REPORT N^{O} 101-53675-00

2015 SUMMARY OF AMBIENT AIR QUALITY MONITORING

CHEAKAMUS CROSSING AMBIENT AIR QUALITY MONITORING STATION

FEBRUARY 11, 2016

WSP

2015 SUMMARY OF AMBIENT AIR QUALITY MONITORING

CHEAKAMUS CROSSING AMBIENT AIR QUALITY MONITORING STATION

Resort Municipality of Whistler

Type of document (version)

Project no: 101-53675-00
Date: February 11, 2016

WSP Canada Inc.
150-12791 Clarke Place
Richmond, BC V6V 2H9

Phone: +1 604-278-1411
Fax: +1 604-278-1042
www.wspgroup.com

File Number: 101-53675-00

February 11, 2016

Andrew Tucker
Resort Municipality of Whistler
4325 Blackcomb Way
Whistler, BC V0N 1B4

WSP Canada Inc.
150-12791 Clarke Place
Richmond, BC V6V 2H9

Tel: +1 604 278 1411
Fax: +1 604 278 1042

www.wspgroup.com
www.pbworld.com

Dear Mr. Tucker,

Subject: Summary of 2015 Ambient Air Quality Monitoring, Cheakamus Crossing Neighborhood

WSP Canada Inc. (WSP), which acquired Levelton Consultants Ltd (Levelton) as of July 1, 2015, is pleased to provide the Annual Ambient Air Monitoring Report for the Resort Municipality of Whistler for 2015. The report outlines the monitoring program conducted during 2015 and compares the data to current standards.

Yours sincerely,

Braden Bartnik, B.Sc., BC-CESCL
Air Quality Specialist, Environment

TABLE OF CONTENTS

1 INTRODUCTION 1

2 STATION DETAILS 1

2.1 2015 STATION MAINTENANCE AND AUDITS 4

3 DATA SUMMARY 5

3.1 WIND DIRECTION AND WIND SPEED 5

3.2 PM2.5 CONCENTRATIONS 6

4 CONCLUSION 9

BIBLIOGRAPHY 9

TABLES

TABLE 1 ANNUAL PM2.5 TEOM DATA (2011 – 2015) 8

FIGURES

FIGURE 1 HIGH PERFORMANCE CENTRE (HPC) IN CHEAKAMUS CROSSING NEIGHBOURHOOD 2
FIGURE 2 LOCATION OF THE MONITORING STATION IN THE CHEAKAMUS CROSSING NEIGHBOURHOOD (SHOWN AS A RED STAR) 2
FIGURE 3 TEOM SENSOR UNIT (LEFT), CONTROL UNIT (MIDDLE) AND INLET SYSTEM (RIGHT)..... 3
FIGURE 4 TRIPOD MOUNTED ANEMOMETER AND TEOM INLET LOCATED ON THE ROOF OF THE HPC BUILDING 4
FIGURE 5 HISTORICAL WINDROSE OF THE CHEAKAMUS CROSSING ANEMOMETER DATA, JANUARY 1ST, 2011 TO DECEMBER 31ST, 2014 5
FIGURE 6 WINDROSE OF THE CHEAKAMUS CROSSING ANEMOMETER DATA, JANUARY 1ST, 2015 TO DECEMBER 31ST, 2015..... 6
FIGURE 7 PM2.5 MONTHLY 24-HOUR AVERAGE, 24-HOUR MAXIMUM, AND 1-HOUR MAXIMUM CONCENTRATIONS..... 7
FIGURE 8 PM2.5 24-HOUR 98TH PERCENTILE AND ANNUAL AVERAGE DATA FOR 2011 - 2015 COMPARED TO BC AAQOS FOR PM2.5..... 8

APPENDICES

APPENDIX A MOE AUDIT REPORTS

1 INTRODUCTION

WSP (formerly Levelton Consultants Ltd.) has operated and maintained the Cheakamus Crossing Ambient Air Monitoring Station on behalf of the Resort Municipality of Whistler (RMOW) since September, 2010. The station was installed to assist in addressing local citizen's concerns of potential ambient air quality issues associated with an asphalt plant located near the neighbourhood. The station continuously monitors ambient particulate ($PM_{2.5}$). WSP provides public access to the monitoring data via a dedicated website. This report summarizes the data from the monitoring station for the calendar year of 2015 (January 1st 2015, to December, 31st 2015).

2 STATION DETAILS

The Cheakamus Crossing Ambient Air Monitoring Station is located on the High Performance Centre (HPC) building (Figure 1). The High Performance Centre (HPC) building (Figure 1) was selected for the monitoring site because:

- the HPC building is one of the closest structures to the property currently occupied by the asphalt plant;
- the HPC building is located in the Cheakamus Crossing neighbourhood (Figure 2) and provides a suitable location to record representative measurements of particulate matter concentrations in the neighbourhood;
- the location minimizes interference from surrounding buildings or vegetation;
- the monitoring station's indoor sensors/controllers as well as the rooftop equipment are safely accessible for routine maintenance and cleaning; and,
- the HPC building is a secure location to house the monitoring station, as it contains sensitive/expensive scientific equipment.

Figure 1 **High Performance Centre (HPC) in Cheakamus Crossing Neighbourhood**

Figure 2 **Location of the Monitoring Station in the Cheakamus Crossing Neighbourhood (shown as a red star)**

The monitoring equipment at the station includes:

- TEOM Series 1400a Ambient Particulate Monitor (TEOM) (Figure 3)
- R.M. Young 05305 Air Quality Wind Anemometer

The TEOM Series 1400a Ambient Particulate Monitor incorporates the patented Tapered Element Oscillating Microbalance (TEOM) technology to measure particulate matter mass concentrations continuously. The TEOM has been recognized by the US EPA as an acceptable continuous monitor of particulate matter concentrations (Rupprecht, 2002). This unit is outfitted with a Sharp Cut Cyclone (SCC) $PM_{2.5}$ inlet. Ambient air is pumped through the SCC inlet, which only allows airborne particulate matter with an aerodynamic diameter of 2.5 micrometers (2.5 µm = 0.0000025 meters) or less into the TEOM's sensor unit. The TEOM then measures the mass of particulate matter per volume of air sampled and displays it in micrograms per cubic meter (µg/m³).

$PM_{2.5}$, also known as fine particulate, is so small it can only be detected with an electron microscope. Sources of fine particles include all types of combustion, including motor vehicles, power plants, residential wood burning, forest fires, agricultural burning, and some industrial processes.

The R.M. Young anemometer was installed to determine hourly wind direction and speed, which is useful in interpreting the particulate matter concentrations recorded at the monitoring station. The anemometer is mounted on a 10 foot tripod installed on the roof of the HPC building in the Cheakamus Crossing Neighbourhood adjacent to the TEOM inlet (Figure 4).

The datalogger records 1-hour averages for both the TEOM and anemometer data to an onsite computer system. Along with storing the data on the onsite computer system, data is also transferred to Levelton's Air Quality website (www.airquality.ca/clients/Whistler) where it is displayed in 'real-time'. A link to this site is provided on the RMOW website (www.whistler.ca)

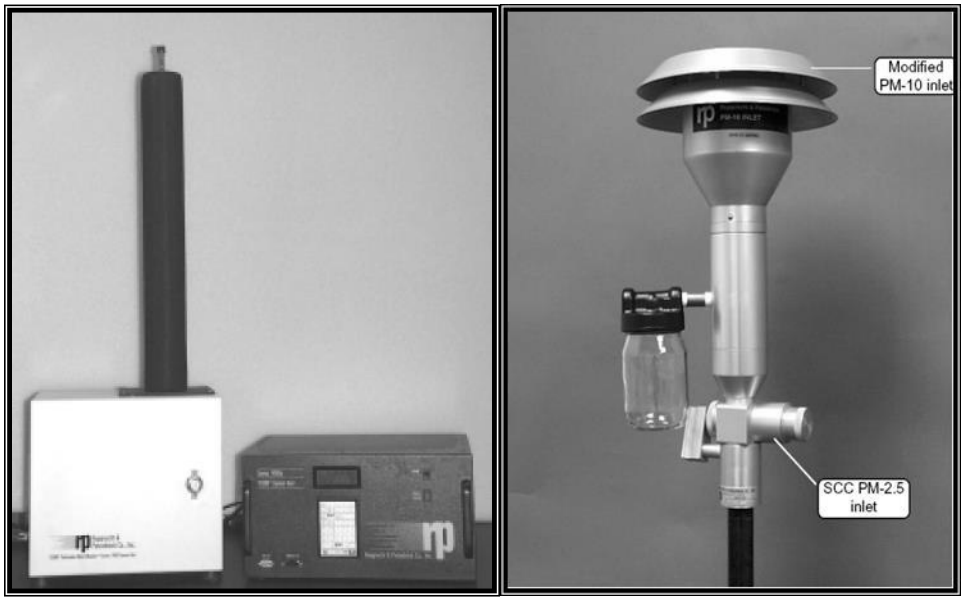

Figure 3 TEOM Sensor Unit (left), Control Unit (middle) and Inlet System (right)

Figure 4 Tripod Mounted Anemometer and TEOM Inlet located on the Roof of the HPC building

2.1 2015 STATION MAINTENANCE AND AUDITS

WSP has consulted with the British Columbia Ministry of Environment (BC MOE) and follows the same maintenance and calibration standards by which the BC MOE operates their provincial system of ambient air monitoring stations. WSP and the RMOW coordinated with the BC MOE to have the Cheakamus Crossing Ambient Air Monitoring Station audited by the BC MOE's provincial auditing team. This team conducts semi-annual audits on all of the BC MOE stations to validate the proper operation of the equipment. During 2015, the MOE conducted an audit on February 5th. All of the audited parameters passed which means the data was validated by the MOE. A second audit was not completed due to the decommissioning of the TEOM equipment at the end of 2015. A copy of the audit report can be found in Appendix A.

WSP completed six (6) site visits (bi-monthly) during 2015 to complete necessary audits, calibrations and maintenance on the monitoring equipment. During the September site visit a full audit of the onsite anemometer was also completed. The maintenance/calibration and verification schedule for the monitoring station are more stringent than the manufacturer's recommended schedule.

3 DATA SUMMARY

Data collection began on September 3rd, 2010 for $PM_{2.5}$ data and on September 15th, 2010 for the wind data. The TEOM and anemometer continuously collect data. Required monthly maintenance results in the system being offline for short periods of time. A report was presented in December 2010 summarizing the first 3 months of monitoring data (September 15th, 2010 to November 30th, 2010) and details on the station installation. Annual reports have been presented following each year of data collection. A Summary report was also published in 2015 which consolidated the four years of data collected until that point.

This report summarizes the data collected for the calendar year of 2015 (January 1st, 2015 to December, 31st, 2015) with comparisons to previous years.

3.1 WIND DIRECTION AND WIND SPEED

A wind rose was created using the wind data collected onsite for 2015 (Figure 6). Wind roses are used to display the frequency of wind speed at wind direction. The annual windrose is similar in wind direction and speed when compared to the historical wind data (Figure 5). Winds typically show a dominant wind path dictated by the topography of the site. The dominant direction of wind at the station continues to be from the west. This was also the direction that recorded the highest wind speeds. Winds from the southwest and south-southwest have the greatest potential to transport emissions directly from the asphalt plant towards the monitoring station. These winds occurred approximately 2.7% of the time over the 2015 monitoring period (less than in 2014).

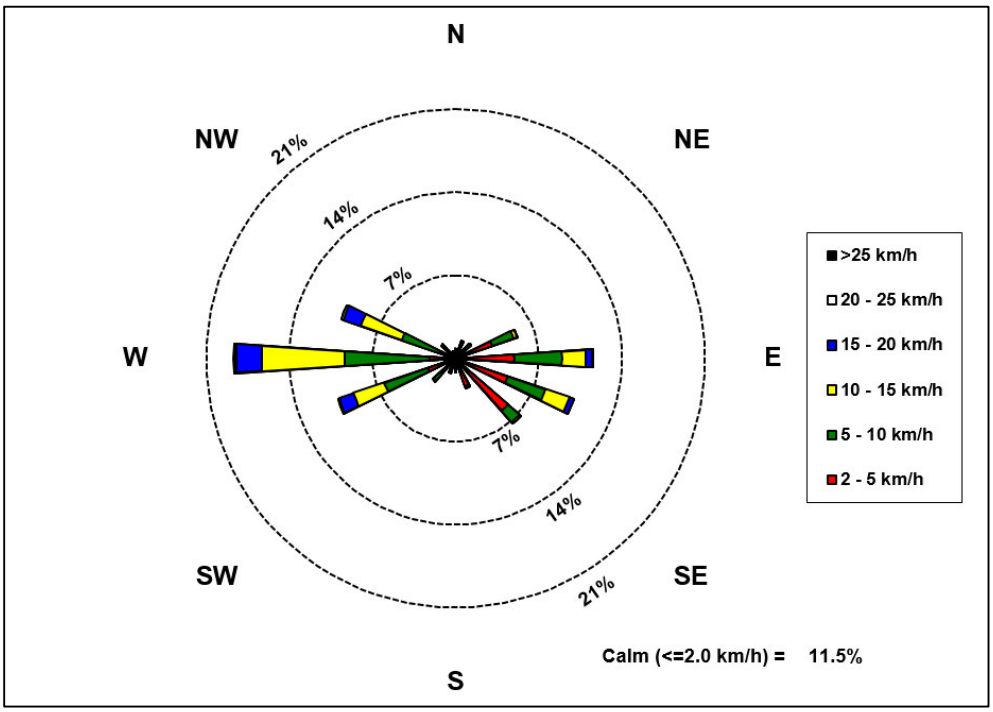

Figure 5 Historical Windrose of the Cheakamus Crossing Anemometer Data, January 1st, 2011 to December 31st, 2014

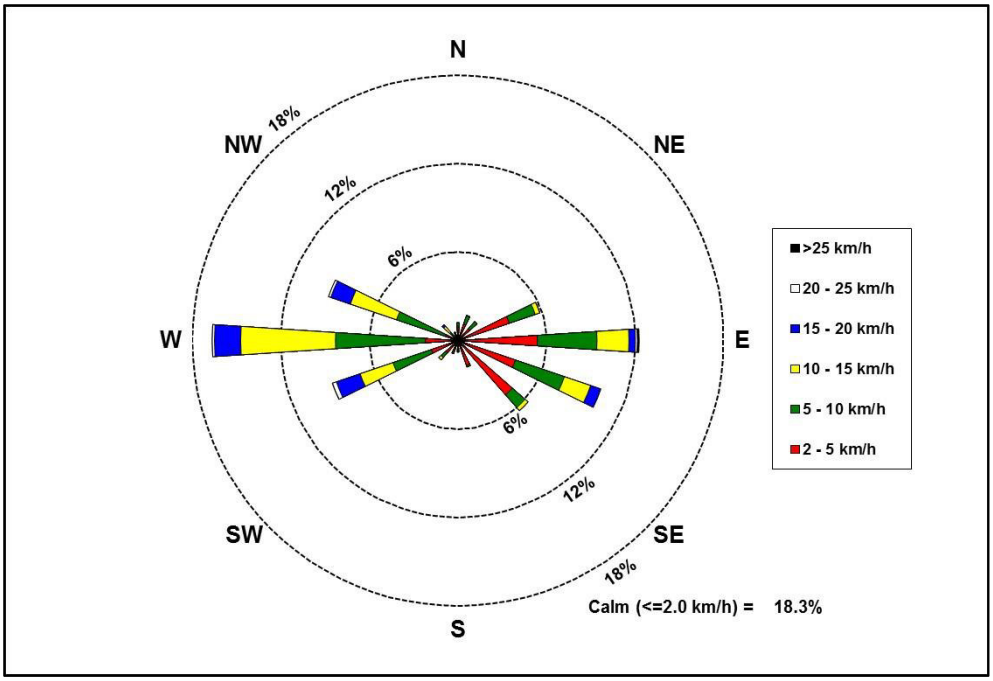

Figure 6 Windrose of the Cheakamus Crossing Anemometer Data, January 1st, 2015 to December 31st, 2015

3.2 $PM_{2.5}$ CONCENTRATIONS

The continuous monitoring data from the TEOM unit was used to calculate 1-hour average $PM_{2.5}$ concentrations. From these hourly averages a rolling 24-hour average is calculated using the last 24 hourly averages at each hour of the data set. The rolling 24-hour average displayed on the WSP and RMOW website provides a 'real-time' representation of current conditions but is not compared to the provincial objectives. When comparing the results to the British Columbia Ambient Air Quality Objectives (BC AAQO), a daily 24-hour average (midnight to midnight), also referred to as block average is used. Figure 7 displays a monthly breakdown of the 24-hour block averages and maximums, along with the hourly maximums.

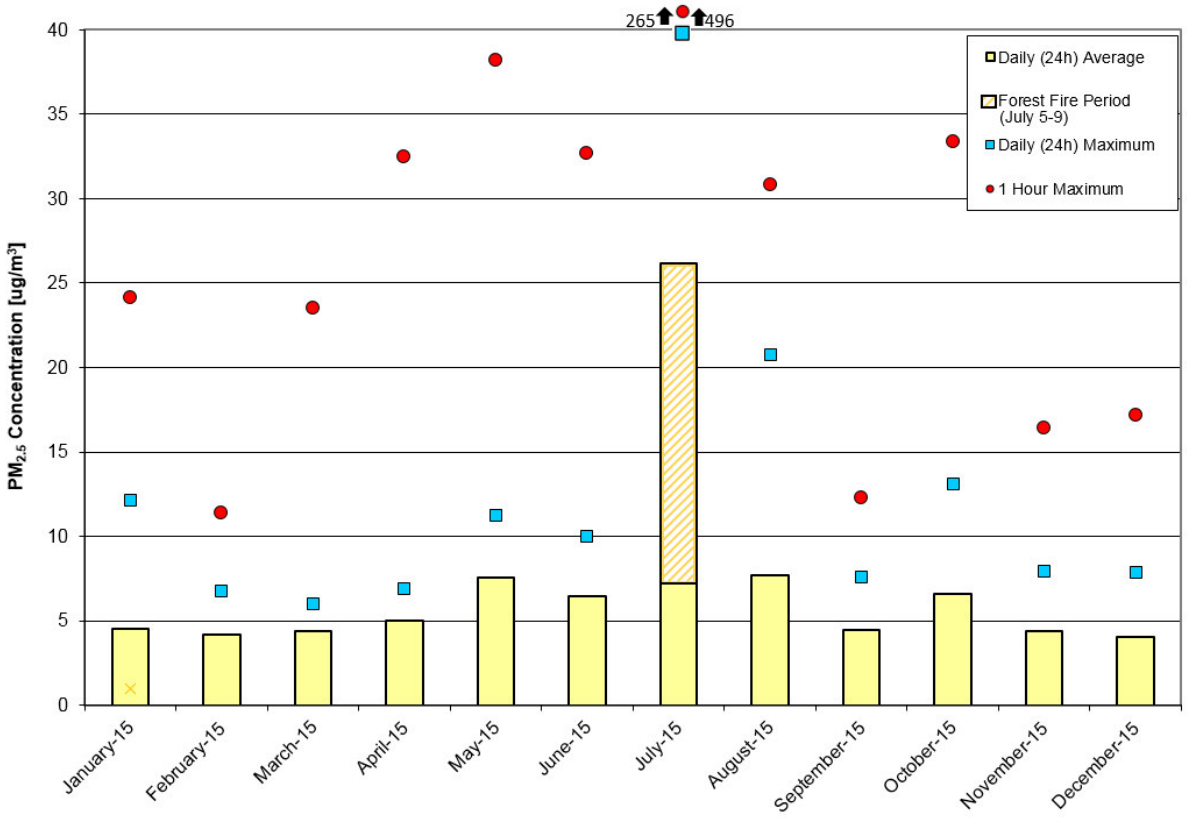

Figure 7 $PM_{2.5}$ Monthly 24-hour Average, 24-hour Maximum, and 1-hour Maximum Concentrations

Using the complete annual data set, the 98th percentile value for a 24-hour block is determined and compared to the BC AAQO of 25 µg/m³. In 2015, the 98th percentile value was 17.5 µg/m³, which is below the provincial objective. The maximum 24-hour value recorded during 2015 was 265.2 µg/m³. Both of these values were affected by the forest fires in the region during early July, 2015. Multiple forest fires in southwest BC caused extremely high level of smoke in the Whistler/ Pemberton area for approximately five days (July 5th to 9th, 2015). The smoke was thick and affected visibility throughout the region. During this period, the MOE air monitoring equipment at Whistler Meadow Park recorded similar spikes in $PM_{2.5}$ concentrations. If this five day period of elevated readings are excluded from the annual calculations, the 98th percentile value drops to 12.2 µg/m³ and the maximum 24-hour value to 20.8 µg/m³.

The complete data set is averaged to calculate the annual average $PM_{2.5}$ concentration. This is compared to the annual BC AAQO for $PM_{2.5}$ (8 µg/m³). In 2015, the annual average $PM_{2.5}$ concentration recorded at Cheakamus Crossing was 7.2 µg/m³, which is below the provincial objective, yet higher than previous years of monitoring. If the five days of elevated PM data associated with the forest fire period are excluded from the calculation, the annual average $PM_{2.5}$ concentration is 5.5 µg/m³, comparable to the previous four years of monitoring. The 2011 - 2015 data is compared in Table 1 and Figure 8.

Table 1 Annual $PM_{2.5}$ TEOM Data (2011 – 2015)

Year	$PM_{2.5}$ (mg/m^3)				
	Maximum (24-hour)	98th Percentile (24-hour)	BC AAQO (24-hour)*	Annual Average (24h)	BC AAQO (Annual)
2011	14.5	10.0	25	4.9	8.0
2012	19.8	12.9		5.3	
2013	14.0	10.3		5.0	
2014	22.1	13.3		5.3	
2015	265.2	17.5		7.2	
2015**	20.8	12.2		5.5	

* The 24-hour $PM_{2.5}$ BC AAQO is compared to the annual 98th Percentile 24-hour block average concentration

** Monitoring results with the five days of elevated PM data due to the forest fire period (July 5-9, 2015) excluded from the analysis

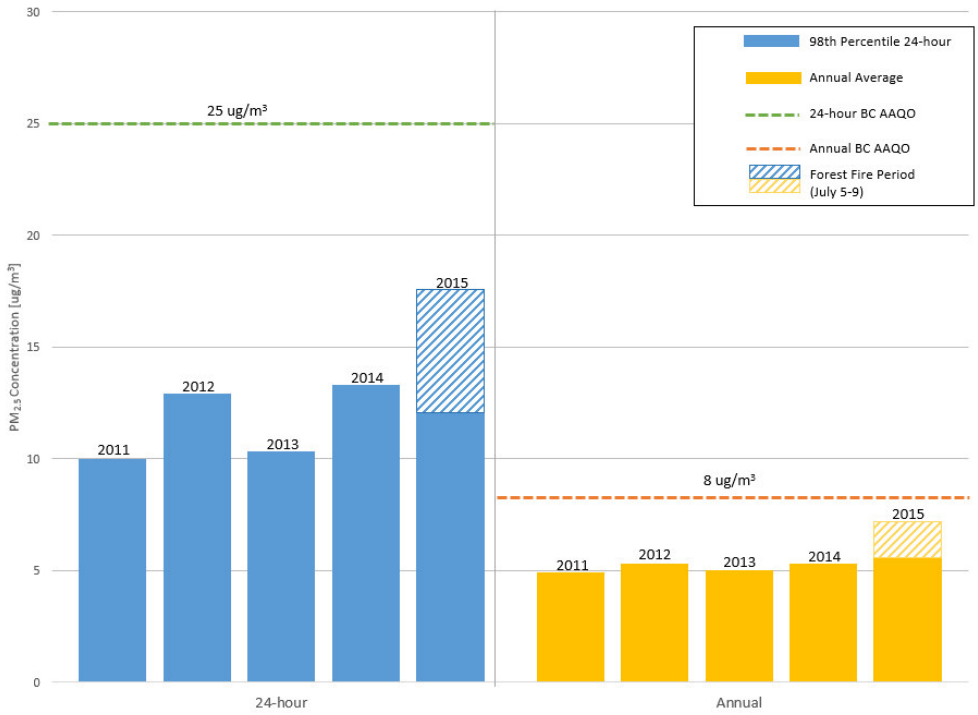

Figure 8 $PM_{2.5}$ 24-hour 98th Percentile and Annual Average Data for 2011 - 2015 Compared to BC AAQOs for $PM_{2.5}$

4 CONCLUSION

WSP has operated and maintained the Cheakamus Crossing Ambient Air Monitoring Station on behalf of the Resort Municipality of Whistler (RMOW) since September, 2010. The station is equipped with a Series 1400a TEOM unit to measure $PM_{2.5}$ and a R.M. Young anemometer to measure wind speed and direction. The station was installed to address the concerns of potential ambient air quality issues associated with an asphalt plant located near the neighbourhood. The data from the monitoring station for the calendar year of 2015 was summarized in this report.

The dominant wind direction recorded at the monitoring station continues to be from the west. Winds from the southwest and south-southwest have the greatest potential to transport emissions from the asphalt plant directly towards the monitoring station.

In 2015, the 24-hour average $PM_{2.5}$ concentration for comparison to air quality objectives (based on the annual 98th percentile value) was 17.5 µg/m^3 and the annual average $PM_{2.5}$ concentration was 7.2 µg/m^3. For both averaging periods these concentrations fall below the BC AAQO of 25 µg/m^3 and 8 µg/m^3, respectively. These values were both elevated compared to the previous four years of monitoring.

The increase in the annual statistics (98th percentile 24-hour value and the annual average) can be directly associated with unusually smoky conditions caused by local forest fires during early July, 2015. If the five days of monitoring data from this extreme forest fire period are excluded from the analysis, the annual 98th percentile 24-hour value was 12.2 µg/m^3 and the annual average $PM_{2.5}$ concentration was 5.5 µg/m^3. These values are more comparable to the historic PM data collected at the monitoring station, indicating that the increases in the annual comparison statistics were heavily influenced by the forest fire period.

Given the proximity of the monitoring station to the Cheakamus Crossing neighbourhood, it is likely that the values recorded at the station are representative of the $PM_{2.5}$ concentrations in the neighbourhood.

BIBLIOGRAPHY

- Campbell Scientific, Inc., 2000, Operator's Manual: CR510 Basic Datalogger.
- Rupprecht & Patashnick Co., Inc., 2002, Operating Manual: TEOM® Series 1400a Ambient Particulate (PM-10) Monitor (AB Serial Numbers), Revision B, March.

Appendix A

MOE AUDIT REPORTS

Continuous Ambient Monitor Audit Certificate

Date:	February 05/15	Barometric Pressure:	697 mmHg
Station Name:	Whistler Cheakamus Cross	AmbientTemperature:	1.2 °C
Permit #:	n/a		
M-Code:	MA491		
Auditors:	Morrissette		
Method:	Mass Transducer	Flow Adjust Main:	1.020
Parameter:	TEOM PM2.5	Flow Adjust Aux:	0.102
Make/Model:	TEOM 1400AB		
Serial #:	140AB239860202	Flowmeter:	**Streamline**

Parameter:	PM2.5	Calibration Verification Kit	
Range:	-25 to 475	CVK:	grams
Start Time:	09:42	**Streamline Data**	**Total** **Main**
Finish Time:	10:30	m:	0.4083 0.0791
		b:	-0.5816 -0.3241

	Target L/Min.	**(1)** In. H2O	**(2)** In. H2O	**(3)** In. H2O	**(Avg)** In. H2O		**Actual** L/Min.	**%Error**
Sample Flow:	16.67	6.12	6.11	6.06	6.10		16.83	0.9%
	3.00	5.98	6.02	6.03	6.01		3.02	0.8%

Temperature:	**°C**	**Pressure:**	**atm**
Ambient Temperature (Audit)	1.2	Ambient Pressure (Audit)	0.917
Ambient Temperature (TEOM)	0.0	Ambient Pressure (TEOM)	0.920

Ko Verification

Element K number:	13074
Audit K0 number:	13134

Audit Criteria:

Sample Flow Error:		**PASS**
Temperature Error:	1.2	**PASS**
Pressure Error:	0.0	**PASS**
Ko Ver. Error:	0.5%	**PASS**
Leak Test		
Main:	**-0.02**	**PASS**
Aux:	**0.04**	**PASS**
Head Condition:	Clean	**PASS**

Leak Check: (L/min)

Aux Read:	0.16
Aux Offset:	0.12
Aux Final:	0.16
Main Read:	0.05
Main Offset:	0.07
Main Final:	0.04

Report:

Audit Results: PASS

Air Audit Programme
Knowledge Management Branch