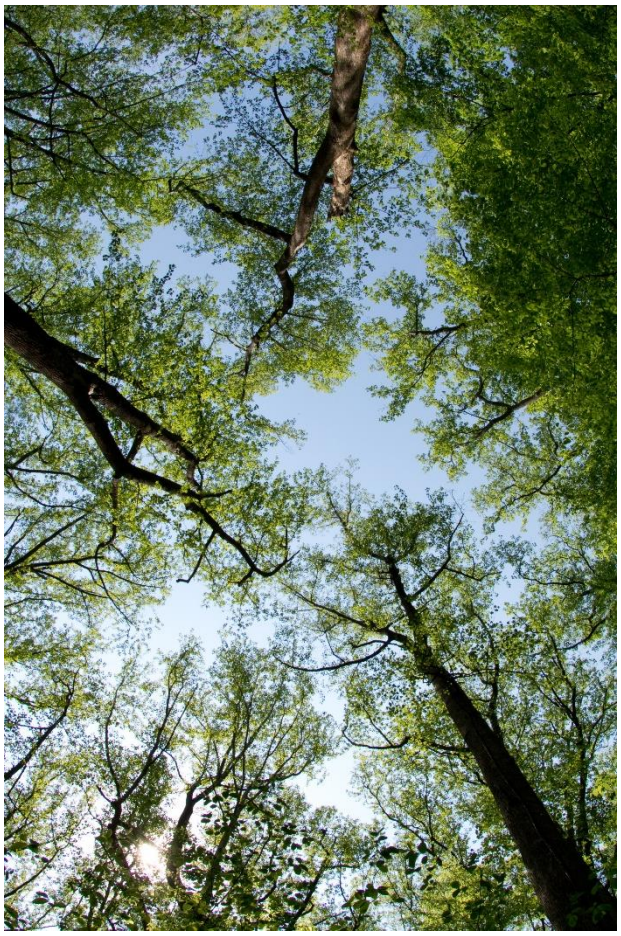
Chuntoh Ghuna Facility Air Quality Technical Report



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Executive Summary

Arbios Biotech Canada LP (Arbios) is proposing to construct the Chuntoh Ghuna Facility (the Facility) located at 2233 Prince George Pulpmill Road, Prince George, British Columbia (BC) adjacent to the Canfor Pulp Products Inc. Intercontinental Pulp Mill site. The Facility will receive approximately 50,000 dry tonnes of woody biomass per year and create 100,000 barrels of renewable bio-oil using the breakthrough Cat-HTR™ technology.

The key air contaminants of concern associated with Facility operations are particulate matter (PM), nitrogen dioxide (NO_2), and sulphur dioxide (SO_2). Dispersion modelling was conducted using the CALPUFF modelling system to estimate maximum ambient concentrations of these contaminants associated with proposed maximum authorized discharges from the Facility.

During normal operations, maximum modelled concentrations of PM may exceed relevant ambient air quality objectives primarily due to the high background concentrations in the Prince George region. Modelled concentrations from Facility discharges exceed the objectives only within 200 m of the Facility, in an area encompassing industrial lands where public exposure would be minimal. The magnitude of the modelled Facility contribution to ambient PM concentrations decreases rapidly with distance from the Facility and is minimal in areas with public receptors. Maximum modelled NO_2 concentrations may exceed the 1-hour objective within 3 km of the Facility, in an area encompassing few public receptors. The frequency of excursion above the numerical value of the NO_2 objective at these public receptors will be infrequent, less than 3% of the time. Furthermore, the use of the ambient ratio method to estimate the conversion of nitric oxide (NO) (from Facility emissions) to NO_2 (in the atmosphere) is expected to result in substantially over-estimated NO_2 concentrations in the model results. Maximum modelled SO_2 concentrations during normal Facility operations remain well below relevant air quality objectives.

In the event of a site-wide power failure, all process gas at the Facility will be diverted to the vapour combustor. The duration of such a scenario is expected to be short, up to 1 hour, and the occurrence is expected to be infrequent, less than 4 times per year. Within this scenario, maximum modelled NO_2 concentrations may exceed the numerical value of the 1-hour NO_2 objective in isolated areas within 4 km of the Facility. Assuming this scenario over a full year, the frequency of excursion is very low, occurring approximately 0.01% of the time. Therefore, it is highly unlikely that a site-wide power failure will occur at the same time as meteorological conditions conducive to elevated concentrations. Maximum modelled SO_2 concentrations during the site-wide power failure also remain well below relevant air quality objectives.

It is important to note that these impacts are associated with the Facility emission rates at their maximum permitted levels throughout the year. In reality, the average emission rates during Facility operation are expected to be considerably lower. Modelled impacts associated with these high end estimates are added to background air quality levels that represent the 4^{th} to 8^{th} worst day of the year (depending on the contaminant). The coincidence of highest Facility impacts with these background contaminant levels in the airshed is unlikely. This, combined with a number of other precautionary measures in the assessment, including assumption of no proactive management of emissions from biomass handling and no accounting for reductions in industrial emissions in the Prince George region, result in a portrait of maximum potential impacts from Facility operations. In summary, expectations are that Facility operations will not lead to adverse air quality in the community.

Disclaimer

This work was performed in accordance with the Professional Services Agreement between Ausenco Sustainability Inc., a wholly owned subsidiary of Ausenco Engineering Canada Inc. (Ausenco), and Arbios (Client), dated May 6, 2022] (Contract). This report has been prepared by Ausenco, based on fieldwork conducted by Ausenco, for sole benefit and use by Arbios. In performing this work, Ausenco has relied in good faith on information provided by others, and has assumed that the information provided by those individuals is both complete and accurate. This work was performed to current industry standard practice for similar environmental work, within the relevant jurisdiction and same locale. The findings presented herein should be considered within the context of the scope of work and project terms of reference; further, the findings are time sensitive and are considered valid only at the time the report was produced. The conclusions and recommendations contained in this report are based upon the applicable guidelines, regulations, and legislation existing at the time the report was produced; any changes in the regulatory regime may alter the conclusions and/or recommendations.

This Executive Summary is not intended to be a stand-alone document, but a summary of findings as described in the following Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

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List of Acronyms and Abbreviations

Acronym / Abbreviation	Definition
AAQO	ambient air quality objective
Arbios	Arbios Biotech Canada Limited Partnership (LP) represented by its general partners Arbios Biotech Canada (GP 1) Ltd. and Arbios Biotech Canada (GP 2) Ltd
ARM	ambient ratio method
BC	British Columbia
BC ENV	British Columbia Ministry of Environment and Climate Change Strategy
BPIP-PRIME	Building Profile Input Program Plume Rise Model Enhancement
CAAQS	Canadian ambient air quality standard
D1HM	daily 1-hour maximum
ECCC	Environment and Climate Change Canada
Facility	Chuntoh Ghuna Facility
MPOI	maximum point of impingement (i.e., according to modelled results, the location of maximum concentration within the study area)
NO	nitric oxide
NO_2	nitrogen dioxide
NO_X	nitrogen oxides
PM	particulate matter
$PM_{2.5}$	particulate matter less than 2.5 microns in diameter
PM_{10}	particulate matter less than 10 microns in diameter
SO_2	sulphur dioxide
TSP	total suspended particulate
WRF	Weather Research Forecast model

List of Symbols and Units of Measure

Symbol / Unit of Measure	Definition
%	percent
°C	degrees Celsius
$\mu g/m^3$	micrograms per cubic metre
g/s	grams per second
K	degrees Kelvin
km	kilometres
m	metres
m/s	metres per second
m^3/min	cubic metres per minute
mg/m^3	milligrams per cubic metre
mm	millimetres
s^{-1}	per second

1.0 Introduction

Arbios Biotech Canada LP (Arbios) is proposing to construct the Chuntoh Ghuna Facility (the Facility) located at 2233 Prince George Pulpmill Road, Prince George, British Columbia (BC) adjacent to the Canfor Pulp Products Inc. Intercontinental Pulp Mill site in Prince George, BC. The Facility will produce renewable bio-oil with a low-carbon footprint, using the breakthrough Cat-HTR™ technology, from low-value woody biomass feedstock. This report describes the approach and findings of an air quality technical assessment, conducted in support of the application for a Waste Discharge Authorization. The air quality technical assessment considers operation of the Facility, sized to process approximately 50,000 dry tonnes of woody biomass to create 100,000 barrels of renewable bio-oil per year.

2.0 Facility Description

Woody biomass feedstock is transported to the Facility by truck and unloaded into a covered biomass storage pile, sized to store biomass for approximately 3 days. The biomass is drawn from the storage pile via a mechanical reclaimer to a system of covered conveyors and transferred to screening equipment and size reduction equipment whereby biomass is processed to remove unwanted objects, rocks and ice, and shredded to reduce particle size. The shredded biomass is then dried using single pass belt dryers and fed into a high-pressure reactor where the biomass undergoes hydrothermal liquefaction to produce bio-oil. Liquid products from the high-pressure reactor undergo flash separation to separate bio-oil from non-condensable gases and wastewater. Bio-oil is sent to a vacuum column for further fractionation of distillates prior to storage in the tank farm where it is later shipped out by truck.

During normal operation, the Facility process results in air discharges from the following authorized discharge points:

- Biomass belt dryers (x2)
- Natural gas fired supercritical water boilers (x4)
- Biomass feedstock handling air collection system
- Natural gas vacuum column heater
- Vapor combustor.

Handling of woody biomass feedstock may also generate fugitive dust. The size of the feedstock material will range from 25 mm to 100 mm, with a nominal size of 50 mm, and will have a moisture content of 45% to 55% by weight. All biomass handling points after size reduction and drying will have air collection and will be vented through a baghouse.

In addition to these authorized and fugitive discharges, there may be other minor discharges consistent with an industrial site:

- Wind erosion of biomass storage pile: Under high winds, wind erosion of exposed pile areas may generate fugitive dust. As the pile will be under a roof cover, and the biomass has a large particle size and high moisture content, fugitive dust from wind erosion is expected to be minimal.
- Boiler blowdown and vents: Exhaust from the boiler blowdown and vents is expected to consist primarily of steam.
- Storage tanks: Vapours venting from storage tanks will be captured and routed to the vapour combustor. Fugitive discharges from storage tanks will be minimal.
- Wastewater treatment plant: Vapours from the anaerobic reactor will be captured and routed to the vapour combustor. There may be a small amount of fugitive discharges from the flash oxidation tank, downstream of the anaerobic reactor, consisting primarily of carbon dioxide with a trace amount of organic compounds, typical for this type of water treatment.
- Metalwork: Any discharges from metalwork (e.g., welding) are expected to be infrequent and minor in comparison to the authorized and fugitive discharges considered for the Facility.
- Nitrogen generator: Discharge from the nitrogen generator is expected to consist primarily of oxygen.

In the event of a site-wide power failure, all process gas will be diverted to the vapour combustor. Air discharges associated with this emergency release scenario is considered in the air quality technical assessment. The duration of such a scenario is expected to be short, up to 1 hour, and the frequency of occurrence is expected to be ,less than 4 times per year.

3.0 Air Discharges

This section summarizes the maximum expected air discharges from the Facility during normal operation and during the emergency release scenario. A site plan of all point and fugitive sources from the Facility is provided in **Figure 1** attached.

This air quality technical assessment considers discharges of the following criteria air contaminants[1]:

- Total suspended particulate (TSP)
- Particulate matter less than 10 microns in diameter (PM_{10})
- Particulate matter less than 2.5 microns in diameter ($PM_{2.5}$)
- Nitrogen oxides (NO_X), comprised of nitric oxide (NO) and nitrogen dioxide (NO_2)
- Sulphur dioxide (SO_2).

3.1 Authorized Point Discharges

Maximum and typical discharges associated with the normal operation of authorized point sources at the Facility are summarized in **Table 3.1** and **Table 3.2**, respectively. Typical discharge rates were determined based on manufacturer specifications, with the exception of the biomass dryers which were estimated based on a review of stack testing data of a similar unit at the Canfor Fort St. John sawmill. A margin of safety has been added to derive the maximum discharge rates. Only the maximum discharge rates, which represent the requested permit limits, are carried forward in the air quality technical assessment. For the purposes of this air quality technical assessment, all discharges from the Facility were assumed to occur continuously (i.e., 24 hours per day, 365 days per year).

[1] The Facility will also result in the discharge of carbon monoxide, a standard product of combustion. There are currently no ambient air quality objectives for carbon monoxide; the previous pollution control objectives were developed in the 1970's and rescinded in 2006. An addendum on potential emissions of carbon monoxide from the Facility is provided in **Appendix A**.

Table 3.1 Maximum Discharges from Authorized Point Sources

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 $PM_{2.5}$.

Table 3.2 Typical Discharges from Authorized Point Sources (For Information and Comparative Purpose)

Source	Flow Rate (m^3/min)	Discharge Concentration (mg/m^3)			Typical Discharge Rate (g/s)				
		TSP	NO_X	SO_2	TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2
Biomass Dryer 1	1,610	12.2[(a)]	-	-	0.33	0.33[(b)]	0.20[(c)]	-	-
Biomass Dryer 2	1,610	12.2[(a)]	-	-	0.33	0.33[(b)]	0.20[(c)]	-	-
Biomass Feedstock Handling Air Collection System (Baghouse)	450	15	-	-	0.11	0.11[(d)]	0.08[(d)]	-	-
Vapour Combustor	405	-	65.0	5.0	-	-	-	0.44	0.03
Supercritical Water Boiler 1	50.3	7.3	337.0	0.7	0.006	0.006[(c)]	0.006[(c)]	0.28	5×10^{-4}
Supercritical Water Boiler 2	50.3	7.3	337.0	0.7	0.006	0.006[(c)]	0.006[(c)]	0.28	5×10^{-4}
Supercritical Water Boiler 3	50.3	7.3	337.0	0.7	0.006	0.006[(c)]	0.006[(c)]	0.28	5×10^{-4}
Supercritical Water Boiler 4	50.3	7.3	337.0	0.7	0.006	0.006[(c)]	0.006[(c)]	0.28	5×10^{-4}
Vacuum Column Heater	8.6	7.1	66.0	0.4	0.001	0.001[(c)]	0.001[(c)]	0.009	5×10^{-5}
				Total Discharges	**0.79**	**0.79**	**0.50**	**1.6**	**0.04**

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

(a) Based on the maximum measured discharge concentration from stack test data of the Stela dryer at the Canfor Fort St. John sawmill.

(b) PM_{10} emissions are estimated using particle size fractions from Gitxsan Development Corporation 2019.

(c) $PM_{2.5}$ emissions are estimated using the maximum measured particle size fraction from stack test data of the Stela dryer at the Canfor Fort St. John sawmill.

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

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

3.2 Fugitive Discharges

Fugitive dust may be released from the following points of biomass feedstock handling (see **Figure 1**):

- Drop from mechanical reclaim to reclaim conveyor
- Drop from reclaim conveyor to scalping screen
- Drop from scalping screen to transfer conveyor
- Drop from transfer conveyor to size reduction equipment.

As a mitigation to fugitive emissions, with the exception of the mechanical reclaim, all biomass feedstock transfer points will be covered. All other points of biomass handling will be collected and vented to the baghouse.

Emissions of particulate matter associated with these fugitive discharge points were estimated based on a maximum material handling rate of 8.25 dry tonnes per hour using emission factors from the National Council for Air and Stream Improvement, Inc. These emission factors pertain to handling of wood residue at wood product operations such as sawmills and lumber mills and have been published by Environment and Climate Change Canada for use in facility reporting to the National Pollutant Release Inventory (ECCC 2020). Emission factors for PM_{10} and $PM_{2.5}$ are not available for green/wet wood material handling, and therefore emissions were estimated using PM size ratios for dry wood material handling. The PM emissions related to fugitive material handling used in the modelling are therefore expected to represent a high end estimate of actual Facility emissions.

Estimated fugitive discharges associated with normal operation of the Facility are presented in **Table 3.3**. These estimates do not account for the covered transfer system for all but the mechanical reclaim conveyor.

Table 3.3 Maximum Discharges from Fugitive Sources

Discharge Point	Maximum Discharge Rate (g/s)		
	TSP[(a)]	PM_{10}[(b)]	$PM_{2.5}$[(b)]
Drop from mechanical reclaim to reclaim conveyor	0.022	0.015	0.002
Drop from reclaim conveyor to scaling screen	0.022	0.015	0.002
Drop from scalping screen to transfer conveyor	0.022	0.015	0.002
Drop from transfer conveyor to size reduction equipment	0.022	0.015	0.002
Total Fugitive Discharges	**0.088**	**0.059**	**0.008**

Notes:

(a) TSP emissions are estimated based on emission factors for green wood material handling.

(b) PM_{10} and $PM_{2.5}$ emissions are estimated based on TSP emission rates using particle size fractions derived from emission factors for dry wood material handling.

3.3 Emergency Discharges

Maximum discharges associated with the emergency release scenario are summarized in **Table 3.4**. This scenario relates to the treatment of all process gas through the vapour combustor during a site-wide power failure. All other sources will be shut down during emergency release.

Table 3.4 Maximum Discharges from Emergency Release

Parameter	Value
Flow rate (m^3/min)	1,350
Discharge concentrations (mg/m^3)	
TSP	-
NO_X	127.8
SO_2	22.2
Discharge rates (g/s)	
TSP	-
PM_{10}	-
$PM_{2.5}$	-
NO_X	2.9
SO_2	0.5

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

3.4 Summary

A summary of maximum potential emission rates from the Facility during normal operation is presented in **Table 3.5** and compared to total emissions in the Prince George region, based on the most recent emission inventory completed by UNBC for the Prince George Air Improvement Roundtable. As shown in the table, the Facility is expected to represent 2% or less of PM and NO_X emissions in the region, and only 0.1% of SO_2 emissions in the region. It should be noted that regional emissions in this table represent the best available information (e.g., actual emissions test results for pulp mills) whereas the Arbios Facility emissions are based on maximum requested permit limits.

Table 3.5 Facility Contribution to Regional Emissions

Source	PM_{10} Emission Rate (g/s)	Percent Contribution	$PM_{2.5}$ Emission Rate (g/s)	Percent Contribution	NO_X Emission Rate (g/s)	Percent Contribution	SO_2 Emission Rate (g/s)	Percent Contribution
Arbios Facility	2.30	1.3%	0.96	2.0%	2.30	1.8%	0.15	0.1%
Industry	39.93	45.5%	30.33	64.4%	40.22	31.3%	220.07	99.1%
On-Road Mobile	1.00	1.1%	0.70	1.5%	52.47	40.8%	0.78	0.4%
Residential and Commercial Heating	6.31	7.0%	6.22	13.2%	6.16	4.8%	0.14	0.1%
Rail Yards / Lines	0.42	0.5%	0.40	0.8%	22.46	17.5%	0.45	0.2%
Fugitive Dust	37.11	42.3%	6.76	14.4%	-	-	-	-
Miscellaneous	1.80	1.1%	1.73	2.1%	4.84	3.8%	0.55	0.2%
Total	**87.71**	**100.0%**	**47.10**	**100.0%**	**128.45**	**100.0%**	**222.14**	**100.0%**

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

4.0 Regulatory Framework

Ambient air quality objectives (AAQOs) are developed by environment and health authorities to provide context to air quality measurements and to guide air management decisions for facility permitting. BC Ministry of Environment and Climate Change Strategy (BC ENV) has developed AAQOs for the criteria air contaminants included in this air quality technical assessment as shown in **Table 4.1**.

Also shown in **Table 4.1** are the Canadian Ambient Air Quality Standards (CAAQS) developed by the Canadian Council of Ministers of the Environment as a driver for air quality management across Canada to further protect human health and the environment through continuous improvement of air quality. It should be noted that the CAAQS are intended to be considered on an airshed or air zone basis which cover broad geographical areas and are not intended to be applied to individual projects and facilities or to be used as "fenceline" standards. The CAAQS are presented for information and comparative purposes.

Table 4.1 Ambient Air Quality Criteria

Contaminant	Averaging Period	BC AAQO (µg/m^3)	CAAQS (µg/m^3)	
			2020	2025
TSP	24-hour	120	-	-
	Annual	60[(a)]	-	-
PM_{10}	24-hour	50	-	-
$PM_{2.5}$	24-hour	25[(b)]	27[(c)]	-
	Annual	8[(d)]	8.8[(e)]	-
NO_2	1-hour	113[(f)]	113[(f)]	79[(f)]
	Annual	32	32	23
SO_2	1-hour	183[(g)]	183[(g)]	170[(g)]
	Annual	13	13	10

Sources: BC ENV 2020, CCME 2023

Notes:

(a) Based on annual geometric mean.
(b) Based on annual 98th percentile of daily average, over one year.
(c) Based on annual 98th percentile of daily average, averaged over three consecutive years.
(d) There is also a planning goal of 6 µg/m^3 to guide airshed planning efforts.
(e) Based on annual average, averaged over three consecutive years.
(f) Based on annual 98th percentile of daily 1-hour maximum (D1HM), averaged over three consecutive years.
(g) Based on annual 99th percentile of D1HM, averaged over three consecutive years.

5.0 Baseline Air Quality

Air quality in Prince George is measured at one core site located at Plaza 400 and at several additional sites throughout the community. The Plaza 400 air quality monitoring station is located in downtown Prince George approximately 3 km from the Facility. Based on communications with the BC ENV, baseline air quality was determined based on historical air quality monitoring data from the Plaza 400 station, as follows:

- One year of data from January 1 to December 31, 2016 for PM_{10} and $PM_{2.5}$
- Three years of data from January 1, 2018 to December 31, 2020 for NO_2 and SO_2.

These data periods were selected to provide an understanding of current air quality conditions in the community without the Facility. The 2018 to 2020 period represents the most recent 3-year period for which quality assured monitoring data are available from the BC ENV. Due to poor data capture for PM_{10} and $PM_{2.5}$ in 2019 and 2020, and extensive wildfire impacts in 2018, the 2016 year was selected to provide best available data for PM_{10} and $PM_{2.5}$.

There have been significant changes in the category of industrial emissions since the time periods of air quality monitoring used to support development of background concentrations. **Table 5.1** provides a summary of these changes. As a result, the baseline air quality conditions presented herein may not be fully representative of baseline conditions when the Facility begins operation. The total reduction in industrial emissions presented in **Table 5.1** (11.92 g/s TSP and 8.28 g/s NO_X) should be viewed in the context of total emissions from the Facility (1.20 g/s TSP and 2.30 g/s NO_X).

Table 5.1 Summary of Changes in Industrial Emissions

Permit No.	Data Source	Owner / Purpose of Change	Unit	Change in Discharge Rate (g/s)	
				TSP	NO_X
2065	PA-2065 dated November 24, 2022, as amended from August 2017	Tidewater - Addition of renewable diesel facility	Steam boiler	0.02	0.09
			Reformer	0.00	0.20
			Dewaxing heater	0.00	0.01
18312	MEI[a]	Pacific Bioenergy - Permanent closure	Vacuum and hog area baghouse	-0.01	0.00
			Fibre and cyclone baghouse	-0.01	0.00
			Plant baghouse	-0.01	0.00
			Pellet cooling system	-2.02	0.00
			Wood fibre dryers (2), combined stack	-0.61	0.00
2761	MEI[a]	Prince George Pulp and Paper - Closure of pulp line[b]	Lime kiln	-0.94	0.00
			Power boiler 1	-0.09	-1.36
			Cogeneration power boiler	-1.90	-0.50
			Recovery boiler	-4.63	-1.24
			Chip building dust cyclone	-0.13	0.00
			Chip fines cyclone	-0.13	0.00
			Chip unloading building cyclone	-0.13	0.00
			Smelt tank	-1.04	-5.21
			Incinerator stack	-0.29	-0.27
			Total Change	**-11.92**	**-8.28**

Notes:

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

(b) Scheduled for shut down end of Q1 2023. Power boiler may operate until end of Q4 2023.

Key statistics from the historical air quality monitoring data from Plaza 400 are presented in **Table 5.2**. Due to its location in a bowl-shaped depression near the confluence of the Fraser and Nechako rivers, Prince George is susceptible to elevated levels of air contaminants during temperature inversions that can occur during stable conditions with low winds. In 2016, daily average PM_{10} and $PM_{2.5}$ concentrations reached levels above the numerical values of the AAQOs approximately 1% of the time. The annual mean concentration of $PM_{2.5}$ in 2016 also exceeded the AAQO of 8 µg/m^3. Measured NO_2 concentrations remained below the 1-hour AAQO from 2018 to 2020 but exceeded the 2025 CAAQS during the 3-year period. As discussed in **Section 4.0**, the CAAQS are intended to be considered on an airshed or air zone basis which cover broad geographical areas and the Plaza 400 station represents only one monitoring station in the Central Interior Air Zone which encompasses the communities of Smithers, Prince George, Quesnel, and Williams Lake. Measured SO_2 concentrations remained below the 1-hour AAQO and 2025 CAAQS from 2018 to 2020 .

In accordance with the BC Air Quality Dispersion Modelling Guideline (BC ENV 2022), this historical monitoring data is used to develop a set of background concentrations, then added to modelled Facility impacts to estimate potential cumulative air quality for comparison with the AAQOs. Since it is not feasible to fully depict the temporal and spatial variation of actual background concentrations, a set of background concentrations are developed based on the 98th to 99th percentile of historical observations to provide a worst-case analysis of potential cumulative air quality including the Facility. This is further explained in **Section 6.3.2**.

Table 5.2 Summary of Historical Air Quality Monitoring at Plaza 400

Contaminant	Averaging Period	Percentile Concentrations (µg/m^3)					Mean Concentration (µg/m^3)	Frequency > AAQO
		100th	99th	98th	90th	75th		
PM_{10}	24-hour	69.8	52.5	48.8	28.3	20.7	16.1	1.2%
$PM_{2.5}$	24-hour	42.7	26.1	21.2	14.7	10.9	8.4	1.1%
NO_2	1-hour D1HM	111.5	90.9	88.3	69.4	48.6	17.9	0%
SO_2	1-hour D1HM	283.1	102.8	89.2	37.1	16.4	3.1	0.1%

Notes: D1HM = daily 1-hour maximum

6.0 Dispersion Modelling Methodology

Dispersion modelling was conducted using the CALPUFF dispersion modelling system to predict maximum ambient concentrations associated with the Facility discharge rates described in Section 3. The modelling approach is summarized in the following subsections. Overall, the modelling approach is consistent with the BC Air Quality Dispersion Modelling Guideline (BC ENV 2022) and with a model plan submitted to and approved by the BC ENV. A copy of the model plan and letter of approval is provided in **Appendix B**.

6.1 CALMET

CALMET is a meteorological model that develops hourly three-dimensional meteorological fields of wind and temperature used to drive contaminant transport in CALPUFF. The CALMET model has the ability to assimilate both observations from multiple meteorological stations and input meteorological fields from prognostic (weather forecasting) models. The model additionally simulates the changes in mixing height and boundary layer mechanics that result from the variable land cover characterization and terrain in the model domain. A summary of the CALMET model inputs is provided below.

6.1.1 Model Domain

The CALMET model domain is defined as a 40 km by 40 km area centred at the Facility as illustrated in Figure 2 attached. This area was chosen to encompass the complex terrain surrounding the Prince George area that can affect meteorological conditions in the community.

6.1.2 Model Period

CALMET was run for a 3-year period from January 1, 2013 to December 31, 2015. This represents the most recent 3-year period during which prognostic meteorological data were available (see **Section 6.1.3**).

6.1.3 Meteorology

CALMET was initialized using a BC prognostic model dataset to enhance the accuracy of modelled meteorological fields, in accordance with the BC Air Quality Dispersion Modelling Guideline (BC ENV 2022). The BC prognostic model was developed by the atmospheric science firm Exponent using the Weather Research and Forecasting (WRF) model, a mesoscale numerical prediction system designed to serve both atmospheric research and operational forecasting needs. The WRF model was run using the Advanced Research WRF core at a 4-km grid resolution. Although model results have been quality tested (by Exponent) with comparisons to observations at selected surface and upper air stations to provide assurance that the output can be used for dispersion modelling purposes, no comparisons have been completed in the Prince George region. At the request of the BC ENV, comparisons of the WRF model to surface and upper air observations in the Prince George region were completed and discussed in **Appendix C**.

The prognostic meteorological data was supplemented with surface observations from 7 stations as presented in **Table 6.1** and upper air observations from 1 station in Prince George. A map of the surface stations is provided in Figure 2 attached.

Table 6.1 Surface Meteorological Data for CALMET Modelling

Station	Data Provider	Data Period	Parameters Measured
PG Airport	ECCC	January 1, 2013 to December 31, 2015	Ambient temperature, relative humidity, station pressure, wind speed and direction, precipitation, cloud cover, ceiling height
PG Massey	ECCC	January 1, 2013 to December 31, 2015	Ambient temperature, relative humidity, station pressure, wind speed and direction, precipitation
PG Exploration Place	BC ENV	July 7, 2013 to December 31, 2015	Ambient temperature, relative humidity, wind speed and direction
PG Gladstone School	BC ENV	January 1, 2013 to November 12, 2015	Ambient temperature, relative humidity, wind speed and direction
PG Glenview School	BC ENV	January 1, 2013 to December 31, 2015	Ambient temperature, wind speed and direction
PG Plaza 400	BC ENV	January 1, 2013 to December 31, 2015	Ambient temperature, relative humidity, wind speed and direction
PG Pulp	BC ENV	January 1, 2013 to December 31, 2015	Ambient temperature, wind speed and direction

Notes: There is an additional surface station located at PG Marsulex. Only scalar mean wind speed data are available which does not satisfy requirements in the BC Air Quality Dispersion Modelling Guideline. This station is therefore excluded from dispersion modelling but used in the evaluation of CALMET model outputs.

6.1.4 Terrain Elevation and Land Cover Characterization

The terrain elevation used as input in the CALMET model was obtained from 0.75 arc-second Canadian Digital Elevation Model (Natural Resources Canada 2017). Land cover characterization was obtained from the 2015 Land Cover of Canada which contains remote sensing data at a 30-m spatial resolution (Natural Resources Canada 2019).

6.1.5 Geophysical Parameters

The CALMET model requires gridded geophysical parameters including surface roughness length, albedo, Bowen ratio, soil heat flux, anthropogenic heat flux, and leaf area index. To more accurately represent the seasonally dependent geophysical parameters in the CALMET model, five seasons were specified:

- Season 1: Midsummer with lush vegetation (June to August)
- Season 2: Autumn with cropland that has not been harvested (September)
- Season 3: Late autumn/winter after frost, no snow on ground (October)
- Season 4: Winter with snow on ground and subfreezing temperatures (November to March)
- Season 5: Transitional spring with partially green short annuals (April to May).

All geophysical parameters except anthropogenic heat flux were defined by land cover characterization and seasonal category as per the BC Air Quality Dispersion Modelling Guideline (BC ENV 2022). Default values for anthropogenic heat flux are provided for a mid-latitude city with mild winters and summers such as Vancouver. Therefore, more representative values were calculated for the Prince George region based on population density and per capita energy usage (Oke 1987).

6.1.6 Model Options and User Switches

Diagnostic model options for CALMET were chosen in accordance with the BC Air Quality Dispersion Modelling Guideline (BC ENV 2022) and with the model plan approved by the BC ENV. A list of the CALMET model options is provided in **Appendix D**.

6.2 CALPUFF

CALPUFF is a multi-layer, multi-species, non-steady state puff dispersion model approved for use for refined dispersion modelling assessments in BC and represents the model of choice in areas with complex terrain. CALPUFF simulates the influence of time-varying and space-varying meteorological conditions on contaminant transport, transformation, and deposition to predict ambient concentrations resulting from Facility discharges.

6.2.1 Model Domain and Receptor Locations

Puff transport and dispersion is computed within CALPUFF for the entire 40 km by 40 km CALMET domain. A discrete set of receptor points are specified in the CALPUFF model at which ambient concentrations are predicted. A Cartesian grid of nested receptors was defined within the study area based on communications with the BC ENV:

- 20-m spacing along the Facility boundary
- 50-m spacing within an area of 5.75 km by 5 km around the Facility, encompassing portions of downtown Prince George and the Millar Addition residential neighbourhood
- 250-m spacing within an area of 7.5 km by 8 km around the Facility, encompassing the community of Prince George east of Highway 97
- 500-m spacing over populated areas of Prince George
- 1,000-m spacing within the remainder of the CALPUFF domain.

This Cartesian grid of nested receptors exceeds requirements in the BC Air Quality Dispersion Modelling Guideline. In addition to the gridded receptors described above, a number of special receptors were defined at:

- Hospitals
- Schools
- Senior care facilities
- Nearest residences at the Spruce Capital Trailer Park and on Hoferkamp Road
- 7 Lheidli T'enneh First Nation traditional use sites (4 along the Fraser River, Cottonwood Island Nature Park, Kiwanis Park, Lheidli T'enneh Memorial Park)
- Air quality monitoring sites at Plaza 400, the Prince George Regional Correctional Centre, and the CBC Transmitter.

A map of the receptor locations is provided in Figure 3 attached. Terrain elevations for all receptors were extracted from the 0.75 arc-second Canadian Digital Elevation Model used in CALMET.

6.2.2 Source Parameters

All authorized discharges were modelled as point sources in CALPUFF, with stack parameters summarized in **Table 6.2**. All stack heights, diameters, and discharge flow rates were provided by Arbios. To model the varying ambient temperatures associated with the baghouse, the exit temperature was specified at 220 K (-53°C), below the range of ambient temperatures expected at the Facility based on CALMET modelling, such that the temperature excess and thermal buoyancy is zero at all model timesteps.

All fugitive discharges were modelled as volume sources in CALPUFF with source parameters summarized in **Table 6.3**. Release heights were estimated based on drawings provided by Arbios and initial plume sigmas were chosen to reflect the size of the initial dust cloud expected from the material transfer points, in accordance with guidance from the United States Environmental Protection Agency (US EPA 1995).

Table 6.2 Point Source Parameters for CALPUFF Modelling

Source	Elevation of Stack Base (m ASL)	Stack Height (m)	Inside Stack Diameter (m)	Exit Temperature (°C)	Exit Velocity (m/s)
Normal Operation					
Biomass Dryer 1	590.3	7.6[(a)]	2.00	35	10.0
Biomass Dryer 2	590.5	7.6[(a)]	2.00	35	10.0
Biomass Feedstock Handling Air Collection System (Baghouse)	591.3	5.5	0.64	Ambient[(b)]	24.2
Vapour Combustor	591.0	16.8	3.66	650	2.2
Supercritical Water Boiler 1	591.3	12.0	0.51	451	13.2
Supercritical Water Boiler 2	591.4	12.0	0.51	451	13.2
Supercritical Water Boiler 3	591.0	12.0	0.51	451	13.2
Supercritical Water Boiler 4	591.0	12.0	0.51	451	13.2
Vacuum Column Heater	591.1	6.8	0.15	482	25.9
Emergency Release					
Vapour Combustor	591.0	16.8	3.7	926	9.7

Notes:

(a) This represents an update in Facility design since submission of the approved model plan.

(b) Modelled as -53°C as described above.

Table 6.3 Volume Source Parameters for CALPUFF Modelling

Source	Release Height (m)	Initial Horizontal Plume Sigma (m)	Initial Vertical Plume Sigma (m)
Drop from mechanical reclaim to reclaim conveyor	1.0	0.2	0.2
Drop from reclaim conveyor to scalping screen	7.0	0.2	0.2
Drop from scalping screen to transfer conveyor	1.5	0.2	0.2
Drop from transfer conveyor to size reduction equipment	8.0	0.2	0.2

6.2.3 Building Downwash

Buildings located close to stacks (i.e., point sources) may influence dispersion. The effect of buildings and structures at the Facility (see Figure 1) on modelled point sources was incorporated using the Building Profile Input Program Plume Rise Model Enhancement (BPIP-PRIME) algorithm. The algorithm explicitly treats the trajectory of the plume near the building and uses the position of the plume relative to the building to calculate interactions with the building wake. All building dimensions were estimated based on information provided by Arbios.

6.2.4 Wet and Dry Deposition

Wet and dry deposition of particulate matter were enabled for all sources to more accurately predict ambient concentrations. Dry deposition was modelled using particulate size parameters from the Newfoundland Guideline for Plume Dispersion Modelling (Newfoundland and Labrador Department of Environment and Conservation 2012). Wet deposition was modelled using scavenging coefficients of 1×10^{-4} per second (s^{-1}) in liquid rain and 3×10^{-5} s^{-1} in frozen precipitation for all size categories. These represent the default CALPUFF values for PM_{10} and were assumed to also be representative of TSP and $PM_{2.5}$ due to the lack of size-specific information.

6.2.5 Technical Dispersion Options

Technical dispersion options for CALPUFF were chosen in accordance with the BC Air Quality Dispersion Modelling Guideline (BC ENV 2022) or with CALPUFF model defaults. A list of the CALPUFF model options is provided in **Appendix B**.

6.3 Post-Processing

The CALPUFF modelling outputs to a binary file containing predicted ambient concentrations at each receptor for each of the model timesteps. Post-processing techniques were employed to estimate the maximum ambient concentrations of contaminants of interest for comparison with AAQOs.

6.3.1 NOX to NO2 Conversion

Emissions of NO_X from Facility discharges are comprised of NO and NO_2. The primary emission is in the form of NO with reactions in the stack and atmosphere resulting in the conversion of NO to NO_2. Health effects and therefore AAQOs are based on NO_2, not NO_X or NO. Regulatory dispersion models, such as CALPUFF, as applied in this assessment, predict NO_X concentrations without simulating the chemical conversion mechanisms.

The Guidance for NO_2 Dispersion Modelling in BC (BC ENV 2022b) provides updated guidance specific to estimating ambient NO_2 concentrations from NO_X. According to the guidance document, there are a few NO_X conversion techniques available. Total conversion is the simplest and most conservative approach, assuming 100% of NO_X emissions are converted to NO_2. Recommended methods for refining NO_2 concentrations include the ozone limiting method and the ambient ratio method or ARM. The approach used in this assessment is the ARM.

The ARM applies a ratio of NO_2 to total NO_X in the atmosphere to calculate NO_2 concentrations based on modelled NO_X concentrations. The Guidance for NO_2 Dispersion Modelling in BC provides default ARM curves for a number of categories based on historical observation data from the provincial monitoring network. For this assessment, the industrial curve was considered most appropriate given existing NO_X emissions from industrial facilities adjacent to the Facility. This industrial curve is illustrated in **Figure 6.1** relative to 2018 to 2020 monitoring data from the Plaza 400 station.

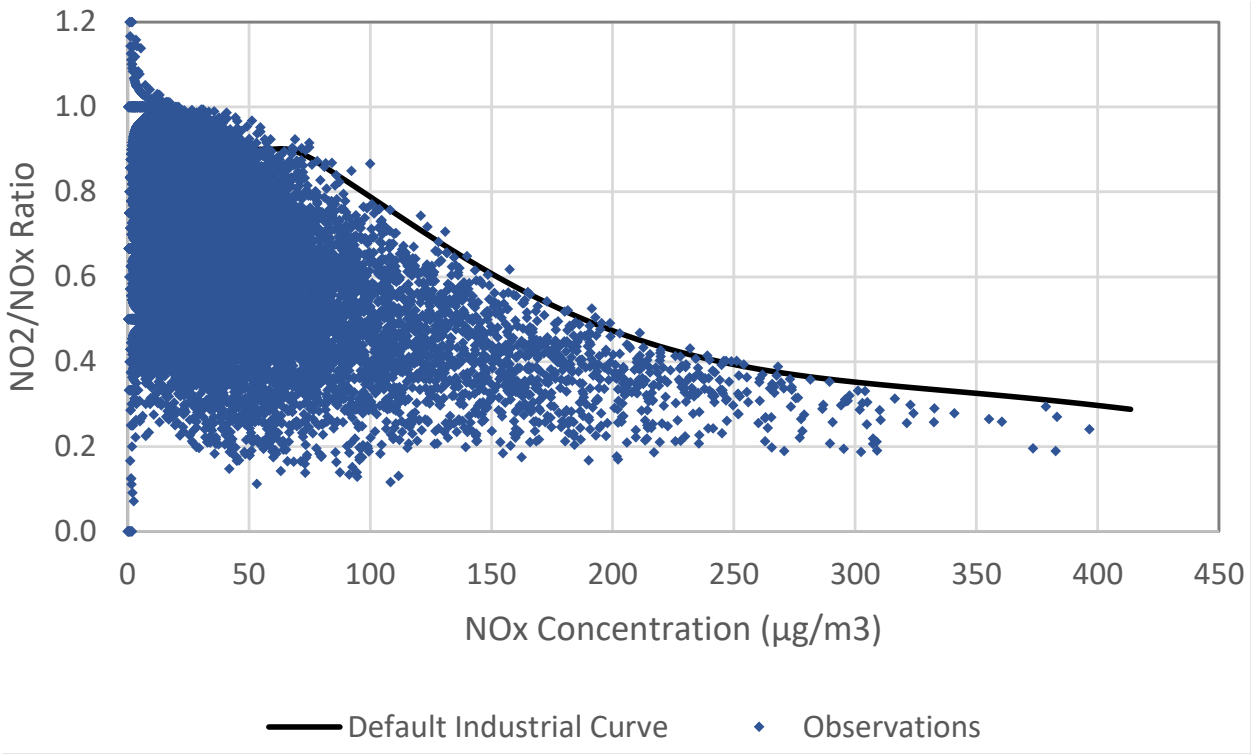

Figure 6.1 Dependence of NO2/NOX Ratios on Observed NOX Concentrations

6.3.2 Representative Background Concentrations

The BC Air Quality Dispersion Modelling Guideline (BC ENV 2022) requires that representative background concentrations be added to concentrations predicted by dispersion modelling to account for the contribution of other emission sources in the study area.

For this assessment, background concentrations were developed based on historical monitoring data from the Plaza 400 station (see Section 5.0), in accordance with the BC Air Quality Dispersion Modelling Guideline (BC ENV 2022):

- Background 24-hour average PM_{10} and $PM_{2.5}$ concentrations were based on the 98th percentile of observations from 2016 (i.e., average concentration for the 8th highest day)
- Background 1-hour average NO_2 concentrations were based on the annual 98th percentile of the daily 1-hour maximum (i.e., maximum concentration for the 8th highest day), averaged over the 3-year period from 2018 to 2020

- Background 1-hour average SO_2 concentrations were based on the annual 99th percentile of the daily 1-hour maximum (i.e., maximum concentration for the 4th highest day), averaged over the 3-year period from 2018 to 2020
- Background annual average concentrations were based on the mean of observations in the full dataset (1-year or 3-year depending on contaminant).

TSP is not monitored in Prince George. Since smaller particles can be inhaled and pose a greater risk to human health, TSP is often not monitored in the provincial network and a greater emphasis is placed on PM_{10} and $PM_{2.5}$. In the absence of TSP monitoring data in the region, background TSP concentrations were estimated as 3.3 times the background $PM_{2.5}$ concentrations (Lall et al. 2004).

The background concentrations are summarized in **Table 6.4**. As discussed in **Section 5.0**, industrial emissions in Prince George have changed since the time of air quality monitoring used to support the development of these background concentrations. Therefore, the background concentrations used in this air quality technical assessment are expected to be higher than the actual background concentrations when the Facility is in operation.

In addition to these "default" background concentrations, which are applied at all receptor locations and all model timesteps, the Guidance for NO_2 Dispersion Modelling in BC (BC ENV 2022b) provides options for developing a more refined background NO_2 dataset. The option to apply background concentrations by month and hour-of-day was used to provide a more realistic estimate of cumulative NO_2 concentrations. The resulting background NO_2 dataset, consisting of 288 values (i.e., 12 months × 24 hours), is presented in **Table 6.5**, and better accounts for diurnal and seasonal variations in observed NO_2 concentrations.

Table 6.4 Default Background Concentrations

Contaminant	Averaging Period	Background Concentration (µg/m^3)	AAQO (µg/m^3)
TSP	24-hour	69.3	120
	Annual	27.7	60
PM_{10}	24-hour	48.8	50
$PM_{2.5}$	24-hour	21.0	25
	Annual	8.4	8
NO_2	1-hour	88.3	113
	Annual	17.9	32
SO_2	1-hour	102.8	183
	Annual	3.1	13

Table 6.5 Refined Background NO2 Concentrations by Month and Hour-of-Day

Hour	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	57.0	86.4	87.4	66.5	46.8	40.0	31.7	29.0	27.3	45.1	37.2	45.6
1	58.5	80.6	84.4	66.2	41.5	35.7	31.7	28.8	22.6	43.0	43.2	43.0
2	57.7	78.5	83.9	64.0	45.8	31.8	27.8	27.6	26.4	46.6	44.4	45.9
3	56.4	84.9	81.7	57.3	40.2	32.2	31.0	27.8	25.6	41.1	41.1	44.0
4	55.1	77.4	81.5	57.4	40.2	31.6	33.2	26.8	25.3	36.8	36.0	38.9
5	56.5	85.1	77.5	54.5	40.7	26.1	25.7	26.1	25.6	41.9	35.7	44.6
6	60.5	84.0	75.3	53.6	41.7	26.4	27.5	28.1	31.8	39.6	39.4	45.1
7	64.9	84.2	80.5	58.5	35.5	30.3	22.2	29.4	35.1	47.9	41.6	46.3
8	65.9	81.9	79.7	59.0	40.6	29.6	28.1	30.1	41.1	50.2	48.6	57.1
9	67.3	80.9	80.9	57.9	30.9	27.0	35.3	36.9	27.6	47.5	47.8	55.4
10	64.8	82.2	80.0	56.2	30.0	22.6	26.6	33.9	21.2	48.3	48.1	53.0
11	62.9	80.5	65.4	41.5	25.8	17.1	19.9	33.6	20.6	38.8	39.4	43.7
12	55.3	71.6	59.4	43.3	28.5	10.7	14.9	30.4	20.4	36.2	38.2	46.7
13	57.8	60.3	50.5	30.1	26.6	9.8	14.3	20.5	22.8	25.2	34.3	47.1
14	56.4	56.9	43.3	18.1	25.6	11.3	11.2	15.5	19.7	22.1	36.8	44.6
15	66.8	56.1	45.4	17.3	18.3	14.4	10.7	19.6	16.8	24.8	40.2	44.1
16	67.7	56.2	44.5	14.9	15.7	17.2	11.1	26.4	23.0	31.1	39.5	47.2
17	61.2	54.3	46.4	18.2	22.7	13.8	13.5	30.1	25.9	40.7	46.6	63.7
18	72.5	75.0	65.1	15.6	14.6	9.0	14.3	27.8	25.8	55.0	46.3	68.6
19	73.1	83.6	79.0	22.2	21.7	9.3	14.2	31.1	40.3	64.3	51.3	63.7
20	61.5	88.9	86.9	39.6	25.6	13.9	26.8	43.1	43.4	61.4	45.6	57.7
21	60.2	90.4	90.8	63.6	40.0	28.5	30.5	40.9	39.2	52.6	45.3	58.7
22	61.2	91.0	95.1	63.2	47.4	31.8	34.9	41.2	33.3	47.6	42.7	52.5
23	59.7	86.7	87.5	68.3	45.8	35.7	37.1	35.7	31.2	44.9	41.8	54.2

7.0 Results

7.1 Normal Operation

Maximum modelled concentrations of the key contaminants of concern with and without background, at various receptors in the model domain are summarized in **Table 7.1**. As discussed in **Section 3.1**, dispersion modelling is based on continuous operation of all sources at their maximum discharge rates.

It is recognized that there is larger uncertainty with characterizing emissions from fugitive discharges and incorporating them in dispersion modelling. For this reason and in accordance with BC Air Quality Dispersion Modelling Guideline (BC ENV 2022), maximum modelled concentrations are also provided in **Table 7.2** for authorized discharges from the Facility in isolation (i.e., without fugitives). This provides perspective on the range of potential impacts from the Facility.

Further discussion of the results is presented by contaminant in the following subsections.

Table 7.1 Maximum Modelled Concentrations, All Sources - Normal Operation

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	-

Contaminant	Averaging Period	MPOI	Senior Care Facility	School	Hospital	Nearest Residence	Lheidli T'enneh Traditional Use Area	AAQO
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 NO_X are equivalent to NO_2 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.

Table 7.2 Maximum Modelled Concentrations, Authorized Discharges - Normal Operation

Contaminant	Averaging Period	MPOI	Senior Care Facility	School	Hospital	Nearest Residence	Lheidli T'enneh Traditional Use Area	AAQO
Without Background								
TSP	24-hour	**295.5**	3.5	6.9	3.0	6.1	7.8	120
	Annual	50.0	0.2	0.5	0.1	0.7	0.9	60
PM_{10}	24-hour	**290.2**	3.5	6.9	3.0	6.1	7.8	50
$PM_{2.5}$	24-hour(a)	**126.5**	1.2	2.7	0.8	3.1	3.9	25
	Annual	**37.8**	0.2	0.4	0.1	0.6	0.8	8
With Background								
TSP	24-hour	**364.8**	72.8	76.2	72.3	75.4	77.1	120
	Annual	**77.7**	27.9	28.2	27.8	28.4	28.6	60
PM_{10}	24-hour	**339.0**	**52.3**	**55.7**	**51.8**	**54.9**	**56.6**	50
$PM_{2.5}$	24-hour(a)	**147.5**	22.2	23.7	21.8	24.1	24.9	25
	Annual	**46.2**	**8.6**	**8.8**	**8.5**	**9.0**	**9.2**	8

Notes: MPOI = maximum point of impingement, AAQO = ambient air quality objective.
Values in bold font exceed the relevant air quality objective.
(a) Based on 98th percentile of daily average, over one year.

7.1.1 Particulate Matter

Isopleths of maximum predicted TSP, PM_{10}, and $PM_{2.5}$ concentrations including background contribution are presented in Figure E-1 to Figure E-15 (**Appendix E**). Isopleth figures are used to graphically display the maximum modelled concentrations within the study area. Modelled concentrations at each receptor point are interpolated and contour lines generated, representing lines of equal modelled concentrations. It should be noted that isopleth figures do not represent snapshots in time; the modelled concentrations at each receptor could occur at a different time and under different meteorological conditions. Furthermore, the isopleth figures include a constant background level applied across the study area and do not illustrate the spatial variation of existing air quality conditions within the study area (refer to **Section 6.3.2**).

As shown in **Table 7.1** and the isopleth figures, maximum modelled concentrations of particulate matter may exceed relevant AAQOs. However, modelled exceedances of the AAQOs are largely related to high background concentrations (refer to **Table 6.4**). For example, background 24-hour PM_{10} and $PM_{2.5}$ concentrations, developed based on the 98th percentile of measured data from the Plaza 400 station, are already at 98% and 84% of the relevant AAQO, respectively.

For further context, isopleths of maximum modelled TSP, PM_{10}, and $PM_{2.5}$ from Facility discharges alone (i.e., without background) are illustrated in Figure E-16 to Figure E-30. As shown in these figures, modelled 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. This 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. For comparison, the predicted PM concentrations are well below the WorkSafe BC exposure limit of 3,000 µg/m^3 for respirable dust, based on an 8-hour time weighted average (WorkSafe BC 2022).

The extent of modelled Facility contribution is further confirmed in **Figure 7.1** and **Figure 7.2** which show a time series of background and Facility PM_{10} and $PM_{2.5}$ concentrations at the Plaza 400 monitoring station.

The frequency of modelled 24-hour TSP, PM_{10}, and $PM_{2.5}$ concentrations, including background contribution, exceeding the numerical values of the AAQOs are illustrated in Figure E-31 to E-33. Similar to the isopleth figures of maximum modelled concentrations, these figures are used to graphically display the percentage of time over the three-year model period at which modelled concentrations may exceed a specified value within the study area. For example, Figure E-32 illustrates the percentage of time modelled PM_{10} concentrations from the Facility may exceed 1.2 µg/m^3, resulting in potential exceedances of the AAQO when combined with a constant background level of 48.8 µg/m^3.

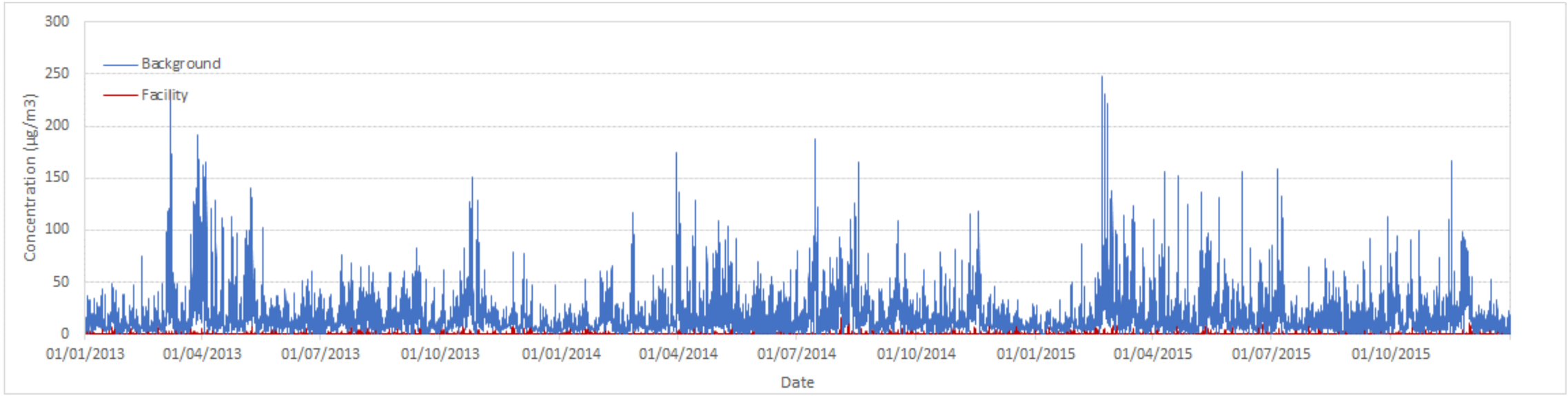

Figure 7.1 Hourly Time Series of Modelled PM10 Concentrations at Plaza 400, showing Background and Facility Contributions

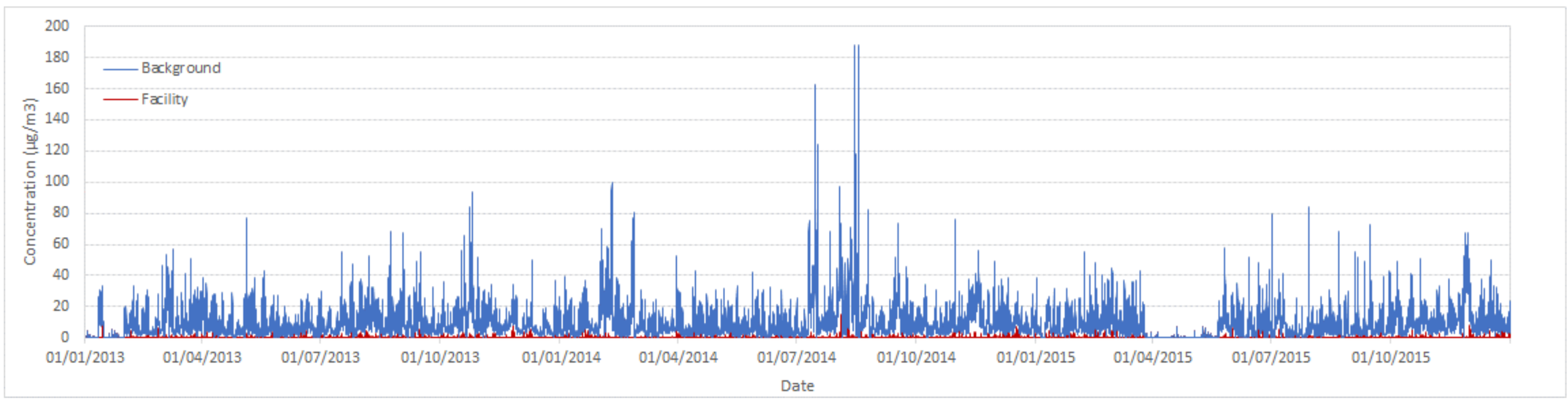

Figure 7.2 Hourly Time Series of Modelled PM2.5 Concentrations at Plaza 400, showing Background and Facility Contributions

7.1.2 Nitrogen Dioxide

Isopleths of maximum modelled NO_2 concentrations including background contribution (based on the refined background dataset in **Table 6.5**) are illustrated in Figure E.32 to Figure E.40. As shown in **Table 7.1** and the isopleth figures, modelled NO_2 concentrations may exceed the 1-hour AAQO of 113 µg/m^3 within 3 km south the Facility, encompassing the Prince George Regional Correctional Centre and several private residences on Guay Road. Modelled annual NO_2 concentrations, however, remain below the AAQO of 32 µg/m^3.

Modelled NO_2 concentrations at the Prince George Regional Correctional Centre was further analyzed to understand the Facility contribution to air quality in the area of public receptors that may be exposed to NO_2 exceedances. A frequency distribution of modelled NO_2 concentrations is presented in **Figure 7.3**, which shows that concentrations are less than 10 µg/m^3 over 97% of the time. Relatively high NO_2 concentrations due to Facility operation are infrequent, occurring primarily due to stagnation in the atmosphere under extended periods of temperature inversion. During such stagnation events, ambient NO_2 concentrations will represent a mixture of all low-lying emission sources in the region (e.g., rail yard, vehicle traffic), of which the Facility will be a small portion (see **Table 3.5**).

It should be noted that Facility-related NO_2 concentrations presented in **Table 7.1** are expected to be substantially over-estimated due to the required NO_X to NO_2 conversion method. Facility-related NO_2 concentrations are estimated by applying the ARM curve (see **Figure 6.1**) to modelled NO_X concentrations from the Facility alone. At such low NO_X concentrations, it is effectively assumed that 90% of all Facility-emitted NO_X will be converted to NO_2. In reality, the NO_X to NO_2 conversion occurs on cumulative NO_X concentrations in the atmosphere. At these substantially higher NO_X levels, especially under temperature inversion conditions, the NO_2/NO_X ratio would be much lower; expected to be about half of that assumed in the ARM conversion. As shown in **Table 3.5**, the Facility is expected to contribute less than 2% to overall NO_X emissions in the Prince George region, based on the most recent emission inventory completed by UNBC for the Prince George Air Improvement Roundtable. This is expected to be more reflective of actual Facility contribution to maximum NO_2 concentrations in the area of public receptors.

The extent of Facility contribution is further confirmed in **Figure 7.4** which shows a time series of background and Facility NO_2 concentrations at the Plaza 400 monitoring station.

The frequency of modelled 1-hour NO_2 concentrations exceeding the numerical value of the AAQO is presented in Figure E.41. In the area of public receptors, the frequency of excursion above the numerical value of the AAQO is expected to be less than 3%.

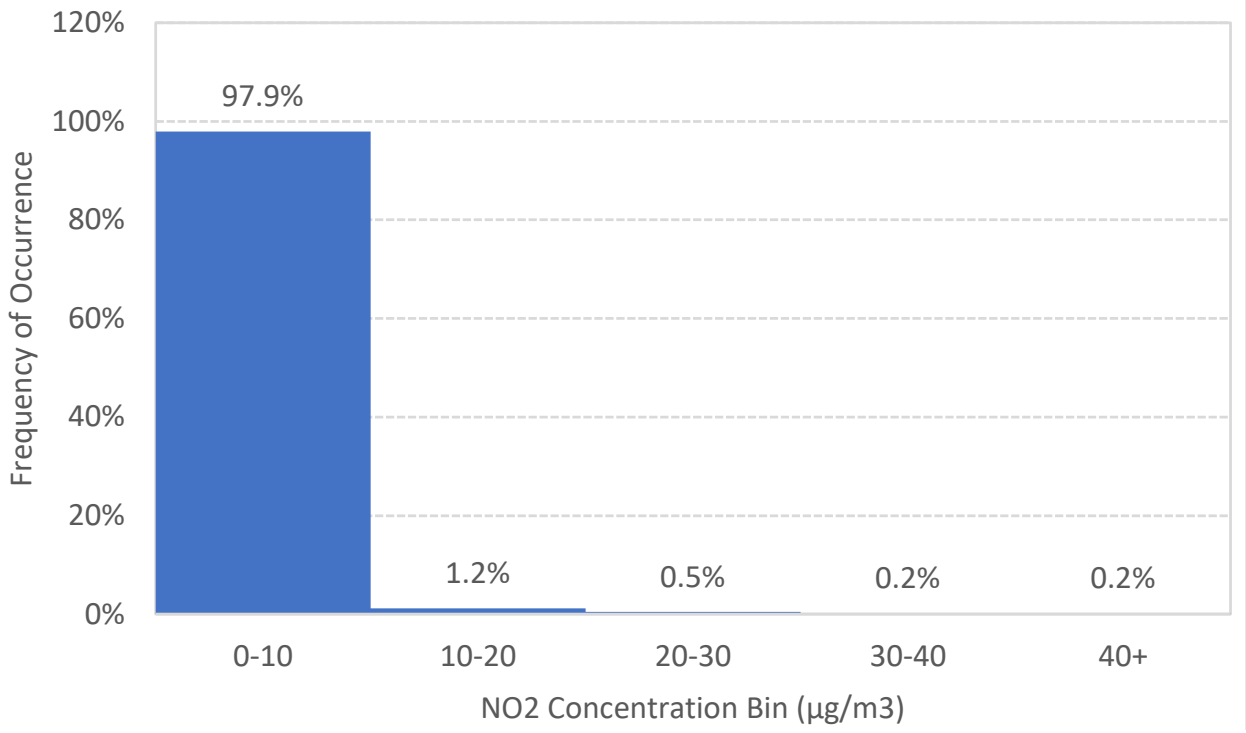

Figure 7.3 Frequency Distribution of Modelled NO2 Concentrations from Facility Emissions at Prince George Regional Correctional Centre

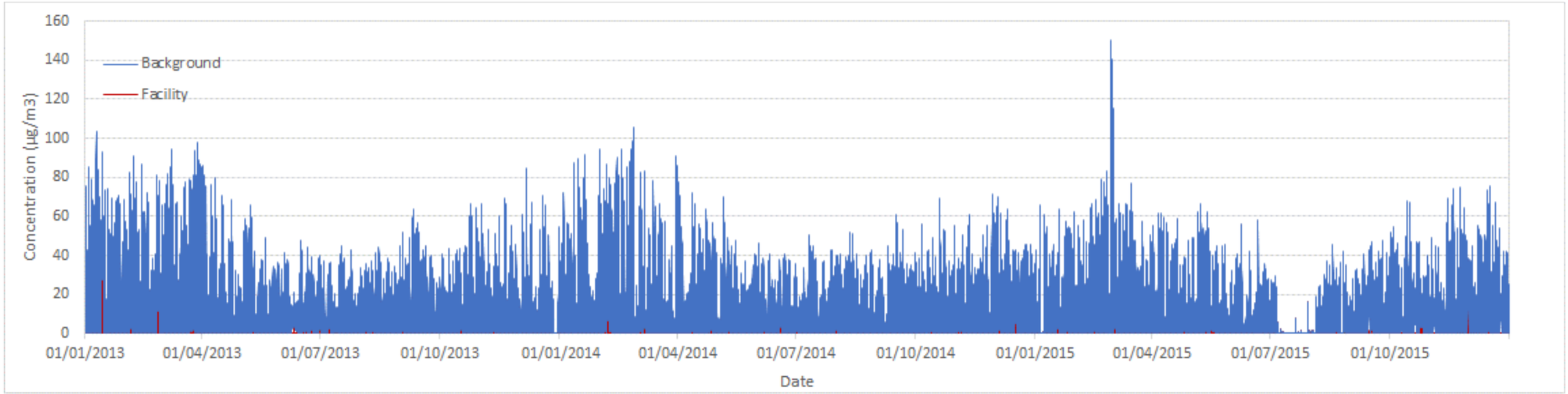

Figure 7.4 Hourly Time Series of Modelled NO2 Concentrations at Plaza 400, showing Background and Facility Contribution

7.1.3 Sulphur Dioxide

As shown in **Table 7.1**, maximum modelled SO_2 concentrations both with and without background remain well below the AAQOs. Isopleths of maximum modelled SO_2 concentrations including background contribution are illustrated in Figure E.42 to Figure E.48.

A time series of Facility-related SO_2 concentrations relative to background at the Plaza 400 monitoring station, the Prince George Regional Correctional Centre, and the CBC Transmitter are illustrated in **Figure 7.5** to **Figure 7.7**. These figures show that the contribution of Facility operation on SO_2 concentrations will be imperceptible at the three monitoring stations.

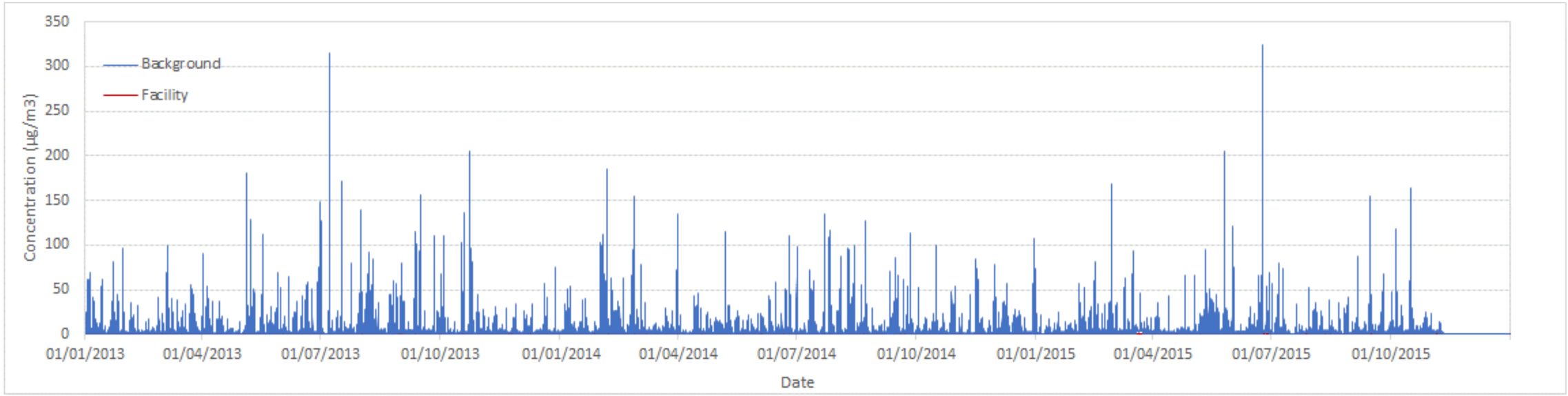

Figure 7.5 Hourly Time Series of Modelled SO2 Concentrations at Plaza 400, showing Background and Facility Contribution

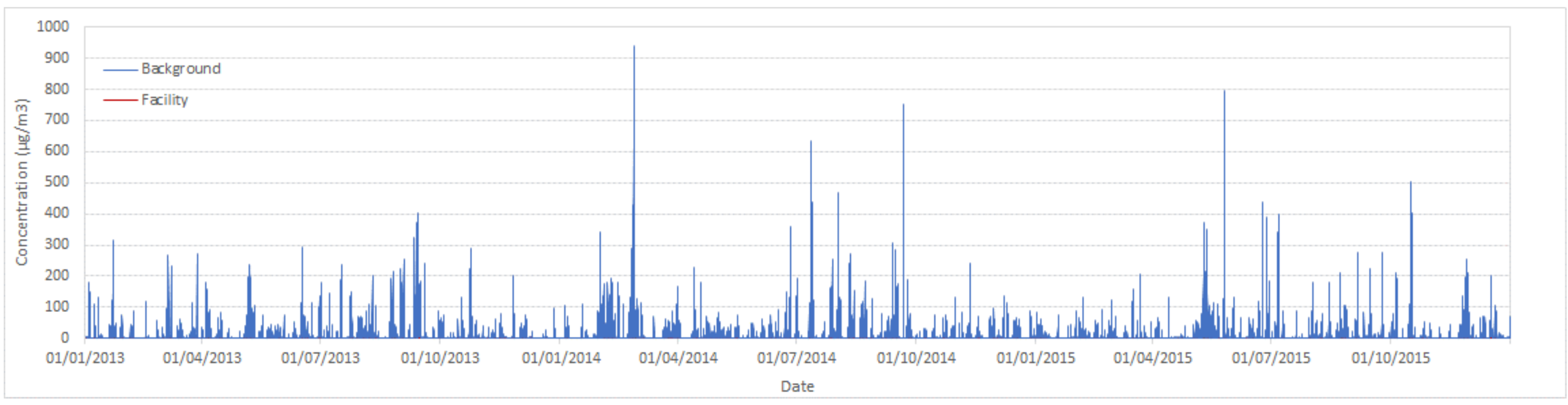

Figure 7.6 Hourly Time Series of Modelled SO2 Concentrations at Prince George Regional Correctional Centre, showing Background and Facility Contribution

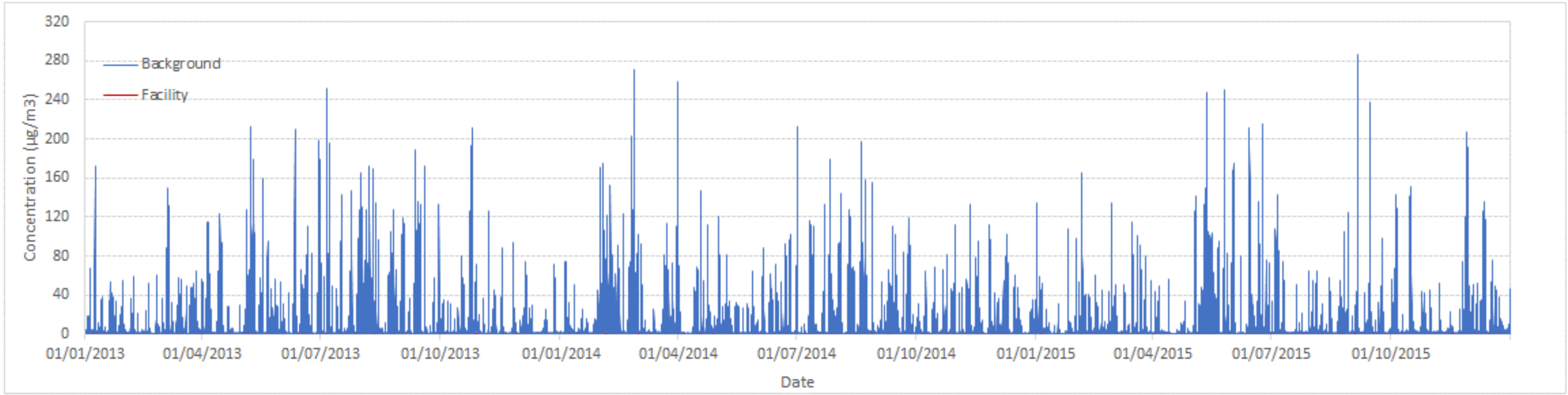

Figure 7.7 Hourly Time Series of Modelled SO2 Concentrations at CBC Transmitter, showing Background and Facility Contribution

7.2 Emergency Release

Maximum modelled concentrations of 1-hour NO_2 and SO_2 during the emergency release scenario are summarized in **Table 7.3**. Isopleths of maximum modelled concentrations of 1-hour NO_2 and SO_2 including background contribution are illustrated in Figure F.1 to Figure F.6 (**Appendix F**). As the emergency release scenario can occur at any given time, emissions are modelled as continuous emissions throughout the 3-year model period.

Modelled concentrations of NO_2 exceed the numerical value of the AAQO in isolated areas within 4 km of the Facility up to 3 hours of the 3-year model period, representing approximately 0.01% of the time. Since the AAQO is based on the 98th percentile of the daily 1-hour maximum, modelled excursions above the numerical value of the AAQO do not represent exceedances of the AAQO. As explained in **Section 7.1.1**, isopleth figures are intended to graphically display maximum modelled concentrations and do not represent snapshots in time; the modelled concentrations at each receptor could occur at a different time and under different meteorological conditions. Therefore, the isolated areas in Figure F.2 where modelled NO_2 concentrations exceed the numerical value of the AAQO represent areas that may experience elevated NO_2 concentrations should the emergency release scenario occur during the worst-case meteorological conditions for the respective location. The probability of the emergency release scenario occurring at the same time as meteorological conditions conducive to elevated ambient NO_2 concentrations is very low. Furthermore, NO_2 concentrations are modelled to remain below the AAQO at all public receptors. Modelled concentrations of SO_2 remain low, well below the AAQO.

Given the infrequent nature of this scenario, the annual averaging period is not relevant. The emergency release scenario is not expected to result in discharges of particulate matter (refer to **Table 3.4**).

Table 7.3 Maximum Modelled Concentrations – Emergency Release

Contaminant	Averaging Period	MPOI	Senior Care Facility	School	Hospital	Nearest Residence	Lheidli T'enneh Traditional Use Area	AAQO
Without Background								
NO_X	1-hour	76.2	13.0	30.0	7.1	17.6	18.6	-
NO_2	1-hour	66.8	11.7	27.0	6.4	15.9	16.7	113
SO_2	1-hour	13.2	2.2	5.2	1.2	3.1	3.2	183
With Background								
NO_X	1-hour	**164.5**	101.3	**118.3**	95.4	105.9	106.9	-
NO_2 – default background	1-hour	**155.1**	100.0	**115.3**	94.7	104.2	105.0	113
NO_2 – refined background	1-hour	**129.6**	97.4	111.3	97.4	96.4	95.2	113
SO_2	1-hour	116.0	105.0	108.0	104.0	105.9	106.0	183

Notes: MPOI = maximum point of impingement, AAQO = ambient air quality objective.
Values in bold font exceed the relevant air quality objective.
All values represent the 100th percentile of model predictions.

8.0 Limitations

Limitations are inherent in any air quality assessment. These include limitations in estimating emissions from Facility operation, limitations in dispersion modelling, and limitations associated with the development of background concentrations to represent the contribution of other emission sources in the model domain.

Emissions for authorized point sources at the Facility have been estimated based on manufacturer specifications including a margin of safety to derive maximum requested permit limits. These represent an upper estimate of maximum potential emissions from the sources; actual emissions are expected to remain below these values at all times.

Emissions from fugitive releases associated with biomass handling have been estimated based on the maximum material handling rate using emission factors from the National Council for Air and Stream Improvement, Inc. While it is understood that these emission factors pertain to handling of wood residue at wood product operations such as sawmills and lumber mills, background information on the derivation of these emission factors is not available. Consequently, there is uncertainty related to the applicability of these emission factors to the Facility, which will accept feedstock with relatively large chunk sizes (25 to 100 mm) and high moisture contents (45 to 55% by weight). Furthermore, emission factors for PM_{10} and $PM_{2.5}$ are not available for green/wet wood material handling, and therefore emissions were estimated using PM size ratios for dry wood material handling. The PM emissions related to fugitive material handling used in the modelling are therefore expected to represent a high end estimate of actual Facility emissions. To provide perspective on the range of potential Facility impacts, results have been presented for maximum modelled concentrations with and without fugitive handling emissions.

Air quality dispersion models can only approximate atmospheric processes. Many assumptions and simplifications are required to describe real phenomena using mathematical equations. Model uncertainties can result from:

- Simplifications and accuracy limitations related to source inputs to represent Facility operations
- Extrapolation of meteorological data from select locations to a larger region
- Simplification of model physics to replicate the nature of atmospheric processes.

Background concentrations have been developed based on historical monitoring data from the Plaza 400 monitoring station. This station is located in downtown Prince George and is likely strongly influenced by community sources and vehicle traffic. Data from this station are likely influenced to some extent by existing large industrial operations adjacent to the Facility, located approximately 3 km northwest of the station. Conversely, the area in the immediate vicinity of the Facility where the highest concentrations are modelled would be more influenced by industry rather than by community sources and vehicle traffic.

To overcome these limitations, a number of conservative assumptions have been made in the air quality assessment. These assumptions include:

- The use of requested permit limits and maximum material handling rates: The resulting emission estimates are expected to represent the maximum potential discharges from the Facility during normal operation. Typical operating emission rates are expected to be substantially lower (see **Table 3.2**) and prudent management of the discharge sources will ensure that the maximum emission rates are not experienced.

- The use of 98th to 99th percentile of observed concentrations as background concentrations: By definition, the 98th to 99th percentile concentrations will only be observed 1 to 2% of the time. It is unlikely that these background concentrations will occur at the same time as the maximum modelled concentrations from dispersion modelling.
- The background levels are based on past ambient monitoring data from 2016 to 2020. Significant changes in industrial emissions that will have occurred by the time of the Arbios commissioning include closure of the Pacific Bioenergy Pellet Facility, addition of the Tidewater Renewables Facility, and closure of the pulp line at the Prince George Pulp Mill. The net impact of these events, combined with the addition of the Arbios sources is a significant reduction in PM and NO_X emissions. Refer to **Table 5.1**.
- Modelling of the emergency release scenario as a continuous emission source: The CALPUFF model is a non-steady-state model and ambient concentrations for a given model time step is influenced not only by emissions during that time step, but also by emissions during preceding time steps. In reality, the duration of an emergency release is expected to be 1 hour or less and there will be no influence from preceding hours on air quality.
- The use of the ARM: The default industrial ARM curve used in the NO_X to NO_2 conversion was developed based on the upper end of historical observation data from the provincial monitoring network. Actual NO_2/NO_X ratios will be lower most of the time. The ARM has been shown to overpredict the highest NO_2 concentrations by a factor of 1.8 on average (US EPA 2013).

In general, models are reasonable and reliable in estimating the maximum concentrations occurring on an average basis; the maximum predicted concentration that may occur at some time somewhere within the model domain, as opposed to the exact concentration at a point at a given time, will usually be within the ±10% to ±40% range (US EPA 2017) of the observed maximum concentration, assuming that emission sources are accurately reflected in the model. Typically, a model is viewed as replicating dispersion processes well if it can predict within a factor of two.

9.0 Conclusions

The key air contaminants associated with Facility operations are PM, NO_2, and SO_2. Dispersion modelling was completed assuming maximum permitted emission rates for each contaminant to predict maximum potential ambient concentrations for comparison with AAQOs. 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.

For PM (all size fractions), maximum potential Facility discharges may result in exceedances of the AAQO only within 200 m of the Facility. This area of potential exceedance encompasses existing industrial facilities where public exposure would be minimal and where AAQOs typically do not apply.

For NO_2, exceedances of the 1-hour AAQO are modelled in an area within 3 km of the Facility. There are few public receptors within this area of potential exceedance and excursions above the numerical value of the objective are expected to be very infrequent. Furthermore, the use of the ambient ratio method to estimate the conversion of NO (from Facility emissions) to NO_2 (in the atmosphere) is expected to result in substantially over-estimated NO_2 concentrations in the model results. This expectation is supported by past model evaluations published by the US EPA (2013).

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

In the event of a site-wide power failure, the Facility may result in emissions of NO_2 and SO_2 higher than those during normal operation. This emergency release scenario is expected to be short-term (approximately 1-hour) in duration and infrequent. Dispersion modelling shows that maximum NO_2 concentrations may exceed the numerical value of the 1-hour AAQO in isolated areas within 4 km of the Facility. The meteorological conditions leading to such excursions are expected to be infrequent, occurring approximately 0.01% of the time, and the probability of a site-wide power failure occurring at the same time as such meteorological conditions is even lower. Maximum modelled concentrations for SO_2 are expected to remain well below the AAQO.

It is important to note that these modelled impacts are associated with the Facility emission rates at their maximum permitted levels throughout the year. In reality, the average emission rates during Facility operation are expected to be considerably lower. Modelled impacts associated with these high end estimates are then added to background levels that represent the 4^{th} to 8^{th} worst day of the year (depending on the contaminant). The coincidence of highest Facility impacts with these background contaminant levels in the airshed is unlikely. This, combined with a number of other precautionary measures in the assessment, including expected lower emissions from biomass handling and reductions in industrial emissions in the Prince George region, result in a portrait of maximum potential impacts from Facility operations. With adherence to an environmental management plan, the Facility is not expected to adversely affect air quality in Prince George.

10.0 Closure

We sincerely appreciate the opportunity to have assisted with this project and if there are any questions, please do not hesitate to contact the undersigned by phone at 604.669.0424.

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11.0 References

BC Ministry of Environment and Climate Change Strategy (BC ENV). 2020. BC Ambient Air Quality Objectives.

BC ENV. 2022. British Columbia Air Quality Dispersion Modelling Guideline.

BC ENV. 2022b. Guidance for NO2 Dispersion Modelling in British Columbia.

Canadian Council of Ministers of the Environment (CCME). 2023. Canada's Air. Available online at: https://ccme.ca/en/air-quality-report.

Environment and Climate Change Canada (ECCC). 2020. Wood Product Operations. Available online at: https://www.canada.ca/en/environment-climate-change/services/national-pollutant-release-inventory/report/tools-calculating-emissions/wood-products-operations.html.

Gitxsan Development Corporation. 2019. New Hazelton Pellet Facility Air Quality Assessment. Prepared by SNC-Lavalin.

Lall, R., M. Kendall, K. Ito, and G.D. Thurston. 2004. Estimation of historical annual PM2.5 exposures for health effects assessment. Atmospheric Environment, Volume 38, pp. 5217-5226.

Natural Resources Canada. 2017. Canadian Digital Elevation Model. Available online at: https://maps.canada.ca/czs/index-en.html.

Natural Resources Canada. 2019. 2015 Land Cover of Canada. Available online at: https://open.canada.ca/data/en/dataset/4e615eae-b90c-420b-adee-2ca35896caf6.

Newfoundland and Labrador Department of Environment and Conservation. 2012. Guideline for Plume Dispersion Modelling.

Nilson, B., P. Jackson, B. Ainslie, and G. Roth. 2020. Prince George Air Quality Emissions and Modelling (2014-2016).

Oke, T. 1987. Boundary Layer Climates.

Pinnacle Renewable Energy Inc. 2014. Technical Assessment Report – Air Dispersion Modelling Study. Prepared by RWDI AIR Inc.

United States Environmental Protection Agency (US EPA). 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, Volume I – User Instructions. EPA-454/B-95-003a.

US EPA. 2013. Ambient Ratio Method Version 2 (ARM2) for use with AERMOD for 1-hr NO2 Modeling – Development and Evaluation Report. Available online at: https://gaftp.epa.gov/Air/aqmg/SCRAM/models/preferred/aermod/ARM2_Development_and_Evaluation_Report-September_20_2013.pdf.

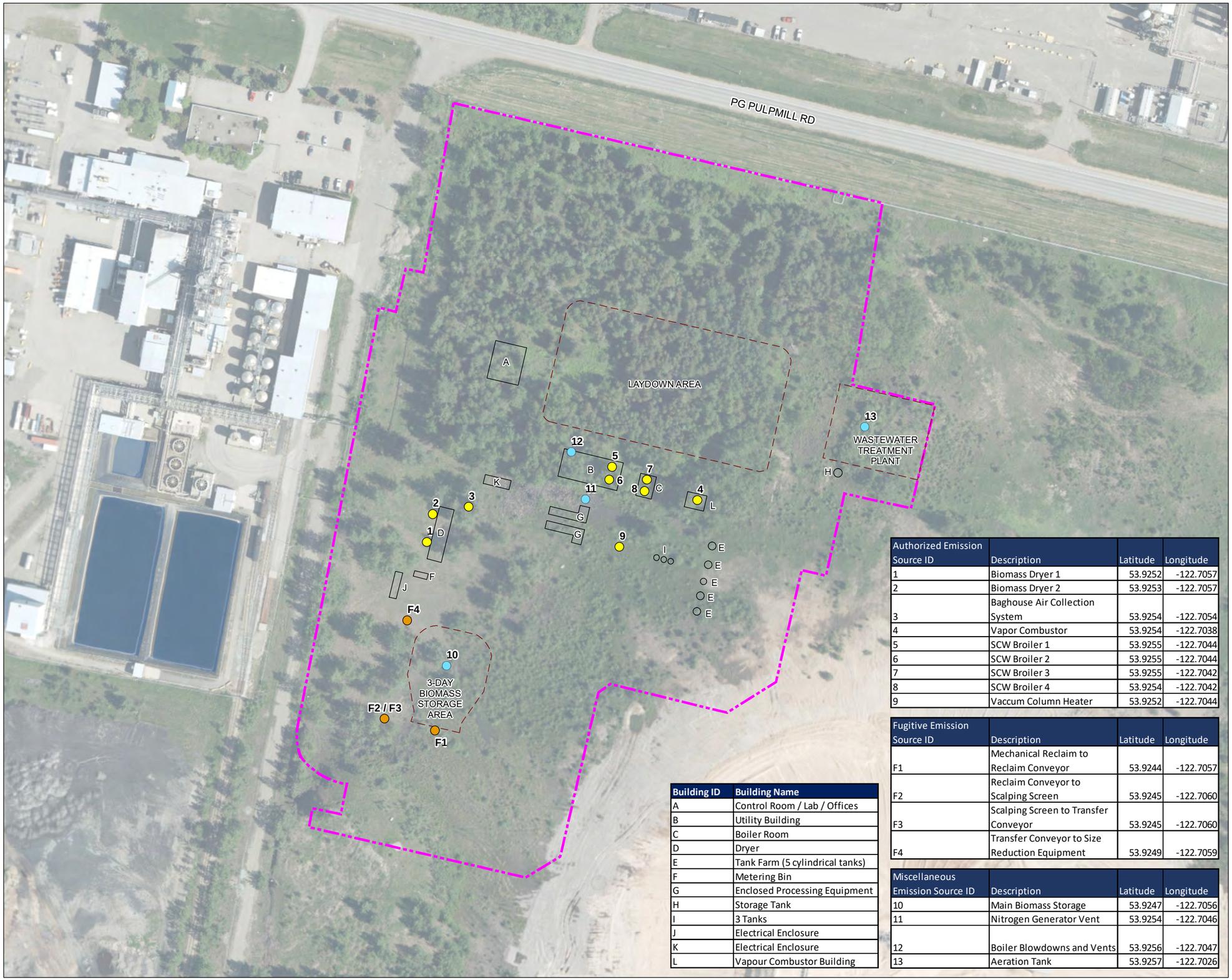
US EPA. 2017. 40 CFR Part 51, Appendix W: Revisions to the Guideline on Air Quality Models. Available online at: https://www.epa.gov/sites/default/files/2020-09/documents/appw_17.pdf.

WorkSafe BC. 2022. Table of Exposure Limits for Chemical and Biological Substances. Available online at: https://www.worksafebc.com/en/resources/health-safety/ohsr-searchable/table-exposure-limits-chemical-biological-substances.

Figures

Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Site Plan



Legend

- Authorized Emission Source
- Fugitive Emission Source
- Miscellaneous Emission Source
- Project Development Area (fence line)
- Building or Structure
- Site Feature
- Waterbody

Building ID	Building Name
A	Control Room / Lab / Offices
B	Utility Building
C	Boiler Room
D	Dryer
E	Tank Farm (5 cylindrical tanks)
F	Metering Bin
G	Enclosed Processing Equipment
H	Storage Tank
I	3 Tanks
J	Electrical Enclosure
K	Electrical Enclosure
L	Vapour Combustor Building

Authorized Emission Source ID	Description	Latitude	Longitude
1	Biomass Dryer 1	53.9252	-122.7057
2	Biomass Dryer 2	53.9253	-122.7057
3	Baghouse Air Collection System	53.9254	-122.7054
4	Vapor Combustor	53.9254	-122.7038
5	SCW Broiler 1	53.9255	-122.7044
6	SCW Broiler 2	53.9255	-122.7044
7	SCW Broiler 3	53.9255	-122.7042
8	SCW Broiler 4	53.9254	-122.7042
9	Vaccum Column Heater	53.9252	-122.7044

Fugitive Emission Source ID	Description	Latitude	Longitude
F1	Mechanical Reclaim to Reclaim Conveyor	53.9244	-122.7057
F2	Reclaim Conveyor to Scalping Screen	53.9245	-122.7060
F3	Scalping Screen to Transfer Conveyor	53.9245	-122.7060
F4	Transfer Conveyor to Size Reduction Equipment	53.9249	-122.7059

Miscellaneous Emission Source ID	Description	Latitude	Longitude
10	Main Biomass Storage	53.9247	-122.7056
11	Nitrogen Generator Vent	53.9254	-122.7046
12	Boiler Blowdowns and Vents	53.9256	-122.7047
13	Aeration Tank	53.9257	-122.7026

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

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- Aerial Image: ESRI World Imagery
- Inset Basemap: ESRI World Topographic Map

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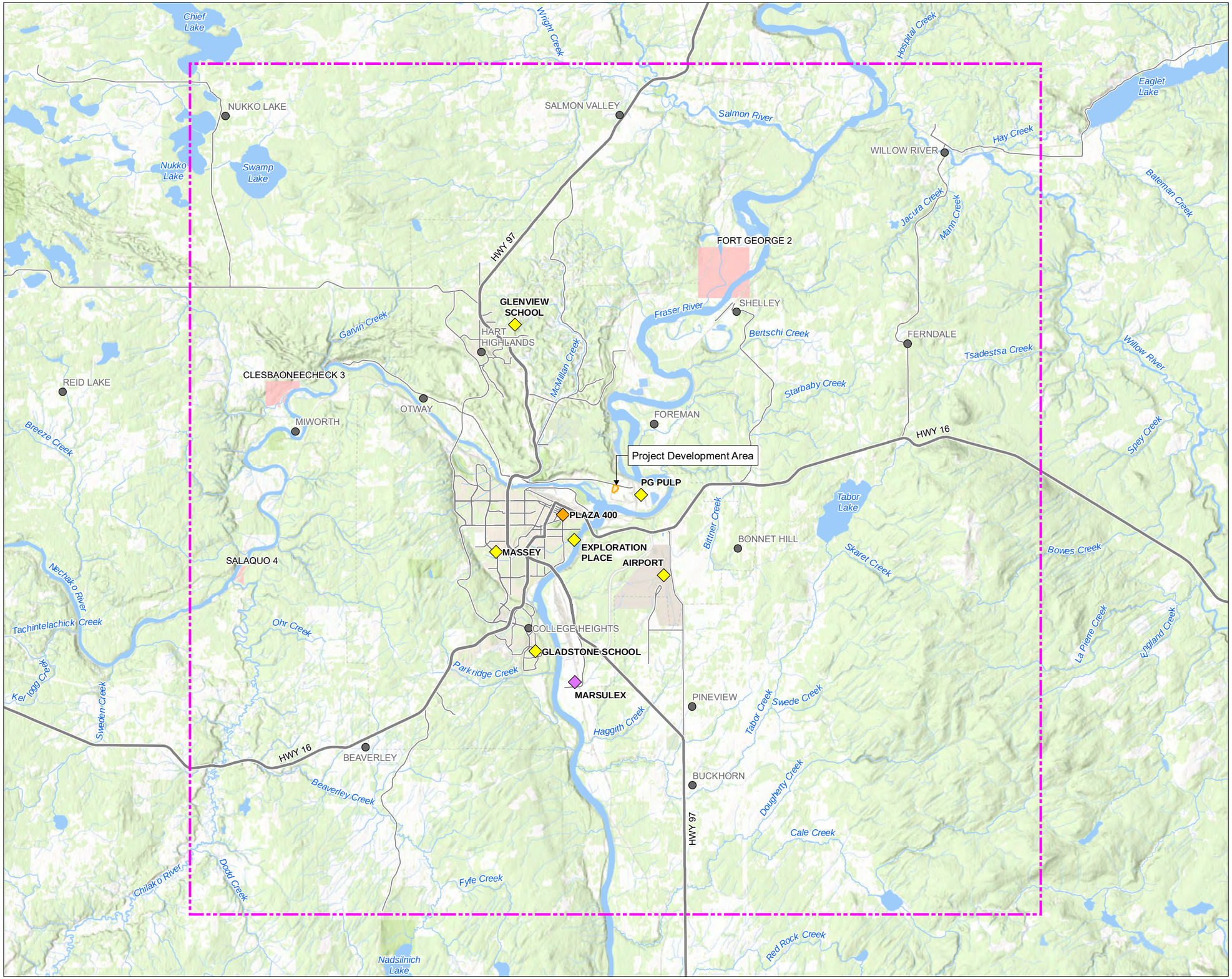
Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Study Area



Legend

- Meteorological Monitoring Station
- Meteorological Monitoring Station / Air Quality Monitoring Station
- Meteorological Monitoring Station - Not Used
- Project Development Area
- Study Area
- Community
- Highway
- Road
- First Nations Reserve
- Watercourse
- Waterbody

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

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- Inset Basemap: ESRI World Topographic Map

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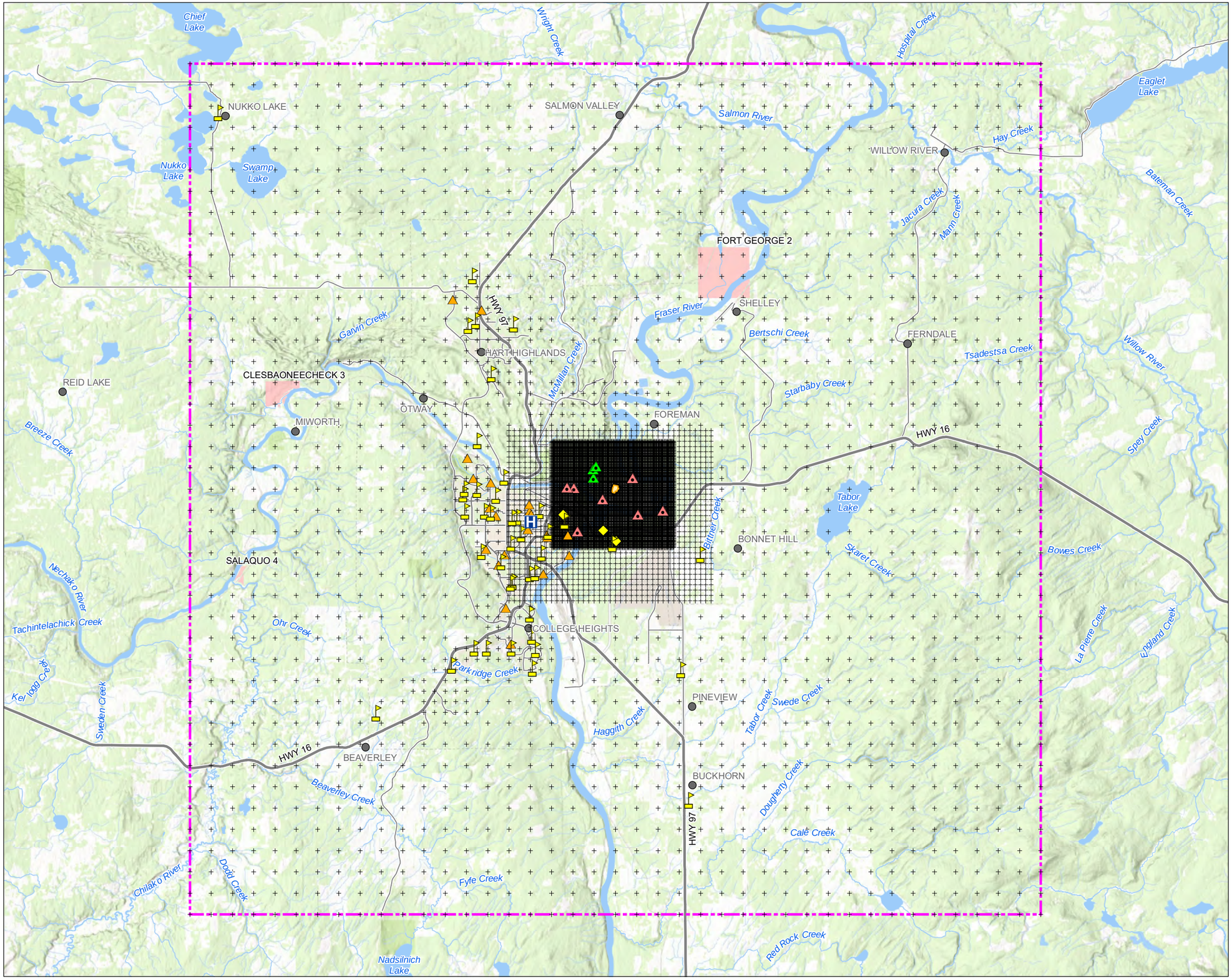
Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Receptor Grid



Legend

- Receptor Grid
- Facility Development Area
- Study Area
- Community
- Highway
- Road
- Watercourse
- Waterbody

Sensitive Receptors

- Air Quality Monitoring Station
- Hosptial
- L'heidli T'enneh Traditional Use Area
- Nearest Residence
- School
- Senior Care Facility

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

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- Inset Basemap: ESRI World Topographic Map

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Appendix A

Addendum on Carbon Monoxide Emissions

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May 3, 2023
File No. 105520-02

Arbios Biotech Canada LP
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Vancouver BC V6P 6G2

Re: Addendum to Chuntoh Ghuna Facility Air Quality Technical Report – Carbon Monoxide Emissions

1.0 Introduction

Arbios Biotech Canada LP (Arbios) is proposing to construct the Chuntoh Ghuna Facility (the Facility) located at 2233 Prince George Pulpmill Road, Prince George, British Columbia (BC) adjacent to the Canfor Pulp Products Inc. Intercontinental Pulp Mill site in Prince George, BC. An Air Quality Technical Report was prepared, dated March 24, 2023, to describe the approach and findings of an air quality technical assessment conducted in support of the application for a Waste Discharge Application. This addendum presents additional information for the Air Quality Technical Report, related to potential emissions of carbon monoxide (CO) from the Facility.

2.0 Air Discharges of Carbon Monoxide

During normal operation, the Facility process will result in air discharges of CO as a standard product of combustion from the vapour combustor, supercritical water boilers, and vacuum column heater. In the event of a site-wide power failure, all process gas will be diverted to the vapour combustor and all other sources will be shut down. The maximum and typical expected discharge rates during normal operation and the emergency release scenario are summarized in **Table 3.1**.

3.0 Regulatory Framework

Ambient air quality objectives for CO have been rescinded since 2006; however, the pollution control objectives previously developed in the 1970s continue to be used for reference purposes. These pollution control objectives are presented in **Table 3.2**.

Table 3.1 Expected Discharges of Carbon Monoxide

Source	Maximum Discharge, Normal Operation			Typical Discharge, Normal Operation			Maximum Discharge, Emergency Release		
	Flow Rate (m^3/min)	Discharge Concentration (mg/m^3)	Discharge Rate (g/s)	Flow Rate (m^3/min)	Discharge Concentration (mg/m^3)	Discharge Rate (g/s)	Flow Rate (m^3/min)	Discharge Concentration (mg/m^3)	Discharge Rate (g/s)
Vapour Combustor	405	133	0.90	405	133	0.90	1,350	100	2.30
Supercritical Water Boiler 1	53.6	576	0.51	50.3	576	0.48	-	-	-
Supercritical Water Boiler 2	53.6	576	0.51	50.3	576	0.48	-	-	-
Supercritical Water Boiler 3	53.6	576	0.51	50.3	576	0.48	-	-	-
Supercritical Water Boiler 4	53.6	576	0.51	50.3	576	0.48	-	-	-
Vacuum Column Heater	9.2	360	0.06	8.6	360	0.05	-	-	-
Total Discharge	**-**	**-**	**3.01**	**-**	**-**	**2.88**	**-**	**-**	**2.30**

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

Table 3.2 Ambient Air Quality Criteria for Carbon Monoxide

Averaging Period	Pollution Control Objective (µg/m³)
1-hour	14,300
8-hour	5,500

Sources: BC ENV 2020

4.0 Baseline Air Quality

Carbon monoxide is not often measured in the BC air quality monitoring network and no representative historical monitoring data are available for the Prince George region. Background concentrations are therefore not characterized but are expected to be low relative to the AAQOs.

5.0 Effects Assessment

Dispersion modelling was conducted using the CALPUFF model to predict maximum ambient concentrations associated with proposed discharges from Facility operation. Maximum modelled concentrations of CO at various receptors normal operation and the emergency release scenario are summarized in **Table 5.1**. Given that the emergency release scenario is expected to last up to one hour in duration, the eight-hour averaging period is not relevant for this scenario and only the one-hour averaging period is presented.

The maximum predicted concentrations of CO are less than 5% of the pollution control objectives. Even considering background contribution from other sources in the Prince George region, cumulative air quality are expected to remain well below the pollution control objectives and the Facility is not expected to adversely affect air quality in the community.

Table 5.1 Maximum Modelled Concentrations of Carbon Monoxide

Scenario	Averaging Period	MPOI	Senior Care Facility	School	Hospital	Nearest Residence	Lheidli T'enneh Traditional Use Area	Pollution Control Objective
Normal Operation	1-hour	680.2	82.4	101.3	89.5	133.9	121.3	14,300
	8-hour	199.3	17.4	32.3	18.1	29.8	37.4	5,500
Emergency Release	1-hour	59.5	10.1	23.4	5.6	13.8	14.5	14,300

Notes: MPOI = maximum point of impingement.
All values are shown in micrograms per cubic metre.

Yours sincerely,

ORIGINAL SIGNED

Nancy Chan, B.A.Sc., P.Eng.
Atmospheric Specialist

ORIGINAL SIGNED

Bryan McEwen, M.Sc.
Practice Leader, Atmospheric Sciences

Appendix B

Model Plan and Acceptance

February 1, 2023 **Memorandum**

VIA EMAIL: ian.rose@arbiosbiotech.com
Waddellenvironmental@gmail.com

Arbios Biotech Canada LP
100-1700 West 75th Avenue Park Place
Vancouver, B.C. V6P G62

To: Ian Rose, General Manager, Arbios Biotech Canada LP
Glenda Waddell, President, Waddell Environmental Inc.

From: Gail Roth, Air Quality Meteorologist, B.C. Ministry of Environment and Climate Change Strategy

Re: Environmental Management Act (EMA) waste discharge application, dispersion modelling plan accepted

The B.C. Ministry of Environment and Climate Change Strategy (ENV) requires dispersion modelling to be included in the EMA waste discharge application for Arbios Biotech Canada (preliminary authorization number: 111155; tracking number: 413286). As per item 4.4 of the Information Request Table (IRT) provided by ENV, the dispersion modelling conducted to support the application must align with a dispersion modelling plan that has been reviewed and accepted by an ENV Air Quality Meteorologist.

This memo constitutes written acceptance of the dispersion modelling plan. To the best of my knowledge, this plan is consistent with the British Columbia Air Quality Dispersion Modelling Guideline (2022) [1] and the supplemental Guidance for NO_2 Dispersion Modelling in British Columbia (2022) [2] (herein, *modelling guideline* and *NO_2 guidance document* respectively).

The accepted dispersion modelling plan accompanies this memo and is inclusive of

- 230105_Arbios_Model Plan_V3.pdf
- Tables 2,3 and 4 in 230105_Comment Response Table Comments.doc
- 230105 Arbios Emissions.xlsx

The acceptance of the dispersion modelling plan is based upon the following materials and correspondence:

[1] British Columbia Air Quality Dispersion Modelling Guideline (2022). British Columbia Ministry of Environment and Climate Change Strategy. Available from https://www2.gov.bc.ca/assets/gov/environment/air-land-water/air/reports-pub/bc_dispersion_modelling_guideline.pdf

[2] Guidance for NO2 Dispersion Modelling in British Columbia. British Columbia Ministry of Environment and Climate Change Strategy. Available from https://www2.gov.bc.ca/assets/gov/environment/air-land-water/air/reports-pub/modelling_guidance_nitrogen_dioxide.pdf

Initial draft modelling plan and review

- 2022-11-29 Model Plan Review Arbios Assessment 413296.pdf and documents cited within
- 2022-11-29 Arbios receptors

Draft modelling plan and review, version 2

- 20221209_Aribios_Model Plan_V2.pdf
- 221209 Arbios Emissions (002).xlsx
- 221209_Comment Response Table.docx

Draft modelling plan and review, version 3

- 230105_Comment Response Table Comments.doc
- 230105_Arbios_Model_Plan_V3.pdf
- 230105 Arbios Emissions.xlsx
- Chan, Nancy. "Re: [Review of dispersion modelling plan] Environmental Management Act (EMA) waste discharge application 413286. Received by Gail Roth, 30 Jan. 2023.

A discussion between ENV, Arbios, and WSP on February 1, 2023 regarding the Best Achievable Technology (BAT) assessment. During this conversation, Arbios and Sr. EPO Laila Potvin confirmed that BAT modelling scenarios were not required for the waste discharge application.

Final comments

Please ensure the AQTR addresses model uncertainties (such as baseline concentrations in the near-field of the facility and emission factors).

Along with the Air Quality Technical Report (AQTR), please submit model input and output files (via external drive or ftp site) such that all model results can be reproduced (as necessary) to support the AQTR review.

Sincerely,

G. Roth.

Gail Roth M.Sc., A.Ag.
Air Quality Meteorologist
B.C. Ministry of Environment and Climate Change Strategy
Environmental Protection Division
Regional Operations Branch
Monitoring Assessments and Stewardship Section
Phone: 250-645-9358
Email: Gail.Roth@gov.bc.ca

cc. Benjamin Weinstein, Head, Monitoring Assessments and Stewardship
Laila Potvin, Sr. Environmental Protection Officer, Authorizations – North
Peter Lawrie, Head, Authorizations – South
Nancy Chan, Atmospheric Specialist, Ausenco

Dispersion Modelling Plan

An electronic version of this plan template is available from the Ministry website.

Dispersion model applications in the Metro Vancouver region should use the 'Metro Vancouver Dispersion Modelling Plan' available from:
http://www.metrovancouver.org/services/Permits-regulations-enforcement/PermitRegulationEnforcementPublications/MVDispersionModellingPlan.docx

GENERAL

Date: January 5, 2023

Facility Name, Company, Location (Lat, Long): Arbios Biotech Canada LP, represented by its general partners Arbios Biotech Canada (GP1) Ltd. and Arbios Biotech Canada (GP2) Ltd. Chuntoh Ghuna Facility located at 53.9257 N, 122.7055 W.

Air Quality Consultant and Contact Name: Ausenco Sustainability Inc., Bryan McEwen and Nancy Chan

Ministry Contact Name: Gail Roth

Level of Assessment (1, 2 or 3) and also provide rationale for the proposed level of assessment:

Level 3. The facility is unique and located in proximity to sensitive receptors, in a region with complex terrain. The Prince George airshed is considered sensitive, occasionally experiencing exceedances of air quality objectives for particulate matter.

Does this plan follow a modelling approach that is similar to the approach taken in a previous air quality assessment already reviewed and accepted by the Ministry? If so, provide the project name and Ministry contact:

N/A

PROJECT DESCRIPTION AND GEOGRAPHIC SETTING

Provide an overview of the project, including process description and the purpose of the dispersion modelling study.

Arbios Biotech (Arbios) will produce renewable biofuels with a low-carbon footprint, using the breakthrough Cat-HTR™ technology. Arbios will create high-value, sustainable carbon-based products, including advanced biofuels, from low-value wood residues. Transportation fuels from renewable biomass represents a significant opportunity to address the climate crisis.

The facility will convert low value biomass to a bio-hydrocarbon suitable for use as a feedstock in a conventional oil refinery. The process will consist of the following:

- Biomass belt dryers

- Feed to a high pressure reactor
- Pressure letdown
- Vapor, liquid and product separation
- Product storage

The dispersion modelling study will consider a facility sized to process approximately 50,000 ODT/yr of biomass to produce approximately 100,000 BBLs/yr bio-hydrocarbon). Expected points of discharge to the environment are:

- Biomass belt dryer stacks (x2)
- Natural gas fired supercritical water boiler stacks (x4)
- Biomass feedstock handling air collection system
- Natural gas vacuum column heater
- Vapor combustor
- Minor and/or intermittent discharges consistent with an industrial site

Provide a description of the following:

- Terrain characteristics within domain: flat terrain or complex terrain (i.e., will complex flow need to be considered?) Complex terrain. The urban community of Prince George sits in a "bowl" shaped depression. Two river valleys traverse the model domain, with Tabor Mountain located to the southeast. Terrain will be considered in the modelling.
- Dominant land cover: urban, rural, industrial, agricultural, forested, rock, water, grassland Land cover in model domain is predominantly urban, rural, and forested.

DISPERSION MODEL

Selected Dispersion Model:

- List model(s) and version to be used (see Section 2).

CALMET v6.5.0, CALPUFF v7.2.1

- Specify any non-guideline models or versions (i.e., beta-test versions) planned for use (Section 2.3.1). Provide rationale.

N/A

- If modifications to any of the models are planned, provide a description and the rationale (Section 2.3.2).

No modifications to the models are planned.

Default Switch Settings

- For AERMOD identify any switch settings that will be different than the recommended defaults (Section 7.7). Provide rationale.

N/A

- For CALMET/CALPUFF identify any key switch settings in CALMET and CALPUFF that will be different from the "black (do not touch)" defaults as per Tables 6.2 and 7.1. Provide rationale.

Switch settings will follow the BC Air Quality Dispersion Modelling Guideline. No deviations from the "black (do not touch)" defaults are anticipated.

- If the CALMET model is used, provide:
  - a CALMET domain map that also shows the locations of surface meteorological stations and upper air stations See Figure 1
  - anticipated grid resolution:_500____ (m)
  - number of grids in X and Y direction (NX = _80___ ,NY = _80____)
  - vertical levels (m): _0___,_20__,_40__,_80__,_160_,_300_,_600_,_1000,_1500,_2200,_3000

AERMOD and Receptors

If the AERMET/AERMOD model is used, provide the following:

- proposed receptor grid spacing (see Section 7.2):
- an AERMET/AERMOD domain map that shows the locations of surface meteorological stations, upper air stations and receptor grid
- anticipated sensitive receptors (see Section 7.4) and also indicate them on the domain map (if applicable)
- receptor (flagpole) height (m) (see Section 7.5):

N/A

CALPUFF and Receptors

If the CALPUFF model is used, provide the following:

- proposed receptor grid spacing (see Section 7.2):
- a map of the CALPUFF domain and receptor grid
- anticipated sensitive receptors (see Section 7.4)) and also indicate them on the CALPUFF domain map (if applicable)
- receptor (flagpole) height (m) (see Section 7.5):

The standard receptor grid spacing specified in the British Columbia Air Quality Dispersion Modelling Guideline will be followed, with the 50 m and 250 m grid spacing extended further to capture the downtown district, residential neighbourhoods, and city parks in the near-field. A maximum grid spacing of 500 m will be applied over the urban centre to avoid underprediction in this key area. Nearest residences on Hoferkamp Road, Lheidli T'enneh First Nation traditional use areas, schools, senior care facilities, and hospitals will be added as sensitive receptors. Traditional use areas were identified in consultation with the Lheidli T'enneh First Nation. All other sensitive receptors were identified based on aerial imagery and publicly available databases. See Figure 2.

PLANNED MODEL OUTPUT: AIR QUALITY ASSESSMENT NEEDS

Output Requirements for

What model output is required for decision makers and stakeholders? (i.e. what is the purpose of the assessment?). Circle as appropriate.

- Air Quality: concentrations, depositions, visibility, fogging, icing, other (specify)

Tables and Figures for Level 1 Assessment:

- maximum concentration of contaminants predicted including location and corresponding meteorological conditions
- printout of AERSCREEN model output

Tables and Figures for Level 2 and 3 Assessments (see detailed list in Section 8.3.2):

- spatial distribution maps of air quality parameters (maximums, exceedance frequencies, annual averages)
- tables of maximum short and long term average air quality parameters (locations and associated meteorological conditions)
- tables of air quality parameters at select receptors of interest (maximums, frequency distributions)
- tables of air quality parameters under abnormal emission situations (upsets, start-up)
- output spatial scale: near-field (<10 km), local (<50 km), regional (>50 km)
- special output required for vegetation, health risk or visibility assessments
- other (specify):

EMISSION SOURCES AND CHARACTERISTICS

Provide a map showing the source locations, buildings, and facility fence line.

See Figure 3

Model Emission Scenarios

If applicable, describe the different model emission scenarios required for the assessment if multiple options are under consideration. For example, different source characteristics (stack dimensions, emission rates) or source arrangements (locations, types, buildings) may need separate modelling runs to examine the air quality implications of different scenarios.

Modelling will consider two scenarios:

- maximum emissions based on requested permit limits for normal operations,
- emergency release scenario in the event of a site wide power failure.

Contaminants Emitted for Each Emission Scenario

Provide the following details of the sources to be modelled:

Specify Source, Type, Contaminants (extend Table as necessary)

Source	Type: Point (P), Area (A), Line (L), Volume(V), etc. Indicate type	Contaminants (SO_2, NO_2, $PM_{2.5}$*. . .)	Basis of Emissions (Section 3.3)
Biomass Dryers (x2)	P	PM filterable	_x_approved/proposed emission limits ___manufacturer specifications ___emission factors ___CEM ___modelled emission rates ___stack sample ___other (specify)
Biomass Feedstock Handling Air Collection System (Baghouse)	P	PM filterable	_x_approved/proposed emission limits ___manufacturer specifications ___emission factors ___CEM ___modelled emission rates ___stack sample ___other (specify)
Vapor Combustor	P	PM filterable + condensable, SO2, NOX	_x_approved/proposed emission limits ___manufacturer specifications ___emission factors ___CEM ___modelled emission rates ___stack sample ___other (specify)
Supercritical Water Boiler (x4)	P	PM filterable + condensable, SO2, NOX	_x_approved/proposed emission limits ___manufacturer specifications ___emission factors ___CEM ___modelled emission rates ___stack sample ___other (specify)
Vacuum Column Heater	P	PM filterable + condensable, SO2, NOX	_x_approved/proposed emission limits ___manufacturer specifications ___emission factors ___CEM ___modelled emission rates ___stack sample ___other (specify)

Material Handling	V	PM filterable	___approved/proposed emission limits ___manufacturer specifications _x_emission factors ___CEM ___modelled emission rates ___stack sample ___other (specify)

***** for PM emissions indicate whether it is filterable, or filterable + condensable, or if unknown (see Section 3.6)

Source Emission Rate Variability

Do emissions have sub-hourly variation (e.g., blow-down flares with high emission peaks during the hour)? If so, describe the approach to assess air quality implications of those sub-hourly high emission peaks.

No, emissions will be assumed constant 24/7/365 based on requested permit limits.

Describe the approach to assess air quality implications under the 25, 50, 75% emission scenario. See Section 3.4.2.

N/A. Use of constant emission rates based on requested permit limits is expected to provide a worst-case scenario of normal facility operations. Other emission scenarios will not be modelled.

If there are batch processes, provide a temporal emission profile (emission rate vs time) for each batch process.

N/A

Describe anticipated abnormal emission scenarios (e.g., start-up, shut-down, maintenance of control works) and their anticipated frequency of occurrence. See Section 3.4.3.

Emergency release scenario will be modelled whereby all process gas in the pressure relief system is directed to the vapour combustor.

Start ups and shutdowns may occur occasionally, especially during the initial 12-month commissioning process. Start ups and shutdowns will be at 25% of permitted throughput and emissions are expected to remain below requested permit limits.

BASELINE CONCENTRATION

- Indicate method used to determine baseline concentrations for each pollutant (Section 8.1):

  _x___monitoring data (Section 8.1.1 and 8.1.2)

  _____establish monitoring program (Section 8.1.3)

_____modelled sources (Section 8.1.5)

_____other method (describe)

- If existing monitoring data to be used, complete the following Table:

Representative Air Quality Measurements

Station Name (Lat./Long./ or indicate on map)	Period of Record (start/end date)	Contaminants Measured
Plaza 400 (see Figure 1)	January 1, 2018 to December 31, 2020	SO2, NO2
Plaza 400 (see Figure 1)	January 1, to December 31, 2016	PM10, PM2.5

Note: BC ENV will provide the screened PM dataset with wildfire influence removed for use in development of baseline concentrations.

If baseline concentrations are anticipated to change in the future due to planned significant reductions or increases in emissions, provide a description of how these will be accounted for (e.g., construction of a nearby new facility or the planned decommissioning of a currently operating facility) and the uncertainties involved in estimating future emissions.

No major projects known that will substantially change baseline concentrations.

- For NO_2 models, provide a description of how NO_2 chemistry, location and proximity of urban regions relative to the modelled source, and proximity of nearby large industrial or transportation sources of NO_X are considered when selecting the baseline dataset (Section 3.3.2, GUIDANCE FOR NO_2 DISPERSION MODELLING IN BRITISH COLUMBIA).

The study area is considered urban and industrial, influenced by residential and transportation sources in Prince George as well as surrounding industrial sources (e.g., Canfor Pulp Ltd.) that emit greater than 500 tonnes/year of NOX based on NPRI reporting.

- For NO_2 models, if refined baseline options are proposed (Section 3.3.2, GUIDANCE FOR NO_2 DISPERSION MODELLING IN BRITISH COLUMBIA), show the baseline value(s) in the form of each sequential step (e.g., show the 98^{th} percentile of daily 1-hour maximum and the 98^{th} percentile of monthly hour-of-day values if proposing to use the Monthly Hour-of-Day option).

Default baseline option is proposed.

- If the Monte Carlo method (Section 3.3.2.1, GUIDANCE FOR NO_2 DISPERSION MODELLING IN BRITISH COLUMBIA) is applied for NO_2 baseline, submit the computer code used to generate results.

N/A

BUILDING DOWNWASH

- Potential for building downwash. Please provide rationale if building downwash is not modelled.

N/A

- If building downwash included, provide a site map to indicate buildings to be processed by BPIP-PRIME, and complete the following Table: See Figure 3

Source Height (m)	Building	Building Length (m)	Building Height (m)	Building Width (m)
-	Offices	18.1	4.3	15.0
12 m – SCW boilers 1 & 2	Utility building	28.6	10	13.4
12 m – SCW boilers 3 & 4	Boiler room	10.7	10	7.6
16.8 m – Vapor combustor	Vapor combustor building	9.2	17	7.3
7 m – Dryer stacks	Dryer	25.5	10	6.9
-	Tank farm	4 tanks x 3.6 m diameter 1 tank x 3.0 m diameter	4 tanks x 5.3 m height 1 tank x 3.6 m height	-
-	Biomass metering bin	6.6	6.7	2.6
-	Processing equipment enclosure (x2)	18.2	4.1 / 7.8	3.8 / 7.4 (L-shaped structure)
-	Storage tanks at biomass conversion area	3 tanks x 2.75 m diameter	3.4	-
-	Waste treatment plant storage tank	4.0 m diameter	6.6	-
-	Electrical enclosure J	12.5	4.4	3.4
-	Electrical enclosure K	12.5	4.4	4.3

GEOPHYSICAL DATA INPUT

Topography and Land Use Data

- Terrain data (specify source of data) and an elevation map for the model domain:

0.75 arc second Canadian Digital Elevation Model from Natural Resources Canada (see Figure 4)

- Land use data (specify source of data) and a land use map for the model domain:

30-m land cover data from Natural Resources Canada (see Figure 5)

Surface Characteristics

For AERSCREEN, provide seasonal values of surface characteristics (surface roughness, albedo and Bowen ratio) for input to MAKEMET.

N/A

For Level 2 and 3 Assessments, indicate if recommended seasonally varied surface characteristics (surface roughness, albedo, Bowen ratio, etc.) (see Section 4.3 and 4.4) are used for the dispersion modelling study. If not, provide the proposed surface characteristics and the rationale.

Seasonal geophysical parameters from Tables 4.8 to 4.12 of the BC Air Quality Dispersion Modelling Guideline will be used with the exception of anthropogenic heat flux which are provided for a mid-latitude city such as Vancouver. Anthropogenic heat flux will be estimated for Prince George based on population and energy consumption data as per the BC Air Quality Dispersion Modelling Guideline.

METEOROLOGICAL DATA INPUT (FOR LEVEL 2 AND 3 ASSESSMENTS ONLY)

Surface Meteorological Data

If surface observation data are used, provide a map with the location of each surface meteorological station identified and also provide the following:

Surface Met Data and Location (lat/long or indicate on map)	**Data Source The Ministry, MV, MSC, Site Specific, Other (specify)** [1]	**Period of Record (start/end data)** [2]	**% of Wind Speeds = 0.0** [3]	**Anemometer Height (m)**	**Parameters**
PG Airport Auto	MSC	January 1, 2013 to December 31, 2015	2.8%	10.0	Wind speed and direction, Temperature, Relative humidity, Pressure, Precipitation, Cloud cover, Ceiling
PG Massey Auto	MSC	January 1, 2013 to December 31, 2015	6.6%	15.0	Wind speed and direction, Temperature, Relative humidity, Pressure, Precipitation

PG Exploration Place	ENV	July 7, 2013 to December 31, 2015	3.3%	14.0	Wind speed and direction, Temperature, Relative humidity
PG Gladstone School	ENV	January 1, 2013 to November 12, 2015	1.4%	15.0	Wind speed and direction, Temperature, Relative humidity
PG Glenview School	ENV	January 1, 2013 to December 31, 2015	1.0%	17.8	Wind speed and direction, Temperature
PG Plaza 400	ENV	January 1, 2013 to December 31, 2015	0.7%	27.0	Wind speed and direction, Temperature, Relative humidity
PG Pulp	ENV	January 1, 2013 to December 31, 2015	2.2%	22..0	Wind speed and direction, Temperature

1. If data from a non - Ministry, MV or MSC station are planned to be used, follow guidance in Section 5.2.3
2. For data completeness and data filling, follow guidance in Section 5.5
3. For light and no wind conditions, follow guidance in Section 5.6

Notes:2013 to 2015 is proposed as it represents the most recent three-year period for which there is province-wide WRF data and the most complete surface data.

Upper-Air Meteorological Data

If upper air meteorological data are used provide the following:

Station Name	**Period of Record (start/end date)** [1]	**Distance between the Upper Air Station and Project (km)**
Prince George	January 1 to December 31, 2014	7

1. For data completeness and data filling, follow guidance in Section 5.5.

NWP Model Output

If NWP output (different than the provincewide WRF output) used provide the following:

- Mesoscale Meteorological Model (Name\Version\Model Configuration):
- Model Output Provider:
- Domain (attach a map showing the horizontal extent):
- Horizontal and Vertical Grid Resolution and Height of Each Vertical Level:
- Data Period (start/end date):
- Four Dimensional Data Assimilation is applied (Yes or No):

Province-wide WRF output will be used.

NWP model output use (circle one below for the selected dispersion model):

- AERMET/AERMOD:
  - Extract pseudo surface station and pseudo upper air sounding (as input to AERMET), or
  - Create .SFC and .PFL files (AERMOD-ready files, skip AERMET)

- CALMET:
  - NWP only, or
  - Surface station and NWP, or
  - Surface station, upper air sounding, and NWP, or
  - Other (specify):

TREATMENTS

NO to NO_2 Conversion (Section 3.2, GUIDANCE FOR NO_2 DISPERSION MODELLING IN BRITISH COLUMBIA)

Identify the method to be used. Please note that the results of total conversion must be presented as part of all model reports, regardless of the conversion method selected for the project.

Specify the considerations given to ambient concentrations, characteristics of modelled sources, and availability of relevant monitoring data when selecting the NO_2 modelling method indicated above.

_____Total Conversion

_x___Ambient Ratio Method

- Indicate which NO/NO_2 dataset is used for the ARM2 curve (AERMOD screening ARM2 curve, BC ENV-developed category curve, or single site representative of project site) and explain the basis for selecting the dataset. Default industrial curve. Representative of industrial area in the vicinity of the facility and somewhat conservative of urban area of Prince George based on comparisons with 2018 to 2020 data from Plaza 400.
  - If a single site dataset is used, provide the dataset and completeness statistics (e.g., number of years, percent complete per quarter). N/A

- If CALPOST is used, provide the 24 values used for the step function.

CNOX	36.9	40.0	45.0	50.0	55.0	60.0	65.0	70.0	75.0	80.0	85.0	90.0
NO2/NOX	0.900	0.880	0.847	0.812	0.716	0.740	0.705	0.671	0.638	0.607	0.577	0.549
CNOX	95.0	100.0	110.0	125.0	140.0	155.0	175.0	200.0	210.0	230.0	260.0	293.5
NO2/NOX	0.524	0.500	0.460	0.413	0.380	0.358	0.337	0.312	0.301	0.275	0.233	0.200

_____OLM:

- Indicate which O_3 dataset is used and explain the basis for selecting the O_3 dataset.
    - If a single site representative hourly O_3 dataset corresponding to the meteorological period is used, specify the method of data substitution used for addressing data gaps, provide the dataset, and include the completeness statistics (e.g., number of years, percent complete per quarter).
- If non default equilibrium ratios are used, specify and provide rationale.
- Specify and provide rationale for in-stack ratio(s) used. If multiple NO_X sources are modelled, provide justification for how the ISR(s) is/are selected.

_____PVMRM (for AERSCREEN and AERMOD only):

- Indicate which O_3 dataset is used and explain the basis for selecting the O_3 dataset.
    - If a single site representative hourly O_3 dataset corresponding to the meteorological period is used, specify the method of data substitution used for addressing data gaps, provide the dataset, and include the completeness statistics (e.g., number of years, percent complete per quarter).
- If non default equilibrium ratios are used, specify and provide rationale.
- Specify and provide rationale for each in-stack ratio used.

Chemical Transformation:

- Specify transformation method and provide details on inputs if secondary $PM_{2.5}$, acid deposition or visibility effects are to be estimated. Depending on the transformation method, this could include ammonia, ozone, hydrogen peroxide concentrations, nighttime loss and formation rates for nitrates and sulphates.

Chemical transformation will not be modelled.

Particle Deposition:

- If non-recommended particle size distributions (see Section 3.6) are used, provide Table of particle emission (including heavy meals if modelled) size/density distribution and indicate the basis for the Table.

Standard particle size distribution from BC Air Quality Dispersion Modelling Guideline will be used.

Stagnation:

- Provide an estimate of the frequency of stagnation based on local meteorological data if available. If AERMOD is proposed, provide methodology on how stagnation periods will be treated (see Section 10.2).

Percentage of calm winds are shown in the table of surface meteorological data above. Stagnation effects will be considered in CALPUFF.

Shore/Coastal Effects:

- If included, indicate whether sub-grid-scale Thermal Internal Boundary Layer option is selected along with the required input coastline coordinate data (see Section 10.3).

N/A

Plume Condensation (Fogging) and Icing:

- Indicate if this will be included (Section 10.6).

N/A

QUALITY MANAGEMENT PROGRAM

Model Input Data

Indicate the tests that will be undertaken to assure the quality of the inputs.

For the geophysical input data:

- contour plot of topography
- plots of land use and land cover

For the meteorological data:

- wind rose (annual and/or seasonal)
- frequency distribution of surface wind speeds
- average hourly temperature plot (annual and/or seasonal)

If NWP output is used, describe the tests undertaken to assure the quality of the output (Section 6.1)

- wind rose at selected locations and heights (annual and/or seasonal)
- average hourly temperature plot at selected locations and heights (annual and/or seasonal)
- wind field plots for selected periods that indicate topographic influences such as channeling and thermally generated flows

Some comparisons between NWP output and observation data will be provided, including wind roses and basic statistics for wind speed, wind direction, and temperature.

Model Output Data

For CALMET/CALPUFF applications, provide a list of the tests conducted to confirm the quality of the model output (intermediate pre-processing files and concentration/deposition predictions).

With respect to the pre-processed files that are prepared for CALPUFF input, there are several tests listed in Section 9.1.1 and 9.1.2 to check the output from the pre-processing utility programs to confirm that they have been properly processed. These are related to checking:

- terrain, land use
- sources (locations and elevation) and emission characteristics
- meteorological data (locations) and tests to confirm proper processing of the raw meteorological data (units, parameters)
- receptor locations and elevations

For CALMET output there are several tests listed in Section 9.1.3 to test the quality of the generated meteorological fields. These are related to reviewing the following:

- wind field maps (surface and different elevations) for select periods where topographic influences (channeling, thermally driven flows) would be evident
- wind roses at selected locations and elevations (annual, seasonal)
- frequency distributions of various meteorological parameters (annual, seasonal) such as PG-stability class and mixing heights
- plots of hourly average parameters such as temperature, mixing height, and precipitation at key locations (seasonal and annual)

Model Performance Evaluation

For Level 3 Assessments, indicate whether an assessment of model performance will be conducted as quality assurance for the project (Section 4.3, GUIDANCE FOR NO_2 DISPERSION MODELLING IN BRITISH COLUMBIA). If not, provide rationale.

Modelling will be conducted for the proposed facility only. There is no data to support an assessment of model performance.

Note: The Ministry may require all computer files associated with the modelling to be submitted upon request.

If any of the advanced processing methods like Monte Carlo are applied, the computer code used to generate results should also be included in the submittal.

MINISTRY REVIEW OF PLAN AND REVISIONS

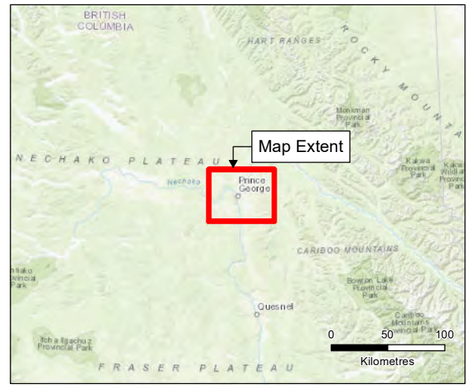
A modelling plan can change over the course of developing the air quality assessment so acceptance of the initial submission of the plan is based on the best information provided to date. Changes to the plan (additions, modifications) should be noted and agreed to with the Ministry as necessary. An updated Dispersion Modelling Plan may be necessary.

Ministry Acceptance of Original Plan (Name):_____

Date:_____

Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Study Area



Legend

- Meteorological Monitoring Station
- Meteorological Monitoring Station / Air Quality Monitoring Station
- Project Development Area
- Study Area
- Community
- Highway
- Road
- First Nations Reserve
- Watercourse
- Waterbody

Notes

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2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Contains information licensed under the Open Government Licence(s) - British Columbia; Statistics Canada
- Basemap: ESRI World Topographic Map
- Inset Basemap: ESRI World Topographic Map

N

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0 2 4 6 8 10
Kilometres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

105520-01	Production Date: Oct 24, 2022	Figure 1

Ausenco

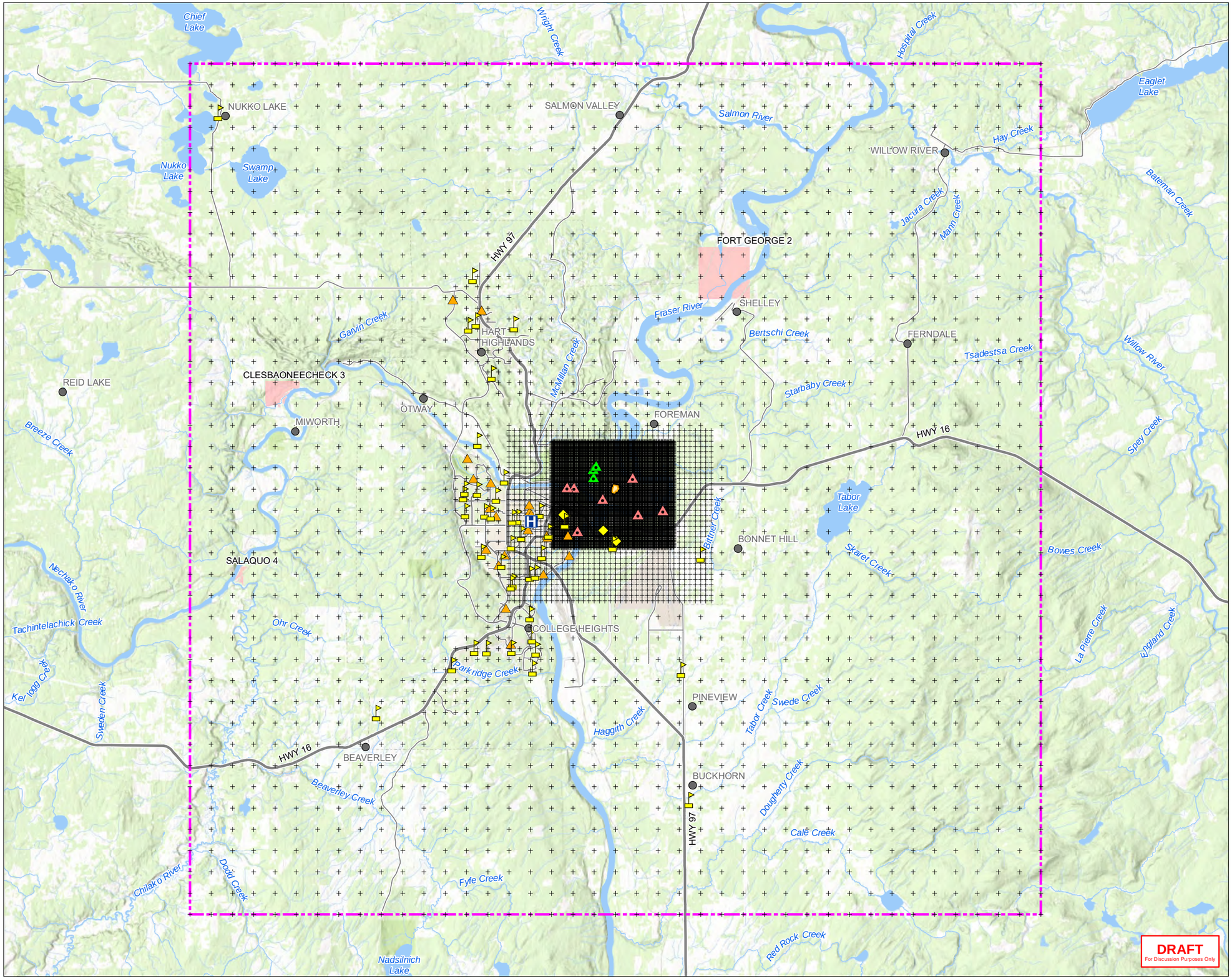
ARBIOS BIOTECH

DRAFT
For Discussion Purposes Only

Path: S:\Geomatics\Projects\105520\02\mxd\air_quality\Fig1_105520_02_AQ_StudyArea_231024.mxd

Arbios Biotech Chuntoh Ghuna Facility
PG Pulpmill Rd, Prince George, BC

Receptor Grid



Legend

- Receptor Grid
- Facility Development Area
- Study Area
- Community
- Highway
- Road
- Watercourse
- Waterbody

Sensitive Receptors

- Air Quality Monitoring Station
- Hosptial
- L'heidli T'enneh Traditional Use
- Nearest Residence
- School
- Senior Care Facility

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Kilometres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

105520-01	Production Date: Dec 6, 2022	Figure 2

DRAFT
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ARBIOS BIOTECH

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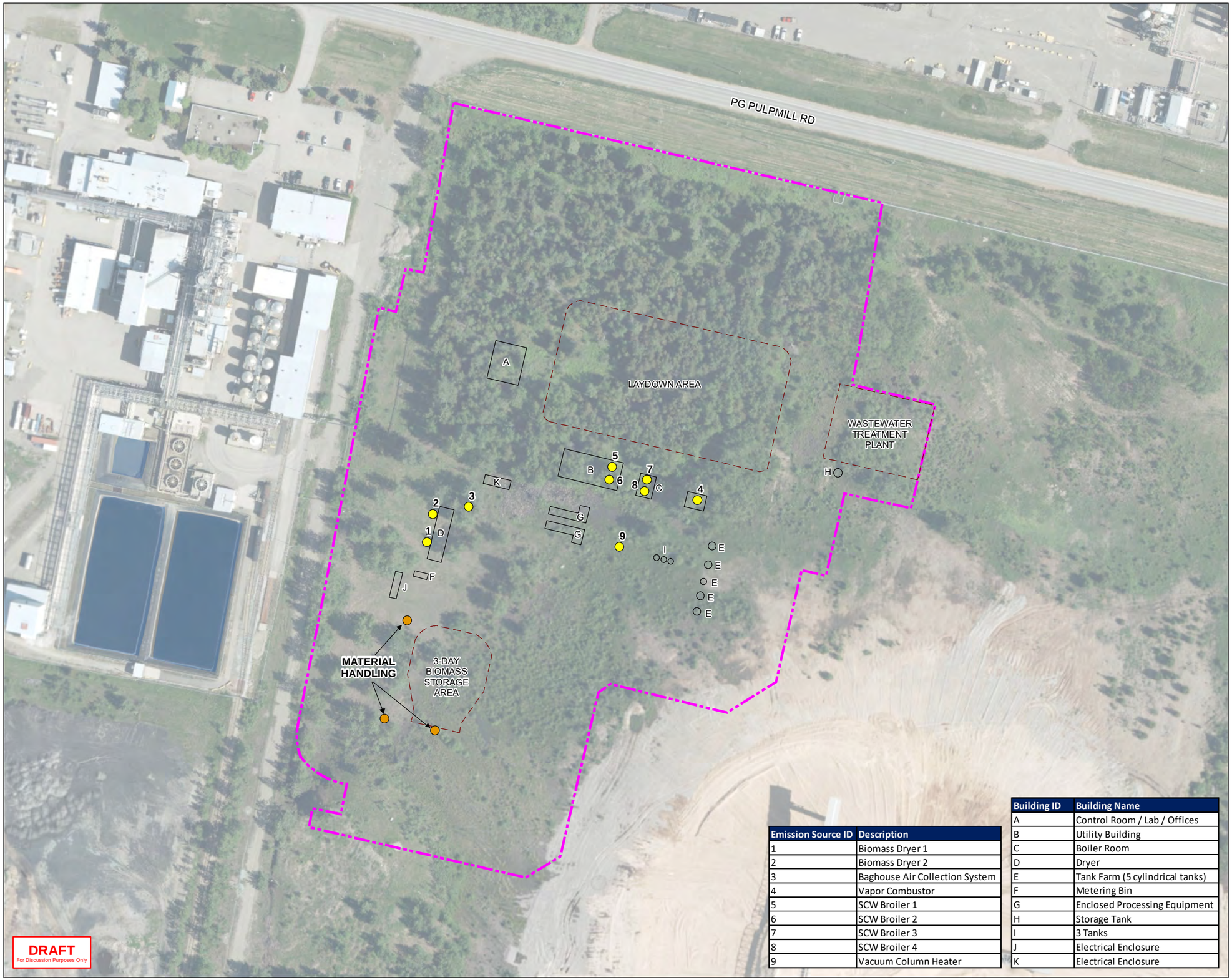
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Site Plan



Legend

- Authorized Emission Source
- Fugitive Emission Source
- Project Development Area (fence line)
- Building or Structure
- Site Feature
- Waterbody

Emission Source ID	Description
1	Biomass Dryer 1
2	Biomass Dryer 2
3	Baghouse Air Collection System
4	Vapor Combustor
5	SCW Broiler 1
6	SCW Broiler 2
7	SCW Broiler 3
8	SCW Broiler 4
9	Vacuum Column Heater

Building ID	Building Name
A	Control Room / Lab / Offices
B	Utility Building
C	Boiler Room
D	Dryer
E	Tank Farm (5 cylindrical tanks)
F	Metering Bin
G	Enclosed Processing Equipment
H	Storage Tank
I	3 Tanks
J	Electrical Enclosure
K	Electrical Enclosure

Notes

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Sources

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- Aerial Image: ESRI World Imagery

N

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0 20 40 60 80 100

Metres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

105520-02	Production Date: Nov 4, 2022	Figure 3

Ausenco

ARBIOS BIOTECH

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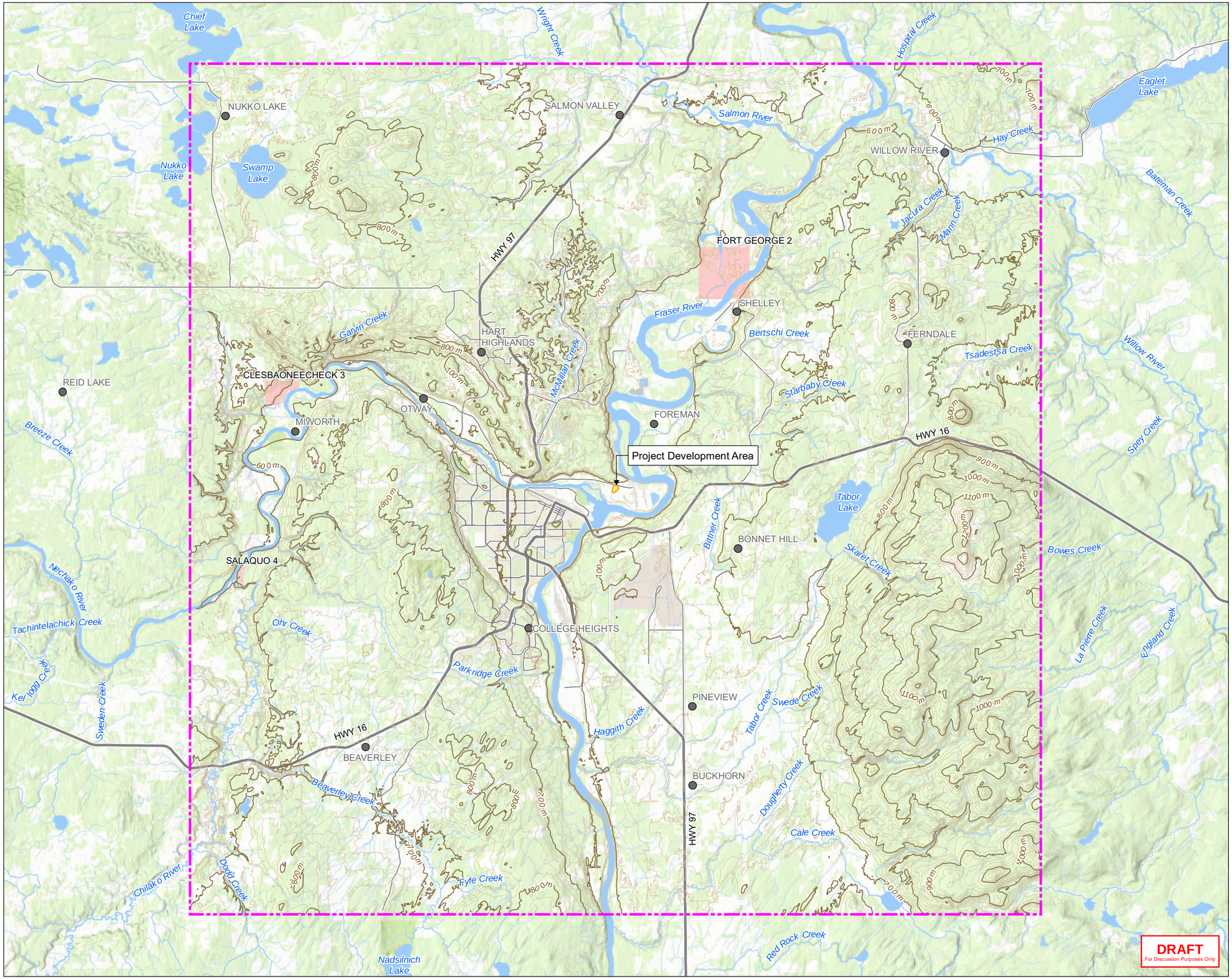
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Terrain Elevations



Legend

- Major Contour Line (100 m interval)
- Minor Contour Line (20 m interval)
- Project Development Area
- Study Area
- Community
- Highway
- Road
- First Nations Reserve
- Watercourse
- Waterbody

Notes

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Kilometres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

105520-01	Production Date: Oct 24, 2022	Figure 4

Ausenco ARBIOS BIOTECH

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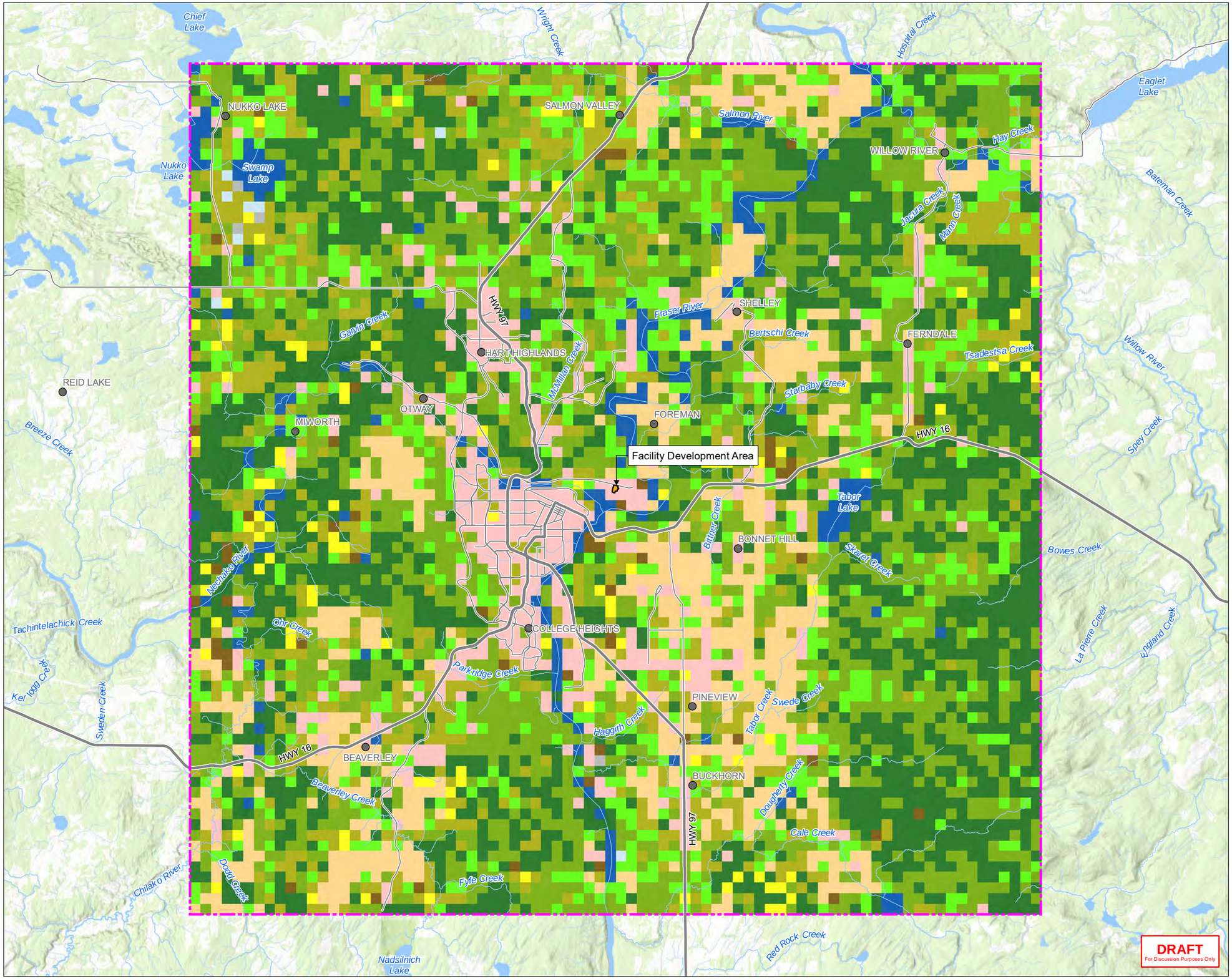
Arbios Biotech Chuntoh Ghuna Facility
PG Pulpmill Rd, Prince George, BC

Land Cover Characterization



DRAFT
For Discussion Purposes Only

Legend

- Facility Development Area
- Study Area
- Community
- Highway
- Road
- Watercourse
- Waterbody

Land Cover Characterization

- Urban or Built-up Land
- Cropland and Pasture
- Herbaceous Rangeland
- Shrub and Brush Rangeland
- Deciduous Forest Land
- Coniferous Forest Land
- Mixed Forest Land
- Water
- Wetland
- Barren Land
- Snow and Ice

Notes

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- Basemap: ESRI World Topographic Map
- Inset Basemap: ESRI World Topographic Map

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0 2 4 6 8 10
Kilometres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

105520-01	Production Date: Dec 6, 2022	Figure 5

Ausenco

ARBIOS BIOTECH

Path: S:\Geomatics\Projects\105520\02\mxd\ae_qualityFig5_105520_02_AQ_LandCover_221206.mxd

Table 1 Comment Responses

ID	Comment	Response
1	I agree a Level 3 assessment is appropriate although rational provided should be based on characteristics of the facility and surrounding area. For example, • The facility proposes to produce bio-hydrocarbon and is unique to BC. • Emissions information from some of the technology proposed for the facility are unavailable in BC. • Sensitive receptors exist in the near-field of the proposed facility location. • The proposed location of the facility is in complex terrain within a sensitive airshed where, ▫ PM2.5 and PM10 approach or at times exceed BC air quality objectives (AQOs) and ▫ PM2.5 has been consistently assigned an orange management level for PM2.5 under the national Air Quality Management System (AQMS) which speaks to the need for active air quality management to prevent exceedance of the PM2.5 Canadian Ambient Air Quality Standards (CAAQS).	Rationale for a Level 3 assessment has been revised to reflect the facility and surrounding area.
2	As noted during the November 8, 2022 call, CALPUFF Version 7.3.2 is a beta release and introduced a new source type (spray) which is unapplicable to this assessment. What is the rationale for proposing CALPUFF 7.2.1 over the standard version? Were additional changes applied to the 7.2.1 model code that are applicable to this assessment or are the two versions (7.21 and 7.32) expected to behave identically for this assessment?	The model plan has been revised to use CALPUFF Version 7.2.1.
3	Retaining the default “black (do not touch)” settings as outlined in Tables 6.2 and 7.1 of the modelling guideline is acknowledged. Please confirm the remaining CALMET/CALPUFF switch settings that will be applied for this assessment. Switch settings that require user input such as NOOBS, MTIP, etc. must be confirmed with appropriate rationale prior to modelling.	Please see Tables 2 to 4 below.
4	For review purposes, please provide the coordinates of the centre or southwest corner of the CALMET grid. Given the complexity of the terrain surrounding the proposed location, proximity of sensitive receptors to the proposed facility and requirement for a refined understanding of predicted incremental increases of PM2.5, was the CALMET 500m grid resolution evaluated to ensure terrain effect on the wind field are sufficiently resolved, particularly in the near-field of the proposed facility? For example, ▫ An evaluation of a light wind case where terrain induced flows dominate – and compare 500m and 250m grid resolutions. ▫ A graphical analysis to ensure adequate resolution of the terrain including peak terrain heights, valley bottoms, unique terrain features such as local relief in the near-field of the proposed site and elevation of the proposed site.	Southwest corner of the CALMET grid is at UTM coordinate is 499413 mE, 5955266 mN (UTM Zone 10). The valley width in the vicinity of the facility is relatively wide, with a ridge-to-ridge distance of approximately 10 km (i.e., TERRAD = 5 km). A 500 m grid resolution would provide 10 grid cells which is more than sufficient to resolve TERRAD (5 to 10 grid cells is recommended). A graphical analysis of the terrain based on a 500 m grid resolution and a 250 m grid resolution is provided in Figures A.1 and A.2, respectively. The terrain in the two figures is very similar and a 500 m grid resolution is expected to be sufficient. Ausenco has previously evaluated valley flow in CALMET at 250 m and 500 m and have found no significant differences in wind orientation. We note that at a resolution of 1 km, UNBC was able to achieve reasonable agreement with observation data.
5	Receptor grid resolutions specified in the model guideline (section 7.2) are the minimum. Land use surrounding the proposed facility supports increasing the area of the 50m and 250m grids in the near-field, even if concentration gradients are low: • Several sensitive receptors are located within 2 km of the proposed facility and along the river (residential neighbourhoods, parks, a museum, winery, correctional institutions, etc.). • A city park is located on the valley sidewall to the south of the facility. • The city downtown/business district is located within 3km. The .kmz file that accompanies this memo contains polygons, provided for consideration, as conservative but appropriate areas, when assigning the 50m and 250m receptor grids.	The model plan has been revised to include a denser receptor grid in the vicinity of the facility as recommended.
6	The .kmz file that accompanies this memo contains six discrete receptors that appear to be absent from Figure 2 of the model plan but are recommended to be included. These receptors include three senior care facilities located at lower elevations within the urban area and three ambient monitoring sites. While the ambient monitoring sites are not sensitive receptors themselves, they are in areas of interest and the modelled concentrations at these locations may inform additional ambient monitoring, should it be required.	The six discrete receptors identified have been added to Figure 2 of the revised model plan.

ID	Comment	Response
7.1	In additional maximums, exceedance frequencies and annual averages, as proposed, please include isopleth maps of current BC ambient air quality objectives (AQOs) and Canadian Ambient Air Quality Standards (CAAQS). For objectives based on multiple years (e.g., 1-hour NO2), provide maps of the annual metric for each year as well as the multi-year objective. For AQOs or CAAQS based on a single year, provide a map of the metric for each year modelled. If modelled concentrations are approaching or exceeding the AQO or CAAQS threshold outside the facility boundary, please ensure the maps include an isopleth equal to the objective threshold value. For reference purposes only, please also include an isopleth equal to the 2025 CAAQS threshold on isopleth maps where applicable.	Isopleth maps will be produced for each year modelled as requested, showing exceedances of the AQOs, including 2025 CAAQS for reference purposes.
7.2	Similar to the isopleth maps, please include comparisons to current BC AQOs and CAAQS in the tables of air quality parameters at receptors of interest.	Tables will be provided for the receptors of interest as well as maximum point of impingement, including comparisons to AQOs and CAAQS.
7.3	If modelled concentrations from the facility-only emission scenario(s) intersect with the Plaza 400, CBC, or Corrections Centre ambient monitoring station, please include time series that illustrate the change in air quality at the station: a) monitored concentrations and b) model predicted + monitored concentrations to determine the change in air quality at that receptor.	Timeseries of modelled concentrations from the facility and monitored concentrations (paired in time and space) will be included in the AQTR as requested. Monitoring data from the CBC station does not appear to be available via the BC ENV Envista website. We therefore request BC ENV to provide the CBC monitoring dataset (concurrent to the model period of 2013 to 2015).
7.4	The modelling plan (p. 4) indicates that tables of air quality parameters under abnormal emission situations (e.g., upsets, start-up, shut-down, maintenance of control works) will be included in the planned model output. What emission scenario will be applied in this case? The proposed model emission scenarios do not appear to include an abnormal emissions scenario.	The abnormal emission scenario to be model represents a site wide power failure, whereby all process gas will be vented to the vapour combustor.
8.1	To confirm, will the maximum emissions scenario for normal operations (i.e., requested permit limits) reflect maximum emission rates and maximum discharge flow rates presented in the emissions table (221104 Arbios Emissions.xlsx)?	Yes, the maximum emissions scenario is based on the maximum emission rates and maximum discharge flow rates as presented in the emissions table.
8.2	Please clarify what emission sources, rates and discharge flow rates will be included in the emergency release scenario and provide rationale.	The emergency release scenario will consist of only one emission source, the vapour combustor. Emission rates and discharge flow rates are as presented in the emissions table. All other emission sources will be shut down during this emergency release.
8.3	As per comment 7.4, will an abnormal emissions scenario (upsets, start-up) be included? If not, please provide rationale. Are abnormal emissions expected to remain within the "maximum emissions for normal operations" scenario proposed?	The emergency release scenario described above will be modelled. As shown in the emissions table, SO2 and NOX during emergency release (row 55) are expected to be higher than those during normal operation (row 61). PM and CO during emergency release will remain within the maximum emissions for normal operation. As identified in the model plan, there may be additional abnormal emissions related to start ups and shutdowns. Start ups and shutdowns will be at 25% of permitted throughput and therefore, emissions are expected to remain below permitted levels. Start up and shutdowns may occur during the initial 12-month commissioning process but is expected to be infrequent during normal operations. Given the short-term and infrequent nature of start ups and shutdowns, effects on air quality are expected to be minor in comparison to air quality objectives.
8.4	Please clarify how the flare will be specified in the model (e.g., as a point source with pseudo-stack parameters as per section 10.1 of the model guideline) and, for the emergency release scenario, provide the anticipated duration and frequency of occurrence.	The vapour combustor is an enclosed flare and will be modelled as a point source with stack parameters as specified in the emissions table. The pseudo-stack parameters in Section 10.1 of the model guideline do not apply. The emergency release scenario is expected to be up to a maximum of 1 hour in duration. Frequency of occurrence is conservatively assumed to be 4 times per year.
8.5	For each emissions scenario, please report on a) facility-alone emissions and b) facility emissions plus baseline.	The AQTR will present predicted concentrations associated with the facility alone as well as cumulative concentrations including baseline.
8.6	The IRT included with the AID for this application indicates a Best Achievable Technology (BAT) assessment is required. Do the proposed emissions scenarios take the BAT assessment into account? Are any BAT emissions scenarios necessary or helpful to inform the impact assessment?	A BAT assessment is currently being conducted. Overall, the proposed emission limits are in line with the BAT assessment. The BAT assessment is not expected to result in any additional or different emissions scenarios. Rather, it will inform operational or maintenance procedures to ensure performance remains below stated limits.
9.1	The Discharge Factors Form, Arbios – Discharge Factors Mar 2022.pdf, indicates Stela biomass dryers are planned for use. Stela dryers often have multiple stacks. How many stacks will each dryer have? Does the discharge flow rates and emission rates of the dryer presented in the emissions table (221104 Arbios Emissions.xlsx) represent a single stack or combined flow and emission rates for each dryer? If there are multiple stacks per dryer, will each stack be modelled separately?	There will be one exhaust stack on each dryer. Each dryer stack will be modelled separately as shown in the emissions table.
9.2	What fuel source will be used to fire the dryers? Are there any associated emissions?	Heat for the dryer is supplied by a closed loop heat recovery system. Startup is fueled by an electric boiler and therefore no emissions are associated with the heat source.
9.3	Do the emission rates presented in the emissions inventory (221104 Arbios Emissions.xlsx) correspond to a 1-hour averaging time?	Emission rates presented correspond to proposed authorized limits, based on manufacturer specifications including a margin of safety. Emission rates therefore correspond to a hypothetical maximum and are expected to be a reasonably conservative estimate for the 1-hour averaging time.

ID	Comment	Response
9.4	What is the expected size of biomass particles at each of the handling points? I note that emission factors in US EPA AP-42 Section 13.2.4 Aggregate Handling and Storage Piles were developed for mineral aggregates. Given that the material of interest in this case is biomass, which likely has a different density and aerodynamic diameter than many minerals, is the entrainment of biomass particles expected to have a similar behaviour as mineral aggregates? Further discussion on fugitive emissions may be needed.	Size of biomass material will range from 25 mm to 100 mm, with a nominal size of 50 mm. Emission factors and particle size distribution from AP-42 Section 13.2.4 represents the best available information to estimate fugitive dust emissions due to the lack of information specific to biomass material. Overall, it is expected that the range of aggregates used to develop emission factors in AP-42 Section 13.2.4 will be reasonably representative of the material sizes at the facility. Given the high moisture contents (approximately 50%) of the biomass material, fugitive dust emissions are expected to be minimal and will not contribute substantially to air quality effects.
10.1	NO2 and SO2. Developing baseline concentrations from Plaza 400 measurements (2018-2020) as proposed appears reasonable.	Thank you for your comment.
10.2	As shown in the table below, data capture of PM2.5 at Plaza 400 falls below the recommended minimums in 2019 and 2020 (75% per calendar quarter). Further, wildfire impacts in Prince George during the summer of 2018 were extensive. It is preferable to develop baseline values from a complete year of data, without substantial wildfire impacts. Given these limitations, 2016 appears to be the best available data to develop PM2.5 and PM10 baseline concentrations.	The model plan has been revised to use 2016 PM data from Plaza 400. As per the call on November 8, 2022, it is expected that BC ENV will provide the screened dataset in which wildfire influenced data has been removed. The AQTR will provide rationale for the baseline selection including discussion of limitations.
11	Neighbouring buildings and large sawdust piles are located adjacent to the proposed site, and the proposed site has a small footprint. Were nearby objects considered when determining which buildings/object would be included in the building downwash modelling?	Only on-site buildings will be included in the modelling as shown in Figure 3 of the model plan. The zone of influence around buildings/structures is estimated to be 5 times the lesser of the projected height or projected width of the building/structure. The nearest distance from a point source to an off-site building is approximately 80 m (dryer to eastern most building at United Initiators). The height of off-site buildings is expected to be well below the height at which building downwash may affect facility emissions (about 16 m).
12.1	Deciduous forest is quite prevalent across the model domain but appears to be absent in the land cover data presented in Figure 5 of the model plan. As indicated in the modelling guideline, Tables 4.8 – Tables 4.12, geophysical parameters of deciduous and coniferous forest most notably differ in the cool seasons. Is this limitation expected to impact model results? For consideration, more recent land cover data, which includes deciduous forest, is available in a 30m resolution from Natural Resources Canada.	The model plan has been revised to use 30 m land cover data from Natural Resources Canada.
12.2	The model plan indicates that anthropogenic heat flux will be estimated rater than applying standard values in the modelling guideline. Please provide the estimated anthropogenic heat flux values and a brief description of the method applied, once available.	Anthropogenic heat flux will be estimated in accordance with Oke 1987 as referenced in Section 4.4.1 of the model guidelines. AHF = Population Density × Per Capita Energy Usage / Total Time in Period of Interest Population density of Prince George is about 0.00091 per m^2 based on Statistics Canada. Annual energy usage is about 3.96×10^9 MJ based on the Community Energy and Emissions Inventory (CEEI) for 2019. Energy usage divided into the 5 seasons based on heating degree days (below 18°C) from 1981-2010 climate normal data. Resulting AHF is as follows: ▫ 0.4 for Season 1/Summer (June to August) ▫ 1.0 for Season 2/Autumn (September) ▫ 1.7 for Season 3/Winter 1 (October) ▫ 2.9 for Season 4/Winter 2 (November to March) ▫ 1.3 for Season 5/Spring (April to May)
13.1	A minimum of three years is required to be able to evaluate multi-year objectives and enable the evaluation of year-to-year variation, which is important insight for airsheds that are approaching or exceeding ambient objectives, such as Prince George.	The model plan has been revised to include three years.
13.2.1	Note than Meteorological Service of Canada dataset record calm wind conditions as 0 km/h and wind direction as a blank cell. Please ensure these datasets are preprocessed to assign a value of zero (0) to the wind direction prior to running SMERGE. Otherwise, calm winds are assigned as not available (NA).	Calm wind data will be processed as suggested.
13.2.2	PG Marsulex. Please note that only vector wind speed is available at this site. The model guideline (section 5.2.2) requires scalar wind speed.	The model plan has been revised to exclude this station given the lack of scalar wind speed data.
13.2.3	Will missing data be filled as per section 5.5 of the modelling guideline?	CALMET requires that there be data for each meteorological parameter from at least one station for each hour of the model period. With 7 surface stations, this is unlikely to occur. Where required, filling will be completed in accordance with the model guideline.
13.2.4	UNBC data. If included in the model, please include a brief description of the maintenance, QA/QC and data verification checks for the station.	This information is currently not available. The model plan has been revised to exclude this station.
13.3	WRF data (2011-2015, 4km resolution) may be downloaded from the ministry website at https://wrf.nrs.gov.bc.ca/	WRF data will be downloaded from the ministry website as suggested.

ID	Comment	Response
14.1	While it is acknowledged that data from Plaza 400 will be used to develop the NO2 baseline (with recognized limitations as discussed under comment 10.2), the proposed facility location is in a heavy industrial park. The rationale to apply the industrial ARM2 curve appears stronger than the urban curve as proposed. Please review selection of the ARM2 curve and the 24 values applied in the step function.	Acknowledged. The model plan has been revised to use the industrial ARM2 curve.
14.2	As per section 3.2.1 of the NO2 guidance document, please also provide Tier 1 (total conversion) in the AQTR.	Predicted NOX concentrations, equivalent to Tier 1 total conversion, will be presented in the AQTR along with predicted NO2 concentrations using the ambient ratio method.
14.3	What percentage of calm winds is considered low? How will stagnation effects be considered in CALPUFF?	The percentage of calm winds observed during the model period is shown in the table of surface meteorological data of the model plan. Unlike AERMOD, the CALPUFF model is inherently able to model calm conditions and the accumulation of contaminants under such conditions.
15.1	With respect to the WRF data made available from the ministry, WRF parameters were not compared against observations in Prince George when the data were developed. For this reason, conducting quality tests on WRF, as outlined in section 6.1 of the model plan, is considered necessary.	Comparisons of WRF data to observation data will be presented in the AQTR.
15.2	Given that the model domain contains several surface meteorological stations, will a leave-one-out analysis be performed to evaluate the performance of CALMET?	The Marsulex station will not be used in CALMET given the lack of scalar wind speed data. Data from this station will be used to evaluate the performance of CALMET.

Table 2 CALMET Model Options Group 4 – Meteorological Data Options

Parameter	Default	Project	Comments
No Observation Mode			
NOOBS	0	0	Use surface and upper air observation data
Number of Surface and Precipitation Meteorological Stations			
NSSTA	-	7	Number of surface stations as per model plan
NPSTA	-	0	No precipitation stations
Cloud Data Options			
ICLDOUT	-	0	No CLOUD.DAT output written
MCLOUD	-	4	Cloud cover generated from observation data

Table 3 CALMET Model Options Group 5 – Wind Field Options and Parameters

Parameter	Default	Project	Comments
Wind Field Model Options			
IWFCOD	1	1	Diagnostic wind module used
IFRADJ	1	1	Froude number adjustment effects computed
IKINE	0	0	Kinematic effects not computed
IOBR	0	0	No adjustment to vertical velocity profile at top of model domain
ISLOPE	1	1	Slope flow effects computed
IEXTRP	-4	-4	Similarity theory used except layer 1 data at upper air stations ignored
ICALM	0	0	Calm winds not extrapolated as recommended when used with prognostic data
BIAS	0, 0, 0, 0, 0, 0, 0, 0, 0, 0	-1, -1, -0.5, 0, 0.5, 1, 1, 1, 1, 1	Bias surface data within the valley and upper air data above
RMIN2	4	-1	Used to ensure extrapolation of all surface stations for IEXTRP = -4
IPROG	0	14	WRF prognostic data used as initial guess field
ISTEPPGS	3600	3600	Timestep of prognostic data
IGFMET	0	0	No coarse CALMET fields used as initial guess field
Radius of Influence Parameters			
LVARY	F	F	Varying radius of influence not used
RMAX1	-	3	Limit applicability of observation data based on topography in model domain
RMAX2	-	15	Limit applicability of observation data based on topography in model domain
RMAX3	-	50	Not used since no overwater station data

Parameter	Default	Project	Comments
Other Wind Field Input Parameters			
RMIN	0.1	0.1	Small value used as per BC model guidelines
TERRAD	-	5	Identified from terrain features
R1	-	1	Small value used as recommended
R2	-	1	Small value used as recommended
RPROG	-	0	Not used since IPROG = 14
DIVLIM	5×10-6	5×10-6	Not used since IKINE = 0
NITER	50	50	Not used since IKINE = 0
NSMTH	2, 4, 4, 4, 4, 4, 4, 4, 4, 4	2, 4, 4, 4, 4, 4, 4, 4, 4, 4	Default number of passed in smoothing procedure
NINTR2	99	99	All stations can be used for interpolation of data to a grid point
CRITFN	1	1	Default critical Froude number used
ALPHA	0.1	0.1	Not used since IKINE = 0
FEXTR2	0, 0, 0, 0, 0, 0, 0, 0, 0, 0	0, 0, 0, 0, 0, 0, 0, 0, 0, 0	Not used since IEXTRP = -4
Barrier Information			
NBAR	0	0	Barriers not used
KBAR	NZ	10	Not used since NBAR = 0
XBBAR, YBBAR, XEBAR, YEBAR	-	0	Not used since NBAR = 0
Diagnostic Module Data Input Options			
IDIOPT1	0	0	Surface temperatures computed internally
ISURFT	-1	-1	2-D spatially varying temperatures
IDIOPT2	0	0	Lapse rate computed internally
IUPT	-1	-1	2-D spatially varying lapse rate
ZUPT	200	200	Lapse rate computed for default depth
IDIOPT3	0	0	Domain-scale winds computed internally
IUPWND	-1	-1	3-D initial guess fields
ZUPWND	1, 1000	1, 1000	Domain-scale winds computed for default layer
IDIOPT4	0	0	Read wind speed and direction from surface data file
IDIOPT5	0	0	Read wind speed and direction from upper air data file
Lake Breeze Information			
LLBREZE	F	F	Lake breeze module not used
NBOX	-	0	Not used since LLBREZE = 0
XG1, XG2, YG1, YG2	-	0	Not used since LLBREZE = 0

Parameter	Default	Project	Comments
XBCST, YBCST, XECST, YECST	-	0	Not used since LLBREZE = 0
NLB	-	0	Not used since LLBREZE = 0
METBXID	-	0	Not used since LLBREZE = 0

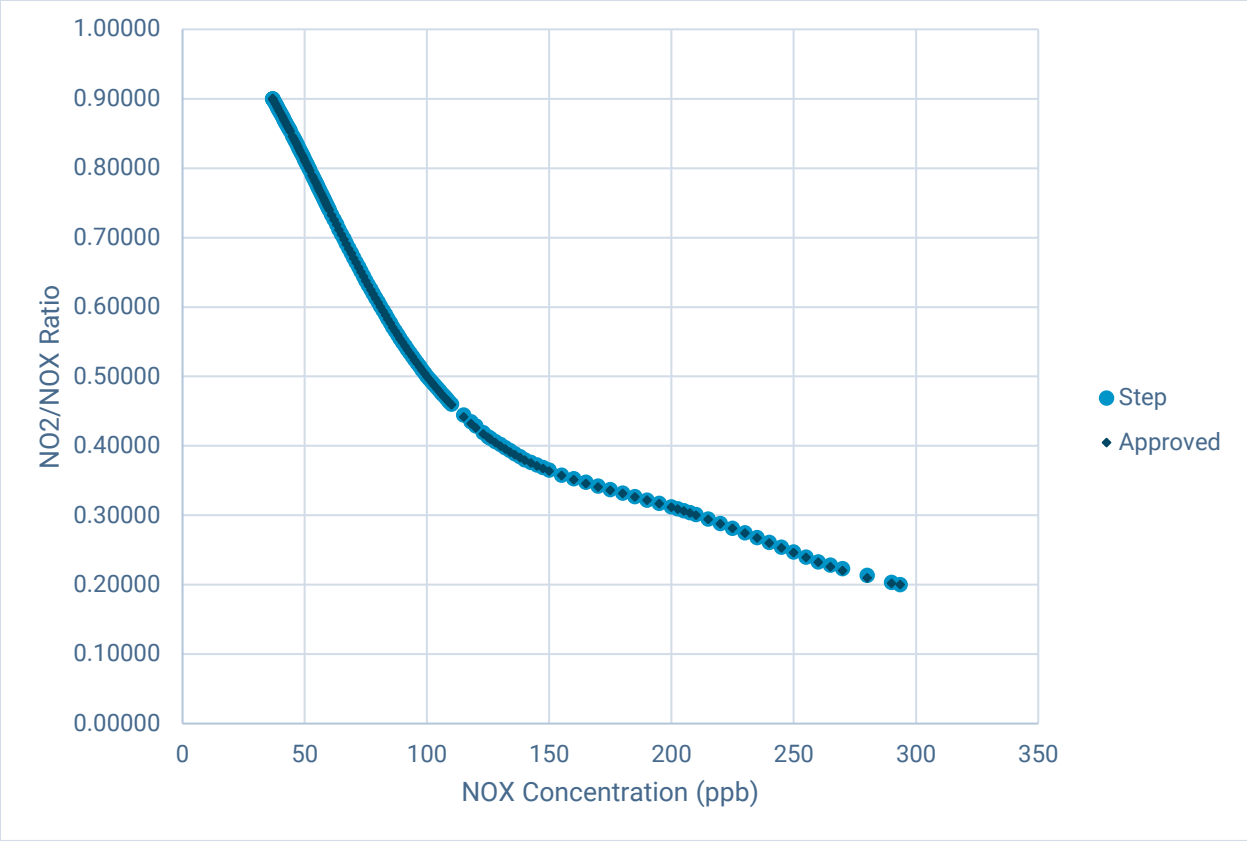
Table 4 CALPUFF Input Group 2 – Technical Options

Parameter	Default	Project	Comments
MGAUSS	1	1	Gaussian distribution used in near field
MCTADJ	3	3	Partial plume path terrain adjustment
MCTSG	0	0	Sub-grid scale complex terrain not modelled
MSLUG	0	0	Near-field puffs not modelled as elongated
MTRANS	1	1	Transitional plume rise modelled
MTIP	1	1	Stack tip downwash modelled
MRISE	1	1	Briggs plume rise used
MTIP_FL	0	0	Stack tip downwash not applied to flare sources
MRISE_FL	2	2	Not applicable
MBDW	1	2	PRIME method used for building downwash
MSHEAR	0	0	Vertical wind shear not modelled
MSPLIT	0	0	No puff splitting
MCHEM	1	0	Chemical transformation not modelled
MAQCHEM	0	0	Not used since MCHEM = 0
MLWC	1	1	Not used since MAQCHEM = 0
MWET	1	1	Wet deposition modelled
MDRY	1	1	Dry deposition modelled
MTILT	0	0	Gravitational settling not modelled
MDISP	3	2	Near-field dispersion coefficients internally calculated using micrometeorological variables as per BC model guidelines
MTURBVW	3	3	Not used since MDISP = 2
MDISP2	3	3	Not used since MDISP = 2
MTAULY	0	0	Draxler default used for Lagrangian timescale
MTAUADV	0	0	No turbulent advection
MCTURB	1	1	Standard CALPUFF subroutines used
MROUGH	0	0	No adjustment for surface roughness
MPARTL	1	1	Partial plume penetration of elevated inversion modelled for point sources
MPARTLBA	1	1	Partial plume penetration of elevated inversion modelled for buoyant area sources

Parameter	Default	Project	Comments
MTINV	0	0	Strength of temperature inversion computed from default gradients
MPDF	0	1	PDF used for dispersion under convective conditions for MDISP = 2 as per BC model guidelines
MSGTIBL	0	0	Sub-grid TIBL module not used for shoreline
MBCON	0	0	Boundary conditions not modelled
MSOURCE	0	0	Individual source contributions not saved
MFOG	0	0	Not configured for FOG model output
MREG	1	0	Options not tested for conformance to US EPA regulatory values

Flatline wind speeds detected at proposed surface stations during study period

Site	Parameter	Start	End
Prince George Gladstone School	WSPD_SCLR	2013-01-13 0200	2013-01-13 0800
Prince George Gladstone School	WSPD_SCLR	2013-06-20 1300	2013-06-26 1400
Prince George Gladstone School	WSPD_SCLR	2013-08-30 1000	2013-09-05 0900
Prince George Gladstone School	WSPD_SCLR	2014-12-21 0300	2014-12-21 0800
Prince George Gladstone School	WSPD_SCLR	2015-01-01 1700	2015-01-12 1100
Prince George Plaza 400 Met_60	WSPD_SCLR	2013-02-25 1000	2013-02-27 0900
Prince George Plaza 400 Met_60	WSPD_SCLR	2015-01-01 2000	2015-01-03 1600



Ambient ratio method

Appendix C

WRF Evaluation

1.0 Introduction

A prognostic meteorological dataset was used to develop initial guess fields in the CALMET meteorological model in accordance with the BC Air Quality Dispersion Modelling Guideline (BC ENV 2022). The prognostic meteorological dataset, generated using the Weather Research Forecast (WRF) model at a 4-km grid resolution, was obtained from the BC Ministry of Environment and Climate Change Strategy (BC ENV) website. While the WRF model results have been quality tested with comparisons to observations at selected surface and upper air stations in order to provide assurance that the output can be used for dispersion modelling purposes, comparisons have not been done specifically in the Prince George region. This Appendix summarizes the evaluation performed on the WRF dataset based on comparisons with surface and upper air stations in the CALMET domain.

2.0 Methodology

The WRF prognostic meteorological dataset was validated with observations from one upper air station at Prince George and from the following surface observation stations:

- PG Airport, operated by Environment and Climate Change Canada (ECCC)
- PG Massey, operated by ECCC
- PG Exploration Place, operated by BC ENV
- PG Gladstone School, operated by BC ENV
- PG Glenview School, operated by BC ENV
- PG Plaza 400, operated by BC ENV
- PG Pulp, operated by BC ENV.

The validation follows general guidance from the BC Air Quality Dispersion Modelling Guideline (BC ENV 2022) and other validation studies (Hanna and Yang 2001, McEwen and Murphy 2004, Lakes Software 2022). The primary variables of interest are wind speed, wind direction, and ambient temperature. The following performance measures are considered:

- Bias: This is the average difference between modelled and observed values. Negative values indicate an underprediction in the model, while positive values show overprediction in the model.
- Mean absolute error (MAE): This is the average absolute difference between modelled and observed values.
- Root mean square error (RMSE): This is another measure of average error in the model.
- Frequency distribution of wind speed and direction, as illustrated using wind roses.
- Vertical profiles of wind and temperature.

The typical performance benchmarks for meteorological model performance are summarized in **Table 2.1**.

Table 2.1 Typical Performance Benchmarks

Parameter	Bias	MAE	RMSE
Temperature (K)	±1.0	2.5	-
Wind speed (m/s)	±1.5	-	2 to 3
Wind direction (°)	±10	55	50 to 60[(a)]

Sources: Hanna and Yang 2001, McEwen and Murphy 2004, Lakes Software 2022

Notes:
(a) For average wind speeds of 3 to 4 m/s.

3.0 Validation Results

3.1 Statistical Performance

Table 3.1 presents the key statistics of surface winds and temperatures in the WRF prognostic meteorological dataset compared to surface observations. The following observations are made:

- The bias in surface temperatures is within ±1° at all stations except PG Massey and PG Exploration Place. While the bias at these stations exceeds the typical benchmark in **Table 2.1**, the MAE remains within the typical benchmark. The MAE in surface temperatures at PG Plaza 400 also exceeds the typical benchmark of 2.5°.
- The bias in surface wind speeds is within ±1 m/s at all stations. The RMSE in surface wind speeds ranges from 1.3 to 1.6 m/s which is within the typical benchmark.
- The bias in surface wind directions is within ±10° at all stations, although the MAE is marginally above the typical benchmark of 55° at PG Massey, PG Exploration Place, and PG Plaza 400. The RMSE also exceeds the typical benchmark of 50 to 60° at most stations. However, a somewhat higher RMSE is expected in the Prince George region given the low wind speeds and thus greater variability in wind directions.

Table 3.1 WRF Validation Statistical Summary

Parameter	Mean Modelled	Mean Observed	Bias	MAE	RMSE
PG Airport					
Temperature (K)	278.5	278.1	0.5	1.3	1.6
Wind speed (m/s)	2.7	2.9	-0.2	1.1	1.4
Wind direction (°)	179	190	-1.5	40	58
PG Massey					
Temperature (K)	278.3	279.4	-1.1	1.6	2.1
Wind speed (m/s)	2.3	1.5	0.7	1.2	1.5
Wind direction (°)	193	206	9.9	59	75

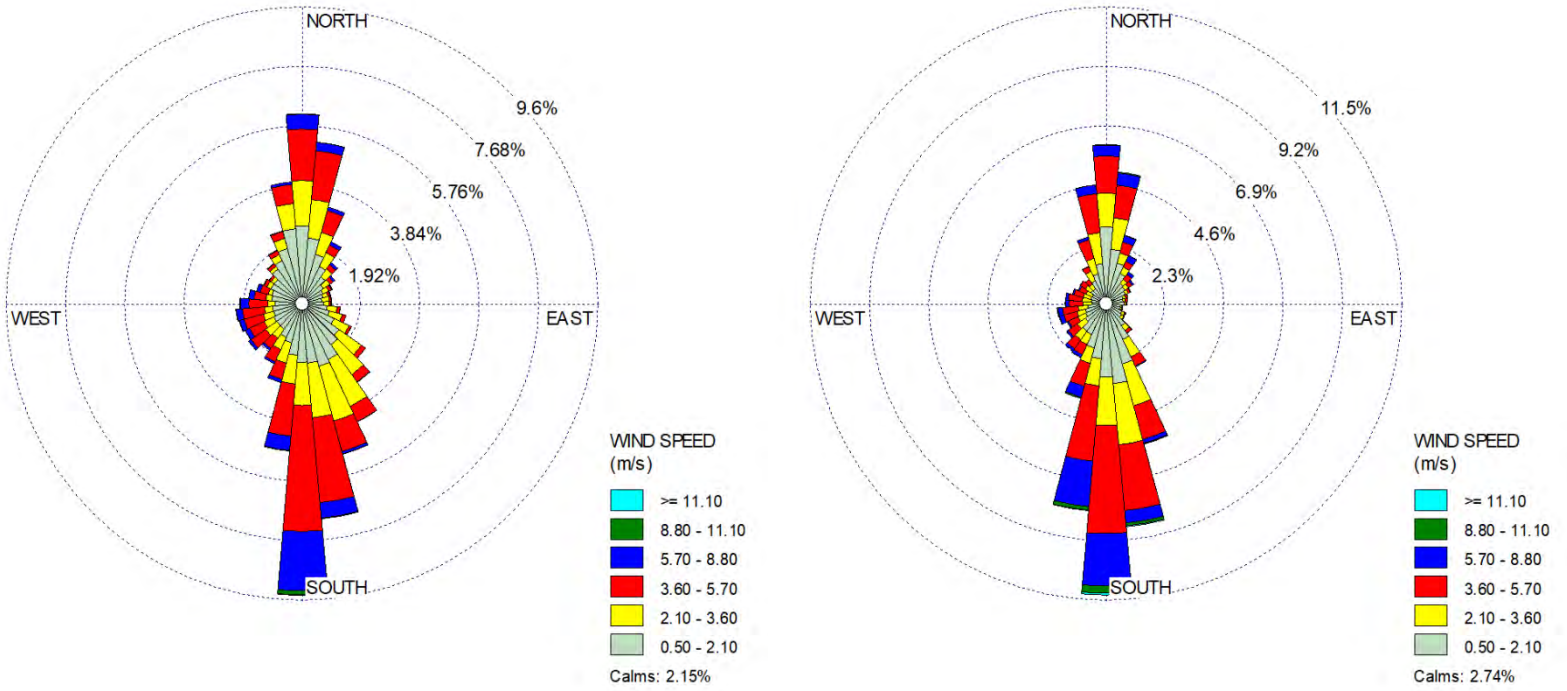
Parameter	Mean Modelled	Mean Observed	Bias	MAE	RMSE
PG Exploration Place					
Temperature (K)	279.2	280.8	-1.6	2.1	2.6
Wind speed (m/s)	2.3	1.9	0.4	1.1	1.6
Wind direction (°)	190	165	1.2	58	76
PG Gladstone School					
Temperature (K)	278.5	280.1	-0.7	1.8	2.7
Wind speed (m/s)	2.4	1.8	0.6	1.0	1.4
Wind direction (°)	199	182	-8.0	49	66
PG Glenview School					
Temperature (K)	278.1	278.2	-0.2	1.9	2.4
Wind speed (m/s)	2.5	2.1	0.5	1.1	1.4
Wind direction (°)	184	185	2.9	47	65
PG Plaza 400					
Temperature (K)	278.5	279.3	-0.9	3.0	5.9
Wind speed (m/s)	2.4	2.2	0.2	1.0	1.3
Wind direction (°)	187	179	-12	60	77
PG Pulp					
Temperature (K)	278.5	279.3	-0.8	2.0	2.5
Wind speed (m/s)	2.6	2.4	0.2	1.0	1.3
Wind direction (°)	167	167	-7.9	50	70

3.2 Frequency Distribution of Surface Wind Speed and Direction

Modelled and measured wind roses are compared in **Figure 3.1** to **Figure 3.7**. The following observations are made:

- The modelled and measured wind roses for PG Airport are in close agreement.
- The modelled and measured wind roses for PG Exploration Place, PG Gladstone School, PG Glenview School, and PG Pulp capture similar predominant wind directions. The WRF model shows somewhat higher wind speeds than observations which is not too surprising given that the WRF model has been found in other studies to overestimate surface wind speeds, particularly at the lower wind speeds experienced in the Prince George region (Solbakken and Birkelund 2018).
- The modelled and measured wind roses for PG Massey are substantially different. The modelled wind rose shows a higher frequency of winds from the west-southwest and north, whereas the measured wind rose shows a higher frequency of winds from the south-southeast and west-northwest. The modelled wind rose is extracted from the centre of the 4 km by 4 km grid cell, approximately 1.3 km northwest of the surface station. Differences between the two wind roses may be related to the actual versus extraction locations in relation to elevated terrain to the west of the city combined with the higher wind speeds in the WRF model that tend to be less impacted by terrain flow. In addition, the smaller peaks in the area may not be captured in the WRF data at the 4-km horizontal grid elevation.

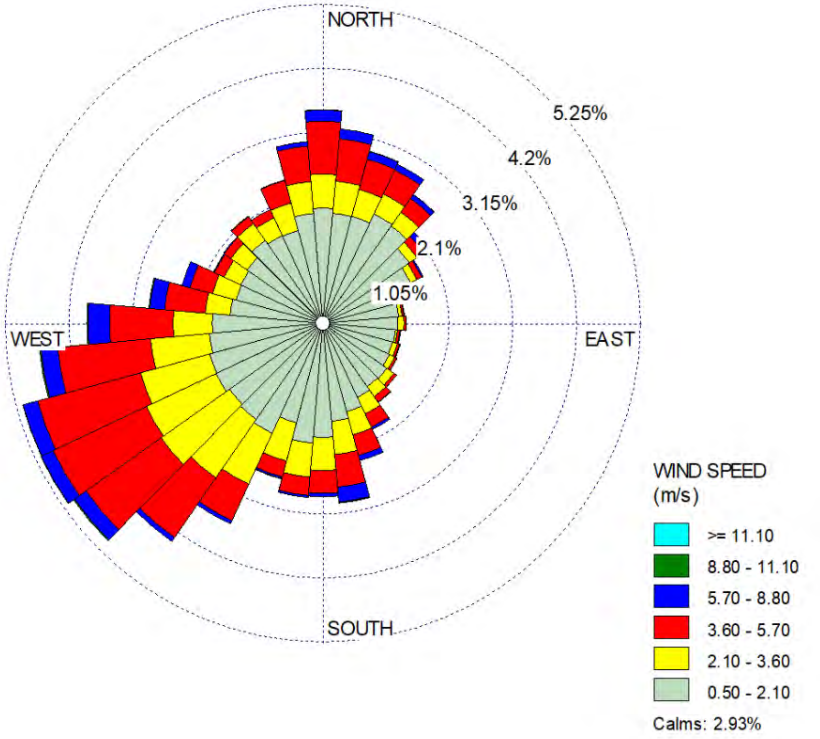
- The modelled and measured wind roses for PG Plaza 400 are substantially different. The modelled wind rose shows predominant winds from the north and south, whereas the measured wind rose shows predominant winds from the east and south. The modelled wind rose is extracted from the centre of the 4 km by 4 km grid cell, approximately 1 km south of the surface station. This general area is within the confluence zone of the Nechako and Fraser Rivers and greater spatial differences in surface and near-surface wind flow are expected compared to other locations in and around Prince George. Therefore, differences between the two wind roses may be related to the actual versus extraction locations in relation to the Fraser River but also may relate to greater complexity in the actual wind flow here that is more difficult to simulate.



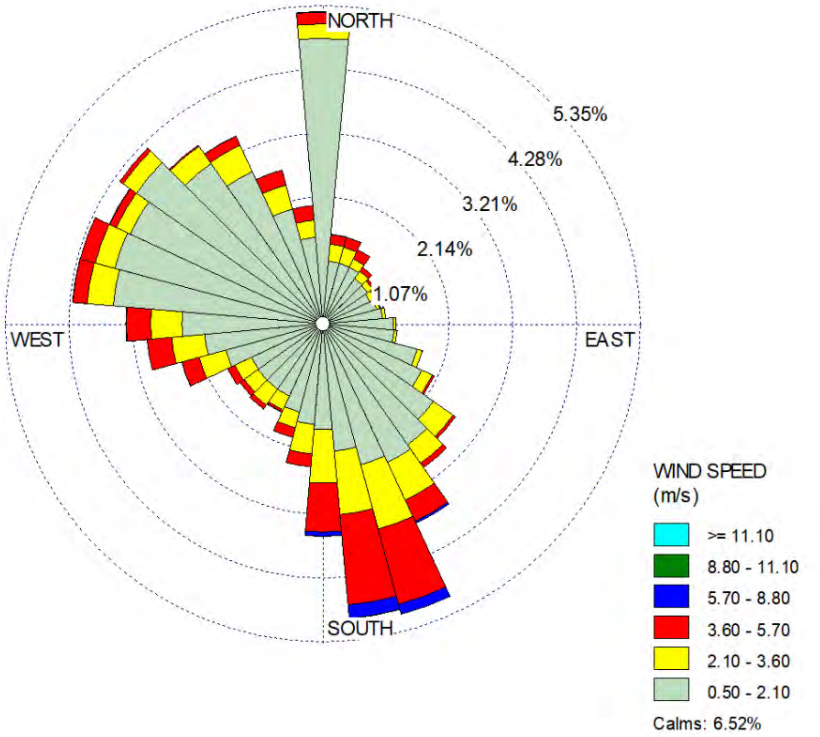
Modelled (WRF)

Measured

Figure 3.1 Comparison of Wind Roses for PG Airport

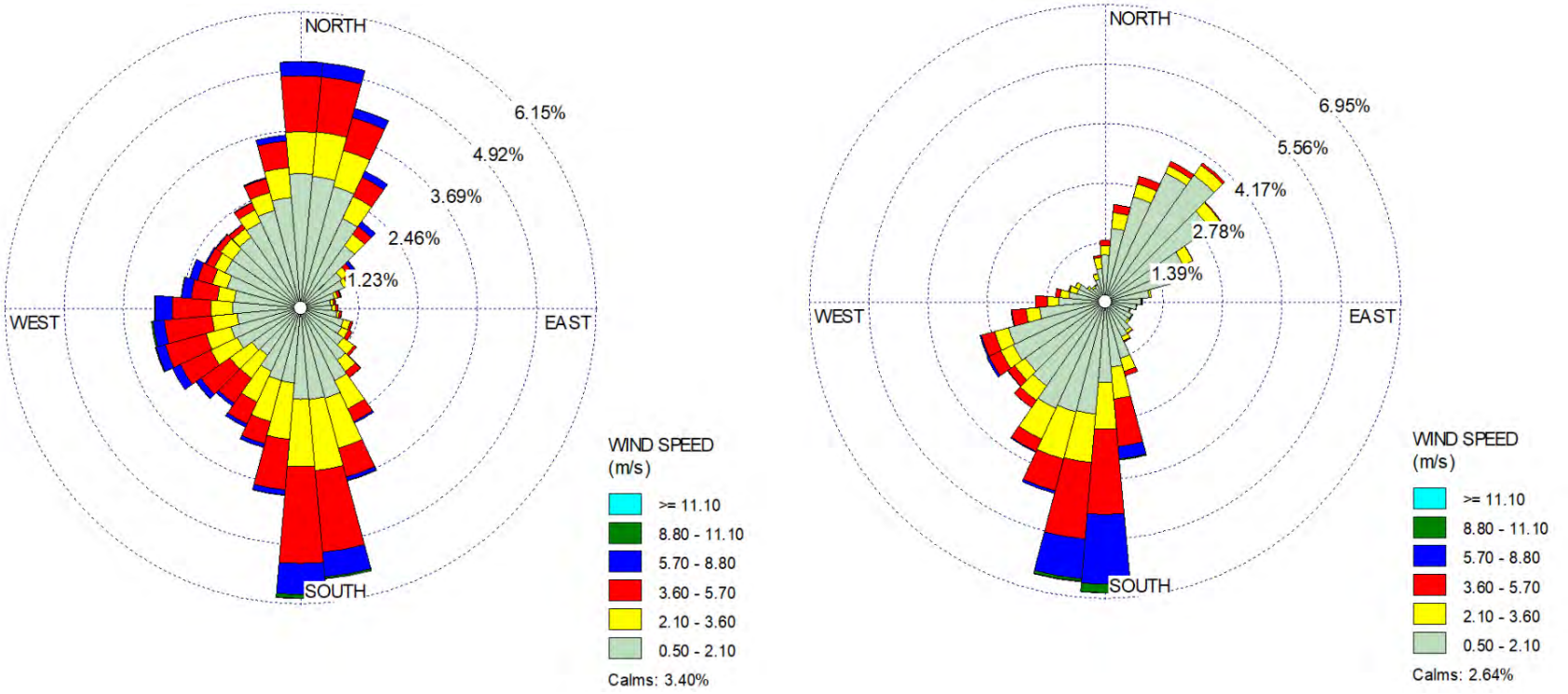


Modelled (WRF)



Measured

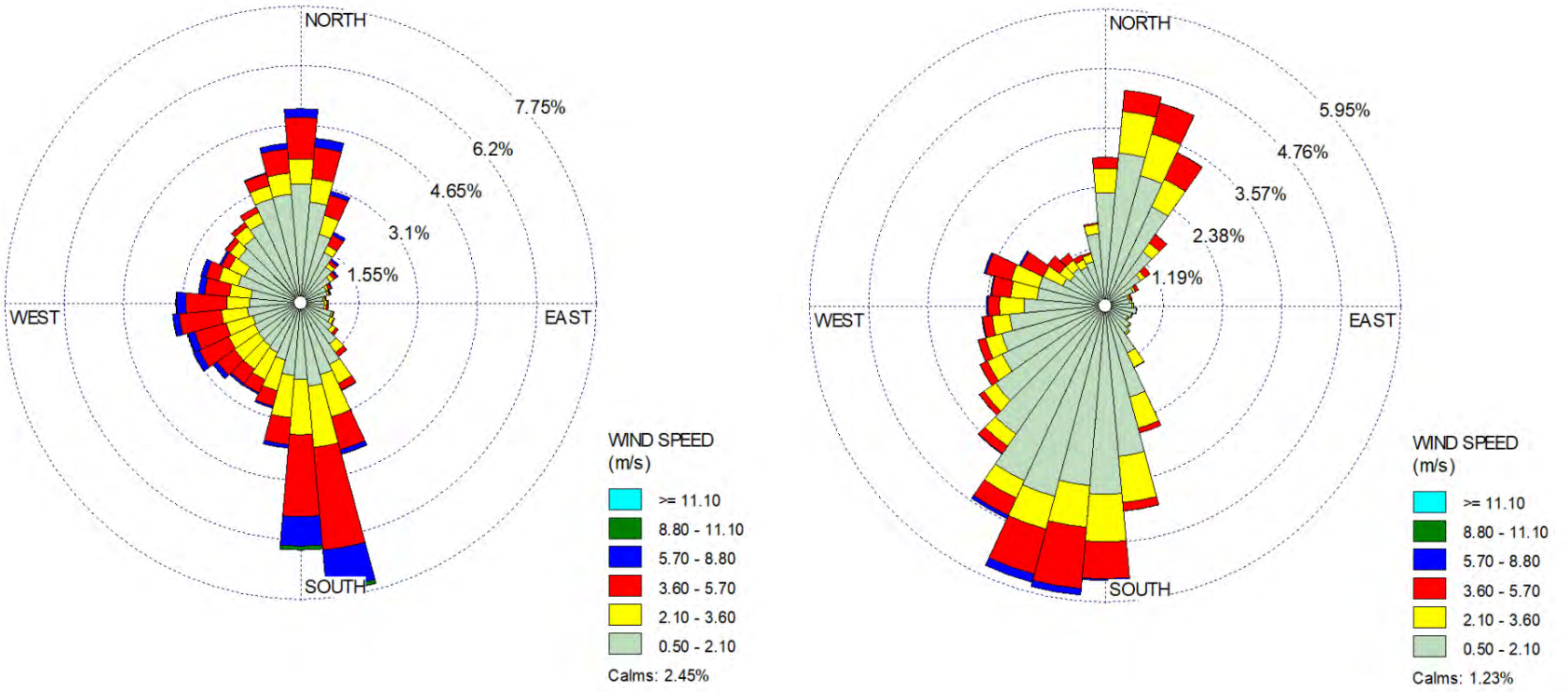
Figure 3.2 Comparison of Wind Roses for PG Massey



Modelled (WRF)

Measured

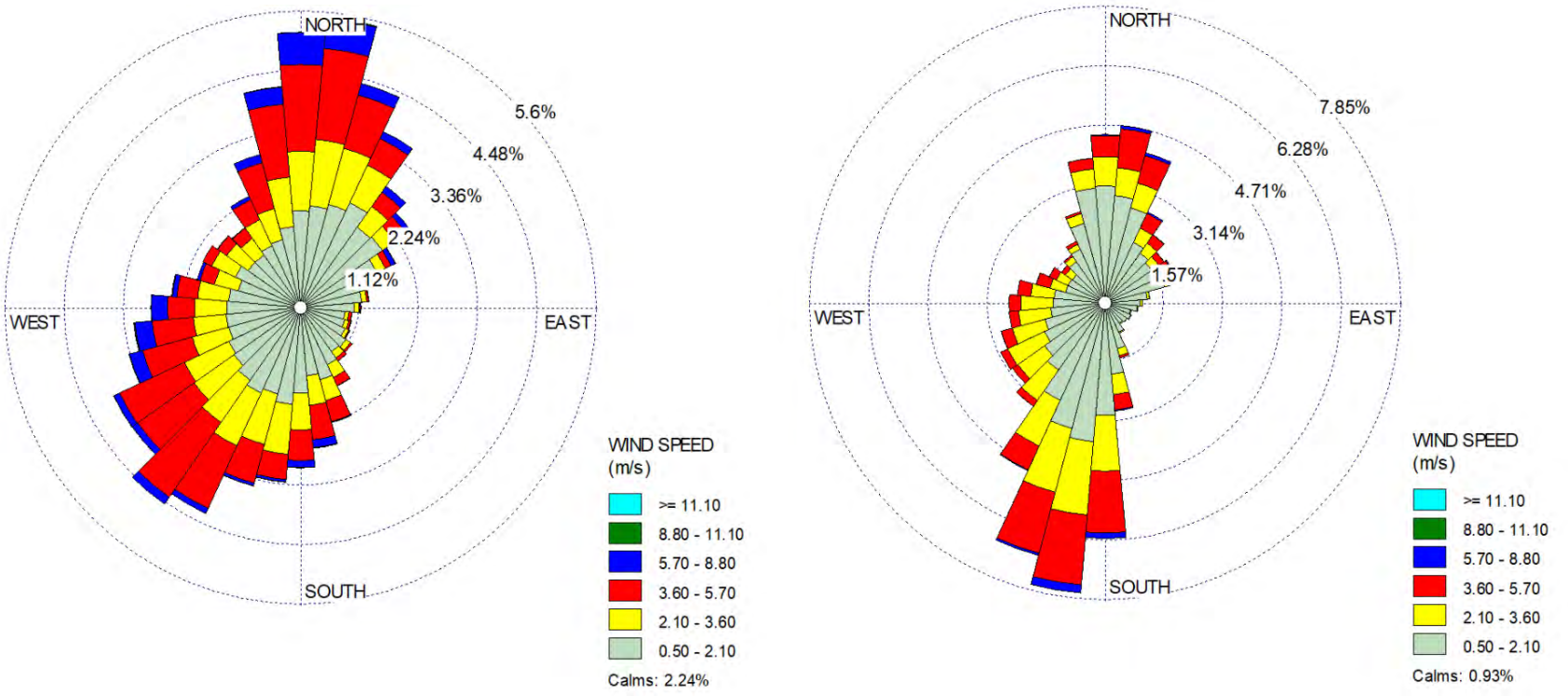
Figure 3.3 Comparison of Wind Roses for PG Exploration Place



Modelled (WRF)

Measured

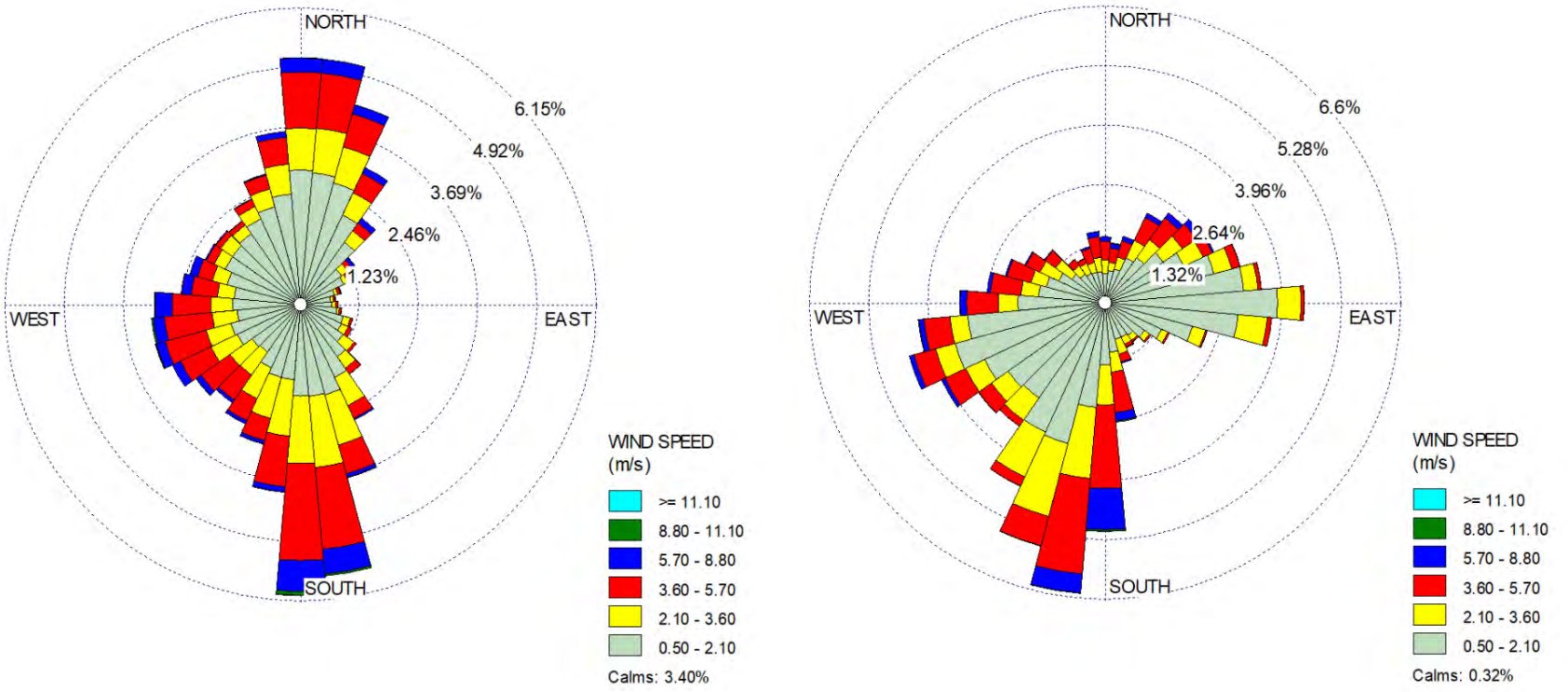
Figure 3.4 Comparison of Wind Roses for PG Gladstone School



Modelled (WRF)

Measured

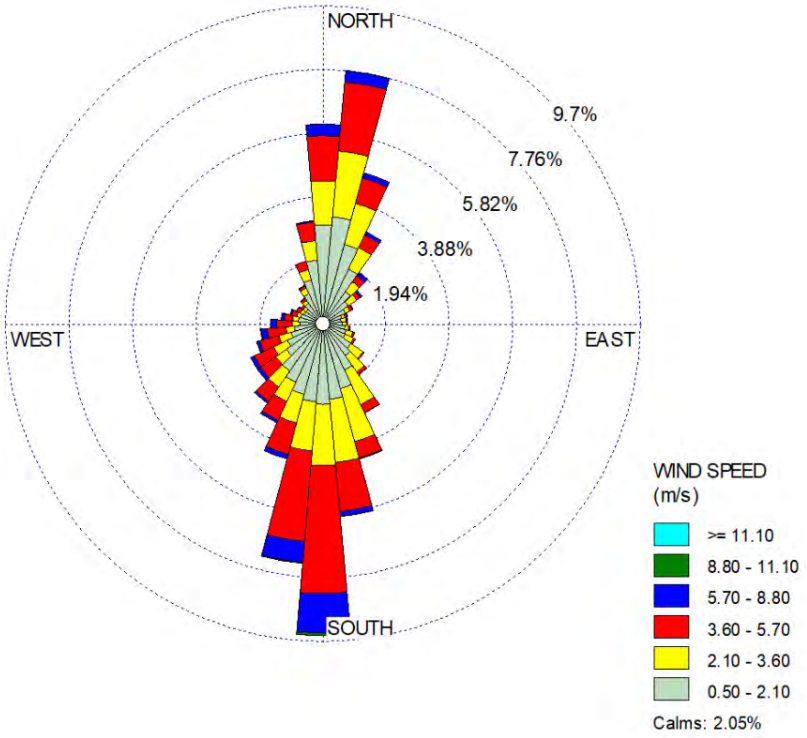
Figure 3.5 Comparison of Wind Roses for PG Glenview School



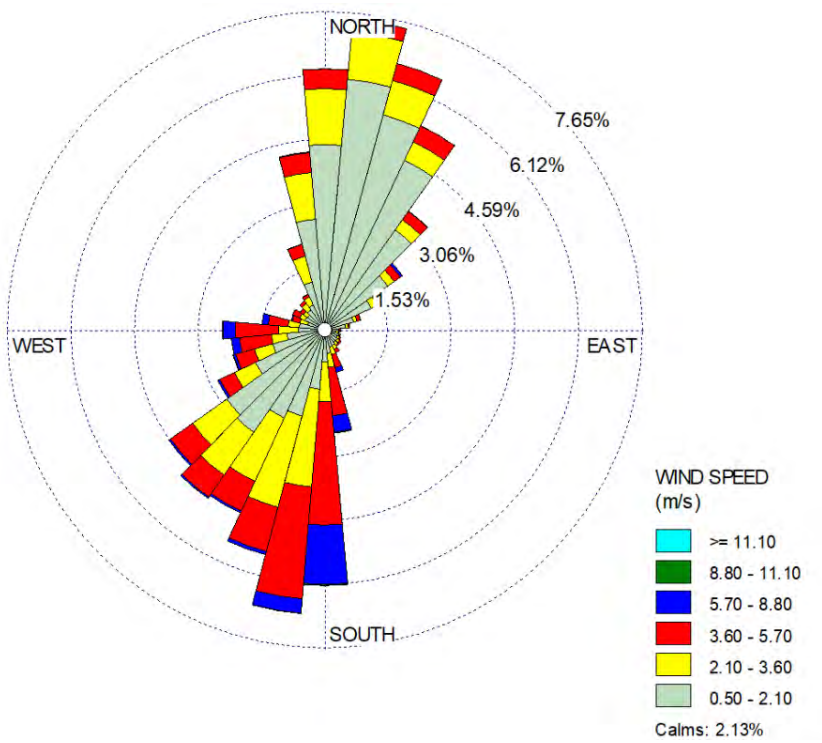
Modelled (WRF)

Measured

Figure 3.6 Comparison of Wind Roses for PG Plaza 400



Modelled (WRF)

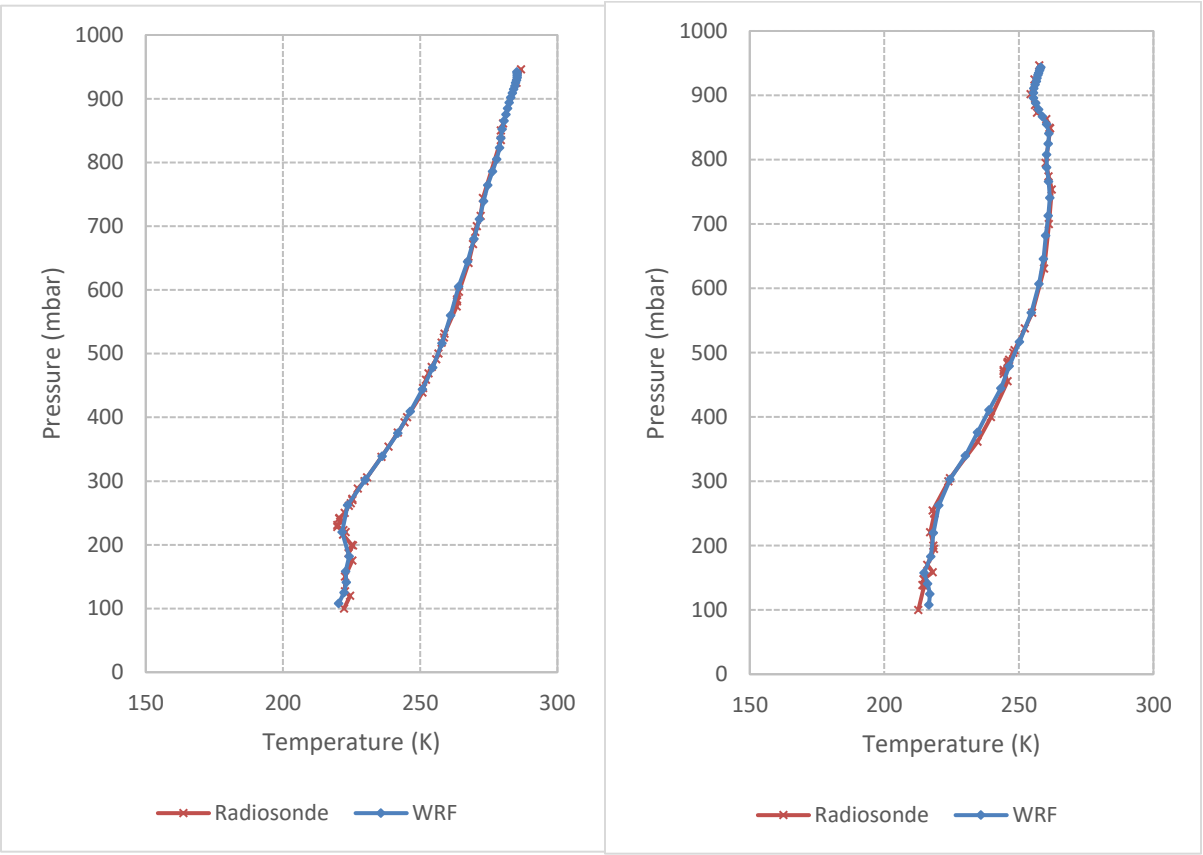


Measured

Figure 3.7 Comparison of Wind Roses for PG Pulp

3.3 Vertical Profiles of Wind and Temperature

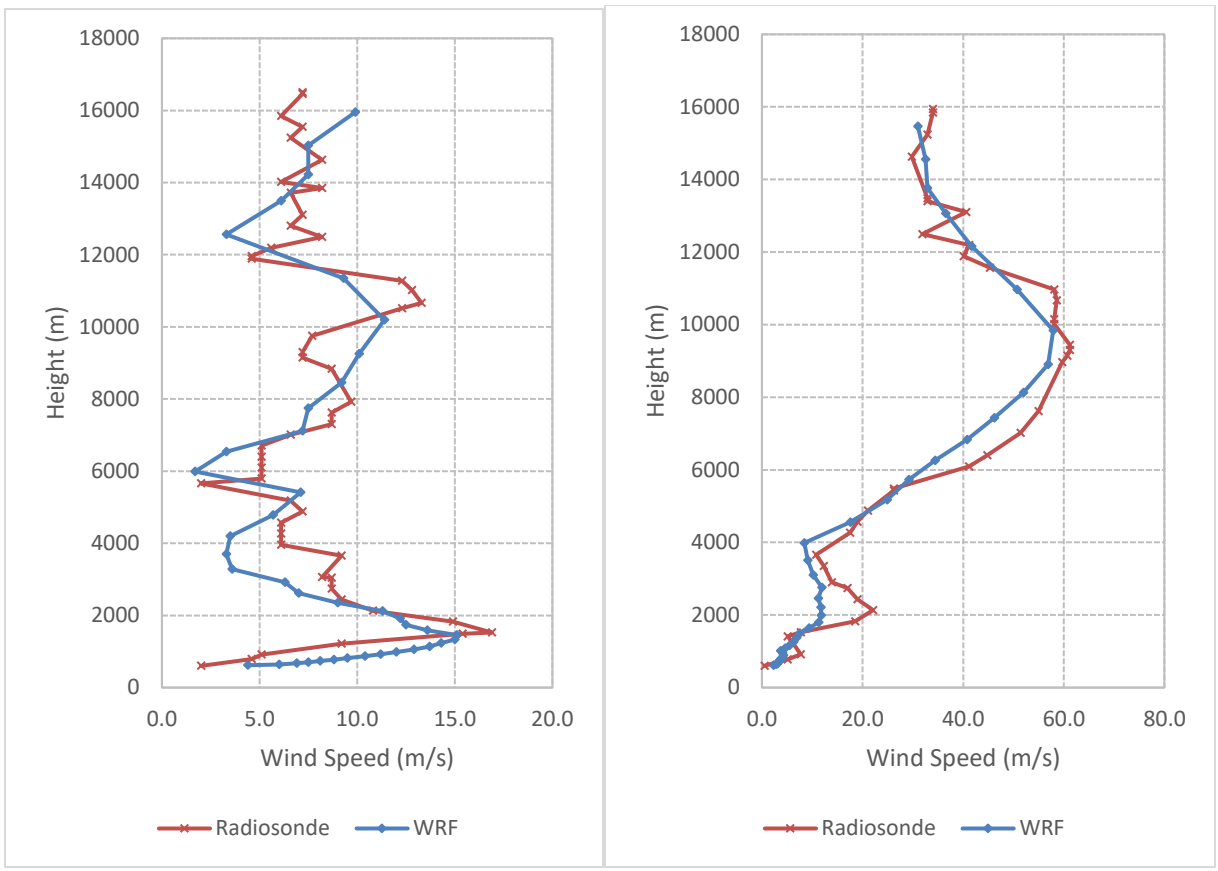
This section compares radiosonde data from the Prince George upper air station to WRF model output at the same location. Two examples of modelled versus measured vertical profiles of wind and temperature are illustrated in **Figure 3.8** and **Figure 3.9**. The vertical profiles of temperature are very similar and the vertical profiles of wind follow the same trend, although specific wind speeds may differ somewhat. Overall, the WRF model captures the vertical profiles and the height of the boundary layer fairly well.



July 25, 2014 12:00 UTC

January 5, 2015 00:00 UTC

Figure 3.8 Comparison of Vertical Temperature Profile



July 25, 2014 12:00 UTC

January 5, 2015 00:00 UTC

Figure 3.9 Comparison of Vertical Wind Speed Profile

4.0 Conclusions

Overall, the WRF prognostic meteorological dataset appears to be representative of meteorological conditions in the region. Statistical measures for surface temperature, wind speed and direction are generally within the typical performance benchmarks. The RMSEs in wind direction are somewhat higher than the typical performance benchmark but are reasonable considering the lower wind speeds experienced in the region. There are some differences between modelled and measured wind roses at the stations evaluated but are not expected be reflective of WRF model performance. Modelled vertical profiles of wind and temperature show similar trends compared to measured data.

Differences between the simulated wind flow in WRF versus measured data, particularly at the PG Massey and PG Plaza 400 stations, will be addressed in the CALMET model during the Stage 2 correction procedure. The CALMET model will incorporate surface data and terrain elevation data at a 500-m grid resolution.

5.0 References

Lakes Software. 2022. WRF Data Validation – Surrey, BC, Canada.

Hanna, S.R. and R. Yang. 2001. Evaluations of Mesoscale Models' Simulations of Near-Surface Winds, Temperature Gradients, and Mixing Depths. Journal of Applied Meteorology, Vol. 40:6.

McEwen, B. and B. Murphy. 2004. Use of High Resolution Numerical Fields with the CALPUFF Modelling System: An Analysis of RAMS and MC2 Fields Over Kamloops, B.C.

Solbakken, K. and Y. Birkelund. 2018. Evaluation of the Weather Research and Forecasting (WRF) model with respect to wind in complex terrain. Journal of Physics: Conference Series, Vol. 1102.

Appendix D

CALMET/CALPUFF Model Inputs

1.0 Introduction

This Appendix provides technical details of the CALMET and CALPUFF model inputs used for the dispersion modelling of Arbios Biotech Canada LP (Arbios). A discussion of the CALMET model outputs is also provided to demonstrate that CALMET produces meteorological input for CALPUFF that qualitatively agrees with expected meteorological conditions.

2.0 CALMET Inputs

The CALMET model options are provided in **Table 2.1** and **Table 2.2**.

Table 2.1 CALMET Model Options Group 4 – Meteorological Data Options

Parameter	Default	Project	Comments
No Observation Mode			
NOOBS	0	0	Use surface and upper air observation data
Number of Surface and Precipitation Meteorological Stations			
NSSTA	-	7	Number of surface stations as per model plan
NPSTA	-	7[(a)]	Number of precipitation stations (same as surface stations)
Cloud Data Options			
ICLDOUT	-	0	No CLOUD.DAT output written
MCLOUD	-	4	Cloud cover generated from prognostic data

Notes:

(a) This represents an update since submission of the approved model plan. NPSTA = 0 is not a valid CALMET option with NOOBS = 0. Available precipitation data from the surface stations is included separately in a PRECIP.DAT file. Prognostic data continues to be used with IPROG = 14.

Table 2.2 CALMET Model Options Group 5 – Wind Field Options and Parameters

Parameter	Default	Project	Comments
Wind Field Model Options			
IWFCOD	1	1	Diagnostic wind module used
IFRADJ	1	1	Froude number adjustment effects computed
IKINE	0	0	Kinematic effects not computed
IOBR	0	0	No adjustment to vertical velocity profile at top of model domain
ISLOPE	1	1	Slope flow effects computed
IEXTRP	-4	-4	Similarity theory used except layer 1 data at upper air stations ignored
ICALM	0	0	Calm winds not extrapolated as recommended when used with prognostic data

Parameter	Default	Project	Comments
BIAS	0, 0, 0, 0, 0, 0, 0, 0, 0, 0	-1, -1, -0.5, 0, 0.5, 1, 1, 1, 1, 1	Bias surface data within the valley and upper air data above
RMIN2	4	-1	Used to ensure extrapolation of all surface stations for IEXTRP = -4
IPROG	0	14	WRF prognostic data used as initial guess field
ISTEPPGS	3600	3600	Timestep of prognostic data
IGFMET	0	0	No coarse CALMET fields used as initial guess field
Radius of Influence Parameters			
LVARY	F	F	Varying radius of influence not used
RMAX1	-	3	Limit applicability of observation data based on topography in model domain
RMAX2	-	15	Limit applicability of observation data based on topography in model domain
RMAX3	-	50	Not used since no overwater station data
Other Wind Field Input Parameters			
RMIN	0.1	0.1	Small value used as per BC model guidelines
TERRAD	-	5	Identified from terrain features
R1	-	1	Small value used as recommended
R2	-	1	Small value used as recommended
RPROG	-	0	Not used since IPROG = 14
DIVLIM	5×10^{-6}	5×10^{-6}	Not used since IKINE = 0
NITER	50	50	Not used since IKINE = 0
NSMTH	2, 4, 4, 4, 4, 4, 4, 4, 4, 4	2, 4, 4, 4, 4, 4, 4, 4, 4, 4	Default number of passes in smoothing procedure
NINTR2	99	99	All stations can be used for interpolation of data to a grid point
CRITFN	1	1	Default critical Froude number used
ALPHA	0.1	0.1	Not used since IKINE = 0
FEXTR2	0, 0, 0, 0, 0, 0, 0, 0, 0, 0	0, 0, 0, 0, 0, 0, 0, 0, 0, 0	Not used since IEXTRP = -4
Barrier Information			
NBAR	0	0	Barriers not used
KBAR	NZ	10	Not used since NBAR = 0
XBBAR, YBBAR, XEBAR, YEBAR	-	0	Not used since NBAR = 0
Diagnostic Module Data Input Options			
IDIOPT1	0	0	Surface temperatures computed internally
ISURFT	-1	-1	2-D spatially varying temperatures
IDIOPT2	0	0	Lapse rate computed internally

Parameter	Default	Project	Comments
IUPT	-1	-1	2-D spatially varying lapse rate
ZUPT	200	200	Lapse rate computed for default depth
IDIOPT3	0	0	Domain-scale winds computed internally
IUPWND	-1	-1	3-D initial guess fields
ZUPWND	1, 1000	1, 1000	Domain-scale winds computed for default layer
IDIOPT4	0	0	Read wind speed and direction from surface data file
IDIOPT5	0	0	Read wind speed and direction from upper air data file
Lake Breeze Information			
LLBREZE	F	F	Lake breeze module not used
NBOX	-	0	Not used since LLBREZE = 0
XG1, XG2, YG1, YG2	-	0	Not used since LLBREZE = 0
XBCST, YBCST, XECST, YECST	-	0	Not used since LLBREZE = 0
NLB	-	0	Not used since LLBREZE = 0
METBXID	-	0	Not used since LLBREZE = 0

3.0 CALMET Outputs

The CALMET model was assessed by reviewing various model outputs, and where possible, comparing to observations. These outputs include: surface temperatures and surface wind roses for various monitoring locations, CALMET-derived stabilities, mixing heights and domain wind vector plots under various stability and flow regimes, as well as precipitation patterns.

3.1 Surface Temperature

The monthly surface temperature as observed and as modelled by CALMET at select surface stations in the study area[1] are illustrated in **Figure 3.2** to **Figure 3.4** and the modelled surface temperature at the Facility is shown in **Figure 3.5**. For all surface stations, CALMET-derived temperatures were almost identical to observations. The monthly average temperature ranged from approximately -13°C in December to approximately 23°C in July.

The diurnal variation in surface temperatures as observed and as modelled by CALMET at the same surface stations and at the Facility are illustrated in **Figure 3.6** and **Figure 3.7**, respectively. Surface temperatures tend to be highest in the mid-afternoon (14:00 to 16:00) and lowest in the early morning (04:00 to 07:00). Overall, CALMET-derived temperatures were similar to observations at all surface stations.

[1] The PG Marsulex station was not included in the dispersion modelling as described in Section 6.1.3 of the Technical Report.

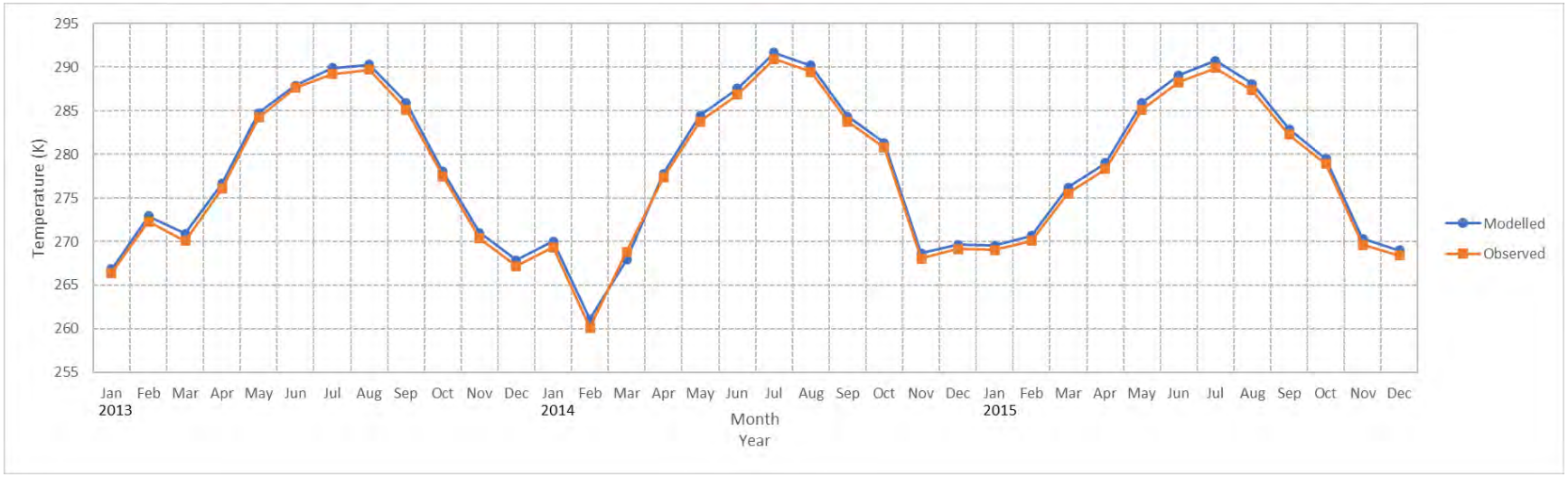


Figure 3.1 Monthly Observed and Modelled Surface Temperatures at PG Airport

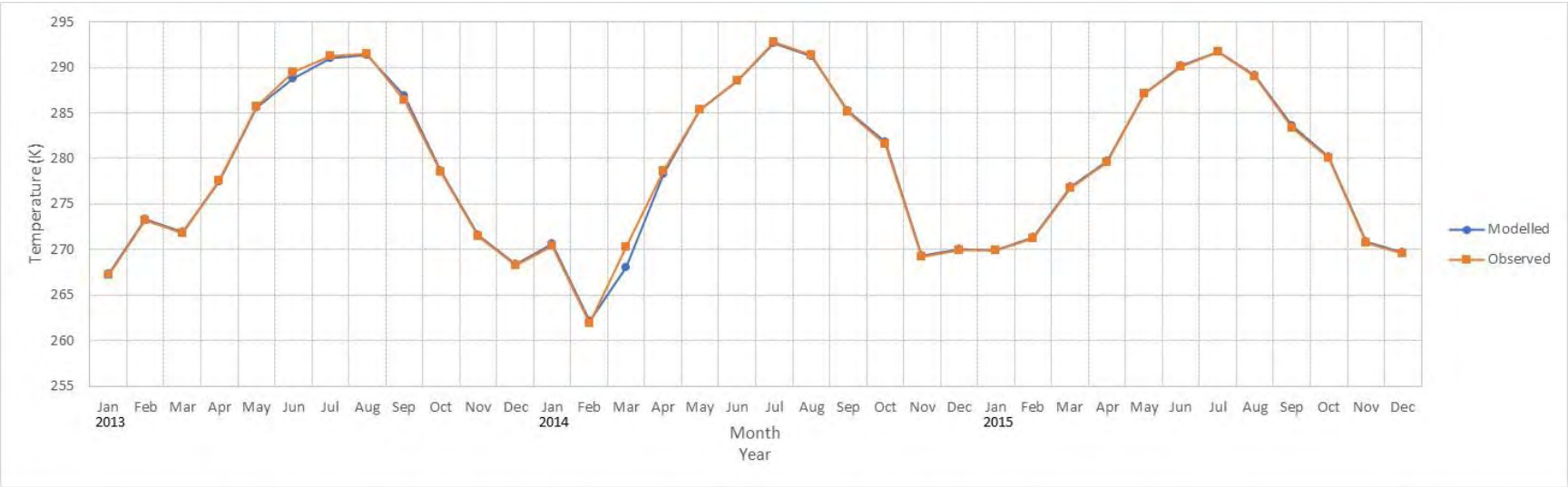


Figure 3.2 Monthly Observed and Modelled Surface Temperatures at PG Massey

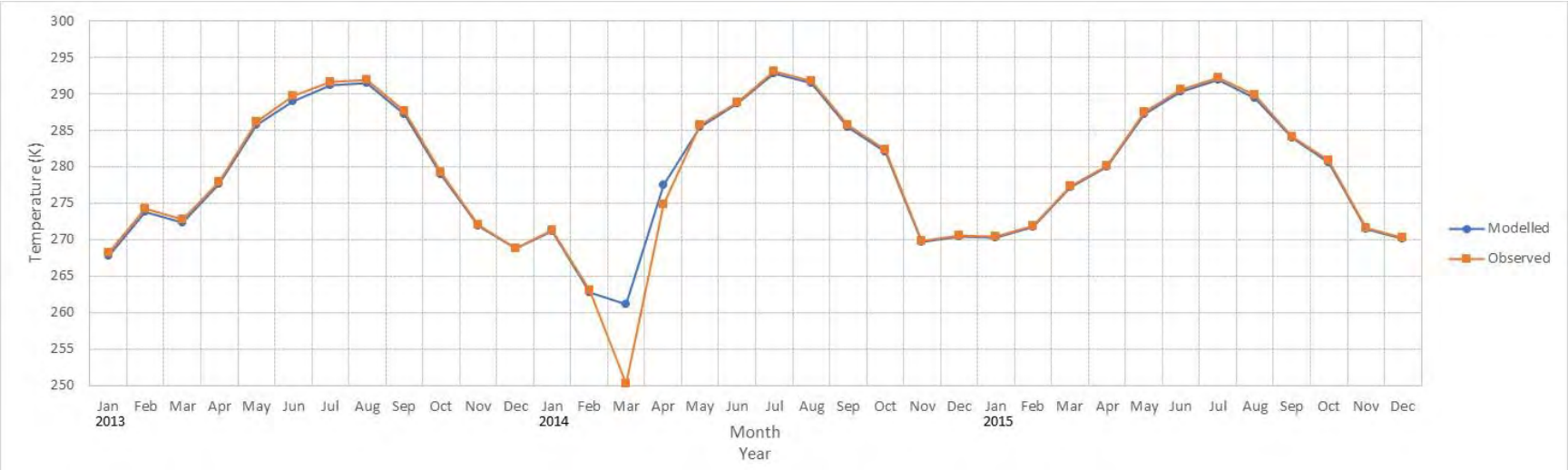


Figure 3.3 Monthly Observed and Modelled Surface Temperatures at PG Plaza 400

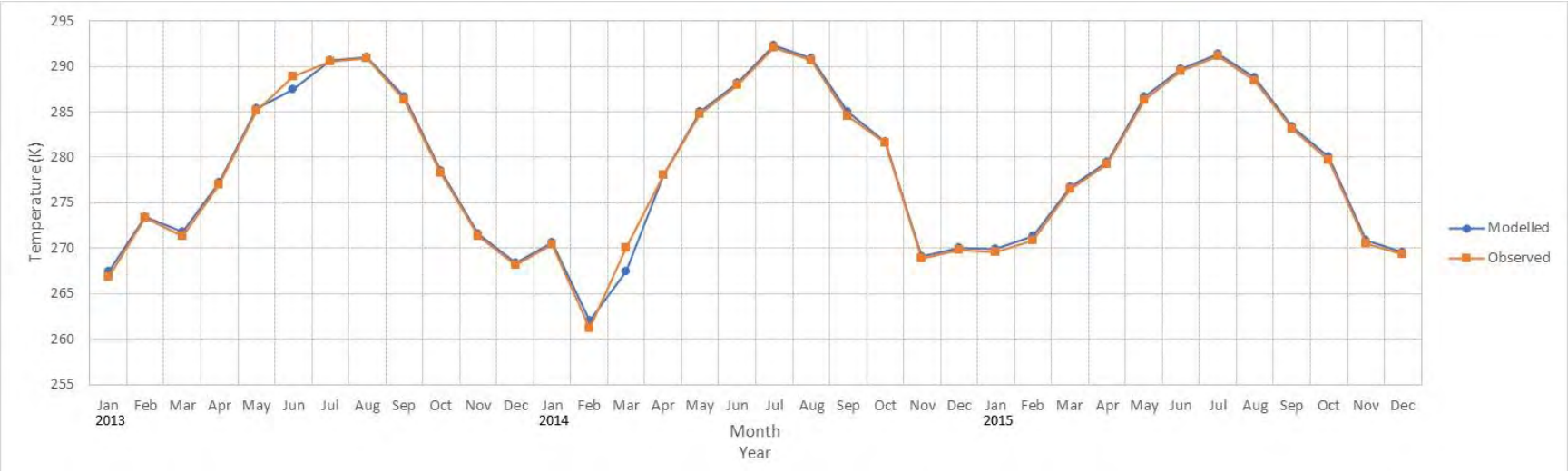


Figure 3.4 Monthly Observed and Modelled Surface Temperatures at PG Marsulex

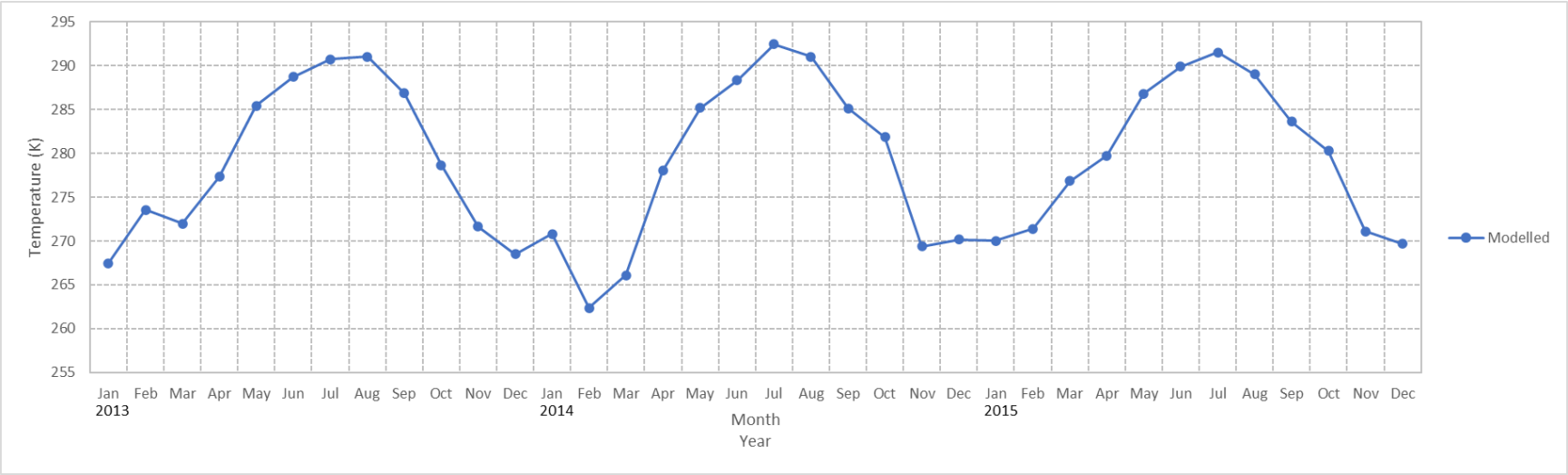
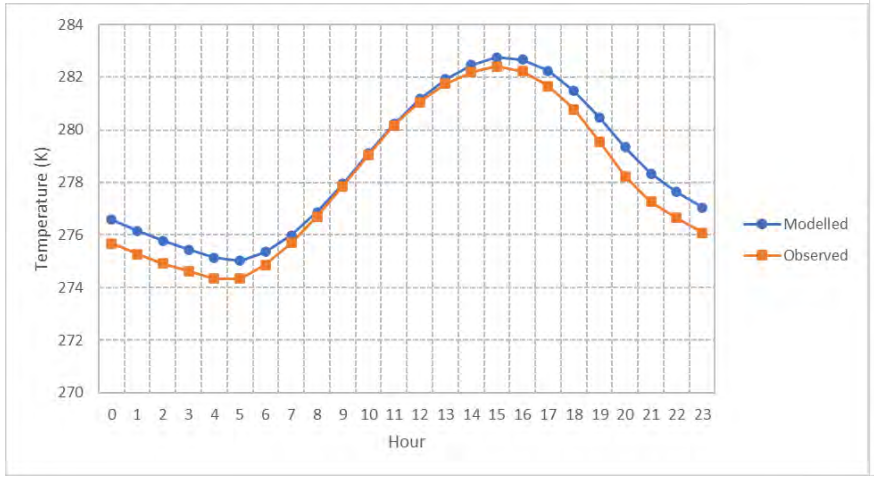
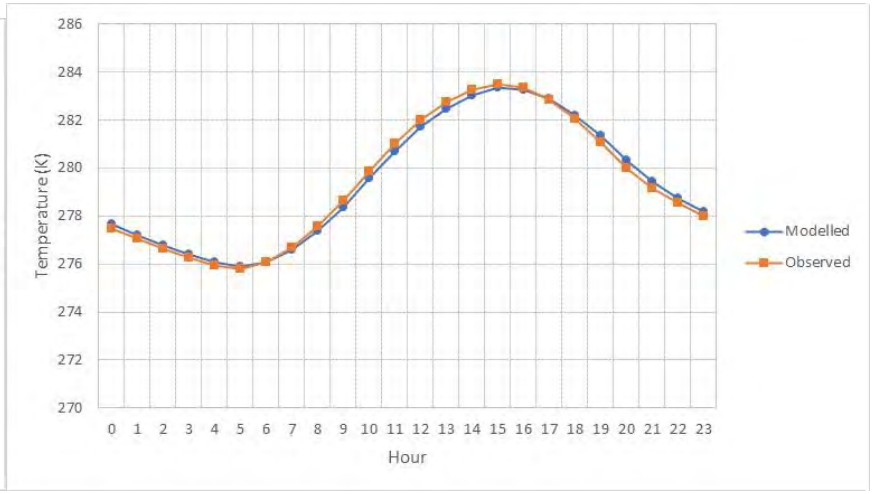


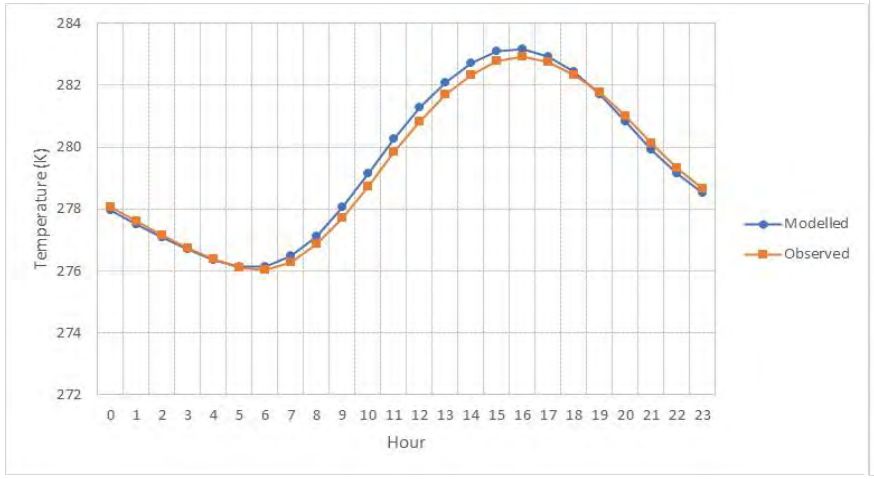
Figure 3.5 Monthly Modelled Surface Temperatures at the Facility



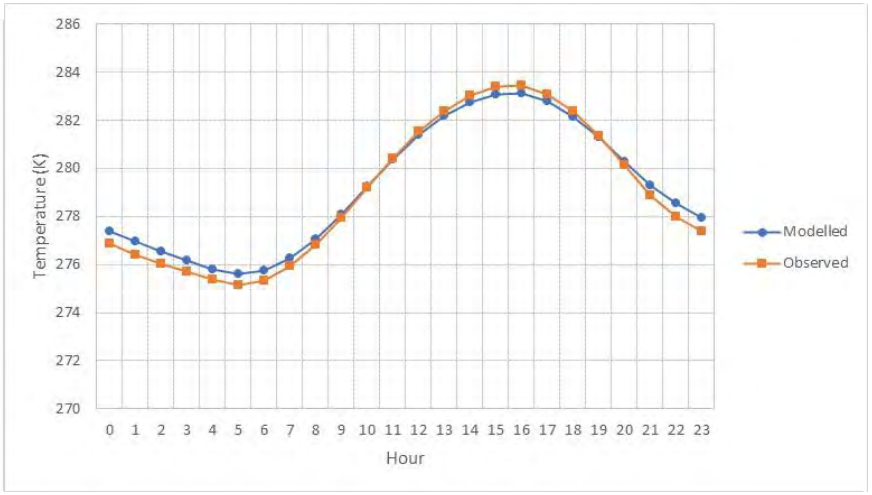
PG Airport



PG Massey



PG Plaza 400



PG Marsulex

Figure 3.6 Diurnal Variation of Observed and Modelled Surface Temperatures at Surface Stations

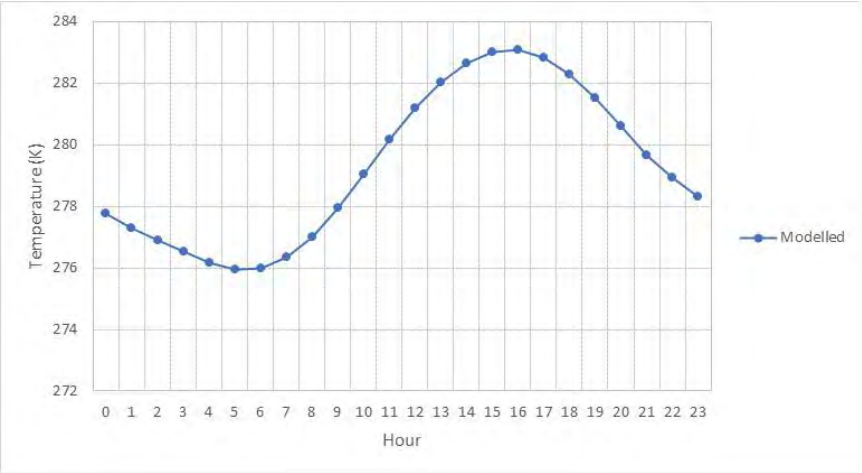
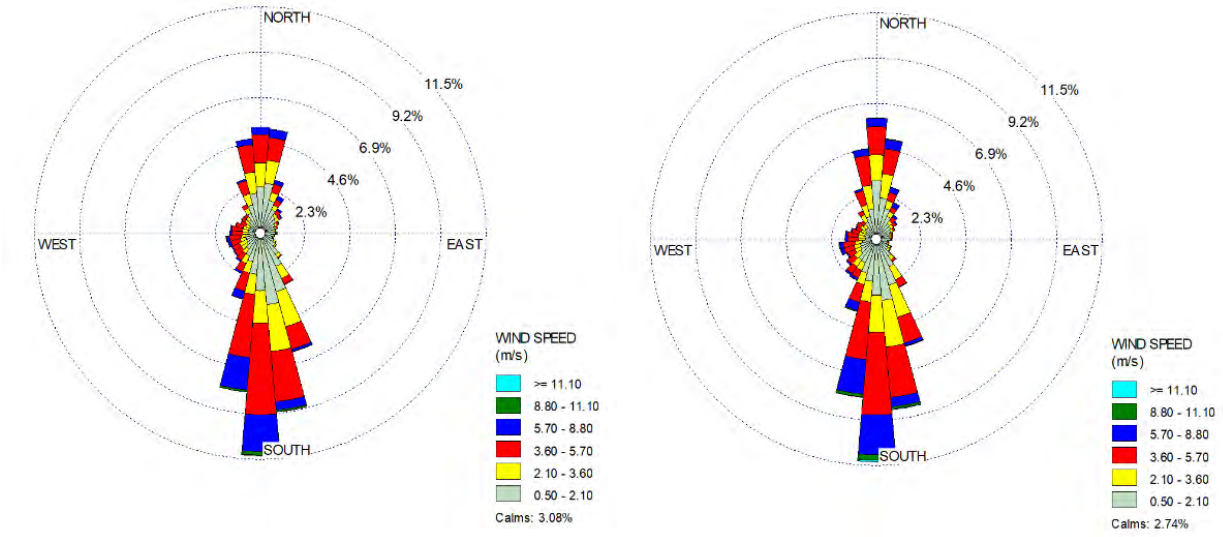


Figure 3.7 Diurnal Variation of Modelled Surface Temperatures at the Facility

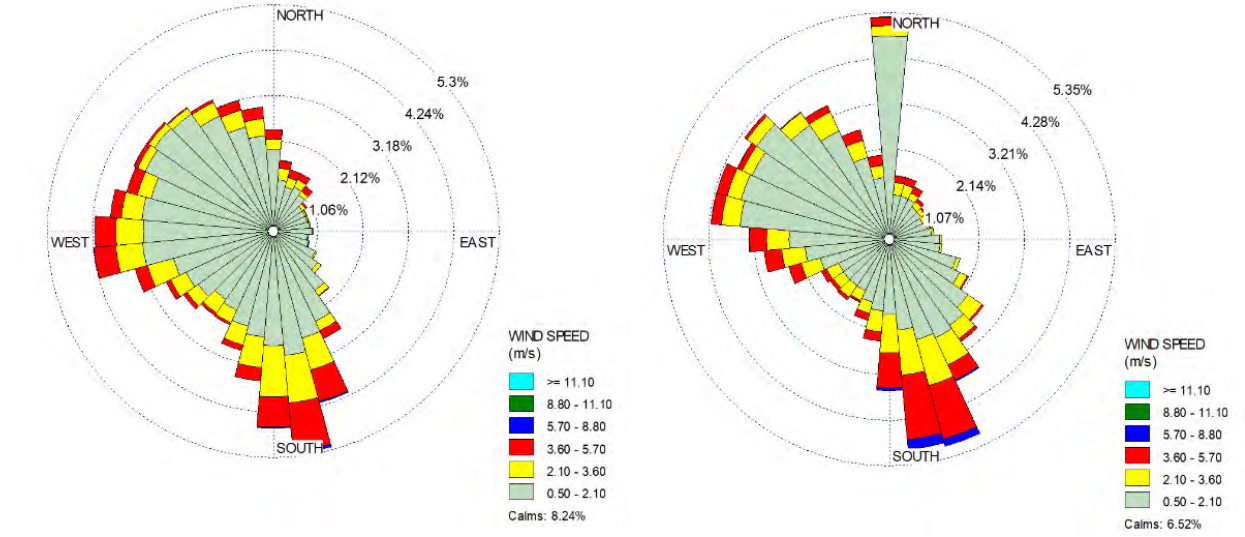
3.2 Surface Wind Roses

The combined frequency distribution of wind speed and direction as observed and modelled by CALMET at select surface stations are shown as wind roses in **Figure 3.9** to **Figure 3.11** and the wind rose for the Facility are shown in **Figure 3.12**. Overall, observed and modelled wind patterns are similar to each other at all surface stations. The modelled wind data were extracted from the CALMET grid cell in which the surface stations are located. Because the surface stations are not located at the exact centre of the grid cells, the modelled wind roses may differ slightly from the observed wind roses.



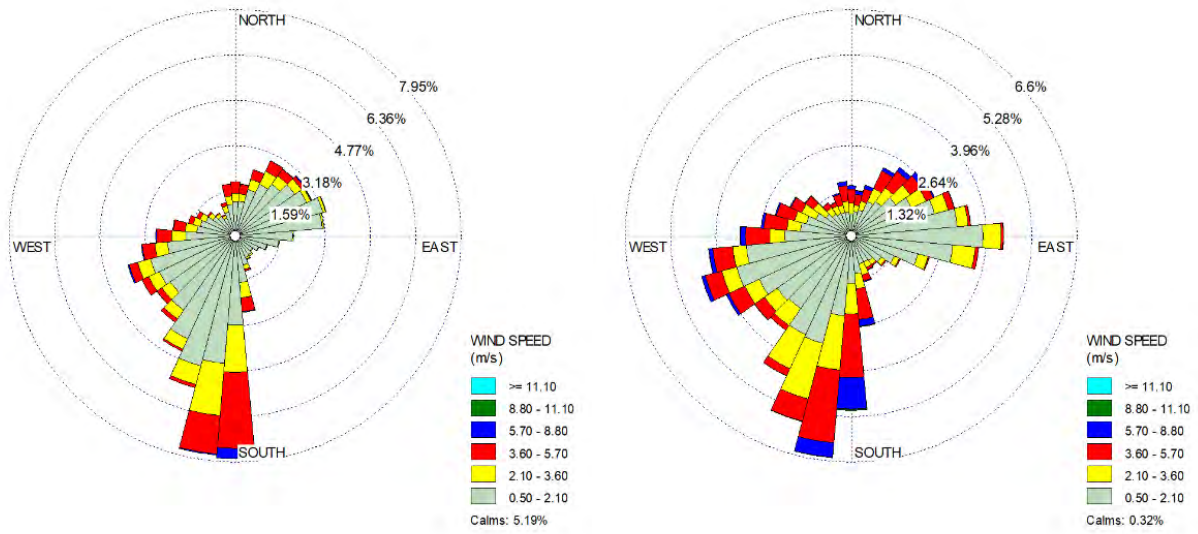
Modelled Observed

Figure 3.8 Modelled versus Observed Wind Roses at PG Airport



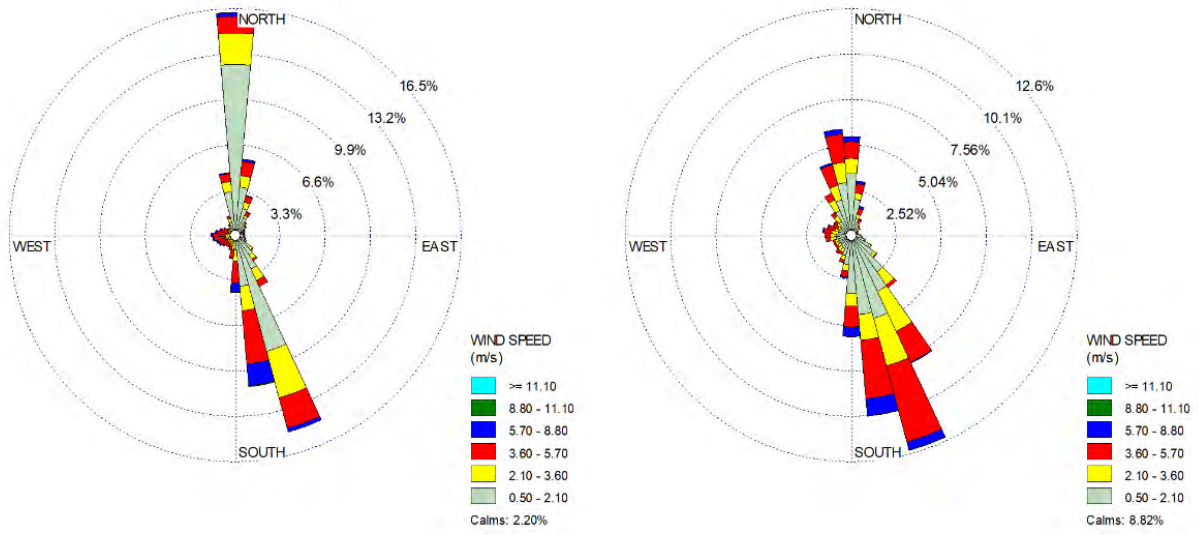
Modelled Observed

Figure 3.9 Modelled versus Observed Wind Roses at PG Massey



Modelled Observed

Figure 3.10 Modelled versus Observed Wind Roses at PG Plaza 400



Modelled Observed

Figure 3.11 Modelled versus Observed Wind Roses at PG Marsulex

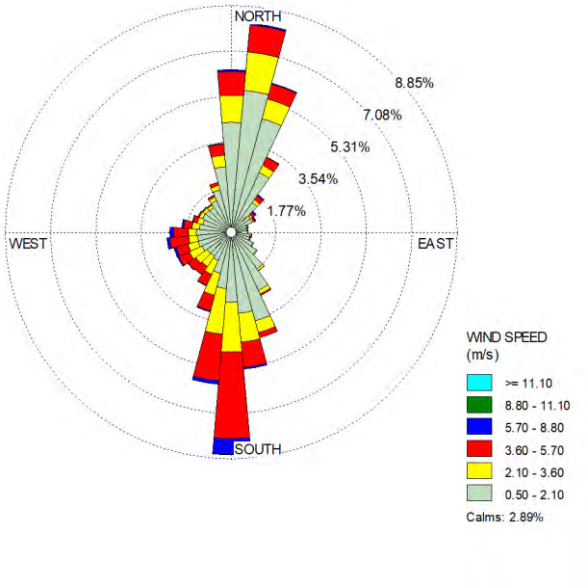
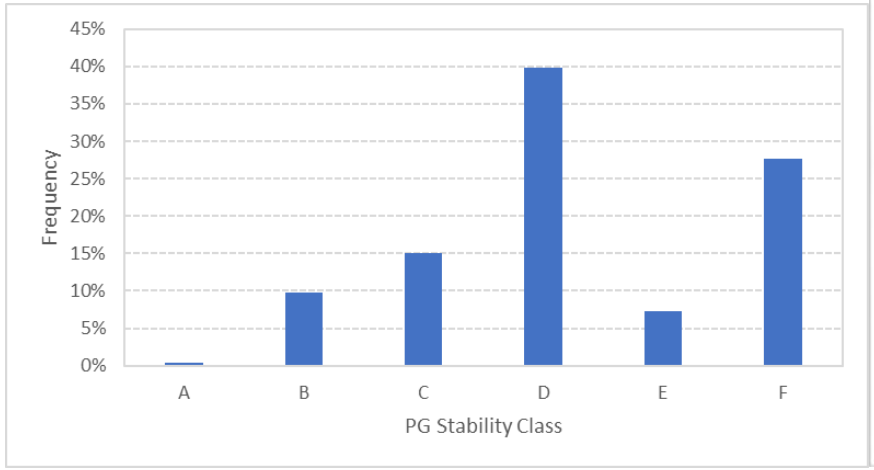


Figure 3.12 Modelled Wind Rose at the Facility

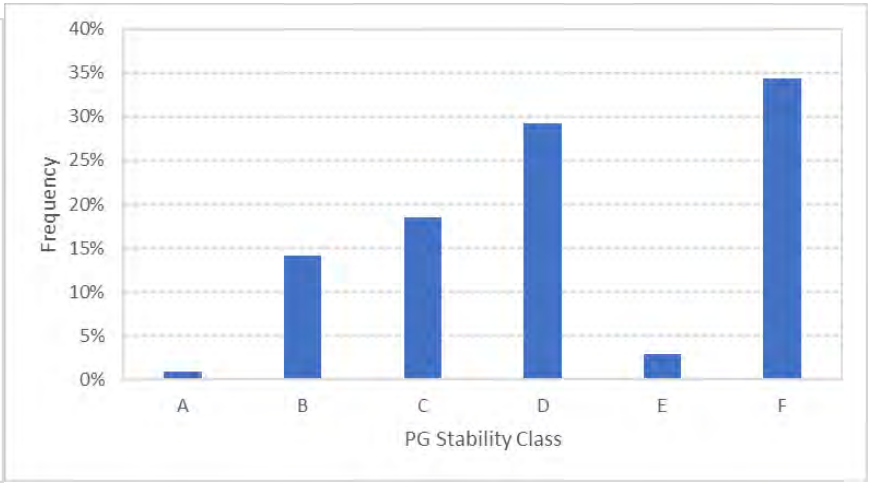
3.3 Pasquill-Gifford Stability Class

In CALMET, the Pasquill-Gifford stability scheme is used to classify atmospheric stratification in the boundary layer over land. These stability classes range from unstable (Classes A, B, and C), through neutral (Class D), to stable (Classes E and F). Normally, unstable conditions are associated with daytime ground-level heating, which results in thermal turbulence activity in the boundary layer. Stable conditions are primary associated with nighttime cooling, which results in the suppression of turbulence levels and temperature inversion at lower levels. Neutral conditions are mostly associated with high wind speeds or overcast sky conditions.

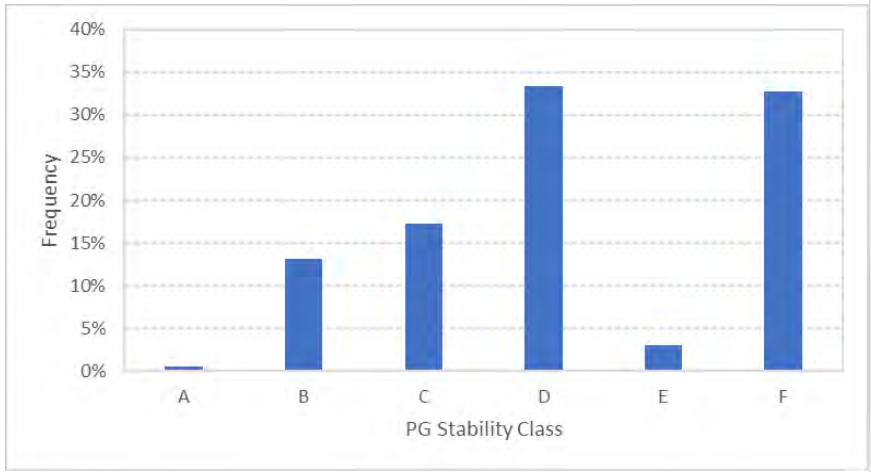
The frequency distributions of CALMET-derived Pasquill-Gifford stability classes for select surface stations are shown in **Figure 3.13** and for the Facility in **Figure 3.14**. For all locations, the most frequent stability class is Class D or neutral, followed by Class F or unstable. This is typical of atmospheric stabilities observed in the region.



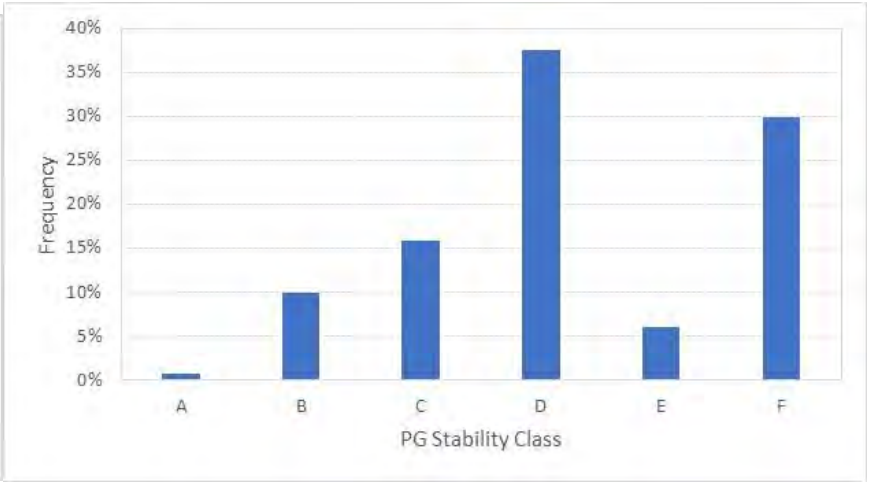
PG Airport



PG Massey



PG Plaza 400



PG Marsulex

Figure 3.13 Frequency Distribution of Pasquill-Gifford Stability Class at Surface Stations

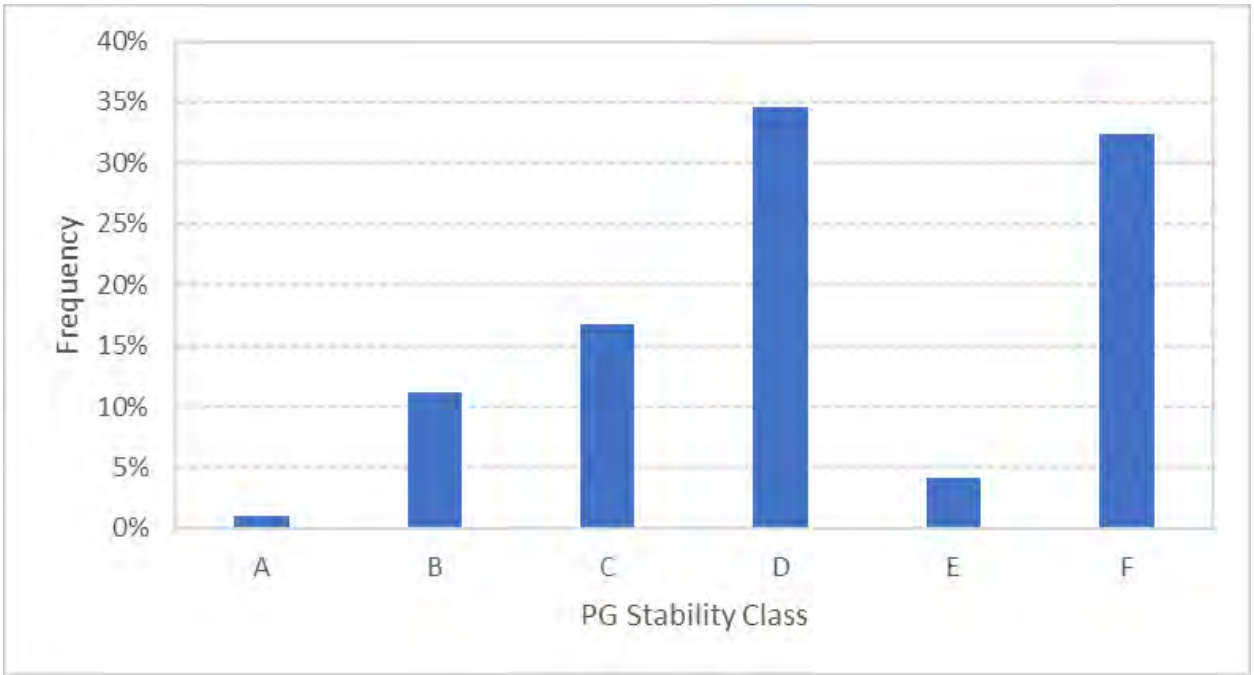
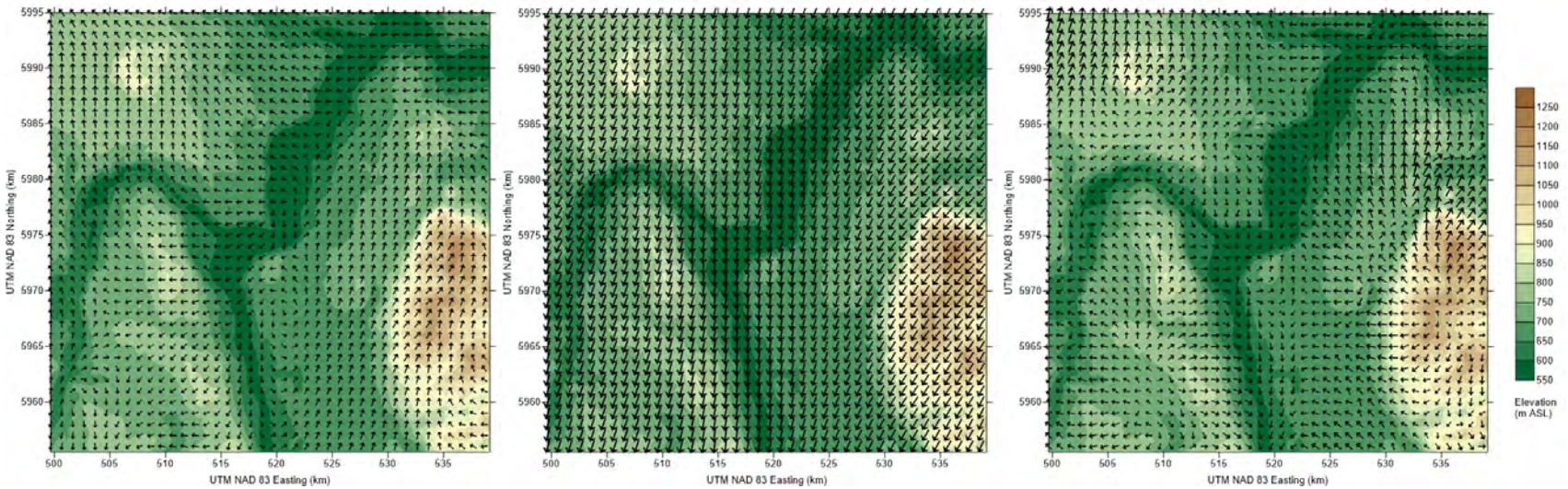


Figure 3.14 Frequency Distribution of Pasquill-Gifford Stability Class at the Facility

3.4 Modelled Wind Fields

To evaluate how CALMET performed in replicating the wind flow patterns in the model domain, wind field plots representing unstable, neutral, and stable atmospheric conditions are illustrated in **Figure 3.15**, **Figure 3.16,** and **Figure 3.17** for the surface layer, mid-layer, and upper layer, respectively. In general, CALMET-derived wind fields follow the expected terrain flows under various stability and flow regimes, flowing upslope during unstable daytime conditions and downslope during stable nighttime conditions. Under neutral conditions, the characteristic high wind speeds result in less noticeable terrain effects and wind fields are fairly uniform across the model domain. As expected, terrain flows are less evident in higher layers and more dominated by upper air winds.

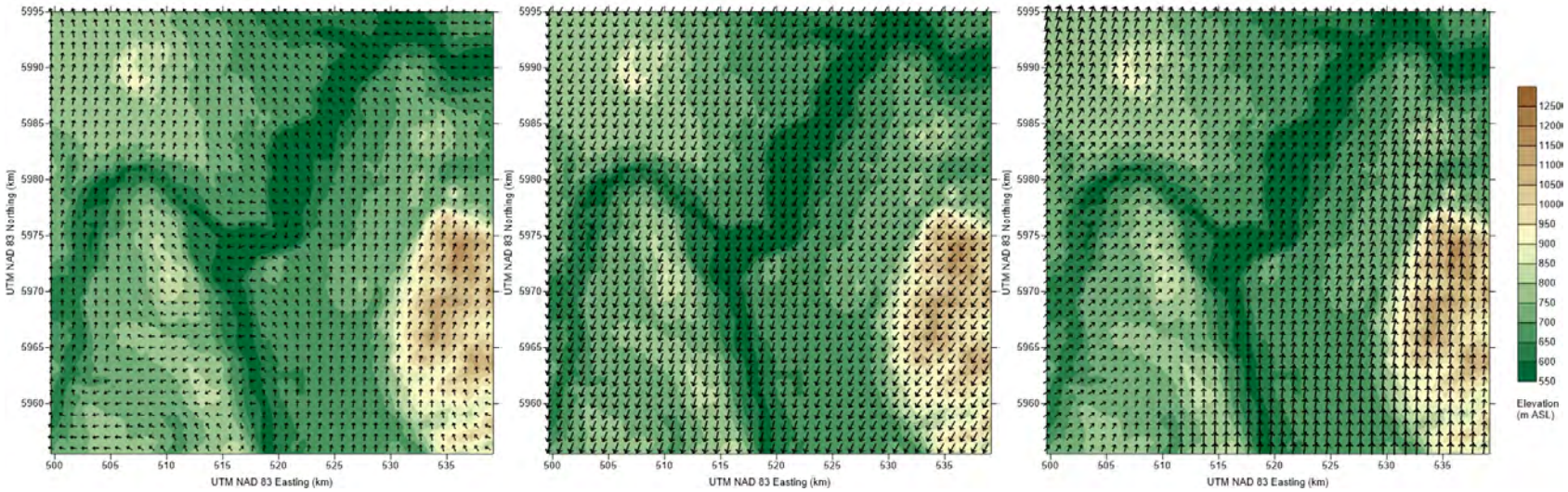


Unstable | Neutral | Stable

July 12, 2014 09:00 | October 27, 2013 16:00 | January 15, 2015 02:00

Arrow lengths show relative wind speed from 0.03 to 7.03 m/s.

Figure 3.15 Modelled Wind Fields at 10 m Above Ground Level (Layer 1) During Unstable, Neutral, and Stable Conditions

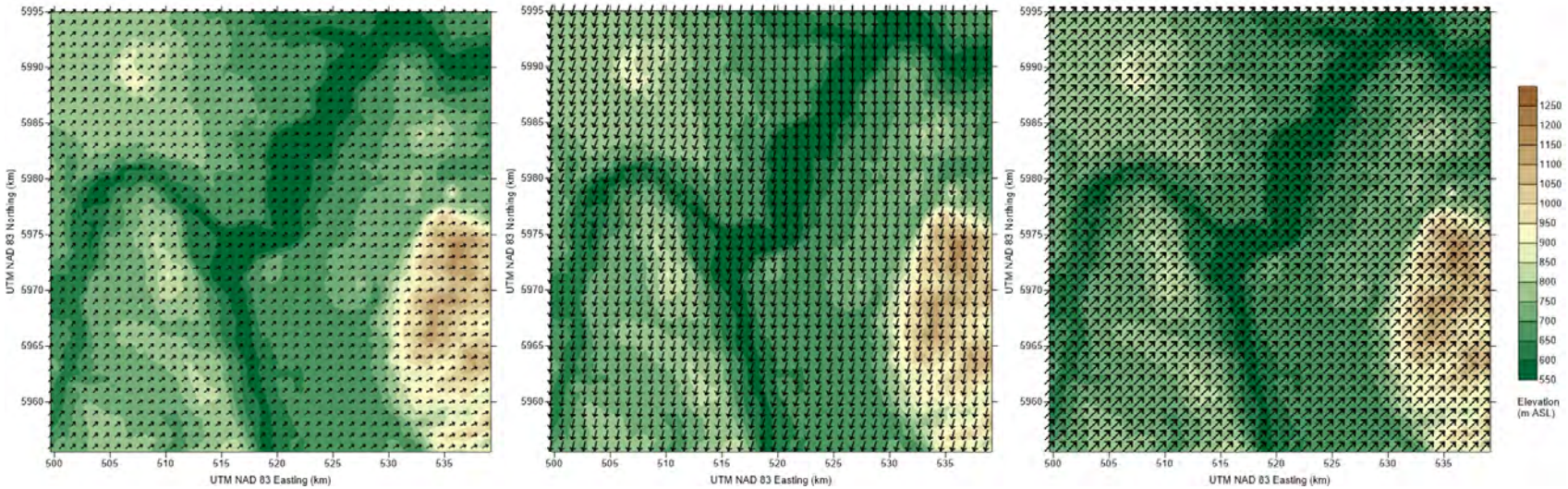


Unstable | Neutral | Stable

July 12, 2014 09:00 | October 27, 2013 16:00 | January 15, 2015 02:00

Arrow lengths show relative wind speed from 0.05 to 17.7 m/s.

Figure 3.16 Modelled Wind Fields at 230 m Above Ground Level (Layer 5) During Unstable, Neutral, and Stable Conditions



Unstable | Neutral | Stable

July 12, 2014 09:00 | October 27, 2013 16:00 | January 15, 2015 02:00

Arrow lengths show relative wind speed from 1.9 to 17.3 m/s.

Figure 3.17 Modelled Wind Fields at 2,600 m Above Ground Level (Layer 10) During Unstable, Neutral, and Stable Conditions

3.5 Mixing Heights

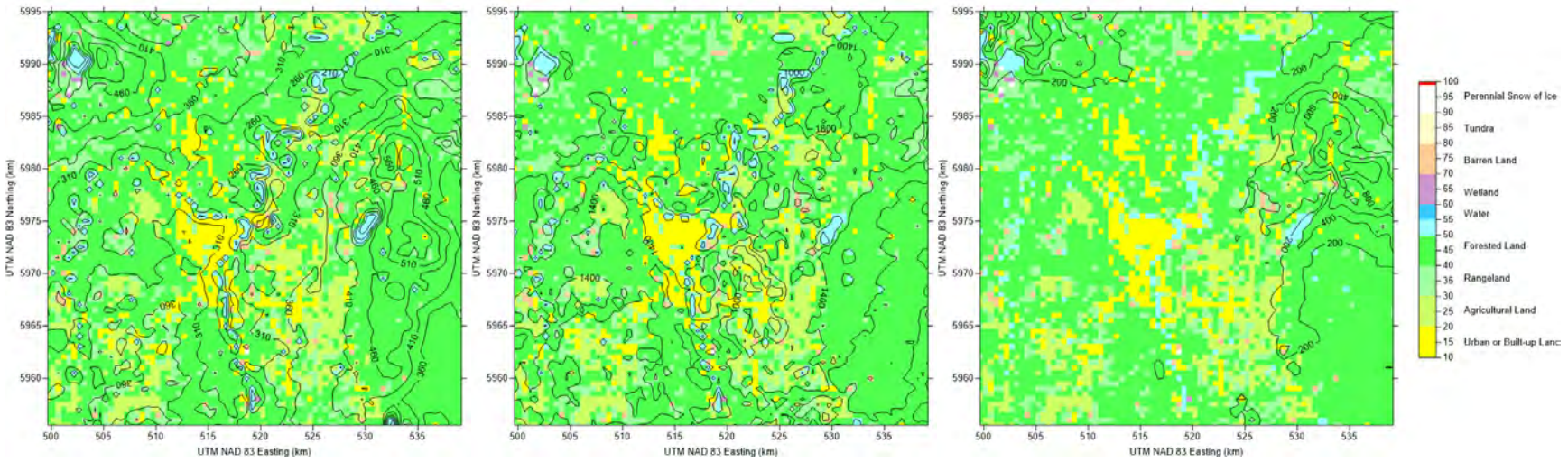
Mixing heights are estimated in CALMET through methods that are based on either surface heat flux (thermal turbulence) and vertical temperature profiles, or friction velocities (mechanical turbulence). **Table 3.1** shows the average modelled mixing heights by Pasquill-Gifford stability class over 3-year model period from 2013 to 2015. Overall, the highest mixing heights are associated with unstable conditions (Classes A, B, and C), while the lowest mixing heights are associated with stable conditions (Classes E and F).

The spatial distribution of mixing heights under unstable, neutral, and stable conditions is shown in **Figure 3.18**. Spatial changes in mixing height align with changes in land use. Mixing heights tend to be lowest over water and increases with distance more quickly in areas where surface roughness is greater (i.e., where surface elements are larger), such as forested land or urban areas.

Diurnal variations in mixing heights are shown in **Figure 3.19** for a typical summer day (August 2, 2014) and a typical winter day (February 4, 2014) at select surface stations and for the Facility in **Figure 3.20**. Mixing heights tend to increase during the day and decrease during the night, although daytime mixing heights in the winter may be suppressed during stable winter conditions due to weak solar insolation, high reflectivity of snow-covered surfaces, low wind speeds and synoptic subsidence.

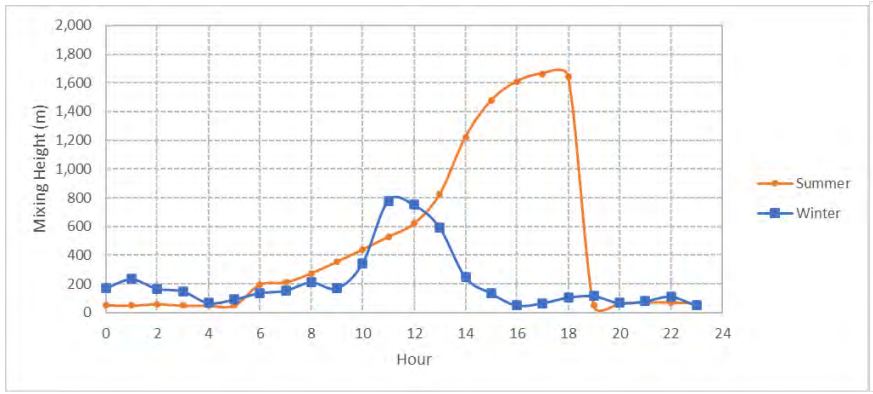
Table 3.1 Average Modelled Mixing Height by Pasquill-Gifford Stability Class (in metres)

Location	A	B	C	D	E	F
PG Airport	974	1084	782	578	242	76
PG Massey	1135	1126	692	461	543	112
PG Plaza 400	920	1042	677	497	450	79
PG Marsulex	1044	1021	799	649	400	94
Facility	983	971	685	524	376	82

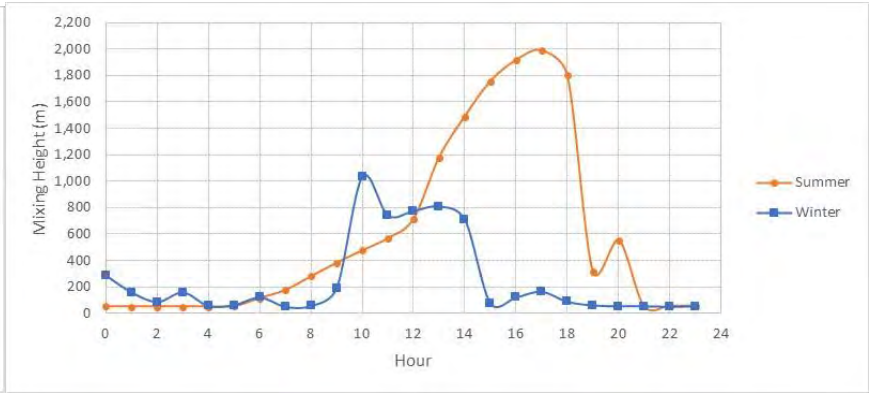


Unstable	Neutral	Stable
July 12, 2014 09:00	October 27, 2013 16:00	January 15, 2015 02:00
Contour interval: 50 m	Contour interval : 400 m	Contour interval : 200 m

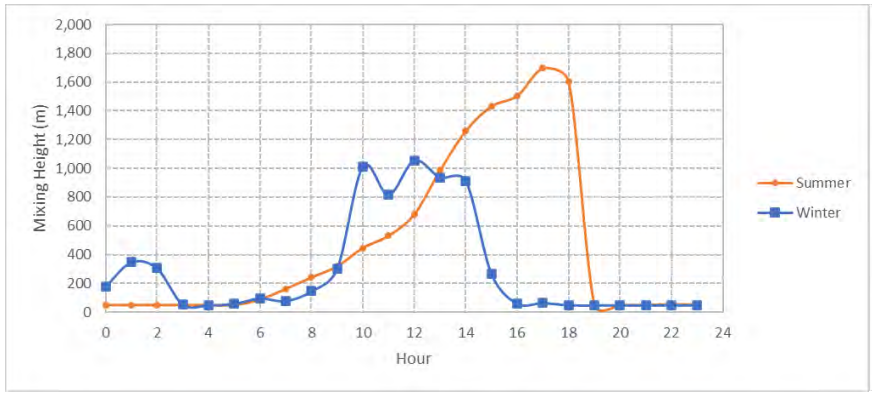
Figure 3.18 Modelled Mixing Heights Overlaid on Land Use Characterization During Unstable, Neutral, and Stable Conditions



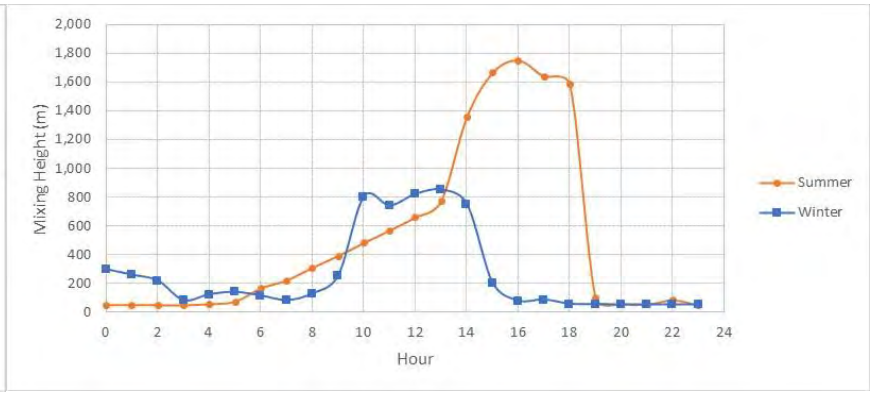
PG Airport



PG Massey



PG Plaza 400



PG Marsulex

Figure 3.19 Diurnal Variation of Modelled Mixing Heights at Surface Stations

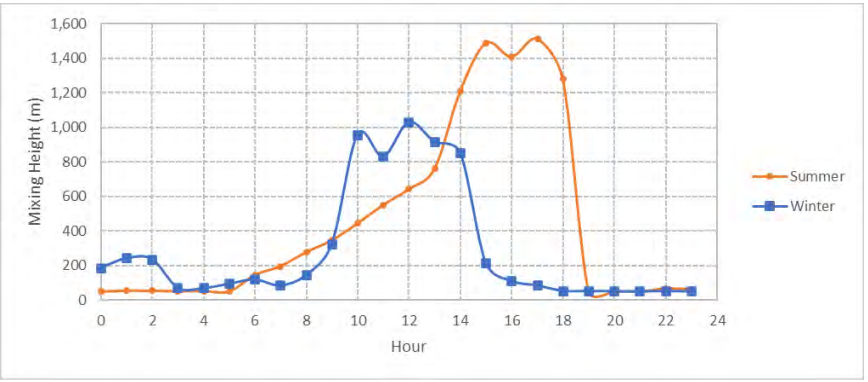


Figure 3.20 Diurnal Variation of Modelled Mixing Heights at the Facility

3.6 Precipitation

CALMET-derived monthly precipitation patterns at the Facility are illustrated in **Figure 3.21** and compared to surface observations from the PG Airport station as well as to 30-year climate normal data (1981 to 2010) from PG Airport. The PG Airport station represents the nearest climate normal station, located approximately 5 km south-southeast of the plant site.

CALMET-derived precipitation patterns for the Facility are very similar to observations at the PG Airport station. While the amount of precipitation may differ, the overall monthly precipitation patterns predicted by the CALMET model are representative of conditions expected for the area, although the region appears to have experienced drier summers during the 2013 to 2015 model period.

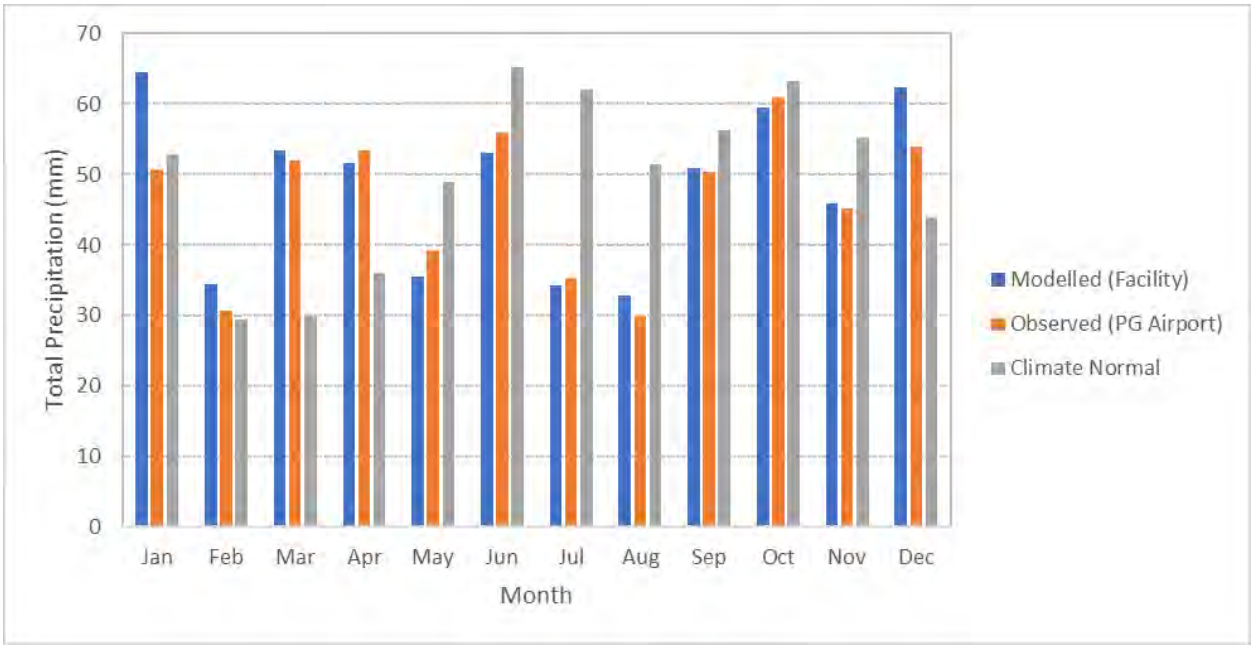


Figure 3.21 Comparison of Modelled Precipitation with Observations and Climate Normal

4.0 CALPUFF Inputs

A list of the technical options used in the CALPUFF dispersion model is provided in **Table 4.1**.

Table 4.1 CALPUFF Input Group 2 – Technical Options

Parameter	Default	Project	Comments
MGAUSS	1	1	Gaussian distribution used in near field
MCTADJ	3	3	Partial plume path terrain adjustment
MCTSG	0	0	Sub-grid scale complex terrain not modelled
MSLUG	0	0	Near-field puffs not modelled as elongated
MTRANS	1	1	Transitional plume rise modelled
MTIP	1	1	Stack tip downwash modelled
MRISE	1	1	Briggs plume rise used
MTIP_FL	0	0	Stack tip downwash not applied to flare sources
MRISE_FL	2	2	Not applicable
MBDW	1	2	PRIME method used for building downwash
MSHEAR	0	0	Vertical wind shear not modelled
MSPLIT	0	0	No puff splitting
MCHEM	1	0	Chemical transformation not modelled
MAQCHEM	0	0	Not used since MCHEM = 0
MLWC	1	1	Not used since MAQCHEM = 0
MWET	1	1	Wet deposition modelled
MDRY	1	1	Dry deposition modelled
MTILT	0	0	Gravitational settling not modelled
MDISP	3	2	Near-field dispersion coefficients internally calculated using micrometeorological variables as per BC model guidelines
MTURBVW	3	3	Not used since MDISP = 2
MDISP2	3	3	Not used since MDISP = 2
MTAULY	0	0	Draxler default used for Lagrangian timescale
MTAUADV	0	0	No turbulent advection
MCTURB	1	1	Standard CALPUFF subroutines used
MROUGH	0	0	No adjustment for surface roughness
MPARTL	1	1	Partial plume penetration of elevated inversion modelled for point sources
MPARTLBA	1	1	Partial plume penetration of elevated inversion modelled for buoyant area sources
MTINV	0	0	Strength of temperature inversion computed from default gradients

Parameter	Default	Project	Comments
MPDF	0	1	PDF used for dispersion under convective conditions for MDISP = 2 as per BC model guidelines
MSGTIBL	0	0	Sub-grid TIBL module not used for shoreline
MBCON	0	0	Boundary conditions not modelled
MSOURCE	0	0	Individual source contributions not saved
MFOG	0	0	Not configured for FOG model output
MREG	1	0	Options not tested for conformance to US EPA regulatory values

Appendix E

Isopleth Maps – Normal Operations

Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Maximum 24-Hour TSP Concentrations Including Background Contribution, 2013 - Normal Operations

PG PULPMILL RD
RIVER RD
Fraser River
Nechako River
444.63 µg/m³
80
100
120

Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use Area
- Nearest Residence

Maximum 24-Hour TSP Concentrations Including Background Contribution, 2013 - Normal Operations

- Ambient Air Quality Objective (120 µg/m³)
- Isopleth (µg/m³)

Includes background concentration of 69.3 µg/m³

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

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- Aerial Image: ESRI World Imagery

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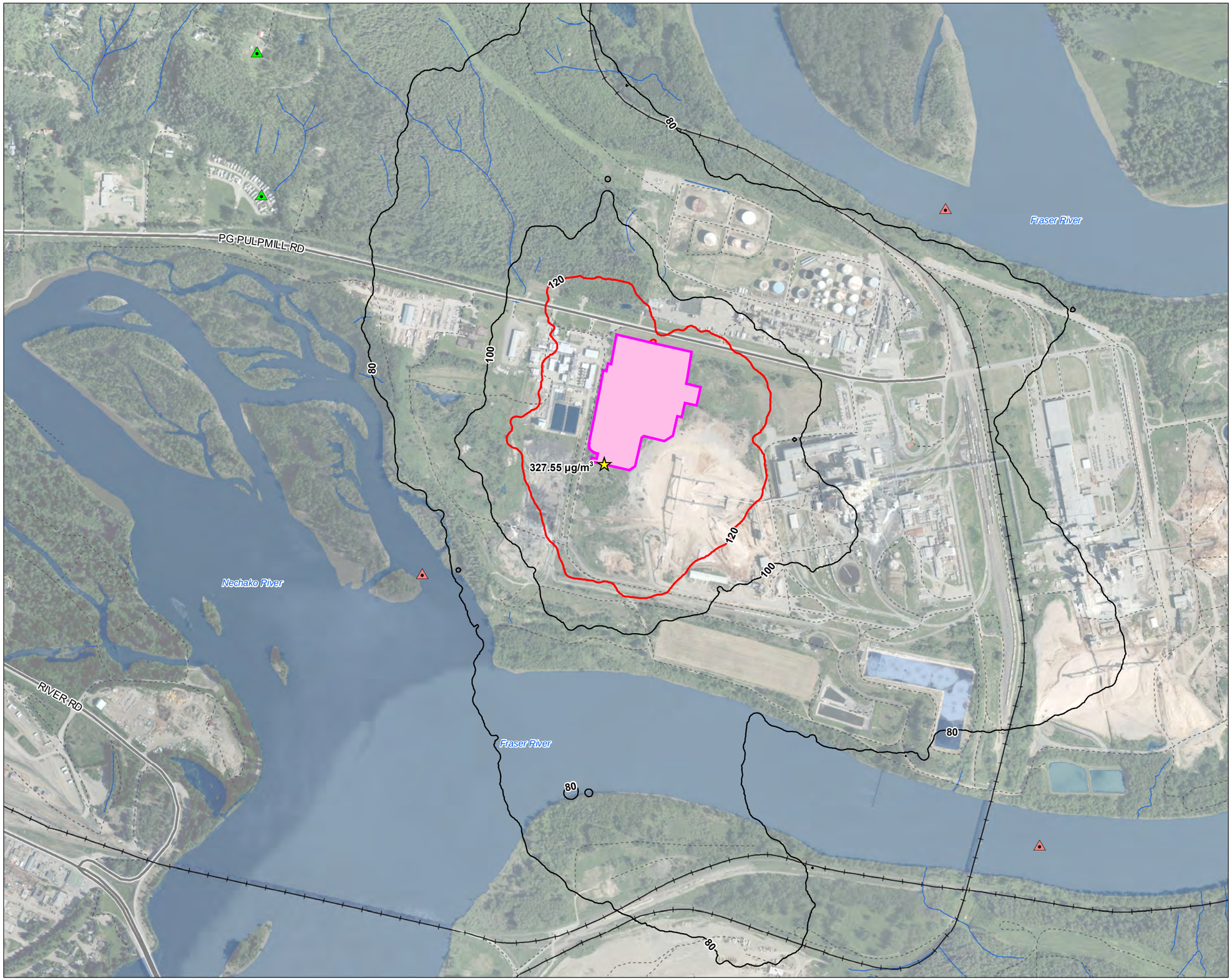
Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Maximum 24-Hour TSP Concentrations Including Background Contribution, 2014 - Normal Operations



Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use Area
- Nearest Residence

Maximum 24-Hour TSP Concentrations Including Background Contribution, 2014 - Normal Operations

- Ambient Air Quality Objective (120 µg/m^3)
- Isopleth (µg/m^3)

Includes background concentration of 69.3 µg/m^3

Notes

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Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Maximum 24-Hour TSP Concentrations Including Background Contribution, 2015 - Normal Operations

PG PULPMILL RD
RIVER RD
Fraser River
Nechako River
383.13 µg/m^3
120
100
80

Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use Area
- Nearest Residence

Maximum 24-Hour TSP Concentrations Including Background Contribution, 2015 - Normal Operations

- Ambient Air Quality Objective (120 µg/m^3)
- Isopleth (µg/m^3)

Includes background concentration of 69.3 µg/m^3

Notes

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Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Annual TSP Concentrations Including Background Contribution, 2013 - Normal Operations

PG PULPMILL RD
RIVER RD
Fraser River
Nechako River
30
40
50
60
81.669 µg/m³

Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use Area
- Nearest Residence

Annual TSP Concentrations Including Background Contribution, 2013 - Normal Operations

- Ambient Air Quality Objective (60 µg/m³)
- Isopleth (µg/m³)

Includes background concentration of 27.7 µg/m³

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

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Metres

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Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Annual TSP Concentrations Including Background Contribution, 2014 - Normal Operations

PG PULPMILL RD
RIVER RD
Fraser River
Nechako River
30
40
50
60
79.534 µg/m³

Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use Area
- Nearest Residence

Annual TSP Concentrations Including Background Contribution, 2014 - Normal Operations

- Ambient Air Quality Objective (60 µg/m³)
- Isopleth (µg/m³)

Includes background concentration of 27.7 µg/m³

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

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Metres

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Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Annual TSP Concentrations Including Background Contribution, 2015 - Normal Operations

PG PULPMILL RD
RIVER RD
Fraser River
Nechako River
Fraser River
85.54 µg/m³
30
40
50
60
30
30

Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use Area
- Nearest Residence

Annual TSP Concentrations Including Background Contribution, 2015 - Normal Operations

- Ambient Air Quality Objective (60 µg/m³)
- Isopleth (µg/m³)

Includes background concentration of 27.7 µg/m³

Notes

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Sources

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- Aerial Image: ESRI World Imagery

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Metres

NAD 1983 UTM Zone 10N

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105520-02	Production Date: Mar 13, 2023	Figure E-6

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Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Maximum 24-Hour PM10 Concentrations Including Background Contribution, 2013 - Normal Operations

354.96 µg/m³

CHIEF LAKE RD
OLD SUMMIT LAKE RD
HART HWY
Fraser River
SHELLEY RD
UPPER FRASER RD
PRINCE GEORGE HWY 16 E
Nechako River
TYNER BLVD
PACIFIC ST
HWY 97 S
ELLIS RD
CARIBOO HWY
OLD CARIBOO HWY
HALDI RD
HWY 16 W
PRINCE GEORGE HWY 16 W
BLACKWATER RD

Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Waterbody

Sensitive Receptors

- Air Quality Monitoring Station
- Hosptial
- L'heidli T'enneh Traditional Use Area
- Nearest Residence
- School
- Senior Care Facility

Maximum 24-Hour PM10 Concentrations Including Background Contribution, 2013 - Normal Operations

- Ambient Air Quality Objective (50 µg/m³)
- Isopleth (µg/m³)

Includes background concentration of 48.8 µg/m³

Notes

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Kilometres

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105520-02	Production Date: Mar 13, 2023	Figure E-7

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Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Maximum 24-Hour PM10 Concentrations Including Background Contribution, 2014 - Normal Operations

Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Waterbody

Sensitive Receptors

- Air Quality Monitoring Station
- Hosptial
- L'heidli T'enneh Traditional Use Area
- Nearest Residence
- School
- Senior Care Facility

Maximum 24-Hour PM10 Concentrations Including Background Contribution, 2014 - Normal Operations

- Ambient Air Quality Objective (50 µg/m^3)
- Isopleth (µg/m^3)

Includes background concentration of 48.8 µg/m^3

Notes

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Kilometres

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105520-02	Production Date: Mar 13, 2023	Figure E-8

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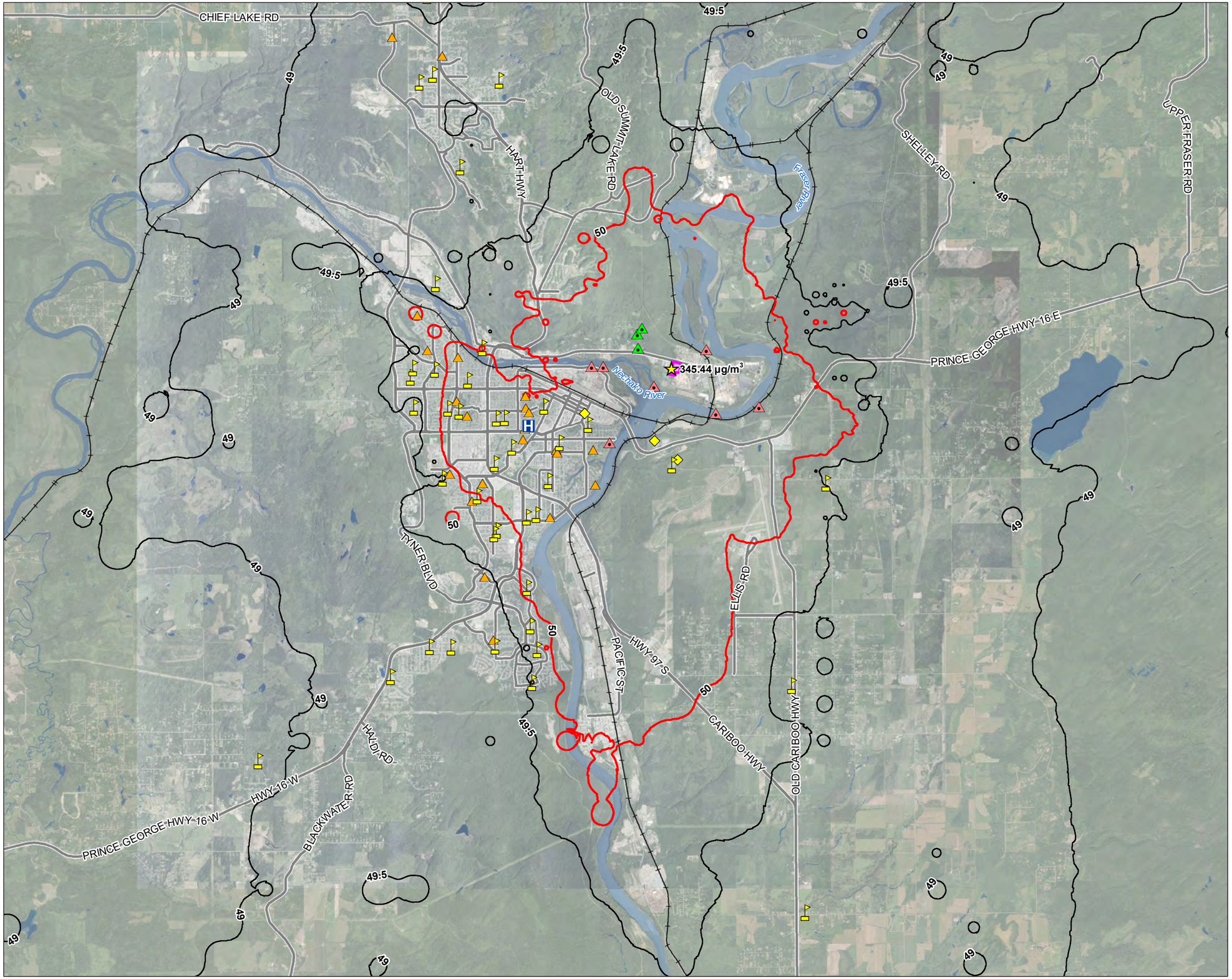
Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Maximum 24-Hour PM10 Concentrations Including Background Contribution, 2015 - Normal Operations



Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Waterbody

Sensitive Receptors

- Air Quality Monitoring Station
- Hosptial
- L'heidli T'enneh Traditional Use Area
- Nearest Residence
- School
- Senior Care Facility

Maximum 24-Hour PM10 Concentrations Including Background Contribution, 2015 - Normal Operations

- Ambient Air Quality Objective (50 µg/m^3)
- Isopleth (µg/m^3)

Includes background concentration of 48.8 µg/m^3

Notes

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Kilometres

NAD 1983 UTM Zone 10N

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105520-02	Production Date: Mar 13, 2023	Figure E-9

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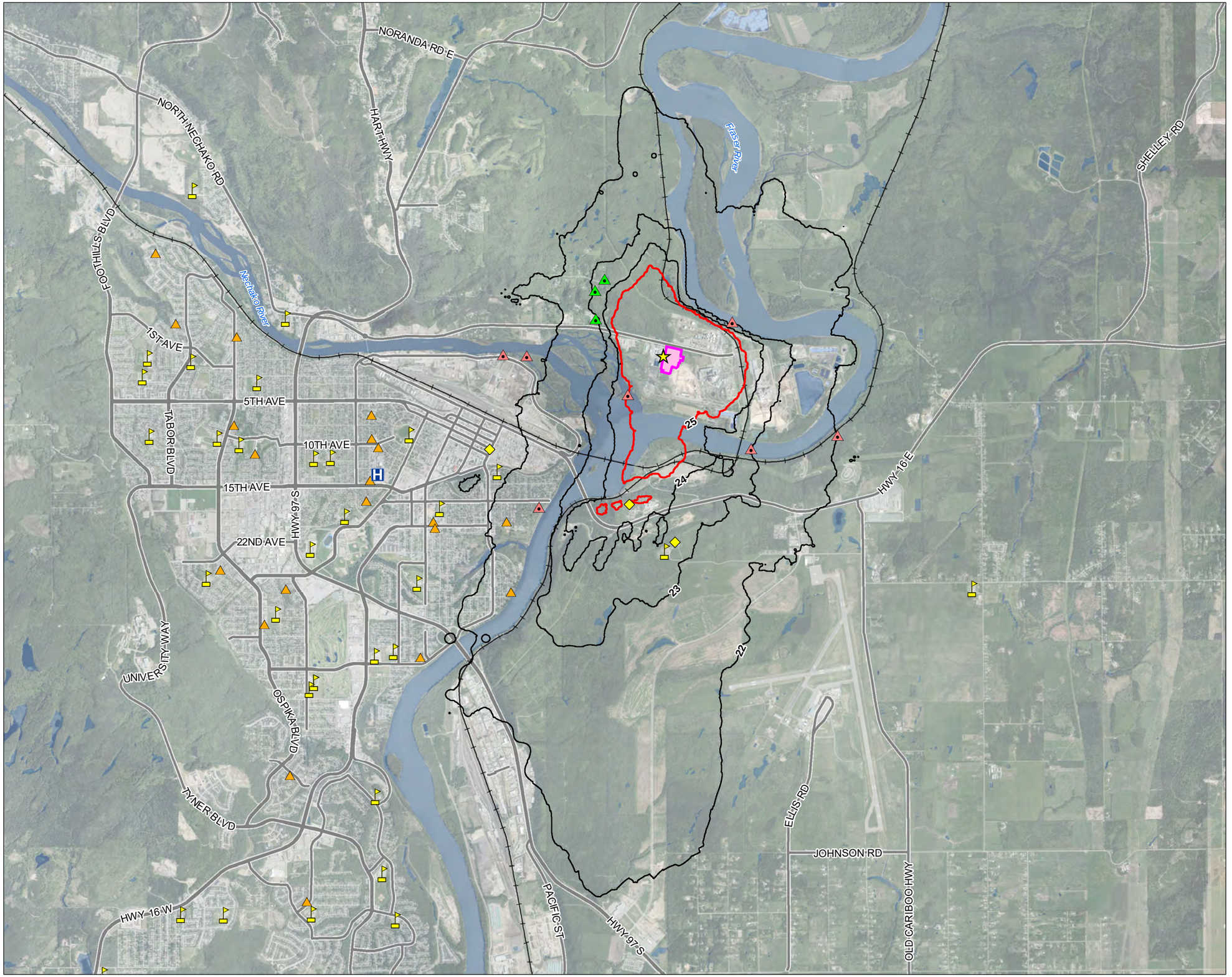
Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

98th Percentile 24-Hour PM2.5 Concentrations Including Background Contribution, 2013 - Normal Operations



Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Waterbody

Sensitive Receptors

- Air Quality Monitoring Station
- Hosptial
- L'heidli T'enneh Traditional Use Area
- Nearest Residence
- School
- Senior Care Facility

98th Percentile 24-Hour PM2.5 Concentrations Including Background Contribution, 2013 - Normal Operations

- Ambient Air Quality Objective (25 µg/m^3)
- Isopleth (µg/m^3)

Includes background concentration of 21.0 µg/m^3

Notes

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Kilometres

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105520-02	Production Date: Mar 13, 2023	Figure E-10

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Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

98th Percentile 24-Hour PM2.5 Concentrations Including Background Contribution, 2014 - Normal Operations

Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Waterbody

Sensitive Receptors

- Air Quality Monitoring Station
- Hosptial
- L'heidli T'enneh Traditional Use Area
- Nearest Residence
- School
- Senior Care Facility

98th Percentile 24-Hour PM2.5 Concentrations Including Background Contribution, 2014 - Normal Operations

- Ambient Air Quality Objective (25 µg/m^3)
- Isopleth (µg/m^3)

Includes background concentration of 21.0 µg/m^3

Notes

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Kilometres

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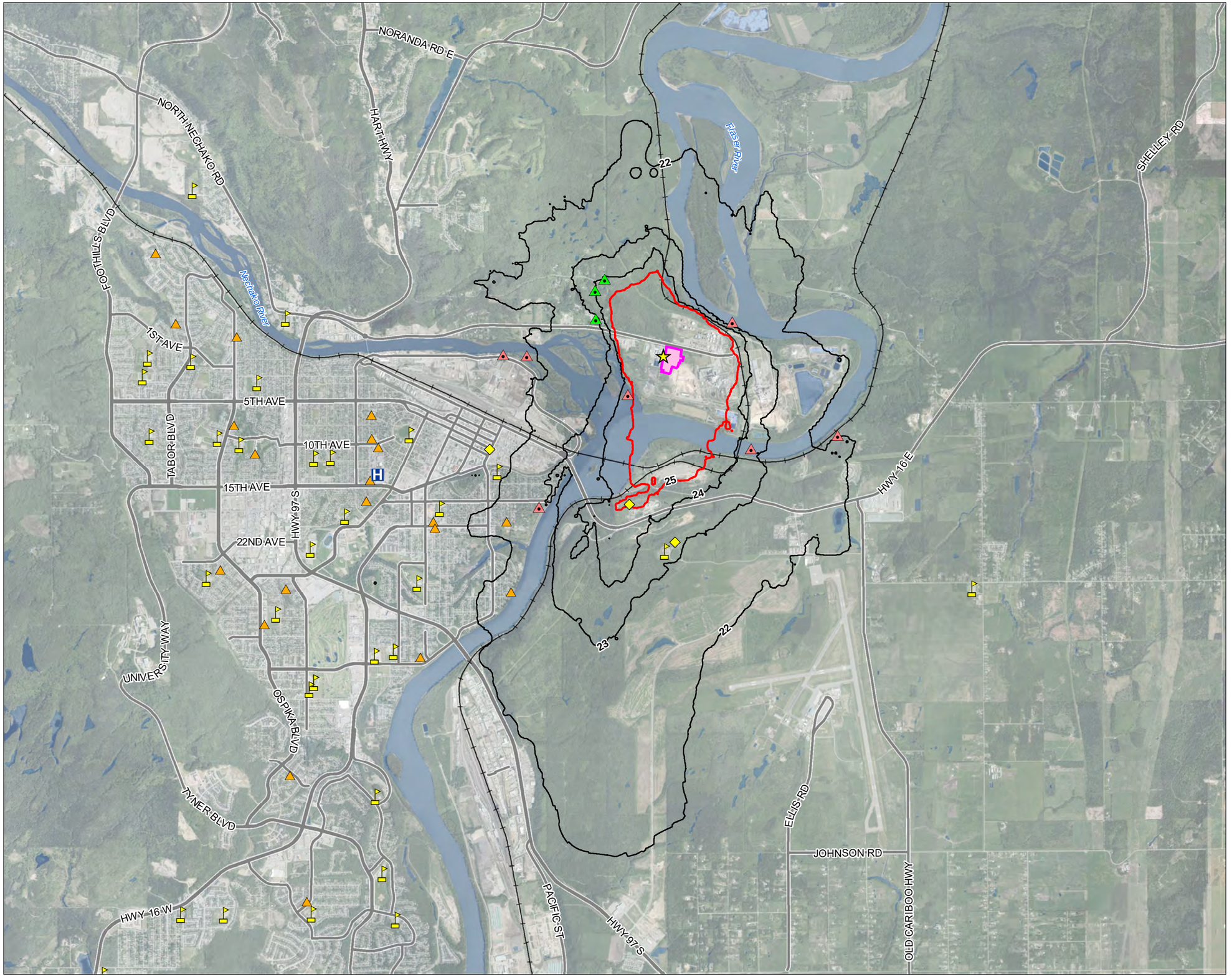
Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

98th Percentile 24-Hour PM2.5 Concentrations Including Background Contribution, 2015 - Normal Operations



Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Waterbody

Sensitive Receptors

- Air Quality Monitoring Station
- Hosptial
- L'heidli T'enneh Traditional Use Area
- Nearest Residence
- School
- Senior Care Facility

98th Percentile 24-Hour PM2.5 Concentrations Including Background Contribution, 2015 - Normal Operations

- Ambient Air Quality Objective (25 µg/m^3)
- Isopleth (µg/m^3)

Includes background concentration of 21.0 µg/m^3

Notes

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Kilometres

NAD 1983 UTM Zone 10N

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105520-02	Production Date: Mar 13, 2023	Figure E-12

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Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Annual PM2.5 Concentrations Including Background Contribution, 2013 - Normal Operations

PG PULPMILL RD
RIVER RD
Nechako River
Fraser River
Fraser River
43.92 µg/m³
25
20
15
10
10
10

Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use Area
- Nearest Residence

Annual PM2.5 Concentrations Including Background Contribution, 2013 - Normal Operations

- Ambient Air Quality Objective (8 µg/m³)
- Isopleth (µg/m³)

Includes background concentration of 8.4 µg/m³

Notes

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Metres

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105520-02	Production Date: Mar 13, 2023	Figure E-13

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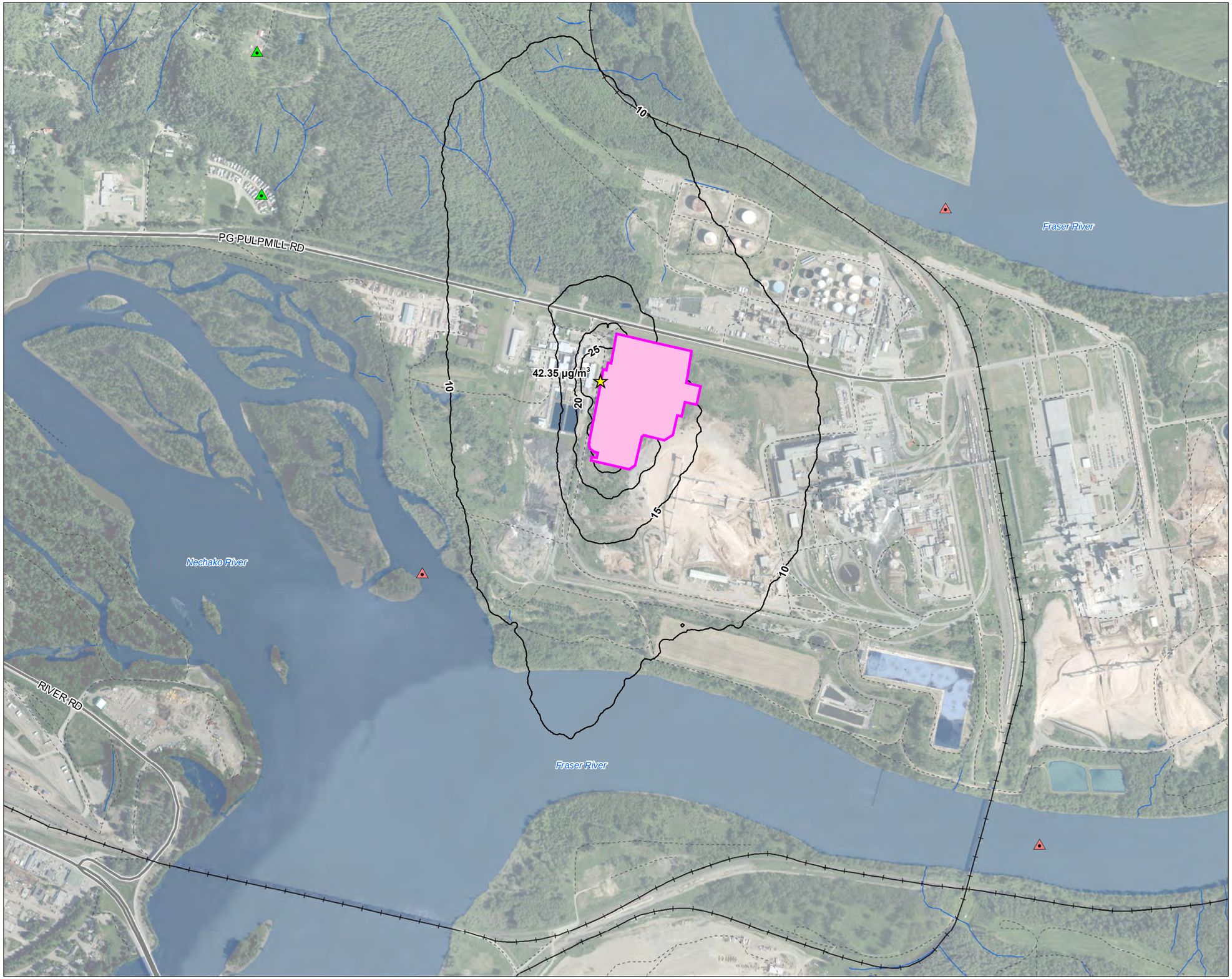
Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Annual PM2.5 Concentrations Including Background Contribution, 2014 - Normal Operations



Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use Area
- Nearest Residence

Annual PM2.5 Concentrations Including Background Contribution, 2014 - Normal Operations

- Ambient Air Quality Objective (8 µg/m³)
- Isopleth (µg/m³)

Includes background concentration of 8.4 µg/m³

Notes

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Metres

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105520-02	Production Date: Mar 13, 2023	Figure E-14

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Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Annual PM2.5 Concentrations Including Background Contribution, 2015 - Normal Operations

PG PULPMILL RD
RIVER RD
Fraser River
Nechako River
Fraser River
46.591 µg/m³
10
15
20
25
10

Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use Area
- Nearest Residence

Annual PM2.5 Concentrations Including Background Contribution, 2015 - Normal Operations

- Ambient Air Quality Objective (8 µg/m³)
- Isopleth (µg/m³)

Includes background concentration of 8.4 µg/m³

Notes

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105520-02	Production Date: Mar 13, 2023	Figure E-15

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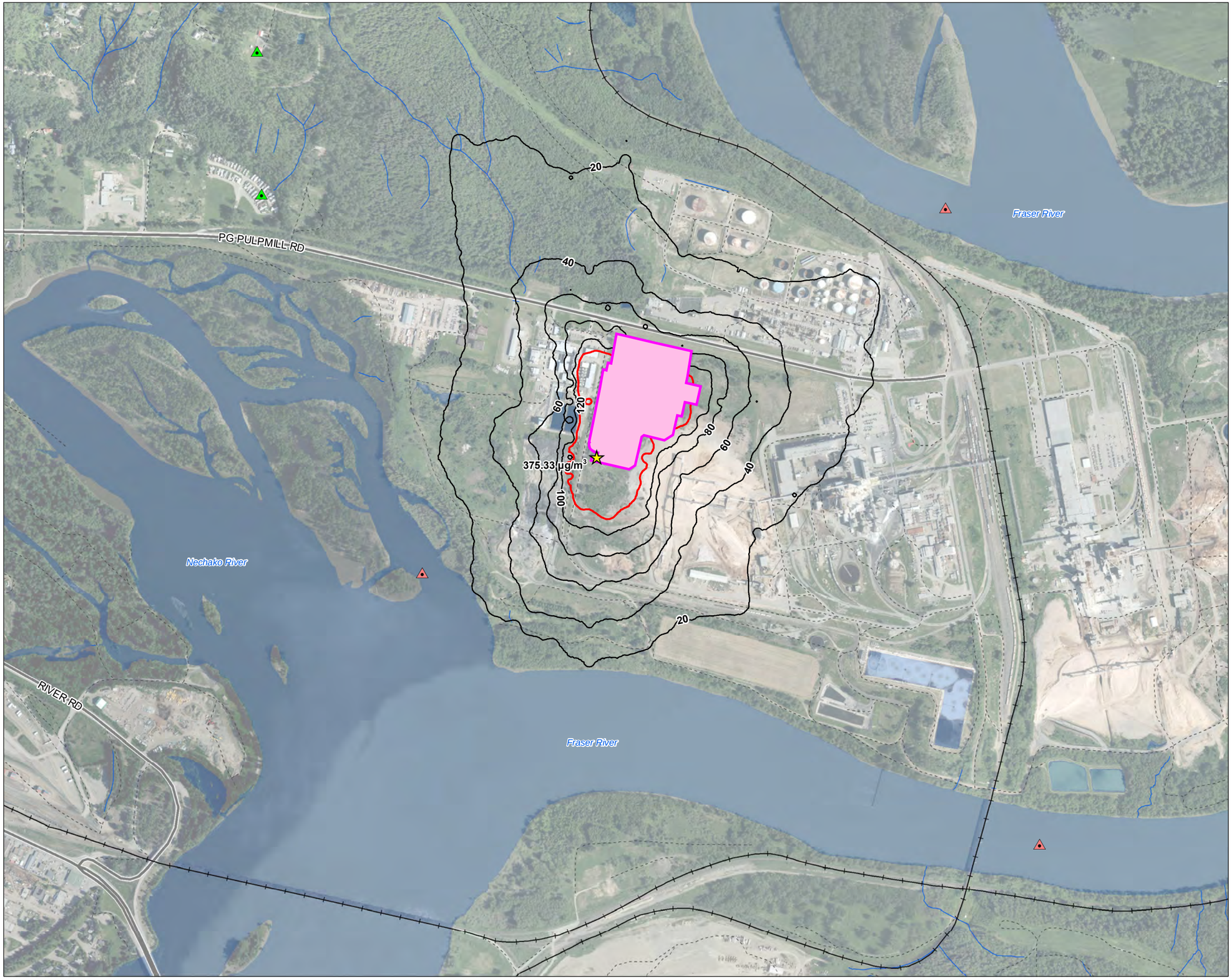
Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Maximum 24-Hour TSP Concentrations without Background Contribution, 2013 - Normal Operations



Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use Area
- Nearest Residence

Maximum 24-Hour TSP Concentrations without Background Contribution, 2013 - Normal Operations

- Ambient Air Quality Objective (120 µg/m³)
- Isopleth (µg/m³)

Notes

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Metres

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105520-02	Production Date: Mar 13, 2023	Figure E-16

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Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Maximum 24-Hour TSP Concentrations without Background Contribution, 2014 - Normal Operations

PG PULPMILL RD
Fraser River
Nechako River
RIVER RD
258.25 µg/m³
120
100
80
60
40
20

Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use Area
- Nearest Residence

Maximum 24-Hour TSP Concentrations without Background Contribution, 2014 - Normal Operations

- Ambient Air Quality Objective (120 µg/m³)
- Isopleth (µg/m³)

Notes

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Metres

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105520-02	Production Date: Mar 13, 2023	Figure E-17

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Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Maximum 24-Hour TSP Concentrations without Background Contribution, 2015 - Normal Operations

PG PULPMILL RD
RIVER RD
Fraser River
Nechako River
313.83 µg/m³
20
40
60
80
100
120

Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use Area
- Nearest Residence

Maximum 24-Hour TSP Concentrations without Background Contribution, 2015 - Normal Operations

- Ambient Air Quality Objective (120 µg/m³)
- Isopleth (µg/m³)

Notes

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Metres

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105520-02	Production Date: Mar 13, 2023	Figure E-18

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Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Annual TSP Concentrations without Background Contribution, 2013 - Normal Operations

Fraser River

PG PULPMILL RD

Nechako River

10
20
30
40
53.94 µg/m³

Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use Area

Annual TSP Concentrations without Background Contribution, 2013 - Normal Operations

- Isopleth (µg/m³)

Notes

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Metres

NAD 1983 UTM Zone 10N

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105520-02	Production Date: Mar 13, 2023	Figure E-19

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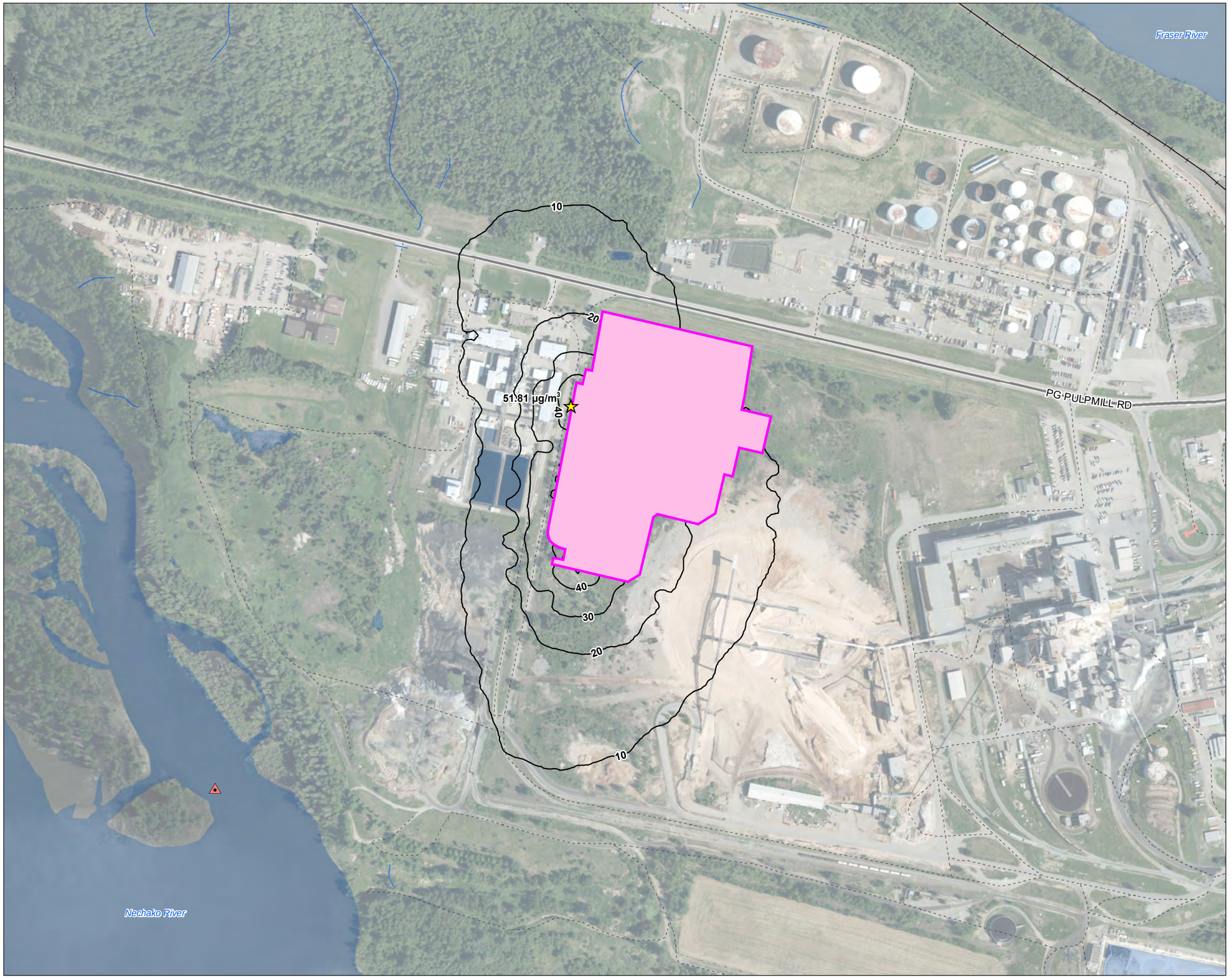
Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Annual TSP Concentrations without Background Contribution, 2014 - Normal Operations



Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use Area

Annual TSP Concentrations without Background Contribution, 2014 - Normal Operations

- Isopleth (µg/m^3)

Notes

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- Aerial Image: ESRI World Imagery

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0 50 100 150 200 250

Metres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

105520-02	Production Date: Mar 13, 2023	Figure E-20

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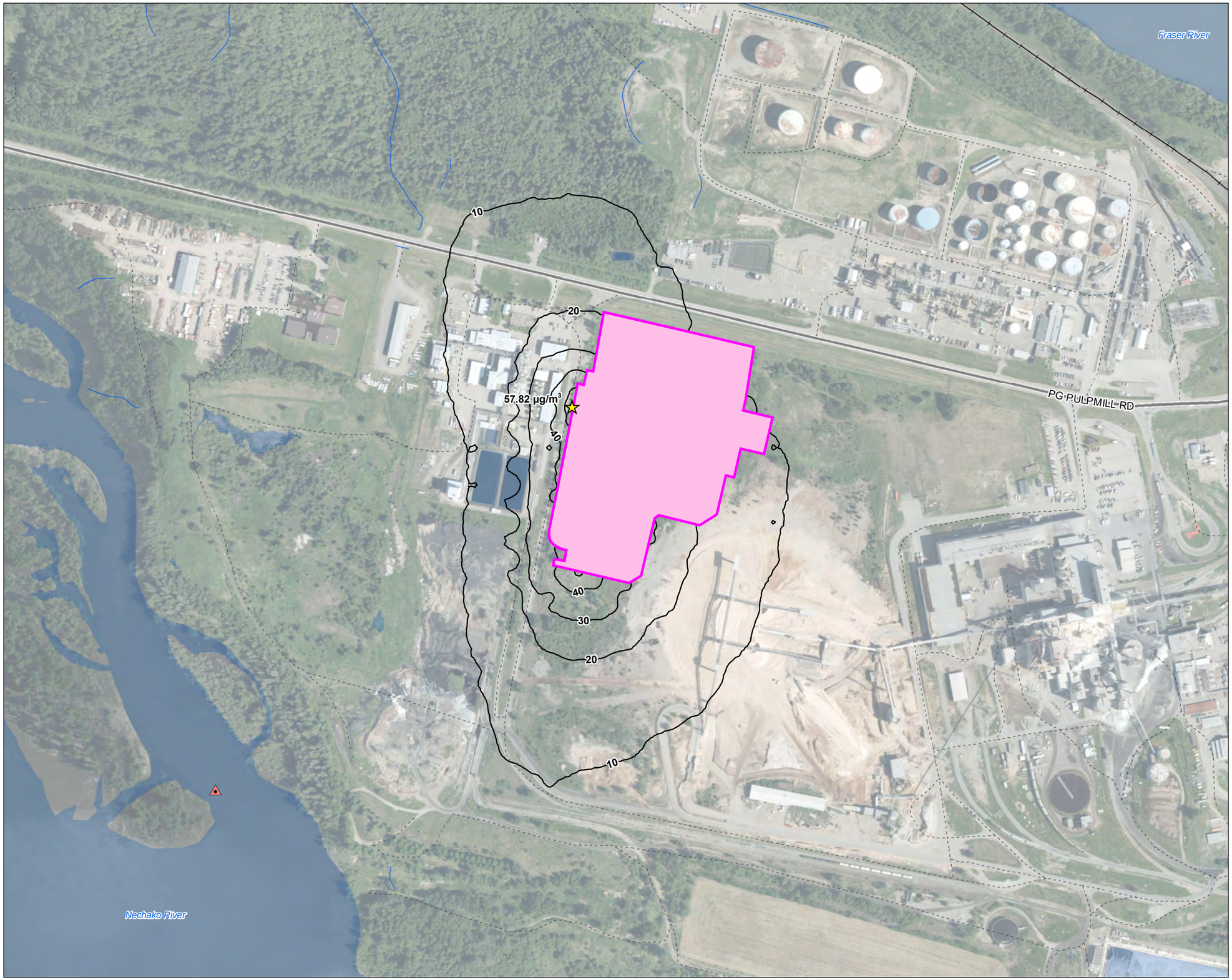
Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Annual TSP Concentrations without Background Contribution, 2015 - Normal Operations



Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use Area

Annual TSP Concentrations without Background Contribution, 2015 - Normal Operations

- Isopleth (µg/m^3)

Notes

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0 50 100 150 200 250

Metres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

105520-02	Production Date: Mar 13, 2023	Figure E-21

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Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Maximum 24-Hour PM10 Concentrations without Background Contribution, 2013 - Normal Operations

PG PULPMILL RD
RIVER RD
Fraser River
Nechako River
306.16 µg/m³
10
20
30
40
50

Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use Area
- Nearest Residence

Maximum 24-Hour PM10 Concentrations without Background Contribution, 2013 - Normal Operations

- Ambient Air Quality Objective (50 µg/m³)
- Isopleth (µg/m³)

Notes

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Sources

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- Aerial Image: ESRI World Imagery

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Metres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

105520-02	Production Date: Mar 13, 2023	Figure E-22

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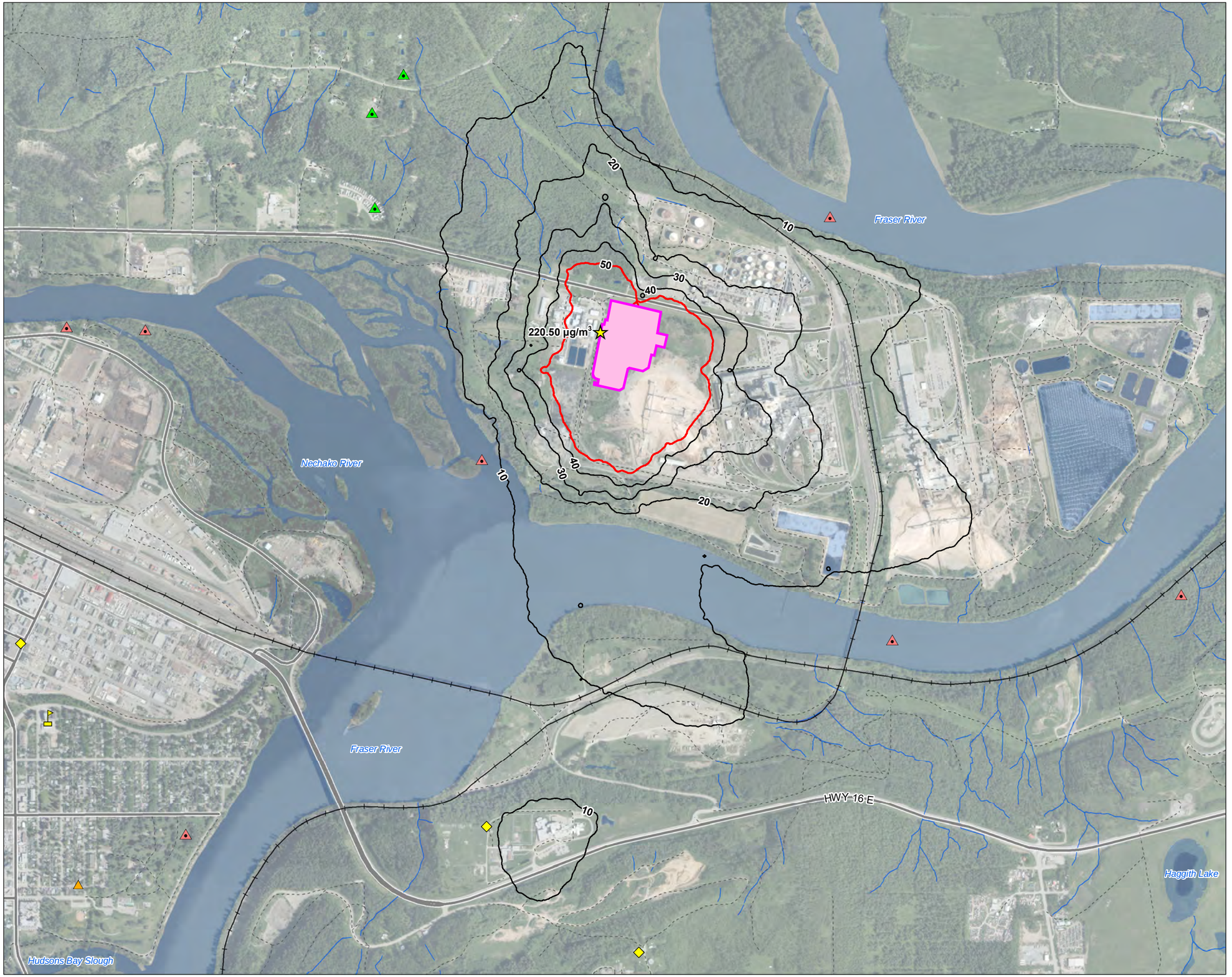
Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Maximum 24-Hour PM10 Concentrations without Background Contribution, 2014 - Normal Operations



Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- Air Quality Monitoring Station
- L'heidli T'enneh Traditional Use Area
- Nearest Residence
- School
- Senior Care Facility

Maximum 24-Hour PM10 Concentrations without Background Contribution, 2014 - Normal Operations

- Ambient Air Quality Objective (50 µg/m^3)
- Isopleth (µg/m^3)

Notes

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Sources

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- Aerial Image: ESRI World Imagery

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Metres

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105520-02	Production Date: Mar 20, 2023	Figure E-23

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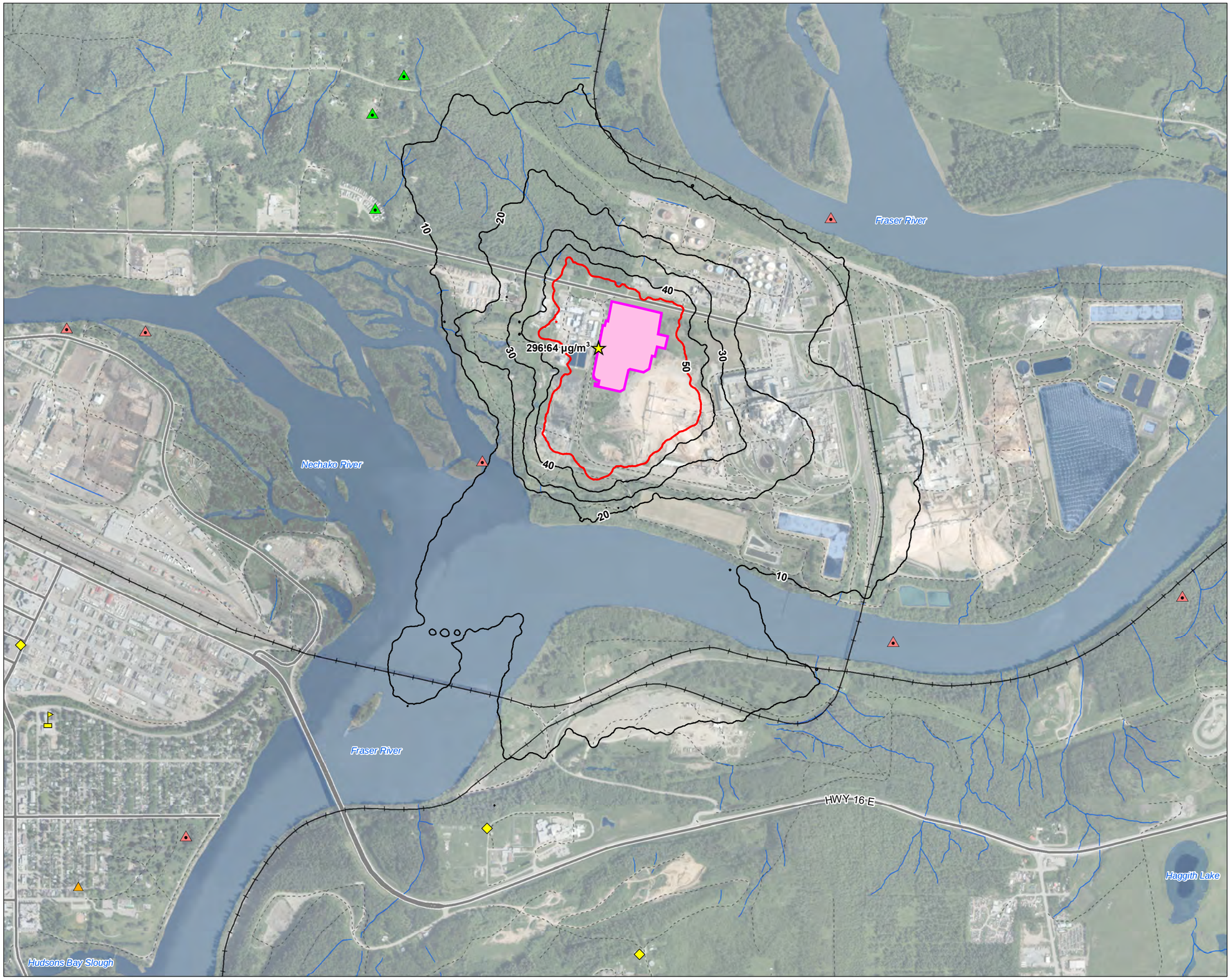
Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Maximum 24-Hour PM10 Concentrations without Background Contribution, 2015 - Normal Operations



Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- Air Quality Monitoring Station
- L'heidli T'enneh Traditional Use Area
- Nearest Residence
- School
- Senior Care Facility

Maximum 24-Hour PM10 Concentrations without Background Contribution, 2015 - Normal Operations

- Ambient Air Quality Objective (50 µg/m^3)
- Isopleth (µg/m^3)

Notes

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Metres

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105520-02	Production Date: Mar 20, 2023	Figure E-24

Ausenco

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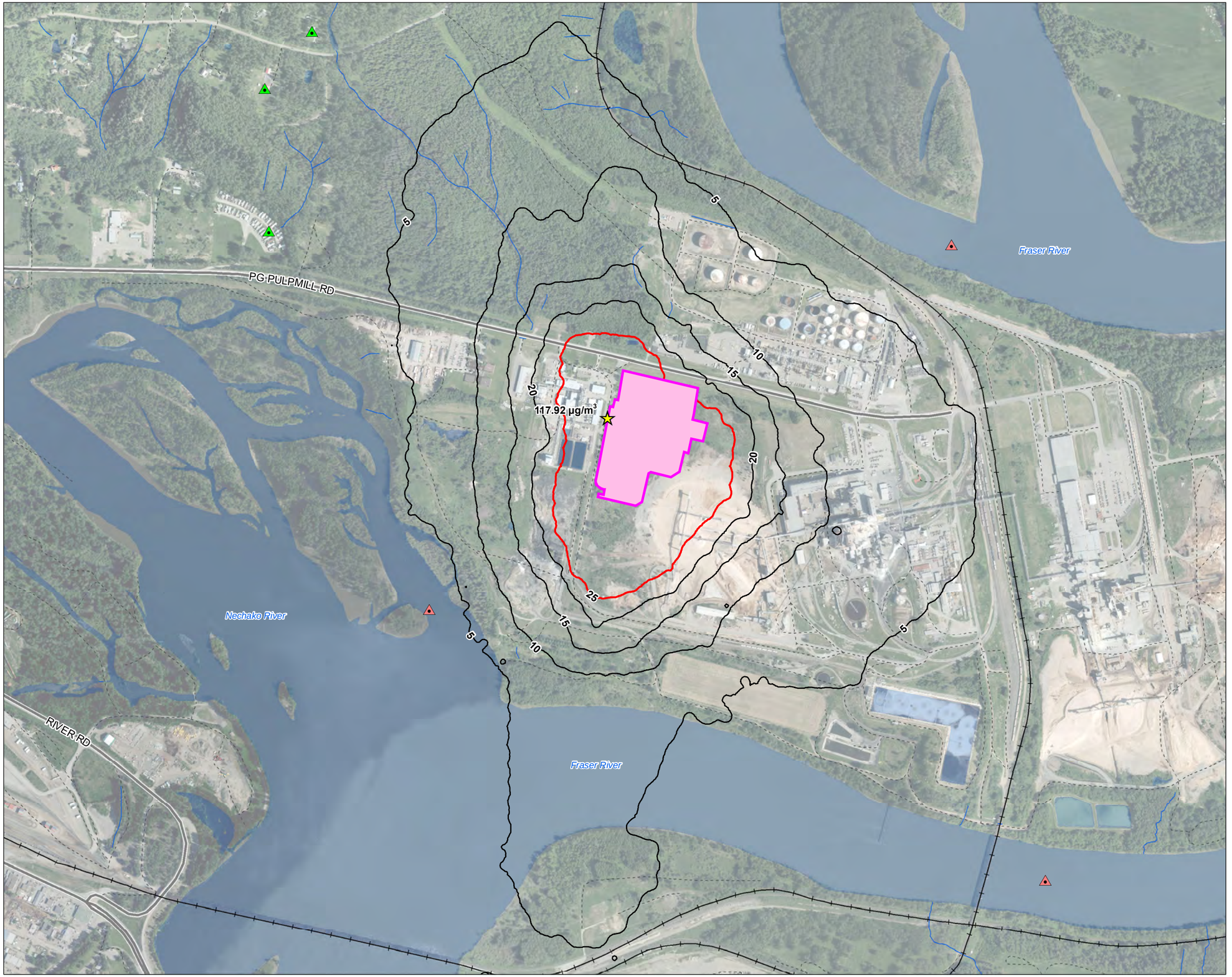
Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

98th Percentile 24-Hour PM2.5 Concentrations without Background Contribution, 2013 - Normal Operations



Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use Area
- Nearest Residence

98th Percentile 24-Hour PM2.5 Concentrations without Background Contribution, 2013 - Normal Operations

- Ambient Air Quality Objective (25 µg/m³)
- Isopleth (µg/m³)

Notes

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- Aerial Image: ESRI World Imagery

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Metres

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105520-02	Production Date: Mar 13, 2023	Figure E-25

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Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

98th Percentile 24-Hour PM2.5 Concentrations without Background Contribution, 2014 - Normal Operations

PG PULPMILL RD
RIVER RD
Fraser River
Nechako River
119.44 µg/m³
25
20
15
10
5

Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use Area
- Nearest Residence

98th Percentile 24-Hour PM2.5 Concentrations without Background Contribution, 2014 - Normal Operations

- Ambient Air Quality Objective (25 µg/m³)
- Isopleth (µg/m³)

Notes

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Metres

NAD 1983 UTM Zone 10N

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105520-02	Production Date: Mar 13, 2023	Figure E-26

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Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

98th Percentile 24-Hour PM2.5 Concentrations without Background Contribution, 2015 - Normal Operations

PG PULPMILL RD
RIVER RD
Fraser River
Nechako River
126.73 µg/m³
5
10
15
20
25

Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use Area
- Nearest Residence

98th Percentile 24-Hour PM2.5 Concentrations without Background Contribution, 2015 - Normal Operations

- Ambient Air Quality Objective (25 µg/m³)
- Isopleth (µg/m³)

Notes

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Metres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

105520-02	Production Date: Mar 13, 2023	Figure E-27

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Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Annual PM2.5 Concentrations without Background Contribution, 2013 - Normal Operations

PG PULPMILL RD
RIVER RD
Fraser River
Nechako River
35.52 µg/m³
2
4
6
8

Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use Area
- Nearest Residence

Annual PM2.5 Concentrations without Background Contribution, 2013 - Normal Operations

- Ambient Air Quality Objective (8 µg/m³)
- Isopleth (µg/m³)

Notes

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Metres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

105520-02	Production Date: Mar 13, 2023	Figure E-28

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Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Annual PM2.5 Concentrations without Background Contribution, 2014 - Normal Operations

PG PULPMILL RD
RIVER RD
Fraser River
Nechako River
33.95 µg/m³
8
6
4
2

Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use Area
- Nearest Residence

Annual PM2.5 Concentrations without Background Contribution, 2014 - Normal Operations

- Ambient Air Quality Objective (8 µg/m³)
- Isopleth (µg/m³)

Notes

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Metres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

105520-02	Production Date: Mar 13, 2023	Figure E-29

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Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Annual PM2.5 Concentrations without Background Contribution, 2015 - Normal Operations

PG PULPMILL RD
RIVER RD
Fraser River
Nechako River
38.19 µg/m³
12
9
8
6
4
4
2

Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use Area
- Nearest Residence

Annual PM2.5 Concentrations without Background Contribution, 2015 - Normal Operations

- Ambient Air Quality Objective (8 µg/m³)
- Isopleth (µg/m³)

Notes

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Metres

NAD 1983 UTM Zone 10N

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105520-02	Production Date: Mar 13, 2023	Figure E-30

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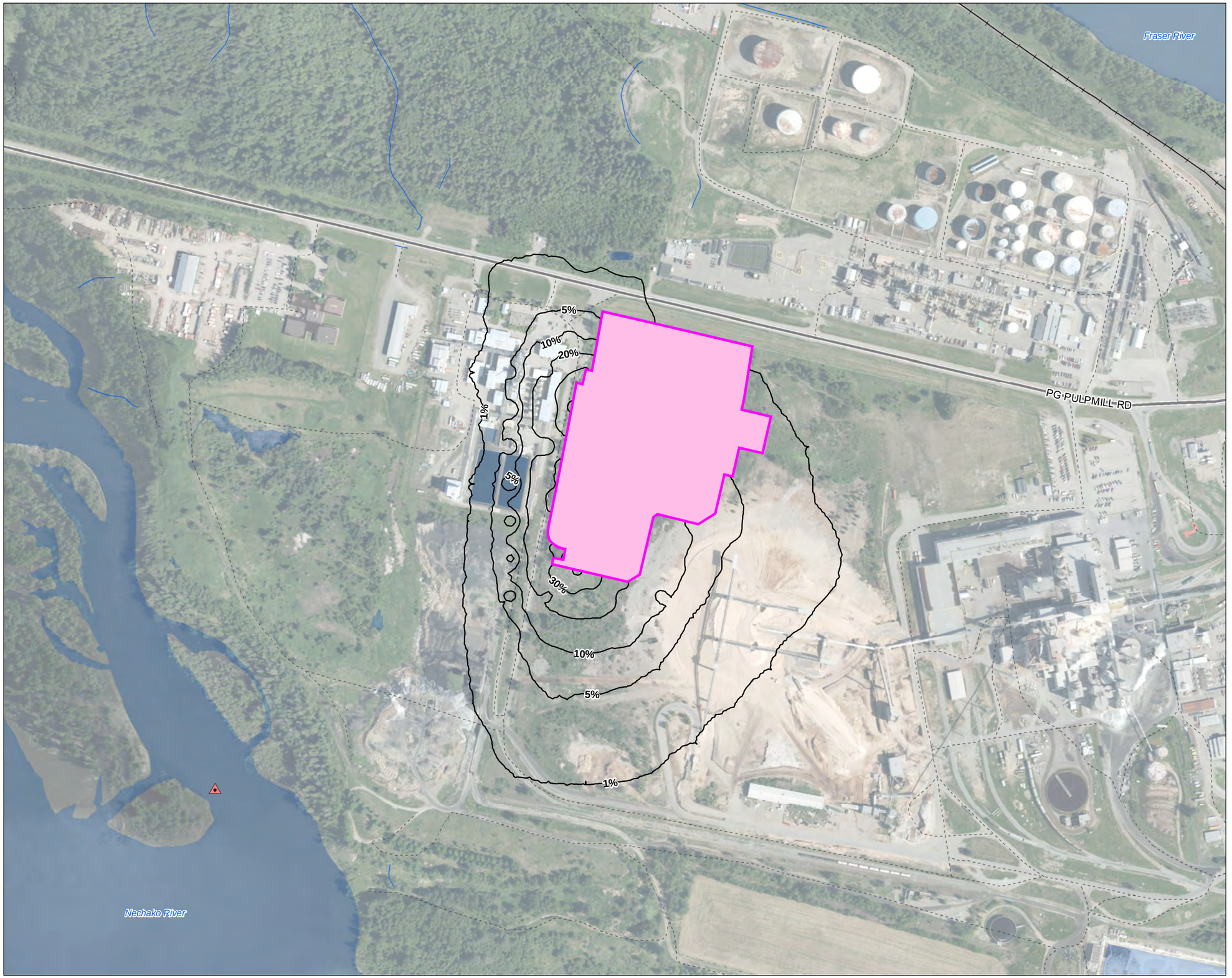
Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Frequency of 24-Hour TSP Concentrations With Background Greater Than Ambient Air Quality Objective - Normal Operations



Legend

- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use

Frequency of 24-Hour TSP Concentrations With Background Greater Than Ambient Air Quality Objective - Normal Operations

- Isopleth (%)

Notes

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Metres

NAD 1983 UTM Zone 10N

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105520-02	Production Date: Mar 13, 2023	Figure E-31

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Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Frequency of 24-Hour PM10 Concentrations With Background Greater Than Ambient Air Quality Objective - Normal Operations

Legend

- Facility Development Area
- Railway
- Major Road
- Waterbody

Sensitive Receptors

- Air Quality Monitoring Station
- Hosptial
- L'heidli T'enneh Traditional Use
- Nearest Residence
- School
- Senior Care Facility

Frequency of 24-Hour PM10 Concentrations With Background Greater Than Ambient Air Quality Objective - Normal Operations

- Isopleth (%)

Notes

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Sources

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- Aerial Image: ESRI World Imagery

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Kilometres

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105520-02	Production Date: Mar 13, 2023	Figure E-32

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Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Frequency of 24-Hour PM2.5 Concentrations With Background Greater Than Ambient Air Quality Objective - Normal Operations

PG PULPMILL RD
RIVER RD
Fraser River
Nechako River
5 %
10 %
20 %
30 %
40 %
60 %
70 %
50 %

Legend

- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use Area
- Nearest Residence

Frequency of 24-Hour PM2.5 Concentrations With Background Greater Than Ambient Air Quality Objective - Normal Operations

- Isopleth (%)

Notes

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- Aerial Image: ESRI World Imagery

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Metres

NAD 1983 UTM Zone 10N

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105520-02	Production Date: Mar 14, 2023	Figure E-33

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ARBIOS BIOTECH

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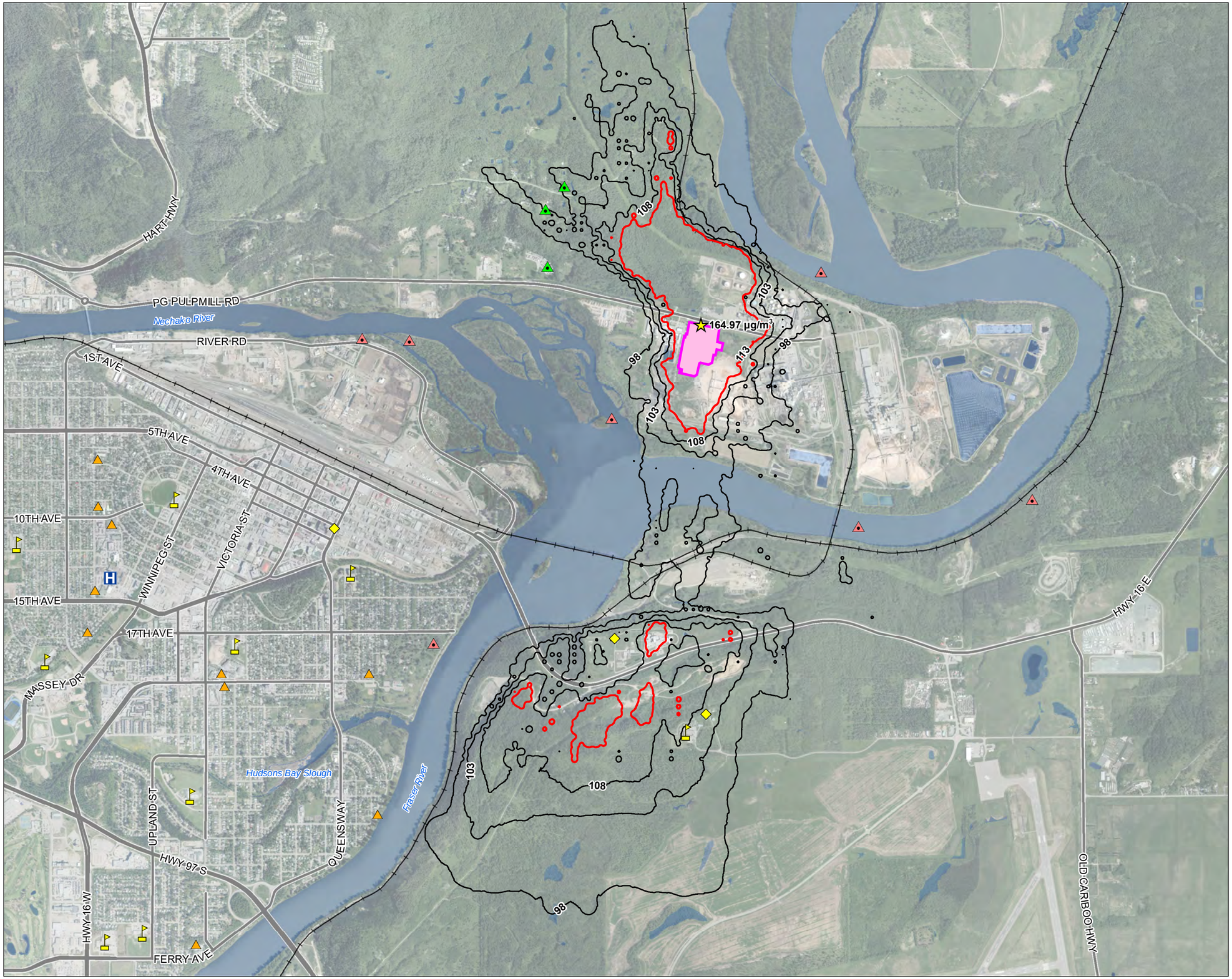
Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

98th Percentile Daily 1-Hour Maximum NO2 Concentrations Including Background Contribution, 2013 - Normal Operations



Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Waterbody

Sensitive Receptors

- Air Quality Monitoring Station
- Hosptial
- L'heidli T'enneh Traditional Use Area
- Nearest Residence
- School
- Senior Care Facility

98th Percentile Daily 1-Hour Maximum NO2 Concentrations Including Background Contribution, 2013 - Normal Operations

- Ambient Air Quality Objective (113 µg/m³)
- Isopleth (µg/m³)

Includes variable background concentration

Notes

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Metres

NAD 1983 UTM Zone 10N

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105520-02	Production Date: Mar 13, 2023	Figure E-34

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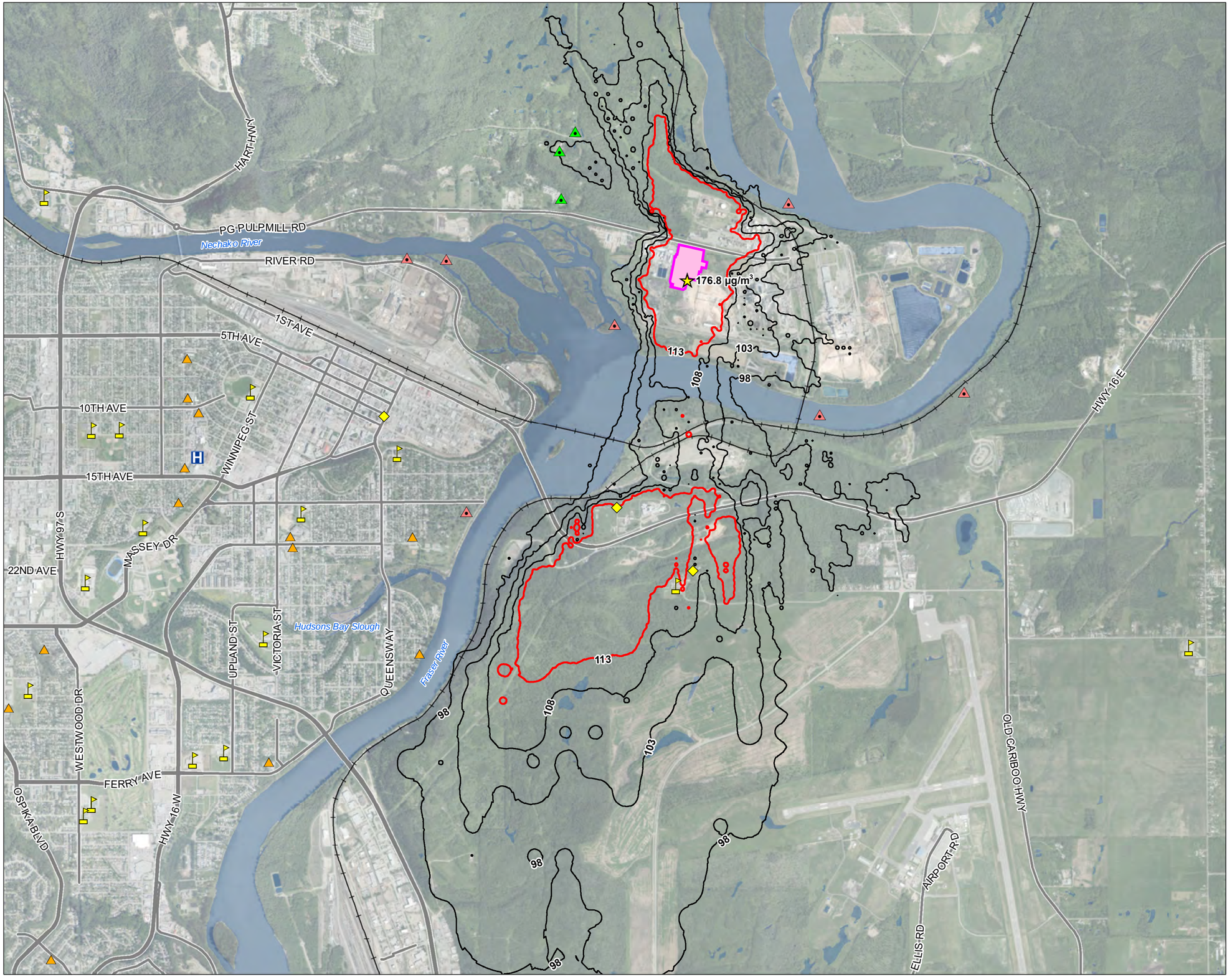
Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

98th Percentile Daily 1-Hour Maximum NO2 Concentrations Including Background Contribution, 2014 - Normal Operations



Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Waterbody

Sensitive Receptors

- Air Quality Monitoring Station
- Hosptial
- L'heidli T'enneh Traditional Use Area
- Nearest Residence
- School
- Senior Care Facility

98th Percentile Daily 1-Hour Maximum NO2 Concentrations Including Background Contribution, 2014 - Normal Operations

- Ambient Air Quality Objective (113 µg/m³)
- Isopleth (µg/m³)

Includes variable background concentration

Notes

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Metres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

105520-02	Production Date: Mar 13, 2023	Figure E-35

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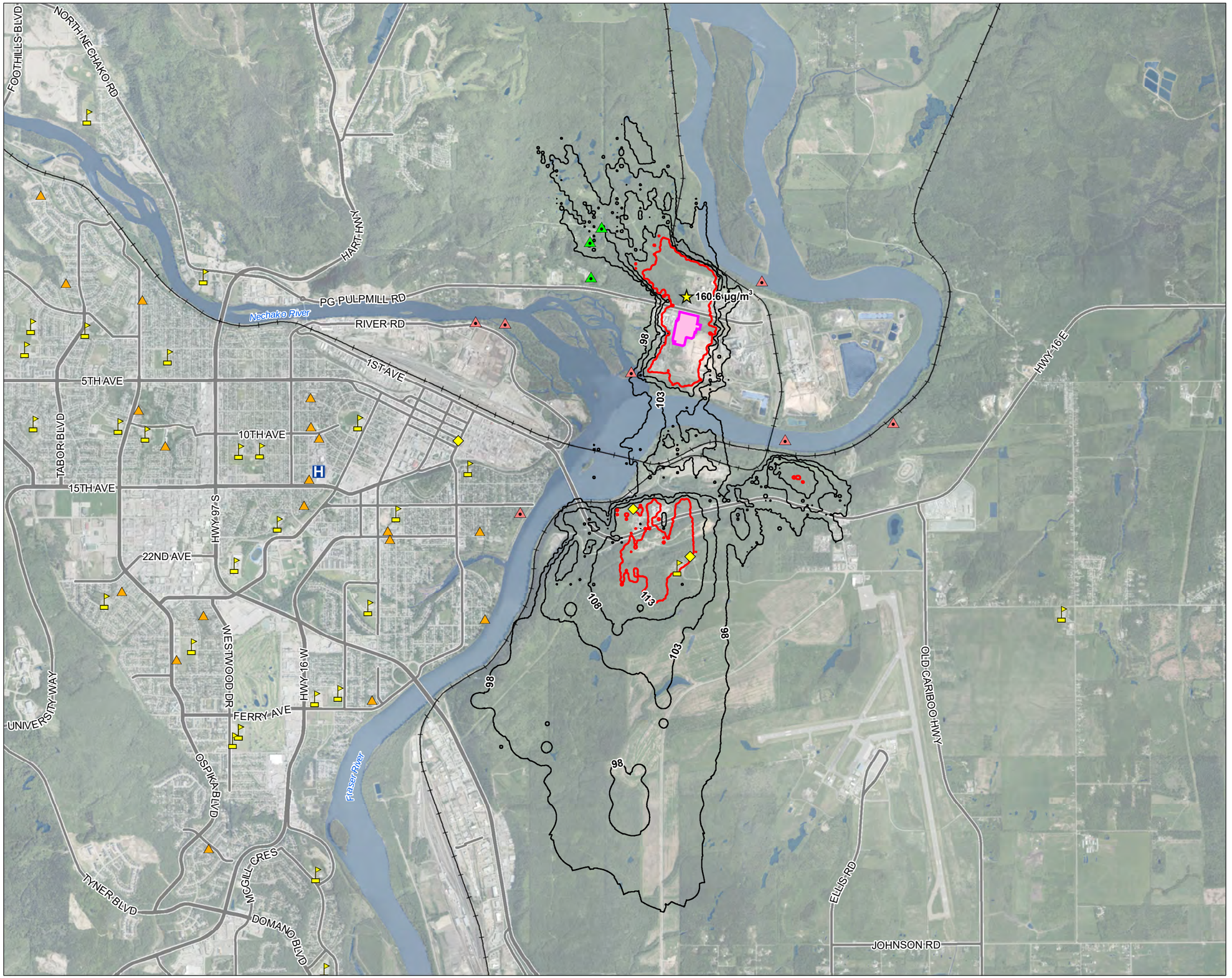
Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

98th Percentile Daily 1-Hour Maximum NO2 Concentrations Including Background Contribution, 2015 - Normal Operations



Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Waterbody

Sensitive Receptors

- Air Quality Monitoring Station
- Hosptial
- L'heidli T'enneh Traditional Use Area
- Nearest Residence
- School
- Senior Care Facility

98th Percentile Daily 1-Hour Maximum NO2 Concentrations Including Background Contribution, 2014 - Normal Operations

- Ambient Air Quality Objective (113 µg/m^3)
- Isopleth (µg/m^3)

Includes variable background concentration

Notes

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- Aerial Image: ESRI World Imagery

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Metres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

105520-02	Production Date: Mar 13, 2023	Figure E-36

Ausenco

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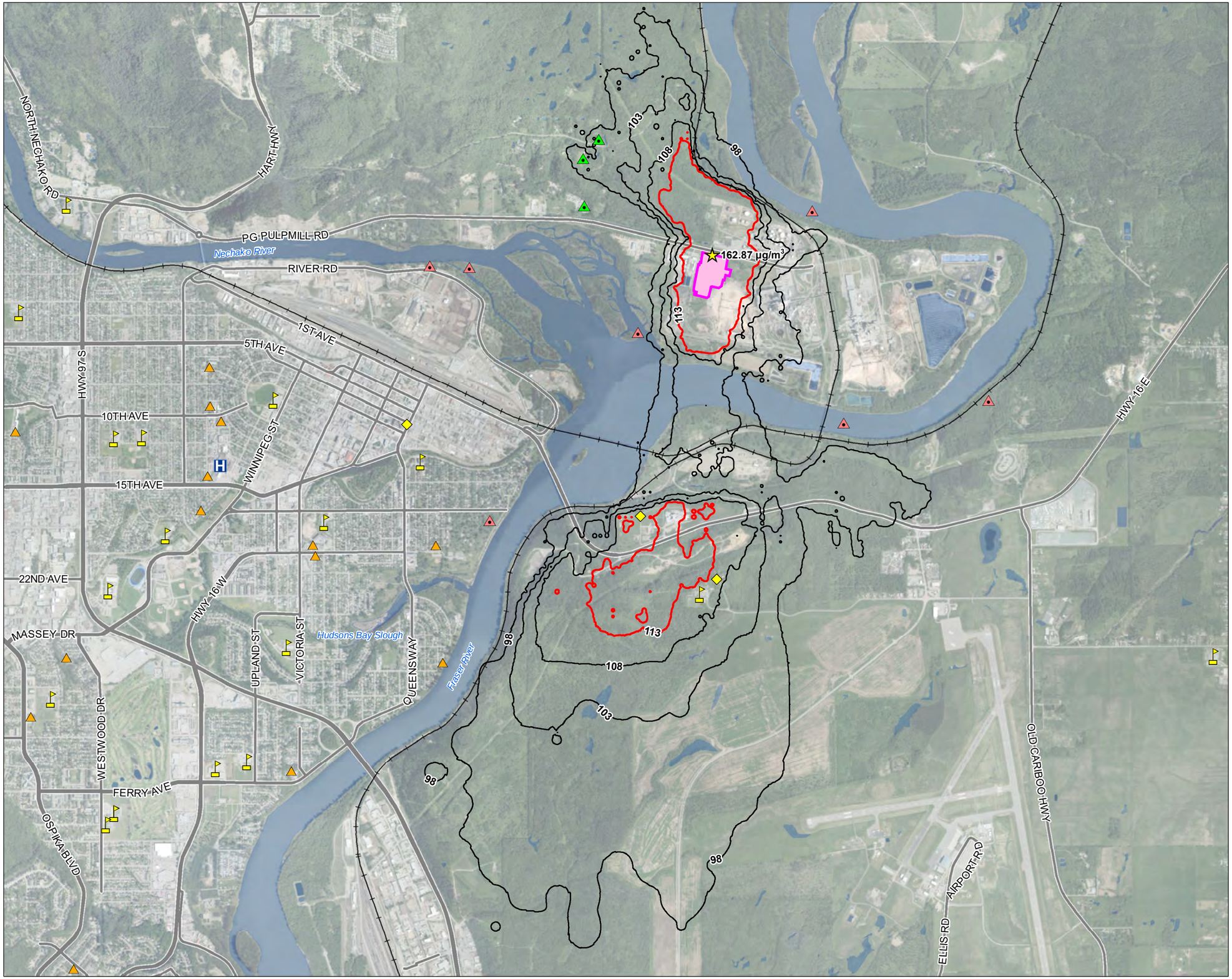
Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

98th Percentile Daily 1-Hour Maximum NO2 Concentrations Including Background Contribution, 2013 to 2015 - Normal Operations



Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Waterbody

Sensitive Receptors

- Air Quality Monitoring Station
- Hosptial
- L'heidli T'enneh Traditional Use Area
- Nearest Residence
- School
- Senior Care Facility

98th Percentile Daily 1-Hour Maximum NO2 Concentrations Including Background Contribution, 2013 to 2015 - Normal Operations

- Ambient Air Quality Objective (113 µg/m³)
- Isopleth (µg/m³)

Includes variable background concentration

Notes

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Metres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

105520-02	Production Date: Mar 13, 2023	Figure E-37

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ARBIOS BIOTECH

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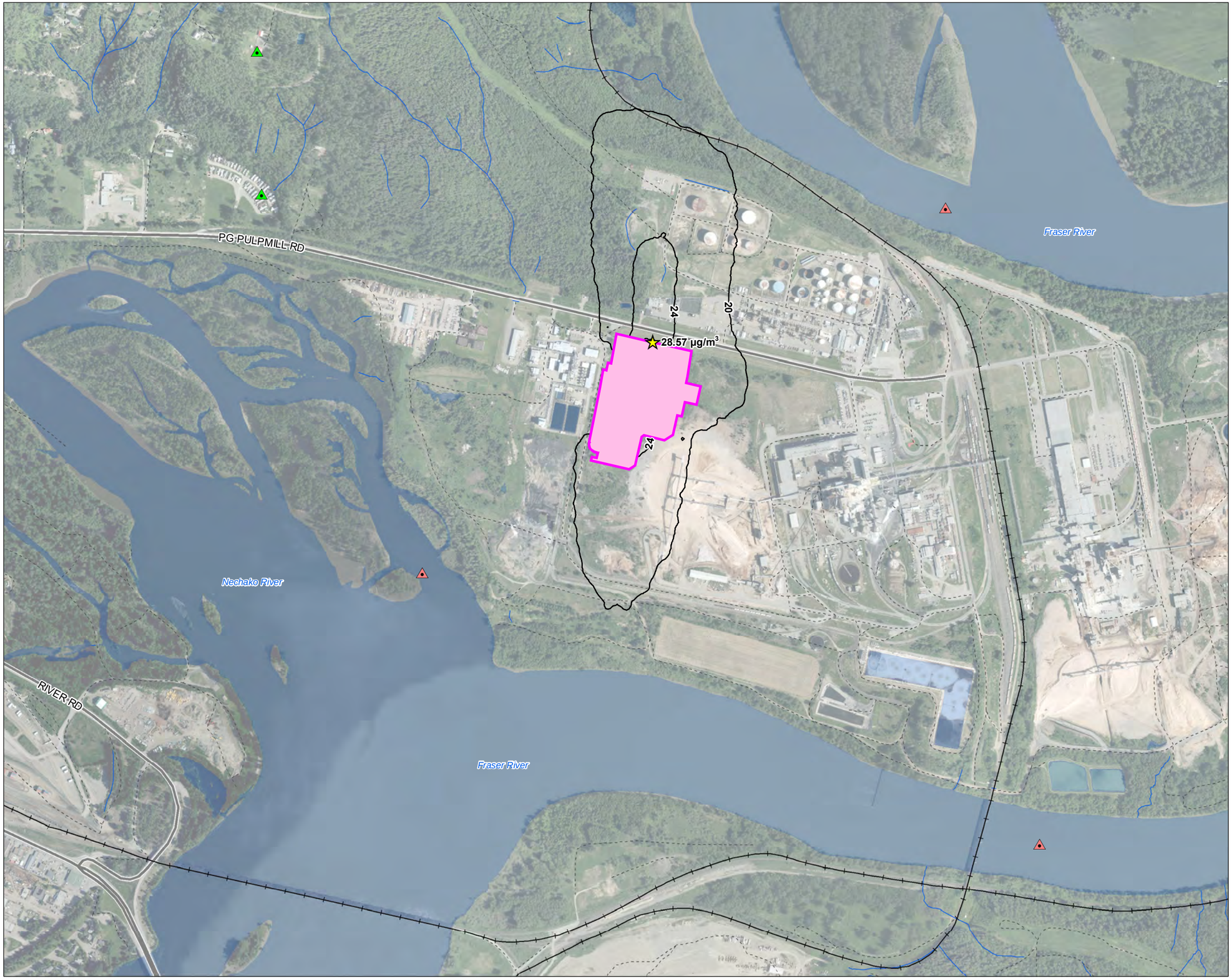
Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Annual NO2 Concentrations Including Background Contribution, 2013 - Normal Operations



Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use
- Nearest Residence

Annual NO2 Concentrations Including Background Contribution, 2013 - Normal Operations

- Isopleth (µg/m^3)

Includes background concentration of 17.9 µg/m^3

Notes

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2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

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- Aerial Image: ESRI World Imagery

N

1:10,000

0 100 200 300 400 500
Metres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

105520-02	Production Date: Mar 13, 2023	Figure E-38

Ausenco

ARBIOS BIOTECH

Path: S:\Geomatics\Projects\105520\2mxd\aq_report\Fig63b__105520_02_AQ_Annual_NO2_2013_230313.mxd

Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Annual NO2 Concentrations Including Background Contribution, 2014 - Normal Operations

PG PULPMILL RD
RIVER RD
Fraser River
Nechako River
Fraser River
26.50 µg/m³
24
20
24
20

Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use Area
- Nearest Residence

Annual NO2 Concentrations Including Background Contribution, 2014 - Normal Operations

- Isopleth (µg/m³)

Includes background concentration of 17.9 µg/m³

Notes

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- Aerial Image: ESRI World Imagery

N

1:10,000

0 100 200 300 400 500
Metres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

105520-02	Production Date: Mar 13, 2023	Figure E-39

Ausenco

ARBIOS BIOTECH

Path: S:\Geomatics\Projects\105520\02\mxd\aq_report\Fig\39__105520_02_AQ_Annual_NO2_2014_230313.mxd

Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Annual NO2 Concentrations Including Background Contribution, 2015 - Normal Operations

PG PULPMILL RD
RIVER RD
Fraser River
Nechako River
20
24
20
27.25 µg/m³

Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use Area
- Nearest Residence

Annual NO2 Concentrations Including Background Contribution, 2015 - Normal Operations

- Isopleth (µg/m³)

Includes background concentration of 17.9 µg/m³

Notes

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Sources

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- Aerial Image: ESRI World Imagery

N

1:10,000

0 100 200 300 400 500
Metres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

105520-02	Production Date: Mar 13, 2023	Figure E-40

Ausenco

ARBIOS BIOTECH

Path: S:\Graphics\Projects\105520\2mxd\aq_report\Fig40_105520_02_AQ_Annual_NO2_2015_v3813.mxd

Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Frequency of Daily 1-Hour Maximum NO2 Concentrations With Background Greater than Ambient Air Quality Objective - Normal Operations

HART HWY
PG PULPMILL RD
Nechako River
RIVER RD
1ST AVE
5TH AVE
4TH AVE
WINNIPEG ST
VICTORIA ST
17TH AVE
UPLAND ST
HWY 97 S
QUEENSWAY
Fraser River
OLD CARIBOO HWY
1%
2%
3%
4%
5%
10%
15%
20%

Legend

- Facility Development Area
- Railway
- Major Road
- Waterbody

Sensitive Receptors

- Air Quality Monitoring Station
- L'heidli T'enneh Traditional Use Area
- Nearest Residence
- School
- Senior Care Facility

Frequency of Daily 1-Hour Maximum NO2 Concentrations With Background Greater than Ambient Air Quality Objective - Normal Operations

- Isopleth (%)

Notes

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Sources

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- Aerial Image: ESRI World Imagery

N

1:20,000

0 200 400 600 800 1,000

Metres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

105520-02	Production Date: Mar 14, 2023	Figure E-41

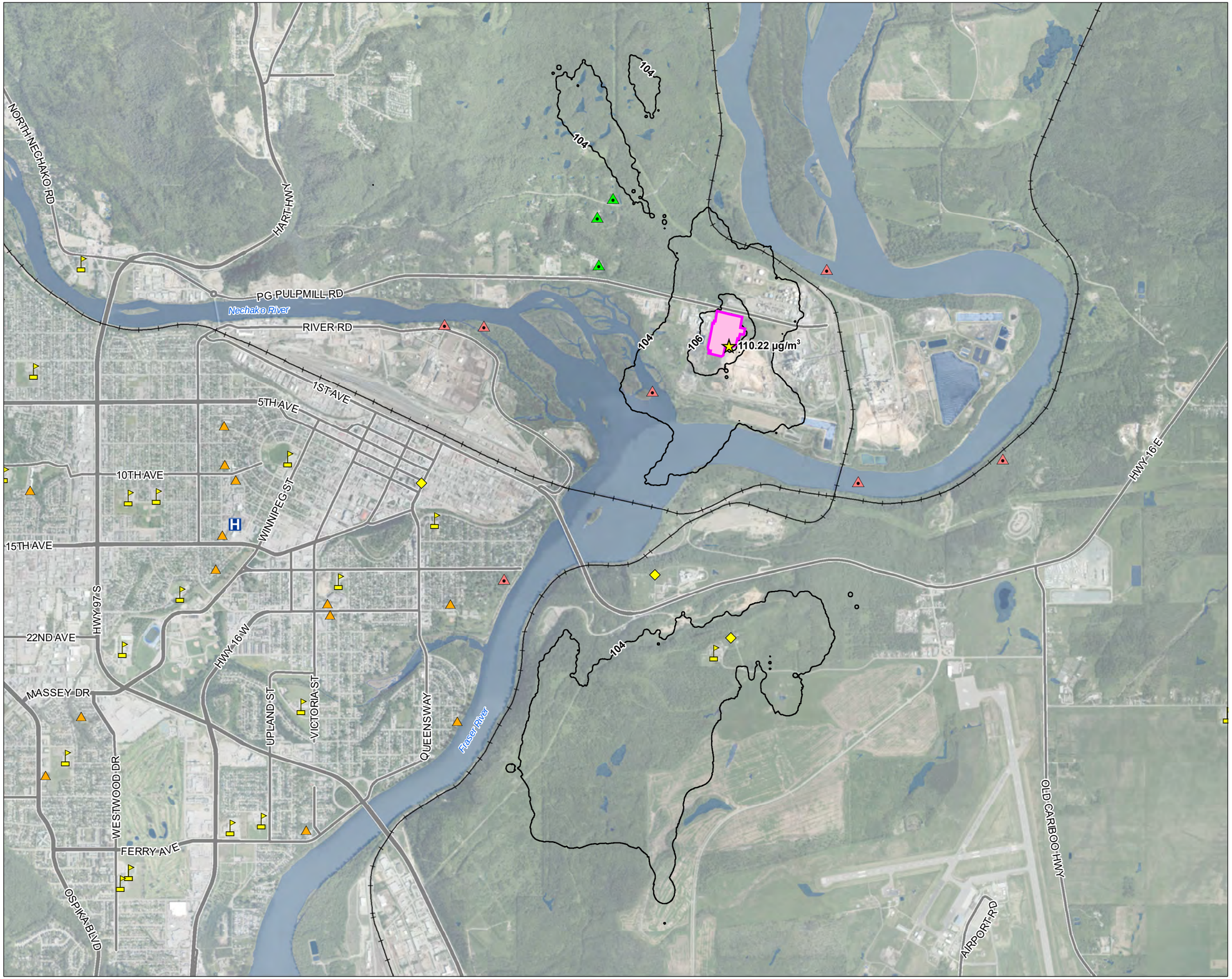
Ausenco

ARBIOS BIOTECH

Path: S:\Geomatics\Projects\105520\02\mxd\ae_report\Fig41_105520_02_AQ_Freq_NNO2_230314.mxd

Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

99th Percentile Daily 1-Hour Maximum SO2 Concentrations Including Background Contribution, 2013 - Normal Operations



Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Waterbody

Sensitive Receptors

- Air Quality Monitoring Station
- Hosptial
- L'heidli T'enneh Traditional Use Area
- Nearest Residence
- School
- Senior Care Facility

99th Percentile Daily 1-Hour Maximum SO2 Concentrations Including Background Contribution, 2013 - Normal Operations

- Isopleth (µg/m^3)

Includes background concentration of 102.8 µg/m^3

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
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Sources

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- Aerial Image: ESRI World Imagery

N

1:30,000

0 250 500 750 1,000 1,250

Metres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

105520-02	Production Date: Mar 13, 2023	Figure E-42

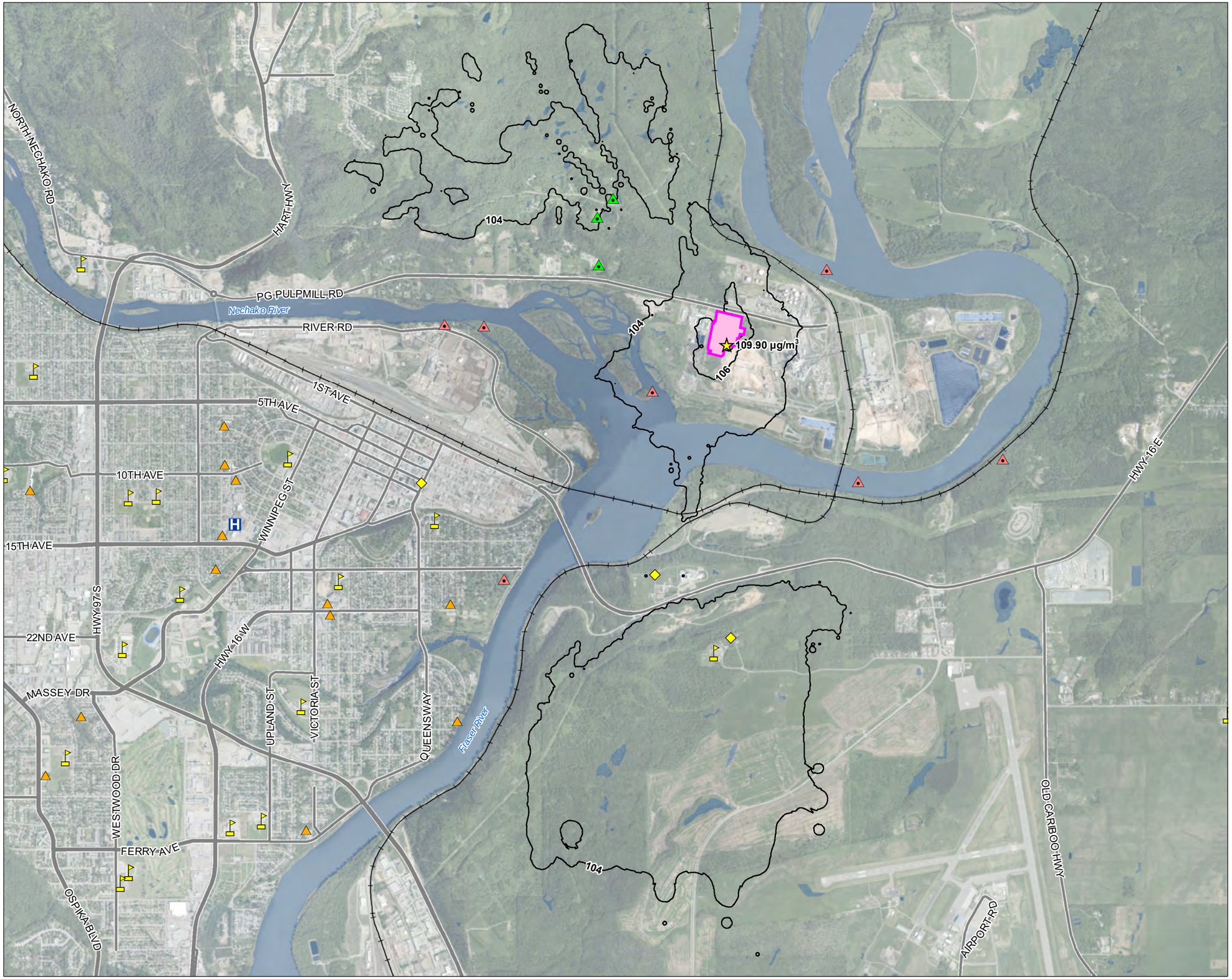
Ausenco

ARBIOS BIOTECH

Path: S:\Geomatics\Projects\105520\2023\mxd\aq_report\Fig42_105520_02_AQ_99th_1NSO2_2013_230313.mxd

Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

99th Percentile Daily 1-Hour Maximum SO2 Concentrations Including Background Contribution, 2014 - Normal Operations



Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Waterbody

Sensitive Receptors

- Air Quality Monitoring Station
- Hosptial
- L'heidli T'enneh Traditional Use Area
- Nearest Residence
- School
- Senior Care Facility

99th Percentile Daily 1-Hour Maximum SO2 Concentrations Including Background Contribution, 2014 - Normal Operations

- Isopleth (µg/m^3)

Includes background concentration of 102.8 µg/m^3

Notes

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- Aerial Image: ESRI World Imagery

N

1:30,000

0 250 500 750 1,000 1,250

Metres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

105520-02	Production Date: Mar 13, 2023	Figure E-43

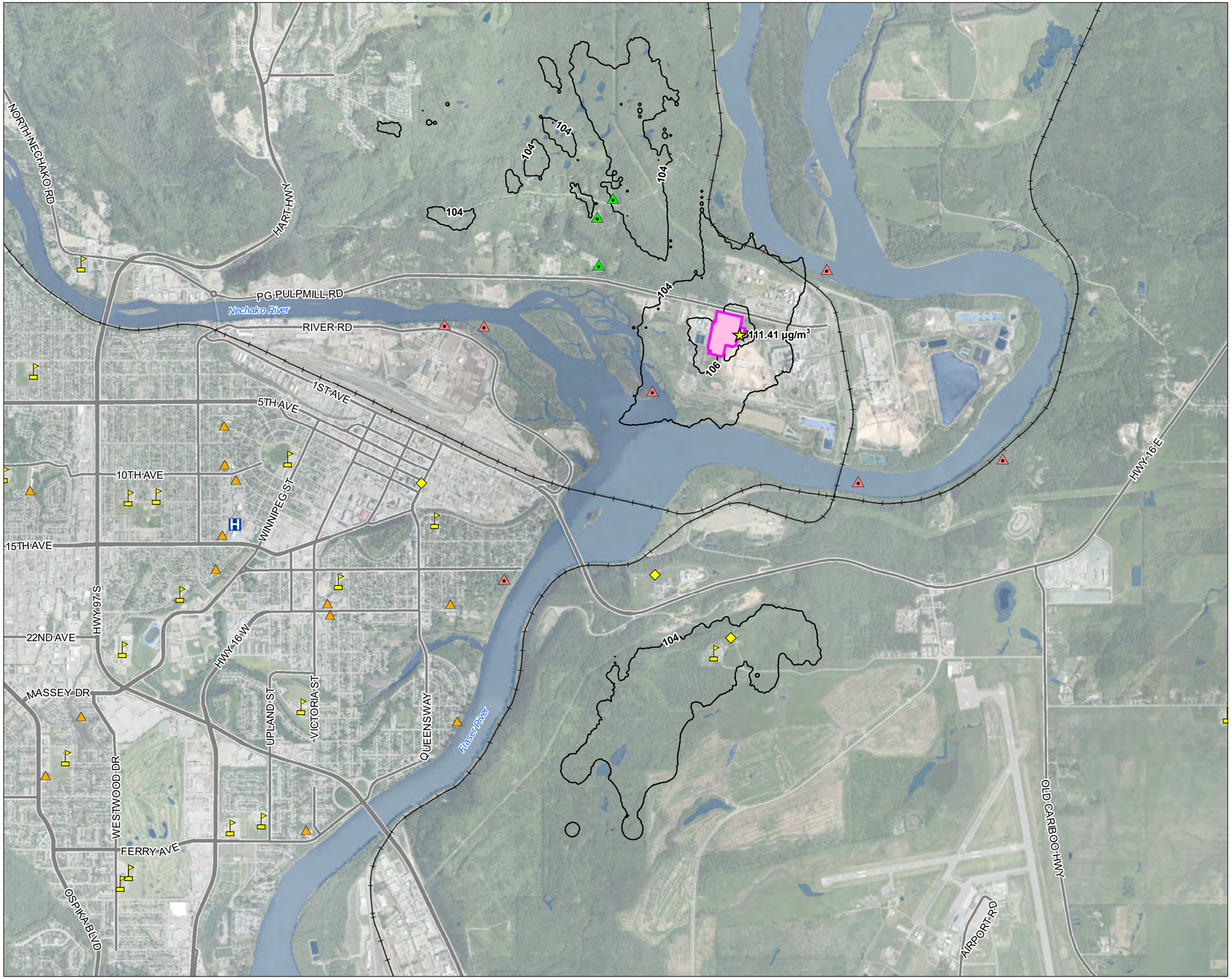
Ausenco

ARBIOS BIOTECH

Path: S:\Geomatics\Projects\105520\02\mxd\aq_report\Fig43_105520_02_AQ_99th_1hSO2_2014_230313.mxd

Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

99th Percentile Daily 1-Hour Maximum SO2 Concentrations Including Background Contribution, 2015 - Normal Operations



Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Waterbody

Sensitive Receptors

- Air Quality Monitoring Station
- Hosptial
- L'heidli T'enneh Traditional Use Area
- Nearest Residence
- School
- Senior Care Facility

99th Percentile Daily 1-Hour Maximum SO2 Concentrations Including Background Contribution, 2015 - Normal Operations

- Isopleth (µg/m^3)

Includes background concentration of 102.8 µg/m^3

Notes

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- Aerial Image: ESRI World Imagery

N

1:30,000

0 250 500 750 1,000 1,250

Metres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

105520-02	Production Date: Mar 13, 2023	Figure E-44

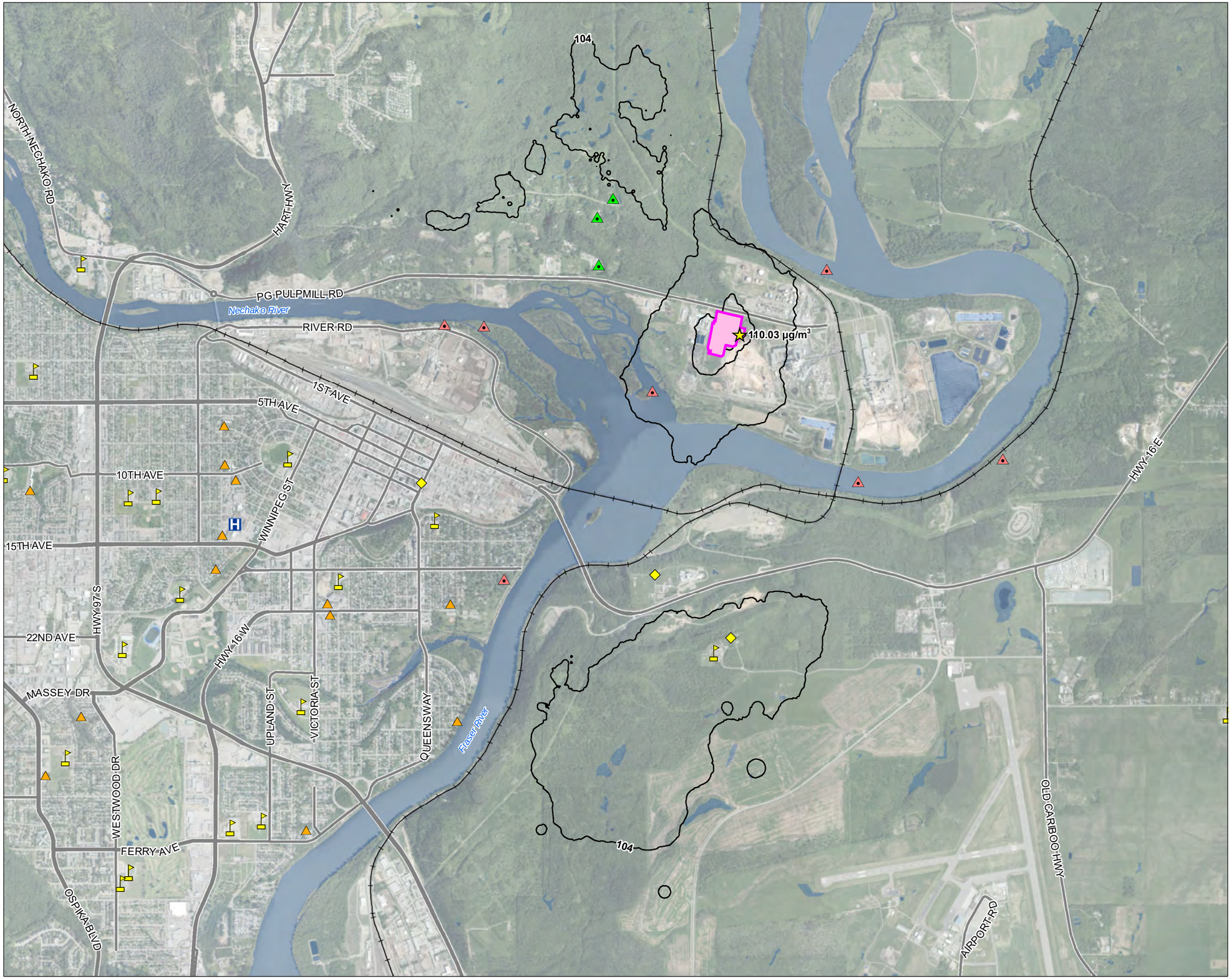
Ausenco

ARBIOS BIOTECH

Path: S:\Geomatics\Projects\105520\02\mxd\aq_report\Fig44__105520_02_AQ_99th_1hSO2_2015_230313.mxd

Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

99th Percentile Daily 1-Hour Maximum SO2 Concentrations Including Background Contribution, 2013 to 2015 - Normal Operations



Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Waterbody

Sensitive Receptors

- Air Quality Monitoring Station
- Hosptial
- L'heidli T'enneh Traditional Use Area
- Nearest Residence
- School
- Senior Care Facility

99th Percentile Daily 1-Hour Maximum SO2 Concentrations Including Background Contribution, 2014 - Normal Operations

- Isopleth (µg/m³)

Includes background concentration of 102.8 µg/m³

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
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- Aerial Image: ESRI World Imagery

N

1:30,000

0 250 500 750 1,000 1,250

Metres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

105520-02	Production Date: Mar 13, 2023	Figure E-45

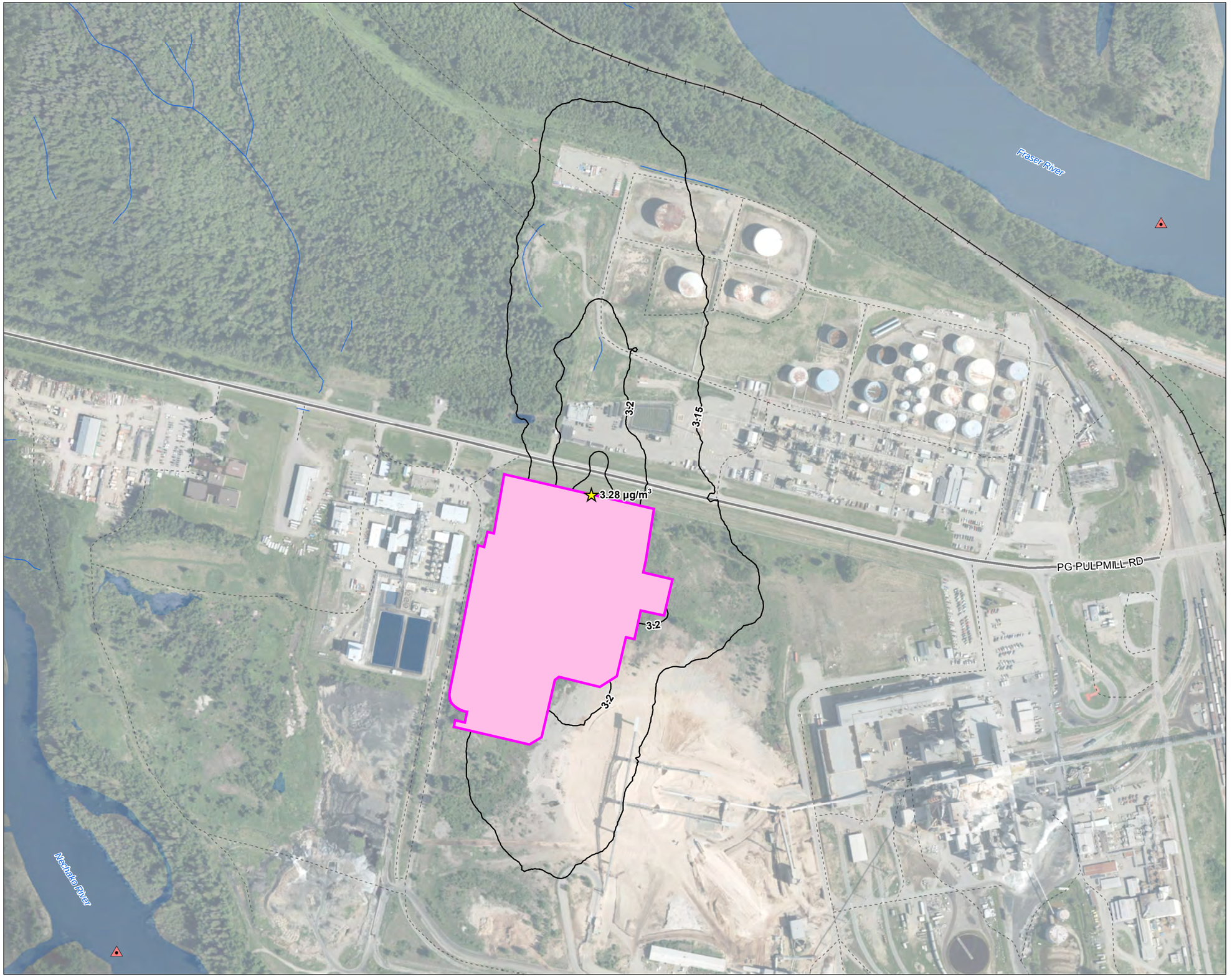
Ausenco

ARBIOS BIOTECH

Path: S:\Geomatics\Projects\105520\2mxd\aq_report\Fig45_105520_02_AQ_99th_1hSO2_Cumulative_230313.mxd

Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Annual SO2 Concentrations Including Background Contribution, 2013 - Normal Operations



Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use Area

Annual SO2 Concentrations Including Background Contribution, 2013 - Normal Operations

- Isopleth (µg/m^3)

Includes background concentration of 3.1 µg/m^3

Notes

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- Aerial Image: ESRI World Imagery

N

1:5,000

0 50 100 150 200 250

Metres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

105520-02	Production Date: Mar 13, 2023	Figure E-46

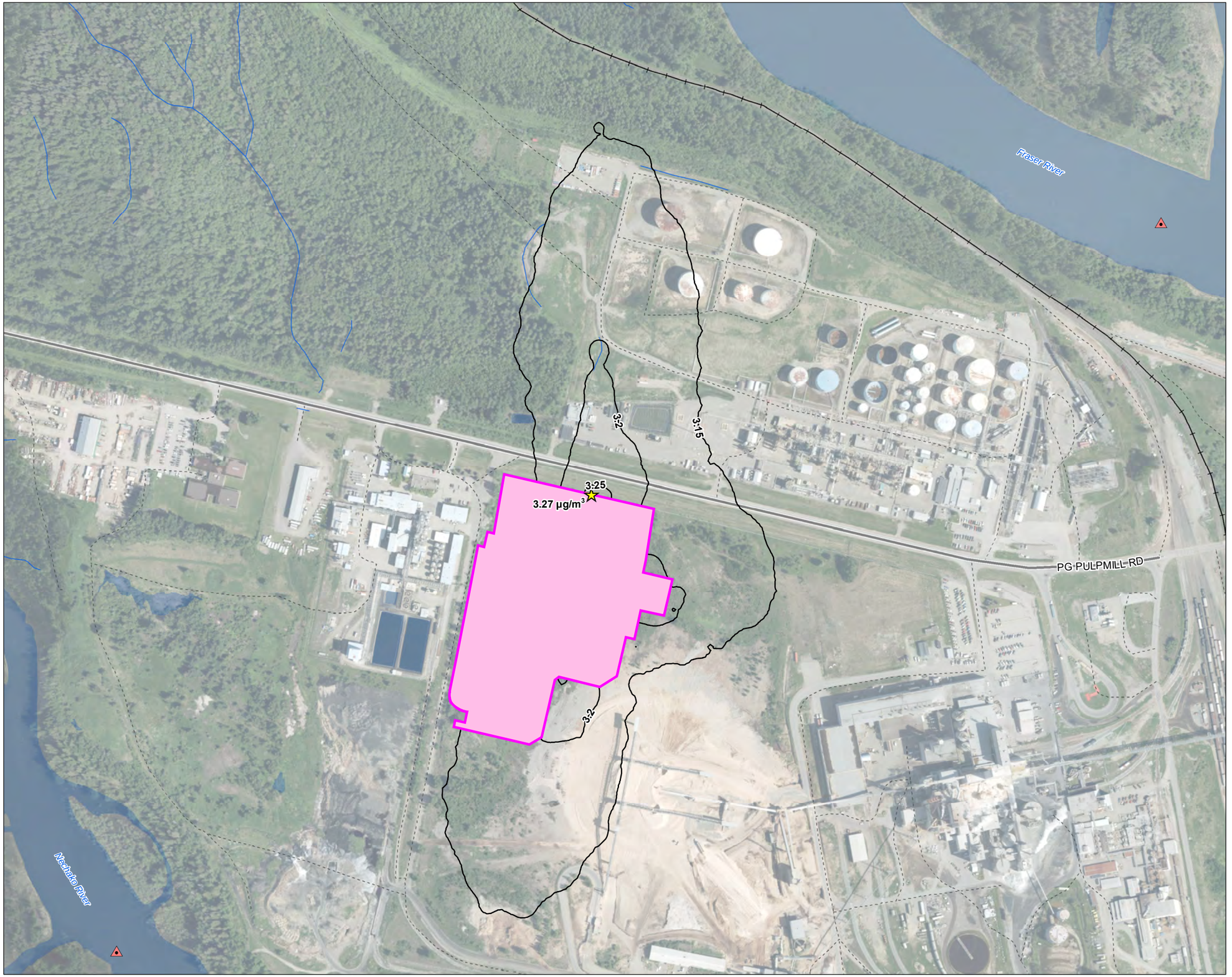
Ausenco

ARBIOS BIOTECH

Path: S:\Geomatics\Projects\105520\2mxd\ag_reports\Fig\E46_105520_02_AQ_Annual_SO2_2013_230313.mxd

Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Annual SO2 Concentrations Including Background Contribution, 2014 - Normal Operations



Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use Area

Annual SO2 Concentrations Including Background Contribution, 2013 - Normal Operations

- Isopleth (µg/m^3)

Includes background concentration of 3.1 µg/m^3

Notes

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N

1:5,000

0 50 100 150 200 250

Metres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

105520-02	Production Date: Mar 13, 2023	Figure E-47

Ausenco

ARBIOS BIOTECH

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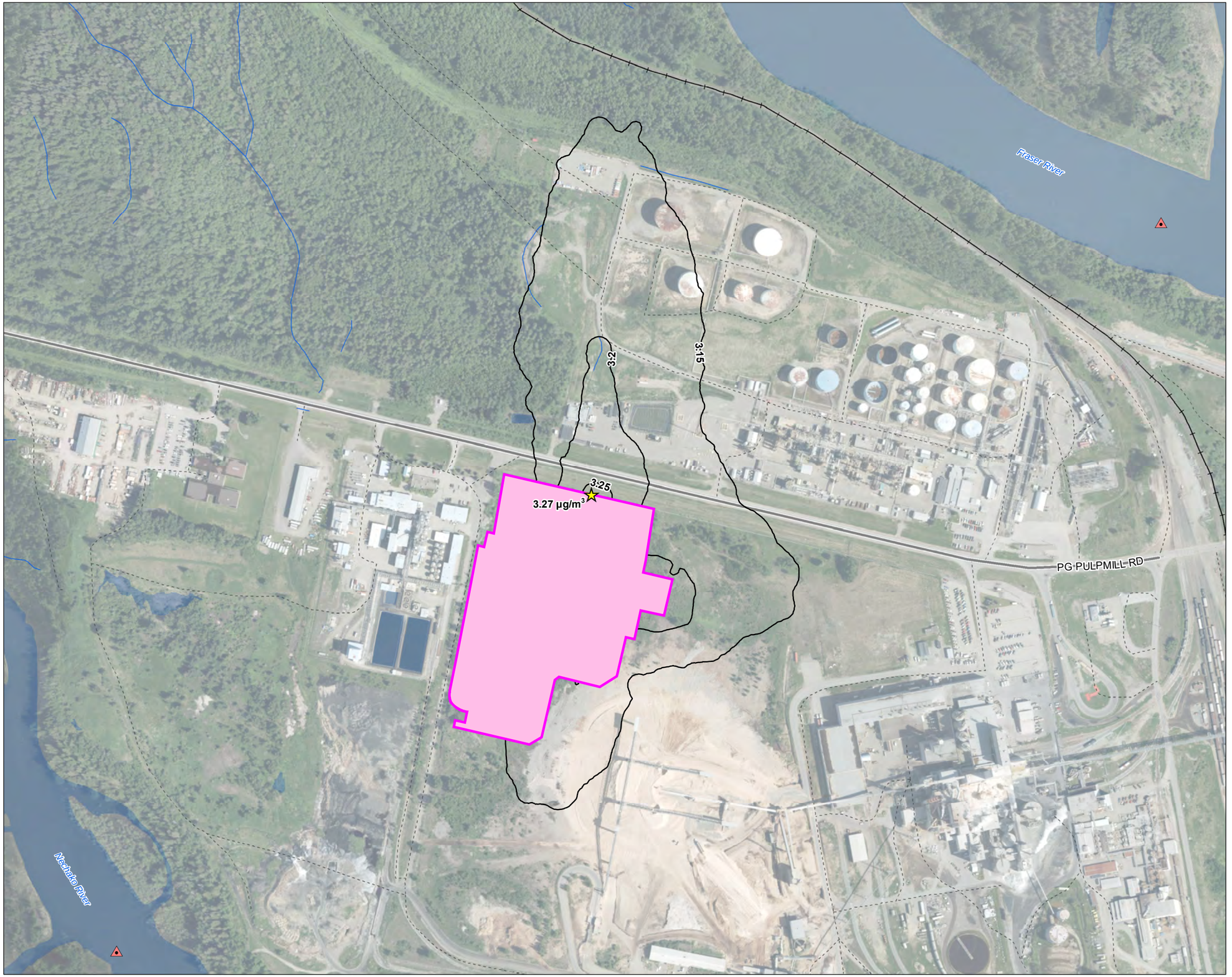
Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Annual SO2 Concentrations Including Background Contribution, 2015 - Normal Operations



Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use Area

Annual SO2 Concentrations Including Background Contribution, 2015 - Normal Operations

- Isopleth (µg/m^3)

Includes background concentration of 3.1 µg/m^3

Notes

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- Aerial Image: ESRI World Imagery

N

1:5,000

0 50 100 150 200 250

Metres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

105520-02	Production Date: Mar 13, 2023	Figure E-48

Ausenco

ARBIOS BIOTECH

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Appendix F

Isopleth Maps – Emergency Release

Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Maximum 1-Hour NO2 Concentrations Including Background Contribution, 2013 - Emergency Release

CHIEF LAKE RD
NESS LAKE RD
HART HWY
OLD SUMMIT LAKE RD
SHELLEY RD
UP PER FRASER RD
Fraser River
Nechako River
PRINCE GEORGE HWY 16 W
HWY 16 W
CARIBOO HWY
BLACKWATER RD
96
98.71 µg/m³

Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Waterbody

Sensitive Receptors

- Air Quality Monitoring Station
- Hosptial
- L'heidli T'enneh Traditional Use Area
- Nearest Residence
- School
- Senior Care Facility

Maximum 1-Hour NO2 Concentrations Including Background Contribution, 2013 - Emergency Release

- Isopleth (µg/m³)

Includes variable background concentration

Notes

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Sources

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- Aerial Image: ESRI World Imagery

N

1:150,000

0 2 4 6 8 10
Kilometres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

105520-02	Production Date: Mar 13, 2023	Figure F-1

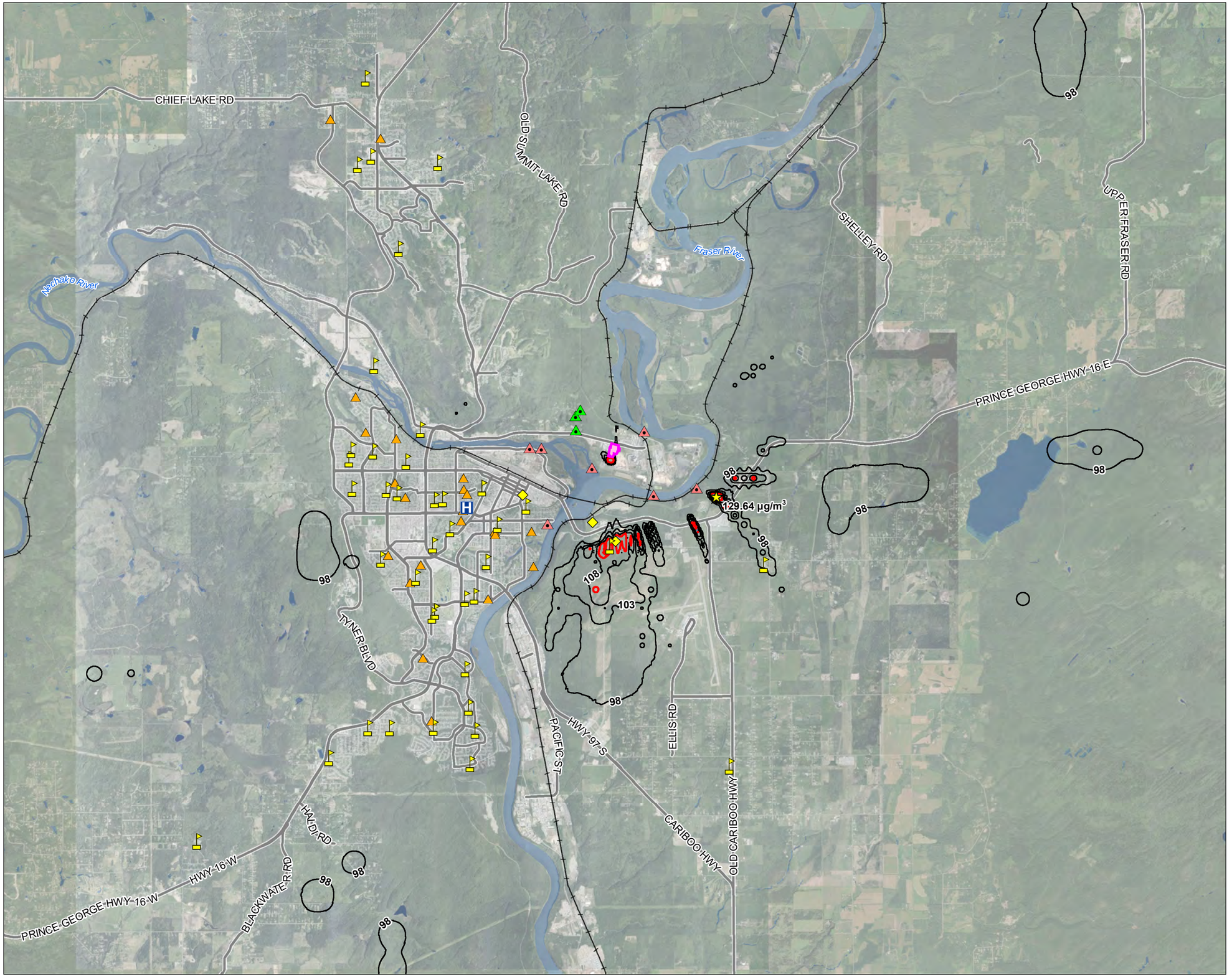
Ausenco

ARBIOS BIOTECH

Path: S:\Geomatics\Projects\105200\Zend\arc_reports\Fig\F1_105520_02_AQ_Max_tNNO2_2013_230313.mxd

Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Maximum 1-Hour NO2 Concentrations Including Background Contribution, 2014 - Emergency Release



Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Waterbody

Sensitive Receptors

- Air Quality Monitoring Station
- Hosptial
- L'heidli T'enneh Traditional Use Area
- Nearest Residence
- School
- Senior Care Facility

Maximum 1-Hour NO2 Concentrations Including Background Contribution, 2014 - Emergency Release

- Ambient Air Quality Objective (113 µg/m³)
- Isopleth (µg/m³)

Includes variable background concentration

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
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- Aerial Image: ESRI World Imagery

N

1:100,000

0 1 2 3 4 5
Kilometres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

105520-02	Production Date: Mar 13, 2023	Figure F-2

Ausenco

ARBIOS BIOTECH

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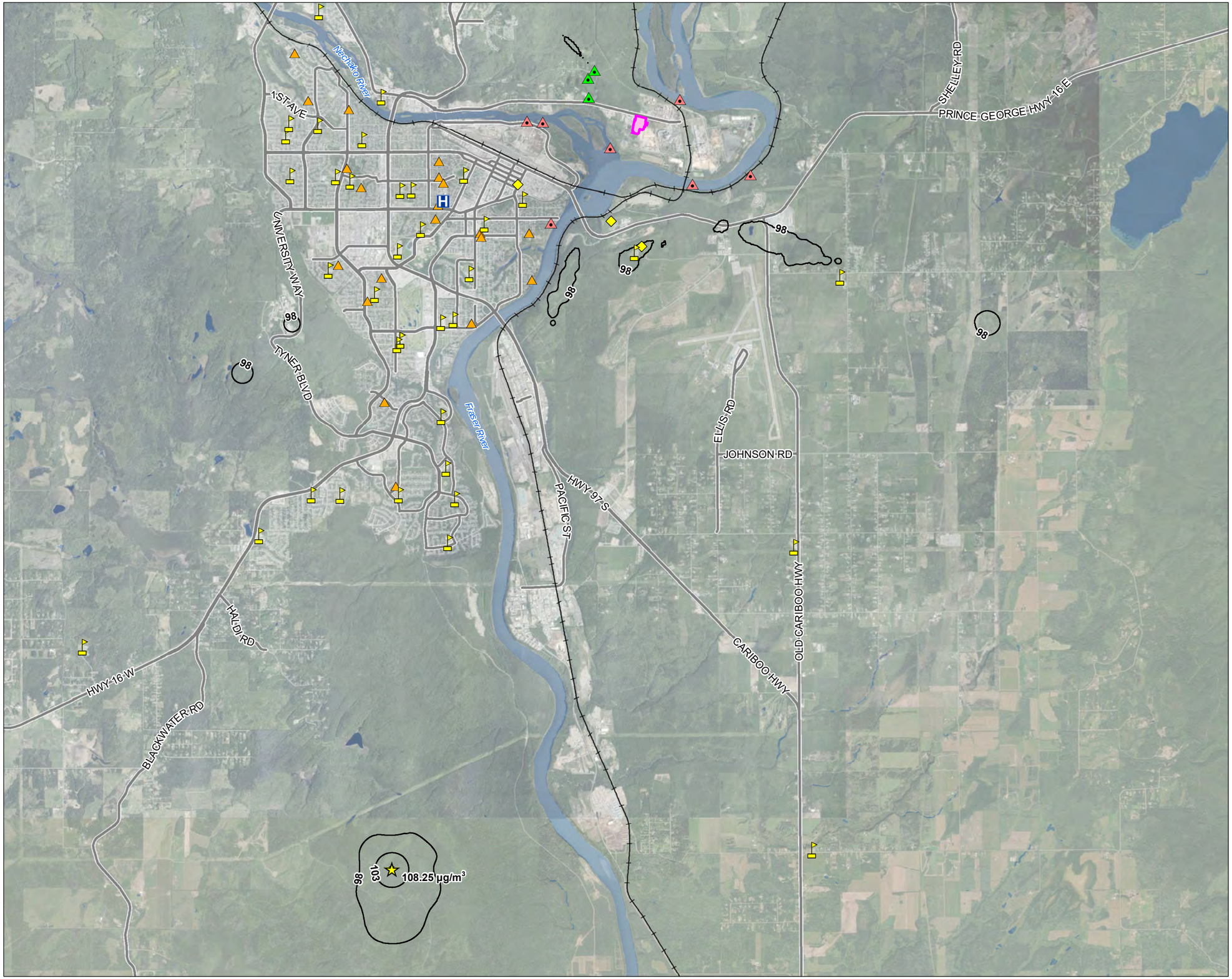
Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Maximum 1-Hour NO2 Concentrations Including Background Contribution, 2015 - Emergency Release



Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Waterbody

Sensitive Receptors

- Air Quality Monitoring Station
- Hosptial
- L'heidli T'enneh Traditional Use Area
- Nearest Residence
- School
- Senior Care Facility

Maximum 1-Hour NO2 Concentrations Including Background Contribution, 2015 - Emergency Release

- Isopleth (µg/m^3)

Includes variable background concentration

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

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- Aerial Image: ESRI World Imagery

N

1:75,000

0 1 2 3 4 5
Kilometres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

105520-02	Production Date: Mar 13, 2023	Figure F-3

Ausenco ARBIOS BIOTECH

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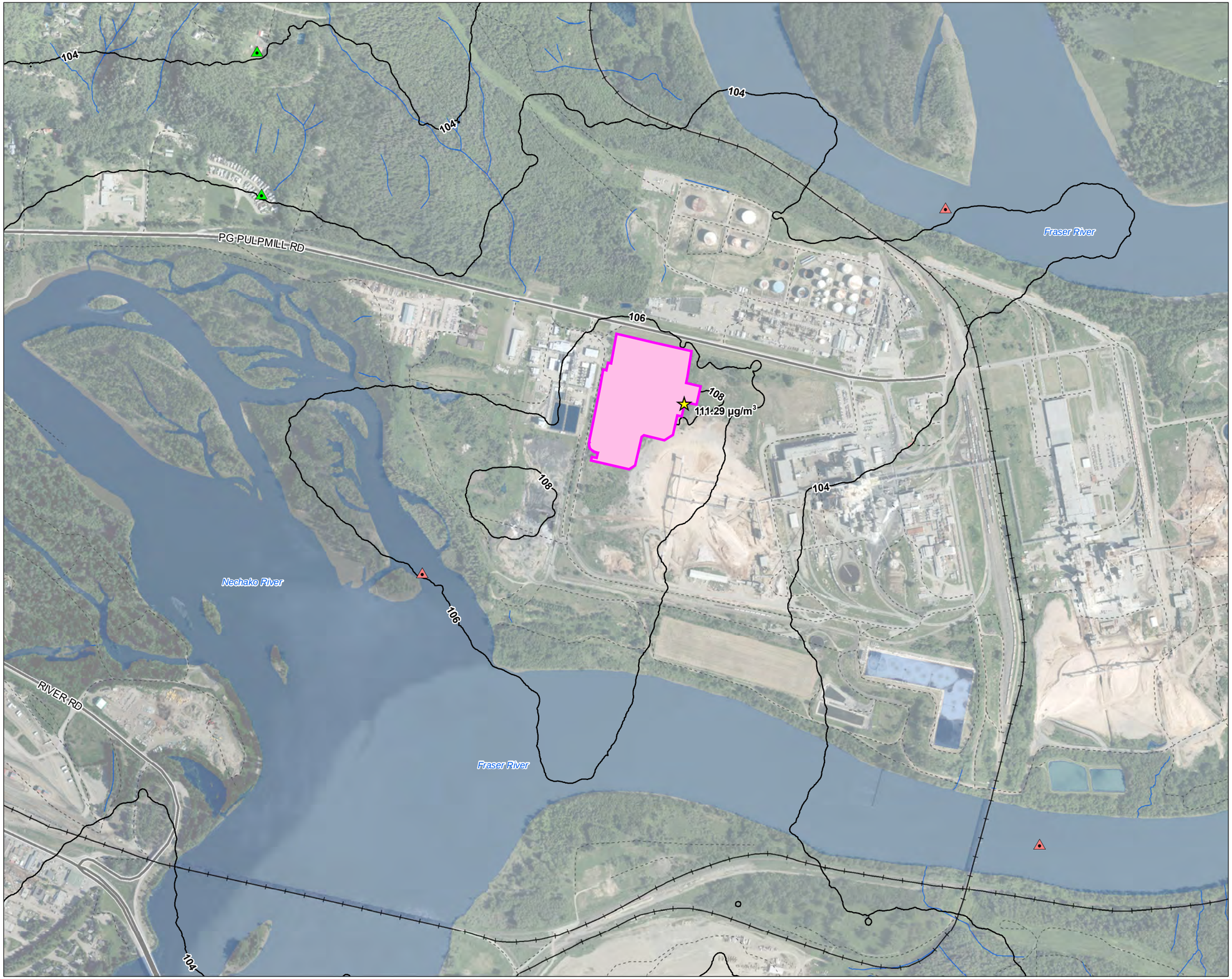
Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Maximum 1-Hour SO2 Concentrations Including Background Contribution, 2013 - Emergency Release



Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use Area
- Nearest Residence

Maximum 1-Hour SO2 Concentrations Including Background Contribution, 2013 - Emergency Release

- Isopleth (µg/m^3)

Includes background concentration of 102.8 µg/m^3

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

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- Aerial Image: ESRI World Imagery

N

1:10,000

0 100 200 300 400 500

Metres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

105520-02	Production Date: Mar 13, 2023	Figure F-4

Ausenco

ARBIOS BIOTECH

Path: S:\Geomatics\Projects\105520\02\mxd\aq_report\Fig#4__105520_02_AQ_Max_1hSO2_2013_230313.mxd

Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Maximum 1-Hour SO2 Concentrations Including Background Contribution, 2014 - Emergency Release

PG PULPMILL RD
RIVER RD
Fraser River
Nechako River
116.02 µg/m³

Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use Area
- Nearest Residence

Maximum 1-Hour SO2 Concentrations Including Background Contribution, 2014 - Emergency Release

- Isopleth (µg/m³)

Includes background concentration of 102.8 µg/m³

Notes

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- Aerial Image: ESRI World Imagery

N

1:10,000

0 100 200 300 400 500
Metres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

105520-02	Production Date: Mar 13, 2023	Figure F-5

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ARBIOS BIOTECH

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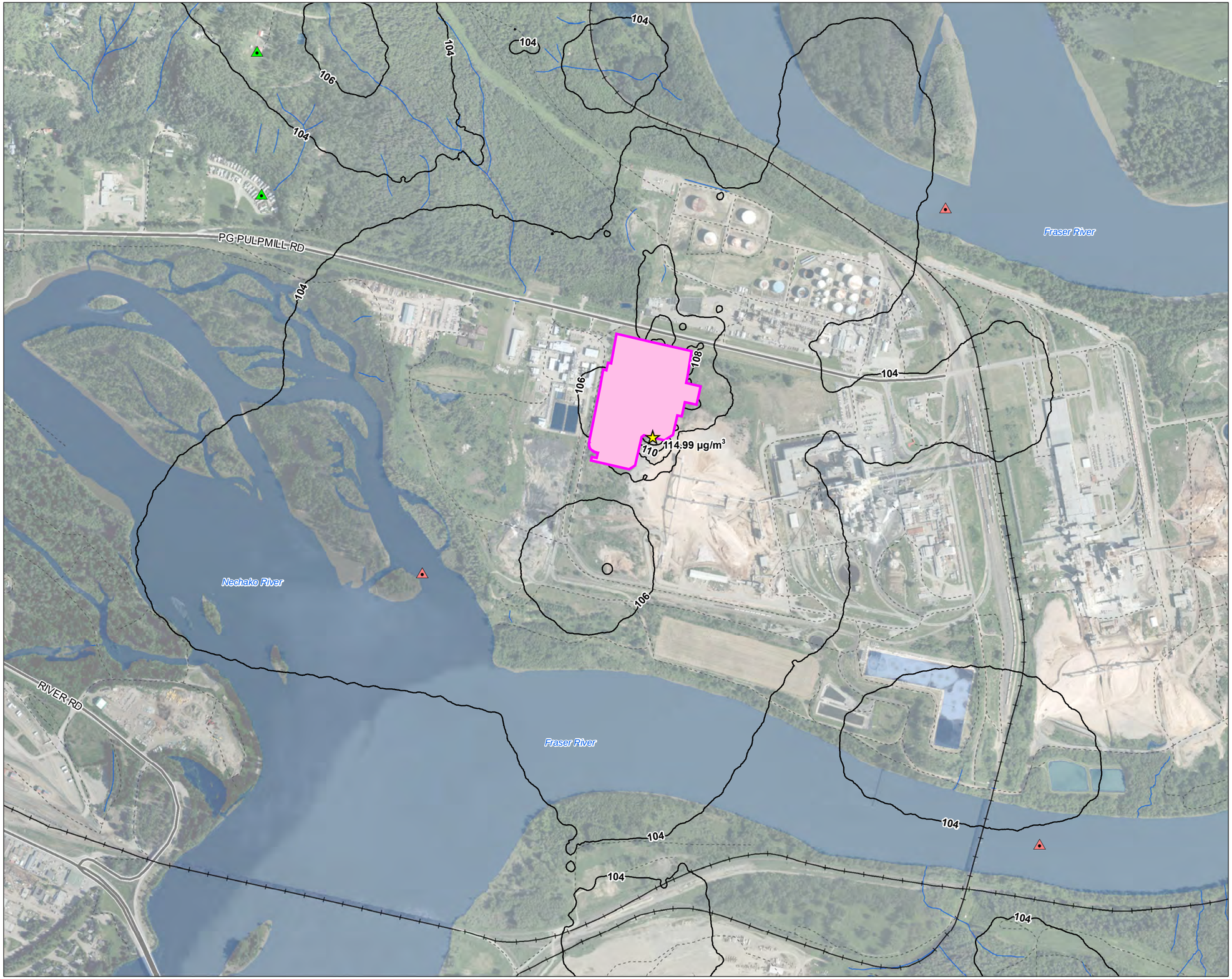
Air Quality Technical Report
Arbios Biomass to Low Carbon Fuel Project
PG Pulpmill Rd, Prince George, BC

Maximum 1-Hour SO2 Concentrations Including Background Contribution, 2015 - Emergency Release



Legend

- Location of Maximum Concentration
- Facility Development Area
- Railway
- Major Road
- Resource Road or Trail
- Watercourse
- Waterbody

Sensitive Receptors

- L'heidli T'enneh Traditional Use Area
- Nearest Residence

Maximum 1-Hour SO2 Concentrations Including Background Contribution, 2015 - Emergency Release

- Isopleth (µg/m³)

Includes background concentration of 102.8 µg/m³

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Contains information licensed under the Open Government Licence(s) - British Columbia; Statistics Canada
- Aerial Image: ESRI World Imagery

N

1:10,000

0 100 200 300 400 500

Metres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

105520-02	Production Date: Mar 13, 2023	Figure F-6

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Appendix G

Qualified Professional Forms

BRITISH COLUMBIA | Ministry of Environment and Climate Change Strategy

Declaration of Competency

The Ministry of Environment and Climate Change Strategy relies on the work, advice, recommendations and in some cases decision making of qualified professionals[1], under government's professional reliance regime. With this comes an assumption that professionals who undertake work in relation to ministry legislation, regulations and codes of practice have the knowledge, experience and objectivity necessary to fulfill this role.

1. Name of Qualified Professional: Nancy Chan

   Title: Atmospheric Specialist

2. Are you a registered member of a professional association in B.C.? ☒ Yes ☐ No

   Name of Association: Engineers and Geoscientists BC Registration # 138676

3. Brief description of professional services:

   Preparation of the Air Quality Technical Report for the Arbios Biotech Canada LP Chuntoh Ghuna Facility

This declaration of competency is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Declaration

I am a qualified professional with the knowledge, skills and experience to provide expert information, advice and/or recommendations in relation to the specific work described above.

Signature: ORIGINAL SIGNED

X _____

Print Name: Nancy Chan

Witnessed by: ORIGINAL SIGNED

X _____

Print Name: Sarah Bowie

Date signed: March 24, 2023

[1] *Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and

b) *through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.*

Ministry of Environment and Climate Change Strategy

Conflict of Interest Disclosure Statement

A qualified professional [1] providing services to either the Ministry of Environment and Climate Change Strategy ("ministry"), or to a regulated person for the purpose of obtaining an authorization from the ministry, or pursuant to a requirement imposed under the *Environmental Management Act,* the *Integrated Pest Management Act* or the *Park Act* has a real or perceived conflict of interest when the qualified professional, or their relatives, close associates or personal friends have a financial or other interest in the outcome of the work being performed.

A real or perceived conflict of interest occurs when a qualified professional has

a) an ownership interest in the regulated person's business;

b) an opportunity to influence a decision that leads to financial benefits from the regulated person or their business other than a standard fee for service (e.g. bonuses, stock options, other profit sharing arrangements);

c) a personal or professional interest in a specific outcome;

d) the promise of a long term or ongoing business relationship with the regulated person, that is contingent upon a specific outcome of work;

e) a spouse or other family member who will benefit from a specific outcome; or

f) any other interest that could be perceived as a threat to the independence or objectivity of the qualified professional in performing a duty or function.

Qualified professionals who work under ministry legislation must take care in the conduct of their work that potential conflicts of interest within their control are avoided or mitigated. Precise rules in conflict of interest are not possible and professionals must rely on guidance of their professional associations, their common sense, conscience and sense of personal integrity.

Declaration

I Nancy Chan (Print First and Last Name), as a member of Engineers and Geoscientists BC (Print Name of Professional Association) declare

Select one of the following:

☒ Absence from conflict of interest

Other than the standard fee I will receive for my professional services, I have no financial or other interest in the outcome of this Chuntoh Ghuna Facility Waste Discharge Application (Insert Name of Work).
I further declare that should a conflict of interest arise in the future during the course of this work, I will fully disclose the circumstances in writing and without delay to Gail Roth (Insert Ministry Contact Name), erring on the side of caution.

☐ Real or perceived conflict of interest

Description and nature of conflict(s):

_____

_____

_____

I will maintain my objectivity, conducting my work in accordance with my Code of Ethics and standards of practice.

In addition, I will take the following steps to mitigate the real or perceived conflict(s) I have disclosed, to ensure the public interest remains paramount:

_____

_____

_____

Further, I acknowledge that this disclosure may be interpreted as a threat to my independence and will be considered by the statutory decision maker accordingly.

This conflict of interest disclosure statement is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Signature: ORIGINAL SIGNED

X _____

Print name: Nancy Chan

Date: March 24, 2023

Witnessed by: ORIGINAL SIGNED

X _____

Print name: Sarah Bowie

[1]*Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and

b) *through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.*

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