REPORT

SINCLAR GROUP FOREST PRODUCTS

AIR QUALITY ASSESSMENT

RWDI #2004605

September 8, 2021

SUBMITTED TO

Joshua Kelly, P.Eng., PMP
Energy Manager
Joshua.Kelly@sinclar.com

Sinclar Group Forest Products Ltd.
1515 Nicholson St.
Prince George, BC V2N 1V7
T: 250.561.4646

SUBMITTED BY

Jeff Lundgren, M.Sc.
Technical Director / Principal
Jeff.Lundgren@rwdi.com

Golnoosh Bizhani, Ph.D.
Senior Air Quality Scientist
Golnoosh.Bizhani@rwdi.com

Matthew Sawycky, B.Sc.
Senior Project Manager / Associate
Matthew.Sawycky@rwdi.com

RWDI AIR Inc.
Suite 280 – 1385 West 8th Avenue
Vancouver, BC V6H 3V9
T: 604.730.5688

EXECUTIVE SUMMARY

RWDI AIR Inc. (RWDI) was retained by Sinclar Group Forest Products Ltd. (Sinclar) to conduct an air quality assessment in support of a permit amendment for proposed air emission sources at Sinclar's facility, Premium Pellet Ltd., in Vanderhoof, BC (the Project). The additional sources include a new rotary pellet dryer multiclone, a chiller cyclone, a hammermill baghouse, and a biosizer/dryer line cyclone.

The primary concerns related to air quality impacts of the Project are emissions of particulate matter (PM) (i.e., airborne particles) less than 2.5 µm in diameter ($PM_{2.5}$), particulate matter less than 10 µm in diameter (PM_{10}), Nitrogen Dioxide (NO_2), and Volatile Organic Compounds (VOCs).

Existing ambient concentrations of PM_{10}, $PM_{2.5}$ and NO_2 at the District of Vanderhoof already exceed their respective B.C. Ambient Air Quality Objectives (BC AAQO) published by B.C. Ministry of Environment (ENV, 2020) and, the Canadian Ambient Air Quality Standard (CAAQS) established by Environment and Climate Change Canada (ECCC). This assessment provides the predicted increments to ambient concentrations of the contaminants of concern resulting from the Project and compares them with the relevant BC AAQO and CAAQS, and with the existing ambient concentrations in Vanderhoof. All proposed major point sources of PM, NO_2, and VOC associated with proposed additional operations onsite were included in the study. Furthermore, at the request of the ENV, this assessment studies the contribution of Sinclar's existing and proposed operations to the ambient levels of $PM_{2.5}$ and PM_{10} in more detail.

An Air Dispersion Modelling Plan was developed in consultation with ENV. The modelling approach of this assessment follows the methodology laid out in the modelling plan and is consistent with the BC Air Quality Modelling Guideline (AQDMG, ENV, 2015). The plan was approved by ENV on November 27, 2020, and later amended on May 18, 2021.

Dispersion modelling using the CALMET/CALPUFF (version 7) modelling system was conducted to predict ambient concentrations of $PM_{2.5}$, PM_{10} and NO_2 resulting from Project emissions. Modelled concentrations were compared to the respective BC AAQO and CAAQS criteria. Predicted VOC concentrations are were reported, but there are no federal or provincial objectives against which to compare them.

A total of six modeling scenarios were considered in this assessment. These scenarios were categorized into two study cases as follows:

Case 1: Assessment of proposed sources

This study case determines the <u>increase</u> in ambient air concentrations due to emissions from the proposed sources at the facility. The cumulative ambient concentrations, resulting from those emissions and, the existing air contaminant levels arising from existing sources at the facility and in the surrounding area, are also considered here. Case 1 scenarios include:

- **S1 without BAT**, where proposed sources are considered without the application of best achievable technology (BAT);
- **S1 with BAT**, where proposed sources are modelled with the application of BAT (via a wet electrostatic precipitator); and,
- **S2 without BAT**, where proposed sources are considered without the application of BAT, but with adjustment to design stack heights to improve dispersion conditions.

Case 2: Assessment of existing and proposed sources combined

This study case predicts the contribution of Sinclar's existing and proposed sources to the ambient concentrations of PM and determines the effect of applying BAT to the dryers at the facility. Cumulative effects are not considered here. Scenarios considered for Case 2 include:

- **Scenario 3a (S3a)**, where only current existing sources are modelled;
- **Scenario 3b (S3b)**, where existing sources and proposed sources are modelled without the application of BAT; and,
- **Scenario 3c (S3c)**, where existing source and proposed sources are modelled with the application of BAT (via a wet electrostatic precipitator).

For Case 1, the highest predicted concentrations from the proposed sources occur near the facility fence line. Predicted concentrations decrease rapidly with distance from the facility. For $PM_{2.5}$ and PM_{10}, predicted concentrations at the facility fence line are comparable to the existing background, but decrease rapidly with distance from the facility. At the Vanderhoof Courthouse downtown, predicted $PM_{2.5}$ and PM_{10} concentrations due to the Project are less than 5% of their respective existing ambient levels. NO_2 concentrations due to the project stay below their objectives.

For Case 2 scenarios, predicted $PM_{2.5}$ and PM_{10} concentrations close to the facility exceed their respective objectives, however in downtown Vanderhoof, concentrations are less than 10% of their respective existing ambient levels.

In both case studies, model results show that application of BAT results in lower predicted PM concentrations due to the facility. For Case 1, PM concentrations decrease between 20% – 80% and for Case 2 PM concentrations decrease between 5% – 30% with the application of BAT.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1 INTRODUCTION

RWDI AIR Inc. (RWDI) was retained by Sinclar Group Forest Products Ltd. (Sinclar) to conduct an air quality assessment in support of a permit amendment for proposed additional air emission sources at Sinclar's facility, Premium Pellet Ltd., in Vanderhoof, BC (the Project). The proposed sources include a new rotary pellet dryer multiclone, a chiller cyclone, a hammermill baghouse, and a biosizer/dryer line cyclone.

The primary concerns related to air quality impacts of the Project are emissions of particulate matter (PM) (i.e., airborne particles) less than 2.5 µm in diameter ($PM_{2.5}$), particulate matter less than 10 µm in diameter (PM_{10}), Nitrogen Dioxide (NO_2), and Volatile Organic Compounds (VOCs).

Existing ambient levels of $PM_{2.5}$, PM_{10} and NO_2 measured at the District of Vanderhoof monitoring station already exceed the B.C. Ambient Air Quality Objectives (BC AAQO) published by B.C. Ministry of Environment (ENV, 2020) and the Canadian Ambient Air Quality Standard (CAAQS) established by Environment and Climate Change Canada (ECCC). This assessment provides the predicted increment to ambient concentrations resulting from the Project and compares them with the BC AAQO and CAAQS, and with the existing ambient concentrations in Vanderhoof. All proposed major point sources of PM, NO_2, and VOC associated with proposed additional operations onsite were included in the study. Furthermore, at the request of the ENV, this assessment studies the contribution of Sinclar's existing and proposed operations to the ambient levels of $PM_{2.5}$ and PM_{10} in more detail.

An Air Dispersion Modelling Plan was developed in consultation with ENV. The modelling approach of this assessment follows the methodology laid out in the modelling plan and is consistent with the BC Air Quality Modelling Guideline (AQDMG, ENV, 2015). The plan was approved by ENV on November 27, 2020, and later amended on May 18, 2021.

Dispersion modelling using CALMET/CALPUFF (version 7) modelling system was conducted to predict ambient concentrations of $PM_{2.5}$, PM_{10} and NO_2 with their respective BC AAQO and CAAQS criteria. VOC concentrations are also reported, but do not have associated compliance levels listed in either BC AAQO or CAAQS.

A total of six modeling scenarios were considered in this assessment. These scenarios were categorized into two study cases as follows:

- **Case 1: Assessment of proposed sources**
  This study case determines the increase to ambient air concentrations due to emissions from the proposed sources at the facility. The cumulative ambient concentrations, resulting from those emissions, plus the existing air contaminant levels arising from existing sources at the facility and in the surrounding area, are also considered here. The existing air contaminant levels are referred to as the ambient background concentrations. For this study case, emission sources for the existing facility operations are considered to be included in the background concentrations reported by nearby monitoring stations as approved in the Air Dispersion Modelling Plan. Scenarios considered in this study case include:

  - **S1 without BAT**, where proposed sources are considered without the application of best achievable technology (BAT);
  - **S1 with BAT**, where proposed sources are modelled with the application of BAT (via a wet electrostatic precipitator (WESP)); and,
  - **S2 without BAT**, where proposed sources are considered without the application of BAT, but with adjustment to design stack heights to improve dispersion conditions.

For this study case, predicted concentrations of all contaminants of concern are provided for each scenario over all applicable averaging periods for which objectives exist, and are compared to relevant BC AAQO and CAAQS for both 2020 and 2025.

- **Case 2: Assessment of existing and proposed sources combined**
  This study case determines the contribution of Sinclar's existing and proposed sources to the current ambient air quality in Vanderhoof. Scenarios considered for Case 2 include:
  - **Scenario S3a (S3a)**, where only existing sources are considered as per current permit;
  - **Scenario S3b (S3b)**, where both existing and proposed sources without the application of BAT, are considered; and,
  - **S3c**, where both existing and proposed sources are considered with the application of BAT.

For this study case, predicted concentrations of $PM_{2.5}$ and PM_{10} are provided for each scenario and are compared to relevant BC AAQO.

2 METHODOLOGY

The dispersion modelling methodology was based on guidance provided in the AQDMG (ENV, 2015) and the modelling methodology discussed with ENV. A detailed Air Dispersion Modelling Plan was approved by ENV (Appendix A).

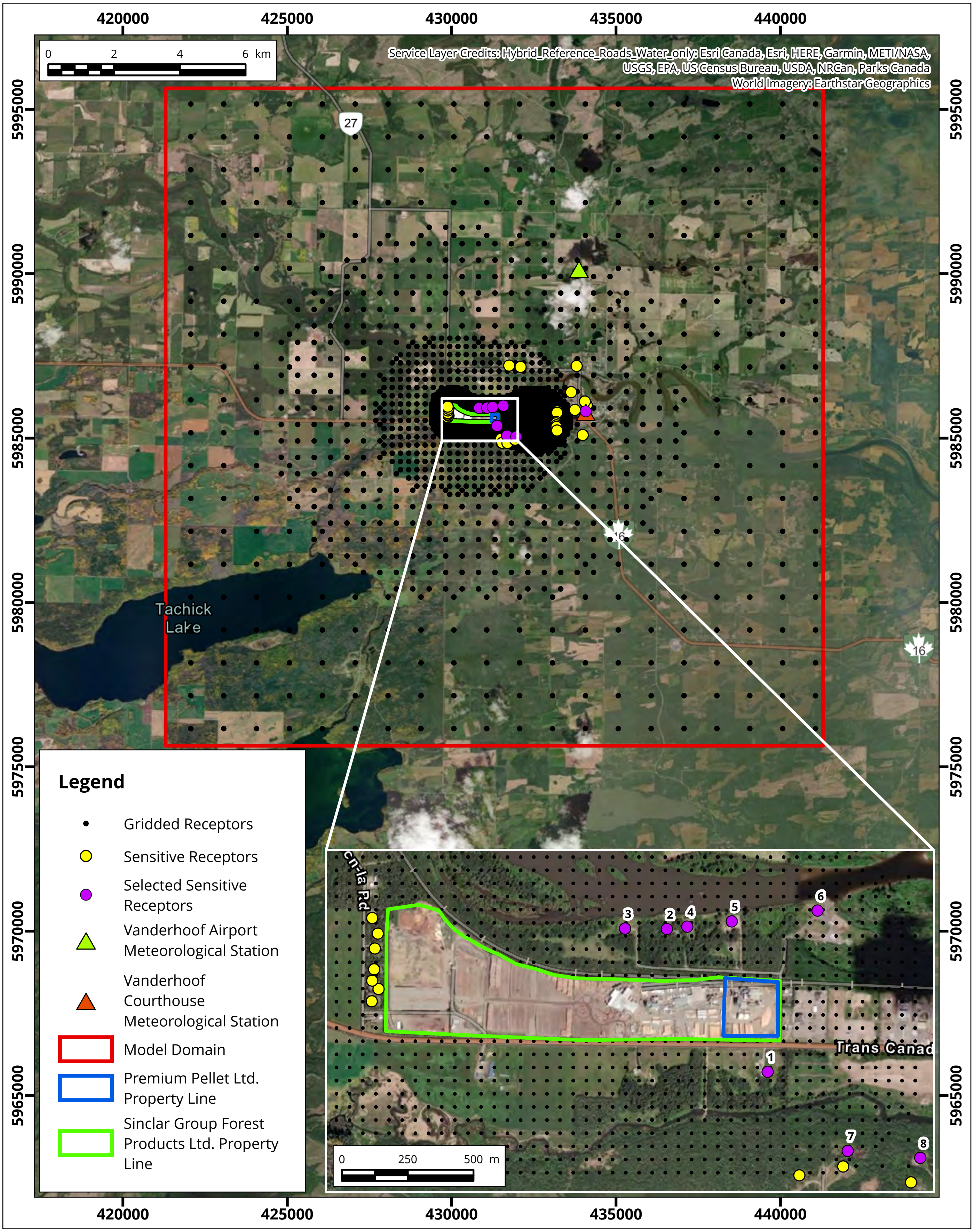
Topography around the Project site is spatially varied, resulting in complex wind flow patterns. Therefore, a refined dispersion model, capable of simulating complex wind flow patterns was selected. The CALMET/CALPUFF dispersion modelling system was selected for this assessment. CALMET is a meteorological model that develops hourly three-dimensional meteorological fields of wind and temperature used to drive emissions transport within CALPUFF. CALPUFF is a multi-layer, multi-species, non-steady-state puff dispersion model that simulates the effects of time-varying and space-varying meteorological conditions on emissions transport, transformation, and deposition. CALPUFF can use three-dimensional meteorological fields developed by the CALMET model or simple, single-station winds in a format consistent with the meteorological files used to drive the ISCST3 steady-state Gaussian model. Dispersion modelling was conducted using the full 3-D CALMET mode because it has the ability to simulate the changes in mixing height and boundary layer mechanics that result from the variable land cover characterization and terrain in the air quality dispersion modelling study area.

Ambient concentrations of $PM_{2.5}$, PM_{10}, NO_2, and VOC were predicted within the dispersion modelling study area. Dispersion modelling was conducted based on the emissions estimated for each source. Predicted concentrations of $PM_{2.5}$, PM_{10}, and NO_2 were compared to BC AAQO and CAAQS, which are listed in the results tables in Sections 3 and 4. VOC concentrations are also provided, but do not have objectives in the BC AAQO or CAAQS.

2.1 Spatial and Temporal Boundaries

A 20 km by 20 km study area, centered on the facility, is illustrated in Figure 1. The study area is sufficiently large to capture the isopleth of model predicted project related concentrations that represents 10% of the relevant ambient air quality objectives for the emissions in question, as per the BC AQDMG (ENV, 2015). Any potential air quality effects due to emissions from the facility are expected to occur within this study area.

Three years of hourly meteorological data comprising the period from January 1, 2013 to December 31, 2015 were used for the modelling, representing the most recent period during which both prognostic meteorological data from the ENV province wide WRF outputs and local surface meteorological data were available.



Domain, Receptors and Facility Location with Surface Meteorological Stations

True North

Drawn by: DJH	Figure: 1
Approx. Scale:	1:160,000
Date Revised:	Jul 22, 2021

Map Projection: NAD 1983 UTM Zone 10N

Sinclar Group Forest Products Ltd. - Vanderhoof, B.C.

Project #: 2004605

Map Document: C:\GIS Temp - Copy\2004605\P2004605_SinclarPellet_fresh210327.aprx

2.2 Source Characterization

The existing and proposed emission sources of $PM_{2.5}$, PM_{10}, NO_X, and VOC were identified and characterized based on information provided by Sinclar.

Emission rates for NO_X and VOC were provided by Sinclar. Total particulate matter (TPM) emissions rates were also provided, which were used to determine $PM_{2.5}$ and PM_{10} emissions based on estimated PM fractions within the total particulate. There are very limited publicly available sources for PM fraction data. Most stack tests measure filterable and condensable PM fractions, which are related to, but are not exactly the same as $PM_{2.5}$ and PM_{10}. Considering these limitations, PM fractions of 74% and 80% of TPM for $PM_{2.5}$ and PM_{10}, respectively were estimated based on previous assessments of similar facilities and equipment, as well as general PM size distribution curves. These fractions were approved to be used by ENV in the Air Dispersion Modelling Plan (Appendix A).

Recent emission tests performed at Premium Pellet and the neighboring Sinclar facility, Nechako Lumber, showed that at these facilities, the PM fractions are 39% and 51% for $PM_{2.5}$/TPM and PM_{10}/TPM, respectively. These fractions are noticeably lower than the values used in this assessment. Stack test report is provided in Appendix G of this report.

Note that the emission rates used in the modelling are based on the substantially more conservative PM fractions approved by ENV, resulting in conservative estimates of the impact of modelled sources on ambient air quality. Applying the new fractions would result in more than 50% lower emissions and subsequently more than 50% lower concentrations of $PM_{2.5}$ and PM_{10} resulting from the facility sources compared to the predictions presented in this assessment.

Stack locations and parameters such as flow rates, stack height and diameter, stack exit temperature and stack exit velocity were also provided by Sinclar.

The existing and proposed sources and their stack parameters are summarized in Table 2-1 and emission rates are provided in Table 2-2. Source locations are shown in Figures 2-5 for different modelling scenarios.

For all sources, emission rates were assumed to be constant for all hours, and the proposed equipment in operation for all hours of the year. This provides a conservative estimation of emissions since there will be periods where the plant is not operating or operating at a reduced capacity from its maximum permitted emission rate.

Table 2-1: Source Parameters

Source	Source Modelled ID	Source Coordinates		Stack Height (m)	Stack Inner Diameter (m)	Exit Velocity (m/s)	Exit Flow Rate [1] (Sm^3/s)	Exit Temp. (°C)	Included in Scenarios
		X (m)	Y (m)						
Existing Sources									
Wood Fibre Dryer	wb_dry	431306	5985630	24.4	1.68	13.16	24.0	83.2	S1 with BAT [2], S3a, S3b
Pellet Cooling System #1	pcs_1	431305	5985671	12.8	0.60	16.32	4.0	65.0	S3a, S3b, S3c
Pellet Cooling System #2	pcs_2	431299	5985657	12.8	0.60	16.32	4.0	65.0	S3a, S3b, S3c
Dry Shavings Bin Storage System (Baghouse #1)	bh_1	431263	5985663	22.9	0.68	24.50	8.0	50.0	S3a, S3b, S3c
Hammermill Dust Recovery System (Baghouse #2)	bh_2	431287	5985671	3.0	1.17	18.49	19.0	35.0	S3a, S3b, S3c
Sawdust Storage Bin Vents	ssb_vt	431270	5985630	27.4	1.68	2.51	5.5	25.0	S3a, S3b, S3c
Dry Sawdust Cyclone	dry_scy	431261	5985662	25.0	0.60	11.46	2.8	62.5	S3a, S3b, S3c
Proposed Sources									
DRYER MULTICLONE	dry_mcl	431341	5985612	16.2	1.22	37.52	36.0	83.0	S1 without BAT, S2 without BAT, S3b
CHILLER CYCLONE	chl_cy	431323	5985673	12.8	0.60	21.21	5.2	65.0	S1 without BAT, S1 with BAT, S2 without BAT, S3b, S3c
HAMMERMILL BAGHOUSE	ham_bh	431335	5985690	3.0 [3] 13.0 [4]	0.80	24.05	11.5	35.0	S1 without BAT, S1 with BAT, S2 without BAT, S3b, S3c
BIOSIZER/DRYER LINE CYCLONE	dry_lcy	431291	5985659	25.0	0.60	18.36	4.5	65.0	S1 without BAT, S1 with BAT, S2 without BAT, S3b, S3c
BAT Source									
WESP	wesp	431335	5985598	18.0	2.10	21.05	60.0	83.0	S1 with BAT, S3c

Notes:

[1] Sample Exit Velocity calculation (e.g. Dryer Multiclone):

$$\textbf{Exit Flow }(Sm^3/s) \times \frac{\textbf{Exit Temperature }(K)}{\textbf{normal Temperatrure }(K)} \;/\; (\pi \times [\textbf{Stack Diamater }(m)]^2/4)$$

= [36 Sm^3/s] / [293.15 °C] x ([83.0 °C] + 273.15 K) / (π x [1.22 m]^2 / 4)
= 37.52 m/s

[2] In S1 with BAT, contribution of this source to ambient concentrations is deducted from total change in concentrations as this source is considered to be removed from the facility in the BAT scenario.

[3] Design stack height for S1

[4] Increased stack height for S2

Table 2-2: Emission Rates

Source	TPM	PM_{10} Emission Rate [1]	$PM_{2.5}$ Emission Rate [1]	VOC Emission Rate	NO_X Emission Rate
	(mg/Sm^3)	(g/s)	(g/s)	(g/s)	(g/s)
Existing Sources					
Wood Fibre Dryer	180	3.46E+00	3.20E+00	2.97E+00	8.34E-01
Pellet Cooling System #1	115	3.68E-01	3.40E-01	n/a	n/a
Pellet Cooling System #2	115	3.68E-01	3.40E-01	n/a	n/a
Dry Shavings Bin Storage System (Baghouse #1)	6	3.84E-02	3.55E-02	n/a	n/a
Hammermill Dust Recovery System (Baghouse #2)	6	9.12E-02	8.44E-02	n/a	n/a
Sawdust Storage Bin Vents	115	5.06E-01	4.68E-01	n/a	n/a
Dry Sawdust Cyclone	115	2.60E-01	2.41E-01	n/a	n/a
Proposed Sources					
DRYER MULTICLONE	120	3.46E+00	3.20E+00	2.97E+00	8.34E-01
CHILLER CYCLONE	115	4.78E-01	4.43E-01	n/a	n/a
HAMMERMILL BAGHOUSE	13.7	1.26E-01	1.17E-01	n/a	n/a
BIOSIZER/DRYER LINE CYCLONE	115	4.14E-01	3.83E-01	n/a	n/a
BAT Source					
WESP	60	2.88E+00	2.66E+00	5.94E+00	1.67E+00

Notes:
[1] $PM_{2.5}$ and PM_{10} emission rates are obtained by applying PM fractions of 74% and 80%, respectively to TPM emissions, as approved by ENV.

2.3 Model Scenarios

A total of six modelling scenarios were considered in this assessment. These scenarios were categorized into two study cases described below:

- **Case 1: Assessment of proposed sources**
  This study case determines the increase to ambient air concentrations due to emissions from the proposed sources at the facility. The cumulative ambient concentrations, resulting from those emissions plus the existing air contaminant levels arising from existing sources at the facility and in the surrounding area, are also considered here.

  For this study case, emission sources for the existing facility operations are considered to be included in the background concentrations reported by nearby monitoring stations as approved in the Air Dispersion Modelling Plan. Scenarios considered in this study case are defined as follows:
  - **S1 without BAT** is a scenario where the proposed new sources would not use best available technology (BAT). Proposed sources at the facility include one dryer multiclone, one chiller cyclone, one hammermill baghouse and one dryer line cyclone. Layout of sources for this scenario is provided in Figure 2, and source characteristics are summarized in Table 2-1 and Table 2-2.
  - **S1 with BAT** is a scenario where the emissions from the proposed dryer multiclone and the existing wood fibre dryer are routed to a wet electrostatic precipitator (WESP) which is considered BAT in decreasing PM emissions. Layout of sources for this scenario is provided in Figure 3, and source characteristics are summarized in Table 2-1 and Table 2-2.
  - **S2 without BAT** is a scenario similar to S1 without BAT, but the proposed hammermill baghouse's stack height is increased from 3 m to 13 m in order to improve dispersion, with intent then to decrease concentrations at nearby receptors. Layout of sources is provided in Figure 2, and source characteristics are summarized in Table 2-1 and Table 2-2.

For this study case, predicted concentrations of all contaminants of concern are provided for each scenario over all applicable averaging periods for which objectives exist. and are compared to relevant BC AAQO and CAAQS for both 2020 and 2025.

- **Case 2: Assessment of existing and proposed sources combined**
  This study case determines the contribution of Sinclar's existing and proposed sources to the ambient air quality. Case 2 scenario are defined as follows:
  - **S3a** is a scenario where only existing sources are modelled as per current permit. The purpose of this scenario is to illustrate the contribution of the existing facility operations at permitted limits to the local air quality. Existing sources at the facility include a wood fibre dryer, two pellet cooling systems, two baghouses for dry shavings bin storage systems, sawdust bin vents and dry sawdust cyclone. Layout of the existing sources along with the proposed sources is provided in Figure 4, and source characteristics are summarized in Table 2-1 and Table 2-2.

- **S3b** is a scenario where both existing and proposed sources are modelled. This scenario does not consider the application of BAT. The purpose of this scenario is to illustrate the cumulative effect of the proposed project with current permitted emissions at the facility. Layout of sources for this scenario is provided in Figure 4, and source characteristics are summarized in Table 2-1 and Table 2-2.
- **S3c** is a scenario where both existing and proposed sources are considered, but with BAT applied. For the BAT scenario, emissions from the proposed dryer multiclone and the existing wood fibre dryer are routed to a wet electrostatic precipitator (WESP). The purpose of this scenario is to illustrate the effect of applying BAT to the dryers on the local air quality. Layout of sources for this scenario is provided in Figure 5, and source characteristics are summarized in Table 2-1 and Table 2-2.

For this study case, predicted concentrations of $PM_{2.5}$ and PM_{10} are provided for each scenario and are compared to relevant BC AAQO and CAAQS for 2020.

Map Document: C:\GIS Temp - Copy\2004605\P2004605_SinclarPellet_fresh210327.aprx

Site Plan Showing Facility Sources and Buildings

Proposed sources - without BAT scenario

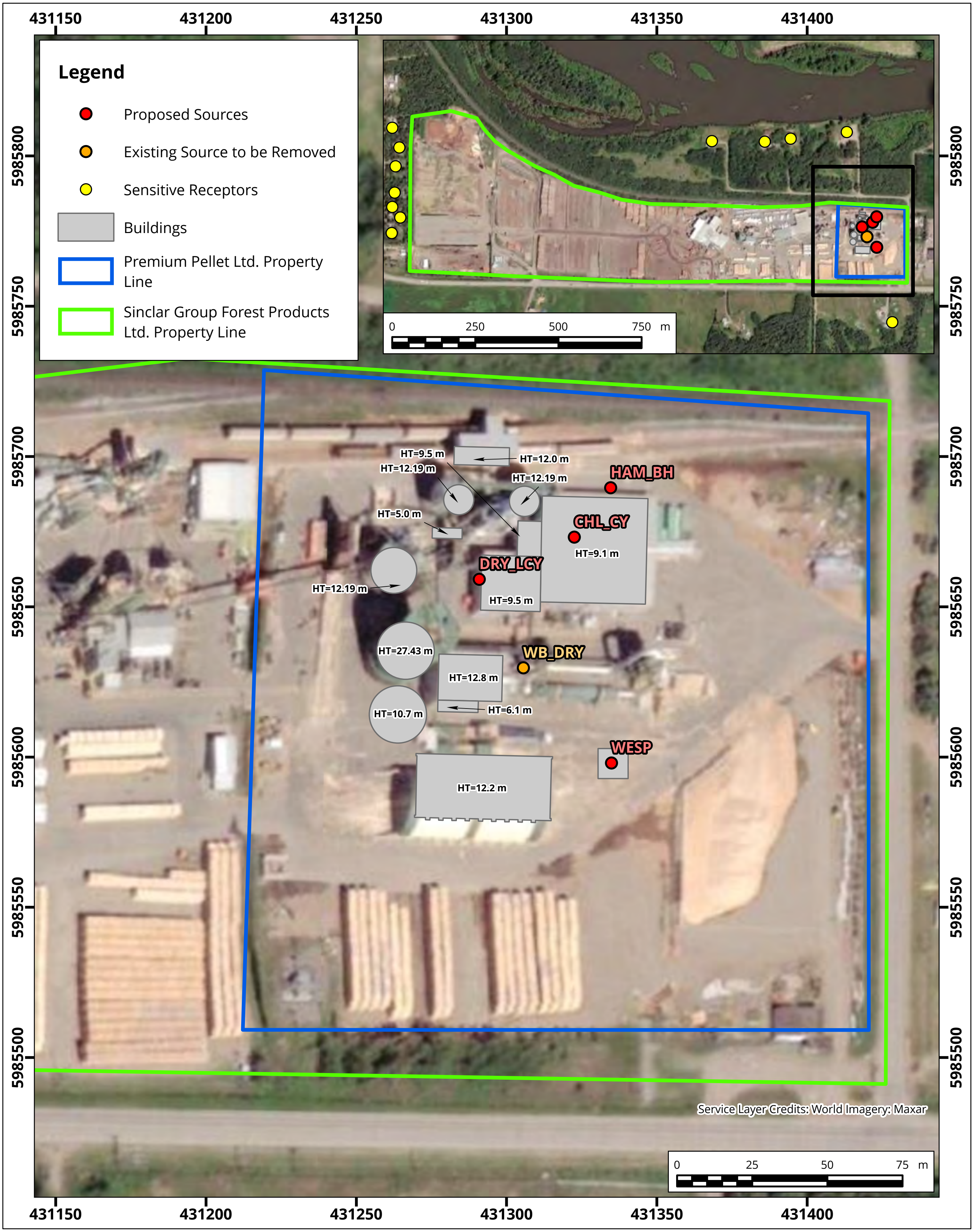
Map Projection: NAD 1983 UTM Zone 10N

Sinclar Group Forest Products Ltd. - Vanderhoof, B.C.

True North

Project #: 2004605

Drawn by: DJH	Figure: 2
Approx. Scale: 1:1,750	
Date Revised: Jul 22, 2021	



Map Document: C:\GIS Temp - Copy\2004605\P2004605_SinclarPellet_fresh210327.aprx

Site Plan Showing Facility Sources and Buildings

Proposed sources - with BAT scenario (WESP)

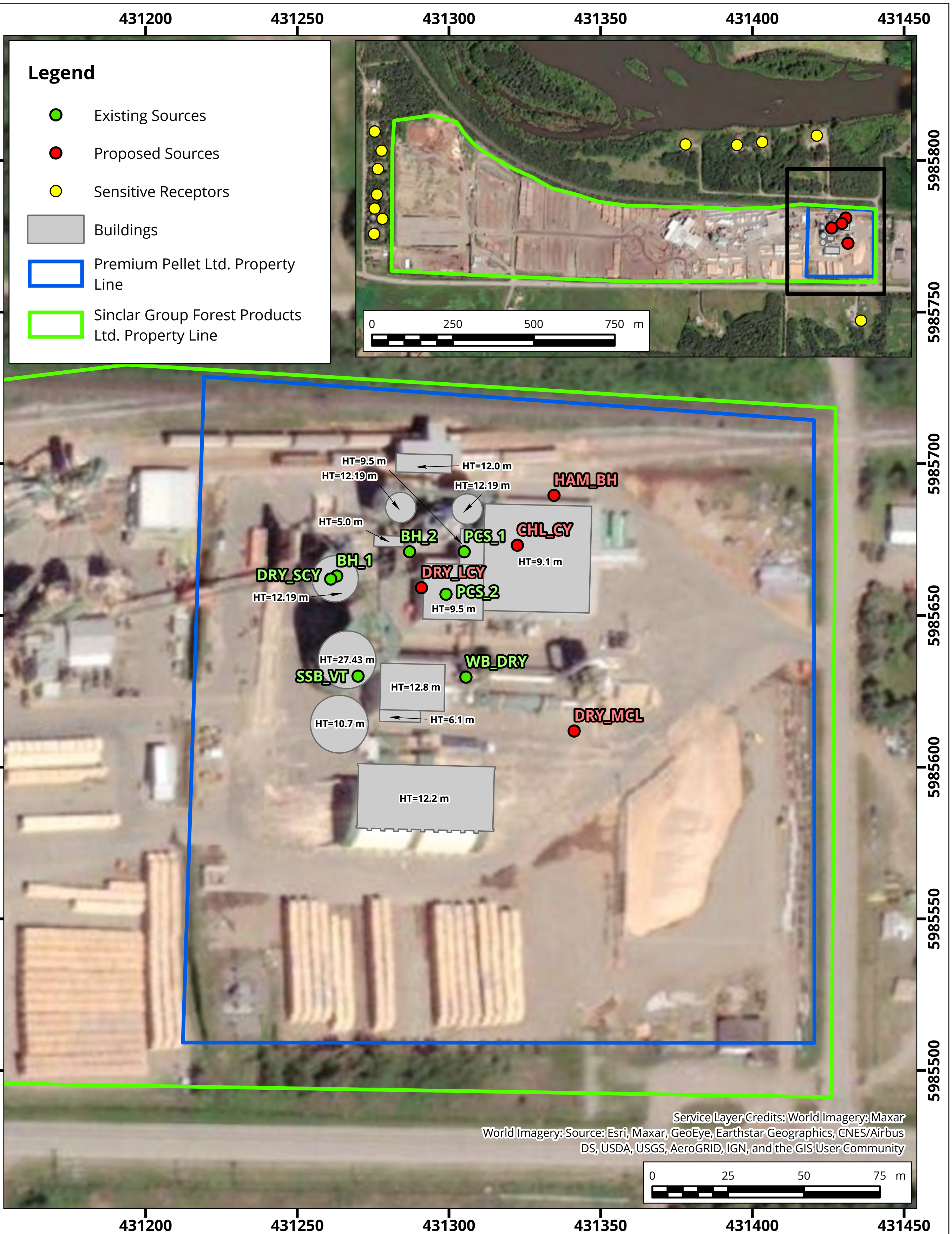
True North

Drawn by: DJH	Figure: 3
Approx. Scale:	1:1,750
Date Revised:	Jul 22, 2021

Map Projection: NAD 1983 UTM Zone 10N

Sinclar Group Forest Products Ltd. - Vanderhoof, B.C.

Project #: 2004605



Map Document: C:\GIS Temp - Copy\2004605\P2004605_SinclarPellet_fresh210327.aprx

Site Plan Showing Facility Sources and Buildings

Proposed and existing sources - without BAT scenario

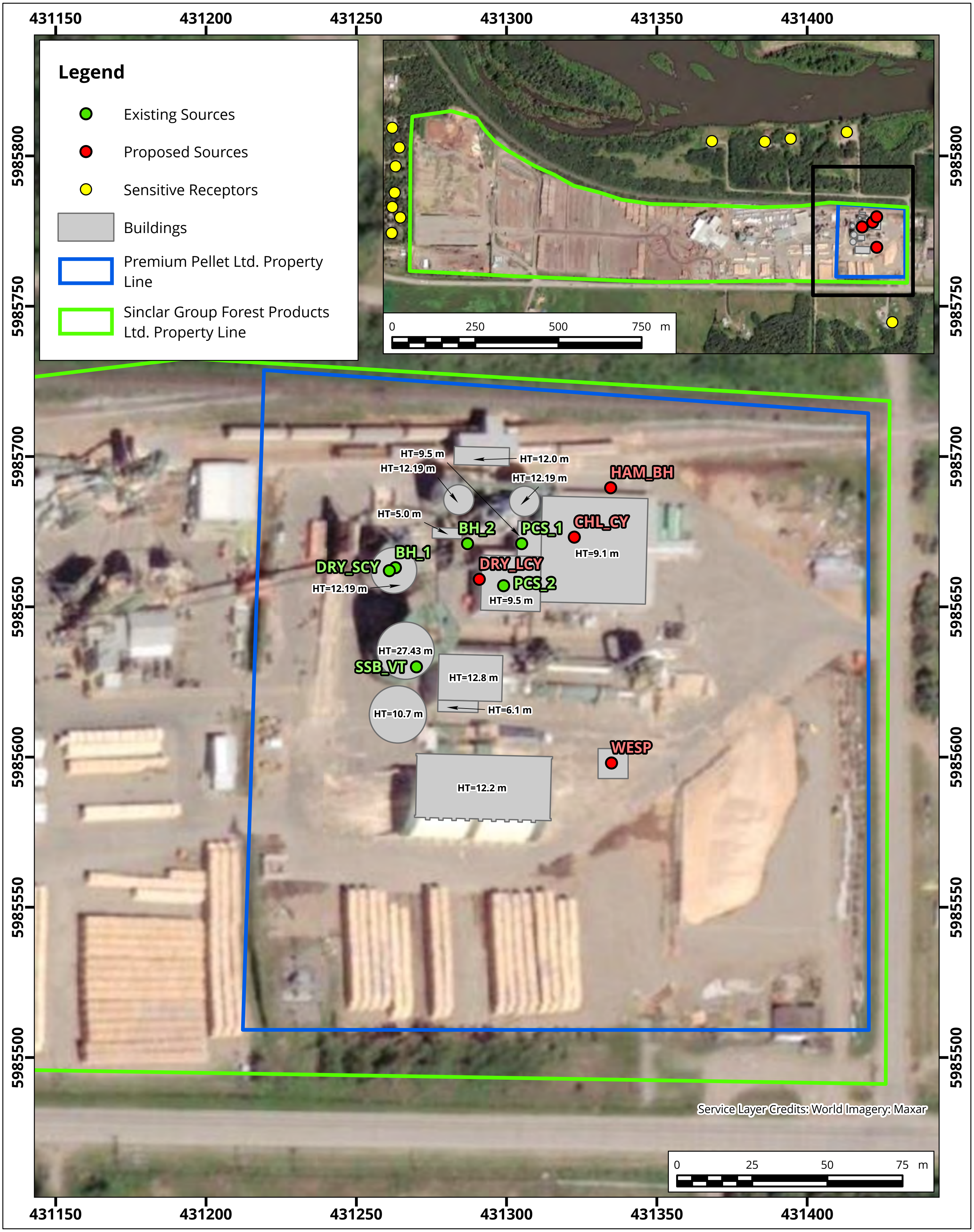
Map Projection: NAD 1983 UTM Zone 10N

Sinclar Group Forest Products Ltd. - Vanderhoof, B.C.

True North

Project #: 2004605

Drawn by: DJH	Figure: 4
Approx. Scale:	1:1,750
Date Revised:	Jul 22, 2021



Site Plan Showing Facility Sources and Buildings

Proposed and existing sources - with BAT scenario (WESP)

True North

Map Projection: NAD 1983 UTM Zone 10N

Sinclar Group Forest Products Ltd. - Vanderhoof, B.C.

Project #: 2004605

Drawn by: DJH	Figure: 5
Approx. Scale:	1:1,750
Date Revised:	Jul 22, 2021

Map Document: C:\GIS Temp - Copy\2004605\P2004605_SinclarPellet_fresh210327.aprx

2.4 Existing Ambient Air Quality

The approach for selecting appropriate data and calculating background concentrations was consistent with the AQDMG (ENV 2015). As per the guideline, the 98th percentile of historical monitoring data is to be added to predicted concentrations. This methodology is conservative as it assumes that the maximum predicted concentration and the background concentration would occur at the same time even though, by definition, concentrations equal to or greater than the 98th percentile occur only 2% of the time. Similarly, model predicted concentration metrics are also either based on maximum or some high percentile of predictions, and thus will occur infrequently compared to all the hours or days of the year.

Ambient monitoring data from the ENV Vanderhoof Courthouse station was used to determine background for $PM_{2.5}$ and PM_{10} concentration used in the study. This station is located about 3 km to the east of the Project.

Background concentrations for NO_2 and VOC were obtained using data from the Prince George Plaza 400 monitoring station, which was the closest station with the monitoring data for those contaminants.

Background concentrations for all contaminants were estimated using the same three years as the meteorological data used for modelling (2013-2015) and assumed to be spatially constant throughout the study area. Some wildfires occurred during the 2013-2015 period. As permitted by the AQDMG the Smokey Skies Bulletin for Prince George (including District of Vanderhoof) provided by the ENV was used to filter out high $PM_{2.5}$ and PM_{10} days.

The annual 98th percentile of 24-hour $PM_{2.5}$, 24-hour PM_{10}, 1-hour NO_X, 1-hour NO_2, and 24-hour VOC concentrations averaged over the three model years was used to estimate the background concentrations for each respective 1-hour or 24-hour averaging period, for each contaminant of concern. Annual background concentrations were calculated based on the hourly average over the full three years. Calculated background values are provided in Table 2-3.

Table 2-3: Calculated Ambient Background Values for $PM_{2.5}$, PM_{10}, NO_2, and VOC

Background Ambient Concentration [1][2]									
Year	$PM_{2.5}$ [3][6]		PM_{10} [4][6]		NO_X [5]		NO_2 [5]		VOC [5][7]
	98th Percentile 24-hour (µg/m³)	Annual Average (µg/m³)	98th Percentile 24-hour (µg/m³)	Annual Average (µg/m³)	98th Percentile of D1HM 1-Hour (µg/m³)	Annual Average (µg/m³)	98th Percentile of D1HM 1-Hour (µg/m³)	Annual Average (µg/m³)	98th Percentile 24-Hour (µg/m³)
2013	35.4	11.6	63.2	20.3	317.2	38.2	86.6	19.2	135.8
2014	39.1	11.1	69.6	18.3	281.8	32.5	88.7	17.9	99.4
2015	29.2	8.8	104.5	19.6	245.5	32.0	74.9	18.4	78.9
Average	34.5	10.5	79.1	19.4	281.5	34.2	83.4	18.5	104.7

Notes:

[1] Determining the background nth percentile value for a contaminant was consistent with AQDMG (ENV, 2015).

[2] Conversion from ppb to µg/m³ based on 25 °C and 1 atm, as per same conversion conditions used in B.C. Ambient Air Quality Objectives, February 2020.

[3] Data from Envista Web - Station: Vanderhoof Courthouse. The station is the closest station with relevant air quality data for $PM_{2.5}$.

[4] Data provided by the Ministry from Vanderhoof Station. The station is the closest station with relevant air quality data for PM_{10}. However, daily data sets consist of less than 75% of the complete data for the years.

[5] Data from Envista Web - Station: Prince George Plaza 400. The station is the closest station with relevant air quality data for NO_X, NO_2, and VOC.

[6] Outliers of PM background concentrations caused by wildfires were removed as per Smoky Skies Bulletins for the Prince George region (includes Vanderhoof) in accordance with B.C. Air Quality Dispersion Modelling Guidelines. List of air quality advisories and Smoky Skies Bulletins were provided by gov.bc.ca.

[7] VOC values are based on daily data sets, and consist of less than 75% of the complete data for the year

2.5 CALMET

CALMET is the meteorological pre-processor for the CALPUFF model. Dispersion modelling was conducted using the full 3-D CALMET mode because in that mode CALMET has the ability to assimilate multiple meteorological stations and to simulate the changes in mixing height and boundary layer mechanics that result from the variable land cover characterization and terrain in the air quality dispersion modelling study area. The following sections provide a summary of CALMET model inputs. CALMET version 6.5.0 was used in the study. More detailed information as to how CALMET was applied is provided in Appendix B.

2.5.1 Model Period

CALMET was run for the full three-year period from January 1, 2013 to December 31, 2015 as noted in Section 2.1. This represents the most recent period during which both prognostic meteorological data from the ENV province wide WRF outputs and local surface meteorological data were available.

2.5.2 Model Domain

The CALMET domain was over the full 20 km by 20 km study surrounding the Sinclar facility, described in Section 2.1. Horizontal domain resolution was set at 250 m. In the vertical direction, 10 layers were chosen, with the top of the layers set as 20, 40, 80, 160, 300, 600, 1000, 1500, 2200 and 3300 m above ground level.

2.5.3 Terrain and Land Cover Characterization

Terrain elevations were obtained from 1:50,000 scale Canadian Digital Elevation Data available from Geogratis. Land cover characterization data information was obtained from GeoBase. Terrain elevations and land use in the CALMET domain are provided in Figure B.1 of Appendix B. The CALMET model requires gridded geophysical parameters including surface roughness length, albedo, Bowen ratio, soil heat flux, vegetation leaf area index, and anthropogenic heat flux. Seasonal values of these parameters for each land use type were taken from the BC AQMG. To represent the seasonally dependent geophysical parameters in the CALMET model more accurately, five seasons were specified:

- Season 1: Mid-summer with lush vegetation (June to July)
- Season 2: Autumn with cropland that has not yet been harvested (August to September)
- Season 3: Winter 1 with freezing temperatures, no snow on ground (October to November)
- Season 4: Winter 2 with sub-freezing temperatures, snow cover on ground (December to March)
- Season 5: Transitional spring with partially green short annuals (April to May)

Variation of seasonal categories by month were based on ENV comments “Re: Premium Pellet Vanderhoof Review of Dispersion Modelling Plan British Columbia Ministry of Environment (PA 16502)” dated September 25, 2020, comment number 18 (Table 3).

2.5.4 Prognostic Meteorology

As recommended by the AQDMG, CALMET was initialized using the province-wide ENV WRF data for the three-year 2013 to 2015 model period. The WRF model is a mesoscale numerical weather prediction system designed to serve both atmospheric research and operational forecasting needs. It is run operationally by the United States National Weather Service and is widely used by the United States military and private meteorological services. The ENV WRF dataset provides prognostic data over all of BC at a 4 km spatial resolution specifically for use in dispersion modelling studies. A subset of the data covering a 100 km by 100 km area centered on the District of Vanderhoof, B.C., was obtained from Exponent Inc.

2.5.5 Surface Meteorology

Available surface meteorology was also incorporated into CALMET. The stations used, the source of each, and the data collected are listed in Table 2-4. Wind speed and direction, surface temperature and relative humidity were obtained from the ENV station at the Vanderhoof Courthouse and the ECCC station at the Vanderhoof Airport, were available. The locations of these stations are shown in Figure 1.

CALMET also requires surface pressure, which is not recorded at either location. Surface pressure was obtained from two nearby station run BC Ministry of Forests, Lands, and Natural Resource Operations. These stations are located outside of the study area and thus are not shown in Figure 1.

Table 2-4: Surface meteorological data stations.

Surface Met Data and Location (see Figure 1)	Data Source	Period of Record (start/end date)	% of Wind Speeds =0.0	Anemometer Height	Parameters
Vanderhoof Courthouse (54.0164, -124.0061)	ENV	January 1, 2013 / December 31, 2015	14.00%	14	Wind speed and direction, humidity, and temperature
Vanderhoof (Airport) (54.0555, -124.0102)	ECCC	January 1, 2013 / December 31, 2015	21.40%	10	Wind speed and direction, humidity, and temperature
GeorgeWx (53.963903, -24.663289)	BC Ministry of Forests, Lands, and Natural Resource Operations	January 1, 2013 / December 31, 2015	-	-	Air pressure
SaxtonWx (54.027527, -23.030078)	BC Ministry of Forests, Lands, and Natural Resource Operations	January 1, 2013 / December 31, 2015	-	-	Air pressure

2.5.6 Model Switch Settings

A list of the switch settings used in the CALMET model is provided in Appendix B. In general, model switch settings were chosen in accordance with the AQDMG (ENV 2015).

2.5.7 CALMET Performance

CALMET model performance was assessed by reviewing various model outputs, and their consistency with available observations, the terrain, landuse, location, diurnal, and seasonal cycles. Parameters including winds, stability class distribution, wind fields, mixing heights and precipitation were considered and compared with station data where applicable. Detailed model performance analysis is provided in Appendix B.

2.6 CALPUFF

The CALPUFF version 7.2.1 model was used in CALMET mode to predict the maximum potential $PM_{2.5}$, PM_{10}, NO_2, and VOC concentrations resulting from estimated emissions.

2.6.1 Model Domain

The CALPUFF model domain was set to be equivalent to the CALMET domain described in Section 2.4.2. Puff transport and dispersion was computed within the CALPUFF model for the entire model domain. Model predictions were reported at discrete receptor locations within the dispersion modelling study area as defined below.

2.6.2 Receptor Locations

In the CALPUFF model, a discrete set of receptor points are specified at which ambient concentrations are predicted. A Cartesian nested grid of receptors was defined within the study area, as per the AQDMG (ENV 2015). Receptor spacing for the Cartesian grid is as follows:

- 20 m spacing along the property fenceline;
- 50 m spacing within 500 m of the Project sources;
- 100 m receptors within 2 km from the Project sources of interest in populated areas (as per ENV request);
- 250 m spacing within 2 km of the Project sources;
- 500 m spacing within 5 km of the Project sources; and
- 1,000 m spacing beyond 5 km of the Project sources.

In addition, a number of sensitive receptors were defined at schools and senior care facilities in the study area as listed below:

- Nechako Valley Secondary School
- WL McLeod Elementary School
- St. John Hospital
- Riverside Place (senior assisted living)
- Residentials; nearby residences or nearby residential areas
- SinKut View Elementary School
- Northside Christian School
- Evelyn Dickson Elementary School
- YMCA of Vanderhoof

Terrain elevations for all receptors included as input to the CALPUFF model were extracted from 1:50,000 scale Canadian Digital Elevation Data obtained from Geogratis.

The full set of receptors used in the modelling is shown in Figure 1. Eight sensitive receptors closer to the facility and one sensitive receptor closer to the Vanderhoof Courthouse were identified at the request of ENV, for further analysis. These receptors are shown with number IDs in Figure 1. For the Courthouse, the sensitive receptor at the elementary school to the north of the courthouse was selected as representative.

2.6.3 Technical Dispersion Options

All technical options relating to the CALPUFF dispersion model were set according to the BC AQDMG (ENV 2015), model defaults, or as recommended specifically by ENV. These include parameters and options such as the calculation of plume dispersion coefficients, the plume path coefficients used for terrain adjustments, exponents for the wind speed profile, and wind speed categories. A list of the technical options is shown in Appendix C.

2.6.4 Point Source Parameters

Point sources parameters for CALPUFF were defined as listed in Table 2-1 and Table 2-2 as discussed in Section 2.2.2.

2.6.5 Building Effects

Buildings located close to stacks (i.e., point sources) may influence the dispersion of emissions. For this reason, building downwash effects were assessed in the dispersion modelling. Building dimensions required for estimation of downwash were provided by Sinclar or estimated based on site plans and approved by Sinclar.

2.6.6 NO_X to NO_2 Conversion

Emissions of NO_X from the Project are composed mainly of NO and NO_2, with the latter being the more toxic species and the one on which ambient air quality objectives are based. However, the NO portion of the NO_X emissions must also be considered, as a portion of the emitted NO is converted to NO_2 in the atmosphere. The amount of NO transforming into NO_2 is limited by the amount of ozone in the atmosphere.

In this assessment, three methods were considered for the conversion of NO_X to NO_2.

Firstly, as per guidance, it was assumed that 100% of NO_x is converted to NO_2. As this method results in exceedance of NO_2, the less conservative ozone limiting method (OLM) was then applied. The use of monthly maximum ozone concentrations, as recommended by ENV, again results in 100% conversion of NO_x to NO_2 for all receptors. The use of maximum monthly ozone concentrations is conservative as high ozone concentrations and high NO_X concentrations do not necessarily coincide. Because the OLM results in the same predictions as 100% conversion, the Ambient Ratio Method (ARM) was selected for use. The AQDMG recommends ARM in areas where representative NO_X and NO_2 ambient monitoring data are available. Such data was obtained from the meteorological station at Prince George (Plaza 400); the resulting ARM curve is shown in Figure 6. The assessment presents results for predicted NO_2 using both 100% conversion and the ARM.

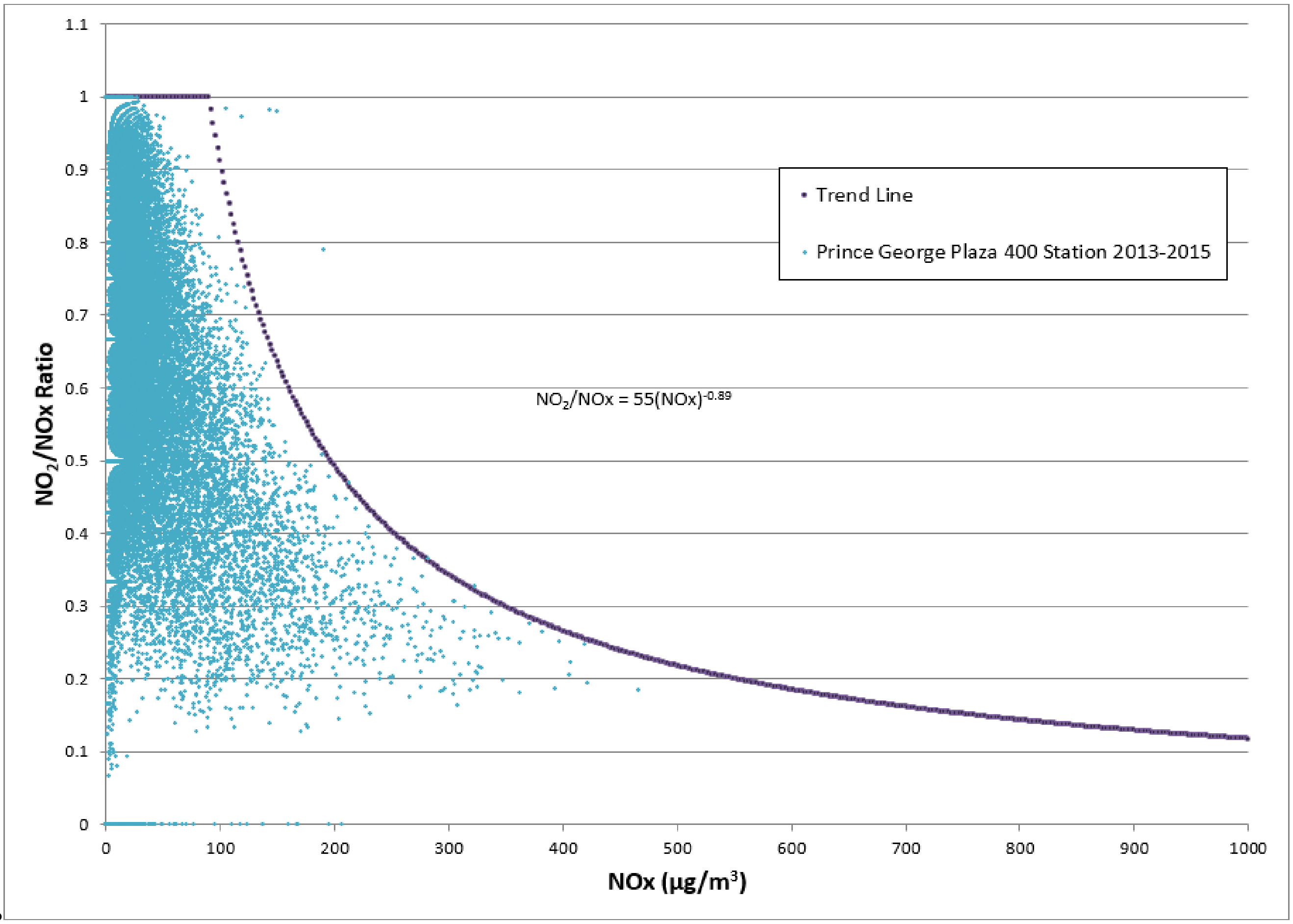


Figure 6: Ambient Ratio Method (ARM) curve from hourly NO_x and NO_2 measurements at Prince George Plaza 400 monitoring station, 2013-2015.

2.6.7 Cumulative Concentrations

As discussed in Section 2, for Case 1 scenarios, only proposed sources were modelled. These sources were modelled separately in CALPUFF and then combined in post processing to obtain the total Project contribution to ambient concentrations, using the post-processing tools POSTUTIL and CALSUM. CALPOST was then used to obtain required metrics for each contaminant/averaging time combination at each receptor in the domain. The cumulative concentration in the domain was then obtained by adding the calculated background concentrations (discussed in Section 2.4) to the model predictions.

For Case 2 scenarios, cumulative effects were not studied.

2.6.8 Study Limitations

A number of limitations are inherent in the air quality study. These include limitations in emissions estimation and limitations in dispersion modelling.

Limitations and conservative measures specific to this study include:

- Conservative estimates on PM fractions due to lack of reliable data
- Use of measured concentrations at one location as representative of existing background concentrations over the entire modelling domain
- Background concentrations from higher populated area than the site location likely more influenced by traffic and residential hating emissions (most notably woodsmoke) than project area
- Modeling of maximum permitted operations and emission rates rather than expected actual operational emission rates

In addition, air quality dispersion models by definition, can only approximate atmospheric processes. Many assumptions and simplifications are required to describe real phenomena in mathematical equations. Model uncertainties can result from:

- Simplifications and accuracy limitations related to source data
- Extrapolation of meteorological data from selected locations to a larger region
- Simplifications of model physics to replicate the random nature of atmospheric dispersion processes

Dispersion models are reasonable and reliable in estimating the maximum predicted concentration that may occur at some time, somewhere within the model domain, as opposed to the exact concentration at a specific point at a given time. The accuracy is usually within the range of ±10% to ±40% of the observed maximum concentration (US EPA 2005). However, the conservatism built into dispersion models and other conservative measures taken through out the study, ensure that the model predictions err on the high side.

3 ASSESSMENT RESULTS FOR CASE 1: PROPOSED SOURCES

3.1 Dispersion Model Predictions

This section presents model results for the Case 1 modelling scenarios outlined in Section 2.

A summary of CALPUFF dispersion modelling results for each of the S1 without BAT, S1 with BAT and S2 without BAT emission scenarios is presented in Tables 3-1, 3-2, and 3-3, respectively. For each scenario, highest predicted concentration for the applicable averaging period over the entire modelling domain is compared with the respective air quality objective. No objective is provided for VOCs as neither BC AAQO nor CAAQS identify an objective for total VOCs. Exceedances to the objectives of the BC AAQO, CAAQS 2020 or CAAQS 2025 are shown as bolded. Note that the background concentrations for $PM_{2.5}$, PM_{10} and NO_2 already exceed BC AAQO and CAAQS criteria; therefore, they are also shown in bold font.

Table 3-1: S1 without BAT Modelled $PM_{2.5}$, PM_{10}, NO_2, and VOC Concentrations [1]

Contaminant [2]	Averaging Period	BC AAQO [2] (µg/m³)	CAAQS 2020 [2] (µg/m³)	CAAQS 2025 [2] (µg/m³)	Project Contribution (without BG) (µg/m³)	Background (µg/m³)	Cumulative (with BG) (µg/m³)
$PM_{2.5}$ [3]	24	25	27	-	**29.9**	**34.5**	**64.5**
$PM_{2.5}$	Annual	8	8.8	-	6.6	**10.5**	**17.1**
PM_{10}	24-hour	50	-	-	**54.7**	**79.1**	**133.8**
NO_2 (100% conversion from NO_X) [4]	1	113	113	79	21.0	**83.4**	**104.4**
NO_2 (100% conversion from NO_X)	Annual	32	32	23	0.7	18.5	19.2
VOC	24-hour	NA	NA	NA	12.8	105	117.5
NO_2 (ARM Conversion from NO_X) [4] [5]	1	113	113	79	-	-	**103.1**
NO_2 (ARM Conversion from NO_X) [5]	Annual	32	32	23	-	-	18.9

Notes:
[1] Highest predicted concentration over the entire modelling domain
[2] Percentile values and criteria from the B.C. Ambient Air Quality Objectives, February 2020 (Interim Provincial AQO are no longer applicable and follow CAAQS 2020 criteria. Document also provides info or links for CAAQS 2020 and CAAQS 2025 criteria.
[3] 98th percentile of daily average for each year, averaged over the three year modelling period.
[4] 98th percentile of the daily 1-hour maximum, for each year, averaged over the three year modelling period.
[5] NO_2 conversion from NO_X using Ambient Ratio Method (ARM). Only cumulative concentrations are provided as ARM is applied to cumulative concentrations.
***** Values in bold font signify exceedances from objectives.

Table 3-2: S1 with BAT Modelled $PM_{2.5}$, PM_{10}, NO_2, and VOC Concentrations [1]

Contaminant [2]	Averaging Period	BC AAQO [2] (µg/m³)	CAAQS 2020 [2] (µg/m³)	CAAQS 2025 [2] (µg/m³)	Project Contribution (without BG) (µg/m³)	Background (µg/m³)	Cumulative (with BG) (µg/m³)
$PM_{2.5}$ [3]	24	25	27	-	**26.2**	**34.5**	**60.7**
$PM_{2.5}$	Annual	8	8.8	-	3.9	**10.5**	**14.4**
PM_{10}	24	50	-	-	28.2	**79.1**	**107.3**
NO_2 (100% conversion from NO_X) [4]	1	113	113	79	20.1	**83.4**	**103.6**
NO_2 (100% conversion from NO_X)	Annual	32	32	23	0.1	18.5	18.6
VOC	24	NA	NA	NA	6.7	105	111.5
NO_2 (ARM Conversion from NO_X) [4][5]	1	113	113	79	-	-	**103.1**
NO_2 (ARM Conversion from NO_X) [5]	Annual	32	32	23	-	-	18.6

Notes:

[1] Highest predicted concentration over the entire modelling domain

[2] Percentile values and criteria from the B.C. Ambient Air Quality Objectives, February 2020 (Interim Provincial AQO are no longer applicable and follow CAAQS 2020 criteria. Document also provides info or links for CAAQS 2020 and CAAQS 2025 criteria.

[3] 98th percentile of daily average for each year, averaged over the three year modelling period.

[4] 98th percentile of the daily 1-hour maximum, for each year, averaged over the three year modelling period.

[5] NO_2 conversion from NO_X using Ambient Ratio Method (ARM). Only cumulative concentrations are provided as ARM is applied to cumulative concentrations.

***** Values in bold font signify exceedances from objectives.

Table 3-3: S2 without BAT Modelled $PM_{2.5}$, PM_{10}, NO_2, and VOC Concentrations [1]

Contaminant [2]	Averaging Period	BC AAQO [2] (µg/m³)	CAAQS 2020 [2] (µg/m³)	CAAQS 2025 [2] (µg/m³)	Project Contribution (without BG) (µg/m³)	Background (µg/m³)	Cumulative (with BG) (µg/m³)
$PM_{2.5}$ [3]	24	25	27	-	**27.4**	**34.5**	**61.9**
$PM_{2.5}$	Annual	8	8.8	-	6.4	**10.5**	**16.9**
PM_{10}	24	50	-	-	**51.6**	**79.1**	**130.8**
NO_2 (100% conversion from NO_X) [4]	1	113	113	79	21.0	**83.4**	**104.4**
NO_2 (100% conversion from NO_X)	Annual	32	32	23	0.7	18.5	19.2
VOC	24	NA	NA	NA	12.8	105	117.5
NO_2 (ARM Conversion from NO_X) [4][5]	1	113	113	79	-	-	**103.1**
NO_2 (ARM Conversion from NO_X) [5]	Annual	32	32	23	-	-	18.9

Notes:
[1] Highest predicted concentration over the entire modelling domain
[2] Percentile values and criteria from the B.C. Ambient Air Quality Objectives, February 2020 (Interim Provincial AQO are no longer applicable and follow CAAQS 2020 criteria. Document also provides info or links for CAAQS 2020 and CAAQS 2025 criteria.
[3] 98th percentile of daily average for each year, averaged over the three year modelling period.
[4] 98th percentile of the daily 1-hour maximum, for each year, averaged over the three year modelling period.
[5] NO_2 conversion from NO_X using Ambient Ratio Method (ARM). Only cumulative concentrations are provided as ARM is applied to cumulative concentrations.
***** Values in bold font signify exceedances from objectives.

Plots of the spatial distribution of model predictions throughout the entire model domain are provided in Appendix D. For the S1 without BAT scenarios, contour plots both including and excluding background concentrations are provided. For the S1 with BAT and S2 without BAT emissions scenarios, only plots of concentrations excluding background are provided. For all scenarios, the plots for NO_2-ARM show only cumulative results as the background concentration is added prior to the ARM calculation.

3.2 Additional Information

At the request of ENV, additional information is provided consisting of predicted concentrations tables and contour plots for each year of the modelling period, as well as concentrations at selected sensitive receptors of interest identified by ENV. The information is provided in Appendix F includes:

- Highest predicted concentrations for each year of the modelling period over the modelling domain. These results are provided for $PM_{2.5}$ (24-hour and annual average), and PM_{10} (24-hour average) only, in Tables F1 through F9;
- Predicted concentrations for each year of the modelling period at the selected sensitive receptors for $PM_{2.5}$ (24 hour and annual average) only, in Tables F19 through F27;
- Predicted concentrations for $PM_{2.5}$ (24-hour and annual average) at the selected sensitive receptors, averaged over the three year modelling period in Tables F37 through F39; and,
- Contour plots of predicted concentrations for each year of the modelling period for $PM_{2.5}$ (24-hour and annual average) in Figures F1 through F36.

3.3 Discussion

For Case 1, a predicted maximum cumulative PM and NO_2 concentrations (except annual NO_2) exceed their respective objectives. This is mainly due to high background concentrations already measured in Vanderhoof. In particular, background concentrations for 24-hour and annual $PM_{2.5}$, 24-hour PM_{10} and 1-hour NO_2 all exceed their respective objectives. Therefore, the discussion of the model results focuses on the contribution of the Project emissions to ambient concentrations irrespective of existing background.

3.3.1 S1 without BAT

For this scenario, the highest PM concentrations are predicted at or near the fence line receptors to the north, east, and south of the Project's proposed new sources. 24-hour $PM_{2.5}$ concentrations exceed the BC AAQO and CAAQS objectives on the northern fence line of the facility. Concentrations decrease rapidly with distance from the facility. At 1 km from the facility predicted 24-hour $PM_{2.5}$ concentrations are below 5 $\mu g/m^3$. In downtown Vanderhoof (approximately 2.5 km east of the facility), maximum predicted 24-hour $PM_{2.5}$ concentrations are about 1.5 $\mu g/m^3$, which is less than 5% of the existing background levels.

For annual $PM_{2.5}$, predicted Project concentrations do not exceed the objectives. At about 1 km to the east of the facility predicted annual concentrations are about 1.5 $\mu g/m^3$. In downtown Vanderhoof predicted annual concentrations decrease to 0.5 $\mu g/m^3$, which is less than 5% of existing background levels.

For 24-hour PM_{10}, similar to $PM_{2.5}$, concentrations exceed the objective on the northern fence line of the facility. In downtown Vanderhoof 24-hour PM10 concentrations decrease to about 3 $\mu g/m^3$, which is less than 5% of the existing background levels.

Predicted maximum 1-hour and annual Project concentrations of NO_2 are well below the objectives. In downtown Vanderhoof 1-hour and annual concentrations are approximately 2.5 and 0.1 µg/m^3, respectively.

3.3.2 S1 with BAT

The mitigation scenario of S1 with BAT shows an overall decrease of predicted PM concentrations. However, exceedances are still predicted to occur at or near the fence line receptors to the north of the proposed new sources. Maximum predicted 24-hour $PM_{2.5}$ concentrations without background exceed the BC AAQO, while 24-hour PM_{10} concentrations without background no longer exceed the BC AAQO. Similar to the S1 without BAT scenario, concentrations decrease rapidly with distance from the facility. Maximum predicted 24-hour $PM_{2.5}$ concentration is approximately 0.06 µg/m^3 at downtown Vanderhoof.

With the application of BAT, predicted PM concentrations at selected sensitive receptors close to the facility (Table F38) show a reduction of between 20% – 80% compared to S1 without BAT results. Farther from the facility and at the downtown Vanderhoof Courthouse, concentrations are decreased approximately 15% for 24-hour $PM_{2.5}$ and 64% for annual $PM_{2.5}$.

3.3.3 S2 without BAT

With the S1 scenarios, elevated concentrations of short-term (24-hour) PM are predicted close to the fence line. Specifically, maximum concentrations are predicted to occur to at the northern fence line of the facility, close to the hammermill baghouse. An additional scenario S2 without BAT was conducted to determine if increasing the stack height of the hammermill baghouse, from 3 m to 13 m would decrease the PM concentrations at the receptors to the north of the Project. S2 without BAT results still showed exceedances of the BC AAQO and CAAQS similar to S1 without BAT; however, overall concentration close to the facility decreased slightly. Concentrations beyond 1 km from the facility were minimally affected by the increased stack height.

4 ASSESSMENT RESULTS FOR CASE 2: EXISTING AND PROPOSED SOURCES COMBINED

4.1 Dispersion Model Predictions

This section presents model results for the Case 2 modelling scenarios outlined in Section 2. Case 2 was developed to better demonstrate the effect of applying BAT to the existing and proposed dryers on the predicted changes to ambient air quality. For Case 2 scenarios, only emissions of $PM_{2.5}$ and PM_{10} were considered, as they are the main contaminants of concern in that the are the only species showing either predicted or observed concentration above ambient objectives in the district of Vanderhoof.

A summary of CALPUFF dispersion modelling results for each of the Case 2 scenarios is presented in Table 4-1. Maximum predicted levels are compared with their respective Ambient air quality objectives, and existing background levels are also provided in Table 4-1 for comparison.

Table 4-1: S3 Modelled $PM_{2.5}$ and PM_{10} Concentrations [1]

Contaminant	Averaging Period	Maximum Predicted Concentration			BC AAQO [2] (µg/m³)	Background (µg/m³)
		S3a	S3b	S3c		
$PM_{2.5}$ [3]	24-hour	**69.2**	**87.6**	**82.8**	25	34.5
$PM_{2.5}$	Annual	**16.7**	**20.6**	**18.8**	8	10.5
PM_{10}	24-hour	**97.5**	**127.4**	**121.5**	50	79.1

Notes:
[1] Highest predicted concentration over the entire modelling domain
[2] Percentile values and criteria from the B.C. Ambient Air Quality Objectives, February 2020 (Interim Provincial AQO are no longer applicable and follow CAAQS 2020 criteria. Document also provides info or links for CAAQS 2020 and CAAQS 2025 criteria.
[3] 98th percentile of daily average for each year, averaged over the three year modelling period.
***** Values in bold font signify exceedances from objectives.

Plots of the spatial distribution of model predictions throughout the entire model domain are provided in Appendix E.

4.2 Additional Information

Additional information on Case 2 model results is provided in Appendix F. This information includes:

- Highest predicted concentrations over the modelling domain for each year of the modelling period shown in Tables F10 through F18;
- Predicted concentrations for each year of the modelling period for $PM_{2.5}$ (24-hour and annual average) at the selected sensitive receptors, shown in Tables F-28 through F-36;
- Predicted concentrations for $PM_{2.5}$ (24-hour and annual average) at the selected sensitive receptors, averaged over the three year modelling period shown in Tables F40 through F42; and,
- Contour plots of predicted concentrations for each year of the modelling period for $PM_{2.5}$ (24-hour and annual average) shown in Figures F37 through F54.

4.3 Discussion

For all of Case 2 scenarios, highest predicted PM concentrations over the modeling domain exceed their respective objectives as well as the existing background levels.

Note that the predicted concentrations from the existing sources at the facility exceed the existing background concentrations. This at least partially due to the several items of conservatism considered in all stages of assessment, including:

- Emission sources are modelled at maximum permitted emission rates for all modelled hours, rather than the actual operating emissions.
- Conservative PM fractions are used to determine $PM_{2.5}$ and PM_{10} emission rates.
- Dispersion models are themselves inherently conservative. Facility is assumed to operate at its full permitted emission limit for all hours of the year.
- Background levels are measured at the Vanderhoof Courthouse, located approximately 3 km away from the facility
- The background location is in a more highly populated area that is likely more influenced by local traffic and residential heating emissions than the immediate project area.

4.3.1 S3a

For this scenario, only existing sources at the facility are modelled. The highest PM concentrations are predicted at or near the fence line to the north, east, and south of the Project's proposed sources. 24-hour $PM_{2.5}$ concentrations exceed the BC AAQO objectives on the north, east, and south of fence line of the facility. Concentrations decrease rapidly with distance from the facility. At 0.4 km from the facility, predicted concentrations of 24-hour $PM_{2.5}$. are below the objectives of 25 µg/m^3. At downtown Vanderhoof (approximately 2.5 km east of the facility), maximum predicted project related 24-hour $PM_{2.5}$ concentrations are less than 3 µg/m^3, which is less than 10% of the existing background levels.

For annual $PM_{2.5}$, predicted Project concentrations exceed the objective to the north and east of the facility. At about 0.4 km from the facility, predicted annual $PM_{2.5}$ concentration is within the objective limits (8 µg/m^3). In downtown Vanderhoof, annual $PM_{2.5}$ concentrations decrease to 0.8 µg/m^3, which is less than 1% of existing background levels.

For 24-hour PM_{10}, similar to $PM_{2.5}$, concentrations exceed the objective on the north, east, and south of the fence line of the facility. At about 0.2 km from the facility, the predicted 24-hour PM_{10} concentrations are below the objective of 50 µg/m^3. In downtown Vanderhoof, predicted 24-hour PM_{10} concentrations decrease to about 5 µg/m^3, which is less than 7% of the existing background concentrations.

4.3.2 S3b

For this scenario, modelled sources consisted of both existing sources and proposed sources without the application of BAT. Exceedances of ambient objective for $PM_{2.5}$ and PM_{10} are predicted to occur to the north, east and south of the facility. Predicted concentrations for this scenario are generally higher than S3a, but - similar to S3a - concentration levels decrease rapidly with distance from the facility. Approximately 0.6 km from the facility, 24-hour $PM_{2.5}$ concentrations are below the objective of 25 µg/m^3. At downtown Vanderhoof (approximately 2.5 km east of the facility), maximum predicted 24-hour $PM_{2.5}$concentrations are below 4 µg/m^3, which is less than 15% of the existing background levels.

4.3.3 S3c

This scenario is similar to S3b, except BAT is applied with emissions from existing wood fibre dryer and the proposed dryer multiclone are routed to a WESP. For this scenario, predicted PM concentrations are generally less than predicted concentrations for S3b; however, they still exceed their applicable objectives at the north, east, and south of the facility. Approximately 0.5 km from the facility, 24-hour $PM_{2.5}$ concentrations are below the objective of 25 µg/m^3. At downtown Vanderhoof (approximately 2.5 km east of the facility), predicted project concentrations under 3 µg/m^3, which is less than 10% of the existing background concentration.

With the application of BAT, predicted concentrations at selected sensitive receptors close to the facility (Table F42) decrease between 5% – 30%. Farther from the facility and at the Vanderhoof Courthouse downtown, concentrations are decreased by approximately 30% compared to S3b.

5 SUMMARY

RWDI was retained by Sinclar Group Forest Products Ltd. (Sinclar) to conduct an air quality assessment for Sinclar's proposed additional sources to the Premium Pellet Ltd. facility in Vanderhoof, B.C. This assessment focused on emissions of $PM_{2.5}$, PM_{10}, NO_2, and VOC from the Project, and model predicted changes to ambient air concentrations in comparison to their respective BC AAQO and CAAQS. In addition, at the request of the ENV, the contribution of Sinclar's existing and proposed operations to the existing ambient concentrations of $PM_{2.5}$ and PM_{10} was studied in more detail.

The assessment was conducted using the CALMET/CALPUFF dispersion model system following the methods presented in the British Columbia Air Quality Dispersion Modelling Guideline and the approved Air Dispersion Modelling Plan for the Project.

5.1 Modelling Results

This assessment considers two case studies, each with three different scenarios:

Case 1: Assessment of proposed sources, to determine the increase in ambient air concentrations due to emissions from the proposed sources at the facility. The cumulative ambient concentrations, resulting from those emissions and the existing air contaminant concentrations arising from existing sources at the facility and in the surrounding area, are also considered here. Case 1 scenarios include:

- **Scenario 1** (**S1) without BAT**, where proposed sources are considered without the application of best achievable technology (BAT);
- **Scenario 1 (S1) with BAT**, where proposed sources are modelled with the application of BAT (via a wet electrostatic precipitator); and,
- **Scenario 2** (**S2) without BAT**, where proposed sources are considered without the application of BAT, but with adjustment to design stack heights to improve dispersion conditions.

For all Case 1 scenarios, highest predicted cumulative concentrations from the proposed sources occur close to the facility and exceed their respective BC AAQO and CAAQS with the exception of annual NO_2. Predicted project only concentrations for 24-hour $PM_{2.5}$ and PM_{10} in the cases of S1 without BAT and S2 without BAT exceed their objectives, while the S1 with BAT only $PM_{2.5}$ is predicted to exceed the BC AAQO. Predictions of Project only NO_2 concentrations are well below the relevant objectives.

For all Case 1 scenarios, predicted concentrations decrease rapidly with distance from the facility. In downtown Vanderhoof, the increase in ambient concentrations of $PM_{2.5}$ and PM_{10} due to the Project are less than 5% of existing ambient concentrations.

The model predictions for the addition of a WESP (i.e. BAT) as assessed in the S1 with BAT scenario showed noticeable decrease in overall concentrations of PM of between 20% – 80% versus without the WESP). For receptors close the Project site however, 24-hour $PM_{2.5}$ concentrations still exceed its BC AAQO. The WESP noticeably reduces concentrations at receptors further away from the facility. The increased stack height for the hammermill baghouse, as modelled in S2 without BAT scenario, reduces PM concentrations close to the facility fenceline but does not meaningfully affect the overall concentrations in the overall modeling domain.

Case 2: Assessment of existing and proposed sources combined, to determine the contribution of Sinclar's existing and proposed sources to ambient concentrations. Cumulative concentrations are not considered here. Case 2 scenarios include:

- **Scenario 3a (S3a)**, where only current existing sources are modelled;
- **Scenario 3b (S3b)**, where existing sources and proposed sources are modelled without the application of BAT; and,
- **Scenario 3c (S3c)**, where existing source and proposed sources are modelled with the application of BAT (via a wet electrostatic precipitator).

For Case 2 scenarios, predicted concentrations decreased rapidly with distance from the facility. At downtown Vanderhoof, the predicted increase in ambient concentrations due to the Project is less than 10% of existing ambient concentrations of $PM_{2.5}$ and PM_{10}.

Similar to Case 1, addition of a WESP (i.e. BAT) showed decreases (5% to 30%) in concentrations of PM. This decrease is more noticeable further from the facility and at downtown Vanderhoof.

5.2 Comparison to other Pellet Plants in BC

The predicted concentrations from the proposed new sources at the Project are in the same range to concentrations resulting from other recent projects assessed within BC. Similar assessment was performed for Pinnacle Renewable Energy Inc. for their facility at Lavington, B.C (RWDI, 2014). For that project, predicted 24-hour $PM_{2.5}$ concentrations were close to the objectives near the facility, and decreased to about 5 µg/m^3 at about 1 km away, which compares closely to the model results presented in this study. Technical assessment report for that project is available from http://pinnaclepellet.com.

6 REFERENCES

ENV. 2015. Guidelines for Air Quality Dispersion Modelling in British Columbia. British Columbia Ministry of Environment, November, 2015. Accessed: Mar. 2021.

ENV. Feb. 2020. British Columbia Ambient Air Quality Objectives. Provincial Air Quality Objective Information Sheet. Available at: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/air/reports-pub/prov_aqo_fact_sheet.pdf. Accessed: Mar. 2021.

Envista Web. 2021. BC Air Data Archive. Available at: https://envistaweb.env.gov.bc.ca. Accessed: Mar. 2021.

RWDI. 2014. Pinnacle Renewable Energy Inc. Technical Assessment Report, Lavington, B.C. Dec. 9, 2014. Available at: http://pinnaclepellet.com/wp-content/uploads/2018/01/PP_pdf_Publications_Final-Assessment-Lavington.pdf. Accessed: Mar. 2021.