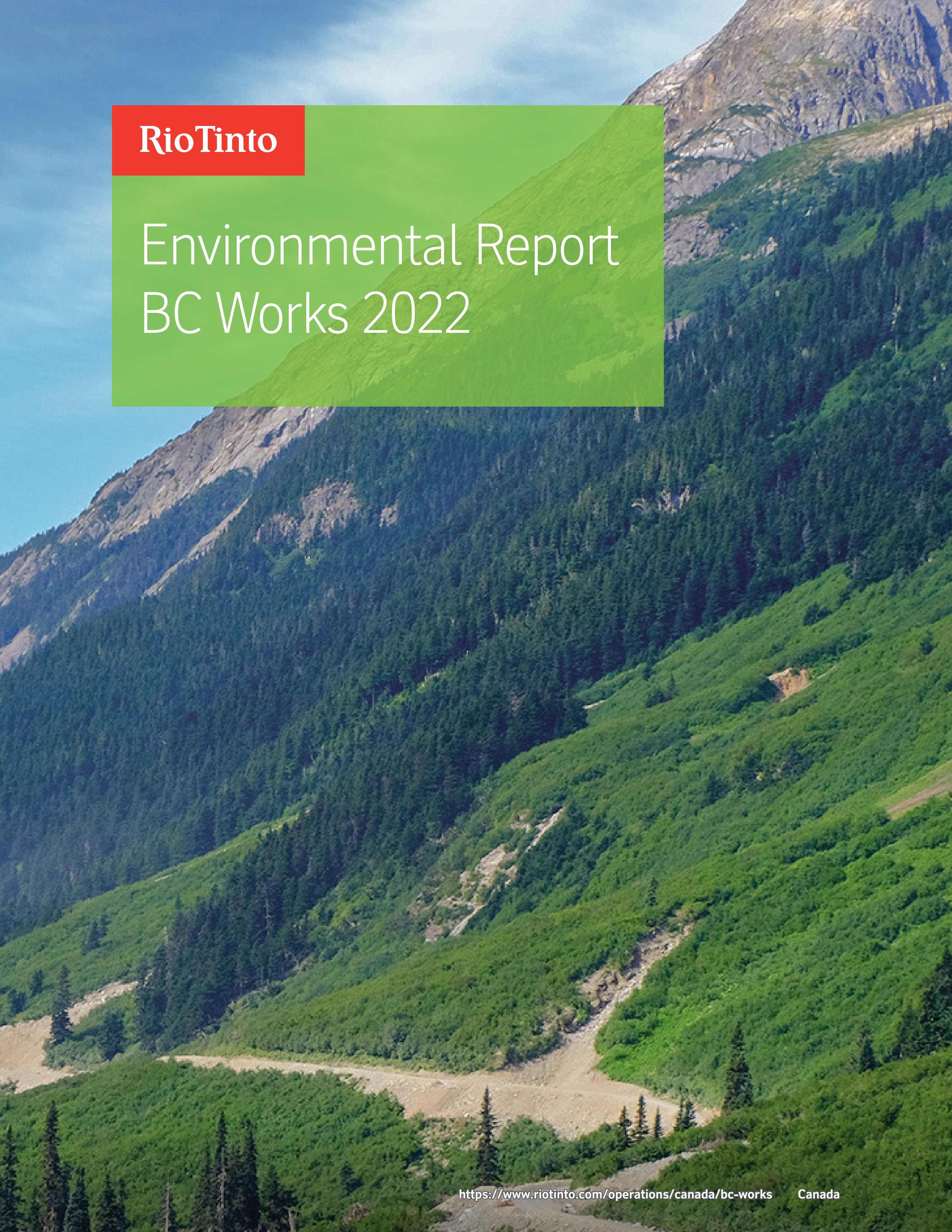
Rio Tinto

Environmental Report
BC Works 2022



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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.

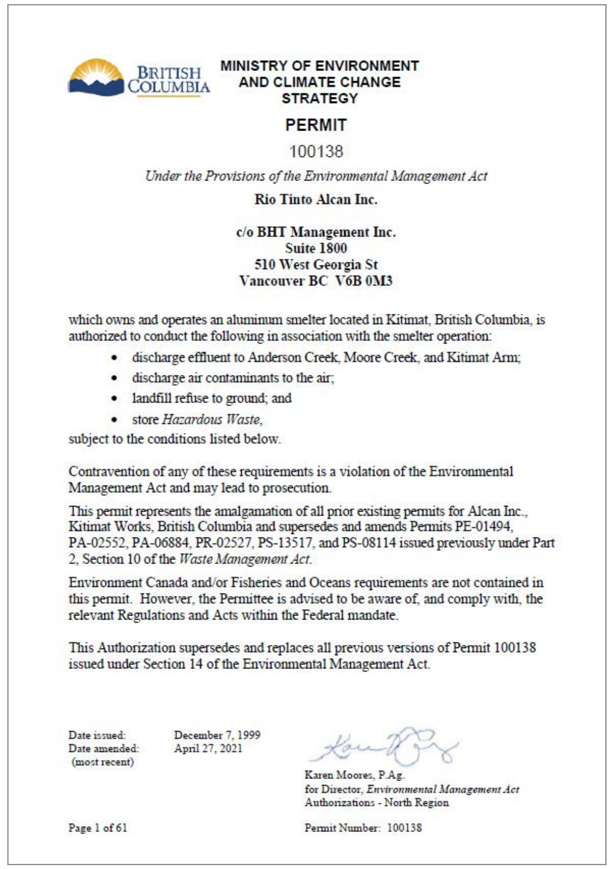
Authorization 100138 context

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 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.

In this report

This report is an annual review of air emissions monitoring, ambient air quality monitoring, surface water and effluents monitoring, groundwater monitoring, vegetation monitoring, and waste management monitoring where applicable for both the Kitimat and Kemano Operations. A summary of the yearly accumulated non-compliances and spills is also 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 re-start initiative was authorized under a temporary amendment to the P2 Permit which included new requirements for monitoring and reporting which are included in this report.



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: April 27, 2021
(most recent)

Karen Moores, P.Ag.
for Director, *Environmental Management Act*
Authorizations - North Region

Page 1 of 61 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.

Access & comments on the report

The 2022 Annual Environmental Report is available online at **www.riotinto.com\bcworks**. The website also provides information on key environmental performance indicators. Questions or comments are welcome and may be made through the contact page on the website.

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 18 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, and in 2022 the process of re-starting pots to return the smelter to normal operations began.

2022 operational year

In January of 2022 the smelter was still operating at 25% aluminium production following the labour dispute in July 2021 and planning was underway to restart the smelter. The Potline had 2 half buildings in operation, the anode paste plant and coke calcination plant in carbon south were shut down, and the anode bake furnace in carbon north was shut down (Figure 2.1). Imported pre-baked anodes were being delivered by ships in order to sustain operations and the smelter had welcomed back all of the unionized employees.

There were a number of operational challenges throughout 2022 that delayed the return to of the smelter to full production; some of the key challenges included the breakdown of the bath pan conveyor in the first quarter which required an alternative method to process the electrolytic bath required in reduction, and the breakdown of the overhead material transport conveyor in third quarter which required an alternative method to move raw alumina and aluminium fluoride from the wharf to the reduction storage silo. In May the re-start of the stopped aluminium smelting pots. Due to the operational challenges, the return to full production was not realized in 2022 and 66% of the pots were operational by year end. Part of the carbon processes were also restarted in 2022, including the re-start of the anode paste plant and three quarters of the anode baking furnace (Figure 2.2).

In 2022 there were 15 permit non-compliances with respect to monitoring and reporting, 8 reportable spills (See Chapter 11).

Operational process

The various components of the plant are described 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.

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.

Figure 2.1 Post labour dispute proces. Baked anodes were imported as the anode paste plant, coke calincation plant and anode bake furnace were shutdown.

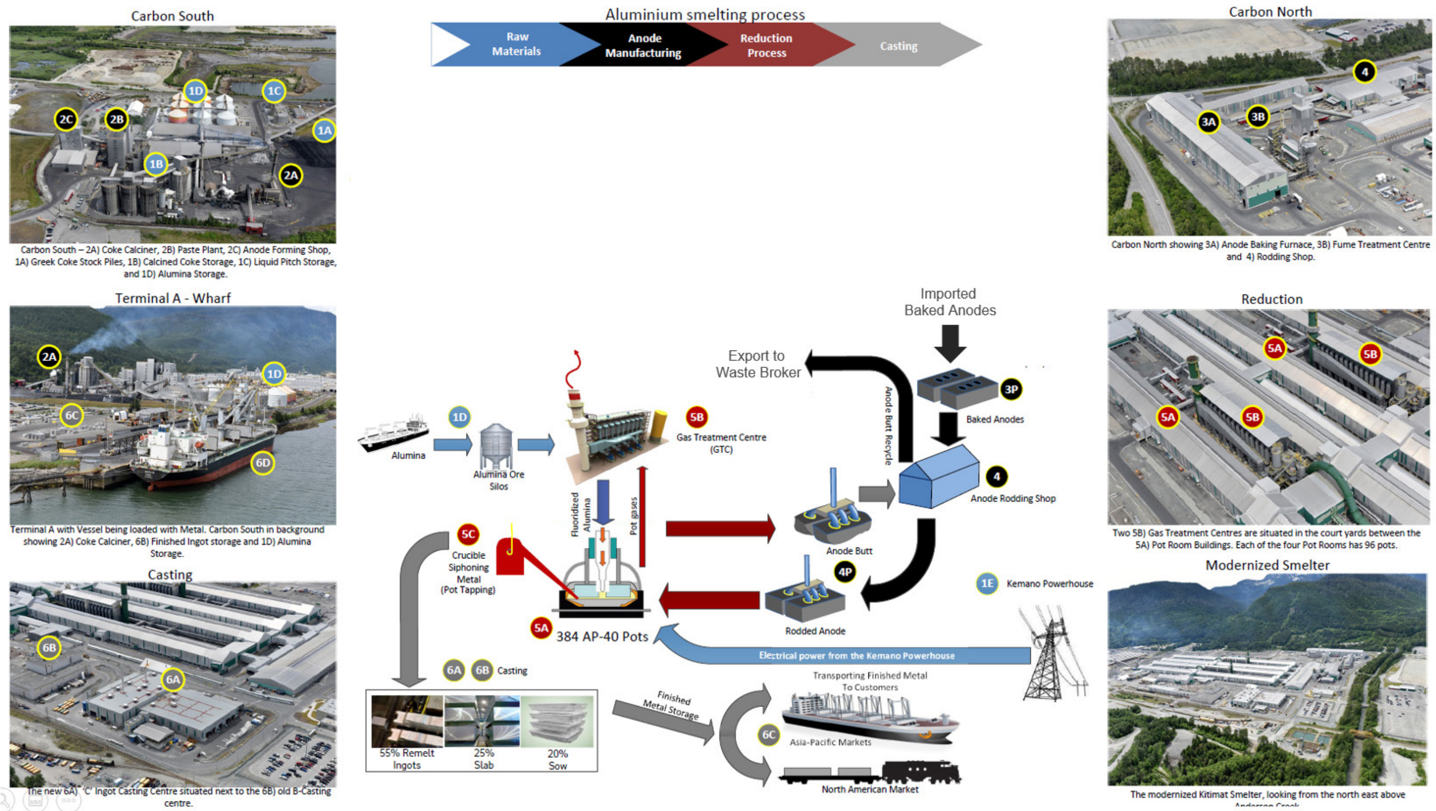
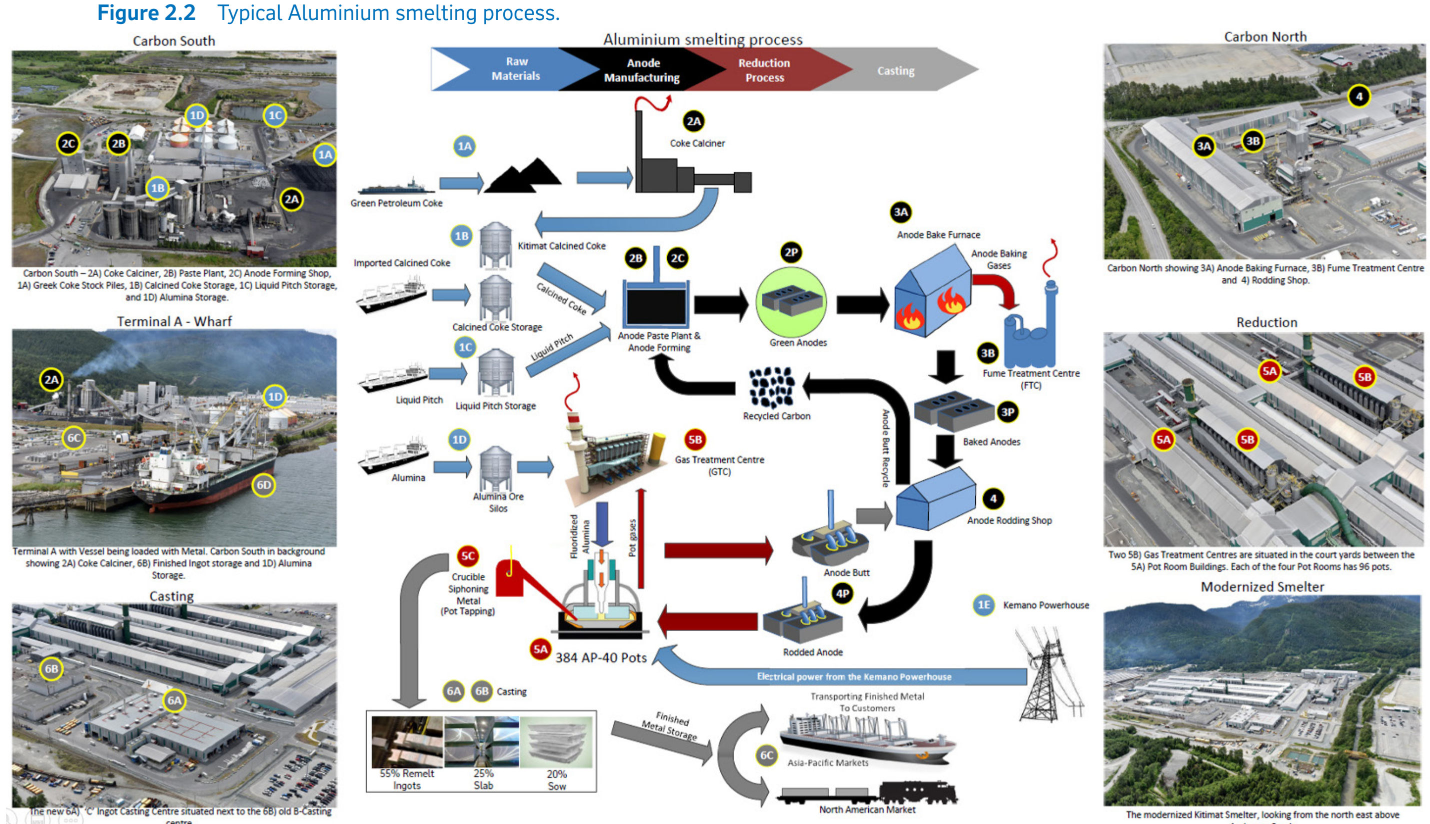


Figure 2.2 Typical Aluminium smelting process.



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.

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 basis of AP-4X smelting technology uses electrolytic cells or pots contains molten bath (composed primarily of sodium fluoride and aluminium fluoride) which dissolves the alumina ore (composed of bonded atoms of aluminium and oxygen Al_2O_3) by an electrolytic reduction process (using electricity to break the aluminium-oxygen bond). The heavier aluminium molecules sink to the bottom of the pot in the form of molten aluminium. Oxygen is combined with carbon from the anode to form carbon dioxide. The molten aluminium that is extracted from the pots is transported to the two casting centres.

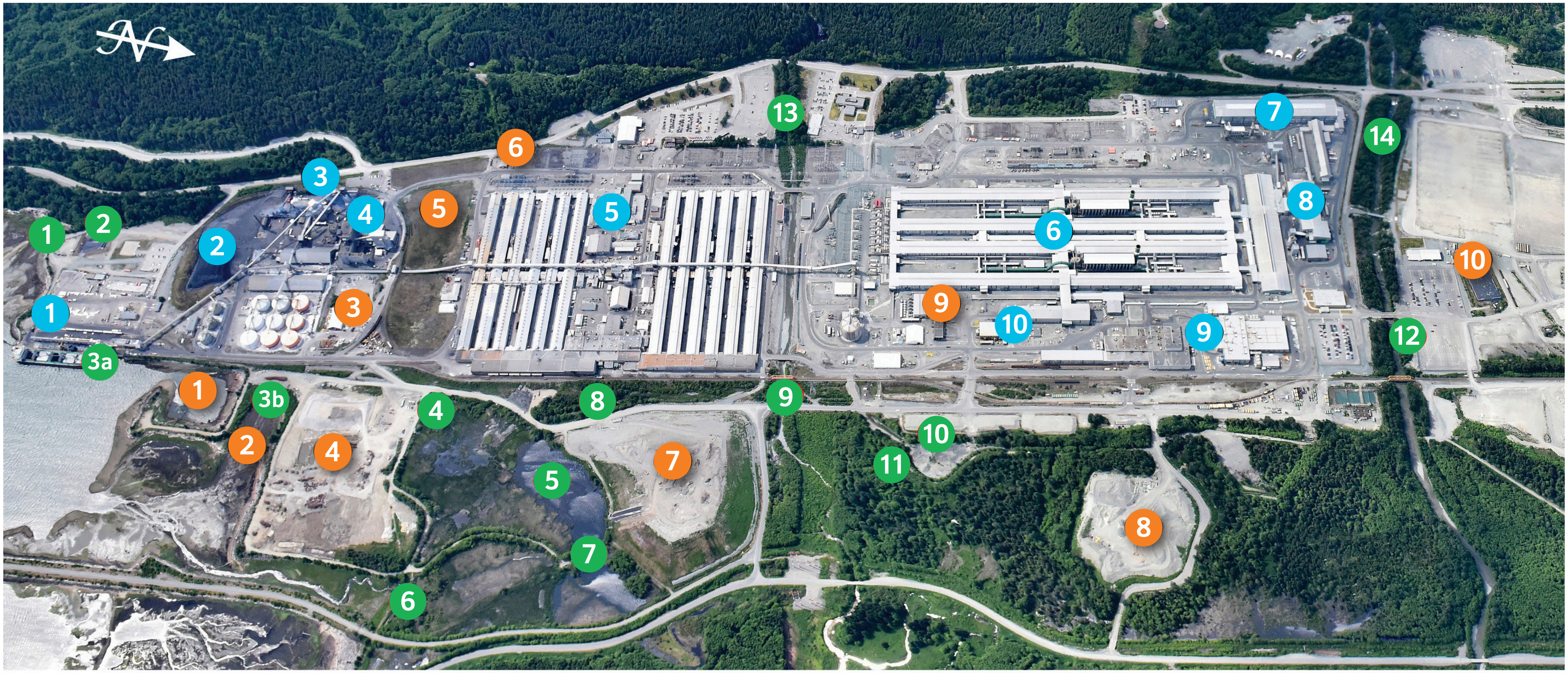
Casting

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 ~~into~~ and is temporarily stored in holding furnaces. Various alloying materials (such as magnesium, copper, silicon and iron) are added to produce specific characteristics such as improved strength, corrosion resistance, etc.

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 sheets and value added remelt ingots, 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.

Kemano

The electrolyte reduction process requires the use of large amounts of electricity. Electricity for BC Works is generated at the Kemano Operations' powerhouse, a 1,000 megawatt hydroelectric generating station located 75 kilometres southeast of Kitimat. This generating station uses water impounded in the 91,000 ha Nechako Reservoir in north-central British Columbia.



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. AP4X potline
7. Anode bake furnace
8. Anode rodding shop
9. Casting centres (B & C)
10. Delining and relining facility

Figure 2.3 Kitimat Environmental operations.

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 2022 as planned. BC Works' integrated certification was successfully maintained and transitioned to the updated ISO 14001 (2015).

In 2018 ASI certification audit took place and this certification was proudly obtained by BC Works. In 2022, BC Works successfully completed the ASI follow-up recertification audit.

Health, Safety, Environment and Communities

Our commitment to health, safety, environment and communities is fundamental to how we do business at Rio Tinto. It applies wherever and whenever we operate, from exploration, to closure.

Delivering world class health, safety, environment and communities performance is essential to our business success. Meeting our commitments in these areas contributes to sustainable development and underpins our continued access to resources, capital and engaged people. Our focus on continuous improvement ensures regular renewal and relevance of our policies, procedures and activities.

We make the safety and wellbeing of our employees, contractors and communities our number one goal. Always. Where everyone goes home safe and healthy every day.

Equally critical, is maintaining stakeholder confidence through accountable and effective management of our risks and our impacts. Safely looking after the environment is an essential part of our care for future generations.

We approach each social, environmental or economic challenge as an opportunity to create safer, more valuable and more responsible ways to run our business. Wherever possible we prevent, or otherwise minimise, mitigate and remediate the effects of our business' operations. We assess the impact of our activities and products in advance, and we work with local communities and agencies to manage and monitor these impacts.

Our approach starts with compliance with relevant laws and regulations. We have the courage and commitment to doing what is right, not what is easiest. We maintain our focus on ethics, transparency and building mutual trust. We support and encourage further action by helping to identify, develop and implement world class practices through the application of our Group wide standards.

Safety
Caring for human life and wellbeing above everything else

Teamwork
Collaborating for success

Respect
Fostering inclusion and embracing diversity

Integrity
Having the courage and commitment to do the right thing

Excellence
Being the best we can be for superior performance

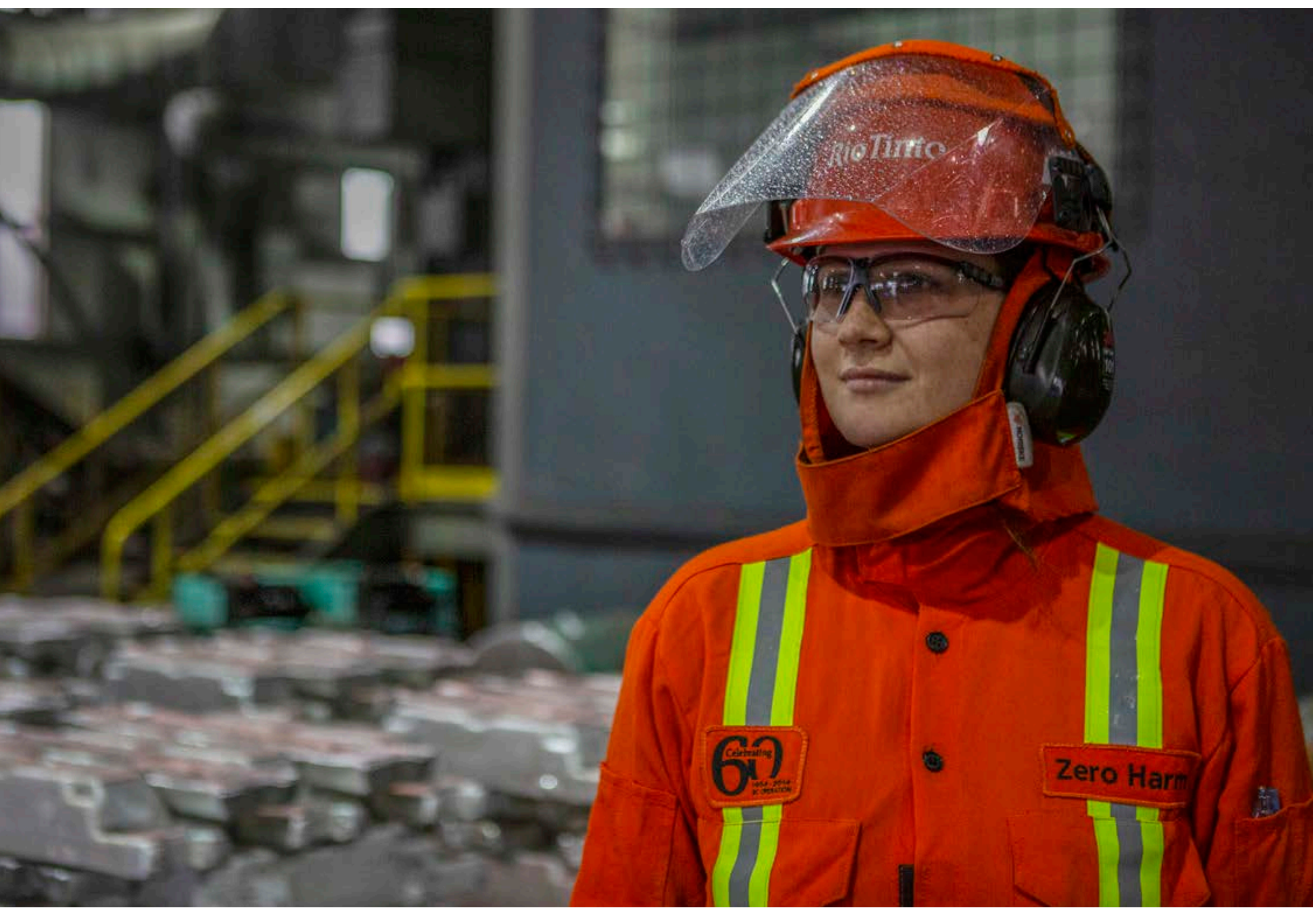
We make the safety and wellbeing of our employees, contractors and communities our number one goal.

We actively monitor and ensure the security and resilience of our operations and collaborate when confronted with unwanted events or interruptions to minimise the impact on our people, communities, stakeholders and operations.

We work together with colleagues, partners and communities globally to deliver the products our customers need. We learn from each other to improve our performance and achieve success. We promote active partnerships at international, national, regional, and local levels, based on mutual commitment and trust. We engage with our joint venture partners to share our practices and insights. We recognise and respect diverse cultures, communities and points of view.

We acknowledge and respect Indigenous and local communities' connections to lands, waters and the environment and seek to develop mutually beneficial agreements with land connected peoples. We prioritise local economic participation through employment and business development. We respect human rights and work with communities to create mutual value throughout and beyond the life of our operations.

Importantly, it is a shared responsibility, requiring the active commitment and participation of all our leaders, employees and contractors. Our business standards, systems and processes, support responsible operations, as well as contributions and innovations that make a positive and sustainable difference in every region we are part of.



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 2022, the average discharge rate was 25,922 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 2022 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.

During the construction of the infrastructure Rio Tinto required a bypass of the continuous monitoring of the lagoons. You will note in the (Figure 4.1) there is missing data from Oct 3rd through Oct 27th. This was due to electrical work that needed to take place during the transfer. During this time sampling was still being completed each day to ensure lagoon parameters were within permitted thresholds.

F-Lagoon and D-Lagoon are also designed with emergency overflows in case of significant surge. In 2022, there were a total of 12 overflow events at B-Lagoon. All parameters tested were compliant with the P2 permit.

Discharge measurements related to permit requirements and additional monitoring are described below in the following 2022 performance section.

2022 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.

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 2022 (2098 mm) was very similar comparing to previous years. Most of the rain came in the fall months of 2022.

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 2022 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.

In 2022 Rio Tinto made a significant investment to the B-Lagoon outfall.

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 12 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 2022. Average dissolved fluoride concentration for the year derived from composite sampling was 4.41 mg/L. The long-term trend is illustrated in Figure 4.2. The 2022 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.

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 2022, concentrations of dissolved aluminium did not exceed the maximum permit limit of 3.0 mg/L. The annual average of dissolved aluminium concentration was 0.32 mg/L (Figure 4.4).

In 2022 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.

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 2022 were much lower than the permit level. The annual average concentration for the composite samples was 2.45 mg/L (Figure 4.5) which is consistent with previous years.

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 2022. Weak acid dissociable cyanide is also monitored, although there is no permit requirement (Figure 4.6).

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 2022 (Figure 4.7).

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 2022.

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 2022 annual pH composite sample average was 7.08. All sample measurements were within the permit limits during 2022 (Figure 4.9).

Polycyclic Aromatic Hydrocarbons (PAHs)

Polycyclic Aromatic Hydrocarbons (PAHs) are a large family of chemical compounds (more than 4,000 have been identified) generated by the incomplete combustion of organic material.

Various operations at the smelter generate PAH in both particulate and gaseous forms.

Other sources include raw materials (green coke and pitch) handling. PAHs are monitored using monthly grab samples. PAHs are also analysed from grab samples taken during special events. B-Lagoon discharges are monitored and analysed for 15 PAH compounds as required in the P2 Permit. (Figure 4.10). In 2022 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 2022 were within permit limits set at 0.01 mg/L.

Figure 4.1

Flow variability, B-Lagoon 2022

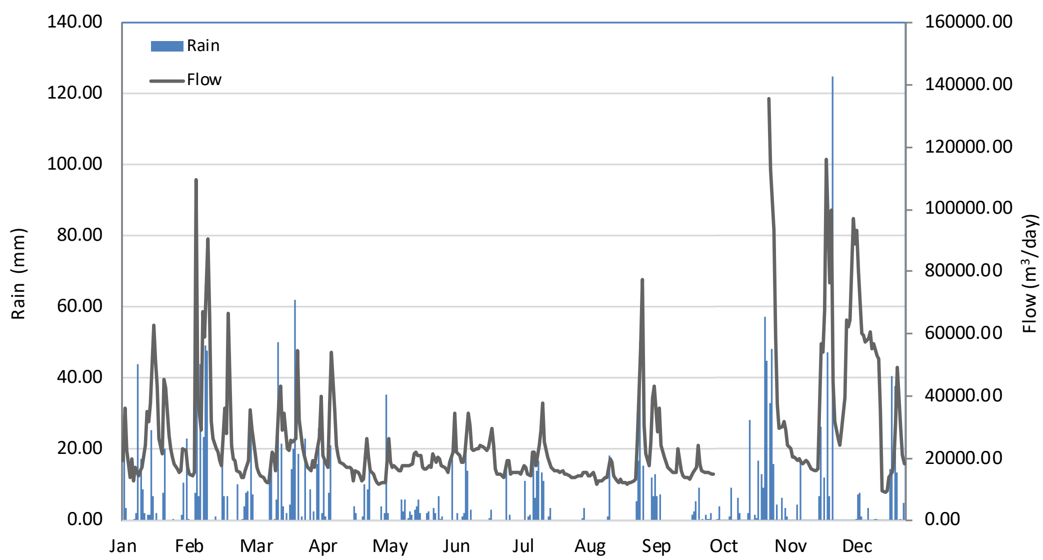


Figure 4.2

Dissolved Fluoride, Dissolved Aluminium and Total Suspended Solids, B-lagoon 2022

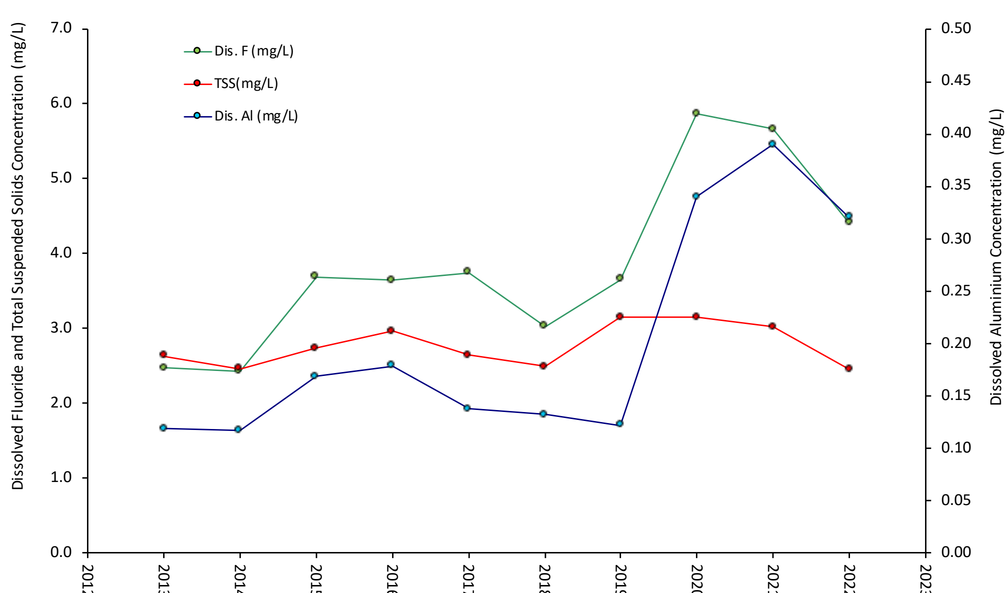


Figure 4.3
Dissolved fluoride, B-lagoon 2022

Figure 4.4
Dissolved Aluminium, B-lagoon 2022

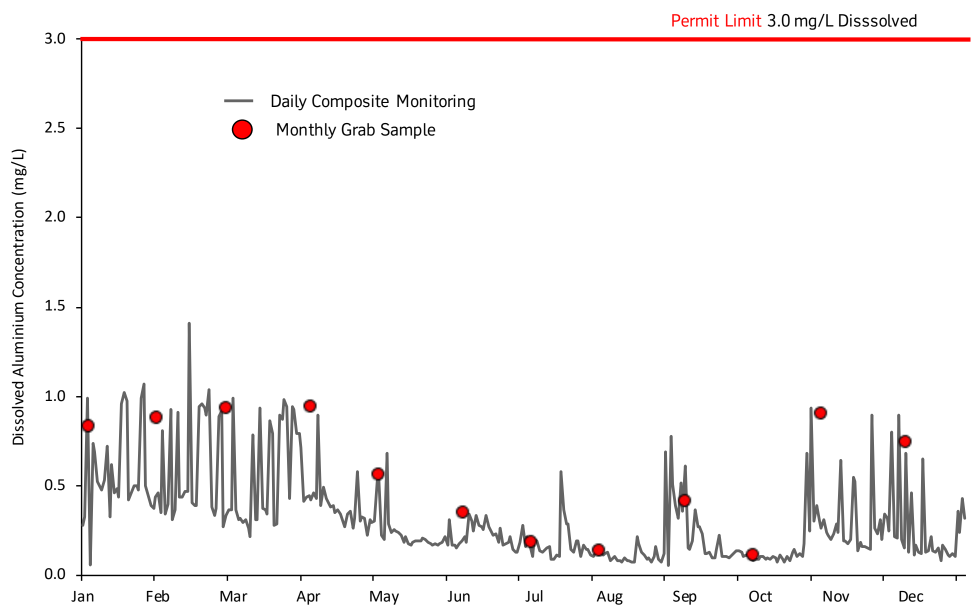


Figure 4.5
Total Suspended Solids, B-lagoon 2022

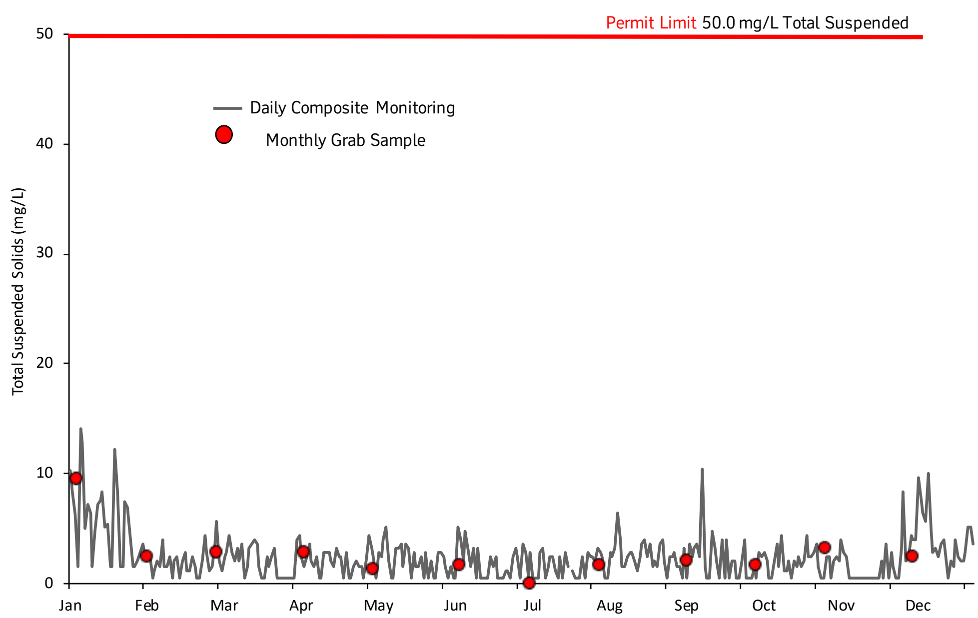


Figure 4.6

Cyanide, B-lagoon 2022

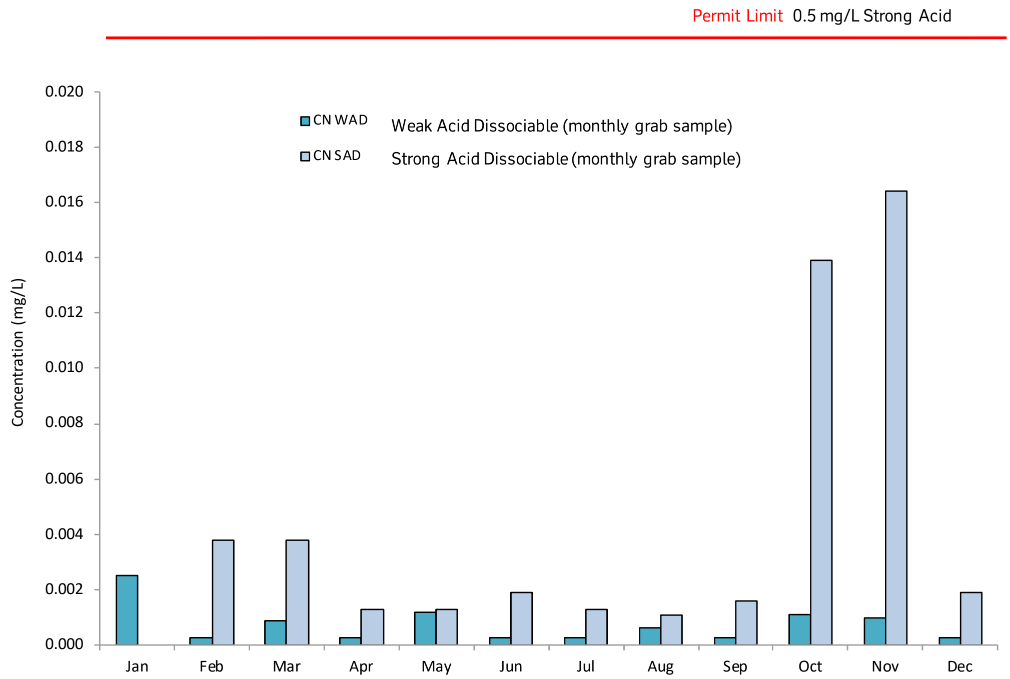


Figure 4.7

Temperature B-lagoon 2022

Figure 4.8

Conductivity and hardness, B-lagoon 2022

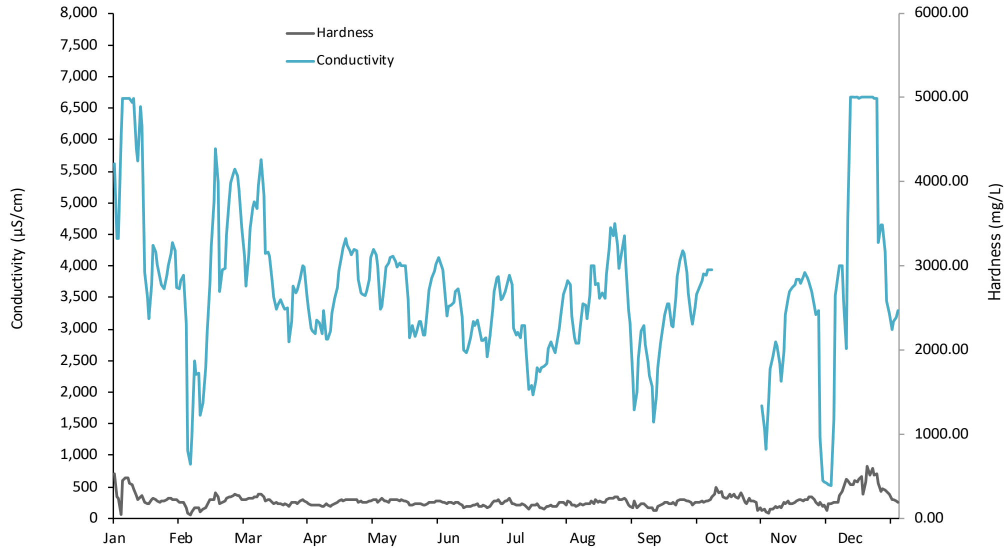


Figure 4.9

Acidity, B-lagoon 2022

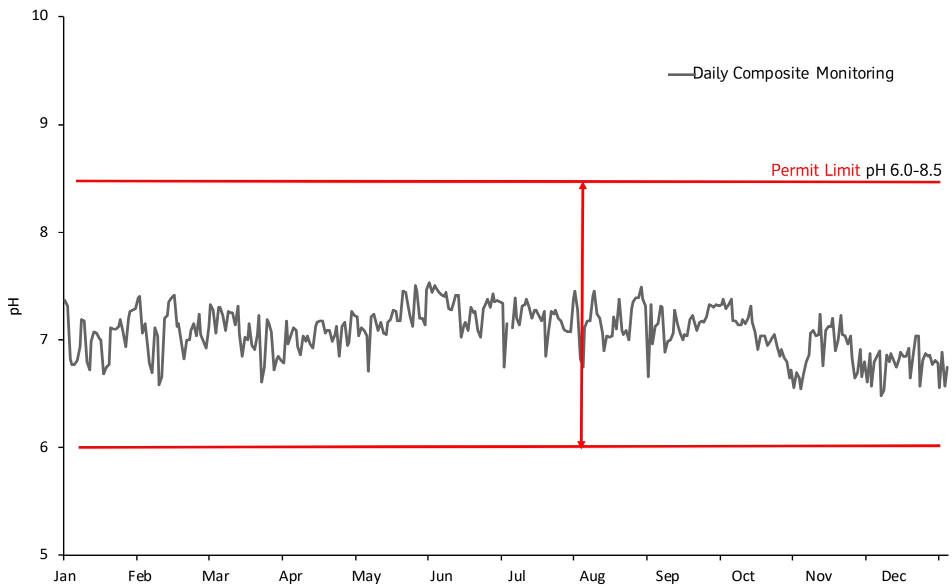
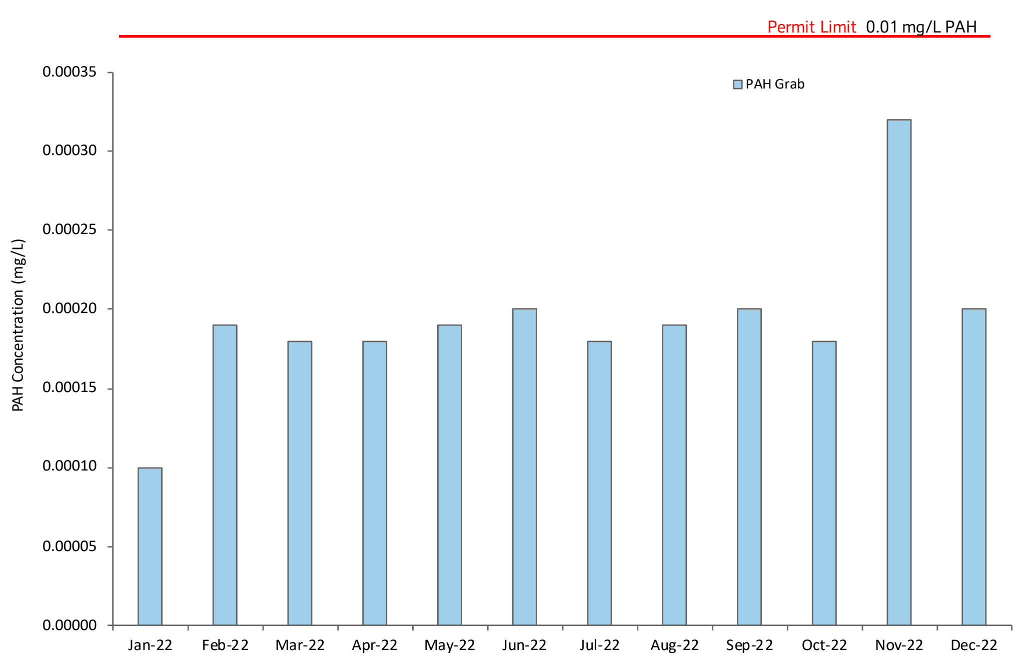


Figure 4.10

Polycyclic Aromatic Hydrocarbons, B-lagoon 2022



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.

2022 overview

Operational sources & emission types

At BC Works the process of making aluminium releases emissions at various steps in the process. The first step of the process is using raw materials to form green anodes in Carbon South, these anodes are then transferred to Carbon North for baking. The baked anodes are then rodded and transferred to Reduction (AP-4X prebake technology) to be used in the electrolytic process to generate molten aluminium which is tapped and transferred to the Casting departments. As the baked anodes are consumed in the electrolytic process they are replaced with new anodes in the anodes change process. The used (spent) anodes and bath collected from this change process is sent back to Carbon North to be recycled back into the process of making aluminium.

Emissions control equipment are situated in each operational areas as required, some of which are monitored annually or biennially by a 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 (NOx), 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 fluoride total (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.

Operational performance

2023 was a unique year for BC Works as the operation initiated a restart to recover from the labour dispute that occurred in late July that resulted in reducing operations by 75%. In reduction, and the complete shutdown of the anode baking furnace, anode paste plant and coke calcination operations. There were some self-reported non-compliance's: 3 regarding reporting emission control device upsets, 1 due to invalid monitoring of air emissions, 2 related to stack sampling requirements, and 1 due to a continued operation generating dust without the prescribed dust collector in operation.

For each self-reported permit non-compliance an investigation and closure reports were completed for the non-compliances and action plans executed to bring back stability (see Chapter 11 on permit non-compliances for more information). All other compliance points (stacks) for air monitoring at BC Works were compliant in 2022.

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. In Q3 the conveyor system was found to have structural issues that required the immediate cease of use. With the shutdown of the conveyor contingency plans were required to transport both alumina and aluminium fluoride to the operations. The contingency plans that were developed utilized mobile dust collectors and tanker trucks to move alumina from the south silos to the north silo, as well as the use of big bags of aluminium fluoride to manually fill hoppers for use in reduction operations.

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. Due to the labour dispute, the anode paste plant was shut down during the first few months of 2022 and the coke calciner remained shutdown throughout 2022.

The emission control devices located in the coke calcination plant and in the anode paste plant are operational when the plants are operational, however due to emergencies and planned maintenance these devices may be bypassed, meaning not in use during operations. Each time a device is bypassed 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 bypass). The date, bypass duration as well as the cause must be documented and reported to the ministry within 1 business day for emergency bypasses and on a monthly basis for pre-approved bypasses. Table 5.1 shows each bypass that occurred for each pollution control device in 2022 in Carbon South. In 2022 there were 3 self-reported permit non-compliances due to missed or late reporting of upsets related to the pitch incinerators in APP (See Chapter 11 for additional information).

Coke calcination plant

Green coke is fed through the kiln to produce calcined coke during this process the moisture in volatiles are incinerated in the kiln and in the pyroscrubber. The freshly calcined coke is cooled with water and the vapours are 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. Due to the labour dispute and the subsequent shutdown of the coke calcination no stack tests were completed in 2022 for both the pyroscrubber and cooler.

Anode paste plant

The anode paste plant uses calcined petroleum coke (from the coke calcination plant and from the wharf), coal tar 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 to the atmosphere from the green anode production process. Each of the devices are stack sampled once a year and have permit limits related to particulate emissions, and certain devices used to mitigate emissions that come from coal tar pitch are stack sampled for polycyclic aromatic hydrocarbons (PAHs). There were no permit non-compliances at the anode paste plant in 2022.

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 to the atmosphere. This pollution control device is analysed for PAHs and has a permit limit for particulate emissions. The stack test results within permit limits for particulates (Table 5.2).

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 for associated with particulate emissions (Table 5.3).

Dust collectors

Dry raw materials (calcined coke and baked recycle carbon) go through a screening and grinding process and is separated based 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 crushes 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 mixture as it is transferred to building 5130 for the anode making process (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 5.4).

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 5.5).

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 emergency bypasses and on a monthly basis for approved bypasses. Table 5.6 shows each upset that occurred in 2022 after April as the FTC was re-started in May.

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 fluoride total permit limit (see section on Plant Wide – Fluoride Total Emissions below).

The FTC is required to have the stack tested once a year, in 2022 the stack test was completed twice, once in August and once in November in order to complete all parameters (Table 5.7).

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 tonne of aluminium 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 fluoride total permit limit (see section on Plant Wide – Fluoride Total Emissions below).

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 anodes 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 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 5.8 is a list of dust collectors that are reported for leak detection.

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. At the end of 2021 the bath pan conveyor was non functional and an alternative method for transporting cool bath from the pallet storage building to the bath plant was required. To maintain the flow of bath, a temporary crusher was installed in the pallet storage building. Two contingency methods were deployed, the first method utilized an external conveyor to move crushed bath from the pallet storage building to the bath plant, this continency was in place from December 2021 to February 2022. The second method utilized a mobile dust collector inside pallet storage building used in conjunction with a crusher to crush bath and load into sealed hoppers which were then transported to the bath plant using a modified screw conveyor. This contingency took place from February to May.

5710-DCB-001 & 5710-DCB-003

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 2022 (Table 5.9). These two dust collectors are also monitored for leak detection (Table 5.8). For a number of months DCB 001 was not in use as the bath pan conveyor was not operational, in the interim a mobile dust collector was used to collect dust generated from the contingency bath crushing.

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 June of 2022 a permit amendment to increase the permit limits for both total fluoride from 0.9 kg/Mg Al to 2.8 kg/Mg Al and particulate matter from 1.3 kg/Mg Al to 2.9 kg/Mg Al was authorized to facilitate the re-start of pots until December 31, 2022. Additional details on the re-start are provided in chapter 13. At the beginning of 2022, only 25% of the pots were operational due to the labour dispute and in December approximately 65% of the pots were operational.

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 to be operational 24/7, however due to emergencies and laned maintenance the GTCs may be bypassed. Each time a GTC 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 within 1 business day for emergency bypasses and on a monthly basis for approved bypasses. Table 5.10 shows each upset that occurred in 2022.

The GTC is monitored on an annual basis as per permit requirements for fluoride, particulates and sulphur dioxide (Table 5.11). In 2022 in part of the authorization for the re-start the GTC's was required to undergo two stack sampling events, one during peak emissions of the re-start and another after the ramp down of the re-start. During peak emissions in August the stacks were sampled for particulate matter and total fluoride, however they were not sampled for PM2.5 and SO_2. In November the West GTC was stack sampled for particulates, PM2.5 and SO_2, however total fluoride was not measured, the East GTC was stack sampled for particulates, however PM2.5, SO_2 and total fluoride was not measured. These missing parameters were self reported as non-compliances, additional information on the corrective actions can be found in chapter 11. The results for fluoride and particulates are used in the monthly compliance reporting against the plant wide fluoride total permit limit (see section on Plant Wide – Fluoride Total Emissions & Plant Wide – Particulate Emissions below).

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) equipped with 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. In January a self reported non-compliance was issued due to insufficient shuttles in operation to meet the requirements of the monitoring method.

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 fluoride total (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 and additional pots in other half buildings were started, additional continuous monitors were used to monitor the emissions from the restart following the restart roof vent sampling methodlogy. At the end of 2022, when the operation reached 65% operational pots, the continuous monitors in 6 half buildings were utilized to monitor the emissions from the 6 operational half buildings.

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.

The anodes are removed and transferred to the pallet storage building for recycle, the superstructure (which houses the anodes) is also removed from the pot and 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 2022 as per permit requirements for (Table 5.12), and monitored for leak detection (Table 5.13).

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 (anodes and dry bath are added), energized (power re-connected) and started up (aluminium making).

In 2022, the restart campaign utilized 3 methods for restarting pots. Cold metal, hot bath and dry starts. Of these three methods only the conventional method requires the lining delining process. Of the 163 pots restarted, 71 used cold metal, 92 used hot bath, of these 20 had the cathode replaced, and 0 dry starts took place.

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 SF6 consumption in 2022 during the process of casting aluminium.

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 oxide, chloride, chlorine and particulate emissions as per permit requirements but neither stack has have 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 5.13.

C- Casting

In C-casting aluminium is transferred from cruces into either furnace 62, 63 or 64. Furnace 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 both furnace 63 and 64. Both stacks are sampled twice a year for nitrogen oxide emissions and particulate emissions as per permit requirements but neither stack have specific permit limits associated to 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 that is monitored for leaks and there were no leaks detected in 2022.

In 2022 furnace 62 was out for maintenance during the first sampling campaign, a non-compliance was self reported to indicated the missed sampling parameter requirements.

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 5.14). This furnace was out for maintenance during the August stack sampling campaign.

Furnace 63/64

Furnace 63/64 was stack sampled twice as per permit requirements and the results can be seen in table 5.14

Plant wide

Fluoride total emissions

The plant wide fluoride total emissions are calculated using reduction's roof vents and gas treatment centers as well as carbon north's fume treatment center and pallet storage building (Figure 5.5). The plant wide fluoride total permit limit is typically set at 0.9 kg / tonne of aluminium, however during the 2022 re-start (June – December) the permit limit were raised to 2.8 kg/ tonne of aluminium.

In 2022, there were no permit exceedances of the total fluoride emissions permit limit (Figure 5.6), however there was 1 self-reported non-compliance in January of 2022 after not having enough operational monitoring equipment to comply with the monitoring methodology.

A review of the historical data from 2012 to 2022 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).

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 fluoride total permit limit is set at 1.3 kg/tonne of Al.

During 2022, there were no permit exceedances of particulate emissions permit limit (Figure 5.9) however there was 1 self reported non-compliance in January of 2022 after not having enough operational monitoring equipment to comply with the monitoring methodology. The plant wide particulate matter permit limit is typically set at 1.3 kg / tonne of aluminium, however during the 2022 re-start (June – December) the permit limit were raised to 2.9 kg/ tonne of aluminium.

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).

Particulate emissions from the Gas Treatment Centres accounted for 48 per cent of total particulate emissions for BC Works in 2022 (Figure 5.11).

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). During 2022 the pyroscrubber and cooler were not operational.

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 2022 the monthly average SO_2 emission levels remained well below the permit limit due to the reduced consumption of carbon material due to the reduction in operational pots (Figure 5.12). Near the mid 2022 the amount of sulphur released per day started to increase as aluminium production increased leading to a increase in consumption of raw materials resulting in an increase in sulphur dioxide emissions.

The plant wide sulphur dioxide permit limit was at 27 tonnes per day from 2000 – 2013 due the quality challenges observed in the global coke market. In April 2013 the operation permit was updated to reflect the new SO_2 emission permit limit of 42.0 tonnes per day on annual average in preparation to the modernised smelter production increase (Figure 5.13).

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**.

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 5.16.

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 (86%) and most smelting-related emissions are attributable to anode consumption and subsequent PFC emissions (Figure 5.15). 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 (Figure 5.16). During the start up, an increase in anode effect frequency and duration is expected as the pots are energized.

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 202 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 tonne of aluminium.

BC Works aims to increase the stability of the operations and therefore decrease the greenhouse gas emissions with a reduction target of 65% in term of anode effect minutes duration and 25% reduction in terms of CO_2 equivalent /Mg Al in comparison reference to 2022 average once the operation is returned to a stable phase in September-2023.

Nitrogen Oxide 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 2022 due to the use of diesel preheaters in the re-start the emissions from these devices were also included into the NOx Calculation. The monthly emissions in 2022 were below the permit limit of 1.12 Mg /day (Figure 5.18).

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 5.0).

Table 5.0

Operational Area	Process Description	Exhaust Type	Bypass	Duration
Overhead Conveyor	Process modification during overhead alumina conveyor break down. Two mobile dust collectors were used to capture the dust generated from filling tanker trucks from two discharge points.	Outside	Yes	5 months
Cruice Cleaner	Additional dust management during cruce cleaner, managing cryolite.	Outside	No	5+ months
Pan Conveyor	Process modification during bath pan conveyor break down, managing cryolite.	Inside Pallet storage building	Yes	3 months

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).

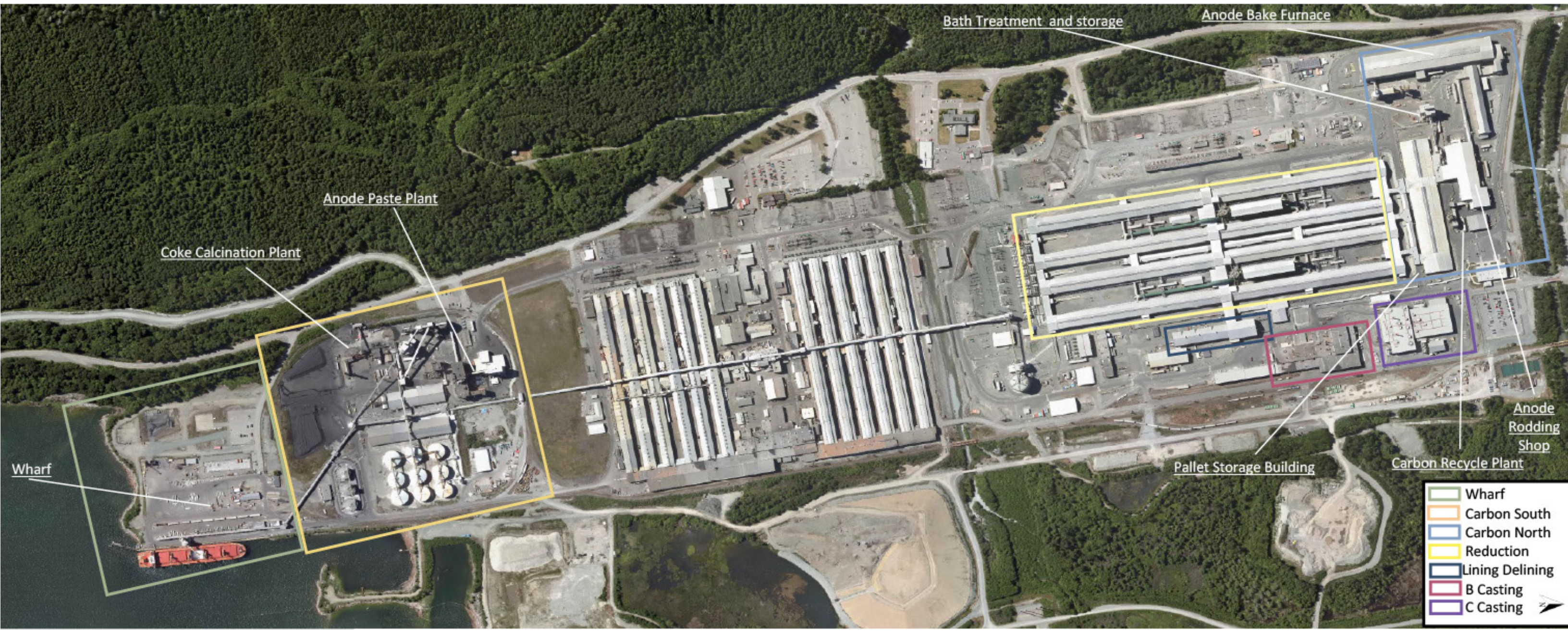


Figure 5.2 Operational Performance

There were 5 locations that resulted in 7 permit non-compliances (red) related to air emissions discharges in 2022, the remaining discharge points were compliant (green).

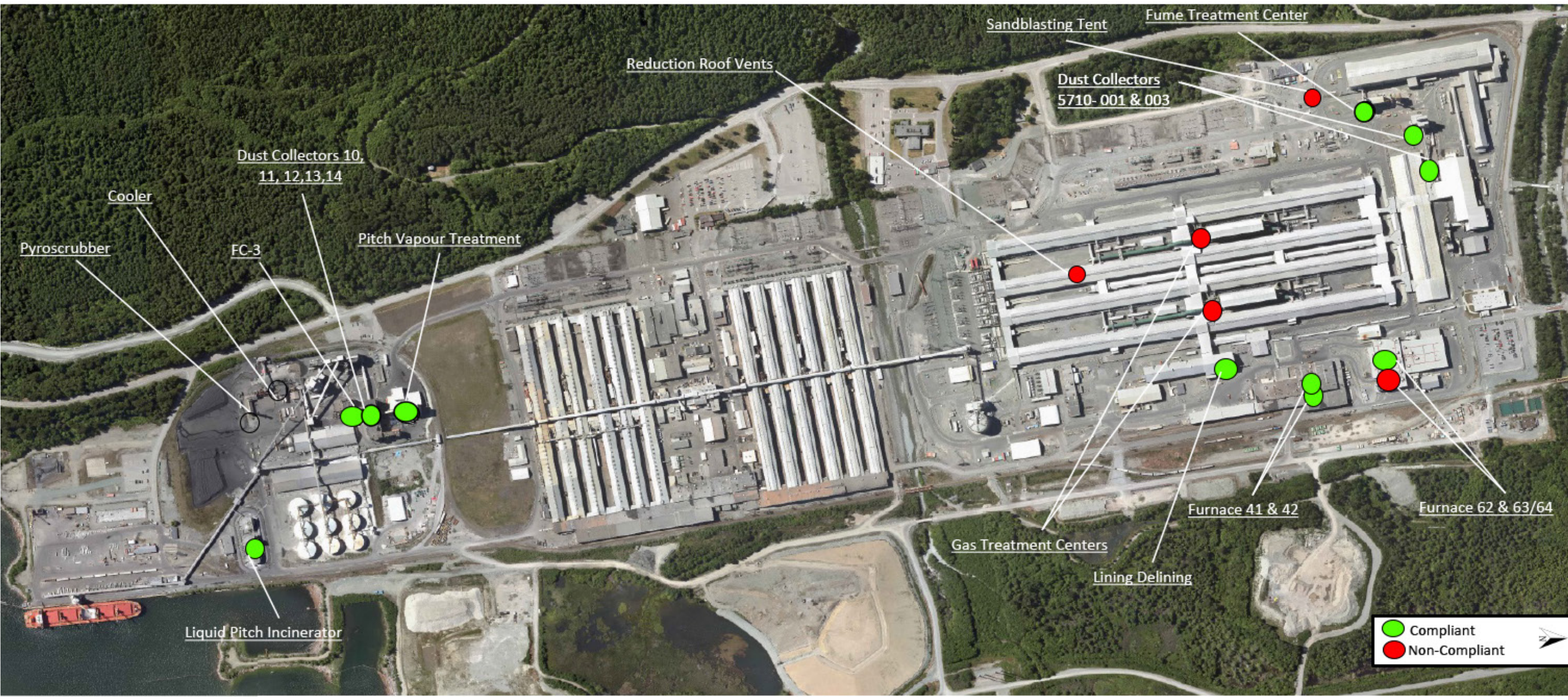


Figure 5.3
Reduction Roof Vent Fluoride Total

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

There were no permit limit exceedence in 2022, however there was a self reported non-compliance for not meeting the required number of shuttles in operation for January.

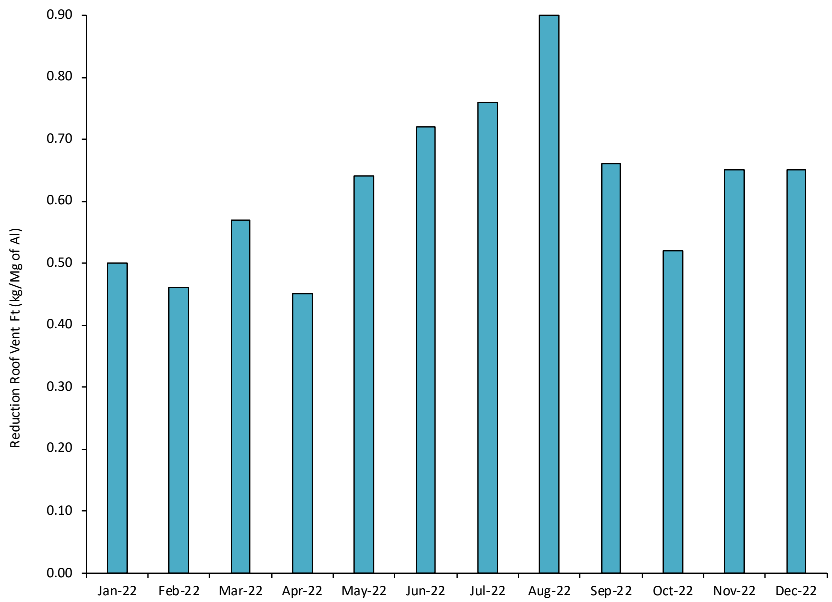


Figure 5.4
Reduction Roof Vent Particulate Emissions

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

There were no permit limit exceedence in 2022, however there was a self reported non-compliance for not meeting the required number of shuttles in operation for January.

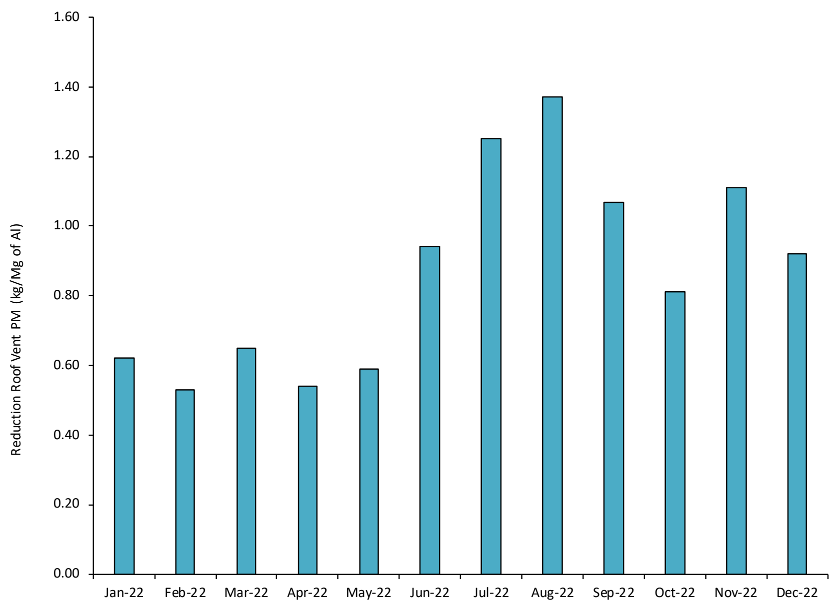
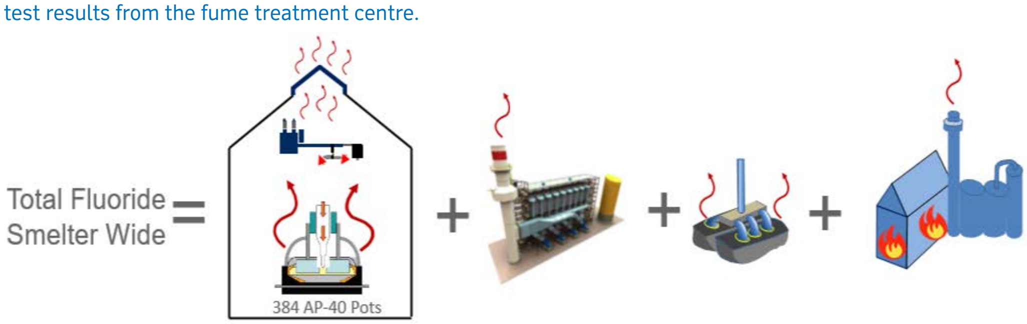


Figure 5.5
Plant Wide Fluoride Total Emissions Calculation

The plant wide fluoride total is calculated in kilograms per tonne of aluminium 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 Fluoride Total Emissions

The plant wide fluoride total is calculated in kilograms per tonne of aluminium each month by adding the emissions from the reduction roof vents plus the GTC, FTC and PSB.

In June of 2022, the re-start authorization increased the permit limits from 0.9 to 2.8 kg/Mg Al.

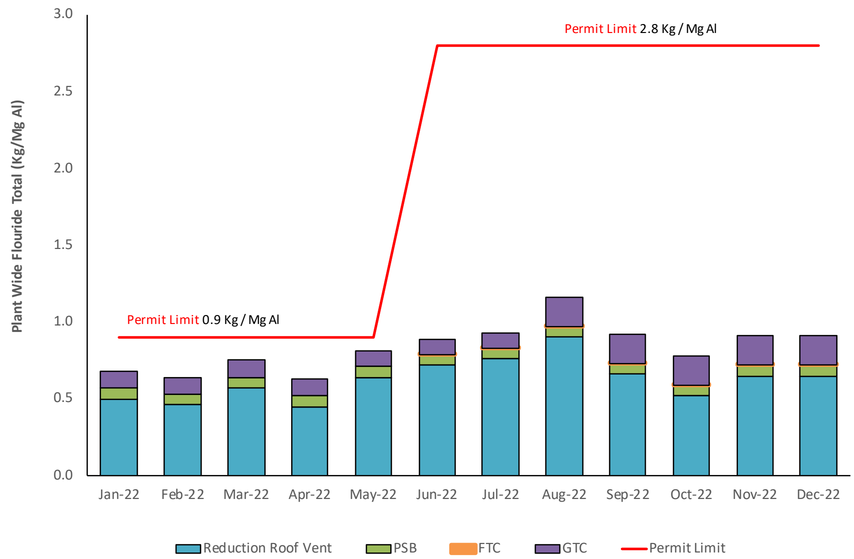


Figure 5.7
Historical Fluoride Total Emissions

The average monthly roof vent emissions for fluoride total 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.

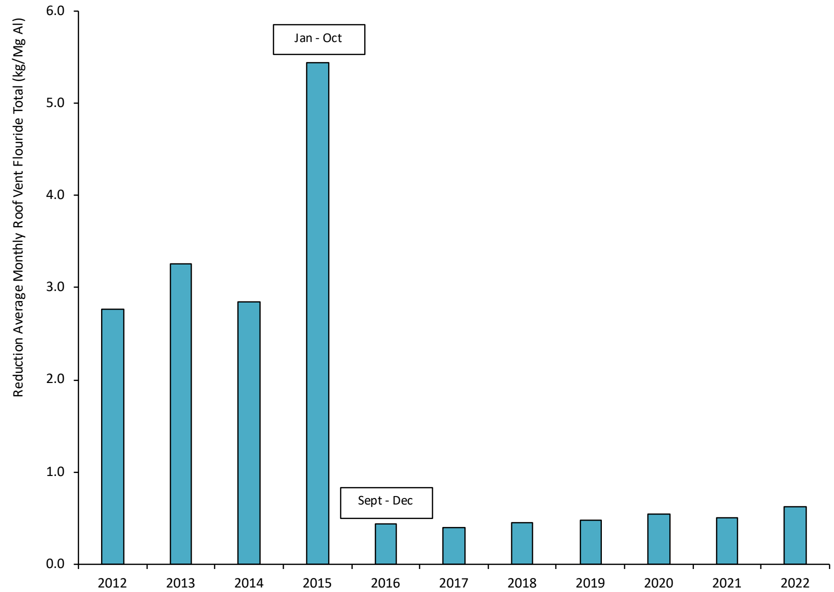
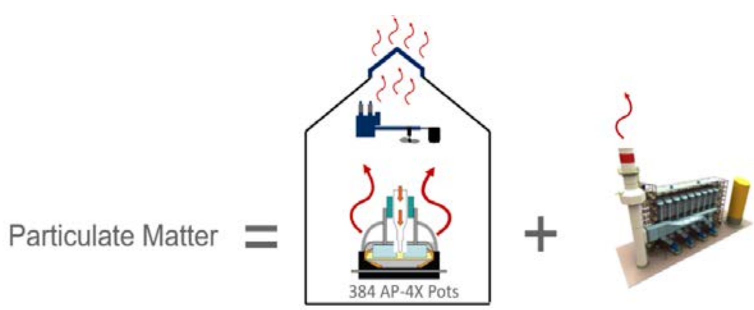


Figure 5.8
Plant Wide Particulate Emissions Calculation.

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



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

Figure 5.9
Plant Wide Particulate Emissions Calculation

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

In June of 2022, the re-start authorization increased the permit limits from 1.3 to 2.9 kg/Mg Al.

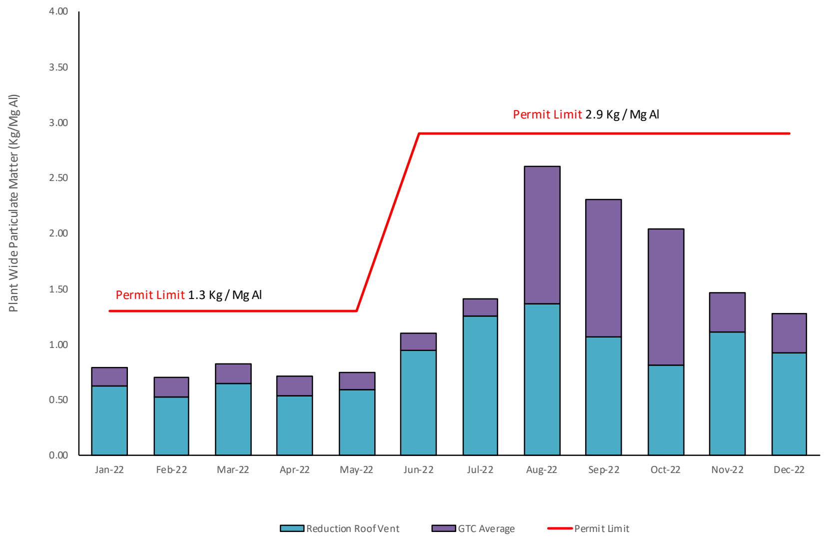


Figure 5.10
Historical Particulate Emissions

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.

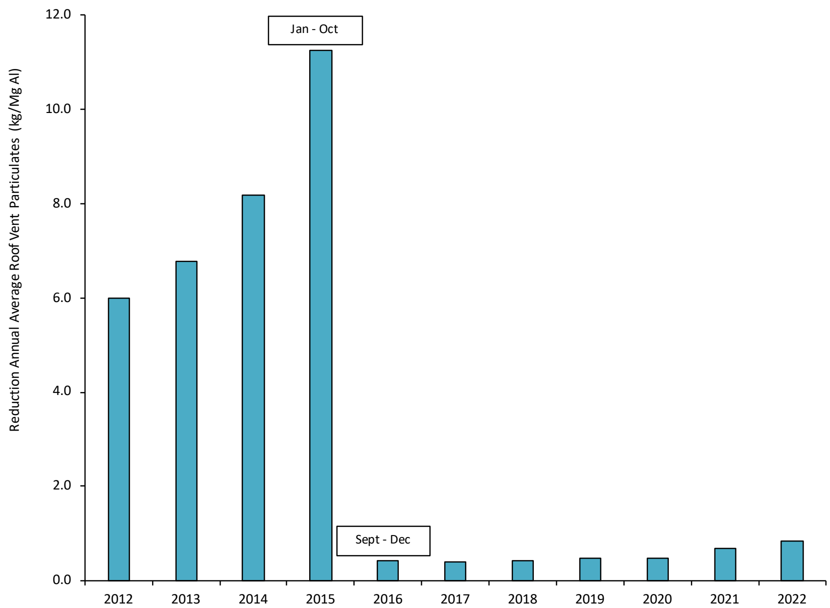


Figure 5.11
Particulate Emissions by Operational Area

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.

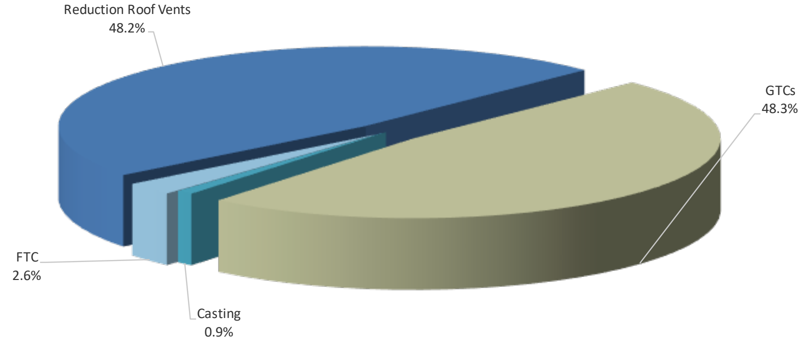


Figure 5.12
Sulphur Dioxide Emissions

Sulphur Dioxide emissions in 2022 were low due to the low number of operating pots.

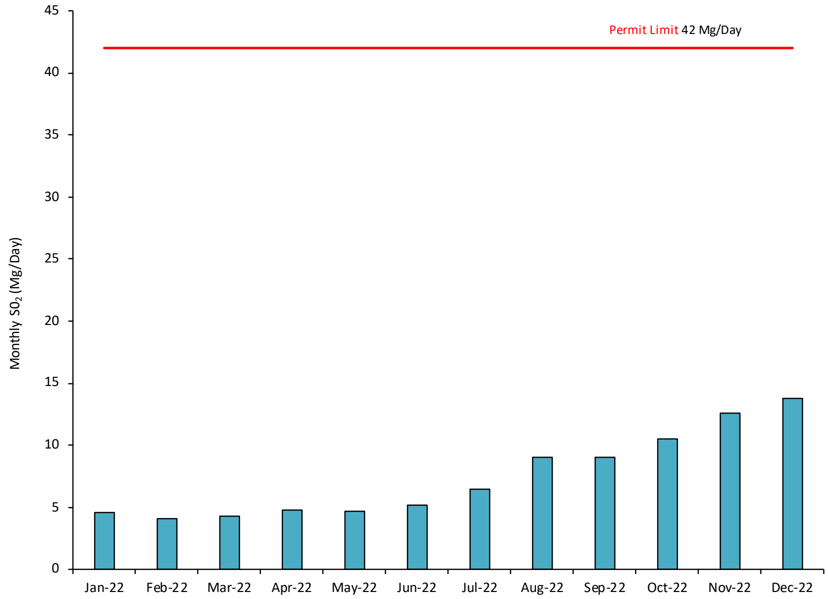


Figure 5.13
Historical Sulphur Dioxide Emissions

Increased in Sulphur Dioxide emissions started to occur in 2016 as the new AP-4X smelter became fully operational, in 2020 a decrease in emissions is attributed to the low number of operational pots, in 2022 this trend continued with a reduced production due to the shutdown of the coke calcination centre and partial operation of the anode bake furance.

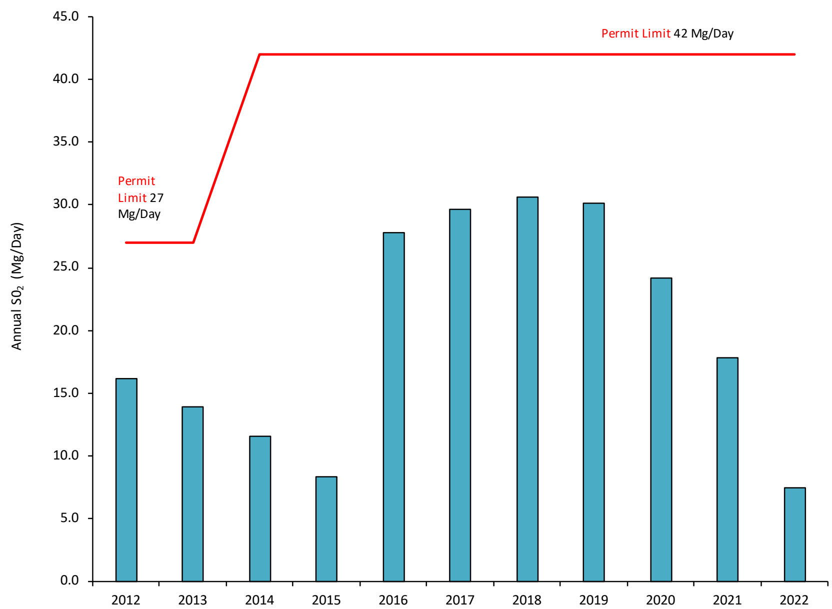


Figure 5.14
Operational sources of GHG Emissions

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

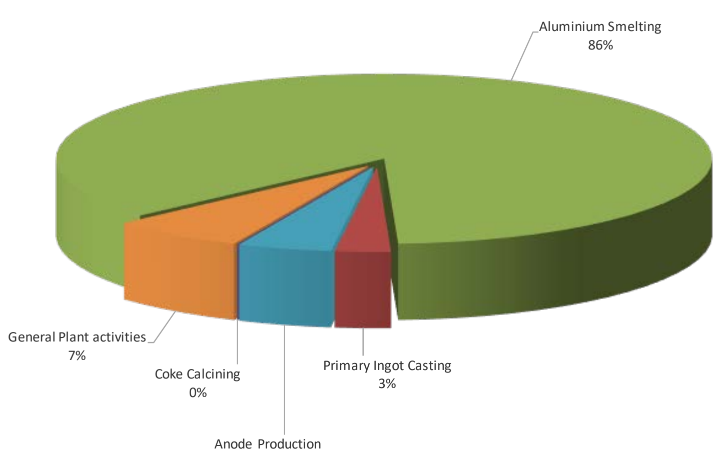


Figure 5.15
GHG Emissions from Aluminium Smelting

The consumption of anodes in the electrolytic process is the typically the main contributor of greenhouse gas emissions from the aluminium smelting process, in 2022 dur the large number of pots started there was large increase in the contribution from PFC emissions due to a large increase in anode effects.

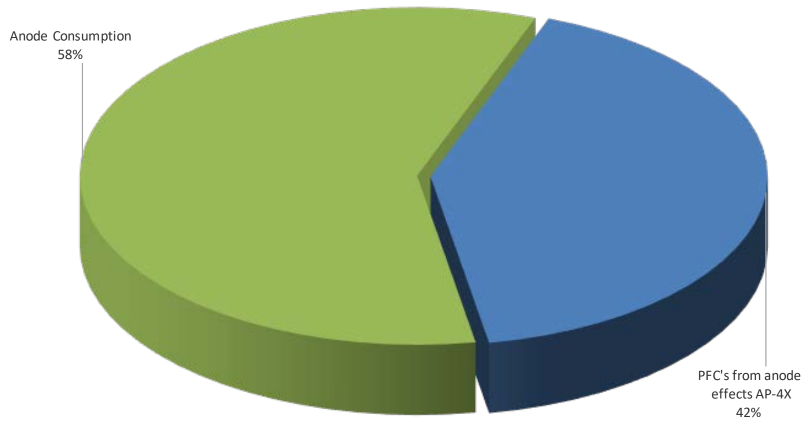


Figure 5.16
Monthly GHG Emissions & Anode Effect Duration

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.

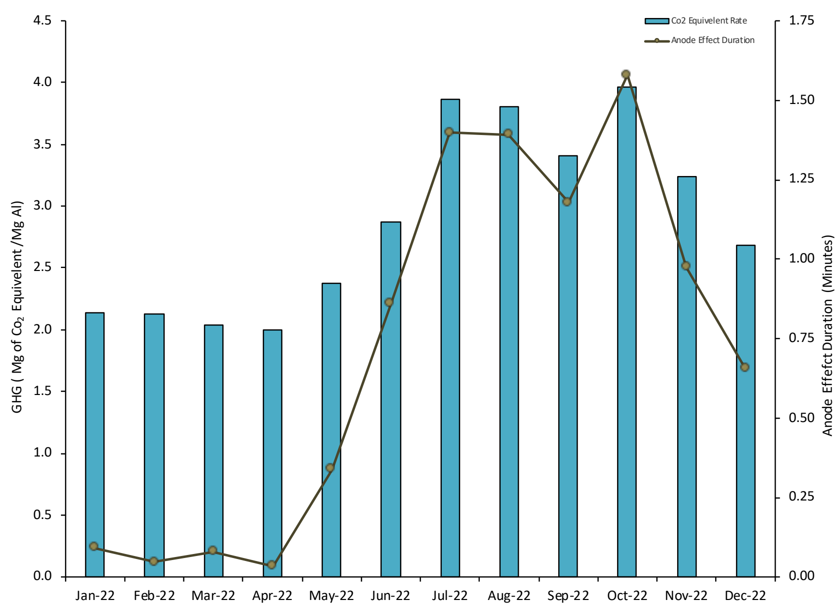


Figure 5.17
Historical GHG Emissions & Anode Effect Duration

The annual average GHG emissions (Mg of CO_2 equivalent per tonne of aluminium) 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 tonne of aluminium and in unstable years (since 2019) the emissions were above 2.0 tonnes of CO_2 equivalent per tonne of aluminium.

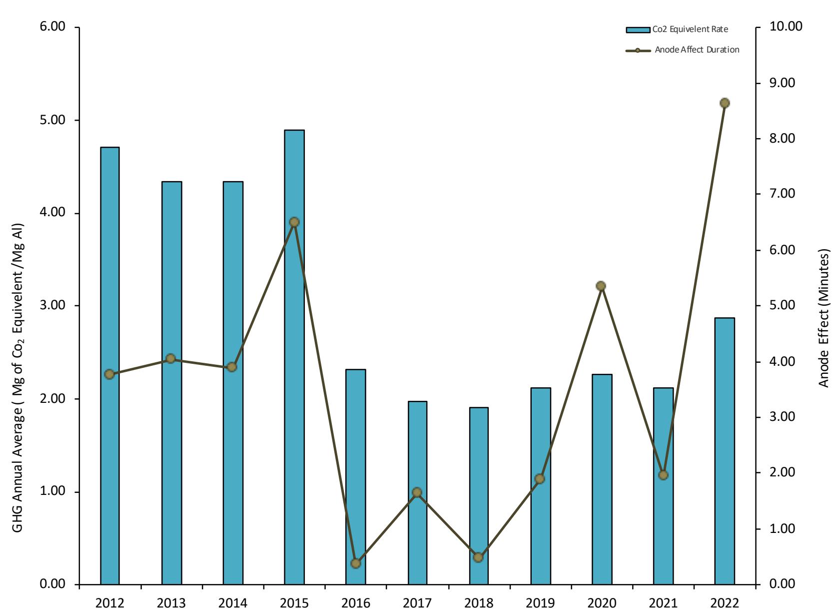


Figure 5.18
Monthly Nitrogen Oxide Emissions

Throughout 2022 NOx emission were below the proposed permit limit of 1.12 tonnes per day.

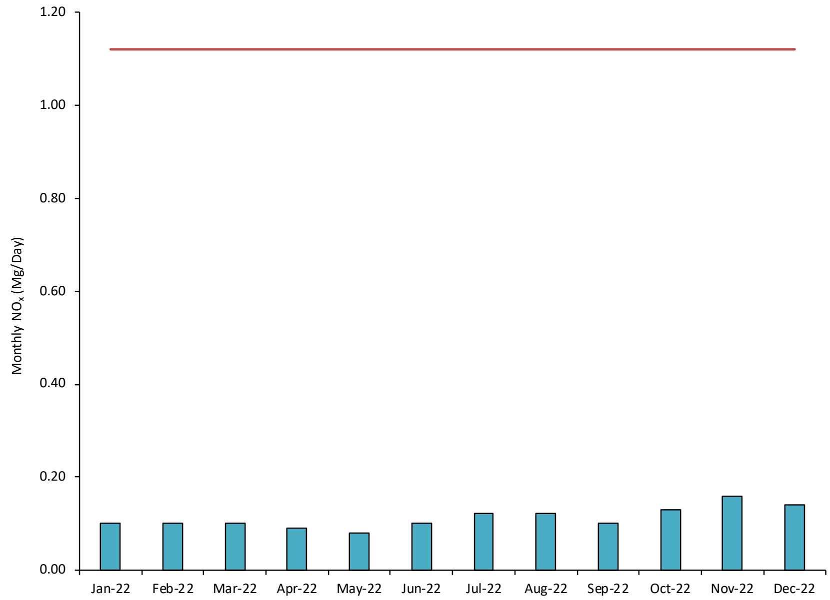


Figure 5.19
Historical Nitrogen Oxide Emissions

Summation of annual NOx emissions from 2012 to 2022.

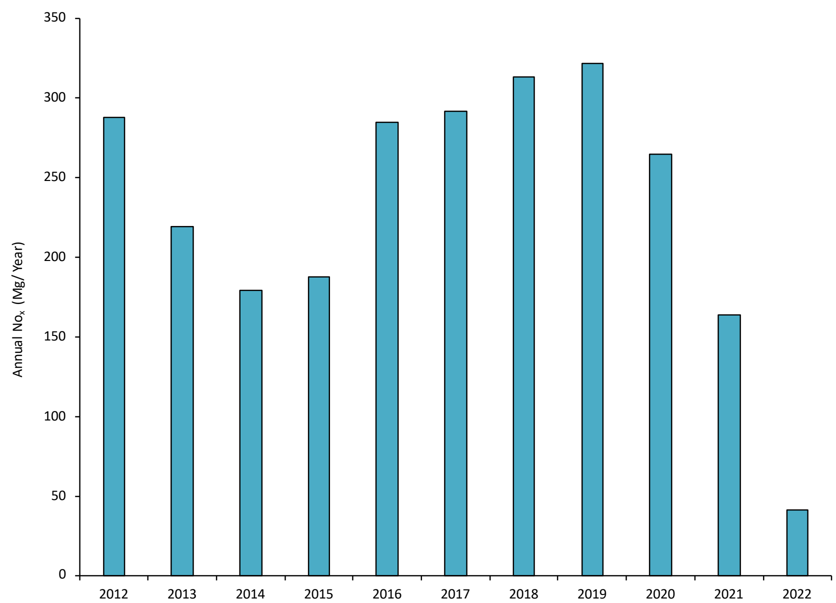


Table 5.1 Carbon South Emission Control Bypass Hours

Carbon South emission control devices that are bypassed during emergency scenarios (such as a power outage) or for maintenance purposes.

Date	Equipment	Bypass Type	Duration	Cause
22-Dec-21	FC-3	Emergency	2712h 48m	Low temperature
4-May-22	FC-3	Emergency	10h 03m	Low temperature
10-May-22	LPI	Planned but not approved	8h 48m	Maintenance
19-May-22	FC-3	Emergency	2h 16m	Low temperature
20-May-22	FC-3	Emergency	1h 47m	System trip
20-May-22	FC-3	Emergency	1h 19m	Combustion blower trip
30-May-22	FC-3	Emergency	11h 37m	Low temperature
30-Jun-22	LPI	Approved	1h 47m	Maintenance
5-Jul-22	FC-3	Emergency	4h 08m	PLC Card Failure
16-Jul-22	LPI	Emergency	1h 08m	undetermined
18-Aug-22	FC-3	Approved	11h 10m	Maintenance
18-Aug-22	LPI	Emergency	Indeterminate	Fume Leak on crossover piping atop of silo
19-Aug-22	LPI	Approved	8h 10m	Maintenance
6-Sep-22	LPI	Emergency	1h 41m	undetermined
7-Sep-22	LPI	Emergency	1h 56m	undetermined
21-Sep-22	LPI	Emergency	1h 24m	Power outage
21-Sep-22	FC-3	Emergency	1h 06m	Power outage
27-Sep-22	FC-3	Emergency	1h 30m	Loss of communication
28-Oct-22	FC-3	Emergency	2h 41m	Vacuum spiked causing it to trip
1-Dec-22	LPI	Emergency	1h 11m	Low temperature
4-Dec-22	FC-3	Emergency	6h 49m	Low inlet temperature
7-Dec-22	LPI	Emergency	504h	Leak where fumes are bypassing the LPI
11-Dec-22	FC-3	Emergency	1h 10m	Power outage
11-Dec-22	FC-3	Emergency	11h 20m	Stuck in warm up mode after power outage
21-Dec-22	LPI	Emergency	225h 07m	Motor failure
24-Dec-22	FC-3	Emergency	1h 13m	Trip on high temperature due to controller issue
25-Dec-22	FC-3	Emergency	37m	Trip on high temperature due to controller issue
26-Dec-22	FC-3	Emergency	8m	Trip on high temperature due to controller issue
27-Dec-22	FC-3	Emergency	13m	Trip on high temperature due to controller issue
27-Dec-22	FC-3	Emergency	2h 44m	Trip on high temperature due to controller issue

Table 5.2 Liquid Pitch Incinerator Stack Test

The LPI is used to incinerate fumes released from the three pitch tanks in Carbon South, the stack test result was compliant.

Performance Measure	LPI
Date	November, 2022
Particulate (mg/m^3) Permit Limit: 500 (mg/m^3)	1.0
PAH (mg/m^3)	0.0009

Table 5.3 FC-3 Stack Tests

The FC-3 incinerator stack results were within permit requirements for particulates.

Performance Measure	LPI
Date	August, 2022
Particulate (mg/m^3) Permit Limit: 120 mg/m^3	4.4
PAH (mg/m^3)	0.5

Table 5.4 Anode Paste Plant Dust Collector Stack Tests

The dust collectors were stack sampled and came back as compliant.

	Dust Collectors				
Performance Measure	DC10	DC11	DC12	DC13	DC14
Dates	Jul-22	Jul-22	Nov-22	Jul-22	Jul-22
Particulate (mg/m^3) Permit Limit: 120 (mg/m^3)	1.6	3.7	2.7	1.2	3.1

Table 5.5 PVT Sack Tests

The PVT was stack results were within permit requirements for particulates and PAHs.

Performance Measure	PVT
Date	July, 2022
Particulate (mg/m^3) Permit Limit: 30 mg/m^3	2.7
PAH (mg/m^3) Permit Limit: 0.03 Kg/Mg of Paste	0.026

Table 5.6 Fume Treatment Center Bypass Hours

This emission control devices is bypassed during emergency scenarios (such as a power outage) or for preventative maintenance purposes.

Date	Bypass Mode	Bypass Type	Duration	Cause
12-Jul-22	Mode 2	Planned	9h 30m	Maintenance
21-Sep-22	Mode 4	Emergency	35m	Power outage
4-Oct-22	Mode 4	Emergency	3h 14m	Issues with LRP-017 that prevented going back to mode 1
27-Oct-22	Modes 2-3-4	Emergency	6h 57m	Localized fire in the FTC ducting system
28-Oct-22	Mode 2	Emergency	4h 38m	Embers seen at the bottom of cooling tower and inlet plenum
29-Oct-22	Mode 2	Emergency	13h 2m	Embers seen at the inlet plenum
8-Nov-22	Mode 2	Planned	8h 24m	Maintenance
8-Nov-22	Mode 2	Emergency	4h 52m	Water lines feeding the cooling tower froze during planned maintenance
10-Nov-22	Mode 2	Emergency	49m	Failure of the fluidization fan belt
11-Nov-22	Mode 2	Emergency	25m	Draft pressure too low after fire move
12-Nov-22	Mode 3	Emergency	33m	High temperature inlet of cooling tower
14-Nov-22	Mode 4	Emergency	11m	E-stop pressed by accident

Note: on August 9, 2022, high particulate at the stack was generated for total duration 10 minutes due to filter challenges

Table 5.7 Fume Treatment Center Stack Test

The FTC was stack sampled and was within permit expectations.

Performance Measure	FTC	
Dates	Aug-22	Nov-22
Particulate (Kg/Mg of baked Anode) Permit Limit: 0.3 Kg/Mg of baked Anode	0.086	NA
PAH (Kg/Mg of baked Anode) Permit Limit: 0.05 Kg/ Mg of baked Anode	NA	0.00009
Particulate Fluoride (mg/m^3)	0.040	0.060
Gaseous Fluoride (mg/m^3)	0.319	0.037
Fluoride Total (Kg/Mg Al) Permit Limit: Included in Plant Wide limit	0.0021	0.0004
SO_2 (Mg/day) Permit Limit: Included in Plant Wide limit	1.6	1.8
NOx (Mg/day) Permit Limit: Included in Plant Wide limit	0.14	0.19

Table 5.8 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	0	0	1	0	0	0
Anode Rodding Shop 5610-DCB-003	0	0	0	0	0	0	0	0	1	0	1	0
Carbon Recycling 5810-DCB-001	2	2	0	0	1	1	0	1	2	3	2	2
Bath treatment and storage 5710-DCB-001	NA	NA	NA	NA	NA	3	2	3	3	7	5	2
Bath treatment and storage 5710-DCB-003	0	0	1	0	0	0	0	0	0	1	0	3

NA = Due to bath pan conveyor break down.

Table 5.9 Bath Treatment and Storage Stack Test

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

Performance Measure	DCB-001	DCB-003
Dates	July, 2022	August, 2022
Particulate Emissions (mg/m^3) Permit Limit: 30 mg/m^3	0.9	1.8

Table 5.10 Gas Treatment Center (GTC) Bypass Hours

The East and West GTC are emission control devices that are bypassed during emergency scenarios (such as a power outage) or for preventative maintenance purposes (such as airlift cleaning).

Date	GTC	Upset Condition	Upset Type	Duration	Cause
30-Jan-22	East	No feed	Emergency	7h 45m	Hole in SPS pipe
3-Feb-22	East	No feed	Emergency	35m	Power outage
3-Feb-22	East	No exhaust	Emergency	35m	Power outage
10-Mar-22	East	No feed	Planned	27m	Electrical maintenance
21-May-22	East	No feed	Emergency	2h 2m	Power outage
21-May-22	East	No exhaust	Emergency	1h 15m	Power outage
21-May-22	West	No feed	Emergency	2h 2m	Power outage
21-May-22	West	No exhaust	Emergency	1h 15m	Power outage
9-Jun-22	West	No feed	Planned	2h	Airlift Commissioning
16-Jun-22	East	No feed	Planned	4h 30m	Airlift installation
20-Jun-22	East	No feed	Planned	6h	Airlift installation
28-Jun-22	West	Dusting	Emergency	25m	Dust accumulation in exhaust fan
12-Jul-22	East	No feed	Planned	6h	Airlift installation
14-Jul-22	East	No feed	Planned	5h 50m	Airlift installation
9-Aug-22	West	Dusting	Emergency	2h 25m	Starting Main fans for North restart
21-Sep-22	East	No feed	Emergency	1h 50m	Power outage
21-Sep-22	East	No Suction	Emergency	50m	Power outage
21-Sep-22	West	No feed	Emergency	2h 10m	Power outage
21-Sep-22	West	No Suction	Emergency	2h 10m	Power outage
6-Dec-22	West	Reduced Feed	Emergency	8h 13m	Non-Functioning Valve
16-Dec-22	East	No feed	Emergency	1h 40m	System tripped during fan swap
22-Dec-22	West	Reduced Feed	Emergency	24h	SPS Failure
24-Dec-22	West	Fresh Feed	Emergency	43h 30m	Contamination in the distribution box

Table 5.11 Gas Treatment Center Stack Test

During the re-start the expectation was to stack sample both GTCs during peak emissions (during cold metal re-start) and a second time during the ramp down of the re-start. A self reported non-compliance was communicated due to the missing parameters.

Performance Measure	GTC East	GTC West	GTC East	GTC West
Date	Aug-22	Aug-22	Nov-22	Nov-22
Total Particulates (mg/m^3)	7.8	4.0	1.3	2.6
Particulates (Kg/Mg of Aluminium) Permit Limit: Included in Plant Wide limit	0.95	1.51	0.23	0.48
Particulate Fluoride (mg/m^3)	0.082	0.166	NA	NA
Gaseous Fluoride (mg/m^3)	0.819	0.567	NA	NA
Total Fluoride (mg/m^3)	0.901	0.732	NA	NA
Fluoride Total (Kg/Mg of Aluminium) Permit Limit: Included in Plant Wide limit	0.1106	0.2745	NA	NA

Table 5.12 Delining Stack Test

The 4421-DCB-001 dust collector was stack sampled and was within permit limits.

Performance Measure	4421-DCB-001
Date	August, 2022
Particulates (mg/m^3) Permit Limit: 10 mg/m^3	1.4

Table 5.13 Delining leak detection

Leaks are monitored.

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	1	0	0	0	2	3	0	1	1	0	3

Table 5.14 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	Jul-22	Nov-22	Jul-22	Nov-22
NOx (mg/m^3)	14.1	2.4	7.2	3.4
Chloride (mg/m^3)	140.8	228.0	212.0	308.6
Chlorine (mg/m^3)	2.40	4.0	4.0	6.3
Particulate (mg/m^3)	60.80	78.4	52.8	86.6

Table 5.15 C Casting - Bi-Annual Stack Test

Furnace 62 could not be completed during the first campaign as it was undergoing maintenance, it was available and in use during the second campaign. A self reported non-compliance was communicated due tot he missed sampling parameters in August.

Performance Measure	C Casting			
	Furnace 62*		Furnace 63-64	
Dates	Aug-22	Nov-22	Aug-22	Nov-22
NOx (mg/m^3)	-	1.2	2.5	1.5
Particulate (mg/m^3)	-	4.2	2.6	1.5

* The F-62 furnace was not sampled as it was undergoing maintenance during the first annual visit.

Table 5.16 Plant Wide - Natural Gas Consumption and Associated Emissions

The amount of natural gas consumption varies depending on operational dynamics.

Year	Natural Gas Consumption (m^3/y)	Associated Emissions (tons /year)			
		Nitrogen Oxides	Total Particulate	Sulphur Dioxide	Carbon Monoxide
2010	23,564,629	37.70	2.87	0.23	31.67
2011	20,864,400	33.38	2.54	0.20	28.04
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

6. Air quality monitoring

BC Works conducts continuous ambient air quality and meteorological monitoring at five stations in the lower Kitimat valley and one specialized station at Lakelse Lake. The monitoring parameters are illustrated in Table 6.1.

Network overview

Five air quality parameters related to the smelter's emission are monitored: hydrogen fluoride (HF), sulphur dioxide (SO_2), polycyclic aromatic hydrocarbons (PAHs), 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 new Nitrous Oxide (NOx) and Ozone (O_3) monitors so that an Air Quality Health Index Plus (AQHI-Plus) for Kitimat can be reported.

Meteorological (weather) monitoring data are collected at all four air quality monitoring stations plus the Yacht Club station. Precipitation monitoring and analysis is undertaken using samples collected at the Haul Road and Lakelse Lake stations. The weather and the precipitation data provide additional insight into air quality data interpretation.

Parameters measured at each station are presented in Table 6.1.

The collected air quality data are reported out according to the P2-00001 Multimedia Waste Discharge permit. Specifically, Section 8.5 of the P2 permit 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 on a NAPS cycle.
- 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. Additionally, hourly NOx, O_3 and AQHI-Plus are presented.

Weather monitoring

Meteorological monitoring is conducted at all the air quality monitoring stations and consists of wind speed, wind direction and temperature. The Yacht Club located at the south end of the plant site is a dedicated meteorological station. Meteorological data is important for understanding the contributing factors for high air quality measurements as well as to allow the forecasting of the dispersion of air emissions (dispersion modelling).

In 2022, an error was found in the alignment of wind direction sensors at the Yacht Club and Whitesail stations. A statistical analysis of the historical wind data set was undertaken to develop correction factors and the time periods to apply the correction factors.

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 monthly, validated, 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 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**).

Air quality monitoring network review

A second phase study for rationalizing the air quality monitoring network for SO_2 was completed in 2021. This study was expanded to include fine particulates, HF, and PAHs in addition to SO_2.

2022 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 on February 28, 2023.

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 (less than 1 ppb). A calibration method for the HF Picarro analyzers was developed in 2022 and the two instruments were tested and found to be reporting accurately. A new HF Picarro was also installed at the Haul Road Station in 2022 as part of the smelter restart activities.

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 and the Service Centre. The P2 permit requires the reporting on hourly daily maximums and monthly averages. A summary of the 2022 monitoring results is provided in Table 6.2 and monthly means are shown in Figures 6.3a and 6.3b. Beyond the required P2 permit reporting, the daily hourly averages for 2022 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. In comparison to the SO_2 air quality objective of 70 ppb, the Service Centre measured the highest 99th percentile of the 1 hourly daily maximum concentration which was 26.6 ppb. The maximum hourly average SO_2 concentrations shown in Table 6.2 ranged from 11.5 ppb to 48.5 ppb. There were no days in 2022 where the residential SO_2 hourly concentrations were above 70 ppb. The maximum residential annual average SO_2 concentration was 0.6 ppb.

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' web site.

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 g/m^3 evaluated at the 98^{th} percentile of the daily average for 1 year.

The P2 permit 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 2.8 ug/m^3 to 4.6 ug/m^3. Residential stations were below the BC AQO for $PM_{2.5}$ in 2022, however there were episodes of elevated $PM_{2.5}$ levels.

AQHI-Plus, NO_2, and O_3

Information on NOx, O_3 and AQHI-Plus is provided in addition to P2 Permit requirements. The Whitesail station was upgraded in the spring of 2018 with two new monitors for measuring ambient NOx (NO and NO_2) and O_3. The addition of these new monitors along with the existing $PM_{2.5}$ monitor allows for the reporting of the Air Quality Health Index (AQHI). The AQHI-Plus is an adjustment to AQHI for smoke. Information on the AQHI-Plus and health risk information can be found at **https://www2.gov.bc.ca/gov/content/environment/air-land-water/air/air-quality/aqhi**. AQHI-Plus results are presented in Table 6.3. The Average AQHI-Plus value for Kitimat is low. Figures 6.7 and 6.8 present the NO_2 and O_3 monitoring data.

Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs are generated by the incomplete combustion of organic material. Various procedures at Kitimat Operations 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. The P2 permit requires the monitoring of 15 PAH congeners.

The 2022 ambient PAH monitoring results are summarized in Table 6.4. Annual geomean PAH concentrations observed at Haul Road station was 17.3 ng/m^3, Whitesail station was 3.7 ng/m^3 and Kitimat Village was 5.1 ng/m^3. In 2022, total PAH concentrations by station are presented in figures Figures 6.9a to 6.9c. The Haul Road station had some high PAH measurements that may be due to the restart of the anode baking furnace and third-party construction related activities.

The PAH congeners are sorted according to molecular weight. As can be seen in Figure 6.10, over 80% of the PAHs for all three stations are light molecular 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.

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 6.11. Samples are assessed for rain acidity and concentrations of 11 specific substances. Weekly measurements between January 2^{nd} to October 18^{th} are presented in Figures 6.11a to 6.11e. The full year of precipitation chemistry data was not available from the US National Atmospheric Deposition Program at the publication time of this report. The Precipitation chemistry is used in the SO_2 EEM program to estimate the amount of sulfate deposition in the Kitimat Valley.

Figure 6.1
Location of Ambient Air Monitoring Stations in Kitimat Valley.

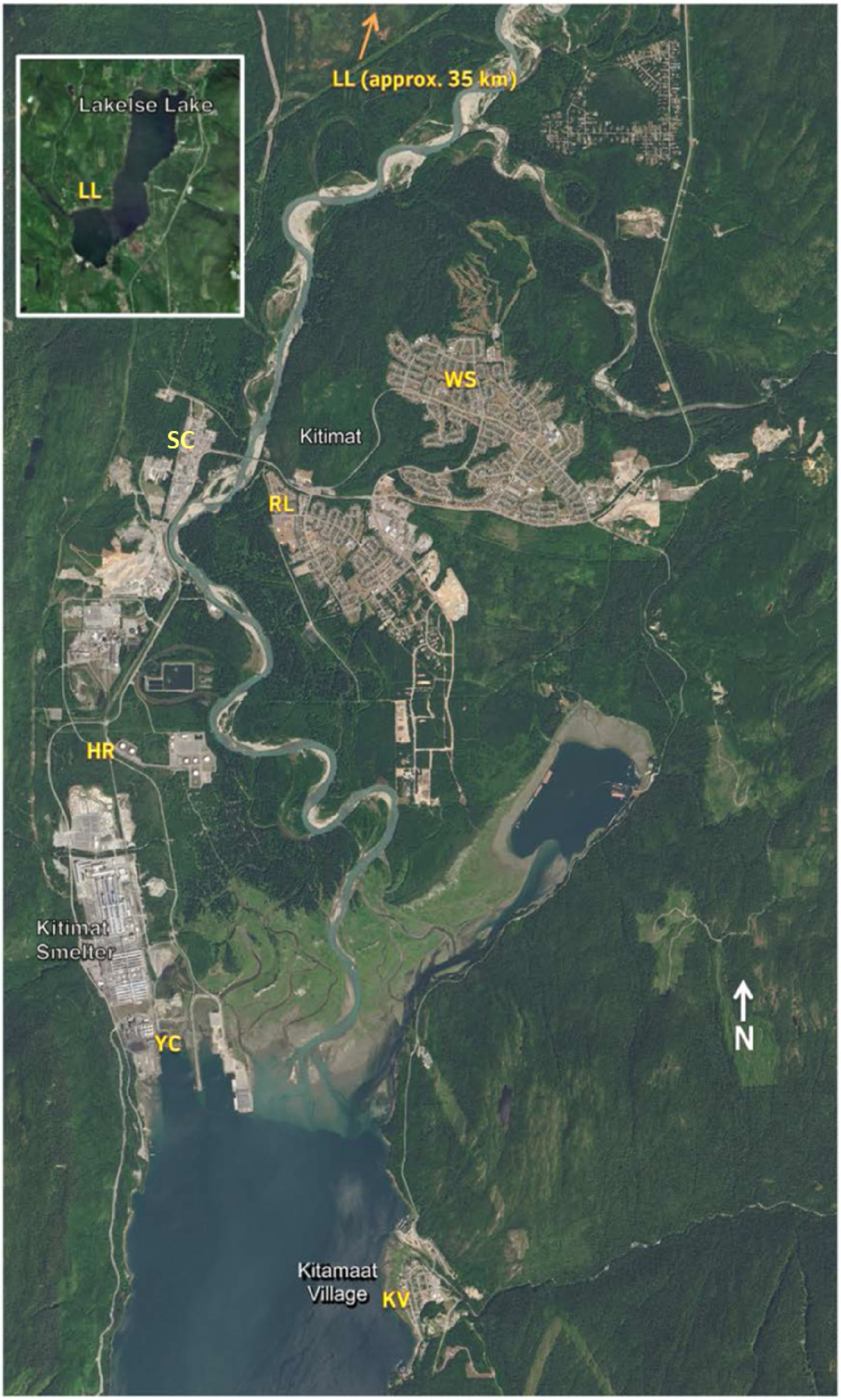


Figure 6.2

Hydrogen Fluoride Monthly Averages

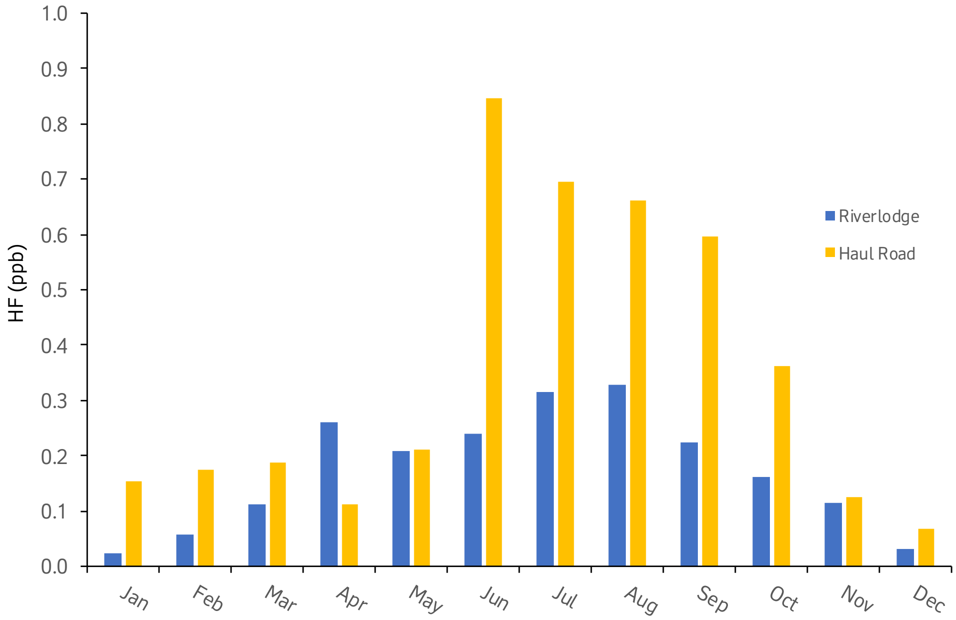


Figure 6.3a

Residential Monthly SO_2 Averages

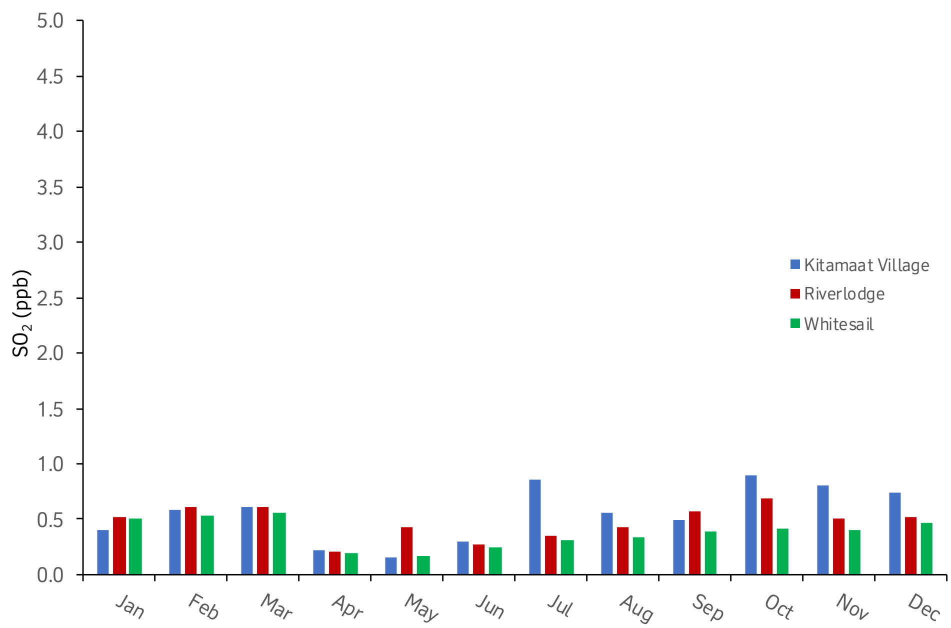


Figure 6.3b

Service Centre Monthly SO_2 Averages

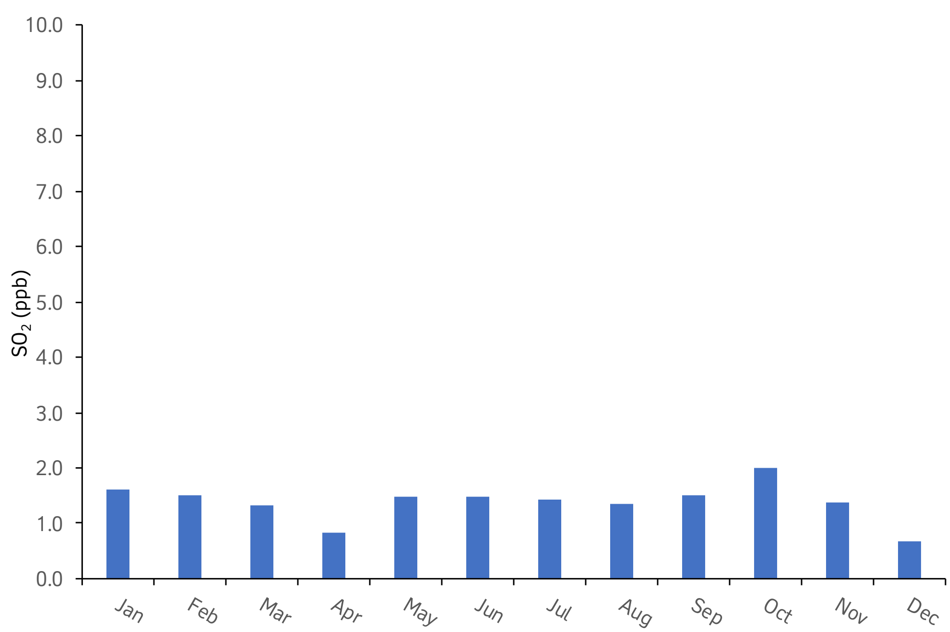


Figure 6.3c

Haul Road Monthly SO_2 Averages

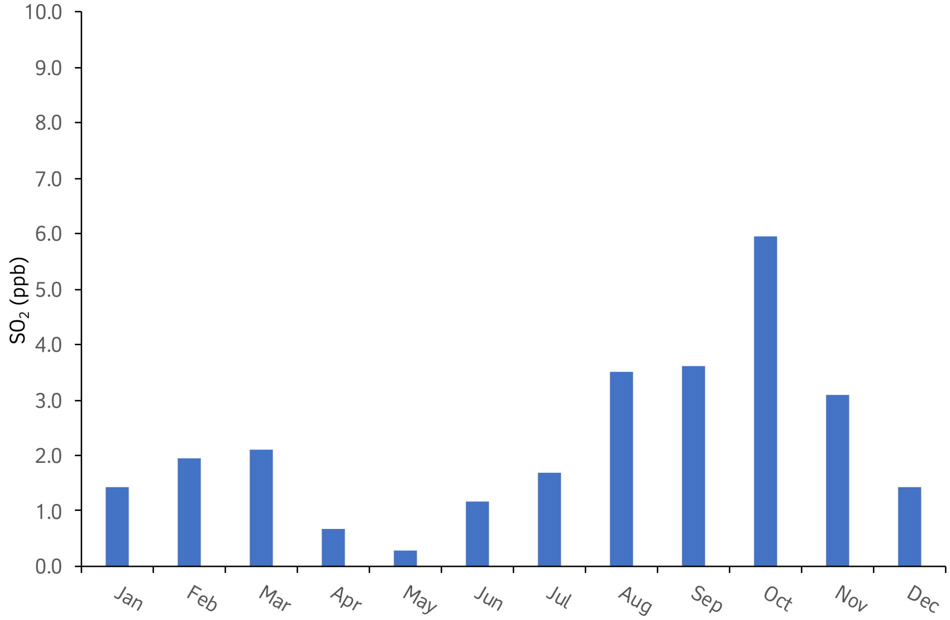


Figure 6.4a

Riverlodge SO_2 1 Hour Daily Maximum

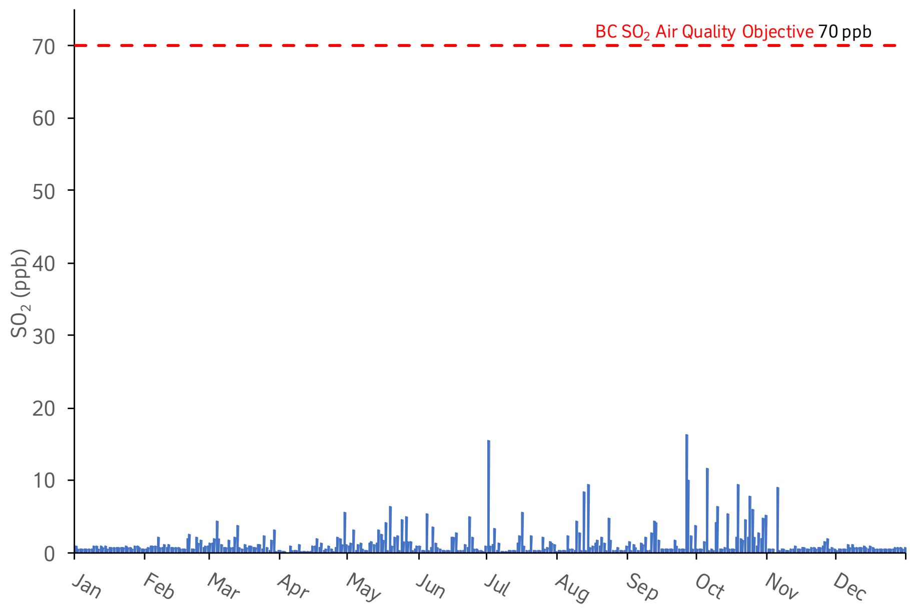


Figure 6.4b

White Sail SO_2 1 Hour Daily Maximum

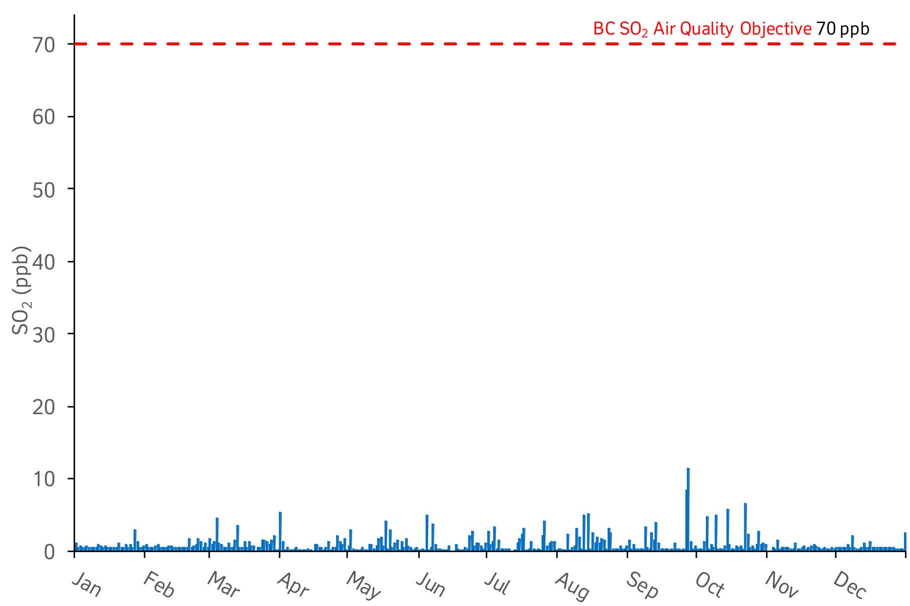


Figure 6.4c

Kitamaat Village SO_2 1 Hour Daily Maximum

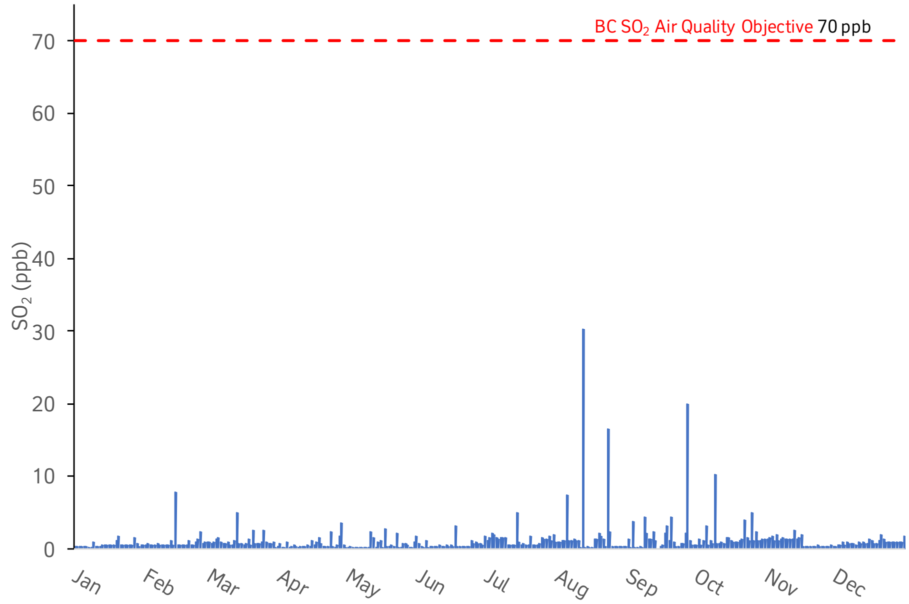


Figure 6.4d

Service Centre SO_2 1 Hour Daily Maximum

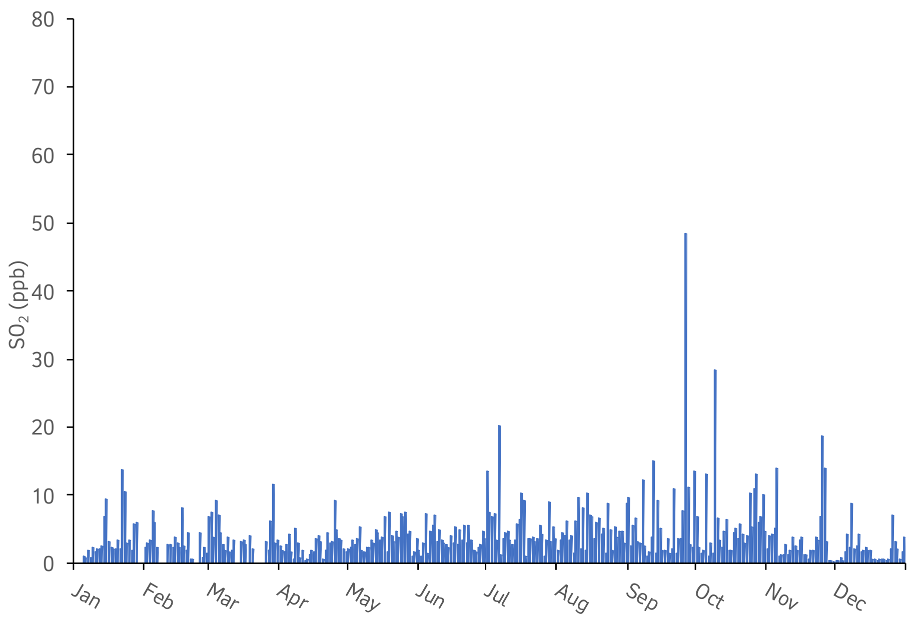


Figure 6.4e

Haul Road SO_2 1 Hour Daily Maximum

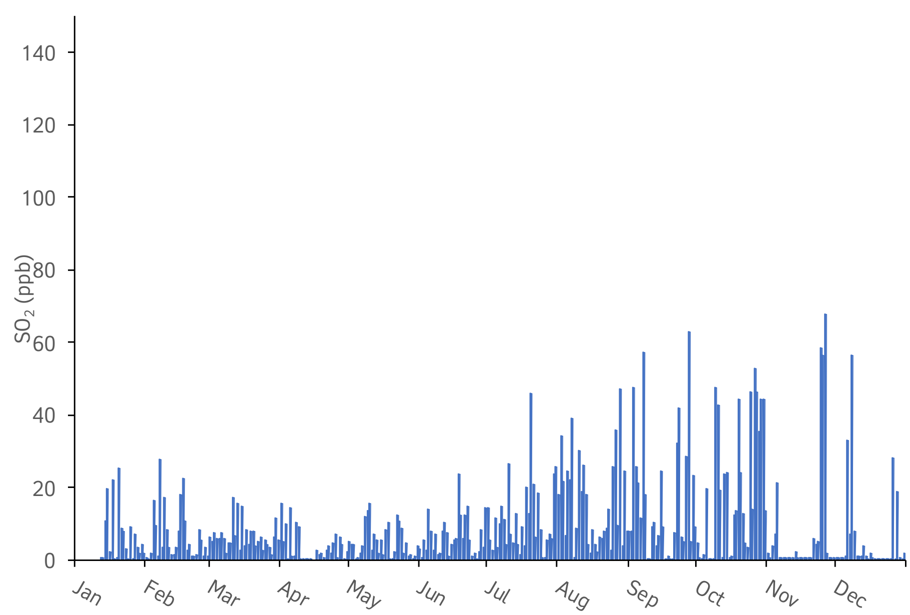


Figure 6.4f

Lakelse Lake Deposition Station SO_2 1 Hour Daily Maximum.

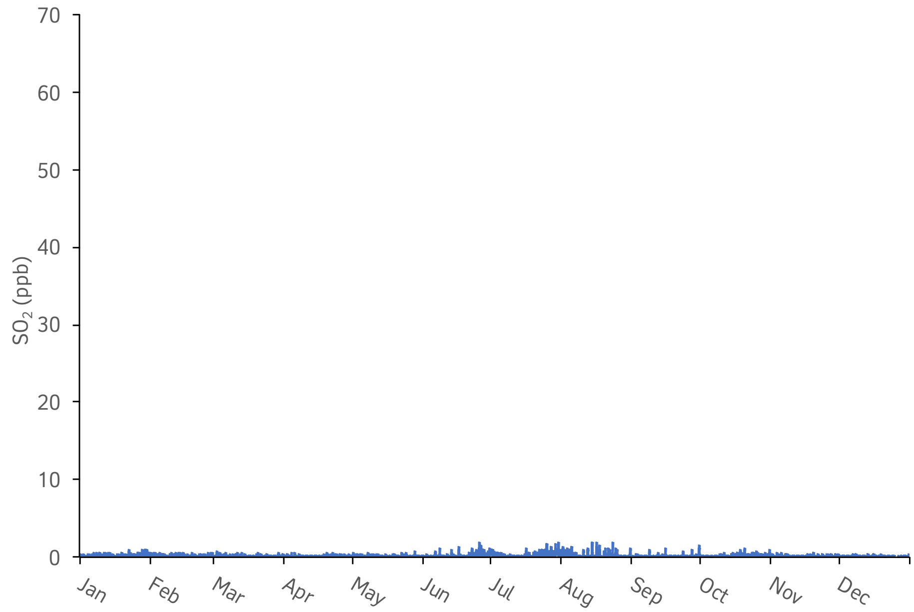


Figure 6.5a

Riverlodge $PM_{2.5}$ 24 Hour Average

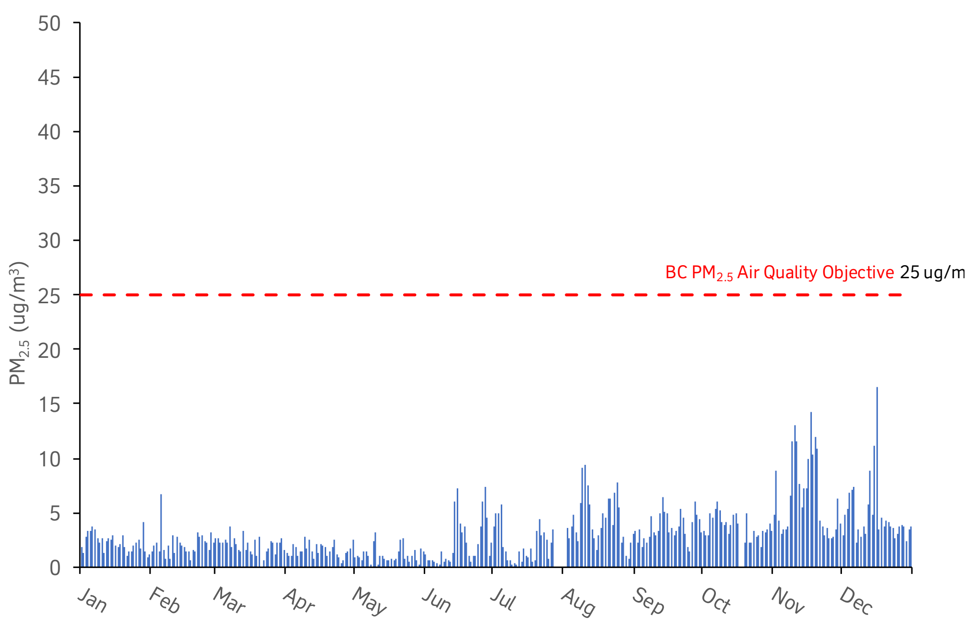


Figure 6.5b

Whitesail $PM_{2.5}$ 24 Hour Average

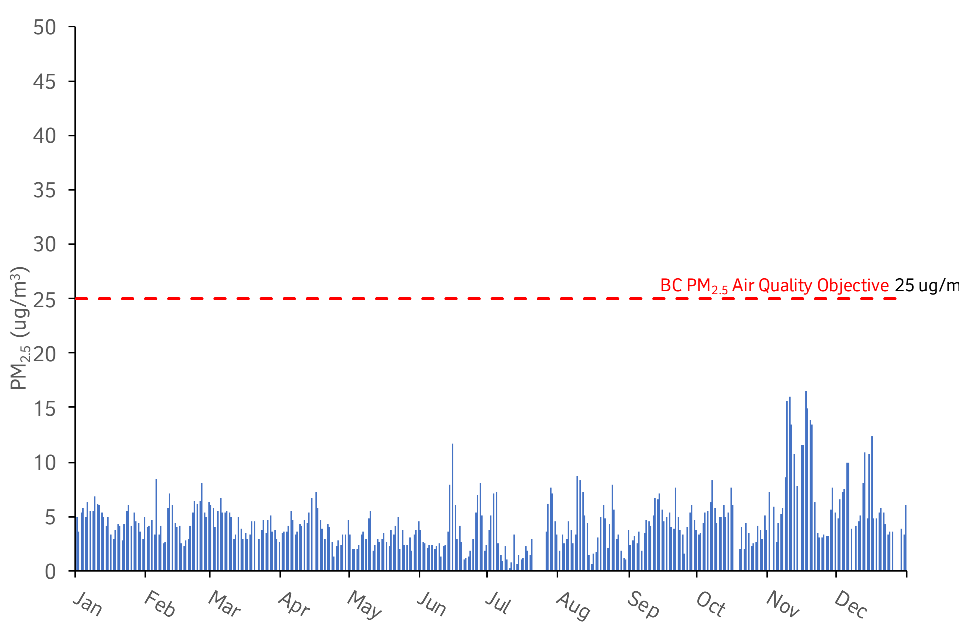


Figure 6.5c

Kitamaat Village $PM_{2.5}$
24 Hour Average

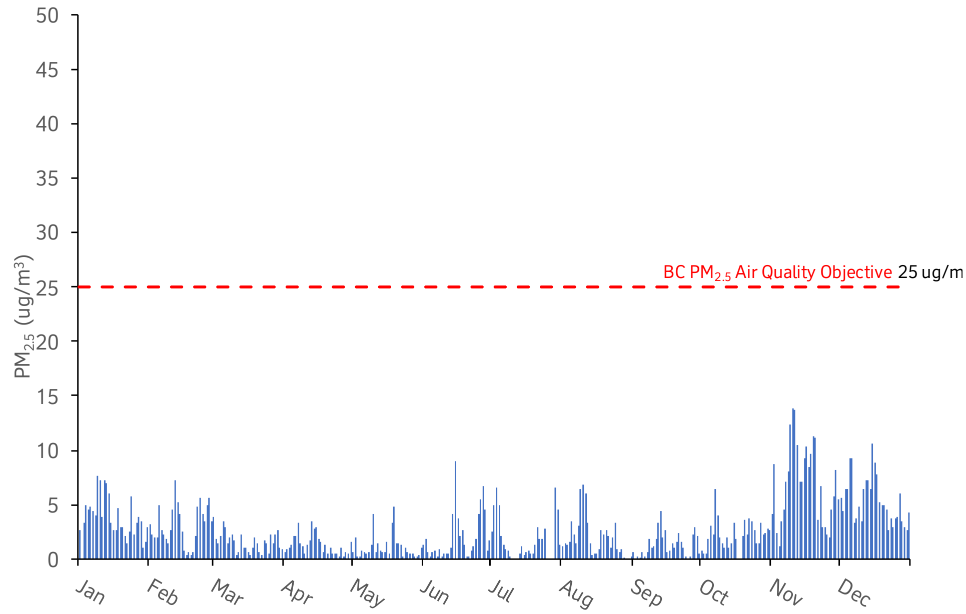


Figure 6.5d

Haul Road $PM_{2.5}$
24 Hour Average

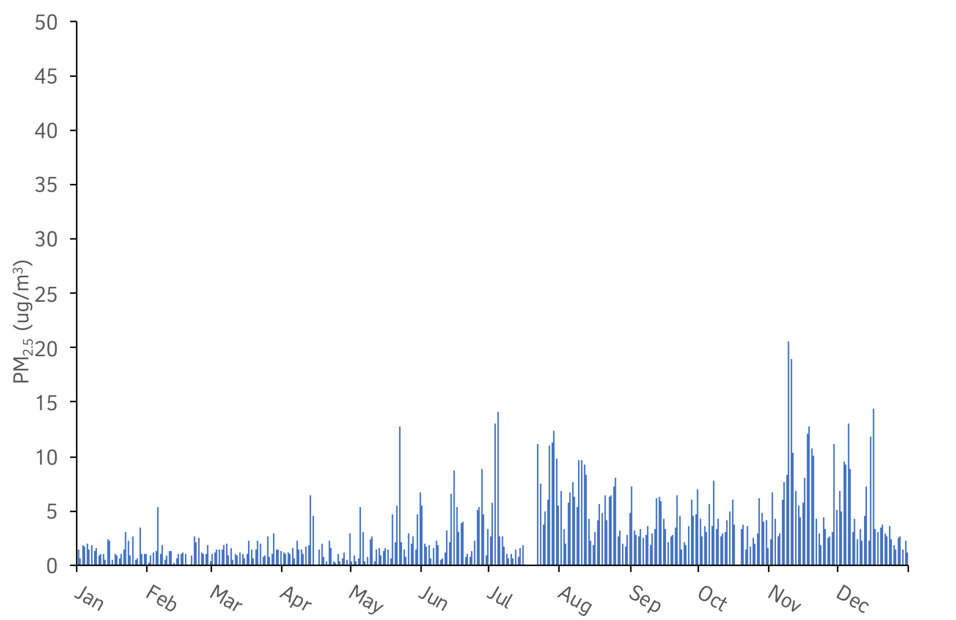


Figure 6.6

Riverlodge PM_{10}
24 Hour Average

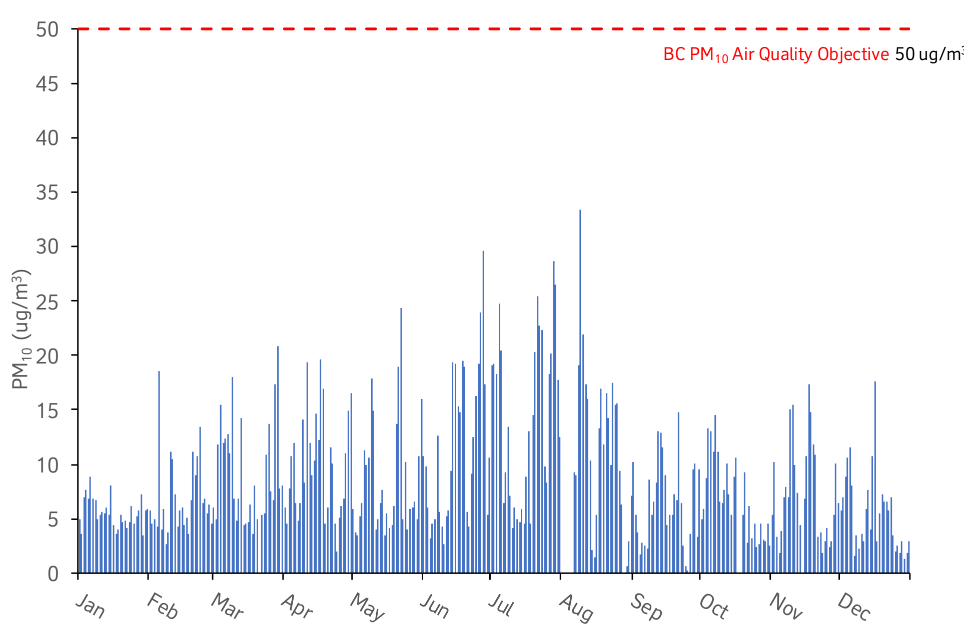


Figure 6.7

Whitesail NO_2
1 Hour

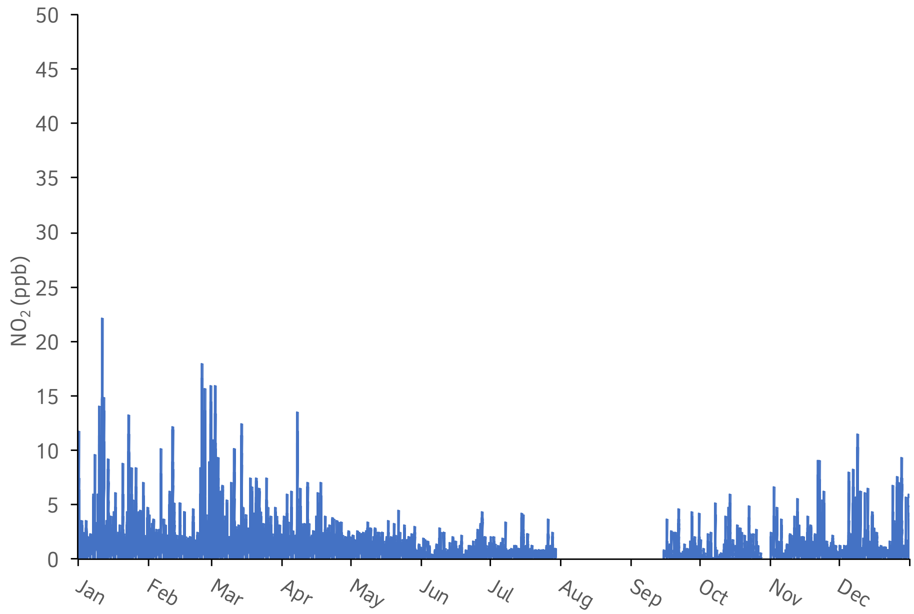


Figure 6.8

Whitesail O_3
1 Hour

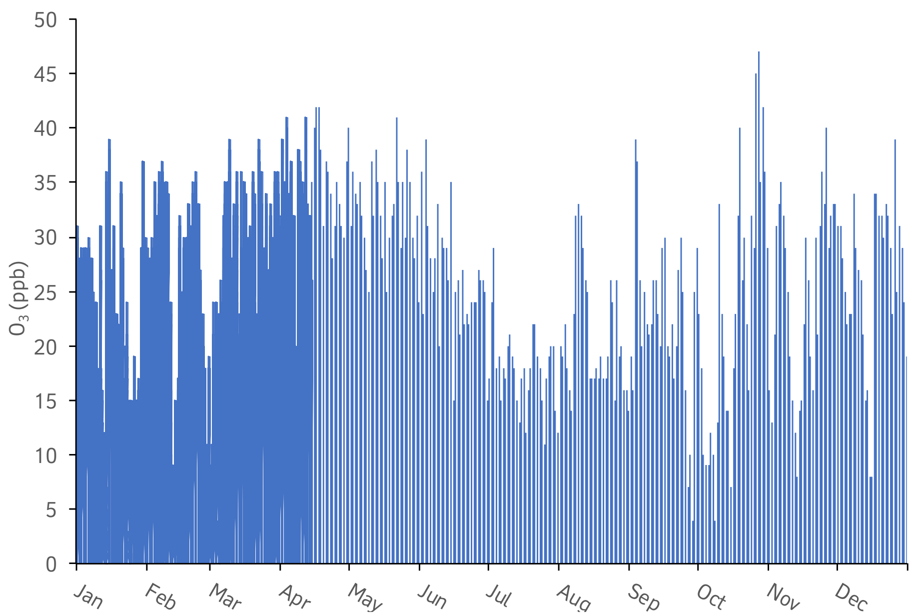


Figure 6.9a

Total 15 PAH
Kitamaat Village
2022

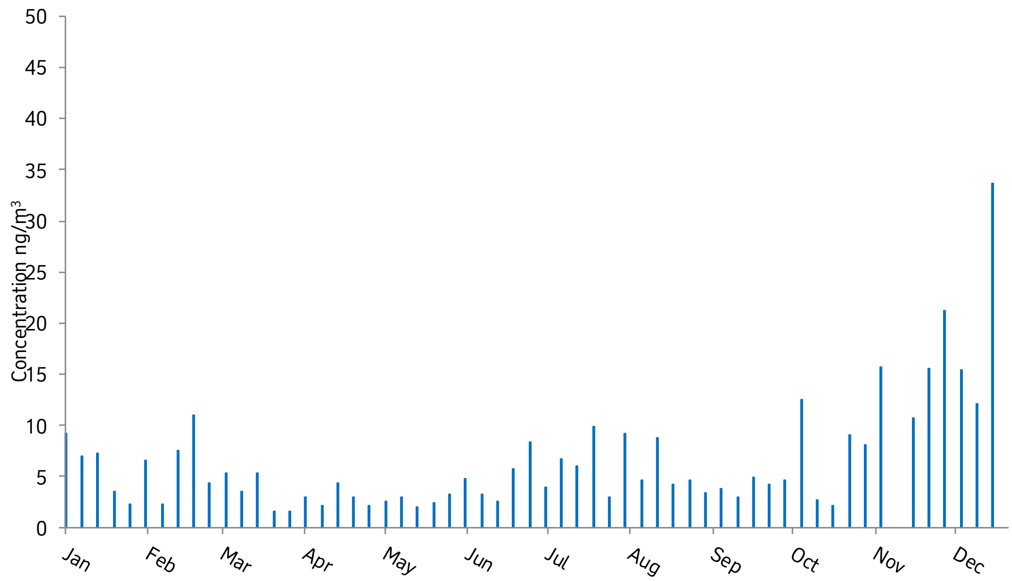


Figure 6.9b

Total 15 PAH
Whitesail 2022

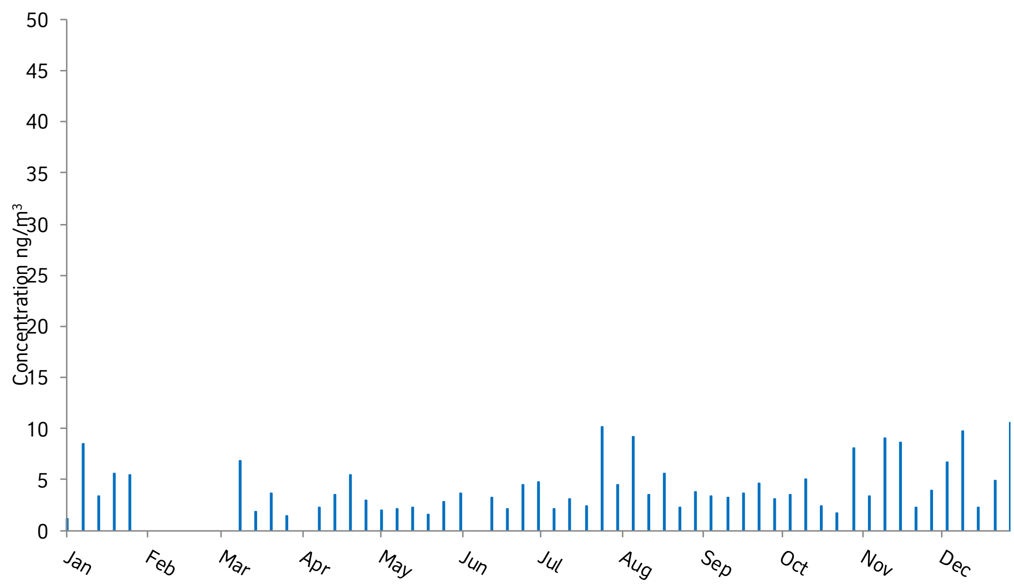


Figure 6.9c

Total 15 PAH
Haul Road 20212

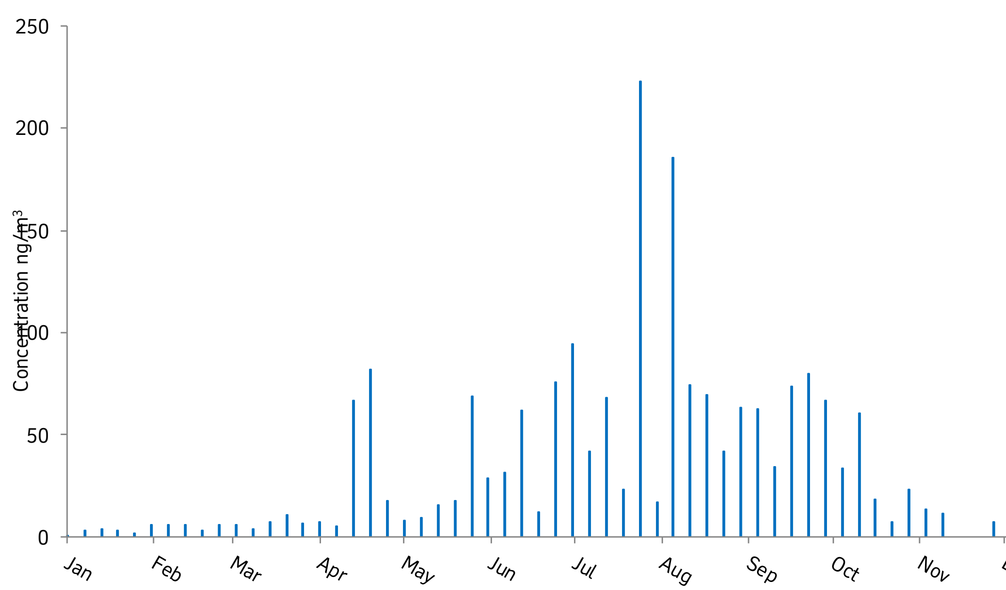


Figure 6.10
2022 PAH
Congener Distribution

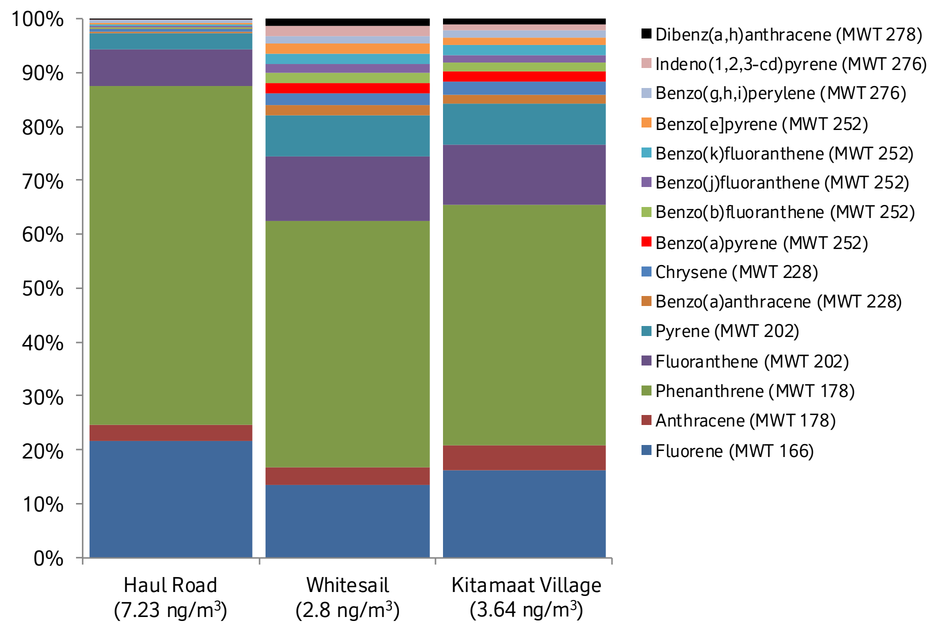


Figure 6.11a
Precipitation Depth

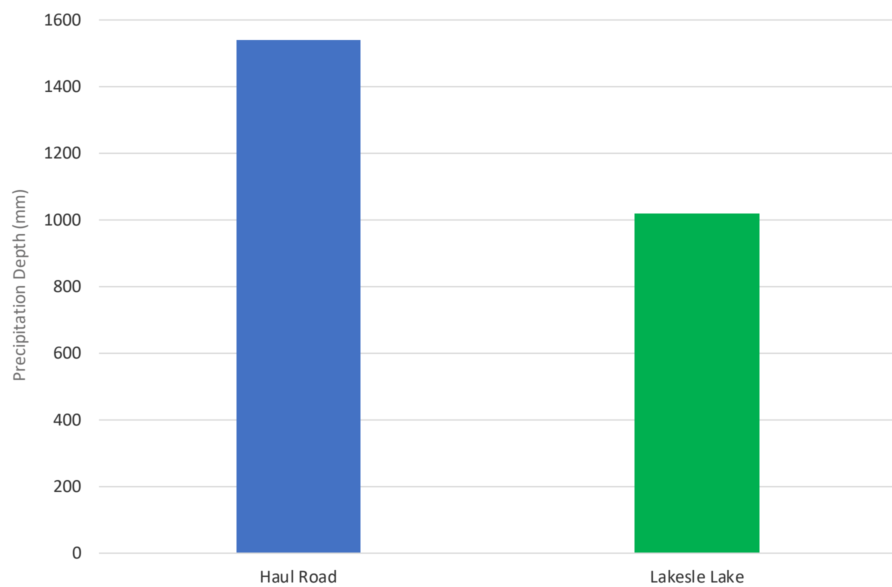


Figure 6.11b
Precipitation pH

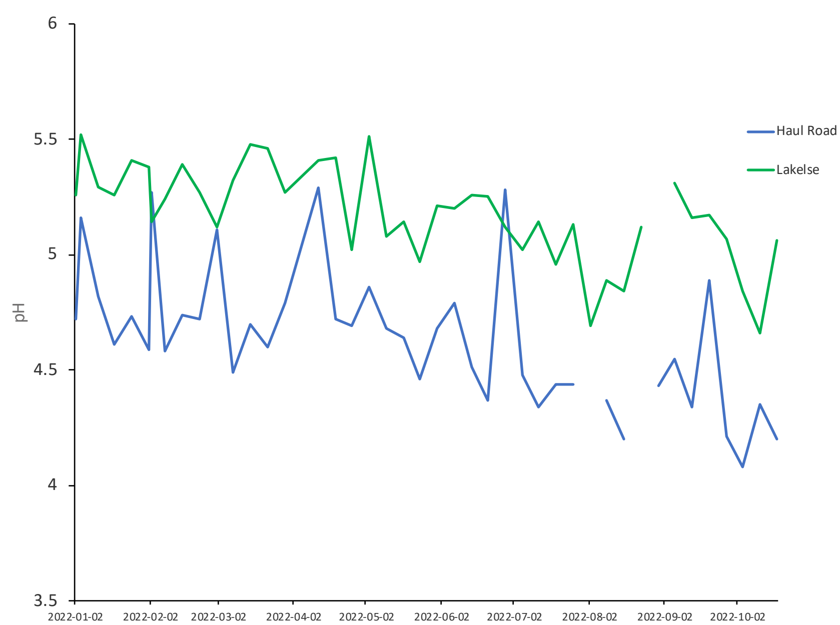


Figure 6.11c

SO_4 Concentration in Precipitation

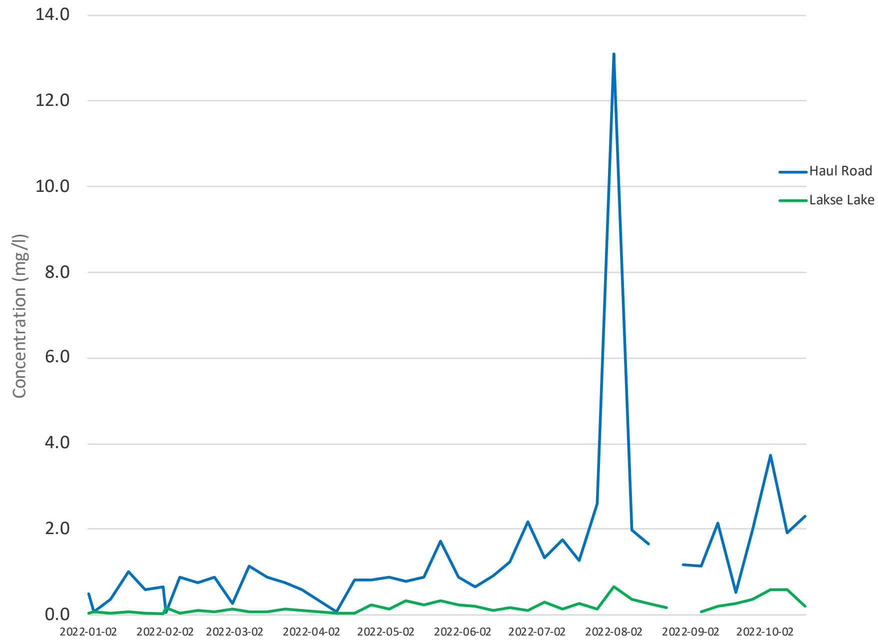


Figure 6.11d

Haul Road Precipitation Chemistry Base Cations

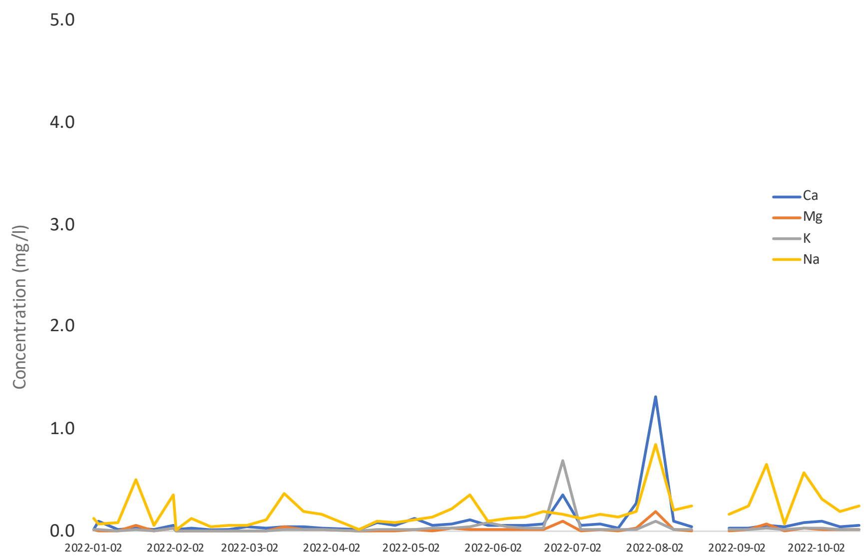


Figure 6.11e

Lakelse Lake Precipitation Chemistry Base Cations

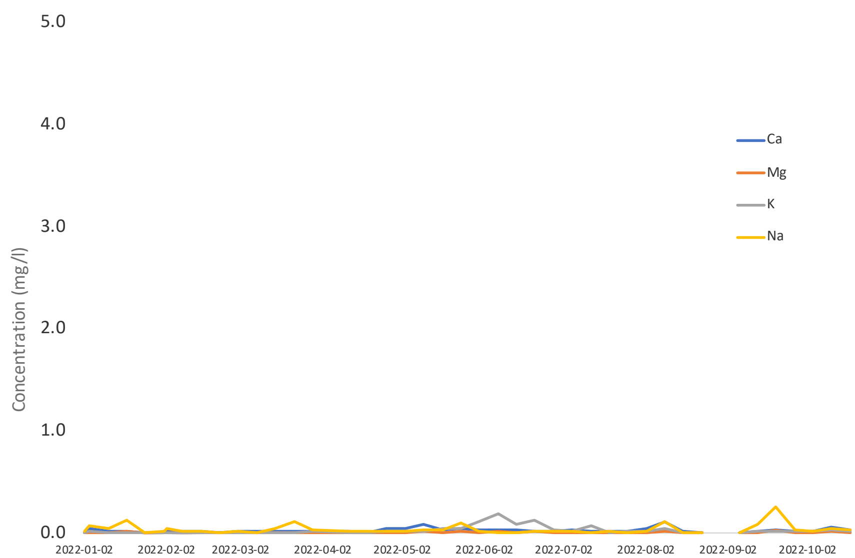


Table 6.1
Ambient Air Monitoring Network

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 (NOx)			✔				
Ozone (O_3)			✔				
AQHI Plus			✔				
Rain Chemistry	✔						✔
Meteoroidal Monitoring	✔	✔	✔	✔	✔	✔	

Table 6.2 2022 Ambient Air Quality Monitoring Results[1]

Statistic				Residential		
	Industrial Haul Road	Industrial Avenue	Lakelse Lake Desposition Station	Riverlodge	Whitesail	Kitamaat Village
SO_2						
Annual Average (ppb)	2.3	1.4	0.2	0.5	0.4	0.6
99th Percentile, D1HM[2]	57.5	18.6	1.9	10.1	5.7	10.2
Days above 70 ppb (Hourly)	0	0	0	0	0	0
Minimum (Hourly, ppb)	-0.9	0.0	-0.1	-0.2	-0.1	-0.1
Maximum (Hourly, ppb)	67.8	48.5	2.0	16.4	11.5	30.3
Percent Data Capture (%)	96.4	94.3	94.6	99.7	97.8	99.7
Standard Deviation (ppb)	5.8	1.6	0.2	0.6	0.4	0.7
$PM_{2.5}$						
Annual Average (ug/m^3)	3.5			3.1	4.6	2.8
98th Percentile, 24 hour	2.0			10.9	12.4	10.3
Days above 25 ug/m^3 (24 hour)	0			0	0	0
Minimum (Hourly, ug/m^3)	0.0			0.0	-2.0	0.0
Maximum (Hourly, ug/m^3)	120			38	33	98
Maximum daily average (ug/m^3)	20.6			16.5	16.5	13.9
Percent Data Capture (%)	96.7			97.8	95.9	96.7
Standard Deviation (ug/m^3)	4.9			8.9	3.4	3.6
PM_{10}[3]						
Annual Average (ug/m^3)				8.6		
Minimum (Hourly, ug/m^3)				0.0		
Maximum (Hourly, ug/m^3)				182		
Maximum daily average (ug/m^3)				33.4		
Days above 50 ug/m^3 (24 hour)				0		
Percent Data Capture (%)				97.5		
Standard Deviation (ug/m^3)				8.9		
HF						
Annual Average (ppb)	0.3			0.2		
Minimum (Hourly, ppb)	0.0			0.0		
Maximum (Hourly, ppb)	1.5			0.6		
Days above 65 ug/m^3 (Hourly)[4]	0			0		
Percent Data Capture (%)	87.4			93.2		
Standard Deviation (ppb)	0.3			0.1		
NO_2						
Annual Average (ppb)					1.5	
Minimum (Hourly, ppb)					-0.4	
Maximum (Hourly, ppb)					22.1	
Percent Data Capture (%)					83.6	
Standard Deviation (ppb)					1.6	
O_3						
Annual Average (ppb)					18.5	
Minimum (Hourly, ppb)					-1.0	
Maximum (Hourly, ppb)					47	
Percent Data Capture (%)					95.3	
Standard Deviation (ppb)					10.2	

Notes: [1] Data extracted from BC ENV's Envista database on February 28, 2023.
[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.

Table 6.3
Air Quality Health Index Plus (AQHI +)

	AQHI +	
Month	**Average**	**Maximum**
January	2 LOW	3 LOW
February	2 LOW	2 LOW
March	2 LOW	3 LOW
April	2 LOW	3 LOW
May	2 LOW	2 LOW
June	1 LOW	3 LOW
July	1 LOW	2 LOW
August	0 LOW	0 LOW
September	1 LOW	2 LOW
October	1 LOW	3 LOW
November	2 LOW	3 LOW
December	2 LOW	3 LOW

What is an AQHI?

An AQHI can help you understand what the air quality around you means to your health. The following table provides the health messages for 'at risk' individuals and the general public for each of the AQHI Health Risk Categories.

General Population	AQHI	At Risk Population
Ideal air quality for outdoor activities	1, 2, 3	**Enjoy** your usual outdoor activities
No need to modify your usual outdoor activities unless you experience symptoms such as coughing and throat irritation	4, 5, 6	**Consider reducing** or rescheduling strenuous activities outdoors if you are experiencing symptoms
Consider reducing or rescheduling strenuous activities outdoors if you experience symptoms such as coughing and thoat irritation	7, 8, 9, 10	**Reduce** or reschedule strenuous activities outdoors. Children and the elderly should also take it easy.
Reduce or reschedule strenous activities outdoors, especially if you experience symptoms such as coughing and thoat irritation	+	**Avoid** strenous activities outdoors. Children and the elderly should also avoid outdoor physical activity.

Table 6.4
Geometric mean Total 15 PAH Concentrations (2020, 2021 and 2022)

	15 PAH Geomean (ng/m^3)			2021 15 PAH Statistics (ng/m^3)		
Station	**2020**	**2021**	**2022**	**Min**	**Max**	**Standard Deviation**
Haul Road	5.6	5.0	17.3	0.5	222.9	41.9
Whitesail	2.3	2.2	3.7	1.2	10.6	2.5
Kitamaat Village	3.1	3.2	5.1	1.6	33.6	5.5

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 Fluoride 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 Comprehensive Review, the Vegetation Monitoring program was re-structured to develop a terrestrial line of evidence integrating the vegetation and soils. 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.

The new 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 (unless otherwise listed as culturally important) and the overall health of vascular plants. The locations of plots are distributed fairly evenly across 3 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)

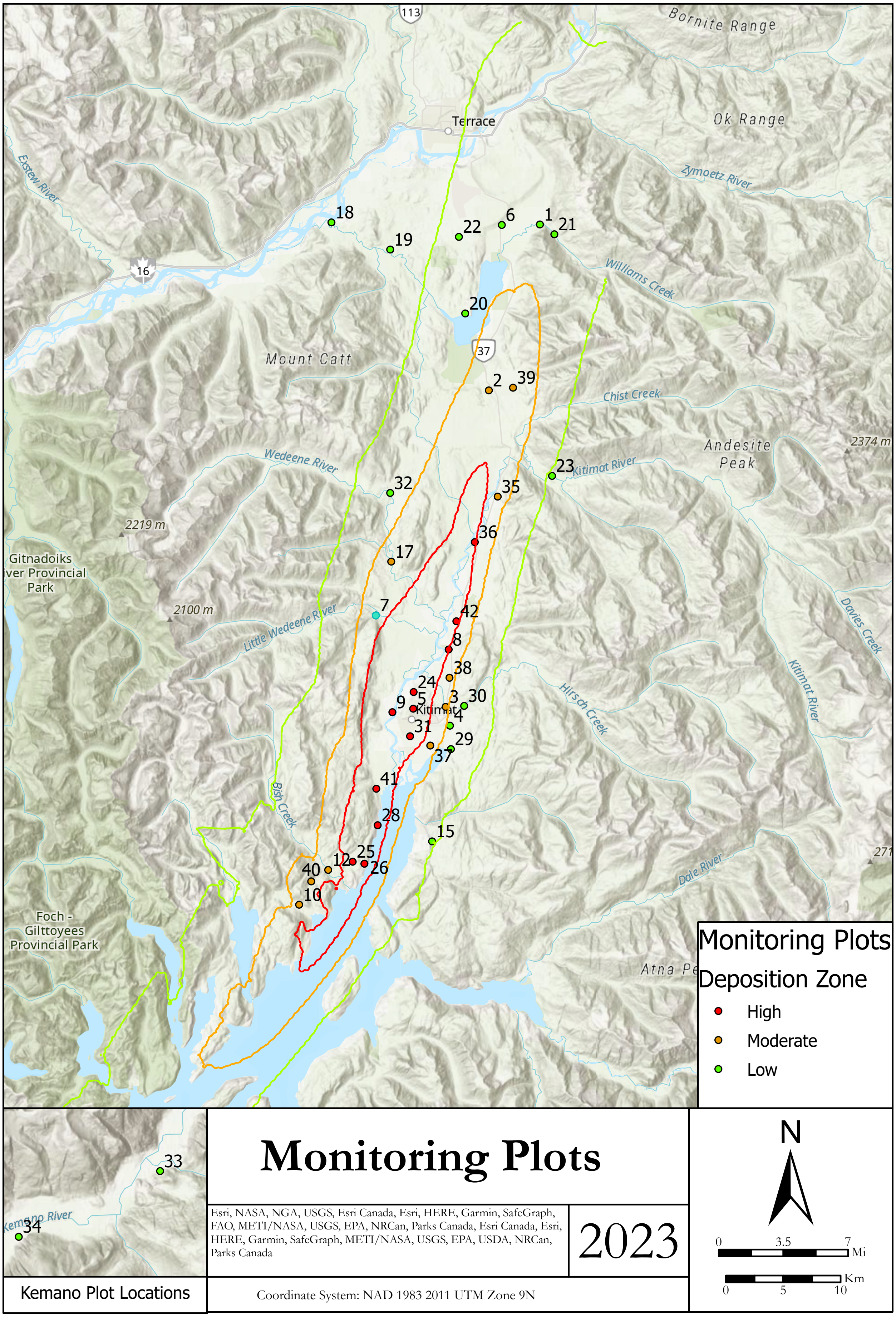
Each year for up to 3 years, 10-12 sites will be monitored and the same sites will be re-monitoring on a rotating 3 year basis (Figure 7.1).

Program progress

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 11 sites of the ~35 plots, in 2022 the second year of the monitoring program was conducted at 14 sites of the ~35 plots. In 2023 the third year of the monitoring program the plots will have been visited at least once. In 2024 will be the first year of the program that revisits the 2021 monitoring year plots, and the first year where data on differential trends will be collected.

For the Annual Reports, only baseline data were presented, as no trend analyses are possible yet (this will take place in year 2024). The annual monitoring report can be found in submissions required for the Rio Tinto SO_2 Environmental Effects Monitoring Program.

Figure 7.1 Monitoring Plots



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.

2022 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 2022 984.49 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 2022, 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 2022 there was no wood burned onsite.

South Landfill management

The South Landfill is the main landfill for smelter operations. It has been operational since the plant opened and is expected to be open until full capacity. Incoming waste streams included: industrial waste, putrescible waste, contaminated soils, asphalt and asbestos contaminated materials which include soil and concrete.

In 2022 there was no material landfilled in the South Landfill as Rio Tinto is in transition for the closure of the landfill in 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 2022 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.

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 Works' Kitimat landfill sites that are, or have the potential to be, a source of contamination. In 2022, these efforts focused on the spent potlining landfill and the dredgate disposal site. Long-term initiatives are underway with objectives to further reduce groundwater contamination and identify disposal and treatment options for stored materials.

2022 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 2022 was 272,394 m^3/yr.

The 2022 mass loading estimate for fluoride was 17,476 kg/yr. This represents a 3% decrease compared to 2021, due to a slight overall decrease in fluoride concentrations in the nearshore wells.

The 2022 mass loading estimate for SAD-cyanide was 110 kg/yr. This represents an 8% decrease compared to 2021, reflecting an overall decrease in concentrations.

The 2022 mass loading estimate for dissolved aluminium was 528 kg/yr. This represents a 10% decrease compared to 2021.

The 2022 mass loading estimate for dissolved iron was 734 kg/yr. This represents a 209% increase compared to 2021, reflecting an increase in concentrations at several locations at locations with larger sub-areas.

SPL overburden cell

The SPL overburden cell is located North of Anderson creek. The SPL material is composed of approximately 10,500 m^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 2022 no water was pumped from the two sumps.

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 53,474 m^3 of IL+ sediment that was dredged and placed in cell as of December 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 January, May and August and November 2022 four sampling events occurred.

All Groundwater analytical results in 2022 met the P2 permit limits and CSR AW-M 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.

2022 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 2022 all effluent discharge permit measurements were in compliance. One lab sample came back in March 2022 with elevated TSS above permitted limits. When following up with the lab there were complications with the analysis. The sample was collected again in April for TSS and within permitted limits (Figure 10.1).

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 2022 permit requirements were in compliance. The Incinerator permit allows up to 1000 m^3 of domestic waste to be processed and in 2022 the total volume was 511 m^3 for the year.

Kemano landfill

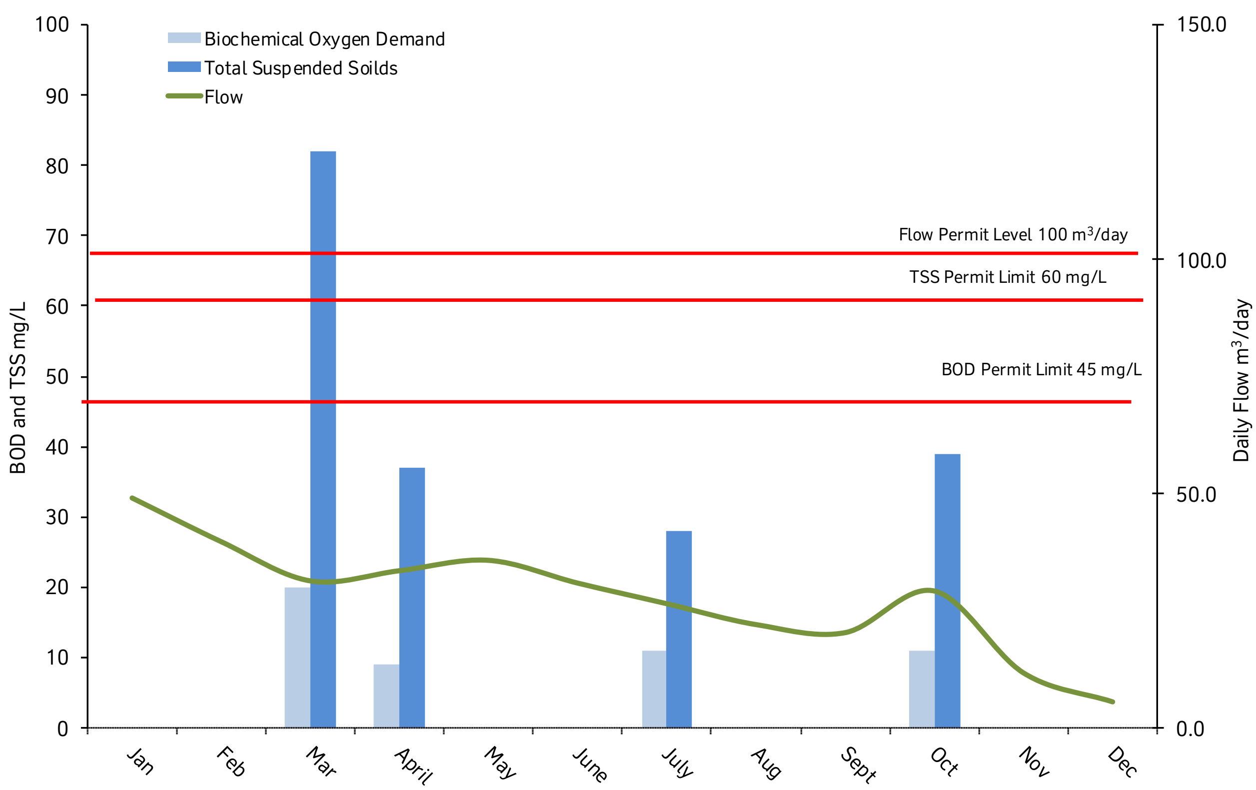
Non-combustible refuse and ash from the incinerator is buried in a landfill near Kemano. The landfill permit limits the amount of material to an annual maximum of 300 m^3. In 2022, 26.35 m^3 of ash and refuse was buried.

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 2022, 66.7 m^3 of sludge was disposed of.

Seekwyakin camp effluent discharge

Seekwyakin construction camp, located three kilometers 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 2022 the Seekwyakin treatment plant was decommissioned and no longer discharging to the drain field ~~there for there was no discharge~~ in 2022.

Figure 10.1
Effluent discharge, Kemano 2022



11. Summary of non-compliance and spills

In 2022 BC works reported 16 non-compliant conditions to the BC Ministry of Environment and Climate Change Strategy for the Kitimat Smelter operations.

2022 performance

Non-compliance summary

In 2022 sixteen non-compliances were reported to 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). In 2022 a warning letter was received from BC ENV for a period from 2019 to 2021 that was reviewed.

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 2022, eight 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 enlisted.

Investigations and root cause analysis of reportable spills is 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.

When spills occur in water, consultants are deployed to assess the impacts on the receiving environment. No known environmental damage was associated with any of the spills reported during 2022.

Table 11.1

Summary of non- compliances, 2022

Occurrence	Non-Compliance	Permit Requirement	Cause	Corrective Actions
January, 2022	Insufficient operational shuttles to report the Reduction roof vent emissions.	Potline emissions include primary (stack) and secondary (potline emissions - Roof vent).	The most probable cause of the non-compliance was the extreme cold weather compounded by reduced workforce due to covid-19 absenteeism.	1) Met the required number of shuttles for subsequential sampling period. 2) Set up method to monitor the shuttles. 3) Reviewed SLA.
February, 2022	Kemano Sewage treatment Plant effluent TSS above permit.	TSS Permit Limit = 60mg/L	Sample exceeded waiting period time.	1) Resampled and sent to Laboratory for analysis. 2) Reviewed daily check sheets and logbook for anomalies. 3) Reviewed sample results with lab technician.
February and March, 2022	Invalid PAH puff samples at Whitesail Ambient Air Station.	PAH data reported on the NAPS cycle.	Broken elapsed time indicator on Whitesail PAH sampler.	1) Replaced elapsed time indicator 2) Developed of maintenance plan for PAH puff system. 3) Developed QAQC plan for the ambient air station. 4) Implementation of field sheets to improve communication.
May, 2022	Missed reporting of planned upset of APP emission control devices.	Notify within one business day.	Missed reporting & maintenance planned without upset authorization.	1) Corrective action to improve emission control device logic to reduce number of upsets 2) Finalize procedure and roles and responsibility for reporting and requesting bypasses.
June, 2022	Effluent analysis reported late.	All monthly reports shall be submitted within 30 days of the subject monitoring period.	Water sample collected but not received by the laboratory. Shipping department misplaced the coolers.	1) Coolers were found and sent samples to laboratory for analysis. 2) Reviewed procedures for collecting and shipping B lagoon samples.
July, 2022	Water sample bottle leaked during transit and could not be analyzed by the laboratory.	Permitee shall ensure that proper care is taken in sampling, storing, and transporting the samples.	Sample lid jostled loose during transportation.	1) Reviewed procedures for collecting and shipping B lagoon samples.
October, 2022	Dust collector motor stopped working and sandblasting activities continued.	Notify within one business day.	The operational area was not aware of the permit requirements.	1) Communicated permit requirements to the operational area. 2) Implemented operational checklist for ensuring the dust collector is operating as per specification before use. 3) Implemented a clear line of communication between contractor and Rio Tinto.
October, 2022	Late emergency upset reporting for LPI.	Notify within one business day.	Email sent by operational area was not visualized on time by ESD.	1) Procedure and logbook were updated and improved. 2) Performed trending analysis of Carbon South upsets.
October, 2022	96LC50 bioassay analysis result missed for overflow event.	Overflow samples analyzed for Dissolved Al, Dissolved Fluoride, pH, TSS and $96LC_{50}$ Bioassay.	Incorrect chain of custody submitted to the laboratory.	1) Reviewed procedure. 2) Reinforced with team the proper process for documenting overflow events. 3) Requested lab to communicate discrepancies between samples and documentation.
November, 2022	Late emergency upset reporting for FTC.	Notify within one business day.	The most probable cause is due to a lack of verification step in the reporting process to the Ministry of Environment.	1) Procedure and logbook were updated and improved. 2) Past emergency upsets reviewed to understand causes.
2022	Stack test reports for the GTC and Casting does not meet permit requirements.	GTCs stack sampling for TP, F-T & SO_2 Annually C-Casting stack sampling for NOx & TP biannually.	Sample not taken.	Under investigation

Table 11.2

Summary of reportable spills, 2022

Occurrence	Substance	Amount	Environmental Media	Cause	Corrective Actions
April 12, 2022	Particulate	Unknown	Air	Trucks hauling the material out did not have proper containment.	1) Developed safe procedure to load material into box liner bags to eliminate the escapement of dust during transit.
August 18, 2022	Sewage	8 L	Asphalt	A piece of gravel got caught in the truck valve stopping it from closing fully.	1) Released sewage was cleaned up from asphalt using a vacuum truck.
September 14, 2022	Sewage	Unknown	Gravel	An alarm error led to overflow in the Sewage lift station during high storm event.	1) The spill was cleaned up immediately. 2) Replaced Ultrasonic head. 3) Replaced backup floats. 4) Repaired drywell sump pump.
December 8, 2022	Aluminium Fluoride	~95 t	Paved ground	The spill occurred during maintenance to unplug the silo. There was no pad behind the plate to stop material from coming out of the silo.	1) Cleaned up material with vacuum truck.
December 16, 2022	Charged Alumina	~20 t	Paved ground	The unloading spout opened via an air actuated valve due a faulty high level switch which caused it to open.	1) Shut off valve. 2) Material was clean up using a vacuum truck. 3) Recovered material was shipped offsite for proper disposal.
December 21, 2022	Diesel	1000 L	Gravel	Mechanical failure.	1) Material was clean up using a vacuum truck. 2) Recovered material was shipped offsite for proper disposal.
December 21, 2022	Diesel	600 L	Gravel	Locomotive was repaired 12 hours earlier for a different mechanical failure.	1) Cleaned up material with vacuum truck. 2) Recovered material was shipped offsite for proper disposal.
December 22, 2022	Charged Alumina	~800 Kg	Paved ground	Mechanical failure of unloading spout.	1) Cleaned up material with vacuum truck. 2) Recovered material was shipped offsite for proper disposal.

12. Smelter restart

To support the smelter restart a temporary amendment of the P2 permit was 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 year end. To support the restart of the smelter, a temporary amendment of the P2 Permit was obtained that increased the smelter wide total fluoride emissions from 0.9 kg/t Al to 2.8 kg/t Al and the reduction particulate matter emission limit from 1.3 kg/t Al to 2.9 kg/t Al. The temporary permit amendment required new monitoring and reporting requirements that are presented in the following sections.

Pot start up plan

Three different pot start methods were planned for returning the smelter to a normal operating level of 384 pots; these methods are cold metal pots start and two conventional pots methods of either hot bath or dry bath starts. Details on the pot start methods and the overall smelter restart can be found in the 2022 BC Works' Smelter Restart Technical Assessment Report, Version 3 (this report is available on the BC Works' website). Completion of the pot starts was planned for year end. However, due to technical and safety challenges with adapting the cold metal start method to Kitimat, shut down of the overhead alumina transport conveyor, BC Hydro constraints and challenges with the bath supply, it was not possible to complete the pot starts in 2022. An extension of the temporary emission limits has been obtained to allow the completion of the pot starts until October 31, 2023. Figure 12.1, shows the planned pot start schedule and the completed pot starts by start-up method.

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) (Figure 12.2). The average data was reviewed daily, and where internal thresholds were exceeded actions were prescribed to understand the issue and to mitigate (Table 12.1).

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 before closing out the end of the year. 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 supervisor and the best practices for handling / removing hoods to inform on the performance of the start-up (Figure 12.3). The average boreal data was reviewed daily, and where internal thresholds were exceeded actions were prescribed to understand the issue and to mitigate (Table 12.2).

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 (Figure 12.4). The average boreal data was reviewed daily, and where internal thresholds were exceeded actions were prescribed to understand the issue and to mitigate (Table 12.3).

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 have been installed at the Kitimat ambient air quality monitoring stations. Particulate fluoride sampling will be implemented 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 will be established in the Kitimat valley, including the town of Kitimat (residential and commercial) and Kitamaat Village to monitor the levels of HF for both human and environmental exposures. Vegetation health monitoring will also be done at each of the passive monitoring stations. The passive monitoring program will be in place for the duration of the pot starts where accessible through winter conditions.

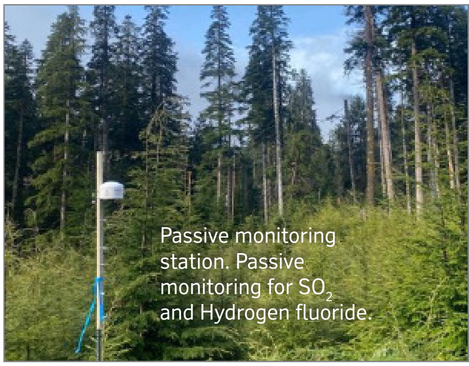
Ambient air

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} take places 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) (Figure 12.4).

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 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. The HF samples were collected via a prepared diffusion tube (passive sampler) supplied by Ormantine USA Ltd. Laboratory (Ormantine). The exposed samplers were returned to Ormantine and subsequently sent to Gradko Environmental Laboratory in the United Kingdom (UK) for analysis by ion chromatography following European Standard EN13528-1:2002 The Gradko analysis met a reporting limit of detection of 0.047 g/m^3, samples below the limit of detection were reported as half the detection limit.



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

The monthly results for the passive samplers ranged mostly below detection limits with 7 exceedances that were linked to water ingress into samplers or complications at the lab related to coelution of chromotograph peaks (Figure 12.6). In October all the samples that were deployed were invalidated due to contamination in travel blanks and complications with coeluted peaks.

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 as 13 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 re-start no injury was observed at these locations with the exception of site A01 (haul road station, Figure 12.5) where leaf cupping was observed on Elderberry and an injury rating of 5% was noted in the monthly report. This injury rating was reduced to 0% the following month as the observed injury did not progress and no marginal chlorosis or necrosis was observed that would be expected with continued exposure, no other injuries were observed on any other plant species. The monthly rating from May – September was 0 for every site with the expectation of site A01 for the month of August.

Chronic injury Inspection

Inspection for chronic injury and Western Hemlock sampling took place at the end of the growing season as 12 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 12.7). Sites closest to the smelter had higher emissions than previous operational years (44, 37, 89), but were all below the threshold where visible injury is rarely detected on sensitive species below 75 ppm. In comparison to the historical concentrations of fluoride in western hemlock (Figure 12.8) were below concentrations measured when the VSS smelter was in operation (1954 - 2015).

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. There were no observations of damage on sampling trees, however at site 37 evidence of minor needlecast (fungal infection) was observed.


Minor needlecast observed at site 37.

The general vegetation condition at all sites was described as either *All* or *Most Green/Lush*, with Sites 37, 44, 86, 90 and 490 described with *Few Dry/Brown* (owing to normal seasonal senescence). Western redcedar growth form was described as *Normal* at Sites 57, 68, 86 and 490, and Conical at the remaining seven sites; Sites 37 and 90 had significant dieback of this species. Where present, spruce needle retention typically ranged from 5-8 years at sites, with a total range observed from 3 (at Site 68) to 10 years (at Site 91A). While there were numerous observations across the sites of damage from pests and pathogens, none were found to be particularly atypical of the region during the 2022 season, and no signs of injury from F were observed.

Trigger-Action response plan

A trigger-action response plan (Figure 12.9) has been established that applies air quality objective and vegetation health thresholds to trigger control actions for improving smelter operation performance and reducing the rate of pot starts. In 2022 there were a number of thresholds exceeded that triggered actions due to exceedances of the air quality health objective for hydrogen fluoride and visible injury observed on vegetation (Table 12.5).

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 the best practices for materials management in accordance with 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.

Figure 12.1

Pot restart plan vs actual starts

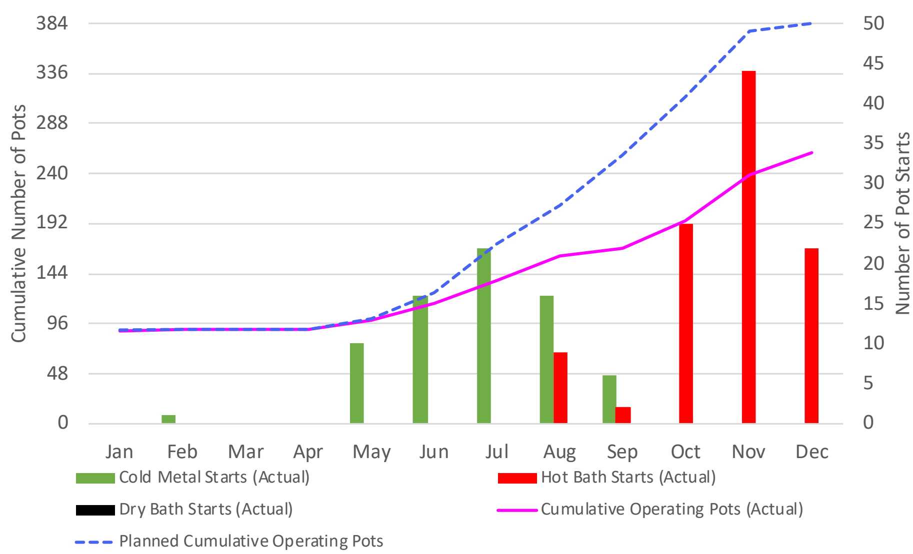


Figure 12.2

Gas treatment centre KPIs

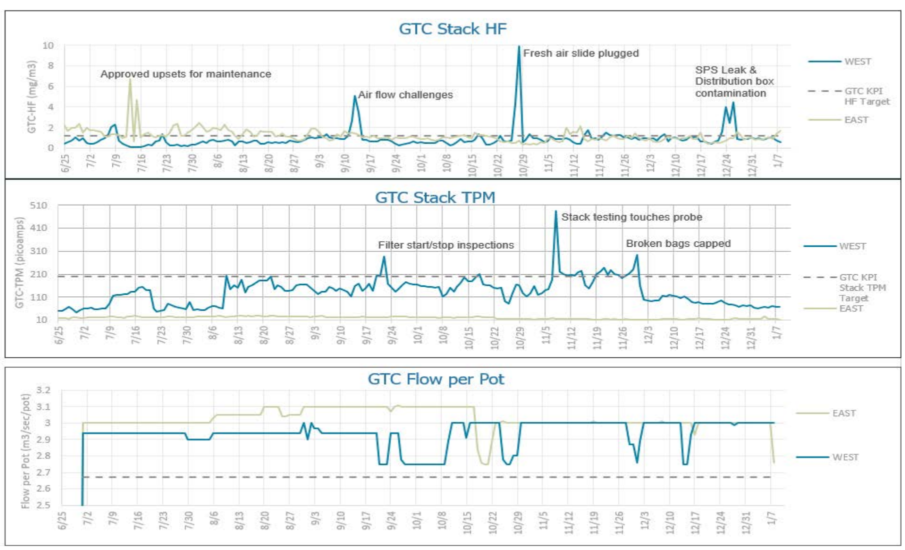


Table 12.1

GTC KPI percent exceedances during the 2022 restart.

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

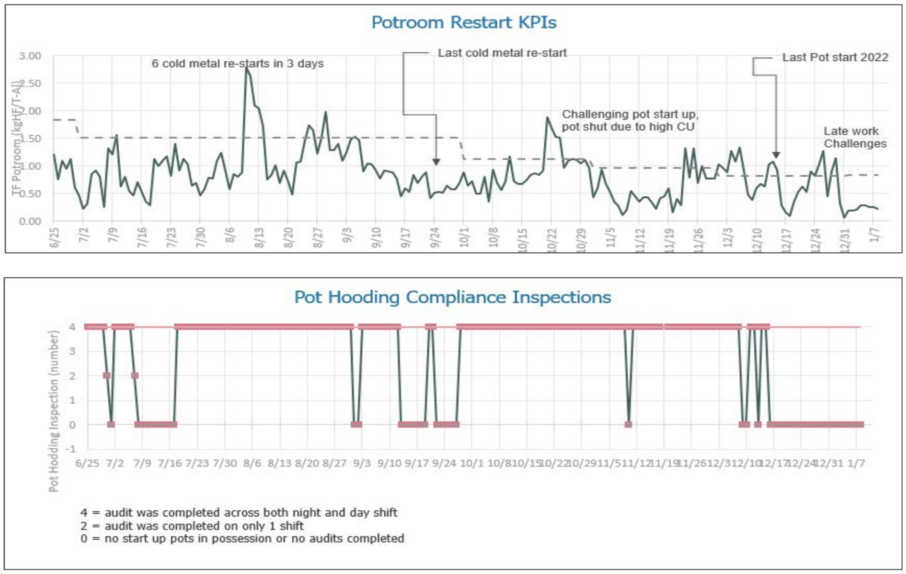


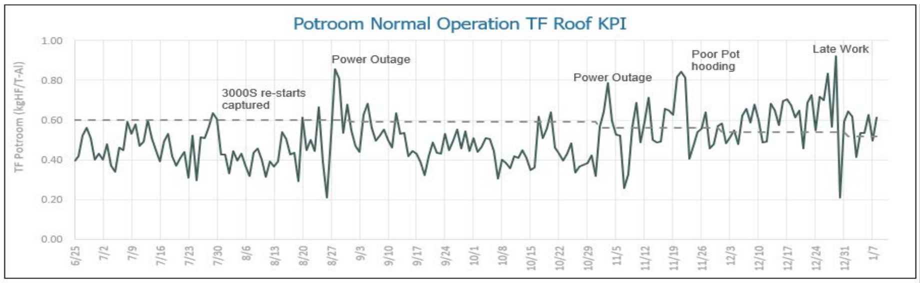
Figure 12.3

Start up section KPIs

Table 12.2

Reduction start-up KPI percent exceedances during the 2022 restart.

Key Performance Indicator	Start up sections (%)
Boreal total Fluoride	18
Percent pot sealage	0



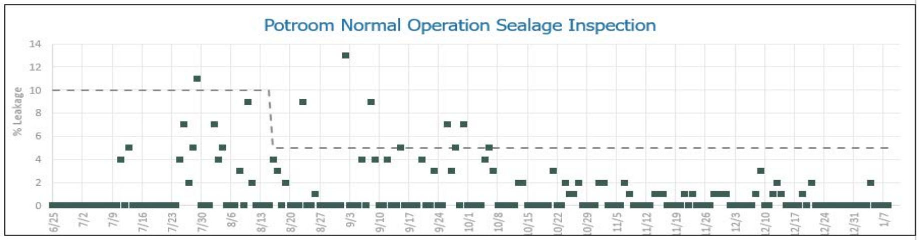


Figure 12.4

Normal operating section KPIs

Table 12.3

Reduction Normal Operations KPI percent exceedance.

Key Performance Indicator	Normal sections (%)
Boreal total Fluoride	54
Percent pot sealage	3

Table 12.4 KPI exceedances at ambient air stations during the 2022 restart.

Key Performance Indicator	Haul Road Station (%)	Riverlodge Station (%)	Whitesail Station (%)	Kitamaat Village Station (%)
Max hourly HF	42	0	NA	NA
Average hourly HF	33	0	NA	NA
30 day HF	40	0	NA	NA
90 day HF	67	0	NA	NA
Max hourly $PM_{2.5}$	11	1	2	1
Daily average $PM_{2.5}$	0	0	0	0
Max hourly PM_{10}	NA	10	NA	NA
Daily average PM_{10}	NA	0	NA	NA

Figure 12.5

Passive monitoring and vegetation inspection and sampling sites.

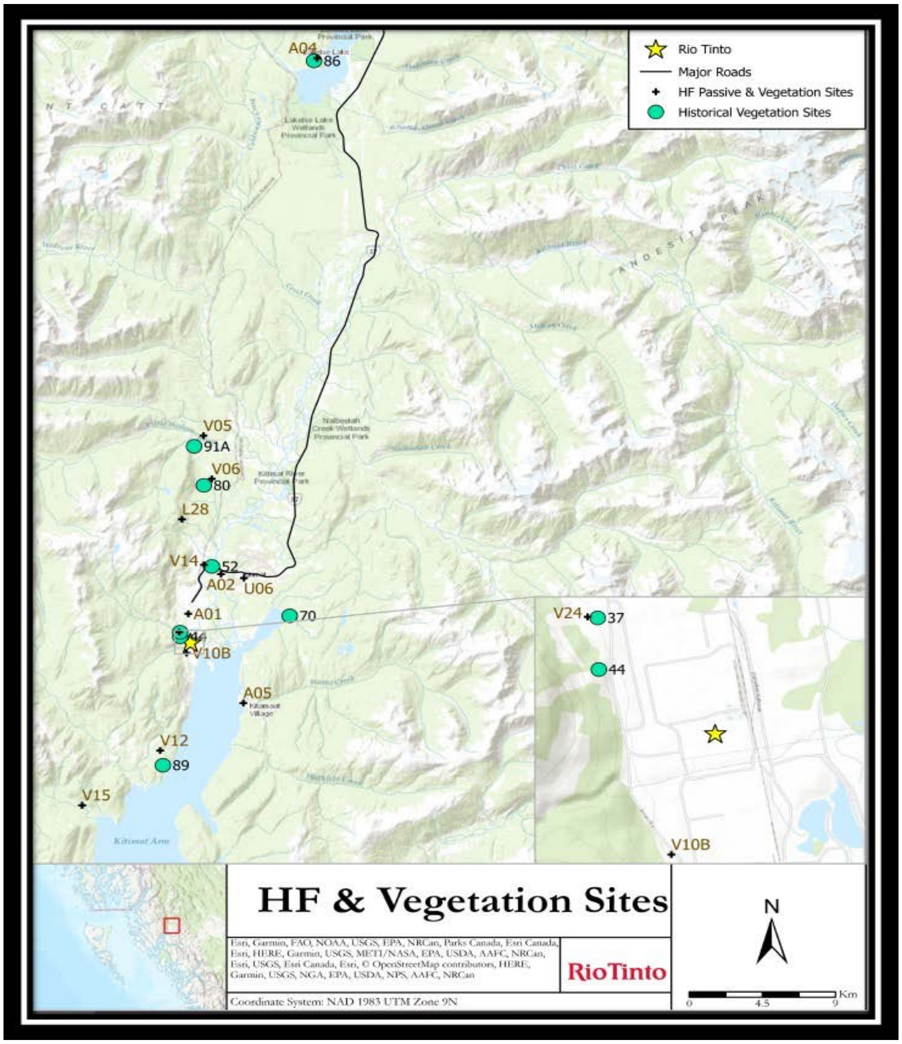
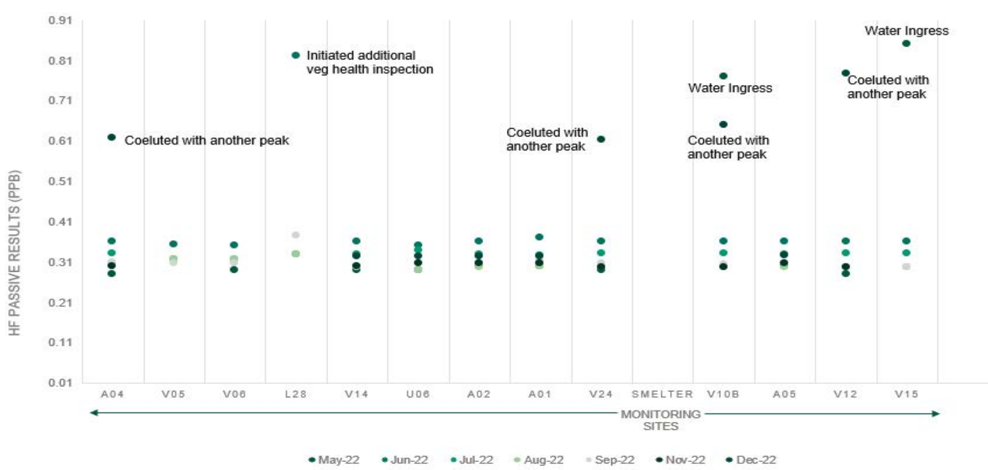


Figure 12.6

HF passive monitoring sampling results.



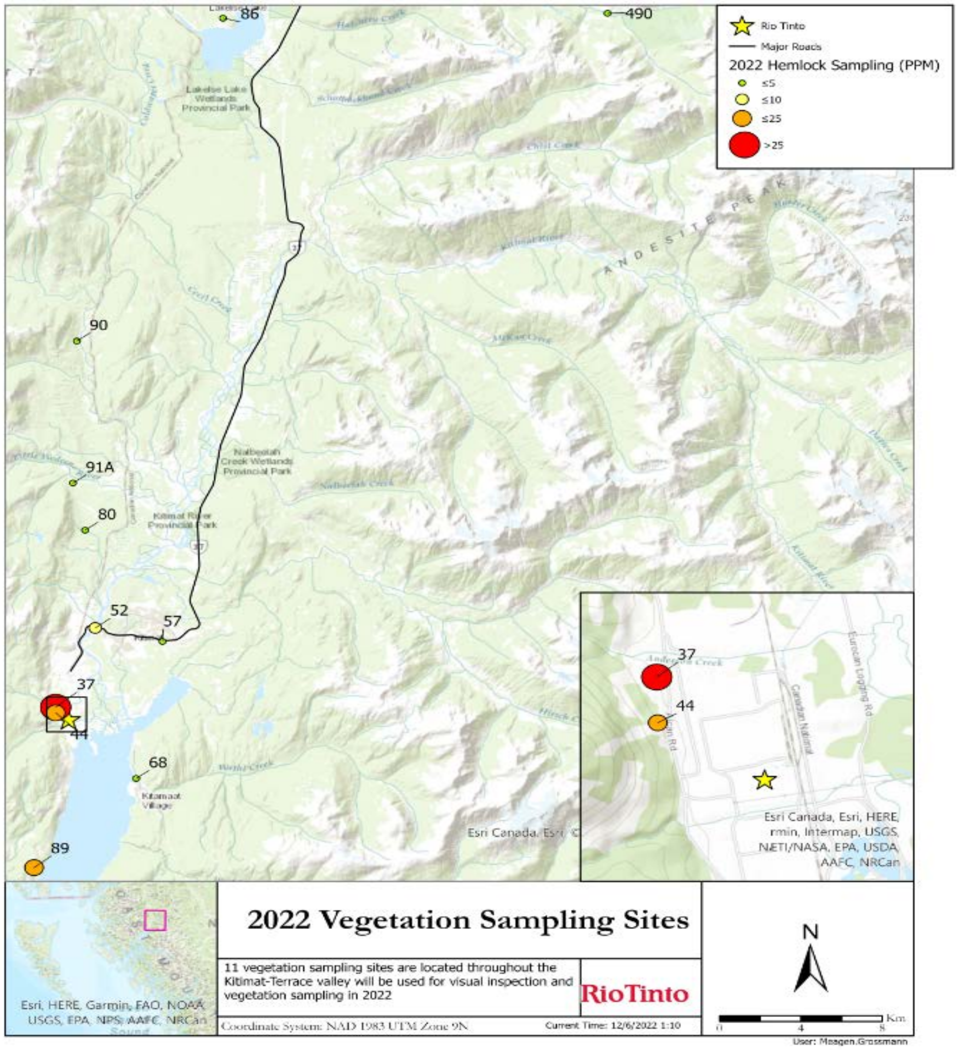


Figure 12.7

Fluoride concentrations in western hemlock needles.

Figure 12.8

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.

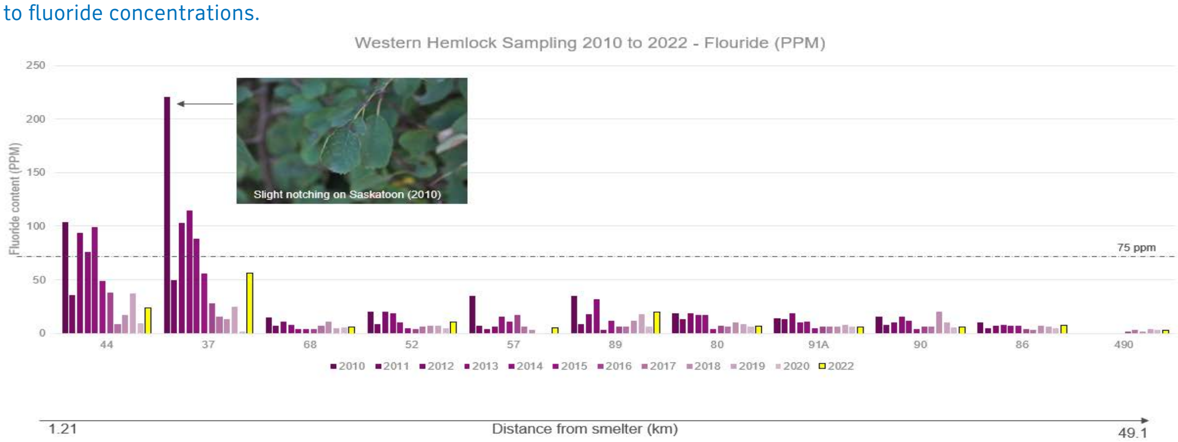


Figure 12.9

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

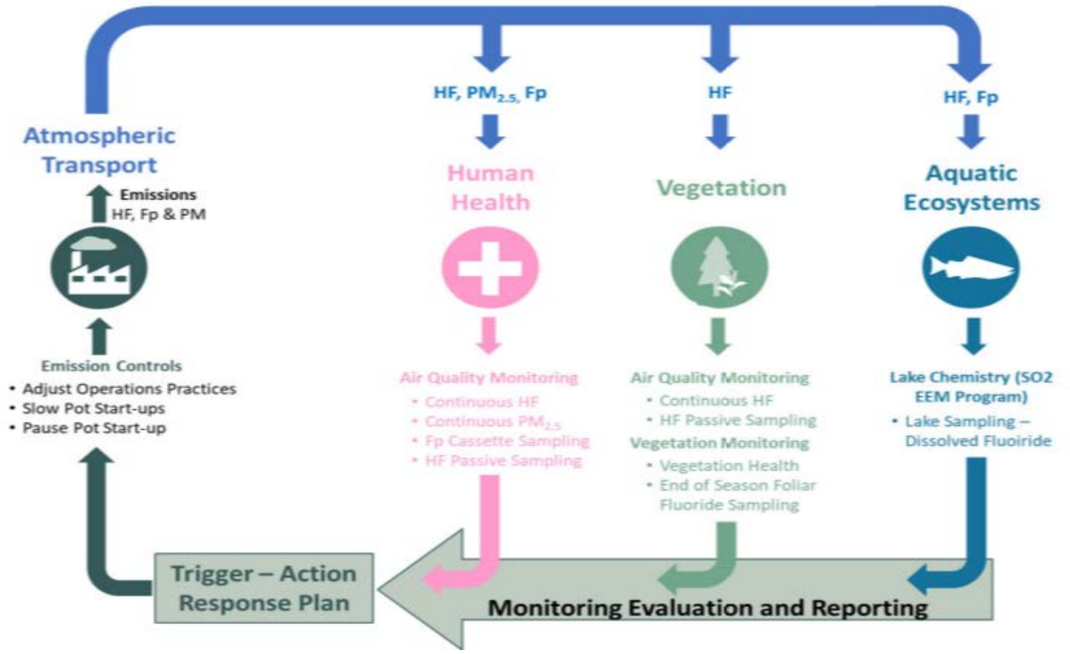


Table 12.5 Trigger-Action Response Plan.

Parameter	Threshold	Action taken
Ambient air station continuos monitor for HF	90 day or 30 day average greater than 0.5 ppb	• Reduced pot hooding sealage from 10% to 5% • Adjusted bath donor temperature targets
Passive monitoring for HF	30 day average greater than 0.5 ppb	• Continued vegetation inspections
Vegetation inspection	Visible injury observed outside of RT owned property	• Initiated valley assessment at historical locations and areas with historical observed injury

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)	478	178 were returned. 140 were rejected; sent to the Anode Rodding Shop (ARS) for dismantling in accordance with normal operating procedures. 160 still in storage – awaiting inspection to determine if they can be re-used in the potlines or require recycling in the ARS.	Re-usable used anodes remained connected to their anode assemblies at all times and were stored in Buildings 1A, 2B and 2C. As of February 3, 2023, all but 160 used anode assemblies were returned to potlines for re-use (178), or to the ARS for dismantling (140). In the ARS, bath adhered to the anodes was milled off and was processed in the bath plant, and remaining anode butts were processed in Carbon Recycling, as per regular operations. All assemblies where shipped from the old lines to the potlines or to the ARS on dedicated pallets using dedicated ATVs, and following the procedure outlined in the MMP.
Spent Bath (bulk piles)	568 tons (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 volume unknown. All cover bath was crushed and transferred into bulk bags within Building 2C.	Quantity returned unknown – as of February 3, 2023, 1,200 tons of bath remains in storage, within bulk bags.	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	N/A – Remained in storage in basements.	N/A – Recycled back to potlines (not re-start related) or shipped off-site in SPL containers.	10,275 tons of basement bath were shipped off-site for disposal in dedicated SPL bins in 2022, that would otherwise have been re-used during normal operations.
Aluminium Pot Pads	168 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. 5,280 tons of aluminium was transported off-site.

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

Gas Treatment Centre
Is 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 emitted amount of a contaminate in a given time period.

Maximum allowable level
This level provides adequate protection against pollution effects 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 that 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 that 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 Center
GTC	Gas Treatment Center
HR	Haul Road
HSE	Health, Safety, Environment
HSEQ	Health, Safety, Environment and Quality
ISO	International Organization for Standardization
KMP	Kitimat Modernization Project

Abbreviation	Definition
KPAC	Kitimat Public Advisory Committee
KPI	Key Performance Indicator
KV	Kitimaat Village
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
RCF	Refractory Ceramic Fibres
RL	Riverlodge
SPL	Spent Potlining
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 liter
mm	Millimeter
MWT	Molecular weight

Notation	Parameter
ng/m^3	nanogram per cubic meter
NO	Nitrogen monoxide
NO_2	Nitrogen dioxide
NOx	Nitrogen Oxides
O_3	Ozone
PAH	Polycyclic Aromatic Hydrocarbons
PFC	Perfluorocarbons (CF4 and C2F6)
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 meter
yr	year
µS/cm	microsiemens per centimeter

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