

**Ambient Air Quality Data
Summary Report
Greeley School Monitoring Station
Butte, Montana**

(March 2019 → June 2020)

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Appendix A: Guideline Threshold

Executive Summary

This report summarizes the particulate matter (PM) data collected and analyzed from samplers installed at the Greeley School monitoring site located in Butte, Montana. The collection period covers March 2019 through and including June 2020, a period of 16 consecutive months.

This project focused on monitoring total suspended particulate (TSP) and particulate matter less than 10 microns in diameter (PM₁₀). In addition to determining particulate mass concentrations, concentrations of seven metals were also measured and reported for both the TSP and PM₁₀ particle sizes.

Various descriptive statistical data are provided along with some figures that show how concentrations vary over time. Finally, the data are compared to ambient air quality standards or various guidelines (EPA, ATSDR, etc.) where available. All data indicate measured concentrations well below those standards or guidelines.

1.0 INTRODUCTION

Particulate monitoring has been conducted in the Greeley School area since the 1970s and continues to this day. Historically, the Greeley School location has experienced the highest average particulate concentrations in Butte. Prior to this project, the Montana Department of Environmental Quality (MDEQ) and Butte-Silver Bow (BSB) County were, and still are, conducting ambient monitoring at that location. The existing monitoring includes several combinations of PM₁₀ and PM_{2.5}.¹ Both of these parameters are measured on a continuous (hourly) basis. Additionally, PM_{2.5} is also measured on an 'episodic' basis for a period of 24 hours one day out of every six.² This sampler collects particulate on a filter which is then subjected to trace metals analysis by an EPA-certified laboratory.³

While this degree of particulate sampling is suitable in most situations, there was an interest at this site to determine:

- 1) Concentrations of metals in PM₁₀,
- 2) Real-time Total Suspended Particulate (TSP) concentrations, and
- 3) Metals concentrations in the TSP.

Including these additional parameters could then fill out a range of particulate sampling, including metals concentrations within different particulate size ranges.

Montana Resources (MR) requested Bison Engineering, Inc. (Bison) to set up a monitoring program co-located at the Greeley site that would fill these perceived data gaps. In cooperation with DEQ and BSB, such a program was added to the monitoring station in March 2019. A PM₁₀ monitor was installed to collect particulate matter on a filter that was subsequently analyzed for total (PM₁₀) mass and for seven metals. Additionally, a real-time TSP monitor was installed to collect hourly data; that monitor also includes filters that are analyzed for total (TSP) mass and metals.

To better understand the monitoring program, Table 1 provides an overview of the sampling matrix at the site. The table shows the parameters, methods, equipment and other items of interest.

Figure 1 offers a Google map image showing the location of the monitoring station. It is located on the grounds adjacent to what was once the Greeley Elementary School. The school building itself was demolished in early 2020.

The remainder of this document will focus primarily on the data collected by Bison / BSB from March 2019 (the start of the project) through June 2020. This will mostly include PM₁₀, PM₁₀-metals, TSP and TSP-metals. Various statistics and graphical information are

¹ PM₁₀ refers to particulate matter less than 10 microns in diameter while PM_{2.5} refers to particulate matter less than 2.5 microns in diameter.

² This one-day-in-six sample schedule is an EPA standardized event that is generally followed on a national level. The sampling schedule for this parameter followed that EPA schedule.

³ Certification also includes the National Environmental Laboratory Accreditation Program (NELAP).

provided. This document does not attempt to draw specific conclusions but offers several apparent observations.

Table 1: Greeley Ambient Monitoring Matrix

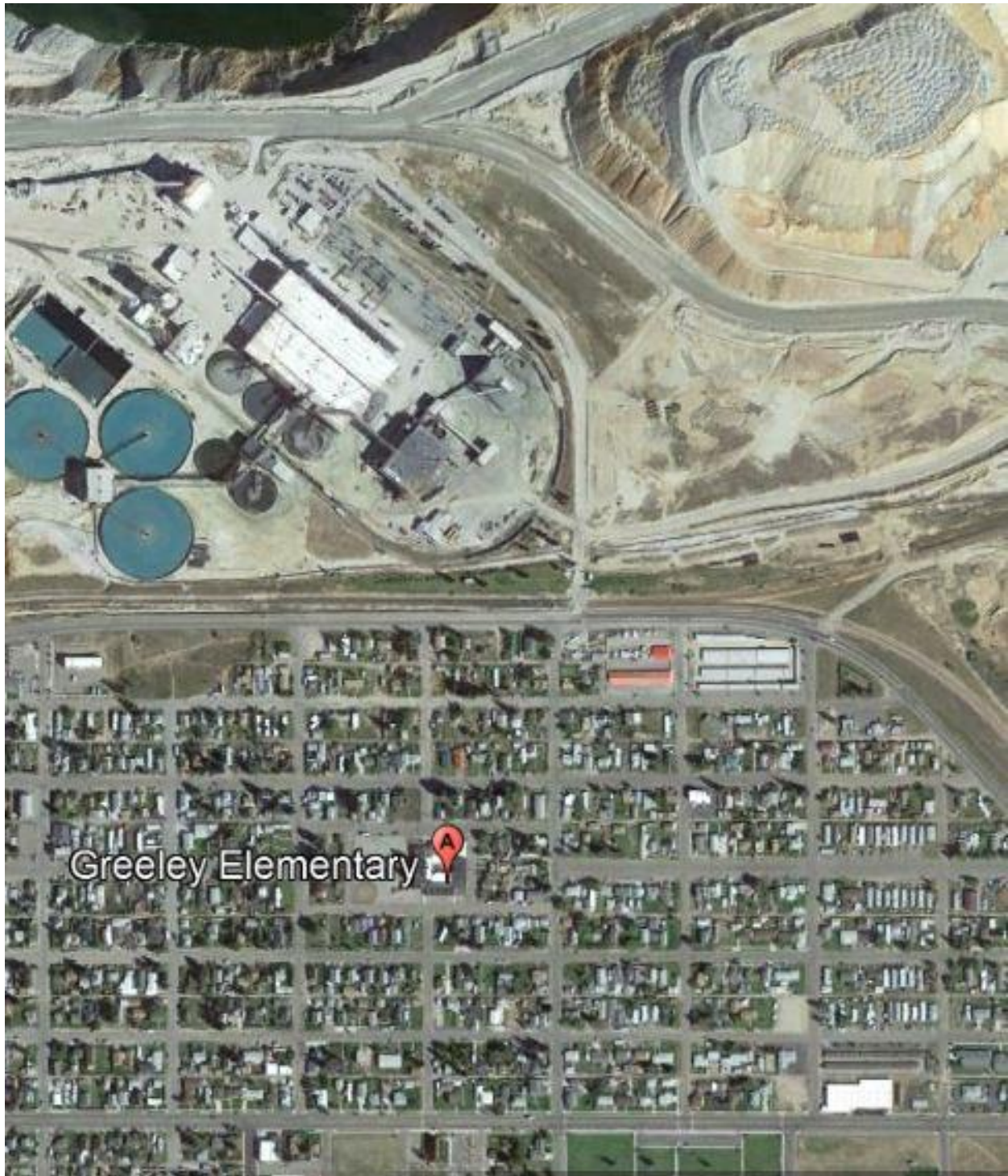
Parameter	Monitor Frequency	Metals	Monitor Method	Equipment	Responsible Party
PM_{2.5}	Hourly	n/a	Beta-Attenuation	Met One BAM-1020	DEQ / BSB
	1-day-in-6	As, Cd, Cr, Mn, Ni, Pb	Gravimetric / ICP-MS	BGI Model PQ-200	DEQ / BSB / EPA
PM₁₀	Hourly	n/a	Beta-Attenuation	Met One BAM-1020	DEQ / BSB
	1-day-in-6	As, Cd, Cu, Mn, Mo, Pb, Zn	Gravimetric / ICP-MS	BGI Model PQ-200	Bison / BSB / Energy Labs
TSP*	Hourly	n/a	Light-scatter Nephelometer	Met One E-Sampler ⁴	Bison / BSB
	6-Day Sample**	As, Cd, Cu, Mn, Mo, Pb, Zn	Gravimetric / ICP-MS	Met One E-Sampler	Bison / BSB / Energy Labs
Meteorology	Hourly	n/a	Wind speed, direction, temperature	Integrated sensor set	DEQ / BSB

* TSP = Total Suspended Particulate (typically less than 30 to 40 microns in diameter)

** Sample run time is typically between 5 and 7 days in length

⁴ The E-Sampler includes an external sensor that measures hourly relative humidity. It also includes internal ambient temperature and pressure sensors.

Figure 1: Greeley School Monitoring Station



2.0 SUMMARY STATISTICS

Section 1 introduced the data collected at the Greeley School monitoring station. The summary only applies to data collected under the auspices of Bison and does not include data collected by DEQ/BSB.⁵ The tables below summarize the observed data. A few key points are necessary when reviewing the data.

- a) For all seven metals, numerous samples were below the laboratory Method Detection Limit (MDL). In those cases, the data was reported and analyzed as $\frac{1}{2}$ of the MDL. (The MDL varied by metal and is shown where appropriate in the tables and figures that follow.) There are no “zero” values incorporated into the metals statistics presented herein.
- b) For PM₁₀-metals data, each reported value represents a 24-hour sample run. A sample run was conducted once every six days.
- c) For TSP-metals data, each reported value represents on average a six-day sample run. (Individual runs varied typically from five to seven days).

⁵ Comparisons of hourly TSP, PM₁₀ and PM_{2.5} data have been conducted but for the sake of brevity are not included in this report. In general, average TSP values are only slightly higher than PM₁₀ values. Both TSP and PM₁₀ concentrations are, on average, roughly 3 to 4 times greater than PM_{2.5} values.

Table 2: PM₁₀ Summary Data – Greeley School

Parameter ^a	Mass (µg/m³)	Arsenic (ng/m³)	Cadmium (ng/m³)	Copper (ng/m³)	Manganese (ng/m³)	Molybdenum (ng/m³)	Lead (ng/m³)	Zinc (ng/m³)
Mean	14	1.8	0.23	44	14	4.2	3.9	26
# of Samples	75	69	69	69	56	59	69	67
Standard Deviation	9.1	0.70	0.13	43	13	4.5	5.5	16
Coef. of Variance ^b	64%	38%	57%	98%	95%	109%	140%	62%
Non-Detect Threshold	n/a	3.3	0.38	13	13	4.2	3.8	33
% of Non-Detect Samples	n/a	93%	87%	28%	52%	66%	68%	66%
Guideline Threshold ^c	150 ^e	15	10	2,000	300	400	150 ^d	47,600

^a Data Period = March 2019 through June 2020.

^b Coefficient of Variance = Ratio of standard deviation to the mean (expressed as %). It is a measure of the variability compared to the mean.

^c The Guideline Threshold in this table is shown in Appendix A.

^d Lead National Ambient Air Quality Standard (NAAQS) is based on TSP particulate. (40 CFR 50.16).

^e National Ambient Air Quality Standard (NAAQS) for PM₁₀ (40 CFR 50.6).

Table 3: TSP Summary Data – Greeley School

Parameter ^a	Mass (µg/m³)	Arsenic (ng/m³)	Cadmium (ng/m³)	Copper (ng/m³)	Manganese (ng/m³)	Molybdenum (ng/m³)	Lead (ng/m³)	Zinc (ng/m³)
Mean	18	2.5	0.28	49	14	3.7	17	33
# of Samples	71	64	68	68	52	59	68	60
Standard Deviation	7.0	0.22	0.032	28	7.3	1.9	83	25
Coef. of Variance ^b	39%	9%	11%	58%	53%	52%	499%	76%
Non-Detect Threshold	n/a	4.9	0.55	18	18	6.1	5.5	49
% of Non-Detect Samples	n/a	98%	96%	10%	58%	80%	81%	75%
Guideline Threshold ^c	260 ^d	15	10	2,000	300	400	150	47,600

^a Data Period = March 2019 through June 2020.

^b Coefficient of Variance = Ratio of standard deviation to the mean (expressed as %). It is a measure of the variability compared to the mean.

^c The Guideline Threshold in this table is shown in Appendix A.

^d This is the historical NAAQS standard for TSP no longer in effect. It was replaced by a PM₁₀ standard in 1987. (52 FR 24663).

While a summary of the entire dataset (16 months) is of interest, reviewing the data in shorter monthly time periods is also instructive. Tables 4 and 5 present monthly averages for each parameter except as otherwise noted. The PM₁₀ data is shown in Table 4 while TSP is presented in Table 5.

A discussion of various caveats and observations is found following the tables.

Table 4: PM₁₀ Monthly Means – Greeley School

Month	Mass ($\mu\text{g}/\text{m}^3$)	Arsenic (ng/m^3)	Cadmium (ng/m^3)	Copper (ng/m^3)	Manganese (ng/m^3)	Molybdenum (ng/m^3)	Lead^a (ng/m^3)	Zinc (ng/m^3)
March 2019	25	1.7	0.26	68				45
April 2019	9	1.7	0.19	18	42 ^b	2.1 ^b		17
May 2019	10	1.7	0.19	66	15	2.1	7.9	17
June 2019	11	1.7	0.19	32	12	7.9	2.4	17
July 2019	17	1.7	0.19	83	19	5.7	2.8	27
August 2019	17	1.7	0.19	57	20	7.5	3.4	27
September 2019	9	2.7	0.19	18	12	2.8	3.3	17
October 2019	13	1.7	0.28	22	13	2.1	3.2	40
November 2019	16	2.0	0.37	51	7	2.5	2.4	37
December 2019	26	1.7	0.36	64	9	4.6	3.5	29
January 2020							3.5	
February 2020	15	1.7	0.41	41	13	2.6	3.9	22
March 2020	11	1.7	0.19	18	6	4.0	2.4	17
April 2020	15	1.7	0.19	42	12	2.9	2.7	
May 2020	7	1.7	0.19	26	6	3.4	2.3	17
June 2020	10	1.7	0.29	35	8	4.7	2.3	17
Non-Detect Threshold	n/a	4.9	0.55	18	18	6.1	5.5	49
Guideline Threshold	150 ^c	15	10	2,000	300	400	150	47,600

^a Expressed as a 3-month running average to be consistent with the National Ambient Air Quality Standard (40 CFR 50.16).

^b Not a valid mean. Data represents a single sample.

^c National Ambient Air Quality Standard (NAAQS) for PM₁₀ (40 CFR 50.6).

Table 5: TSP Monthly Means – Greeley School

Month	Mass ($\mu\text{g}/\text{m}^3$)	Arsenic (ng/m^3)	Cadmium (ng/m^3)	Copper (ng/m^3)	Manganese (ng/m^3)	Molybdenum (ng/m^3)	Lead^a (ng/m^3)	Zinc (ng/m^3)
March 2019	23	2.4	0.28	66				91
April 2019	14	2.4	0.28	41				24
May 2019	13	2.4	0.28	22	9	3	82	24
June 2019	19	2.4	0.28	62	22	5	6	29
July 2019	26	2.4	0.28	100	19	4	4	31
August 2019	15	2.4	0.28	43	24	7	4	24
September 2019	15	2.7	0.28	40	17	5	4	24
October 2019	18	2.4	0.28	44	9	3	3	44
November 2019	24	2.4	0.34	61	13	3	3	38
December 2019	21	2.4	0.31	54	11	3	3	27
January 2020	17	2.4	0.28	65	9	3	3	24
February 2020	18	2.4	0.28	49	9	4	3	39
March 2020	16	2.4	0.28	31	11	3	3	24
April 2020	21	2.4	0.28	44	12	4	3	
May 2020	13	2.4	0.28	27	9	3	3	24
June 2020	14	2.4	0.28	40	9	3	3	24
Non-Detect Threshold	n/a	4.9	0.55	18	18	6.1	5.5	49
Guideline Threshold	260 ^b	15	10	2,000	300	400	150	47,600

^a Expressed as a 3-month running average to be consistent with the National Ambient Air Quality Standard (40 CFR 50.16).

^b This is the historical NAAQS standard for TSP no longer in effect. It was replaced by a PM₁₀ standard in 1987. (52 FR 24663).

Based on the data in the tables above, a few caveats and observations are noteworthy.

- i) A degree of caution should be exercised when comparing PM₁₀ data to TSP data (applies to mass and metals analyses). The PM₁₀ is collected for a 24-hour period once every six days. The TSP data, on the other hand, is collected continuously; each sample period is roughly six days in length; i.e., the individual PM₁₀ and TSP sampling periods are not directly concurrent.
- ii) It is also worth recalling that, for purposes of data analysis and presentation, any data reported by the laboratory as non-detectable was then coded in the tables and graphics that follow as ½ of the laboratory MDL.⁶
- iii) All the data indicates airborne metal and particulate concentrations values much lower than the guideline thresholds presented in the tables.
- iv) At a glance, all (or nearly all) of the TSP parameters are greater than the corresponding PM₁₀ parameters. This is logical since PM₁₀ is merely a subset of TSP.
- v) It is interesting to note that PM₁₀ accounts for most of the TSP. (This can also be seen in the graphic presented further in this document.) Thus, most of the total particulate seen at the site is, in fact, PM₁₀.

⁶ Note that the original laboratory result is expressed in units of micrograms (of the analyte) on the filter. That value then is divided by the total air volume sampled to determine the average airborne concentration of the analyte. All of the metals data is expressed in nanograms per cubic meter (ng/m³).

3.0 GRAPHICAL PRESENTATION

To facilitate data interpretation, a series of graphics has been created. These graphics chart the various parameters over time. This allows a visualization of the data along with an indication how the data does or does not fluctuate over time.

For brevity, multiple parameters are placed in the same graphic. This also allows the reader to compare airborne metal concentrations of similar magnitude on the primary (left) vertical axis against the mass data which are shown on the secondary (right) vertical axis. Note that metal concentrations are shown in units of nanograms per cubic meter (ng/m^3), while particulate concentrations are shown in micrograms per cubic meter ($\mu\text{g}/\text{m}^3$).
(1,000 $\text{ng}/\text{m}^3 = 1\mu\text{g}/\text{m}^3$).

Figure 2: Greeley School – TSP & PM₁₀

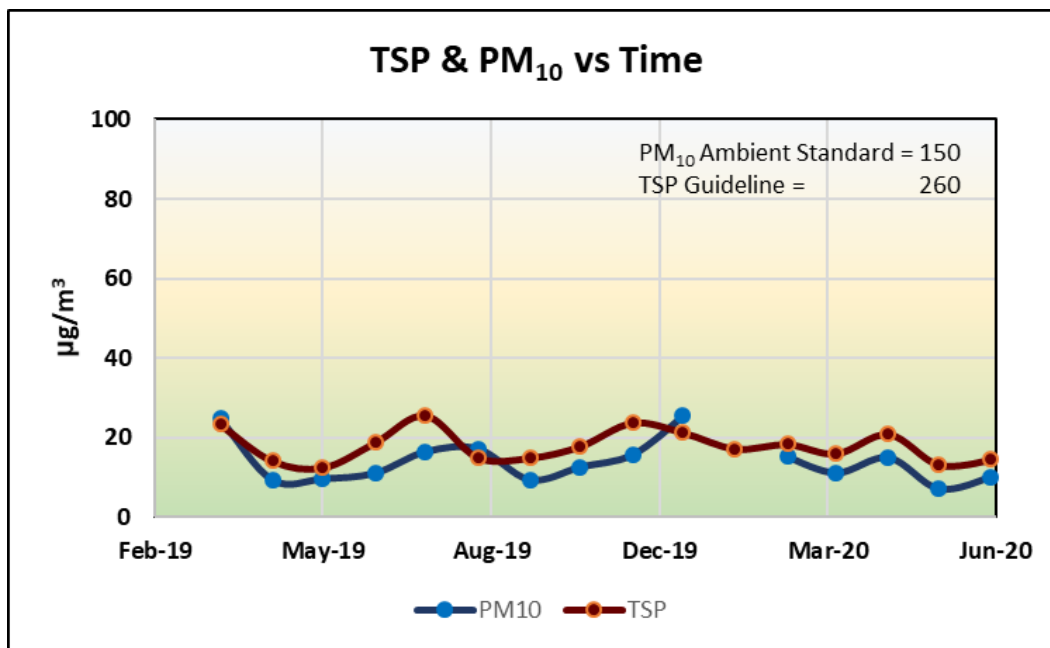


Figure 3: Greeley School – As, Cd & PM₁₀

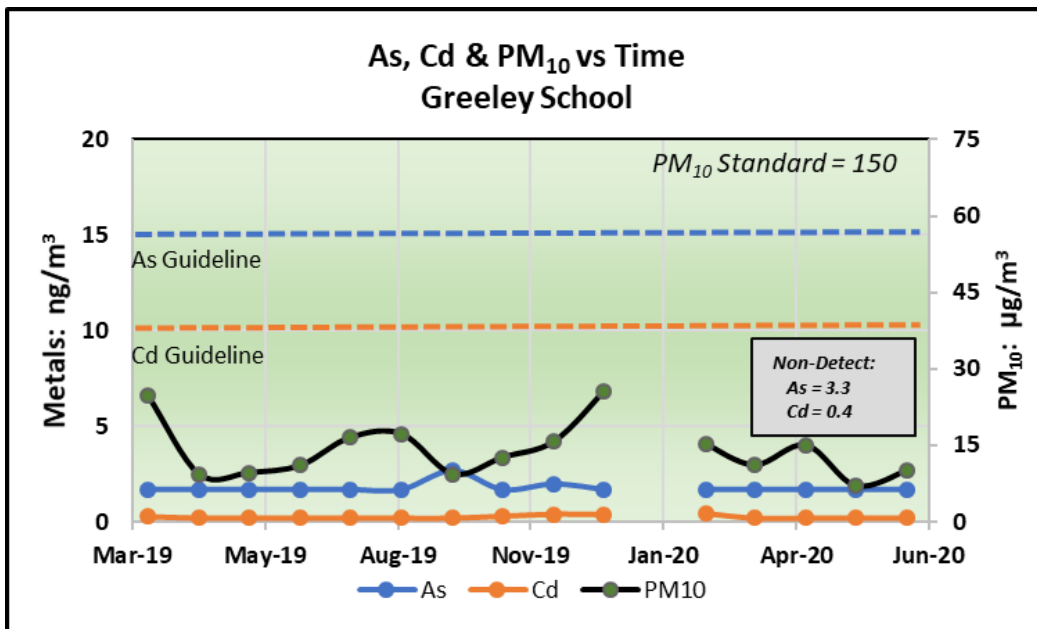


Figure 4: Greeley School – Mn, Mo & PM₁₀

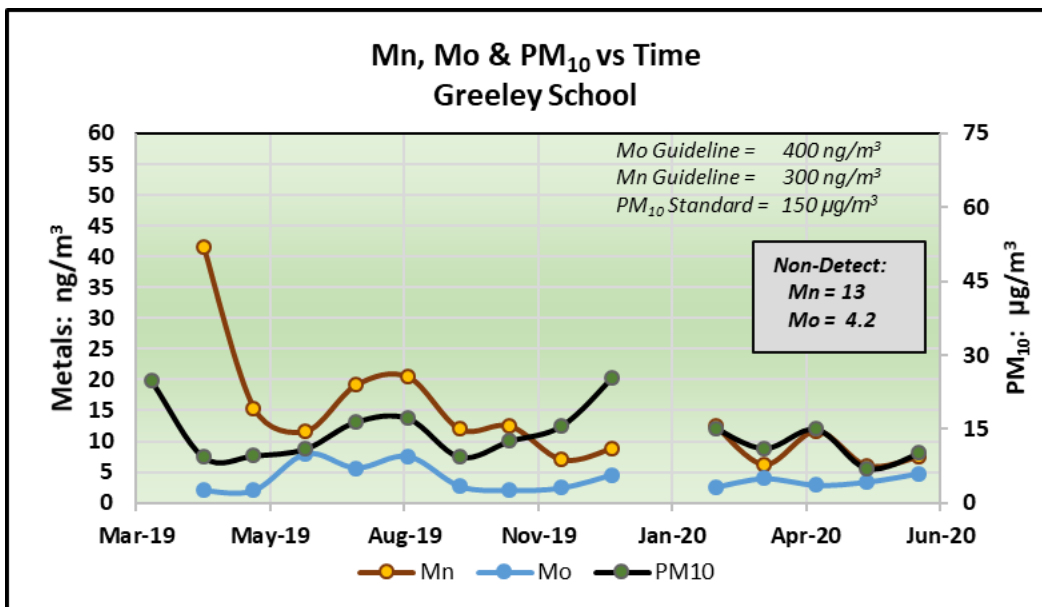


Figure 5: Greeley School – Zn, Pb, Cu & PM₁₀

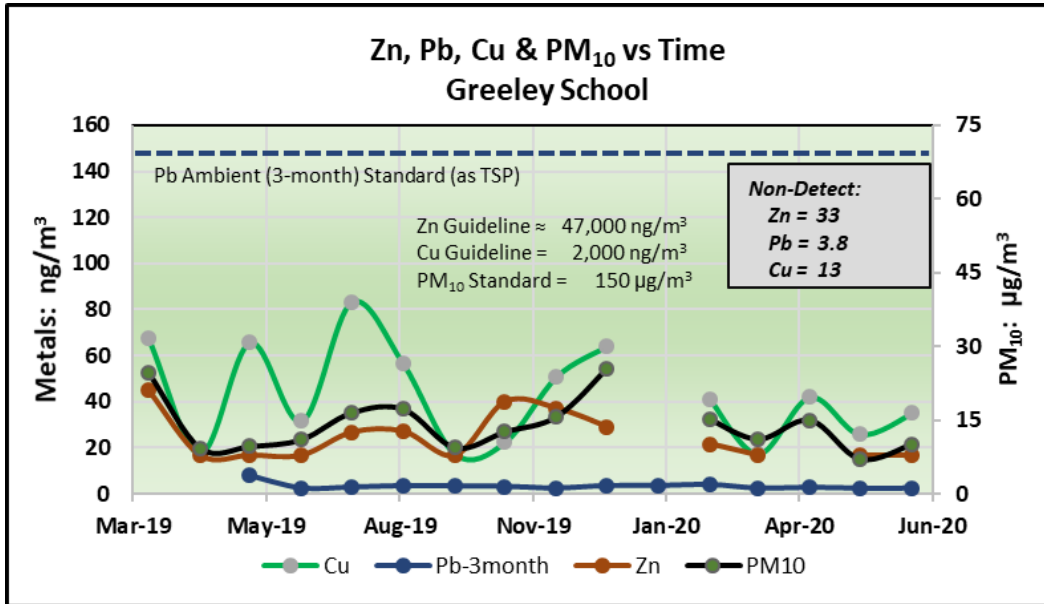


Figure 6: Greeley School – As, Cd & TSP

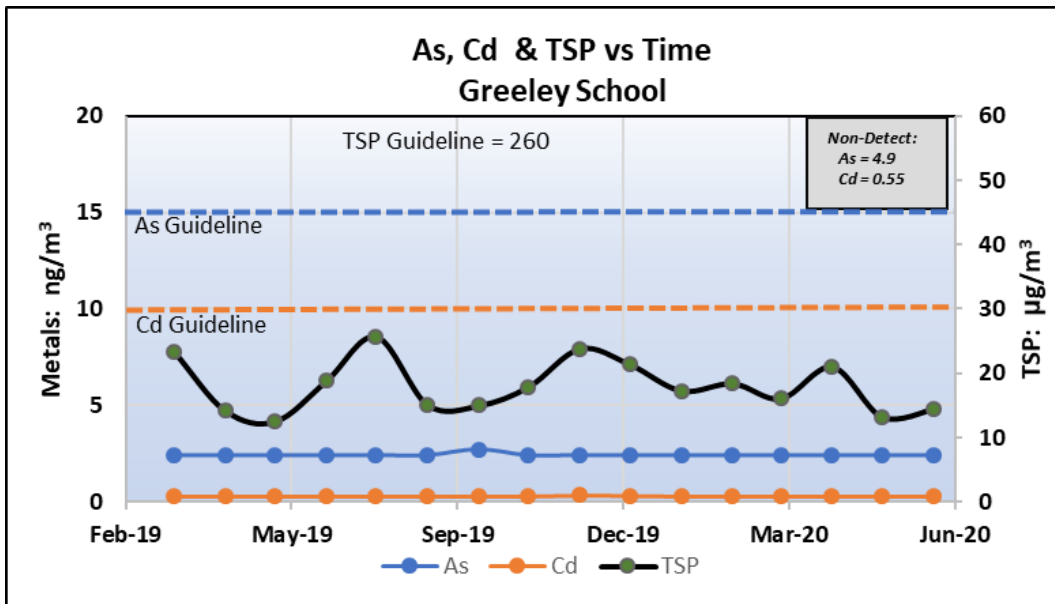


Figure 7: Greeley School – Mn, Mo & TSP

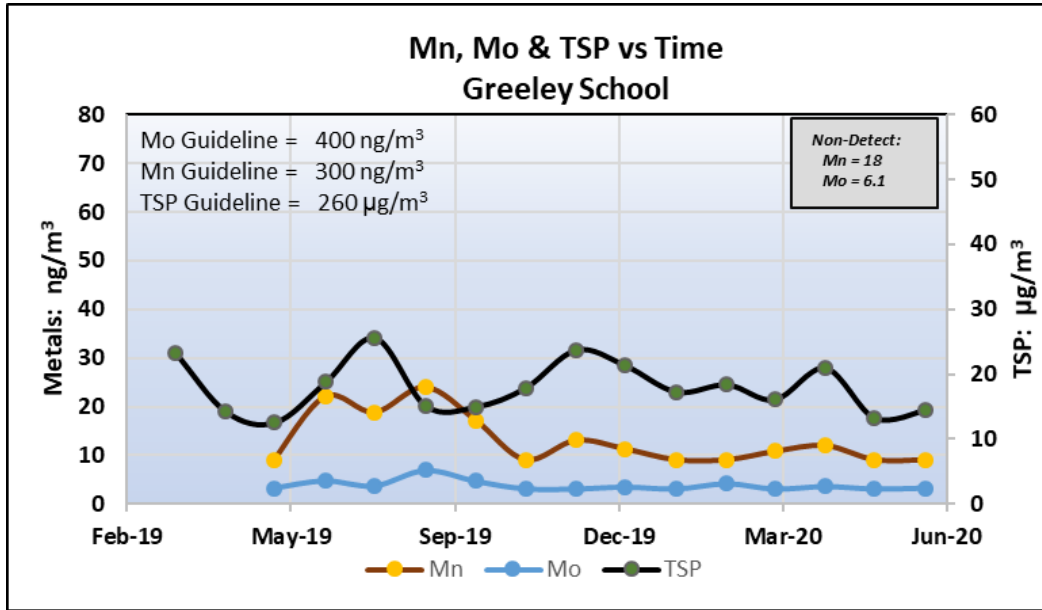
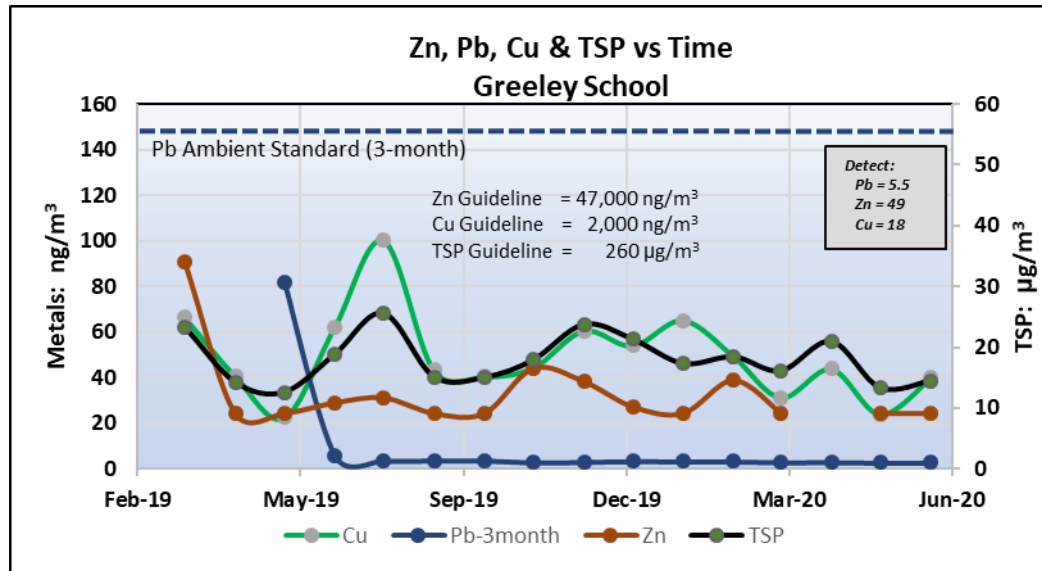


Figure 8: Greeley School – Zn, Pb, Cu & TSP



4.0 METEOROLOGY

As noted earlier, meteorological data is collected at the site. This data is collected by DEQ in cooperation with BSB. The data is collected and processed on an hourly average basis. Among the parameters recorded include:

- Wind Speed
- Wind Direction
- Wind Sigma (Standard deviation of wind direction)
- Temperature

Additionally, the E-Sampler monitor records hourly values of relative humidity, barometric pressure and temperature.

For purposes of completeness a wind rose figure and table are provided below. The wind rose table shows the wind directions, speeds and frequency of occurrence. The wind rose figure provides a visual aid depicting the general winds in the immediate area. The wind roses are based on a 12-month period from July 1, 2019, to June 30, 2020. Earlier data and quarterly data have been prepared and are available upon request.

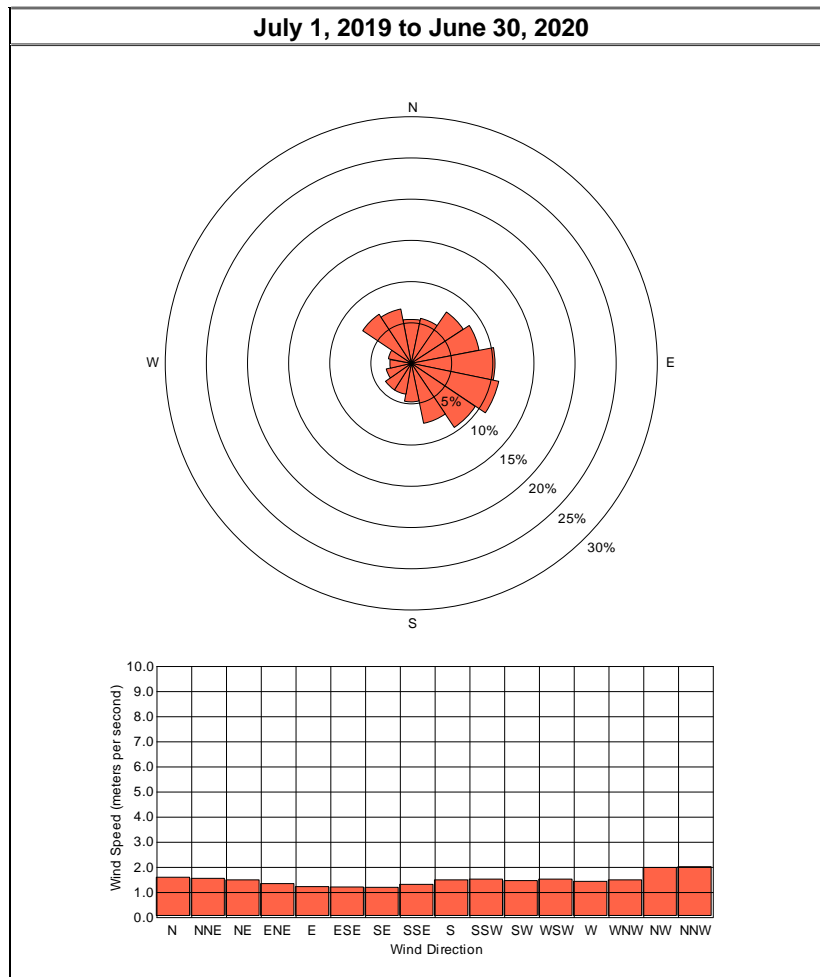
A few observations are of interest:

- The wind speeds at this site are very low; rarely exceeding nine mph (hourly average).
- The most common wind directions are east through south-southeast.
- Winds from the west-northwest through south-southwest are the least common.
- Note that directions on the wind rose figure and table represent where the wind is blowing **from**.

Table 6: Wind Rose Table Summary – Greeley School

July 1, 2019 to June 30, 2020																			
Direction>>>	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total		
Wind Speed (meters per second)	0.1 - 1.0	1.3	2.2	3.6	4.3	5.4	5.6	4.8	3.8	2.1	1.4	1.4	1.1	0.8	0.6	0.9	0.7	40.0	
	1.1 - 2.0	2.9	2.3	2.9	3.2	3.8	4.4	3.8	2.7	1.7	1.5	1.7	1.4	1.3	1.8	3.2	3.0	41.6	
	2.1 - 3.0	0.9	0.6	0.4	0.4	0.4	0.5	0.5	0.6	0.7	0.6	0.6	0.5	0.5	0.4	2.1	2.3	12.1	
	3.1 - 4.0	0.2	0.3	0.4	0.2	0.3	0.3	0.2	0.3	0.1	0.2	0.1	0.1	0.0	0.0	0.6	0.7	4.2	
	4.1 - 5.0	0.0	0.2	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.2	0.1	1.1	
	5.1 - 6.0	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
	6.1 - 7.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
	7.1 - 8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	8.1 - 9.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	9.1 - 10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	10.1 - 11.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	11.1 - 12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	12.1 - 13.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	13.1 - 14.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	14.1 - 15.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	15.1 - 16.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	16.1 - 17.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	17.1 - 18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	18.1 - 19.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	19.1 - 20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
> 20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Calm																	0.0		
Total	5.4	5.6	7.6	8.4	10.2	10.9	9.4	7.5	4.7	3.9	3.9	3.2	2.7	2.9	7.1	6.7	100.0		
Average Speed	1.6	1.6	1.5	1.3	1.2	1.2	1.2	1.3	1.5	1.5	1.5	1.5	1.4	1.5	2.0	2.0	1.5		

Figure 9: Wind Rose Figure – Greeley School



5.0 SUMMARY

Additional ambient air quality monitoring has been conducted at the Greeley School ambient monitoring site in Butte, Montana, to address existing data gaps. This additional monitoring began in March 2019 and is continuing.

The monitoring project added particulate monitoring parameters, including seven metals analyses, to an already operating monitoring site. The monitoring station now includes both mass and metals data for PM_{2.5}, PM₁₀ and TSP. This project was intended to help fill perceived data gaps in the prior dataset. This document has focused on the results of the newly added monitoring parameters and data.

The data has shown that PM₁₀ and TSP values are far below their respective PM₁₀ ambient air quality standard and TSP guideline (which is based on the historic TSP standard which has since been replaced with PM₁₀).⁷

Overall PM₁₀ concentrations have been shown to be only slightly lower than TSP. This indicates that the overwhelming majority of particulate at the site is composed of PM₁₀. Contributions from particulate matter greater than 10 microns in diameter are minimal.

Metals data indicates:

- a) All metals data is well below the reported guideline threshold.
- b) More than 90% of the arsenic values are below detection limits.
- c) More than 85% of the cadmium values are below detection limits.
- d) There appears to be either a slight downward trend, or in most cases no trend at all, in metals concentrations over time. Statistical data (not shown in this report) supports that conclusion.
- e) Several of the metals showed higher than typical concentrations during the first month or two of sampling in 2019.⁸ That trend has not repeated itself in 2020.

⁷ As a side note, the Butte area was officially designated as a 'non-attainment' area for PM₁₀ in 1991. However, no exceedance of the PM₁₀ standard has been observed since 1988; 30+ years ago. To that end, DEQ submitted a request for redesignation to EPA dated August 2019. Given the low PM₁₀ values and extensive time of compliance EPA approval is expected. The redesignation request and associated data may be found at this website:

<http://deq.mt.gov/Portals/112/Public/PublicComment/Documents/Butte%20PM10%20Redesignation%20Request.pdf>

⁸ It is noted that February 2019 was extremely cold and snowy. It is surmised that snowmelt and plowing during March and April of 2019 may have contributed to atypical metal concentrations.

APPENDIX A

Guideline Threshold

Summary of Airborne Trace Metal Threshold Guidelines

Analyte	Dose / Risk ^A	Source(s)	Description	Time Period	Detectable TSP ^D	Detectable PM ₁₀ ^E
Arsenic (inorganic)	15	EPA / DPHHS ^G	RfC ^B	Lifetime	4.86	3.33
Cadmium	10	ATSDR / DPHHS ^G	Non-cancer / CV	Chronic	0.55	0.38
	200	IRIS	Cancer	Chronic		
Copper	2,000	DPHHS ^G / Michigan DEQ	RfC ^B	Chronic	18.2	12.5
Lead	150	EPA / ATSDR / DPHHS ^G	National Ambient Air Quality Standard ^C	3-month	5.46	3.75
Manganese	300	DPHHS ^G / EPA	RSL	Lifetime	18.2	12.5
Molybdenum	11,905 (=500,000/42) ^F	CAL/OSHA, ACGIH	CAL/OSHA, ACGIH	8-Hour	6.07	4.17
	400	Michigan DEQ/ DPHHS	CV	Chronic		
Zinc	47,619 (=2,000,000/42) ^F	ACGIH TLV	ACGIH TLV	8-Hour	48.6	33.3

Units = ng/m³.

^A See data below for definitions and listing of dose and risk assessment values reviewed to produce this summary table. Values for As, Cd, Cu, Mn & Mo were chosen from DPHHS 10/28/20 letter to Butte Silver Bow Health Department. Pb was chosen from NAAQS and Zn from ACGIH.

^B RfC = Reference Concentration (EPA) is an estimate (with uncertainty added) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.

^C This standard is based on a three-month average.

^D Based on average 6-day sampling period and total sample volume of 16.47 m³

^E Based on 24-hour sampling period and total sample volume of 24 m³

^F This value is derived by dividing the OSHA/NIOSH/ACGIH exposure limit by 42. This was done to include a factor of 10 to account for a general population, not just healthy adults and then including another factor of 4.2 to include a year-long exposure as opposed to 8 hours per day, 5 days a week and 52 weeks per year.

^G Reference information from letter and analysis by DPHHS (regarding Greeley School ambient data) to Butte-Silver Bow Health Department dated October 28, 2020.

EPA = Environmental Protection Agency

ATSDR = Agency for Toxic Substances & Disease Registry

DPHHS = Montana Department of Health and Human Services

RfC = Reference Concentration (see above)

RSL = EPA Regional Screening Levels (<https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables>)

OSHA = Occupational Safety and Health Administration

ACGIH = American Congress of Governmental Industrial Hygienists

NIOSH = National Institute of Occupational Safety and Health

TWA = Time weighted average

TLV = Threshold limit value

Dose and Risk Assessment References

Pollutant	Organization	Standard Type	Description	Value	Units	Time Period	Reference
Arsenic							
	WHO	Air Quality Guideline		0.0015	Unit Risk	Life-time	https://www.atsdr.cdc.gov/toxprofiles/tp2-c8.pdf
	NIOSH	REL		2	µg/m ³	15 min	https://www.atsdr.cdc.gov/toxprofiles/tp2-c8.pdf
	ACGIH	TLV (TWA)		10	µg/m ³	8-hour	https://www.osha.gov/dsg/annotated-pels/tablez-1.html
	OSHA	PEL (TWA)	General - organic As	200	µg/m ³	8-hour	https://www.osha.gov/dsg/annotated-pels/tablez-1.html
	OSHA	PEL (TWA)	General - inorganic As	10	µg/m ³	8-hour	https://www.atsdr.cdc.gov/toxprofiles/tp2-c8.pdf
	OSHA	PEL (TWA)	Construction - organic	500	µg/m ³	8-hour	https://www.atsdr.cdc.gov/toxprofiles/tp2-c8.pdf
	OSHA	PEL (TWA)	Shipyard - organic	500	µg/m ³	8-hour	https://www.atsdr.cdc.gov/toxprofiles/tp2-c8.pdf
	EPA	EPA- Ca	Noncancer	0.015	µg/m ³		https://www.epa.gov/sites/production/files/2014-05/documents/table1.pdf
	EPA	IRIS	Risk = 10 ⁻⁶ (lifetime)	0.043	µg/m ³	Life-time	https://www.epa.gov/sites/production/files/2014-05/documents/table1.pdf
	EPA	REL		0.20	µg/m ³	1-Hour	https://www.epa.gov/sites/production/files/2014-05/documents/table2.pdf
	EPA	RFC	Inorganic As	0.015	µg/m ³	Life-time	https://semspub.epa.gov/work/HQ/199638.pdf
	EPA	RSL	Cancer Risk @ 10 ⁻⁶	0.65	ng/m ³	Life-time	https://semspub.epa.gov/work/HQ/199638.pdf
	EPA	RSL	HI = 1	0.016	µg/m ³		https://semspub.epa.gov/work/HQ/199638.pdf
	DPHHS	REL	Reference to Ca REL	15	ng/m ³	Chronic	DPHHS letter to BSB Health Dept. 10/28/2020
Cadmium							
	ACGIH	TLV (TWA)	(total)	10	µg/m ³	8-hour	https://www.osha.gov/dsg/annotated-pels/tablez-1.html
	ACGIH	TLV (TWA)	(respirable)	2	µg/m ³	8-hour	https://www.osha.gov/dsg/annotated-pels/tablez-1.html
	OSHA	PEL (TWA)		5	µg/m ³		https://www.osha.gov/dsg/annotated-pels/tablez-1.html
	EPA	ATSDR	Noncancer - Cd Compounds	0.01	µg/m ³	Chronic	https://www.epa.gov/sites/production/files/2014-05/documents/table1.pdf
	EPA	IRIS	Cancer - Cd Compounds	2	µg/m ³	Chronic	https://www.epa.gov/sites/production/files/2014-05/documents/table1.pdf
	EPA	MRL	Cd Compounds	0.03	µg/m ³	Acute	
	EPA	AELG-1 (1-hr)	Cd Compounds	100	µg/m ³	1-Hour	https://www.epa.gov/sites/production/files/2014-05/documents/table2.pdf
	EPA	AELG-1 (8-hr)	Cd Compounds	41	µg/m ³	8-Hour	https://www.epa.gov/sites/production/files/2014-05/documents/table2.pdf
	EPA	RFC	Cd (water)	0.01	µg/m ³	Life-time	https://semspub.epa.gov/work/HQ/199638.pdf
	EPA	RSL: TR @ 10 ⁻⁶	Cd (water) (Cancer Risk)	1.60	ng/m ³	Life-time	https://semspub.epa.gov/work/HQ/199638.pdf
	EPA	RSL: HI = 1	Cd (water) (Noncancer Risk)	10	ng/m ³	HI=1	https://semspub.epa.gov/work/HQ/199638.pdf
	DPHHS	Comparison Values (CV)	Reference to ATSDR CV	10	ng/m ³	Chronic	DPHHS letter to BSB Health Dept. 10/28/2020
Copper							
	ACGIH	TLV (TWA)	(dust & mist)	1,000	µg/m ³	8-hour	https://www.osha.gov/dsg/annotated-pels/tablez-1.html
	NIOSH	REL (TWA)		1,000	µg/m ³	8-hour	https://www.osha.gov/dsg/annotated-pels/tablez-1.html
	OSHA	PEL (TWA)		1,000	µg/m ³	8-hour	https://www.osha.gov/dsg/annotated-pels/tablez-1.html
	DPHHS	Michigan DEQ	Mi RFC	2,000	ng/m ³	Chronic	https://www.michigan.gov/documents/deq/deq-rrd-chem-CopperDatasheet_527899_7.pdf & DPHHS letter to BSB Health Dept. 10/28/2020
Lead (Pb)							
	ACGIH	TLV (TWA)	(inorganic)	50	µg/m ³	8-hour	https://www.osha.gov/dsg/annotated-pels/tablez-1.html
	NIOSH	REL (TWA)	(inorganic+ organic salts)	50	µg/m ³	8-hour	https://www.osha.gov/dsg/annotated-pels/tablez-1.html
	OSHA	PEL (TWA)	(inorganic)	50	µg/m ³	8-hour	https://www.osha.gov/dsg/annotated-pels/tablez-1.html
	EPA	NAAQS		0.150	µg/m ³	3-month mean	40 CFR 50.12 (and Appendix R)
	NIOSH	IGHL/10	Lead compounds	10	mg/m ³		https://www.epa.gov/sites/production/files/2014-05/documents/table2.pdf
	EPA	RSL: HI = 1	Pb (Noncancer Risk)	0.15	µg/m ³	HI=1	https://semspub.epa.gov/work/HQ/199638.pdf
Manganese							
	ACGIH	TLV (TWA)	(compounds + fumes)	20	µg/m ³	8-hour	https://www.osha.gov/dsg/annotated-pels/tablez-1.html
	NIOSH	REL (TWA)	(compounds + fumes)	1,000	µg/m ³	8-hour	https://www.osha.gov/dsg/annotated-pels/tablez-1.html
	OSHA	PEL (TWA)	(compounds + fumes)	5,000	µg/m ³	8-hour	https://www.osha.gov/dsg/annotated-pels/tablez-1.html
	ATSDR	Screen for Risk Assessment	Noncancer - Mn Compounds	0.30	µg/m ³	Chronic	https://www.epa.gov/sites/production/files/2014-05/documents/table2.pdf
	NIOSH	IGHL/10	Manganese compounds	50	mg/m ³		https://www.epa.gov/sites/production/files/2014-05/documents/table2.pdf
	USDOE	TEEL-1	MnO, MO ₂ & MnSO ₄	4.7	mg/m ³	1-Hour	https://www.epa.gov/sites/production/files/2014-05/documents/table2.pdf
	EPA	RSL: HI = 1	Mn (non-diet) (Noncancer Risk)	0.052	µg/m ³	HI=1	https://semspub.epa.gov/work/HQ/199638.pdf
	EPA	RFC	Mn (non-diet)	0.05	µg/m ³	Life-time	https://semspub.epa.gov/work/HQ/199638.pdf
	DPHHS	RFC	Reference to EPA Regional RSL	300	ng/m ³	Chronic	DPHHS letter to BSB Health Dept. 10/20/2020
Molybdenum							
	ACGIH	TLV (TWA)	(soluble compounds)*	500	µg/m ³	8-hour	https://www.osha.gov/dsg/annotated-pels/tablez-1.html
	NIOSH	REL (TWA)	(soluble compounds)*	N/A	µg/m ³	8-hour	https://www.osha.gov/dsg/annotated-pels/tablez-1.html
	OSHA	PEL (TWA)	(soluble compounds)*	5,000	µg/m ³	8-hour	https://www.osha.gov/dsg/annotated-pels/tablez-1.html
			* Higher limits for insoluble compounds				
	DPHHS	Comparison Values (CV)	Reference to ATSDR CV	400	ng/m ³	Chronic	DPHHS letter to BSB Health Dept dated 10/28/2020

Zinc (Zn)

ACGIH	TLV (TWA)	(zinc oxide - respirable)	2,000	µg/m ³	8-hour	https://www.osha.gov/dsg/annotated-pels/tablez-1.html
	STEL	(zinc oxide - respirable)	10,000	µg/m ³	15 minutes	https://www.osha.gov/dsg/annotated-pels/tablez-1.html
OSHA	PEL (TWA)	(inorganic)	5,000	µg/m ³	8-hour	https://www.osha.gov/dsg/annotated-pels/tablez-1.html

Term **Definition**

ACGIH	American Congress of Governmental Industrial Hygienists
AEGL-1	Acute exposure guideline levels for mild effects: 1-hour and 8-hour
ATSDR	Agency for Toxic Substances & Disease Registry
DPHHS	Montana Department of Health and Human Services
HI (EPA)	Hazardous Index: Aggregate exposures below a HI of 1.0 will likely not result in adverse noncancer health effects over a lifetime of exposure. A respiratory HI greater than 1.0 can be best described as indicating that a potential may exist for adverse irritation to the respiratory system. https://archive.epa.gov/airtoxics/nata/web/html/gloss.html
IDHL/10	One-tenth of levels determined by NIOSH to be imminently dangerous to life and death.
IRIS	Integrated Risk Information System
NAAQS	National Ambient Air Quality Standards: 40 CFR 50.12
NIOSH	National Institute of Occupational Safety and Health (part of CDC)
PEL	Permissible Exposure Limits (expressed as 8-hour time weighted average (TWA)) 29 CFR 1910.1000 Z-1 Table
REL (NIOSH)	Recommended exposure limit: Level at which NIOSH believes protects worker safety and health over a working lifetime.
REL (Ca EPA)	California EPA concentration level at which no adverse health effect are anticipated. Includes most sensitive individuals Levels exceeding REL does not automatically indicate an adverse health impact.
RfC	Reference Concentration (EPA) is an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.
RSL	Residential Regional Screening Level (EPA Region X) @ 10 ⁻⁶ Cancer Risk or (Noncancer) Hazardous Index (HI) = 1 (based on Hazard Quotient (HQ) of 1. https://semspub.epa.gov/work/HQ/199638.pdf
STEL	Short-Term Exposure Limit (15-minutes)
TEEL-1	Temporary emergency exposure limits for mild transient effects for 1-hour exposure
TLV	Threshold Limit Value
TWA	Time Weighted Average
WHO	World Health Organization