaN	NaN	0.87	317.81	6.8	72.1	1.6	101.2
10-Oct-12	NaN	NaN	NaN	0.80	352.18	0.2	81.0	2.5	101.9
11-Oct-12	NaN	NaN	NaN	1.20	129.12	-1.2	76.6	0.0	100.9
12-Oct-12	NaN	NaN	NaN	0.52	340.70	-2.1	88.8	0.0	99.9
13-Oct-12	NaN	NaN	NaN	0.50	50.97	2.2	92.9	7.6	100.2
14-Oct-12	NaN	NaN	NaN	0.85	140.03	3.2	91.4	6.8	99.2
15-Oct-12	NaN	NaN	NaN	0.94	154.88	5.0	79.7	0.2	99.3
16-Oct-12	NaN	NaN	NaN	0.76	345.44	3.4	79.5	2.0	99.3
17-Oct-12	NaN	NaN	NaN	1.51	158.90	1.2	72.3	0.2	101.0
18-Oct-12	NaN	NaN	NaN	1.47	158.47	2.1	85.2	2.0	100.3
19-Oct-12	NaN	NaN	NaN	0.73	325.14	-1.9	83.3	0.0	100.0
20-Oct-12	NaN	NaN	NaN	0.91	321.94	-3.9	79.3	0.0	100.8
21-Oct-12	NaN	NaN	NaN	1.99	333.48	-6.5	67.3	0.0	101.7
22-Oct-12	NaN	NaN	NaN	1.53	330.57	-5.4	68.6	0.2	101.7
23-Oct-12	NaN	NaN	NaN	1.13	335.39	-6.8	68.0	0.0	101.8
24-Oct-12	NaN	NaN	NaN	0.80	327.91	-8.2	66.1	0.0	102.3
25-Oct-12	NaN	NaN	NaN	0.69	331.86	-8.2	65.9	0.0	102.7
26-Oct-12	NaN	NaN	NaN	1.23	331.80	-11.0	67.3	0.0	102.1
27-Oct-12	NaN	NaN	NaN	1.64	331.81	-12.8	65.1	0.0	101.4
28-Oct-12	NaN	NaN	NaN	1.90	330.98	-10.9	54.4	0.0	101.0
29-Oct-12	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
30-Oct-12	12.5	89.6	0.14	0.58	334.83	-17.7	61.2	0.0	101.6
31-Oct-12	9.3	76.7	0.12	0.79	350.42	-15.2	66.7	0.0	101.2

Fort Ware PM and Meteorological Data (2012)									
Date	$PM_{2.5}$ (μg m^{-3})	PM_{10} (μg m^{-3})	PM Ratio	Wind Speed (ms^{-1})	Wind Direction (degrees)	Air Temp. (^{0}C)	RH (%)	Total Precip (mm)	Barometric Pressure (kPa)
1-Nov-12	13.2	72.9	0.18	0.83	334.58	-12.7	67.6	0.0	101.0
2-Nov-12	3.3	15.2	0.22	0.37	345.41	-7.9	77.8	0.0	101.1
3-Nov-12	9.8	12.1	0.81	0.37	10.29	-2.0	93.3	0.0	100.5
4-Nov-12	1.5	1.8	0.85	2.30	153.35	1.7	93.5	6.6	100.0
5-Nov-12	2.8	3.8	0.74	0.87	254.82	-9.0	76.69	1.10	100.90
6-Nov-12	7.7	8.2	0.94	0.92	241.48	-7.5	79.27	1.28	100.79
7-Nov-12	1.7	2.0	0.87	0.95	223.32	-6.2	81.36	1.50	100.73
8-Nov-12	3.6	5.0	0.72	0.97	204.78	-5.1	83.66	1.75	100.67
9-Nov-12	2.0	2.9	0.67	1.06	181.34	-4.7	84.64	2.04	100.60
10-Nov-12	3.1	3.9	0.78	1.46	338.97	-5.1	70.29	0.00	100.51
11-Nov-12	6.3	7.8	0.80	1.51	338.62	-6.3	70.07	0.00	100.45
12-Nov-12	7.5	8.7	0.86	1.47	337.54	-15.7	69.29	0.00	100.49
13-Nov-12	6.8	8.2	0.83	1.43	338.55	-16.0	68.72	0.00	100.55
14-Nov-12	5.8	7.0	0.83	1.31	339.15	-16.0	69.12	0.00	100.69
15-Nov-12	3.5	4.4	0.81	1.26	339.71	-15.3	70.74	0.00	100.68
16-Nov-12	6.3	7.7	0.81	1.20	339.61	-14.7	72.21	0.00	100.71
17-Nov-12	1.4	10.9	0.12	1.17	339.78	-14.1	73.27	0.00	100.79
18-Nov-12	3.1	8.5	0.36	2.33	338.81	-15.4	68.9	0.0	99.7
19-Nov-12	3.1	9.2	0.34	1.92	335.79	-16.3	68.3	0.0	100.0
20-Nov-12	3.4	5.0	0.69	1.15	328.91	-17.5	63.1	0.0	100.8
21-Nov-12	4.2	5.4	0.79	1.06	346.67	-18.6	64.1	0.0	101.1
22-Nov-12	5.1	6.3	0.82	0.39	343.90	-16.4	72.4	0.0	101.7
23-Nov-12	3.7	5.2	0.71	0.87	344.17	-9.5	83.7	0.0	100.6
24-Nov-12	6.1	7.2	0.84	0.73	338.82	-10.1	84.0	0.0	101.0
25-Nov-12	3.7	4.4	0.85	0.90	341.16	-8.9	81.8	0.0	101.4
26-Nov-12	3.0	4.0	0.74	1.16	344.72	-12.2	75.5	0.0	101.7
27-Nov-12	5.5	7.0	0.79	0.68	355.16	-17.5	75.5	0.0	101.6
28-Nov-12	1.1	4.8	0.23	1.82	335.87	-15.9	70.2	0.0	101.2
29-Nov-12	0.7	5.2	0.12	1.89	331.80	-20.7	65.1	0.0	100.5
30-Nov-12	1.2	5.1	0.24	1.80	331.53	-20.5	63.7	0.0	100.3
1-Dec-12	1.4	3.2	0.44	1.21	330.02	-18.8	66.2	0.0	99.7
2-Dec-12	2.4	5.5	0.43	1.50	335.26	-19.0	66.2	0.0	99.3
3-Dec-12	4.6	6.0	0.76	0.67	349.43	-16.5	73.0	0.0	100.2
4-Dec-12	1.9	10.0	0.19	1.74	332.31	-17.5	71.8	0.0	99.3
5-Dec-12	5.1	7.9	0.65	1.56	340.05	-19.0	64.9	0.0	100.5
6-Dec-12	4.4	5.5	0.80	0.59	344.00	-16.2	73.7	0.0	100.9
7-Dec-12	3.0	4.5	0.67	1.88	341.40	-19.0	69.0	0.0	100.9
8-Dec-12	9.5	11.2	0.85	0.74	342.14	-26.0	62.3	0.0	101.9
9-Dec-12	4.4	5.3	0.82	0.30	355.38	-19.4	71.2	0.0	101.0
10-Dec-12	4.4	5.1	0.86	0.30	346.06	-14.4	76.8	0.0	100.4
11-Dec-12	4.9	6.5	0.75	1.14	345.33	-8.4	84.0	0.0	99.6
12-Dec-12	8.4	10.3	0.82	0.47	38.04	-13.0	78.7	0.0	100.3
13-Dec-12	3.6	4.3	0.84	0.55	351.36	-9.0	85.1	0.0	99.4
14-Dec-12	2.1	2.8	0.76	1.15	137.49	-7.6	85.5	0.0	99.8
15-Dec-12	0.6	2.0	0.29	3.09	153.09	-4.3	82.9	0.0	98.8
16-Dec-12	2.4	2.8	0.86	0.87	159.80	-7.4	84.7	0.0	99.0
17-Dec-12	3.2	3.8	0.85	0.68	344.94	-9.4	79.2	0.0	99.4
18-Dec-12	2.4	3.1	0.78	0.69	340.39	-14.3	75.0	0.0	100.1
19-Dec-12	3.1	5.1	0.60	0.94	337.85	-14.7	78.1	0.0	99.9
20-Dec-12	1.7	3.8	0.44	2.19	330.10	-18.5	70.0	0.0	100.8
21-Dec-12	2.3	4.7	0.48	1.74	330.32	-20.2	64.1	0.0	101.6
22-Dec-12	1.7	2.2	0.74	0.90	320.74	-21.3	61.9	0.0	101.4

Fort Ware PM and Meteorological Data (2012)									
Date	$PM_{2.5}$ (µg m^{-3})	PM_{10} (µg m^{-3})	PM Ratio	Wind Speed (ms^{-1})	Wind Direction (degrees)	Air Temp. (^{0}C)	RH (%)	Total Precip (mm)	Barometric Pressure (kPa)
23-Dec-12	2.4	3.3	0.73	1.01	330.33	-23.3	61.3	0.0	101.4
24-Dec-12	2.9	5.0	0.58	1.67	339.70	-21.9	62.6	0.0	102.0
25-Dec-12	4.1	4.9	0.83	1.25	342.07	-25.7	59.5	0.0	101.6
26-Dec-12	6.5	7.6	0.85	1.04	348.96	-28.8	58.4	0.0	101.1
27-Dec-12	5.8	6.9	0.84	0.21	352.59	-28.0	60.3	0.0	101.4
28-Dec-12	5.5	6.6	0.84	0.35	345.87	-19.6	67.7	0.0	101.3
29-Dec-12	14.3	15.8	0.91	0.27	348.79	-23.0	65.4	0.0	101.7
30-Dec-12	9.0	10.6	0.8	0.1	303	-19.0	71.4	0.0	101.8
31-Dec-12	7.1	8.3	0.9	0.4	340	-12.2	82.5	0.0	101.7

APPENDIX III

PARTICULATE AND METEOROLOGICAL DATA FOR THE BGI MONITORING SITES (2012)

TSAY KEH

Date	PM_{10} (µg m^{-3})	$PM_{2.5}$ (µg m^{-3})	Wind Speed (ms^{-1})	Wind Direction (degrees)	Temperature (°C)	RH (%)	Precipitation (mm)
24-May-12	4.1	1.6	3.9	331	9.4	77.7	0.8
27-May-12	30.4	5.7	2.7	190	13.6	42.1	0
30-May-12	42.4	8.3	3.1	147	9	69.4	0
2-Jun-12	2.0	0.2	1.6	201	9.7	59.8	2.2
5-Jun-12	6.6	3.5	2.9	248	10.1	89.9	5.5
8-Jun-12	24.5	14.4	1.7	218	8.9	78.6	0
11-Jun-12	24.5	3.4	2.2	134	12.3	78.6	1.2
14-Jun-12	18.9	3.8	1.8	254	10.5	55.7	0
20-Jun-12	9.8	1.7	1.9	139	12.9	79.5	0.1
26-Jun-12	4.2	1.7	0.4	85	11.8	79.6	0
2-Jul-12	7.0	1.4	0.3	126	12.7	67.9	0
8-Jul-12	21.5	14.3	0.4	114	15.6	70.7	0
14-Jul-12	14.9	4.2	0.7	196	15.6	76.3	7.6
20-Jul-12	27.6	3.4	0.5	185	17	70.8	0
26-Jul-12	29.9	10.5	0.4	161	16.8	78.9	0
1-Aug-12	3.9	0.8	0.4	176	12.6	82.7	7.5
7-Aug-12	23.7	7.2	0.6	105	16.2	76.8	0
13-Aug-12	10.0	5.3	0.7	193	13.1	83.4	0
19-Aug-12	21.9	7.8	0.5	143	15.7	72.8	0
25-Aug-12	5.0	2.5	0.5	65	12.4	82.1	0.3
31-Aug-12	3.3	1.0	0.5	184	9.5	80.7	0.1
6-Sep-12	10.2	2.6	0.6	48	10.6	81.6	0
12-Sep-12	1.6	0.0	0.6	49	6.6	92.3	0
18-Sep-12	13.6	4.3	0.5	265	9.3	79.6	0
24-Sep-12	10.2	6.2	0.3	196	11.4	89.2	1.8
30-Sep-12	0.8	*	0.5	331	7.7	69.1	2
6-Oct-12	11.4	6.7	0.4	122	3.2	93.6	0
14-Oct-12	1.2	0.3	1.3	36	7.4	77.8	2.5

CHOWIKA

Date	PM_{10} (μg m^{-3})	$PM_{2.5}$ (μg m^{-3})	Wind Speed (ms^{-1})	Wind Direction (degrees)	Temperature (°C)	RH (%)	Precipitation (mm)
24-May-12	NaN	NaN	3.9	331	9.4	77.7	0.8
27-May-12	19.4	4.7	3.2	355	11.7	50.6	0
30-May-12	33.1	3.1	4.2	355	9.5	65.2	0
2-Jun-12	0.6	*	0	0	60.6	33.1	0
5-Jun-12	4.4	3.9	0	0	44.8	52.2	7.4
8-Jun-12	2.1	0.6	3.2	290	8.3	79.9	0
11-Jun-12	17.3	5.4	3.2	129	12.3	74	1.8
14-Jun-12	3.4	1.7	2.5	246	9.8	57.2	0
20-Jun-12	4.2	0.5	2.6	124	12.4	82	0.3
26-Jun-12	3.9	*	2.2	237	10.9	82.6	0.5
2-Jul-12	3.6	2.6	1.2	183	11.9	68.3	0
8-Jul-12	12.3	7.8	1.5	204	15.8	66.1	0
14-Jul-12	7.1	1.5	2.1	210	17.1	66	1.7
20-Jul-12	8.2	1.5	1.8	290	17.5	67.2	0
26-Jul-12	14.6	8.4	1.3	267	18.1	73.3	0
1-Aug-12	6.1	*	1.5	212	13.4	74.4	9.1
7-Aug-12	11.0	4.7	2.5	113	17.3	73.5	1.1
13-Aug-12	7.4	5.1	2.1	159	13.5	79.6	3
19-Aug-12	13.3	5.4	2	210	17.1	66.8	0
25-Aug-12	3.7	1.2	1.8	135	13.5	76.6	0
31-Aug-12	2.3	0.7	2	123	10.8	76.6	0
6-Sep-12	6.9	1.3	1.8	94	12.8	73.4	0
12-Sep-12	0.7	0.2	1.7	126	8	85.1	6.5
18-Sep-12	2.6	1.1	1.8	217	11.2	72.3	0
24-Sep-12	4.3	2.0	1.2	319	12.7	79.8	0.7
30-Sep-12	0.0	0.0	1.4	160	8.8	64.3	1.8
6-Oct-12	3.4	1.8	0.9	115	5.7	88.9	0
14-Oct-12	0.5	0.3	3.2	151	7.6	77.6	3

DAVIS SOUTH

Date	PM_{10} (µg m^{-3})	$PM_{2.5}$ (µg m^{-3})	Wind Speed (ms^{-1})	Wind Direction (degrees)	Temperature (°C)	RH (%)	Precipitation (mm)
24-May-12	5.3	1.5	3.5	296	8.3	81.8	1.3
27-May-12	13.5	3.8	3.7	147	14	44.2	0
30-May-12	92.6	5.2	*	*	60.6	33.1	0
2-Jun-12	2.2	*	*	*	60.6	33.1	0
5-Jun-12	3.9	2.0	*	*	44.8	52.2	7.4
8-Jun-12	2.8	0.9	*	*	8.2	84.5	0
11-Jun-12	4.2	1.0	*	*	12.1	75.1	0.6
14-Jun-12	5.6	*	*	*	10.3	60.9	0
20-Jun-12	4.4	1.0	*	*	12.5	84.4	0
26-Jun-12	2.1	0.5	*	*	10.9	86.1	0.2
2-Jul-12	3.2	0.6	*	*	12.1	73.9	0
8-Jul-12	11.4	8.2	*	*	15.2	73.4	0
14-Jul-12	*	1.6	*	*	15.7	75.6	3.6
20-Jul-12	5.9	2.4	*	*	17.2	69.3	0
26-Jul-12	13.4	7.6	*	*	18.4	75.7	0.1
1-Aug-12	2.2	0.5	*	*	13.3	79.7	6
7-Aug-12	*	5.1	*	*	16.2	80.3	0
13-Aug-12	6.8	4.8	*	*	14	80.8	3.9
19-Aug-12	8.5	*	*	*	15.7	74.4	0
25-Aug-12	3.7	1.0	*	*	12.6	84.1	0
31-Aug-12	2.2	0.7	*	*	10.4	79.6	0
6-Sep-12	6.3	1.9	*	*	10.5	83.9	0
12-Sep-12	1.2	0.3	*	*	8.5	84.5	5.7
18-Sep-12	1.6	0.8	0.8	355	10.1	76.5	0
24-Sep-12	3.9	3.2	0.7	355	12	86.5	0.5
30-Sep-12	NaN	NaN	2.6	354	8.4	72.5	3.1
6-Oct-12	NaN	NaN	1.4	355	3.4	91.2	0
14-Oct-12	NaN	NaN	*	*	*	*	*

INGENICA

Date	PM_{10} (µg m^{-3})	$PM_{2.5}$ (µg m^{-3})	Wind Speed (ms^{-1})	Wind Direction (degrees)	Temperature (^{o}C)	RH (%)	Precipitation (mm)
24-May-12	1.0	*	3.5	296	8.3	81.8	1.3
27-May-12	10.5	3.8	1.8	199	13	46.4	0
30-May-12	15.0	2.0	2.2	225	8.7	98.3	0.1
2-Jun-12	7.4	*	1	127	9.4	80	1.2
5-Jun-12	3.2	0.4	0.4	130	9.9	98.2	14
8-Jun-12	2.5	0.7	0.8	172	9.2	93	0
11-Jun-12	16.0	2.2	2.2	204	11.8	85.5	1.4
14-Jun-12	2.7	0.2	0.7	118	11.6	46.9	0
20-Jun-12	4.2	0.3	1.6	207	12.2	80.9	0
26-Jun-12	3.2	0.5	2.5	191	10.7	83.3	0.3
2-Jul-12	2.2	0.0	1.1	203	11.5	68	0
8-Jul-12	23.1	10.3	1.5	211	15.3	65.7	0
14-Jul-12	22.7	1.6	0.8	178	17.3	65.7	5.7
20-Jul-12	7.5	2.2	0.7	158	18.7	60.9	0
26-Jul-12	15.5	8.4	0.7	141	17.7	71.8	0
1-Aug-12	5.4	1.5	1.5	188	13.3	78.3	10
7-Aug-12	13.7	11.7	3.2	175	16.7	75	0
13-Aug-12	7.4	4.7	0.7	217	13.5	77.6	5.1
19-Aug-12	11.6	5.9	1.6	208	16.6	70.6	0
25-Aug-12	3.0	1.0	3.1	175	13.5	75.6	0
31-Aug-12	1.7	0.3	2	192	10.6	80.1	0
6-Sep-12	6.4	1.7	2.7	205	12.2	79.6	0
12-Sep-12	1.2	*	3.3	199	7.9	84.8	4.9
18-Sep-12	3.1	1.0	0.5	243	11.4	68.6	0
24-Sep-12	3.7	1.4	0.6	236	12.3	78.5	1.1
30-Sep-12	NaN	NaN	1.9	170	8.2	66.9	1.1
6-Oct-12	3.7	0.8	1.2	203	4.8	92.3	0
14-Oct-12	NaN	NaN	6.8	189	8	76.6	1.4

LAFFERTY

Date	PM_{10} ($\mu g\ m^{-3}$)	$PM_{2.5}$ ($\mu g\ m^{-3}$)	Wind Speed (ms^{-1})	Wind Direction (degrees)	Temperature (^oC)	RH (%)	Precipitation (mm)
24-May-12	40.9	2.5	3.5	296	8.3	*	1.3
27-May-12	50.4	5.0	3.7	147	14	*	0
30-May-12	82.4	6.4	4.2	133	10	*	0
2-Jun-12	5.2	*	2.9	197	9.9	*	0
5-Jun-12	3.1	1.9	5.5	326	9.6	*	5.4
8-Jun-12	2.2	1.1	2.2	204	8.1	*	0.2
11-Jun-12	1.7	0.8	3.9	115	13.1	*	0.5
14-Jun-12	1.3	1.0	0.7	170	10.2	*	0
20-Jun-12	3.7	0.2	0.9	145	14.2	*	0
26-Jun-12	2.8	0.3	1.6	146	11.5	*	0.5
2-Jul-12	2.7	3.2	0.9	194	13.1	*	0
8-Jul-12	12.9	10.2	0.8	182	16.2	*	0
14-Jul-12	NaN	NaN	0.7	214	15.8	*	8.9
20-Jul-12	4.0	1.8	0.7	112	17	*	0
26-Jul-12	10.2	8.5	0.6	120	17.7	*	0
1-Aug-12	1.8	0.6	0.6	153	12.7	*	4.3
7-Aug-12	8.9	4.4	0.7	179	17.2	*	0
13-Aug-12	6.4	4.3	0.6	0	13.8	*	4.5
19-Aug-12	5.3	4.8	0.4	304	18.3	*	0
25-Aug-12	3.7	1.2	0.9	166	15.3	*	0
31-Aug-12	2.8	1.5	6.5	173	13.6	*	0
6-Sep-12	5.7	2.0	1.1	146	0	*	0
12-Sep-12	1.2	*	1.1	213	14.9	45.6	0
18-Sep-12	4.2	2.0	0.4	236	8.3	79.9	0
24-Sep-12	4.8	3.2	0.9	143	10.6	73.4	0
30-Sep-12	NaN	NaN	2	297	6.1	70.1	0.9
6-Oct-12	3.8	3.1	0.3	176	6.3	86.5	0
14-Oct-12	NaN	NaN	0.4	196	5.2	90.4	15

PETE TOY

Date	PM_{10} ($\mu g\ m^{-3}$)	$PM_{2.5}$ ($\mu g\ m^{-3}$)	Wind Speed (ms^{-1})	Wind Direction (degrees)	Temperature (^{o}C)	RH (%)	Precipitation (mm)
24-May-12	16.2	1.2	3.9	331	9.4	77.7	0.8
27-May-12	61.6	9.1	2.7	190	13.6	42.1	0
30-May-12	51.9	3.2	2.7	193	8.8	66.9	0
2-Jun-12	1.4	0.3	2	227	9	59.5	0
5-Jun-12	3.5	1.4	2.8	331	9.6	92.2	13.4
8-Jun-12	NaN	NaN	1.8	203	8.2	85.4	0.3
11-Jun-12	9.2	1.4	2.4	178	12.8	73.9	0.4
14-Jun-12	1.8	0.3	1.3	133	10.5	53.4	0
20-Jun-12	8.3	0.6	1.3	197	13.5	77.6	0
26-Jun-12	3.9	0.1	1.5	160	11.1	84.9	0.3
2-Jul-12	3.2	0.1	0.8	149	12.2	70.4	0.4
8-Jul-12	0.0	0.0	0.8	190	15.9	69.3	0
14-Jul-12	41.0	0.6	0.7	176	16.9	69.2	3.2
20-Jul-12	6.6	2.2	0.7	112	17	70.5	0
26-Jul-12	8.8	11.3	0.6	120	17.7	79.5	0
1-Aug-12	3.1	0.1	0.6	153	12.7	82.8	4.3
7-Aug-12	9.1	4.3	0.7	179	17.2	76.5	0
13-Aug-12	7.6	5.3	0.6	0	13.8	80.8	4.5
19-Aug-12	9.1	5.1	0.6	171	16.3	73.4	0
25-Aug-12	6.4	1.3	0.7	234	12.9	81.4	0
31-Aug-12	5.4	0.6	0.7	180	11	84.1	0
6-Sep-12	6.5	1.8	0.8	231	11.9	80.2	0
12-Sep-12	3.3	0.2	1	228	7	89.1	8.5
18-Sep-12	4.3	0.4	0.7	163	11.1	72.5	0
24-Sep-12	6.2	2.3	0.6	165	12	83.7	0.1
30-Sep-12	1.5	0.5	0.8	221	7.8	71.5	2.3
6-Oct-12	5.1	1.8	0.9	231	4.6	91	0
14-Oct-12	3.1	1.0	1.1	229	6.5	82.6	12.9

RAT LAKE

Date	PM_{10} (µg m^{-3})	$PM_{2.5}$ (µg m^{-3})	Wind Speed (ms-^{1})	Wind Direction (degrees)	Temperature (^{o}C)	RH (%)	Precipitation (mm)
24-May-12	1.3	*	3.5	296	8.3	81.8	1.3
27-May-12	24.0	4.2	3.2	172	12.5	49.3	0
30-May-12	13.0	1.7	3.4	159	8	70.7	0
2-Jun-12	1.5	0.0	1.4	132	9	62.1	2.5
5-Jun-12	6.0	2.8	0.8	251	9.6	94.3	10.2
8-Jun-12	41.6	1.9	1.4	204	8.8	75.6	0
11-Jun-12	13.9	*	3.5	135	11.5	78.5	0.8
14-Jun-12	15.0	1.0	1.3	237	10.6	49	0
20-Jun-12	5.1	0.4	2.6	139	12.3	80.4	0
26-Jun-12	6.1	0.0	5.2	117	11.1	76.4	0.1
2-Jul-12	20.1	0.8	2.2	142	11.9	65.1	0
8-Jul-12	29.6	9.1	2.4	157	14.9	67.5	0
14-Jul-12	63.5	4.3	1.8	206	15.9	67.8	6.8
20-Jul-12	91.3	4.8	1.2	157	18	62.2	0
26-Jul-12	33.9	8.5	1.2	161	17.4	71.3	0
1-Aug-12	2.6	1.0	0.6	153	12.7	82.8	4.3
7-Aug-12	80.4	10.3	4	154	16.3	73.7	0
13-Aug-12	13.3	6.6	1.2	230	12.6	78.5	4.3
19-Aug-12	19.7	5.7	2.9	190	15.3	71.7	0
25-Aug-12	4.0	1.7	4	141	13.2	75	0
31-Aug-12	6.3	0.8	3	172	9.4	79.7	0
6-Sep-12	165.7	4.8	4	185	10.2	83.5	0
12-Sep-12	0.9	0.0	3.7	159	7.5	81.1	5.4
18-Sep-12	11.4	1.3	1.3	232	9.6	74.4	0
24-Sep-12	7.9	4.4	1.2	213	11.2	88.5	2.1
30-Sep-12	35.4	3.0	2.8	155	7.6	65.8	2.1
6-Oct-12	3.2	1.6	1.7	223	3.2	95.3	0
14-Oct-12	2.6	4.8	6.8	120	7.1	76.5	2.4

STROMQUIST

Date	PM_{10} (μg m^{-3})	$PM_{2.5}$ (μg m^{-3})	Wind Speed (ms^{-1})	Wind Direction (degrees)	Temperature (°C)	RH (%)	Precipitation (mm)
24-May-12	3.1	0.5	3.5	296	8.3	81.8	1.3
27-May-12	35.8	5.2	2.6	158	12.6	45.9	0
30-May-12	139.4	8.7	3	170	8.2	70.5	0
2-Jun-12	2.7	2.5	2.3	254	8.7	57.8	0.1
5-Jun-12	3.9	1.4	3.6	295	9.5	91.3	14
8-Jun-12	0.0	0.0	2.5	251	8	84.2	0
11-Jun-12	48.6	3.1	2.9	152	12.5	73.4	0.3
14-Jun-12	5.5	0.5	1	256	11.5	47.6	0
20-Jun-12	5.2	0.0	2	171	12.7	79.9	0.1
26-Jun-12	3.6	0.0	1.9	181	10.6	86.5	0.3
2-Jul-12	4.7	1.4	0.9	186	11.2	79.5	1.8
8-Jul-12	12.9	9.9	1.3	171	14.6	74.9	0
14-Jul-12	7.7	1.4	1.2	210	16	73	4
20-Jul-12	NaN	3.5	0.8	222	17.1	69.8	0
26-Jul-12	NaN	8.0	0.7	185	17.6	78.6	0
1-Aug-12	NaN	0.5	0.7	169	12.2	83.7	4.1
7-Aug-12	NaN	4.7	1.6	139	16.9	76.4	0
13-Aug-12	NaN	5.1	0.7	215	13.5	80.7	3.5
19-Aug-12	NaN	5.2	1.1	167	15.7	73.8	0
25-Aug-12	NaN	6.0	1.5	145	12.3	83.5	0
31-Aug-12	NaN	0.5	1.2	168	10.2	84.6	0
6-Sep-12	NaN	2.2	2.1	154	10.9	83.7	0
12-Sep-12	NaN	0.3	1.2	170	6.8	90.3	4.8
18-Sep-12	NaN	1.2	1	220	10.3	74.2	0
24-Sep-12	NaN	2.4	0.6	265	12.4	79	0
30-Sep-12	NaN	0.2	1.1	188	7.3	74.7	1.4
6-Oct-12	NaN	1.9	1.3	203	4.4	93	0
14-Oct-12	NaN	NaN	2.4	154	6.7	82.2	8.1

VAN SOMER

Date	PM_{10} ($\mu g\ m^{-3}$)	$PM_{2.5}$ ($\mu g\ m^{-3}$)	Wind Speed (ms^{-1})	Wind Direction (degrees)	Temperature (^oC)	RH (%)	Precipitation (mm)
24-May-12	5.1	2.3	3.9	331	9.4	77.7	0.8
27-May-12	18.7	4.7	2.7	190	13.6	42.1	0
30-May-12	98.8	8.3	3.1	147	9	69.4	0
2-Jun-12	NaN	NaN	1.6	201	9.7	59.8	2.2
5-Jun-12	3.6	1.3	2.9	248	10.1	89.9	5.5
8-Jun-12	3.0	1.1	1.7	218	8.9	78.6	0
11-Jun-12	16.3	2.2	2.2	134	12.3	78.6	1.2
14-Jun-12	2.1	0.7	1.8	254	10.5	55.7	0
20-Jun-12	3.3	0.8	1.9	139	12.9	79.5	0.1
26-Jun-12	3.4	0.5	0.4	85	11.8	79.6	0
2-Jul-12	3.3	2.2	0.3	126	12.7	67.9	0
8-Jul-12	10.8	8.7	0.4	114	15.6	70.7	0
14-Jul-12	3.8	1.9	0.7	196	15.6	76.3	7.6
20-Jul-12	6.2	1.8	0.5	185	17	70.8	0
26-Jul-12	11.0	7.9	0.4	161	16.8	78.9	0
1-Aug-12	2.0	0.0	0.4	176	12.6	82.7	7.5
7-Aug-12	9.8	4.1	0.6	105	16.2	76.8	0
13-Aug-12	6.8	5.0	0.7	193	13.1	83.4	0
19-Aug-12	9.9	5.9	0.5	143	15.7	72.8	0
25-Aug-12	4.2	1.2	0.5	65	12.4	82.1	0.3
31-Aug-12	3.4	0.0	0.5	184	9.5	80.7	0.1
6-Sep-12	7.6	1.7	0.6	48	10.6	81.6	0
12-Sep-12	1.7	0.0	0.6	49	6.6	92.3	0
18-Sep-12	4.2	1.4	0.5	265	9.3	79.6	0
24-Sep-12	4.6	2.7	0.3	196	11.4	89.2	1.8
30-Sep-12	0.2	0.0	0.5	331	7.7	69.1	2
6-Oct-12	2.6	0.7	0.4	122	3.2	93.6	0
14-Oct-12	NaN	NaN	1.3	36	7.4	77.8	2.5