
ARBIOS
BIOTECH
CHUNTOH GHUNA PRINCE GEORGE
AIR DISCHARGE PERMIT OVERVIEW
Q2 2023

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ARBIOS
BIOTECH

UNCEDED TERRITORY OF THE **LHEIDLI T'ENNEH FIRST NATION**

The Arbios Chuntoh Ghuna ("Chan-toh Hannah") facility in Prince George is situated on the **traditional and unceded territory** of the Lheidli T'enneh First Nation .

T'enneh literally means "The People". They are a sub-group of the "Dakelh" people whose traditional territory includes the city of Prince George, British Columbia. The name "Lheidli" means "The People from the Confluence of the River" in the Carrier language, referring to how the **Nechako River enters the Fraser River at Prince George.**

"

Hello

HADIH!

PRESENTING TODAY

TESSA GILL
EXTERNAL RELATIONS LEAD, ARBIOS BIOTECH

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GENERAL MANAGER, OPERATIONS, ARBIOS BIOTECH

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APRIL 2023

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BACKGROUND
CHUNTOH GHUNA
PRINCE GEORGE

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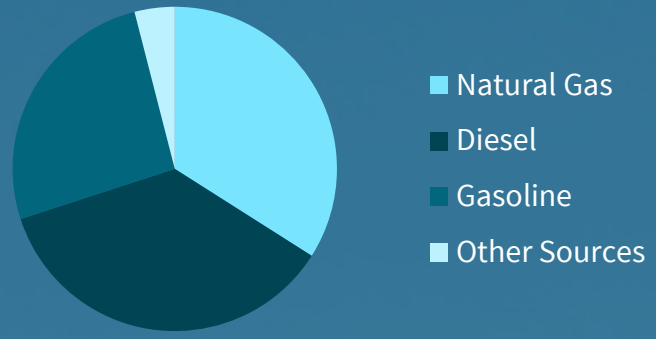
WE NEED TO REDUCE OUR RELIANCE ON FOSSIL FUELS

ARBIOS CAN PLAY AN IMPORTANT ROLE IN MOVING TO A LOWER CARBON FUTURE

BC 2020 Emissions by Energy Source for Transportation, Buildings and Industry



"Fossil fuel production and consumption accounts for approximately 80% of B.C. emissions" - Clean BC Roadmap to 2030

LOWER CARBON FUTURE

The world needs to move to a lower carbon future - quickly

SUSTAINABLE AND RENEWABLE ENERGY SOURCES

All sustainable sources of energy need to be evaluated

COMPETITION FOR LIMITED LAND BASE

Solutions to focus on residues and post-consumer waste

HIGH VALUE BIO-OILS FROM FORESTRY RESIDUES

Bio-oil from wood biomass is a great example of expanding the opportunities to use the *other 50% of the log*

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CANFOR

Licella™

Cat-HTR™

WE ARE **ARBIOS**

Arbios Biotech is a joint venture between

Canfor, a global leader in the manufacturing of high-value low-carbon forest products, and

Licella, global leaders in hydrothermal liquefaction technology.

For over 15 years, Licella has been developing their hydrothermal liquefaction technology, **Cat-HTR™**

DEMONSTRATING FIRST OF A KIND TECHNOLOGY **IN PRINCE GEORGE TO REDUCE GLOBAL CARBON EMISSIONS**

Cat-HTR™ is the world's most advanced hydrothermal liquefaction (HTL) technology - an innovation that uses water under high pressure and temperature to transform waste biomass into a high-quality, sustainable bio-oil; a direct substitute for fossil crude.

The commercial-ready Cat-HTR™ technology has been developed over 15 years. The first Cat-HTR™ Pilot Plant was commissioned in 2007, with three successful reactor scale ups since.

Cat-HTR™

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ARBIOS IS COMMITTED TO **A CIRCULAR SUSTAINABLE BIO-ECONOMY**

PARTNERSHIP WITH THE LHEIDLI T'ENNEH FIRST NATION

Working in partnership, with formal agreement to work together

Facility named by Lheidli T'enneh elders - Chuntoh Ghuna means "the forest lives"

Committed to protecting the values of the Lheidli T'enneh

SUSTAINABLE BIOFUELS FROM RENEWABLE RESIDUES

Economic diversification and creation of high value, bio-fuels with a low carbon footprint

Significant opportunity to reduce reliance on fossil fuels

PROXIMITY TO FEEDSTOCKS MAKES PRINCE GEORGE A NATURAL CHOICE

ACCESS TO BIOMASS

Availability of forest residues where we can derive greater value from the biomass. Arbios has already secured initial small volume supply for this facility.

EXISTING INDUSTRIAL SITE

Located adjacent Canfor Pulp's Intercon Pulp Mill site.
Benefits from the efficiencies of utility infrastructure on a brownfield site.

STRONG SUPPORT AND EXPERIENCE

BC's carbon policies provide strong incentives to locate such developments in the province.
Canfor's experience in forest products and Licella's leadership in bio-innovation are the perfect combination for a successful renewables solution.

FACILITY OVERVIEW

CHUNTOH GHUNA
PRINCE GEORGE

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ARBIOS FACILITIES ARE SMALL AND MODULAR

LOW CARBON INTENSITY

Designed to be close to feedstocks to lower the carbon footprint of gathering the biomass

COMMERCIAL SCALE

Line 1 Chuntoh Ghuna Prince George will demonstrate the technology at a commercial scale

MODEST SIZE

1st line with capacity of 50,000 BBLs/yr

Applying for permit of 100,000 BBLs/yr

PHASED APPROACH

Allows for improvements in carbon intensity and to integrate learnings into expansion

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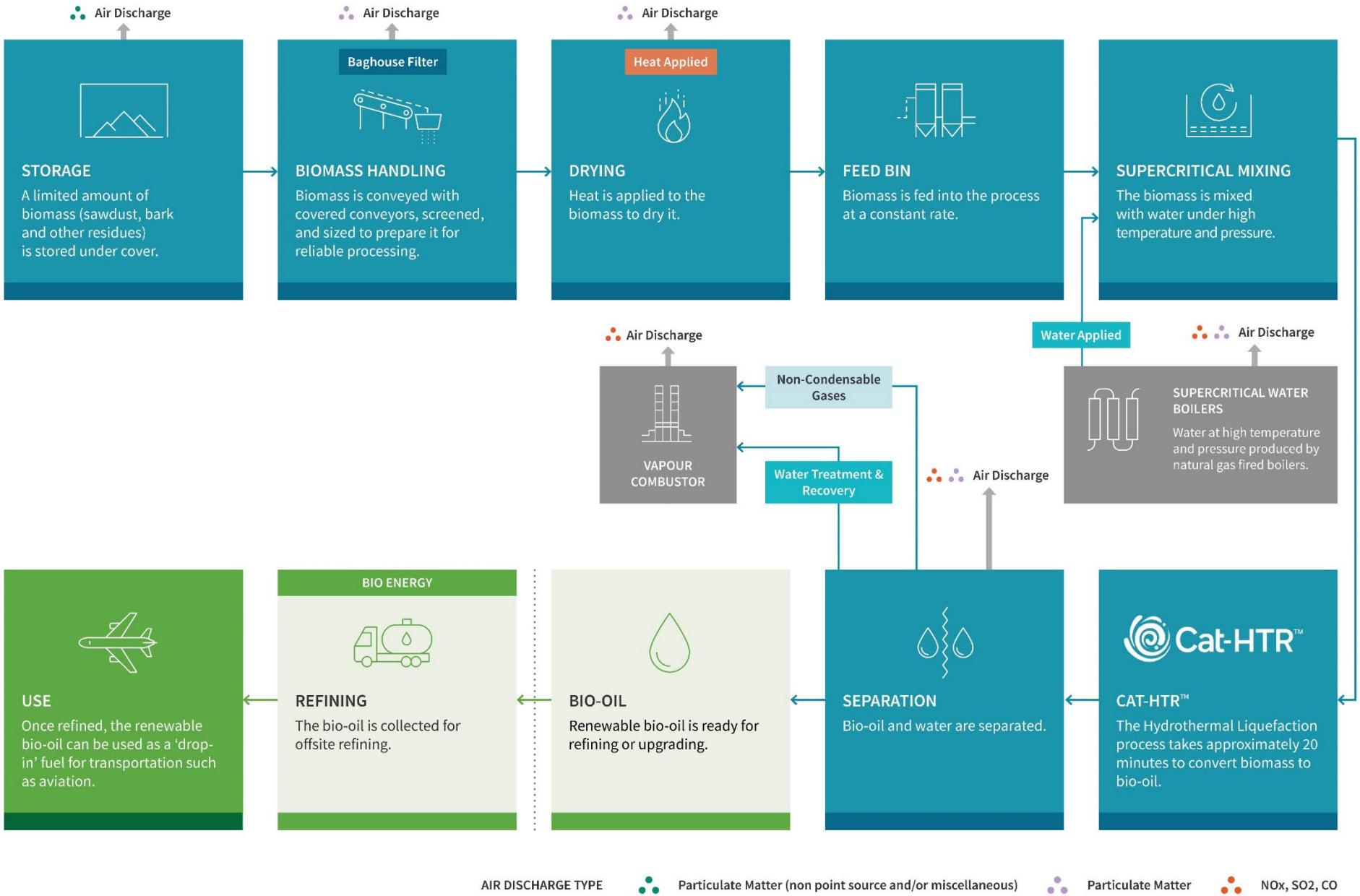
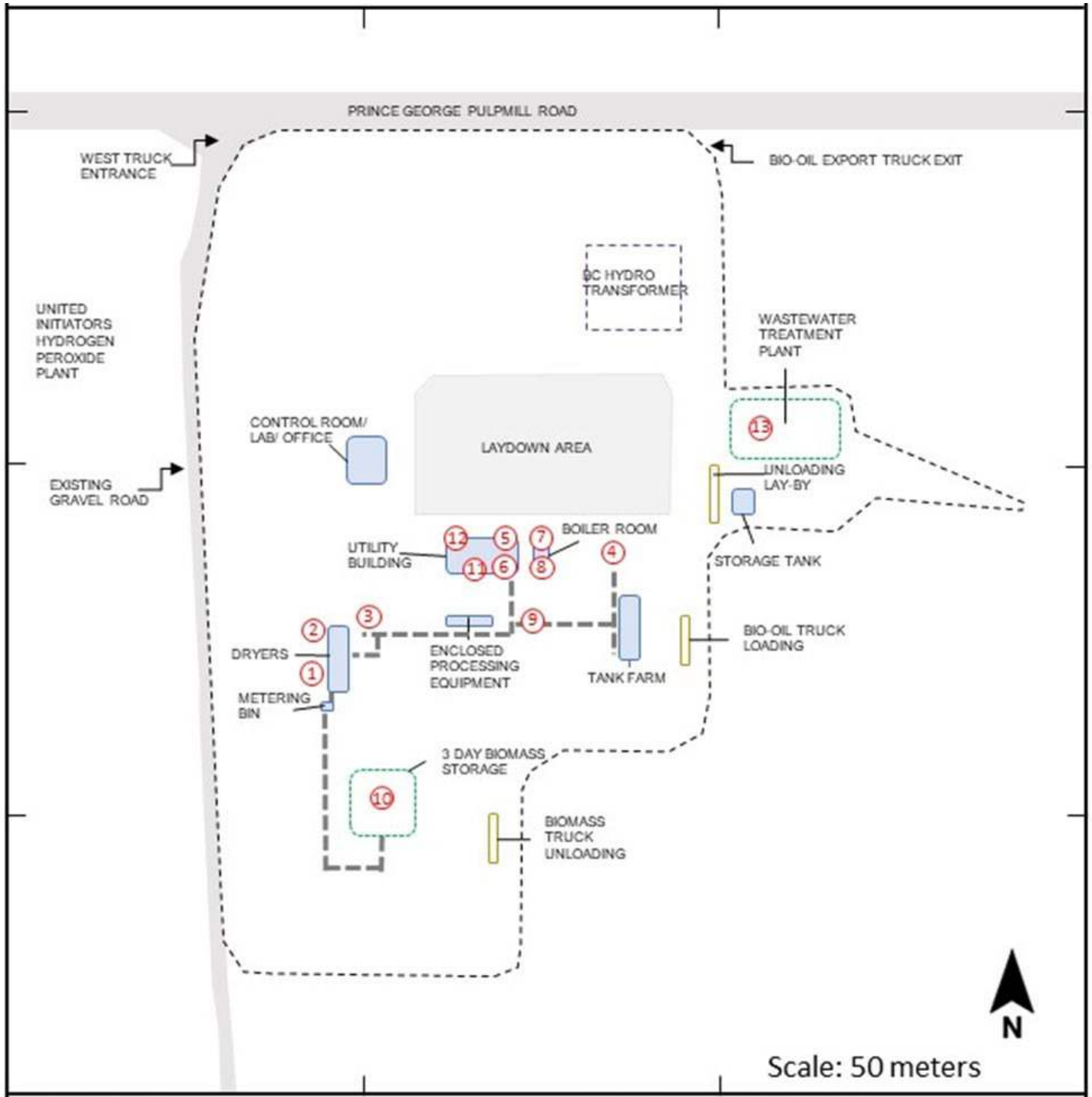
Biomass residues, such as biomass from the forestry industry, are transformed into a bio-oil, ready to be upgraded into a 'drop-in' renewable fuel with a lower carbon footprint for industries such as aviation, trucking, and marine transportation.



THE FACILITY IS LOCATED IN AN **EXISTING INDUSTRIAL AREA**

ARBIOS IS APPLYING FOR AN **AIR DISCHARGE PERMIT**

- An **authorization to discharge waste** under the Environmental Management Act (British Columbia).
- Reviews will be conducted by the **Ministry of Environment & Climate Change Strategy, Environmental Protection Division (ENV).**
- Arbios submitted a **Preliminary Application Form** and Discharge Factor Form for a New Permit on March 2, 2022, to initiate the permitting process.
- Since submission, we've **made improvements**, such as the addition of a baghouse to control dust emissions, and other mitigations as shown in the Best Achievable Technology (BAT) report.
- As a result, some of the air emission discharge characteristics have changed since the preliminary application, requiring an **updated Discharge Factor Form**



FACILITY LAYOUT AND EMISSION SOURCES

Discharge Locations:

1. Biomass Dryer 1 (53.9252N / 122.7058W)
2. Biomass Dryer 2 (53.9253N / 122.7057W)
3. Baghouse air collection system (53.9254N / 122.7055W)
4. Vapor Combustor (53.9254N / 122.7038W)
5. SCW Boiler 1 (53.9255N / 122.7045W)
6. SCW Boiler 2 (53.9255N / 122.7044W)
7. SCW Boiler 3 (53.9255N / 122.7042W)
8. SCW Boiler 4 (53.9254N / 122.7042W)
9. Vacuum Column Heater (53.9252N / 122.7042W)

Miscellaneous and Non-Point Sources:

10. Main Biomass Storage (122.7056N / 53.9247W)
11. Nitrogen Generator Vent (122.7046N / 53.9254W)
12. Boiler Blowdowns and Vents (122.7047N / 53.9256W)
13. Aeration Tank (122.7026N / 53.9257W)

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BEST ACHIEVEABLE TECHNOLOGY

REPORT OVERVIEW

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BAT ASSESSMENT CONDUCTED BY A 3RD PARTY QUALIFIED PROFESSIONAL

As defined by the BC MoECCS , “A best achievable technology is **a technology that has been evaluated for its feasibility, reliability, control effectiveness, and cost-effectiveness and is demonstrated to be best-suited to meet waste discharge standards for the protection of the environment and human health**.”

Conducted by Reputable 3rd Party

Arbios engaged WSP to perform the BAT assessment

A Requirement for the Air Discharge Permit

In compliance with the Best Achievable Technology Assessment to Inform Waste Discharge Standards

Detailed Review of Process Equipment and Pollution Controls

WSP reviewed the facility design to determine reliable, effective, feasible controls

Industry Comparisons

Similar facilities were reviewed for standard and best practices.

CHUNTOH GHUNA FACILITY IS USING **BEST ACHIEVABLE TECHNOLOGY**

Measures that have been taken to minimize emissions at the facility include:

BIOMASS DRYER

Selection of a low temperature belt dryer for biomass

DUST COLLECTION

Dust collection systems for dry wood residue handling systems utilizing a bag filter dust collector

RECYCLING HEAT

Recycled process heat used to power the biomass dryer

VAPOUR COMBUSTER

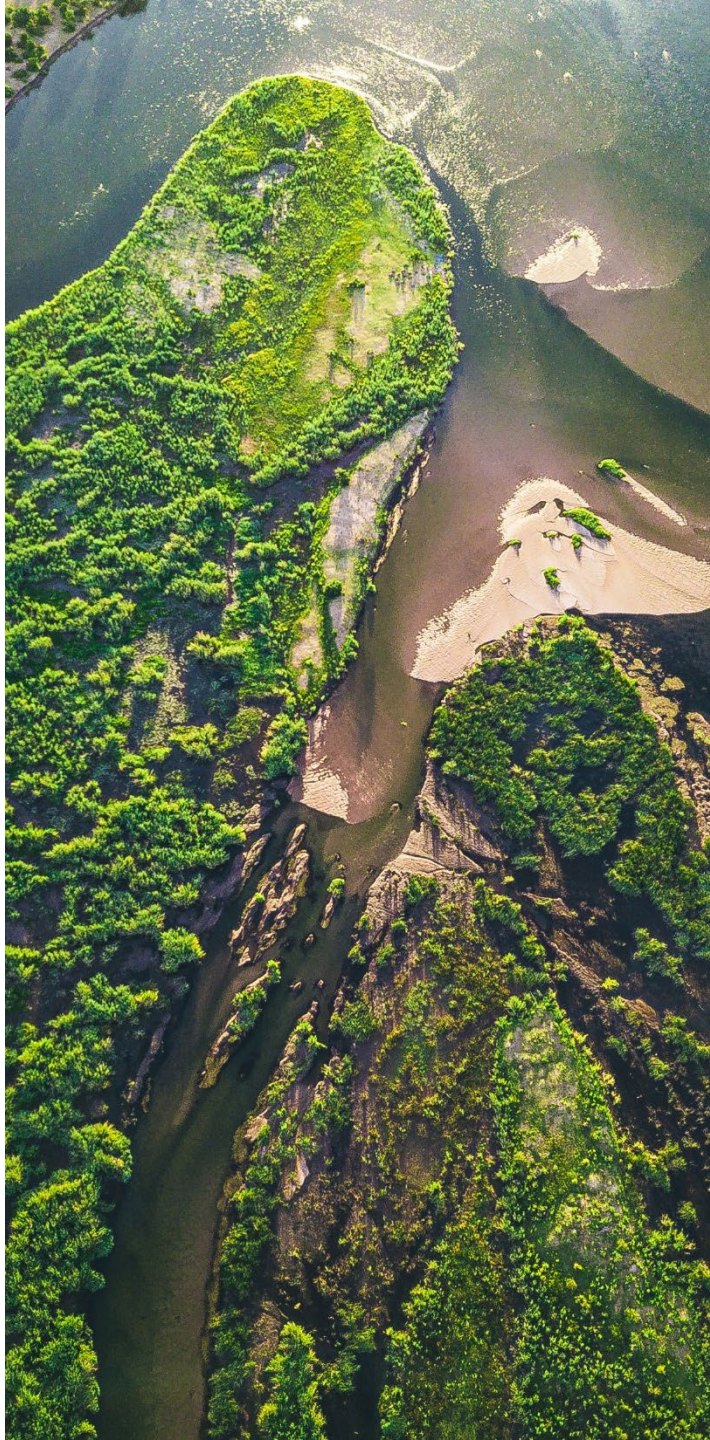
Thermal oxidizer to treat process emissions

COVERED BIOMASS

Biomass pile is mostly under cover and with a limited storage size

COVERED CONVEYORS

Covered conveyers and drop chutes where practicable



BEST ACHIEVABLE TECHNOLOGY ASSESSMENT
OBSERVATIONS - A DEEPER DIVE

FUGITIVE DUST

Managed via Fugitive Dust Management Plan which includes a range of monitoring activities, triggers and actions to manage dust emissions.

BIOMASS HANDLING DUST

BAT for dry biomass particulate emissions control is a well operated and maintained bag filter dust collector achieving particulate emissions performance of 20 mg/m3 (or better).

BIOMASS DRYERS

BAT for particulate emission control from biomass drying is a well operated and maintained low temperature belt dryer.

COMBINED SUPERCRITICAL WATER BOILERS

Due to technical constraints and prohibitive cost of alternative and treatment solutions, BAT for control of emissions from the supercritical boiler is the use of the manufacturer's standard burners with good combustion practices.

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BATA OBSERVATIONS
CONTINUED

VACUUM COLUMN HEATER

Based on standard industry practice and air permitting practice in BC, BAT for control of emissions from the Vacuum Column Heater: use manufacturer's standard low NOx burner together with good combustion practices.

VAPOR COMBUSTOR

Informed by the BCOGC Flaring and Venting Guideline, BAT for control of emissions from the Vapor Combustor is the use of an enclosed combustor that achieves greater than 99% destruction of waste gases.

PROCESS EQUIPMENT LEAKS

Managed via preventative maintenance program that includes leak detection and repair of equipment that contains gases or high-pressure liquids.

WASTEWATER TREATMENT EMISSIONS

Based on standard industry practice, BAT for control of emissions from the wastewater treatment plant is the use of an Anerobic Wastewater Reactor with all off-gases treated in the Vapor Combustor.

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AIR QUALITY TECHNICAL REPORT

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AIR DISPERSION MODELLING IS USED TO PREDICT CHANGES TO AIRSHED

CONDUCTED BY INDEPENDENT THIRD-PARTY QUALIFIED PROFESSIONAL, AUSENCO

Modelling plan submitted to ENV before modelling commenced

Model uses a baseline for a specified period

- 2016 for PM_{10} and $PM_{2.5}$
- 2018, 2019 and 2020 for NO_2 and SO_2

Model then adds Chuntoh Ghuna facility in operation

Full Air Quality Technical Report can be found online at www.arbiosbiotech.com

THE AIR DISPERSION MODEL TAKES A **CAUTIOUS AND PRUDENT APPROACH**

PRINCE GEORGE IS CONSIDERED AS HAVING A SENSITIVE AIRSHED PRIMARILY DUE TO A HISTORY OF $PM_{2.5}$ EXCEEDING THE BC AMBIENT AIR QUALITY OBJECTIVES

THE FOLLOWING CAUTIOUS CHOICES PRODUCE RESULTS THAT DELIBERATELY SHOW THE HIGHEST POSSIBLE IMPACTS

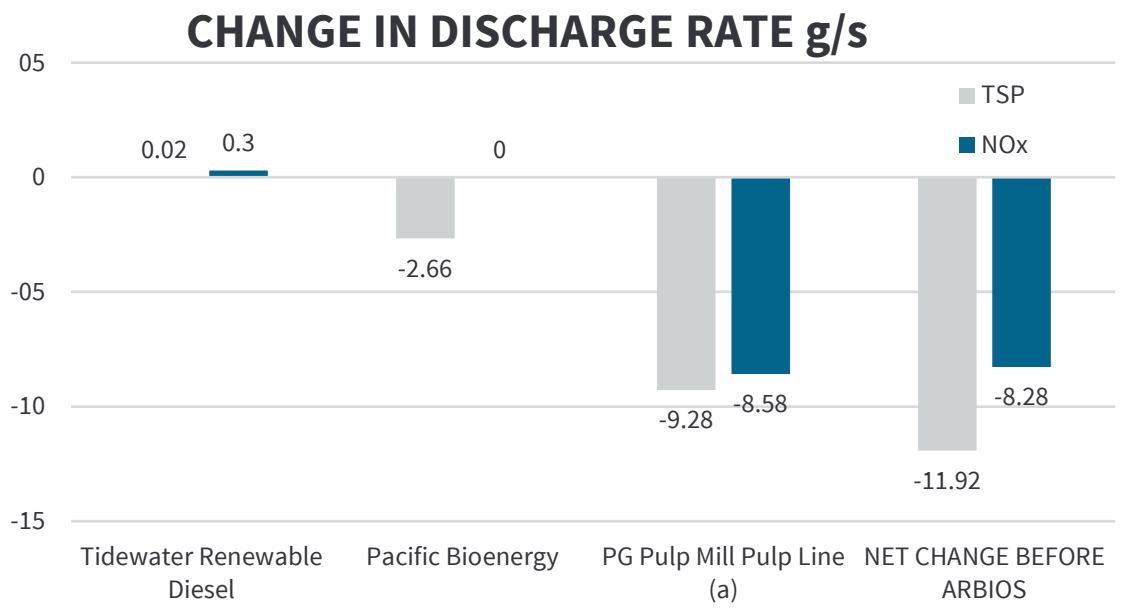
Inputs are based on **maximum flows and concentrations** as shown in the Permit application. These are “never to exceed” values and not representative of normal daily operations.

The **model’s estimations for NO_2 ambient levels are significantly higher than actual** due to the procedure for estimating NOx conversion.

Estimates of particulate emissions from the green wood (i.e. pre-dryer) handling system are based on emission factors for dry wood handling systems. At 45 to 55% moisture content and biomass in a size range of 2.5 to 10cm, **Arbios’ biomass will be far less prone to dust emissions than dry wood fibre**.

There have been some **changes in Industrial activity** in Prince George that would result in **significant reductions in overall TSP, PM_{10}, $PM_{2.5}$ and NOx.**

THE INDUSTRIAL IMPACT ON **THE AIRSHED IN PRINCE GEORGE IS CHANGING**



(a) Based on data input for the most recent Micro Emissions Inventory (Nilson, B., Jackson, P., Ainslie, B., and Roth, G. 2020)

Since the emissions inventory was last updated, three key changes in industrial sources have or will occur before the Chuntoh Ghuna facility is commissioned:

- the closure of the Pacific Bioenergy Pellet facility,
- the future addition of the Tidewater Renewables facility, and
- the closure of the pulp line at PG Pulp Mill.

These three changes, even when taking in to account new sources at the Chuntoh Ghuna facility, **represent significant reductions in $PM_{2.5}$ and NO_2 in the Prince George airshed**.

The **TSP reductions are 10 times the Arbios additions** and **NOx reductions are 2.6 times more than the Arbios additions.**

These reductions are not accounted for in the dispersion modelling for this facility.

SOURCES OF **EMISSIONS**
(NORMAL OPERATIONS)

THE MAXIMUM DISCHARGE RATES WERE BASED ON EQUIPMENT MANUFACTURER SPECIFICATIONS OR BY TAKING MONITORED DATA FROM COMPARABLE INSTALLATIONS, AND A MARGIN OF SAFETY WAS ADDED TO REPRESENT THE UPPER END OF EACH DISCHARGE SOURCE DURING NORMAL OPERATIONS.

These requested permit limits were used in the model on an operational basis of 24 hours per day, 365 days a year.

Source	Flow Rate (m^3/min)	Discharge Concentration (mg/m^3)			Maximum Discharge Rate (g/s)				
		TSP	NO_X	SO_2	TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2
Biomass Dryer 1	1,800	15	-	-	0.45	0.45[a]	0.41[a]	-	-
Biomass Dryer 2	1,800	15	-	-	0.45	0.45[a]	0.41[a]	-	-
Biomass Feedstock Handling Air Collection System (Baghouse)	460	20	-	-	0.15	0.15[b]	0.11[b]	-	-
Vapour Combustor	405	0.0	83.3	22.2	-	-	-	0.56	0.15
Supercritical Water Boiler 1	53.6	7.3	472.7	0.7	0.007	0.007[c]	0.007[c]	0.42	6×10^{-4}
Supercritical Water Boiler 2	53.6	7.3	472.7	0.7	0.007	0.007[c]	0.007[c]	0.42	6×10^{-4}
Supercritical Water Boiler 3	53.6	7.3	472.7	0.7	0.007	0.007[c]	0.007[c]	0.42	6×10^{-4}
Supercritical Water Boiler 4	53.6	7.3	472.7	0.7	0.007	0.007[c]	0.007[c]	0.42	6×10^{-4}
Vacuum Column Heater	9.2	7.1	71.4	0.4	0.001	0.001[c]	0.001[c]	0.01	6×10^{-5}
				Total Authorized Discharges	**1.08**	**1.08**	**0.95**	**2.3**	**0.15**

Notes: Flow rates and discharge concentrations are expressed at 293.15 K, 103.15 kPa, 0% moisture, actual oxygen contents.

(a) PM_{10} and $PM_{2.5}$ emissions are estimated using particle size fractions from Gitxsan Development Corporation 2019.

(b) PM_{10} and $PM_{2.5}$ emissions are estimated using particle size fractions from Pinnacle Renewable Energy Inc. 2014.

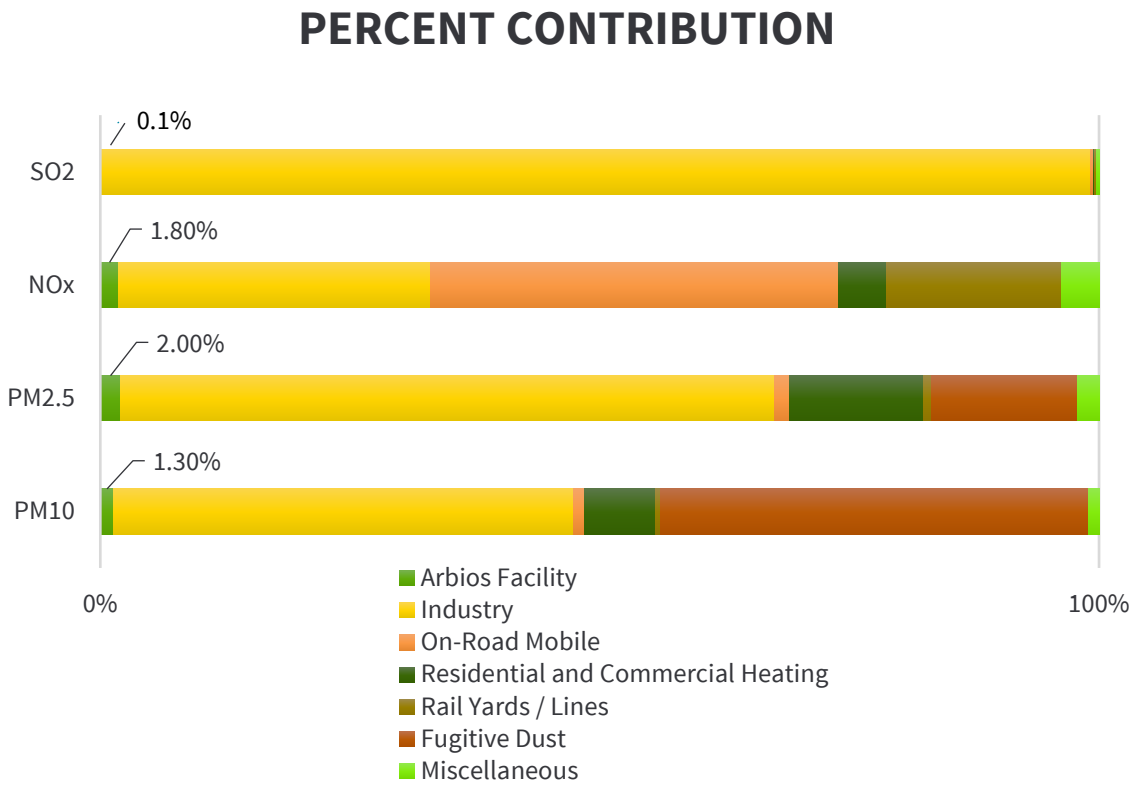
(c) All particulate matter emissions from natural gas combustion are assumed to be $PM_{2.5}$.

FACILITY CONTRIBUTION TO REGIONAL EMISSIONS

The Chuntoh Ghuna facility dispersion model is based upon a community model that was, in turn, based upon an inventory of all sources in the airshed.

Of that inventory, the Chuntoh Ghuna facility Permit limits would account for 2% of all $PM_{2.5}$ emissions and 1.8% of all NOx emissions.

Source: Nilson, B., Jackson, P., Ainslie, B., and Roth, G. 2020



MODELLING RESULTS

THE MODELLING SHOWS THAT MAXIMUM CUMULATIVE CONCENTRATIONS OF PM AND NO_2 MAY EXCEED RELEVANT AAQOS WHEN COMBINED WITH THE **HIGH BACKGROUND CONCENTRATIONS IN THE PRINCE GEORGE REGION**

Uncertainty with characterizing emissions from fugitive discharges and incorporating them in dispersion modelling.

Maximum modelled concentrations of particulate matter may exceed relevant AAQOs. However, modelled exceedances of the AAQOs are largely related to high background concentrations.

Background 24-hour PM_{10} and $PM_{2.5}$ concentrations, based on the 98th percentile of measured data from the Plaza 400 station, are already at 98% and 84% of the relevant AAQO, respectively.

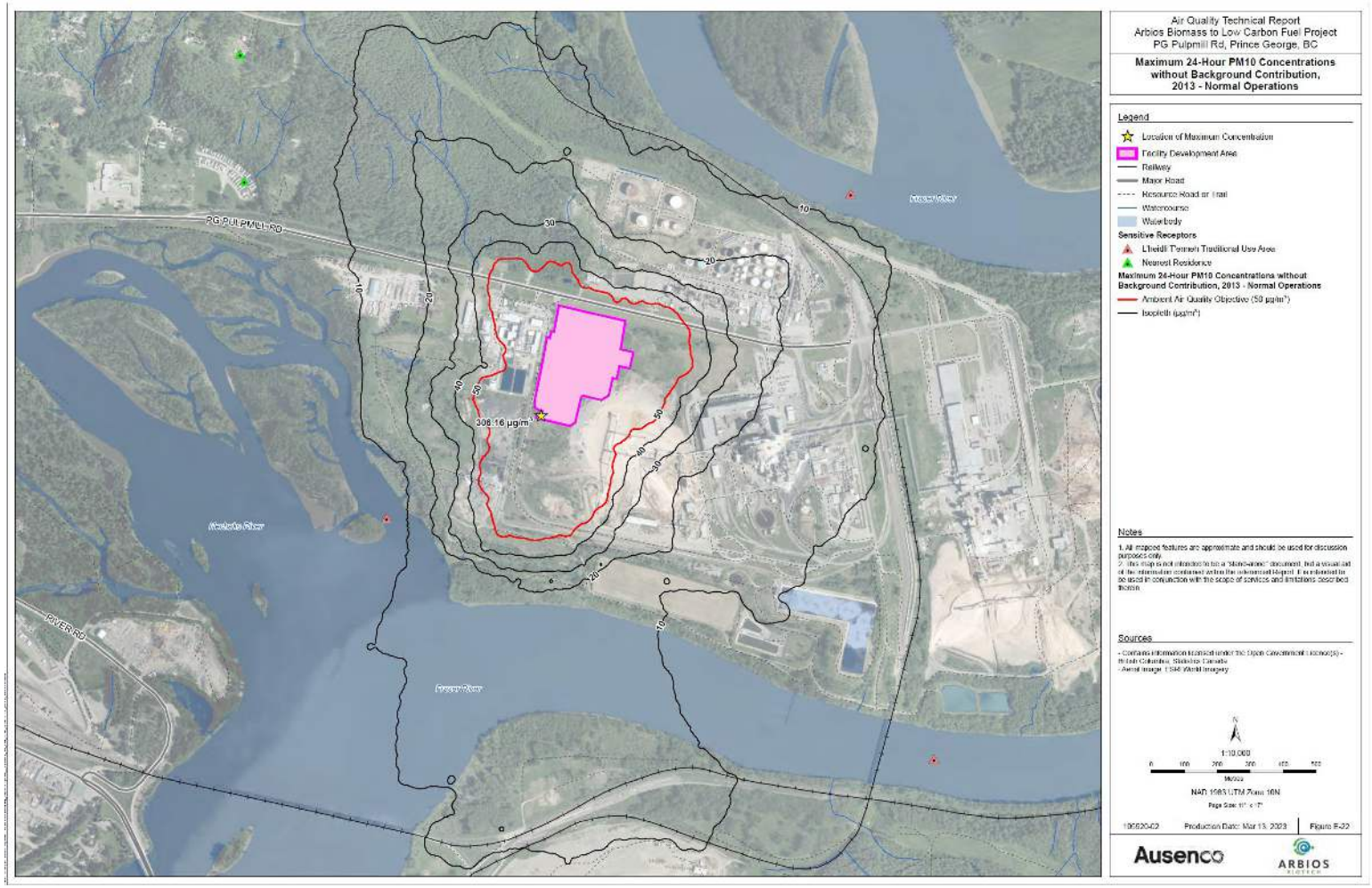
PM concentrations due to the Facility alone are very low throughout the City of Prince George, exceeding the AAQOs only within 200 m of the Facility. Area of modelled exceedances encompasses existing industrial facilities where public exposure would be minimal. Air quality objectives typically do not apply within industrial facilities, which are subject to workplace health and safety regulations.

AQTR Table 7.1 Maximum Modelled Concentrations, All Sources - Normal Operation (includes fugitive emissions)

Contaminant	Averaging Period	MPOI	Senior Care Facility	School	Hospital	Nearest Residence	Lheidli T'enneh Traditional Use Area	AAQO
Without Background								
TSP	24-hour	**377.5**	3.6	7.7	3.1	7.8	9.5	120
	Annual	58.4	0.3	0.6	0.2	0.9	1.2	60
PM_{10}	24-hour	**307.8**	3.6	7.7	3.1	7.7	9.2	50
$PM_{2.5}$	24-hour[a]	**128.1**	1.2	2.7	0.8	3.1	4.0	25
	Annual	**38.6**	0.2	0.5	0.1	0.6	0.8	8
NO_X	1-hour[b]	148.3	17.0	43.5	15.2	39.5	40.3	-
	Annual	12.5	0.2	1.1	0.2	0.4	0.6	-
NO_2	1-hour[b]	91.0	15.3	39.2	13.6	35.5	36.3	113
	Annual	10.7	0.2	0.9	0.2	0.4	0.6	32
SO_2	1-hour[c]	7.3	0.9	1.8	0.6	1.1	1.5	183
	Annual	0.2	0.005	0.02	0.004	0.009	0.01	13
With Background								
TSP	24-hour	**446.8**	72.9	77.0	72.4	77.1	78.8	120
	Annual	**86.1**	28.0	28.3	27.9	28.6	29.0	60
PM_{10}	24-hour	**356.6**	**52.4**	**56.5**	**51.9**	**56.5**	**58.0**	50
$PM_{2.5}$	24-hour[a]	**149.1**	22.2	23.7	21.8	24.1	25.0	25
	Annual	**47.0**	**8.6**	**8.9**	**8.5**	**9.0**	**9.2**	8
NO_X	1-hour[b]	236.6	105.3	131.8	103.5	127.8	128.6	-
	Annual	30.4	18.1	18.9	18.1	18.3	18.5	-
NO_2 – default background	1-hour[b]	**179.3**	103.6	**127.5**	101.9	**123.8**	**124.6**	113
NO_2 – refined background	1-hour[b]	**163.0**	95.2	110.0	95.1	99.5	95.4	113
NO_2	Annual	28.6	18.1	18.8	18.1	18.3	18.5	32
SO_2	1-hour[c]	110.1	103.7	104.6	103.4	103.9	104.3	183
	Annual	3.3	3.1	3.1	3.1	3.1	3.1	13

Notes: MPOI = maximum point of impingement, AAQO = ambient air quality objective.
Values in bold font exceed the relevant air quality objective.
Values for NOX are equivalent to NO2 following the total conversion method.
(a) Based on 98th percentile of daily average, over one year.
(b) Based on annual 98th percentile of daily 1-hour maximum, averaged over three years.
(c) Based on annual 99th percentile of daily 1-hour maximum, averaged over three years.

EXAMPLE PM_{10} CONCENTRATIONS
24HR MAXIMUM, WITHOUT BACKGROUND, NORMAL OPERATIONS



This image shows the maximum modelled 24hr period concentrations of PM_{10} due to facility emissions in 2013. It shows the maximum impact that could occur in any direction, regardless of timing.

Modelled cumulative (facility + background) concentrations may exceed ambient air quality objectives primarily due to high background concentrations.

Maximum modelled concentrations from facility emissions exceed objectives within 200 m of facility

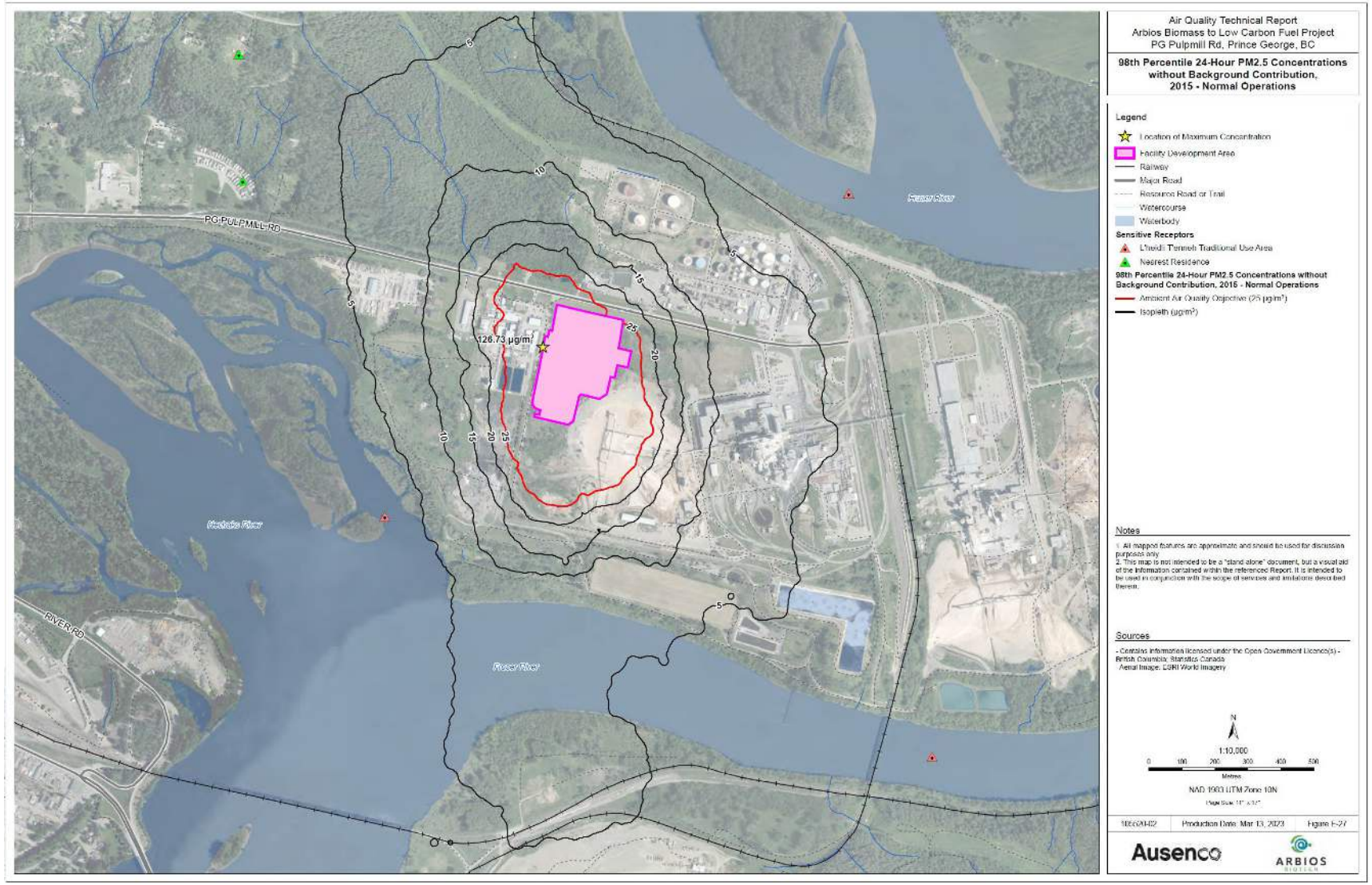
- Ambient air quality objectives do not typically apply to industrial facilities
- Public exposure is minimal

Facility emissions are modelled against a background which is based on the 8th “worst” day over the year 3 years during which the baseline is established (49 µg/m3).

- The 24-hour Ambient Air Quality Objective is 50 µg/m3
- Modelled cumulative (facility + background) concentrations may exceed the ambient air quality objective primarily due to high background concentrations.
- **Facility contributions at sensitive receptors are low relative to background air quality.**

EXAMPLE $PM_{2.5}$ CONCENTRATIONS

98^{TH} %ILE, 24 HR, WITHOUT BACKGROUND, NORMAL OPERATIONS



This image shows the maximum modelled 24hr period concentrations of $PM_{2.5}$ due to the facility emissions in 2015. It shows the maximum impact that could occur in any direction, regardless of timing.

Similar to PM_{10}, maximum modelled concentrations from facility emissions exceed the objective within 200 m of facility.

Facility emissions are modelled against a background which is based on the 8th “worst” day over the year 3 years during which the baseline is established (21 µg/m3).

- The 24-hour Ambient Air Quality Objective is 25 µg/m3
- Modelled cumulative (facility + background) concentrations may exceed ambient air quality objectives primarily due to high background concentrations.
- **Facility contributions at sensitive receptors are low relative to background air quality.**
- **No cumulative exceedances at sensitive receptor locations.**

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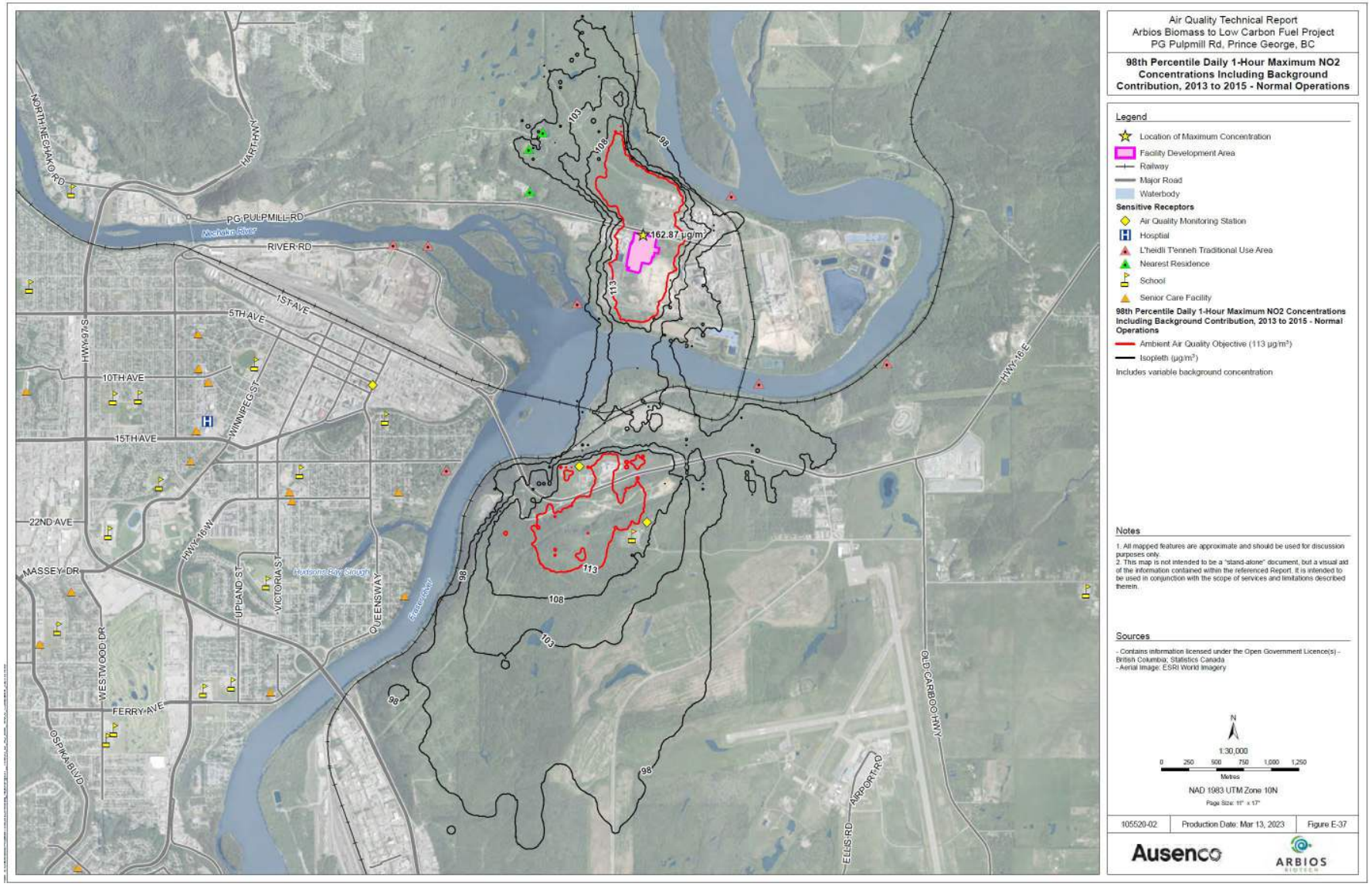
EXAMPLE MAX NO_2 CONCENTRATIONS
1 HR MAXIMUM, INCLUDING BACKGROUND NORMAL OPERATIONS



This image shows the maximum modelled NO2 concentration during a 1-hour period, with cumulative (facility + background contributions)

- No exceedances in any locations due to facility contributions
- Cumulative (facility + background) concentrations may exceed the 1-hour objective within 3 km of the facility.
- No exceedances at sensitive receptors
- Areas of cumulative modelled exceedances include area around the facility as well as an area on the hillside near the Correctional Facility
- Possible exceedances of 1-hour objective predicted only during periods of temperature inversion, less than 3% of the time.

Modelled cumulative concentrations are less than the annual objective at all locations.

ARBIOS CONTRIBUTIONS TO $PM_{2.5}$ AND NO_2 AT PLAZA 400

FIGURE 7.1 FROM THE AQTR: HOURLY TIME SERIES OF MODELLED $PM_{2.5}$ CONCENTRATIONS AT PLAZA 400, SHOWING BACKGROUND AND FACILITY CONTRIBUTIONS

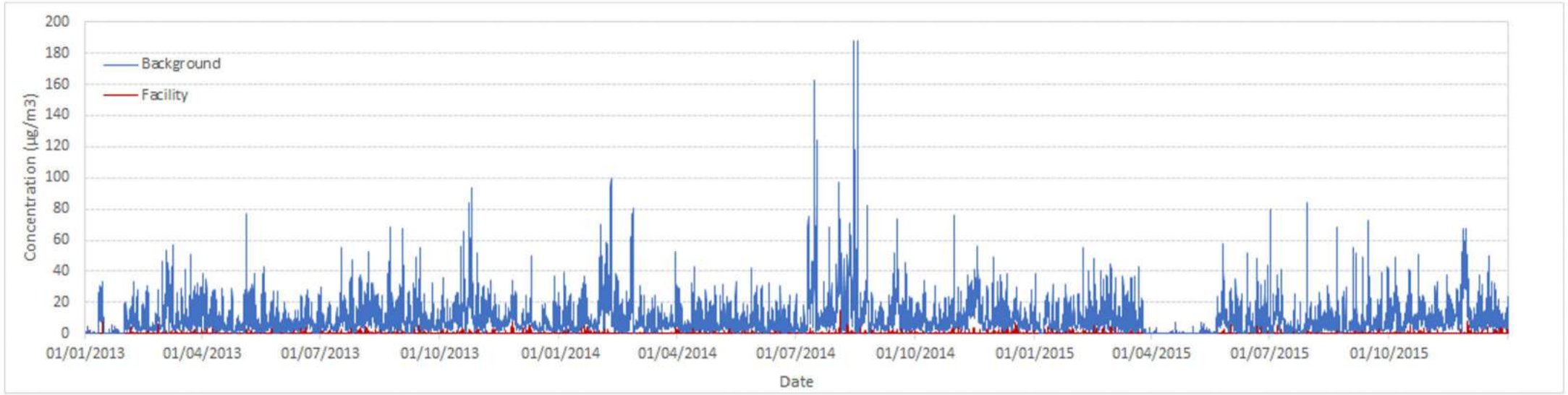
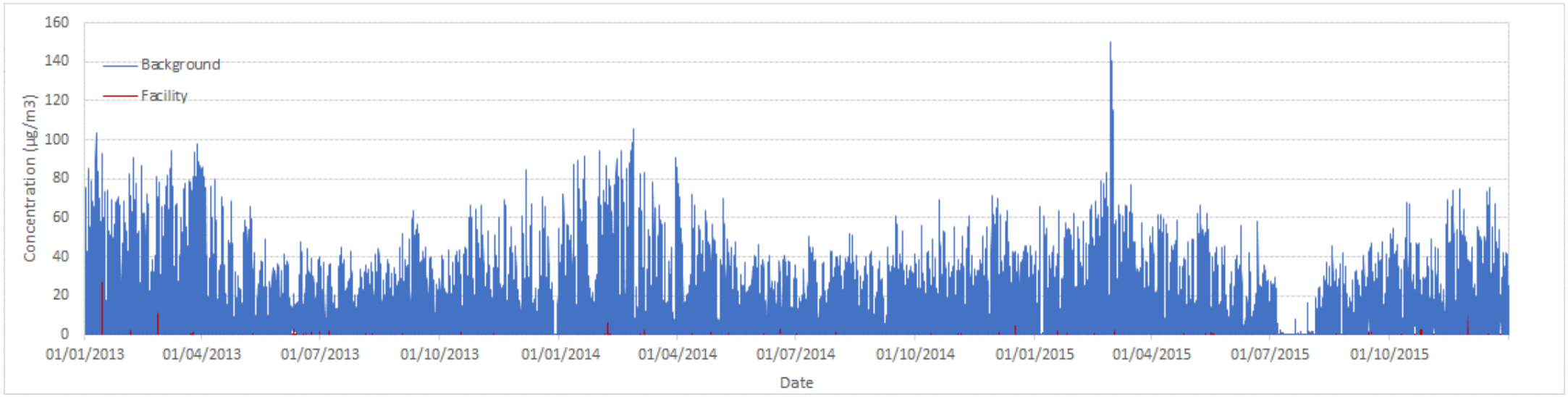


FIGURE 7.4 FROM THE AQTR: HOURLY TIME SERIES OF MODELLED NO_2 CONCENTRATIONS AT PLAZA 400, SHOWING BACKGROUND AND FACILITY CONTRIBUTION



WITH ADHERENCE TO AN ENVIRONMENTAL MANAGEMENT PLAN **THE FACILITY IS NOT EXPECTED TO ADVERSELY AFFECT AIR QUALITY IN PRINCE GEORGE.**

For PM (all size fractions), maximum potential discharges from the Chuntoh Ghuna facility may result in exceedances of the AAQO only within 200 m of the Facility

For NO_2, exceedances of the 1-hour AAQO are found in an area within 3 km of the Facility. There are few public receptors within this area of potential exceedance. Exceedances are expected to be very infrequent.

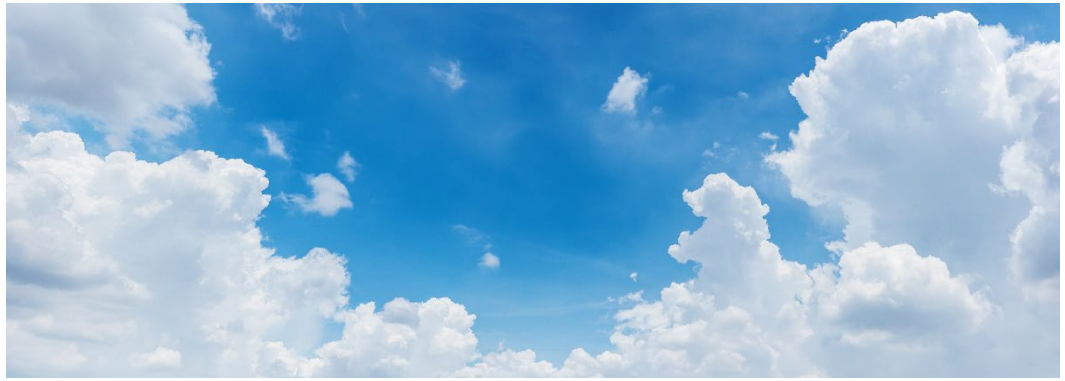
The calculation for the conversion of NO to NO_2 is expected to result in substantially over-estimated NO_2 concentrations in the model results.

Closure of the PG Pulp Mill pulp line will result in a reduction of over 8g/s of NO_X; Arbios total permitted maximum emissions will be 2.3g/s.

Maximum modelled concentrations for SO_2 are expected to remain well below the AAQOs.

MODELLED IMPACTS ARE ASSOCIATED WITH THE CHUNTOH GHUNA FACILITY EMISSION RATES AT THEIR MAXIMUM PERMITTED LEVELS THROUGHOUT THE YEAR

"In reality, the average emission rates during facility operations are expected to be considerably lower"



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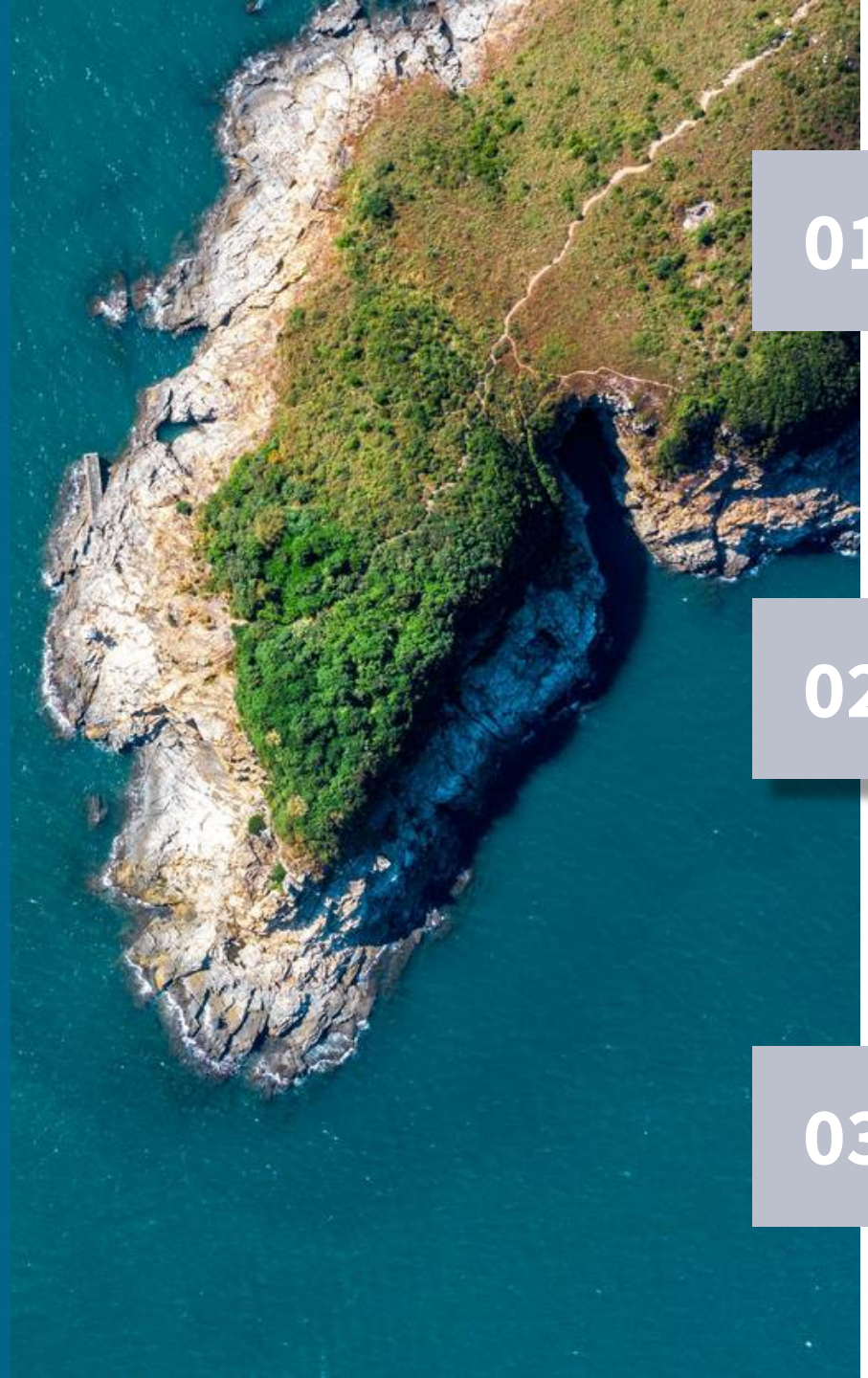
NEXT STEPS



01

Public Notification Period

The BC Public Notification Regulation requires a 30 day notification period; anyone is encouraged to comment on the Air Discharge Permit

02

Finalize Submission

After the 30 day notification period, Arbios will submit a Consultation Report, along with a Technical Assessment Report, to ENV.

03

Air Permit Review

After receiving the TAR from Arbios, ENV will review the submission and, when complete, will begin the process of drafting an Air Permit. In the meantime, Arbios will prepare for the construction of the Chuntoh Ghuna facility.

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