Rio Tinto

Environmental Report BC Works 2019

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

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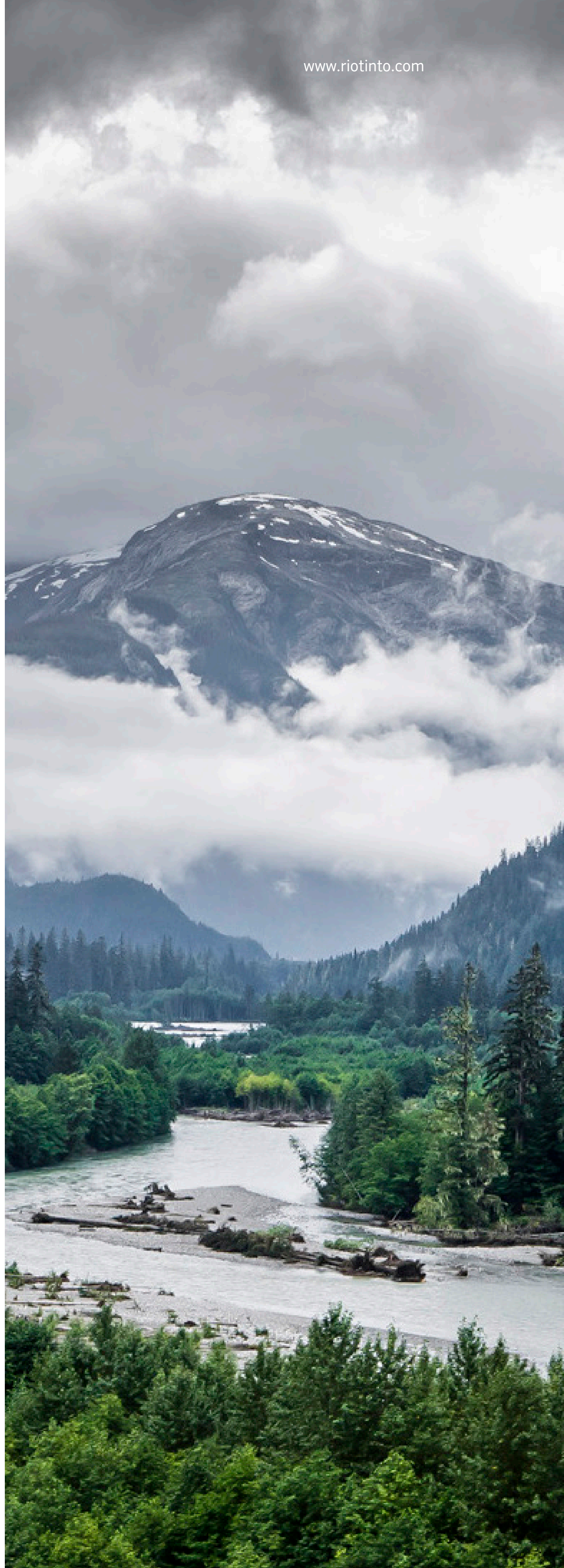


1. About this Report

This Annual Environmental Report is provided to share yearly environmental performance with our stakeholders and meet the reporting requirements under the multi-media permit from the provincial government of British Columbia. It is submitted to the provincial government and made available to the public through the BC Works web site and at the Kitimat Public Advisory Committee (KPAC).

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. The P2-00001 Multi-Media Waste Discharge Permit comprehensively addresses multiple air, water and solid waste discharges, sets limits and establishes monitoring and reporting requirements. This permit is the key environmental regulatory compliance benchmark for smelter operations.

The permit provides guidelines for a results-oriented environmental management approach.

BC Works uses the permit guidelines with other proactive strategies to facilitate vigilant compliance monitoring and regular communications with public and private stakeholders.

The multi-media permit requires annual reporting to measure performance against established permit limits. More specifically, the annual reporting program includes results of air emissions monitoring, ambient air quality monitoring, surface water and effluents monitoring, groundwater monitoring, vegetation monitoring, and waste management monitoring. The yearly performance of the smelter is shared with the public in an Annual Environmental Report produced on a yearly basis by BC Works. A summary of the yearly accumulated non-compliances and spills is also included in the Annual Environmental Report.

In addition to the permit reporting for Kitimat Operation, a summary report for compliance of the Kemano Operations environmental permits is provided..

The 2018 Annual Environmental Report is available online at www.riotinto.com\bcworks.

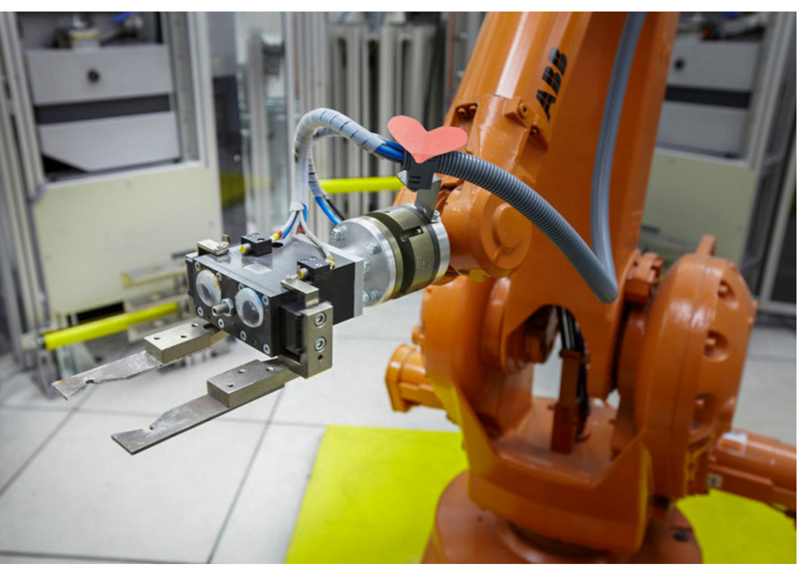
The website also provides information on key environmental performance indicators. Questions or comments are welcome and may be made through the contact page on the website.

When the permit was amended in 2016 to account for the discharges of the newly modernized smelter, regulatory requirements pertaining to the old smelter were kept since both smelter's operated simultaneously for a brief period of time. In 2019, since the old smelter has been fully decommissioned, the permit was refreshed to remove obsolete clauses. The final amendment will be completed in 2020. This new version of the permit will be easier to manage and regulate, helping maintaining compliance.

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 includes the Kitimat smelter, the power house at Kemano and the Nechako reservoir.

The main raw material used at the smelter is alumina ore; large volumes of which are imported from international suppliers and delivered by ship. Alumina is composed of bonded atoms of aluminium and oxygen (Al_2O_3). An electrolytic reduction process is used to break the bond and produce aluminium. The electrolytic reduction process takes place in the potroom buildings. These buildings house specially designed steel structures called pots. The pots function as electrolytic cells. They contain a molten bath or electrolyte made up mainly of highly conductive cryolite bath in which alumina ore is dissolved. Electricity flows through the electrolyte from an anode to a cathode. The electricity breaks 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.



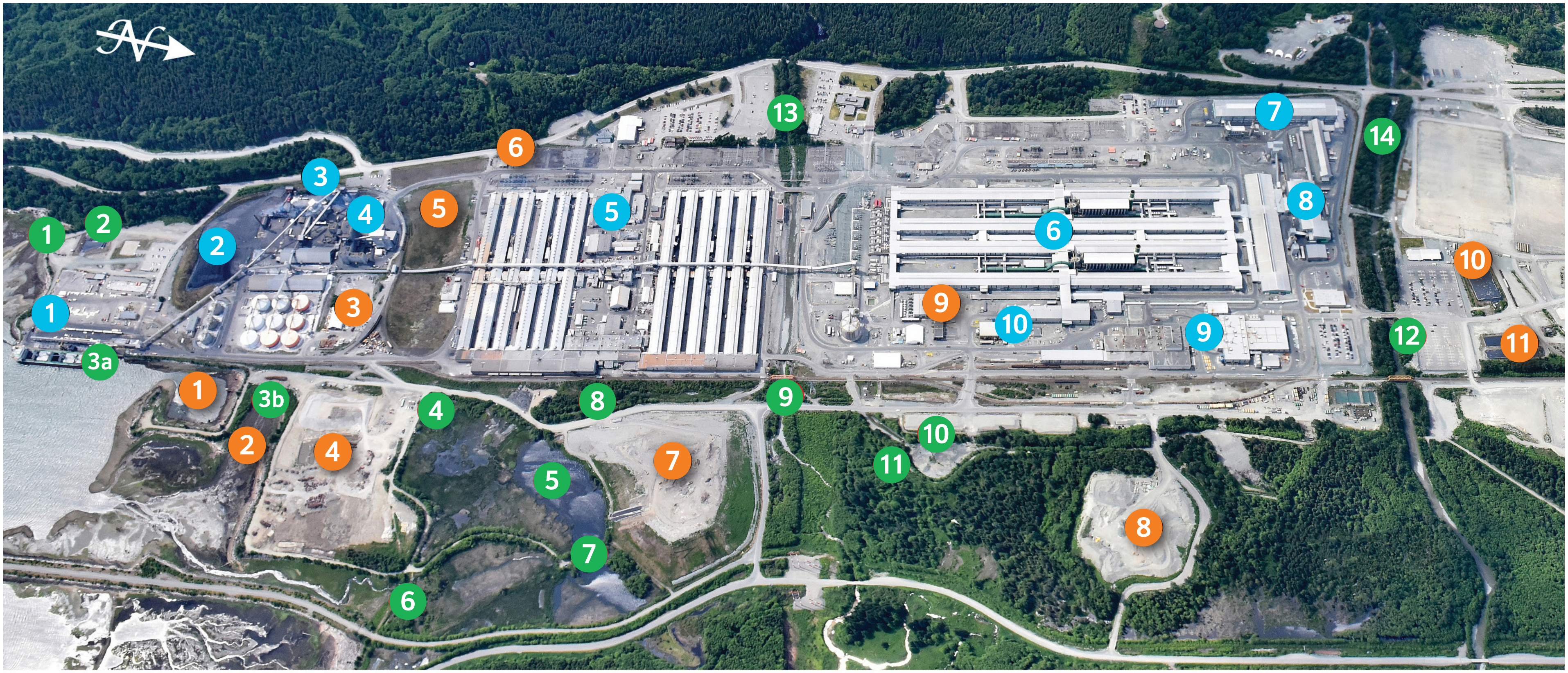
The molten aluminium that is extracted from the pots is transported to the two casting centers (B & C) located within the smelter, where it is temporarily stored in holding furnaces. Various alloying materials (such as magnesium, copper, silicon and iron) are added to produce specific characteristics such as improved strength, corrosion resistance, etc. The new "C" Casthouse has a state-of-the-art water cooling and recycling system.

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.

The smelter site also includes facilities that produce materials required for aluminium production including the on-site Anode Paste Plant, Anode Rodding Shop, Coke Calciner, Carbon Recycling and Anode Baking Furnace, which produce materials used in the manufacturing and recycling of anodes. The new process also includes a Bath Treatment and Storage Facility for the recycling of electrolytic bath materials.

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 kilometers southeast of Kitimat. This generating station uses water impounded in the 91,000 ha Nechako Reservoir in north-central British Columbia.

In addition to the process related facilities, there are a number of environmental facilities for waste management, storm water management and managed sites. These environmental facilities are shown in Figure 2.1.



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
11. Wharf dredgeate 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 2.1 Kitimat Environmental operations.

3. Environmental management and certification

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(2008) 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. It validates our efforts to invest in high energy efficiency processes and to embed sustainability and human rights principles.

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 2018 as planned. BC Works' integrated certification was successfully maintained and transitioned to the updated ISO 14001 (2015). The ASI certification audit also took place in 2018 and this certification was proudly obtained by BC Works. Compliance with all environmental laws and regulations is the foundation of our environmental performance standards. Internal compliance audits of Rio Tinto Corporate standards, which are intimately linked with Rio Tinto's core operating values, was also successfully completed in 2018.

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

Teamword
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 2019, the average discharge rate was 21,166 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 addition to the B-Lagoon outfall, there is an emergency outfall that can accommodate significant inflow surges. F-Lagoon and D-Lagoon are also designed with emergency overflows in case of significant surge. In 2019, there were a total of 5 overflow events 4 of them in B and one at F Lagoons. All parameters tested were compliant with the P2 permit.

Discharge measurements related to permit requirements and additional monitoring are described below in the following 2019 performance section.

2019 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 2019 (2015 mm) was very similar comparing to 2018 (2240 mm). Most of the rain came in the fall months of 2019.

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 2019 dissolved fluoride, and total suspended solids loads slightly decreased over a 10 year trend, in 2019 the results were slightly elevated from the previous year. The most significant change has been the reduction of dissolved aluminium in the lagoon system over the 10 years that can be attributed to the shutdown of the old smelter.

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.

BC Works aimed to reduce fluoride loading to receiving environment from the South Landfill by 30% by the end of 2018 compared to 2013 baseline. BC Works actually achieved 79% reduction.

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 2019. Average dissolved fluoride concentration for the year derived from composite sampling was 3.65 mg/L. The long-term trend is illustrated in Figure 4.2. The 2019 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. One sample in February was elevated and reached 10mg/L just at the permit limit.

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 gas treatment center. In this form, scrubbed alumina has a higher solubility and is a contributor to both dissolved aluminium and dissolved fluoride.

In 2019, concentrations of dissolved aluminium did not exceed the maximum permit limit of 3.0 mg/L. The annual average of dissolved aluminium concentration was 0.120 mg/L (Figure 4.4).

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 2019 were much lower than the permit level. The annual average concentration for the composite samples was 3.15 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 2019. 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 2019 (Figure 4.7).

During the month of April there were some challenges with the continuous monitoring probe. Some of the data was not able to be processed as a result of a failed conductivity and temperature probe. Temperatures in the lagoons both before and after the repair indicate a stable temperature reading.

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 fulfillment of section 8.2.5 of the multi-media permit requirement. 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 percent for trout tested. All effluent discharge bioassay tests at B-Lagoon passed during 2019.

A similar comment can be made for the missing conductivity data during the month of April, there were some challenges with the continuous monitoring probe. Some of the data was not able to be processed as a result of a failed conductivity temperature probe. The composite hardness readings were very stable during this period confirming that there was stability in the readings during this period.

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 2019 annual pH composite sample average was 7.44. All sample measurements were within the permit limits during 2019 (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. PAH are monitored using monthly grab samples. PAHs are also analyzed from grab samples taken during special events. B-Lagoon discharges are monitored and analyzed for 15 of the most common PAH compounds (Figure 4.10). In 2019 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 2019 were within permit limits set at 0.01 mg/L. The average reading for 2019 was 0.004 mg/L the same as 2018.

Figure 4.1

Flow variability, B-Lagoon 2019

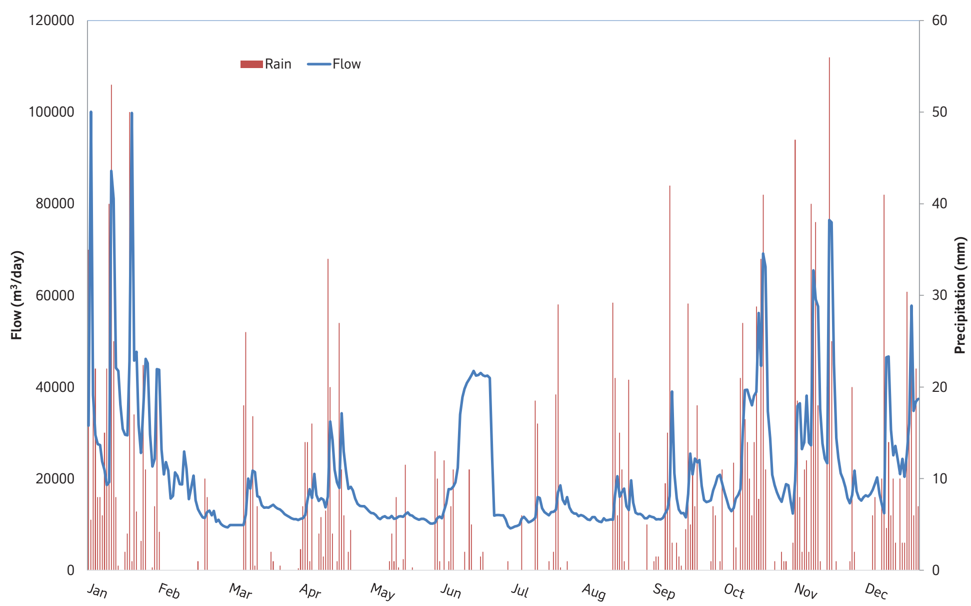


Figure 4.2

Dissolved Fluoride, Dissolved Aluminium and Total Suspended Solids, B-lagoon 2019

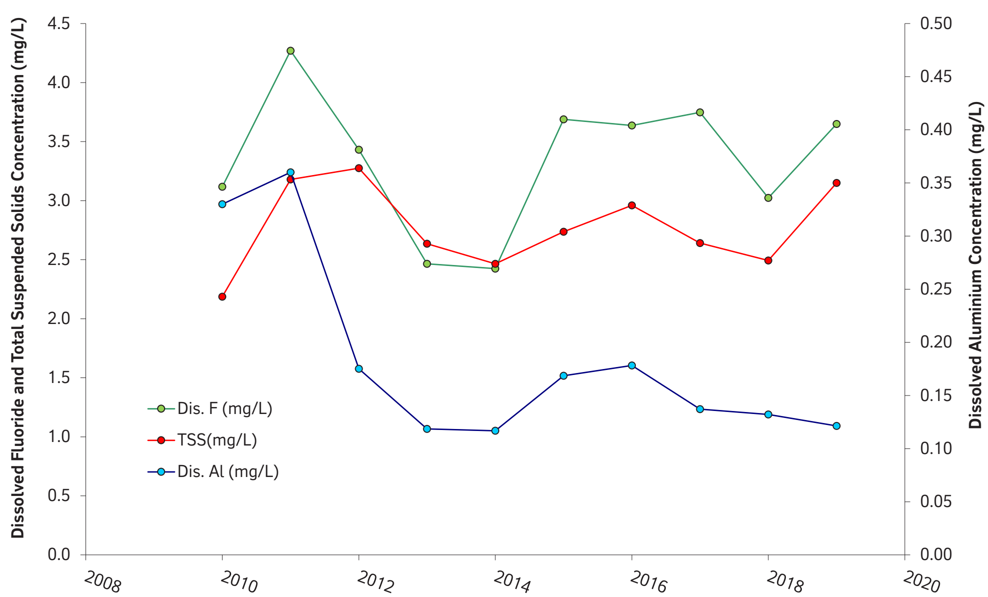


Figure 4.3
Dissolved fluoride, B-lagoon 2019

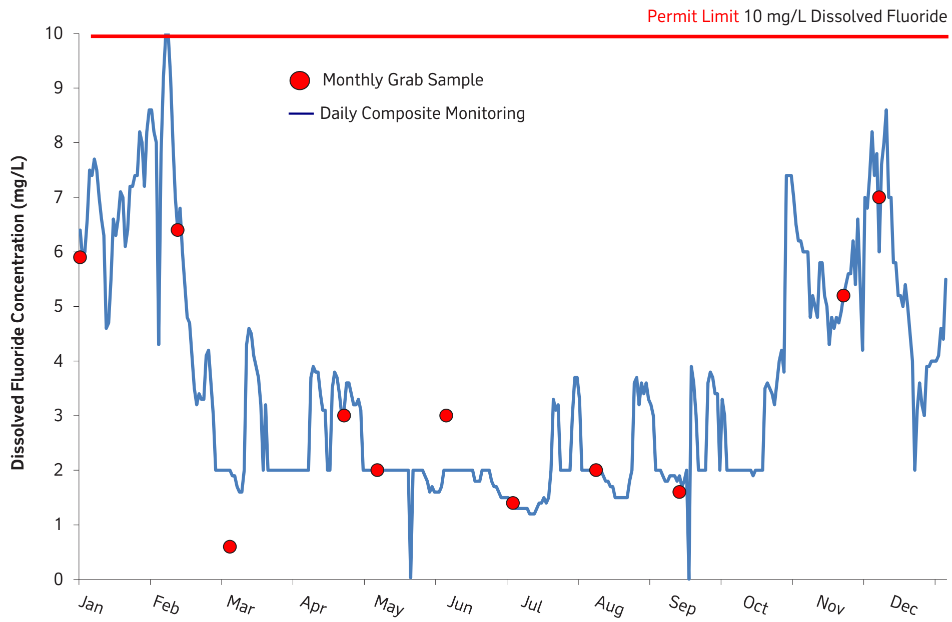


Figure 4.4
Dissolved Aluminium, B-lagoon 2019

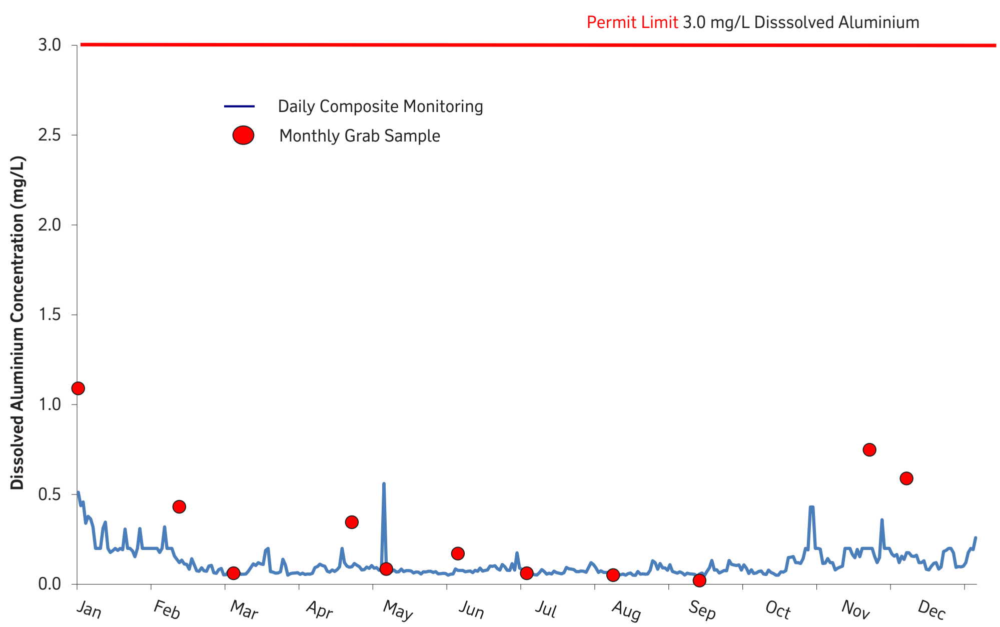


Figure 4.5
Total Suspended Solids, B-lagoon 2019

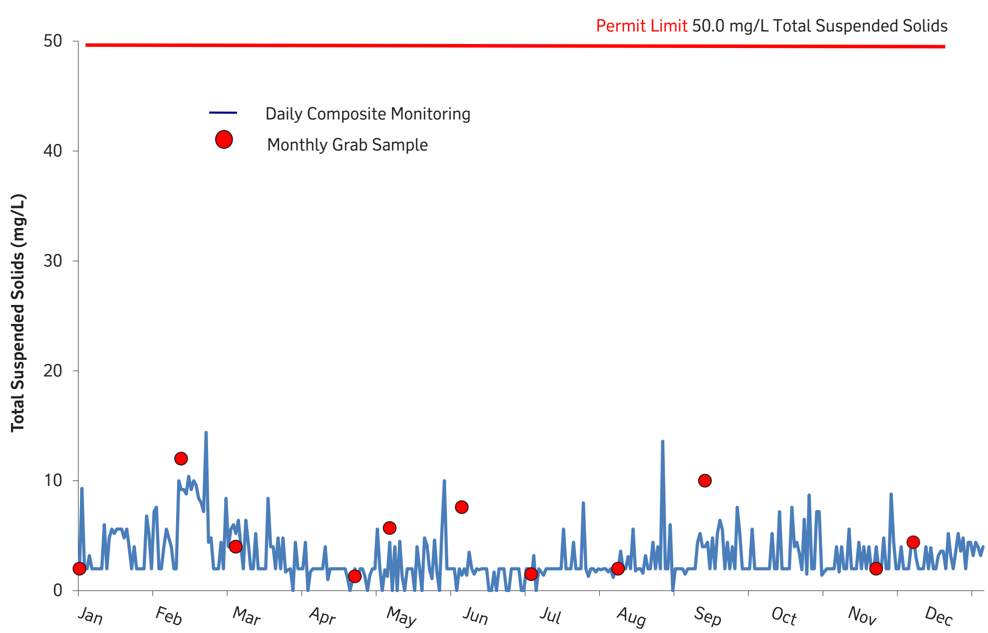


Figure 4.6

Cyanide, B-lagoon 2019

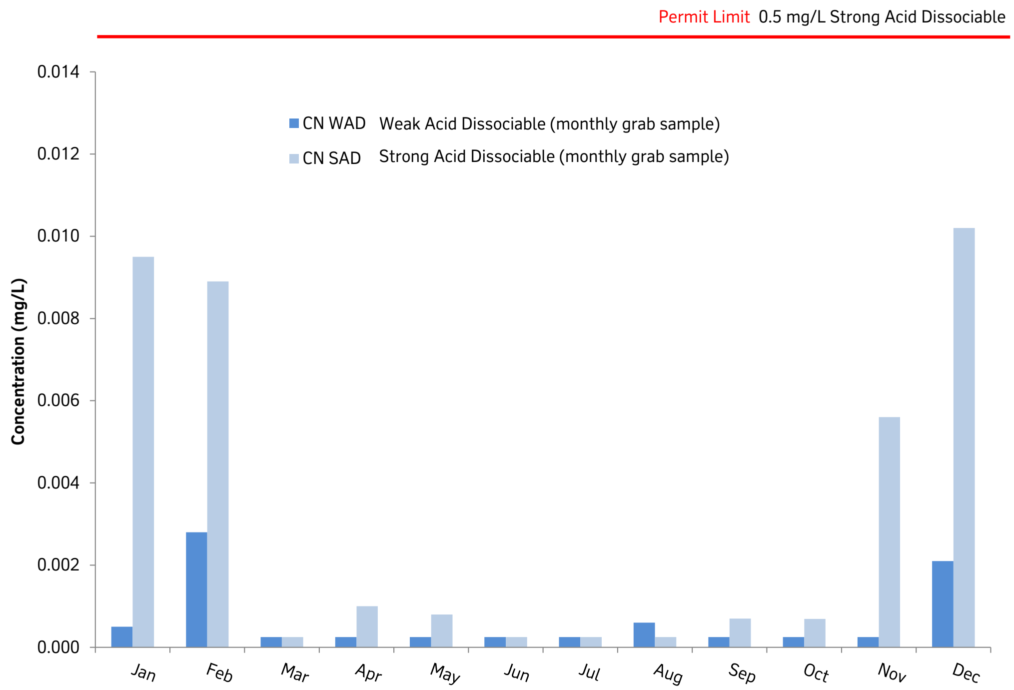


Figure 4.7

Temperature B-lagoon 2019

Figure 4.8

Conductivity and hardness, B-lagoon 2019

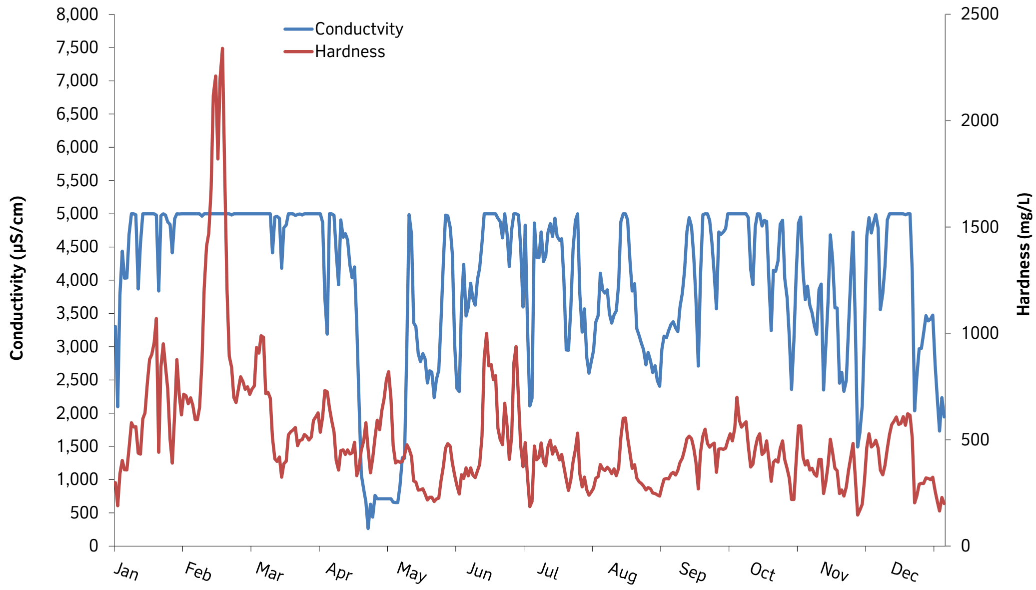


Figure 4.9

Acidity, B-lagoon 2019

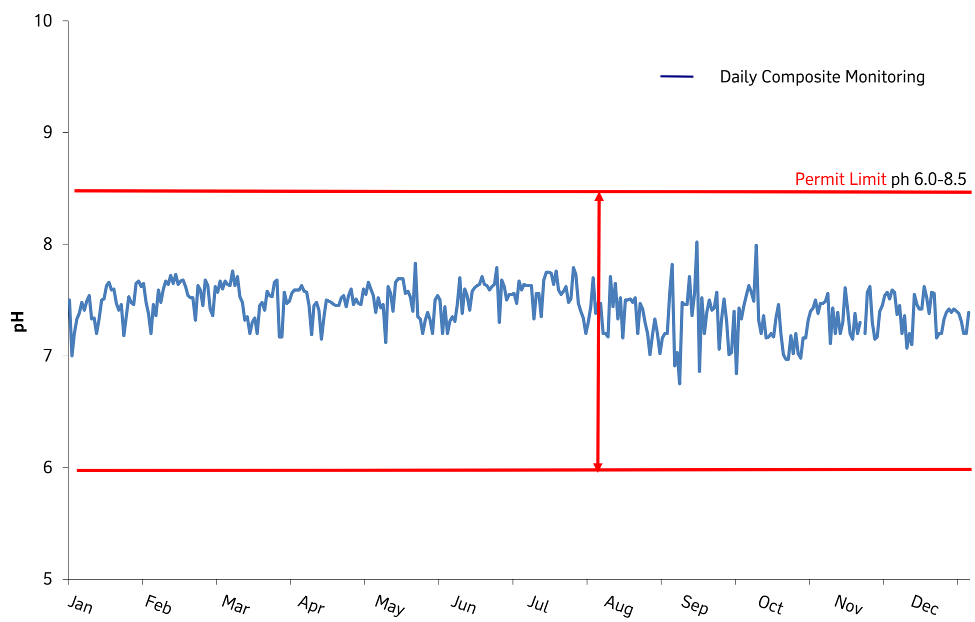
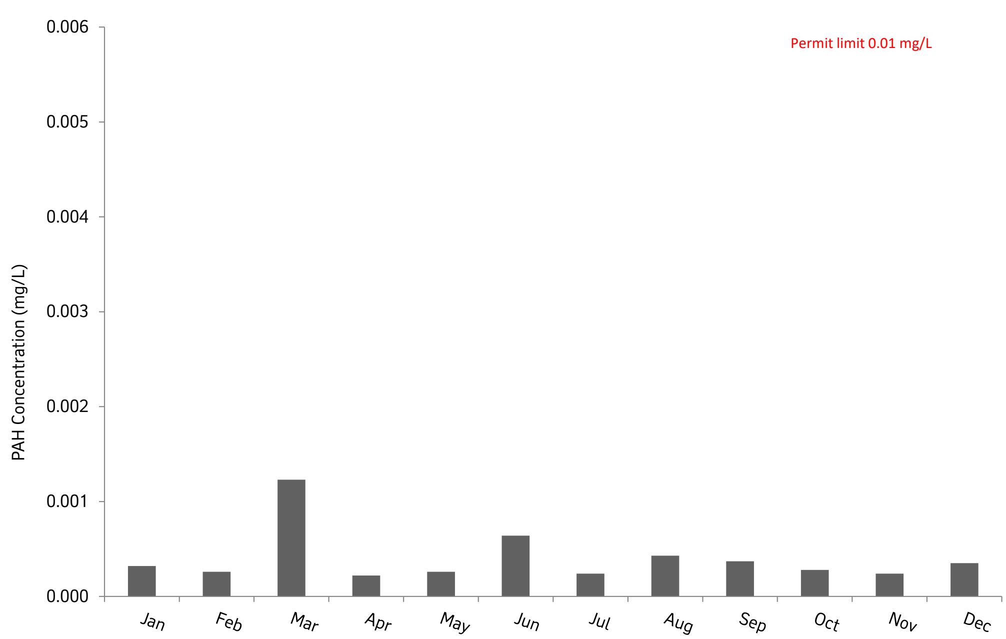


Figure 4.10

Polycyclic Aromatic Hydrocarbons, B-lagoon 2019



5. Emissions

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

2019 overview

Operational Sources & Emission Types

At BC Works the process of making aluminium releases various emissions at various steps of the process. (Figure 5.1 outlines the different operational areas of the smelter). Raw materials are formed into green anodes in Carbon South and these anodes are then baked in Carbon North. The baked anodes are then used in the electrolytic process in Reduction (AP-4X prebake technology) to generate molten aluminium which is then processed at 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 needed (Figure 5.2), some of which are monitored annually or biennially by a third party consulting company to monitor 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

2019 was a challenging year for BC Works with significant changes in operational dynamics which provided opportunities for learning and growth across the plant. There were three P2-00001 permit non-compliances related to particulate emissions from emission control devices in 2019 and one non-compliance related to a missed stack sample at dust collector. There were two non-compliances in Carbon South (Cooler Stack - particulate emissions & Dust Collector 12 – missed sample), one in Carbon North (Fume Treatment Centre stack – particulate emissions) and one from the Alumina Conveyor System (Dust Collector 1– fugitive dust particulate emissions). Investigations were completed and action plans executed to ensure the devices were operating within proper specification. The emission control devices located in Carbon South and in Carbon North were re-tested as per permit requirements and the re-test results were compliant due to the actions taken by the operational areas. The dust collector on the Alumina Conveyor System was fixed and fugitive dust emissions reduced and it was determined that DC-12 would have to be stack sampled in 2020. All other compliance points (stacks) for air monitoring at BC Works were compliant in 2019 and all reported plant wide monthly emissions were compliant.

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. A permit non-compliance was received for a dust collector along the alumina conveyor system (DC-1) due to fugitive dust emissions and an action plan was executed to bring the equipment back within operation specifications (see Chapter 11 on permit non-compliances for more information).

Carbon South

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

The emission control devices located in the coke calcination plant and in the anode paste plant 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 maintenance) 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 2019 in Carbon South.

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 monitored twice a year through stack tests, and due to the permit non-compliance at the cooler stack, the cooler stack was monitored three times in 2019.

Pyroscrubber

The emissions from the pyroscrubber are analysed for particulates, sulphur dioxide and nitrogen oxide as per permit requirements but the pyroscrubber only has one permit limit associated to particulates. The stack was sampled twice in 2019 and both the June and October stack tests results were within the permitted limits for particulates (Table 5.2).

Cooler

Similar to the pyroscrubber the cooler stack is analysed for particulates, sulphur dioxide and nitrogen oxide as per permit requirements but the cooler has only one permit limit associated with particulates. The stack was sampled three times in 2019 in June, October and December. The third stack test was required after the results of the second stack test (October) came back non-compliant for the particulate emissions (Table 5.3).

The non-compliance prompted an investigation to determine the cause of the exceedance in particulates at the stack, and an action plan was completed to rectify the issue. The results from the third stack test came back as compliant providing a learning opportunity for the operational area (see Chapter 11 on permit non-compliances for more information).

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 2019.

Liquid Pitch Incinerator

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 were within permit limits for particulates (Table 5.4).

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. The stack test results were within permit limits for particulates (Table 5.5).

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.

DC12 was not stack sampled in 2019 due to operational and scheduling constraints with the third party stack sampling company. This resulted in a permit non-compliance and more information can be found in chapter 11. The remaining dust collectors were stack sampled and were within permit limits for particulate emissions (Table 5.6).

Pitch Vapour Treatment

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. The results for both the particulates and the PAHs were within permit limits and compliant (Table 5.7).

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 5.8 shows each upset that occurred in 2019.

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 on page 19).

The FTC is required to have the stack tested once a year but due to the permit non-compliance related to particulates on the first stack test it was sampled twice (Table 5.9).

The non-compliance prompted an investigation to determine the cause of the exceedance in particulates at the stack, an action plan was completed to rectify the issue (more information on the non-compliance can be found in chapter 11).

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 are reported on a monthly basis to the Ministry of Environment and Climate Change Strategy. Table 5.10 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.

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 2019 (Table 5.11). These two dust collectors are also monitored for leak detection (Table 5.10).

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.

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 planned 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 5.12 shows each upset that occurred in 2019.

The GTC is monitored on an annual basis as per permit requirements for fluoride, particulates and sulphur dioxide (Table 5.13). 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).

A measurement campaign will be completed in the potroom and at the Gas Treatment Centres to analyse PAHs once the reduction operations has stabilized.

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 are monitored for fluoride gas, fluoride particulates and particulate matter on a bi-monthly basis (14 +/- 3 days) in the 4 reduction potline buildings. 32 continuous samplers (shuttles) and treated air filters (cassettes) are used to conduct the monitoring. Each shuttle also records temperature, air speed, pump flow and sampling time, all of which are used to calculate the emissions for each sampling period.

The reduction roof vent particulate emissions (Figure 5.3) and fluoride 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). In late summer of 2019 it was identified that the changes in operational dynamics was changing the air profile of the potroom buildings and that the current method in place for monitoring the roof vent emissions may no longer be suitable. The situation was presented to the Ministry of Environment and Climate Change Strategy and an extension was granted in November until a new method for reporting is approved.

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 2019 as per permit requirements for (Table 5.14), it will also be monitored for leak detection starting in 2020.

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).

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 2019 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 41 was operated 708 times in 2019 and its emissions can be seen in Table 5.15.

Furnace 42

Furnace 42 was operated 657 times in 2019 and its emissions can be seen in Table 5.15.

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 has have 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 was no leaks detected in 2019.

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. The stack from furnace 62 was stack sampled three times in 2019, twice for routine stack sampling and a third time during the trial for Foundry (Table 5.16). All three stack tests were within expectation, and no additional permit requirements were needed for the Foundry as the stack test results were within expectations.

Furnace 63/64

Furnace 63/64 was stack sampled twice as per permit requirements and the results can be seen in table 5.16.

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 set at 0.9 kg/Mg Al.

In 2019, there were no permit exceedances of the total fluoride emissions permit limit (Figure 5.6).

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. Note this is calculated with 2019 roof vent emissions and 2018 stack test.

A review of the historical data from 2009 to 2019 shows a 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/Mg Al.

During 2019, there were no permit exceedances of particulate emissions permit limit (Figure 5.9).

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 (Figure 5.10).

Particulate emissions from the Gas Treatment Centres accounted for 46.6 percent of total particulate emissions for BC Works in 2019 (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).

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 2019 the monthly average SO_2 emission levels remained below the permit limit (Figure 5.12). Near the end of 2019 the amount of sulphur released per day was reduced as aluminium production decreased leading to a decrease in consumption of raw materials, less coke being calcined, less anodes being baked and less anodes being consumed.

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 5.17.

Greenhouse Gas Emissions

There are a number of sources of greenhouse gas (GHG) emissions at BC Works (Figure 5.14), and operational data from these sources are 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 generally occurs after the submission of this report.

Most GHG emissions are generated through the smelting process (77%) and most smelting-related emissions are attributable to anode consumption (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 (Figure 5.16). Stability disruptions have been increasing since May when challenges with stability of operating pots began to arise. The trend of decreasing stability can be seen in the anode effects duration which continues to increase for the remainder of the year.

BC Works GHG 2019 emissions have been steadily decreasing since 2015 (Figure 5.17) although there has been a slight increase in tonnes of CO_2 equivalent per tonne of aluminium due to the decrease in aluminium production in 2019 with the annual average up from 1.91 in 2018 to 2.11 tonnes of CO_2 equivalent per tonne of aluminium in 2019.

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 2019 BC Works started to report NOx emissions on a monthly basis to the Ministry of Environment and Climate Change Strategy in preparation for the 2020 permit limit to affect in January 2020. The monthly emissions in 2019 were below the assigned permit limit of 1.12 Mg/day for 2020 (Figure 5.18).

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 4 non-compliances (red) related to emissions monitoring in 2019, the remaining monitored discharge points were compliant (green).

Figure 5.3
Reduction Roof Vent Fluoride Total

The roof vent emissions are reported monthly from January – October, an extension was granted for November and December reporting due to changes in potroom dynamics. There is no permit limit associated with reduction roof vent emissions as this data is incorporated with the plant wide fluoride total permit limit.

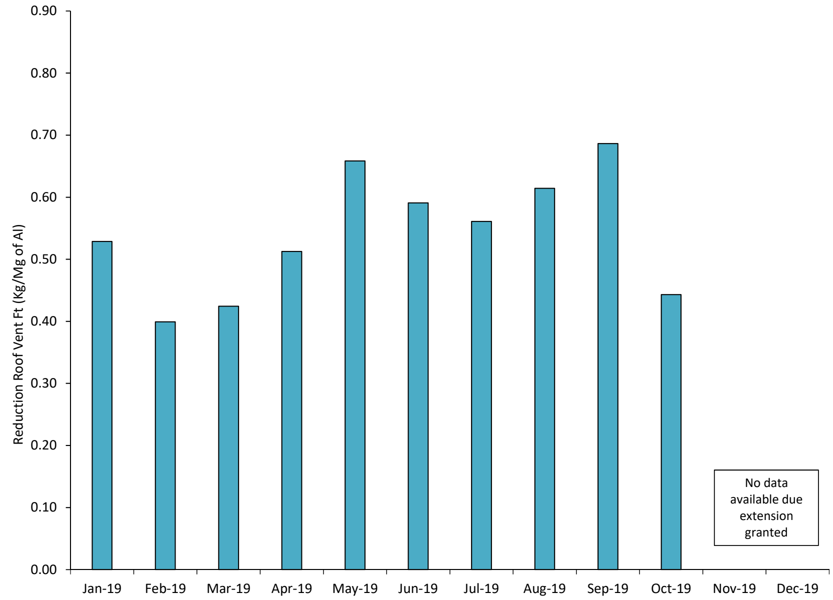


Figure 5.4
Reduction Roof Vent Particulate Emissions

The roof vent emissions are reported monthly from January – October, an extension was granted for November and December reporting due to changes in potroom dynamics. There is no permit limit associated with reduction roof vent emissions as this data is incorporated with the plant wide particulate permit limit.

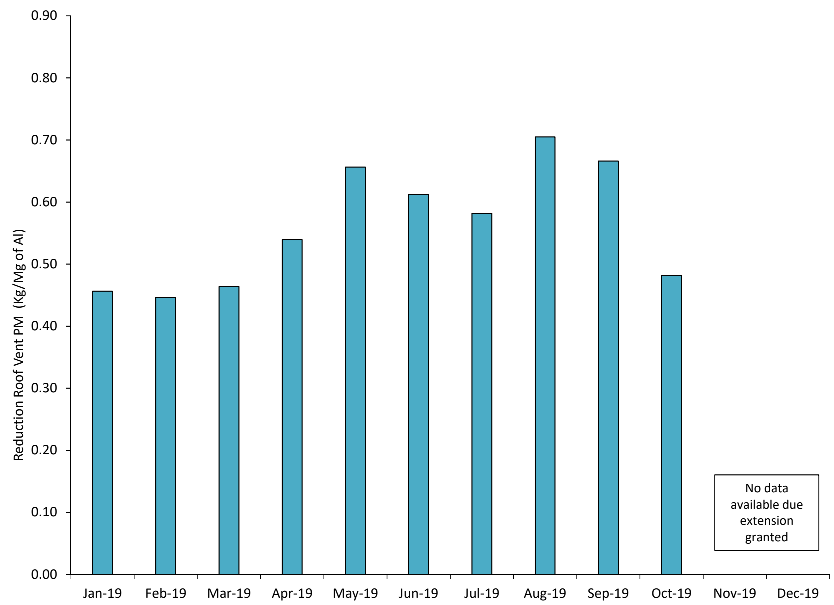
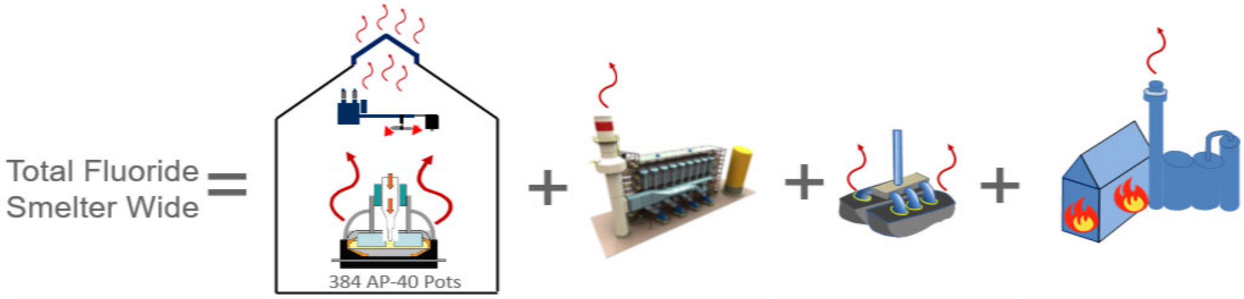


Figure 5.5
Plant Wide Fluoride Total Emissions Calculation

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. Note this is calculated with 2019 roof vent emissions and 2018 stack test.

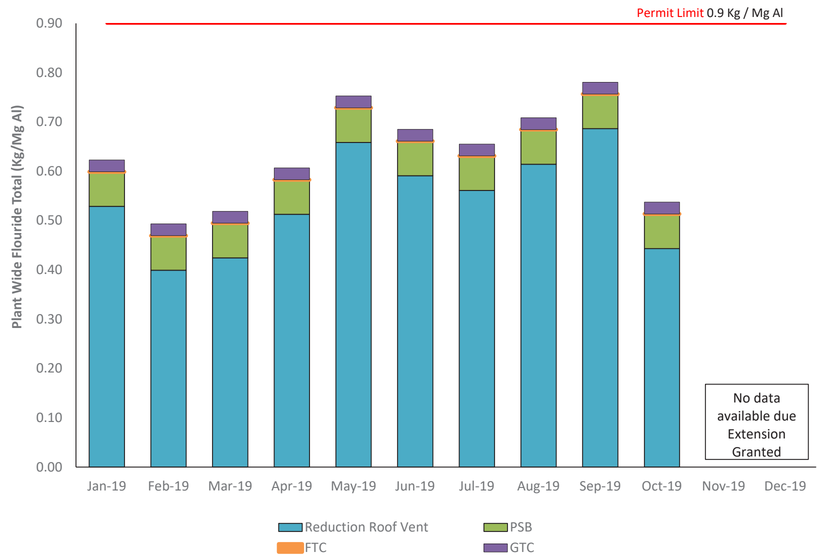


Figure 5.7
Historical Fluoride Total Emissions

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, 2016 and 2019 did not take into account the entire year's monthly data into the average due to data availability.

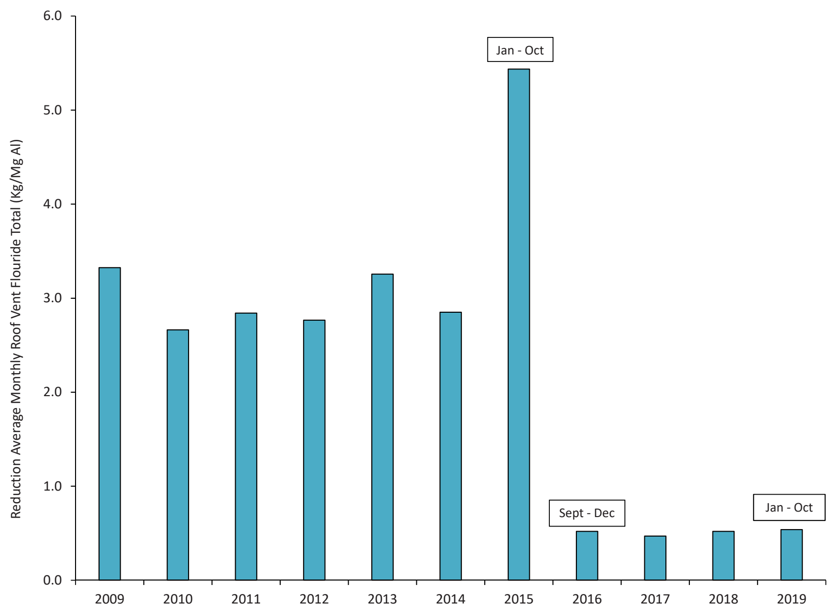
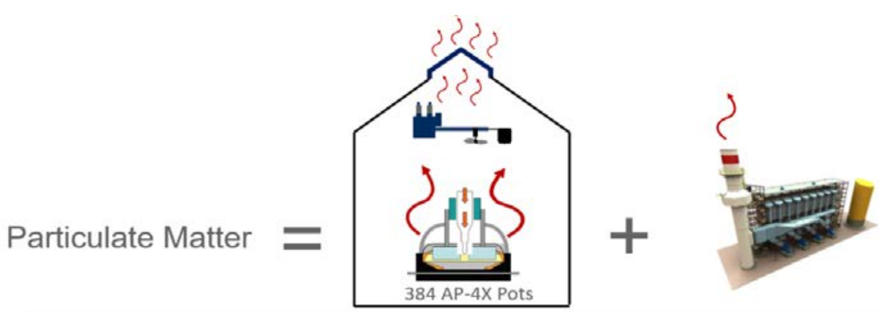


Figure 5.8
Plant Wide Particulate Emissions Calculation

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. Note this is calculated with 2019 roof vent emissions and 2018 stack test.

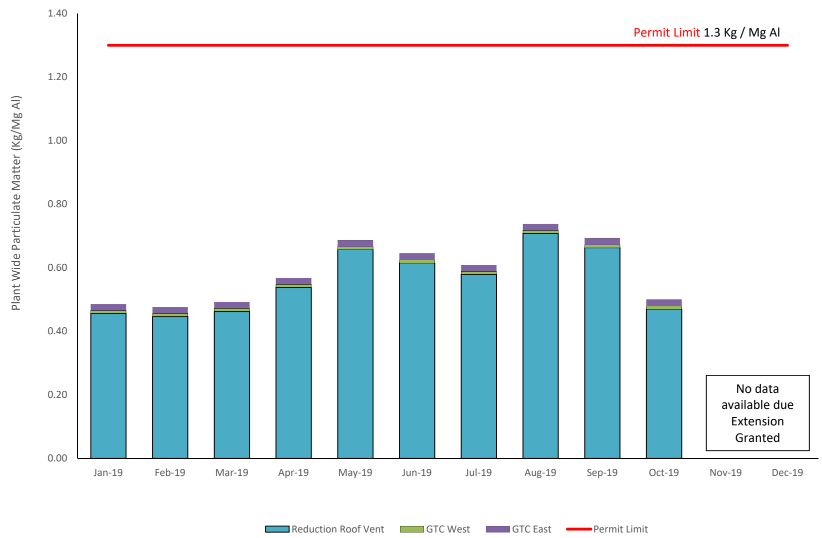


Figure 5.10
Historical Particulate Emissions

The average monthly roof vent emissions for particulates have decreased since 2015 when the VSS smelter was shut down in October. Note years 2015, 2016 and 2019 did not take into account the entire year's monthly data into the average due to data availability.

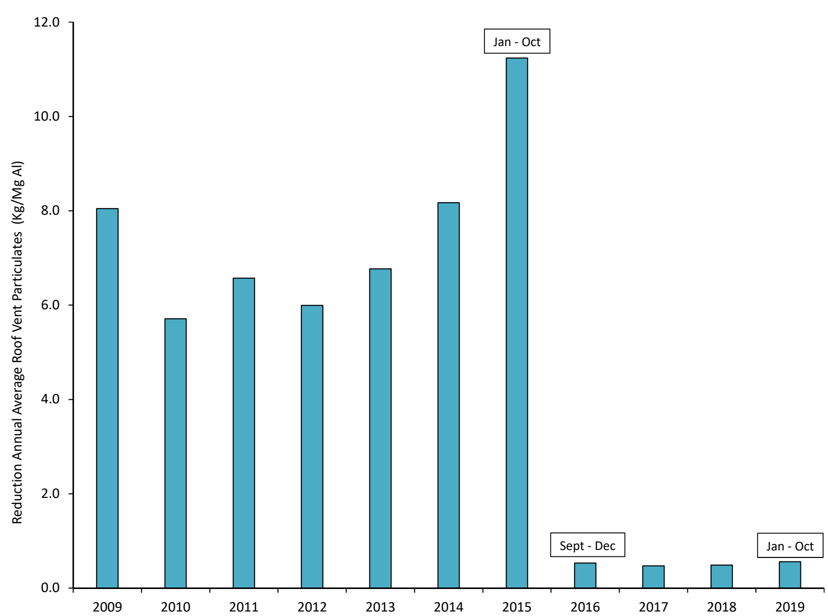


Figure 5.11
Particulate Emissions by Operational Area

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. Note this is calculated with 2019 stack test results.

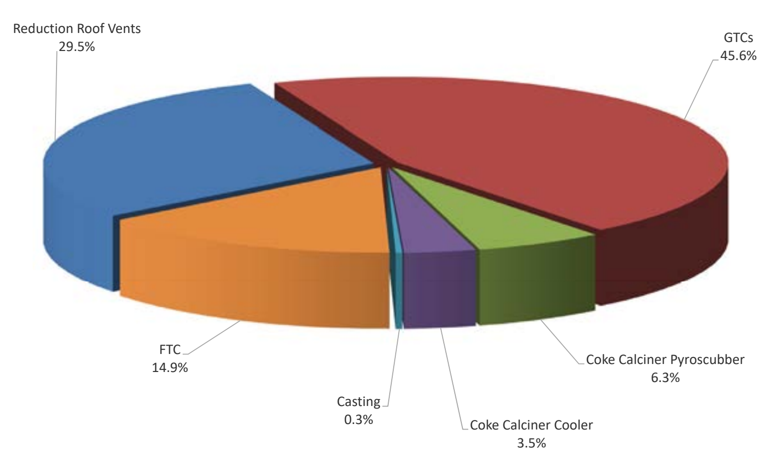


Figure 5.12
Sulphur Dioxide Emissions

Decreases in Sulphur Dioxide emissions started to occur in the Fall as production decreased and consumption of raw materials decreased.

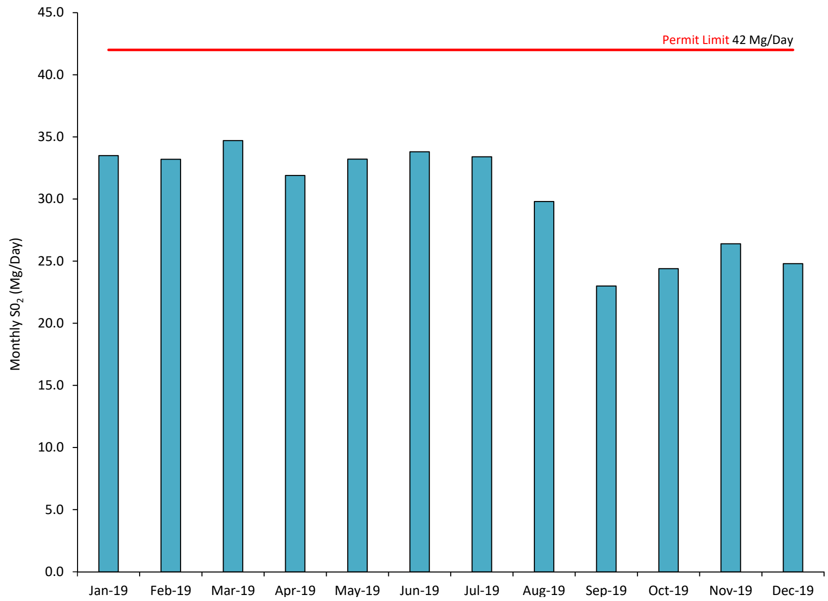


Figure 5.13
Historical Sulphur Dioxide Emissions

Increased in Sulphur Dioxide emissions started to occur in 2017 as the new AP-4X smelter became fully operational.

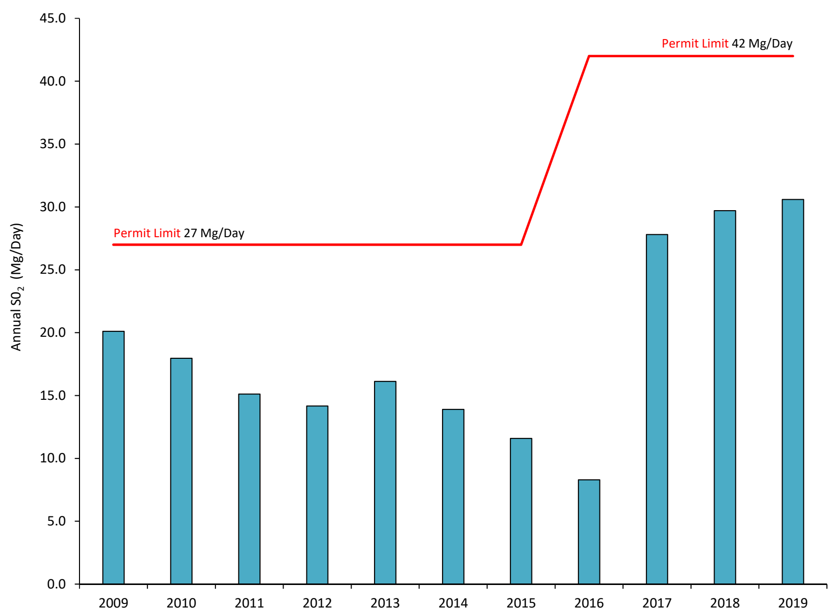
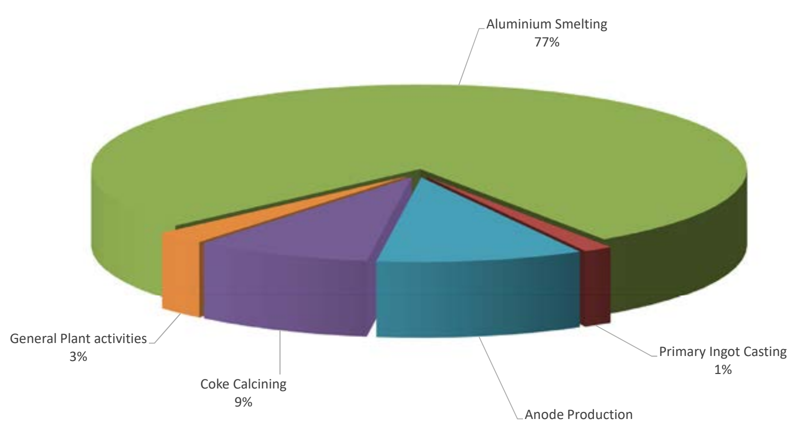


Figure 5.14
Operational sources of GHG Emissions

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



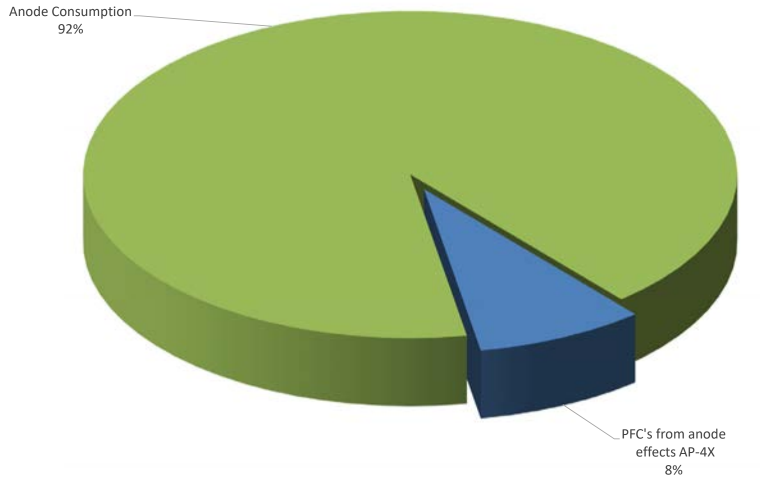


Figure 5.15
GHG Emissions from Aluminium Smelting

The consumption of anodes in the electrolytic process is the main contributor of greenhouse gas emissions, PFC emissions from anode effects make up 8 % of the GHG emissions from aluminium smelting.

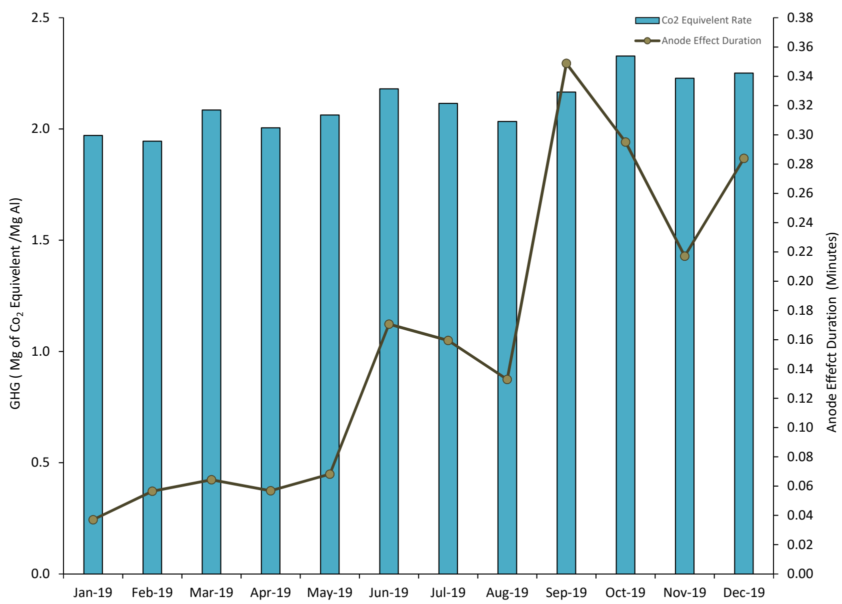


Figure 5.16
Monthly GHG Emissions & Anode Effect Duration

Throughout 2019 the anode effect duration increased as the operations became less stable.

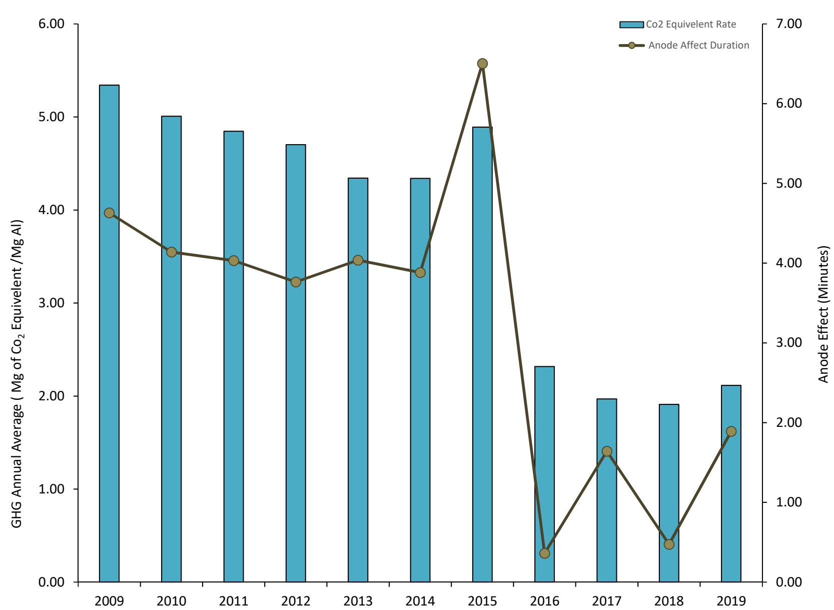


Figure 5.17
Historical GHG Emissions & Anode Effect Duration

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 (2017 and 2018) the emissions were below 2.0 tonnes of CO_2 equivalent per tonne of aluminium and in unstable years (2016 and 2019) the emissions were above 2.0 tonnes of CO_2 equivalent per tonne of aluminium.

Figure 5.18
Monthly Nitrogen Oxide Emissions

Throughout 2019 NOx emission were below the proposed permit limit of 1.12 tonnes per day which will come into effect in January 2020. In September the coke calcination plant shut down, reducing the amount of calcined coke produced and the amount of NOx emissions.

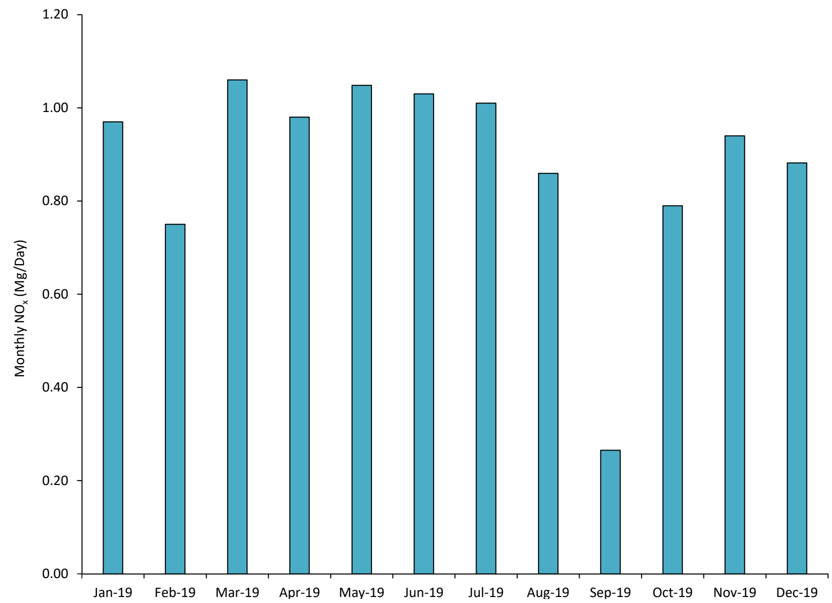


Figure 5.19
Historical Nitrogen Oxide Emissions

Summation of annual NOx emissions from 2009 to 2019.

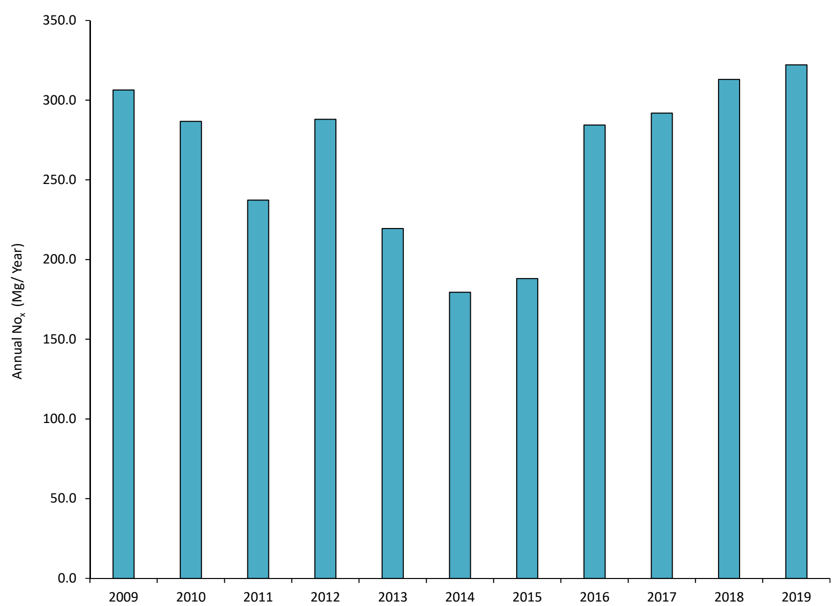


Table 5.1 Carbon South Emission Control Bypass Hours

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
9-Jan-19	FC-3	Approved	3h	Maintenance
11-Feb-19	FC-3	Emergency	10min	Power Outage
11-Apr-19	LPI	Emergency	16h 5 min	Power Outage
15-Apr-19	LPI	Approved	10h	Maintenance
16-Apr-19	LPI	Approved	10h	Maintenance
15-May-19	LPI	Emergency	4h	Power Outage
14-May-19	FC-3	Approved	48h	Maintenance
7-Jul-19	LPI	Emergency	40 min	Power Outage
25-Jul-19	LPI	Approved	2h 15m	Maintenance
11-Sep-19	FC-3	Emergency	3h 15m	Power Outage
11-Sep-19	LPI	Emergency	11h 16m	Power Outage

Table 5.2 Pyroscrubber Biennial Stack Tests

The pyroscrubber stack tests were compliant for particulates during both stack tests in 2019. Emissions were slightly higher in June due to increased feed rate at the kiln (7794 tons compared to 5963 tons of calcined coke produced respectively).

Performance Measure	Pyroscrubber	
Dates	June 19, 2019	Oct. 29, 2019
Particulates (Kg/hr) Permit Limit: 21.1 (Kg/Hr)	7.5	4.5
SO_2 (Kg/hr)	268.2	167
NO_X (Kg/hr)	26.8	19.7

Table 5.3 Cooler Biennial Stack Tests

The cooler stack was sample three times in 2019 as per permit requirements due to the non-compliance (4.8 Kg / hour) of particulates during the October stack test.

Performance Measure	Cooler		
Dates	June 21, 2019	Oct. 16, 2019	Dec. 18, 2019
Particulates (Kg/hr) Permit Limit: 3.9 (Kg/Hr)	2.4	4.8	2.9
SO_2 (Kg/hr)	0.028	0.06	0.036
NO_X (Kg/hr)	0.005	0.03	0.051

Table 5.4 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	Nov. 4, 2019
Particulate Permit Limit: 500 (mg/m^3)	0.6
PAH (mg/m^3)	0.00043

Table 5.5 Stack Tests

The FC-3 incinerator was stack sampled in June and was within permit requirements for particulates.

Performance Measure	FC-3
Date	June 19, 2019
Particulate Permit Limit: 120 (mg/m³)	1.3
PAH (mg/m³)	0.0140

Table 5.6 Anode Paste Plant Dust Collector Stack Tests

The dust collectors were stack sampled and came back as compliant except for DC12 as no data was collected.

Performance Measure	Dust Collectors				
	DC10	DC11	DC12	DC13	DC14
Dates	Aug. 14, 2019	Aug. 22, 2019	*	June 25, 2019	Aug. 18, 2019
Particulate (Kg/hr) Permit Limit: 120 (Kg/hr)	1.3	22.0	*	3.6	1.0

*No Data as stack was not sampled due to logistics.

Table 5.7 PVT Sack Tests

The PVT was stack sampled in June and was within permit requirements for particulates and PAHs.

Performance Measure	PVT
Date	June 23, 2019
Particulate Permit Limit: 30 (mg/m³)	2.0
PAH Kg/Mg Paste) Permit Limit: 0.3 (Kg/Mg Paste)	0.005

Table 5.8 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
16-Jan-19	Mode 2	Emergency	15 min	Communication error with sensor
23-Jan-19	Mode 3	Emergency	12 min	Cooling tower temperature
6-Feb-19	Mode 2	Emergency	35 min	Cooling tower fault
15-Feb-19	Mode 2	Emergency	15m	Process upset regarding draft pressure
27-Mar-19	Mode 2	Approved	6h 16 min	Maintenance
17-Apr-19	Mode 2	Emergency	46 min	Cooling tower fault
17-Apr-19	Mode 2	Emergency	21 min	Cooling tower fault
19-Jun-19	Mode 2	Approved	9h 9 min	Maintenance
7-Jul-19	Mode 4	Emergency	2h 14 min	Power outage
28-Aug-19	Mode 2	Approved	5h 42 min	Maintenance
11-Sep-19	Mode 4	Emergency	3h 14 min	Power outage
8-Oct-19	Mode 2, 3, 4	Approved	15h 52 min	Maintenance
18-Nov-19	Mode 3	Emergency	55 min	Loss of communication
22-Nov-19	Mode 2	Emergency	29 min	Sensor tripped

Table 5.9 Fume Treatment Center Stack Test

The FTC was stack sampled twice due to the particulate permit limit exceedance during the October stack test.

Performance Measure	FTC	
Dates	Oct. 25, 2019	Dec. 18, 2019
Particulate (Kg/Mg of baked anode) Permit Limit: 0.3 Kg/ Mg of baked An.	1.02	0.046
PAH (Kg/Mg of baked anode) Permit Limit: 0.05 Kg/ Mg of baked An.	0.00040	NA
Particulate Fluoride (mg/m^3)	NA	0.032
Gaseous Fluoride (mg/m^3)	NA	0.143
Fluoride Total (Kg/Mg Aluminium) Permit Limit: Included in Plant Wide limit	NA	0.0006
SO_2 (Kg/hr)	42	37.9
NOx (Kg/hr)	9.9	8.9

NA: Not Applicable

Table 5.10 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. The leaks were started to be reported in June once the monitoring equipment was set up for reporting.

	Number of Leaks Detected					
Emissions control device	July	Aug.	Sep.	Oct.	Nov.	Dec.
Anode Rodding Shop 5610-DCB-001	1	0	1	0	0	1
Anode Rodding Shop 5610-DCB-003	5	4	1	0	0	0
Carbon Recycling 5810-DCB-001	3	1	2	1	2	0
Bath treatment and storage 5710-DCB-001	0	2	0	1	0	0
Bath treatment and storage 5710-DCB-003	0	0	0	0	0	0

Table 5.11 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	Aug. 13, 2019	Aug. 12, 2019
Particulate Emissions (mg/m^3) Permit Limit: 30 (mg/m^3)	0.5	0.7

Table 5.12 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	Bypass Type	Duration	Cause
6-Feb-19	East	No Feed	Approved	6h 10 min	Airlift cleaning maintenance
7-Feb-19	West	No Feed	Approved	6h 29 min	Airlift cleaning maintenance
12-Mar-19	West	No Feed	Emergency	5h 44 min	plugged air-slides
17-Apr-19	West	No Feed	Emergency	4h 40 min	plugged air-slides
15-May-19	East	No Feed	Approved	5h 30 min	Airlift cleaning maintenance
16-May-19	West	No Feed	Approved	4h 45 min	Airlift cleaning maintenance
7-Jul-19	East	No Feed	Emergency	9h 14 min	Power Outage
7-Jul-19	West	No Feed	Emergency	7h 19 min	Power Outage
7-Jul-19	East	No exhaust	Emergency	1h 35 min	Power Outage
7-Jul-19	West	No exhaust	Emergency	1h 39 min	Power Outage
16-Jul-19	East	No Feed	Emergency	4h 35 min	Equipment failure
21-Aug-19	East	No Feed	Approved	5h 15 min	Airlift cleaning maintenance
22-Aug-19	West	No Feed	Approved	6h 15 min	Airlift cleaning maintenance
11-Sep-19	East	No exhaust	Emergency	3h 25 min	Power Outage
11-Sep-19	East	No Feed	Emergency	3h 20 min	Power Outage
11-Sep-19	West	No exhaust	Emergency	3h 30 min	Power Outage
11-Sep-19	West	No Feed	Emergency	7h 30 min	Power Outage
10-Oct-19	West	No Feed	Emergency	5h	PLC communication loss
10-Oct-19	West	No Feed	Emergency	14h 30 min	PLC communication loss
11-Dec-19	East	No Feed	Approved	5h 50 min	Airlift cleaning maintenance
12-Dec-19	West	No Feed	Approved	5h 55 min	Airlift cleaning maintenance

Table 5.13 Gas treatment center Stack Test

Both GTCs are stack sampled and the results for particulates and fluoride total are used in the plant wide permit limits (1.3 kg / Mg Al and 0.09 kg/ Mg Al respectively). Particulates were higher in the GTC East due to a bag pulsing operation.

Performance Measures	GTC East	GTC West
Dates	Oct. 31, 2019	Nov. 1, 2019
Particulates (mg/m^3)	4.1	1.7
Particulates (Kg/ Mg of Aluminium) Permit Limit: Included in Plant Wide limit	0.67	0.19
Particulate Fluoride (mg/m^3)	0.15	0.11
Gaseous Fluoride (mg/m^3)	1.27	1.22
Fluoride Total (Kg/Mg of Aluminium) Permit Limit: Included in Plant Wide limit	0.23	0.15
Sulphur Dioxide (mg/m^3)	138.9	191.3

Table 5.14 Delining Stack Test

The 4421-DCB-001 dust collector had its first stack test completed in 2019.

Performance Measure	4421-DCB-001
Date	Nov. 11, 2019
Particulates (mg/m^3) Permit Limit: 10 (mg/m^3)	0.4

Table 5.15 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	Aug. 12, 2019	Oct. 22, 2019	Aug. 13, 2019	Oct. 22, 2019
NOx (Kg/hr)	0.01	0.58	0.30	0.16
Chloride (Kg/hr)	0.03	0.04	0.04	0.06
Chlorine (Kg/hr)	1.1	1.5	1.1	1.1
Particulate (Kg/hr)	0.8	1.1	0.54	1.4

Table 5.16 C Casting - Bi-Annual Stack Test

The stack tests were completed as per permit requirements for both stacks.

Performance Measure	C Casting				
	Furnace 62			Furnace 63-64	
Dates	Aug. 9, 2019	Oct. 21, 2019	Oct. 24, 2019*	Aug. 8, 2019	Oct. 21, 2019
NOx (Kg/hr)	0.012	0.09	0.2	0.06	0.018
Particulate (Kg/hr)	0.011	0.13	0.315	0.04	0.04
Chloride (Kg/hr)	NA	NA	<0.022	NA	NA
Chlorine (Kg/hr)	NA	NA	0.57	NA	NA

NA: Not Applicable
*Foundry Alloy stack test trial

Table 5.17 Plant Wide - Natural Gas Consumption and Associated Emissions 2019

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

Year	Natural Gas Consumption m^3/yr	Associated Emissions (tons/year)			
		Nitrogen Oxides	Total Particulates	Sulphur Dioxide	Carbon Monoxide
2008	25,931,400	41.49	3.15	0.25	34.85
2009	24,013,100	38.42	2.92	0.23	32.27
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

6. Air quality monitoring

BC Works conducts continuous ambient air quality monitoring at four 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 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 (AQHI) 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.

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 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 are presented.

Table 6.1
Ambient Air Monitoring Network

Ambient Air Network	Haul Road (HR)	Riverlodge (RL)	Whitesail (WS)	Kitamaat Village (KV)	Yacht Club (YC)	Lakelse Lake (LL)
Sulphur Dioxide (SO_2)	✔	✔	✔	✔		
Particulates ($PM_{2.5}$)	✔	✔	✔	✔		
Particulates (PM_{10})		✔				
Hydrogen Fluoride (HF)	✔	✔		✔		
Nitrous Oxides (NO_x)			✔			
Ozone (O_3)			✔			
AQHI Plus			✔			
Rain Chemistry	✔					✔
Meteoroidal Monitoring	✔	✔	✔	✔	✔	

Weather monitoring

Two new meteorological stations became operational in 2011, one at the Kitamaat Village station and the other at the Yacht Club located at the south end of the plant site. Each station measures temperature, wind direction and wind speed. Additionally, the Kitimat Smelter Road Station measures relative humidity.

The 2013 upgraded meteorological and weather monitoring data control program operated by BC Works is carried out to meet Ministry standards. In the event that air quality monitoring data indicate a problem on a particular date, weather data can provide insight into pollutant sources and other contributing factors. The upgraded meteorological installations at the ambient air quality monitoring stations go beyond the two weather station requirements in the P2 permit.

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 criteria 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 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).

2019 monitoring results

Ambient air quality monitoring for all results stations and parameters are presented in Table 6.2. This summary table has been changed from the previous Annual Environmental Reports, to include summary statistics for the reporting year in addition to comparisons against the BC Air Quality Monitoring Objectives (AQO).

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 very low (less than 1 ppb).

Sulphur dioxide (SO_2)

SO_2 is monitored at three residential stations (Riverlodge, Whitesail and Kitamaat Village) in addition to the Industrial Haul Road station. The P2 permit requires the reporting on hourly daily maximums and monthly averages. A summary of the 2018 monitoring results are provided in Table 6.2 and monthly means are shown in Figure 6.3. Beyond the required P2 permit reporting, the daily hourly averages for 2019 for all four stations are presented in Figure 6.4. Additionally the summary statistics in Table 6.2 include the percentile results for comparison to the 2017 adopted Provincial SO_2 Interim Air Quality Objective. In comparison to the new interim SO_2 air quality objective of 75 ppb (that came into effect in 2017), Riverlodge had the highest value but was only 24% of the BC air quality objective. SO_2 levels in the form of the BC AQO have increased over 2018's values due to the SO_2 interim AQO's escalating schedule of annual percentiles and having three years of full smelter production captured in the three year averaging period. In 2020, the BC AQO will use the SO_2 Canadian Ambient Air Quality Standards (CAAQS), which will be the 3 year average of the 99^{th} percentile 1 hour daily maximum evaluated at 70 ppb.

The residential maximum hourly average SO_2 concentrations shown in Table 6.2 ranged from 43.6 ppb to 73.3 ppb. There were no days in 2019 where the residential SO_2 hourly concentrations were above 75 ppb. Figure 6.4 shows the plots of hourly average SO_2 concentrations. Compiled annual SO_2 monitoring data are provided in Table 6.2. The maximum residential annual average SO_2 concentration was 0.5 ppb.

SO_2 hourly monitoring data from the Lakelse Lake deposition station is presented in figure 6.4 E. Average SO_2 hourly concentrations for 2019 was 0.6 ppb with a maximum hourly concentration of 9.4 ppb. The Lakelse Lake deposition station was established for BC Works SO_2 Environmental Effects Monitoring Program for the purpose of estimating deposition of sulphate in the Kitimat Valley. In addition to measuring ambient SO_2 concentrations, this station also collects precipitation chemistry samples (presented in the rain chemistry section).

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

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 particulate emissions.

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 objectives define the 24 hour average for PM_{10} as 50 micrograms per cubic metre ($\mu g/m^3$) and the 98th percentile of the daily average over 1 year for PM2.5 is 25 ug/m^3.

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 6.5 and 6.6. Average residential $PM_{2.5}$ levels for Kitimat are low, ranging between 4.1 ug/m^3 to 4.5 ug/m^3. Residential stations were below the BC AQO for $PM_{2.5}$ in 2019, however there were episodes of elevated $PM_{2.5}$ levels associated with third party open burning activities.

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. Peak AQHI-Plus levels of Moderate to High were measured in March, April May and September, and were related to third party open burning. 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 BC Works generate PAHs, in both dissolved and gaseous forms. They occur in emissions primarily as a by-product of the anode manufacturing process; other sources include vehicle exhaust and smoke from forest fires and wood-burning stoves.

Ambient air monitoring is conducted to test for the presence of some of the most common PAHs, although no permit limits exist. Sampling is done on a schedule that is coordinated with the National Air Pollution Surveillance (NAPS) to enable comparison of findings from different monitoring sites. The P2 permit requires the monitoring of 15 PAH congeners.

The 2019 ambient PAH monitoring results are summarized in Table 6.4. The geometric mean PAH concentration observed at Haul Road station was 7.7 ng/m^3, Whitesail station was 4.5 ng/m^3 and Kitimat Village was 3.7 ng/m^3. In 2019, total PAHs showed a reduced degree of variability (Figure 6.9) when compared to previous years. This is due to the significant reductions in PAH emissions by the modernised smelter.

Figure 6.9 shows the distribution of the 15 PAH congeners for the three stations. 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 stations. Rain chemistry monitoring has been conducted since 2000 and was expanded to include Lakelse Lake in 2013. Rainfall quantity is recorded. Samples are assessed for rain acidity and concentrations of 11 specific substances. Annual averages of weekly samples and the geometric mean measures are presented in Table 6.5. High levels of acidity (i.e. a low pH) and concentrations of certain substances are characteristic of the condition referred to as ‘acid rain’. Long-term vegetation monitoring (refer to Chapter 7 – Vegetation monitoring) in the Kitimat valley has confirmed an absence of this type of damage.

Table 6.2

2019 Ambient Air Quality Monitoring Results

Statistic	Industrial	Residential		
	Haul Road	Riverlodge	Whitesail	Kitamaat Village
	SO_2			
Annual average (ppb)	4.8	0.6	0.7	0.4
BC AQO for SO_2*		24.4	16.4	10.7
Days above 75 ppb (hourly)		0	0	0
Minimum (hourly, ppb)	0	0	0	0
Maximum (hourly, ppb)	87.4	66.6	43.6	73.3
Percent Data Capture (%)	95	95	94	95
Standard Deviation (ppb)	4.3	2.6	2.5	2.5
	$PM_{2.5}$			
Annual average (ug/m^3)	7.1	4.5	7.1	4.1
BC AQO for $PM_{2.5}$		10.8	10.3	10.5
Days above 25 ug/m^3		0	0	0
Minimum (hourly, ug/m^3)	0	0	0	0
Maximum (hourly, ug/m^3)	123	153	65	55
Maximum daily average (ug/m^3)	31	24.1	19.9	16.8
Percent Data Capture (%)	98	98	98	89
Standard Deviation (ug/m^3)	4.3	2.6	2.5	2.5
	PM_{10}			
Annual average (ug/m^3)		8.9		
Minimum (hourly, ug/m^3)		0		
Maximum (hourly, ug/m^3)		36.3		
Maximum daily average (ug/m^3)		180		
Days above 50 ug/m^3		0		
Percent Data Capture (%)		98		
Standard Deviation (ug/m^3)		4.4		
	HF			
Annual average (ppb)		0.1		
Minimum (hourly, ppb)		0		
Maximum (hourly, ppb)		0.9		
Days above 1ppm (hourly)		0		
Percent Data Capture (%)		100		
Standard Deviation (ppb)		0.1		
	NO_x			
Annual average (ppb)			1.6	
Minimum (hourly, ppb)			0	
Maximum (hourly, ppb)			14.0	
Percent Data Capture (%)			91	
Standard Deviation (ppb)			1.5	
	O_3			
Annual average (ppb)			20.3	
Minimum (hourly, ppb)			0	
Maximum (hourly, ppb)			50.0	
Percent Data Capture (%)			93	
Standard Deviation (ppb)			10.6	

*2019 BC Ambient Air Quality Objective (AAQO) for SO_2 is the 3 year average of the 98th percentile of the annual 1 hour daily maximum

** Annual BC Air quality objective for PM2.5 is the 98th percentile of the 24 hour average over one year.

Table 6.3
Air Quality Health Index Plus (AQHI +)

	AQHI +	
Month	**Average**	**Maximum**
January	1 LOW	2 LOW
February	2 LOW	3 LOW
March	2 LOW	7 HIGH
April	2 LOW	4 MODERATE
May	2 LOW	5 MODERATE
June	1 LOW	2 LOW
July	1 LOW	2 LOW
August	1 LOW	2 LOW
September	1 LOW	5 MODERATE
October	1 LOW	2 LOW
November	1 LOW	3 LOW
December	1 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 (2017, 2018 and 2019)

	15 PAH Geomean (ng/m^3)			2019 15 PAH Statistics (ng/m^3)		
Station	**2017**	**2018**	**2019**	**Min**	**Max**	**Standard Deviation**
Haul Road	9.5	7.9	7.7	1.6	63.1	9.0
Whitesail	3.3	3.1	4.5	1.2	30.9	30.9
Kitimat Village	5.2	4.0	3.7	1.4	14.3	2.8

Table 6.5

Rain chemistry monitoring (2016 to 2019)

			Haul Road				Lakelse Lake			
Year			2016	2017	2018	2019	2016	2017	2018	2019
Important Milestones / Parameter			AP4X Last	AP4X Last	Smelter stabilization	Normal operations	AP4X Last	Smelter stabilization	Smelter stabilization	Normal operations
Precipitation	Precipitation Depth	Total	1700	2467	2467	2005	1661	1506	979	1236
Acidity	Rain (pH)	average	4.4	4.6	4.6	4.3	5.0	4.9	4.9	4.8
		geomean	4.4	4.5	4.5	4.3	5.0	4.9	4.9	4.8
	Acidity (to pH 8.3) $CaCO_3$ (mg/L)	average	3.4	4.0	4.0	4.5	1.0	2.1	0.5	0.9
		geomean	2.5	3.4	3.4	3.6	1.0	1.2	0.5	0.6
	Acidity - Free (µeq/L)	average	27.8	21.0	21.0	33.7	5.4	7.6	1.2	16.2
		geomean	13.6	10.5	10.5	22.9	3.1	5.1	1.2	11.0
	Alkalinity - Total $CaCO_3$ (mg/L)	average	0.9	1.1	1.1	0.3	0.8	0.9	0.1	0.4
		geomean	0.8	1.0	1.0	0.3	0.8	0.9	0.0	0.3
Concentration of Specific Substances (mg/L)	Chloride (Cl)	average	0.5	0.3	0.3	0.3	0.1	0.1	0.2	0.2
		geomean	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1
	Fluoride (F)	average	0.8	0.6	0.6	0.8	0.02	0.11	0.01	0.10
		geomean	0.5	0.4	0.4	0.6	0.02	0.02	0.01	0.02
	Sulphate (SO_4)	average	1.9	1.8	1.8	2.6	0.56	0.55	0.74	1.1
		geomean	1.3	1.4	1.4	2.1	0.37	0.37	0.45	0.53
	Ammonia Nitrogen (NH_4)	average	0.07	0.06	0.06	0.06	0.02	0.03	0.05	0.10
		geomean	0.03	0.0	0.0	0.04	0.01	0.02	0.02	0.02
	Nitrate Nitrogen (NO_3)	average	0.27	0.17	0.17	0.23	0.17	0.17	0.31	0.4
		geomean	0.16	0.13	0.13	0.16	0.13	0.13	0.18	0.19
	Total Dissolved Phosphate (PO_4)	average	0.01	0.03	0.03	0.03	0.01	0.00	0.00	0.03
		geomean	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
	Aluminium (D-Al)	average	0.11	0.17	0.17	0.21	0.02	0.03	0.00	0.18
		geomean	0.07	0.11	0.11	0.14	0.01	0.01	0.00	0.00
	Calcium (D-Ca)	average	0.09	0.14	0.14	0.16	0.04	0.03	0.07	0.05
		geomean	0.06	0.06	0.06	0.09	0.03	0.02	0.04	0.03
	Magnesium (D-Mg)	average	0.03	0.03	0.03	0.03	0.01	0.01	0.02	0.01
		geomean	0.02	0.03	0.03	0.02	0.01	0.01	0.01	0.01
	Potassium (D-K)	average	0.02	0.08	0.08	0.05	0.02	0.01	0.02	0.04
		geomean	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01
	Sodium (D-Na)	average	0.35	0.27	0.27	0.34	0.06	0.06	0.10	0.07
		geomean	0.23	0.20	0.20	0.27	0.04	0.03	0.04	0.05

Figure 6.1

Location of Ambient Air Monitoring Stations in the Kitimat Valley.

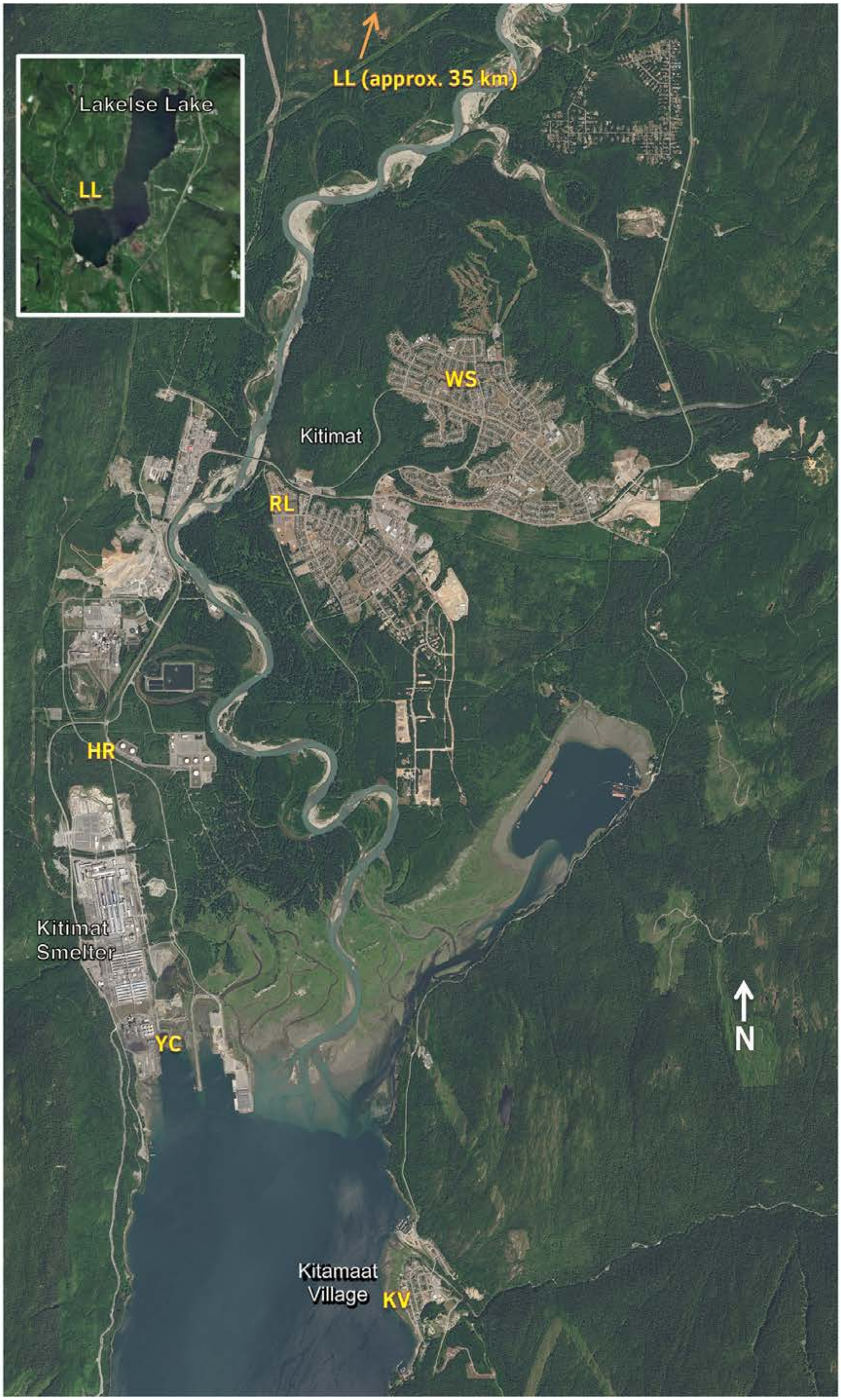


Figure 6.2

Hydrogen Fluoride Monthly Average Concentrations

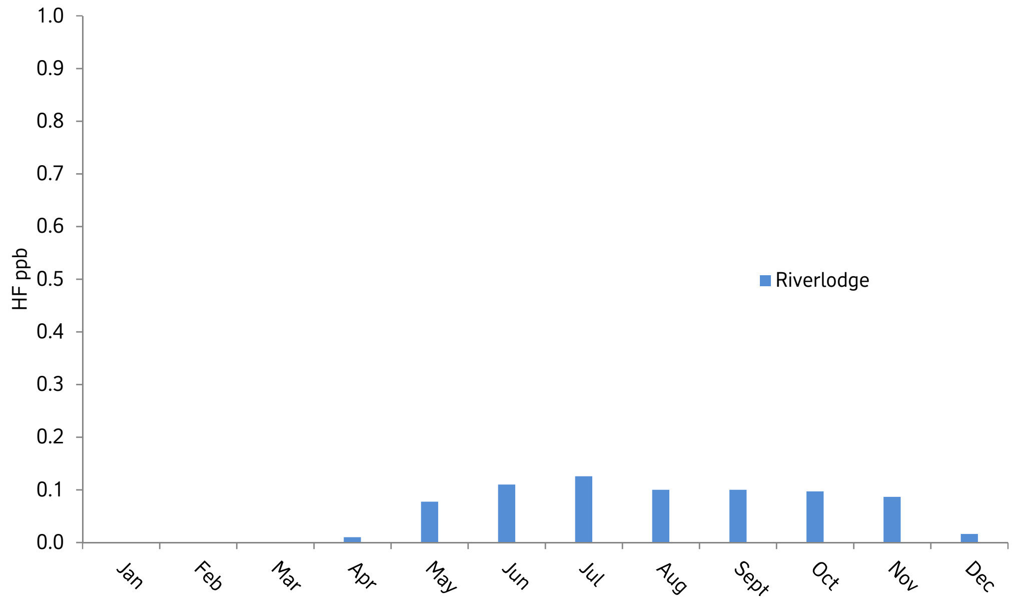


Figure 6.3a

SO_2 Residential Monthly Average Concentrations

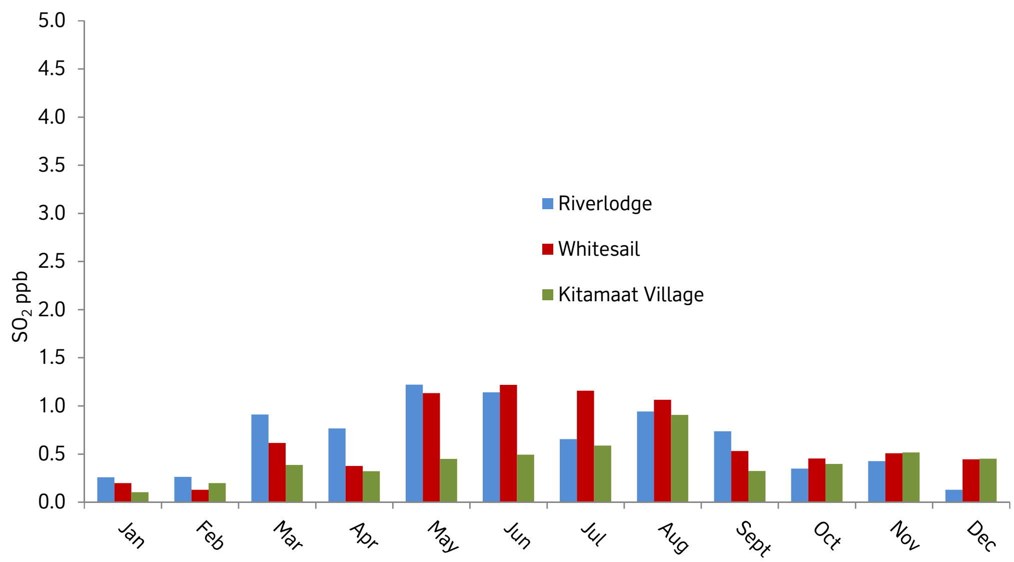


Figure 6.3b

SO_2 Haul Road Monthly Average Concentrations

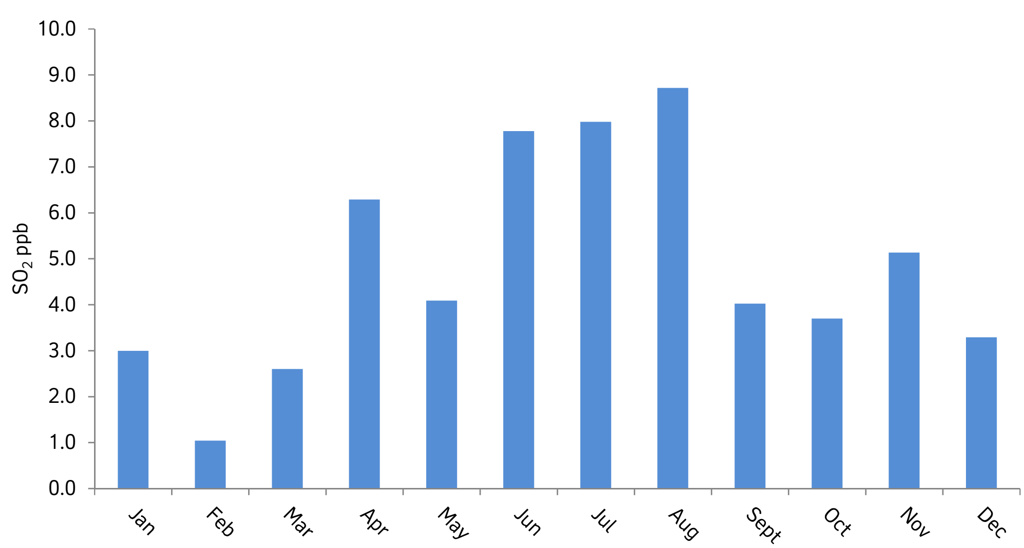


Figure 6.4a

Haul Road 2019 Hourly SO_2 Concentrations

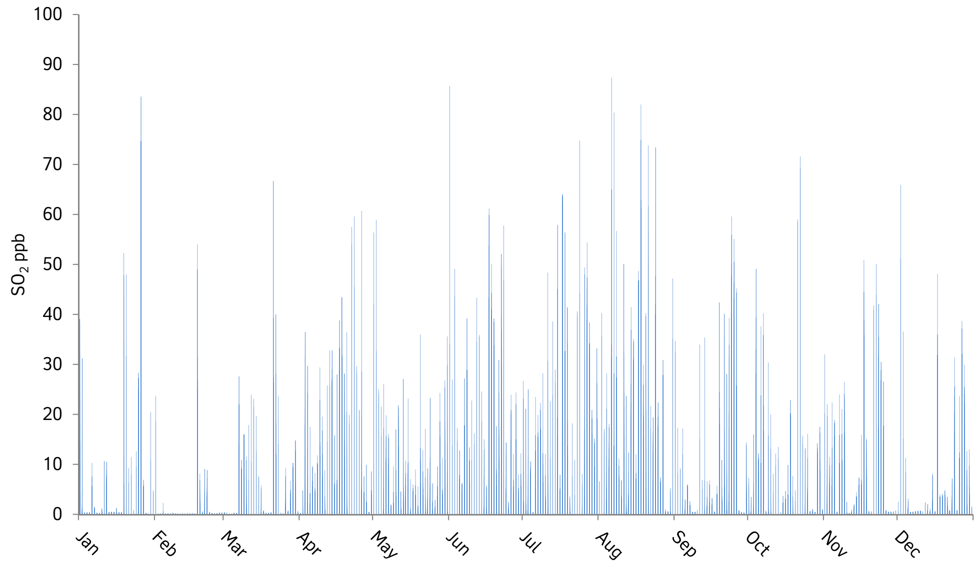


Figure 6.4b

Riverlodge 2019 Hourly SO_2 Concentrations

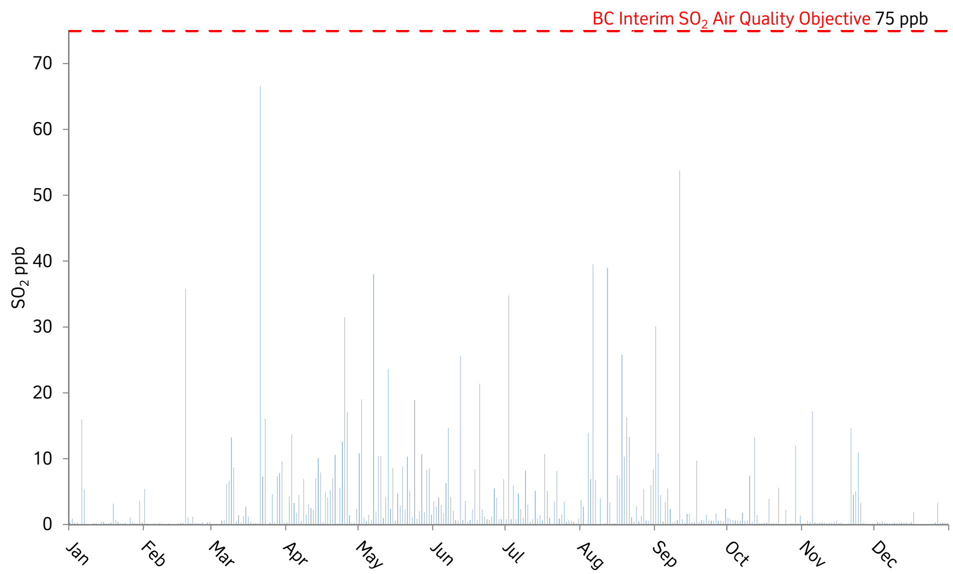


Figure 6.4c

Whitesail 2019 Hourly SO_2 Concentrations

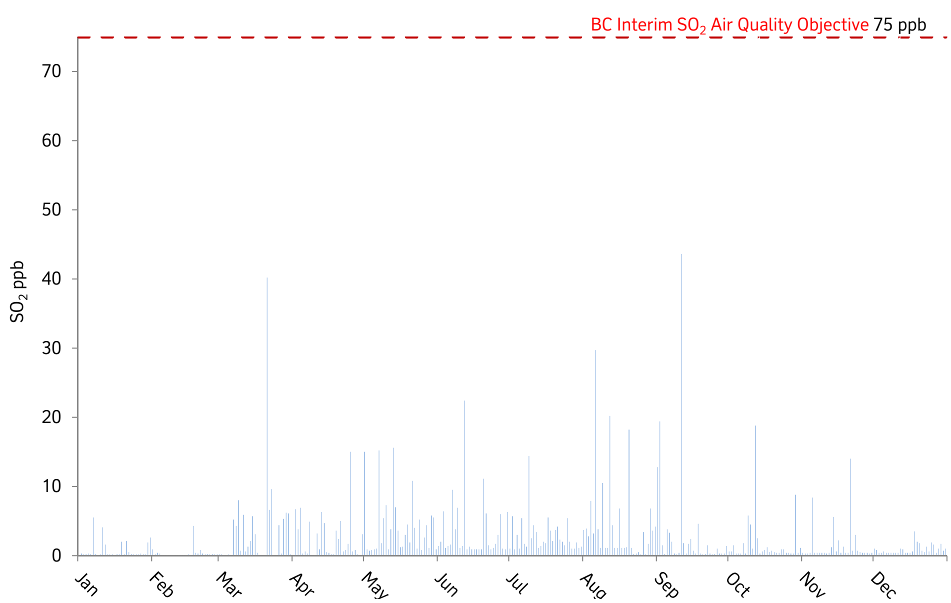


Figure 6.4d

Kitamaat Village 2019 Hourly SO_2 Concentrations

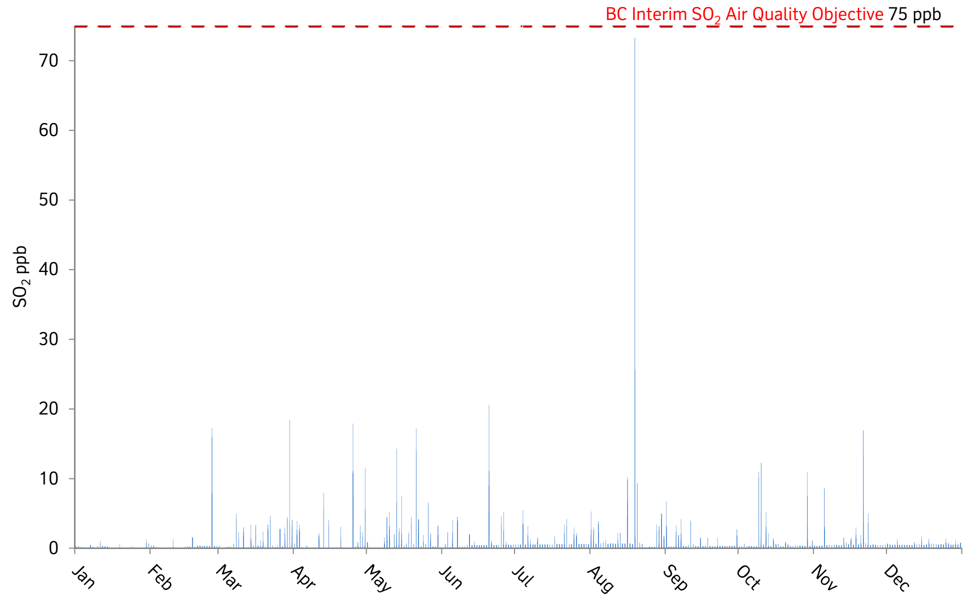


Figure 6.4e

Lakesle Lake Desposition Station 2019 Hourly SO_2 Concentrations

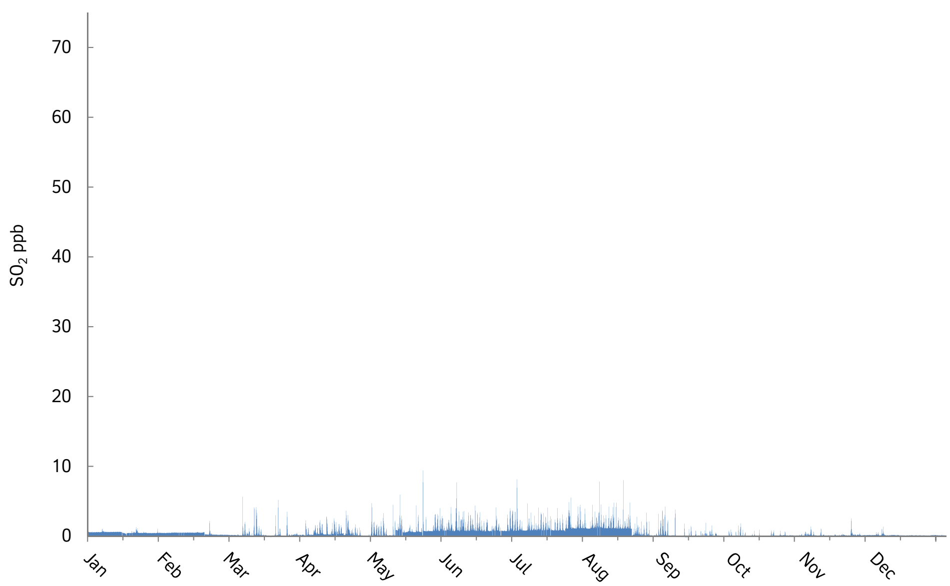


Figure 6.5a

Haul Road $PM_{2.5}$ 2019 Daily Average

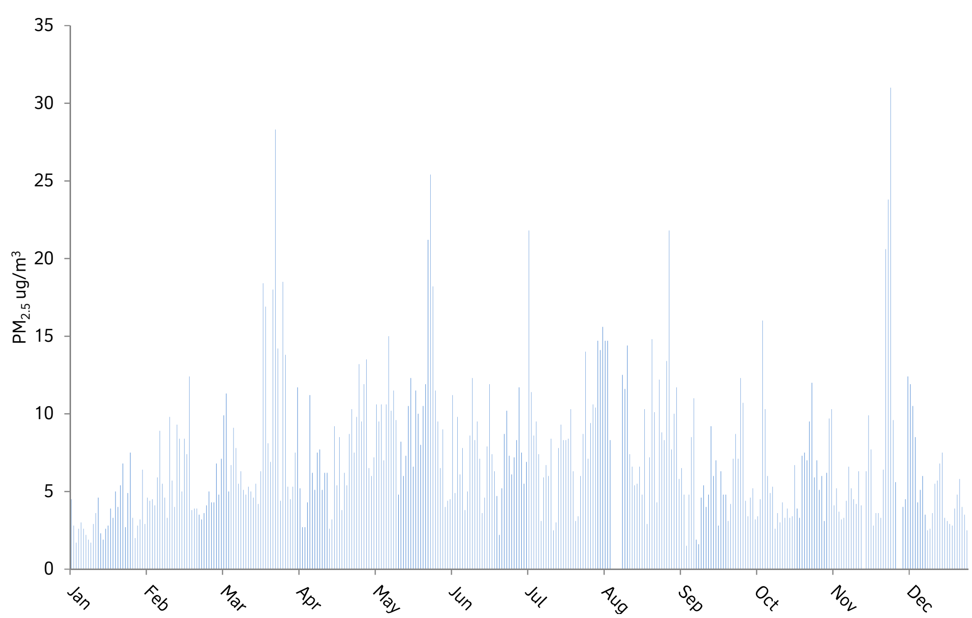


Figure 6.5b

Riverlodge
2019 $PM_{2.5}$
Daily Average

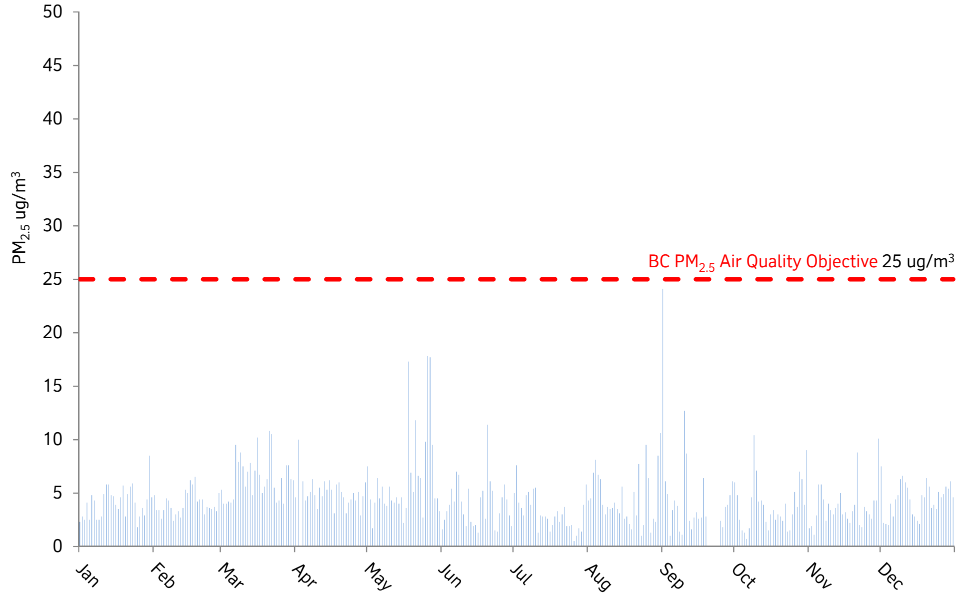


Figure 6.5c

Whitesail
2019 $PM_{2.5}$
Daily Average

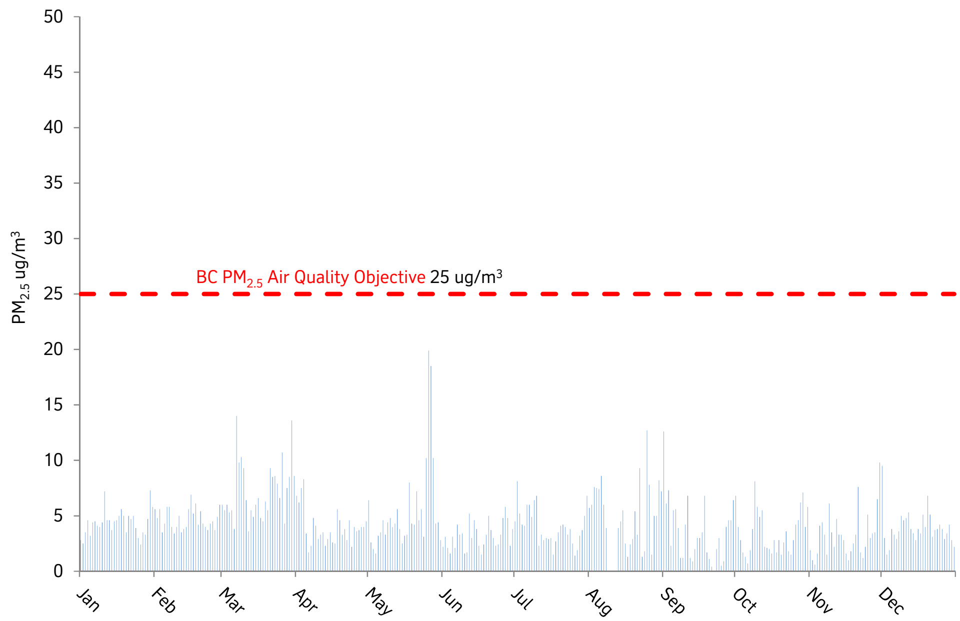


Figure 6.5d

Kitamaat Village
2019 $PM_{2.5}$
Daily Average

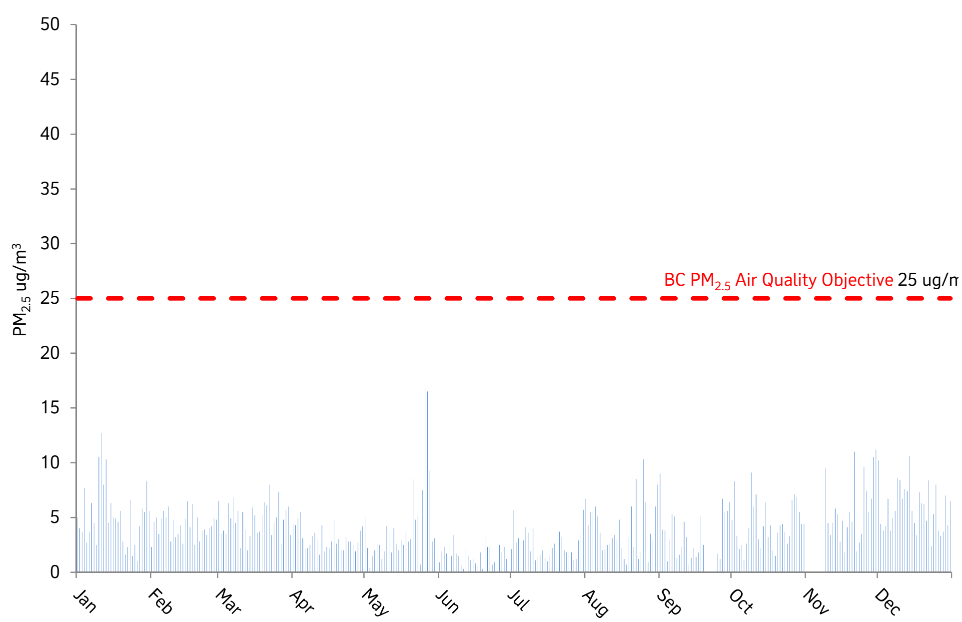


Figure 6.6

Riverlodge
2019 PM_{10}
Daily Average

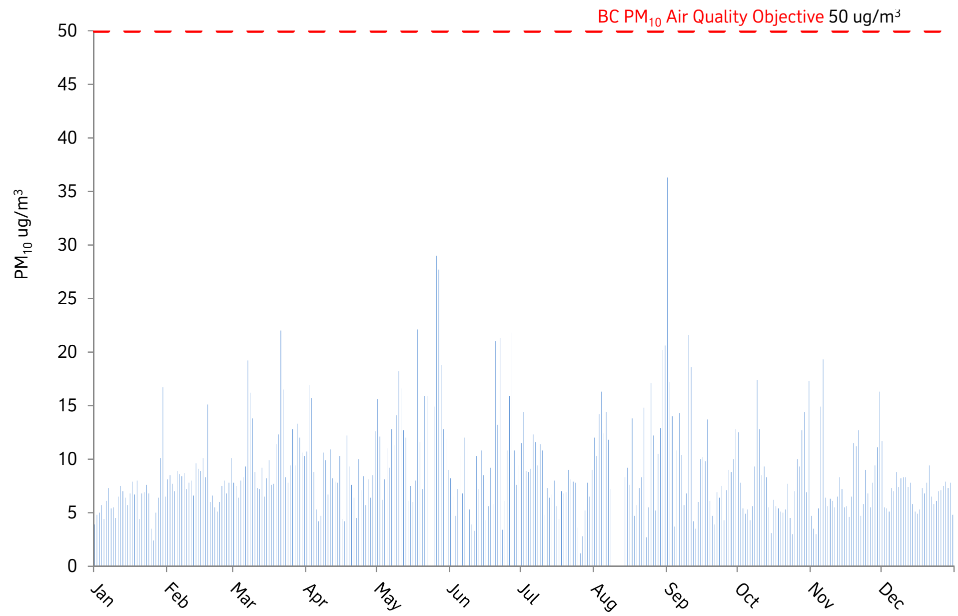


Figure 6.7

Whitesail 2019
NO_2 Hourly
Concentrations

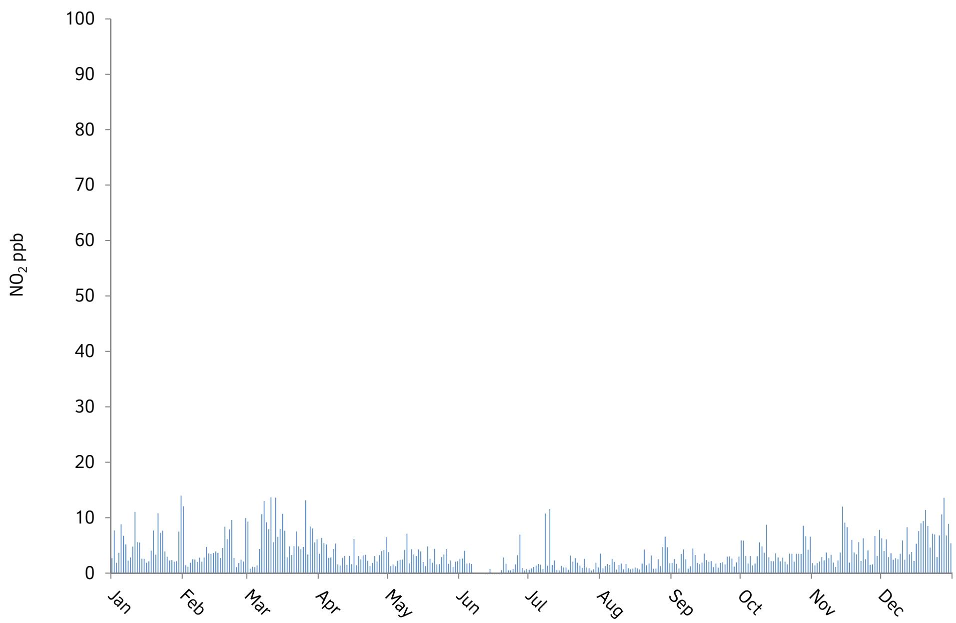


Figure 6.8

Whitesail 2019
O_3 Hourly
Concentrations

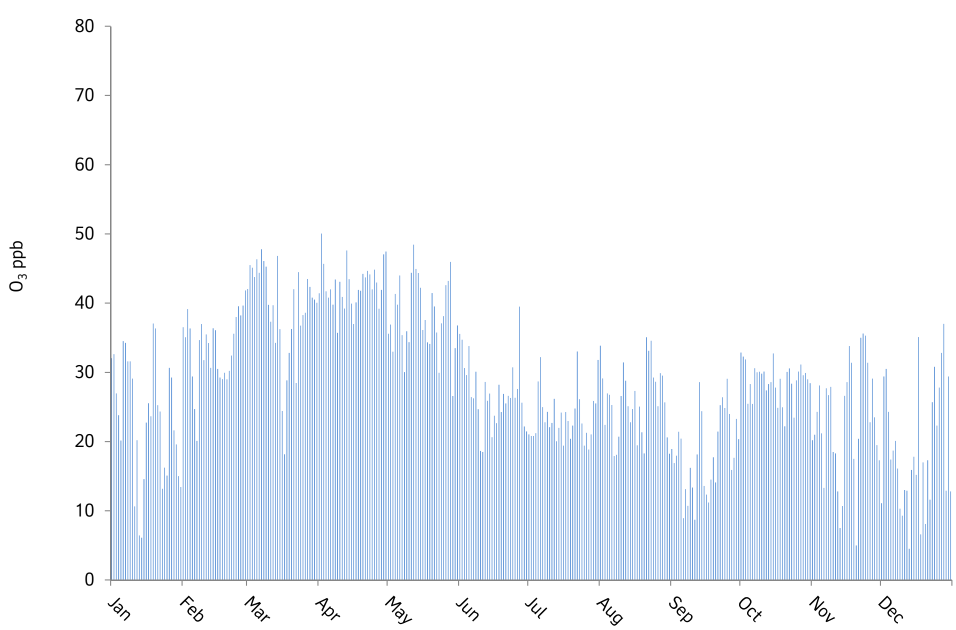


Figure 6.9a

Total 15 PAH
Haul Road, 2019

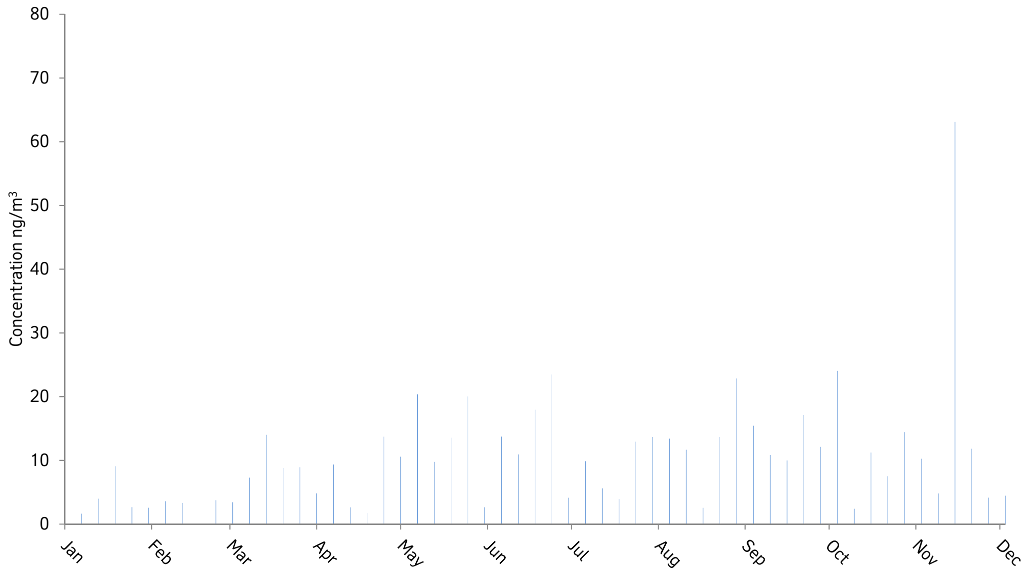


Figure 6.9b

Total 15 PAH
Whitesail, 2019

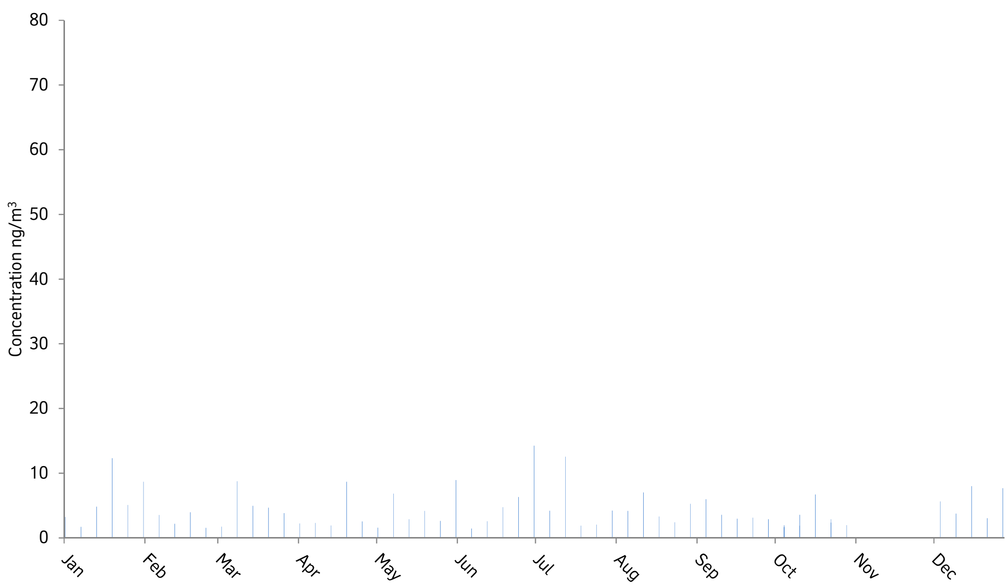


Figure 6.9c

Total 15 PAH Kitamaat Village, 2019

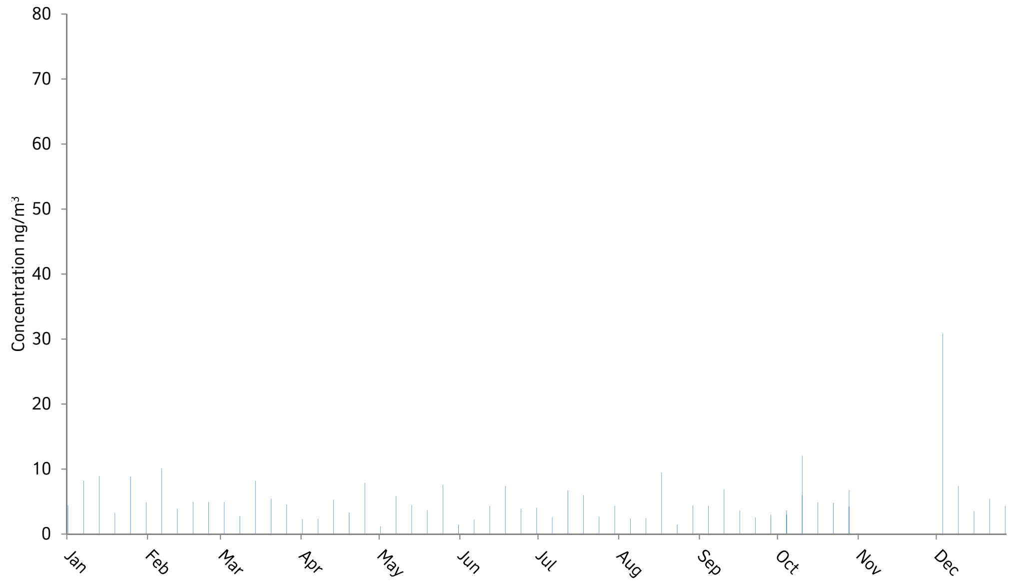
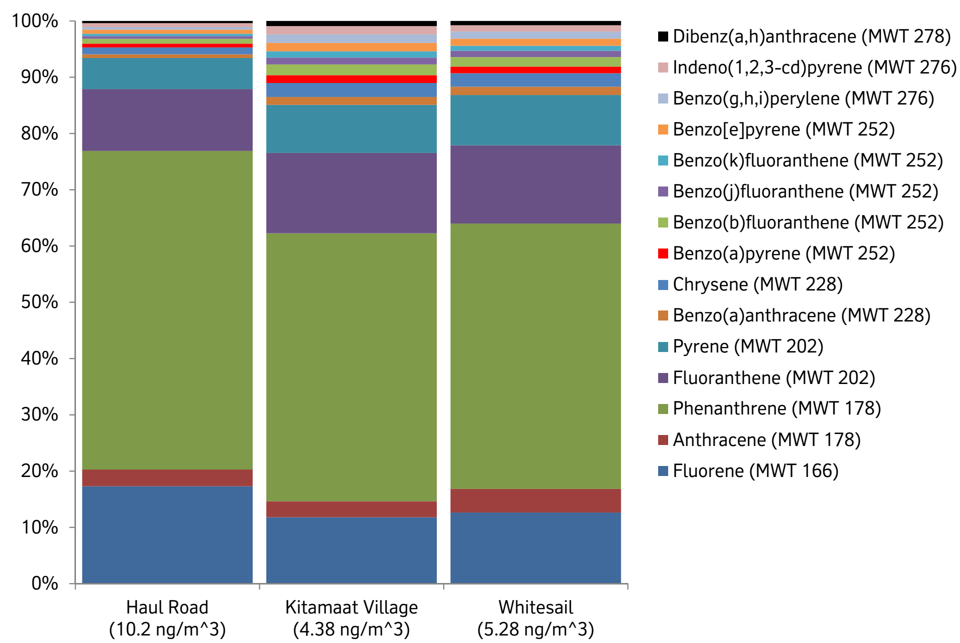


Figure 6.10

2019 PAH Congener Distribution



7. Vegetation monitoring

The vegetation monitoring and assessment program consists of two parts: An annual collection of western hemlock needles and analysis of the concentration of fluoride and Sulphur in needle tissue; as well as an inspection of vegetation in the vicinity of Operations on a biennial basis

Introduction

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 one of the largest historical databases of this type in British Columbia. The purpose of the vegetation monitoring and assessment program is to:

- Document the general growing conditions in the Kitimat area during the year of the inspection.
- Provide an assessment of the overall health of vegetation in the area, including documenting significant occurrences of insects and diseases.
- Document the concentration of fluoride and Sulphur content in vegetation.
- Document the extent and severity of injury to vegetation that may be associated with emissions from BC Works.
- Provide early warning of changes in conditions.

In 2019 changes were made to the vegetation monitoring and assessment program based on Dr. John Laurence's (plant pathologist consultant) recommendations. The recommendations were provided to the Ministry of Environment and Climate Change Strategy who also found that there were a number of redundant sites that could be removed. Therefore in the 2019 field-sampling season the number of sites were reduced from 40 to 27 (Figure 7.1).

Vegetation Monitoring and Assessment Program

The 2019 growing season was characterized by slightly warm and dry conditions, although not as dry as 2018. Precipitation during the summer months was 80 percent of the historical summer total and rainfall during the growing season was 3.2 mm higher than the long – term average. Mean monthly temperatures during the growing season (April – September) were similar to the historical annual daily means. Winds in January – March were dominated by north-north easterly winds, summer months had southerly winds, followed by a mix of northerly and southerly winds in October and December.

Collection and Analysis of Western Hemlock Needles

Western Hemlock was selected to be the monitoring species because it is found throughout the study area and it is a bioaccumulator. This means it is not generally injured by aerial emissions and is tolerant to air pollutants including fluoride and Sulphur. At the end of the growing season, the 27 sample sites were visited and the current year's growth of hemlock needles was collected. The samples were processed and then analyzed at Rio Tinto's Vaudreuil Analytical Laboratory in Quebec.

Fluoride Content Results

Fluoride emissions from the smelter in 2019 were within permit limits 0.9 kg/Mg Aluminium (see Chapter 5 – Emissions) and historically a correlation between fluoride concentrations in hemlock and fluoride emissions from the reduction roof vents at BC Works is still documented (Figure 7.2). The results from 2014 – 2016 were re-analyzed in 2019 after it became apparent that the chromatography column at the Vaudreuil Analytical Laboratory was failing. The re-analyzed values were an average of 7 ppm lower in 2014, 23 ppm lower in 2015 and 18 ppm lower in 2016.

Fluoride concentration in foliage was higher in 2019 than in 2018 for 12 of the 27 sites, with differences in F concentration between 2019 values and 2018 values ranging from 32 ppm under, to 20 ppm over 2018 values.

Sulphur Content Results

Sulphur emissions from the smelter in 2019 were within permit limits of 42 Mg/Day (see Chapter 5 – Emissions). In 2019, the Sulphur concentration in western hemlock foliage ranged from 0.05% to 0.15%. All Sulphur concentrations measured are within the range of background concentrations specified in the scientific literature except for one high elevation site just northwest of the smelter. Historically (since 2009) the annual average percentage of Sulphur accumulation in plants have been below 0.13%.

Vegetation Inspection

In 2019 the vegetation inspection took place and was completed by Dr. John Laurence. At each sample sites and some additional sites of local or cultural importance and inspection of vegetation was made to document the presence or absence of injury due to Fluoride or Sulphur dioxide, disease, insects and other environmental stressors.

Assessment results

The vegetation inspection in 2019 found the condition of the vegetation in the Kitimat Valley was similar to that observed in 2018 however; there was some dieback of vegetation on thin soils due to the 2018 drought conditions. There were no symptoms of Sulphur or fluoride exposure was observed at any of the vegetation sites. The insect activity of the hemlock wooly adelgid was not observed in the area and is considered a reduction from the 2018 insect activity.

Figure 7.1 Current and Retired Sampling Sites

In 2019 the program was reduced to 27 sampling sites following an agreement with the Ministry of Environment and Climate Change Strategy that there was redundancy in the sampling sites (Source: Stantec LTD. & Laurence, 2019).

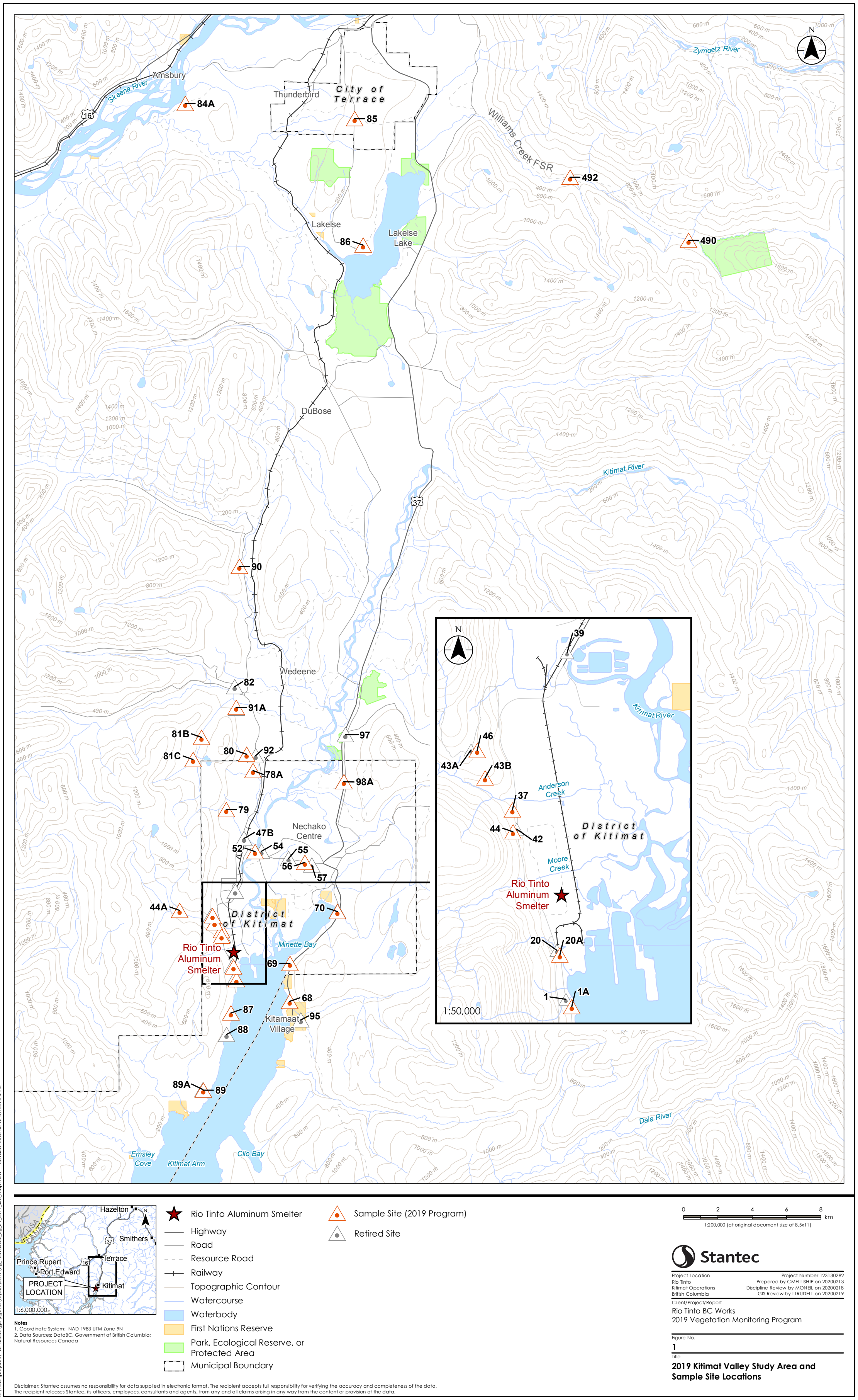


Figure 7.2
Historical Results for Fluoride gas Emissions and Fluoride content in Vegetation

The reduction of fluoride content in vegetation can be attributed to the change in technology, when the VSS smelter shut down in 2015 and the AP-4X smelter started in 2016.

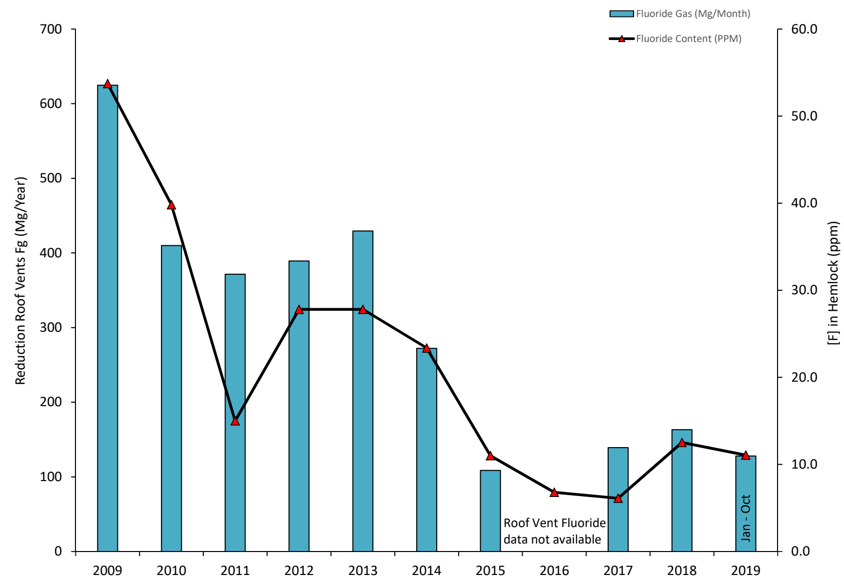
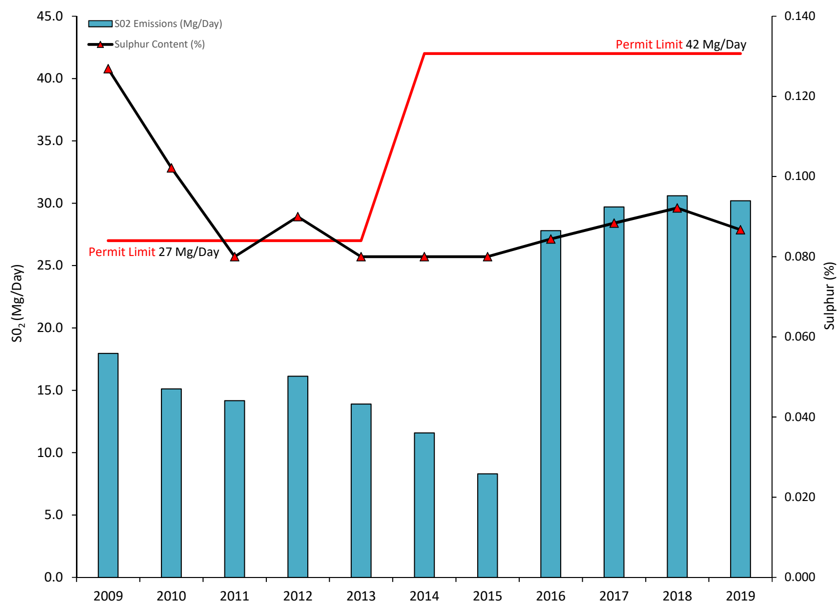


Figure 7.3
Historical Results for Sulphur Dioxide Emissions and Sulphur content in Vegetation.

The average Sulphur content in hemlock needles has an annual average of below 0.15% ranging from 0.08% (2015) to 0.13% (2008).



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.

2019 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 2019, 7,365 metric tonnes of SPL was generated and shipped off-site. 100 percent of that material was sent to the Spent Potlining Recycling Plant located in Saguenay, Quebec where the material was treated and recycled. The SPL generated in 2019 originated from the replacement campaign of the AP4X pots.

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 2019, 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 2019, a total of 2,286 m^3 of wood waste was burned during the year using open burning.

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.

A survey is carried out once a year for reconciliation of the forecasted disposed volumes. The total volume of materials disposed at the South Landfill in 2019 was 4,505 m^3, which corresponds to 6,948 metric tonnes.

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 2019 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

Several areas at BC works maintain an annual groundwater-monitoring program to assess landfill cap effectiveness and monitor for changes in groundwater quality. Bellow are details and highlights from the 2019 programs for the Spent Potlining landfill, South landfill and the Dredgeate Disposal site landfill (DDS). In addition to the landfills, Rio Tinto also maintains a groundwater program for the short-term storage cells that are located at the North end of the BC works site.

2019 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. The existing program consists of a quarterly monitoring program where selected wells are visited to monitor water level trends. In addition to monitoring water levels a geochemical sampling campaign that occurs in the fall of each year also occurs as part of the annual program. The information collected is used to assess groundwater quality for any significant changes in chemistry that may exceed previous year's results. This year there was no significant changes noted.

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.

The estimated groundwater flux for 2019 was 273,139 m^3/yr. This is an 11% increase compared to 2018, reflecting increased precipitation in 2019.

The 2019 mass loading estimate for fluoride was 18,764 kg/yr. This represents a 13% increase compared to 2018, mainly due to the increase groundwater flux, with a minor overall increase in fluoride concentrations.

The 2019 mass loading estimate for SAD-cyanide was 114 kg/yr. This represents a 1% increase compared to 2018, reflecting an overall decrease in concentrations, offsetting the increased groundwater flux.

The 2019 mass loading estimate for dissolved aluminium was 550 kg/yr. This represents a 3% decrease compared to 2018, reflecting an overall decrease in concentrations, offsetting the increased groundwater flux.

The 2019 mass loading estimate for dissolved aluminium was 233 kg/yr. This represents a 5% increase compared to 2018, reflecting an overall decrease in concentrations, partially offsetting the increased groundwater flux.

South landfill

The South landfill is the oldest landfill at the BC works site that is still operational. It was commissioned in the early stages of construction in the 50s to service the smelter. In 2011 during the construction of the new smelter site, the landfill was optimized to receive soils from the constriction project to assist shaping the landfill for closure. To understand and evaluate the risk of contaminants moving through groundwater an environmental effects monitoring program (EEM) was developed. The program comprises of multiple lines of evidence to develop and over all conclusion. The overall conclusions of the 2015 to 2018 EEM programs was that there was a low risk to ecological receptors due to impacts from the South Landfill. The results of the 2019 EEM program do not change the conclusion of low risk to aquatic organisms in Moore Creek main channel. However, during low flow conditions in the creek, localized elevated concentrations have been identified in side-channels. This may result in an elevated risk to aquatic organisms during low-flow periods in Moore Creek in these localized sites.

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 Dec 31, 2019.

Baseline and operational groundwater monitoring began August 26, 2018 and continued until October 8, 2019. Dewatering phase sampling occurred between November 16, 2019 and January 14, 2020. A November 30, 2018 sampling event showed low pH and elevated metals concentrations which initiated additional sampling events and monitoring as well as an investigation that ended in the spring of 2019.

A trigger response plan (TRP) was developed for the CWMP in response to adverse results encountered during the 2018 groundwater monitoring. The TRP outlines additional monitoring to be executed if groundwater results exceed identified trigger thresholds. As per the TRP, exceedances at one well during Season 2 monitoring required notification to the Ministry of Environment and Climate Change Strategy and re-sampling. Re-sampling on December 12, 2019 did not show exceedances and as such, no further actions were required.

Dredgeate cells and SPL overburden cell

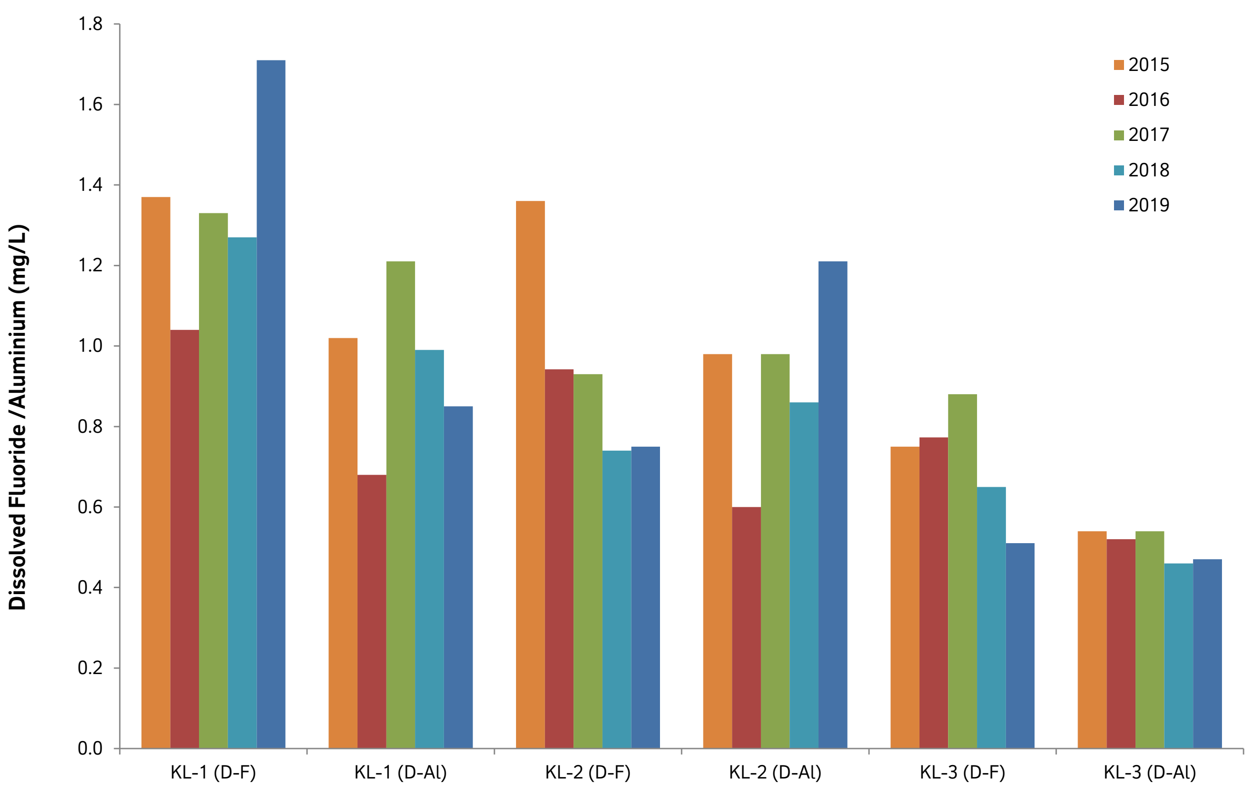
The wharf dredgeate cells consist of two lined cells located north of Anderson Creek. They contain approximately 2,000 m^3 of ocean sediment dredged from the wharf berthing area in 1995. This sediment was removed during a normal dredging operation and required special disposal because of the presence of PAHs in the form of solid pitch (pencil pitch). BC Works no longer receives pitch in this form. Three wells are used to monitor groundwater in the area surrounding the wharf dredgeate cells. They are referred to as KL-1, KL-2 and KL-3 and are located to the West, South and East of the cells respectively. Groundwater sampling was conducted on a quarterly basis in 2019. The samples were analyzed for dissolved fluoride and dissolved aluminium. The 2019 contaminant monitoring results are comparable to historical trends from previous years. (Figure 9.1). The two dredgate wharf cells were decommissioned in the summer of 2019 and the site reclaimed.

The spent pot lining (SPL) overburden cell is located west of the wharf dredgeate cells. 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.

Both the wharf dredgeate cells and 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 2019 7 m^3 of water was pumped out from the six pumps.

Figure 9.1

Dissolved fluoride & aluminium, wharf dredgeate monitoring cells



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.

2019 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. Figure 10.1 presents the results of Kemano effluent discharges.

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 2019 permit requirements were in compliance.

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 2019 15 m^3 of 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 2019, 253 m^3 of sludge was disposed of which is a slight increase from 2018.

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 2018, Seekwyakin camp sewage treatment plant was re-established to manage the T2 Project sewage in a transition period while they awaited the municipal wastewater discharge authorization for the construction camp.

In May 2019 Rio Tinto received an Advisory letter for the following non compliances: elevated Biological Oxygen Demand (BOD) in effluent; lack of flow monitoring; and lack of effluent sampling. The flow monitoring and effluent sampling were missed in the third quarter 2019 reporting, which was rectified in forth quarter. Elevated DOB in effluent was resolved through the implementation of corrective actions to restore system functionality. The drainage of the effluent is a tile field and the Kemano river is approximate 250 meters away, adverse effects on aquatic life are not anticipated from this discharge. The T2 Project ceased use of the Seekwyakin camp sewage treatment plant on June 16. Figure 10.2 presents the results of Seekwyakin effluent discharges.

Figure 10.1

Effluent discharge, Kemano 2019

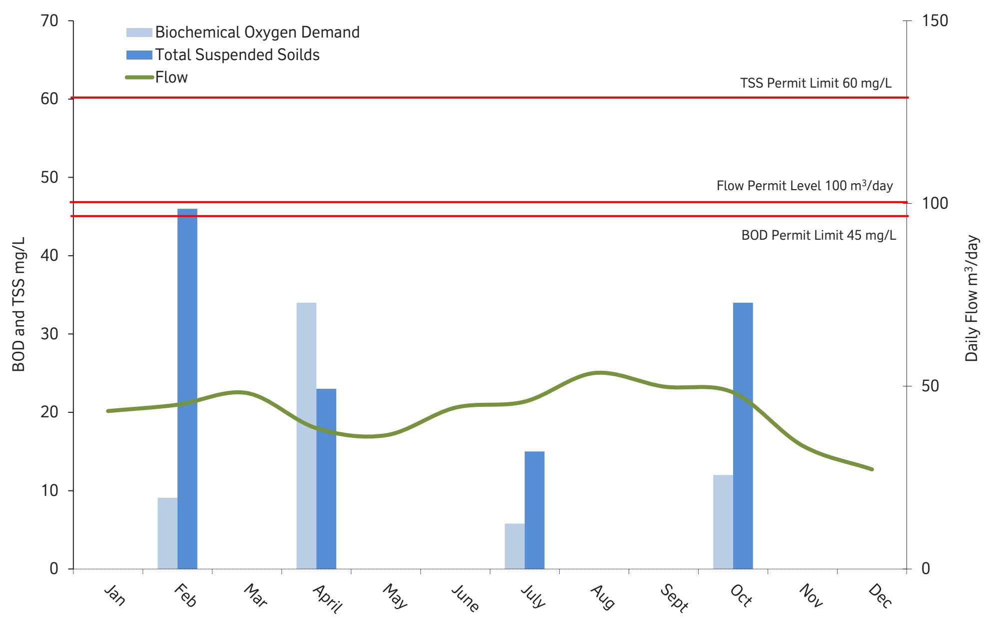
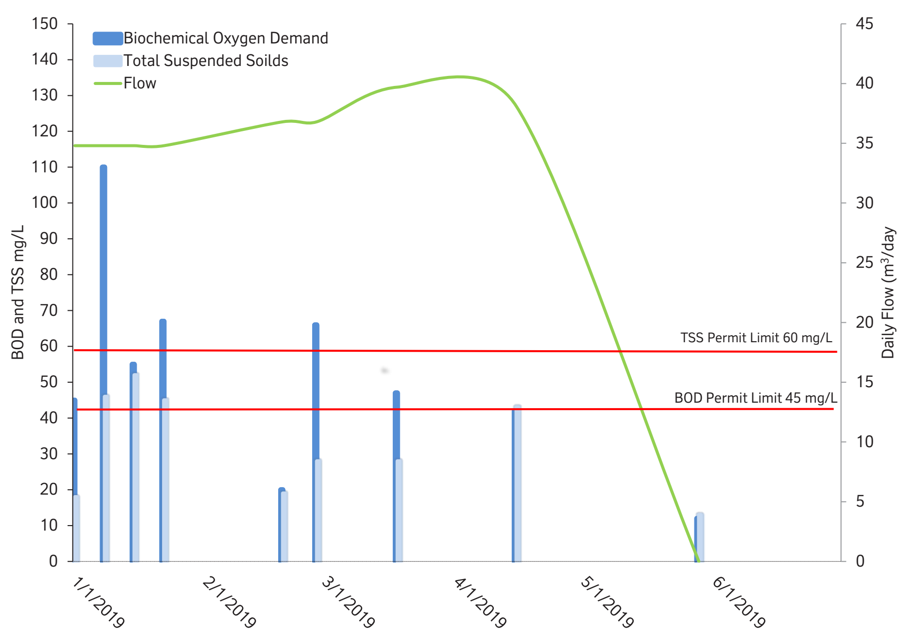


Figure 10.2

Effluent discharge, Seekwyakin 2019



11. Summary of non-compliance and spills

In 2018, BC Works received two notices of non-compliance from Ministry of Environment for Kitimat smelter.

2019 performance

Non-compliance summary

The stabilization of the modernized smelter now fully complete, maintaining environmental compliance was a key part of the operation in 2019. Several 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).

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 BC ENV (referred to as "reportable" spills), depending on the nature and volume of the substance spilled. In 2019, several 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 2019.

Table 11.1

Summary of non- compliances, 2019

Non-Compliance	Occurrence date	Impact	Permit Requirement	Cause	Implemented Corrective Actions
Seekwyakin sewage treatment plant : BOD sample not taken & flow measurement not reported.	3rd Quarter of 2018.	Administrative	Ensure monitoring and reporting requirements related to pollution control works are fulfilled.	The Seekwyakin sewage treatment plant had not been operated in many years and permit requirements had not been clarified.	Corrective action: • Clarify permit requirements • Training and on permit requirements to • Monitoring and reporting schedule established with operations
Permit Limit for BOD exceeded at Seekwyakin sewage treatment plant.	January 31, 2019	Discharge to fresh water habitat	Ensure sewage treatment system functionality is optimal before discharging to the environment.	The Seekwyakin sewage treatment plant had not been operated in many years.	Thirteen corrective actions were implemented to restore the sewage treatment system functionality.
Late reporting of the interpretation of TSS measurements at the B-lagoon outfall and of the dates and times of effluent discharge from the DDS to the B-lagoon.	Fall of 2018. Reported on January 15, 2019.	Administrative	Monitor and report as per permit requirements.	Multiple permit amendments related to the DDS commissioning led to some confusion for the first weeks of monitoring & reporting.	Corrective action: Assessed a number of lessons learned from the first dredge season in 2018-2019, including several learnings related to field environmental reporting and timely adaptation to changing requirements.
F-Lagoon effluent pipe breach on the bank of Moore creek.	23 January, 2019	Discharge to fresh water habitat	Ensure that no waste is discharged without being processed through the relevant pollution control works unless prior approval is received from the Regional Director.	The pipe got disconnected due to malfunction of the effluent pipe.	Corrective action: Receiving environment assessed, pipe was reattached with a more robust clamp, routine inspection of the critical parts of the pipe line was implemented, and repair to the shoulder of the road was completed.
IL – material from the DDS entered the marine environment.	3 February, 2019	Discharge to marine habitat	Ensure that no waste is discharged without being processed through the relevant pollution control works unless prior approval is received from the Regional Director.	Flex hose transporting the material got disconnected due to malfunction.	Corrective action: • A vacuum truck cleaned the spill as much as possible • Repairs were made to the damaged flex pipe. • Routine inspection implemented.
Dust collector 1 in conveyor tower 2 was malfunctioning resulting in dust emissions.	February 7, 2019	Discharge to air	Ensure that no waste is discharged without being processed through the relevant pollution control works unless prior approval is received from the Regional Director.	Damage to the dust collector.	Corrective action • Process parameters adjusted to reduce the amount of material processed by the dust collector • Maintenance of critical parts of the dust collector. • Future replacement of the dust collector
Discharge of untested water from soil cell to drain.	August 25, 2019	Discharge to marine environment	Ensure that no waste is discharged without being processed through the relevant pollution.	Caused by operator error.	Corrective action • Procedures implemented on proper pump operations • Training completed for the crew.
Large coarse woody debris found in IL+ cell.	September 23, 2019	Improper disposal of waste material	Coarse woody debris disposal restricted to IL- cell.	Dredge material was transferred by truck to DDS and included un-authorized debris.	Corrective action • Material was segregated and removed from the IL+ cell • Assessment of the IL+ cell liner by specialized firm

Table 11.1 continued…

Summary of non- compliances, 2019

Non-Compliance	Occurrence date	Impact	Permit Requirement	Cause	Implemented Corrective Actions
Dust collector 12 from the anode paste plant was not sampled in 2019.	November 28, 2019	Administrative	Monitor and report as per permit requirements.	Down-time of equipment and logistical difficulties during sampling planning.	Corrective action Ensure the equipment is operational and accessible for sampling during the campaign.
FTC stack test result above permit limit.	December 12, 2019	Discharge to air	Ensure pollution control works efficiently treat and process the waste prior to discharge.	Damage to certain components of the FTC.	Corrective action • Addressed immediate issues • Improved maintenance planning • Improved process monitoring
Cooler Venturi stack test result above permit limit..	December 12, 2019	Discharge to air	Ensure pollution control works efficiently treat and process the waste prior to discharge.	Process parameters modified without assessing impacts to discharge.	Corrective action • Implementation of management of change • Improved process monitoring
Spill of storm drain discharge from hose to Moore Creek.	December 18, 2019	Discharge to fresh water	Ensure that no waste is discharged without being processed through the relevant pollution control works unless prior approval is received from the Regional Director.	A rain on snow event creating an ice jam, flooded the area, and impacted the equipment.	Corrective action • Storm drain was repaired, and the hose is no longer needed. • The hose was decommissioned

Table 11.2

Summary of reportable spills, 2019

Occurrence	Substance	Amount	Environmental Media	Cause	Corrective Actions
February 5, 2019	Sewage	600 L	Gravel	Overflow of the holding tank during the night.	Clean up of gravel immediately.
March 1, 2019	Silicon bag	1 empty bag (1 m^3)	Fresh water	The bag was blown away from a waste bin by high winds and ended up in a creek.	Bag removed from the creek.
March 2, 2019	Oil	1 Litre	Marine	A dolly with a reservoir was being transported down the boat ramp. The reservoir was tipped a some contents spilled.	Spill response boat was deployed, spill socks were used to contain and absorb the spill, spill pads were used to clean up spill on the boat ramp.
March 23, 2019	High pH water	3 m^3	Ground	Trans-mixer (mining concrete mixer truck) discharged water with pH levels possibly >9pH to the ground.	Improved training of operators.
April 23, 2019	Sewage	>1530 m^3	Ground	A bypass of the UV light and denitrification tank occurred within the Sewage Treatment Plant, causing effluent to be discharged to the drain field.	Discharged ceased. Water restriction implemented. UV treatment repaired. Contingency monitoring implemented. 3rd party assessment of the treatment plant.
May 6, 2019	Rock and concrete fines with washout water	3 m^3	Ground	Operator deposited material in the incorrect location.	Area was bermed and material was contained.
May 22, 2019	High pH water	200 L	Fresh water	The waste water pump transformer failed, which stopped the pump transferring waste water from sump to the waste water treatment.	Increased in-situ water quality monitoring, treatment at the portal sump, transformer and pump replaced, shotcrete applied for prevention, back-up pump installed.
June 4, 2019	High pH water	unknown	Ground	Tank overflow.	Pumping stopped and overflow ceased. Water flow redirected to another tank.
July 14, 2019	Cryolitic bath	unknown	Asphalt	Bag punctured during transport.	Spill was cleaned up and methodology for transporting bags was improved.
10 August, 2019	Fresh alumina	900 kg	Asphalt	Leak in material transfer equipment.	Spill cleaned up and repaired the equipment.
11 August, 2019	High pH water	7 m^3	Ground	Crack in the concrete containment.	Repaired the crack in the concrete containment.
1 September, 2019	Hydraulic oil	50 ml	Gravel	Impact hammer leak.	Repaired the damage to the equipment.
14 September, 2019	Storm water	12 m^3	Marine	Pumps failed.	Repaired the damage to the equipment.
15 September, 2019	Acid water	1.6 m^3	Ground	Containers punctured by forklift.	Water was pumped into secured containment. Spill was cleaned-up.
18 September, 2019	Hydraulic oil	1 L	Marine	Mechanical failure.	Repaired the damage to the equipment.
20 September, 2019	Engine Oil	250 ml	Marine	Mechanical failure.	Repaired the damage to the equipment.
11 October, 2019	Sewage	87 m^3	Fresh water	Overflow of settling pond.	Improved monitoring controls to prevent future overflow events.
22 November, 2019	Storm water	200 L	Marine	Overflow of containment area.	Installation of pumps to avoid overflow.
18 December, 2019	Storm water	unknown	Fresh water	Rain on snow flooded Moore Creek and overwhelmed the temporary storm water drainage system.	A berm was erected along Moore Creek.
30 December, 2019	Pitch	300 T	Asphalt	Expansion joint failed in a transfer pump.	Spilled cleaned up. Equipment repaired. Monitoring improved.
31 December, 2019	Oil	1 l	Marine	Unknown.	N/A.

12. 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
An 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.

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.

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.

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.

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.

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