RESORT MUNICIPALITY OF WHISTLER

2018 SUMMARY OF AMBIENT AIR QUALITY MONITORING

CHEAKAMUS CROSSING AMBIENT AIR QUALITY MONITORING STATION

APRIL 11, 2019

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RESORT MUNICIPALITY OF WHISTLER

PROJECT NO.: 171-03296-01
DATE: APRIL 11, 2019

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RESORT MUNICIPALITY OF WHISTLER
4325 Blackcomb Way
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Attention: Mrs. Chelsey Roberts

Dear Mrs. Roberts:

Subject: Summary of 2018 Ambient Air Quality Monitoring, Cheakamus Crossing Neighborhood

WSP Canada Inc. (WSP) is pleased to provide the Annual Ambient Air Monitoring Report for the Resort Municipality of Whistler for 2018. The report outlines the monitoring program conducted during 2018 and compares the data to current objectives.

Yours sincerely,

Braden Bartnik, B.Sc., CPESC
Air Quality Specialist, Environment

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1 INTRODUCTION

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 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 originally monitored ambient particulate matter less than 2.5 microns ($PM_{2.5}$). As of January 8th 2016, the station was upgraded from a TEOM unit (Tapered Element Oscillating Microbalance) to a BAM unit (Beta Attenuation Mass Monitor) and switched to continuously monitor ambient particulate matter less than 10 microns (PM_{10}). 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 2018 (January 1st 2018, to December, 31st 2018).

2 STATION DETAILS

The Cheakamus Crossing Ambient Air Monitoring Station is located on the High Performance Centre (HPC) building (Figure 1). The HPC building 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:

⇒ BAM-1020 Beta Attenuation Mass Monitor (BAM) (Figure 3)

⇒ R.M. Young 05305 Air Quality Wind Anemometer

The BAM-1020 Beta Attenuation Mass Monitor automatically measures and records airborne particulate concentration levels using the principle of beta ray attenuation. This method provides a simple determination of concentration in units of micrograms of particulate per cubic meter of air. The BAM has been recognized by the US EPA as an acceptable continuous monitor of particulate matter concentrations (August, 1998). This unit is outfitted with a PM_{10} inlet directly connected onto the inlet tube. Ambient air is pumped through the inlet, which only allows airborne particulate matter with an aerodynamic diameter of 10 micrometers (10 µm = 0.00001 meters) or less into the BAM's sensor unit. The BAM collects the ambient dust on a filter tape from a measured amount of ambient air which causes an attenuation of the beta particle signal. The degree of attenuation of this beta particle signal is used to determine the mass concentration of particulate matter on the filter tape, and hence the volumetric concentration of particulate matter in ambient air (µg/m³).

PM_{10}, also known as inhalable particulate, is so small it can only be detected with an electron microscope. Sources of this fraction of particles include motor vehicles, wood burning stoves and fireplaces, dust from construction and industrial sources and windblown dust from erosion. $PM_{2.5}$, the fraction of particulate that was previously monitored at the station, is a smaller subset of PM_{10}, and is included in the particulate measured as PM_{10}. The sources of this smaller subset would 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 BAM inlet (Figure 4).

The datalogger records 1-hour averages for both the BAM and anemometer data to an onsite computer system. Along with storing the data on the onsite computer system, data is also transferred to WSP'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 BAM Monitor with PM_{10} Inlet System

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

2.1 2018 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 2018, the MOE conducted an audit on February 1st and August 16th. All the audited parameters passed and a copy of the audit report can be found in Appendix A.

WSP completed twelve (12) site visits (monthly) during 2018 to complete necessary audits, calibrations and maintenance on the monitoring equipment. The maintenance/calibration and verification schedule for the monitoring station are the recommended standards.

3 DATA SUMMARY

Data collection began at the station on September 3rd, 2010 for $PM_{2.5}$ data and on September 15th, 2010 for the wind data. As of January 2016, the TEOM was replaced by the BAM which now records PM_{10}. The BAM and anemometer continuously collect data. The monthly equipment 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 2018 (January 1st, 2018 to December 31st, 2018).

This is the third full year of collecting PM_{10} data with the BAM unit so the annual data is compared to the 2016 and 2017 data. A summary of $PM_{2.5}$ data collected from 2011-2015 is available in previous annual reports.

3.1 WIND DIRECTION AND WIND SPEED

A wind rose was created using the wind data collected onsite for 2018 (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 3.2% of the time over the 2018 monitoring period (slightly less then 2017).

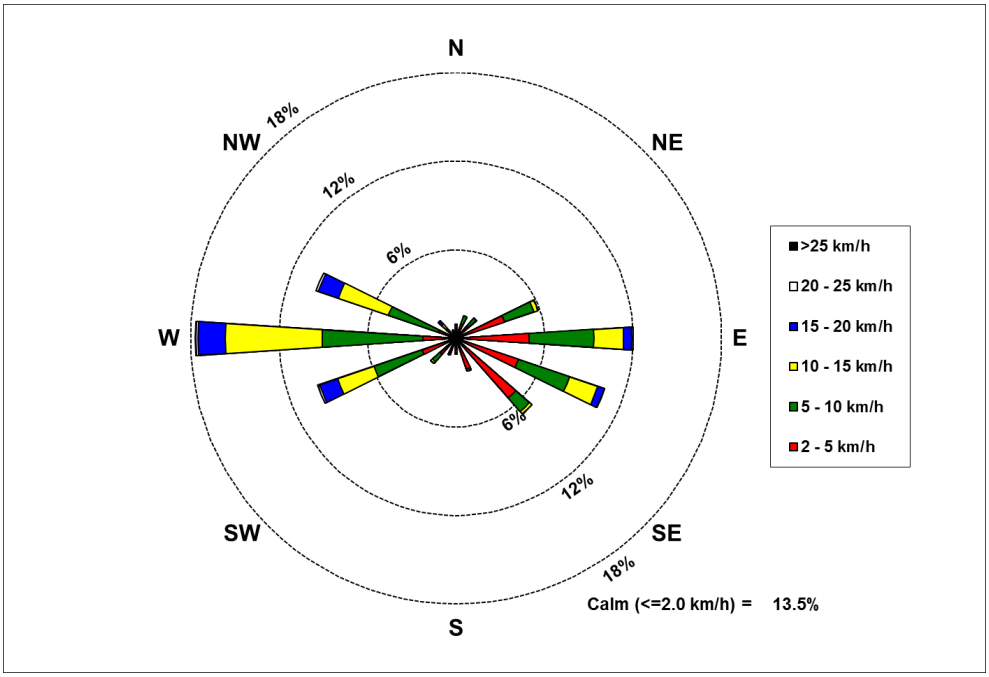

Figure 5 Historical Windrose of the Cheakamus Crossing Anemometer Data, January 1st, 2011 to December 31st, 2017

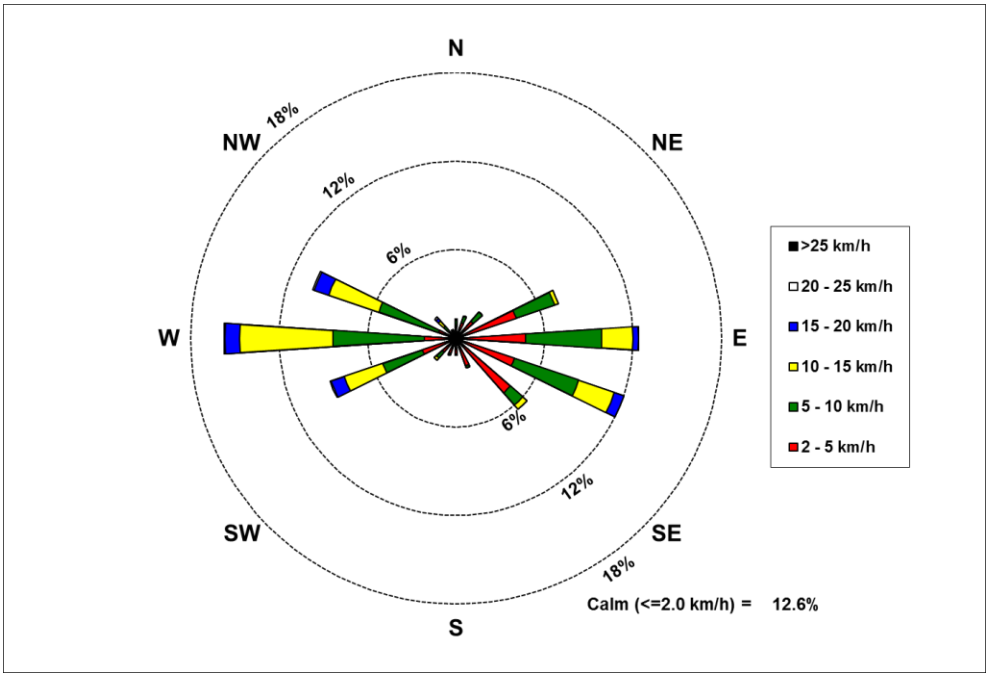

Figure 6 Windrose of the Cheakamus Crossing Anemometer Data, January 1st, 2018 to December 31st, 2018

3.2 PM_{10} CONCENTRATIONS

The continuous monitoring data from the BAM unit was used to calculate 1-hour average PM_{10} 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, 50µg/m^3), a daily 24-hour average (midnight to midnight), also referred to as block average is used.

Figure 7 displays the monthly breakdown of the 24-hour block averages and maximums, along with the hourly maximum. The BC AAQO is shown in Figure 7 by the green line. This is compared to the 24-hour maximum recorded during each month (blue squares). The other data displayed in the figure is the monthly average (yellow column) and the 1 hour maximum (red circles).

Although a direct comparison can only be made between the BC AAQO (green line) and the 24-hour maximum (blue square), the other data can also show trends. There is no objective for hourly data but you can see in Figure 7 that during the drier months of the year there is higher hourly particulate matter levels.

The yellow columns, which displays the monthly average, peak during the summer months (July, August, September) which would be expected as that is the driest time of the year. However, during 2018, the PM_{10} levels in the airshed were heavily influenced by smoke from forest fires burning across the region and province. The effects of the smoke from the forest fires acutely affects the 24-hour maximum values (blue squares) and 1-hour maximums (red circles) reported in Figure 7, but also impacts the monthly average (yellow column). Air quality advisories were issued throughout the summer months due to the forest fire smoke.

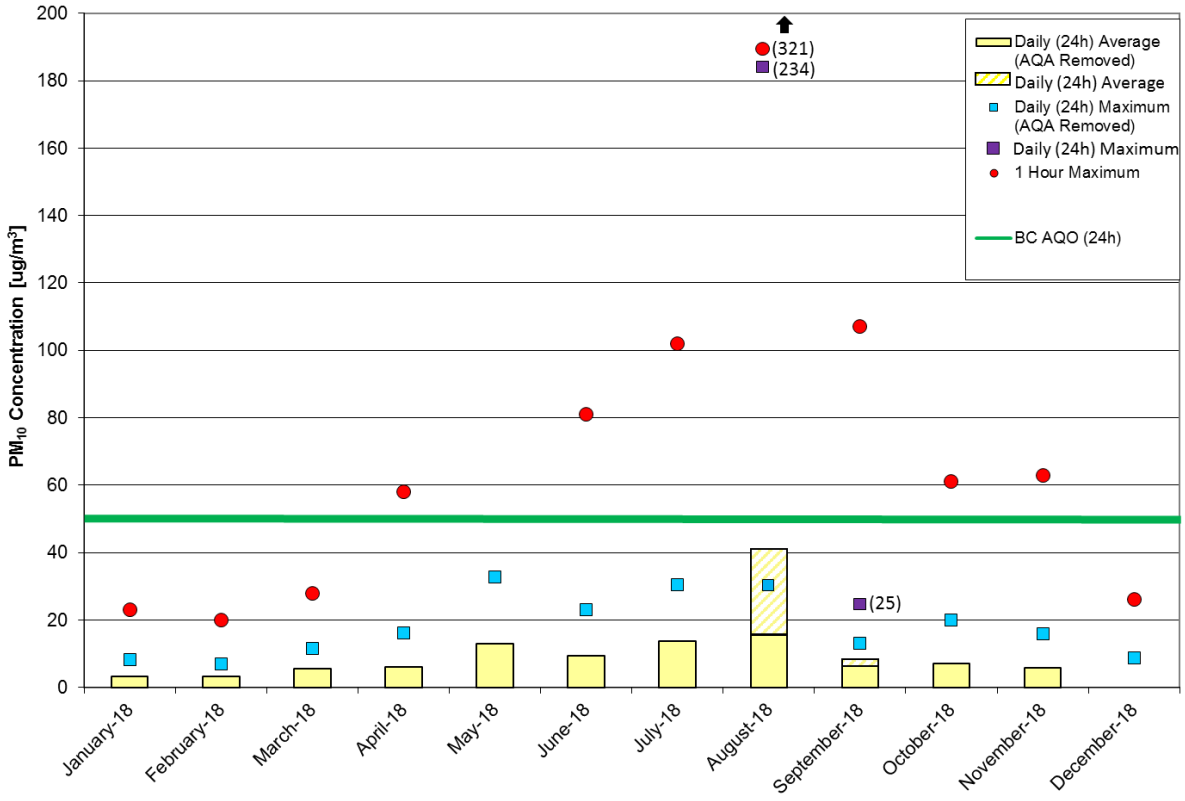

Figure 7 PM_{10} Monthly Average, 24-hour Maximum, and 1-hour Maximum Concentrations

During August and September there were multiple Air Quality Advisory's (AQA) issued by Metro Vancouver due to elevated ambient air quality levels as the result of regional forest fires. (August 10th to 11th, 13th to 27th, and Sept 7th). These elevated particulate matter levels are dissociated from local activities, such as impacts from the asphalt plant, and therefore an analysis where these periods are removed from the data set is also provided so that an evaluation of the data without the impacts of forest fires can also be provided. For the 18 days removed from the data set due to AQAs from regional forest fires, 8 of them were above the Air Quality Objective (AQO = 50µg/m^3) and the 24-hour average ranged from 14 to 234 µg/m.^{3} When the data from these periods is excluded the 24-hour maximum is significantly reduced in the months impacted. Excluding the impacts of the forest fire periods, the 24-hour maximum recorded in 2018 is below the BC AAQO and comparable to previous years 24-hour maximum (Table 1).

There is no provincial or federal annual objective for PM_{10}, but the Metro Vancouver region does currently have an objective level of 20 µg/m³ for annual average PM_{10}. This objective was included in Table 1 to provide a comparison. The annual average of PM_{10} at the Cheakamus Crossing monitoring location was 9.9 µg/m³ for 2018 which is well below the Metro Vancouver objective. When the data collected during the air quality advisory periods is removed from the dataset this annual average is even lower (7.2 µg/m³) and is similar to previous annual averages.

Figure 8 shows the 24-hour maximums as well as the annual average for 2016-2018. The hashed portion of the columns indicates the impact of the forest fire smoke on the annual statistics.

Table 1 24-hour Maximum and Annual PM_{10} Data Summary

YEAR	PM_{10} ($\mu G/M^3$)			
	MAXIMUM (24-HOUR)	BC AAQO (24-HOUR)	ANNUAL AVERAGE (24H)	METRO VANCOUVER AAQO (24-HOUR ANNUAL AVERAGE)
2016	39.3	50	6.8	20
2017	147.1		10.2	
	37.2*		6.8*	
2018	233.6		9.9	
	32.8*		7.2*	

*Dates listed as Air Quality Advisories by Metro Vancouver were removed from the data sets.

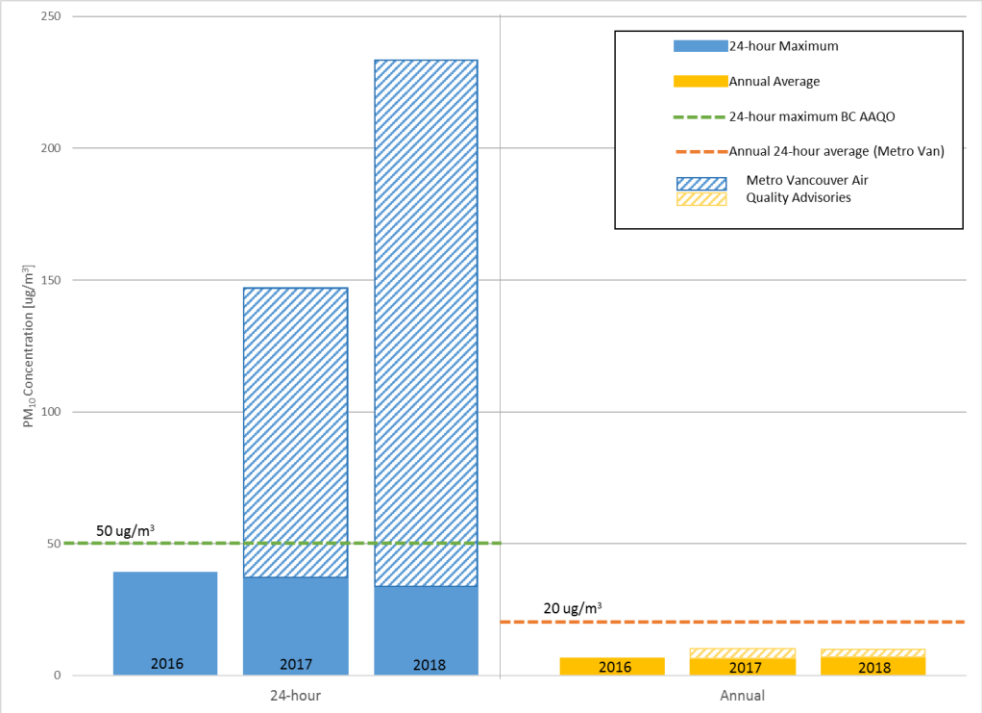

Figure 8 PM_{10} 24-hour Maximum Data Compared to BC AAQOs and Annual Average Data compared to Metro Vancouver Objectives

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 was installed to address the concerns of potential ambient air quality issues associated with an asphalt plant located near the neighbourhood. After over five years of monitoring $PM_{2.5}$, in 2016 the RMOW decided to investigate another particulate matter fraction (PM_{10}) typically associated with fugitive dust emissions by installing a new particulate matter monitor. Data from the historic $PM_{2.5}$ monitoring at the Station can be found in previous annual reports. The PM_{10} data from the monitoring station for the calendar year of 2018 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 2018, the 24-hour maximum PM_{10} concentration was 233.6 µg/m³ which exceeded the BC air quality objective of 50 µg/m³. However, this maximum was recorded in August during an air quality advisory issued due to regional forest fire smoke. When the elevated particulate matter data during air quality advisories related to the forest fires is excluded from the annual data the 24-hour maximum PM_{10} concentration was 32.8 µg/m³ which is below the BC air quality objective. The annual average PM_{10} concentration was 9.9 µg/m³ which is below the Metro Vancouver regional annual air quality objective of 20 µg/m³. When the elevated particulate matter data during air quality advisories related to the forest fires is excluded from the data the annual average PM_{10} concentrations drops to 7.2 µg/m³. Outside of the impacts of the forest fire smoke, the 2018 data is comparable to the data collected from the previous two years.

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_{10} concentrations in the neighbourhood.

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- ⇒ Campbell Scientific, Inc., 2000, Operator's Manual: CR510 Basic Datalogger.
- ⇒ Met One Instruments, Inc., 2008, BAM-1020 Continuous Particulate Monitor Operation Manual, Rev K
- ⇒ Metro Vancouver, 2016, Ambient Air Quality Objectives, updated June 30, 2016, http://www.metrovancouver.org/services/air-quality/AirQualityPublications/CurrentAmbientAirQualityObjectives.pdf, accessed [Feb, 2017]
- ⇒ 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 1, 2018	Barometric Pressure:	710 mmHg
Station Name:	Whistler Cheakamus Crossing	AmbientTemperature:	1.1 °C
Permit #:	N/A		
M-Code:	MA638		
Auditors:	Chudak/Kubotani		
Method:	Beta-Attentuation	K-Factor:	1.016
Parameter:	BAM PM10		
Make/Model:	MET ONE 1020	Flowmeter:	**Streamline**
Serial #:	T21162		

Parameter:	PM10	**Streamline Data**		**Total**	
Start Time:	1400	PST		m:	0.4087
Finish Time:	1409	PST		b:	-0.6171

	Target L/Min.	**(1)** In. H2O	**(2)** In. H2O	**(3)** In. H2O	**(Avg)** In. H2O		**Actual** L/Min.	**%Error**
Sample Flow:	16.700	5.81	5.81	5.82	5.81		16.24	-2.8%

Target flow is read from calibration screen

Temperature:	**°C**	**Pressure:**	**mmHg**
Ambient Temperature (Audit)	1.1	Ambient Pressure (Audit)	710
Ambient Temperature (BAM)	1.7	Ambient Pressure (BAM)	708

Relative Humidity:	**%**	**Leak Check:**	**mmHg**
Relative Humidity (Audit)	NA	Leak Flow:	0.2
Relative Humidity (BAM)	NA	Leak Offset:	0

Audit Criteria:			**Operational Parameters:**			
Sample Flow Error:	-2.8%	**Pass**	C_v:	0.966	Q_o:	0
			ABS:	0.796	m_{sw}:	0.312
Temperature Error:	0.6	**Pass**	K:	0.986	BKGD:	-0.0024
Pressure Error:	2.00	**Pass**	Flow Mode:	Actual		
			RH Control ON:	Yes		
			RH Set Point:	0.35		
Leak Test:	0.2	**Pass**				
Self-test:	Pass	**Pass**				
Head Condition:	Clean	**Pass**				

Report:

Audit Results: Pass

Air Audit Programme
Knowledge Management Branch

Continuous Ambient Monitor Audit Certificate

Date: August 16, 2018	Barometric Pressure: 712 mmHg
Station Name: Whistler Cheakamus Crossing	AmbientTemperature: 26.4 °C
Permit #: N/A	
M-Code: MA638	
Auditors: Kubotani/Chudak	K-Factor: 0.932
Method: Beta-Attentuation	Flowmeter: **Streamline**
Parameter: BAM PM10	
Make/Model: MET ONE 1020	
Serial #: T21162	
Parameter: PM10	**Streamline Data** **Total**
Start Time: 1411 PST	m: 0.4267
Finish Time: 1430 PST	b: -0.4932

	Target L/Min.	(1) In. H2O	(2) In. H2O	(3) In. H2O	(Avg) In. H2O		Actual L/Min.	%Error
Sample Flow:	16.700	4.98	5.00	5.10	5.03		16.59	-0.7%

Target flow is read from calibration screen

Temperature:	°C	**Pressure:**	mmHg
Ambient Temperature (Audit)	26.4	Ambient Pressure (Audit)	712
Ambient Temperature (BAM)	25.2	Ambient Pressure (BAM)	707

Relative Humidity:	%	**Leak Check:**	L/min
Relative Humidity (Audit)	N/A	Leak Flow:	0.4
Relative Humidity (BAM)	N/A		

Audit Criteria:			**Operational Parameters:**			
Sample Flow Error:	-0.7%	Pass	C_v:	0.966	Q_o:	0
			ABS:	0.796	μ_{sw}:	0.312
Temperature Error:	1.2	Pass	K:	0.986	BKGD:	-0.0024
Pressure Error:	5.00	Pass	Flow Mode:	Actual		
			RH Control ON:	Yes		
Humidity Error:	0	Pass	RH Set Point:	0.35		
Leak Test:	0.4	Pass				
Self-test:	Pass	Pass				
Head Condition:	Clean	Pass				

Report:

Audit Results: Pass

Air Audit Programme
Regional Operations Branch,Compliance