RioTinto

B.C. Works SO$_2$ EEM Program – Technical Memo P06

Atmospheric Sulphur Dioxide
Passive Diffusive Sampler Network: 2022 Results

June 2023

Prepared for:

Rio Tinto, BC Works
1 Smeltersite Road, P.O. Box 1800,
Kitimat, BC, Canada V8C 2H2

Prepared by:

Trinity Consultants
4525 Wasatch Blvd. Suite 200
Salt Lake City, UT 84124

Table of Contents

Table of Figures

Table of Tables

1 Introduction

The network of passive samplers was redeployed in the Kitimat Valley during 2022 following the same procedures that were utilized in previous years. The network was deployed at 22 sites within the Kitimat Valley (Figure 1), starting April 27, 2022[1]. The network was primarily focused along the Wedeene and Bish roads to capture the plume path. This network is referred to as the plume path network and historically referred to as the valley network.[2]

2 Overview

During 2022, the sulphur dioxide (SO_2) passive diffusive sampler network in the Kitimat Valley began monitoring on 27 April and finished on 28 October, following (approximately) six one-month exposures.

Based on Trinity Consultant's 2020 passive sampling plan, a detailed site evaluation was conducted and documented during the 2020 deployment. The original 15 sites deployed in 2020 were deployed in 2022. In addition, the six sites added in 2021 based on reconnaissance performed in early 2021 were also deployed in 2022.[3] Location A05 (Kitamaat Village) was added in 2022 to understand the extent of the plume to the southeast and for another site to compare with continuous ambient SO_2 monitoring.

As detailed in the Phase III EEM work plan's 2021-Specific Work Plan for Passive Sampling (ESSA et. al., 2021), the network changed from employing IVL SO_2 passive samplers to Bureau Veritas (BV) All-Season Passive Air Sampling System (PASS) and laboratory. All 2022 sample analysis was performed using the BV PASS system.

3 Study Design

Six deployments, with an approximate exposure time of one-month (27-34 days), were carried out under the plume path network between April and November 2022. Lake 28 sampling had five deployments from June – November 2022.

In 2022, there were 155 sample exposures across the plume path network collected and analyzed during the six deployments. These included replicate samplers deployed approximately 18% of the time (28 duplicate exposures) and 23 blank samples (approximately four per sampling period).

[1] The Lake 28 sampler was deployed later than the other sites, on June 13, 2022.

2 A second network of passive samplers deployed in the urban and residential areas of Kitimat was in continuous operation from June 2018 through December 2019. The urban network study concluded in 2019 (before the time period of this report).

3 Three of the six new 2021 sites (V17, V18/V18b, and V20) were added east and west of V01 create an east-west transect to better understand the eastern and western boundaries of the plume path. The remaining three new 2021 sites (V21, V22, and V23) were added farther north near Terrace to better understand the northern boundary of the plume path (and to verify where the plume is not).

4   Results

The observed data show elevated atmospheric SO₂ along the plume path (Figure 1). Results shown in Figure 1 are uncalibrated because the BV PASS results need to undergo a new calibration analysis (different from the historic calibration based on IVL sampler data). The BV PASS calibration analysis will be performed after sufficient data have been collected from BV PASS samplers co-located at continuous monitoring stations.

The 2022 results within the plume path network are similar to the 2021 observations, although concentrations in 2022 are slightly lower as expected during the low emission levels from the smelter in 2022. Higher concentrations were monitored later during the 2022 year due to the restart and increased smelting capacity coming on-line. The spatial pattern is consistent with previous years. It is recommended that deployments are continued during 2023 to further define the plume throughout the restart and into the transition to normal operation.
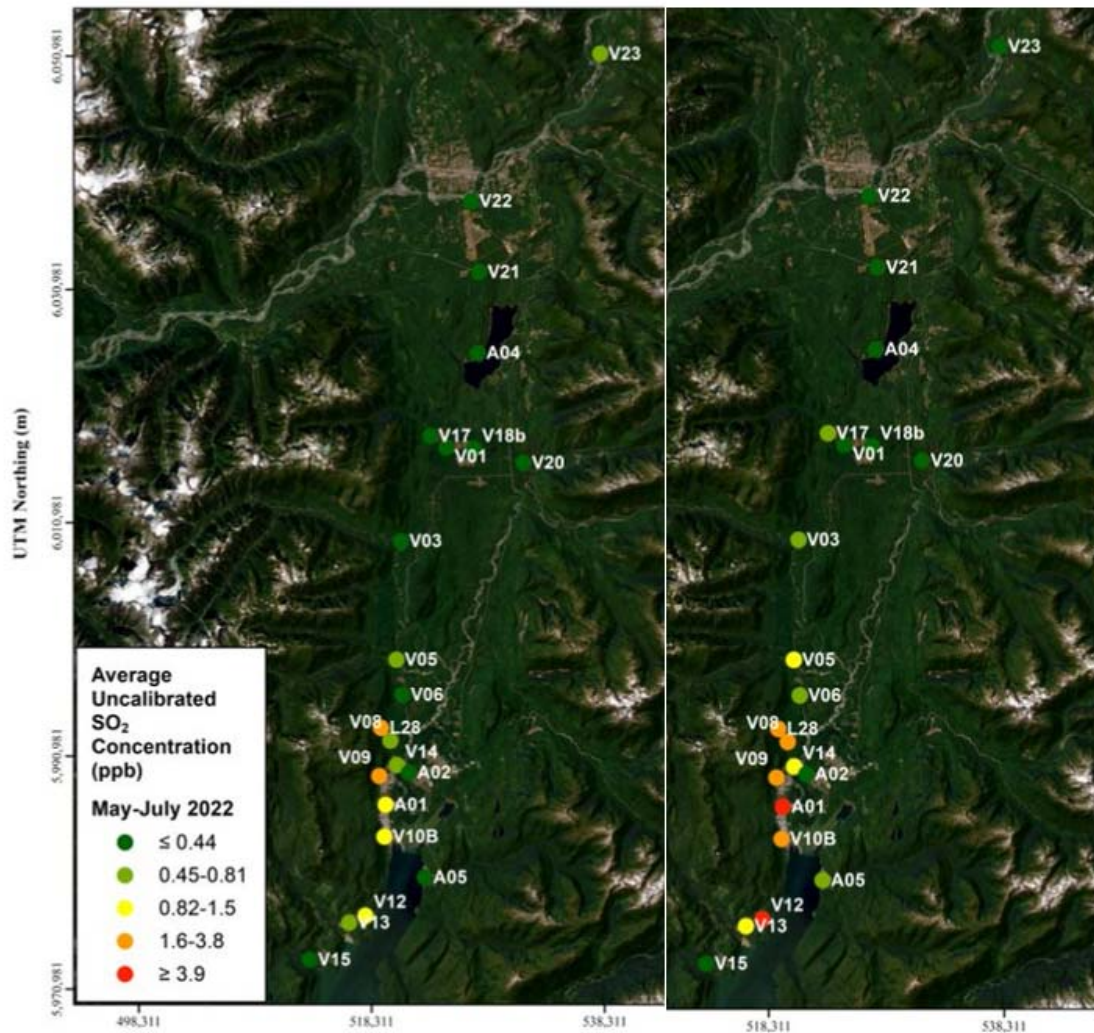
Figure 1. Average Atmospheric Sulphur Dioxide (SO₂) Concentration during May to July 2022 (left) and during August to October (right) in the Kitimat Valley Passive Diffusive Monitoring Network (uncalibrated).

Ambient SO_2 data were collected from the continuous SO_2 analyzers at Haul Road, Riverlodge, Lakelse, and Kitamaat Village were compared to the passive SO_2 sampling data to understand accuracy and precision of the passive method. In general, there was good correlation between passive and active at sites with higher concentrations however, correlation decreases at sites that have average passive concentrations below 1 ppb.

Tables 1 and 2 present a comparison of the ambient sampler results with the collocated passive SO_2 samples analyzed by Bureau Veritas laboratory collected for the Haul Road (AO1), Riverlodge (AO2), Lakelse (A04), and Kitamaat Village (A05) monitoring stations. SO_2 comparisons were made on a 30-day sampling basis.

Table 1 Comparison of SO₂ Passive Sampling Data to Ambient SO₂ Data at Station A01 and A02

End Date (2022)	Haul Road (AO1)			Riverlodge (AO2)		
	Bureau Veritas Passive (ppb)	Active (ppb)	Diff. (ppb)	Bureau Veritas Passive (ppb)	Active (ppb)	Diff. (ppb)
May	1.1	0.8	-0.3	0.2	0.3	0.1
June	1.35	1	0.35	0.2	0.2	0
July	1.8	1.7	0.1	0.2	0.2	0
August	3.9	3.4	0.5	0.2	0.3	0.1
Sept.	5.2	3.4	1.8	0.2	0.3	0.1
Oct	6.95	4.8	2.15	0.2	0.4	0.2
		Average	0.767		Average	0.083
		St. Dev.	0.895		St. Dev.	0.069

Table 2 Comparison of SO₂ Passive Sampling Data to Ambient SO₂ Data at Station A04 and A05

End Date (2022)	Lakelse (AO4)			Kitimaat Village (AO5)		
	Bureau Veritas Passive (ppb)	Active (ppb)	Diff. (ppb)	Bureau Veritas Passive (ppb)	Active (ppb)	Diff. (ppb)
May	0.2	0.0	0.2	0.2	0.2	0.1
June	0.2	0.0	0.2	0.1	0.1	0.1
July	0.3	0.0	0.3	0.2	0.2	0.1
August	0.5	0.2	0.3	0.2	0.2	0.0
Sept.	0.5	0.0	0.5	0.2	0.2	-0.2
Oct	0.5	0.0	0.5	0.1	0.1	0.0
		Average	0.302		Average	0.027
		St. Dev.	0.117		St. Dev.	0.095

The statistical differences between the active and passive monitors are shown below in Table 3. The averages column shows the average concentration difference between the active and passive monitors. The standard deviations and correlation coefficients (r^2) for the difference between active and passive monitors are also listed.

Table 3 Statistical Analysis of Active to Passive Concentrations

Statistic	Haul Road	Riverlodge	Lakelse	Kitamaat Village
Average (ppb)	0.77	0.08	0.30	0.02
Standard Deviation	0.90	0.07	0.12	0.09
r^2	0.96	0.00	0.19	0.21

The correlation coefficient for the Haul Road is high, but the correlation coefficients aremuch lower for the other locations. The passive and active sampling at the Haul Road show clear trends and provide similar results. The passive sampling appears to be biased high compared to the active sampling across all sites that have colocation. The Riverlodge specifically does not show a correlation between the passive and active sampling values. The Lakelse and Kitamaat Village colocation have a slight correlation but the results are not as significant as at the Haul Road location.

5 Conclusion

The 2022 results demonstrate a similar spatial pattern in SO$_2$ compared with 2021. Higher concentrations were monitored later during the 2022 year due to the restart and increased smelting capacity coming on-line.

In summary, the results from the 2022 network continue to support the use of passive samplers to provide empirical observations of atmospheric SO$_2$ concentrations to (a) assess spatial and temporal changes, (b) evaluate modelled concentration fields, and (c) estimate dry deposition of SO$_2$. It is recommended that deployments are continued during 2023.

Appendix A.

Table 4: Passive SO$_2$ Sampling Network Station Identifier, Name, and UTM Location

| ID	Site Name	UTM E	UTM N
A01	Haul Road Station	519527	5986823
A02	Riverlodge Station	521538	5989580
A04	Lakelse Lake NADP Station	527457	6025573
A05	Kitamaat Village Station	522907	5980600
V01	Onion Lake Ski Trail North	524757	6017435
V03	Mound TKTP92	520853	6009407
V05	LNG Muster Station	520457	5999250
V06	Sand Pit	520970	5996240
V08	Claque Mountain Trail at Powerline	519938	5992329
V09	Sand Hill at Powerline	518985	5989292
V10B	Pullout before Bish FSR	519425	5984090
V12	Bish Road Pullout 4	517790	5977294
V13	Bish Road at Chevron LNG	516389	5976708
V14	Industrial Area Kitimat Hotel	520490	5990236
V15	Bish Mainline	512994	5973534
V17	West Lake	523359	6018434
V18B	Wedeene mainline	527088	6017351
V20	Pipeline laydown	531354	6016121
V21	South of airport	527566	6032493
V22	Kitselas Development	526862	6038551
V23	Gitaus water tower	537941	6051192

Table 5 Passive Sampling Results in ppb

Station	May (ppb)	June (ppb)	July (ppb)	August (ppb)	September (ppb)	October (ppb)
A01	1.1	1.4	1.8	3.9	5.2	7.0
A02	0.3	0.2	0.2	0.3	0.3	0.4
A04	0.2	0.1	0.2	0.2	0.2	0.1
A05	0.2	0.2	0.3	0.5	0.5	0.5
V01	0.2	0.1	0.3	0.5	0.3*	0.3
V03	Not Collected	0.3	0.5	0.7	0.5*	0.5
V05	Not Collected	0.6	0.8	1.1	0.9	0.7
V06	0.4	0.4	0.6	0.8	0.7	0.7
V08	0.7	0.8	0.9	2.2	1.2*	1.7
V09	1.5	1.6	2.8	3.6*	3.2	3.9
V10B	0.6	1.7	1.2	3.3	4.0	2.8
V12	0.6	1.6	0.9	2.3	5.4	5.1
V13	0.4	0.7	0.4	0.8	1.6*	1.7
V14	0.7	0.4	0.4	0.6	0.9*	1.1
V15	0.2	0.3	0.2	0.3	0.4	0.3*
V17	Not Collected	0.3	0.5	0.9	0.6	0.9
V18B	0.2	0.1	0.1	0.2	0.2	0.2
V20	0.2	<0.1	0.1	0.2	0.1	0.2
V21	0.2	<0.1	0.2	0.2	0.2	0.2
V22	0.1	<0.1	0.1	0.2	0.3	0.2
V23	1.5	<0.1	<0.1	0.1	<0.1	0.1
L28[1]	Not Collected	1.6	2.4	3.4	2.0	2.0

Green - Sample below reporting limit and reported as 1/2 RL.

[1] Dates are the end month of each sampling period (for deployments that started and ended near the end of the month), except for L28, dates are listed month-beginning (because L28 deployments began near the beginning of the month).

* Means sample had seeds, insect eggs, or webs in the PASS assembly during the sampling period
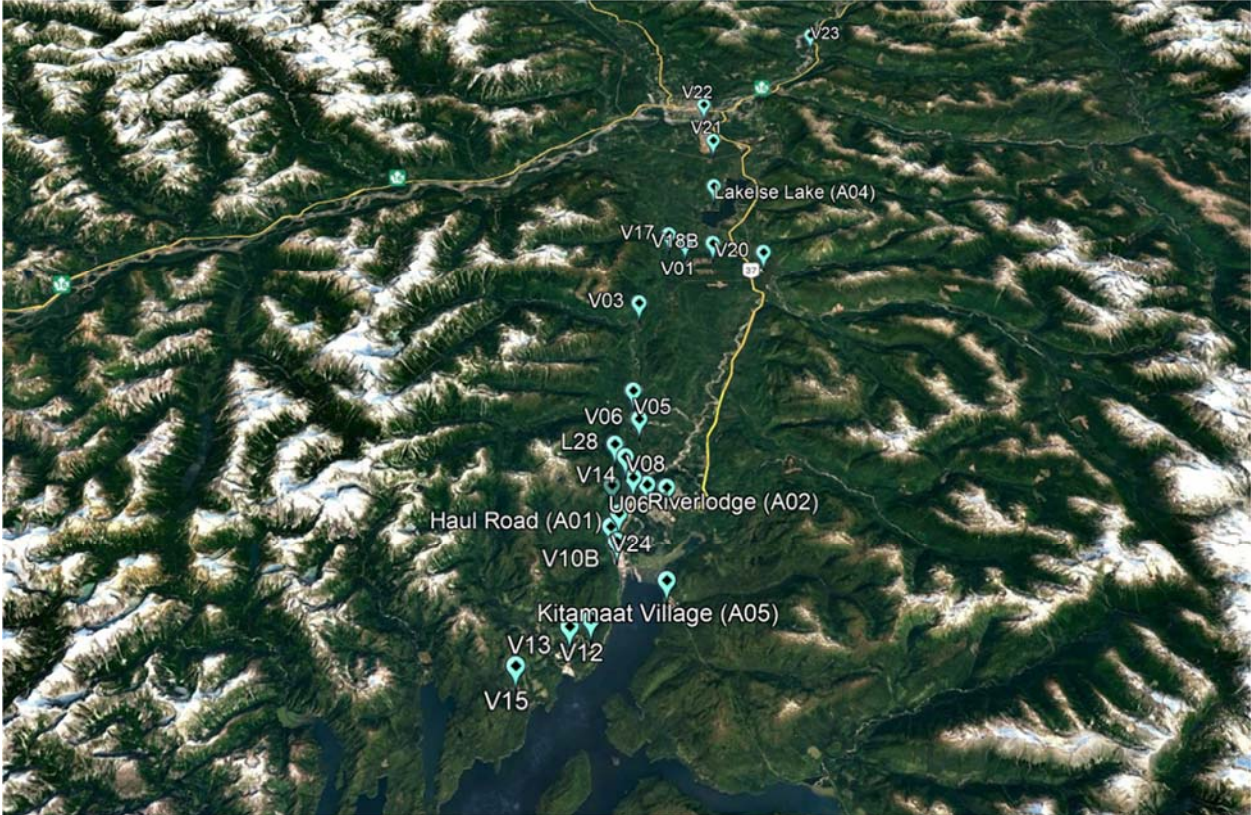
Figure 2 : Site Locations and IDs for the Kitimat Urban (U) and Ambient (A) Passive Diffusive Sampler Network; see Figure A1 and Table A1 for Further Details on Site Locations.