RESORT MUNICIPALITY OF WHISTLER

2023 SUMMARY OF AMBIENT AIR QUALITY MONITORING

CHEAKAMUS CROSSING AMBIENT AIR QUALITY MONITORING STATION

MARCH 21, 2024

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RESORT MUNICIPALITY OF WHISTLER

PROJECT NO.: CA-WSP-171-03296-05
DATE: MARCH 21, 2024

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March 21, 2024

File Number: CA-WSP-171-03296-05

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

Attention: Andrew Tucker

Dear Mr. Tucker:

Subject: Summary of 2023 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 2023. The report outlines the monitoring program conducted during 2023 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 which also collected $PM_{2.5}$ data. WSP provides public access to the monitoring data via a dedicated website (www.airquality.ca/clients/Whistler). This report summarizes the data from the monitoring station for the calendar year of 2023 (January 1st 2023, to December, 31st 2023).

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 PM2.5 concentrations, adding to the spatial resolution of the monitoring in the neighbourhood, and assist in addressing local citizen's concerns of potential ambient air quality issues associated with an asphalt plant located near the neighbourhood.

Appendix B of this report summarizes the PM2.5 data collected by the PA monitors in the year of 2023 and compares it with data from the BAM Monitor.

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 2023 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 the BC MOECCS stations to validate the proper operation of the equipment. During 2023, the BC MOECCS conducted an audit on September 21. All the audited parameters passed, and a copy of the audit reports can be found in Appendix A.

WSP completed twelve (12) monthly site visits during 2023 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 2023 calendar year was 98.0% as a result of a standard zero calibration audit as well and the minor downtimes each month to complete the standard audits and maintenance.

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 2023 (January 1st, 2023 to December 31st, 2023) and compares it with data from 2022. 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 2023 (Figure 6). Wind roses show the general wind direction during the sampling period. The cardinal points on the wind rose show the direction the winds blew from and the length of each "spoke" around the circle shows how often the wind blew from that direction (in percentage). The colors of each “spoke” represent the wind speed. The annual wind rose 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 5.6% of the time over the 2023 monitoring period (in 2022, they occurred 5.4% of the time).

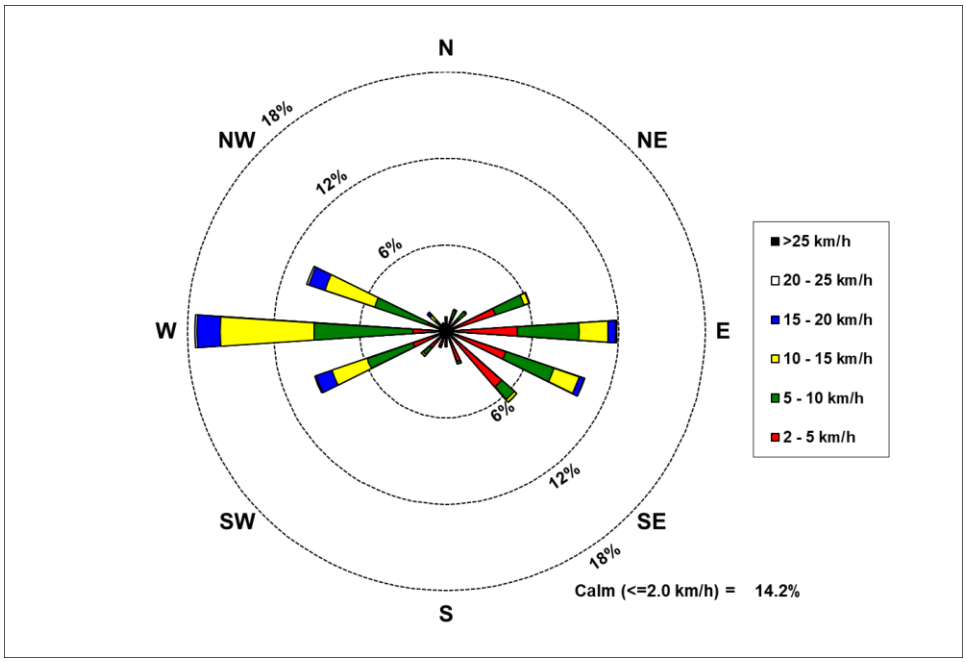

Figure 5 Historical Windrose of the Cheakamus Crossing Anemometer Data, January 1st, 2011 to December 31st, 2022

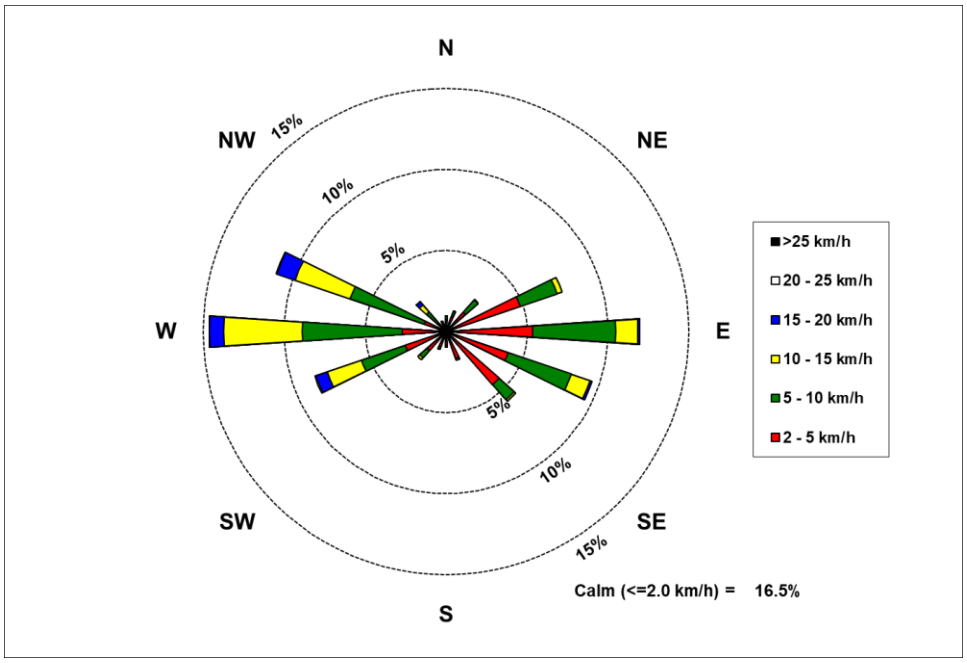

Figure 6 Windrose of the Cheakamus Crossing Anemometer Data, January 1st, 2023 to December 31st, 2023

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-hour 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. Comparisons to the British Columbia Ambient Air Quality Objectives (BC AAQO) for $PM_{2.5}$ are determined based on the annual data set and the metrics summarized below.

Table 1 BC Ambient Air Quality Objectives (BC AAQO) for $PM_{2.5}$

Air Contaminant	Averaging Period	Air Quality Objective	Statistical Form Compared to Objective
$PM_{2.5}$	24-hour (Block)	25	Achievement based on annual 98th percentile of daily average, over one year
	Annual	8	Achievement based on annual average, over one year

Figure 7 displays the monthly breakdown of the 24-hour block averages and maximums, along with the hourly maximum. This provides an idea of how the $PM_{2.5}$ concentrations vary throughout the year. There is no objective for hourly data, but Figure 7 shows that the highest concentrations occurred in August when forest fires were impacting the airshed. The BC AAQO is not shown in Figure 7 because a direct comparison can only be made between the objective and the annual 98th percentile of the 24-hour block averages (as seen in Figure 8),

The brown columns, which display the 24-hour block average for each month, increase in August. During August 2023 regional ambient air quality was impacted by forest fires. 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).

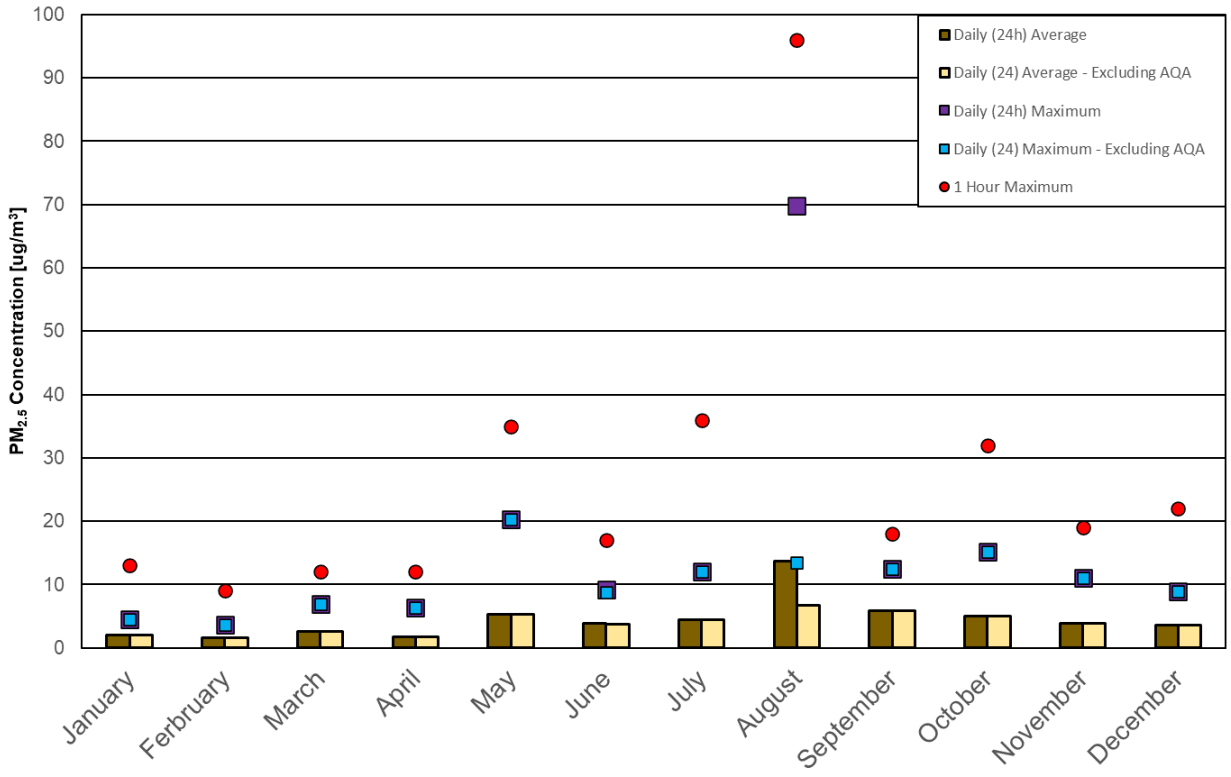

Figure 7 $PM_{2.5}$ Monthly Average, 24-hour Maximum, and 1-hour Maximum Concentrations

During June and August, there were a total of 8 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 3-2). 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 August exceed the BC AAQO (25 µg/m^3). When the data from AQA periods is excluded the 24-hour maximum is reduced in that month. There were minimal differences in the month of June, because there was only one day where an AQA was in effect. Excluding the impacts of the forest fire periods, the 24-hour maximum recorded in 2023 is below the BC AAQO (Table 3-2 and Figure 8).

It was reported by the RMOW that there were open burning activities during the end of October and start of November. Due to the low winds the smoke could be observed settling in the valley and would have been a source of increased PM levels.

Table 3-2: Air Quality Advisories (AQA) Issued by Metro Vancouver in 2023

AQA Period	Number of AQA days
June 7 to 8	1
August 19 to 22	3
August 25 to 29	4
Total	8

The annual average concentration of $PM_{2.5}$ at the Cheakamus Crossing monitoring location was 4.4 µg/m³ for 2023 which is well below the Annual BC AAQO of 8 µg/m³ (Table 3-2). When the data collected during the air quality advisory periods is removed from the dataset, this annual average is slightly lower (3.9 µg/m³).

Figure 8 shows the annual 98th percentile of the daily block average for $PM_{2.5}$ (compared to the 24-hour AAQO of 25 µg/m³) as well as the annual average (compared to the annual AAQO of 8 µg/m³) for 2022 and 2023. The hashed portion of the columns indicates the impact of the forest fire smoke on the annual statistics.

Table 3-3 Annual $PM_{2.5}$ Data Summary

Year	Maximum (24-hour)	98th Percentile (24-hour)	BC AAQO (24-hour)**	Annual Average (24-hour)	BCAAQO (Annual)
2022	64.1	15.3	25	4.8	8
2022*	13.5	10.1		3.9	
2023	69.8	19.0		4.4	
2023*	20.3	12.4		3.9	

*Excluding data from days with Air Quality Advisories (AQA)
**The 24-hour PM2.5 BC AAQO is compared to the annual 98th Percentile 24-hour block average concentration

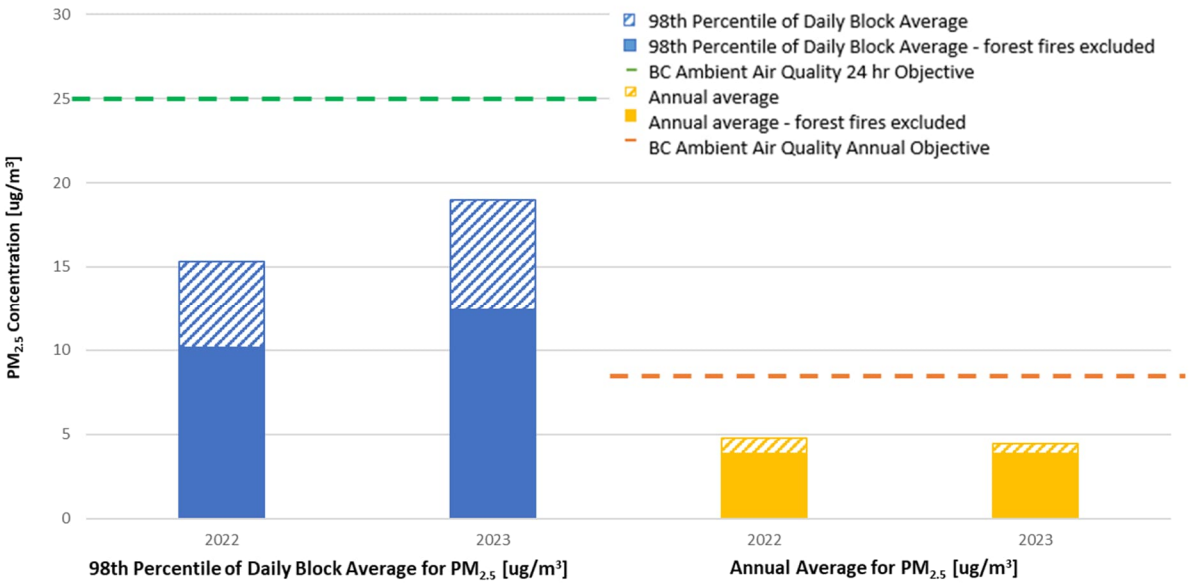

Figure 8 Annual 98th Percentile of 24-hour Block Average Data and Annual Average Data Compared to BC AAQOs for the years of 2022 and 2023.

2022 and 2023 $PM_{2.5}$ concentrations were below the AAQOs, even with the forest fire data included. However, there was a significant impact of forest fire smoke on the daily block averages, with a 35% and 34% reduction on the 98th percentile when excluding the AQA days in 2023 and 2022, respectively.

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 5.6% of the time over the 2023 monitoring period.

In 2023, the 98th Percentile of 24-hour Block Average $PM_{2.5}$ concentration was 19.0 µg/m³ which is below the 24-hour BC ambient air quality objective (BC AAQO) of 25 µg/m³. When the elevated particulate matter data during air quality advisories related to forest fires were excluded from the annual data, there was a 35% reduction of the 98th Percentile of 24-hour Block Average $PM_{2.5}$ concentrations to 12.4 µg/m³, less than 50% of the BC AAQO. The annual average $PM_{2.5}$ concentration was 4.4 µg/m³ which is below the annual 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:	September 21, 2023		
Station Name:	Whistler Cheakamus Crossing	Barometric Pressure:	709 mmHg
Permit #:	N/A	AmbientTemperature:	18.9 °C
Auditors:	Pedlar/Williams		
Method:	Beta-Attentuation	K-Factor:	0.952
Parameter:	BAM PM_{10}		
Make/Model:	Met One 1020	Flowmeter:	**Streamline**
Serial #:	T21162		

Parameter:	PM_{10}		**Streamline Data**	**Total**	
Start Time:	1105	PST	m:	0.4267	
Finish Time:	1120	PST	b:	-0.4970	

	Target L/Min	**(1)** In. H2O	**(2)** In. H2O	**(3)** In. H2O	**(Avg)** In. H2O		**Actual** L/Min	**Error** %
Sample Flow:	16.700	4.90	4.92	4.99	4.94		16.25	-2.7%

Target flow is read from calibration screen

Temperature:	**°C**	**Pressure:**	**mmHg**
Ambient Temperature (Audit):	17.8	Ambient Pressure (Audit):	709
Ambient Temperature (BAM):	16.8	Ambient Pressure (BAM):	710

Audit Criteria:			**Leak Check**	**L/Min**
Sample Flow Error:	-2.7%	Pass	Leak Flow:	0.6
Temperature Error:	1.0	Pass		
Pressure Error:	1	Pass		
Leak Test:	0.6	Pass		
Self-test:	Pass	Pass		
PM Inlet Condition:	Satisfactory	Pass		

Operational Parameters:

$C_{v:}$	0.966	$Q_{o:}$	0.0
ABS:	0.796	$\mu_{sw:}$	0.312
K:	0.986	BKGD:	-0.0008
		Flow Mode:	Actual
		RH Control ON:	Yes
		RH Set Point:	35%

Report:

Audit Results: Pass

Air Audit Programme
Regional Operations Branch

APPENDIX

B 2023 SUMMARY OF AIR QUALITY PROGRAM: PURPLEAIR MONITORS

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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, and assist in addressing local citizen's concerns of potential ambient air quality issues associated with an asphalt plant located near the neighbourhood.

This report summarizes the $PM_{2.5}$ data collected by the PA monitors in 2023 and compares it with data from the Beta Attenuation Mass (BAM) Monitor, which has been in operation at the top of the High-Performance Center (HPC) building since September 2010.

2 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 1 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 1 Map with locations for PurpleAir Monitors (purple), BAM monitor (green) and Asphalt plant (red).

The BAM monitor at the HPC is 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. The BAM also collected wind direction and wind speed data to be viewed with PM2.5 data.

2.1 2023 DATA QUALITY

Table 1 summarizes the data completeness for each month of the year of 2023 in which the monitors were operational. PA monitors are designed to require minimal maintenance and calibration. All monitors exhibited data completeness above 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. The lowest data completeness was in September for the Mt. Fee Road monitor at 87.6%, due to loss of power from September 11th to September 14th.

Table 1 Summary of Data Completeness for 2023

Month	Cloudburst	Co-Located	Mt Fee Road	Fenceline
January	100.0%	100.0%	100.0%	100.0%
February	100.0%	100.0%	100.0%	100.0%
March	100.0%	100.0%	100.0%	100.0%
April	100.0%	100.0%	100.0%	100.0%
May	100.0%	100.0%	100.0%	100.0%
June	100.0%	100.0%	100.0%	100.0%
July	100.0%	100.0%	100.0%	100.0%
August	100.0%	100.0%	100.0%	100.0%
September	100.0%	99.6%	87.6%	100.0%
October	100.0%	100.0%	100.0%	100.0%
November	100.0%	99.0%	100.0%	99.9%
December	100.0%	99.5%	100.0%	100.0%
Total	**100.0%**	**99.8%**	**99.0%**	**100.0%**

Data from PA monitors is checked weekly to ensure that the monitors are operating properly. If there are any persisting issues, the monitors is scheduled for replacement.

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 2023, sensor A from the Cloudburst station was not operating properly up until its replacement on August 22nd, 2023. Before August 22nd, only readings from the sensor B for this monitor were used in the analysis. After that data, readings for sensor A and B were averaged.

The Co-located monitor exhibited a similar issue from October 5th, 2023 to November 17th, 2023. During that period, only readings from the sensor B for this monitor were used in the analysis. From January 1st to October 5th, and after replacement on November 17th, readings for sensor A and B were averaged.

For all other stations the two sensors at each location were averaged to provide the hourly $PM_{2.5}$ concentrations.

2.2 DATA SUMMARY

2.2.1 WIND DIRECTION AND WIND SPEED

A wind rose was created using the wind data collected from the HPC monitoring location for 2023 (Figure 3). Wind roses show the general wind direction during the sampling period. The cardinal points on the wind rose show the direction the winds blew from and the length of each "spoke" around the circle shows how often the wind blew from that direction (in percentage). The colors of each “spoke” represent the wind speed. The annual wind rose is similar in wind direction and speed when compared to the historical wind data (Figure 2). 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 5.6% of the time over the 2023 monitoring period (in 2022, they occurred 5.4% of the time).

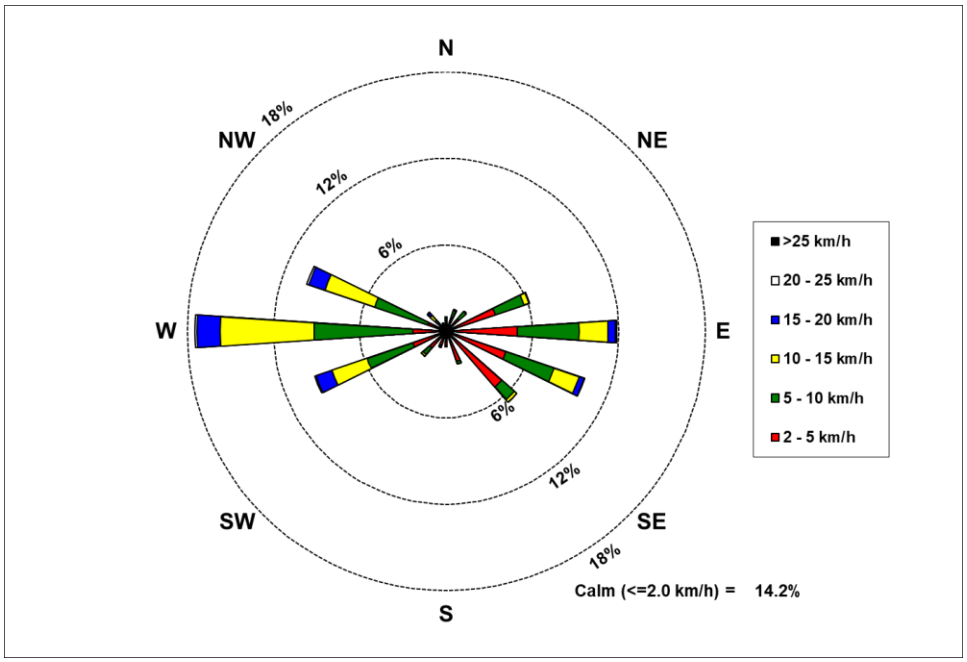

Figure 2 **Historical Windrose of the Cheakamus Crossing Anemometer Data, January 1st, 2011 to December 31st, 2022**

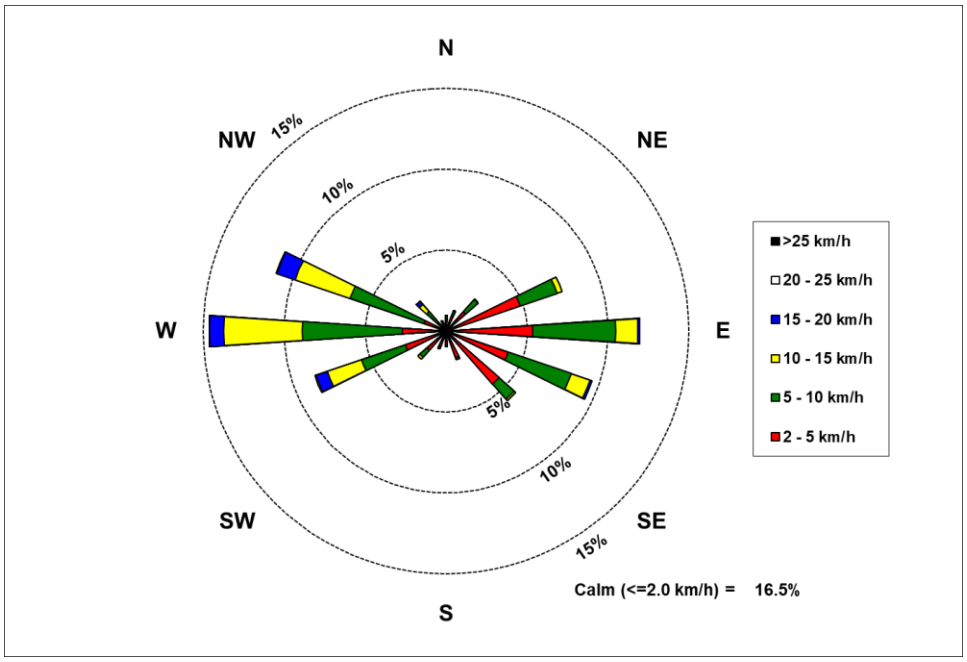

Figure 3 **Windrose of the Cheakamus Crossing Anemometer Data, January 1st, 2023 to December 31st, 2023**

2.2.2 PM2.5 CONCENTRATIONS

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:

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

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, according to 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.

Monthly 24-hour block averages and maximum 24-hour block averages were calculated for each month of 2023 and plotted in Figure 4.

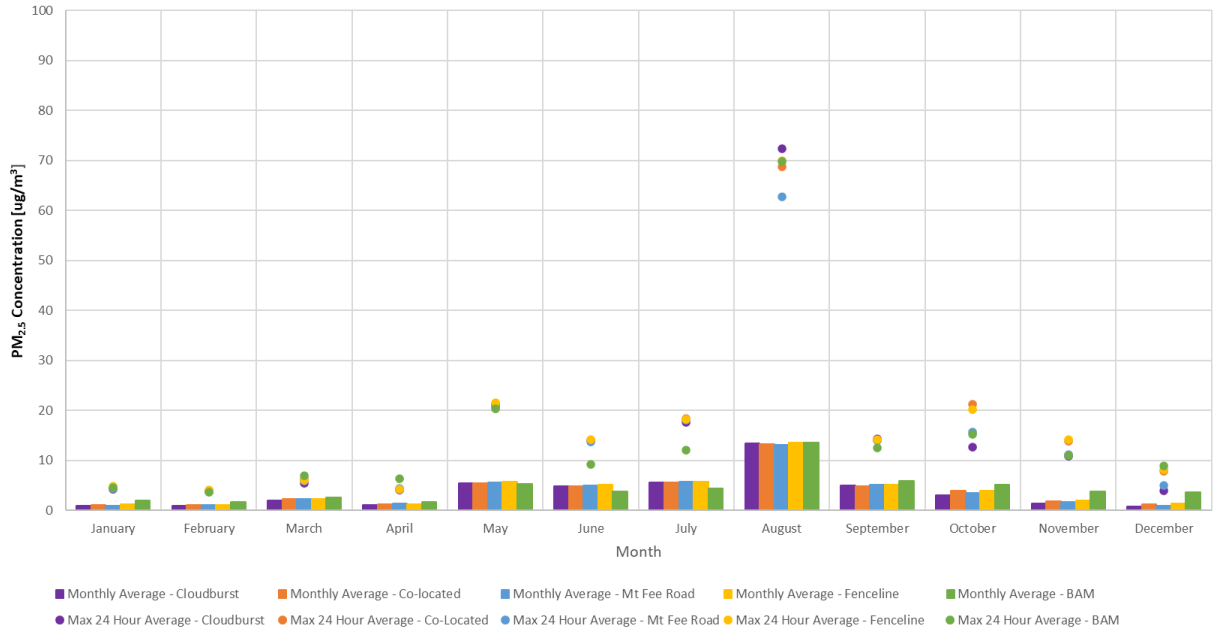

Figure 4 $PM_{2.5}$ Monthly 24-hour Averages (boxes) and Maximum 24-Hour Averages (circles) for 2023.

The monthly 24-hours averages and maximum 24-hour averages for the month of August are significantly higher than for the rest of the year. That is because the regional ambient air quality during that month was heavily impacted by forest fires.

During June and August, there were a total of 8 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 2 identifies the periods with AQAs issued by Metro Vancouver that were excluded from the analysis.

Table 2 Air Quality Advisories (AQA) Issued by Metro Vancouver in 2023

AQA Period	Number of AQA days
June 7 to 8	1
August 19 to 22	3
August 25 to 29	4
Total	8

Figure 5 summarizes the monthly 24-hour block averages and maximum 24-hour block averages for 2023 with exclusion of AQA days. With the exclusion of $PM_{2.5}$ originated from forest fires, the values for August are significantly lower. There were no significant changes for June, since there was only 1 day of AQA in the month.

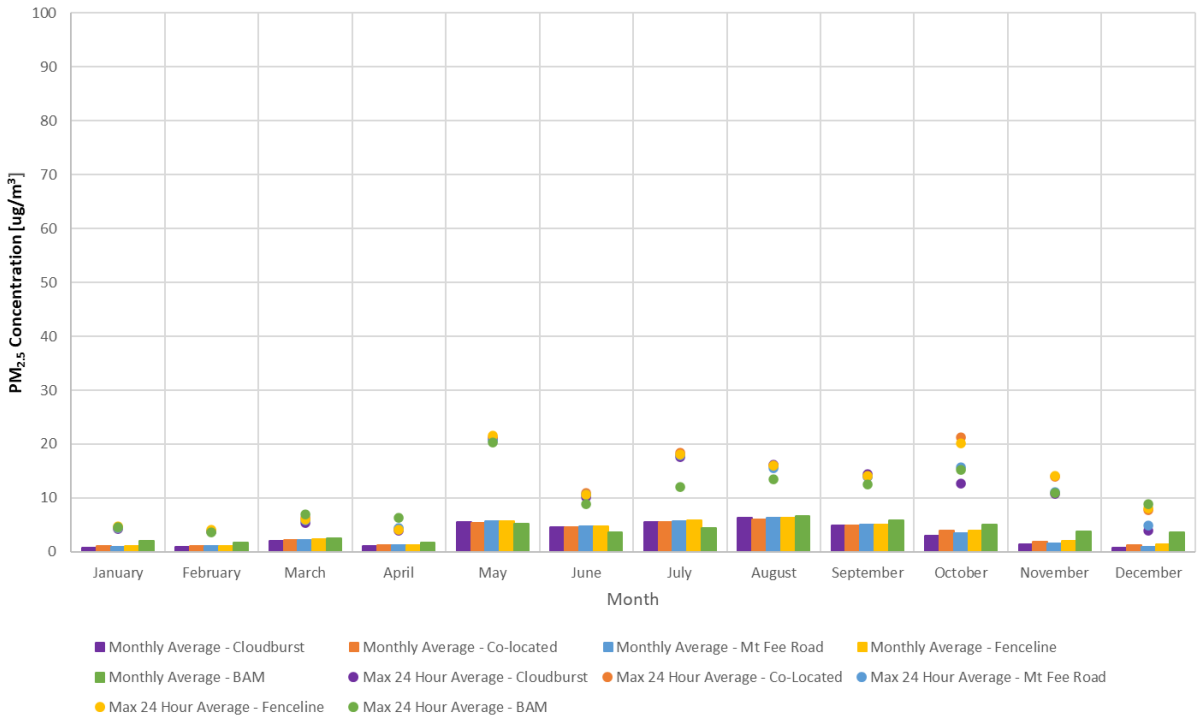

Figure 5 $PM_{2.5}$ Monthly 24-hour Averages (boxes) and Maximum 24-Hour Averages (circles) for 2023. – Air Quality Advisory Days Deleted

Comparisons to the British Columbia Ambient Air Quality Objectives (BC AAQO) for $PM_{2.5}$ are determined based on the annual data set and the metrics summarized below.

Table 3 BC Ambient Air Quality Objectives (BC AAQO) for $PM_{2.5}$

Air Contaminant	Averaging Period	Air Quality Objective	Statistical Form Compared to Objective
$PM_{2.5}$	24-hour (Block)	25	Achievement based on annual 98th percentile of daily average, over one year
	Annual	8	Achievement based on annual average, over one year

In order to compare the 2023 data collected to the 24-hour BC AAQO, the 98th percentile of the daily block averages was calculated. For comparison to the annual average all hourly $PM_{2.5}$ concentrations were averaged. Figure 6 shows the annual 98th percentile of the daily block average for $PM_{2.5}$ (compared to the 24-hour AAQO of 25 µg/m³) as well as the annual average (compared to the annual AAQO of 8 µg/m³) for 2023. The hashed portion of the columns indicates the impact of the forest fire smoke on the annual statistics.

Table 4 Annual $PM_{2.5}$ Data Summary

Monitor	AQA Days Included	Maximum (24-hour)	98th Percentile (24-hour)	BC AAQO (24-hour)*	Annual Average (24-hour)	BCAAQO (Annual)
Cloudburst	Yes	72.4	21.0	25	3.7	8
	No	21.0	13.8		3.1	
Co-Located	Yes	68.7	21.3		3.9	
	No	21.3	14.8		3.2	
Mt Fee Road	Yes	62.8	20.7		3.9	
	No	20.7	14.0		3.3	
Fenceline	Yes	69.9	21.5		4.0	
	No	21.5	14.5		3.4	
BAM	Yes	69.8	19.0		4.4	
	No	20.3	12.4		3.9	

*The 24-hour PM2.5 BC AAQO is compared to the annual 98th Percentile 24-hour block average concentration

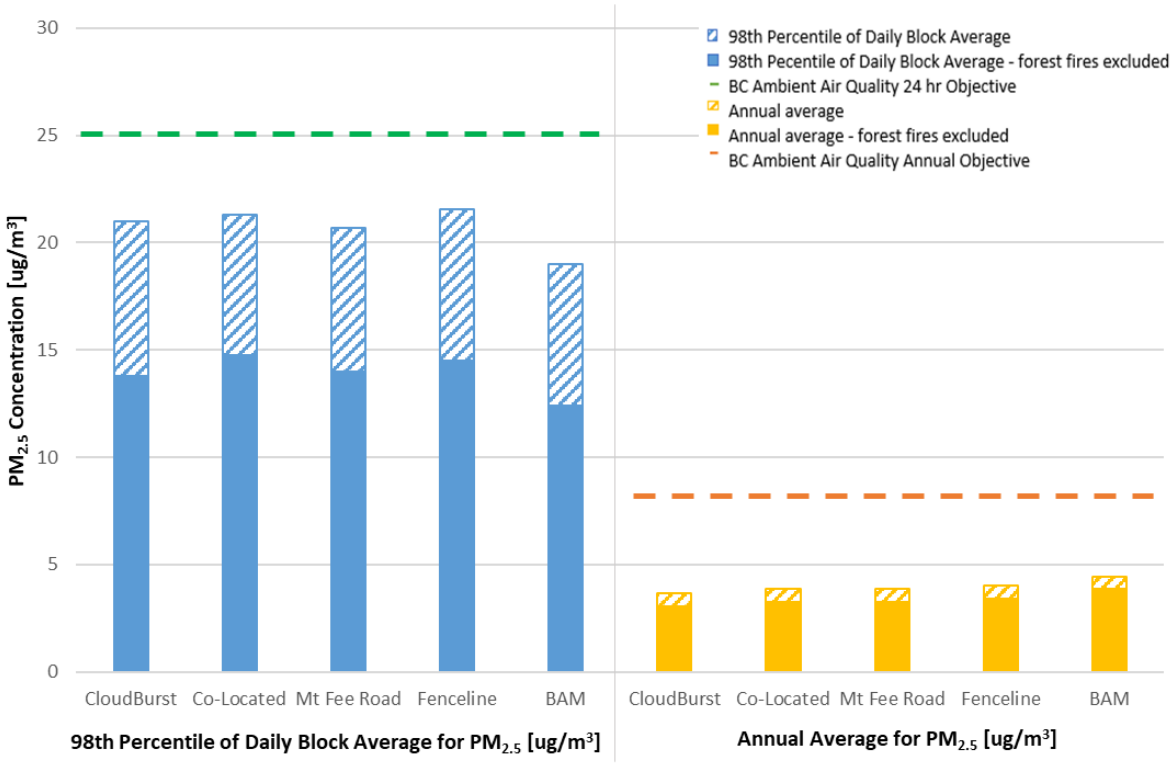

Figure 6 **Annual 98th Percentile of 24-hour Block Average Data and Annual Average Data Compared to BC AAQOs for 2023.**

The 24-hour and Annual BC AAQOs were not exceeded, even with the forest fire data (AQA) included. However, there was a significant impact of forest fire smoke on the daily block averages. The monitored values at each location are remarkably similar. This indicates that there is little spatial variability in $PM_{2.5}$ concentrations monitored across the Cheakamus Crossing neighborhood.

3 SUMMARY

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. The results showed minimal spatial variability across the Cheakamus Crossing neighborhood. $PM_{2.5}$ concentrations monitored during the year of 2023 were below BC AAQOs.

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]