Rio Tinto

Environmental Report BC Works 2023

www.riotinto.com/operations/canada/bc-works Canada

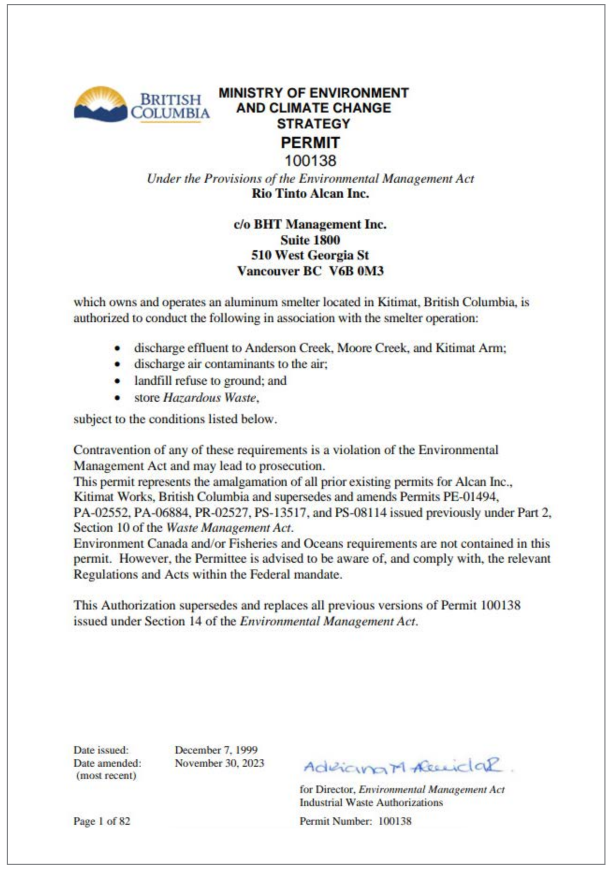
Table of contents

1. About the annual environmental report

The annual environmental report is a summary of the environmental performance for the year. This report is written for stakeholders and is a requirement under authorization 100138 for the P2-00001 permit. This report is submitted to the Ministry of Environment and Climate Change Strategy and made available to the public through the BC Works website.

Authorization 100138 context

In 1999, Rio Tinto's BC Works became the first industrial facility in British Columbia to obtain a multi-media environmental permit from the provincial government under authorization 100138. The P2-00001 Multi-Media Waste Discharge Permit (P2 Permit) comprehensively addresses multiple air, water and solid waste discharges, sets limits and establishes monitoring and reporting requirements. This permit is the key environmental regulatory compliance benchmark for smelter operations. This process was transparent with Rio Tinto and the Kitimat Public Advisory Committee (KPAC) collaborating with the Ministry of Environment and Climate Change Strategy (BC ENV) to rationalize concerns and to mutually agree on priorities that will influence Rio Tinto's goal of continuous improvement.



BRITISH COLUMBIA

MINISTRY OF ENVIRONMENT AND CLIMATE CHANGE STRATEGY

PERMIT

100138

Under the Provisions of the Environmental Management Act

Rio Tinto Alcan Inc.

c/o BHT Management Inc.
Suite 1800
510 West Georgia St
Vancouver BC V6B 0M3

which owns and operates an aluminum smelter located in Kitimat, British Columbia, is authorized to conduct the following in association with the smelter operation:

- discharge effluent to Anderson Creek, Moore Creek, and Kitimat Arm;
- discharge air contaminants to the air;
- landfill refuse to ground; and
- store *Hazardous Waste*,

subject to the conditions listed below.

Contravention of any of these requirements is a violation of the Environmental Management Act and may lead to prosecution.
This permit represents the amalgamation of all prior existing permits for Alcan Inc., Kitimat Works, British Columbia and supersedes and amends Permits PE-01494, PA-02552, PA-06884, PR-02527, PS-13517, and PS-08114 issued previously under Part 2, Section 10 of the *Waste Management Act*.
Environment Canada and/or Fisheries and Oceans requirements are not contained in this permit. However, the Permittee is advised to be aware of, and comply with, the relevant Regulations and Acts within the Federal mandate.

This Authorization supersedes and replaces all previous versions of Permit 100138 issued under Section 14 of the *Environmental Management Act*.

Date issued: December 7, 1999
Date amended: November 30, 2023
(most recent)

for Director, *Environmental Management Act*
Industrial Waste Authorizations

Page 1 of 82 Permit Number: 100138

Authorization 100138. The multimedia permit was issued in 1999 and is a living document, it under goes review's and updates as needed to reflect changes in operating conditions.

In this report

This report includes results of an annual review of air emissions monitoring, ambient air quality monitoring, surface water, effluent monitoring, groundwater monitoring, vegetation monitoring, and waste management monitoring where applicable for both the Kitimat and Kemano Operations. A summary of the annual non-compliances and reportable spills is included in this report in Chapter 11.

In 2022 the smelter began an initiative to increase production following a labor dispute in 2021 that resulted in a 75% decrease in aluminium production. The restart was concluded in 2023 and was authorized under three temporary amendments to the P2 Permit, which included new requirements for monitoring and reporting, which are included in this report.

Access & comments on the report

The 2023 Annual Environmental Report is available online at **www.riotinto.com/en/operations/canada/bc-works.** The website also provides information on key environmental performance indicators. Questions or comments are welcome and can be made via email: **BCWorksInfo@riotinto.com** and via phone: **1 250 639 8383.**

Interested in joining KPAC?

The primary focus of the KPAC is environment and regulatory matters, and more generally, Rio Tinto's operations in Kitimat. The purpose of the KPAC is to provide input in an advisory capacity to ensure community interests are represented and considered in Rio Tinto's operations in Kitimat. The KPAC provides a platform to facilitate communication, consultation and information sharing between Rio Tinto, the Ministry of environment and climate change and the community on Rio Tinto's environmental permit (P2 Multimedia Permit). We encourage those interested in joining the KPAC to reach out to our Environment and Communities and Social Performance teams at **BCWorksInfo@riotinto.com** .

2. Operational overview

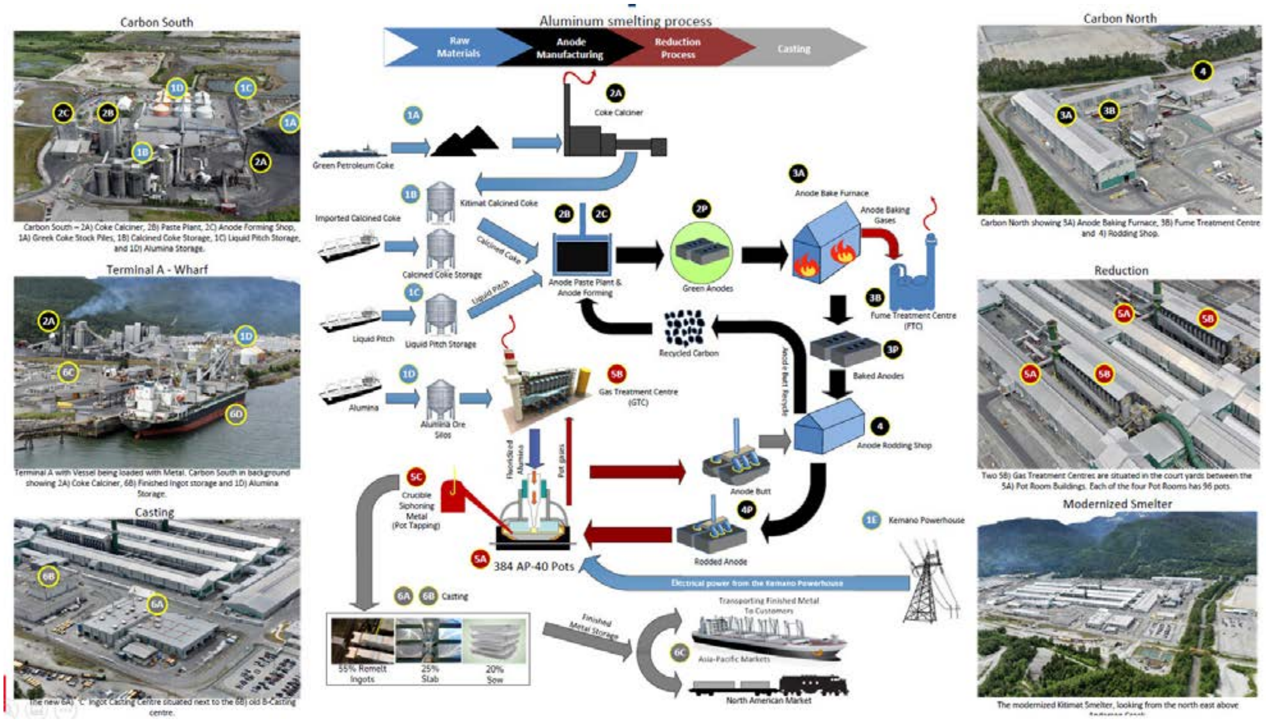
Rio Tinto operates a multi-faceted industrial complex in northern British Columbia, which is one of the largest industrial sites in the province. The operational footprint extends into 17 different First Nations Traditional Territories in Kitimat, Kemano, and in the Nechako Reservoir which encompasses Southside (Ootsa Nadina and Wisteria), Nechako River and tributaries, Fraser lake, Vanderhoof and Prince George.

In 2021, 75% of the smelter was shutdown following a labour dispute, three temporary amendments to the P2 permit were required in order to facilitate the restart of the operations which was completed in the fall of 2023.

2023 operational year

At the beginning of January of 2023 the smelter was at about 63% operational pots following the restart process that began in May of 2022 following the labour dispute in July 2021 which resulted in the shutdown of 75% of operations. In 2023, the rester process continued with the ramp-up of pot starts and and the restart of the coke calciner which had undergone major maintenance. The full operational smelting process is presented in Figure 2.1.

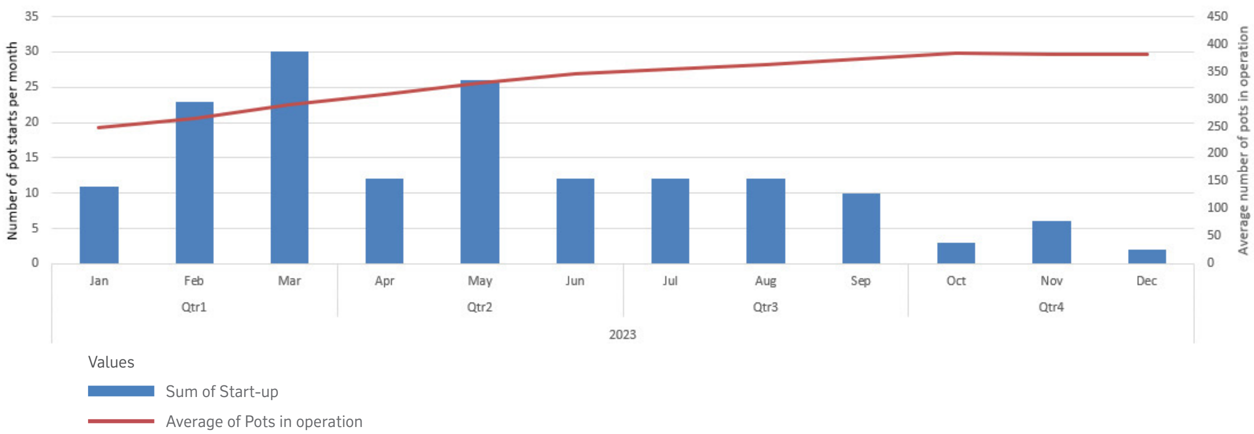
Figure 2.1 Typical Aluminium smelting process.



The focus of 2023 was to achieve full operations safely with continued focus on stable operations. The temporary amendment to the permit for the restart was authorized in June of 2022 and expired at the end of December 2022, and two temporary permit amendments were issued by the Ministry in 2023 to support the completion of the smelter. And two temporary amendment conditions expired on October 31st, 2023. The restart reached 96% operational pots in August of 2023, and completed the restart target of 99% in September of 2023 before continuing with normal operations pot replacement campaign (Figure 2.2)

In 2023 there were 4 permit non compliances with respect to the P2 permit, and 10 reportable spills (See Chapter 11).

Figure 2.2 2023 Operational Overview



Operational process

The various components of the plant are described below and shown in Figure 2.3

Wharf & logistics

The main raw materials used in the aluminium smelting process are received at the wharf. These materials are alumina, green coke, petroleum pitch and calcined coke. Alumina is stored in 10 storage silos at BC Works and is used in Reduction in the smelting process. Green coke is stored at carbon south and is used in the coke calcination process. Petroleum pitch is stored in 3 storage tanks and is used in combination with calcined coke among other ingredients to form carbon anodes. There were 3 reportable spills in 2023 related the transportation of alumina and 1 reportable spill related to the unloading of green coke (see Chapter 11). There were no permit non compliances in 2023 associated to the Wharf.

Carbon South

Carbon South is located at the southern end of the site near the wharf and contains the anode paste plant and the coke calcination plant. Carbon South is responsible for making the green anodes, the first step of the aluminium production process. Carbon South receives raw materials (coal tar pitch, green petroleum coke and calcined coke) from the wharf as well as recycled anodes from Carbon North which are used to make the green anodes. In 2023 there was 2 permit non compliances that due to late reporting of emission control device upsets in Carbon South (see Chapter 11).

Carbon North

Carbon North is located at the north end of the site and contains the anode bake furnace, anode rodding shop, pallet storage building, carbon crushing plant and bath treatment centre. Carbon North is responsible for baking the green anodes and then rodding the baked anodes into anode assemblies (two anode blocks plus a stem) so that they can be used in the reduction process. Carbon North also receives spent anodes (consumed anodes that come out of the reduction process) as well as bath collected from the anode change process, both of which are stored in the pallet storage building until the material is cooled. The spent anodes are then cleaned, de-rodded and crushed so that the carbon can be recycled at the anode paste plant and the bath can be recycled at the bath treatment centre before being sent back to reduction to be used in the anode change process. In 2023 there was 1 reportable spill of charged alumina at the anode baking furnace. There were no non compliances in 2023 in Carbon North.

Reduction

The aluminium smelting process takes place in the 4 reduction buildings, each building houses 96 pots (with each half building housing 8) totalling 384 pots. The aluminium smelting process in Kitimat takes place in 384 AP-4X aluminium smelting pots that are housed in four potroom buildings. The smelting pots use the Hall-Heroult electrolytic reduction process to reduce alumina (bonded atoms of aluminium and oxygen, Al_2O_3) to molten aluminium. The aluminium is extracted (siphoned) from the pots and transported to the two casting centres. In reduction there was 1 reportable spill of hydraulic oil that occurred inside a building and there were no non compliances in 2023 in Reduction (see Chapter 11).

Casting

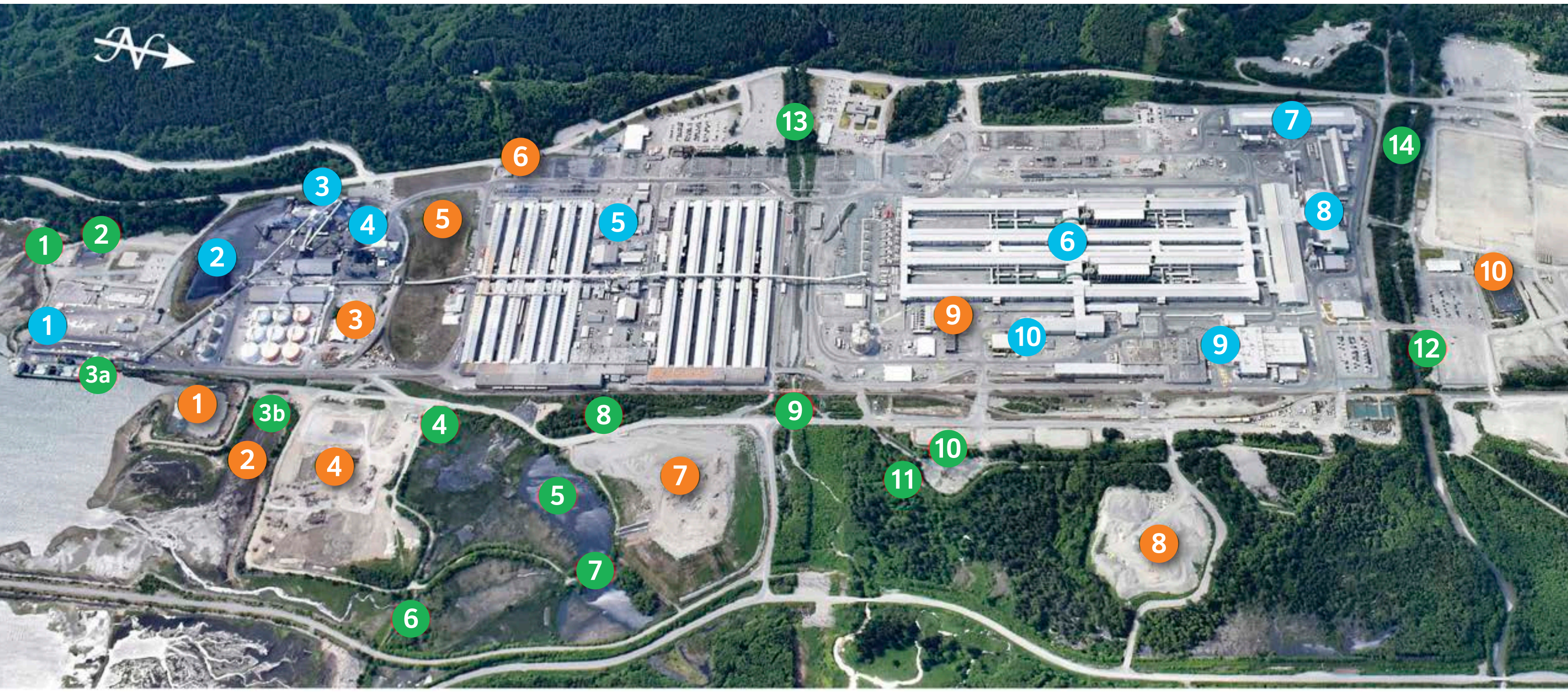
The molten aluminium that is siphoned from the pots in reduction is transported to the casting departments in cruces and depending on the customer needs the metal will either go to B or C casting. Various alloying materials (such as magnesium, copper, silicon and iron) are added to produce specific characteristics such as improved strength and corrosion resistance.

The aluminium is then poured into moulds and chilled, forming solid ingots of specified shapes and sizes. BC Works produces four types of aluminium ingots: value added sheet and remelt ingots (both which are alloyed with various materials according to customer specifications) and non-value added (pure aluminium) ingots and sows for remelt. The cast aluminium products are sold to customers in North America, Asia and Europe who produce a wide variety of aluminium products, which both uses a combination of pure aluminium mixed with alloying materials to enhance the properties of the product, pure aluminium remelt ingots, and pure aluminium sows which are sold to customers in North America, Asia and Europe, resulting in a variety of end-use applications. There were zero non-compliances in 2023 in Casting (see Chapter 11).

Kemano

The electrolytic reduction process requires the use of large amounts of electricity. Electricity for BC Works is generated at the Kemano Operations' powerhouse, a maximum of 976 megawatt hydroelectric generating station located 75 kilometres southeast of Kitimat. This generating station uses water impounded in the 910 square kilometers Nechako Reservoir in north-central British Columbia. In 2023 there was 1 reportable spill of transformer oil at the switchyard in Kitimat and no permit non compliances (see Chapter 11).

Figure 2.3 Kitimat Environmental operations.



Effluent Collection and Treatment

1. D-Lagoon emergency outfall
2. D-Lagoon
- 3a 3b Stormwater discharges
4. J-Stream discharge
5. B-Lagoon
6. B-Lagoon outfall discharge
7. Saltwater addition
8. A-Lagoon
9. Inverted siphon
10. F-Lagoon
11. F-Lagoon emergency overflow and sampling station
12. Anderson Creek parking lot stormwater discharges
13. Moore Creek
14. Anderson Creek

Waste Storage, Disposal and Managed Sites

1. Yacht basin
2. Scow grid
3. Scrap and salvage recycling
4. Dredgeate disposal site
5. SPL landfill
6. Waste oil storage (building 104)
7. South landfill
8. North landfill
9. Hazardous waste storage
10. SPL overburden soil cell

Plant Components

1. Terminal A wharf
2. Green coke storage
3. Coke calciner
4. Anode paste plant and green anode forming shop
5. VSS potline 1-5
6. AP-4X potline Anode bake furnace
8. Anode rodding shop
9. Casting centres (B & C)
10. Delining and relining facility

3. Environmental management and certifications

The foundation for environmental management throughout Rio Tinto's global operations is the Health, Safety and Environment (HSE) Policy. HSE directives establish corporate- wide standards on major and minor environmental, health and safety topics.

The HSE Policy and the more specific requirements of the Rio Tinto Health, Safety, Environment and Quality (HSEQ) standards are put into practice at BC Works through a comprehensive, operation specific Risk Management System. The system is maintained through adherence to the HSEQ Management System's 17 elements encompassing the continuous improvement cycle of Plan, Do, Check and Review (PDCR).

Independent certification

Since 2001, BC Works has been successfully certified under the requirements of ISO 14001 (1996) environmental program, and more recently updated to the ISO 14001 (2015) certification. ISO 14001 (2015) provides independent conformance verification that BC Works evaluates its environmental impacts, has procedures in place to address practice, and works continually to lighten or eliminate its environmental footprint. In keeping with a corporate-wide commitment to a sustainable management approach, BC Works attains certification of ISO 14001 standards (Environment) and the ISO 9001 standards for Product Quality. For Environment, this covers all Rio Tinto BC Works activities and locations where risks of the business are managed. For Quality, the scope is for the processes of manufacturing of aluminium ingot and shipping.

In 2018, BC Works also achieved the Aluminium Stewardship Initiative (ASI) performance standard certification. This prestigious certification demonstrates our compliance with the highest environmental, social and governance standards. The ASI certification is directly related to Rio Tinto values in applying the precepts of sustainable development and gives our customers independent assurance that the metal they use to make coffee pods, cars, smartphones and other products is made responsibly: with low-carbon emissions and to high standards on biodiversity, respect for Indigenous peoples' rights and responsible water management.

Audit program

Independent ISO compliance and conformance audits are conducted as a condition of certification. The internal and external Environment and Quality Management System recertification audits took place in 2023 as planned. BC Works' integrated certification was successfully maintained and transitioned to the updated ISO 14001 (2015).

In 2018 ASI recertification certification audit took place in 2022 and this certification was proudly obtained by BC Works. Looking forward Kitimat will be audited against the new ASI Performance Standard in 2024.

4. Effluents

Surface runoff from the smelter site, originating as snowmelt and rain, accounts for most of the water discharge. Seasonal precipitation varies significantly, and total discharges can be over 100,000 m^3 per day during fall and winter storms.

Sources and infrastructure

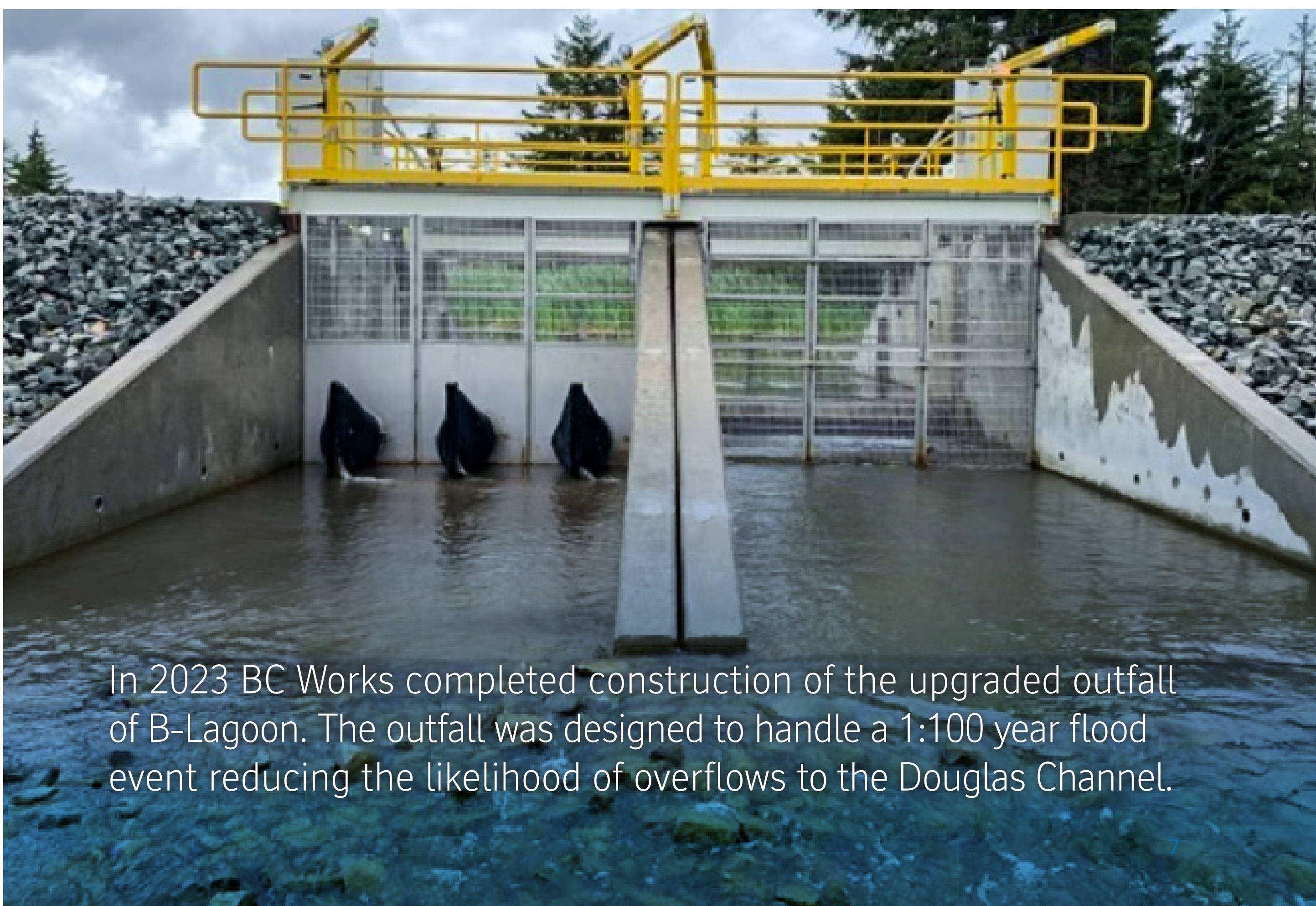
Whether water is in use at the smelter or accumulating through surface runoff, it collects contaminants from various sources. It is directed through underground drains and surface channels to one of six inflows into B-Lagoon that discharges into the Douglas Channel.

B-Lagoon consists of a primary and a secondary pond: Upper and Lower B-Lagoons. It is designed to remove contaminants by sedimentation, phytoremediation, along with salt water addition to smooth fluctuations of inflows and contaminant levels. B-Lagoon discharges effluent continuously into the Douglas Channel. In 2023, the average discharge rate was 20,188 m^3 per day.

The retention time for water in the lagoon is usually more than ten hours (confirmed by measurements conducted in 2018) but is reduced to about five hours during runoff events and heavy rainfall.

In 2023 Rio Tinto made a significant investment to the B-Lagoon outfall improving the structure to reduce emergency overflows to the Douglas channel along with reduce the likelihood of fish passage into the lagoons. Outfall was designed to retain a 1 in 100 storm event. The outfall also has integrated technology to adjust water levels flowing out of the lagoons based on tide elevation. In 2023 there were no overflow events.

Discharge measurements related to permit requirements and additional monitoring are described in the following 2023 performance section.



In 2023 BC Works completed construction of the upgraded outfall of B-Lagoon. The outfall was designed to handle a 1:100 year flood event reducing the likelihood of overflows to the Douglas Channel.

2023 performance

Effluent water quality monitoring

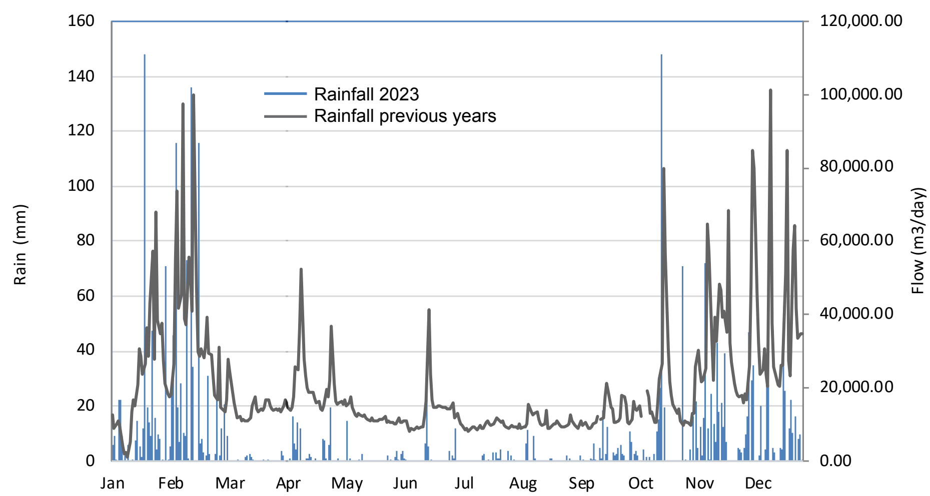
Effluent water quality is monitored annually for the following parameters: flow variability, dissolved fluoride, dissolved aluminium, TSS, cyanide, temperature, conductivity, hardness, toxicity, acidity and Total PAH. Of these parameters, dissolved fluoride, dissolved aluminium, and TSS are monitored for long term trends. There was 1 permit non compliance associated to the lagoon system due to a low pH sample. More information on the non-compliance can be found in Chapter 11.

Flow variability

Variability in the flow from B-Lagoon into the Douglas Channel is mainly a function of precipitation. As shown in Figure 4.1, peak rain events and flows occurred in January to March and in September through December. The total amount of rainfall in 2023 (2637 mm) was very similar comparing to previous years. Most of the rain came in the fall months of 2023.

Figure 4.1

Flow variability, B-Lagoon 2023



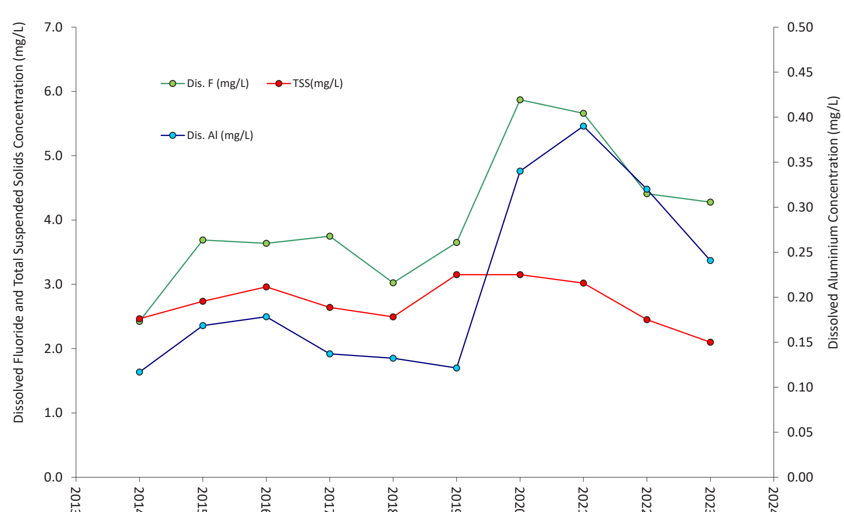
Long-term trends

Dissolved fluoride, dissolved aluminium, and total suspended solids are the most meaningful performance indicators of plant effluent water quality. Average annual performance for these have been consistently maintained below permit levels (10 mg/L, 3 mg/L and 50 mg/L respectively) in recent years. Figure 4.2 illustrates the long-term trend performance.

In 2023 dissolved fluoride, dissolved aluminium and total suspended solids loads slightly decreased from the previous year. TSS has been the most stable of the parameters often coming back as non-detect from the lab. TSS is one of the key performance indicators as it allows operations to monitor the efficiency of the lagoon.

Figure 4.2

Dissolved Fluoride, Dissolved Aluminium and Total Suspended Solids, B-lagoon 2023



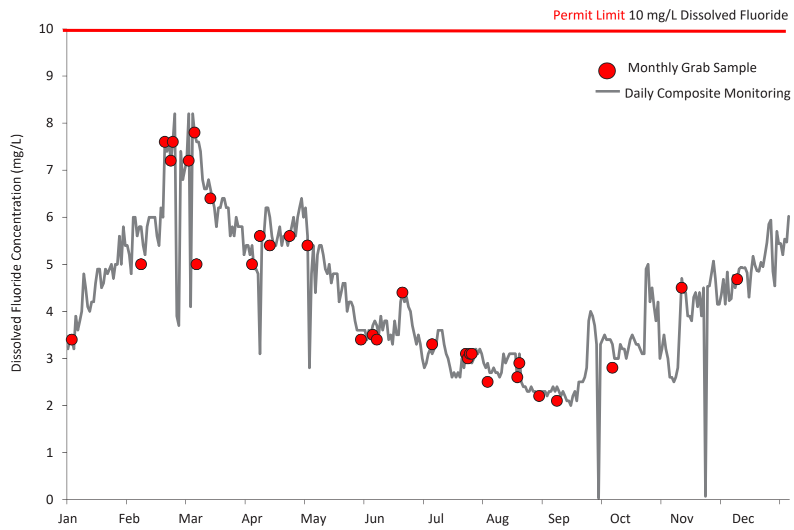
Dissolved Fluoride

Dissolved fluoride originates mainly from the leaching of a landfill formerly used to dispose of spent pot lining. Information on the spent pot lining landfill is reported in Chapter 9, Groundwater monitoring. Other sources of fluoride are raw material losses around the smelter.

Dissolved fluoride is monitored continuously through daily composite sampling and monthly grab sampling. Daily composite and grab samples are sent to an outside laboratory for analysis (refer to Chapter 13 Glossary for sample method definitions).

The permit specifies a maximum concentration of 10 mg/L of dissolved fluoride in effluent; this level was not exceeded in 2023. Average dissolved fluoride concentration for the year derived from composite sampling was 4.28 mg/L. The long-term trend is illustrated in Figure 4.2. The 2023 composite and grab sampling results (Figure 4.3) profile the higher concentrations that occurred during the higher precipitation and surface run-off events during the year.

Figure 4.3
Dissolved fluoride, B-lagoon 2023



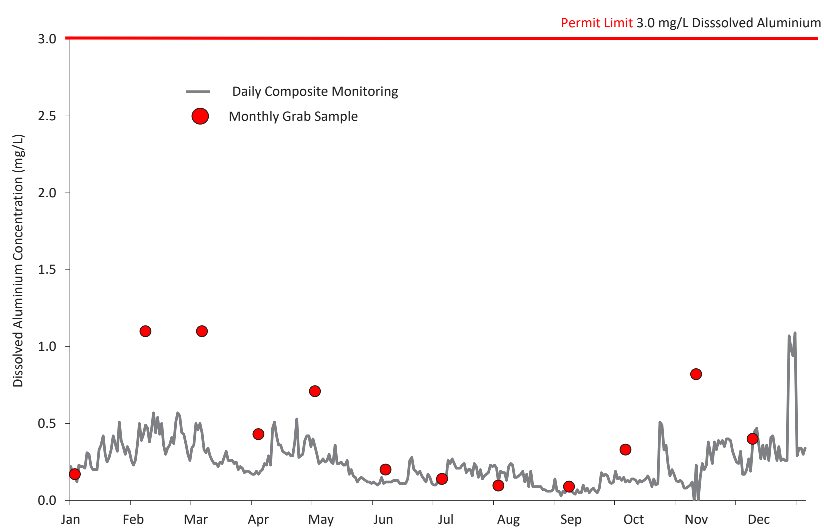
Dissolved Aluminium

Aluminium metal at BC Works, such as finished products stored outside at the wharf, have a very low solubility and contribute little to the discharge of dissolved aluminium.

In addition to its use as a raw material, alumina is also used in the scrubbing process to remove fluoride from smelter emissions. Some scrubbed alumina is released through the potroom gases collection centres. In this form, scrubbed alumina has a higher solubility and is a contributor to both dissolved aluminium and dissolved fluoride.

In 2023, concentrations of dissolved aluminium did not exceed the maximum permit limit of 3.0 mg/L. The annual average of dissolved aluminium concentration was 0.24 mg/L (Figure 4.4).

Figure 4.4
Dissolved Aluminium, B-lagoon 2023



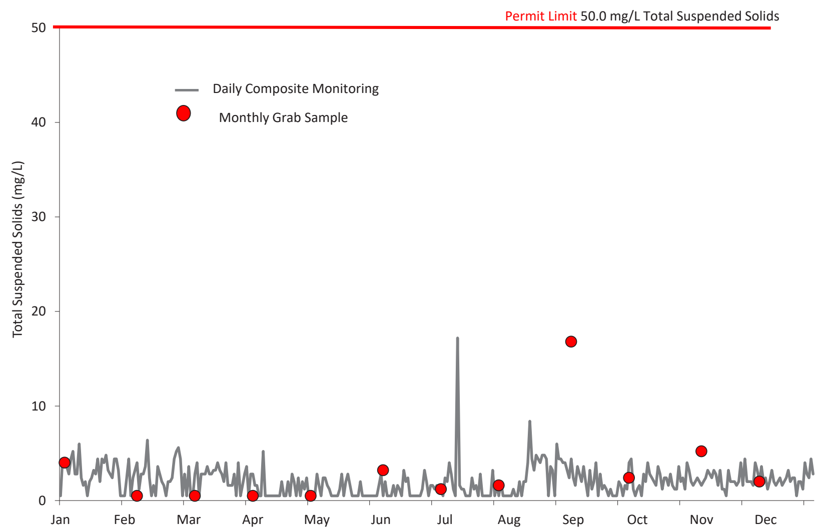
Total suspended solids (TSS)

Solids that remain suspended in discharge from B-Lagoon include small amounts of materials used in industrial processes at the smelter and other naturally occurring substances like dust, pollen and silt. There is a proportional relationship between TSS levels and concentrations of both dissolved aluminium and polycyclic aromatic hydrocarbons (PAHs) because these contaminants are usually bound to suspended solids in water when entering the B-Lagoon system.

B-Lagoon is a large and well-vegetated area that is highly efficient in absorbing and processing effluent compounds. The permit specifies a concentration maximum of 50 mg/L of TSS in effluent.

Concentrations in 2023 were much lower than the permit level. The annual average concentration for the composite samples was 2.1 mg/L (Figure 4.5) which is consistent with previous years.

Figure 4.5
Total Suspended Solids, B-lagoon 2023

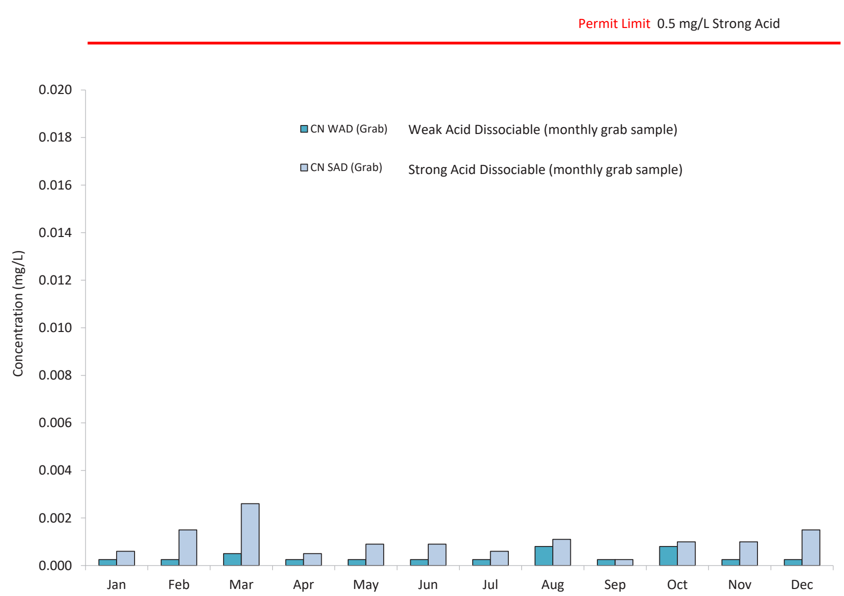


Cyanide

Cyanide is formed during the electrolytic reduction process and retained in the cathode lining material known as spent pot lining (SPL). In the past, material in the cathode was deposited on-site at the SPL landfill. Today, all generated SPL is shipped off-site to a Rio Tinto SPL treatment facility where the material is decontaminated and repurposed for various use. Groundwater and the bottom of the SPL landfill lining interact, generating a leachate containing cyanide. The source of the cyanide in B-Lagoon is from the J-Stream outlet.

The permit specifies a maximum concentration of 0.5 mg/L of strong acid dissociable cyanide (the more abundant, although less toxic form) in B-Lagoon. Concentrations are determined from the monthly grab samples. The permit level was not exceeded in 2023. Weak acid dissociable cyanide is also monitored, although there is no permit requirement (Figure 4.6).

Figure 4.6
Cyanide, B-lagoon 2023



Temperature

Water used for cooling is the major source of effluent at BC Works. B-Lagoon is designed to retain effluent long enough to ensure water temperatures are not elevated when discharged. The permit requires that the temperature of the lagoon discharge does not exceed 30°C. Temperatures were within permit requirements during 2023 (Figure 4.7).

Figure 4.7

Temperature B-lagoon 2023

Conductivity, hardness, salt water addition and toxicity

Since 1997, salt water has been pumped into B-Lagoon at the connection between the primary and secondary ponds. As per permit requirements, the addition of salt water is monitored and managed to maintain non-toxic discharges.

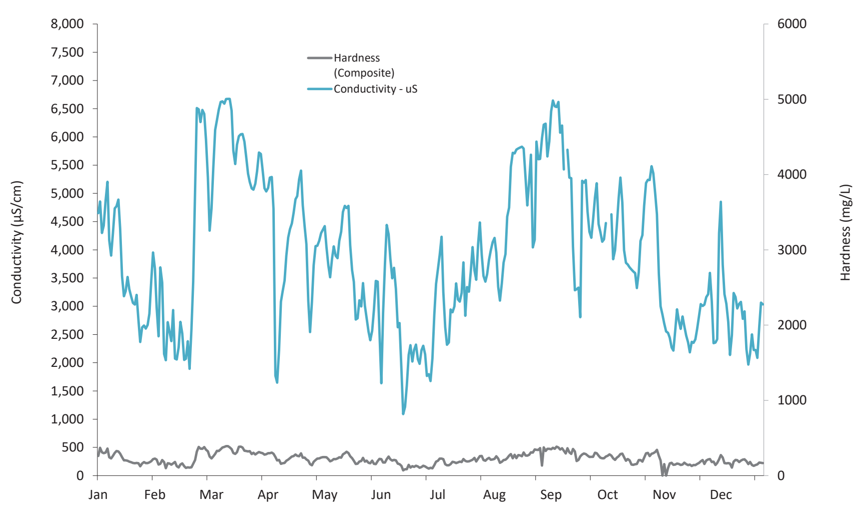
In 2008, an independent consulting firm conducted a review to examine the correlation between seawater addition rates, conductivity, hardness, and toxicity. The review was in fulfilment of section 8.2.5 of the multi-media permit requirements. Results confirmed that the addition of sea water was successful at reducing the toxicity of the B-Lagoon effluent.

The data also confirmed the best way to predict toxicity is via aluminium concentration, conductivity and pH. Conductivity and hardness are monitored on a continuous and daily composite basis respectively, even though there are no permit limits for either parameter (Figure 4.8). These measures provide information that ensures the salt water addition system is contributing to the reduction of toxicity at the at the B Lagoon outfall.

Water toxicity is determined through the application of a bioassay test. The toxicity of water discharged from B-Lagoon is tested by exposing juvenile rainbow trout to the effluent in a certified laboratory under controlled conditions (96LC50 bioassay test). The permit requires quarterly monitoring with a survival rate of at least 50 per cent for trout tested. All effluent discharge bioassay tests at B-Lagoon passed during 2023.

Figure 4.8

Conductivity and hardness, B-lagoon 2023

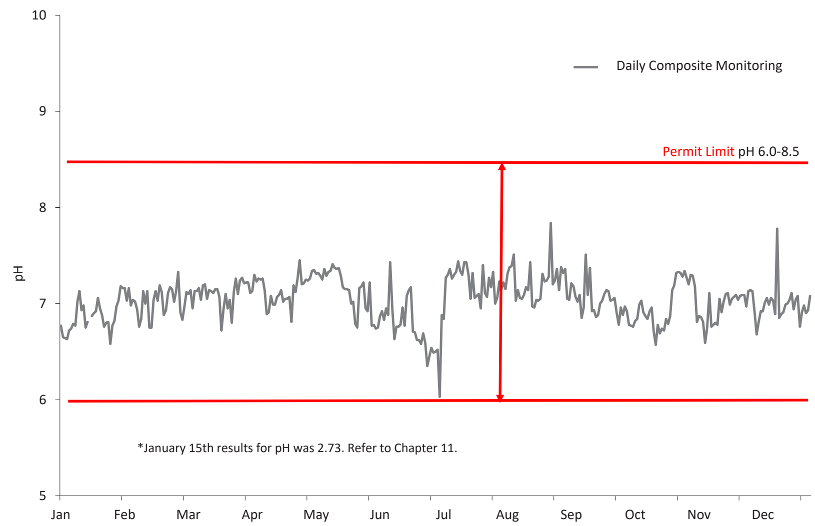


Acidity

A variety of contaminants can influence the acidity of effluent, by either increasing or decreasing the pH levels. A pH level of 7.0 is neutral, and water sources found adjacent to BC Works (Anderson Creek and the Kitimat River) usually have a pH level slightly below neutral (i.e. acidic, rather than alkaline).

Acidity is monitored using a variety of methods (continuous, daily composite and monthly grab samples). Daily composite samples are provided to an external laboratory for analysis. The permit requires that the pH of the effluent is maintained between 6.0 and 8.5. The 2023 annual pH composite sample average was 7.03. All sample measurements were within the permit limits during 2023 with the exception of one sample (Figure 4.9). January 15th result came back as 2.73. This result was abnormal when compared to the continuous data at the lagoon outall along with composite samples collected on January 14th and 16th.

Figure 4.9
Acidity, B-lagoon 2023



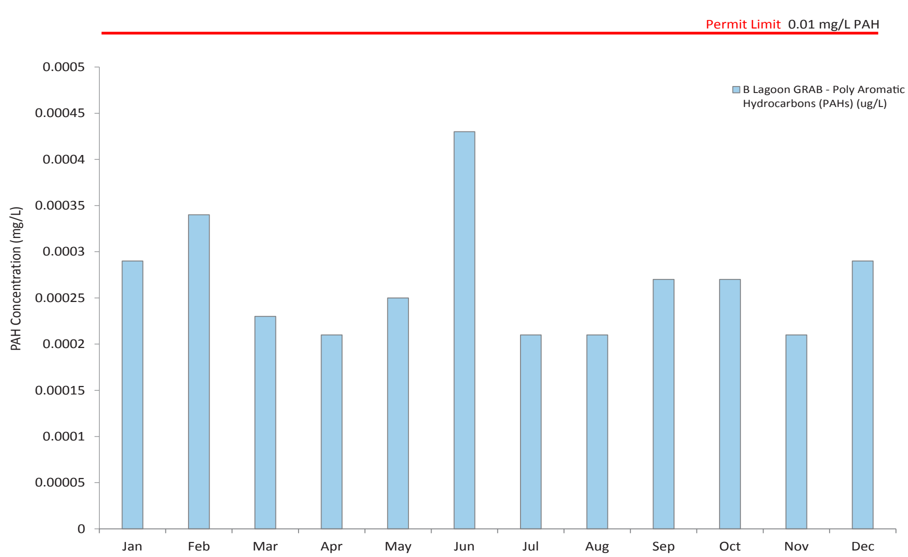
Polycyclic Aromatic Hydrocarbons (PAHs)

Polycyclic Aromatic Hydrocarbons (PAHs) are a large family of chemical compounds (more than 4,000 have been identified) most of the smelter PAHs originate from pitch a raw material used in creation of anodes for the smelter.

Other sources include raw materials (green coke and pitch) handling. PAHs are collected and analyzed with the monthly grab sample. B-Lagoon discharges are monitored and analysed for 15 of the most common PAH compounds (Figure 4.10). In 2023 the overall trend PAHs appear to be less than previous years which may highlight some of the benefits of the new smelter technology.

All PAH results from 2023 were within permit limits set at 0.01 mg/L.

Figure 4.10
Polycyclic Aromatic Hydrocarbons, B-lagoon 2023



5. Emissions

This chapter describes the results from air emissions as per the P2-00001 Permit for the various air discharge points from BC Works.

2023 overview

Operational sources & emission types

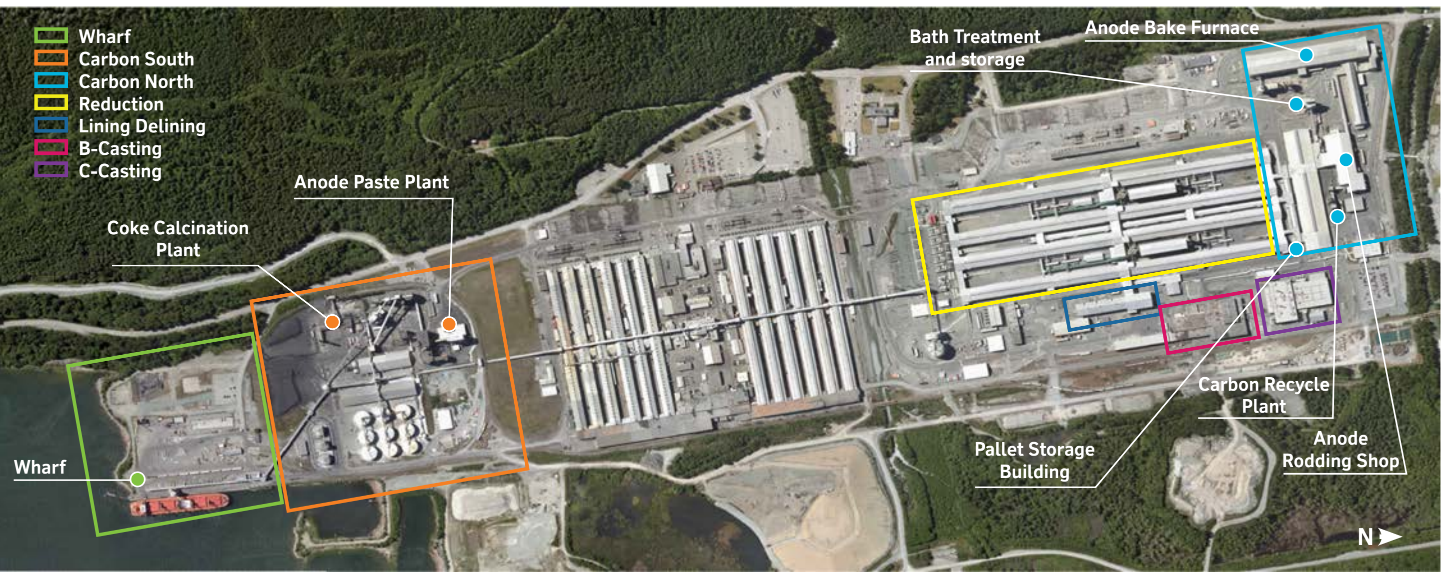
At BC Works the process of making aluminium releases emissions at various steps in the process. Emissions control equipment is situated in each operational areas as required, some of which are monitored annually or biennially by a qualified third-party consulting company to sample emissions such as: fluoride gas (Fg), fluoride particulate (Fp), sulphur dioxide (SO_2), polycyclic aromatic hydrocarbons (PAHs), nitrogen oxides (NO_X), and particulates (PM) as they exit from the stacks. Operational data from various areas within the plant is also used to calculate plant wide emissions for total fluoride (Ft), sulphur dioxide, greenhouse gas (GHG) and nitrogen oxide emissions.

In addition to monitoring emissions, regular air quality and vegetation monitoring is conducted in the Kitimat Valley. Information on these monitoring programs is detailed in Chapters 6 and 7, respectively.

Reported values are in standard conditions according to section 1.3.4 of the Permit.

Figure 5.1 Operational Areas

There are seven operational areas where emissions are vigilantly monitored. Starting at the south end of the site, there is the Wharf (green), followed by Carbon South (orange) which contains the coke calcination plant and the anode paste plant, then Reduction (yellow), Lining Delining (dark blue), Carbon North (light blue) which contains the anode bake furnace, bath treatment and storage centre, anode rodding shop, carbon recycle plant, and the pallet storage building, as well as C-Casting (purple) and B-Casting (pink).



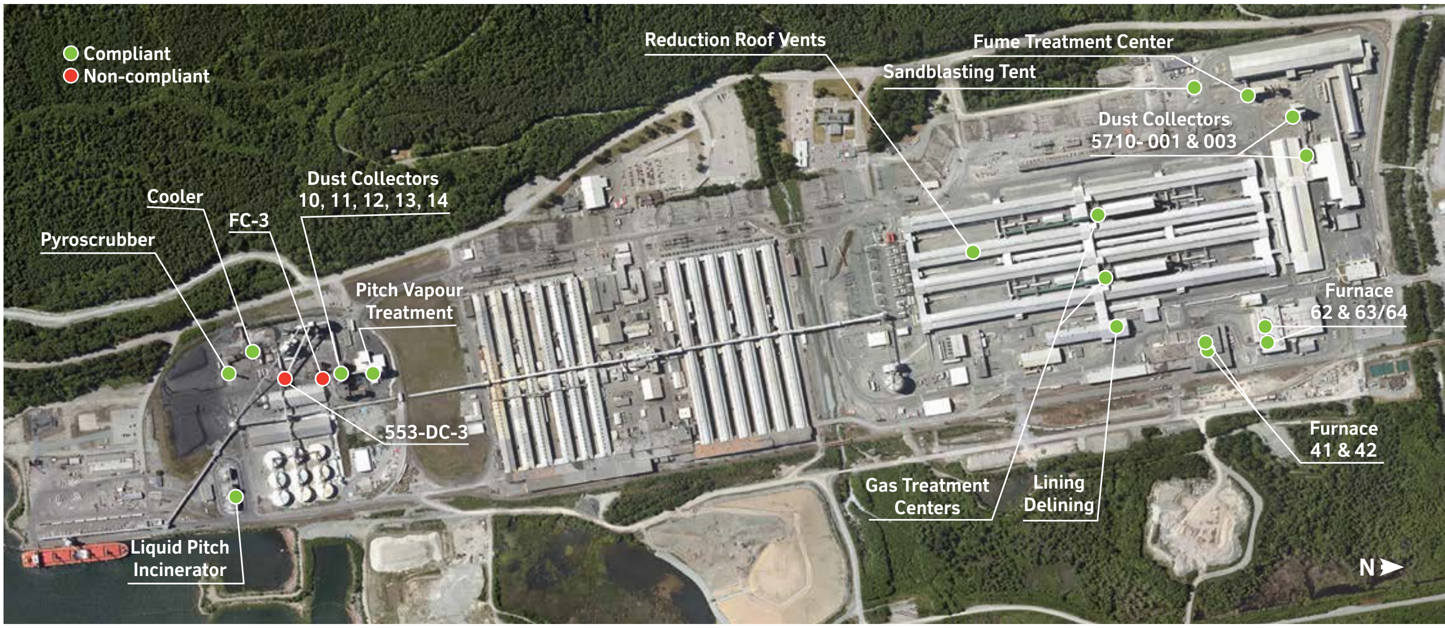
Operational performance

2023 was a milestone year for BC Works as the operation reached full production for the first time since 2018. There were three self-reported non-compliances: 2 related to reporting of emission control device upsets and 1 due to invalid monitoring of air emissions.

For each self-reported permit non-compliance an investigation and closure reports were completed (see Chapter 11 on permit non-compliances for more information). All other compliance points (stacks) for air monitoring at BC Works were compliant in 2023.

Figure 5.2 Operational Performance

There were 2 locations that resulted in 2 permit non-compliances (red) related to air emissions discharges in 2023; the remaining discharge points were compliant (green).



Operational sources

Wharf

The wharf is located at the southern end of the site and receives raw materials such as coal tar pitch, green petroleum coke, calcined coke and alumina which is transferred off ships and barges into silos and storage areas. When the raw materials are transferred (on conveyors or trucks), there can be sources of fugitive dust. The alumina conveyors and calcined coke conveyors have dust collectors located along the conveyor transfer points and are responsible for containing any fugitive dust. When a dust collector is not treating the emissions at the expected treatment level during material conveyance, an upset notification must be sent to the Ministry of Environment and Climate Change Strategy. Six upsets related to the dust collection of wharf operations were reported in 2023 (Table 5.1).

Table 5.1 Wharf Emission Control Upsets Hours.

Wharf dust collectors that had upset conditions during unplanned maintenance challenges.

Date	Equipment	Type	Duration	Cause
22-Mar-2023	6260-DCB-001	Unplanned	96h	Broken dust collector bags
12-Jul-2023	T6-DC3A	Unplanned	21h 30 min	Pulsing fault
5-Sept-2023	airslide transfer C12 -DC4 on B504A	Unplanned	20 min	Operational fault
5-Sept-2023	Tower 6	Unplanned	2h 30 min	Operational fault
9-Nov-2023	K3-DC (K3 alumina unloader)	Unplanned	8h 30 min	Insufficient dust collector bags
16-Dec-2023	T2-DC1A	Unplanned	1h 25 min	Insufficient dust collector bags

Carbon South

Carbon South is located at the southern end of the site near the wharf and contains the anode paste plant and the coke calcination plant. Carbon South is responsible for making the green anodes, the first step of the aluminium production process. Carbon South receives raw materials (coal tar pitch, green petroleum coke and calcined coke) from the wharf as well as recycled anodes from Carbon North which are used to make the green anodes.

The emission control devices located in the coke calcination plant and in the anode paste plant (APP) must be operational when the plants are operational; however upsets and or bypasses may occur during operations due to maintenance or unplanned events. A bypass of an emissions control device is defined as engineered pathway for emissions to pass through the equipment without treatment, whereas an upset is defined as any condition of an emissions control device that is not treating the emissions at the expected treatment level. Each time an emission control device is bypassed or has an upset, a notification must be sent to the Ministry of Environment and Climate Change Strategy. Table 5.2 shows each bypass/upset that occurred for each pollution control device in 2023 in Carbon South. In 2023, there were 2 self-reported permit non-compliances due to late reporting of upsets related to the liquid pitch incinerator atop of the day tank (FC-3) in APP and the calcined coke dust collector (C38-DC-3 in building 553) attached to the coke calcination plant (See Chapter 11 for additional information).

Table 5.2 Carbon South Emission Control Bypass/Upset Hours

Carbon South emission control devices that were not treating the emissions as expected during unplanned scenarios (such as a power outage) or for planned and unplanned maintenance activities.

Date	Equipment	Type	Duration	Cause
17-Jan-23	FC-3	Planned	18 h	Routine Maintenance
17-Jan-23	FC-3	Unplanned	23 h 17 min	Additional maintenance
28-Feb-23	FC-3	Unplanned	7 h 56 min	Equipment Tripped
3-Apr-23	FC-3	Unplanned	1 h 11 min	Low inlet temperature
4-Apr-23	FC-3	Unplanned	48 min	Equipment Tripped
25-May-23	PFTC 5130-DCB-002	Unplanned	1 h 12 min	System Tripped
19-Jun-23	LPI	Unplanned	2 h 15 min	Exhaust fan tripped
25-Jun-23	LPI	Unplanned	10 h 3 min	System alarm & part replace
29-Jun-23	553-DC-3	Unplanned	15 min	Insufficient dust collector bags
7-Jul-23	LPI	Unplanned	31 min	Exhaust fan tripped
10-Jul-23	LPI	Unplanned	1 h 33 min	Power outage
11-Jul-23	LPI	Unplanned	3 h 44 min	Power outage
11-Jul-23	FC-3	Unplanned	1 h 1 min	Power outage
12-Jul-23	FC-3	Unplanned	30 min	Alarm triggered
20-Jul-23	LPI	Unplanned	25 min	Low gas pressure fault
20-Jul-23	LPI	Unplanned	43 min	Power outage
5-Aug-23	LPI	Unplanned	6 h 39 min	Incinerator tripped
16-Aug-23	LPI	Unplanned	5 h 48 min	Incinerator tripped
28-Aug-23	FC-3	Unplanned	6 h	Earlier start of planned maintenance due to breakdown
29-Aug-23	FC-3	Approved	38 h	Routine Maintenance
30-Aug-23	FC-3	Unplanned	1 h 30 min	Instrumentation error
30-Aug-23	LPI	Approved	13 h	Routine Maintenance
8-Sep-23	B558-vacuum	Unplanned	10 min	Dust collector bags plugged
14-Sep-23	5130-DCB-001	Unplanned	10 min	Insufficient dust collector bags
15-Oct-23	LPI	Unplanned	1 h 5 min	Combustion blower fault
25-Oct-23	LPI	Unplanned	5 h 35 min	Power outage
25-Oct-23	FC-3	Unplanned	5 h 35 min	Power outage
8-Nov-23	FC-3	Unplanned	5 h 45 min	Communication with blower fan failed
15-Nov-23	LPI	Unplanned	2 h 37 min	Power spike due to Power Ops changing capacitor bank
16-Nov-23	FC-3	Unplanned	1 h 23 min	Power outage
4-Dec-23	FC-3	Approved	98 h	Overhaul repair
8-Dec-23	FC-3	Unplanned	10 h 35 min	Unstable system after repair
11-Dec-23	LPI	Approved	85 h 8 min	Overhaul repair

Coke calcination plant

Green coke is fed through the kiln to produce calcined coke. During this process, moisture and volatiles are removed from the green coke, and the volatiles are incinerated in both the kiln and the pyroscrubber. The freshly calcined coke is cooled with water, and the resultant steam is processed through the venturi scrubber before being discharged through the cooler stack. Emissions from both the cooler and the pyroscrubber stacks are typically monitored twice a year through stack tests. In 2023, the pyroscurbber and the cooler were stack sampled in May and October, and the results were within permit limits.

Table 5.3 Calcined Coke Stack Test – Pyroscrubber.
The Pyroscrubber was stack sampled twice in 2023 and was within permit limits.

Performance Measure	Pyroscrubber	
Date	May-23	Oct-23
Particulates (kg/hr) Permit Limit: 21.1 kg/Hr	5.4	4.6
SO_2 (kg/hr)	119.1	197.5
NO_x (kg/hr)	0.51	14.8

Table 5.4 Calcined Coke Stack Test - Cooler.
The Venturi scrubber was stack sampled twice in 2023 and was within permit limits.

Performance Measure	Venturi	
Date	May-23	Oct-23
Particulates (kg/hr) Permit Limit: 3.9 kg/Hr	0.9	2.0
SO_2 (kg/hr)	0.25	0.3

Anode paste plant

The anode paste plant uses calcined petroleum coke (from the coke calcination plant and from the wharf), Liquid pitch, and a portion of recycled carbon (from spent anodes crushed in Carbon North as well as reject paste and green anodes from APP) to produce green anodes. There are five dust collectors, two pitch incinerators and one pitch fume treatment device used to mitigate the emissions being released into the atmosphere from the green anode production process. Each of the devices is stack sampled once a year and has permit limits related to particulate emissions, and certain devices used to scrub fumes that come from the liquid pitch are stack sampled for polycyclic aromatic hydrocarbons (PAHs).

Liquid Pitch Incinerator (LPI)

The liquid pitch incinerator (LPI) is located on top of three storage tanks which are used to store liquid pitch after it has been transferred off boats at the wharf. The three tanks are connected to the liquid pitch incinerator, and when the pressure in the tank increases, the fumes travel to the pollution control device, which incinerates the fumes prior to releasing them into the atmosphere. This pollution control device is analysed for PAHs and has a permit limit for particulate emissions. The stack test results were within permit limits for particulates (Table 5.5).

Table 5.5 Liquid Pitch Incinerator (LPI) Stack Test.
The LPI was stack sampled once in 2023 and the stack test result was compliant.

Performance Measure	LPI
Date	Oct-23
Particulates (mg/m^3) Permit Limit: 500 mg/m^3	4.6
PAH (mg/m^3)	0.006

FC-3

The liquid pitch is pumped from the three storage tanks as needed into a day tank, where it is stored until it is used in the green anode forming process. The day tank has a liquid pitch incinerator and is called the FC-3 day tank incinerator, it is analysed for PAHs and has a permit limit associated with particulate emissions (Table 5.6).

Table 5.6 FC-3 Stack Tests.
The FC-3 incinerator stack was sampled once in 2023 and the results were within permit requirements for particulates.

Performance Measure	FC-3
Date	May-23
Particulates (mg/m^3) Permit Limit: 120 mg/m^3	4.4
PAH (mg/m^3)	0.1

Dust collectors

Dry raw materials (calcined coke and baked recycle carbon) go through a screening and grinding process and are separated based on granulometries (sizes). The material is then stored in bins depending on the granulometries (Fraction's 1-3). Dust Collector 10 (DC10) collects dust during the screening process, and the dust collected in DC10 is sent to the ball mill feed bins. There are two ball mills (1 and 2) which crush the dust collected from DC10 as well as larger calcined coke particles into ultrafine material. The dust collected from the two ball mills is done by dust collector 11 (DC11) and dust collector 12 (DC12). The dust collected by DC11 and 12 is transferred into a storage bin (Fraction 4). All four fractions of material (Fraction 1, 2, 3 and 4) are then mixed together in building 558 and dust collector 13 (DC13) and dust collector 14 (DC14) collect the dust from the mixture as it is transferred to building 5130 for the anode making process (liquid pitch fumes and dust are treated from this process by the pitch vapour treatment device). The dust collected from DC13 and DC14 is then recycled back into the dry material mixture that is used in the anode mixing and forming process.

All dust collectors were stack sampled and were within permit limits for particulate emissions (Table 5.7).

Table 5.7 Anode Paste Plant Dust Collector Stack Tests.
The dust collectors at the anode paste plant were stack sampled once in 2023 and were compliant with permit limits.

Performance Measure	Dust Collectors				
	DC10	DC11	DC12	DC13	DC14
Dates	Oct-23	May-23	Dec-23	Oct-23	Oct-23
Particulate (mg/m^3) Permit Limit: 120 (mg/m^3)	1.0	2.7	4.0	3.3	2.4

Pitch Vapour Treatment (PVT)

The pitch vapour treatment (PVT), also called the pitch fume treatment centre (PFTC), is used to control emissions coming from the anode mixing and forming process which takes place in building 5130 in which pitch (from the FC-3 day tank) is mixed with the dry materials (from building 558) are compacted together to physically form a green anode. The emissions from this device were analysed for particulates and PAHs as per permit requirements (Table 5.8).

Table 5.8 Pitch Vapor Treatment (PVT) Stack Test.
The PVT was stack results were within permit requirements for particulates and PAHs.

Performance Measure	PVT
Date	May-23
Particulates (mg/m^3) Permit Limit: 30 mg/m^3	2.6
PAH (Kg/Mg of Paste) Permit Limit: 0.03 Kg/Mg of Paste	0.020

Carbon North

Carbon North is located at the north end of the site and contains the anode bake furnace, anode rodding shop, pallet storage building, carbon crushing plant and bath treatment centre. Carbon North is responsible for baking the green anodes and then rodding the baked anodes into anode assemblies (two anode blocks plus a stem) so that they can be used in the reduction process for anode change. Carbon North also receives spent anodes (baked anodes that come out of the reduction process) as well as bath collected from the anode change process, both of which are stored in the pallet storage building until the material is cooled. The spent anodes are then cleaned, de-rodded and crushed so that the carbon can be recycled at the anode paste plant and the bath can be treated at the bath treatment centre before being sent back to reduction to be used in the anode change process.

Anode baking furnace

The anode bake furnace receives green anodes from the anode paste plant in Carbon South and bakes them at the anode bake furnace. The baking process releases emissions which are collected and treated by the fume treatment centre which is attached to the anode bake furnace. Once the anodes are baked, they are transported to the anode rodding shop.

Fume Treatment Centre (FTC)

The fume treatment centre pulls air from the anode bake furnace, the air is cooled, then injected with alumina which scrubs fluoride and PAHs from the air, the air then passes through filter bags to remove any particulates before the air exits through the stack.

The FTC is to be operational when the anode bake furnace is running, however due to emergencies and planned maintenance the device may be bypassed. Each time the FTC is bypassed or being planned to be bypassed (for maintenance purposes) a notification must be sent to the ministry of environment and climate change strategy as either a request for an approved bypass (for planned maintenance) or as an emergency notification (due to an unplanned bypass such as power outage). The date, bypass duration as well as the cause must be documented and reported to the Ministry of Environment and Climate Change Strategy within 1 business day for unplanned bypasses and on a monthly basis for approved bypasses. Table 5.9 shows each upset that occurred in 2023.

Table 5.9 Fume Treatment Centre Bypass Hours.
This emission control device may be bypassed during unplanned scenarios (such as a power outage) or for preventative maintenance purposes.

Date	Bypass Mode	Type	Duration	Cause
26-Jan-23	Mode 4	Unplanned	13 min	Operational fault
1-Mar-23	Mode 2	Unplanned	1 h 15 min	Low draft problem
12-Apr-23	Mode 2	Unplanned	10 min	Fire movement
2-May-23	Mode 2	Unplanned	1 h 3 min	High temperature at the cooling water outlet
10-May-23	Mode 2	Approved	9 h	Routine Maintenance
20-Jul-23	Mode 2	Unplanned	53 min	Power outage
22-Aug-23	Mode 2	Approved	6 h 31 min	Routine Maintenance
6-Sep-23	Mode 2	Unplanned	4 h 43 min	High temperature at cooling tower outlet
13-Oct-23	Mode 3	Unplanned	7 min	Loose wire
21-Nov-23	Mode 2	Unplanned	16 min	Alumina feed disruption
30-Nov-23	Mode 2	Approved	6 h 30 min	Routine Maintenance

The FTC is monitored on an annual basis as per permit requirements for fluoride, particulates, PAHs, nitrogen oxide and sulphur dioxide. There are permit limits in place for PAHs and particulate emissions, while the results for fluoride are used in the monthly compliance reporting against the plant wide total fluoride permit limit (see section on plant wide – total fluoride emissions).

The FTC is required to have the stack tested once a year. In 2023, the parameters were compliant (Table 5.10).

Table 5.10 Fume Treatment Centre Stack Test.
The FTC was stack sampled in 2023 and was within permit expectations.

Performance Measure	FTC
Date	May-2023
Particulates (Kg/Mg of baked Anode) Permit Limit: 0.3 Kg/Mg of baked Anode	0.03
PAH (Kg/Mg of baked Anode) Permit Limit: 0.05 Kg/ Mg of baked Anode	0.0003
Particulate Fluoride (mg/m^3)	0.027
Gaseous Fluoride (mg/m^3)	0.114
Fluoride Total (Kg/Mg Al) Permit Limit: Included in Plant Wide limit	0.0005
SO_2 (Mg/day) Permit Limit: Included in Plant Wide limit	2.7
NOx (Mg/day) Permit Limit: Included in Plant Wide limit	0.65

Pallet storage building

The pallet storage building is used to store spent anodes and bath from the reduction anode change process so it can be cooled before being recycled back into the process (see anode rodding shop and bath treatment centre sections). An emissions factor of 0.07 kg of fluoride gas per Mg Al is used to calculate the amount of fugitive fluoride that is released through the cooling process, and this factor is used in the plant wide total fluoride permit limit (see the section on plant wide – total fluoride emissions).

Anode rodding shop

The anode rodding shop receives baked anodes from the anode baking furnace as well as spent anodes from the pallet storage building. Baked anode blocks are received from the anode bake furnace and re-rodded to create rodded assemblies (two anode blocks per assembly) which are transported to reduction to be used in the electrolytic process.

Spent anodes are received from the pallet storage building and go through a series of processes to remove any bath that may be attached to the anode (see bath treatment and storage section below) to de-rod the anode by removing the carbon. The carbon is then transferred to the carbon recycle plant.

Carbon recycle plant

De-rodded anodes are conveyed from the ARS to the carbon recycle plant where they are crushed, the dust collected from this process is captured by dust collector 5810-DCB-001. This dust from the dust collector and the crushed anodes are stored in a silo before it is shipped down to carbon south to be recycled into the recipe for making green anodes.

Dust collectors

Some of the dust collectors used at the anode rodding shop, carbon recycle plant and the bath treatment and storage plant are monitored and reported for leak detection as per permit requirements. Leak detection is reported on a monthly basis to the ministry of environment and climate change strategy. Table 5.11 is a list of dust collectors that are reported for leak detection.

Table 5.11 Leak Detection

Leaks are monitored on a number of dust collectors in Carbon North that play a role in the anode rodding, carbon recycling and bath treatment.

	Number of Leaks Detected											
Emissions control device	**Jan**	**Feb**	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Anode Rodding Shop												
5610-DCB-001	0	0	0	0	0	0	1	0	0	0	0	1
Anode Rodding Shop												
5610-DCB-003	1	0	0	0	0	0	0	0	0	1	0	0
Carbon Recycling 5810-DCB-001	6	4	3	2	1	2	3	0	1	2	5	4
Bath treatment and storage 5710-DCB-001	2	3	0	0	0	0	0	0	0	0	0	0
Bath treatment and storage 5710-DCB-003	5	3	4	0	0	0	0	0	0	0	0	1

Bath treatment and storage

The bath treatment centre receives bath from the pallet storage building and from the anode rodding shop. The bath is crushed under suction and is stored in silos where it is recycled back into reduction in the anode change process.

5710-DCB-001 & 5710-DCB-00

There are two major dust collectors at the bath treatment and storage facility that are monitored relative to permit levels for total particulate. There were no exceedances of the permit limits in 2023 (Table 5.12). These two dust collectors are also monitored for leak detection (Table 5.11).

Table 5.12 Bath Treatment and Storage Stack Test.

The bath treatment stacks are monitored annually for particulates, and both stacks were compliant.

Performance Measure	DCB-001	DCB-003
Dates	Oct-2023	May-2023
Particulates (mg/m^3) Permit Limit: 30 mg/m^3	1.2	2.3

Reduction

The aluminium smelting process takes place in the 4 reduction buildings, each building houses 96 pots totalling 384 using AP-4X technology. The basis of AP-4X smelting technology is similar to that of the old Söderberg Vertical Stud smelting technology where each operational pot contains molten bath (composed primarily of sodium fluoride and aluminium fluoride) which dissolves the alumina ore by an electrolytic reduction process, the output of the process is molten aluminium. The difference between the two technologies is that the AP-4X smelter has the pots covered with hoods which are used to prevent emissions from being released from the pots as the emissions are continuously pulled from each pot and to a gas treatment centre (GTC). Fugitive emissions that escape through the pot hoods during operational activities such as anode change, tapping, etc. are released and monitored through the reduction buildings' roof ventilators. In January and February a minor amendment to increase the permit limits by 10% was authorized until March of 2023 when a temporary permit amendment to increase the emission limits for both smelter wide total fluoride from 0.99 kg/Mg Al to 2.8 kg/Mg Al and reduction particulate matter from 1.43 kg/Mg Al to 2.9 kg/Mg Al was authorized to facilitate the re-start of pots until October 31, 2023, when the permit limits were reduced to their original values (0.9 kg/Mg Al of total fluoride and 1.3 kg/Mg Al particulates). Additional details on the re-start are provided in Chapter 12.

Gas Treatment Centres (GTCs)

There are two gas treatment centres which are used to treat the emissions being pulled from the pots in the four reduction buildings. Emissions from building 1000 and 2000 are treated by the East GTC and the emissions from building 3000 and 4000 are treated by the West GTC. Each GTC pulls air from 192 pots, the air is then injected with alumina which scrubs fluoride from the air, the air then passes through filter bags to remove any particulates before the air exits through the stack. The alumina that is used to scrub the air is then recycled back into the reduction process and is fed into the pots to make aluminium.

The GTCs are required to run 24/7, but there may be instances where they may not perform to the expected level due to unplanned or planned maintenance. When this occurs, it's known as an upset. If there is an upset, whether it's planned or unplanned, a notification must be sent to the Ministry of Environment and Climate Change Strategy. For planned upset for routine maintenance may be approved under the P2 permit whereas planned upsets for non routine maintenance must be approved prior to the planned date. For unplanned upsets, a notification to the Ministry must be sent within 1 business day. The unplanned notification must indicate cause, date, and upset duration. Additionally, all planned or unplanned upsets are reported on a monthly basis. Table 5.13 shows each upset that occurred in 2023.

Table 5.13 Gas Treatment Centre (GTC) Upset Hours.

The East and West GTC are emission control devices that can cause an upset during unplanned scenarios (such as a power outage) or for preventative maintenance purposes (such as airlift cleaning).

Date	GTC	Upset Condition	Type	Duration	Cause
4-Mar-23	West	No Feed	Unplanned	3 h 40 min	System Tripped
5-Mar-23	West	Reduced Feed	Unplanned	8 h 25 min	SPS Leak
6-Mar-23	West	Reduced Feed	Unplanned	16 h 56 min	SPS Leak
11-Apr-23	East	No Feed	Approved	8 h	SPS Leak
6-Apr-23	West	Reduced Feed	Unplanned	20 h 30 min	SPS Leak
6-Apr-23	West	Reduced Feed	Unplanned	22 h 27 min	Sheer pin broke
6-Apr-23	West	No Feed	Unplanned	1 h 30 min	Sheer pin broke
6-Apr-23	West	No Feed	Unplanned	26 min	SPS issues
6-Apr-23	West	Reduced Feed	Unplanned	14 h 16 min	Sheer pin broke
6-Apr-23	West	Reduced Feed	Unplanned	14 h 35 min	Sheer pin broke
10-Apr-23	West	Reduced Feed	Unplanned	7 h	Routine Maintenance
11-Apr-23	West	Reduced Feed	Unplanned	24 h 32 min	SPS Leak
21-Jun-23	West	No Feed	Planned	8 h	Part adjust & system restart
21-Jun-23	West	No Feed	Unplanned	4 h 30 min	Part repair
21-Jun-23	East	No Feed	Unplanned	1 h 50 min	Routine Maintenance
20-Jul-23	East	No Exhaust	Unplanned	38 min	Power outage
20-Jul-23	West	No Exhaust	Unplanned	38 min	Power outage
14-Aug-23	East	No Feed	Approved	4 h	Routine Maintenance
15-Aug-23	East	No Feed	Planned	8 h 20 min	Routine Maintenance
17-Aug-23	East	No Feed	Unplanned	4 h 30 min	SPS Leak
12-Oct-23	East	No Feed	Planned	9 h 38 min	Airlift upgrade project
19-Oct-23	West	No Feed	Planned	5 h 45 min	Airlift upgrade project
26-Oct-23	East	No Feed	Planned	7 h 30 min	Airlift upgrade project
14-Nov-23	East	No Feed	Unplanned	3 h 20 min	Repairing distribution box canvas
17-Nov-23	East	No Feed	Planned	5 h 42 min	East Airlift commissioning
21-Nov-23	East	No Feed	Planned	6 h	East distribution canvas replacement
21-Dec-23	East	No Feed	Planned	1 h 31 min	Part installation

The GTC is monitored on an annual basis as per permit requirements for fluoride, particulates and sulphur dioxide (Table 5.14). In 2023 in part of the authorization for the re-start the GTC's was required to undergo two stack sampling events for both GTCs during peak emissions and during the ramp down of the re-start. The stack sample in January and October represent these periods. An additional test was completed in November for particulates due to the higher than anticipated values for the West measured in September. The results for fluoride and particulates are used in the monthly compliance reporting against the plant wide total fluoride permit limit (see section on plant wide – total fluoride emissions & plant wide – particulate emissions).

Table 5.14 Gas Treatment Centre Stack Test.

During the re-start the expectation was to stack sample both GTCs during peak emissions and a second time during the ramp down of the re-start. The stack sample in January and October represent these periods. An additional test was completed in November for particulates due to the higher than anticipated values for the West measured in September.

Performance Measure	GTC East	GTC West	GTC East	GTC West	GTC East	GTC West	GTC East	GTC West
Date	Jan-23	Jan-23	Jun-23	Jun-23	Oct-23	Sep-23	Oct-24	Nov-23
Total Particulates (mg/m^3)	2.8	1.7	1.8	1.5	1.3	5.1	1.3	1.6
Particulates (Kg/Mg of Aluminium) Permit Limit: Included in Plant Wide limit	0.29	0.19	0.20	0.14	0.11	0.44	0.11	0.15
Particulates (Kg/Mg of Aluminium) Permit Limit: Included in Plant Wide limit	0.2400		0.1700		0.2750		0.1300	
Particulate fluoride (mg/m^3)	0.035	0.078			0.1	0.14		
Gaseous fluoride (mg/m^3)	0.805	0.726			0.991	0.598		
Total fluoride (mg/m^3) Permit Limit: Included in Plant Wide limit	0.09	0.09			0.1	0.06		
Fluoride total (Kg/Mg of Aluminium) Permit Limit: Included in Plant Wide limit	0.0900				0.0800			

Roof vents

The design of each of the 4 potroom buildings allows for fresh air to be pulled in from the basement panels through to the main floor and out through the roof vent. This design minimizes the exposure to employees working in reduction. This design also allows for any fugitive emissions (emissions that do not get pulled through to the GTCs) to escape through the top of the reduction buildings. The fugitive emissions leaving through the reduction roof vents in each operational building are monitored for fluoride gas, fluoride particulates and particulate matter on a bi-monthly basis (14 +/- 3 days). In each half building there are 4 continuous samplers (shuttles) and treated air filters (cassettes) are used to conduct the monitoring. Each shuttle also records temperature, air speed, pump flow and sampling time, all of which are used to calculate the emissions for each sampling period.

The reduction roof vent fluoride emissions (Figure 5.3) and particulate emissions (Figure 5.4) are reported on a monthly basis to the Ministry of Environment and Climate Change Strategy and are used for compliance reporting against the P2-0001 plant wide permit limits for total fluoride (see Plant Wide Emission Section - Figure 5.6) and particulates (see Plant Wide Emission Section - Figure 5.9). Due to the shutdown of 75% of the pots following the labour dispute, only two half buildings were operational which led to only the continuous monitors being utilized to monitor emissions from the only 2 operational half buildings. As the restart campaign was initiated in 2022 and additional pots in other half buildings were started, additional monitors were used to monitor the emissions from the restart following the restart roof vent sampling methodology. At the end of 2023, when the operation reach 99% operational pots, the continuous monitors in 8 half buildings were utilized to monitor the emissions from the 8 operational half buildings. The roof vent emissions for both total fluoride and particulate emissions were higher in 2023 due ot the restart activities.

Figure 5.3
Reduction Roof Vent Total Flouride

The roof vent emissions are reported monthly from January – December.

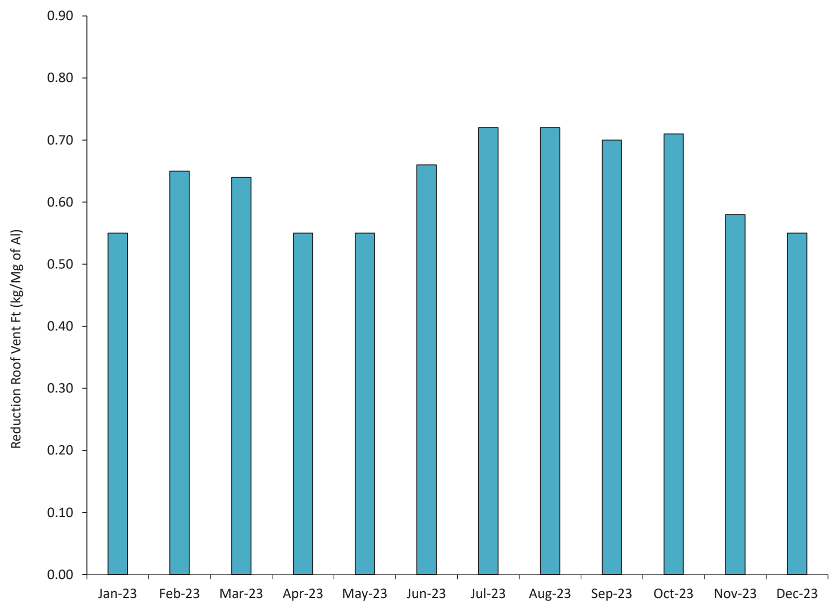
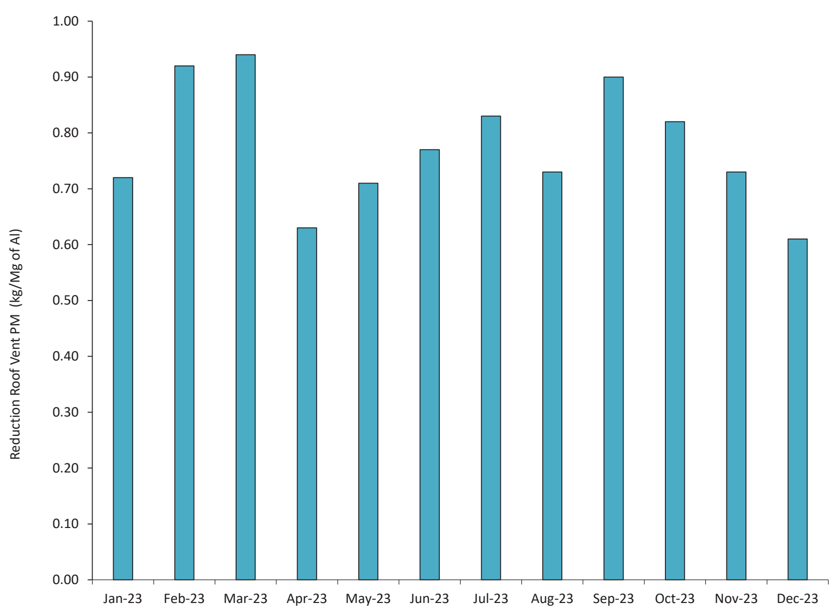


Figure 5.4
Reduction Roof Vent Particulate Emissions.

The roof vent emissions are reported monthly from January – December.



Lining de-lining

When a pot is nearing the end of its operational life it is cut off from the power supply, the remaining aluminium siphoned out and the anodes are raised out of the molten bath. The pot is cooled under the suction of the GTC for about 2 days before the process of delining followed by the lining begins (For additional details on the restart methods see Chapter 12).

The beginning of the delining process starts with the anodes being removed and transferred to the pallet storage building for recycle, the superstructure (which houses the anodes) removed from the pot and then the pot shell is moved out of the reduction lines and into the lining delining building. Once in the lining delining operation the remaining bath, cathode and refractory are removed from the pot shell under the suction of the 4421-DCB-001 dust collector. This dust collector was stack sampled in 2023 as per permit requirements for (Table 5.15), and monitored for leak detection (Table 5.16).

The pot shell is then lined with new refractory and cathodes and moved back into the reduction lines, where the superstructure is replaced and the pot is prepped, energized (power re-connected) and started up (aluminium making).

Table 5.15 Delining Stack Test.
The 4421-DCB-001 dust collector was stack sampled and was within permit limits.

Performance Measure	4421-DCB-001
Date	Nov-23
Particulates (mg/m^3) Permit Limit: 10 mg/m^3	4.5

Table 5.16 Leak Detection
Leaks are monitored at the lining delining dust collector.

Emissions control device	Number of Leaks Detected											
	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Lining Delining 4421-DCB-001	1	3	3	1	0	0	4	2	0	3	1	0

Casting

The molten aluminium that is siphoned from the pots in reduction is transported to the casting departments in cruces and depending on the customer needs the metal will either go to B or C casting. Over the years, the use of chlorine was reduced and finally removed from casting operations in April 2014, the permit limit for chlorine consumption remains at 300 kg per day. There was no SF_6 consumption in 2022 during the process of casting aluminium.

When an emission control device is not able to treat the emissions at the expected treatment level, this is reported as an upset. Each time a device had or planned to have an upset, a notification must be sent to the Ministry of Environment and Climate Change Strategy as either a request for an approved bypass (for planned works) or as an emergency notification (due to an unplanned event). Table 5.17 is a list of reported upsets for dust collectors in 2023.

Table 5.17 Casting Emission Control Upsets Hours.
Casting dust collectors that had upset conditions in 2023.

Date	Equipment	Upset Type	Duration	Cause
02-May -2023	3310-DCB-002 3310-DCB-003	Unplanned	24h	Insufficient dust collector bags

B-Casting

In B-casting aluminium is transferred from cruces into either furnace 41 or furnace 42, both furnaces feed into the DC4 pit which is used to create slab/sheet metal that is made to customer specification. The casts from DC4 are considered final product which means it is not re-melted by the customer. Both furnaces have stacks that release emissions to the atmosphere, and both stacks are sampled twice a year for nitrogen oxides, chloride, chlorine and particulate emissions as per permit requirements but neither stack has permit limits associated to the results. B casting also contains the sow caster which pours metal directly from cruces (no furnace and no stacks involved) into moulds which are cooled until in solid state (known as a sow), there are no direct emissions monitored from this process, and the metal is shipped to customers for re-melt.

Furnace 41 & Furnace 42

Furnace 41 and its emissions can be seen in Table 5.18.

Table 5.18 B-Casting - Bi-Annual Stack Test.

The stack tests were completed as per permit requirements for both furnace 41 and furnace 42.

Performance Measure	B-Casting			
	Furnace 41		Furnace 42	
Dates	May-23	Sep-23	May-23	Oct-23
NO_X (mg/m^3)	0.24	0.0003	0.03	0.001
Chloride (mg/m^3)	121.4	184.9	132.7	181
Chlorine (mg/m^3)	3.10	0.01	2.9	2.5
Particulate (mg/m^3)	49.50	89.3	74.7	50.8

C-Casting

In C-casting, aluminium is transferred from cruces into either furnaces 62, 63 or 64. Furnaces 63 and 64 feed into the ingot chain, casting pure aluminium 23 kg ingots, while furnace 62 is now also used for foundry alloy ingot casting. There are only two stacks at C casting, one for furnace 62 and one for furnaces 63 and 64. Both stacks are sampled twice a year for nitrogen oxides emissions and particulate emissions as per permit requirements, but neither stack has specific permit limits associated with the results. The metal produced at C casting is sold to customers for re-melt purposed. There is also a dust collector (6900-DCB-001) for dross cooling monitored for leaks.

Table 5.19 Dross treatment leak detection.

Leaks are monitored at the dross treatment dust collector.

Emissions control device	Number of Leaks Detected											
	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Dross Treatment 6900-DCB-001	1	3	3	1	0	0	4	2	0	3	1	0

Furnace 62

Furnace 62 was historically used for ingot chain, but in 2019, this process was modified so that furnace 62 can also be used to produce Foundry, a type of value-added product (Table 5.20).

Furnace 63/64

Furnace 63/64 was stack sampled twice as per permit requirements, and the results are shown in Table 5.20.

Table 5.20 C-Casting - Bi-Annual Stack Test.

The stack tests were completed as per permit requirements for both furnaces 62 and 63/64.

Performance Measure	C-Casting			
	Furnace 62		Furnace 63-64	
Dates	May-23	Sep-23	May-23	Sep-23
NO_x (mg/m^3)	2.3	2.1	3.0	2.3
Particulate (mg/m^3)	2.6	1.2	1.9	4.7

Plant wide

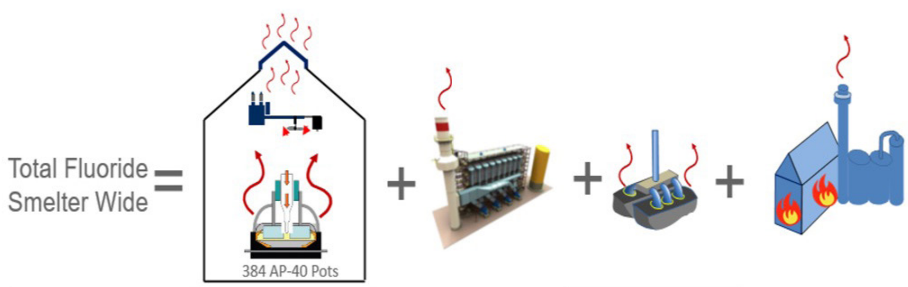
Total flouride emissions

The plant wide total fluoride emissions are calculated using reduction's roof vents and gas treatment centres as well as Carbon North's fume treatment centre and pallet storage building (Figure 5.5). The plant wide total fluoride permit limit is typically set at 0.9 kg / Mg Al, in January and February of 2023 the permit limit was increased by 10% to facilitate the continued restart until the March – October 31, 2023 temporary amendment for the restart was authorized which raised the permit limit to 2.8 kg/ Mg Al and 1.5 kg/Mg Al as the restart subsided.

In 2023, there were no permit exceedances of the total fluoride emissions permit limit (Figure 5.6).

Figure 5.5
Plant Wide Total Flouride Emissions Calculation.

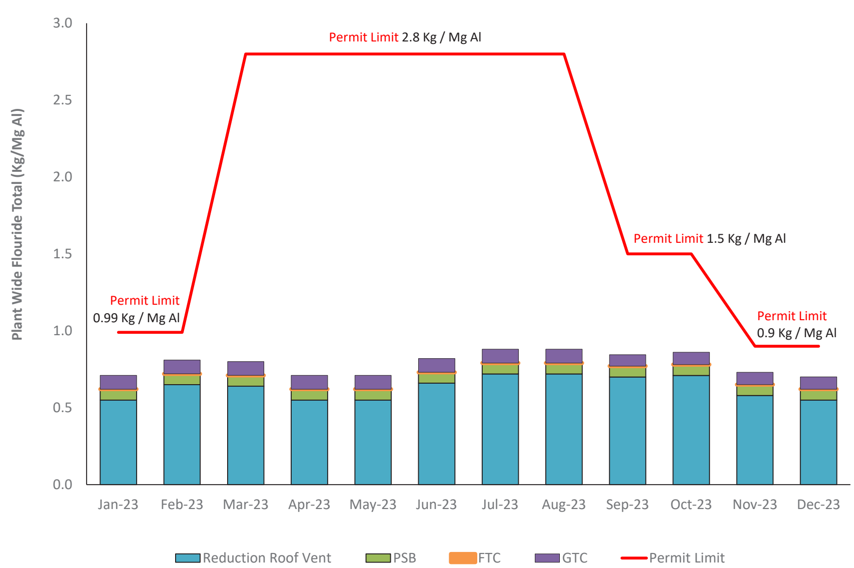
The plant wide total fluoride is calculated in kilograms per Mg Al each month by adding the emissions from the reduction roof vents plus the gas treatment centre stack test results plus the emissions factor from the pallet storage building plus the stack test results from the fume treatment centre.



Source	Pot room roof vents	Gas Treatment Centers	Anode Butts	Fume Treatment Centre
Emission Type	Fugitive	Direct	Fugitive	Direct
Method	Roof cassette	Stack sample	Emission factor	Stack sample

Figure 5.6
Plant Wide Total Flouride Emissions Calculation.

The plant wide total fluoride is calculated in kilograms per Mg Al each month by adding the emissions from the reduction roof vents plus the GTC, FTC and PSB. The Permit limit in 2023 moved from 10% above normal limits in January and February to the temporary restart limit from March – October 31 which included a step change from 2.8 to 1.5 kg/Mg Al as the restart activities subsided.



A review of the historical data from 2013 to 2023 shows a significant decrease in fluoride emissions which is largely attributed to the change in technology (pots with hoods, GTC and FTC) (Figure 5.7). In 2022 and 2023 there is a slight increase in emissions which is largely attributed to the restart activities.

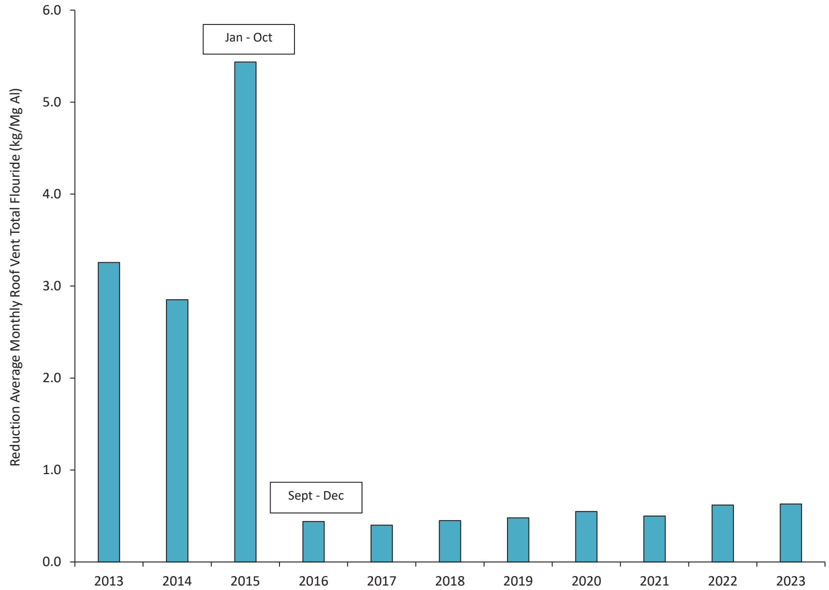
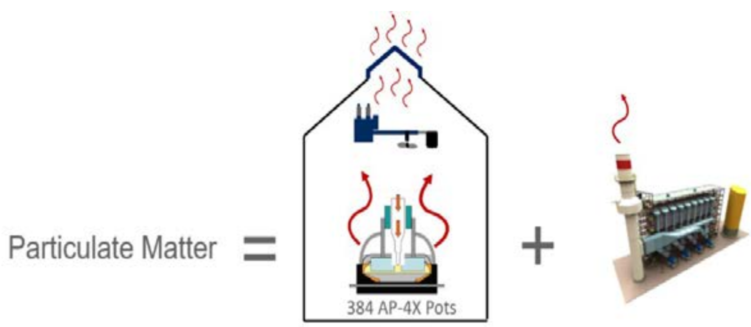


Figure 5.7
Historical Total Fluoride Emissions

The average monthly roof vent emissions for total fluoride have decreased since 2015 when the VSS smelter was shut down in October. Note years 2015 and 2016 did not take into account the entire year's monthly data into the average due to data availability.

Total particulate emissions

The plant wide particulate emissions are calculated using reductions roof vents and the gas treatment centre (Figure 5.8). The plant wide total fluoride permit limit is typically set at 1.3 kg/tonne of Al. In January and February of 2023 the permit limit was increased by 10% to facilitate the continued restart until the March – October 31, 2023 temporary amendment for the restart was authorized which raised the permit limit to 2.9 kg/ Mg Al and 2.0 kg/Mg Al as the restart subsided.



Source	Pot room roof vents	Gas Treatment Centers
Emission Type	Fugitive	Direct
Monitoring Method	Roof Vent Cassette	Stack sample

Figure 5.8
Plant Wide Particulate Emissions Calculation.

The plant wide particulate emissions is calculated in kilograms per Mg Al for each month by adding the emissions from the reduction roof vents plus the gas treatment centre stack test results.

In 2023, there were no permit exceedances of particulate emissions permit limit (Figure 5.9). The plant wide particulate matter permit limit is typically set at 1.3 kg / Mg Al, however in January and February of 2023 the permit limit was increased by 10% to facilitate the continued restart until the March – October 31, 2023 temporary amendment was authorized which raised the permit limit to 2.9 kg/Mg Al.

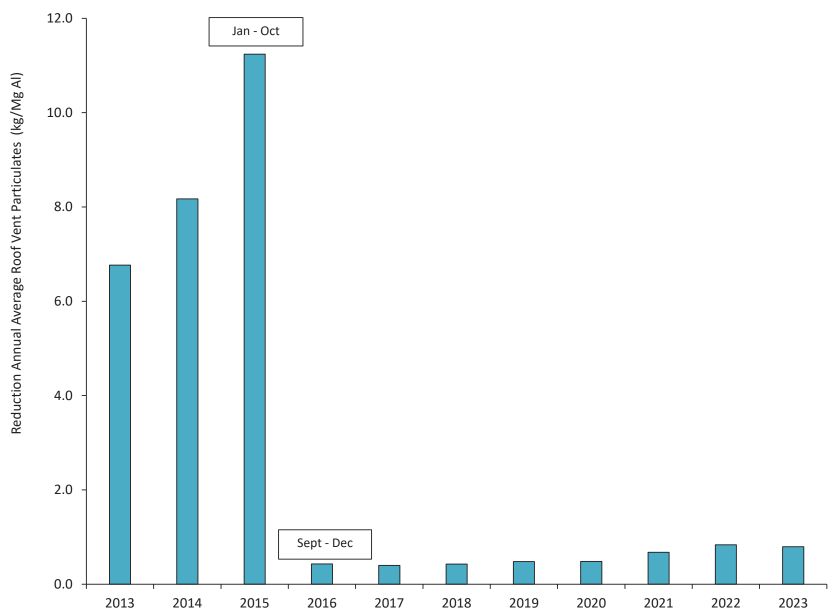
Figure 5.9
Plant Wide Particulate Emissions Calculation

Figure 5.9 Plant Wide Particulate Emissions Calculation. The plant wide particulate emissions is calculated in kilograms per megagram of aluminium for each month by adding the emissions from the reduction roof vents plus the gas treatment centre stack test results. The Permit limit in 2023 moved from 10% above normal limits in January and February to the temporary restart limit from March – October 31, 2023 which included a step change from 2.9 to 2.0 kg/Mg Al as the restart activities subsided.

The decrease in measured particulate emissions after 2015 is a result of the modernised smelter coming on-line and the full shutdown of the old VSS operation and the change in technology (pots with hoods, GTC and FTC) (Figure 5.10), the slight increase in 2022 and 2023 is largely attributed to the restart activities.

Figure 5.10
Historical Particulate Emissions

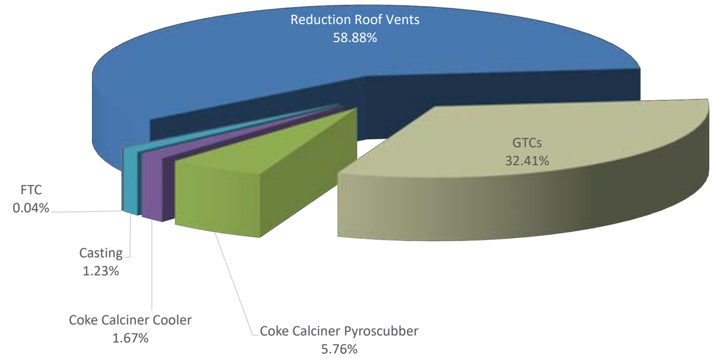
The average monthly roof vent emissions for particulates have decreased since 2015 when the VSS smelter was shut down in October. Note years 2015 and 2016 did not take into account the entire year's monthly data into the average due to data availability.



Across the site the main contributors of particulate emissions were linked to the restart with reduction roof vents contributing to 59% and the Gas Treatment Centres accounted for 32% of total particulate emissions for BC Works (Figure 5.11).

Figure 5.11
Particulate Emissions by Operational Area.

The particulate emissions from the stack tests and roof vents for each operational area was used to determine percent of particulate emissions from each operational area.



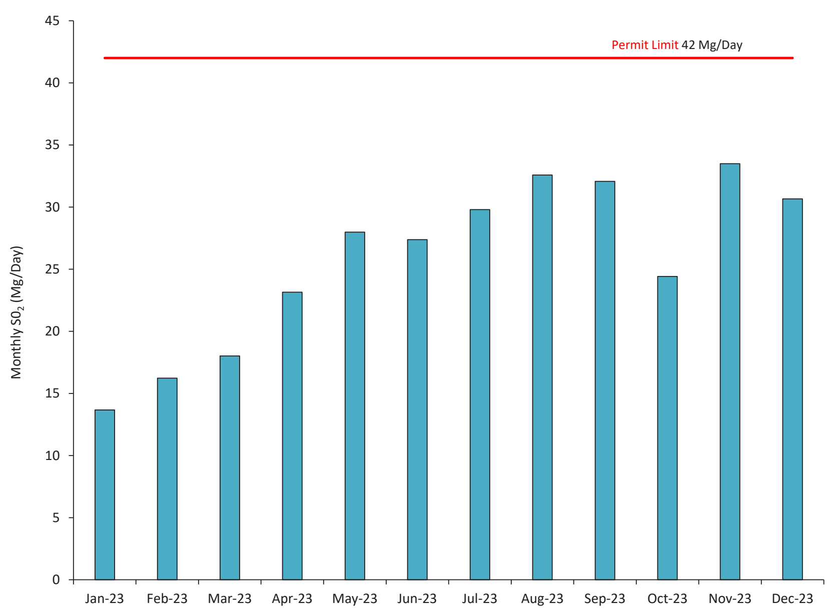
Sulphur Dioxide emissions

The plant wide sulphur dioxide emissions are calculated using a mass balance calculation using sources from Carbon South from coke calcination process (when green petroleum coke is processed into calcined coke, sulphur dioxide emissions are released from the pyroscrubber and the cooler), from Carbon North in the anode baking process (when green anodes made of calcined coke, recycled anodes and pitch are baked, sulphur dioxide is released through the Fume treatment centre) and from Reduction from the electrolytic process (anodes are consumed and sulphur dioxide is released through the reduction roof vents and the gas treatment centres).

In 2023, the monthly average SO_2 emission levels remained well below the permit limit (Figure 5.12). The amount of sulphur dioxide released per day continued to increase until reaching full production in the fall.

Figure 5.12
Sulphur Dioxide Emissions

Sulphur Dioxide emissions in 2023 show an increasing trend corresponding to the aluminium production increase as the restart progressed. Note in October there was a shutdown of the coke calcination plant linked to the reduction in emissions.

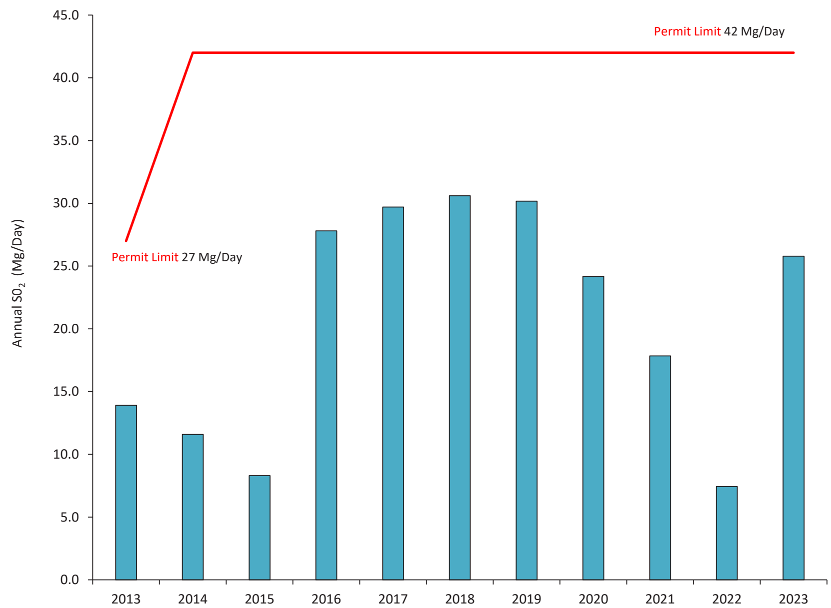


The plant wide sulphur dioxide permit limit was at 27 Mg per day from 2000 – 2013. In April 2013, the operation permit limit was increased to 42.0 Mg per day for the modernised smelter aluminium production increase and anticipated future decline in global anode grade coke quality (Figure 5.13). The average SO_2 emissions have increased since 2015 which can be attributed to the smelter reaching full metal production in 2016 and continuing to produce approximately 50% more tonnes of aluminium.

In addition to monitoring emissions, BC Works carries out every year extensive monitoring activities under the SO_2 Environmental Effects Monitoring program (SO_2 EEM), where four different lines of evidence are studied; water, human heath, soil and vegetation. Results and information about the SO_2 EEM can be found online at **www.riotinto.com\bcworks.**

Figure 5.13
Historical Sulphur Dioxide Emissions

Increased in Sulphur Dioxide emissions started to occur in 2017 as the new AP-4X smelter became fully operational. In 2020 and 2021 a decrease in emissions is attributed to the low number of operational pots, this trend continued until the plant reached full production at the end of 2023.



Natural Gas consumption

Natural gas is widely used at BC Works in various applications where heat is required. Variables affecting usage levels include production levels and the availability of energy generated by the hydroelectric facility at Kemano Operations.

BC Works consumption rates and associated emissions are calculated using standards developed by the US Environmental Protection Agency (US- EPA). Plant-wide natural gas consumption can be seen in Table 5.21.

Table 5.21 Plant Wide - Natural Gas Consumption and Associated Emissions.
The amount of natural gas consumption varies depending on operational dynamics. In 2021 and 2022 the amount of natural gas consumed on site was reduced due to the shutdown of 75% of the smelter and the progress to restart all the operational assets.

Year	Natural Gas Consumption (m^3/y)	Associated Emissions (tonnes /year)			
		Nitrogen Oxides	Total Particulate	Sulphur Dioxide	Carbon Monoxide
2012	19,695,700	31.51	2.39	0.19	26.47
2013	19,492,700	31.19	2.37	0.19	26.20
2014	18,048,900	28.88	2.19	0.17	24.26
2015	22,801,400	36.48	2.77	0.22	30.65
2016	32,066,200	51.31	3.90	0.31	43.10
2017	31,360,000	50.18	3.81	0.30	42.15
2018	31,240,900	49.99	3.80	0.30	41.99
2019	30,746,100	49.19	3.74	0.30	41.32
2020	30,966,900	49.55	3.77	0.30	41.62
2021	25,955,000	41.53	3.16	0.25	34.88
2022	22,750,900	36.40	2.77	0.22	30.58
2023	29,700,000	47.52	3.61	0.29	39.92

Greenhouse Gas emissions (GHG)

There are a number of sources of greenhouse gas (GHG) emissions at BC Works (Figure 5.14), and operational data from these sources is used to calculate the monthly and annual GHG emissions. These emissions are reported to the federal and provincial government once they are verified via a third party audit process which occurs after the submission of this report.

Most GHG emissions are generated through the smelting process (85%) and most smelting-related emissions are attributable to anode consumption while 15% is attributable to PFC emissions (Figure 5.15).

Figure 5.14
Operational sources of GHG Emissions

Aluminium smelting produces the majority of green house gas emissions during the electrolytic process.

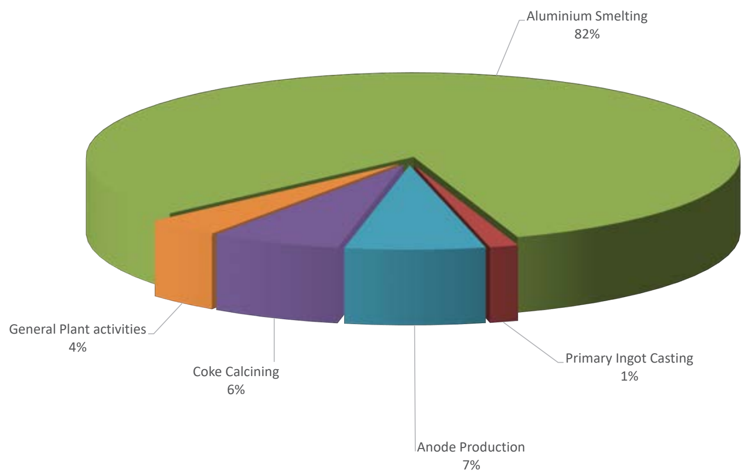
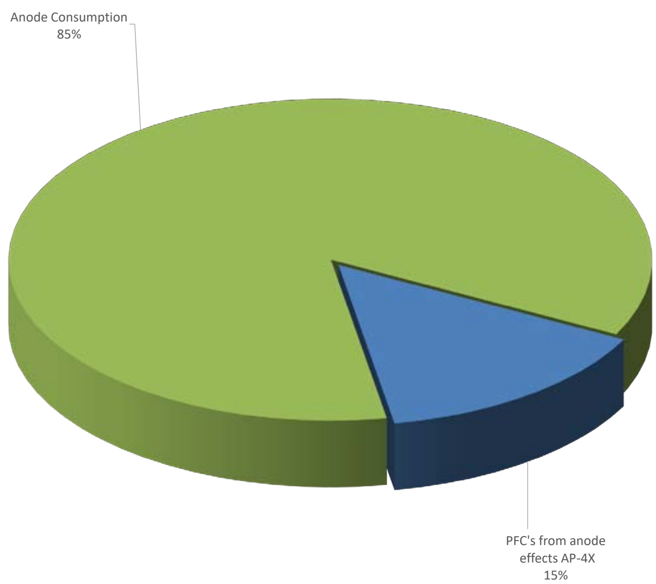


Figure 5.15
GHG Emissions from Aluminium Smelting

The consumption of anodes in the electrolytic process is the typically the main contributor of greenhouse gas emissions from the aluminium smelting process.



The frequency and duration of anode effects in aluminium smelting can either increase or decrease the amount of CO_2 equivalent produced in aluminium smelting which impact the amount of PFC emissions. During the restart, an increase in anode effect frequency and duration is expected and observed to peak in 2022 while steadily decreasing throughout 2023 (Figure 5.16)

BC Works GHG emissions were steadily decreasing since 2015 (Figure 5.17) however, due to operational instability starting in 2019 with the early pot failure and 2020 pot replacement campaign followed by the 2021 labour dispute and subsequent 75% shutdown of the smelter and the 2022 re-start there has been an increasing trend in tonnes of CO_2 equivalent per Mg Al. In 2023 as the operations began to stabilize GHG emissions began to decrease.

BC Works aims to continue to increase the stability of the operations and decrease the greenhouse gas emissions with a reduction target of 5% for 2024.

Figure 5.16
Monthly GHG Emissions & Anode Effect Duration

The re-start for the smelter started to ramp up in June and continued until the end of the year where ramp down occurred in December heading into the holiday season.

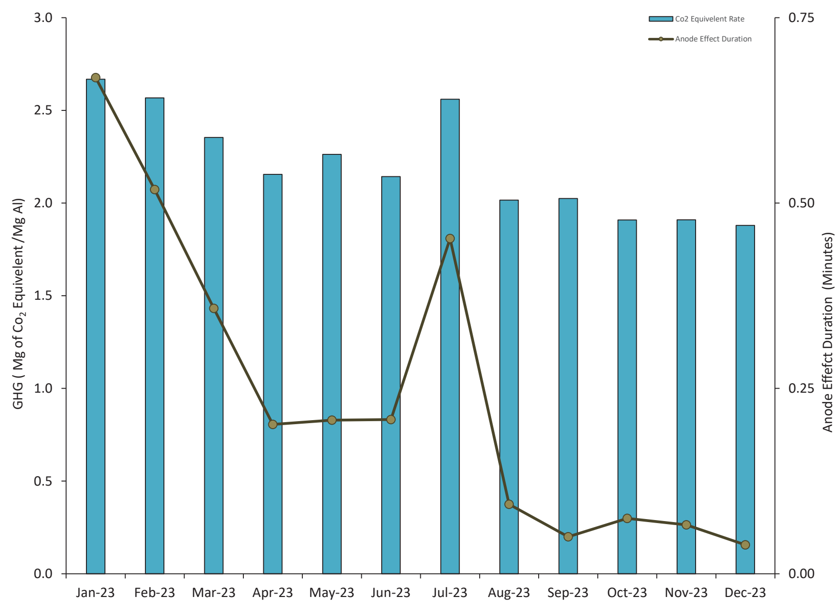
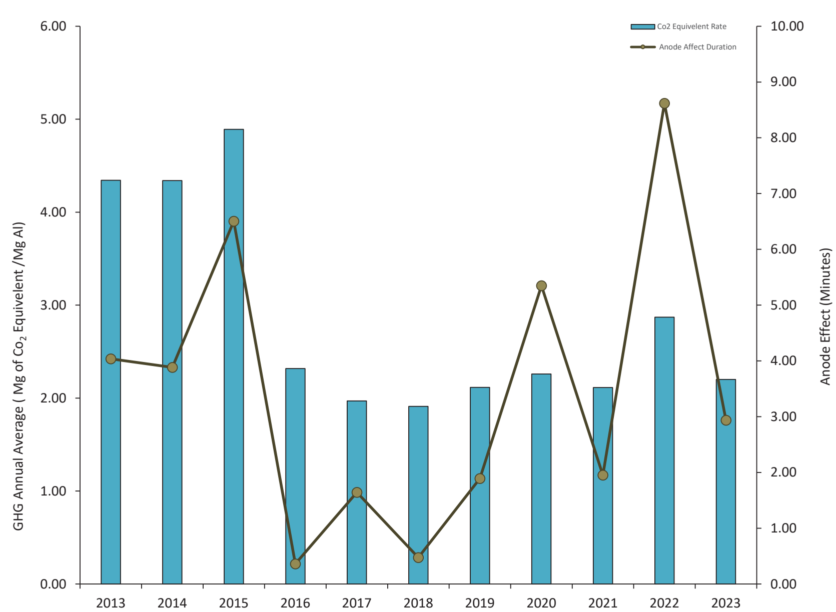


Figure 5.17
Historical GHG Emissions & Anode Effect Duration

The annual average GHG emissions (Mg of CO_2 equivalent per Mg Al) have decreased since 2015 when the VSS smelter was shutdown. During stable operational years the emissions were below 2.0 tonnes of CO_2 equivalent per Mg Al and in unstable years (since 2019) the emissions were above 2.0 tonnes of CO_2 equivalent per Mg Al.



Nitrogen Oxides emissions

Nitrogen oxides emissions are generated plant wide from four main sources: natural gas consumption, coke calcination, metal production and open burning of wood. In 2023, the NO_X emissions from the use of diesel preheaters were included into the monthly calculation and in Figure 5.18, the increase in emissions is largely attributed to the restart of the coke calcination plant at the end of March 2023.

When the new plant reached full production in 2016 so did the NO_X emissions, the emissions started to decrease in 2020 as pots were removed from operation due to the early pot failure, this trend continued in 2021 due to additional pots removed from production due to the labour dispute which also included the shut down of the coke calcination plant in 2021 and 2022. Emissions began to increase in 2023 as the plant reached full production.

Figure 5.18
Monthly Nitrogen Oxides Emissions

Throughout 2023 NO_X emission were below the permit limit of 1.12 Mg per day. The restart of the coke calcination plant at the end of March 2023 attributed to the increase in NO_X emissions. A subsequent shutdown of the coke calcination plant in October 2023 is seen in the decrease in emissions.

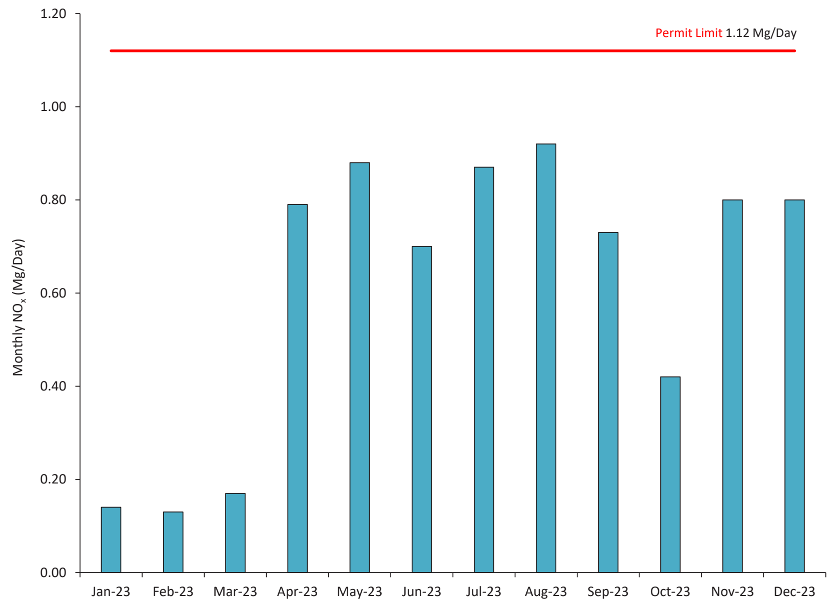
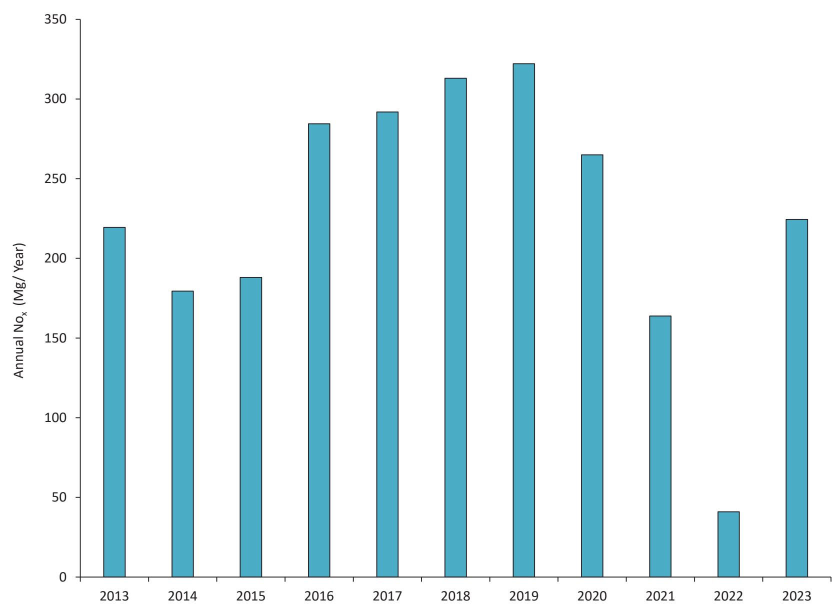


Figure 5.19
Historical Nitrogen Oxides Emissions

Summation of annual NO_X emissions from 2013 to 2023.



Fugitive Dust Management Plan (FDMP)

The fugitive dust management plan (FDMP) provides guidance for manging and controlling fugitive dust. The FDMP does not address requirements under Work Safe BC or other regulatory requirements beyond EMA. The FDMP is intended to cover handling of raw materials and by-products that are normal to both the current AP4-X Pre-Bake Smelter and legacy raw materials and by-products left over from the VSS Smelter. The FDMP may be used to support construction projects within the smelter's fence line, but it is not intended to support major construction works or demolition works, which may require project-specific fugitive dust management and action plan.

Mobile dust collectors

The fugitive dust management plan allows for use of mobile dust collectors that meet the minimum specification of 20,000 CFM, and filter efficiency of 99.99% efficiency at 0.067 microns to control fugitive emissions at the source.

Table 5.22 Mobile dust collectors utilized in 2023.

Operational Area	Process Description	Exhaust Type	Bypass	Duration
Overhead Conveyor fill station	Process modification during overhead alumina conveyor break down. One mobile dust collectors were used to capture the dust generated from filling tanker trucks at the silo.	Outside	No	12 months on / off as required
Cruice Cleaner	Additional dust management during cruce cleaner, managing cryolite	Outside	No	12 months on / off as required

6. Air quality monitoring

This chapter presents the 2023 air quality and meteorological monitoring reporting requirements according to section 8.5 of the Permit.

Network overview

Seven air quality parameters are monitored: hydrogen fluoride (HF), sulphur dioxide (SO_2), polycyclic aromatic hydrocarbons (PAHs), Ozone (O_3), Nitrous Oxide (NO_X), and two levels of fine particulate matter. Particulate matter is referred to as PM_{10} and $PM_{2.5}$ and is measured against size thresholds of 10 and 2.5 microns, respectively. Rio Tinto voluntarily upgraded the Whitesail monitoring station in 2018 with the Nitrous Oxide (NO_X) and Ozone (O_3) monitors so that an Air Quality Health Index Plus (AQHI-Plus) for Kitimat can be reported by the Province. The location of the stations are presented in Figure 6.1 and the Table 6.1 presents the monitoring parameters by station.

The collected air quality data are reported out according to the Permit 100138 Multimedia Waste Discharge permit. Specifically, Section 8.5 of Permit 100138 requires the following reporting:

- SO_2 and HF: Mean monthly concentration and daily hourly maximums.
- $PM_{2.5}$ and PM_{10}: Daily average and daily hourly maximum concentrations.
- PAH (15 congeners): all PAH data as 24-hour average on the NAPS schedule.
- Rain chemistry for the Haul Road and Lakelse Lake stations (SO_2 EEM deposition stations).

The scope of this chapter is to provide an interpretive summary of the above permit required monitoring and reporting.

Figure 6.1

Location of Ambient Air Monitoring Stations in Kitimat Valley

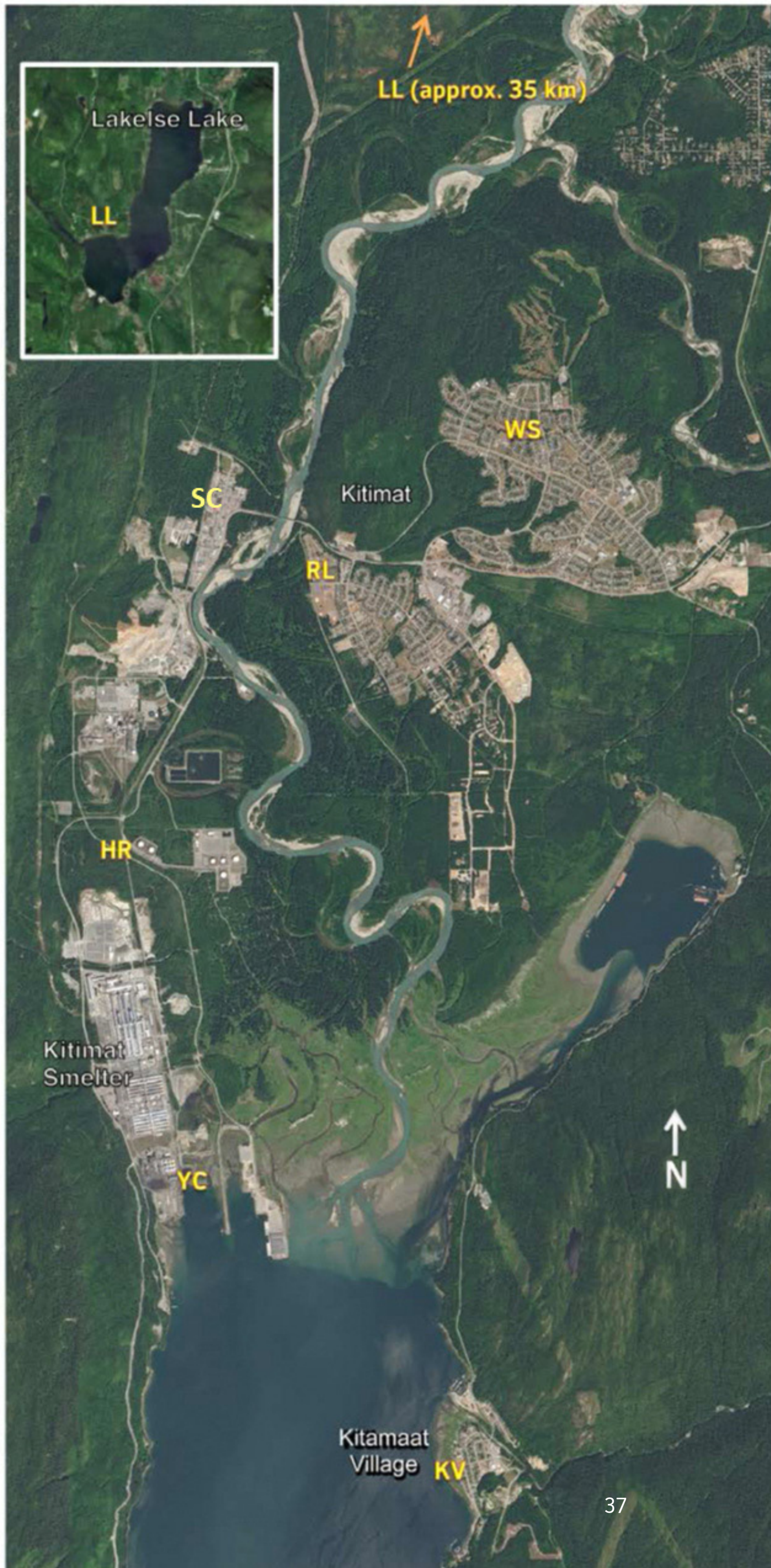


Table 6.1 Ambient Air Monitoring Network

Ambient Air Network	Haul Road Fence Line (HR)	Riverlodge Residential (RL)	Whitesail Residential (WS)	Kitamaat Village Residential (KV)	Service Centre (SC)	Yacht Club (YC)	Lakelse Lake Desposition (LL)
Sulphur Dioxide (SO^2)	✔	✔	✔	✔	✔		✔
Particulates ($PM^{2.5}$)	✔	✔	✔	✔			
Particulates (PM_{10})		✔					
Hydrogen Fluoride (HF)	✔	✔					
Nitrous Oxides (NO_x)			✔				
Ozone (O_3)			✔				
AQHI Plus			✔				
Rain Chemistry	✔						✔
Meteorological Monitoring	✔	✔	✔	✔	✔	✔	
Polycyclic Aromatic Hydrocarbons (PAH)	✔		✔	✔			
Wind Speed and Direction	✔	✔	✔	✔	✔	✔	
Temperature	✔	✔	✔	✔	✔	✔	
Relative Humidity			✔		✔		
Pressure			✔				

Weather monitoring

Meteorological (weather) monitoring data, including wind speed and direction, and temperature, are collected at five air quality monitoring stations (Haul Road, Service Centre (Industrial Ave.), Riverlodge, Kitamaat Village, and Whitesail) plus the Yacht Club station. Precipitation monitoring and chemistry analysis are undertaken using samples collected at the Haul Road and Lakelse Lake stations. Relative humidity is additionally collected at the Industrial and Whitesail monitoring stations. The weather data provides additional insight into air quality data interpretation.

Quality assurance and control

The validation of air quality data is conducted using a quality control/quality assurance process. The quality control component is to ensure that all instrument maintenance and operational guidelines for the instruments are being followed correctly and documented. Moreover, when summarizing air quality data, a data completeness criterion of 75% is applied, as recommended in Ministry of Environment guidance documents.

Air quality monitoring stations in the Kitimat Valley are operated by an independent consultant. A technician performs weekly inspections, calibrations, and routine maintenance on the equipment. Air quality data are reviewed each business day, validated monthly, and submitted to the Ministry. In the event where remedial actions are required to ensure the validity of the data, this information is reported to the Ministry.

The quality assurance audit procedure is conducted by Ministry staff. This involves visits twice per year to the sites. A review of station and instrument documentation, condition and a reference audit calibration check on each instrument being operated under permit is completed. The results of the quality control/quality assurance process are then used to validate the data collected by the Provincial Air Quality Monitoring network (www.env.gov.bc.ca/epd/bcairquality).

The Ministry audited the ambient air quality monitoring network from March 1-2, 2023, and again from June 28-29, 2023. Village (SO_2, $PM_{2.5}$), Haul Road (SO_2, $PM_{2.5}$), Industrial (SO_2), Riverlodge (SO_2, $PM_{2.5}$, PM_{10}), and Whitesail (NO_X, O_3, SO_2, $PM_{2.5}$) were included in each audit. Every audit result passed except for the Haul Road $PM_{2.5}$ monitor during the June audit. The cause was an intermittent malfunction with the monitor's ambient temperature sensor. A new temperature sensor was promptly ordered and installed, resolving the issue.

Amendment to Section 8.5 Ambient Air Monitoring and Reporting

The BC Ministry of Environment and Climate Change Strategy amended section 8.5 of the permit for ambient air monitoirng and reporting requirements on November 30, 2023. This chapter has been updated to include the new reporting requirements for ambient air quality (s. 8.5.5.2) and meteorological monitoring (s. 8.5.7.2). The new reporting requirements require an annual review of the air quality data and meteorological data quality review by a qualified professional (QP). This chapter is intended to meet these reporting requirements. The presentation of monitoirng results, data capture, data validation and instrument validation has been prepared by Trinity Consulting.

2023 monitoring results

Ambient air quality monitoring for all results stations and parameters are presented in Table 6.2. Air quality data used in this report was extracted from BC ENV's ENVISTA database each month throughout 2023.

Table 6.2 2023 Ambient Air Quality Monitoring Results

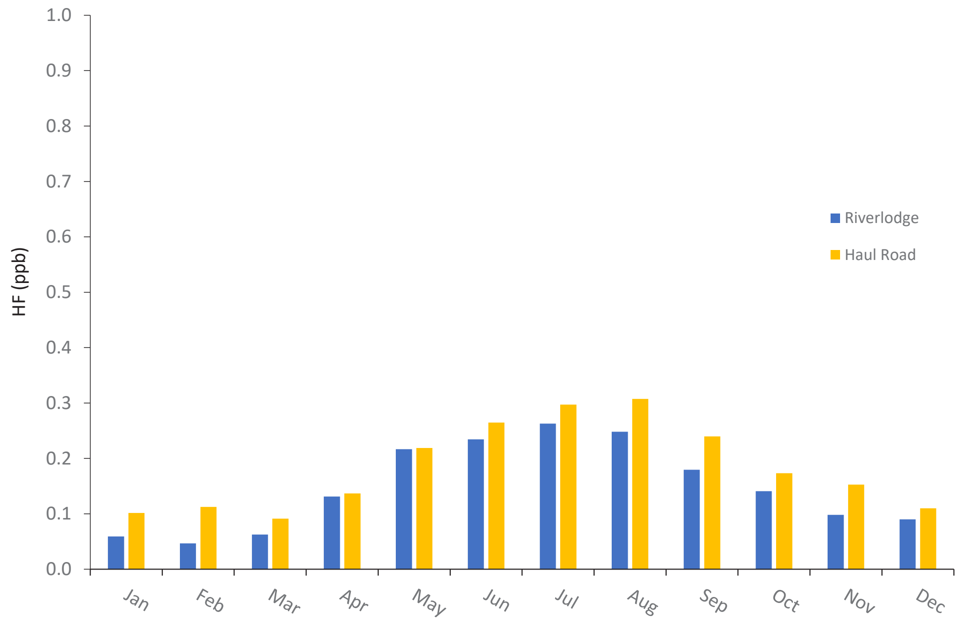
Statistic				Residential		
	Fence line Haul Road	Industrial Avenue	Lakelse Lake Desposition Station	Riverlodge	Whitesail	Kitamaat Village
			SO_2			
Annual Average (ppb)	4.4	2.2	0.50	0.9	0.4	0.4
99th Percentile, D1HM[2]	70.1	41.1	8.4	27.7	20.7	20.5
Days above 70 ppb (Hourly)	4	0	0	0	0	0
Minimum (Hourly, ppb)	-0.3	0.0	-0.4	-0.2	-0.5	-1.3
Maximum (hourly, ppb)	85.5	44.9	11.5	40.0	38.2	40.2
Standard Deviation (ppb)	8.5	3.2	0.7	1.9	1.3	1.4
			$PM_{2.5}$			
Annual Average (ug/m³)	6.5			4.9	4.3	3.5
98th Percentile, 24 hour	20.0			13.8	12.0	11.0
Days above 25 ug/m³ (24 hour)	5			3	3	2
Minimum (Hourly, ug/m³)	-4.0			0.0	-1.0	0.0
Maximum (hourly, ug/m³)	152.0			74.0	98.0	167.0
Maximum daily average (ug/m³)	46.4			44.6	42.7	42.5
Standard Deviation (ug/m³)	7.7			4.7	4.7	4.9
			PM_{10}[3]			
Annual Average (ug/m³)				8.0		
Minimum (Hourly, ug/m³)				-2.0		
Maximum (hourly, ug/m³)				149		
Maximum daily average (ug/m³)				54.5		
Days above 50 ug/m³ (24 hour)				1		
Standard Deviation (ug/m³)				9.4		
			HF			
Annual Average (ppb)	0.18			0.14		
Minimum (Hourly, ppb)	0.03			0.01		
Maximum (hourly, ppb)	0.38			0.43		
Days above 65 ug/m³ (hourly)[4]	0			0		
Standard Deviation (ppb)	0.1			0.1		
			NO_2			
AAnnual Average (ppb)					1.4	
Minimum (Hourly, ppb)					0.1	
Maximum (hourly, ppb)					21.0	
Standard Deviation (ppb)					1.7	
			O_3			
Annual Average (ppb)					20.4	
Minimum (Hourly, ppb)					-1.0	
Maximum (hourly, ppb)					50.0	
Standard Deviation (ppb)					10.8	

Notes: [1] Data extracted from BC ENV's Envista database.
[2] D1HM is the daily 1 hour maximum
[3] PM10 monitoring at the Haul Road station was done under a temporary requirement of the May 5, 2020 Event Response Plan approval
[4] Hydrogen fluoride (HF) is reported against the Quebec hourly HF air quality standard of 65 ug/m3 as a temporary requirement of the approval of the May 5, 2020 Event Response Plan.

Hydrogen Fluoride (HF)

HF monitoring is done with Picarro analyzers (cavity ring down spectroscopy) and are presented in both Table 6.2 and Figure 6.2. Since the smelter has been modernized, ambient HF concentrations are typically very low (typically, less than 1 ppb). In 2023, during the continuation of the smelter restart, the maximum 1-hour ambient HF measurements were below 0.5 ppb.

Figure 6.2
Hydrogen Fluoride Monthly Averages



Sulphur Dioxide (SO_2)

SO_2 is monitored at three residential stations (Whitesail, Riverlodge, and Kitamaat Village) in addition to the Industrial Haul Road station, Service Centre (Industrial Ave.), and Lakelse Lake. Permit 100138 requires the reporting of hourly daily maximums and monthly averages. A summary of the 2023 monitoring results is provided in Table 6.2 and monthly means are shown in Figures 6.3a to 6.3c. Beyond the required Permit 100138 reporting, the daily 1-hour maximum averages for 2023 for all five stations are presented in Figures 6.4a to 6.4f.

Additionally, the summary statistics in Table 6.2 include the percentile results for comparison to the Provincial SO_2 Air Quality Objective. The residential maximum hourly average SO_2 concentrations shown in Table 6.2 ranged from 38.2 ppb to 40.2 ppb. There were no days in 2023 where the residential SO_2 hourly concentrations were above 70 ppb. The maximum residential annual average SO_2 concentration was 0.9 ppb.

Figure 6.3a
Residential Monthly SO_2 Averages

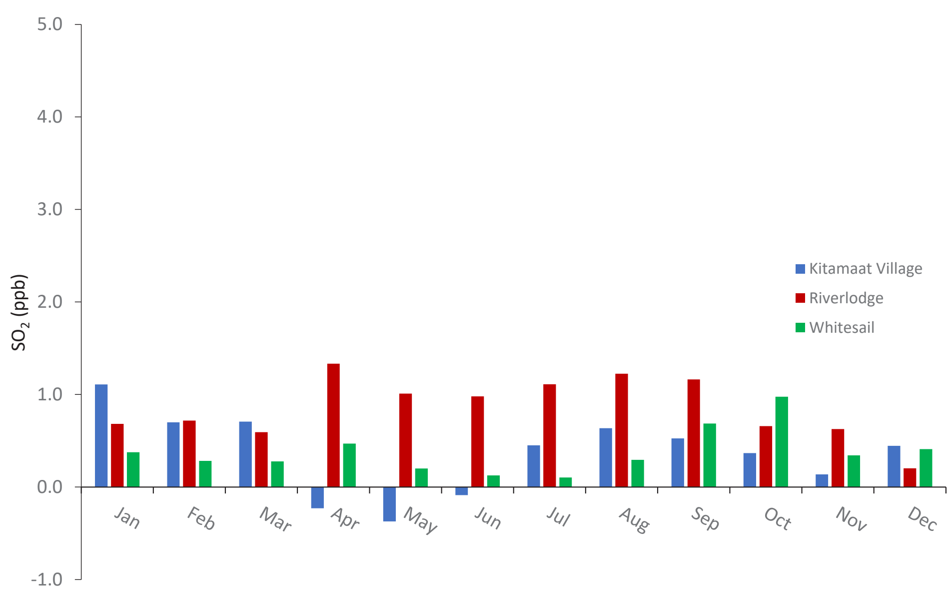


Figure 6.3b

Service Centre Monthly SO_2 Averages

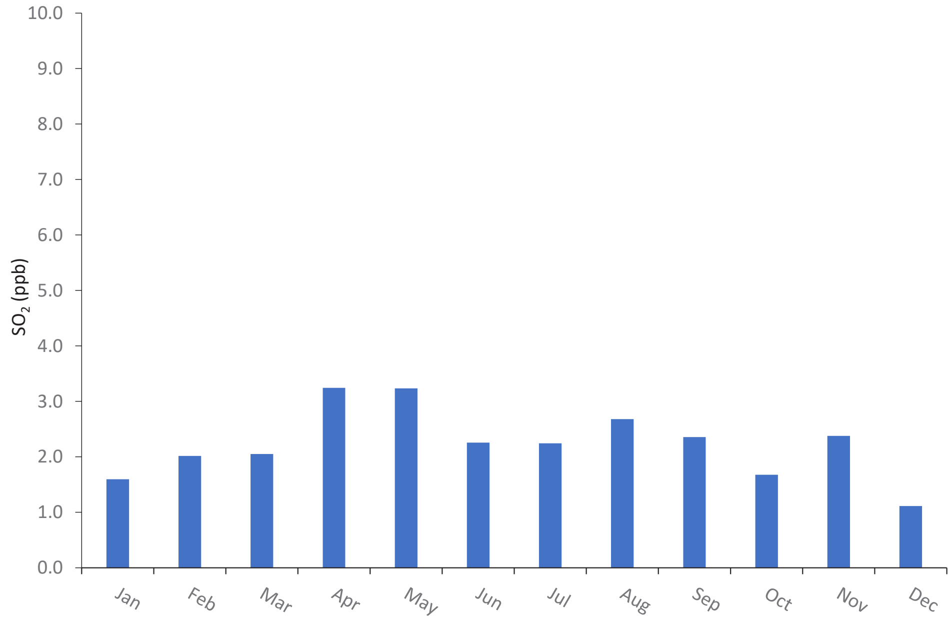


Figure 6.3c

Residential Monthly SO_2 Averages

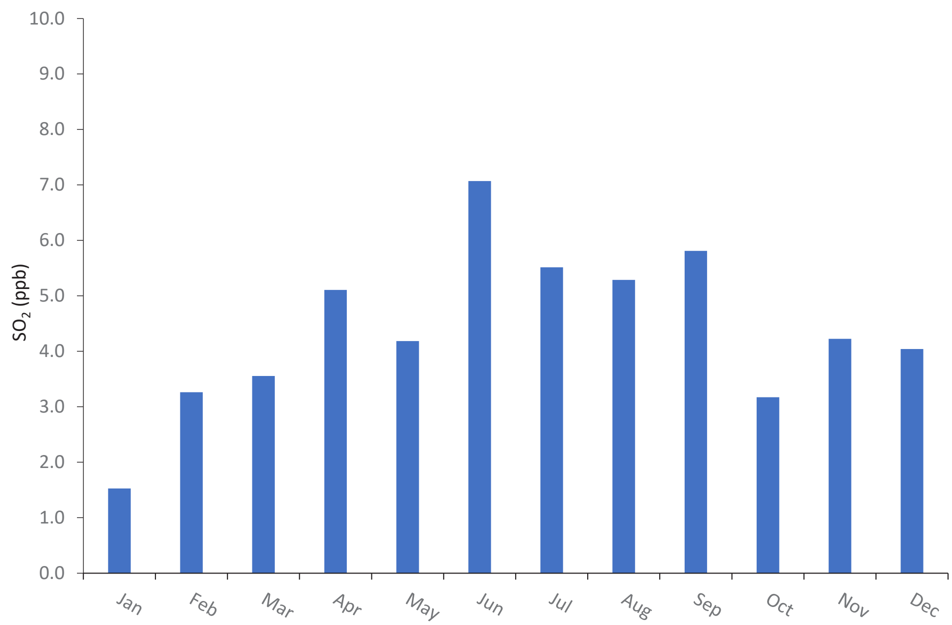


Figure 6.4a

Riverlodge SO_2 1-Hour Daily Maximum

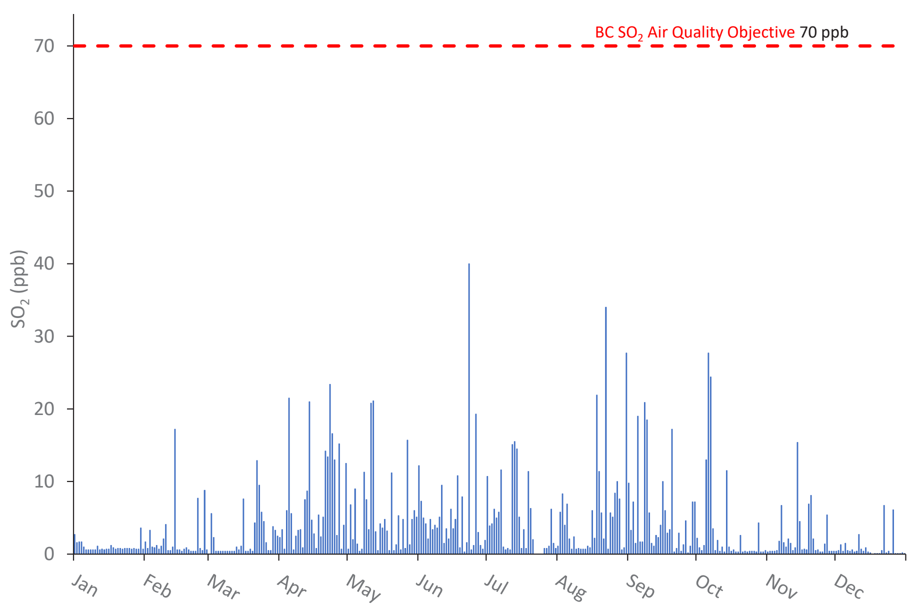


Figure 6.4b

White Sail SO_2 1-Hour Daily Maximum

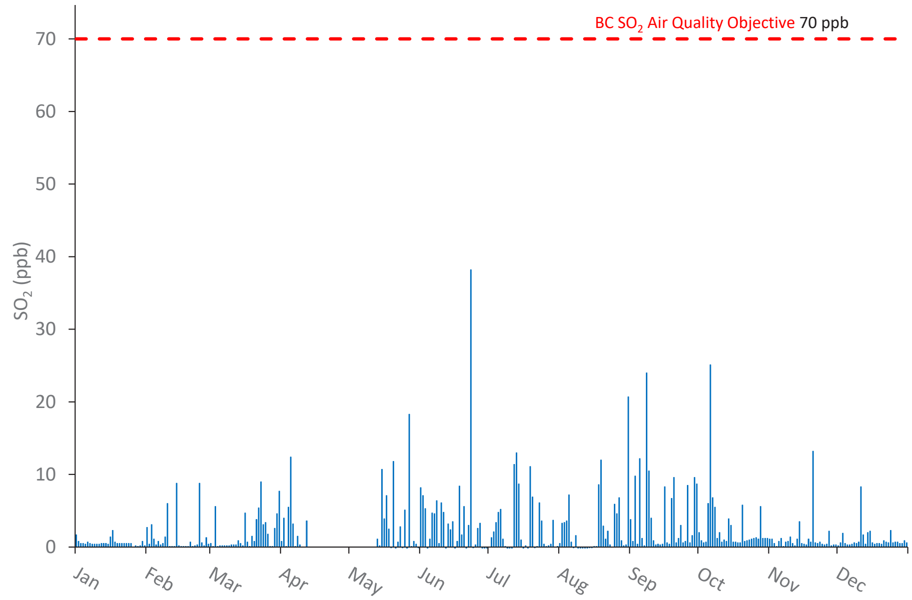


Figure 6.4c

Kitamaat Village SO_2 1-Hour Daily Maximum

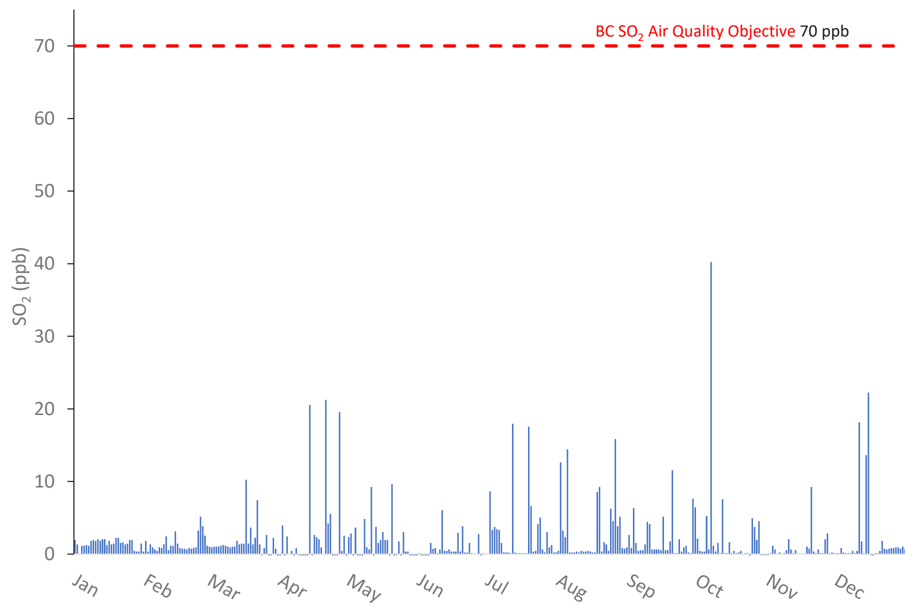


Figure 6.4d

Service Centre SO_2 1-Hour Daily Maximum

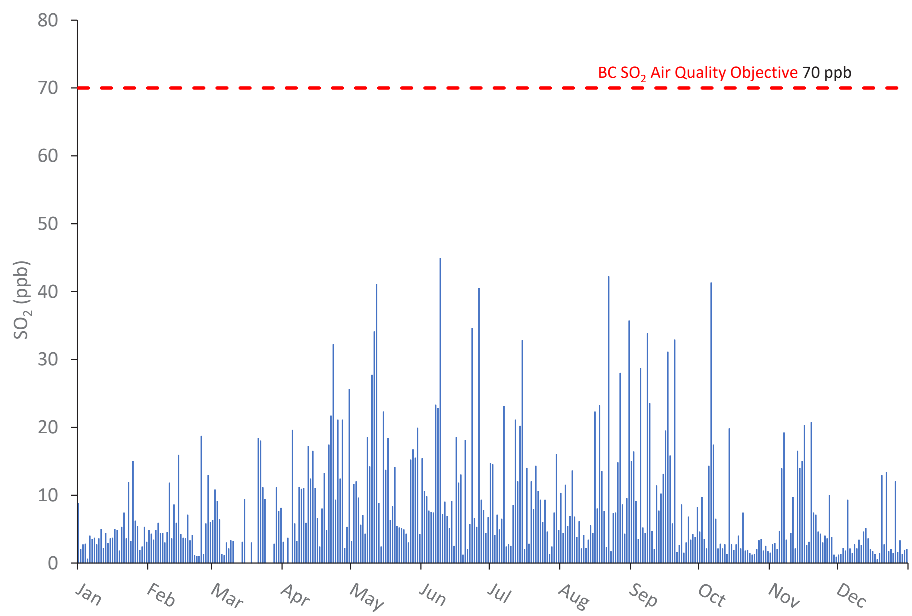


Figure 6.4e

Haul Road SO_2 1-Hour Daily Maximum

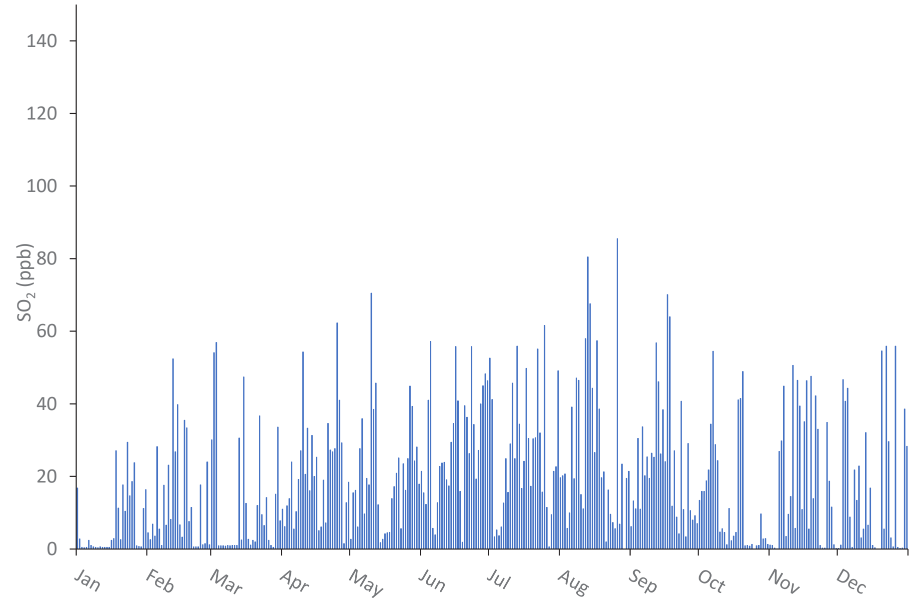
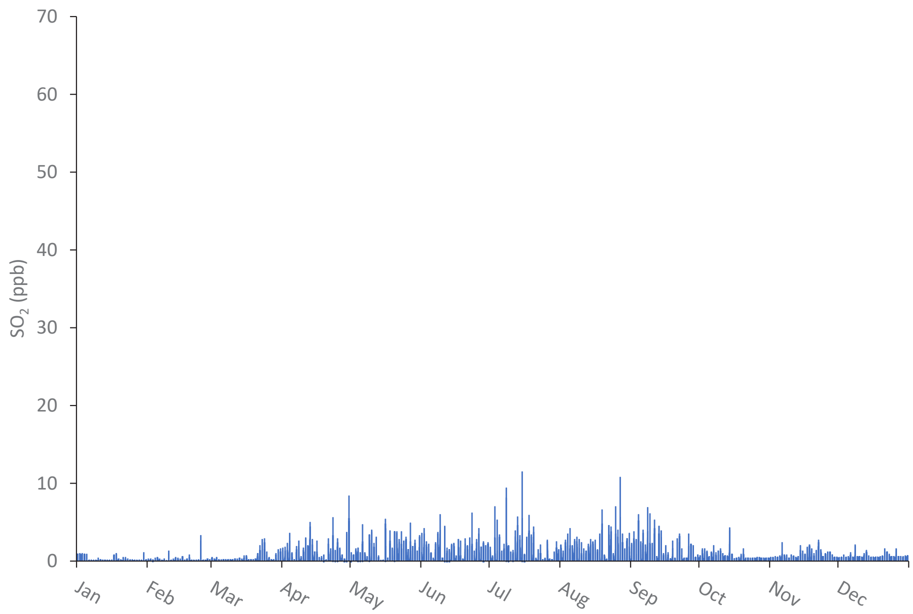


Figure 6.4f

Lakelse Lake Deposition Station SO_2 1-Hour Daily Maximum.



SO_2 enviromental effects monitoring

In 2021, a Comprehensive Review of BC Works' SO_2 EEM program was completed. No exceedances of the KPIs for human health, vegetation, soils and lakes were found and recommendations were provided for consideration in the Phase III monitoring cycle. Links to download SO_2 EEM documents and the Comprehensive Review report can be found on the Rio Tinto BC Works' website. The 2023 SO_2 EEM annual report will be submitted to the Ministry in May, 2024 and will be posted on the Rio Tinto BC Work's website along with the 2024 annual work plans.

Particulate ($PM_{2.5}$ and PM_{10})

Fine particulates have a wide variety of sources, both natural and human caused. In Northern BC, forest fires (prescribed and wild), and emissions from fireplaces and wood burning stoves, are among the major contributors to fine particulates.

In addition to these primary particulate emissions, further contribution occurs due to gas emissions undergoing physical and chemical reactions. Emissions from BC Works, including sulphur dioxide and nitrogen oxides, are among the precursors to these secondary particulates.

Provincial ambient air quality objective for PM_{10} is 50 micrograms per cubic metre (µg/m^3) averaged over 24-hours while the air quality objective for $PM_{2.5}$ is 25 ug/m^3 evaluated at the 98th percentile of the daily average for 1-year.

Permit 100138 requires the reporting for particulate matter to include both daily average and daily hourly maximum concentrations for both $PM_{2.5}$ and PM_{10}. Beyond the required permit reporting, additional statistics for fine particulates are presented in Table 6.2. Charts of the daily average fine particulates for all the reporting stations are provided in Figures 6.5a to 6.5d and 6.6. Average residential $PM_{2.5}$ levels for Kitimat are low, ranging between 3.5 ug/m^3 to 4.9 ug/m^3. Residential stations showed elevated $PM_{2.5}$ levels, with a few days over the 25 ug/m^3 air quality objective in 2023 due to wildfire smoke. PM_{10} data from the Riverlodge station is presented in Figure 6.6.

Figure 6.5a

Riverlodge $PM_{2.5}$ 24-Hour Average

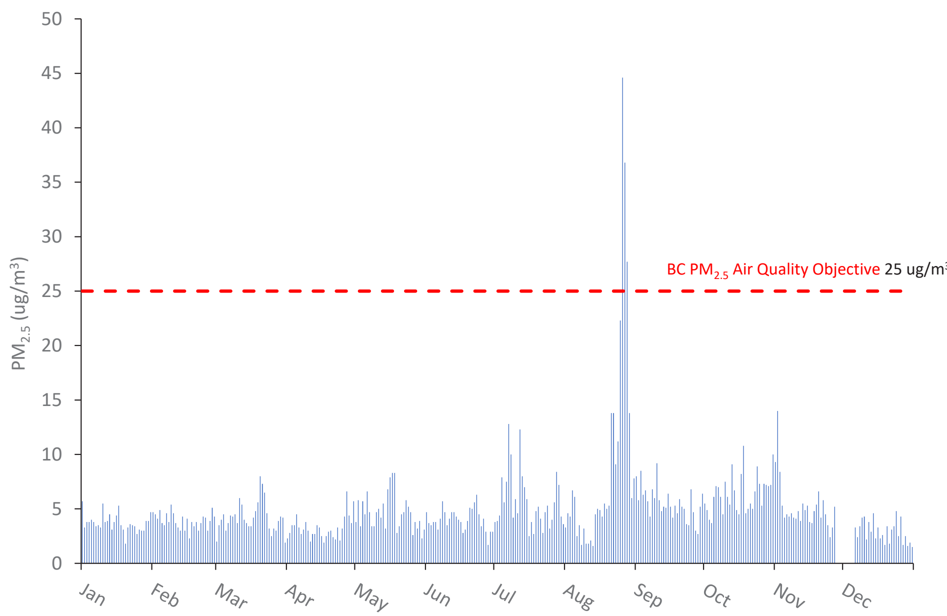


Figure 6.5b

Whitesail $PM_{2.5}$
24-Hour Average

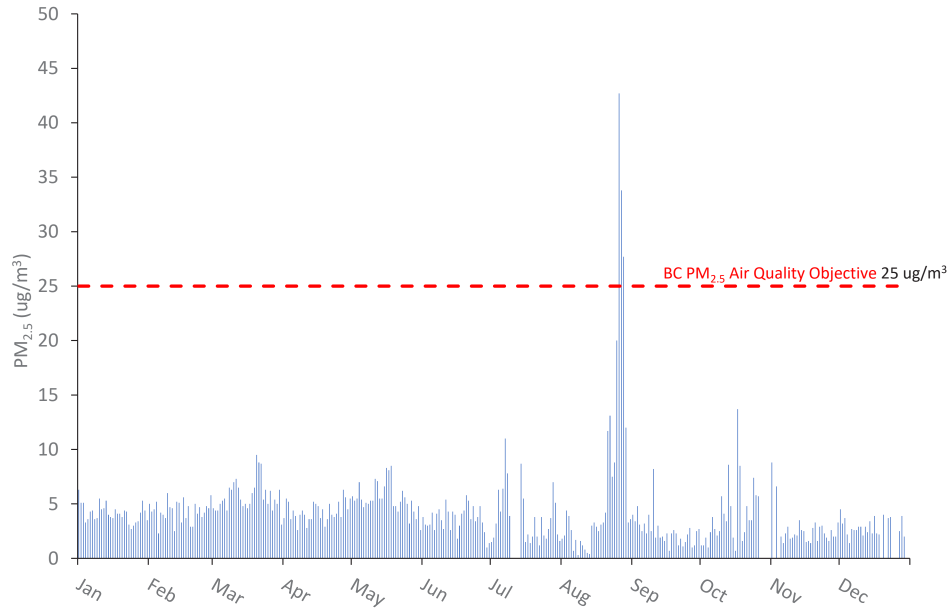


Figure 6.5c

Kitamaat Village $PM_{2.5}$
24-Hour Average

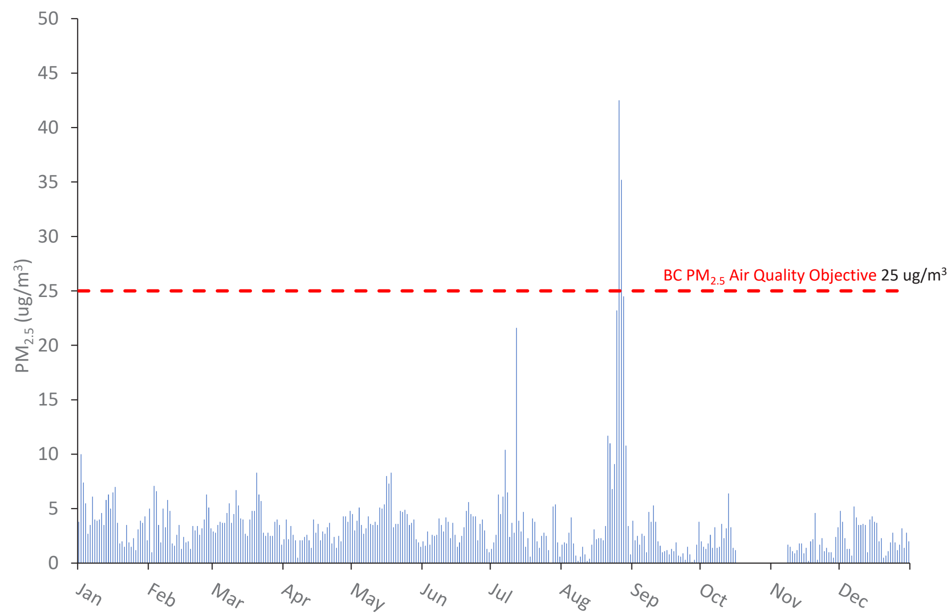


Figure 6.5d

Haul Road $PM_{2.5}$
24-Hour Average

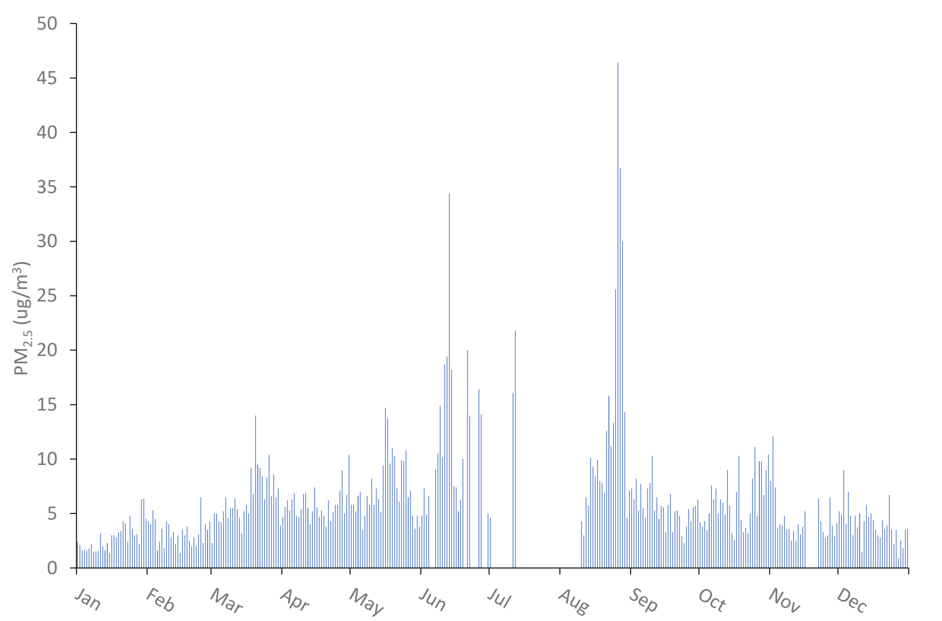
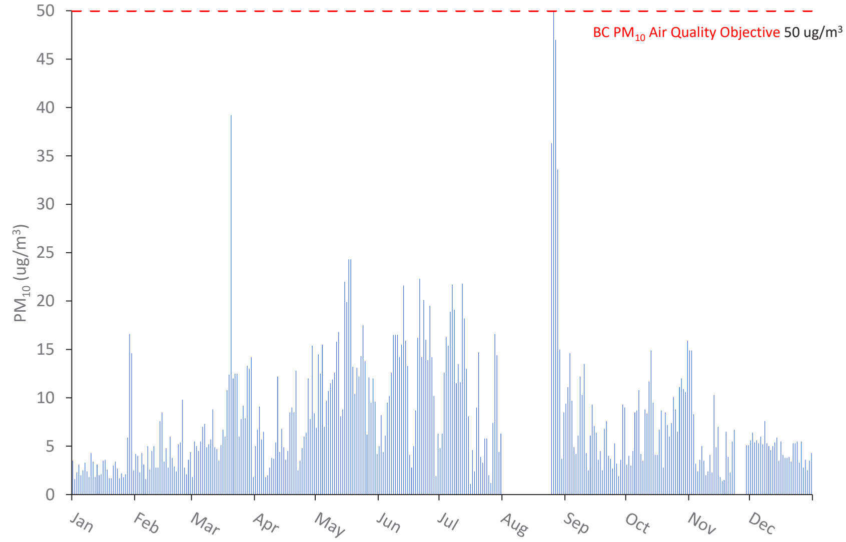


Figure 6.6

Riverlodge PM_{10}
24-Hour Average



Nitrous Oxides (NO_X) and Ozone (O_3)

NO_X and O_3 are monitored voluntarily by Rio Tinto at the Whitesail station in order for an air quality health index to be published by the Ministry. NO_X and O_3 data are presented in figures 6.7 and 6.8, respectively.

Figure 6.7

Whitesail NO_2
1-Hour

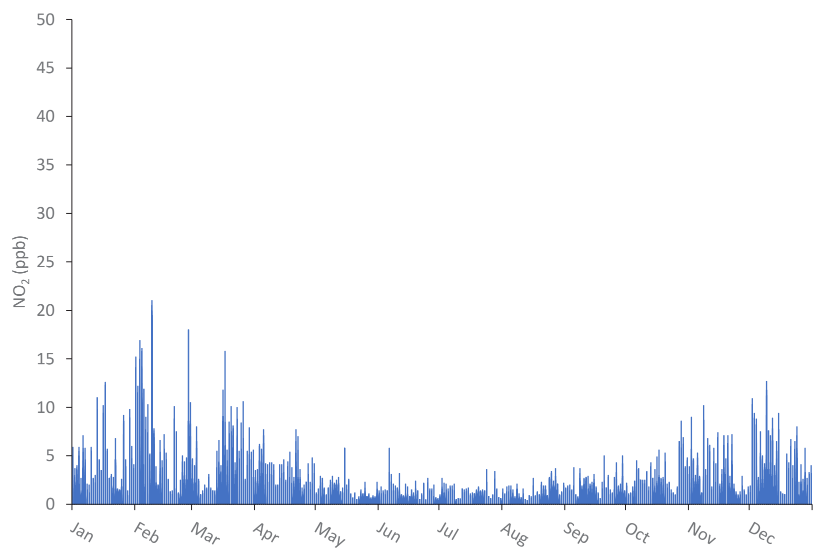
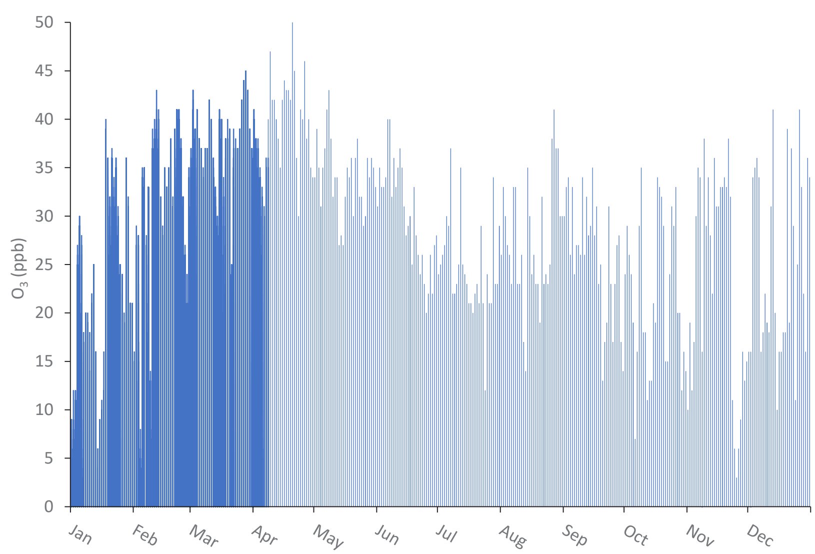


Figure 6.8

Whitesail O_3
1-Hour



Meteorology

Wind direction and wind speed are measured at the air quality stations and Yacht Club meteorological station. Wind roses for 2023 are presented in Figure 6.9a to 6.9e.

Figure 6.9a
Kitamaat Village 2023

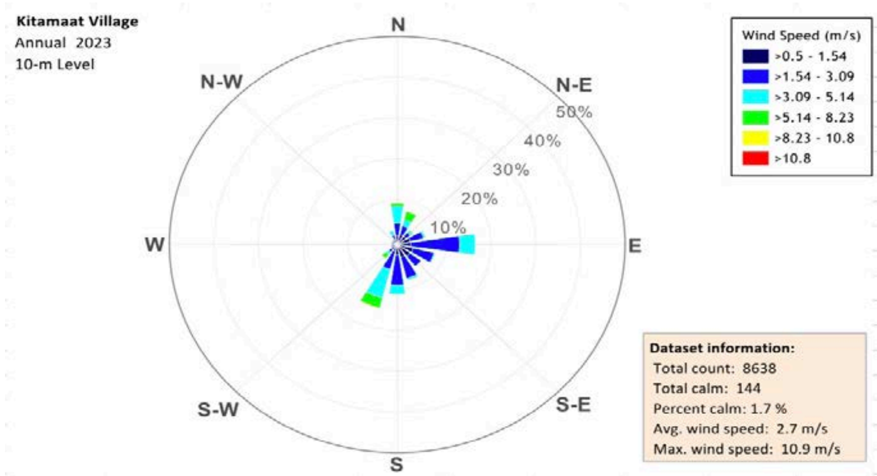


Figure 6.9b
Whitesail 2023

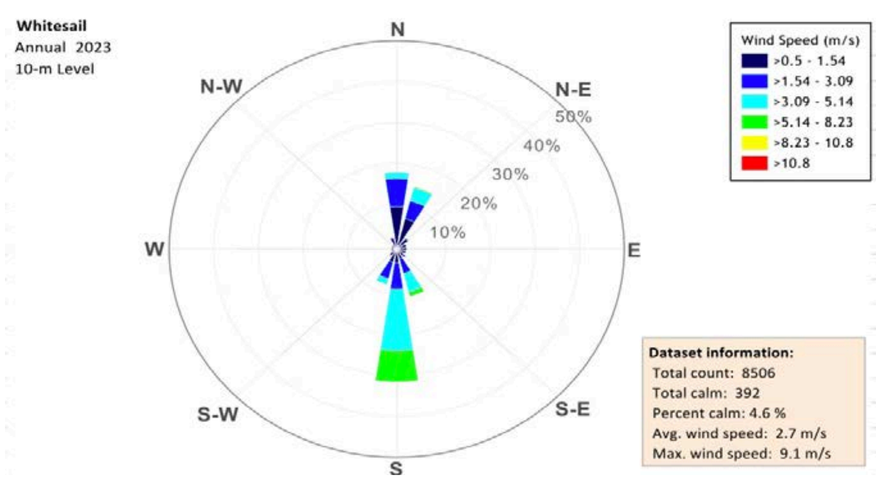


Figure 6.9c
Haul Road 2023

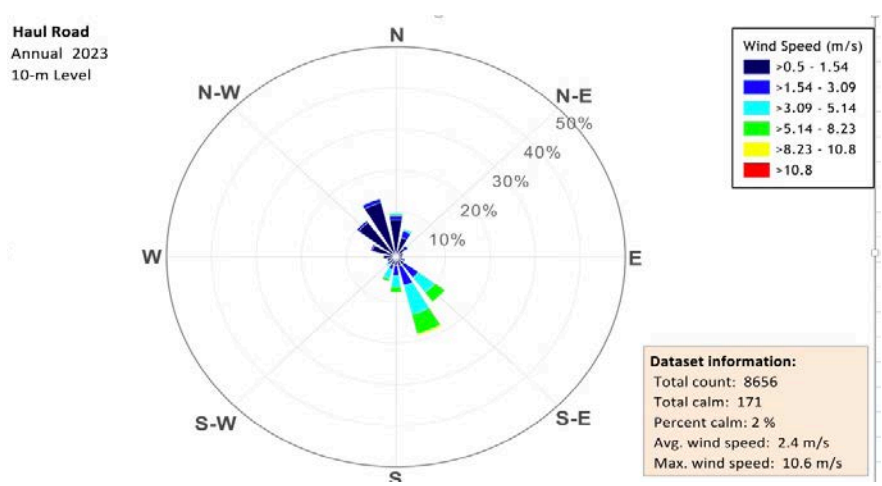


Figure 6.9d
Riverlodge 2023

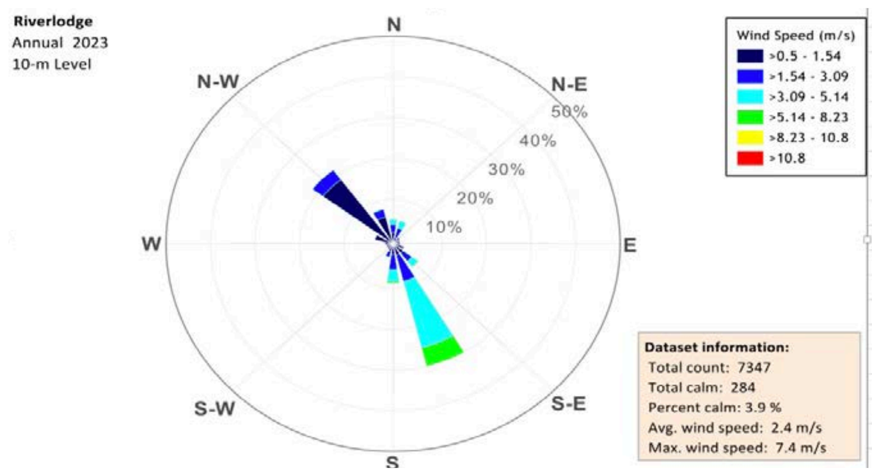
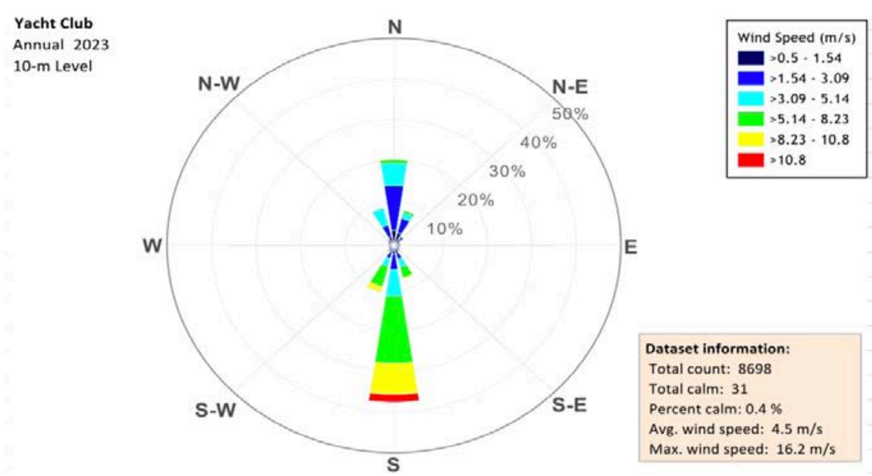


Figure 6.9e
Yacht Club 2023



Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs are generated by the incomplete combustion of organic material. Various procedures at BC Works generate PAHs, in both dissolved and gaseous forms. They occur in emissions primarily as a by-product of the anode manufacturing process; other sources include vehicle exhaust and smoke from forest fires and wood-burning stoves.

Ambient air monitoring is conducted to test for the presence of some of the most common PAHs, although no permit limits exist. Sampling is done on a schedule that is coordinated with the National Air Pollution Surveillance (NAPS) to enable comparison of findings from different monitoring sites. Permit 100138 requires the monitoring of 15 PAH congeners.

The 2023 ambient PAH monitoring results are summarized in Table 6.3. Annual average PAH concentrations observed at Haul Road station was 41.5 ng/m^3, Whitesail station was 5.5 ng/m^3 and Kitimaat Village was 19.7 ng/m^3. In 2023, total PAH concentrations continued to show some degree of variability (Figures 6.10a to 6.10c) when compared to previous years.

The PAH congeners are sorted according to molecular weight. As can be seen in Figure 6.11, over 80% of the PAHs at Haul Road and Kitimaat Village are light molecular weight PAHs. Approximately 70% of the PAHs at Whitesail are light weight PAHs. Changes in distribution of PAH congeners between the stations is not only due to distance from the smelter source, but also photochemical degradation and seasonal contributions of different PAH sources such as vehicle exhaust, petroleum fumes and wood stoves.

Table 6.3

Geometric mean Total 15 PAH Concentrations (2021, 2022 and 2023)

Station	15 PAH Geomean (ng/m³)			2023 15 PAH Statistics (ng/m³)		
	2021	2022	2023	Min	Max	Standard Deviation
Haul Road	5.0	17.3	29.2	5.9	171.1	37.1
Whitesail	2.2	3.7	5.0	2.3	12.6	2.3
Kitimat Village	3.2	5.1	18.1	6.2	50.4	8.0

Figure 6.10a

Kitamaat Village Total 15 PAH 2023

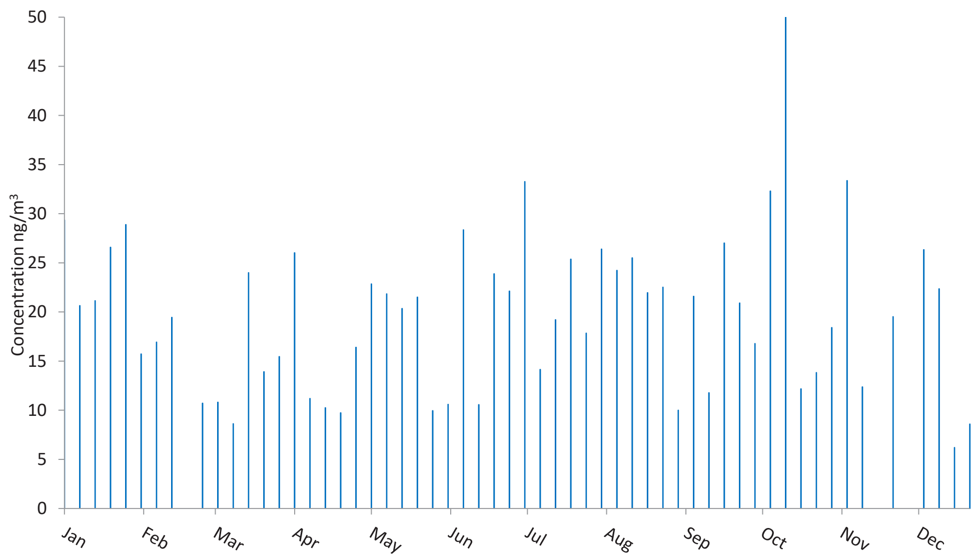


Figure 6.10b

Whitesail Total 15 PAH 2023

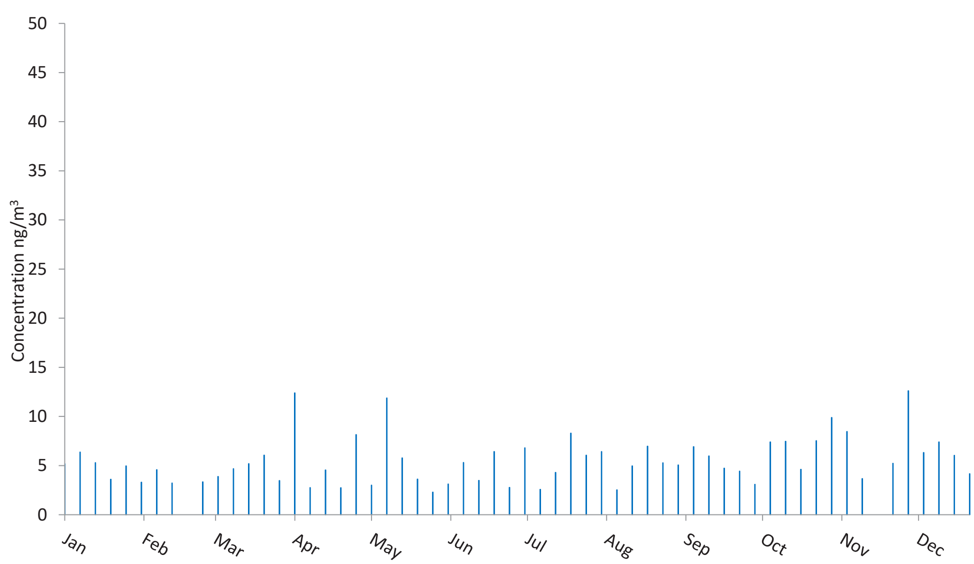


Figure 6.10c
Haul Road
Total 15 PAH
2023

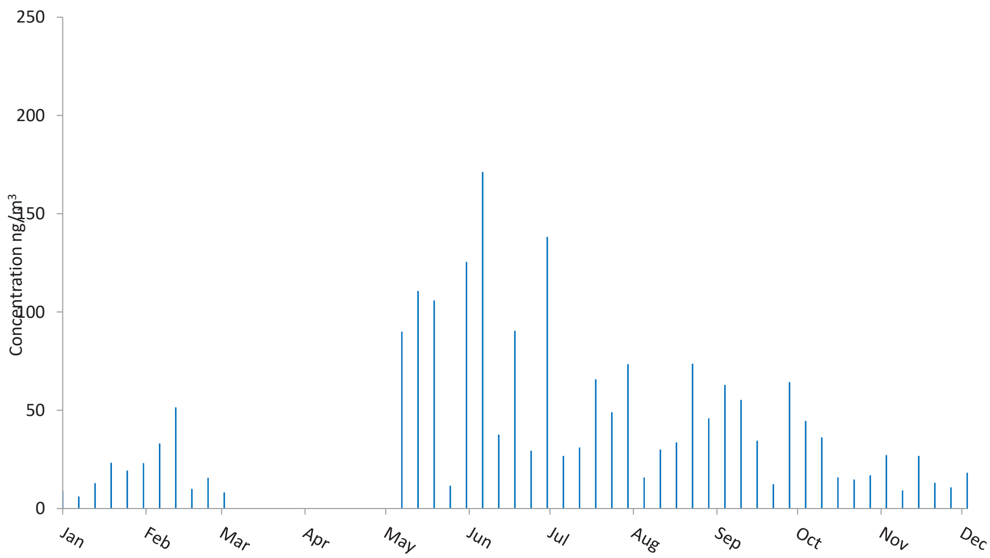


Figure 6.11
PAH Congener
Distribution
2023

Rain chemistry

Precipitation samples are collected on a weekly basis from the Haul Road and Lakelse Lake Deposition stations. Rain chemistry monitoring has been conducted since 2000 and was expanded to include Lakelse Lake in 2013. Total precipitation depths are presented in Figure 6.12a. Samples are assessed for rain acidity and concentrations of 11 specific substances. Weekly measurements with data available at the time of this report's preparation (October 1st, 2022, to September 30th, 2023) are presented in Figures 6.12b to 6.12e. Precipitation chemistry is used in the SO_2 EEM program to estimate the amount of sulfate and base cation deposition in the Kitimat Valley.

Figure 6.12a

Haul Road and Lakesle Lake Precipitation Depths 2023

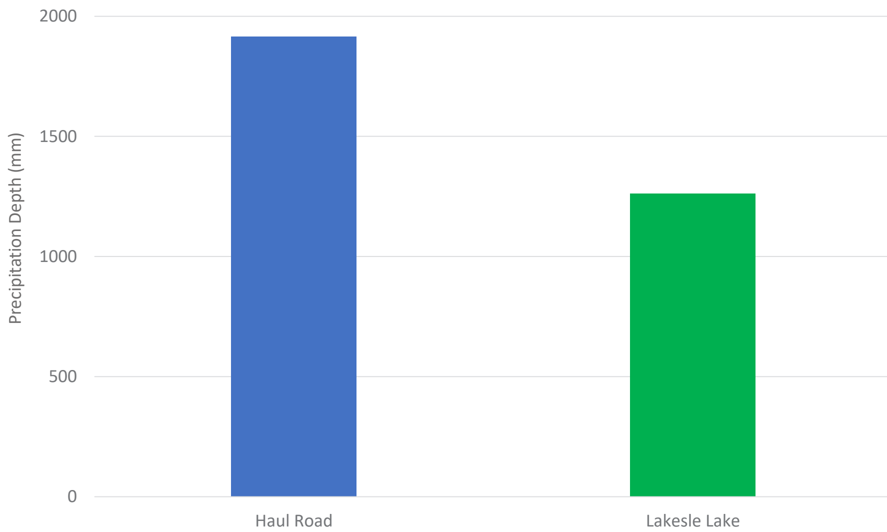


Figure 6.12b

Haul Road and Lakesle Lake Precipitation pH 2023

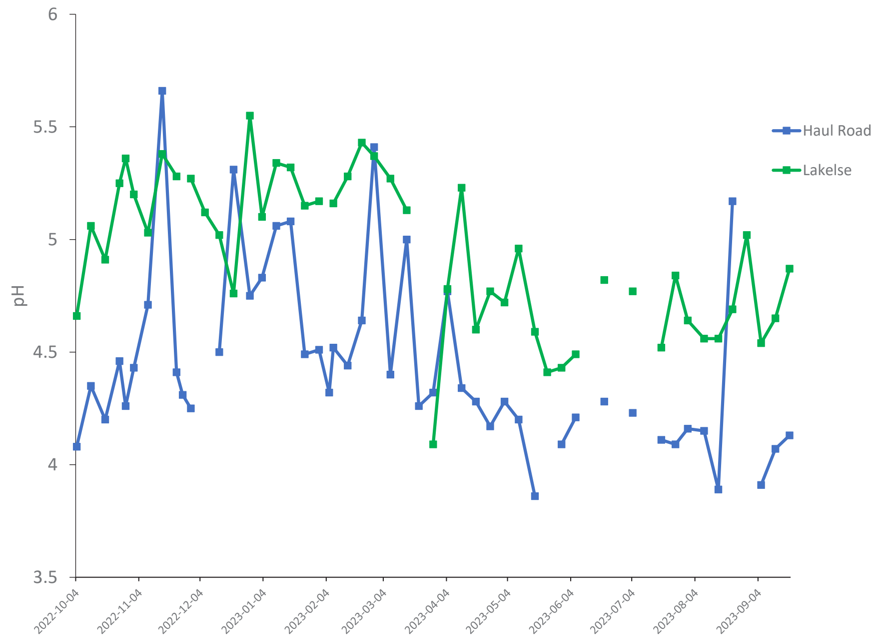


Figure 6.12c

Haul Road and Lakesle Lake SO_4 Concentration in Precipitation 2023

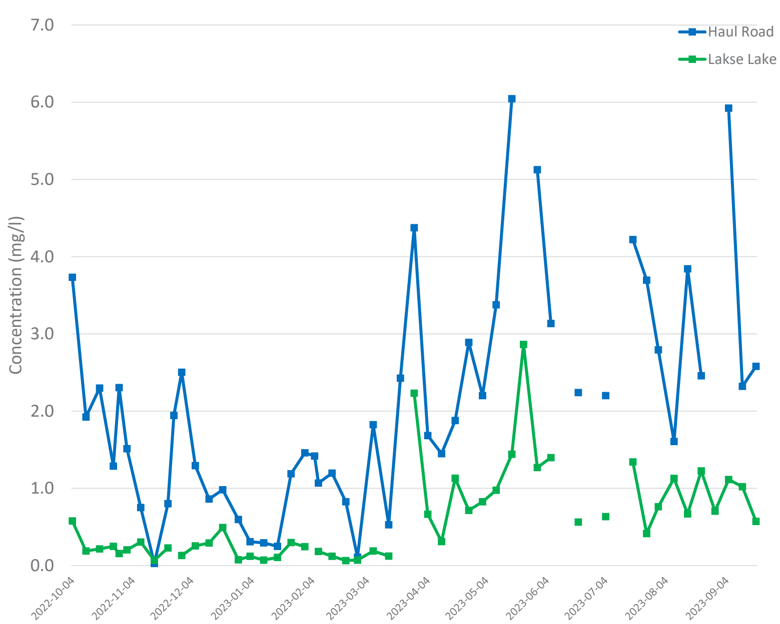


Figure 6.12d

Haul Road Precipitation Chemistry Base Cations 2023

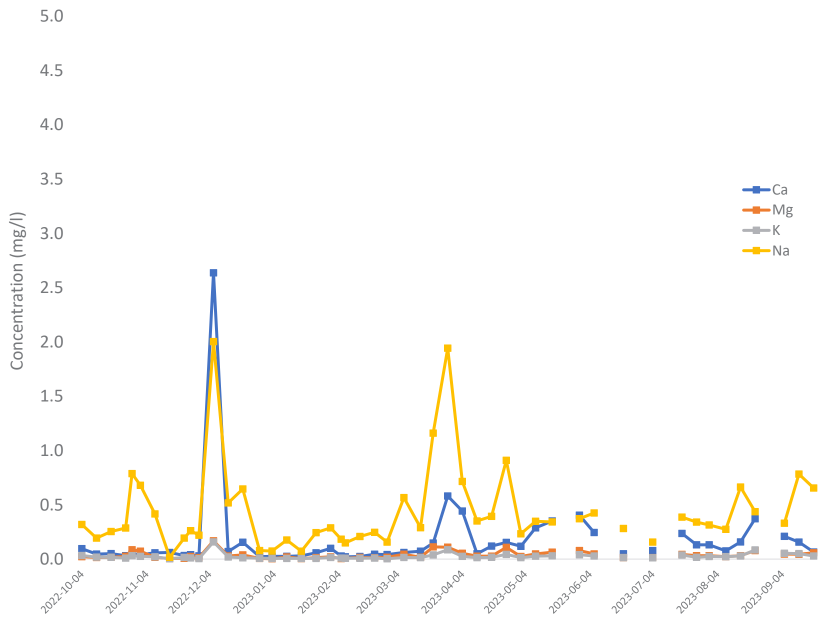
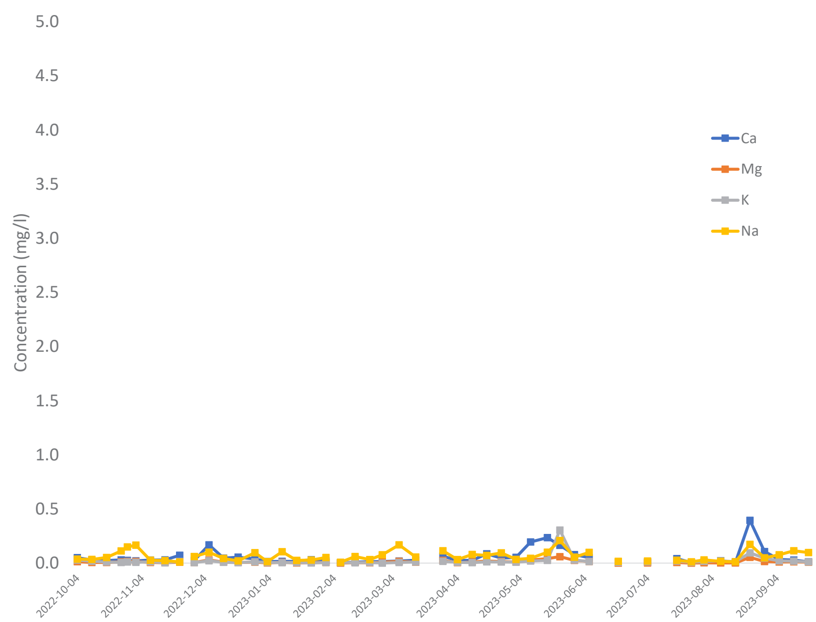


Figure 6.12e

Lakesle Lake Precipitation Chemistry Base Cations 2023



Percent data capture

Most parameters (air quality and meteorological) met the data capture goal of 90% for the year (Table 6.4). The Whitesail SO_2 percent data capture was 86.8% due to issues with analyzer stability in April and May. Several components were replaced until readings ultimately stabilized. The Haul Road $PM_{2.5}$ percent data capture was 88.1% due to an intermittent malfunction of the ambient temperature sensor attached to the $PM_{2.5}$ monitor. Additional systems were put in place to analyze this temperature data more closely, each business day, and a replacement of the sensor resolved the issue. The Riverlodge HF percent data capture was 86.9% due to intermittent issues with maintaining power delivery to the sample line heating coil. A faulty GFCI outlet was determined to be the cause. Lastly, the Riverlodge wind speed and direction percent data capture was 83.9% due to the wind direction sensor failing during winter. Currently, the sensor can only be accessed via man-lift operation, and significant delays were encountered until fair weather conditions permitted the sensor to be replaced safely in February of 2024. The Whitesail pressure percent data capture was 64% for the year as the pressure sensor was added voluntarily by Rio Tinto on May 12th, 2023.

Table 6.4 2023 Percent Data Capture

				Residential		
Parameter (% Data Capture	**Fence line Haul Road**	**Industrial Avenue**	**Lakelse Lake Desposition Station**	**Riverlodge**	**Whitesail**	**Kitamaat Village**
SO_2	94.8	93.0	95.3	94.2	86.8	95.1
$PM_{2.5}$	88.1			97.4	95.2	92.5
PM_{10}				91.8		
HF	93.8			86.9		
NO_X					94.7	
O_3					94.6	
Wind Speed and Direction	98.8	98.1		83.9	97.1	99.3
Temperature	100	96		99.1	99.4	100
Relative Humidity		95.7			99.4	
Pressure					64.0	
Precipitation	100		99.9			

Data validation

The data validation process involves actions and decisions which result in the transition of the as-collected data to a final dataset with an established level of data validity. Level 0 data are obtained directly from the instrument with no modifications.

Level 1 data features the primary removal of data values. Data is removed when a malfunction is present, and it is clear the instrument is not functioning within procedural tolerances. This may include, but is not limited to, power outages, wildlife damage, instrument failure, communication issues, and severe weather. Data is removed when maintenance or automated checks occurred. Cross-references are made between station log entries and manually flagged data. When retrievable, missing data is backfilled anytime the primary collection system failed. Data is removed if automated checks, field calibration checks, or audits indicated the instrument was operating outside of acceptable tolerance levels. Valid data must withstand the criteria outlined in the BC Field Sampling Manual Part B and CSA R101:22 documents.

Level 2 data is the product of the final review process. Data is viewed on time-series plots and compared against independent datasets, such as collocated parameters and parameters from nearby stations. Data is returned to the level 1 process if anomalies are detected. Data are accepted as valid after a final reviewer has examined all justifications for removing data and performed their independent comparison of datasets.

Instrument performance evaluation

Proper siting of ambient air quality monitoring stations is essential to accurately measure gases in the area without bias induced by highly localized environmental factors. Each air quality monitoring station in the Kitimat ambient air network consists of a climate-controlled shelter, which protects equipment from precipitation, rodents, fluctuations in temperature and humidity, vandalism, and excessive dust or dirt. The shelter temperature is maintained between 20 and 30 degrees Celsius (°C) and needs to be stable within ± 2 °C across each 1-hour period. Sample inlets are installed at a minimum height of 2 metres (m) above ground level, and are not installed near building ventilation, HVAC systems, frequently disturbed dust sources, or any other exhaust sources that may interfere with accurate ambient readings.

Routine inspections are performed to ensure monitoring equipment is operating properly as intended. Preventative maintenance is performed, as necessary, which includes shelter integrity checks, routine filter replacements, manifold checks, equipment checks, supply stock checks, and station temperature checks. A non-conformance occurs when manufacturer specifications, or specifications within the B.C. Field Sampling Manual, cannot be met. All non-conformances are investigated to identify the root cause of the failure, documented, a corrective action is implemented, and a corrective action report is sent to the ENV.

Daily zero and span verification checks are conducted on the air quality analyzers. Multi-point verification checks on gas analyzers occur after installation, bi-annually, before and after analyzer maintenance, prior to calibration, prior to shut-down, when zero or span checks indicate a need for calibration, and when instrument behavior indicates a potential problem. A calibration occurs anytime a multi-point verification falls outside of acceptable criteria. Ozone analyzers are calibrated using a calibrator with a UV photometer. Zero-air supply systems that utilize scrubbing media and filters are regularly maintained. Gas cylinders at ambient air monitoring sites are stored to prevent contamination with water. If contamination occurs, the gas cylinder is removed and replaced.

Monthly flow and leak checks are conducted on the PM_{10} and $PM_{2.5}$ monitors using a flow metre which has been calibrated or certified annually against a National Institute of Standards and Technology (NIST) traceable standard. In addition, each PM_{10} or $PM_{2.5}$ sampler's temperature and barometric pressure are also verified during the monthly flow and leak check using certified temperature and pressure standards.

Meteorological field calibration verification checks occur semi-annually to ensure that measurement accuracy is within the manufacturer's specifications. Field verification refers to the process of comparing the measurements by instruments installed with measurements taken by independent devices. Field verifications are conducted using certified instruments brought to the site for the sole purpose of verification.

Independent instrument performance audits are performed by the British Columbia Ministry of Environment and Climate Change Strategy to provide confidence that the data gathered are accurate and of adequate quality for use in environmental decisions.

7. Vascular plant & cyanolichen monitoring

The vascular plant and cyanolichen monitoring program was developed in 2020 and implemented in 2021 following the recommendations of the 2019 comprehensive review of the SO_2 EEM program.

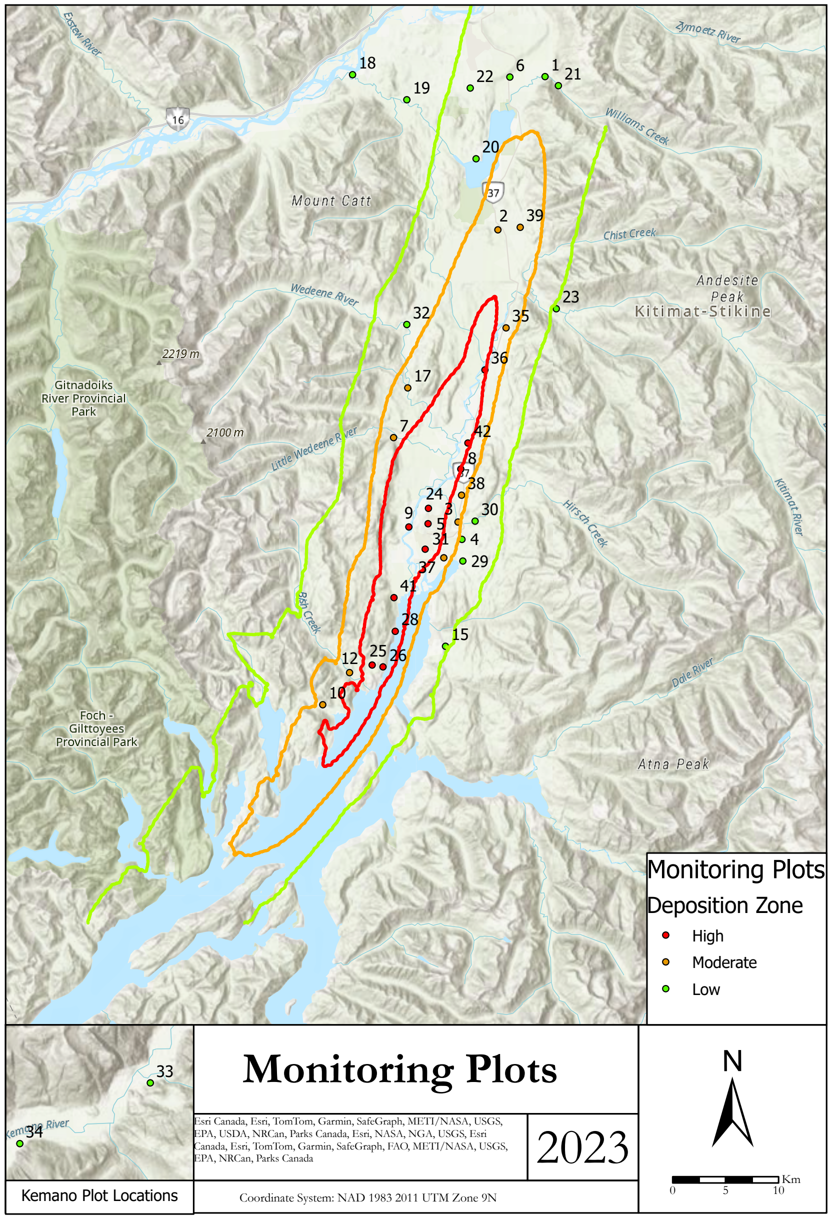
Background

BC Works emits fluorides and sulphur dioxide as byproducts of the aluminium smelting operations (See Chapter 5 – Emissions). The fluoride gas and sulphur dioxide can be absorbed by vegetation and depending on the concentration it may affect plant growth and overall plant health. BC Works has been monitoring vegetation since 1970's for fluoride, as this was one of the main air emissions of the old VSS smelter; in 1984, sulphur monitoring in vegetation was added to the program. Therefore BC Works has one of the largest historical databases of this type in British Columbia. Based on the findings of the 2019 SO_2 EEM Comprehensive Review, the Vegetation Monitoring program was re-structured to develop a terrestrial line of evidence integrating the vegetation and soils (the "BC Works SO_2 Environmental Effects Monitoring Comprehensive Review – Synopsis" can be downloaded from www.riotinto.com/en/operations/canada/bc-works). The vegetation monitoring program adopted many pre-established locations from the ministry of environment and climate change monitoring program for use in the vascular plant and cyanolichen biodiversity monitoring program.

This program seeks to provide an indication of whether future SO_2 emissions from BC Works is causing changes to the number of species and structure of cyanolichens, the number of species and percent cover of vascular plants in the low shrub and herb layer as well as plants

Figure 7.1

Monitoring Plot Locations.
The 33 monitoring plots are distributed across high, moderate and low deposition zones across the Kitimat – Terrace Valley. 2 plots are located in the Kemano Valley.



identified as culturally important. The overall health of vascular plants is also document at each location. The locations of plots are distributed fairly evenly across 3 sulphur deposition zones (High: >7.5 kg SO_4^{2-}/ha/year; Moderate: ~ 7.5 kg SO_4^{2-}/ha/year; Low: <2.5 kg SO_4^{2-}/ha/year), each year for up to 3 years 10-12 sites will be monitored and the same sites will be re-monitoring on a rotating 3 year basis (Figure 7.1).

Program overview

Sites are assessed for general site information, vascular plant biodiversity assessment, cyanolichen biodiversity assessment, plant health assessment and soil sampling. In 2021 the first year of the monitoring program was conducted at 10 sites of the 35 plots, in 2022 the monitoring program was conducted at 14 sites of the 35 plots and in 2023 the final 11 plots of the monitoring program were visited (Table 7.1).

Table 7.1

Monitoring plots per year.
The same monitoring plots will be revisited every three years to understand potential changes to species structure.

Monitoring Year	Biodiversity Monitoring Plots
2021	B4, B9, B10, B12, B17, B20, B22, B26, B30, B32
2022	B1, B2, B3, B5, B7, B8, B15, B21, B24, B25, B27, B29 BK33, BK34 (Kemano control plots)
2023	B6, B18, B19, B23, B31, B35, B37, B38, B39, B41, B42

2023

In 2023, plot assessments were conducted by a minimum crew of four persons, variably composed of Meagen Grossmann and Aleezah Arif (Rio Tinto); Dr. John Laurence; Desiree Bolton, Dalace Bennet and Nathan MacMillan (Wai Wah Environmental); Amanita Coosemans and Frank Doyle (Balanced Ecological Management Company). No plots were lost or damaged by human or natural disturbances and all sites were accessed as planned. Each field day 4 personnel would participate in plot data collection would included activities such as overall percent cover (Figure 7.3), as well as line transect vegetation measurements (7.2).

Figure 7.2

Field Crew at plot B38.
When conducting overall cover assessments it can be helpful to involve the entire team in complex plot for identify the percent cover of a single species in a 20 x 20m plot.

Figure 7.3

Lichen & Transects.
A Loberia species is photographed on a tree while the line transect measuring tape is seen in the background.

Next steps

2024 will be the first year of the program that revisits plots, starting with the 11 plots assessed in the 2021 monitoring year, and will be the first year of the program where data on differential trends can be presented.

For the annual reports (2021, 2022, & 2023) only baseline data was presented as no trend analyses were possible yet, however the first end of year cycle report (summary from 2021, 2022 & 2023) will be completed. The annual monitoring report can be found on the BC Works website with the submissions for the Rio Tinto SO_2 Environmental Effects Monitoring Program (www.riotinto.com/en/operations/canada/bc-works).

8. Waste management

The operation of the smelter results in the generation of various solid and liquid wastes. Appropriate management of these wastes is a central part of BC Work's operating strategy with the objective of limiting the smelter's environmental footprint.

Introduction

In August 2010, the multimedia permit was amended to allow for the disposal of KMP non-hazardous related wastes into the south landfill.

The amendment is inclusive of the design, operation and closure phases. The appropriate procedures for handling, storage and disposal of these wastes are in place and are reviewed as changes in operations occur.

Waste management procedures ensure full compliance with requirements related to regulated hazardous wastes and additional materials deemed to be hazardous by BC Works.

Opportunities for waste reduction and for improvements in waste handling are assessed and implemented on a continuous basis. In particular, opportunities to recover, reuse, and recycle waste materials are pursued whenever feasible. On-going practices include reducing raw material usage, thus reducing demand on the landfill and contributing to reducing the overall impact on the environment.

Waste management activities are tracked and reported. All waste types including those disposed at the South Landfill (i.e. inert industrial waste, asbestos materials, contaminated soil, and putrescibles), monthly wood waste and hazardous waste externally disposed or sent for recycling are reported in compliance with the permit requirements.

2023 performance

Spent potlining

Spent potlining (SPL) is a hazardous waste material produced at BC Works as a result of the disposal of the carbon cathode after years of smelting.

During 2023 approximately 5500 metric tonnes of SPL was generated and shipped off-site. The material was sent to the Spent Potlining Recycling Plant located in Saguenay, Quebec where the material was treated and recycled.

Asbestos and Refractory Ceramic Fibres (RCF)

Asbestos and refractory ceramic fibres (a less hazardous substitute to asbestos) are used for insulation. These materials are considered by BC Works to be sufficiently hazardous to require special disposal methods.

In 2023, no asbestos or ceramic fibers materials were sent to the North and South Landfill.

Wood waste

Wood waste is collected from around the smelter site on a regular basis and sent to a wood containment area. Wood is burned once sufficient volumes have accumulated at the containment area. In 2023, 152 metric tonnes of wood was burned via air curtain incinerators.

South Landfill management

In 2023 the landfill closure team completed the final stage of capping of the South landfill. There was no material landfilled in the South landfill 2023.

As part of the requirement of the P2-00001 Multi-Media Permit related to the South Landfill, Rio Tinto completes and Environmental Effects Monitoring program (South Landfill EEM) annually. The overall objective of the ongoing South Landfill EEM program is to evaluate the health of the receiving environment which is potentially impacted by the landfill.

The overall conclusion of the 2023 South Landfill EEM program was that there was a low risk to ecological receptors due to impacts from the South Landfill. These results were based on consideration of chemistry, toxicity tests, and benthic community. In 2024 Rio Tinto will move into the next phase of monitoring referred to as the South Landfill Closure Receiving Environment Monitoring Program.

9. Groundwater monitoring

Long-term initiatives are underway with objectives to further reduce groundwater impact and identify disposal and treatment options for stored materials.

Introduction

A variety of monitoring programs are conducted relating to groundwater quality and flow in the vicinity of BC Work's Kitimat landfill sites that are, or have the potential to be, a source of contamination. Long-term initiatives are underway with objectives to further reduce groundwater contamination and identify disposal and treatment options for stored materials.

2023 monitoring results

Spent potlining landfill

The spent potlining landfill is comprised of three separate subsections formerly used to dispose of spent potlining (SPL). The landfill is located south of Potroom 1A and north of the Anode Paste Plant (refer to Kitimat Operations map Figure 2.1).

Prior to 1989, approximately 460,000 m^3 of SPL were disposed of at the landfill site as per permit limits. The landfill was decommissioned in the fall of 1989 and initially capped with a low permeability cover. Over the next decade the three subsections were capped with polyvinyl chloride (PVC) liners. The capping significantly reduced surface water infiltration, thus reducing contaminant loading into the environment.

Groundwater monitoring has been carried out in accordance with the requirements of the multi-media permit and the SPL management plan. Estimates of annual contaminant mass loading to Kitimat Arm were prepared for fluoride, SAD-cyanide, dissolved aluminium, and dissolved aluminium. These estimates are based on estimated groundwater flux through a rectangular cross-section across the SPL plume immediately up gradient of the Yacht Basin, coupled with measured contaminant concentrations in groundwater within this cross-section.

Estimated groundwater flux for 2023 was 242,398 m^3/yr.

The 2023 mass loading estimate for fluoride was 15,734 kg/yr. This represents a 26% decrease from 2004 to 2023.

The 2023 mass loading estimate for SAD-cyanide was 87 kg/yr. This represents an 57% decrease from 2004 to 2023.

The 2023 mass loading estimate for dissolved aluminium was 528 kg/yr. This represents a 10% decrease from 2004 to 2023.

The 2023 mass loading estimate for dissolved iron was 441 kg/yr. This represents a 29% decrease from 2004 to 2023.

SPL overburden cell

The SPL overburden cell is located North of Anderson creek. The SPL material is composed of approximately 10,500m^3 of overburden material that came from the eastern lobe of the SPL landfill in 1996. The overburden cell was originally lined with a Claymax liner that has since been replaced several times, with a synthetic liner most recently in 2010.

The SPL overburden cell have a double membrane lining system that collects water between the primary and the secondary liners. This water is tested and pumped out on a regular basis. In 2023 approximate 4000 litres of water was pumped from the two sumps of the SPL overburden cell.

Dredgate Disposal Site (DDS) landfill

In 2018 the Dredgate Disposal Site was commissioned and utilized by the project team leading the Terminal A expansion. Over the course of 2018 and 2019 there was 53,474m^3 of IL+ sediment that was dredged and placed in cell as of Dec 31, 2019. In 2020 the IL+ cell was capped and closed as per the design drawings and closure plan. Groundwater for the cell was measured for a number of analytical different parameters. In 2022 the final sampling requirements for the cell were completed as per the closure plan. All Groundwater analytical results in 2022 met the P2 permit limits and Contaminated Sites Regulation Aquatic and Marine standards with the exception of the up gradient monitoring well closest to the lagoons.

10. Kemano permits

BC Works Kemano facility is the hydroelectric power station that supplies electricity to BC Works.

Introduction

Up until 2000, Kemano Operations included a town site with a resident population of 200 to 250 people. At that time the powerhouse was automated which reduced the operations and maintenance personnel to rotating crews of 20 to 30 people.

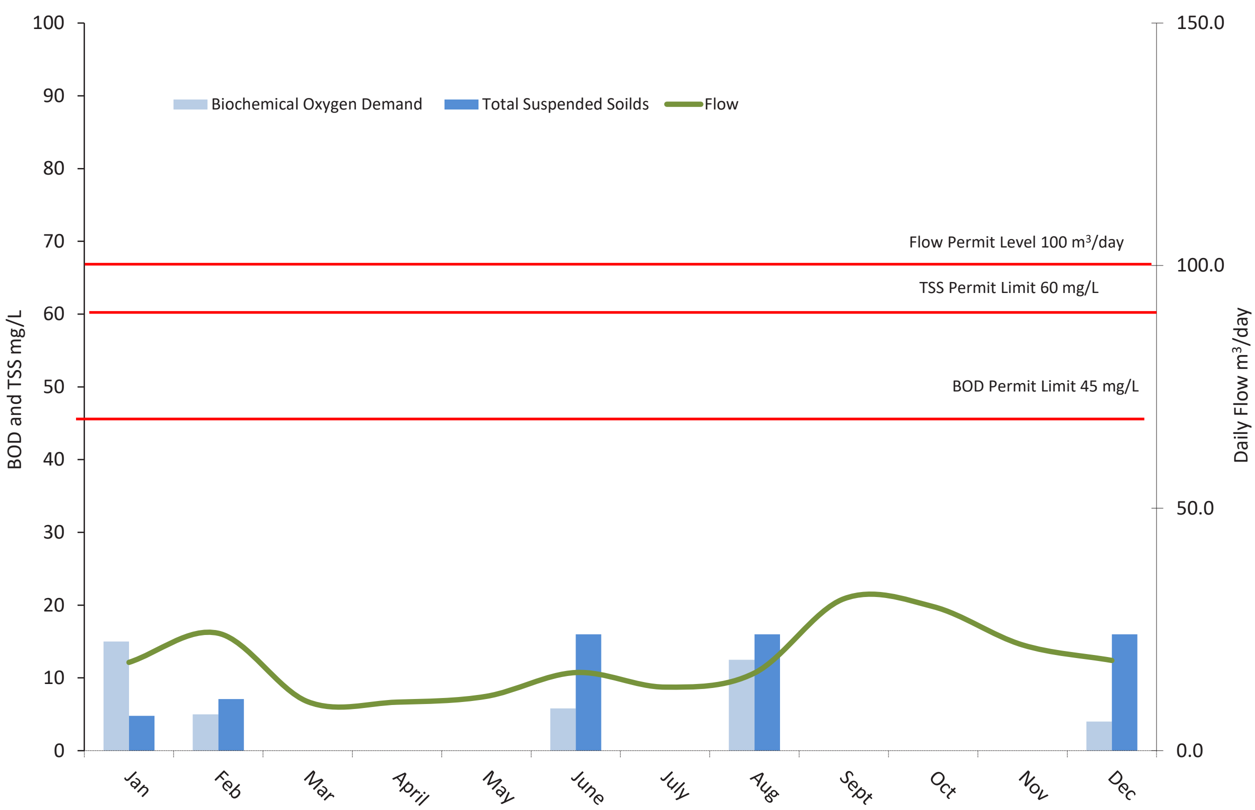
2023 performance

Kemano effluent discharge

The Kemano sewage treatment plant and several septic tanks in the area surrounding Kemano have effluent discharge permits. The discharges consist of treated sewage and are subject to permit requirements with respect to Biological Oxygen Demand (BOD) levels and concentrations of TSS. BOD is an indirect measure of the concentration of biodegradable matter, while TSS is a direct measure of suspended solids.

In 2023 all effluent discharge permit measurements were in compliance (Figure 10.1).

Figure 10.1
Effluent discharge, Kemano 2023



Kemano emission discharge

An incinerator is used to burn municipal-type waste generated by rotating crews while residing at Kemano Operations. The incinerator is a double-chambered, fuel-fired, forced air unit. The permit requires that the exhaust temperature of the Incinerator remain above 980°C and in 2023 permit requirements were in compliance. The Incinerator permit allows up to 1000 m^3 of domestic waste to be processed and in 2023 the total volume was 472 m^3 for the year.

Kemano landfill

Non-combustible refuse and ash from the incinerator is buried in a landfill near Kemano. The landfill permit limits the amount of material to an annual maximum of 300 m^3. In 2023 8.5 m^3 of ash and refuse was buried.

Treated sludge from the sewage treatment plant, septic tanks and biological containers are also deposited in the same landfill. Filtration ponds are used to de-water the sludge before disposal. The permit allows for disposal of up to 900 m^3 of treated sludge per year. In 2023 49 m^3 of sludge was disposed of.

Seekwyakin camp effluent discharge

Seekwyakin construction camp, located three kilometres north of Kemano, was historically used by West Fraser Timber Co. Ltd. and BC Works. Effluent sewage discharges from the camp require a permit when the camp has more than 25 residents. In 2019 the Seekwyakin treatment plant was decommissioned and no longer discharging to the drain field.

11. Summary of non-compliance and spills

In 2023, BC Works reported four non-compliant conditions to the BC Ministry of Environment and Climate Change Strategy for the Kitimat Smelter operations.

2023 performance

Non-compliance summary

In 2023, four non-compliances were reported to the BC Ministry of Environment and Climate Change Strategy. These non-compliances are summarized with a brief description of their causes and the corrective actions that are either being assessed or implemented at the time this report was prepared (Table 11.1).

Table 11.1 Summary of non-compliances, 2023

Occurrence date	Non-Compliance	Permit Requirement	Cause	Corrective Actions
December 31, 2022	Missed a PAH sample at the Kitimaat Village station.	PAH data reported on NAPs cycle.	PAH sample supplies shipment was delayed due to weather conditions, causing insufficient media to deploy a sample on NAPs day at Kitimaat Village station.	1) Acquired additional cartridges to prevent unplanned outage 2) Implemented weekly inventory check
January 15, 2023	B lagoon composite sample pH result below permit limit.	B lagoon pH permit limit = 6.0 - 8.5	Potential contamination after the sample was collected as there were no other lab results or continuous monitoring data indicating low pH levels. All other samples for the month were within the permit limit. Continuous monitoring equipment is calibrated and up to date, and there was no pH alarm on the day of occurrence.	1) Requested lab to reanalyze the sample and another sample from the same day 2) Reviewed maintenance status of continuous monitor
April 3, 2023	Late upset reporting for FC-3.	Notify within one business day.	Lack of awareness of the reporting requirement.	1) Reinforce with the supervisors of the area the bypass/upset procedures, as well as the RACI. 2) Confirm with area Supervisors that everyone has access to the upset folder and provide access if they don't.
June 12, 2023	Late bypass reporting for C38-DC-3 (B553).	Notify within one business day.	Lack of clarification of reporting requirements for bypass and upset on dust collectors.	1) Reinforce the definition of bypass and the dust collector requirements with the area's superintendent. 2) Procedure and logbook were reviewed to identify gaps.

Spill summary

Spills at BC Works are first reported to the Plant Protection Department and subsequently to the Environmental Department. Regulatory requirements are in place to report certain types of spills to the Ministry of Environment (referred to as "reportable" spills), depending on the nature and volume of the substance spilled. In 2023, ten spills were reported to the Ministry (Table 11.2).

Spill-related awareness and prevention is a major focal point throughout BC Works. Immediate containment and minimization of potential environmental damage is the first priority. Specially equipped response teams are available when required. If appropriate, other agencies are informed, and their cooperation is enlisted.

Investigations and root cause analysis of reportable spills are conducted to prevent recurrence, and a system is maintained for recording and reviewing all spills and their frequency by type. This ensures that appropriate corrective actions are identified and tracked through to completion.

Table 11.2 Summary of Reportable Spills, 2023

Occurrence	Substance	Amount	Environmental Media	Cause	Corrective Actions
January 6, 2023	Charged Alumina	~ 100 kg	Paved ground	The unloading spout failed to shut off automatically while the tank was being filled.	1) The spill was cleaned up using a vacuum truck. 2) The shutoff valve was repaired.
February 23, 2023	Fluorinated Alumina	~ 227 kg	Gravel	The valve was not closed all the way after previous maintenance, resulting in an overfilled siphon bin.	1) The spill was cleaned up using a vacuum truck. 2) Communicated to utilize operators' knowledge when they were unfamiliar with the equipment. This was done by having a pre-shift discussion and a discussion at the monthly safety meeting.
March 7, 2023	Sewage	Unknown	Concrete	Sewage pipe burst.	1) The spill was cleaned up, and a work ticket was created to repair the damage. 2) Reviewed spill details with the crew.
March 8, 2023	Alumina	~ 10 kg	Gravel with an asphalt road	Aluminium oxide built up in Tower 10, which leaked through openings in the cladding of Tower 10.	1) Cleaned up material with a vacuum truck. 2) An environmental consulting company was called in to complete the assessment, including sampling at Moore Creek.
March 22, 2023	Alumina	~12 t	Paved ground	Excess material built up in the conveyor system due to a scraper misalignment, causing Alumina to escape the system and spill out of containment.	1) Stopped vessel unloading. 2) Assessed and repaired the conveyor system. 3) Cleaned up materials using a vacuum truck and a sweeper for offsite disposal.
September 8, 2023	Alumina	35 t	Paved ground	Connection part on the conveyor was left open.	1) Stopped unloading and cleaned up materials with a vacuum truck. 2) Sealed area and repaired defects found from inspection.
October 3, 2023	Alumina	~20 t	Paved ground	Incorrect HMI display leading to material backed up and spillage.	1) Cleaned up material with a vacuum truck. 2) Repaired the leak.
October 23, 2023	Transformer Oil	250 L	Gravel	Mechanical failure of valve on tanker truck.	1) Cleaned the surface of the gravel with absorbent pads. 2) An environmental consulting company was called in to take samples of the spill and support the development of a clean-up and disposal plan. 3) Contaminated gravel was removed from the site.
November 20, 2023	Hydraulic Oil	~200 L	Concrete	Mechanical failure of the hydraulic line of the equipment.	1) Cleaned up spill and replaced the damaged line. 2) Reviewed spill details with the crew.
December 7, 2023	Green Coke	~2 t	Marine	Material was observed on the edge of the spill skirt leading to the ocean.	1) Cleaned up area during the unloading operation. 2) Assessed logistical options for transportation and methodology of unloading operation for future vessels. 3) Conducted complete revisions of procedures and hazard analysis.

12. Smelter restart

To support the smelter restart amendments of the P2 permit were obtained, the amendment outlined additional reporting and monitoring requirements, this chapter is a summary of these requirements.

Restart overview

The restart of the pots stopped due to the 2021 labour disruption was planned to commence in May 2022 and finish by December 31, 2022, and as such the major temporary permit amendment that was authorized for this process expired at the end of 2022. To initiate the restart of the smelter in 2023, a minor temporary amendment was issued for the months of January and February, followed by another major temporary permit amendment was required in order to support the increase in emissions expected from restarting pots, the increased permit limits for particulate and total fluoride emissions required extensive consultation with our stakeholders.

In January and February, the minor temporary amendment authorized a 10% increase in permit limits for total fluoride and particulates, whereas in March of 2023, the major temporary amendment of the P2 Permit was obtained. This amendment outlined an increase in the smelter wide total fluoride emissions from 0.9 kg/t Al to 2.8 kg/t Al (section 4.10.2), and the reduction particulate matter emission limit from 1.3 kg/t Al to 2.9 kg/t Al (section 4.1.2.1) for the periods of March 2023 – October 31 2023 as well as reporting requirements for the restart. The restart reports highlighted daily successes and challenges the operation faced while restarting and included additional monitoring data for the receiving environment following hydrogen fluoride and particulate concentrations in the ambient air as well as monitoring data from vegetation inspections for acute and chronic injury. These re-start reports provided assurance through use of key performance indicators linked to trigger action response plans which detailed actions to prevent levels of unacceptable harm to the environment. A summary of these restart reports is presented in the following sections.

2023 Pot restart plan

Completion of the pot starts was planned for 2022; however, due to technical and safety challenges with adapting the cold metal start method to Kitimat, the temporary shut down of the overhead alumina transport conveyor, the BC Hydro constraints and the challenges with the bath supply, it was not possible to complete the restart in 2022. The restart of pots continued into 2023 and was completed in September.

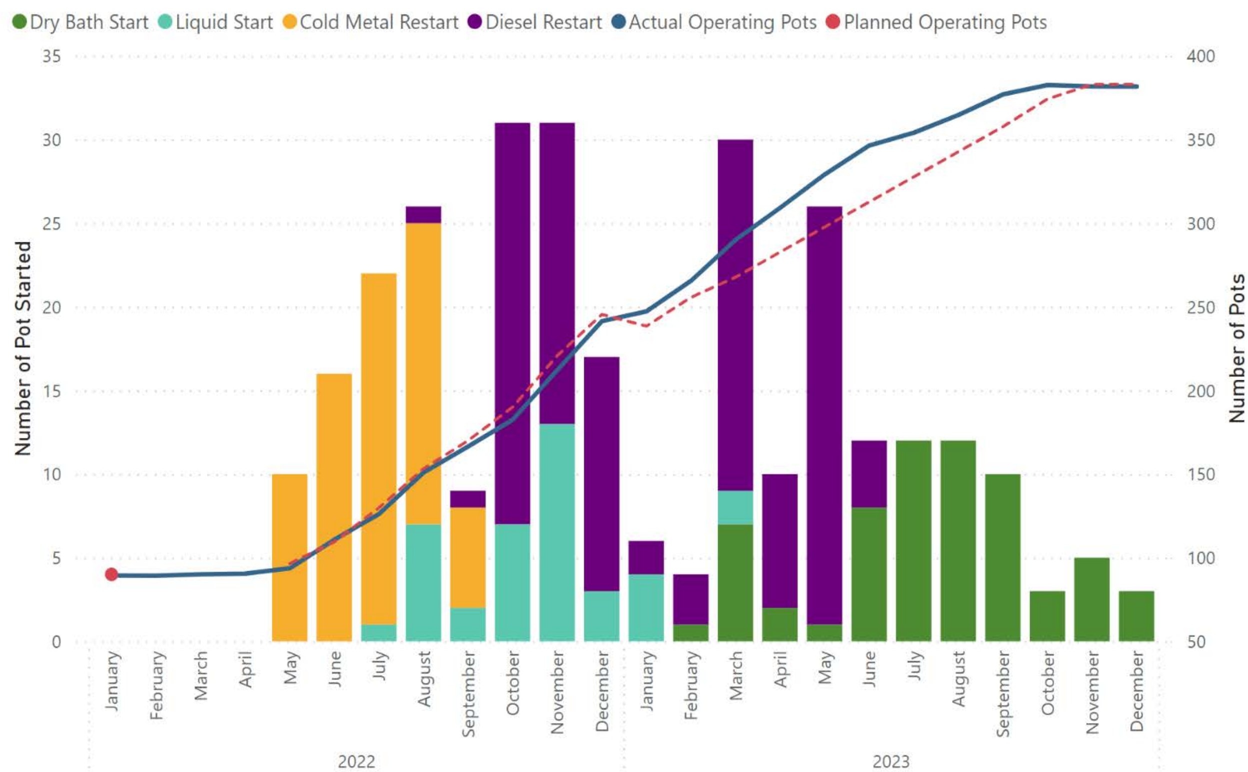
Three different pot start methods were planned for returning the smelter to a normal operating level of 383 pots; these methods are cold metal pots start and two conventional pots methods of either hot bath or dry bath starts.

- The Dry Bath Start is the main startup methodology for pots with brand new cathodes, preheating via electricity is used to turn dry bath into liquid bath and after ~48 hours liquid bath is generated.
- The Hot Bath Start / Restart (electricity) method is an alternative startup methodology for pots with brand new cathodes and the occasional restart with used cathodes. This method preheats the pot via electricity and ~48 hours later liquid bath is added.
- The Hot Bath Restart (diesel)– method is another form of hot bath restart on pots with used cathodes that do not have a metal pad. The preheating of the cathode is completed using diesel burners for ~36 hours after which liquid bath is added.
- Cold Metal Restarts were the main methodology for restarting pots that had a frozen metal pad in them. The pots would be preheated using gas burners and approximately 36 hours later liquid bath would be added.

Figure 12.1 below, shows the planned pot start schedule and the completed pot starts by start-up method.

Figure 12.1 Pot restart plan vs actual starts.

The restart was initiated in May of 2022 and reached completion in September 2023, the normal pot replacement campaign was initiated and continued throughout remainder of the year.



Key performance indicators

Key performance indicators (KPIs) are used to track performance and achieve operational excellence. This is achieved by tracking the outputs of key parameters against pre-defined thresholds that indicate performance. When the outputs of key parameters do not meet the required threshold, action is required to bring the parameter back into expectation. A subset of operational KPIs that inform on source emissions from the electrolytic process as well as a number of environmental KPI's were followed to inform on the receiving environment.

Source emissions

A continuous emission monitoring equipment (Boreal LASER) was used to monitor fluoride levels in potrooms and gas treatment centre stacks, a particulate continuous monitor was also used in the gas treatment centre stack. The continuous monitoring equipment is used to provide daily measurements and trigger control actions if best practice KPI thresholds are exceeded. Other means of visual inspections of pot hooding and of standard work practices were used to inform on best practices.

Gas Treatment Centre

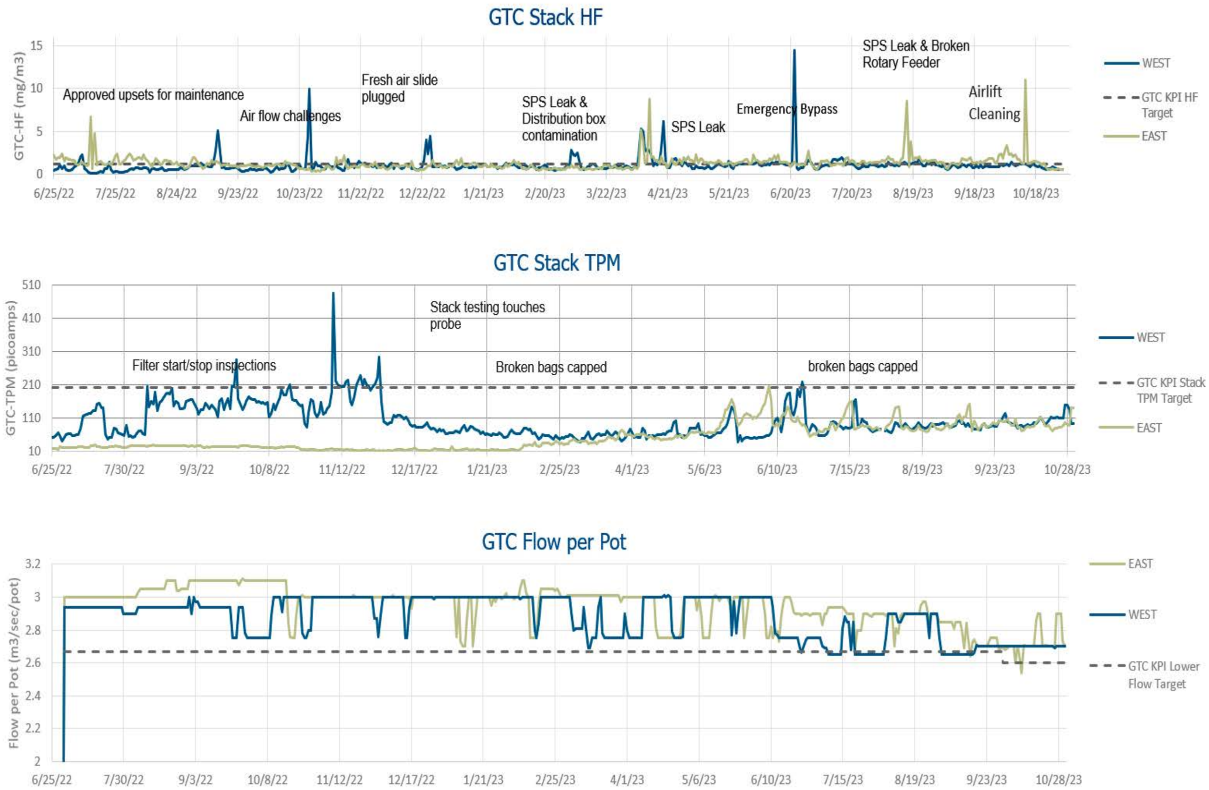
At both the East and West GTC's three KPIs were followed for scrubbing efficiency, filtration efficiency and flow per pot (suction efficiency). The average data was reviewed daily, and where internal thresholds were exceeded, actions were prescribed to understand the issue and to mitigate it.

Table 12.1

GTC KPI percent exceedances during the 2023 restart.

Key Performance Indicator	East GTC (%)	West GTC (%)
Hydrogen Fluoride	37	12
Flow per pot	0	0
Total particulate matter	0	13

Figure 12.2 Gas Treatment Centre KPIs.



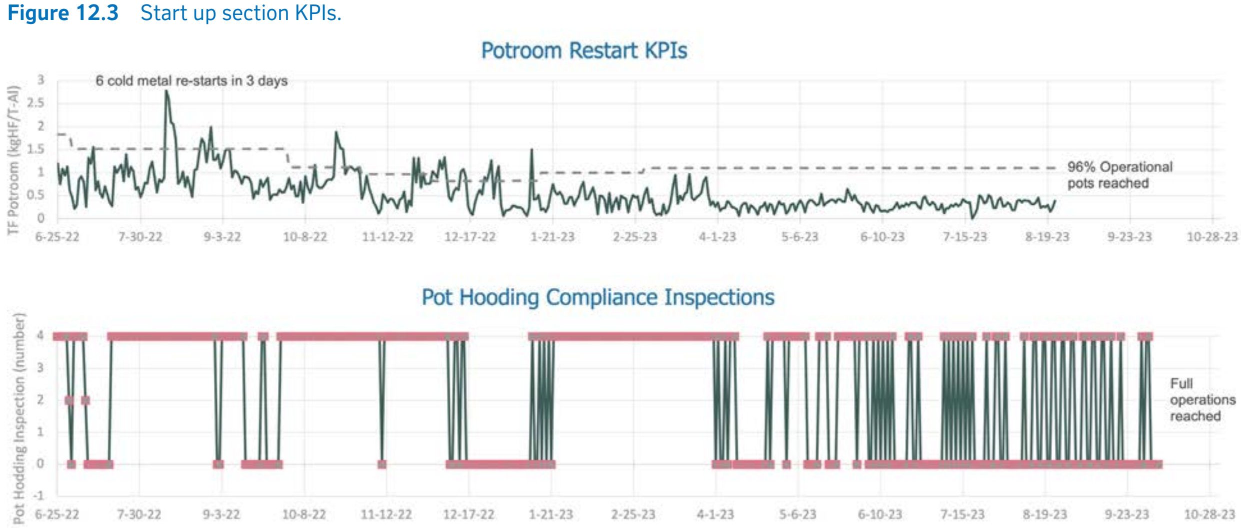
Reduction – Start-up

Start-up sections were designated at less than 90% operational pots in a half building, and as the start-up progressed through the various areas of the potrooms the sections contributing to the start-up sections changed. The restart first began in 3000S, followed by 4000S, 4000N and 3000N, 2000N and 1000N before completing. In start-up sections, continuous emission monitors in the roof vent were used to monitor concentrations of gaseous fluoride which were converted to total fluoride in kg/Mg Al as well as visual inspections performed by the operation supervisor and the best practices for handling / removing hoods to inform on the performance of the start-up. The average boreal data was reviewed daily, and where internal thresholds were exceeded, actions were prescribed to understand the issue and to mitigate it.

Table 12.2
Reduction start-up KPI percent exceedances during the 2023 restart.

Key Performance Indicator	Start up sections %
Boreal total fluoride	0.43
Percent pot sealage	0

Figure 12.3 Start up section KPIs.



Reduction – Normal operations

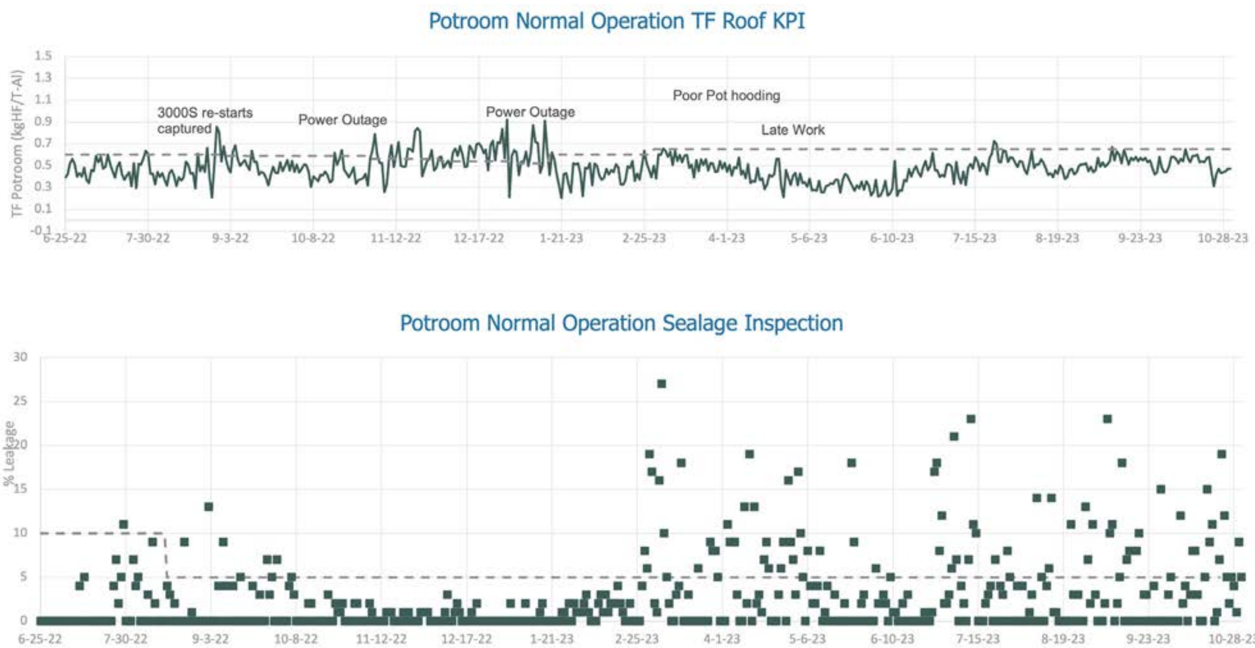
Normal operating sections were designated at greater that 90% operational pots in a half building, and as the start-up progressed through the various areas of the potrooms more sections became considered normal operations following the restart plan. In start-up sections, continuous emission monitors in the roof vent were used to monitor concentrations of gaseous fluoride which were converted to total fluoride in kg/Mg Al as well as visual inspections inform on the performance of the start-up. The average boreal data was reviewed daily, and where internal thresholds were exceeded, actions were prescribed to understand the issue and to mitigate it.

Table 12.3

Reduction Normal operations KPI percent exceedance.

Key Performance Indicator	Normal sections %
Boreal total fluoride	24
Percent pot sealage	38

Figure 12.4 Normal operating section KPIs



Receiving environment

Emissions of fluoride, particulates and SO_2 travel beyond the smelter on air currents into surrounding areas. Elevated fluoride emissions may lead to higher ambient hydrogen fluoride (HF) air concentrations. An ambient air quality monitoring program is in place for HF; the Riverlodge and Haul Road ambient air monitoring stations are equipped with continuous HF Picarro analyzers, and automated calibration systems were installed at the continuous ambient air quality monitoring stations. Particulate fluoride sampling was done at both the Haul Road and Riverlodge Stations during the smelter restart using cassette samplers.

In addition to continuous HF ambient monitoring, a passive HF monitoring network was established in the Kitimat Valley, monitor the levels of HF for both human and environmental exposures. Vegetation health monitoring was also completed at each of the passive monitoring stations. The passive monitoring program was in place for the duration of the pot starts where accessible through winter conditions.

Ambient air

Continuous monitoring

Continuous monitoring for hydrogen fluoride takes place at the Haul Road and Riverlodge station, monitoring for $PM_{2.5}$ takes place across at both the Haul Road and Riverlodge stations as well as at the Whitesail station and the Kitamaat village station, and monitoring for PM_{10} takes place at the Riverlodge station. Primary sources of hydrogen fluoride emissions from the smelter are the reduction roof vents, gas treatment centre stacks and the pallet storage building (anode butt cooling).

Table 12.4 KPI exceedances at ambient air stations during the 2023 restart. Note, none of the particulate exceedances at the Haul Road station were linked to smelter operations.

Table 12.4 KPI exceedances at ambient air stations during the 2023 restart.

Key Performance Indicator	Haul Road Station (%)	Riverlodge Station (%)	Whitesail Station (%)	Kitamaat Village Station (%)
Max hourly HF	0	0	NA	NA
Average hourly HF	0	0	NA	NA
30 day HF	0	0	NA	NA
90 day HF	0	0	NA	NA
Max hourly $PM_{2.5}$	28	4	3	3
Daily Average $PM_{2.5}$	3	1	1	1
Max hourly PM_{10}	NA	8	NA	NA
Daily average PM_{10}	NA	0	NA	NA

Passive monitoring

An HF passive monitoring program was implemented and co-located with monthly vegetation health inspection sites (Figure 12.5). The passive monitors were set up at 12 sites (Figure 12.6) to monitor the health and environment exposures of HF (some sites included SO_2) and were deployed for monthly exposures following the siting requirements specified in the BC Field Sampling Manual.

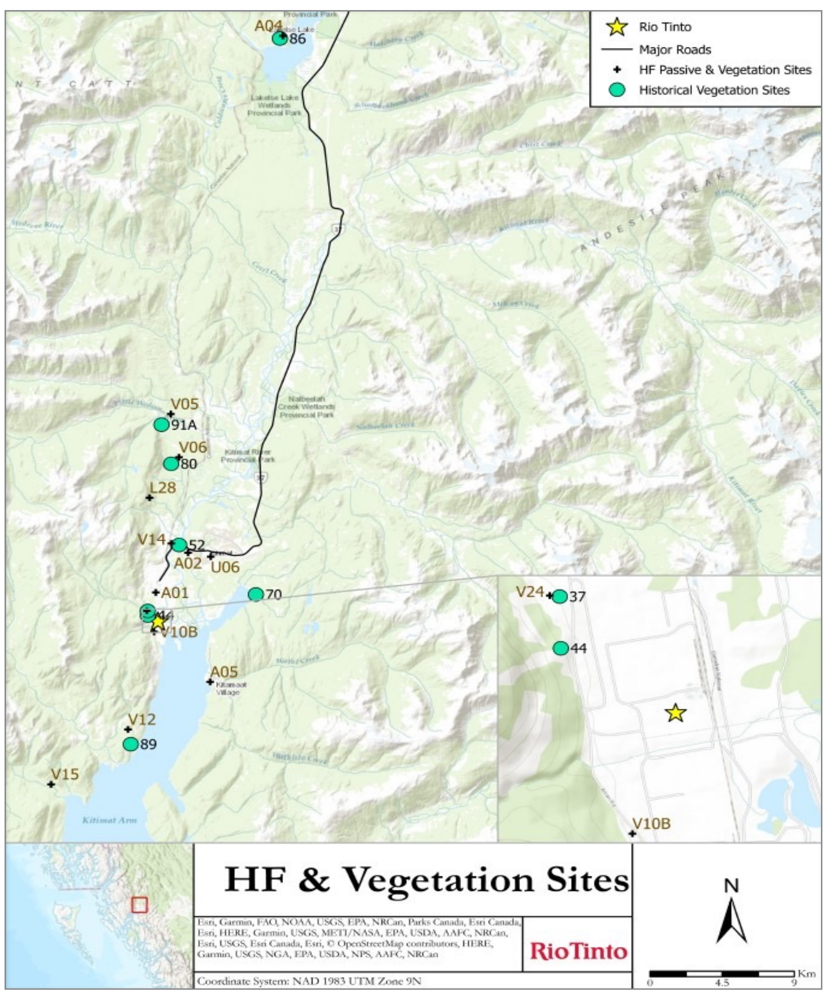


Figure 12.5

Passive monitoring and vegetation inspection and sampling sites.

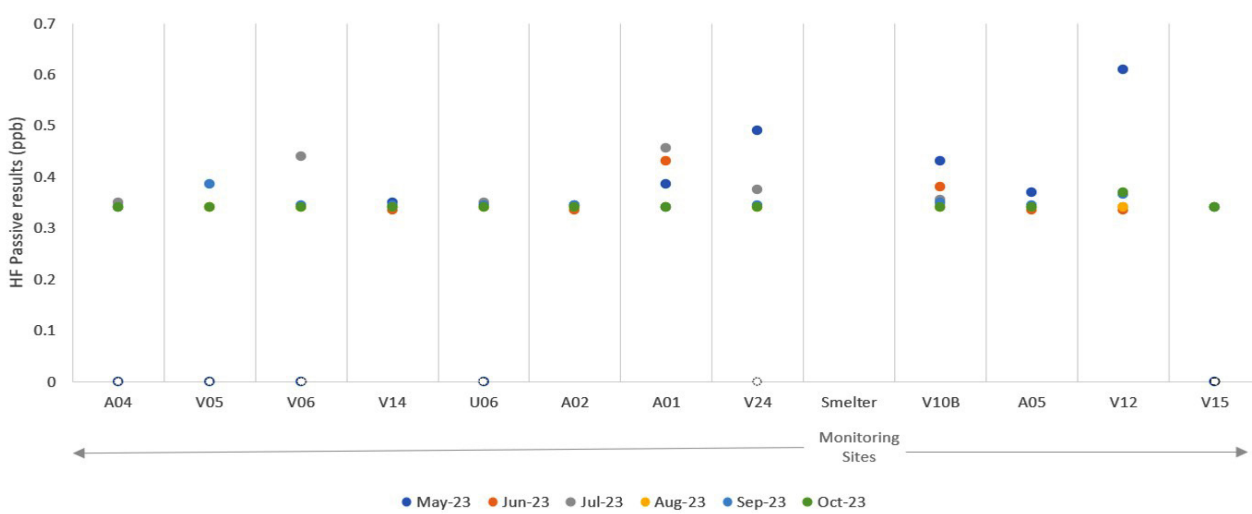
Figure 12.6

Passive monitoring station. Passive monitoring for SO_2 and Hydrogen fluoride.

In 2022 between May and September, acid gas passive samples were collected to understand HF concentrations near the smelter during the smelter restart, while the use of Radiello samples was used to compare the Picarro continuous monitor and the acid gas passive method. Both the acid gas and the Radiello sampling methods returned a high percentage of samples either below the reporting limit (acid gas) or below the detection limit (Radiello). The acid gas method returned 93% of primary samples below the reporting limit, and the Radiello returned 66% of primary samples below the detection limit. Both the acid gas and Radiello methods also showed poor accuracy based on comparisons of the concentration difference between the passive results and the Picarro analyzer. This poor comparison is expected due to the percentage of samples that were below the reporting or detection limit. Based on this analysis a recommendation was made to switch to the Radiello passive sampling method for 2023, as it was determined they were better suited to detect the lower concentrations. The switch to Radiello was made in 2023.

The monthly results for the passive samplers ranged between 0.3 and 0.61 ppb, note 6 samples locations were not collected in May and June and are shown in white dots in Figure 12.7.

Figure 12.7 HF passive monitoring sampling results.



Vegetation

Many species of vegetation are sensitive to gaseous fluoride. An analysis of historic fluoride air concentrations in the Kitimat region from the smelter and associated historical observations of injury in vegetation was used to develop a vegetation inspection and sampling plan to monitor for the effects of plant injury related to gaseous fluoride. The objective of the monitoring program was to detect signs of potential injury related to elevated fluoride concentrations and trigger management actions for controlling fluoride emissions.

Acute injury inspections

Inspections for acute injury took place on a monthly basis at 25 prescribed sites in the Kitimat – Terrace Valley. A list of sensitive and culturally important plants were actively looked for at each inspection site, all vascular vegetation is inspected and any signs of injury are recorded. Throughout the growing season, conditions were noted to be quite dry and the effects on vegetation particularly for species growing on rocky substrate was evident as premature senescence and sun scald due to exposure was observed. No visible injury due to gaseous fluoride was observed at any of these locations with the exception of site A01 (Haul Road station, Figure 12.5) where a small amount of tip burn was observed on Sitka willow (Figure 12.8).

Figure 12.8

A small amount of tip burn was observed on Sitka willow.

Chronic injury inspections

Inspection for chronic injury and Western Hemlock sampling took place at the end of the growing season between August 21 and 24, 2023, at 11 historical sampling sites located throughout the Kitimat – Terrace Valley. At each of the sites, western hemlock first year growth needles were sampled and then, dried, ground and analysed for fluoride content (Figure 12.9). The results of the foliar analysis show that F concentrations in 2023 at most (eight) sites were below the background/baseline level of 10 ppm, although three sites (37, 44 & 89: all located within 8.2 km of the smelter) exceeded background (these four sites ranged from 13.8 ppm to 35.8 ppm).

At each of the sampling sites, the sample tree is observed, and health is recorded along with the health of the vegetation in the area.

Seasonal senescence typical of the region and the time of year were noted at sample sites, with deciduous tree species most conspicuously affected.

Figure 12.9

Fluoride concentrations in western hemlock needles.

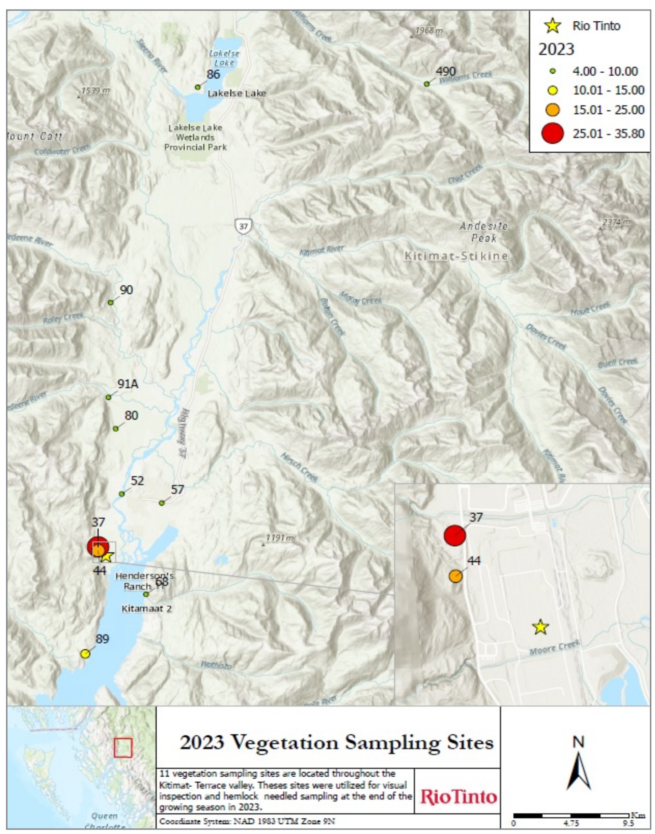
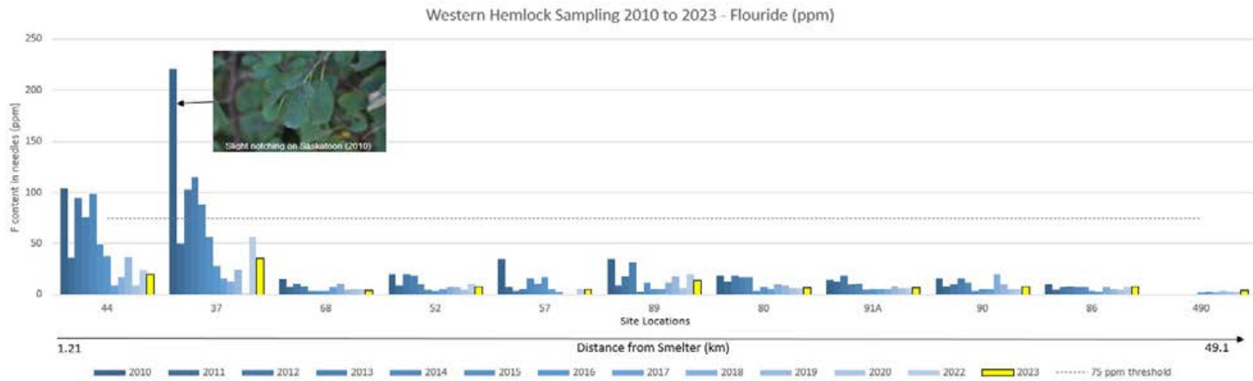


Figure 12.10

Historical fluoride concentrations in western hemlock needles. Site 37 contained the highest concentration of fluoride content during the modernized smelter which is below the level of 75 ppm where it is rare to observe visible injury due to fluoride concentrations.



Several of the sites sampled in 2023 are young stands (notably, Sites 80, 90 and 490), where dense stocking is now resulting in self-thinning (i.e., stems and/or branches are dying owing to competition for light) and a lack of understory development.

Road dust was noted primarily at Site 37, with minor dust at 52 and 68; most sites are located directly adjacent to gravel roads or parking areas and are expected to be at least occasionally affected by road dust, depending on road material, weather, traffic and maintenance activities. Lichens and mosses were often present on sample trees. Although they did not significantly impact sample tree vegetation, disturbances were noted at several sites: Site 37 was highly disturbed by material pushing and mechanical damage, as well as introduction of non-native soils; and Site 86 had some dumped grass clippings but not having a notable impact on the site. Site 52 had previously been disturbed by a gravel pile as well as brushing and mowing, and Site 91A had previously experienced commercial thinning within the site, but no new disturbance was noted at either site.

No insect outbreaks, disease epidemics, or other stress factors appeared to be affecting sample trees.

Trigger-Action response plan

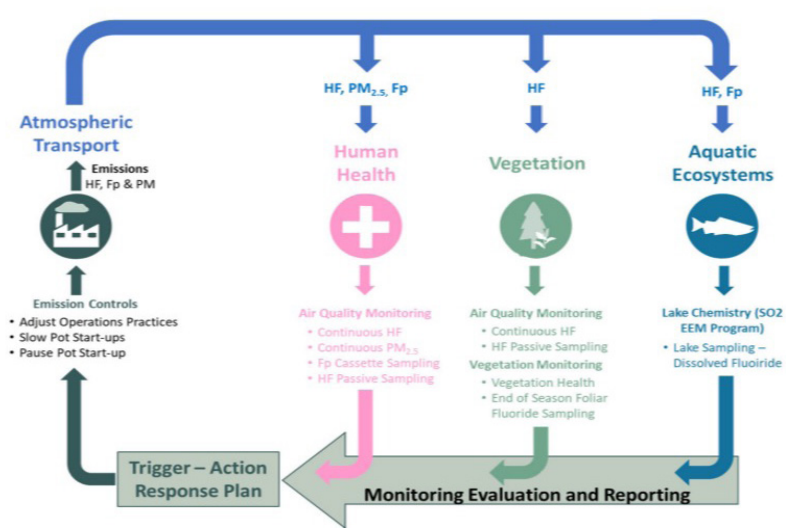
A trigger-action response plan has been established that applies air quality objectives and vegetation health thresholds to trigger control actions for improving smelter operation performance and reducing the rate of pot starts. (Figure 12.11) In 2023 there was one threshold exceeded that triggered actions due to exceedances of the air quality health objective for hydrogen fluoride, this exceedance at site V12 was not linked to any observed visible injury on vegetation.

Table 12.5 Trigger-Action Response Plan

Parameter	Threshold	Action taken
Passive monitoring for HF	30 day average greater than 0.5 ppb	- Continued vegetation inspections

Figure 12.11

Trigger-action response plan using source emission data and receiving environment data.



Materials management plan

A Smelter Restart Materials and Waste Management Plan (SR-M&WMP) developed by a Qualified Professional as per the version of the Smelter Restart Technical Assessment Report (SR-TAR). The main goals of the SR-M&WMP are identifying the input and output materials associated with the smelter restart and describing the appropriate procedures and best practices for materials management in accordance with the BC Environmental Management Act. The key materials managed during the restart included used anodes, spent bulk bath, cover bath, basement bath and aluminium pot pads. A detailed description of these materials and their management can be found in Table 12.6.

Table 12.6 Smelter Restart Materials and Waste management Plan

Material type	Quantity processed or put into storage	Quantity returned to potlines	Comments
Used Anodes (still connected to anode assemblies)	160	160 were recuperated in Diesel re-starts.	Re-usable used anodes remained connected to their anode assemblies at all times and were stored in Buildings 1A, 2B and 2C. As of June, 2023, all butts were recycle from the mothballing after the workconflict.
Spent Bath (bulk piles)	192 tonnes (approximated)	Bath associated with restart has been reclaimed.	At the time of shutdown, all non-reusable used anode assemblies were deconstructed in the PSB rather than the ARS, and all surplus bath broken off of the anode butts was then put into long-term bulk storage in Building 2C West and stored as 'Spent Bath'. During restart, Spent Bath was sent to the ARS/bath plant for processing (crushing and screening) and re-use in the potlines as per normal operations. Transport to the ARS was completed using dump trucks following the procedure outlined in the MMP.
Cover Bath	Initial 2023 volume was at 1200 tonnes. All cover bath was crushed and transferred into bulk bags within Building 2C.	1200 tonnes were recycled in the diesel restart.	At the time of shutdown, all residual bath in the pots (non-molten crust bath and the underlying molten bath in contact with the anodes) was excavated out of the pots after cooling, transferred into crust bins and stored in Building 2C East for temporary storage in bulk piles. All bath was subsequently crushed directly within Building 2C and transferred into bulk bags for ease of transport and re-use as cover bath directly in the potlines. The use of bulk bags mitigated risk of material loss during transport of cover bath back to the potlines, and pre-crushing the material removed the need to process the bath in the bath plant.
Basement Bath	NA	2379 tonnes	Approximately 10,275 tonnes of basement bath were shipped off-site for disposal in dedicated SPL bins, 2379 tonnes was recycled back into the process.
Aluminium Pot Pads	9 metal pads were generated, processed and recycled	N/A – shipped off-site for recycling	Pot pads were cleaned and vacuumed to remove bath prior to extraction; very little residual SPL was observed to be adhered to the bottom of the pot pads at the time of their extraction. Residual SPL was scraped off during processing/cutting of aluminium in the pot pad tent, stored in bulk bags and managed as SPL. All aluminium pot pads were cut up and processed in accordance with the procedure outlined in the MMP.

13. Glossary

Anode
One of two electrodes (the positive electrode) required to carry an electric current into the molten bath, a key component of the electrolytic reduction process that transforms alumina ore into aluminium.

Anode Baking Furnace
Green anodes (un-baked) are brought to the Anode Baking Furnace (ABF) to bake the anodes. This process hardens the anodes and drives off volatile hydrocarbons (such as PAHs) from the liquid pitch used to bind the calcined coke and recycled carbon.

Anode Rodding Shop
The shop where baked anodes are rodded with electrodes and where spent anodes from the potrooms are disassembled.

Anode effects
A chemical reaction that occurs when the level of alumina in a pot falls below a critical level, resulting in reduced aluminium production and the generation of perfluorocarbons (PFCs) – a variety of gases with a high carbon dioxide equivalency.

Anode paste
One of the materials used to manufacture green anodes, composed of calcined coke and coal tar pitch.

Attrition index
An index used to express alumina strength; the higher the value, the weaker the alumina.

Bath
A process material consisting primarily of sodium aluminium fluoride, which is melted in the pots and used to dissolve the alumina for the electrolytic reduction process of making aluminium.

Bath Plant and Bath Tower
Bath generated from the pots is taken to the bath plant for processing and recycling. The bath tower is one component of the plant that conveys the reclaimed bath for processing.

CALPUFF
Advanced non-steady-state meteorological and air quality modeling system.

Carbon dioxide equivalency (CO_2e)
This is a quantity that describes, for a given mixture and amount of greenhouse gas, the amount of CO_2 that would have the same global warming potential as the emission when measured over a specified time period.

Cassette sampling
A sampling procedure for air emissions where contaminants are collected using filters placed at regular intervals along the length of the potroom.

Cathode
One of two electrodes (the negative electrode) required to carry an electric current into the molten bath; a key component of the electrolytic reduction process that transforms alumina ore into aluminium.

Coke calcination/calcined coke
A process involving the use of high temperatures to drive off volatile matter found in green coke, thus producing calcined coke for use in anode manufacturing.

Composite sample
A composite sample is treated as a single sample, despite being made up of multiple temporally discrete samples. For example, all effluent composite samples are taken over 24 hours, during which a 50mL sample is collected every 10 minutes.

Dredgeate
Any material removed by dredging.

Dry scrubber
Pollution control equipment used to remove contaminants (in gaseous or particulate forms) from air emissions.

Effluent (B-lagoon)
Water discharge flowing out of the B-Lagoon outfall after treatment in the B-Lagoon system.

Electrolyte
A chemical compound that provides an electrically conductive medium when dissolved or molten.

Electrolytic reduction
This process uses electricity to remove oxygen molecules from aluminium oxide to form aluminium metal.

ENVISTA
British Columbia Air Resources Manager website.

FC-3
Day Tank Incinerator localized on Carbon South.

Fugitive dust
Solid airborne particulate matter that is emitted from any source other than a stack or a chimney.

Fume Treatment Centre
The primary pollution control system for the anode baking furnace. The Fume Treatment Centre (FTC) uses water to cool the hot fumes from the ABF. The FTC then filters the fumes to remove particulates, fluorides, and PAHs.

Geometric mean
A geometric mean is a type of mean or average which indicates the central tendency or typical value of a set of numbers by using the product of their values. The geometric mean is often used when comparing different items when each item has multiple properties that have different numeric ranges.

Green coke
The raw form of coke received at Kitimat Operations, which is calcined for use in the manufacture of anodes; a by-product of oil refining.

Grab sample
A discrete sample used to collect information for a specific or short time. Variability of this data is much higher than a composite sample.

Gas Treatment Centre
The primary pollution control system for the potline. There are two Gas Treatment Centres (GTCs) for the modernized smelter, replacing the function of the 9 dry scrubbers used in the old VSS smelter. The GTCs filter the pot gases to remove particulates and fluorides.

IL-
For a given contaminant, a level of contamination which is at or below the threshold identified in the Contaminated Sites Regulation as being suitable for industrial lands (IL).

IL+
For a given contaminant, refers to a level of contamination which is below the threshold identified in the Hazardous Waste Regulation as that of being hazardous waste (HW) and is above the threshold identified in the Contaminated Sites Regulation as being suitable for industrial lands (IL).

Leachate
A liquid which results from water collecting contaminants as it passes through waste material.

Leftover metal
Metal which accumulates in a pot when the schedule to remove the metal is not followed.

Loading
Loading is the amount of a contaminant emitted in a given time period.

Maximum allowable level
This level provides adequate protection against the effects of pollution on soil, water, vegetation, materials, animals, visibility, personal comfort, and well-being.

Maximum desirable level
This level is the long-term goal for air quality programs and provides a basis for the federal government's antidegradation policy for unpolluted parts of the country.

Maximum tolerable level
This level denotes time-based concentrations of air contaminants beyond which appropriate action is required to protect the health of the general population.

Ministry
BC Ministry of Environment and Climate Change Strategy (BC ENV), to which BC Operations reports on compliance with its permit requirements.

P2-00001 Permit
P2-00001 Multi-Media Waste Discharge Permit.

Piezometer
A small diameter water well used to measure the hydraulic head of groundwater in aquifers.

Pitch
One of the materials from which anodes are made, and a by-product of metallurgical coke production.

Polycyclic aromatic hydrocarbons (PAHs)
A group of aromatic hydrocarbons containing three or more closed hydrocarbon rings. Certain PAH are animal and/or human carcinogens.

Pots/potline
Pots are large, specially designed steel structures within which electrolytic reduction takes place. The 396 pots at Kitimat Works are housed within a single potline.

Process correction
Accessing the condition of exception or sick pots and bringing them back to normal operating conditions.

Putrescible waste
Waste that rots which can be easily broken down by bacteria, for example food and vegetable waste.

Pyroscrubber
A combustion-based system that controls dust emissions from the coke calciner.

Retention time
The average time a drop of water takes to move through a lagoon from inlet to outlet.

Scow grid
A dry dock for flat bottomed vessels (scows) formed from a series of piles and sills.

Sick pot
A pot that has an elevated bath temperature and cannot be sealed properly or is uncovered.

Spent pot lining (SPL)
Lining from the inside of pots, composed of refractory bricks and carbon, has deteriorated to the point where it needs to be replaced.

Stud
Studs constructed of steel are inserted vertically into the anode to conduct the flow of electricity through the anode and into the electrolyte.

Total suspended solids (TSS)
A water quality measurement refers to the dry weight of particles trapped by a filter, typically of a specified pore size.

Abbreviations

Abbreviation	Definition
ABF	Anode Baking Furnace
AP-4X	Aluminium Pechiney-4XX KAmp prebake technology
APP	Anode Paste Plant
AQHI	Air Quality Health Index
AQHI +	Air Quality Health Index Plus
ARS	Anode Rodding Shop
ASI	Aluminium Stewardship Initiative
BC	British Columbia
DC	Dust Collector
DDS	Dredgate Disposal Site
EEM	Environmental Effects Monitoring
ERP	Event Response Plan
FTC	Fume Treatment Centre
GTC	Gas Treatment Centre
HR	Haul Road
HSE	Health, Safety, Environment
HSEQ	Health, Safety, Environment and Quality
ISO	International Organization for Standardization
KMP	Kitimat Modernization Project
KPAC	Kitimat Public Advisory Committee
KPI	Key Performance Indicator
KV	Kitimaat Village

Abbreviation	Definition
LL	Lakelse Lake
LPI	Liquid Pitch Incinerator
NADP	National Atmospheric Deposition Program
NAPS	National Air Pollution Survey
PDCR	Plan, Do, Check and Review
PFTC	Pitch fume treatment centre
PSB	Pallet Storage Building
PVT	Pitch vapour treatment
RACI	Responsible, Accountable, Consulted, Informed
RCF	Refractory Ceramic Fibres
RL	Riverlodge
SPL	Spent Potlining
SR-M&WMP	Smelter Restart Materials and Waste Management Plan
SR-TAR	Smelter Restart Technical Assessment Report
TBD	To be determined
US- EPA	United States Environmental Protection Agency
VSS	Vertical Söderberg Stud
WS	Whitesail
YC	Yacht Club

Notations

Notation	Parameter
$96LC_{50}$	Rainbow Trout 96hr Static Acute 100% concentration screen (pass/fail)
Al	Aluminium
Al_2O_3	Aluminium Oxide
BOD	Indirect measure of the concentration of biodegradable matter
CN-SAD	Cyanide Strong Acid Dissociable
CN-WAD	Cyanide Weak Acid Dissociable
CO_2	Carbon Dioxide
D1HM	Daily 1 hour maximum
Dis. Al	Dissolved Aluminium
Dis. F	Dissolved Fluoride
Fg	Gaseous Fluoride
Fp	Fluoride particulate
Ft	Total fluoride
GHG	Greenhouse Gases
H_2SO_4	Sulfuric Acid
ha	Hectare
HF	Hydrogen Fluoride
hr	hour
kg	Kilogram
kg/Mg Al	kg of substance per metric tonne of Al
m^3	Cubic metre
Mg	Megagram (1 metric tonne)
mg/L	Milligrams per litre
mm	Millimetre
MWT	Molecular weight

Notation	Parameter
ng/m^3	nanogram per cubic metre
NO	Nitrogen monoxide
NO_2	Nitrogen dioxide
NO_x	Nitrogen Oxides
O_3	Ozone
PAH	Polycyclic Aromatic Hydrocarbons
PFC	Perfluorocarbons (CF_4 and C_2F_6)
pH	Potential hydrogen
PM	Particulate Matter
PM_{10}	Particulate Matter 10 µm or less
$PM_{2.5}$	Particulate Matter 2.5µm or less
ppb	Parts per Billion (vol/vol)
PVC	Polyvinyl chloride
Q1	1st Quarter of the Year
Q2	2nd Quarter of the Year
Q3	3rd Quarter of the Year
Q4	4th Quarter of the Year
SF_6	Sulphur Hexafluoride
SO_2	Sulphur Dioxide
SO_4^{2-}	Sulfate ion
TSS	Total Suspended Solids
ug/m^3	microgram per cubic metre
yr	year
µS/cm	microsiemens per centimetre

Rio Tinto BC Works 1
Smeltersite Road
PO Box 1800
Kitimat BC V8C 2H2
Canada

T +1 250 639 8000

Rio Tinto Plc
6 St Jame's Square
London SW1Y 4AD
United Kingdom

T +44 20 7781 2000

riotinto.com