REPORT_REV. 1

WESTERN FOREST PRODUCTS VAD

AIR QUALITY ASSESSMENT

RWDI #2405727

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DRAFT

SUBMITTED TO

Bettina Sander
Director, Environment
Western Forest Products Inc.
BSander@westernforest.com

SUBMITTED BY

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

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

RWDI AIR Inc.
1385 W 8th Ave #280,
Vancouver, BC,
Canada V6H 3V9
Tel: +1.604.730.5688

EXECUTIVE SUMMARY

RWDI AIR Inc. (RWDI) was retained by Western Forest Products Inc (Western) to conduct an air quality assessment in support of a permit amendment for proposed additional air emission sources at Western's Value Added Division facility in Chemainus, BC (the Project). The proposed Project will see the replacement of ten (10) existing batch kilns with four (4) continuous kilns and two (2) specialty kilns. There will also be addition of a new planer facility that will result in emissions through a new cyclone and an additional baghouse which will have a common exhaust point. All proposed major point sources of PM, NO_2, and VOC associated with proposed changes to operations onsite were included in the study.

An Air Dispersion Modeling Plan was developed in consultation with ENV. The modeling approach of this assessment follows the methodology laid out in the modeling plan and is consistent with the BC Air Quality Modeling Guideline (AQDMG, ENV, 2022). ENV approved the plan on December 27, 2024.

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

Two emissions scenarios were considered as follows:

- **An Existing Scenario**, in which the contribution of sources currently permitted PA-1325 are assessed, consisting of:
  - Resaw/Planer Mill Baghouse
  - Chipper Cyclone 1
  - Lumber Dry Kilns 1-10

- **A Proposed Future Scenario**, in which proposed changes to facility sources are assessed, consisting of:
  - Resaw/Planer Mill Baghouse
  - Chipper Cyclone 1
  - Planer Mill Baghouse 2
  - Two (2) Continuous Kilns
  - Two (2) Small Continuous Kilns
  - Two (2) Specialty Batch Kilns

Predicted concentrations of pollutants 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.

Note that conservative measures were taken through out the modeling procedures and the predicted ambient concentrations err on the high side. These measures include:

- It was assumed that all sources are emitting at their maximum permitted emission rates at all times.
- Ambient levels through out the study area and at all times were assumed to be equal to the annual 98^{th} percentile of the monitoring data used to assess existing ambient concentrations. These concentrations were directly added to the model predictions to obtain total ambient concentrations. Note that existing background concentrations in the region of Chemainus would include existing sources at the Project.
- Dispersion models have built-in conservatisms and their predictions are typically higher than measured concentrations.
- Model predicted concentration metrics for hourly and daily concentrations were based on maximum or some high percentile of predictions, which occur infrequently compared to all the hours of the year.

The Project results in minimal impacts to ambient Air Quality. The are small increases in NO_2 concentrations, but maximum predictions close to the facility are well below ambient objectives. The Project results in in additional predicted exceedances of 24-hr and annual $PM_{2.5}$ objectives and 24-hr PM_{10} objectives.

Predicted PM Exceedances are limited to within approximately 100m of the facility boundary and mainly located to the south of Western over industrial areas. Predicted do not reach the Church or Kennels located in that area. High PM predictions to the north occur over a band of trees that will act as natural mitigation of air borne PM.

For all modelled contaminants in all scenarios, highest predicted concentrations from the proposed sources occur near facility fenceline. Predicted concentrations decrease rapidly with distance from the facility.

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1 INTRODUCTION

RWDI AIR Inc. (RWDI) was retained by Western Forest Products Inc (Western) to conduct an air quality assessment in support of a permit amendment for proposed additional air emission sources at Western's Value Added Division facility in Chemainus, BC (the Project). The proposed Project will see the replacement of ten (10) existing batch kilns with four (4) continuous kilns and two (2) specialty kilns. There will also be addition of a new planer facility that will result in emissions through a new cyclone and an additional baghouse which will have a common exhaust point.

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). All proposed major point sources of PM, NO_2, and VOC associated with proposed changes to operations onsite were included in the study.

Existing ambient levels of $PM_{2.5}$, PM_{10} and NO_2 measured at nearby stations indicate that ambient air quality in the vicinity of the Project is within 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) published 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 to estimated existing ambient concentrations in Chemainus.

An Air Dispersion Modeling Plan was developed in consultation with ENV. The modeling approach of this assessment follows the methodology laid out in the modeling plan and is consistent with the BC Air Quality Modeling Guideline (AQDMG, ENV, 2022). ENV approved the plan on December 27, 2024.

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

Two emissions scenarios were considered as follows:

- **An Existing Scenario**, in which the contribution of sources currently permitted PA-1325 are assessed, consisting of:
    - Resaw/Planer Mill Baghouse
    - Chipper Cyclone 1
    - Lumber Dry Kilns 1-10

- **A Proposed Future Scenario**, in which proposed changes to facility sources are assessed, consisting of:
    - Resaw/Planer Mill Baghouse
    - Chipper Cyclone 1
    - Planer Mill Baghouse 2
    - Two (2) Continuous Kilns
    - Two (2) Small Continuous Kilns
    - Two (2) Specialty Batch Kilns

Predicted concentrations of pollutants 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.

2 METHODOLOGY

The dispersion modelling methodology was based on guidance provided in the AQDMG (ENV, 2022) and the modelling methodology discussed with ENV. A detailed Air Dispersion Modeling Plan was approved by ENV (Appendix A).

Terrain within the proposed modelling domain is complex. There are elevations above 1000m to the west and open ocean to the east. Sea breeze and mountain breeze circulations will need to be considered. 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_{10}, $PM_{2.5}$ and NO_2 were compared to BC AAQO and CAAQS. VOC concentrations are also provided, but do not have objectives in the BC AAQO or CAAQS.

2.1 Ambient Objectives

Ambient Air Quality Objectives for NO_2, $PM_{2.5}$ and PM_{10} concentrations that are used to manage air quality in B.C. are provided in Table 2-1. Note there are no objectives for ambient VOC observed in BC. Objectives of interest sourced from https://www2.gov.bc.ca/assets/gov/environment/air-land-water/air/reports-pub/prov_air_qual_objectives_fact_sheet.pdf

Table 2-1: Ambient Air Quality Objectives for NO_2, $PM_{2.5}$ and PM_{10}

Contaminant	Averaging Period	Objective (ug/m3)	Source
Nitrogen Dioxide (NO2)	1-hour	113	2020 CAAQS
	Annual	32	2020 CAAQS
Particulate Matter <2.5 microns (PM2.5)	24-hour	25	Provincial AQO
		27	2020 CAAQS
	Annual	8	Provincial AQO
		8.8	2020 CAAQS
Particulate Matter <10 microns (PM10)	24-hour	50	Provincial AQO

[1] Achievement based on annual 98th percentile of D1HM, averaged over three consecutive years.
[2] Achievement based on annual average of 1-hour average concentrations over one year.
[3] Achievement based on annual 98th percentile of daily average, over one year.
[4] Achievement based on annual 98th percentile of daily average, averaged over three consecutive years.
[5] Achievement based on annual average, over one year.
[6] Achievement based on annual average, averaged over three consecutive years.

2.2 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,2022). 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.

2.3 Source Characterization

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

The CALPUFF model was used to predict the increase to ambient air concentrations due to sources associated with the Project. Those emissions will add to existing air pollutant levels arising from existing sources at the facility and in the surrounding area, resulting in a cumulative effect. The existing air pollutant levels are referred to as the ambient background concentrations. Emission sources for the existing facility operations were considered to be included in the background concentrations reported by nearby meteorological stations as approved in the Air Dispersion Modelling Plan.

Emission rates for Total particulate matter (TPM), NO_X and VOC were provided by Western. Emissions of TPM from point sources are based on current and/or proposed permit limit for flow rate and in-stack concentration. Emissions of TPM, Nox and VOC for kilns were based on emissions factors for quantity of wood processed and usage of natural gas for heating.

For point sources, emissions of TPM were allocated into $PM_{2.5}$ and PM_{10} using the fractions for 'wood handling sources' given in the NPRI guidance for reporting emissions of 'Wood Products Operations'. https://www.canada.ca/en/environment-climate-change/services/national-pollutant-release-inventory/report/tools-calculating-emissions/wood-products-operations.html. This results in $PM_{2.5}$ and PM_{10} fractions of 11% and 67% of TPM, respectively.

Fractions for $PM_{2.5}$ or PM_{10} for kiln emissions are not provided in the NPRI guidance. Thus, all TPM from kilns was be assumed to be $PM_{2.5}$.

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

The source emissions and stack parameters for the Existing and Future scenarios are summarized in Table 2-2 and Table 2-3, respectively.

For modelling emission rates were assumed to be constant, 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. Prediction of hourly and 24-hour concentrations were calculated directly from the hourly model predictions. Annual averages were prorated by the maximum permitted operating hours per year.

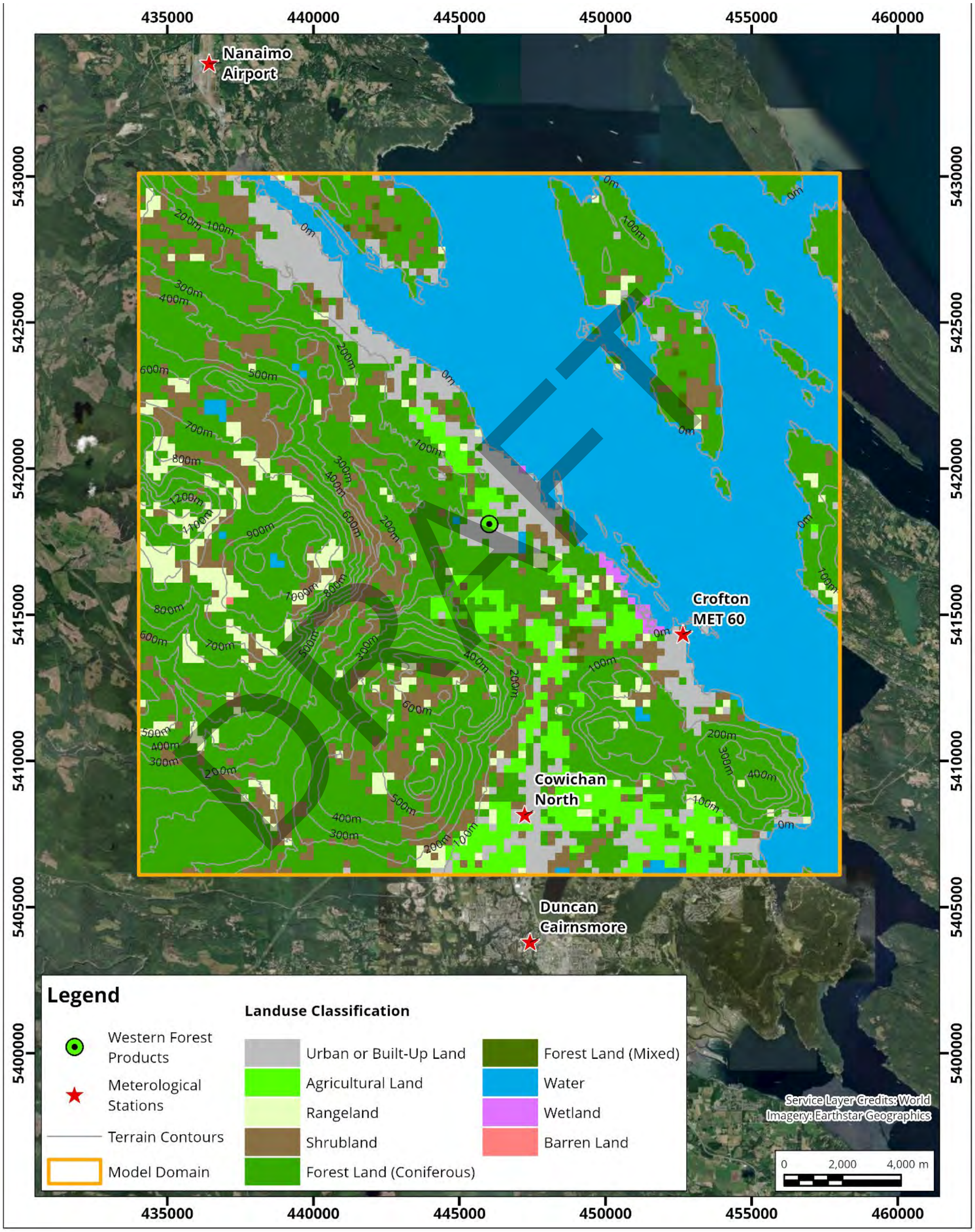


Figure 1: Domain, Receptors and Facility Location with Surface Meteorological Stations.

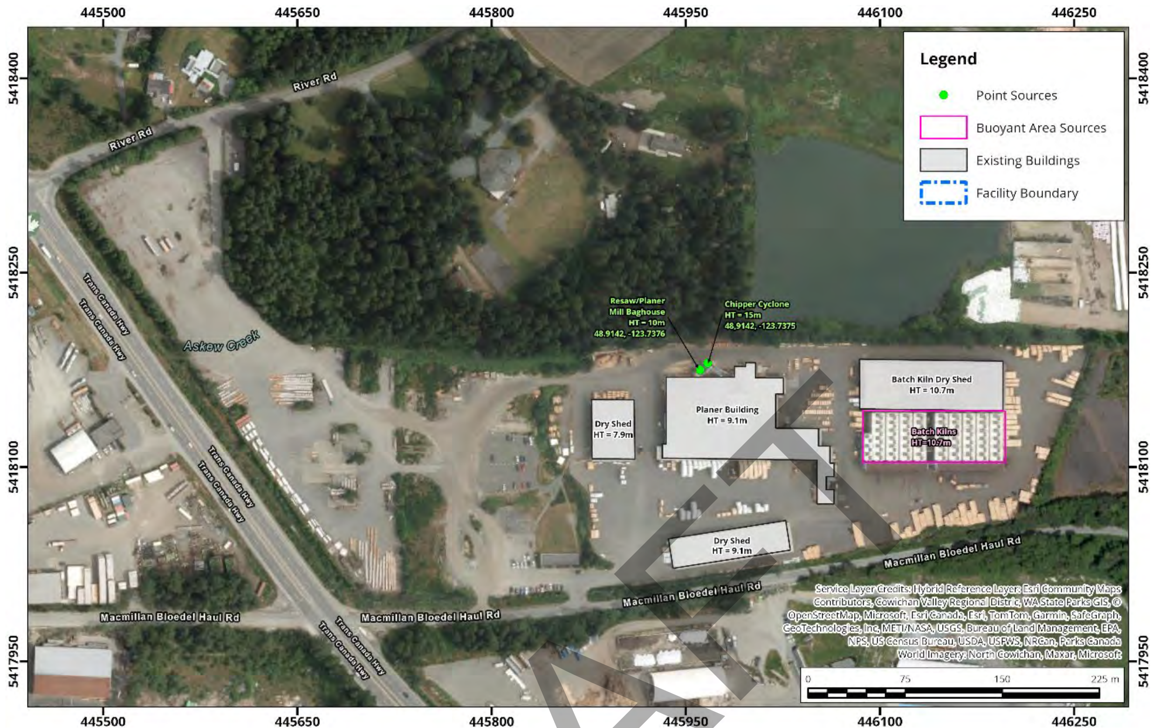


Figure 2: Site plan of Existing Permitted Sources

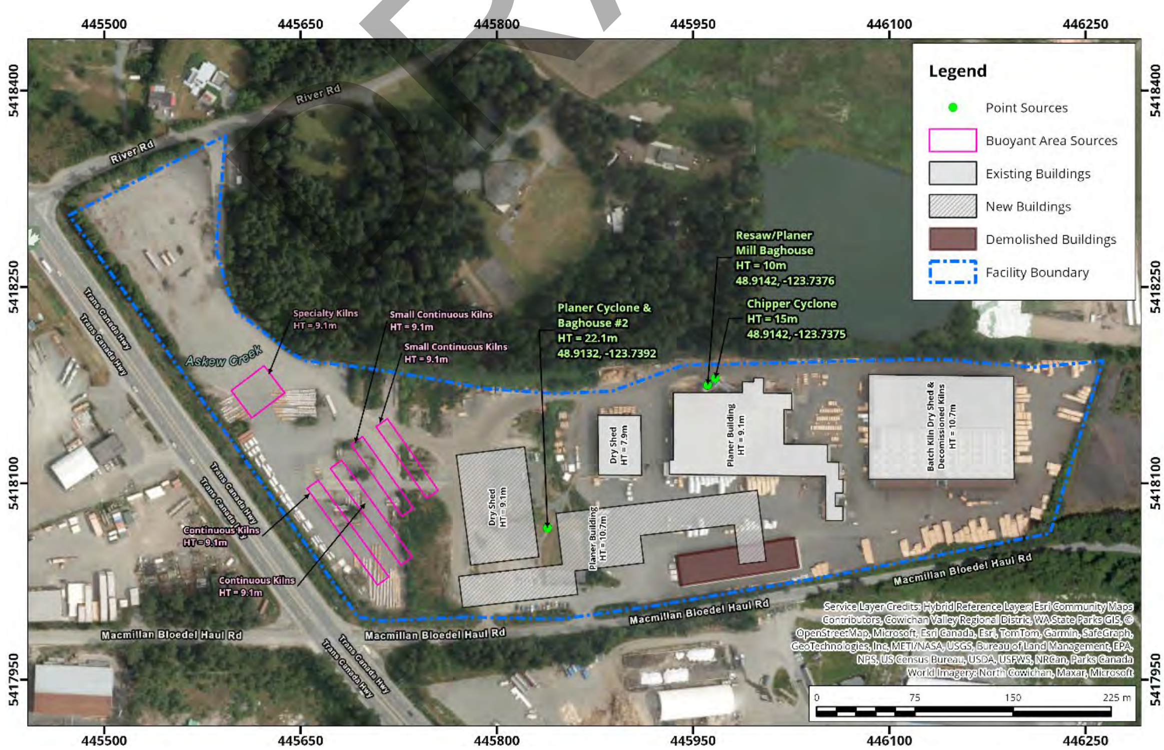


Figure 3: Site Plan of Proposed Future Sources

Table 2-2: Points Sources Emissions for Existing Permitted and Proposed Future Cases

Source	Scenario	EMS ID	Maximum Permitted Flow (SDm3/sec)	Maximum Permitted TPM Concentration (mg/SDm3)	Hours/ year	TPM Emissions		PM_{10} Fraction	PM_{10} emissions		$PM_{2.5}$ Fraction	$PM_{2.5}$ emissions	
						t/yr	g/s		t/yr	g/s		t/yr	g/s
Resaw/Planer Mill Baghouse	Existing Permitted and Future Proposed	E221400	23.3	20.0	6361	10.7	0.466	0.67	7.17	0.312	0.11	1.18	0.051
Chipper Cyclone 1	Existing Permitted and Future Proposed	E310828	3.1	115.0	6361	8.2	0.357	0.67	5.49	0.239	0.11	0.90	0.039
Planer Mill Baghouse 2	Future Proposed		23.3	20.0	6361	10.7	0.466	0.67	7.17	0.312	0.11	1.18	0.051

Table 2-3: Kiln Emissions for Existing Permitted and Proposed Future Cases

Source	Scenario	EMS ID	Hours/year	Production mmfbm/year[1]	Burner MMBTU/hr[2]	PM_{10}[3]		$PM_{2.5}$[3]		VOC		NO_x	
						t/yr	g/s	t/yr	g/s	t/yr	g/s	t/yr	g/s
Lumber Dry Kilns 1-10	Existing Permitted	E221492	8766	110	125	56.494	1.79	56.494	1.79	20.27	0.64	48.61	1.54
2 Continuous Kilns	Future Proposed		8766	140	66	69.155	2.19	69.155	2.19	23.82	0.76	25.73	0.82
2 Small Continuous Kilns	Future Proposed		8766	84	41	41.535	1.32	41.535	1.32	14.32	0.45	15.98	0.51
2 Specialty Batch Kilns	Future Proposed		8766	30	30	15.289	0.48	15.289	0.48	5.44	0.17	11.69	0.37

Notes:
(1) Emissions from MoE Discharge Factors 4.2.1
(2) Emissions from US EPA 42 Factors for Gas Burners
(3) All PM emissions assumed to be PM_{25}

2.4 Existing Ambient Air Quality

The approach for selecting appropriate data and calculating background concentrations was consistent with the AQDMG (ENV 2022). As per the guideline, the 98th to 100th percentile of historical monitoring data is to be added to predicted concentrations. This methodology is very 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 prediction, and thus will occur infrequently compared to all the hours of the year.

Calculated background values are provided in Table 2-4. For $PM_{2.5}$, for which multiple stations were available, each was processed separately and the average taken. There were no nearby PM_{10} stations found. The nearest location with PM_{10} measurements that might be similar to Chemainus was the Langdale station located across the Georgia Strait on the mainland. The nearest station that measures VOC is at Saturna Island. However, this station is located in the middle of a busy shipping corridor so is heavily influenced by shipping traffic and is also known to be affected by outflow from Greater Vancouver, so it was not deemed representative of Chemainus. Therefore, no VOC background value was identified.

The existing air quality in Chemainus can be characterized as good, which the identified stations showing measured concentrations of species of interest all well below applicable objectives.

Table 2-4: Existing ambient background values for $PM_{2.5}$, PM_{10}, and NO_2.

Station Name	Location (Lat/Long)	Period of Record (start/end date)	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m3)	NO_2 (µg/m3)	
			24-hr	Annual	24-hr	1-hr	Annual
Crofton Elementary	(48.8600, -123.6439)	01/01/2021 to 12/31/2023	10.5	4			
Crofton Escarpment Way	(48.8600, -123.6439)	01/01/2011 to 12/31/2013	10	4		10.2	3.4
Crofton Georgia Heights	(48.8496, -123.6370)	01/01/2016 to 12/31/2018	14.8	5.8			
Crofton Substation	(48.8745, -123.6539)	01/01/2022 to 12/31/2023	11.2	4.2			
Langdale Elementary	(48.439, -123.479)	01/01/2022 to 12/31/2023	11.2	4.2	21.1		
Ambient Objectives			27	8	50	113	32
Background Value			**11.6**	**4.5**	**21.2**	**10.2**	**3.4**

Notes:

Determination of background value consistent with AQDMG (ENV, 2022).
All Data from Envista Web.

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 it 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 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 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 more accurately represent the seasonally dependent geophysical parameters in the CALMET model, 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)

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 for 2013 through 2015 covering a 60 km by 60 km area centered on the Western facility was extracted from the ENV WRF database using the WRF Data Mapping Tool https://wrf.nrs.gov.bc.ca/

2.5.5 Surface Meteorology

Available surface meteorology in the vicinity of the Project was also incorporated into CALMET. The stations used, the source of each, and the data collected are listed in Table 2-5. The locations of these stations are shown in Figure 1. Note that the Duncan and Nanaimo Stations lie outside of CALMET domain. They will therefore have limited to no influence on the wind field interpolation but are included to ensure there are no hours with missing data hours that would cause CALMET to fail.

Table 2-5: Surface Meteorological Data Stations.

Surface Met Data and Location (see Figure 1)	Data Source	Period of Record (start/end date)	% Calm (Wind Speeds < 0.5m/s)	Anemometer Height	Parameters
Crofton Met_60 (48.8802, -123.6458)	The Ministry, through BC EnvistaWeb	01/01/2013 to 12/31/2015	0.05%	10m	Temperature, wind speed, and direction, relative humidity
Cowichan North (48.8242, -123.7189)	MSC	01/01/2013 to 12/31/2015	53.7%	10m	Temperature, wind speed and direction, relative humidity, pressure
Duncan Cairnsmore (48.7850, -123.7158)	The Ministry, through BC EnvistaWeb	01/01/2013 to 12/31/2015	26.4%	10m	Temperature, wind speed and direction, relative humidity
Nanaimo Airport (49.05444, -123.8700)	MSC	01/01/2013 to 12/31/2015	15.9%	10m	Temperature, wind speed, and direction, pressure, relative humidity

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 2022).

2.5.7 CALMET Performance

CALMET model performance was assessed by reviewing various model outputs, and their consistency with available observations, the terrain, land use, 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_{10}, $PM_{2.5}$, 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 pollutant concentrations are predicted. A Cartesian nested grid of receptors was defined within the study area, as per the AQDMG (ENV 2022). 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.

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.

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 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 below in Table 2-6.

Table 2-6: Point Source Parameters for Existing Permitted and Proposed Future Sources

Source	Scenario	Stack Height (m)	Stack Inner Diameter (m)	Exit Velocity (m/s)	Exit Temp (°C)	Building Downwash (y/n)
Resaw/Planer Mill Baghouse	Existing Permitted and Future Proposed	10	1.2	20.6	293.2	Y
Chipper Cyclone 1	Existing Permitted and Future Proposed	15	0.8	6.2	293.2	Y
Planer Mill Baghouse 2	Future Proposed	22.1	1.6	6.5	293.2	Y

2.6.5 Buoyant Area Source Parameters

The Kiln exhaust through vents along the walls and are thus not point sources. However, the air release is heated and is thus warmer that ambient and more buoyant than a standard area source release in CALPUFF which does not include the temperature of the release. Emissions from the kiln for both scenarios were modelled as buoyant area sources in CALPUFF. Buoyant area source parameters for both existing and proposed future sources are provided in Table 2-7.

The kilns exhaust through vents at the roofline, so the emissions height was set equal to the building height. The effective radius, R_{eff} was set as that of a circle with the same area as the footprint of the kilns. For sources with a large heat release – such as a flare or a forest fire there is an initial expansion of the emitted air prior to dispersion. R_{eff} is intended for this purpose, but while the kiln are warms, there is not a significant expansion prior to dispersion, so Reff was just set to approximate the size of the kilns themselves. The initial vertical velocity, W_{eff}, and initial plume height, $Sigma_Z$, where set to nominal values of 1 m/s and 1 m, respectively.

Table 2-7: Buoyant Area Source Parameters for Existing Permitted and Proposed Future Sources.

Source	Scenario	Emissions Height (m)	Exit Temp (°C)	Weff (m/s)	Reff (m)	$Sigma_z$ (m)
Lumber Dry Kilns	Existing Permitted	10.7	361	1.0	37.2	1
Continuous Kilns	Future Proposed	9.1	361	1	18.0	1
Small Continuous Kilns	Future Proposed	9.1	361	1	15.9	1
Specialty Kilns	Future Proposed	9.1	361	1	16.2	1

2.6.6 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 modeling. Building dimensions required for estimation of downwash were provided by Sinclar or estimated based on site plans and approved by Sinclar.

2.6.7 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.

Due to the low predicted emissions, for simplicity, NO_x to NO_2 conversion was assumed to be 100%.

2.6.8 Model Limitations

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

By definition, air quality dispersion models 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.

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 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

3.1 Dispersion Model Predictions

A summary of CALPUFF dispersion modelling results for the Existing and Future Propose scenarios is presented in Tables 3-1 and 3-2, For each scenario, maximum predicted levels for applicable averaging periods are compared with their respective air quality objectives. 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.

A spatial plot for each pollutant and averaging time of interest, with and without background concentrations for both the Existing and Future scenarios is provided in Appendix D.

Table 3-1: Existing Sources Predicted $PM_{2.5}$, PM_{10}, NO_2, and VOC concentrations.

Contaminant [1]	Averaging Period	BC AAQO [1] (µg/m³)	CAAQS 2020 [1] (µg/m³)	CAAQS 2025 [1] (µg/m³)	Project Contribution (without BG) (µg/m³)	Background (µg/m3)	Cumulative (with BG) (µg/m³)
$PM_{2.5}$ [2]	24	25	27	-	9.9	11.6	21.5
$PM_{2.5}$	Annual	8	8.8	-	1.8	4.5	6.3
PM_{10}	24-hour	50	-	-	**108**	21.2	**129.2**
NO_2	1-hour	113	113	79	7.5	10.2	17.7
NO_2	Annual	32	32	23	0.8	3.4	4.2
VOC	24-hour	NA	NA	NA	1.7	-	1.7
VOC	Annual	NA	NA	NA	0.4	-	0.4

Notes:
[1] 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.
[2] 98th percentile of daily average.
[3] 98th percentile of the daily 1-hour maximum.
***** Values in bold font signify exceedances from objectives.

Table 3-2: Proposed Future Sources Predicted $PM_{2.5}$, PM_{10}, NO_2, and VOC concentrations.

Contaminant [1]	Averaging Period	BC AAQO [1] (µg/m³)	CAAQS 2020 [1] (µg/m³)	CAAQS 2025 [1] (µg/m³)	Project Contribution (without BG) (µg/m³)	Background (µg/m³)	Cumulative (with BG) (µg/m³)
$PM_{2.5}$ [2]	24	25	27	-	20.4	11.6	**32.0**
$PM_{2.5}$	Annual	8	8.8	-	6.6	4.5	11.1
PM_{10}	24-hour	50	-	-	**112.6**	21.2	**133.8**
NO_2	1-hour	113	113	79	14.5	10.2	24.7
NO_2	Annual	32	32	23	2.1	3.4	5.5
VOC	24-hour	NA	NA	NA	8.8	**-**	8.8
VOC	Annual	NA	NA	NA	1.8	**-**	1.8

Notes:
[1] 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.
[2] 98th percentile of daily average.
[3] 98th percentile of the daily 1-hour maximum.
***** Values in bold font signify exceedances from objectives.

Plots of the spatial distribution of model predictions for contaminants of interest for the Existing and Future with and without background throughout the entire model domain are provided in Appendix D.

3.2 Discussion

Note: In the following discussion the averaging period given refers to the specific metric used to define the ambient objective for that pollutant and averaging time as is defined in the footnotes for Table 2-1. For example, '24-hour $PM_{2.5}$' is short for 'the annual 98th percentile of daily average $PM_{2.5}$ averaged over 3-years'.

Maximum predicted ambient concentrations of NO_2 are well below both the annual and 24-hour objectives for both the Existing and Future sources scenarios, even when assuming 100% conversion of $N0_x$ to NO_2. For the existing scenario the maximum 1-hour concentration from the Project alone is 7.5 µg/m^3 and is 17.7 µg/m^3 with background included. The maximum Project increment is less than 10% of the 2020 CAAQS value of 113 µg/m^3

For the Future scenario, the maximum 1-hour concentration from the Project alone is 14.5 µg/m^3 and is 24.7 µg/m^3 with background included. The Project results in an increase of approximately 7 µg/m^3 in the maximum predicted 1-hour within about 100m of the Project boundary. The maximum concentration including background of 24.7 µg/m^3 is less than 25% of the 1-hour objective.

Similarly, predicted annual NO_2 concentrations for both the Existing and Future scenarios are also well below objectives. For the Existing scenario the predicted maximum annual concentration from the Project alone is 0.8 µg/m^3 and is 3.4 µg/m^3 with background included. For the Future scenario, the maximum 1-hour concentration from the Project alone is 2.1 µg/m^3 and is 5.5 µg/m^3 with background included. The Project contributes an increase in annual NO_2 near the facility boundary of approximately 2 µg/m^3. Resulting annual concentrations are again a small proportional of the annual ambient NO_2 objective of 32 µg/m^3.

Predicted ambient concentrations of $PM_{2.5}$ are well below the annual and 24-hour objectives for the Existing scenario both with and without background added. The maximum predicted 24-hour concentration is 9.9 µg/m^3. The 24-hr background $PM_{2.5}$ is 11.6 µg/m^3 for a cumulative 24-hr concentrations of 21.5 µg/m^3, below the CAAQS objective 27 µg/m^3. Predicted annual average $PM_{2.5}$ is also less than the ambient objectives both with and without background. The modelled annual average $PM_{2.5}$ for Existing sources was 1.8 µg/m^3, with a background of 4.5 µg/m^3, resulting is a cumulative predicted concentration of 6.3 µg/m^3, less than the annual objective of 8 µg/m^3.

Predicted ambient concentrations of $PM_{2.5}$ are below and 24-hour and annual objectives for Future scenario sources alone. The maximum predicted 24-hour and annual concentrations for Future sources are 20.4 µg/m3 and 6.6 µg/m^3, compared the objectives of 27 µg/m^3 and 8 µg/m^3, respectively.

There is an increase of 10.5 µg/m^3 in the predicted 24-hour 4.8 µg/m^3 in the 24-hour and annual averages respectively for Future compared to Existing sources. The area of increased predictions maximums is mainly located near the Project fenceline over the neighbouring industrial area to the south, adjacent to the location of the new baghouse and kilns.

When background $PM_{2.5}$ concentrations are included, there are exceedances of the 24-hour and annual objectives. The 24-hour and annual average predictions of $PM_{2.5}$ for Futures sources with background included are 32.0 µg/m^3 and 11.1 µg/m^3, above the objectives of 25 µg/m^3 and 8 µg/m^3, respectively. Predicted $PM_{2.5}$ exceedances for the Future scenario with background included are limited to within approximately 100m of the facility boundary and mainly located to the south of the facility over industrial areas.

Predicted ambient concentrations of PM_{10} are above the 24-hour objective for both the Existing and Future scenarios, but there is minimal change in the maximum predictions between Existing and Proposed Future scenarios. The maximum 24-hr predictions with and without background are 108.0 and 129.2, respectively, for the Existing sources, and 112.6 µg/m^3 and 133.8 µg/m^3, respectively for the Proposed Future sources. As with $PM_{2.5}$, PM_{10} exceedances are limited to the areas immediately adjacent the Project, though the footprint of exceedances is slightly large for the Future Case.

The are no objectives for ambient VOC concentrations in place in BC. Model predicted concentrations are presented in terms of 24-hr and annual averages due to the potential for VOC to undergo transformation and/or oxidation into secondary organic aerosol that might contribute to $PM_{2.5}$ concentrations. The maximum 24-hr and annual predictions of VOC concentrations were 1.7 µg/m^3 and 0.4 µg/m^3, respectively, compared to 8.8 and 1.8 for the Proposed Future case.

Higher values of VOC that could potentially meaningfully affect PM concentrations are located close to the facility. Within 200-300 meters, 24-hr VOC predictions are less than 1 µg/m^3. Even at a low wind speed of 1 m/s, these distances represent 5 minutes or less of transit time from the emission source. The conversion of VOC to SOA depends on temperature and solar input, but even at times when reactions might be favored, the time scale of secondary formation is closer to hours than minutes. By the time any significant conversion to SOA has occurred the VOC plume will have dispersed to a point of having little to no impact on ambient $PM_{2.5}$.

There will be a transitional period during which the batch kilns will continue to operate while being phased out and the new continuous kilns are being brought up to capacity. This period has not been modelled explicitly as the exact timing of the process and which sources will be running when may vary. To instead model a transitional scenario where all existing and future sources are included at their maximum permitted rates would be overly conservative for a temporary configuration. The existing kilns will not be operating at full capacity as they are being phased out, nor will the continuous kilns be when they are first brought online, so the overall emissions totals will be less that both scenarios combined.

One may reasonably infer the potential results of the transitional period from the existing data and results. The emissions totals presented in Table 2-2 and Table 2-3 for the point sources and kilns, respectively, show that the kilns are the dominant sources of PM associated with the Project. Table 2-3 also shows that the emissions for the Existing Permitted batch kilns are about 40% of those for the Proposed Future continuous kilns. Further, Figure 3 shows that the Existing and Future kilns would be about 300 meters apart. This means that for all but a small percentage of wind directions the plumes from the kilns would not overlap, so any combined effect will be less than a direct sum of the emissions differences.

Therefore, even if the maximum permitted emissions were used to model a scenario of all sources combined, it would not fundamentally change the overall assessment of the Project. The maximum predicted PM concentrations would increase - with corresponding additional exceedances - but the model predictions would be of the same order of magnitude as for the Future Proposed scenario. The higher predictions would still be located in the areas currently indicated by the plots in Append D, but with the spatial footprint extending further out. However, all changes in magnitude or extent would be notably less than implied by the 40% additional emissions. For NO_2, model predicted concentrations for both scenarios are low enough that even if the maximum impact of each were combined the resulting prediction would still be well below ambient objectives.

For a more realistic transitional case where neither the Existing Permitted batch kilns nor the Future Proposed continuous kilns are operating at full capacity, local air quality changes are likely closely approximated by the results of the Future Proposed scenario.

Overall, the proposed project is predicted to result in minimal increases in ambient air quality parameters. There are small increases in predicted NO_2 concentrations, but maximum predictions close to the facility are well below ambient objectives. The Project does result in predicted exceedances of 24-hr and annual $PM_{2.5}$ objectives and additional exceedances of the 24-hr PM_{10} objective, but these are limited to within 100m of the facility boundary to the south over industrial areas and do not reach sensitive receptors such as the Church or dog kennels to the north. Elevation concentrations to the north were predicted to occur over a band of trees that will act as natural mitigation of airborne PM. There are predicted localized increases of VOC concentrations, but these are small and secondary PM formation is not likely to affect ambient PM levels in the vicinity of the Project. There are no predicted discernable changes to local air quality or human health.

4 SUMMARY

RWDI AIR Inc. (RWDI) was retained by Western Forest Products Inc (Western) to conduct an air quality assessment in support of a permit amendment for proposed additional air emission sources at Western's Value Added Division facility in Chemainus, BC (the Project). The proposed Project will see the replacement of ten (10) existing batch kilns with four (4) continuous kilns and two (2) specialty kilns. There will also be addition of one cyclone and an additional baghouse which will have a common exhaust point. All proposed major point sources of PM, NO_2, and VOC associated with proposed changes to operations onsite were included in the study.

Two emissions scenarios were considered as follows:

- **An Existing Scenario**, in which the contribution of sources currently permitted PA-1325 are assessed, consisting of:
    - Resaw/Planer Mill Baghouse
    - Chipper Cyclone 1
    - Lumber Dry Kilns 1-10
- **A Proposed Future Scenario**, in which proposed changes to facility sources are assessed, consisting of:
    - Resaw/Planer Mill Baghouse
    - Chipper Cyclone 1
    - Planer Mill Baghouse 2
    - Two (2) Continuous Kilns
    - Two (2) Small Continuous Kilns
    - Two (2) Specialty Batch Kilns

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.

Overall, the proposed project is predicted to result in minimal increases in ambient air quality parameters. There are small increases in predicted NO_2 concentrations, but maximum predictions close to the facility are well below ambient objectives. The Project does result in predicted exceedances of 24-hr and annual $PM_{2.5}$ objectives and additional exceedances of the 24-hr PM_{10} objective, but these are limited to within 100m of the facility boundary to the south over industrial areas and do not reach sensitive receptors such as the Church or dog kennels to the north. Elevation concentrations to the north were predicted to occur over a band of trees that will act as natural mitigation of airborne PM. There are predicted localized increases of VOC concentrations, but these are small and secondary PM formation is not likely to affect ambient PM levels in the vicinity of the Project. There are no predicted discernable changes to local air quality or human health

5 STATEMENT OF LIMITATION

This report entitled "Western Forest Products Inc. Air Quality Assessment Value Added Division Chemainus" was prepared by RWDI AIR Inc. ("RWDI") for Western Forest Products Inc. ("Client"). The findings and conclusions presented in this report have been prepared for the Client and are specific to the project described herein ("Project"). The conclusions and recommendations contained in this report are based on the information available to RWDI when this report was prepared. Because the contents of this report may not reflect the final design of the Project or subsequent changes made after the date of this report, RWDI recommends that it be retained by Client during the final stages of the Project to verify that the results and recommendations provided in this report have been correctly interpreted in the final design of the Project.

The conclusions and recommendations contained in this report have also been made for the specific purpose(s) set out herein. Should the Client or any other third party utilize the report and/or implement the conclusions and recommendations contained therein for any other purpose or Project without the involvement of RWDI, the Client or such third party assumes any and all risk of any and all consequences arising from such use and RWDI accepts no responsibility for any liability, loss, or damage of any kind suffered by Client or any other third party arising therefrom.

Finally, it is imperative that the Client and/or any party relying on the conclusions and recommendations in this report carefully review the stated assumptions contained herein and to understand the different factors which may impact the conclusions and recommendations provided.

6 REFERENCES

ENV. 2022. Guidelines for Air Quality Dispersion Modelling in British Columbia. British Columbia Ministry of Environment, November, 2015. Accessed: Dec 2024.

ENV. Nov. 2021. 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_air_qual_objectives_fact_sheet.pdf. Accessed: Dec. 2024.

Envista Web. 2024. BC Air Data Archive. Available at: https://envistaweb.env.gov.bc.ca. Accessed: Nov. 2024.

APPENDIX A

Dispersion Modelling Plan

An electronic version of this plan 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: *2024-October-25*

Facility Name, Company, Location (Lat, Long): *WESTERN FOREST PRODUCTS INC., Chemainus Value Added Division, 9469 Trans Canada Highway, Chemainus, BC, V0R 1K4*

Air Quality Consultant and Contact Name: *RWDI Air Inc, Jeff Lundgren*

Ministry Contact Name: Nick Davey

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

The modeling is being done in support of a standard/generic permit or amendment process, which would imply a Level 2 assessment. However, there are multiple sources and varied land use – forest, urban, water – in the model area. Also, PM and NOx are main pollutants of concern and 3-years of modelling are required to properly calculate metrics for application of CAAQS objective for each. Thus, use of a refined model and multiple years of data is required, which indicates a Level 3 assessment.

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:

The modelling methodology – use of a refined model (CALPUFF) over multiple years – has been used for several assessments of forest sector-based emissions, such as:

Sinclar Vanderhoof Ben Weinstein

Pinnacle Renewables Lavington Ralph Adams

Pinnacle Renewables Smithers Ralph Adams

Pinnacle Renewables Williams Lake Ralph Adams

PROJECT DESCRIPTION AND GEOGRAPHIC SETTING

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

The proposed Project is an upgrade to Western Forest Products Inc. Value-Added Division, a remanufacturing facility in Chemainus, BC that produces specialty wood products. The proposed Project will see the replacement of ten (10) existing batch kilns with four (4) continuous kilns and two (2) specialty kilns. There will also be addition of one cyclone and an additional baghouse which will have a common exhaust point.

Provide a description of the following:

- Terrain characteristics within domain: flat terrain or complex terrain (i.e., will complex flow need to be considered?)

Terrain within the proposed modelling domain is complex. There are elevations above 1000m to the west and open ocean to the east. Sea breeze and mountain breeze circulations will need to be considered. Use of a refined model is indicated.

- Dominant land cover: urban, rural, industrial, agricultural, forested, rock, water, grassland

Land cover is a mix of urban, forest, industrial and open water.

DISPERSION MODEL

<u>Selected Dispersion Model:</u>

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

- *CALPUFF v7.3.1*
- *CALMET v6.5.0*
- *CALPOST v7.1.0*

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

None.

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

None.

<u>Default Switch Settings</u>

- 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.

- *All CALMET switches used in the meteorological modelling will be in accordance with "black (do not touch)" defaults listed in the BC AQDMG.*
- *All CALPUFF switches used in this dispersion modelling will be in accordance with "black (do not touch)" defaults listed in the BC AQDMG.*

- If the CALMET model is used, provide:
  - a CALMET domain map that also shows the locations of surface meteorological stations and upper air stations
  - anticipated grid resolution: 250 (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):

n/a

- an AERMET/AERMOD domain map that shows the locations of surface meteorological stations, upper air stations and receptor grid

n/a

- anticipated sensitive receptors (see Section 7.4) and also indicate them on the domain map (if applicable)

n/a

- receptor (flagpole) height (m) (see Section 7.5):

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):

In accordance with BC AQDMG:

- *20 m receptor spacing along the plant boundary.*
- *50 m spacing within 500 m of source.*
- *250 m spacing within 2 km of source.*
- *500 m spacing within 5 km of source.*
- *1000 m spacing beyond 5 km of source.*

Nearby area mostly industrial – no schools, few residences that are not well captured by grid. Nearest residence ~500m to ENE (shown in GE snapshot)

Gridded receptor resolution will be sufficient to capture any exposure to population in model area

Ground level receptors (flagpole height of 0.0) will be used.

A map of the receptor grid is provided in Figure 3.

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*

Tables and Figures for Level 1 Assessment:

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

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

- *Spatial distribution maps of modelled short- and long-term average CAC concentration isopleths (relevant metrics for comparison with BC AAQO and CAAQS), exceedance frequencies (if any).*
- *Tables of maximum short- and long-term average CAC concentrations, and relevant background concentrations (relevant metrics for comparison with BC AAQO and CAAQS).*
- *Output spatial scale: over modelling domain and zoomed-in near the facility.*

EMISSION SOURCES AND CHARACTERISTICS

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

Please see attached Figures 1 and 2 for locations of existing and proposed sources, respectively.

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:

one scenario for the currently permitted emissions

one scenario for the proposed future emissions.

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)**
Existing Planer Mill Baghouse	*P*	*PM10 and PM2.5 (filterable)*	__X_approved/proposed emission limits ___manufacturer specifications _X__emission factors ___CEM ___modelled emission rates ___stack sample ___other (specify) *PA-13257*
10 Existing Kilns	Buoyant Area	*NOx, PM10,PM2.5 (filterable and condensable) and VOCs*	___approved/proposed emission limits ___manufacturer specifications _X_emission factors ___CEM ___modelled emission rates ___stack sample ___other (specify) *permitted heat release and emission factors, PA-13257*
Existing Chipper Cyclone	P	*PM10 and PM2.5 (filterable)*	__X_approved/proposed emission limits ___manufacturer specifications ___emission factors ___CEM ___modelled emission rates ___stack sample ___other (specify) *PA-13257*
6 additional kilns (single discharge)	Buoyant Area	*NOx, PM10,PM2.5 (filterable and condensable) and VOCs*	__X_approved/proposed emission limits ___manufacturer specifications _X__emission factors ___CEM ___modelled emission rates ___stack sample

			___other (specify) *permitted heat release and emission factors, amendment PA-13257*
Planer Cyclone	P	*PM10 and PM2.5 (filterable)*	__*X*_approved/proposed emission limits ___manufacturer specifications ___emission factors ___CEM ___modelled emission rates ___stack sample ___other (specify) *amendment PA-13257*
Baghouse #2	P	*PM10 and PM2.5 (filterable)*	__*X*_approved/proposed emission limits ___manufacturer specifications ___emission factors ___CEM ___modelled emission rates ___stack sample ___other (specify) *amendment PA-13257*

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

Size fractions for $PM_{2.5}$ and PM_{10} in relation to emissions of total particulate matter (TPM) will be estimated using the fractions for 'wood handling sources' given in the NPRI guidance for reporting emissions of 'Wood Products Operations'. https://www.canada.ca/en/environment-climate-change/services/national-pollutant-release-inventory/report/tools-calculating-emissions/wood-products-operations.html

No size fractions for kiln emissions are provided. Thus, All PM from kilns will be assumed to be $PM_{2.5}$.

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 sub-hourly variation

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

n/a

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.

n/a

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:

Note for PM_{10}: A search of the BC Envista online portal going back to 2013 shows that while station with PM10 on Vancouver Islan are listed, the download provides no data. Nearest PM10 stations across Georgia Strain are in Metro Vancouver so not similar setting, Closest station that is a smaller community is Langdale Elementary..

Representative Air Quality Measurements

Station Name (Lat./Long./ or indicate on map)	Period of Record (start/end date)	Contaminants Measured
Crofton Elementary (48.8600,-123.6439)	*01/01/2021 to 12/31/2023*	$PM_{2.5}$
Crofton Escarpment Way (48.8600,-123.6439)	*01/01/2011 to 12/31/2013*	$PM_{2.5}$, *NO*, NO_2
Crofton Georgia Heights (48.8496,-123.6370)	*01/01/2016 to 12/31/2018*	$PM_{2.5}$

Crofton Substation (48.8745,-123.6539)	*01/01/2022 to 12/31/2023*	*$PM_{2.5}$*
Langdale Elementary(49.439, -123.479	*01/01/2022 to 12/31/2023*	*PM_{10}*

Background from multiple stations calculated by determining appropriate value for each according to model guideline and then taking average. Table of background values is given below. All values in µg/m.[3]

Species	**Averaging Period**	**Monitoring Station**					**Background Value**
		Crofton Elementary	**Crofton Escarpment**	**Crofton Georgia Hgts**	**Crofton Substation**	**Langdale**	
PM_{25}	24HR	10.5	10.0	14.8	11.2		11.6
PM_{25}	ANN	4.0	4.0	5.8	4.2		4.5
PM_{10}	24HR					21.2	21.2
NO_2	1HR		10.2				10.2
NO_2	ANN		3.4				3.4

- 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 known changes from other facilities.

- 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).

A search of the NPRI database shows no large emitters of NOx in area. The NPRI Google Earth layer can be provided on request. Other sources of NOx will be from mobile vehicles or residential and/or industrial space heating.

- 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 98th percentile of daily 1-hour maximum and the 98th percentile of monthly hour-of-day values if proposing to use the Monthly Hour-of-Day option).

The Crofton Escarpment Station will be used to estimated background NOx concentrations, However it does not contain a long enough period of record to develop an ARM2 curve. The NOx->NO2 conversion will use the BC *specific ARM2 curve for coastal areas as given in Table A-2 of Guidance on NO2 Dispersion Modelling in British Columbia.*

- 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.

BUILDING DOWNWASH

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

There are several significant buildings on site. Downwash will be considered.

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

Source Height (m)	Distance from the Source to the Nearest Building (m)	Building Length (m)	Building Height (m)	Building Width (m)
Existing Planer Mill Baghouse	*3m*	*93m*	*9.1*	*65m*
Existing Chipper Mill Cyclone	*8m*	*93m*	*9.1*	*65m*
Baghouse #2	*7m*	*150m*	*10.7*	*40m*
Planer Cyclone	*7m*	*150m*	*10.7*	*40m*

GEOPHYSICAL DATA INPUT

Topography and Land Use Data

- Terrain data (*CDEM)* and an elevation map for the model domain:
- *See attached Figure 4*
- *Source of elevation data: https://open.canada.ca*

- Land use data (*LCC*) and land use map for the model domain:

- *See attached Figure 4: Land Use*
- *Source of landuse data: https://open.canada.ca/data*

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.

- *Recommended seasonally varied surface characteristics will be used. (note that the Strait of Georgia does not freeze in winter and snow accumulation is intermittent (mostly rains); therefore, Winter1 characteristics will be used throughout the winter season (no winter 2).*

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

Surface Meteorological Data

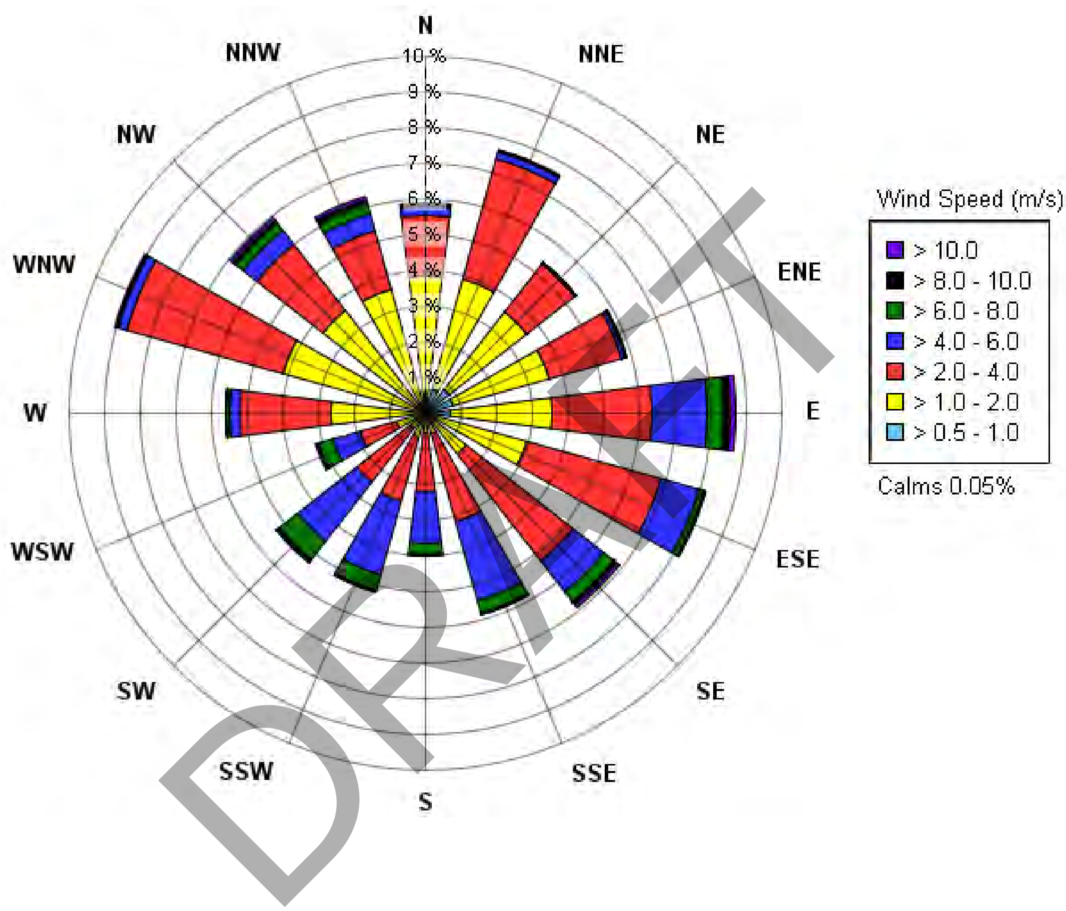
If surface observation data are used, provide a map with the location of each surface meteorological station identified and also provide the following:

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**
Crofton Met_60 (48.8802, -123.6458)	*The Ministry, through BC EnvistaWeb*	*01/01/2013 to 12/31/2015*	*0.05%*	*10m*	*Temperature, wind speed, and direction, relative humidity*
Cowichan North (48.8242,-123.7189)	*MSC*	*01/01/2013 to 12/31/2015*	*53.7%*	*10m*	*Temperature, relative humidity, pressure*
Duncan Cairnsmore (48.7850, -123.7158)	*The Ministry, through BC EnvistaWeb*	*01/01/2013 to 12/31/2015*	*26.4%*	*10m*	*Temperature, wind speed and direction, relative humidity*
Nanaimo Airport (49.05444, -123.8700)	*MSC*	*01/01/2013 to 12/31/2015*	*15.9%*	*10m*	*Temperature, wind speed, and direction, pressure, relative humidity*

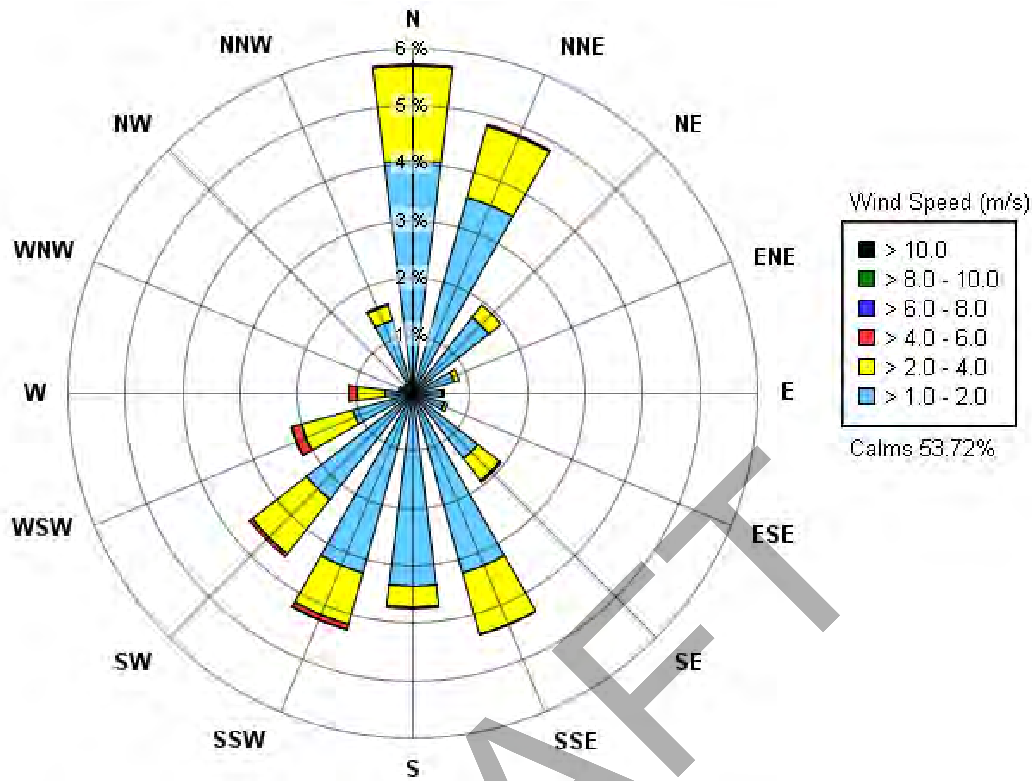
1. If data from a non - Ministry, MV or MSC station are planned to be used, follow guidance in Section 5.2.3
2. For data completeness and data filling, follow guidance in Section 5.5
3. For light and no wind conditions, follow guidance in Section 5.6

The location of each station is shown in attached Figure 4. Note that the Duncan and Nanaimo Stations lie outside of CALMET domain. They will therefore have limited to no influence on the wind field interpolation but are included to ensure there are no hours with missing data hours that would cause CALMET to fail.

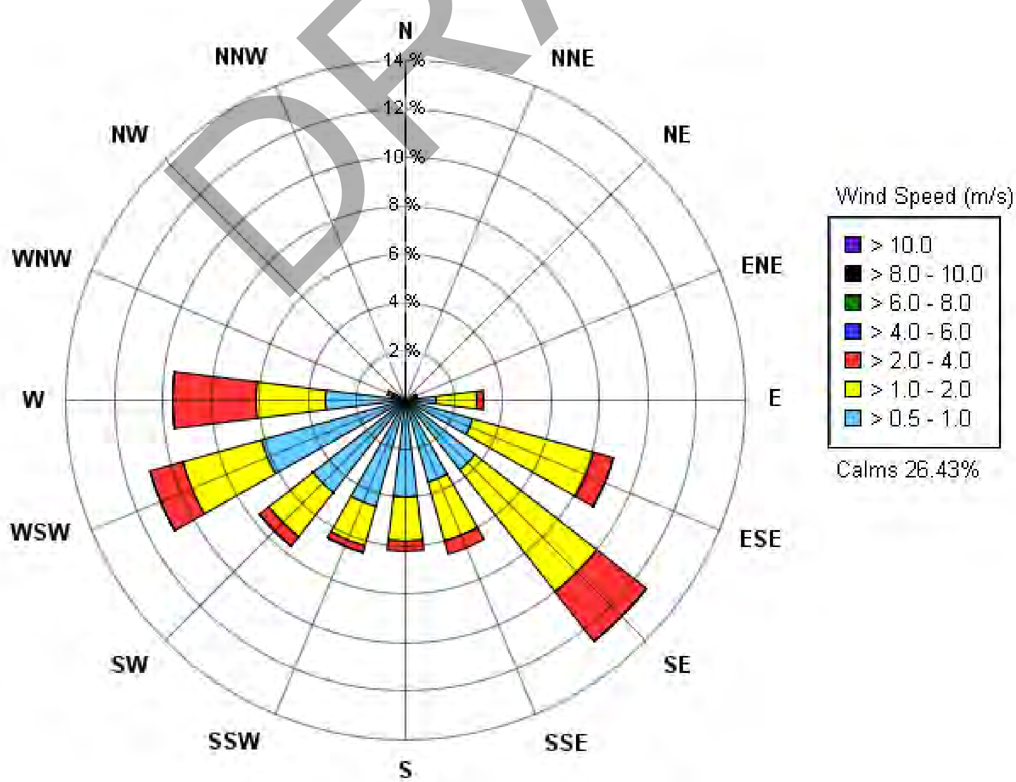
Wind Rose for Crofton_Met60 2013-2015



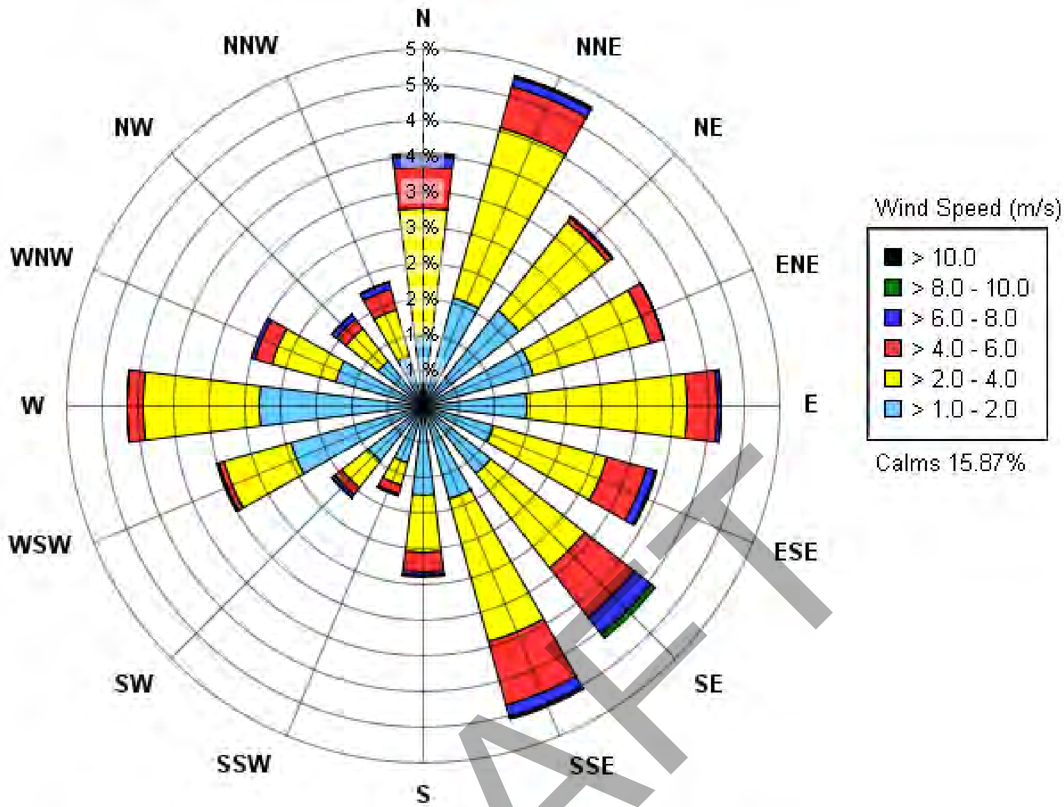
Wind Rose for Cowichan North 2013-2015



Wind Rose for Duncan Cairnsmore 2013-2015



Wind Rose for Nanaimo Airport 2013-2015



<u>Upper-Air Meteorological Data</u>

If upper air meteorological data are used provide the following:

No upper air stations – using BC province-wide WRF

Station Name	Period of Record (start/end date) [1]	Distance between the Upper Air Station and Project (km)
n/a		

[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):

The provincewide 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):

CALMET using Surface station with NWP

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.

_X____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.

- If a single site dataset is used, provide the dataset and completeness statistics (e.g., number of years, percent complete per quarter).

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

If ARM2 is to be used, the rural option with the agreed ambient station data will be used. Source of ambient NOx data will be determined in consultation with BCENV from available stations identified above if full conversion suggests further assessment needed.

_____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.

<u>Chemical Transformation:</u>

- 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.
  Secondary transformation of PM from NOx and Sox emissions will not be considered. There is a potential for emissions of VOC to undergo oxidation in PM as SOA. The ISORROPIA chemical mechanism is capable of simulating reaction of VOC into SOA, but it requires representative measurements background species such as ozone and NH3 that are not available. It is more suitable for regional application rather than for single facility assessments.
  A simplified estimate of the ratio of near source VOC to SOA transformation will be developed from public literature. As a first estimate – similar to how NOX to NO2 is presented – 100% conversion will be presented and further refinements undertaken as necessary.

<u>Particle Deposition:</u>

- 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.

n/a

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).

Occurrence of stagnation in noted in the calms frequencies for each station given in the tables and wind roses in preceding section. Note that use of BC WRF reduces the concerns of stagnation because the WRF model solution is not subject to a 'stall speed' (as wind that is present but too low to affect the sensor) as is an anemometer measurement, and this the assimilation of WRF and observation in CALMET will mitigate effect of calms in obs data. The low wind conditions that do occur at facility site will be handled by the internal calms processing in CALPUFF using the default threshold of 0.5 m/s.

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).

Though open ocean is included in the proposed CALMET domain, Western Forest Products Inc. VAD facility is approximately 2.5km from the shoreline. At that distance, the suggested CALMET grid spacing will be sufficient to resolve coast effects. Use of the sub-grid option not warranted.

Plume Condensation (Fogging) and Icing:

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

  Plume condensation and fogging will not be considered.

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

<u>Model Output Data</u>

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)

RWDI will fallow best practices as outlined in the model guideline. Examples of all the above will be included in the dispersion model report. Specific example of RDWI QA documentation can be see in the CALMET and CALPUFF Appendices attached to the reports for the similar previous studies cited previously in this model plan.

<u>Model Performance Evaluation</u>

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.

Though it is a Level 3 due to complex terrain and need for a refined model, it is still for a permit amendment application (as opposed to a Environmnetal Assessment) so the effort of a quantitative model evaluation is not necessary. In addition, the available data are some distance away and affected by many other sources than Western Forest Products Inc. VAD facility.

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: 2024-12-19

Current Scenario Sources: Emission Sources and Buildings

True North

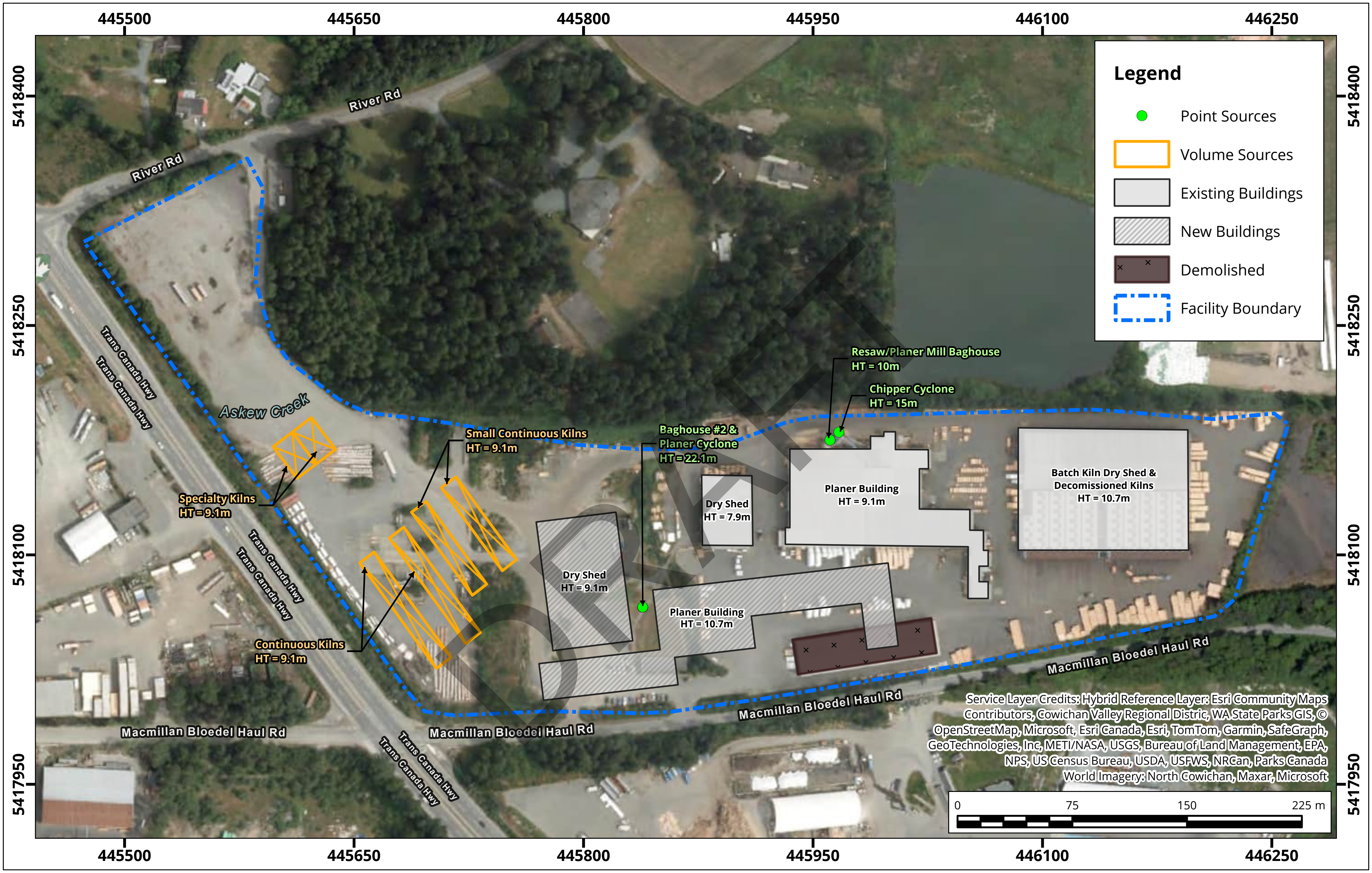
Drawn by: RCL	Figure: 1
Approx. Scale:	1:3,500
Date Revised:	Oct 22, 2024

Map Projection: NAD 1983 CSRS UTM Zone 10N

Western Forest Products | Value Added Division - Chemainus, B.C.

Project #: 2405727

Map Document: C:\GIS\2405727_WesternForest\P2405727_WesternForest_VAD.aprx



New Scenario Sources: Emission Sources and Buildings

True North

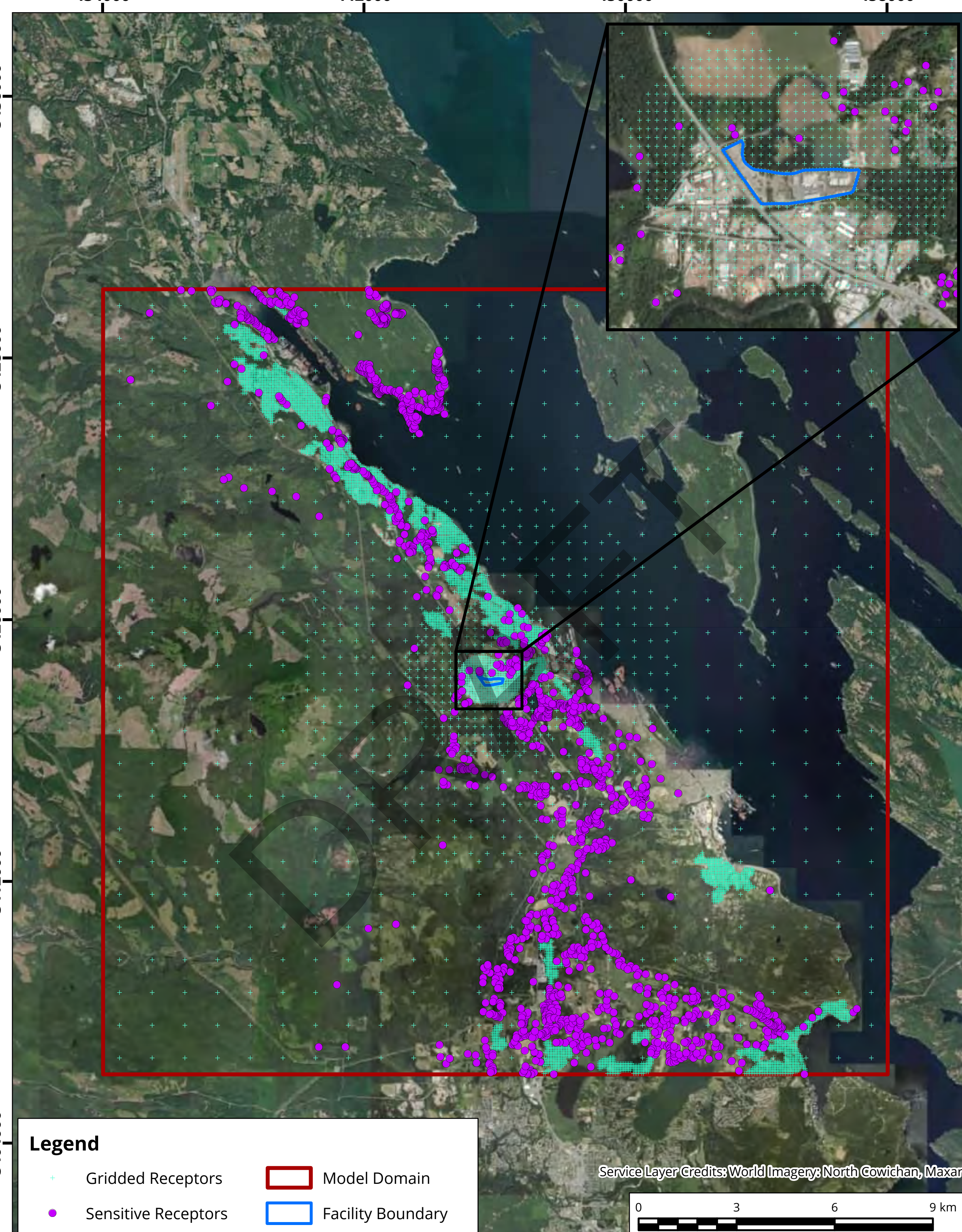
Drawn by: RCL	Figure: 2
Approx. Scale:	1:3,500
Date Revised:	Oct 22, 2024

Map Projection: NAD 1983 CSRS UTM Zone 10N

Western Forest Products | Value Added Division - Chemainus, B.C.

Project #: 2405727

Map Document: C:\GIS\2405727_WesternForest\P2405727_WesternForest_VAD.aprx



Map Document: C:\GIS\2405727_WesternForest\P2405727_WesternForest_VAD.aprx

Receptors in the Model Domain

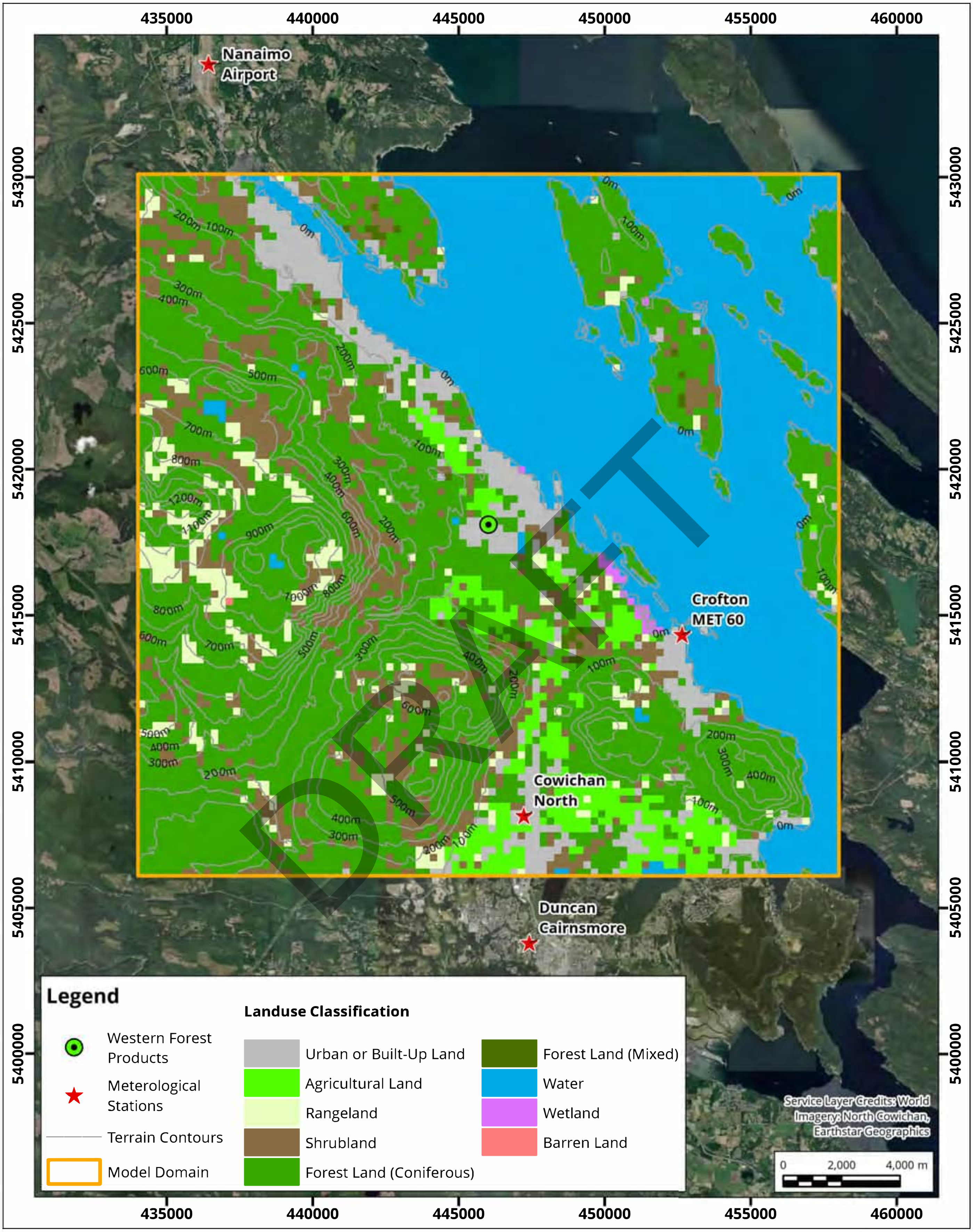
True North

Drawn by: RCL	Figure: 3
Approx. Scale:	1:170,000
Date Revised:	Oct 22, 2024

Map Projection: NAD 1983 UTM Zone 10N

Western Forest Products | Value Added Division - Chemainus, B.C.

Project #: 2405727



Map Document: C:\WorkingFolder\Jobs_America\P2405727\P2405727.aprx

Terrain Elevations and Land Use in CALMET Domain

True North

Drawn by: PIP	Figure: 4	
Approx. Scale:	1:180,000	
Date Revised:	Nov 29, 2024	

Map Projection: NAD 1983 UTM Zone 10N

Western Forest Products - North Cowichan, British Columbia

Project #: 2405727

APPENDIX B

B.1 INTRODUCTION

This Appendix provides details on CALMET (Section B.2) and CALPUFF (Section B.4) inputs that are not provided in the main text of the Air Quality Analysis Memo for the Sinclar Group Forest Products LTD. – Premium Pellet Project. Representative CALMET output is shown and briefly discussed in Section B.3 to demonstrate that CALMET produces meteorological input to CALPUFF that is consistent with observed and expected meteorological conditions. Terrain and land use in the study area are shown in Figure B.1

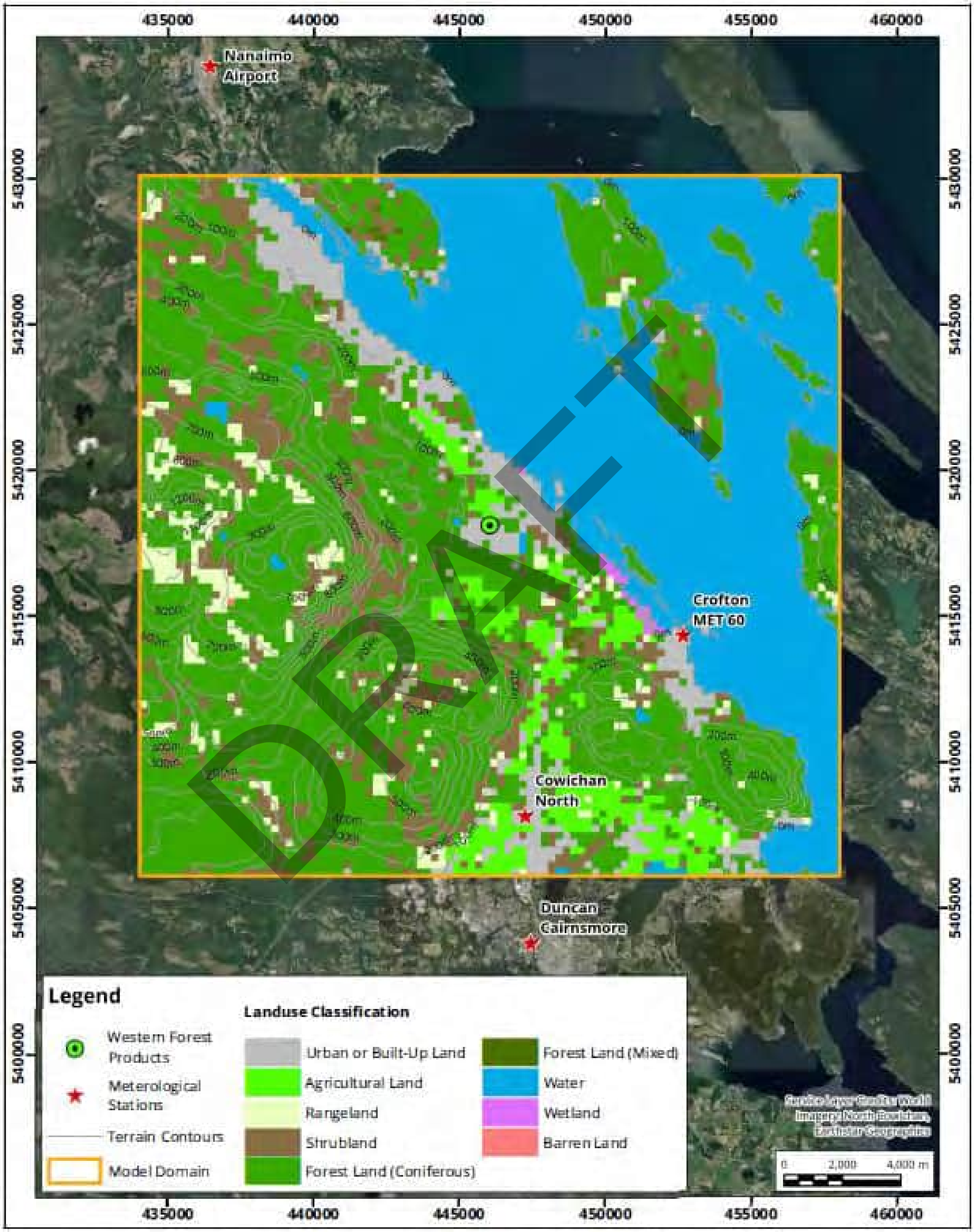


Figure B.1: Terrain Elevation and Land Use in CALMET Domain

B.2 CALMET

CALMET settings

This section presents the input parameters selected to run CALMET (Table B.1, Table B.2 and Table B.3).

Table B.1: CALMET model switch settings group 4 - Wind Field Options and Parameters

Parameter	Default	Project	Comments
NOOBS	0	1	Use of surface observations (surface stations) and mesoscale WRF model for upper air data.
NPSTA	N/A	-1	Interpolate WRF precipitation
MCLOUD	999	4	Cloud fields from prognostic model (MM5toGrads algorithm)

Table B.2: CALMET model switch settings group 5 - Wind Field Options and Parameters

Parameter	Default	Project	Comments
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 at top of domain
ISLOPE	1	1	Slope flow effects computed
IEXTRP	-4	-4	Extrapolate surface observations using similarity theory.
ICALM	0	0	Surface winds not extrapolated if calm
BIAS	NZ*0	NZ*0	Irrelevant since no upper air station data
RMIN2	4	-1	Ensure extrapolation of all surface stations
IPROG	0	14	WRF prognostic model output for initial guess field
ISTEPPGS	3600	3600	Hourly WRF fields
LVARY	F	F	Varying radius of influence not used
RMAX1	NA	8	Maximum radius of influence to use observed surface data in the surface layer
RMAX2	NA	8	Maximum radius of influence to use observed data in aloft data
RMAX3	NA	20	Irrelevant (no overwater stations)
RMIN	0.1	0.1	Small value (default value) to prevent divide-by-zero error
TERRAD	NA	4	Nearest significant hill is 4 km away from the site
R1	NA	4	Favors terrain effects over observed winds further away from met station locations
R2	NA	6	Favors terrain effects over vertically extrapolated observed winds further away from met station locations
NBAR	0	0	Barriers not used
ISURFT	-1	-1	Diagnostic module surface temperatures based on 2-D spatially varying temperature field
IDIOPT2	0	0	Lapse rate computed internally
IUPT	-1	-1	Upper air stations not used
ZUPT	200	200	Lapse rate computed for default depth

Table B.3: CALMET model switch settings group 6 - Mixing Height, Temperature and Precipitation Parameters

Parameter	Default	Project	Comments
IAVEZI	1	1	Conduct spatial averaging of mixing height
MNMDAV	1	1	limited upwind averaging of mixing height (coastal situation with explicit TIBL in CALPUFF)
HAFANG	30	30	Half-angle of upwind looking cone for upwind averaging of mixing height and temperature
ILEVZI	1	1	Layer of winds used in upwind averaging of mixing height
IMIXH	1	1	Method to compute the convective mixing height (Maul Carson for land and water)
THRESHL	0	0	Threshold buoyancy flux required to sustain convective mixing height growth overland (W/m^3)
THRESHW	0.05	0.05	Threshold buoyancy flux required to sustain convective mixing height growth overwater (W/m^3)
IZICRLX	1	1	Flag to allow relaxation of convective mixing height to equilibrium value
TZICRLX	800	800	Relaxation time of convective mixing height to equilibrium value
ITWPROG	0	0	No observed overwater data, therefore, assume neutral conditions (default setting)
ILUOC3D	16	16	Ocean land use category in WRF datasets
ZIMIN	50	50	Default minimum overland mixing height (m)
ZIMAX	3000	3000	Default maximum overland mixing height (m)
ZIMINW	50	50	Default minimum over-water mixing height (m)
ZIMAXW	3000	3000	Default maximum over-water mixing height (m)
ICOARE	10	10	COARE with no wave parameterization
IRHPROG	0	0	3D relative humidity from observations
ITPROG	0	2	3D temperature from prognostic data
IRAD	1	1	temperature spatial interpolation based on 1/R
TRADKM	500	500	Default radius of influence for temperature interpolation (km)
NUMTS	5	5	Max number of stations to include for temperature interpolation (default setting)
IAVET	1	1	Conduct spatial averaging of temperatures
JWAT1	-	99	Disabled - Overwater temperatures from WRF.
JWAT2	-	99	Disabled - Overwater temperatures from WRF.
NFLAGP	2	2	Precipitation interpolation method ($1/R^2$)
SIGMAP	100	100	Radius of Influence (km) – reset automatically by CALMET to sqrt(2)* WRF resolution
CUTP	0.01	0.01	Default minimum precipitation rate cut-off (mm/hr)

B.2.1 Results

The CALMET model performance was assessed by reviewing various model outputs, and their consistency with available observations, the terrain, land use, location, diurnal and seasonal cycles.

B.2.1.1 Surface Winds

A wind rose displays the combined frequency distribution of wind speed and direction at a given location. Wind roses of the CALMET modelled wind speed and direction by season for 2013 - 2015 at the Western facility location are shown in Figure B.2a. Wind directions are predominantly from the west during the spring (top left) and summer (top right). Modelled CALMET results in the winter and spring seasons have a stronger northwest component.

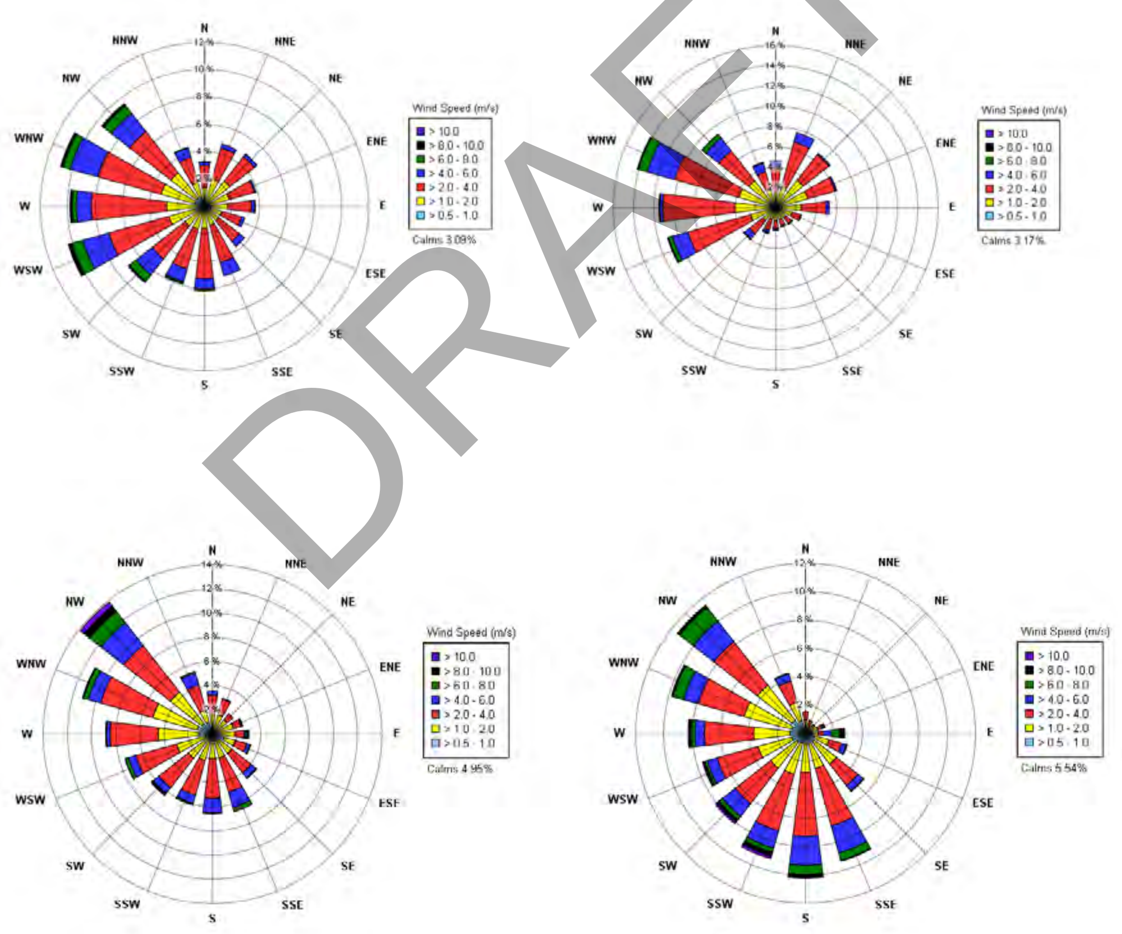
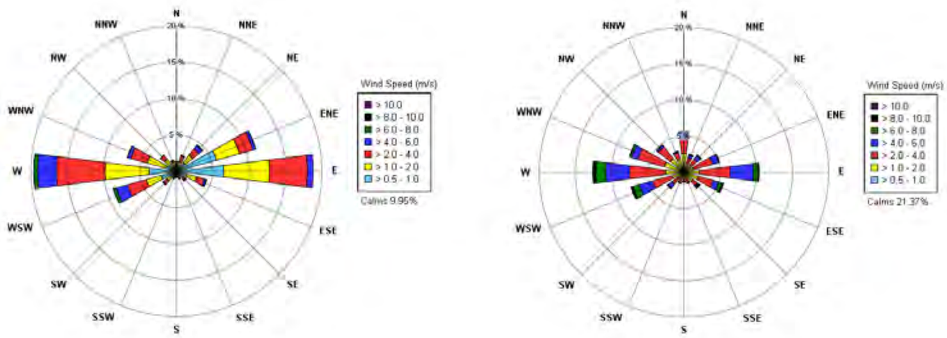


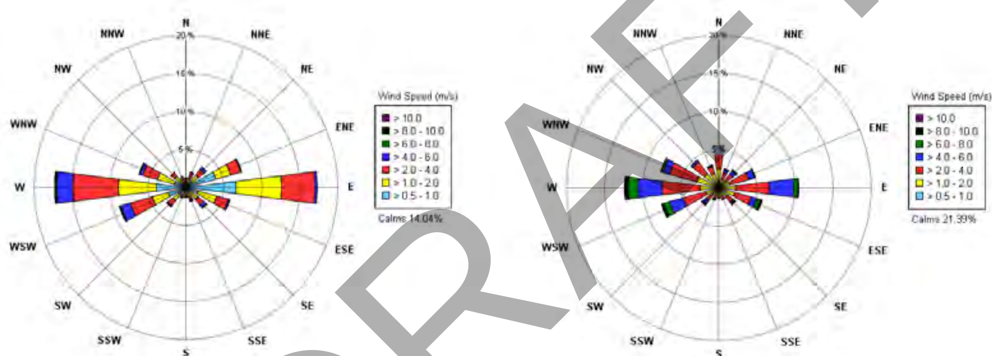
Figure B.2a: Seasonal CALMET wind roses of frequency of counts by wind direction for 2013 - 2015 for Western VAD: Spring (top left), Summer (top right), Fall (bottom left), and Winter (bottom right).

CALMET is designed to match the observations that have been assimilated in the modelling at the observation sites. Surface observations were used along with prognostic model output from WRF (Weather Research and Forecasting) data to determine the wind properties for the modelling domain. The observations, CALMET and WRF windroses are shown in Figure B.3

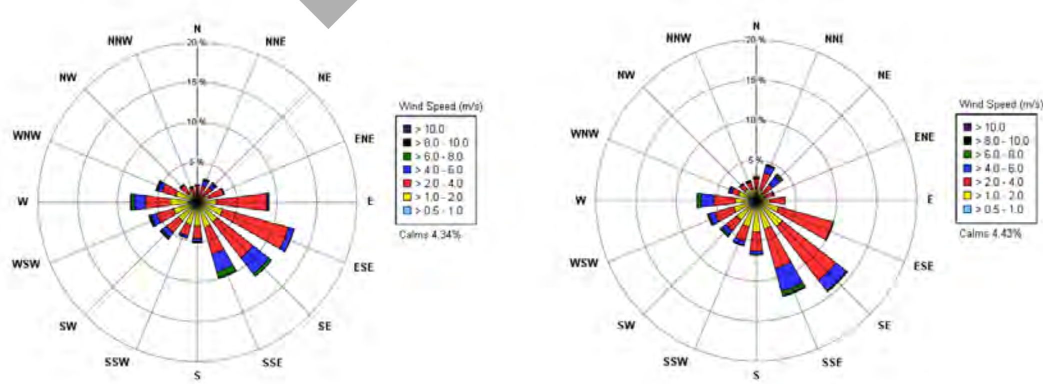
The observations differ somewhat in dominat directions versus what is produced by CALMET at the Western site. This is because the stations are quite distant from the Western location (Crofton is closest at approximately 6km). With any reasonable choice of R1 (a value of 4km was used) the interpolation at Western will be dominated by the winds in the BC WRF data, and this is reflected in the results.



Observations at Crofton Met_60 (left) and Cowichan North (right)



Modelled (CALMET) at Crofton Met_60 (left) and Cowichan North (right)



WRF data for Crofton Met_60 (left) and Cowichan North (right)

Figure B.3: Observed, CALMET, and WRF annual wind rose for 2013 - 2015 at Crofton Met_60 (left), and Cowichan North (right).

B.2.1.2 Pasquill-Gifford Stability Class

CALMET computes advanced stability and turbulence variables, such as the Monin-Obhukov length, for input into CALPUFF, but also outputs Pasquill-Gifford (PG) stability classes, which are often used to classify boundary layer stability. These PG 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 primarily associated with night-time cooling, which results in stable stratification and temperature inversion at lower levels. Neutral conditions are mostly associated with high wind speeds or overcast sky conditions.

The frequency distribution of CALMET-derived Pasquill-Gifford stability classes for the Project site is shown in Figure B.4. The most frequent stability class is Class D (neutral) occurring just under 40% of the time. Class F (or very stable) also occurred quite frequently just less than 25% of the time. This pattern is typical of locations in BC.

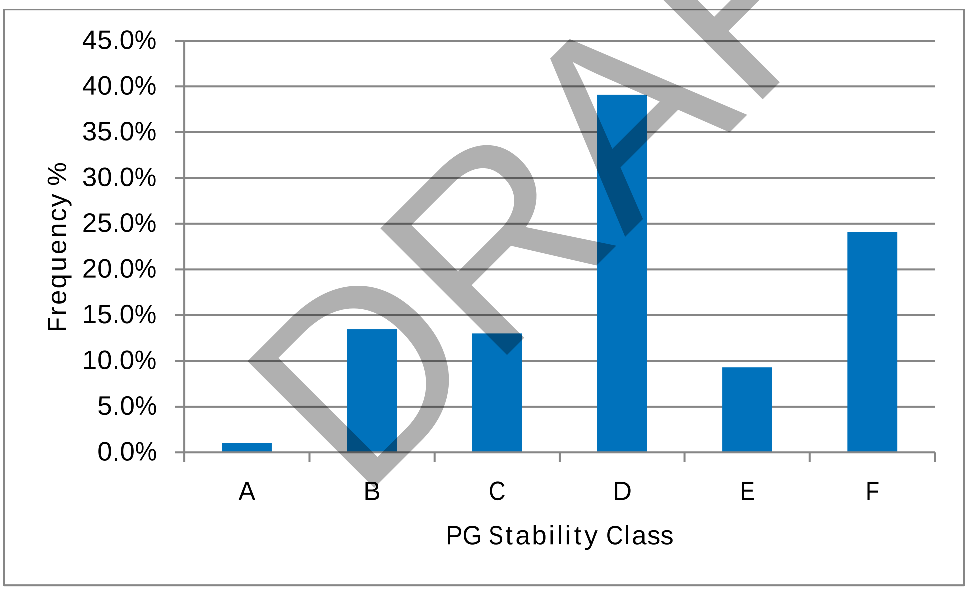


Figure B.4: Frequency of modelled Pasquill-Gifford stability classes at Western VAD.

B.2.1.3 Modelled Wind Fields

Winds in the study area result from a combination of large-scale synoptic patterns, and terrain driven circulations (upslope during daytime, downslope and channeling during nighttime). WRF winds, at 4 km resolution, capture the synoptic and thermal circulations well, and some of the terrain-induced circulations (to the extent they are resolved at the WRF spatial resolution of 4 km). CALMET refines the terrain effects further at the finer scale of 250 m used in the current modelling.

How well the model captures key meteorological patterns is best exemplified with wind vector plots, displaying the modelled wind speed and direction as arrows along the flow (with arrow length proportional to the wind speed, and arrows pointing downwind).

Modelled wind fields vector plots are illustrated in Figure B.5, for representative unstable, neutral, and stable conditions. CALMET-derived wind fields follow the expected terrain flows under various stability and flow regimes, with channeling by the terrain during stable conditions. Under neutral conditions, the characteristic high wind speeds result in less noticeable terrain effects and wind fields reflect larger mesoscale wind patterns across the model domain.

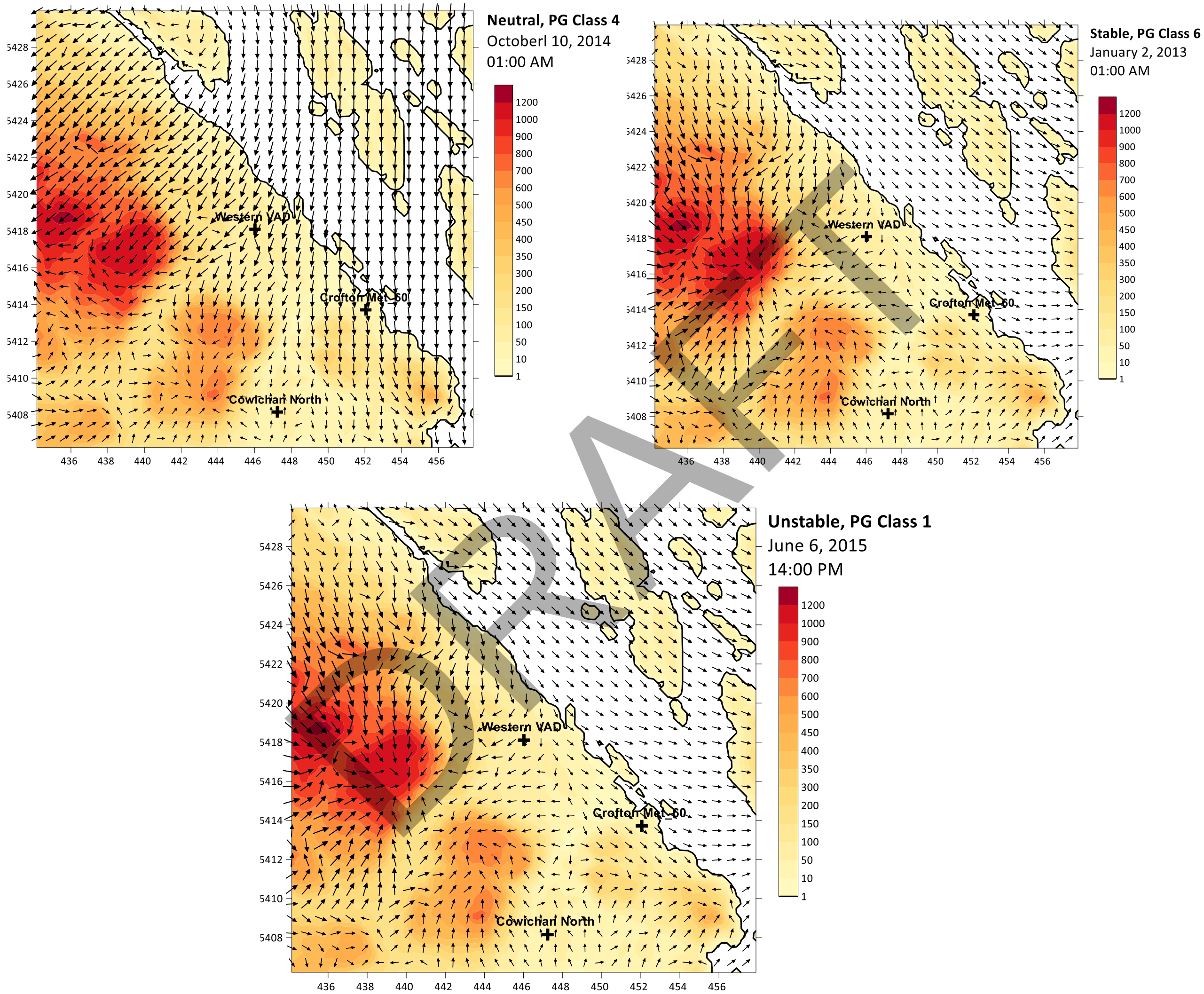


Figure B.5: Modelled wind fields at 10 m above ground level during stable, neutral, and unstable conditions. Note the different scales with the different atmospheric conditions, and difference in wind speed based on relative maximum arrow size.

B.2.1.4 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 B.2 shows the average modelled mixing heights by Pasquill-Gifford stability class. The highest mixing heights tend to be associated with unstable conditions (convective mixing heights) or neutral conditions (high winds leading to large mechanical mixing) while the lowest mixing heights are associated with stable conditions (Classes E and F), when both convective and mechanical turbulence are at their lowest.

The spatial distributions of mixing heights under stable, neutral, and unstable conditions are shown in Figures 6. Spatial changes in mixing height align with changes in the land use. During daytime, when convective mixing peaks overland, mixing heights tend to be lowest over water; during nighttime, when mechanical turbulence takes over, mixing heights are larger in areas where surface roughness is greater (i.e., where surface elements are larger) and winds are stronger.

Diurnal variations in mixing heights are shown in Figure B.7, respectively for a summer day (July 6, 2014) and a typical winter day (January 7, 2015). Mixing heights increase after sunrise due to solar heating and enhanced convection; growth is sometimes hindered by cloud (reduced insolation). Convective mixing heights crash abruptly at sunset (i.e. earlier in winter than in summer) and wind driven mechanical turbulence then dominates during the night, with mixing height correlating with wind speed. Daytime mixing heights may be suppressed during stable winter conditions due to weak solar insolation, low wind speeds and synoptic subsidence.

Table B.2: Modelled mixing height by Pasquill-Gifford Stability Class (in m).

Location		A	B	C	D	E	F
Western VAD	Average	770	683	567	566	612	274
	Range	364 – 1,591	97 -1,917	50 - 2,124	50 - 2,304	50 - 1,600	50 - 1251

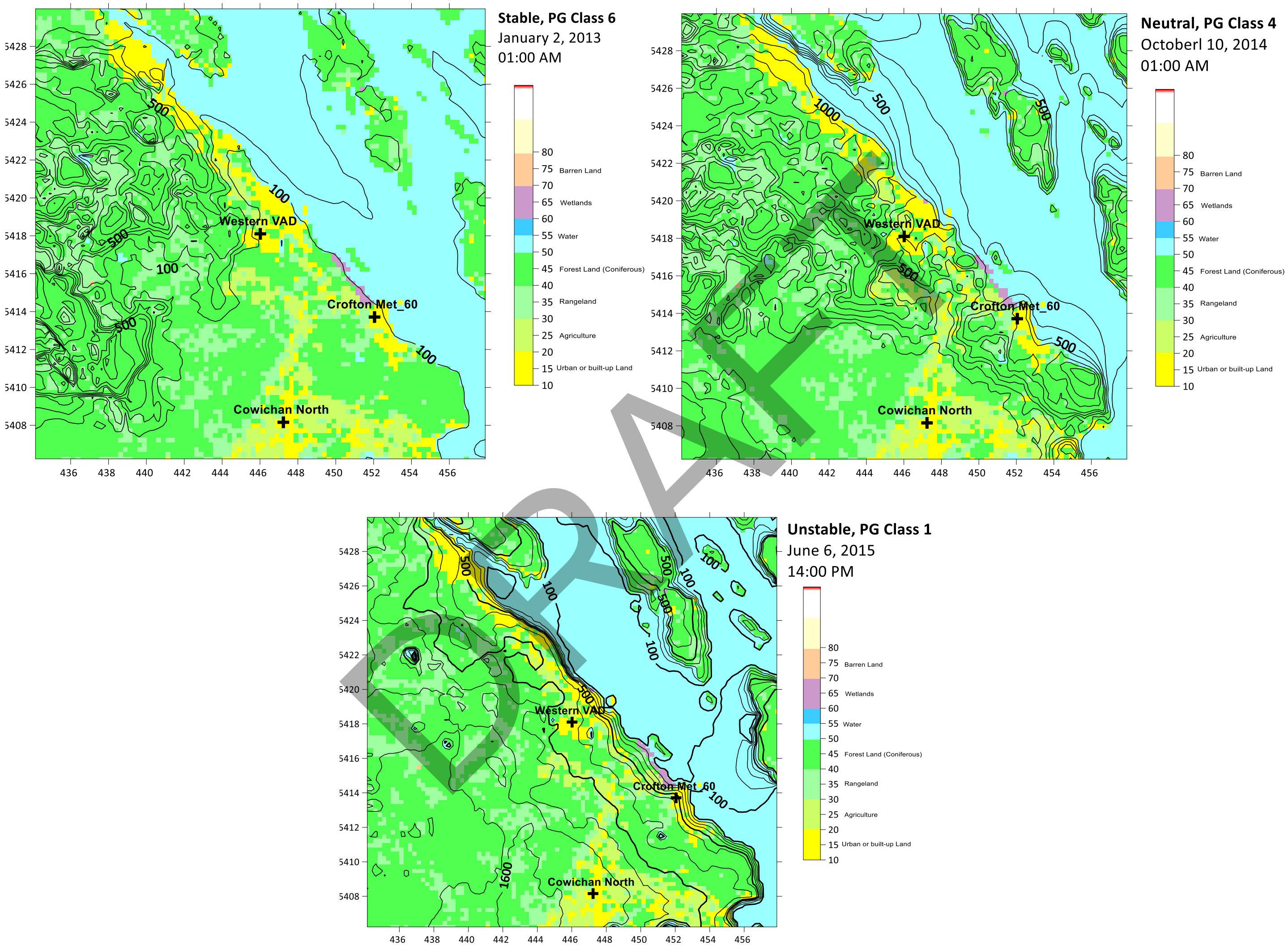


Figure B.6: Modelled mixing heights and land cover characterization during stable, neutral, and unstable atmospheric conditions. Note the different scaling for the boundary layer heights for each of the atmospheric conditions

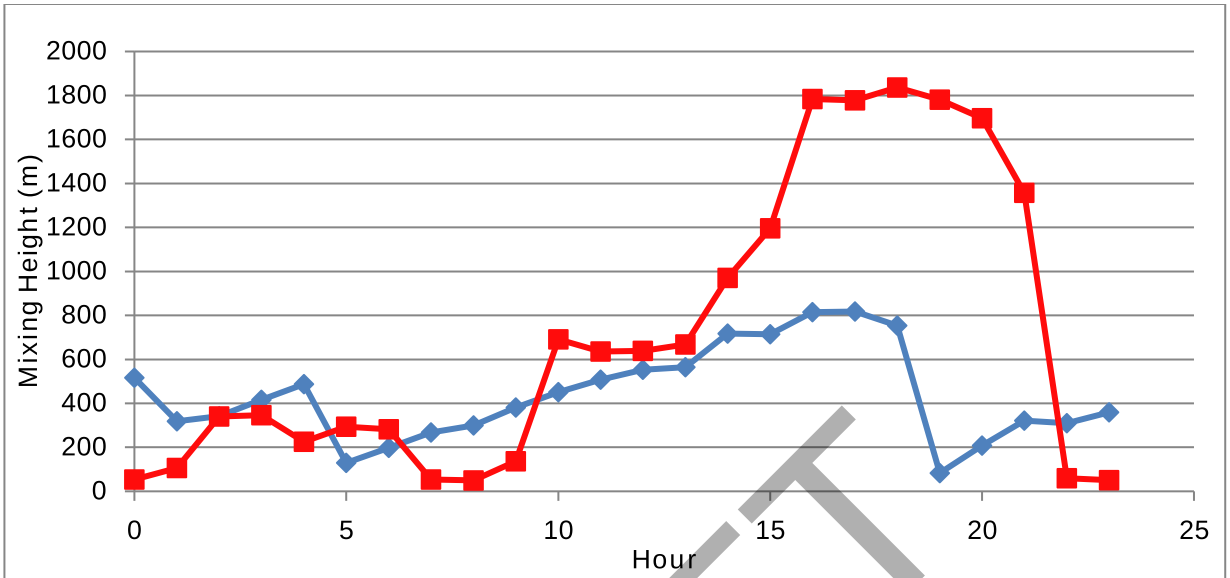


Figure B.7: Diurnal variation of modelled mixing heights. Summer and Winter examples for Western VAD (Winter: January 7, 2015; Summer: July 6, 2014).

B.2.1.5 Precipitation

Observed precipitation from the Environment and Climate Change Canada 30-year climate normals (1981 to 2010) at Nanaimo Airport are displayed in Figure B.8, showing the least amount of precipitation in the spring months and the greatest amount of precipitation in the fall and winter.

CALMET interpolates rainfall rates predicted by WRF (no observations). Average modelled monthly precipitation for 2013-2015 is shown in Figure B.9. WRF simulated precipitation is similar to the climate normal, although January precipitation is a underpredicted and September overpredicted in the WRF data. Note that wet deposition of particulate matter (PM) was not considered in the study (conservative for ambient PM concentrations), but precipitation is reflective of the overall meteorology in the area and therefore a good indicator of the meteorological model rainfall performance; in this case, the WRF MOE (Ministry of Environment) dataset.

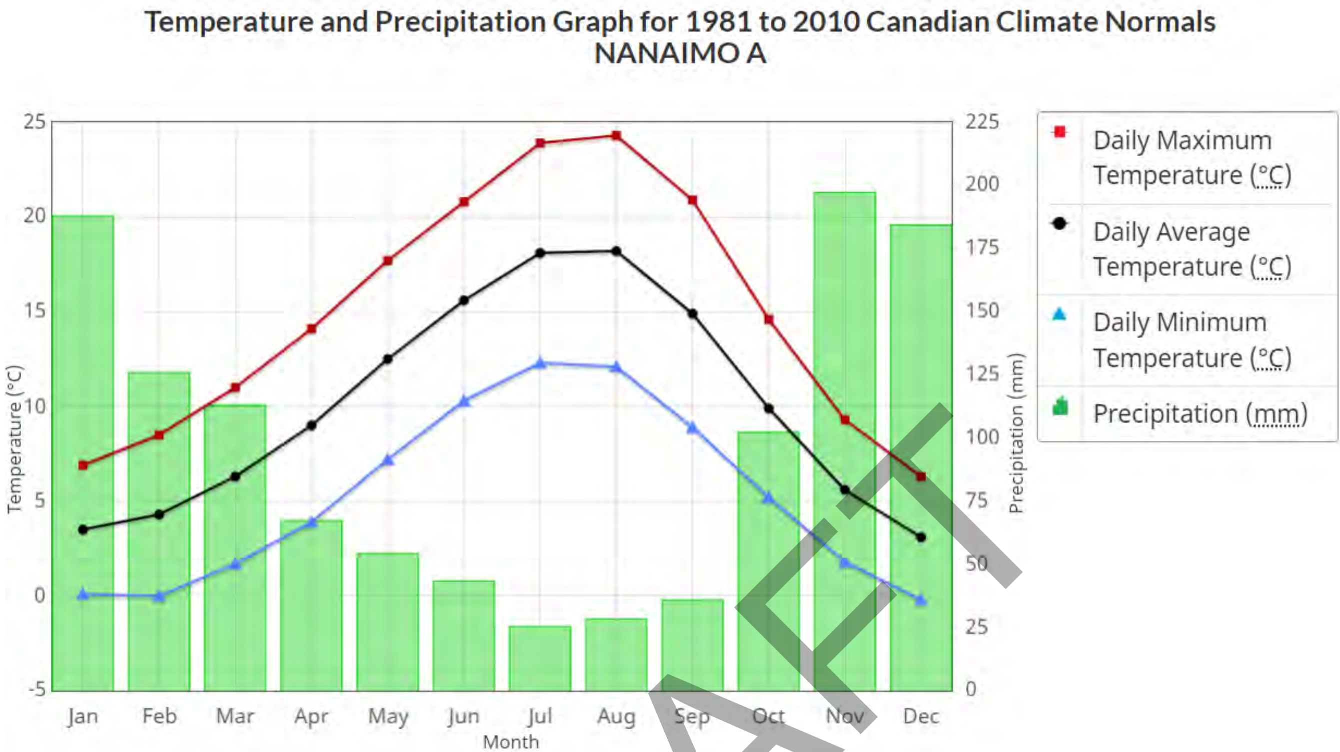


Figure B.8: Environment and Climate Change Canada 1981-2010 Climate Normals with monthly precipitation distribution at Nanaimo Airport (Source: ECCC, 2024).

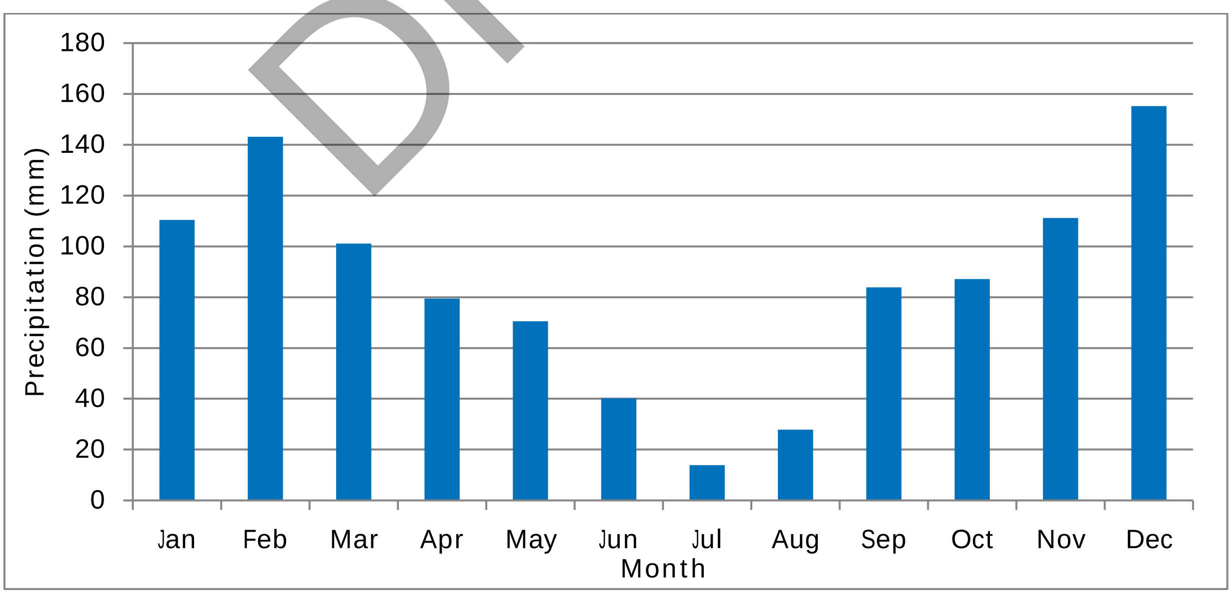


Figure B.9: Monthly distribution of modelled precipitation for Western VAD (average of 2013-2015).

B.3 REFERENCES

Environment and Climate Change Canada (ECCC). 2024. Canadian Climate Normals 1981-2010. https://climate.weather.gc.ca/climate_normals/index_e.html. Accessed Dec 2024.

ENV (BC Ministry of Environment). 2022. British Columbia Air Quality Dispersion Modelling Guideline. 113 pp.

Zhang, L., Moran, M.D., Makar, P.A., Brook, J.R., and Gong, S. 2002. Modelling gaseous dry deposition in AURAMS: a unified regional air-quality modelling system. Atmospheric Environment 36: 537-560.

Zhang, L., Brook, J.R., and Vet, R. 2003. A revised parameterization of gaseous dry deposition in air-quality models. Atmospheric Chemistry and Physics 3: 2067-2082.

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APPENDIX C

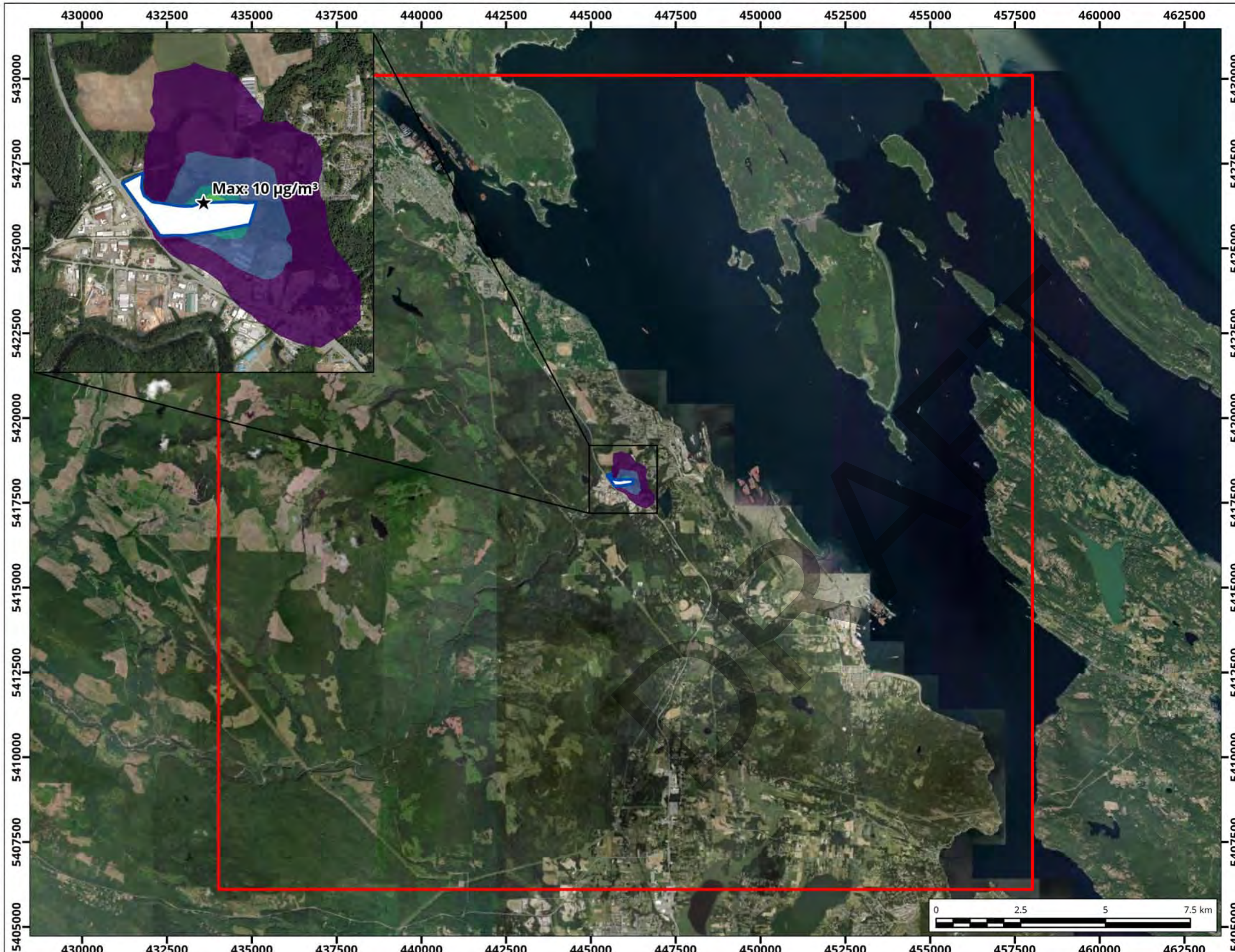
C.1 CALPUFF

All technical options relating to the CALPUFF dispersion model were set according to the Guidelines for Air Quality Dispersion Modelling in BC (ENV, 2022) or, lacking, to model defaults. These include parameters and options such as the calculation of plume dispersion coefficients, plume path coefficients used for terrain adjustments, building downwash methodology, and coastal sub-grid scale thermal internal boundary layer (TIBL). A list of the salient technical options is shown in Table C..

Table C.1: CALPUFF Model Switch Settings

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 used
MBDW	1	2	PRIME method used (ENV, 2015)
MSHEAR	0	0	Explicit meteorology (not parameterized wind shear about stack top)
MSPLIT	0	0	Puffs are not split (short range)
MCHEM	1	0	Chemical transformation not modelled
MWET	1	0	Wet removal not modelled (conservative for ambient concentrations)
MDRY	1	0	Dry deposition not modelled (conservative for ambient concentrations)
MTILT	0	0	Gravitational settling not modelled (small size PM only)
MDISP	3	2	Near-field dispersion coefficients internally calculated from sigma-v, sigma-w using micrometeorological variables from CALMET as recommended by ENV
MCTURB	1	1	Standard CALPUFF subroutines used to compute turbulence sigma-v & sigma-w
MPARTL	1	1	Partial plume penetration of elevated inversion
MPDF	0	1	PDF used for dispersion under convective conditions as recommended for MDISP = 2
MSGTIBL	0	0	Sub-grid TIBL module was not used for shoreline with detailed coastline, as sources are not located near large bodies of water
MBCON	0	0	Boundary concentration conditions not modelled (uniform background concentrations added)
MREG	1	0	Do not test options specified to see if they conform to United States Environmental Protection Agency regulatory values

APPENDIX D



Legend

★ Maximum Concentration

Model Domain

Property Boundary

Concentration (µg/m³)

0.5 - 1

1 - 2.5

2.5 - 5

5 - 10

> 10

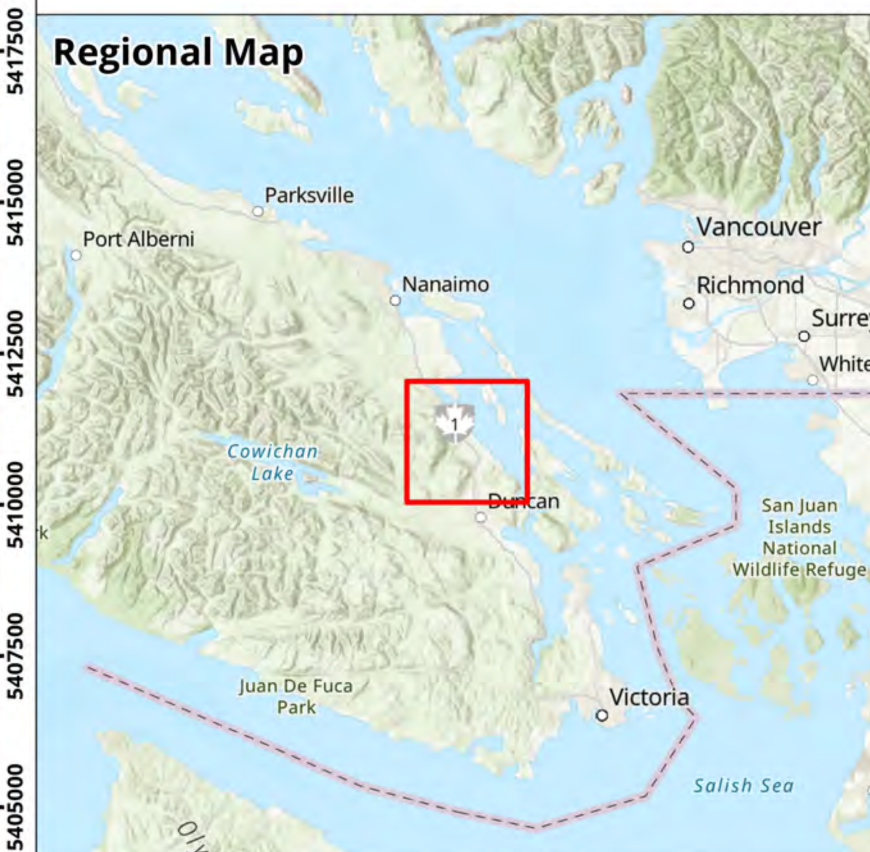
Background Concentration = 11.6 µg/m³

B.C. Ambient Air Quality Objective 1 = 27 µg/m³

B.C. Ambient Air Quality Objective 2 = 25 µg/m³

Service Layer Credits: World Imagery: Earthstar Geographics
World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community
World Imagery: North Cowichan, Earthstar Geographics
World Hillshade: Esri, USGS

Regional Map



Predicted 24-hour $PM_{2.5}$ Concentrations for Existing Sources (without background)

Map Projection: NAD 1983 CSRS UTM Zone 10N

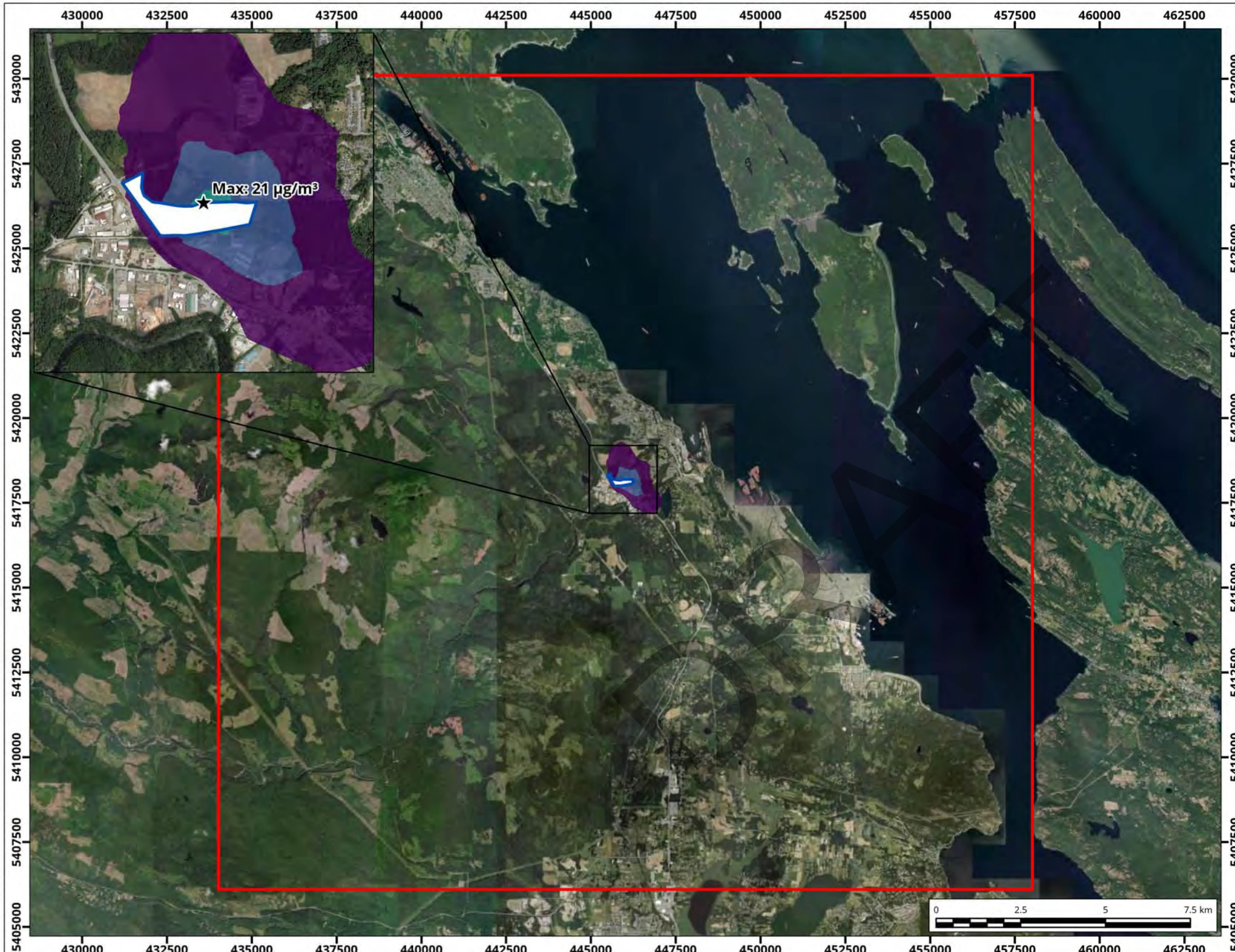
Western Forest Products | Value Added Division - Chemainus, B.C.

True North

Project #: 2405727

Drawn by: DJH	Figure: D1
Approx. Scale:	1:125,000
Date Revised:	Dec 13, 2024

Map Document: C:\GIS\2405727\P2405727_WesternForestProducts.aprx



Legend

★ Maximum Concentration

Model Domain

Property Boundary

Concentration (µg/m³)

- 12 - 12.5
- 12.5 - 15
- 15 - 25 (BC AAQO 1)
- 25 (BC AAQO 1) - 27 (BC AAQO 2)
- > 27 (BC AAQO 2)

Background Concentration = 11.6 µg/m³
B.C. Ambient Air Quality Objective 1 = 27 µg/m³
B.C. Ambient Air Quality Objective 2 = 25 µg/m³

Service Layer Credits: World Imagery: Earthstar Geographics
World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community
World Imagery: North Cowichan, Earthstar Geographics
World Hillshade: Esri, USGS

Regional Map

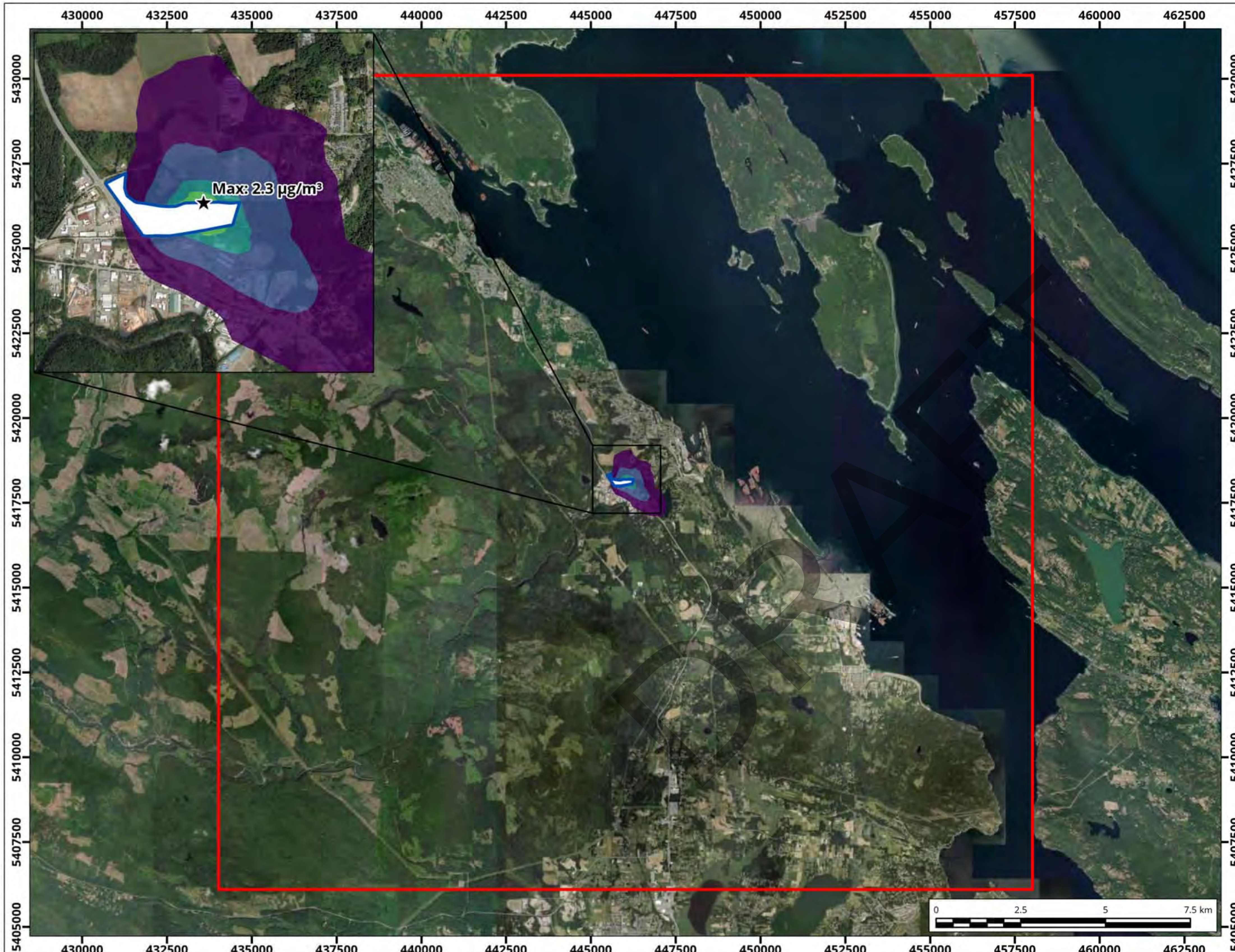
Predicted 24-hour $PM_{2.5}$ Concentrations for Existing Sources (including background)

Map Projection: NAD 1983 CSRS UTM Zone 10N
Western Forest Products | Value Added Division - Chemainus, B.C.

True North

Project #: 2405727

Drawn by: DJH	Figure: D2
Approx. Scale:	1:125,000
Date Revised:	Dec 13, 2024



Legend

★ Maximum Concentration

Model Domain

Property Boundary

Concentration (μg/m³)

0.1 - 0.2

0.2 - 0.5

0.5 - 1

1 - 2.5

> 2.5

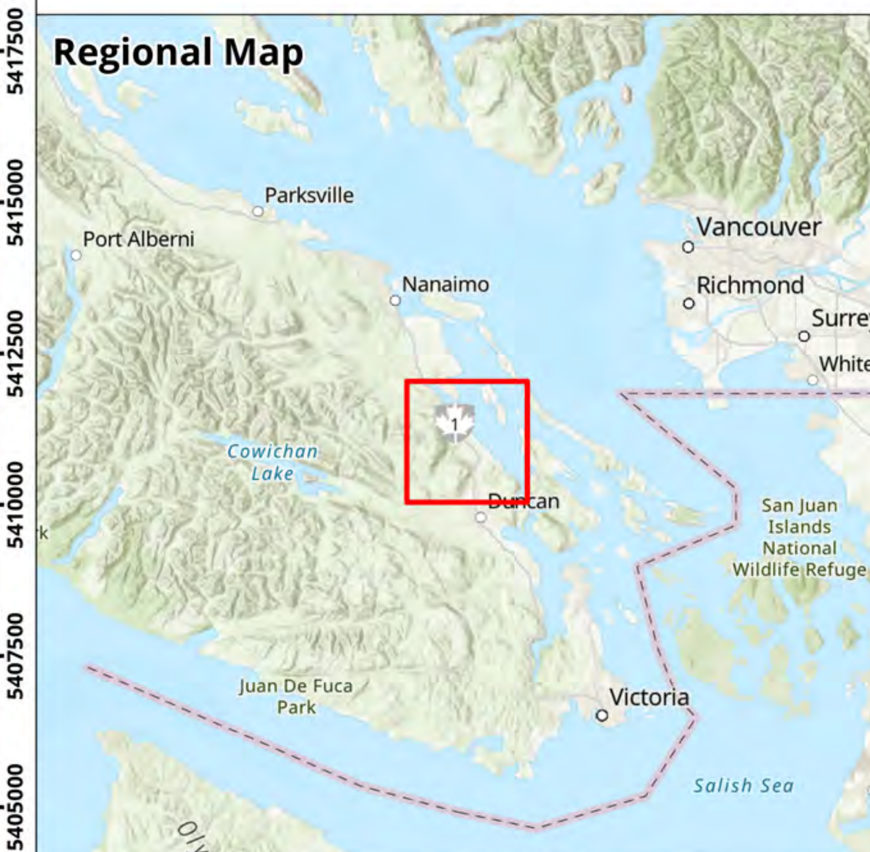
Background Concentration = 4.5 μg/m³

B.C. Ambient Air Quality Objective 1 = 8.8 μg/m³

B.C. Ambient Air Quality Objective 2 = 8 μg/m³

Service Layer Credits: World Imagery: Earthstar Geographics
World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community
World Imagery: North Cowichan, Earthstar Geographics
World Hillshade: Esri, USGS

Regional Map



Predicted Annual $PM_{2.5}$ Concentrations for Existing Sources (without background)

Map Projection: NAD 1983 CSRS UTM Zone 10N

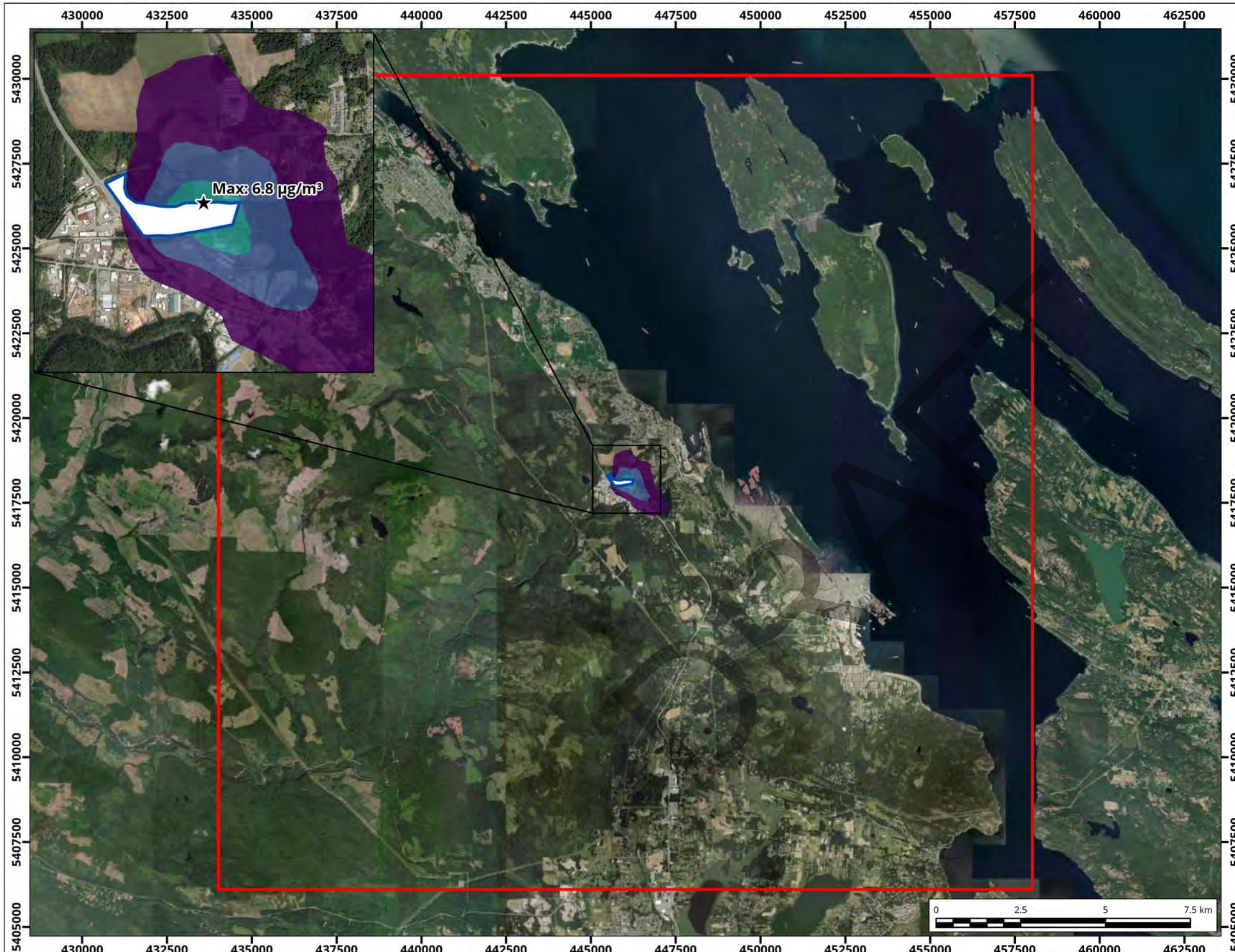
Western Forest Products | Value Added Division - Chemainus, B.C.

True North

Project #: 2405727

Drawn by: DJH	Figure: D3
Approx. Scale:	1:125,000
Date Revised:	Dec 13, 2024

Map Document: C:\GIS\2405727\P2405727_WesternForestProducts.aprx



Legend

★ Maximum Concentration

Model Domain

Property Boundary

Concentration (μg/m³)

- 4.6 - 4.7
- 4.7 - 5
- 5 - 8 (BC AAQO 1)
- 8 (BC AAQO 1) - 8.8 (BC AAQO 2)
- > 8.8 (BC AAQO 2)

Background Concentration = 4.5 μg/m³
B.C. Ambient Air Quality Objective 1 = 8.8 μg/m³
B.C. Ambient Air Quality Objective 2 = 8 μg/m³

Service Layer Credits: World Imagery: Earthstar Geographics
World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community
World Imagery: North Cowichan, Earthstar Geographics
World Hillshade: Esri, USGS

Regional Map

Predicted Annual $PM_{2.5}$ Concentrations for Existing Sources (including background)

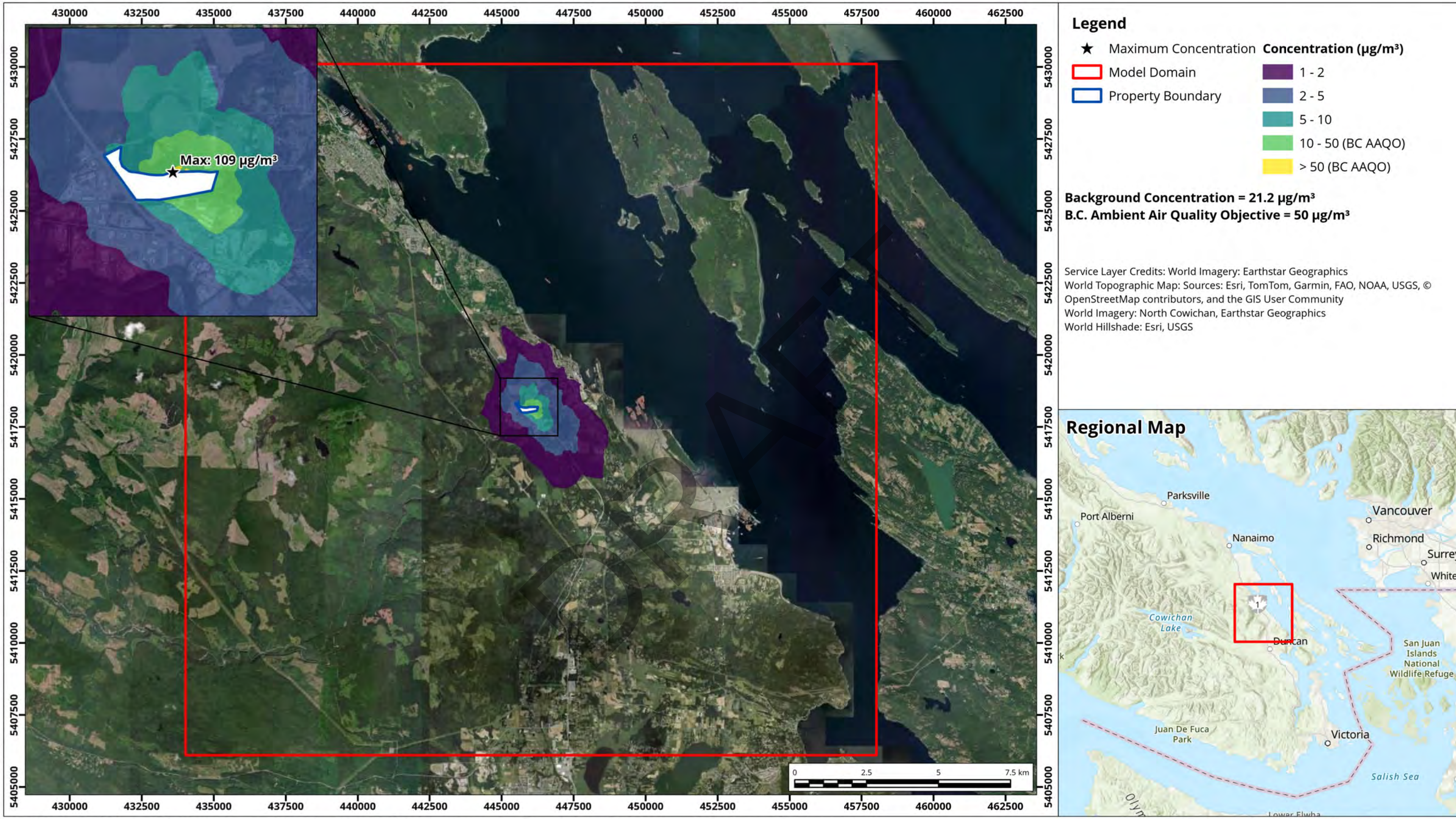
Map Projection: NAD 1983 CSRS UTM Zone 10N

Western Forest Products | Value Added Division - Chemainus, B.C.

True North

Project #: 2405727

Drawn by:	DJH	Figure:	D4
Approx. Scale:	1:125,000		
Date Revised:	Dec 13, 2024		



Predicted 24-hour PM_{10} Concentrations for Existing Sources (without background)

Map Projection: NAD 1983 CSRS UTM Zone 10N

Western Forest Products | Value Added Division - Chemainus, B.C.

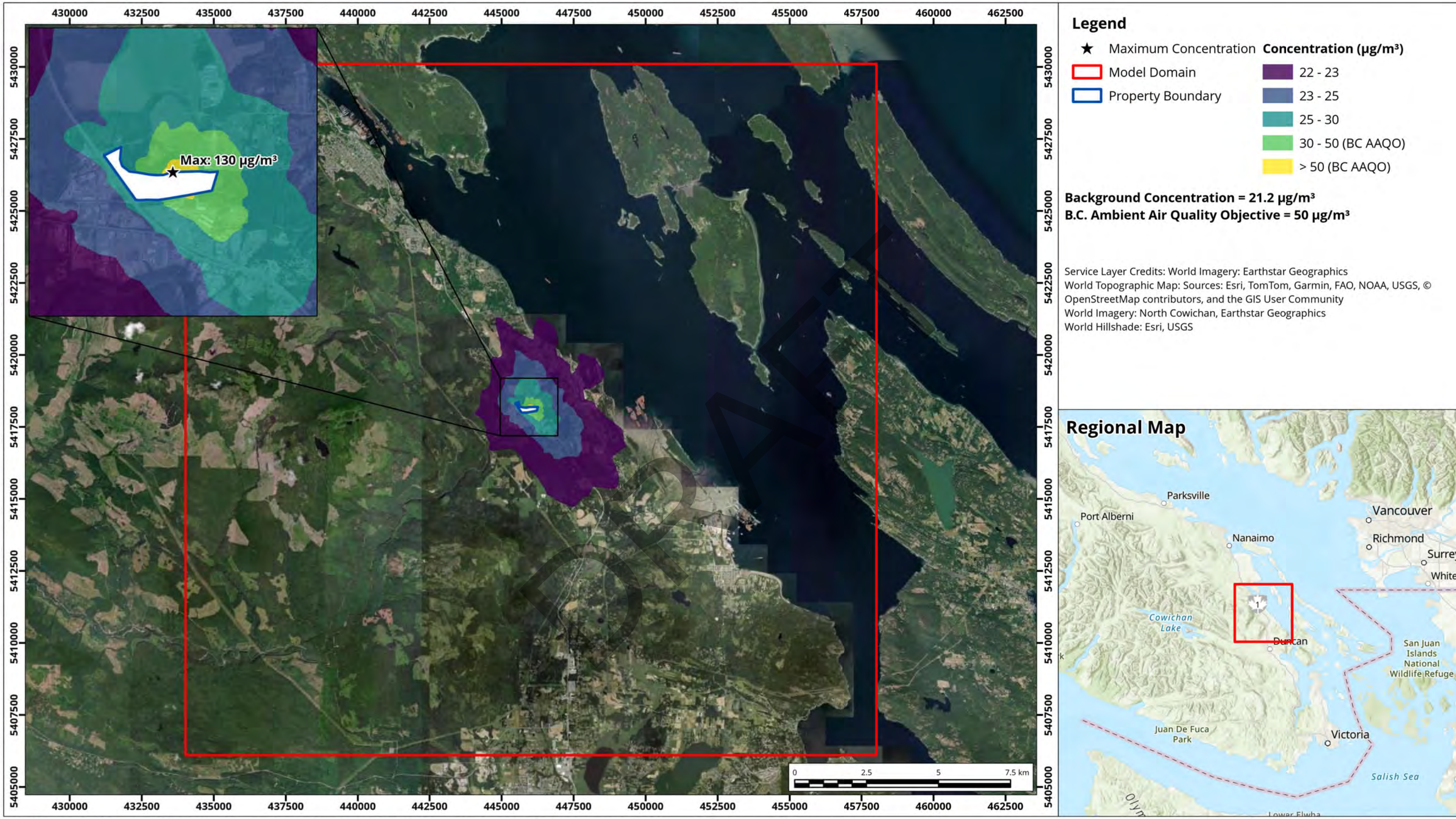
True North

Drawn by: DJH | Figure: D5

Approx. Scale: 1:125,000

Date Revised: Dec 13, 2024

Project #: 2405727



Predicted 24-hour PM_{10} Concentrations for Existing Sources (including background)

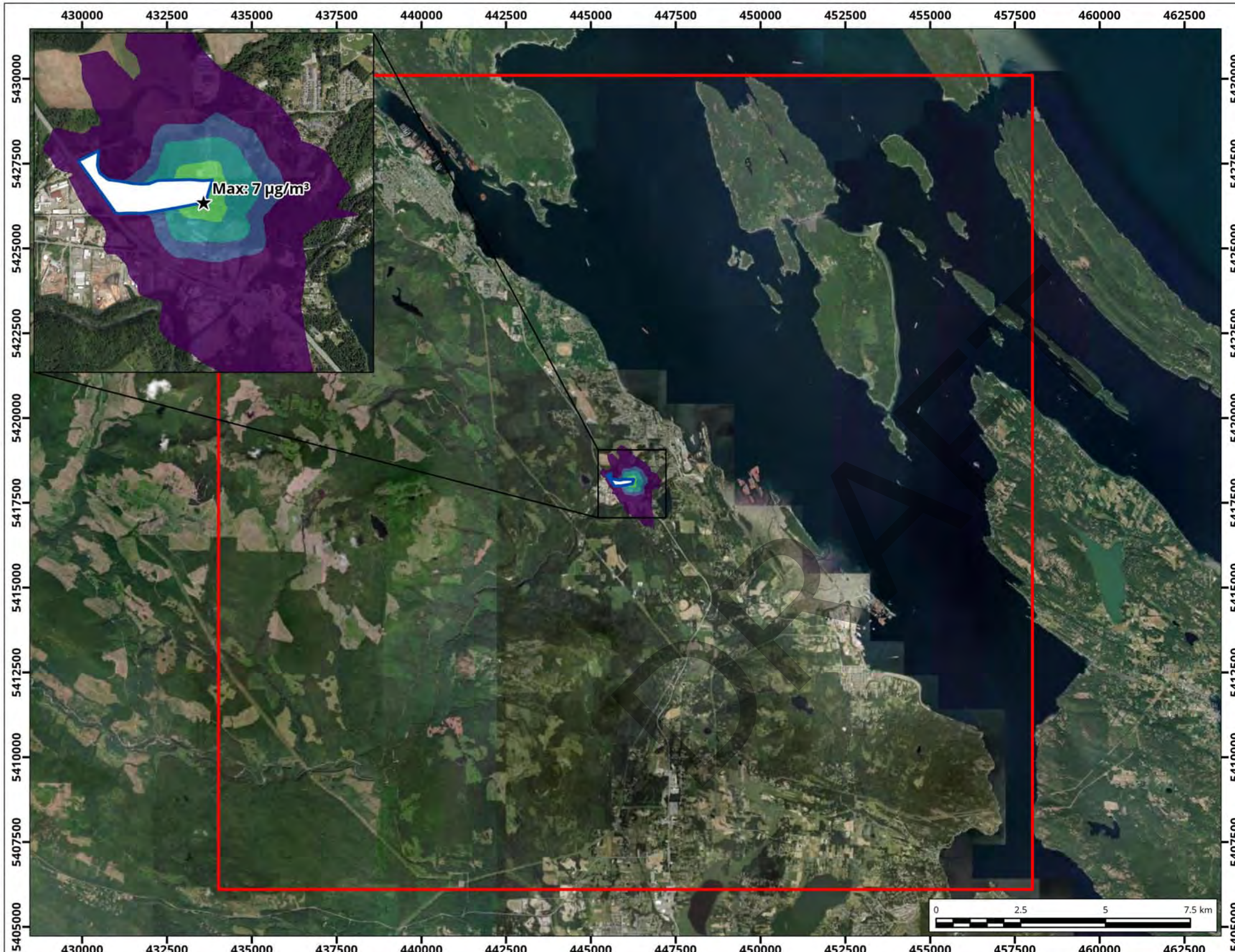
Map Projection: NAD 1983 CSRS UTM Zone 10N

Western Forest Products | Value Added Division - Chemainus, B.C.

True North

Project #: 2405727

Drawn by: DJH	Figure: D6
Approx. Scale:	1:125,000
Date Revised:	Dec 13, 2024



Legend

★ Maximum Concentration
Model Domain
Property Boundary

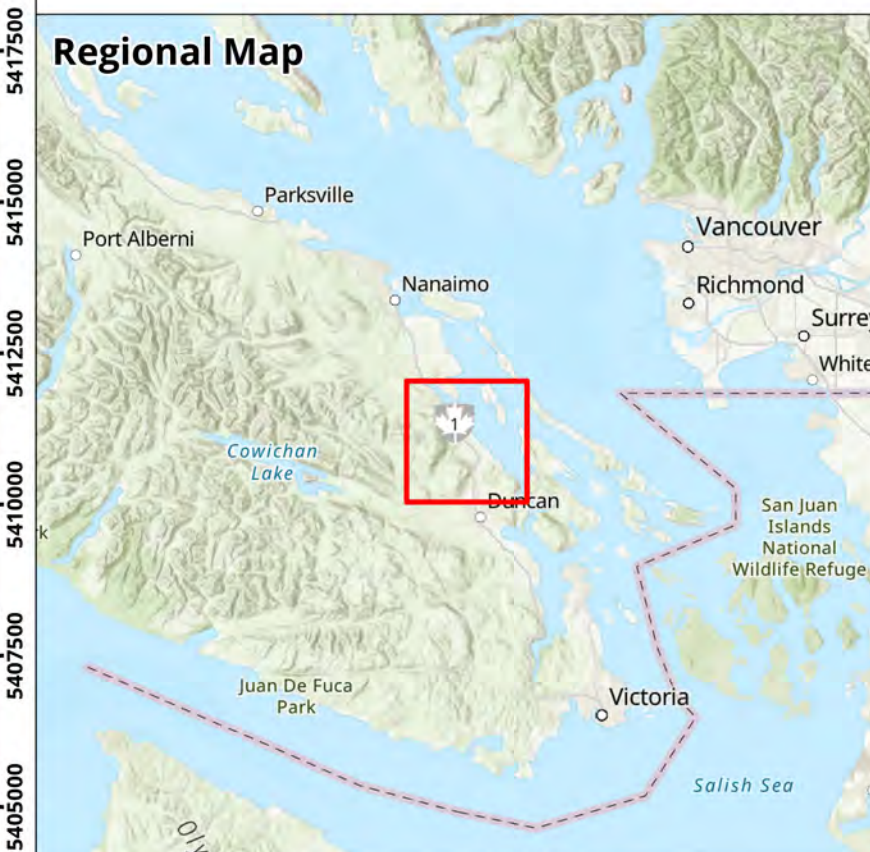
Concentration (µg/m³)

- 1 - 1.5
- 1.5 - 2
- 2 - 3.5
- 3.5 - 7
- > 7

Background Concentration = 10.2 µg/m³
B.C. Ambient Air Quality Objective 1 = 113 µg/m³
B.C. Ambient Air Quality Objective 2 = 79 µg/m³

Service Layer Credits: World Imagery: Earthstar Geographics
World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community
World Imagery: North Cowichan, Earthstar Geographics
World Hillshade: Esri, USGS

Regional Map



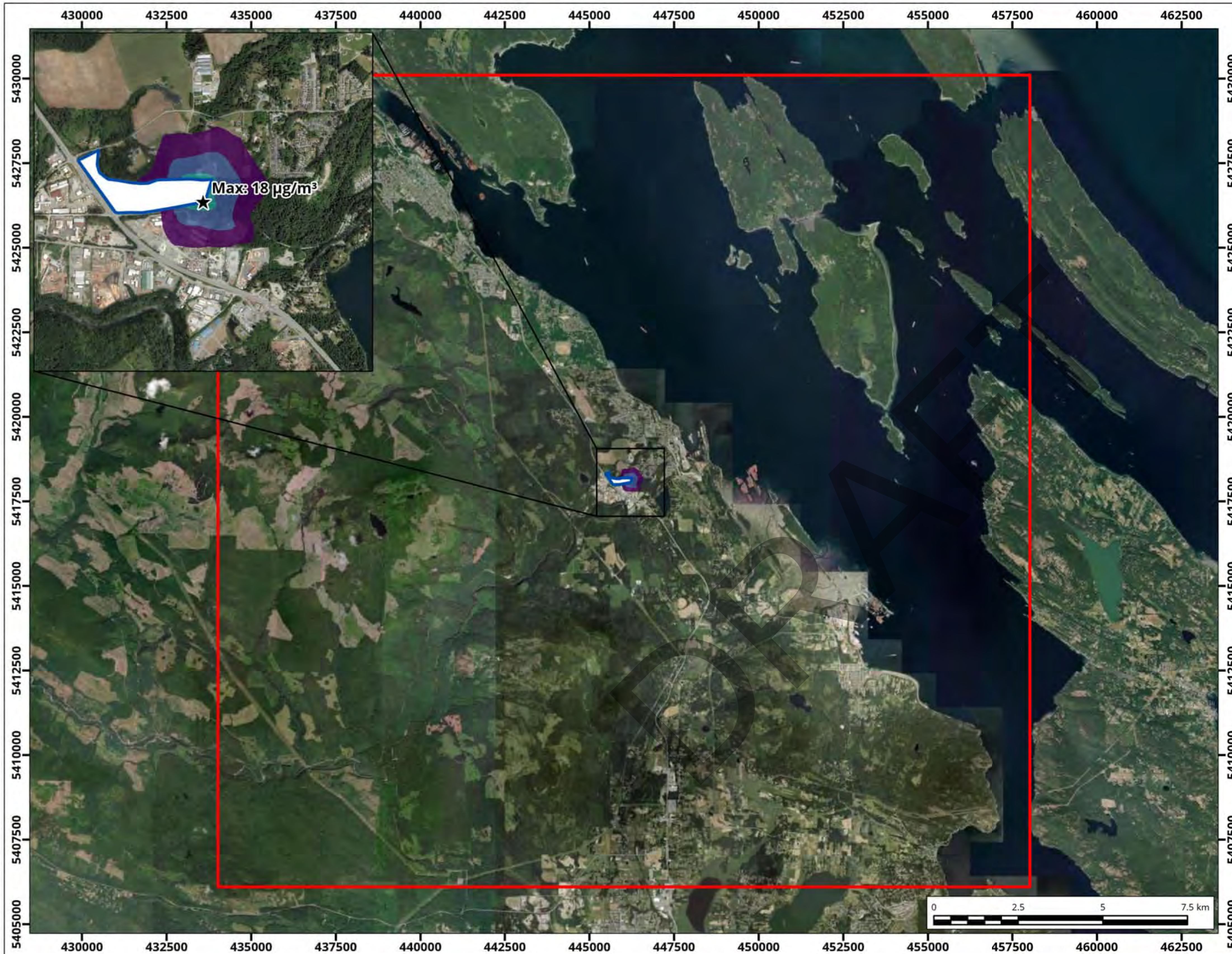
Predicted 1-hour NO_2 Concentrations for Existing Sources (without background)

Map Projection: NAD 1983 CSRS UTM Zone 10N
Western Forest Products | Value Added Division - Chemainus, B.C.

True North

Project #: 2405727

Drawn by: DJH	Figure: D7
Approx. Scale:	1:125,000
Date Revised:	Dec 13, 2024



Legend

★ Maximum Concentration

Model Domain

Property Boundary

Concentration (µg/m³)

- 12 - 13
- 13 - 15
- 15 - 18
- 18 - 20
- > 20

Background Concentration = 10.2 µg/m³
B.C. Ambient Air Quality Objective 1 = 113 µg/m³
B.C. Ambient Air Quality Objective 2 = 79 µg/m³

Service Layer Credits: World Imagery: Earthstar Geographics
World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community
World Imagery: North Cowichan, Earthstar Geographics
World Hillshade: Esri, USGS

Regional Map

Predicted 1-hour NO_2 Concentrations Existing Sources (including background)

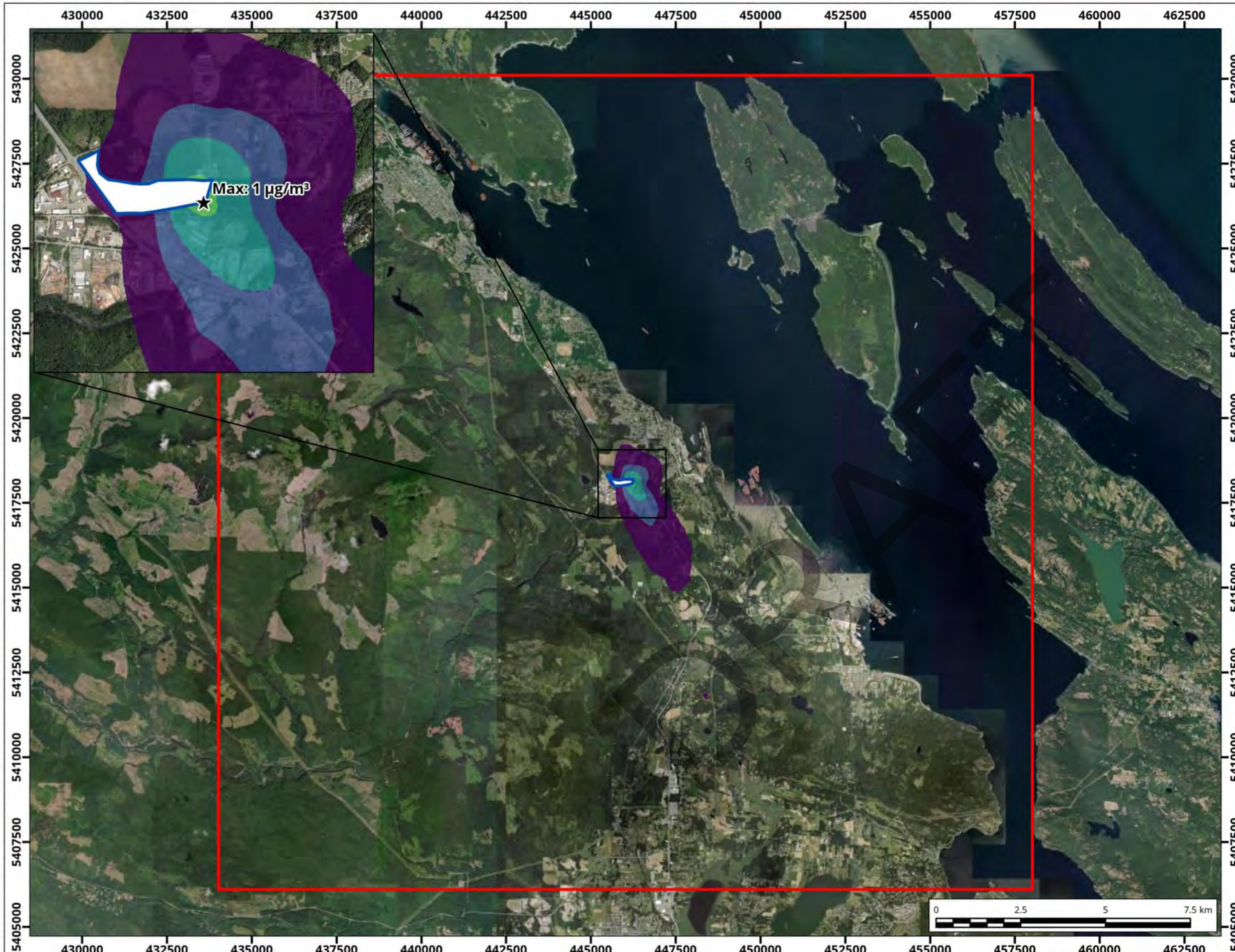
Map Projection: NAD 1983 CSRS UTM Zone 10N

Western Forest Products | Value Added Division - Chemainus, B.C.

True North

Project #: 2405727

Drawn by: DJH	Figure: D8
Approx. Scale:	1:125,000
Date Revised:	Dec 13, 2024



Legend

★ Maximum Concentration	**Concentration (µg/m³)**	
Model Domain		0.025 - 0.05
Property Boundary		0.05 - 0.1
		0.1 - 0.5
		0.5 - 1
		> 1

Background Concentration = 3.4 µg/m³
B.C. Ambient Air Quality Objective 1 = 32 µg/m³
B.C. Ambient Air Quality Objective 2 = 23 µg/m³

Service Layer Credits: World Imagery: Earthstar Geographics
World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community
World Imagery: North Cowichan, Earthstar Geographics
World Hillshade: Esri, USGS

Regional Map

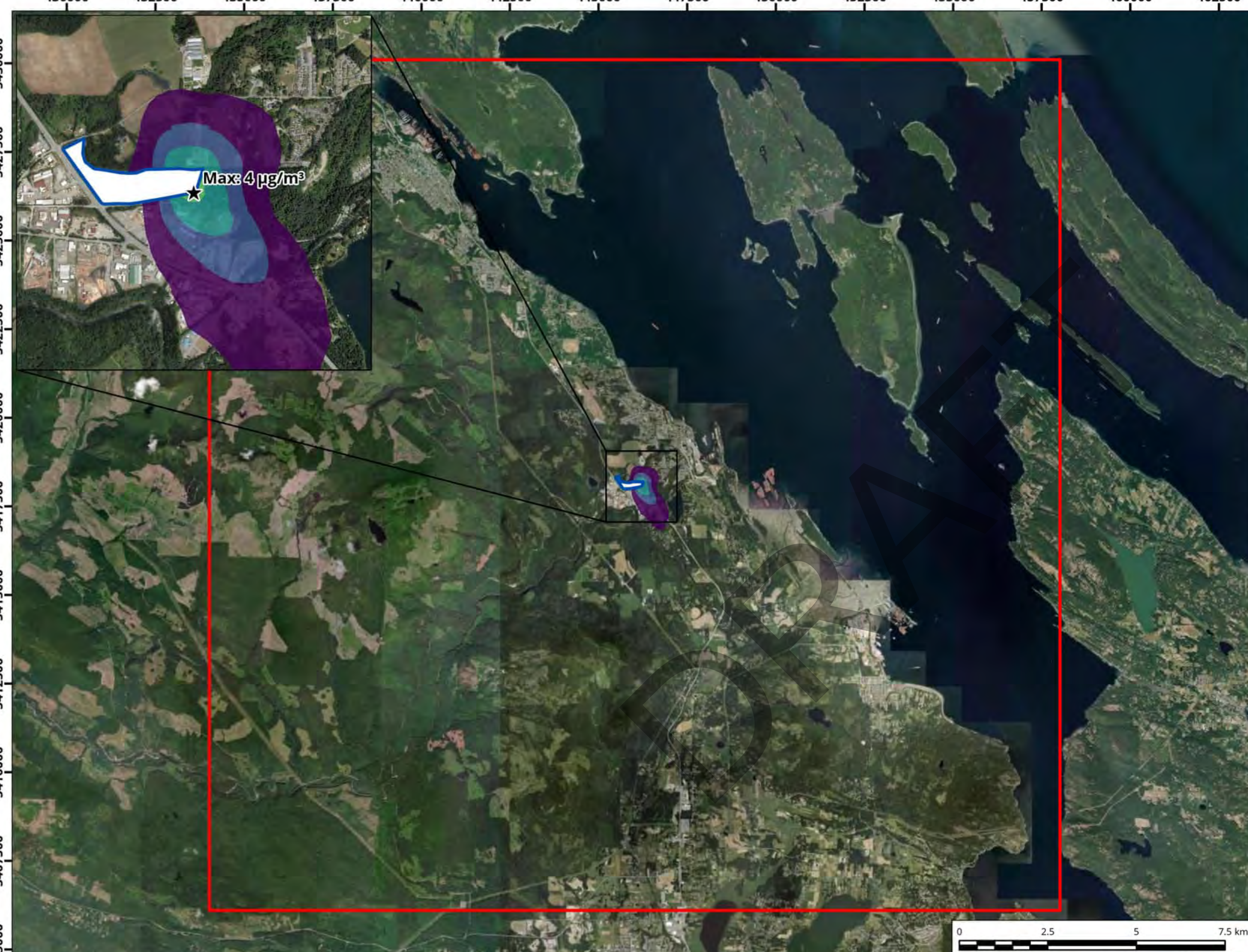
Predicted Annual NO_2 Concentrations for Existing Sources (without background)

Map Projection: NAD 1983 CSRS UTM Zone 10N
Western Forest Products | Value Added Division - Chemainus, B.C.

True North

Project #: 2405727

Drawn by:	DJH	Figure:	D9
Approx. Scale:	1:125,000		
Date Revised:	Dec 13, 2024		

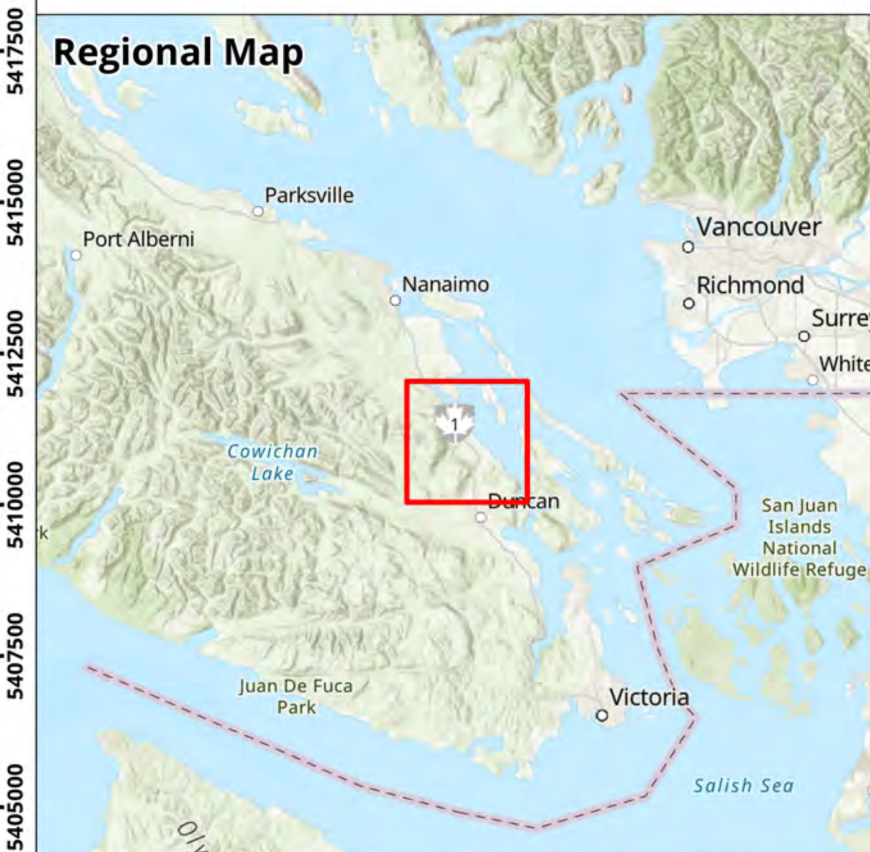


Legend

Background Concentration = 3.4 µg/m³
B.C. Ambient Air Quality Objective 1 = 32 µg/m³
B.C. Ambient Air Quality Objective 2 = 23 µg/m³

Service Layer Credits: World Imagery: Earthstar Geographics
World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community
World Imagery: North Cowichan, Earthstar Geographics
World Hillshade: Esri, USGS

Regional Map



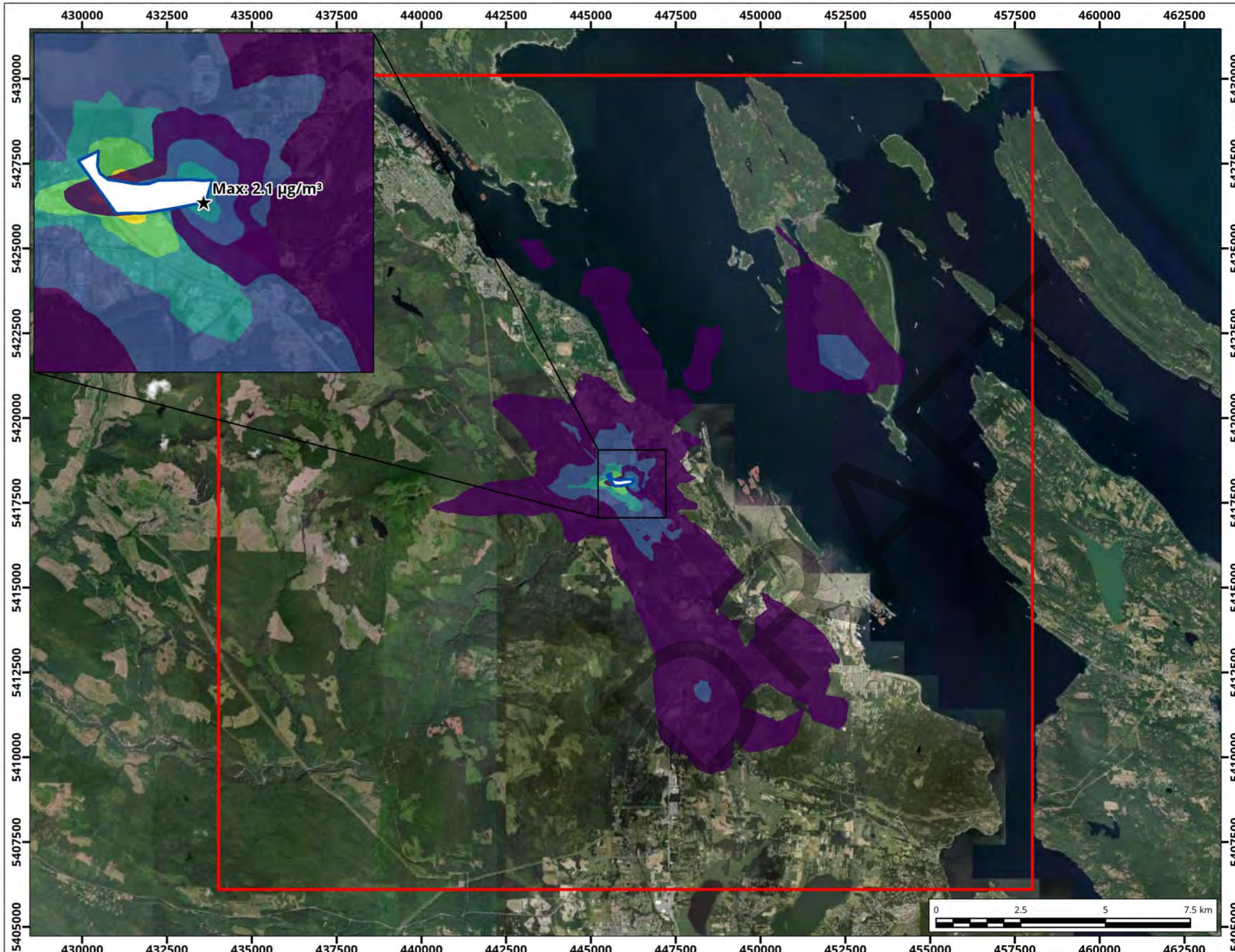
Predicted Annual NO_2 Concentrations for Existing Sources (including background)

Map Projection: NAD 1983 CSRS UTM Zone 10N
Western Forest Products | Value Added Division - Chemainus, B.C.

True North

Project #: 2405727

Drawn by: DJH	Figure: D10
Approx. Scale:	1:125,000
Date Revised:	Dec 13, 2024



Legend

★ Maximum Concentration
Model Domain
Property Boundary

Concentration (µg/m³)
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 5
- > 5

Concentration (µg/m³)
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 5
- > 5

Service Layer Credits: World Imagery: Earthstar Geographics
World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community
World Imagery: North Cowichan, Earthstar Geographics
World Hillshade: Esri, USGS

Regional Map

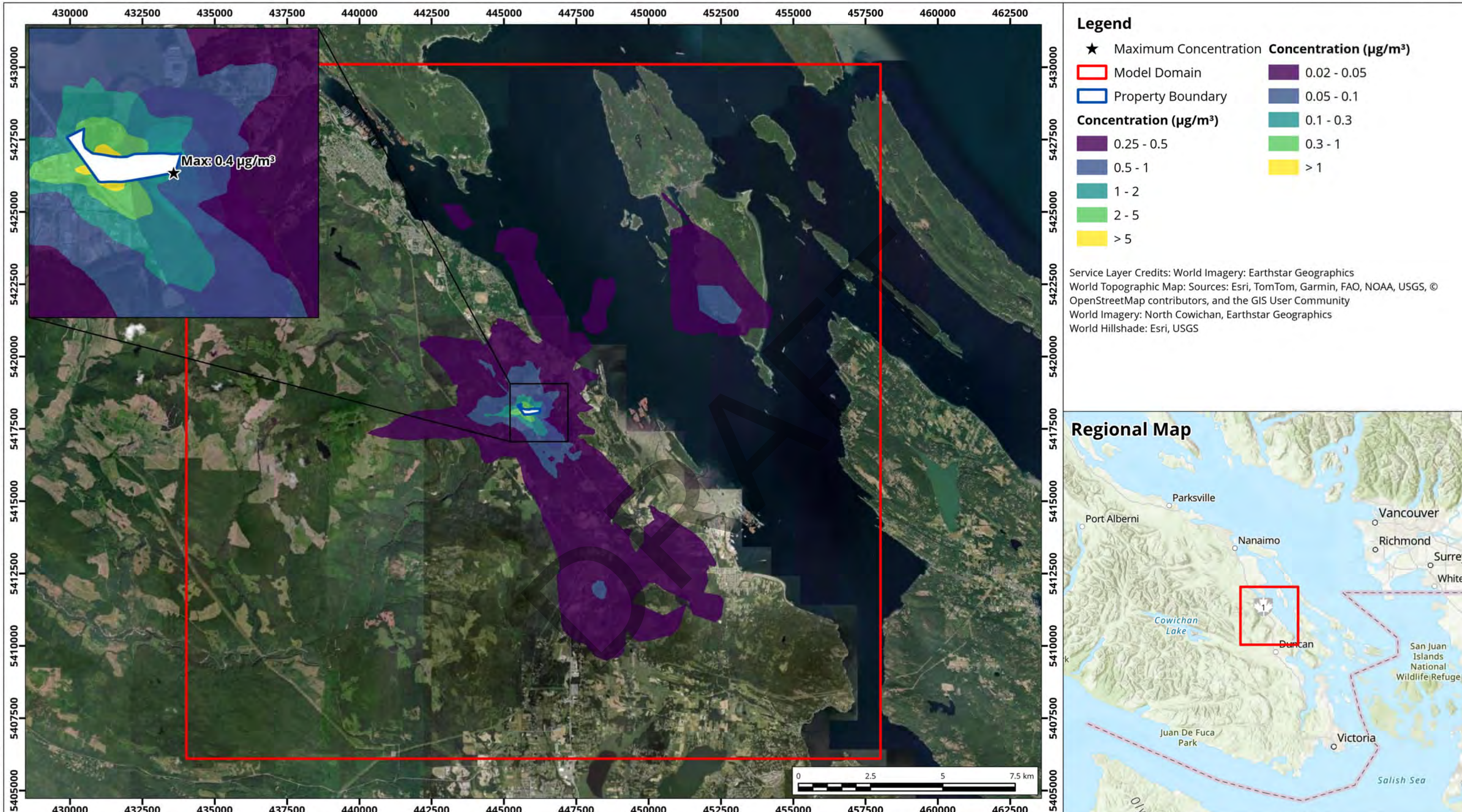
Predicted 24-hour VOC Concentrations for Existing Sources (without background)

Map Projection: NAD 1983 CSRS UTM Zone 10N
Western Forest Products | Value Added Division - Chemainus, B.C.

True North

Project #: 2405727

Drawn by: DJH	Figure: D11
Approx. Scale:	1:125,000
Date Revised:	Dec 13, 2024



Predicted Annual VOC Concentrations for Existing Sources (without background)

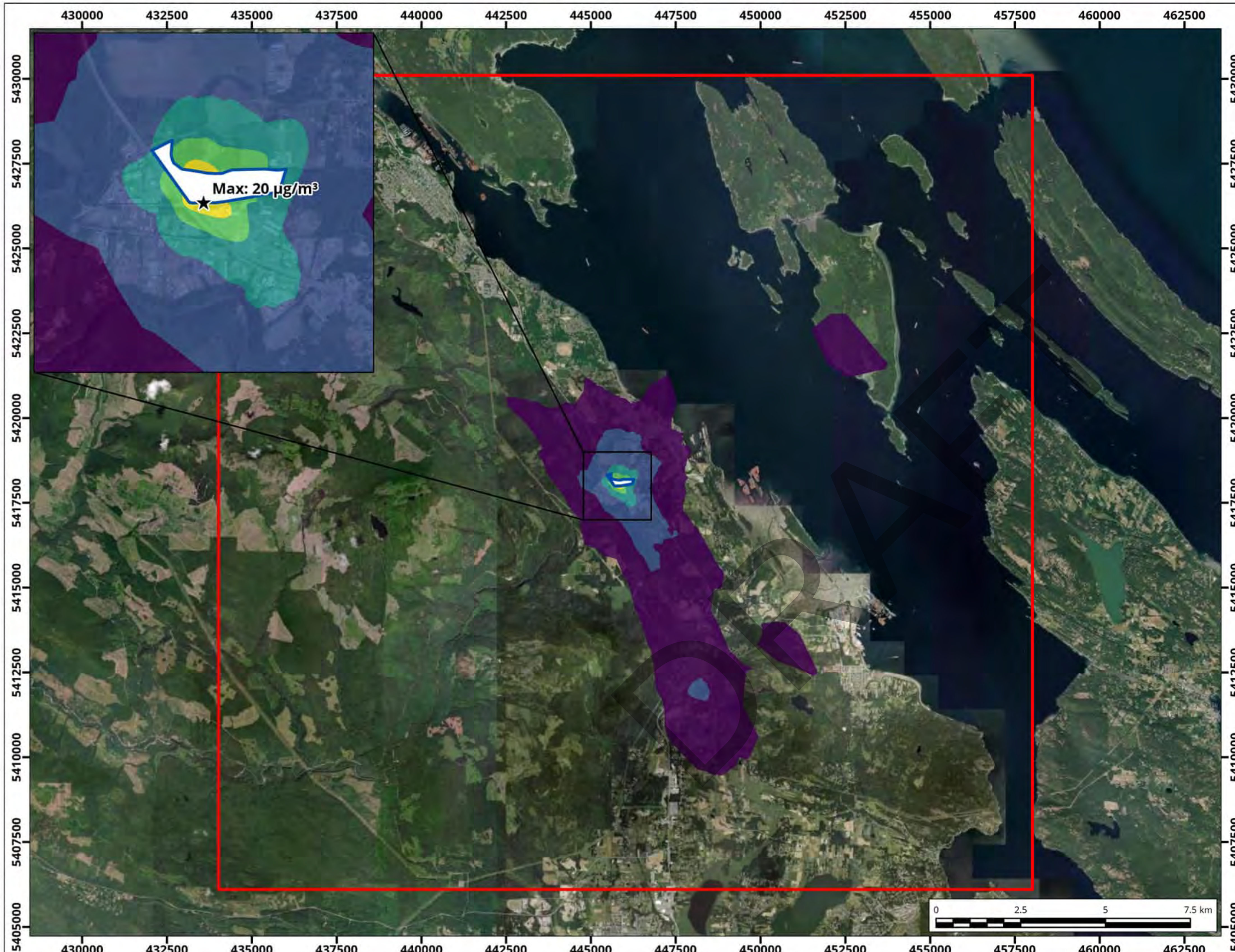
Map Projection: NAD 1983 CSRS UTM Zone 10N

Western Forest Products | Value Added Division - Chemainus, B.C.

True North

Project #: 2405727

Drawn by: DJH	Figure: D12
Approx. Scale:	1:125,000
Date Revised:	Dec 13, 2024



Legend

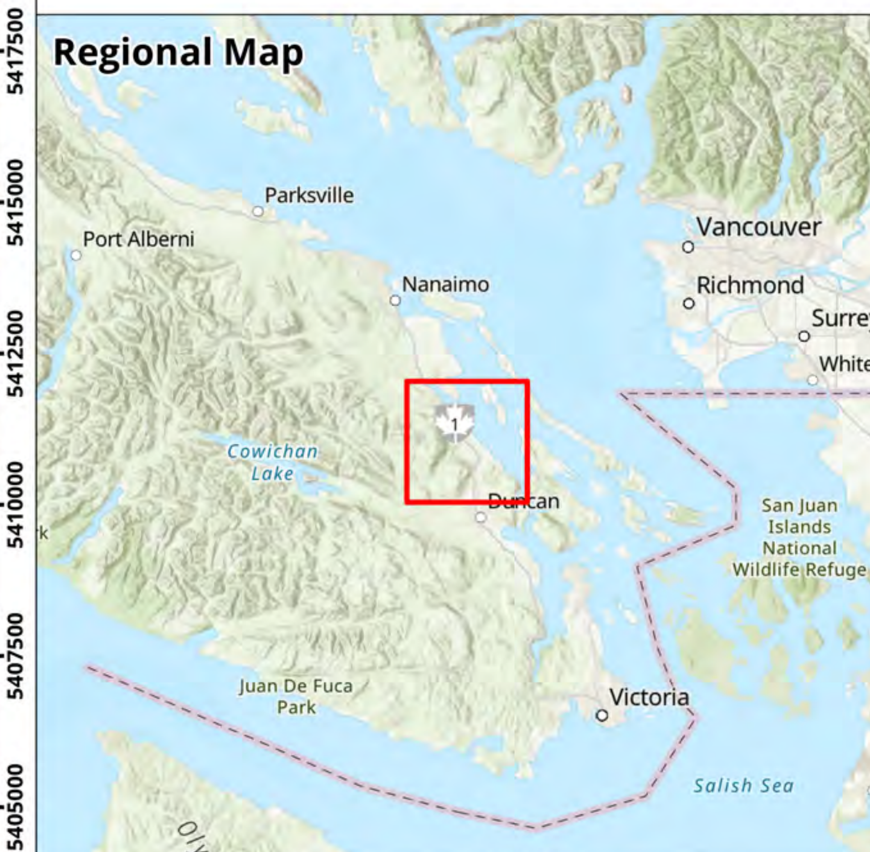
★ Maximum Concentration
Model Domain
Property Boundary

Concentration (µg/m³)
0.5 - 1
1 - 2.5
2.5 - 5
5 - 10
> 10

Background Concentration = 11.6 µg/m³
B.C. Ambient Air Quality Objective 1 = 27 µg/m³
B.C. Ambient Air Quality Objective 2 = 25 µg/m³

Service Layer Credits: World Imagery: Earthstar Geographics
World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community
World Imagery: North Cowichan, Earthstar Geographics
World Hillshade: Esri, USGS

Regional Map

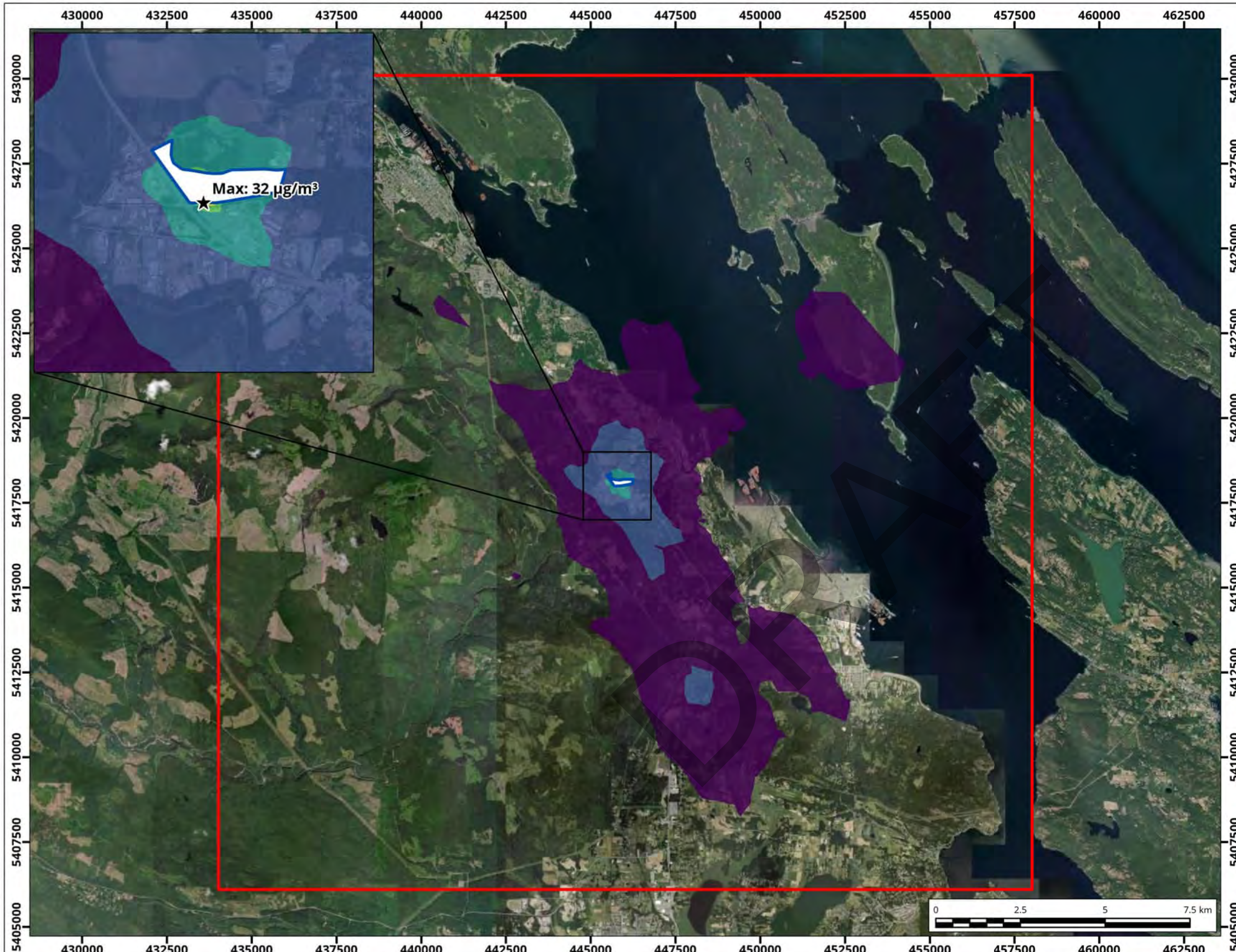


Predicted 24-hour $PM_{2.5}$ Concentrations for Proposed Future Sources (without background)

Map Projection: NAD 1983 CSRS UTM Zone 10N
Western Forest Products | Value Added Division - Chemainus, B.C.

True North
Project #: 2405727

Drawn by: DJH	Figure: D13
Approx. Scale:	1:125,000
Date Revised:	Dec 13, 2024



Legend

★ Maximum Concentration

Model Domain

Property Boundary

Concentration (µg/m³)

12 - 12.5

12.5 - 15

15 - 25 (BC AAQO 1)

25 (BC AAQO 1) - 27 (BC AAQO 2)

> 27 (BC AAQO 2)

Background Concentration = 11.6 µg/m³
B.C. Ambient Air Quality Objective 1 = 27 µg/m³
B.C. Ambient Air Quality Objective 2 = 25 µg/m³

Service Layer Credits: World Imagery: Earthstar Geographics
World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community
World Imagery: North Cowichan, Earthstar Geographics
World Hillshade: Esri, USGS

Regional Map

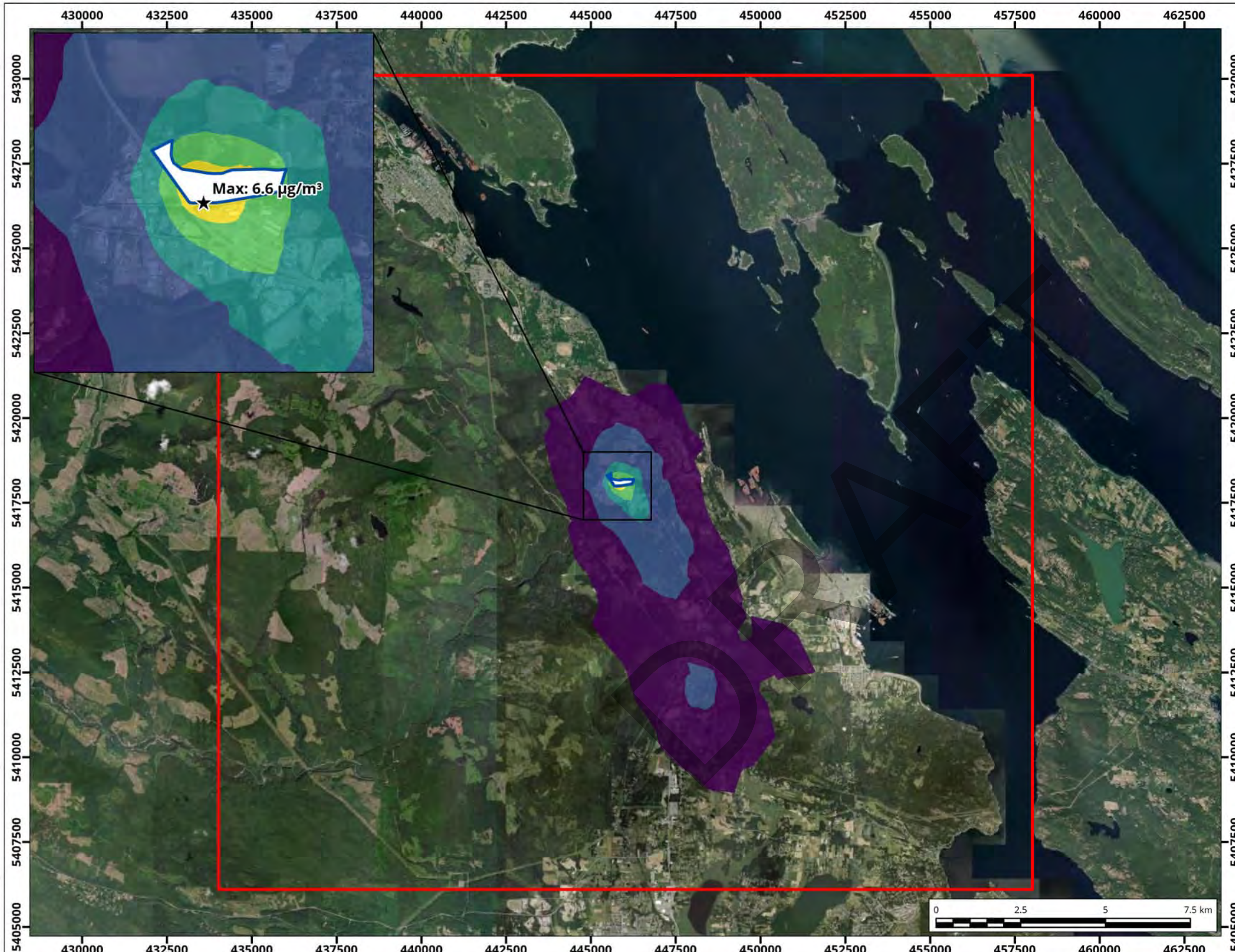
Predicted 24-hour $PM_{2.5}$ Concentrations for Proposed Future Sources (including background)

Map Projection: NAD 1983 CSRS UTM Zone 10N
Western Forest Products | Value Added Division - Chemainus, B.C.

True North

Project #: 2405727

Drawn by: DJH	Figure: D14
Approx. Scale:	1:125,000
Date Revised:	Dec 13, 2024



Legend

★ Maximum Concentration

Model Domain

Property Boundary

Concentration (μg/m³)

- 0.1 - 0.2
- 0.2 - 0.5
- 0.5 - 1
- 1 - 2.5
- > 2.5

Background Concentration = 4.5 μg/m³
B.C. Ambient Air Quality Objective 1 = 8.8 μg/m³
B.C. Ambient Air Quality Objective 2 = 8 μg/m³

Service Layer Credits: World Imagery: Earthstar Geographics
World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community
World Imagery: North Cowichan, Earthstar Geographics
World Hillshade: Esri, USGS

Predicted Annual $PM_{2.5}$ Concentrations for Proposed Future Sources (without background)

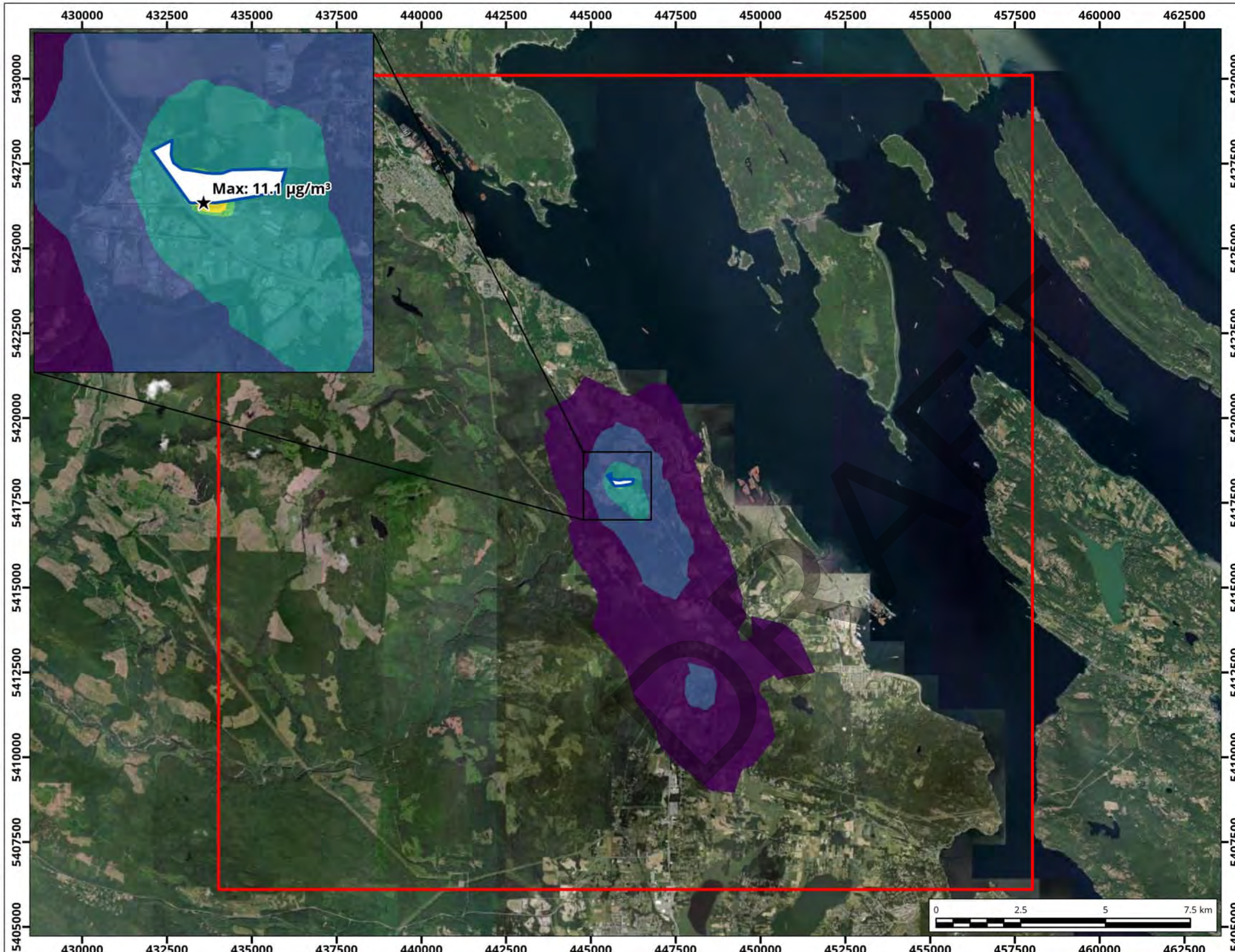
Map Projection: NAD 1983 CSRS UTM Zone 10N

Western Forest Products | Value Added Division - Chemainus, B.C.

True North

Project #: 2405727

Drawn by: DJH	Figure: D15
Approx. Scale: 1:125,000	
Date Revised: Dec 13, 2024	



Legend

★ Maximum Concentration

Model Domain

Property Boundary

Concentration (µg/m³)

- 4.6 - 4.7
- 4.7 - 5
- 5 - 8 (BC AAQO 1)
- 8 (BC AAQO 1) - 8.8 (BC AAQO 2)
- > 8.8 (BC AAQO 2)

Background Concentration = 4.5 µg/m³
B.C. Ambient Air Quality Objective 1 = 8.8 µg/m³
B.C. Ambient Air Quality Objective 2 = 8 µg/m³

Service Layer Credits: World Imagery: Earthstar Geographics
World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community
World Imagery: North Cowichan, Earthstar Geographics
World Hillshade: Esri, USGS

Regional Map

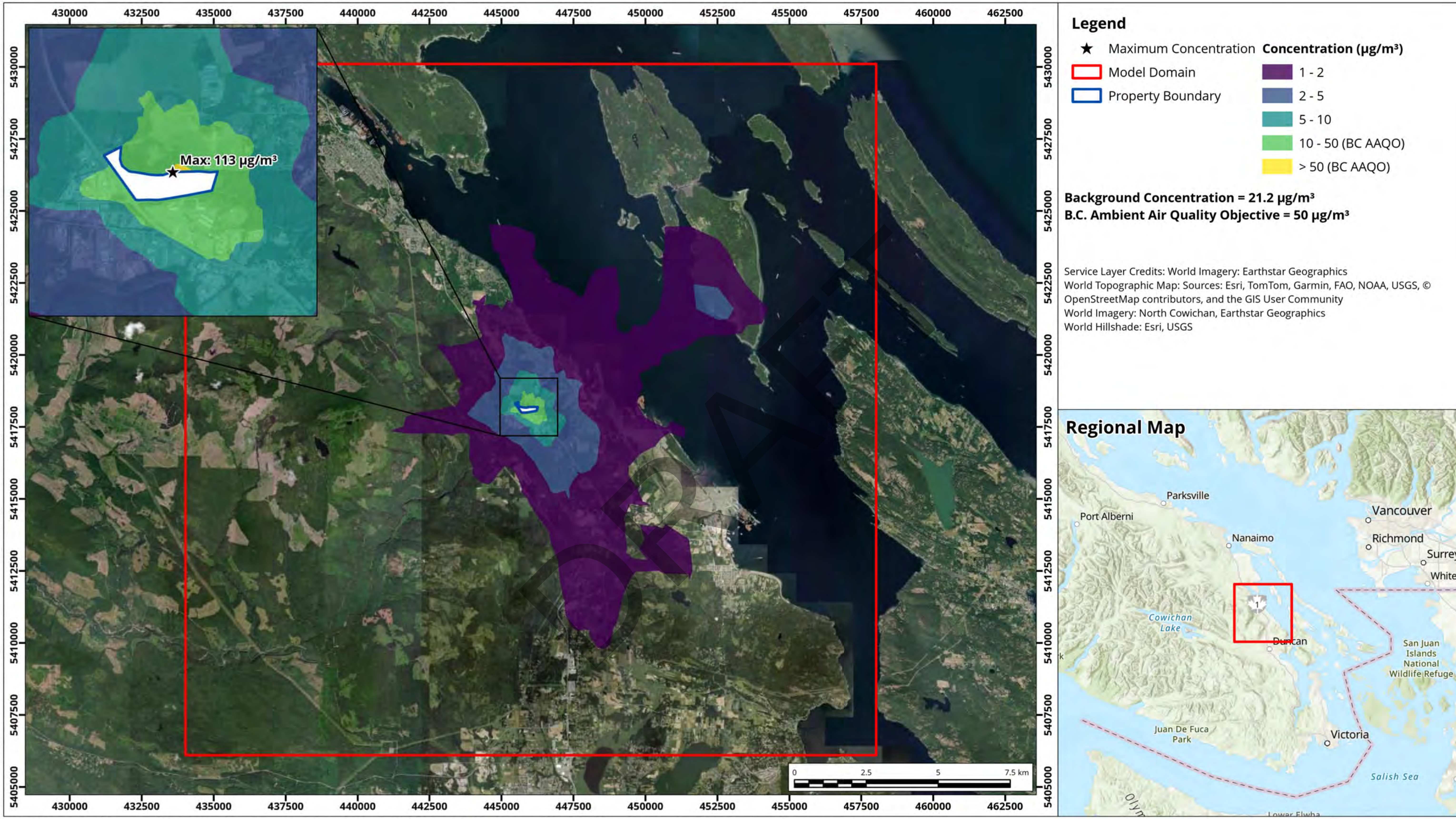
Predicted Annual $PM_{2.5}$ Concentrations for Proposed Future Sources (including background)

Map Projection: NAD 1983 CSRS UTM Zone 10N
Western Forest Products | Value Added Division - Chemainus, B.C.

True North

Project #: 2405727

Drawn by: DJH	Figure: D16
Approx. Scale:	1:125,000
Date Revised:	Dec 13, 2024



Predicted 24-hour PM_{10} Concentrations for Proposed Future Sources (without background)

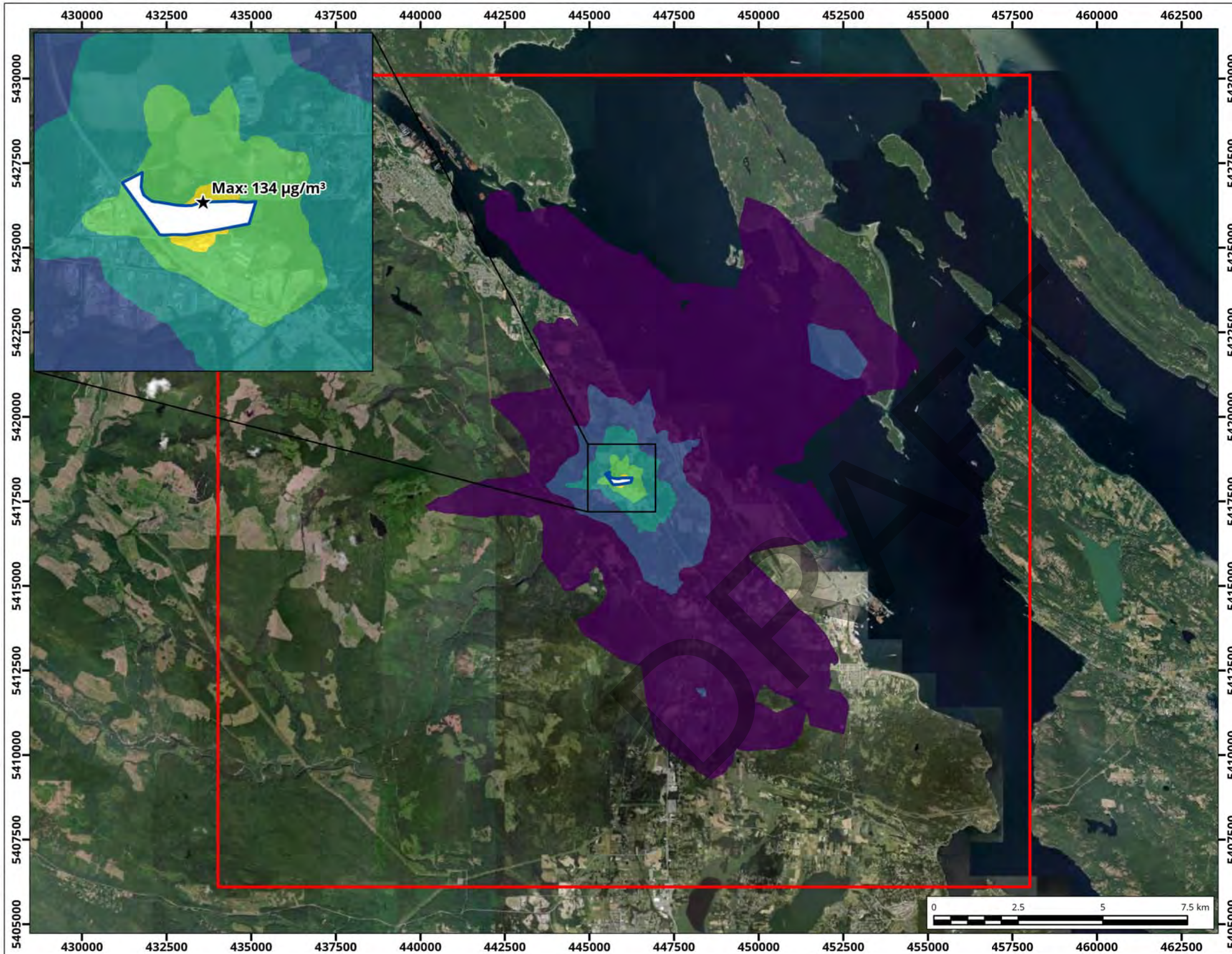
True North

Drawn by: DJH	Figure: D17
Approx. Scale:	1:125,000
Date Revised:	Dec 13, 2024

Map Projection: NAD 1983 CSRS UTM Zone 10N

Western Forest Products | Value Added Division - Chemainus, B.C.

Project #: 2405727



Legend

★ Maximum Concentration

Model Domain

Property Boundary

Concentration (µg/m³)

22 - 23

23 - 25

25 - 30

30 - 50 (BC AAQO)

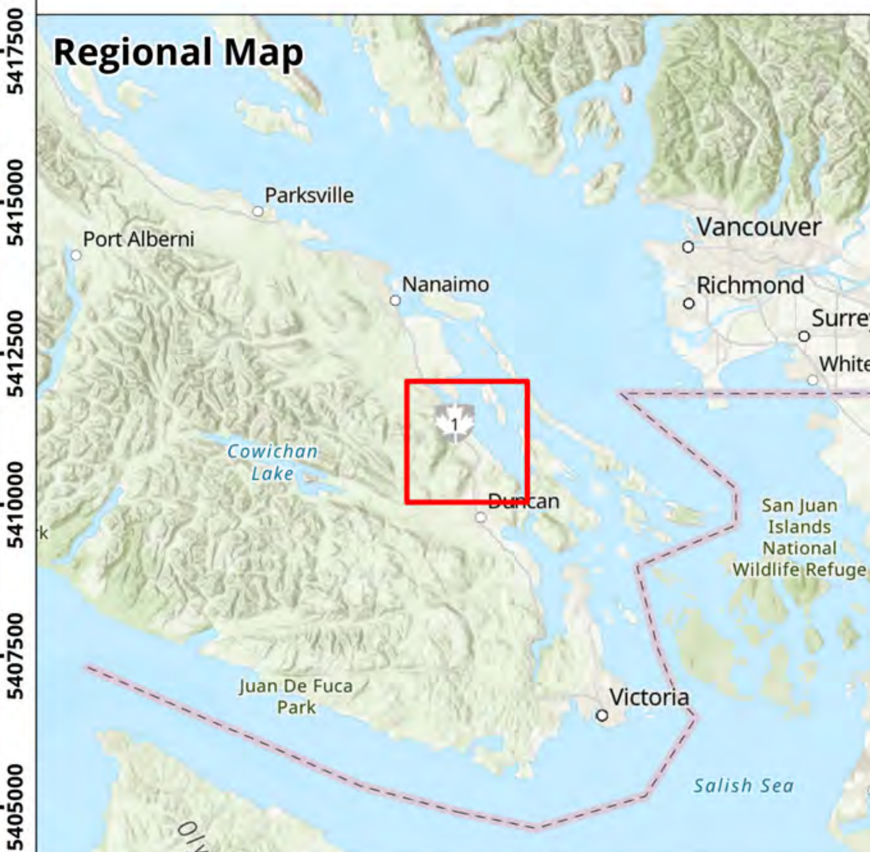
> 50 (BC AAQO)

Background Concentration = 21.2 µg/m³

B.C. Ambient Air Quality Objective = 50 µg/m³

Service Layer Credits: World Imagery: Earthstar Geographics
World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community
World Imagery: North Cowichan, Earthstar Geographics
World Hillshade: Esri, USGS

Regional Map



Predicted 24-hour PM_{10} Concentrations for Proposed Future Sources (including background)

Map Projection: NAD 1983 CSRS UTM Zone 10N

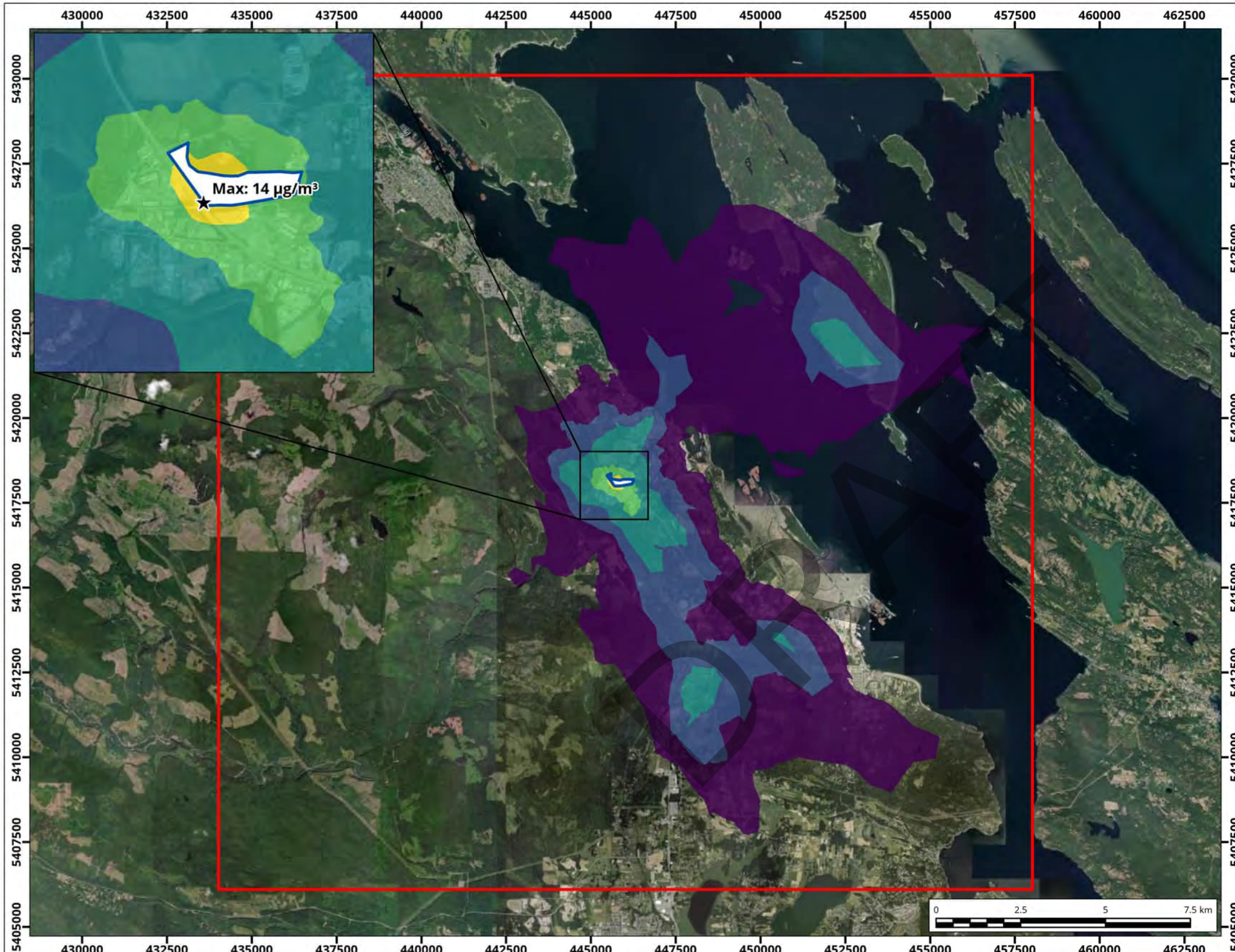
Western Forest Products | Value Added Division - Chemainus, B.C.

True North

Drawn by: DJH	Figure: D18	
Approx. Scale:	1:125,000	
Date Revised:	Dec 13, 2024	

Project #: 2405727

Map Document: C:\GIS\2405727\P2405727_WesternForestProducts.aprx



Legend

★ Maximum Concentration

Model Domain

Property Boundary

Concentration (µg/m³)

- 1 - 1.5
- 1.5 - 2
- 2 - 3.5
- 3.5 - 7
- > 7

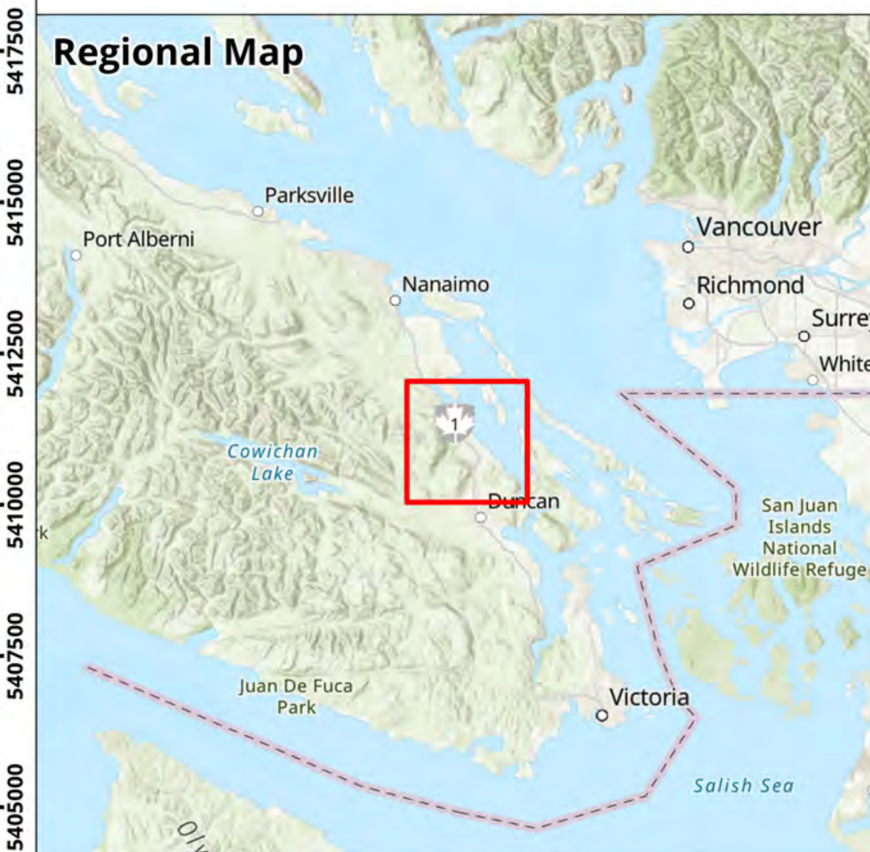
Background Concentration = 10.2 µg/m³

B.C. Ambient Air Quality Objective 1 = 113 µg/m³

B.C. Ambient Air Quality Objective 2 = 79 µg/m³

Service Layer Credits: World Imagery: Earthstar Geographics
World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community
World Imagery: North Cowichan, Earthstar Geographics
World Hillshade: Esri, USGS

Regional Map



Predicted 1-hour NO_2 Concentrations for Proposed Future Sources (without background)

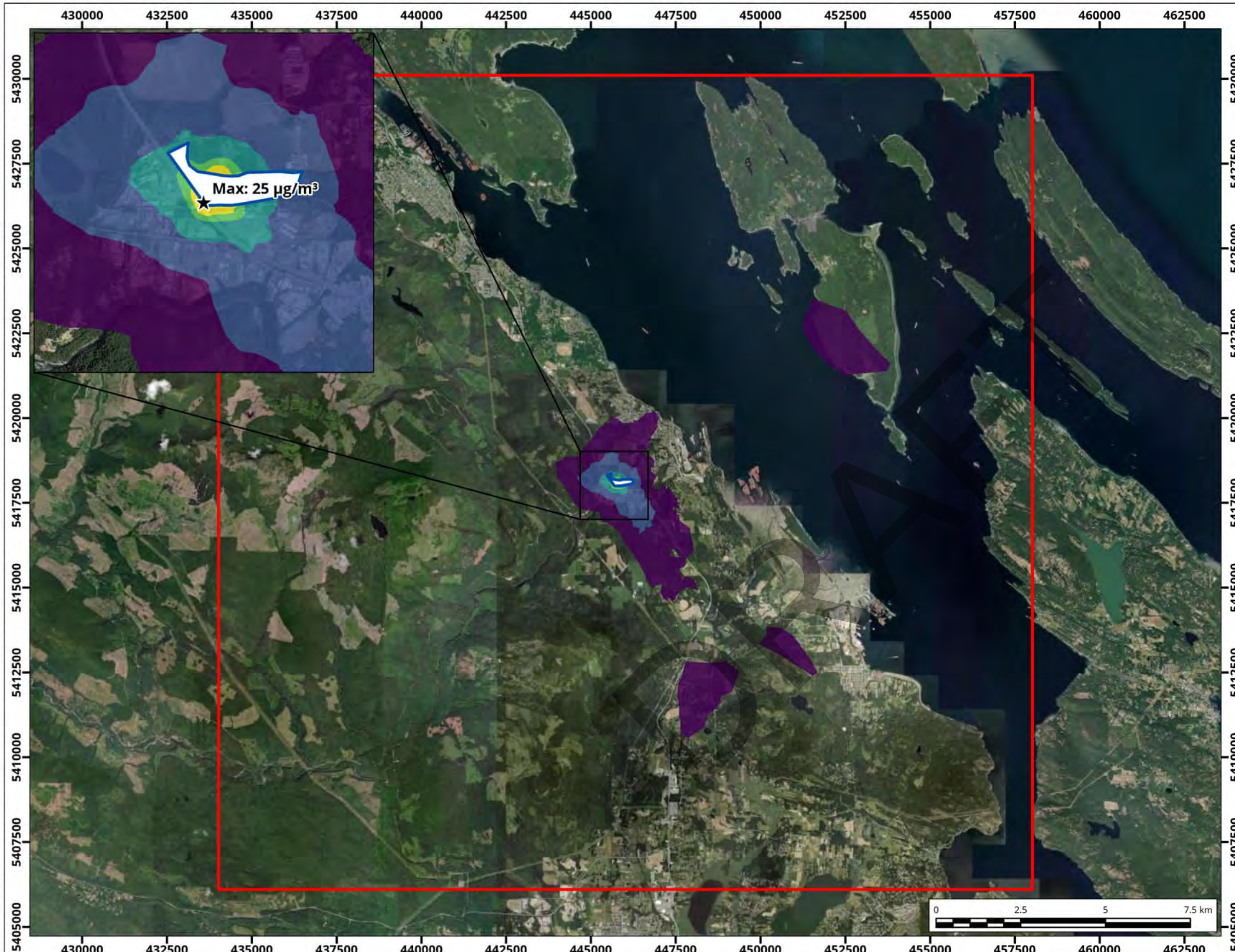
Map Projection: NAD 1983 CSRS UTM Zone 10N

Western Forest Products | Value Added Division - Chemainus, B.C.

True North

Project #: 2405727

Drawn by: DJH	Figure: D19
Approx. Scale: 1:125,000	
Date Revised: Dec 13, 2024	



Legend

★ Maximum Concentration
Model Domain
Property Boundary

Concentration (µg/m³)

- 12 - 13
- 13 - 15
- 15 - 18
- 18 - 20
- > 20

Background Concentration = 10.2 µg/m³
B.C. Ambient Air Quality Objective 1 = 113 µg/m³
B.C. Ambient Air Quality Objective 2 = 79 µg/m³

Service Layer Credits: World Imagery: Earthstar Geographics
World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community
World Imagery: North Cowichan, Earthstar Geographics
World Hillshade: Esri, USGS

Regional Map

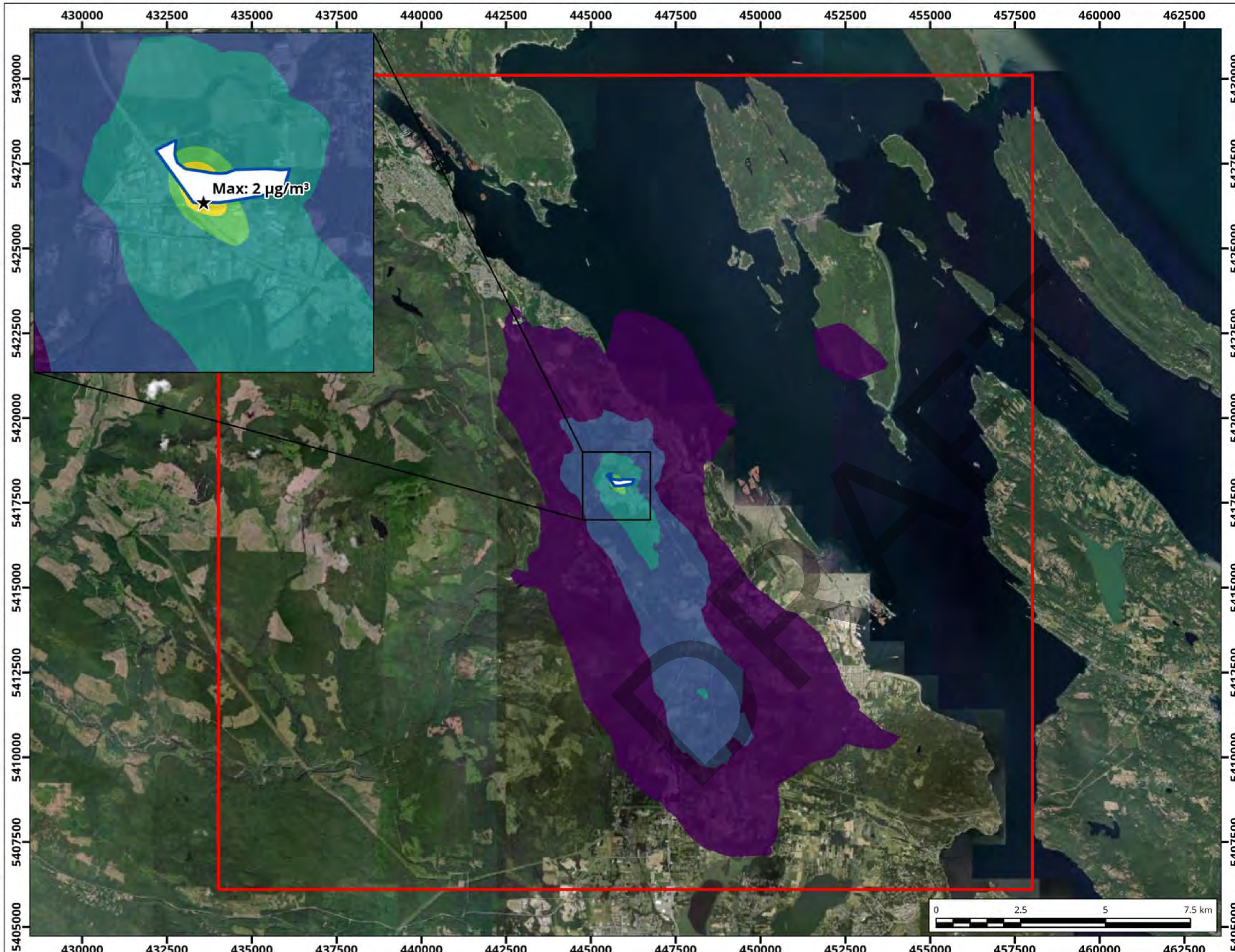
Predicted 1-hour NO_2 Concentrations Proposed Future Sources (including background)

Map Projection: NAD 1983 CSRS UTM Zone 10N
Western Forest Products | Value Added Division - Chemainus, B.C.

True North

Project #: 2405727

Drawn by: DJH	Figure: D20
Approx. Scale: 1:125,000	
Date Revised: Dec 13, 2024	



Legend

★ Maximum Concentration

Model Domain

Property Boundary

Concentration (µg/m³)

- 0.025 - 0.05
- 0.05 - 0.1
- 0.1 - 0.5
- 0.5 - 1
- > 1

Background Concentration = 3.4 µg/m³
B.C. Ambient Air Quality Objective 1 = 32 µg/m³
B.C. Ambient Air Quality Objective 2 = 23 µg/m³

Service Layer Credits: World Imagery: Earthstar Geographics
World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community
World Imagery: North Cowichan, Earthstar Geographics
World Hillshade: Esri, USGS

Regional Map

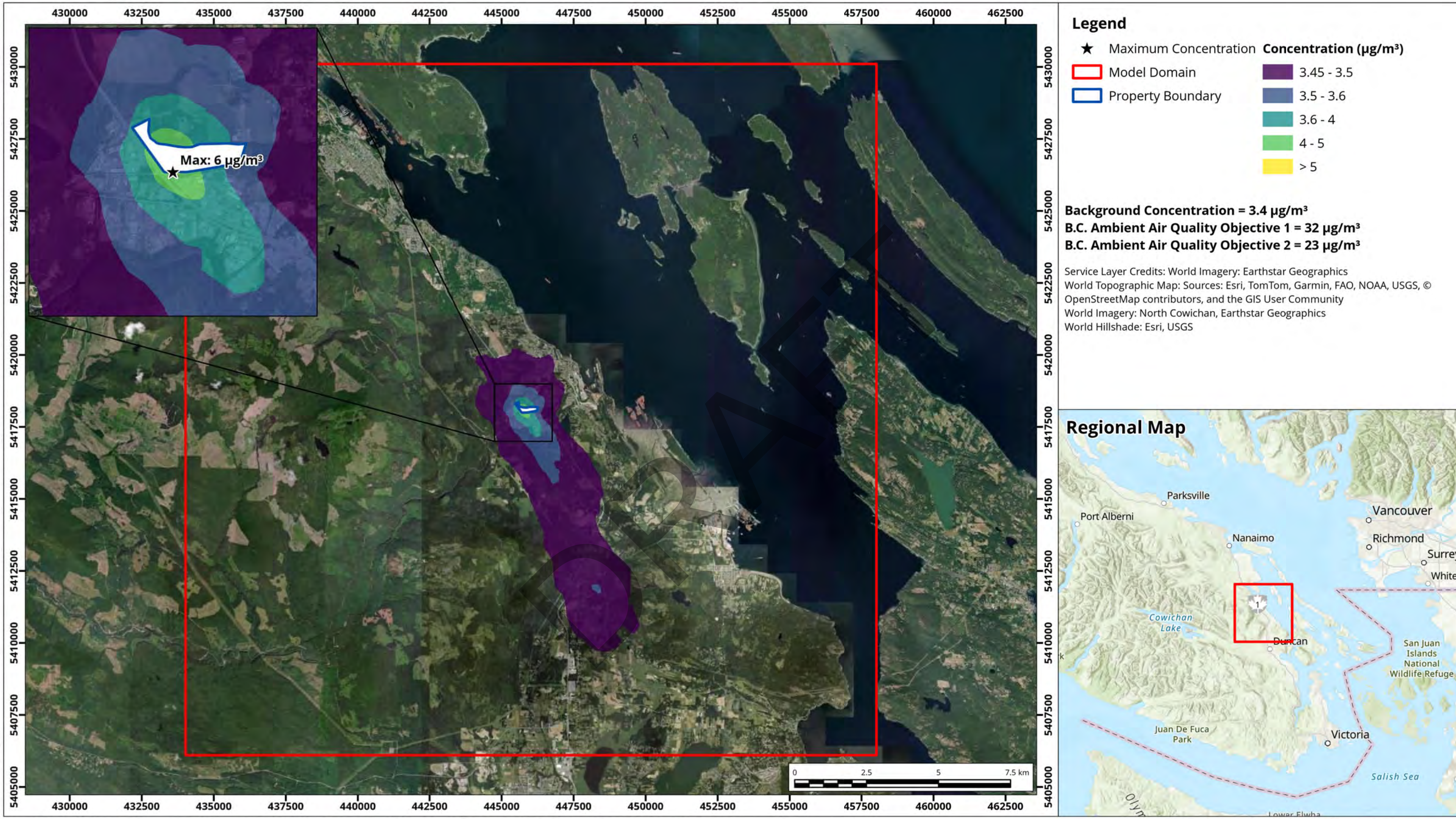
Predicted Annual NO_2 Concentrations for Proposed Future Sources (without background)

Map Projection: NAD 1983 CSRS UTM Zone 10N
Western Forest Products | Value Added Division - Chemainus, B.C.

True North

Project #: 2405727

Drawn by: DJH	Figure: D21
Approx. Scale:	1:125,000
Date Revised:	Dec 13, 2024



Predicted Annual NO_2 Concentrations for Proposed Future Sources (including background)

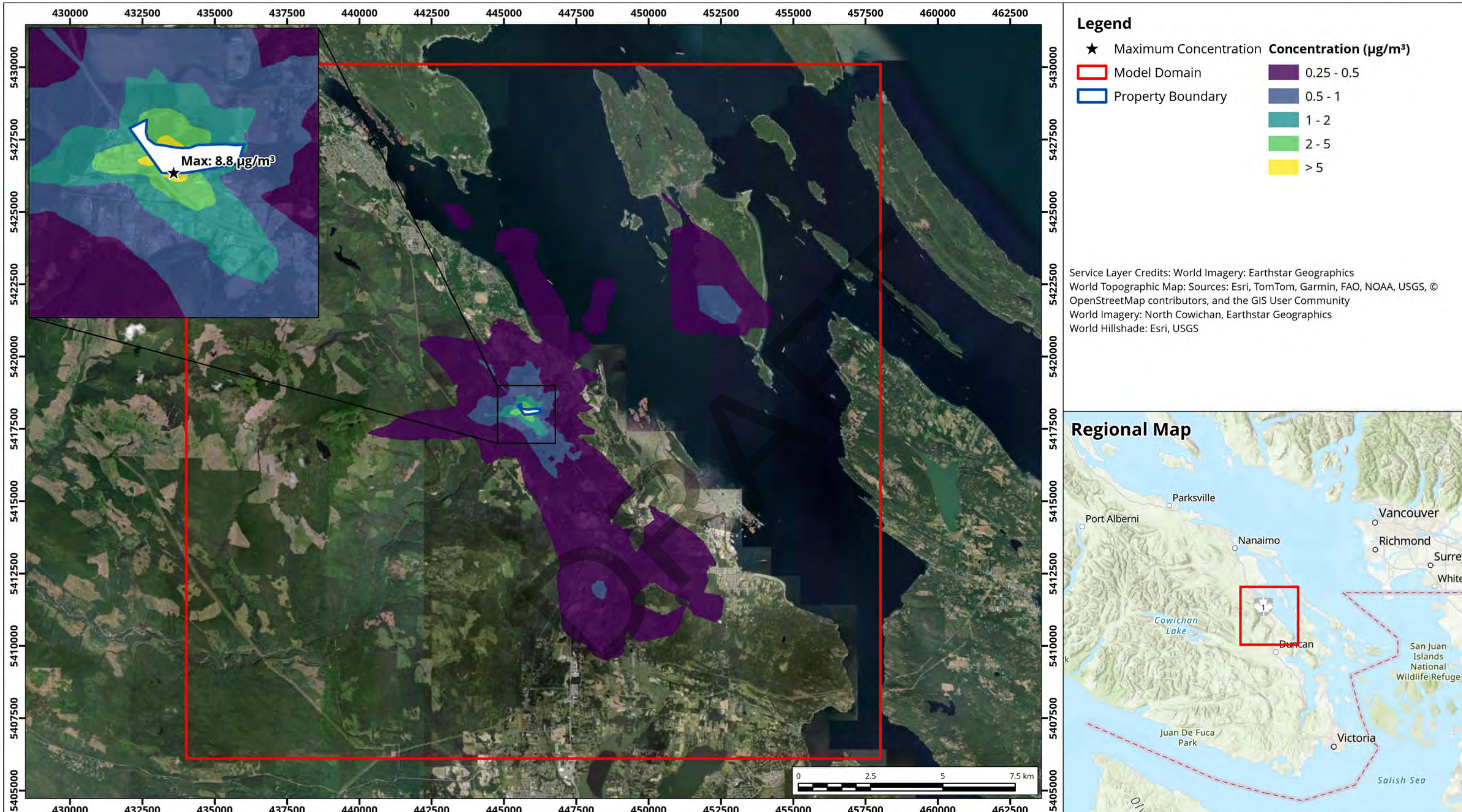
True North

Drawn by: DJH	Figure: D22
Approx. Scale:	1:125,000
Date Revised:	Dec 13, 2024

Map Projection: NAD 1983 CSRS UTM Zone 10N

Western Forest Products | Value Added Division - Chemainus, B.C.

Project #: 2405727



Predicted 24-hour VOC Concentrations for Proposed Future Sources (without background)

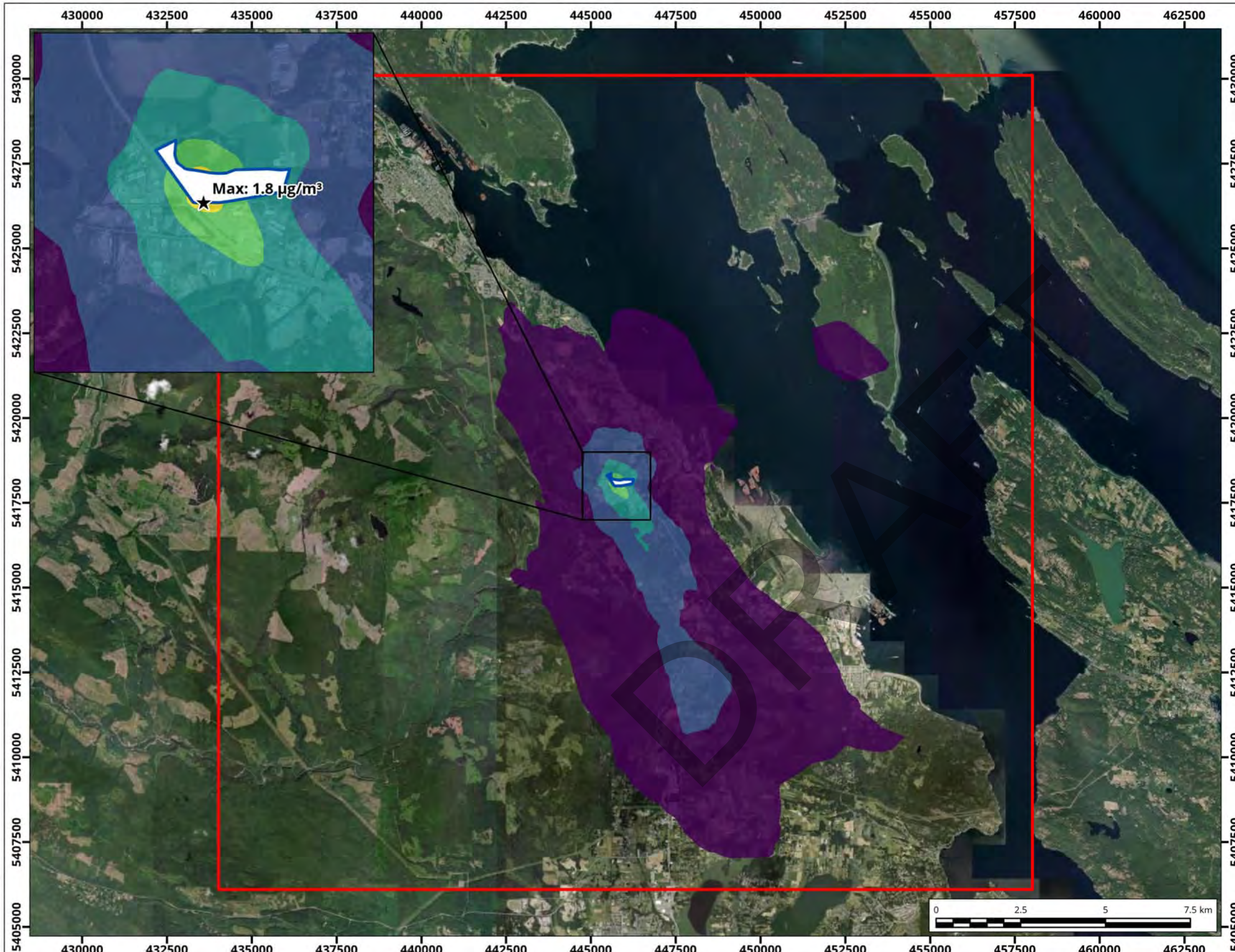
Map Projection: NAD 1983 CSRS UTM Zone 10N

Western Forest Products | Value Added Division - Chemainus, B.C.

True North

Project #: 2405727

Drawn by: DJH	Figure: D23
Approx. Scale:	1:125,000
Date Revised:	Dec 13, 2024



Legend

★ Maximum Concentration

Model Domain

Property Boundary

Concentration (µg/m³)

- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.3
- 0.3 - 1
- > 1

Service Layer Credits: World Imagery: Earthstar Geographics
World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community
World Imagery: North Cowichan, Earthstar Geographics
World Hillshade: Esri, USGS

Regional Map

Predicted Annual VOC Concentrations for Proposed Future Sources (without background)

Map Projection: NAD 1983 CSRS UTM Zone 10N

Western Forest Products | Value Added Division - Chemainus, B.C.

True North

Project #: 2405727

Drawn by: DJH	Figure: D24
Approx. Scale:	1:125,000
Date Revised:	Dec 13, 2024