RESORT MUNICIPALITY OF WHISTLER

2022 SUMMARY OF AMBIENT AIR QUALITY MONITORING

CHEAKAMUS CROSSING AMBIENT AIR QUALITY MONITORING STATION

OCTOBER 03, 2023

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RESORT MUNICIPALITY OF WHISTLER

PROJECT NO.: 171-03296-05
DATE: OCTOBER 03, 2023

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October 03, 2023

File Number: 171-03296-05

RESORT MUNICIPALITY OF WHISTLER
4325 Blackcomb Way
Whistler, BC V0N 1B4

Attention: Andrew Tucker

Dear Mr. Tucker:

Subject: Summary of 2022 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 2022. The report outlines the monitoring program conducted during 2022 and compares the data to current ambient air quality 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}). At the end of 2021 the BAM unit was adjusted to continuously monitor $PM_{2.5}$ at the request of the RMOW to align with the expansion of the air monitoring program in the neighbourhood (see Appendix B) which also collected $PM_{2.5}$ data. 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 2022 (January 1st, 2022, to December, 31st 2022).

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 green dot)**

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 (µg/m³) 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 $PM_{2.5}$ inlet. Ambient air is pumped through the 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 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).

$PM_{2.5}$, also known as fine particulate matter, is so small it can only be detected with an electron microscope. Sources of this fraction of particles 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 $PM_{2.5}$ Inlet System

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

2.1 2022 STATION MAINTENANCE AND AUDITS

WSP has consulted with the British Columbia Ministry of Environment and Climate Change Strategy (BC MOECCS) and follows the same maintenance and calibration standards by which the BC MOECCS operates their provincial system of ambient air monitoring stations. WSP and the RMOW coordinated with the BC MOECCS to have the Cheakamus Crossing Ambient Air Monitoring Station audited by the BC MOECCS's provincial auditing team. This team conducts semi-annual audits on all of the BC MOECCS stations to validate the proper operation of the equipment. During 2022, the BC MOECCS conducted an audit on December 8th. All the audited parameters passed, and a copy of the audit reports can be found in Appendix A.

WSP completed twelve (12) site visits (monthly) during 2022 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.

The data completeness for the 2022 calendar year was 94.2% as a result of a standard zero calibration audit as well as minor downtime each month to complete standard audits and maintenance on the equipment.

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 recorded PM_{10} from 2016 to 2021. At the end of 2021 the BAM inlet was modified so it began collecting $PM_{2.5}$ data. This was done so that the BAM was collecting the same fraction particulate as the additional equipment that was being added to the air monitoring program (see Appendix B). BAM and anemometer continuously collect data. The monthly equipment maintenance results in the system being offline for short periods of time (1-3 hours). 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. Five-year summary reports were also published in 2015 and 2021 which consolidated the years of data collected until those points.

This report summarizes the data collected for the calendar year of 2022 (January 1st, 2022 to December 31st, 2022).

This is the first full year of the BAM unit collecting $PM_{2.5}$ data so the annual data is not compared to the previous years of PM_{10} data A summary of $PM_{2.5}$ data collected from 2011-2015 or the PM_{10} data collected from 2016 - 2021 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 2022 (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 is 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 5.4% of the time over the 2022 monitoring period (in 2021, they occurred 3.9% of the time).

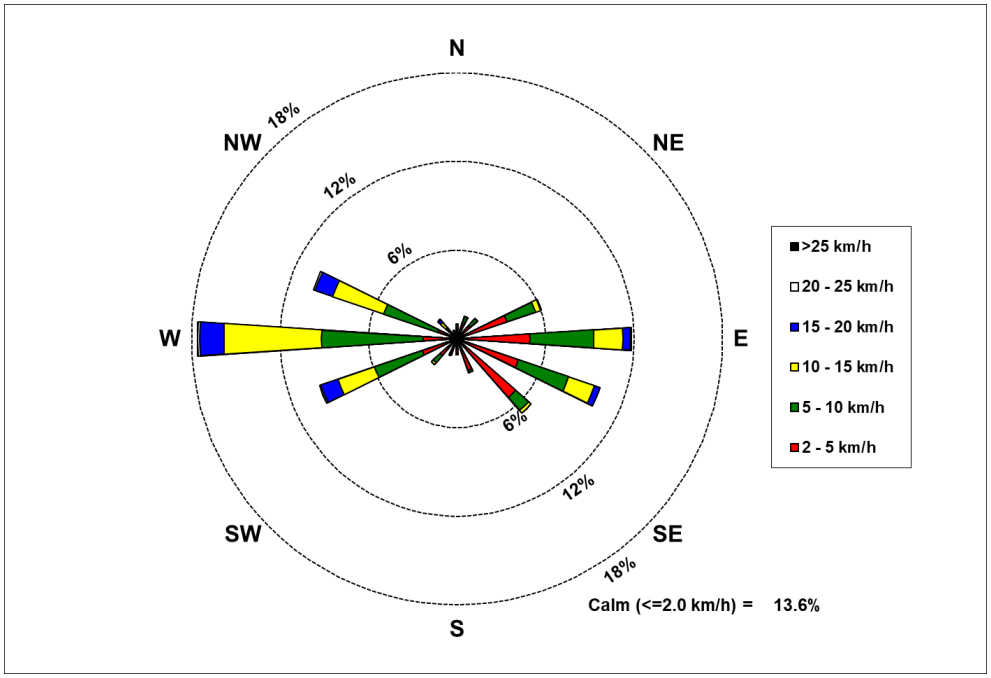


Figure 5 Historical Windrose of the Cheakamus Crossing Anemometer Data, January 1st, 2011 to December 31st, 2021

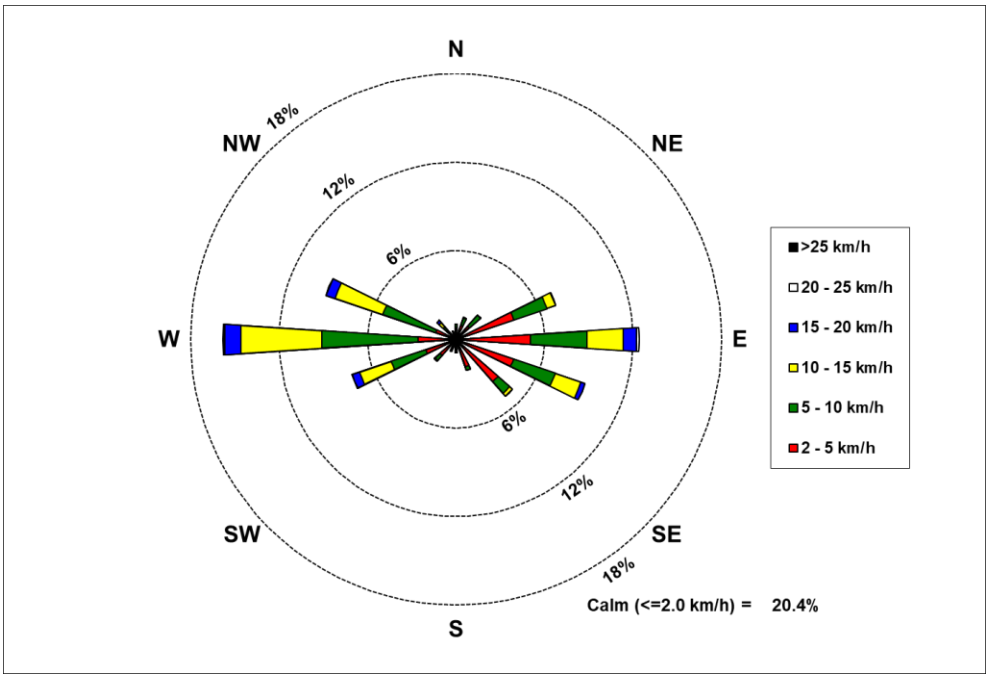


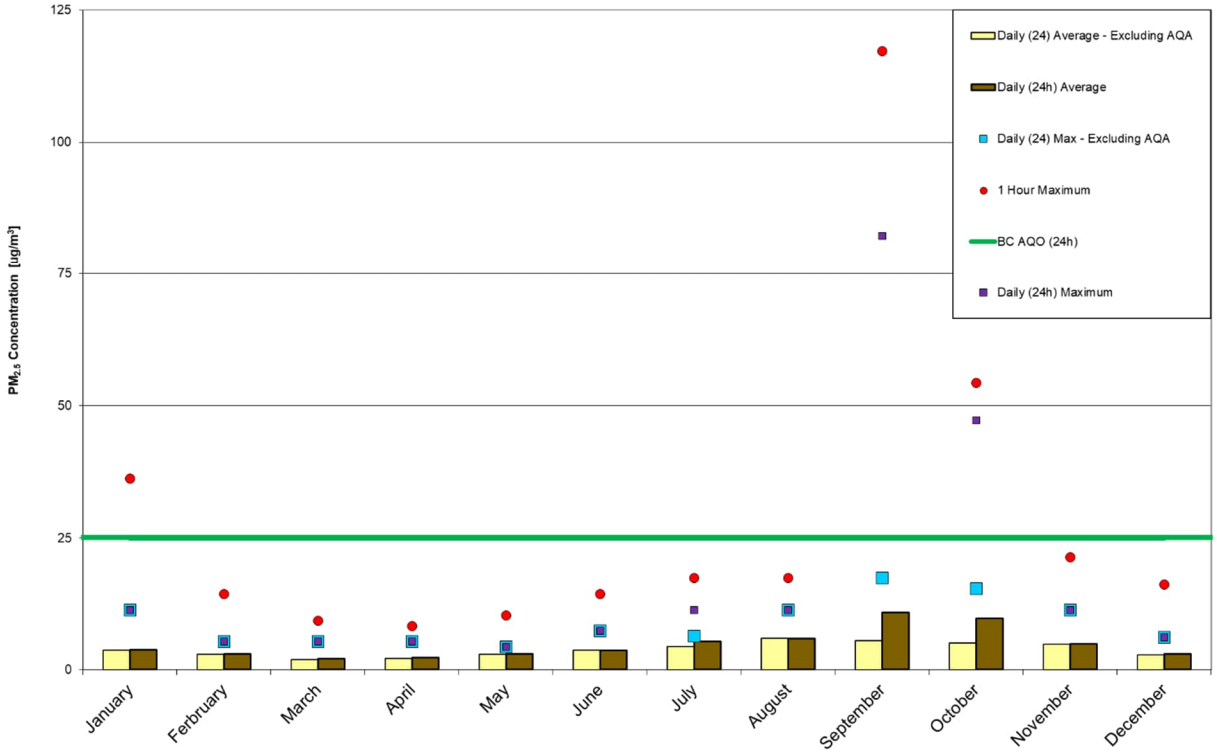
Figure 6 Windrose of the Cheakamus Crossing Anemometer Data, January 1st, 2022 to December 31st, 2022

3.2 $PM_{2.5}$ CONCENTRATIONS

The BAM unit records 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, 25µg/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 (purple squares). The other data displayed in the figure is the monthly average (brown columns) 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 (purple square), the other data can also show trends. There is no objective for hourly data, but Figure 7 shows that the highest concentrations occurred in September and October when forest fires were impacting the airshed. The effects of the smoke from the forest fires acutely affects the 24-hour maximum values (purple squares) and 1-hour maximums (red circles) reported in Figure 7, but also impacts the monthly average (brown column).



* Note that the Green line denoting the BC AAQO for $PM_{2.5}$ is the objective for the 24-hour average data (blue boxes) presented and should not be compared to the 1-hour averages (red dots). There is no BC AAQO for the 1-hour averages.

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

During July, September and October, there were a total of 25 days with an Air Quality Advisory (AQA) issued by Metro Vancouver due to elevated ambient air quality levels as a results of regional forest fires in BC and Washington State (see Table 1). 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 to display results without the impacts of forest fires. Days with AQA were removed from the dataset, and the daily 24-hour average (yellow column) and daily 24-hour maximum (blue squares) were plotted in Figure 7. The daily 24-hour maximums for September and October exceed the BC AAQO (=25 $\mu g/m^3$). When the data from AQA periods is excluded the 24-hour maximum is reduced in those months. Excluding the impacts of the forest fire periods, the 24-hour maximum recorded in 2022 is below the BC AAQO (Table 2 and Figure 8).

Table 1 Air Quality Advisories Issued by Metro Vancouver

AQA Period	Number of AQA days
July 26 to 31	6
September 9 to 14	6
October 4 to 7	4
October 13 to 21	9

AQA Period	Number of AQA days
October 13 to 21	9
Total	25

The annual average concentration of $PM_{2.5}$ at the Cheakamus Crossing monitoring location was 4.8 µg/m³ for 2022 which is well below the BC AAQO of 8 µg/m³. (Table 2). When the data collected during the air quality advisory periods are removed from the dataset this annual average is slightly lower (3.9 µg/m³).

Figure 8 shows the 24-hour maximum as well as the annual average for 2022. The hashed portion of the columns indicates the impact of the forest fire smoke on the annual statistics. The regional forest fire smoke significantly affected the 24-hour maximum value for 2022, as AQA excluded data is below the BC AAQO. The annual average was not severely affected and remained below the BC AAQO with and without the exclusion of AQA data.

Table 2 24-hour Maximum and Annual $PM_{2.5}$ Data Summary for 2022

PM2.5 (µg/m³)	Forest Fires Included	Excluding Forest Fires Periods (AQA Days)	BC Ambient Air Quality Objective
24 hr Maximum	64	14	25
Annual Average	4.8	3.9	8

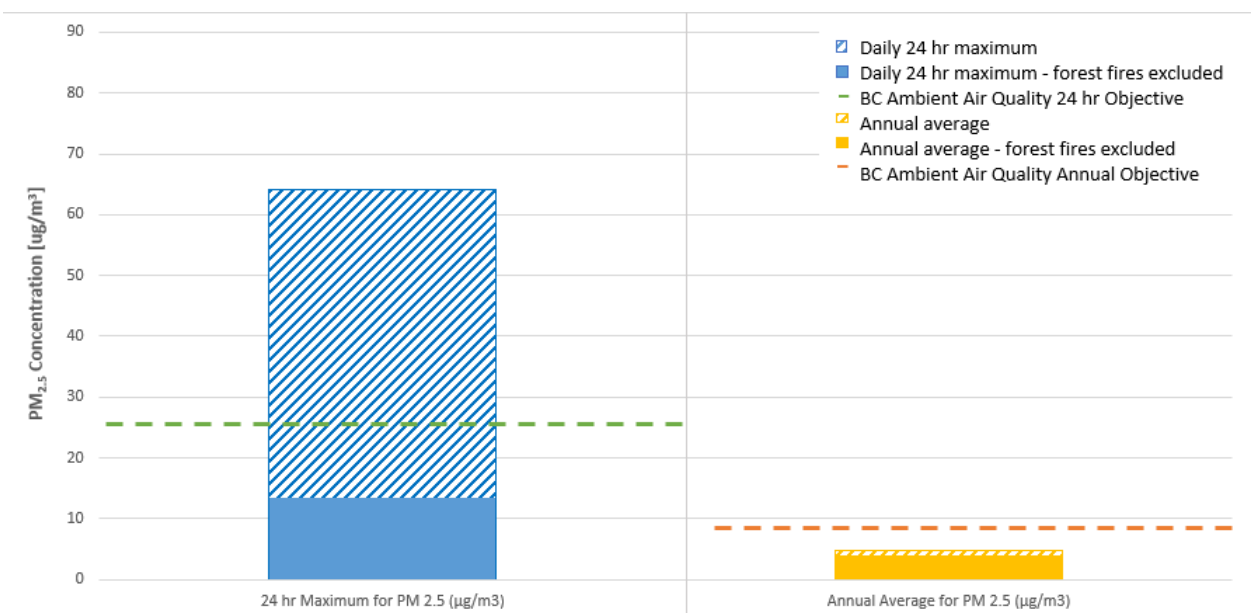


Figure 8 $PM_{2.5}$ 24-hour Maximum Data and Annual Average Data Compared to BC AAQOs.

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.

The dominant wind direction recorded at the monitoring station follow the east - west valley alignment with predominantly 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. Winds from those directions occurred approximately 5.4% of the time over the 2022 monitoring period.

In 2022, the 24-hour maximum $PM_{2.5}$ concentration was 64 µg/m³ which exceeded the BC ambient air quality objective (BC AAQO) of 25 µg/m³. However, this maximum was recorded in September during an air quality advisory issued due to forest fire smoke in the area. When the elevated particulate matter data during air quality advisories related to forest fires were excluded from the annual data the 24-hour maximum $PM_{2.5}$ concentration was 14 µg/m³ which is below the BC AAQO. The annual average $PM_{2.5}$ concentration was 4.8 µg/m³ which is below BC AAQO of 8 µg/m³.

BIBLIOGRAPHY

⇒ British Columbia Ministry of Environment, 2019, British Columbia Ambient Air Quality Objectives, updated December 17, 2019, https://www2.gov.bc.ca/assets/gov/environment/air-land-water/air/reports-pub/aqotable.pdf [Accessed Mar 29, 2023]

⇒ Campbell Scientific, Inc., 2000, Operator's Manual: CR510 Basic Datalogger.

⇒ Met One Instruments, Inc., 2008, BAM-1020 Continuous Particulate Monitor Operation Manual, Rev K

APPENDIX

A

MOE AUDIT REPORTS

Continuous Ambient Monitor Audit Certificate

Date:	December 8, 2022		
Station Name:	Whistler Cheakamus Crossing	Barometric Pressure:	706 mmHg
Permit #:	N/A	AmbientTemperature:	1.1 °C
Auditors:	Chudak/Pedlar		
Method:	Beta-Attentuation	K-Factor:	1.010
Parameter:	BAM PM_{10}		
Make/Model:	Met One 1020	Flowmeter:	**Streamline**
Serial #:	T21162		

Parameter:	PM_{10}		**Streamline Data**		**Total**
Start Time:	1116	PST		m:	0.4279
Finish Time:	1131	PST		b:	-0.5131

	Target L/Min	**(1)** In. H2O	**(2)** In. H2O	**(3)** In. H2O	**(Avg)** In. H2O		**Actual** L/Min	**Error** %
Sample Flow:	16.700	5.25	5.27	5.29	5.27		16.34	-2.2%

Target flow is read from calibration screen

Temperature:	**°C**	**Pressure:**	**mmHg**
Ambient Temperature (Audit):	1.1	Ambient Pressure (Audit):	706
Ambient Temperature (BAM):	0.1	Ambient Pressure (BAM):	701

Audit Criteria:		
Sample Flow Error:	-2.2%	Pass
Temperature Error:	1.0	Pass
Pressure Error:	5	Pass
Leak Test:	0.5	Pass
Self-test:	Pass	Pass
PM Inlet Condition:	Satisfactory	Pass

Leak Check	**L/Min**
Leak Flow:	0.5

Operational Parameters:			
$C_{v:}$	0.966	$Q_{o:}$	0.000
ABS:	0.796	$\mu_{sw:}$	0.312
K:	0.986	BKGD:	-0.0003
Flow Mode:	Actual		
RH Control ON:	Yes		
RH Set Point:	35%		

Report:

Audit Results: Pass

Air Audit Programme
Regional Operations Branch

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B SUPPLEMENTAL MONITORING

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1 INTRODUCTION

In September 2022, supplemental to the Cheakamus Crossing Ambient Air Monitoring Station, WSP started operating and maintaining 4 new PurpleAir (PA) monitors. The PA monitors were installed to measure ambient $PM_{2.5}$ concentrations, adding to the spatial resolution of the monitoring in the neighbourhood.

In another addition to the monitoring program, WSP collected samples of ambient air with SUMMA cannisters and determined concentrations of Volatile Organic Compounds (VOCs) in the ambient air through third-party laboratory analysis. The purpose of this analysis was to determine if nearby asphalt manufacturing operations were impacting the air quality in the neighbourhood.

This appendix summarizes data collected from the PA monitors and VOC tests in 2022.

2 VOC MONITORING

2.1 METHODS

To capture the potential impact of the asphalt plant air emissions, VOC monitoring is conducted at select locations in the Cheakamus Crossing neighbourhood on days when the asphalt plant is in operation and wind conditions are forecasted to be from the general direction of the plant. Figure 1 shows the locations for the VOC sampling points, BAM monitor at the HPC and the asphalt plant. Sampling preference was given to locations directly downwind from the plant (Fenceline and Dog Park).

VOC samples were collected for the following locations and days in 2022:

- September 14, 2022: Co-Located, Fenceline, Mt. Fee, Dog Park
- September 21, 2022: Fenceline, Dog Park
- October 25, 2022: Fenceline, Dog Park

Base image retrieved from Bing Maps on May 05, 2023.

Figure 1 Map with locations for VOC sampling (blue), BAM monitor at HPC (green) and asphalt plant (red).

SUMMA cannisters were deployed at the locations stated above for four hours, and cannister pressures were checked and recorded every hour for quality control. The cannisters were then sent to ALS labs to be analyzed for common VOC concentrations.

DATA PROCESSING

The laboratory analyzed the samples for 60 different VOCs. Section 11.1 of the EPA AP-42 document was consulted to select all VOCs associated with the asphalt plant. This report summarizes VOC concentrations associated with the asphalt plant operations and those that were above the lab's detection limit. This narrows the analysis to 22 VOCs.

Windroses were plotted using the data collected a the HPC building for the period in which the samples were being collected.

2.2 RESULTS

Table 1 outlines the activity of the asphalt plant directly before and / or during the VOC sampling. Since the plant operates intermittently, samples were taken on days when it was running to detect VOCs associated with its activity.

Table 1 Asphalt Plant Activities During VOC Collection Dates

Date	Start Time	End Time	Time Elapsed	Production (tonnes)
14-Sep-22	12:50 PM	1:10 PM	0:20	63
14-Sep-22	2:10 PM	2:22 PM	0:12	
21-Sep-22	7:15 AM	9:30 AM	2:15	840
21-Sep-22	11:15 AM	2:30 PM	3:15	
25-Oct-22	8:00 AM	10:00 AM	2:00	533
25-Oct-22	11:00 AM	12:30 PM	1:30	
25-Oct-22	2:00 PM	3:00 PM	1:00	

Figure 2 displays the windroses for the periods when the VOCs were being sampled. The wind speed and wind direction data were collected at the HPC building. During the September 14 and October 25th sampling events winds were light and in a direction that could carry air emissions from the asphalt plant towards the residential neighbourhood. During the September 21st sampling event the winds were light and from the east despite the forecast. Where possible, sample locations were selected to be directly downwind of the asphalt plant.

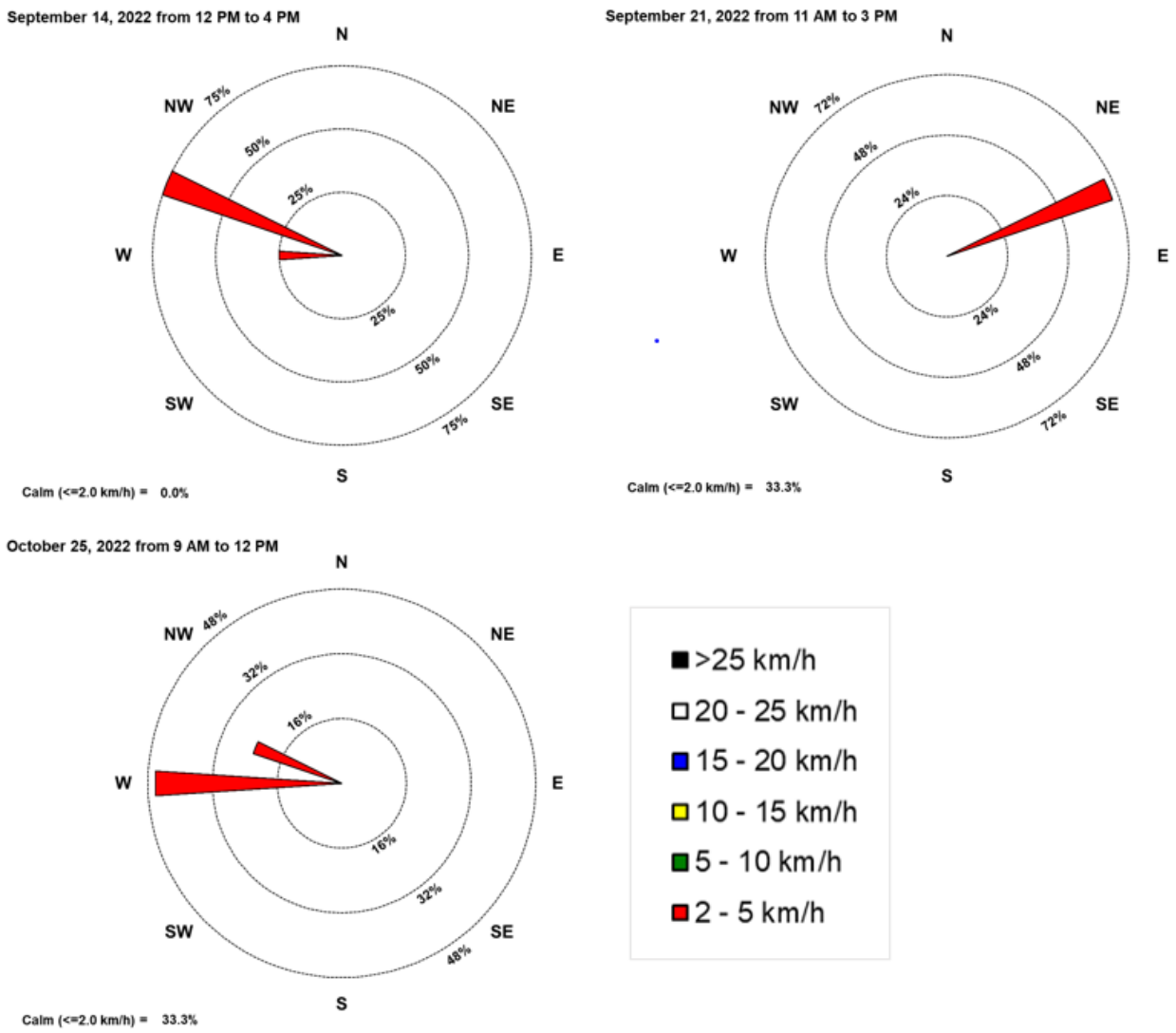

Figure 2 Windroses during VOC sampling periods

Results from the VOC tests (Table 2 and Table 3 below) are compared with 24-hour Ambient Air Quality Criteria (AAQCs) from Ontario (MECP 2020) (BC does not have objectives / criteria for individual VOCs) as an indicator of the potential for impacts in the neighbourhood. Only six of twenty VOCs associated with asphalt plant activities were detected. All detected VOC concentrations were well below the AAQCs in 2022.

Table 2 VOCs that may be emitted by Asphalt plants as per AP-42, Section 11.1. Concentrations in ppbv.

			Collection Date: Sept 14, 2022				Collection Date: Sept 21, 2022		Collection Date: Oct 25, 2022	
VOC	**Detection Limit**	**AAQC** (24-hour **averaging period)**	**Co-Located**	**Fenceline**	**Mt. Fee**	**Dog Park**	**Fenceline**	**Dog Park**	**Fenceline**	**Dog Park**
acetone[1]	1.0	5,004	**3.3**	**3.8**	**3.9**	**4.7**	**6.0**	**3.3**	**3.3**	**2.7**
benzene[1]	0.10	0.72	**0.10**	**0.12**	**0.12**	**0.10**	<0.10	<0.10	<0.10	<0.10
bromomethane	0.20	348	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
carbon disulfide	0.50	106	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
chloroethane	0.20	2,124	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
chloromethane[1]	0.20	155	**0.38**	**0.42**	**0.40**	**0.40**	**0.36**	**0.36**	**0.40**	**0.40**
dichloromethane	0.20	63	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
ethylbenzene	0.10	230	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
hexane, n-	0.20	710	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
methyl ethyl ketone [MEK][1]	0.20	339	**0.26**	**0.24**	**0.24**	**0.26**	<0.20	<0.20	<0.20	<0.20
naphthalene	0.10	4.3	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
styrene[1]	0.20	94	**0.20**	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
tetrachloroethylene	0.20	53	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
toluene[1]	0.10	531	**0.10**	<0.10	<0.10	<0.10	**0.20**	<0.10	<0.10	<0.10
trichloroethane, 1,1,1-	0.20	21,088	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
trichloroethylene	0.020	2.23	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Trichlorofluoromethane	0.20	1,068	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
xylene, m+p-	0.20	168	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
xylene, o-	0.10	168	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
xylenes, total	0.30	168	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30

[1] Values in bold are above the lab detection limit. All values- for 2022 are below the AAQC.

Table 3 Detected VOCs that are not typically emitted by asphalt plants, as per AP-42, Section 11.1. Concentrations in ppbv.

			Collection Date: Sept 14, 2022				Collection Date: Sept 21, 2022		Collection Date: Oct 25, 2022	
VOC	**Detection Limit**	**AAQC (24-hour averaging period)**	**Co-Located**	**Fenceline**	**Mt. Fee**	**Dog Park**	**Fenceline**	**Dog Park**	**Fenceline**	**Dog Park**
carbon tetrachloride[1]	0.020	0.38	**0.072**	**0.074**	**0.073**	**0.076**	**0.076**	**0.076**	**0.080**	**0.081**
dichlorodifluoromethane[1]	0.20	101,159	**0.44**	**0.46**	**0.46**	**0.46**	**0.44**	**0.44**	**0.44**	**0.44**

[1] Values in bold are above the lab detection limit. All values for 2022 are below the AAQC.

3 PURPLEAIR MONITORING

3.1 STATION DETAILS

In September 2022, 4 new PurpleAir (PA) monitor were installed to measure ambient $PM_{2.5}$ concentrations, adding to the spatial resolution of the monitoring in the neighbourhood. Figure 3 shows the locations of the PA monitors relative to the BAM monitor at the HPC Building and the asphalt plant.

Base image retrieved from Bing Maps on May 05, 2023.

Figure 3 Map with locations for PurpleAir Monitors (purple), BAM monitor (green) and Asphalt plant (red).

The BAM monitor at the HPC was used as a reference monitor for the PA monitors. A PA monitor was co-located at this location so that comparisons between the monitoring technologies can be made.

The PA monitors record humidity, temperature and $PM_{2.5}$ hourly averages. For quality control purposes, there are two $PM_{2.5}$ sensors (Sensor A and Sensor B) that can be compared to each other to indicate if a particular sensor is not operating properly. In 2022, sensor A from the Cloudburst station was not operating properly, therefore only readings from the sensor B for this monitor were used in the analysis. For all other stations the two sensors at each location were averaged to provide the hourly $PM_{2.5}$ concentrations.

3.2 2022 EQUIPMENT MAINTENANCE AND AUDITS

Table 4 summarizes the data completeness for each month of the year of 2022 in which the monitors were operational. PA monitors are designed to require minimum maintenance and calibration. Despite this, the Fenceline monitor in November and Mt. Fee Road monitor in December exhibited data completeness below 75%, which is the threshold for data completeness recommended in the "Guidance Document on Achievement Determination Canadian Ambient Air Quality Standards for Fine Particulate Matter and Ozone" by the Canadian Council of Ministers of the Environment. A process has now been put in place where the data from PA monitors is checked weekly to ensure that the monitors were operating. If there are any persisting issues, the monitors are replaced.

Table 4 Summary of Data Completeness for 2022

Month	Cloudburst	Co-Located	Mt Fee Road	Fenceline
September	100%	100%	100%	100%
October	100%	100%	100%	100%
November	100%	100%	100%	33.3%
December	89.4%	98.5%	43.3%	98.8%
Total	**97.3%**	**99.6%**	**85.6%**	**83.3%**

3.3 DATA SUMMARY

DATA CORRECTION

Data collection began at all stations on September 1st, 2022, for $PM_{2.5}$. The Purple Air (PA) monitors record 1-hour average $PM_{2.5}$ concentrations. PA monitors readings are known to be biased by humidity and are not accurate without applying a correction to account for this bias. The hourly $PM_{2.5}$ readings were fitted into an equation which corrects the data for this known bias, as suggested by Nilson et al (2022). Correction Model 7 from that research was applied as per the following equation:

$$\boldsymbol{PM_{2.5,corrected} = 0.534 * PM_{2.5_{atm}} - 0.0844 * RH + 5.71}$$ **Equation 1**

In which:

$\boldsymbol{PM_{2.5,corrected}}$ = The corrected concentration of $PM_{2.5}$, in µg/m^3.

$\boldsymbol{PM_{2.5_{atm}}}$ = $PM_{2.5}$ reading from the PA monitor, in µg/m^3.

$\boldsymbol{RH}$ = Relative humidity reading by the PA monitor, in %.

RESULTS

From the corrected $PM_{2.5}$ hourly averages a 24-hour block average is calculated. Then, monthly averages and the maximum 24-hour block averages for the month are determined and compared to the British Columbia Ambient Air Quality Objectives (BC AAQO, 25µg/m^3).

Figure 4 displays the results for every monitor for the months in which monitors met the minimum data completeness (75%) in 2022. The data is compared to the BC AAQO.

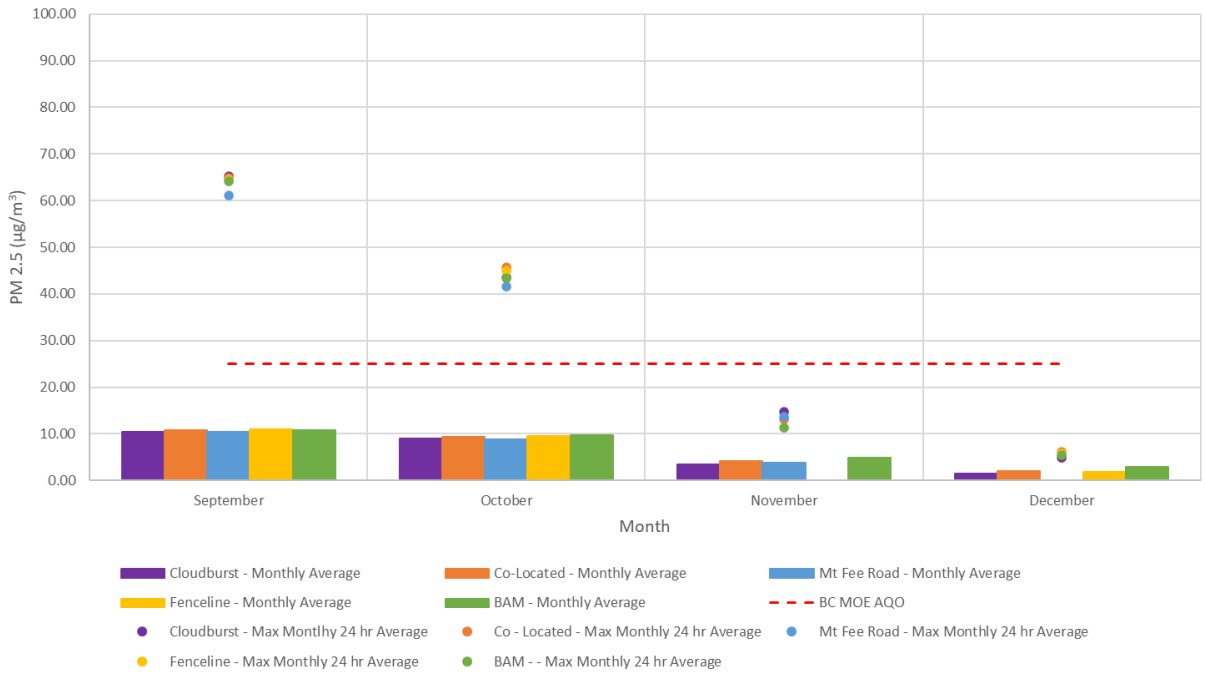

Figure 4 $PM_{2.5}$ Monthly Averages (boxes) and Maximum 24-Hour Averages (circles) for 2022.

The monthly averages for the month of September and October are significantly higher than November and December. Moreover, the maximum monthly 24-hour averages for the former are above the BC AAQO. That is because the regional ambient air quality during those months was heavily impacted by forest fires.

During September and October, there were a total of 19 days with an Air Quality Advisory (AQA) issued by Metro Vancouver due to elevated ambient air quality levels as a results of regional forest fires in BC and Washington State. 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. Table 5 identifies the periods with AQAs issued by Metro Vancouver that were excluded from the analysis.

Table 5 Air Quality Advisories (AQA) Issued by Metro Vancouver Due to Regional Forest Fires

AQA Period	Number of AQA days
September 9 to 14	6
October 4 to 7	4
October 13 to 21	9
Total	19

Figure 5 summarizes the monthly averages and maximum 24-hour block averages for 2022 with exclusion of AQA days. With the exclusion of $PM_{2.5}$ originated from forest fires, the 24-hour block averages from all the monitors are below the BC AAQO.

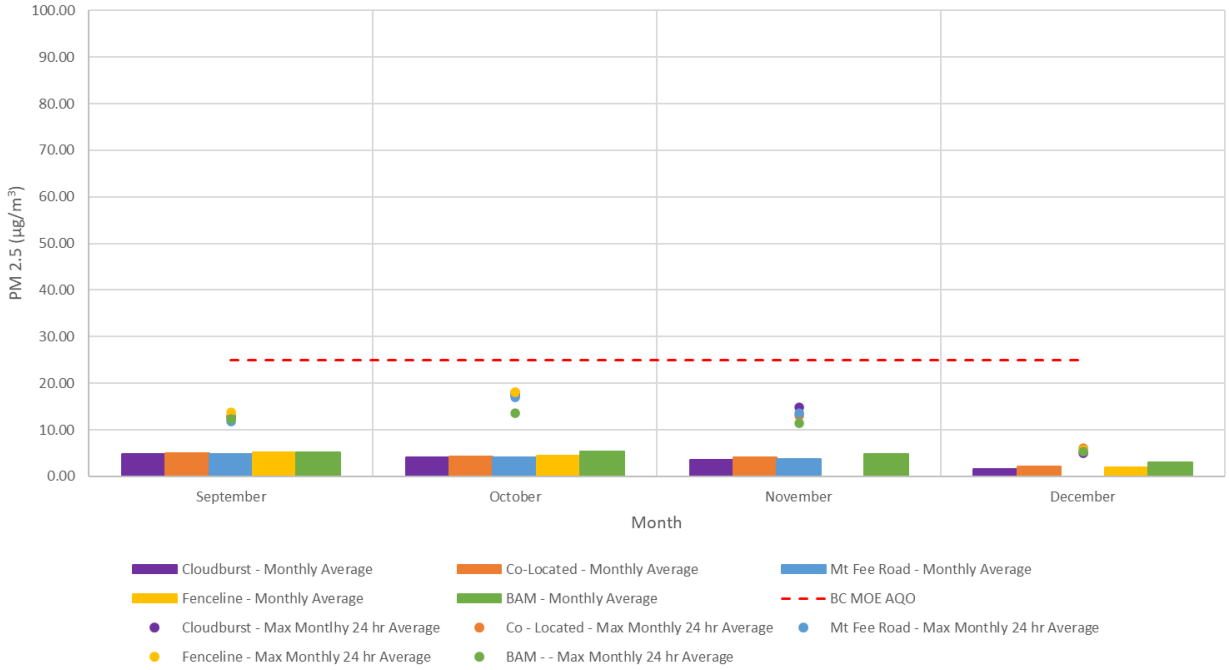

Figure 5 **$PM_{2.5}$ Monthly Averages (boxes) and Maximum 24-Hour Averages (circles) for 2022 – Air Quality Advisory Days Deleted**

4 CONCLUSION

In September 2022, supplemental to the Cheakamus Crossing Ambient Air Monitoring Station, WSP started operating and maintaining 4 new PurpleAir (PA) monitors. The PA monitors were installed to measure ambient $PM_{2.5}$ concentrations adding to the spatial resolution of the monitoring in the neighbourhood. $PM_{2.5}$ concentrations monitored during the year of 2022 (with the exclusion of Air Quality Advisory days due to wildfire smoke) were below BC AAQOs.

In another addition to the monitoring program, WSP collected samples of ambient air with SUMMA cannisters and determined concentrations of Volatile Organic Compounds (VOCs) in the ambient air through third-party laboratory analysis. The purpose of this analysis was to determine if nearby asphalt manufacturing operations were impacting the air quality in the neighbourhood. VOC concentrations measured during the year of 2022 were below AAQC.

BIBLIOGRAPHY

⇒ British Columbia Ministry of Environment, 2019, British Columbia Ambient Air Quality Objectives, updated December 17, 2019, https://www2.gov.bc.ca/assets/gov/environment/air-land-water/air/reports-pub/aqotable.pdf [Accessed Mar 29, 2023]

⇒ Human Toxicology and Air Standards Section, Technical Assessment and Standards Development Branch, Ontario Ministry of the Environment, Conservation and Parks (MECP). 2020. Ontario's Ambient Air Quality Criteria. MECP, Toronto, ON, Canada [Accessed Oct 3, 2023]

⇒ US Environmental Protection Agency (EPA), April 2004, AP42, Fifth Edition, Volume I Chapter 11.1: Mineral Products Industry – Hot Mix Asphalt Plants, https://www.epa.gov/sites/default/files/2020-10/documents/c11s01.pdf [Accessed May 05, 2023]

⇒ Canadian Council of Ministers of the Environment (CCME), 2012, Guidance Document on Achievement Determination Canadian Ambient Air Quality Standards for Fine Particulate Matter and Ozone, https://ccme.ca/en/res/pn1483_gdad_eng-secured.pdf [Accessed May 05, 2023]

⇒ Nilson, B., Jackson, P. L., Schiller, C. L., Parsons, M. T., 18 January 2022, Journal of Atmospheric Measurement Techniques, Development and Evaluation of Correction Models for a Low-Cost Dine Particulate Matter Monitor, https://amt.copernicus.org/preprints/amt-2021-425/amt-2021-425.pdf [Accessed May 05, 2023]