

Metro Vancouver Proposed Operational Certificate Discharge Limits

Metro Vancouver Waste-to-Energy Facility

Vancouver, BC

September 23, 2026

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Acronyms

Acronym	Definition
°C	Temperature in degrees Celsius
°F	Temperature in degrees Fahrenheit
AAAQO	Alberta Environment and Parks Ambient Air Quality Objectives
AGDMG	British Columbia Air Dispersion Modelling Guideline
APC	Air Pollution Control
AQHI	Air Quality Health Index
As	Arsenic
BAT	Best Available Techniques
BC AAQO	British Columbia Ambient Air Quality Objectives
BC ENV	British Columbia's Ministry of the Environment and Parks
CAAQS	Canadian Ambient Air Quality Standards
CACs	Criteria Air Contaminants
CB	Chlorobenzene
CEMS	Continuous Emission Monitoring System
CO	Carbon Monoxide
CO_2e	Carbon Dioxide Equivalent of Greenhouse Gas Discharge
COPC	Contaminants of Potential Concern
CP	Chlorophenols
Cr	Chromium
DCS	Distributed Control System
dscm	Dry Standard Cubic Metre
Durham York	Durham York Energy Centre
EU	European Union
FHA	Fraser Health Authority
FTIR	Fourier Transform Infrared
HCB	Hexachlorobenzenes
HCl	Hydrogen Chloride
HDR	HDR Corporation
HF	Hydrogen Fluoride
Hg	Mercury
ID	Induced Draft
IED	Industrial Emissions Directive
I-TEQ	International Toxic Equivalent
kPa	Kilopascal
LN	Low NOx Combustion System
mg	Milligrams
mmH_2O	mm of Water
MPOI	Maximum Point of Impingement
MSW	Municipal Solid Waste

Acronym	Definition
MV AAQOs	Metro Vancouver Ambient Air Quality Objectives
NH_3	Ammonia
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
N_2O	Nitrous Oxide
ng	Nanograms
O_2	Oxygen
OEHM	Ollson Environmental Health Management
Ontario AAQC	Ontario Ambient Air Quality Criteria
OTNOC	Other Than Normal Operating Conditions
PAC	Powdered Activated Carbon
PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyl
PCDD	Polychlorinated dibenzodioxins (Dioxins)
PCDF	Polychlorinated dibenzofurans (Furans)
PHRA	Public Health Risk Assessment
PM	Particulate Matter
QPs	Qualified Professionals
RE	Removal Efficiency
RWDI	RWDI Consulting Engineers and Scientists
SCADA	Supervisory Control and Data Acquisition
SNCR	Selective Non-Catalytic Reduction
SO_2	Sulphur Dioxide
SP	Set Point
THC	Total Hydrocarbons
Ti	Thallium
TOC	Total Organic Carbon
µg	Microgram
UPLs	Upper Prediction Limits
USEPA	United States Environmental Protection Agency
VCH	Vancouver Coastal Health
VOCs	Volatile Organic Compounds

1 Executive Summary

1.1 Purpose of Work

Metro Vancouver, as owner of the Waste-to-Energy Facility, HDR Corporation (HDR), as provider of engineering, operational and environmental services, and Veolia, as facility operator, collaborated to address the requirements of the British Columbia Ministry of Environment and Parks (BC ENV) Amended Operational Certificate, issued September 23, 2025 and included in **Appendix A**.

The Operational Certificate requires Qualified Professionals (QPs) to complete a series of studies and evaluations to support BC ENV's determination of revised discharge limits for the Waste-to-Energy Facility. Key components of the work include:

1. Reviewing current discharge levels, including but not limited to HCl and SO_2.
2. Documenting the results of testing potential facility operational modifications intended to support reduced discharge limits.
3. Conducting a Public Health Risk Assessment (PHRA), in consultation with Vancouver Coastal Health (VCH) and Fraser Health Authority (FHA), to inform the proposed discharge limits.
4. Developing proposed draft revised discharge limits.
5. Developing a public consultation plan for the draft revised discharge limits.
6. Reviewing emission reporting and public access to data, including recommendations for improvement where warranted.

BC ENV requires proposed final discharge limits to be submitted within five months of the Director's approval of the public consultation plan.

To support the development of revised discharge limits and satisfy the requirements of the Operational Certificate, Metro Vancouver, Veolia, HDR, RWDI Consulting Engineers and Scientists (RWDI), and Ollson Environmental Health Management (OEHM) completed a series of technical reviews, analyses, operational assessments, testing programs, and stakeholder consultations. Together, these activities provide the technical basis for the draft discharge limits proposed in this report.

1.2 Jurisdictional Scan

A series of jurisdictional scans were conducted to provide context for Metro Vancouver's current discharge limits, monitoring requirements, and regulatory approaches across jurisdictions. These were used to inform proposed changes to discharge limits, additional monitoring and regulatory approaches at the Waste-to-Energy Facility.

Metro Vancouver's discharge limits generally fall within the range of those adopted by other waste-to-energy regulatory frameworks; however, several differences were identified. In particular, the current Operational Certificate includes higher interim discharge limits for hydrogen chloride (HCl), sulphur dioxide (SO_2), and nitrogen oxide (NO_x) than those adopted by Durham York Energy Centre (Durham York) and the European Union (EU) Industrial Emissions Directive.

As discussed in subsequent sections, revisions to these limits are proposed as part of this review to better align Metro Vancouver's requirements with current industry practices and comparable regulatory frameworks.

The environmental monitoring requirement review identified opportunities to further align Metro Vancouver's environmental monitoring program with practices adopted in other jurisdictions. Proposed monitoring enhancements and additional monitoring methods considered as part of the Operational Certificate review are presented in Section 6.1.

A review of regulatory approaches and emission reporting practices in Europe and North America was completed to assess the proposed Operational Certificate and Waste-to-Energy Facility practices against leading international regulatory frameworks, confirming that the proposed requirements are consistent with current industry practice.

1.3 Current Operations, Discharge Limits and Monitoring Summary

The Waste-to-Energy Facility consists of three identical, mass burn type combustion units with a current process capacity of approximately 240,000 tonnes per year of municipal solid waste (MSW), or approximately 25% of the residual MSW managed by Metro Vancouver.

Current Monitoring:

There are two types of discharge monitoring methods employed at the Waste-to-Energy Facility. The first method is continuous in-stack discharge monitoring of specific parameters and continuous opacity monitoring systems, as well as continuous monitoring of specific operating parameters. The second is quarterly stack testing conducted for multiple parameters and annually for another broader set of other parameters.

Compared with other waste-to-energy facilities and regulatory jurisdictions in North America and Europe, the Waste-to-Energy Facility conducts stack testing at a relatively high frequency. Most comparable facilities and jurisdictions require stack testing on an annual or semi-annual basis, whereas the Waste-to-Energy Facility conducts comprehensive stack testing quarterly for several parameters.

Discharge Reporting:

The Waste-to-Energy Facility reports continuous discharge monitoring and stack testing results in accordance with the requirements of the Operational Certificate. Reporting includes periodic stack testing reports, monthly discharge reports, and annual environmental performance reporting that document facility operations, emissions performance, and compliance with discharge limits.

Environmental Performance:

The Waste-to-Energy Facility has an excellent environmental performance. Table 6 (Section 3.5) shows average discharge concentrations for regulated contaminants compared to the Operational Certificate limits for 2024. On average, measured discharge values were 17% of the regulatory limit with no parameters exceeding regulatory limits.

1.4 Operational Testing and Analysis

Acid Gas Reduction Trials:

- **Process Optimization**: Operational trials confirmed that adjusting target setpoints, increasing feed rates of hydrated lime and fine-tuning automated control loops to respond dynamically to raw-gas peaks can reduce discharges in the near term without excessive reagent consumption. This approach uses existing infrastructure to improve operating efficiency. Following the initial trials, increased hydrated lime feed rate has been implemented on an ongoing basis resulting in reductions in HCl discharge concentration of 52% and reduction in SO_2 discharge concentration of 17% compared to 2024 discharge concentrations. The emission reductions achieved through increased hydrated lime use allow for proposed draft discharge limits of 120 mg/dscm for SO_2 and 45 mg/dscm for HCl.
- **Alternative Reagent Trials:** Additional trials were conducted with SPS lime and sodium bicarbonate. These trials demonstrated that even lower HCL and SO_2 discharge concentrations are achievable through changing reagents. Operational constraints and challenges prevented complete understanding of potential discharge concentrations if facility reagent feed systems are updated to allow the use of one of these reagents potentially in combination with hydrated lime. Additional testing is planned in advance of the submission of proposed final emission limits that will assist in determining the proposed final emission limits.

NO_x Control Optimization:

- **Optimization Results**: Full-scale testing evaluated the effects of optimizing ammonia injection locations and flow rates. The trials indicated that additional process optimization is unlikely to materially reduce steady state stack NO_x concentrations below current levels but can reduce ammonia requirements. Refined control loops reduced overall ammonia consumption by up to 13% and reduced the discharge of unreacted ammonia, which may help limit secondary particulate formation.
- **Operational Constraints & Stability:** Reductions in steady state nitrogen oxides (NO_x) discharge are limited by the physical capacity of the existing process, which prevents more aggressive ammonia injection. However, historical data analysis indicates that historic emission spikes resulting in a 24-hour discharge concentration of more than 150 mg/dscm can be avoided allowing a reduction from the current 190 mg/dscm discharge limit.
- **Proposed Discharge Limit**: Based on verified operational stability, a reduction in a 24-hour discharge limit to 150 mg/dscm at 11% oxygen (O_2) is proposed.

N_2O Cylinder Explosion Analysis and CO Exceedance Implications

- **Explosion Identification & Trends:** Continuous monitoring data and operator records were used to develop a data-supported methodology for identifying suspected nitrous oxide (N_2O) cylinder explosions. The explosions result in short duration change in both vessel pressure and discharge carbon monoxide (CO) concentrations. Application of the methodology indicated that explosion frequency is increasing.
- **CO Exceedance Contributions:** Approximately 15% of reported 30-minute CO exceedances were associated with suspected N_2O cylinder explosions. A broader

assessment of short-duration CO spike events, including explosion-related events, found that 37.5% of reported exceedances were linked to these short-duration events. The proportion of 30-minute CO exceedances attributable to these short-duration CO spikes is increasing, indicating a growing influence of these events on reported compliance performance.

- **Natural Gas Intervention Effectiveness:** Review of explosion and CO spike events found that CO concentrations typically returned to baseline levels within three minutes regardless of natural gas burner operation. Excess natural gas use associated with operator responses intended to reduce the potential for 30-minute CO exceedance was estimated at approximately 48,500 m³ for explosion events and up to 300,000 m³ when extrapolated across all CO spike events, representing roughly 590 tonnes of carbon dioxide (CO_2e)[1] of associated greenhouse gas discharge. Analysis has shown that increasing natural gas following these short-duration CO exceedances does not reduce the CO concentrations due to the short duration of the exceedance.
- **Public Health Implications:** Air modelling of the maximum release of CO 2,990 g/min during the exceedances determined under even the worst case release that the ground level concentration of CO during these events at the maximum point of impingement was six times lower than the ambient air quality objective and does not present a public health risk. The modelled maximum CO discharge concentration was modelled with the assumption that it was released at this concentration for the full 30-minute period. Consequently, the modelled CO ground level concentration was higher than could be expected under any short-duration exceedance.
- **Proposed 30-Minute CO Exceedance Approach:** Analysis indicates that short-duration CO spikes, including suspected N_2O cylinder explosion events, are increasingly influencing reported 30-minute response limit CO exceedances despite typically resolving within three to five minutes. Because of the short duration of these events, operators are unable to take actions that would reduce the potential to exceed the 30 -minute response limit, and current actions of increasing natural gas use do not impact the exceedances and result in increased natural gas use and greenhouse gas emissions. Metro Vancouver is therefore proposing that CO 30-minute response limit exceedances with a duration of less than five minutes be excluded from the calculations of the hours of 30-minute CO response limit exceedance.

1.5 Proposed Discharge Limits

Based on the research and analysis provided herein, Metro Vancouver is proposing amended discharge limits for the Waste-to-Energy Facility's Operational Certificate. Section 5.2 presents the current and proposed limits, as well as the sampling and analysis frequency proposed. The proposed amendments include new limits for lead, arsenic, and chromium and more stringent emission limits for the following parameters to reflect the Waste-to-Energy Facility's capability and industry best practices:

[1] CO_2e emissions were estimated using the Government of Canada's 2025 emission factor for marketable natural gas in British Columbia (1,966 g CO_2/m^3 natural gas).

- Sum of lead, arsenic and chromium
- Total mercury (Hg)
- Dioxins and furans
- SO_2
- HCl
- Polycyclic aromatic hydrocarbons (PAH)
- Polychlorinated biphenyls (PCB)
- Chlorophenols (CP)

Proposed draft discharge limits are shown in the following table for parameters with new or revised proposed limits. Proposed limits are based on results of operational testing conducted in the spring of 2026 or reviews of current discharge concentrations compared to discharge limits. Discharge limits for parameters not currently included the Operational Certificate are based on a review of current discharge concentrations and review of discharge limits in other jurisdictions.

Table 1: Proposed Discharge Limits

Emission Parameters	Current Emission Limit	Proposed Emission Limit
Lead µg/dscm	N/A	48
Arsenic µg/dscm	N/A	9.2
Chromium µg/dscm	N/A	40
Lead, Arsenic, Chromium µg/dscm	64	60
Total Mercury µg/dscm	20	15
Dioxins and Furans (PCDD/PCDF) TEQ ng/dscm	0.08	0.06
Hydrogen Chloride (HCl) mg/dscm 1-hr	55 (interim)	45
Hydrogen Fluoride (HF) mg/dscm	1	0.52
Sulphur Dioxide (SO_2) mg/dscm 24-hr	200 (interim)	120
Nitrogen Oxides (NO_x) mg/dscm 24-hr	190	150
Polycyclic Aromatic Hydrocarbons (PAH) µg/dscm	5	1.3
Polychlorinated Biphenyls (PCBs) µg/dscm	1	0.4
Chlorophenols µg/dscm	1	0.29

1.6 Proposed Additional Monitoring

Discharge Monitoring

Metro Vancouver proposes expanding the Waste-to-Energy Facility discharge monitoring program to include the addition of condensable particulate stack testing, annual startup and shutdown stack testing, and continuous free ammonia (NH_3) monitoring. The program would also expand existing dioxins and furan stack testing from one combustion line to all three combustion lines annually. In addition, continuous sampling for dioxins and furans would be implemented for extended periods in each combustion line on an annual basis. This additional tracking and monitoring are intended to provide a more comprehensive assessment of facility performance and is informed by discharge monitoring requirements in other jurisdictions. Further details can be found in Table 9 in Section 6.1.

Ambient Air Monitoring

Metro Vancouver will reinstall the ambient air monitoring station adjacent to the Waste-to-Energy Facility (S150 monitoring station). The station is near predicted maximum point of impingement (MPOI) in the air quality dispersion modelling study. The station will include the following continuously monitored parameters:

- HCl
- SO_2
- NO_x
- $PM_{2.5}$
- PM_{10}

Data from the station will be available to the public on the internet as part of Metro Vancouver's AirMap website.

Startup and Shutdown Stack Test Monitoring

Metro Vancouver will undertake annual startup and shutdown stack testing to establish trends in the emissions in comparison to the routine operations emissions from the Waste-to- Energy Facility.

1.7 Regular PHRA Updates

Metro Vancouver will undertake updated air quality dispersion modelling and Public Health Risk Assessment (PHRA) every five years using the latest Continuous Emission Monitoring System (CEMS) and stack test data. The PHRAs would consider current facility discharges and any changes in ambient air quality objectives and the data from the S150 monitoring station. The recommendations from the PHRAs would be integrated into requirements for the Waste-to-Energy Facility.

1.8 Access to Data

Proposed Approach on Access to Data

To enhance accessibility and usability of environmental performance data, Metro Vancouver will update the Waste-to-Energy Facility Internet Publication Plan to specify the development of an online tool to allow users to query emissions data both continuously monitored and stack test data by selecting specific parameters and time periods. Emissions data would be available alongside data from the new ambient air monitoring station adjacent to the Waste-to-Energy Facility, enabling users to compare facility emissions data with real-time ambient air concentrations measured immediately adjacent to the Waste-to-Energy Facility. Data collected after the updated Operational Certificate is issued would be available through the tool, while data from before the update to the Operational Certificate would continue to be available through static reports on the website.

Some of the data that will be available through the new online tool may be subject to revisions as part of regular reporting and data review processes, and as such the tool will include qualifiers noting that some of the data may be subject to change.

1.9 Air Quality Modelling and Public Health Risk Assessment Findings

Overall, the air quality modelling results indicate that Waste-to-Energy Facility emissions contribute a relatively small increment to ambient concentrations of the Lower Fraser Valley for most contaminants. Predicted ambient air quality objective exceedances were generally associated with conservative maximum-permitted emission scenarios, elevated regional background concentrations, or localized areas immediately surrounding the facility. The modelling results presented in this assessment, along with additional data on predicted ambient concentrations and deposition rates, provide inputs required for the companion PHRA.

Based on the results of the ambient air quality monitoring and PHRA, current emissions of contaminants from the Waste-to-Energy Facility do not pose a public health risk. The findings of this PHRA are consistent with the findings of a 2018 report and the past three decades of peer-reviewed scientific literature and government reports on facilities around the world.

The PHRA recommends that that the draft proposed discharge limits presented in this report be included in the Waste-to-Energy Facility Operational Certificate. In addition, annual startup and shutdown stack testing should be conducted, the ambient air monitoring station adjacent to the Waste-to-Energy Facility should be reestablished, and every five years air quality modelling and a PHRA should be conducted.

1.10 Public Consultation and Engagement Plan

The Public Consultation and Engagement Plan describes the process to seek input on proposed updated emission limits and additional environmental monitoring opportunities for the Waste-to-Energy Facility. Engagement would begin following provincial approval of the Public Consultation and Engagement Plan.

To support informed participation, Metro Vancouver will provide information on Waste-to-Energy Facility's environmental performance, PHRA conclusions, and findings from recent studies and modelling. Interested parties will have opportunities to review information, ask questions, and provide feedback.

Engagement audiences will include First Nations, Metro Vancouver member jurisdictions and adjacent regional districts, provincial and federal health authorities, waste and recycling industry representatives, relevant government agencies, organizations and individuals with an interest in the Waste-to-Energy Facility, neighbouring property owners and tenants, subscribers to Metro Vancouver's Solid Waste Services mailing list, and social media audiences.

Following completion of engagement activities, Metro Vancouver will prepare an engagement summary report documenting the engagement process, participation, key feedback themes, First Nations feedback as appropriate, Metro Vancouver's responses, and how feedback influenced

proposed updated emission limits and additional environmental monitoring opportunities. The engagement summary report, along with final proposed emission limits and additional environmental monitoring activities, will be submitted to the Ministry of Environment and Parks for consideration. Engagement and reporting activities will be completed within five months of provincial approval of the Public Consultation and Engagement Plan.

2 Jurisdictional Scan

2.1 Discharge Limits in Other Jurisdictions

Table 2 summarizes discharge limits from a representative selection of North American and international waste-to-energy regulatory frameworks, including the Durham York in Ontario, the EU Industrial Emissions Directive (2010/75/EU), and the United States Environmental Protection Agency (USEPA) 2026 Emission Guidelines. Discharge limits were converted to common reference conditions to support direct comparisons. The review provides context for assessing how Metro Vancouver's current discharge limits compare with peer facilities and established regulatory frameworks.

Metro Vancouver's discharge limits generally fall within the range of those adopted by other waste-to-energy regulatory frameworks; however, several differences were identified. In particular, the current Operational Certificate includes higher interim discharge limits for HCl, SO_2, and NO_x than those adopted by Durham York and the EU Industrial Emissions Directive. As discussed in subsequent sections, revisions to these limits are proposed as part of this review to better align Metro Vancouver's requirements with current industry practices and comparable regulatory frameworks.

Table 2: Emission Limit Jurisdictional Scan

Emission Parameter	Units [1]	Metro Vancouver Waste-to-Energy Facility Current 24 hour Discharge Limits[2]	Durham York Energy Centre Standards	EU Directive 2010/75/EU[7]	USEPA 2026 Emission Guidelines
Particulate Matter (PM)	mg/dscm	9	9	9	20
Particulate Matter (PM) Condensables	mg/dscm	-	(5)		(5)
Cadmium (Cd) only	mg/dscm	0.007	0.007	-	0.007
Cadmium (Cd) + Thallium (Ti)	mg/dscm	-	-	0.046	-
Lead (Pb) only	mg/dscm	-	0.048	-	0.048
Sum of Lead (Pb), Arsenic (As), & Chromium (Cr)	mg/dscm	0.064		-	-
Sum of Antimony (Sb), Lead (Pb), Arsenic (As), Chromium (Cr), Cobalt (Co), Copper (Cu), Manganese (Mn), Nickel (Ni), & Vanadium (V)	mg/dscm	-	-	0.458	-
Mercury (Hg)	mg/dscm	0.020	0.015	0.046	0.035 or 85% RE[6]
PCDD/PCDF Total	ng/dscm	-	-	-	10
PCDD/PCDF, I-TEQ	ng/dscm	0.08	0.06	0.09	-
Hydrogen Chloride (HCl)	mg/dscm	55[4]	9	9	11 or 96% RE[6]
Hydrogen Fluoride (HF)	mg/dscm	1	-	1	-
Sulphur Dioxide (SO_2)	mg/dscm	200[4]	34	47	42 or 75% RE[6]
Nitrogen Oxides (NO_x)	mg/dscm	190	119	140	279
Total Hydrocarbons (THC)	mg/dscm	10	49	9	-
Carbon Monoxide (CO) [3]	mg/dscm	50	39	37	83
Opacity	%	5	10	-	10
Ammonia (NH_3)	mg/dscm	-		28	-

Notes:

[1] All parameters for all standards were converted to Metro Vancouver Reference Conditions: Dry conditions at 11% O_2, 20°C and 101.3 kPa.

[2] "Interim Discharge Limits" are identified as measured by the 24-hour average or approved stack test method for certain parameters up to dates identified in the Operational Certificate, dated April 4. 2025.

[3] Carbon monoxide "interim" discharge limit was measured as a 4-hour average up to December 31, 2016 then switched to a 24-hour average per the Operational Certificate.

[4] HCl is 1-hour based on SO_2 as a surrogate. Operational Certificate also includes final emission discharge limits of 50 mg/dscm for SO_2 and 10mg/dscm for HCl.

[5] $PM_{2.5}$/PM_{10} and Condensable Particulates are measured using USEPA Test Methods 201A and 202, but there is no compliance standard.

[6] RE = Reduction Efficiency allowed as alternate to concentration limit for select emission parameters.

[7] Lower discharges are required during normal operating conditions only (EU Decision 2019/2010), which cannot be compared to Metro Vancouver's 24-hour limits.

2.2 Emission Monitoring in Other Jurisdictions

Table 3 presents the results of a jurisdictional scan comparing air emission monitoring requirements and practices across selected waste-to-energy facilities and regulatory frameworks. The review includes Durham York, the EU Industrial Emissions Directive (2010/75/EU), and the USEPA 2026 Emission Guidelines. The comparison provides context for Metro Vancouver's current monitoring requirements and identifies similarities and differences in monitoring approaches, monitoring frequencies, and compliance verification methods across jurisdictions.

The review identified differences between Metro Vancouver's monitoring requirements and those of the other jurisdictions reviewed. Metro Vancouver uses continuous monitoring for key parameters and periodic stack testing for metals and other contaminants, whereas Durham York and the EU require continuous sampling systems for dioxins and furans (PCDD/PCDF). In addition, NH_3 monitoring is included in Durham York, EU, and USEPA requirements. Monitoring frequencies for certain metals also differ among the jurisdictions reviewed.

The review identified opportunities to further align Metro Vancouver's monitoring program with practices adopted in other jurisdictions. Proposed monitoring enhancements and additional monitoring methods considered as part of the Operational Certificate review are presented in Section 6.1.

Table 3: Emission Monitoring Jurisdictional Scan

Stack Emission Parameter	Metro Vancouver Waste-to-Energy Facility Operational Certificate	Durham York Energy Centre Standards	EU Directive 2010/75/EU	USEPA 2026 Emission Guidelines
Particulate Matter (PM)	Stack (4x/year)	Stack (2x/year)	Continuous	Stack (at least 1x/year)
Particulate Matter (PM) Condensables	NA	Stack (2x/year)[1]	NA	NA
Cadmium (Cd) Only	Stack (4x/year)	Stack (2x/year)	NA	Stack (at least 1x/year)
Cadmium (Cd) + Thallium (Ti)	NA	NA	Stack (2x/year)	NA
Lead (Pb) Only	NA	Stack (2x/year)	NA	Stack (at least 1x/year)
Lead (Pb), Arsenic (As), & Chromium (Cr)	Stack (4x/year)	NA	Stack (2x/year)	NA
Mercury (Hg)	Stack (4x/year)	Stack (2x/year)	Continuous	Stack (at least 1x/year)
PCDD/PCDF, Total	NA	NA	NA	Stack (at least 1x/year)
PCDD/PCDF, I-TEQ	Stack (1x/year)	Stack (2x/year) and Continuous Sampling System[1]	Continuous Sampling System	NA
Hydrogen Chloride (HCl)	Continuous	Continuous	Continuous	Stack (1x/year) or Continuous
Hydrogen Fluoride (HF)	Stack (4x/year)	Continuous	Continuous	NA
Sulphur Dioxide (SO2)	Continuous	Continuous	Continuous	Continuous
Nitrogen Oxides (NO_x)	Continuous	Continuous	Continuous	Continuous
Total Hydrocarbons (THC)	Continuous	Continuous[1]	Continuous	NA
Carbon Monoxide (CO)	Continuous	Continuous	Continuous	Continuous
Opacity	Continuous	Continuous	NA	Continuous
Ammonia (NH3)	NA	Continuous[2]	Continuous	Continuous[2]

Notes: NA = Not Applicable/No requirement.
[1] Facility has continuous monitoring for this parameter but compliance with emission standards is determined by stack testing twice a year.
[2] Facility has continuous monitoring for this parameter but no compliance standard.

2.3 Regulatory Approaches for Short-Term Variations in Continuous Monitoring Parameters

2.3.1 European Regulations

Municipal solid waste varies substantially in physical properties and chemical composition. This variability can directly contribute to transient changes in combustion conditions, including CO spikes, and in raw flue gas chemistry, including short-term variations in HCl, SO_2, and Hg concentrations.

European regulations address the need to maintain stringent environmental protection while recognizing operational variability by establishing specific flexibility mechanisms for short-term monitoring parameters. This approach is supported by a mature, multi-layered regulatory framework, including:

- Directive 2010/75/EU, the Industrial Emissions Directive (IED)
- Commission Implementing Decision (EU) 2019/2010 establishing Best Available Techniques (BAT) conclusions for waste incineration (BREF WI)
- French National Regulations, specifically the Arrêté du 20 septembre 2002 (as amended) and the Arrêté du 12 janvier 2021 regarding BAT applicability for waste incineration facilities

Short-Term Compliance
European regulations impose 30-minute discharge limit values across all continuously monitored contaminants (NO_x, CO, SO_2, Particulates, HCl, hydrogen fluoride [HF], total organic carbon [TOC]) to encourage real-time process control. To manage unavoidable operational fluctuations, short-term compliance is governed by two key mechanisms:

- Cumulative duration limits for short-term excursions: the total cumulative duration of 30-minute exceedances must not exceed 60 hours per year per incineration line.
- A maximum duration of four consecutive hours of unabated operation is permitted before automated waste feed shutdown is required.

30-Minute Flexibility with Carbon Monoxide
Carbon monoxide is used as an indicator of combustion completeness. Localized air starvation, sudden high-calorific waste surges, or improperly disposed items in the incoming waste stream, including pressurized gas or NO_x canisters that rupture in the furnace, can cause short-duration combustion instability and CO spikes. European regulations therefore provide an explicit sub-30-minute compliance alternative:

- Standard 30-minute limit: 100 mg/Nm^3 as a 30-minute average.
- Alternative 10-minute limit: compliance may alternatively be demonstrated if 95% of all 10-minute average values within any 24-hour period do not exceed 150 mg/Nm^3.

Specific Regulatory Details That Impact Parameter Averaging

Under the European Directive, raw automated CEMS readings are not compared directly with legal discharge limits. Before validating 30-minute averages, regulations require the subtraction of standardized measurement uncertainty margins:

- Deduction percentages: validated confidence intervals subtracted from raw readings include 10% for CO; 20% for NO_x, and SO_2; 30% for total dust and TOC; and 40% for HCl, HF, NH_3, and Hg. These deductions are applied at the half-hourly data level before averaging and help account for minor instrumental drift and high-frequency measurement variability during short-term peak events.
- Avoidance of duplicate penalties: where a short-term 30-minute limit is exceeded and formally recorded as a non-compliance event, the associated half-hour data point may be isolated or excluded from cumulative daily calculations to avoid duplicate treatment of the same event.

Management of Uncontrollable Exogenous Events

European policy recognizes that uninterrupted ideal operation is not physically achievable under all waste-feed conditions. Under Other Than Normal Operating Conditions (OTNOC), regulators require operators to establish pre-approved management plans to detect, log, and mitigate unavoidable operational disruptions rather than treating all transient events as equivalent compliance failures.

A key example is the management of pressurized canister explosions. Improperly disposed NO_x and gas canisters in incoming waste are an increasing operational concern at European waste-to-energy facilities. These canisters can rupture in the furnace, causing short-duration CO spikes recorded by CEMS and, in some cases, mechanical damage leading to unplanned outages. Explosion-related 30-minute CO spikes remain logged by the operator; however, regulators may determine that qualifying events should be excluded from cumulative excursion limits where the operator can demonstrate the event and response using supervisory control and data acquisition (SCADA) and operating data.

Explosions associated with improperly disposed NO_x and gas canisters have not yet been widely identified at North American waste-to-energy facilities. However, North American approaches to managing OTNOC-type events are broadly similar to European policies in that operators are required to log and report transient operating conditions that result in emission exceedances. Regulators review these events and may consider them excusable, with no penalties applied, where the operator acted appropriately to control and mitigate the cause of the exceedance. For example, the Certificate of Approval for the Durham York waste-to-energy facility requires that, if CEMS data indicate emissions from a boiler exceed applicable emission requirements for a continuous three-hour period, the operator must stop waste feed to the affected boiler and initiate an emergency shutdown while maintaining combustion-zone temperatures as practicable.

2.4 Emission Reporting and Access to Data in Other Jurisdictions

At the EU level, Directive 2010/75/EU and Directive 2003/4/EC establish baseline requirements for access to environmental information. Operators must transmit discharge data to regulatory authorities and make compliance records accessible to the public. Member states retain flexibility in how CEMS data are disclosed, which has resulted in two general national reporting approaches:

The Regulator-Centric Model (e.g. France, Italy, Spain)
In jurisdictions such as France, real-time CEMS data are transmitted directly to regional environmental authorities for compliance oversight rather than published as a live public feed.

- Mechanism: operators submit validated daily averages, exceedance logs, and quarterly compliance reports to environmental regulators through secure reporting systems.
- Public access: public reporting is managed through consolidated annual environmental reports and local monitoring committees, such as France's Comités de Suivi du Site. This approach supports disclosure of validated data with appropriate operational context.

The Open Data Model (e.g. UK, Germany)
Other jurisdictions prioritize direct, centralized public access to facility discharge data:

- United Kingdom: The Environment Agency maintains an online, searchable Public Register where standardized CEMS summary reports and annual discharge data for every waste-to-energy facility are published and accessible to the public.
- Germany: Regulations mandate high public visibility, with many municipal waste-to-energy facilities publishing validated daily emission averages on public websites or display boards near the plant.

The North American Model (e.g. USEPA, Ontario)
Jurisdictions in the United States and Ontario generally follow a regulator-centric model that requires CEMS for selected pollutants and operating parameters, supported by recordkeeping and periodic reporting submitted directly to the regulatory agency.

- Mechanism: Operators submit validated daily averages, exceedance logs, and quarterly compliance reports to environmental regulators via secure portals.
- Public access: emissions data may be available through permit records, regulatory filings, or agency databases, and some operating permits may impose public disclosure requirements beyond federal minimums. Certain waste-to-energy facilities in the United States and Ontario, including Durham York, voluntarily publish real-time emissions data on public websites. Durham York also displays real-time emissions data and recent stack test results on an exterior electronic board that is visible to the public.

3 Current Operations, Discharge Limits and Monitoring Summary

3.1 Overview of Operations

The Waste-to-Energy Facility is located on a 1.8-hectare site in an industrial area of south Burnaby, British Columbia, near the Fraser River. The facility commenced operation in 1988 and has remained in commercial operation since that time. Metro Vancouver has retained several contractors to operate and maintain the facility on its behalf. The facility was designed and constructed by GKN Birwelco Ltd.

The Waste-to-Energy Facility consists of three identical, mass burn type combustion units with a current process capacity of approximately 240,000 tonnes per year of MSW, or approximately 25% of the residual MSW managed by Metro Vancouver.

MSW is stored in a bunker and fed by an overhead refuse crane into each unit's feed hoppers. From there, the waste enters the combustion chamber and is burned on a stocker grate. The thermal energy from the hot flue gases is recovered in the waterwall boiler to generate superheated steam. The steam is used to generate approximately 23 megawatts of gross electrical power at full load using a steam turbine and electric generator. All the electricity generated is sold to B.C. Hydro under a power purchase agreement, while the Waste-to-Energy Facility purchases approximately 3 megawatts of electrical power directly from B.C. Hydro to satisfy the in-house load required to operate the Waste-to-Energy Facility.

The Waste-to-Energy Facility is also able to export steam through a dedicated turbine extraction port. The Waste-to-Energy Facility previously supplied steam to an adjacent paper mill until its closure in 2011. Each unit has its own heat recovery unit. The air pollution control (APC) system heat recovery unit, referred to as the primary economizer, is used to cool the flue gases leaving the boiler and provides a second means of preheating the boiler feed water. Today, Metro Vancouver is developing a district energy system to supply heat and hot water to nearby neighbourhoods.

To control discharge, the flue gases from each combustion unit are treated in an air pollution control system prior to discharge to the atmosphere. First, NO_x is controlled directly within the furnace through a Low Nitrogen Oxide technology (LN™) system utilizing staged combustion air, combined with the injection of aqueous ammonia to further reduce discharge. After heat recovery, the flue gases enter a dry scrubber, where hydrated lime is injected to neutralize acid gases, and powdered activated carbon (PAC) is introduced to absorb dioxins and furans, Hg and other heavy metals and hydrocarbon-based organic compounds. Finally, the gases are directed to a multi-compartment fabric filter baghouse. The baghouse removes particulates from the flue gas including fly ash from the combustion process and by-products from the dry scrubber. A summary of the Waste-to-Energy Facility's emission control systems is presented on Table 4.

Table 4: Current Emission Control Systems

System	Primary Controlled Contaminants
Consistent, Good Combustion Management (Residence Time, Lime Injection, Furnace Temperature, O_2 for the combustion)	CO, Dioxins and Furans, Organics
Ammonia Injection (LN™)	NO_x
Dry scrubber (Hydrated Lime Addition)	Acid Gases (SO_2, HCl, HF)
Dry Scrubber (Power Activated Carbon)	Mercury, Dioxins and Furans, Heavy Metals
Baghouse	Particulates, Dioxins and Furans, Heavy Metals, Acid Gases (SO_2, HCl, HF)

An induced draft (ID) fan is located downstream of each baghouse to maintain a negative draft through the combustion and APC system. The cleaned flue gas is discharged from the ID fan through three dedicated steel flues, inside a single, common concrete stack. Continuous Discharge Monitoring Systems are installed on these flues to permanently track discharge. Figure 1 provides a representative cross section of the Waste-to-Energy Facility.

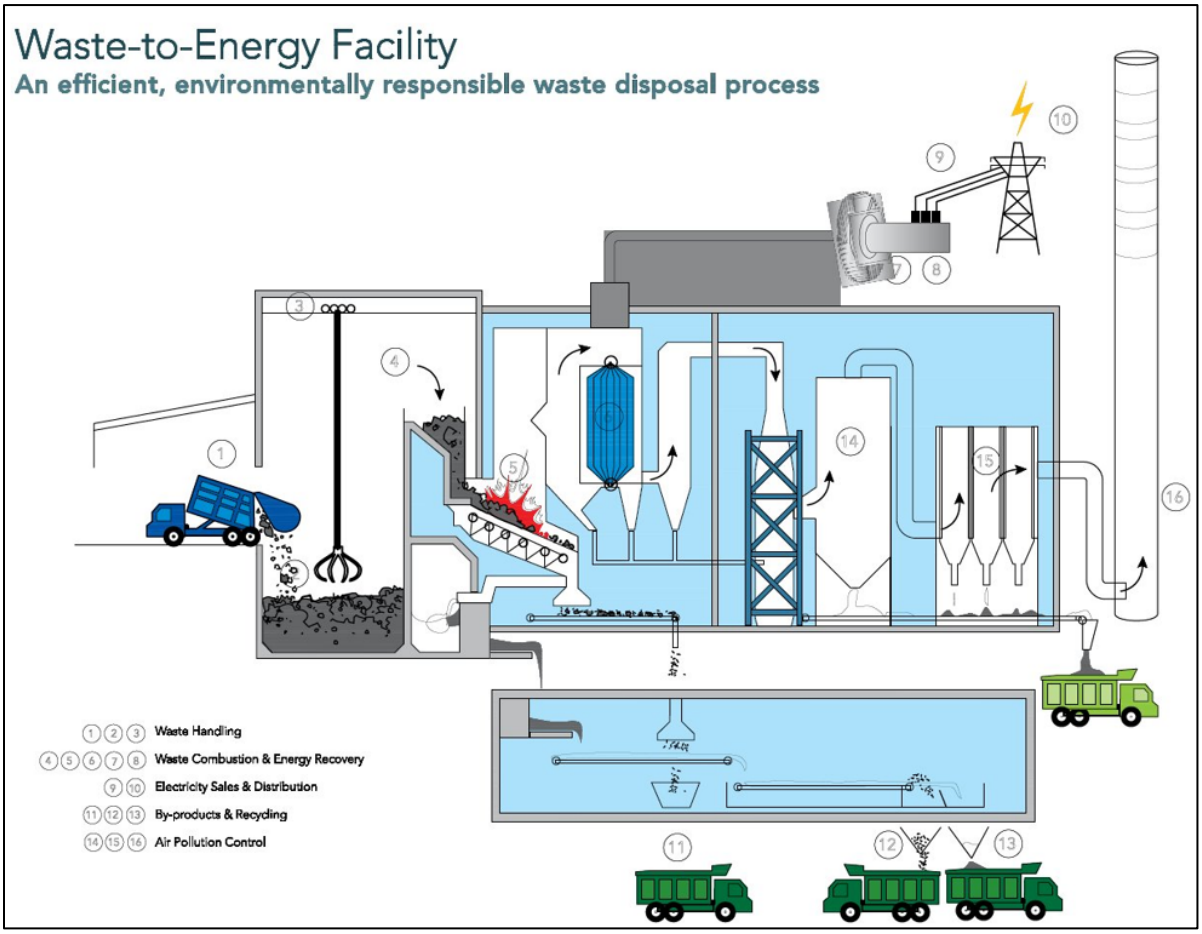


Figure 1: Schematic of the Metro Vancouver Waste-to-Energy Facility

By-products from the combustion process include bottom ash from the boiler system and fly ash from the APC system, which are stored and disposed separately. Ferrous metal is recovered from the bottom ash using a belt magnet positioned perpendicular to the bottom ash conveyor on each combustion unit. Bottom ash and recovered ferrous metals are stored temporarily in a bunker and loaded out with an overhead ash crane.

A non-ferrous metal recovery system was installed in 2018. Bottom ash is batch fed to this system using the ash crane and recovers both non-ferrous metals and an incremental amount of additional ferrous metal. Fly ash is collected in hoppers beneath the dry scrubber and baghouse and conveyed pneumatically to a storage silo. Phosphoric acid is added to the bottom ash to stabilize metal constituents before being loaded into covered trailers. Fly ash is conditioned with water and phosphoric acid in a pugmill to reduce dusting and stabilize metals.

3.2 Current Monitoring

There are two types of discharge monitoring that are employed at the Waste-to-Energy Facility. The first is an in-stack continuous discharge monitoring and continuous opacity monitoring systems, as well as applicable operating parameters. The air quality related parameters that are continuously monitored for compliance purposes include:

- Stack temperature
- Stack gas O_2 concentration
- Stack gas SO_2 concentration
- Stack gas HCl
- Stack gas NO_x concentration
- Stack gas CO concentration
- Stack gas THC concentration
- Opacity (as a surrogate for particulate matter)
- Furnace temperature

The second is quarterly stack testing conducted for a number of constituents and annually for another set of contaminants. The quarterly testing includes:

- Particulate Matter (filterable)
- HF
- Seventeen (17) metals.

The annual testing includes:

- Dioxins and furans
- PCB
- PAH
- Hexachlorobenzenes (HCB)
- CB
- Chlorophenols (CP)

Compared with other waste-to-energy facilities and regulatory jurisdictions in North America and Europe, the Waste-to-Energy Facility conducts stack testing at a relatively high frequency. Most comparable facilities and jurisdictions require stack testing on an annual or semi-annual basis, whereas the Waste-to-Energy Facility conducts comprehensive stack testing quarterly for several parameters. The sampling and analysis requirements and associated discharge limits specified in the Operational Certificate are summarized in Table 5.

Table 5: Operational Certificate Monitoring Requirements and Discharge Limits

Stack Emission Parameters	Sampling and Analysis Frequency	Discharge Limit
Rate of Flue gas Discharge	Continuous and Four times per year	N/A
Oxygen (O_2), % of dry air	Continuous and record ½ hr average values for concentration adjustments	N/A
Total Particulate Matter (PM)	Four times per year	9 mg/dscm
Lead (Pb)	Four times per year	Sum of Lead, Arsenic, Chromium 64 µg/dscm
Arsenic (As)	Four times per year	
Chromium (Cr)	Four times per year	
Cadmium (Cd)	Four times per year	7 µg/dscm
Total Mercury (Hg)	Four times per year	20 µg/dscm
Dioxins and Furans (PCDD/PCDF) TEQ	Annually	0.08 ng/dscm
Hydrogen Chloride (HCl)	Continuous and record ½ hr and 24-hour average values	55 mg/dscm 1-hr (Interim)[1]
Hydrogen Fluoride (HF)	Four times per year	1 mg/dscm
Sulphur Dioxide (SO_2)	Continuous and record ½ hr and 24-hour average values	200 mg/dscm 24-hr (Interim)
Nitrogen Oxides (NO_x)	Continuous and record ½ hr and 24 hours average values	190 mg/dscm 24-hr
Carbon Monoxide (CO)	Continuous and record ½ hr and 24-hour average values	50 mg/dscm 24-hr
Total Hydrocarbons (THC)	Continuous and record ½ hr and 24-hour average values	10 mg/dscm 24-hr
Opacity	Continuous and record one minute average values for inspections	5%
Polycyclic Aromatic Hydrocarbons (PAH)	Annually	5 µg/dscm
Polychlorinated Biphenyls (PCBs)	Annually	1 µg/dscm
Chlorophenols	Annually	1 µg/dscm
Chlorobenzene	Annually	1 µg/dscm

[1]HCl is 1-hour based on SO_2 as a surrogate. Operational Certificate also includes final emission discharge limits of 50 mg/dscm for SO_2 and 10mg/dscm for HCl.

3.2.1 Ambient Air

In addition to source discharge monitoring, Metro Vancouver operates a comprehensive network of air quality monitoring stations within Metro Vancouver and the Fraser Valley. Sophisticated instruments continuously provide high-quality data from 29 permanent stations, which report an hour-by-hour picture of air quality conditions where people live, work and play. Data from the stations are used to assess the effectiveness of initiatives to improve air quality, and to report the

Air Quality Health Index (AQHI), which provides information about the effects of air quality on health. Real-time data are publicly available through AirMap.ca.

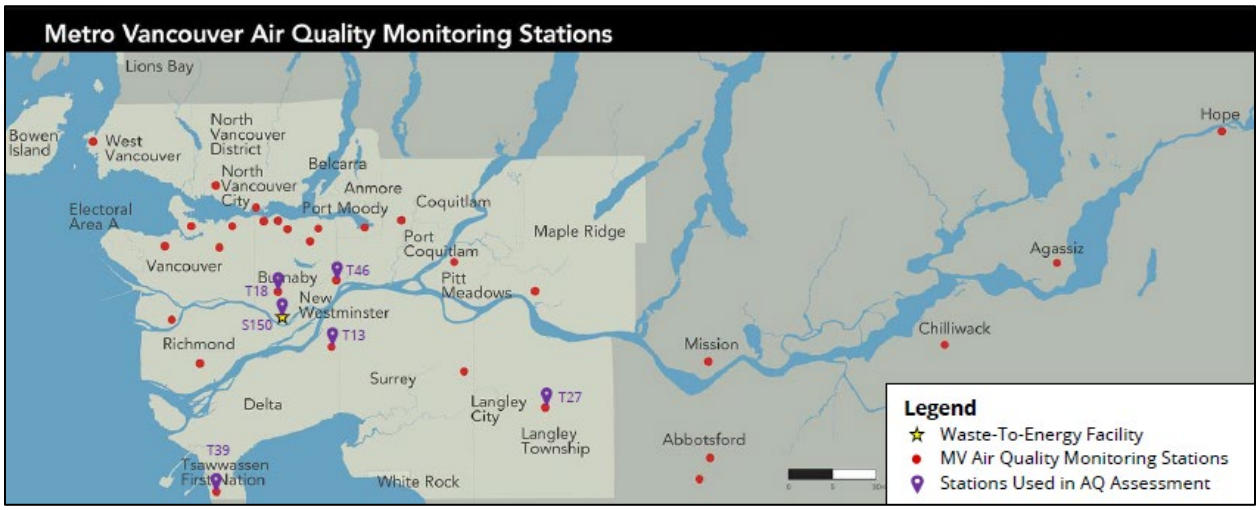


Figure 2: Metro Vancouver Air Quality Monitoring Stations

One of these monitoring stations is Burnaby South (T018) which is located near the Metro Vancouver's Waste-to-Energy Facility. T018 has been in place since the Waste-to-Energy Facility commenced operations in 1988 and was installed as part of the facility's development. From the fall of 2020 to mid-2023, an additional temporary ambient air monitoring station (S-150) was installed adjacent to the Waste-to-Energy Facility in the immediate vicinity of the modelled highest potential contaminant concentration. HCl monitors were installed in both T018 and the temporary ambient air monitoring station. Analysis of the data from the monitoring program for 2021 and 2022 are detailed in the report titled Waste-to-Energy Facility Ambient Air Monitoring Program 2021 - 2022. The report shows similar contaminant concentrations at both T018 and S150.

In 2025, additional HCl monitoring was installed at Tsawwassen (T039) and Langley (T027) to better understand regional ambient HCl concentrations. Monthly summary reports are available on the Metro Vancouver website.

3.3 Description of Discharge Reporting

The Waste-to-Energy Facility reports discharge monitoring and source testing results in accordance with the requirements of the Operational Certificate. Reporting includes periodic source testing reports, monthly discharge reports, and annual environmental performance reporting that document facility operations, emissions performance, and compliance with discharge limits.

BC ENV requires that monthly stack testing reports are provided within 60 days of a test, or 90 days for the annual parameters. Each report must include:

- Test methods
- Description of operation conditions during testing
- Detailed results by unit

- Comparison to Operational Certificate discharge limits
- Quality Assurance/Quality Control documentation

Additionally, BC ENV requires monthly reporting within 45 days following each month. These reports include:

- CEMS data
- Discharge exceedances and responses
- Identification and responses to startup, shut own, process upset, bypass and emergency spill events
- Any complaints received and the corresponding responses

The Operational Certificate also stipulates that the Waste-to-Energy Facility must develop an annual report that includes:

- Summary of CEMS and manual stack test discharge data
- Overview of plant performance, operations and maintenance activities
- Operational information such as quantities of waste processed, fly ash produced, bottom ash disposed, etc.
- Upgrade implementation report, describing completed projects over the past year and projects planned for the upcoming year

3.4 Environmental Performance

The Waste-to-Energy Facility has an excellent environmental performance. Table 6 below shows average discharge concentrations for regulated contaminants compared to the Operational Certificate limits for 2024. On average, measured discharge values were 17% of the regulatory limit with no parameters exceeding regulatory limits.

Over time, for many parameters, both discharge limits and discharge values have reduced. Figure 3 shows both the discharge limit and discharge values for particulate matter from original operations until now. During that time, discharge limits have reduced by approximately 75%, and discharge values have declined even more dramatically. NO_x emissions from the Waste-to-Energy Facility dropped approximately 60% in 2014 following upgrades, as seen in Figure 4. The same trend is present for a range of parameters.

Table 6: Comparison of 2024 Emissions Data with Operational Certificate Limits

Parameter (Median Values)	Units	Current Regulatory Levels	2025 Emissions Data	Percentage of Limit
Manual Stack Tests				
Particulate Matter	mg/dscm	9	1.1	12%
Hydrogen Fluoride (HF)	mg/dscm	1	0.08	8.5%
Sum of Lead, Arsenic, and Chromium	ug/dscm	64.0	5.1	8.0%
Cadmium (Cd)	ug/dscm	7.0	0.2	2.3%
Mercury (Hg)	ug/dscm	20.0	0.1	0.5%
Trace Organics Tests				
Dioxins/Furans (PCDD/PCDF)	ng/dscm	0.08	0.0006	1%
Chlorophenols	ug/dscm	1	0.0023	0%
Chlorobenzenes	ug/dscm	1	0.033	3%
Polycyclic Aromatic Hydrocarbons (PAHs)	ug/dscm	5	0.14	3%
Polychlorinated Biphenyls (PCBs)	ug/dscm	1	0.008	1%
Continuous Emissions Monitoring System:				
Nitrogen Oxides (NOx)	mg/dscm	190	131	69%
Carbon Monoxide (CO)	mg/dscm	50	27	54%
Sulphur Dioxide (SO2)	mg/dscm	200	71	35%

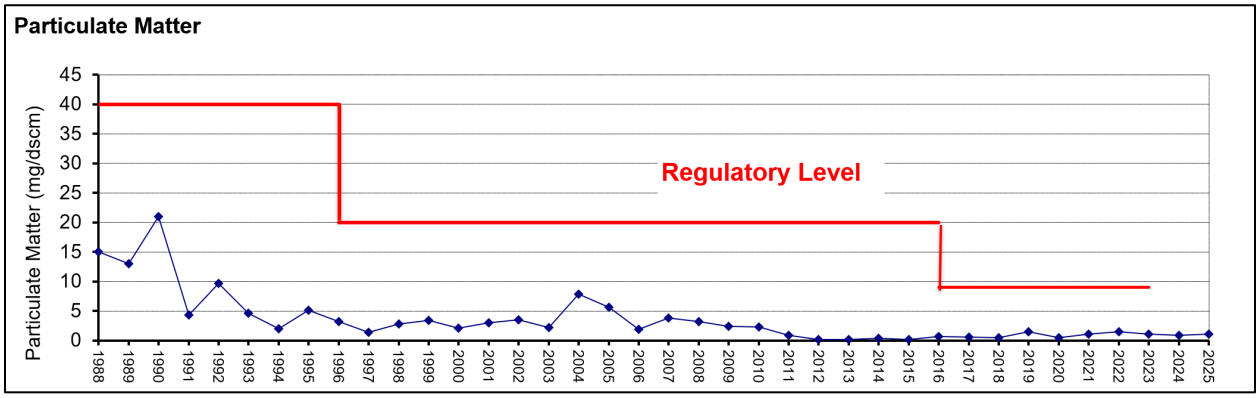


Figure 3: Particulate Matter Emissions and Discharge Limit

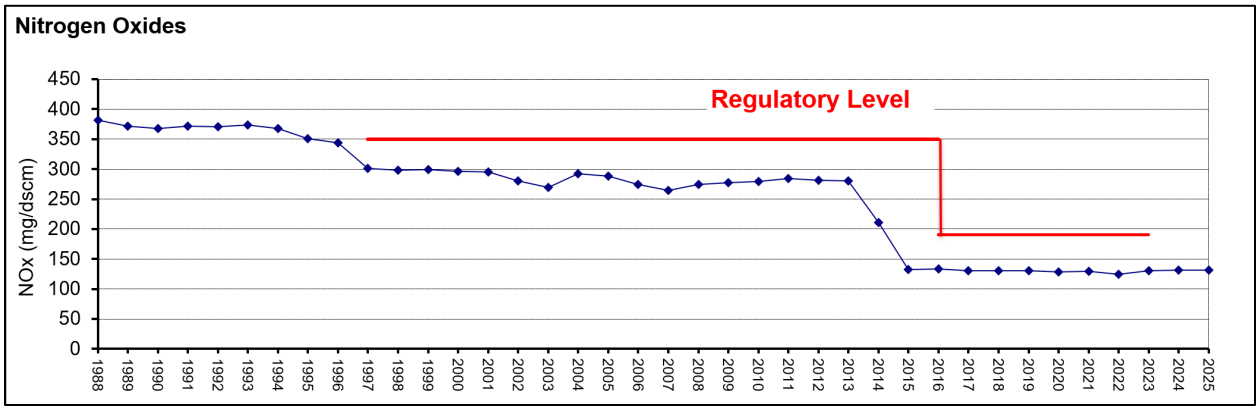


Figure 4: Nitrogen Oxides Emissions and Discharge Limit

Figure 5 below shows the portion of fine particulate matter and nitrous oxides contributed to the Lower Fraser Valley airshed in 2025. The Waste-to-Energy Facility fine particulate matter made up 0.03% of the fine particulates emitted in the lower Fraser Valley, and the Waste-to-Energy Facility NO_x emissions made up 0.5% of the total NO_x emissions.

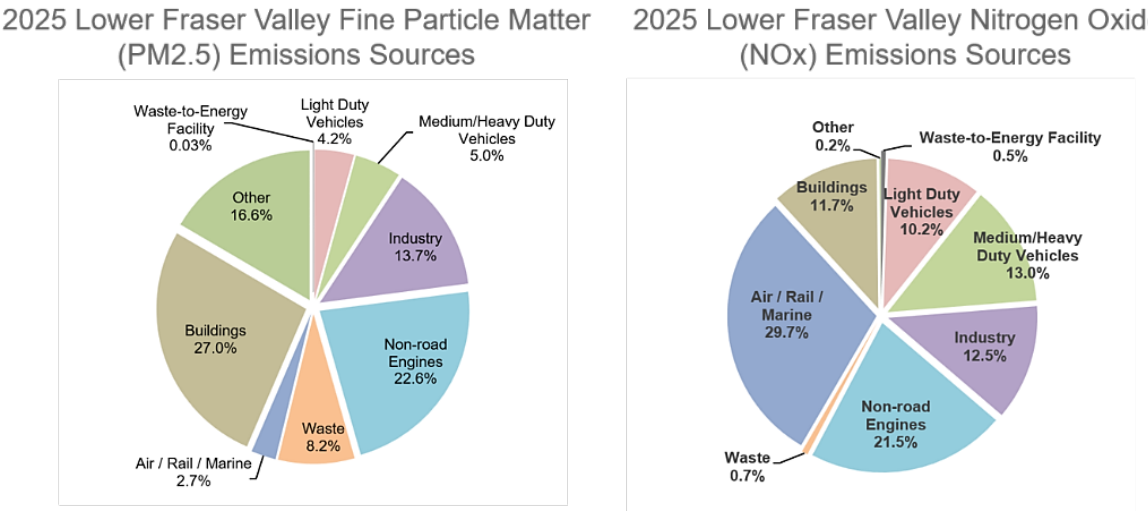


Figure 5: Lower Fraser Valley $PM_{2.5}$ and NO_x Emissions by Source Sector (2025)

4 Operational Testing and Analysis

Section 4 summarizes the operational testing and analytical work undertaken to evaluate opportunities for improving air emission performance and supporting proposed changes to the discharge limits.

4.1 Acid Gas Testing

4.1.1 Context and Rationale for the Selected Solutions

The Operational Certificate states that Qualified Professionals (QPs) are required to undertake a series of actions in support of proposed updated discharge limits including investigating operational improvements to reduce emissions. Operational testing of options to reduce emissions focussed on HCl, SO_2 and NO_x.

A key component of these initiatives involves evaluating the chemical reagents employed in the APC system to reduce contaminant levels. Modifying these reagents represents one of the most economically viable approaches for lowering acid gas concentrations within the flue gas stream.

Collaborative discussions were held between Metro Vancouver, HDR, and Veolia to determine practical, field-tested options that could fit within the facility's current layout and utilize existing equipment. Consequently, a decision was reached to conduct short-term baseline testing (few days per test) within the operational facility to evaluate three specific approaches:

- Enhancing the existing setup by elevating the injection rate of standard hydrated lime.
- Switching to or integrating a specialized high-efficiency lime variant (SPS lime).
- Switching to or integrating a different dry injection compound (sodium bicarbonate).

4.1.2 Full-Scale Testing Methodology and Description

4.1.2.1 TEST PROGRAM OVERVIEW

All tests were performed within two separate weeks of testing, between May and June 2026. The tests were performed only on one unit at a time, letting the two other units at normal use. For the specific schedule of each testing week, refer to **Appendix D1**.

To evaluate reagent performance and abatement accuracy under specific operational conditions, continuous monitoring equipment was deployed at key points across the APC system. These measurement systems were positioned at the following locations:

- Upstream at the inlet APC, following the secondary economizer, and downstream APC. Utilizing Fourier Transform Infrared (FTIR) technology, the setup recorded data points at one-minute intervals for multiple flue gas components, including HCl, SO_2, O_2, and moisture levels.
- For comparative validation, data from our stack analyzers was also compiled from the facility's existing CEMS.

- External laboratory contractor, Lanfranco, was engaged to execute discrete, short-term periodic manual stack testing to supplement the primary dataset.

For reagent injection into the process, Trial 1 utilizes actual plant infrastructure, including the lime silo, conveying systems, day bin, and injection screws, to administer the current hydrated lime solution.

Conversely, because of logistics, and only minimal quantities of the two alternative reagents are needed, a specialized contractor was selected to manage their deployment using a mobile temporary injection setup. This contractor-supplied configuration features an integrated trailer equipped with a storage hopper, a dosing screw to regulate feed velocities, a mechanical blower, and a flexible temporary pipe designed to transport the sorbents directly into the dry scrubber.

4.1.2.2 TRIAL 1: INCREASED HYDRATED LIME

The Metro Vancouver Waste-to-Energy Facility currently utilizes standard hydrated lime as its primary chemical reagent. This calcium-based compound is injected into the flue gas stream to react with acid gas contaminants and neutralize them. The product created, fly ash, is subsequently captured by downstream filter bags. While this reagent demonstrates high removal efficiency for HCl, its performance in capturing SO_2 is more moderate due to the preferential reaction with HCl.

A first trial was performed for three days (May 4th & 5th, & June 1st), in which the lime feed rate was pushed to 100% of the screw speed capacity. The aim of this trial was to better understand the best removal efficiency possible that can be achieved within the current equipment, by pushing it to the maximum. Following the evaluation of this first trial (see Section 4.1.4.1), it was determined that sustaining equipment operations at full capacity for an extended duration is not a viable long-term solution.

To identify realistic and achievable discharge limits without compromising process stability or equipment integrity, a second, extended testing program was established. This phase focused on optimizing the current process controls under standard operating conditions by refining the HCl emission set point and enhancing the dynamic response of the lime feed control loop. This automated control system, already in use, continuously adjusts the lime feed rate based on real-time discharge, accelerating screw speed whenever HCl levels approach the target set point.

This optimized operation was evaluated over a one-month testing period across all three lines. During this campaign, the HCl set point was incrementally lowered in stepped stages on each line to evaluate the corresponding operational impact on the equipment and identify the lowest achievable discharge limit without driving the system too close to its maximum capacity. Emission levels were continuously recorded using the Facility's CEMS analyzers, complemented by periodic manual stack testing performed by an external accredited laboratory (Lanfranco) to validate the dataset.

4.1.2.3 TRIAL 2: SPS LIME

SPS lime is a specialized reagent supplied by Lhoist that shares identical chemical properties with conventional hydrated lime, yet features an advanced formulation engineered to provide a

substantially larger specific surface area. This optimized structure delivers significantly enhanced removal efficiencies when reacting with both HCl and SO_2. Because of these characteristics, this compound is routinely utilized within waste-to-energy facilities.

To evaluate performance, Trial 2 involved injecting SPS lime into the process line using the temporary mobile injection system. The test program spanned four days (May 6th & 7th, June 2nd & 3rd, 2026) during which the system was held at predetermined, constant feed rates for durations of around 2 to 4 hours per run. By monitoring baseline inlet concentrations and corresponding stack discharge, the team successfully documented removal efficiencies and achievable discharge limits across eight distinct feed rates, establishing a robust operational dataset (feed rates from 50 to 200 kg per hour).

4.1.2.4 TRIAL 3: SODIUM BICARBONATE

As a sodium-based reagent, sodium bicarbonate possesses fundamentally distinct characteristics compared to traditional lime. Due to its superior abatement performance when reacting with HCl and SO_2, this compound is widely implemented across various waste-to-energy facilities.

Similar to the setup for SPS lime, Trial 3 utilized a temporary mobile system to inject the reagent into the process line. Conducted over a two-day period (June 4th & 5th), the trial evaluated operations at predetermined, constant feed rates ranging from 80 to 390 kg per hour, with each run lasting between 2 and 4 hours. By monitoring baseline inlet concentrations alongside the corresponding stack discharge, the team successfully documented removal efficiencies and achievable discharge limits across eight distinct feed rates, thereby establishing a robust operational dataset.

4.1.3 Operational Constraints and Challenges

The compressed testing schedule, targeted for completion before September 2026, imposed logistical constraints. The timeframe was further compounded by supply chain disruptions when the primary chemical vendor for the sodium bicarbonate cancelled the supply immediately before the trial, requiring securing an alternative supplier on short notice. The procured sodium bicarbonate was a readily available industrial-grade (coarser, unmilled product), which deviated from the optimal technical specification for waste-to-energy flue gas treatment (ultra-fine milled).

Long-term operational integration is also limited by both existing facility infrastructure and the capacity and robustness of the temporary testing equipment. The baseline design and capacity limits of the existing feed screws restricted maximum delivery rates, notably impacting the hydrated lime trial. Furthermore, trial operations were hampered by contractor equipment failures, including mechanical issues with the mobile injection system, analyzer air leaks, and extended warmup times. A critical failure occurred on the night of May 6th with the injection system, when a Venturi nozzle plugged due to the development of "lime rock", necessitating a system swap. Concurrently, the existing facility infrastructure struggled to accommodate the new reagents: pneumatic conveying systems failed to successfully transport fly ash from the filter baghouse to the main ash silo for reasons that remain unknown, underscoring that high-performance reagent adoption requires significant downstream equipment upgrades beyond simple sorbent replacement.

In addition, trial evaluations revealed a response lag with the current CEMS compared to the additionally FTIR and accredited laboratory testing. While manual stack tests recorded significantly lower concentrations, showing a discrepancy of approximately 7 to 20 mg/dscm, continuous HCl readings decayed much slower. This discrepancy may be attributed to inherent technological limitations of the older analyzers or potential desorption within sampling lines historically exposed to higher concentrations. This underscores the need to upgrade CEMS technology to instrument ranges optimized for lower thresholds.

Finally, unplanned facility outages repeatedly disrupted testing continuity. Specifically, a major outage on Unit 1 caused by broken grate bars, combined with other unscheduled shutdowns, forced the team to alter operations and switch testing between units. These shifts reduced the overall continuity of the dataset and impacted the direct comparability of results across the trials.

4.1.4 Summary of Findings and Recommendations – Short-term Trials

4.1.4.1 SORBENT ABATEMENT EFFICIENCIES

Despite the operational challenges detailed in the section above, the data gathered provides a robust enough basis to evaluate the abatement performance of the reagents, as detailed in the following findings.

The performance metrics across the three reagent trials are summarized in the table below. It displays stack concentrations for HCl and SO_2 in mg/dscm, with the listed percentages representing the removal efficiencies calculated from inlet and stack measurements.

To evaluate and compare the performance of each reagent, the upcoming table integrates three distinct stack monitoring datasets: continuous records from the temporary FTIR, data from the existing facility's CEMS, and results from periodic stack testing. Additionally, it provides with the “Spike” section an overview of how effectively each compound handles sudden increases in inlet acid gas concentrations.

Table 7: Short-Term Acid Trials - Stack Discharge Results

Short-Term Acid Gas Trials: Indicative Stack Discharge results *Acid Gas Concentrations in mg/dscm. Removal Efficiency in w%.*						
	HCl			**SO2**		
	Hydrated Lime	SPS Lime	Sodium Bicarbonate	Hydrated Lime	SPS Lime	Sodium Bicarbonate
Baseline Discharge						
Continuous FTIR	**10** 98%	**10** 98%	20 94%	10 90%	10 90%	**0** 100%
CEMS	**20** 90%	**20** 90%	50 80%	45 50%	**20** 80%	**20** 80%
Punctual Stack Testing	2 98%	**1** 99%	20 90%	45 50%	20 70%	**10** 80%
Spikes						
Continuous FTIR	30 94%	40 90%	**20** 97%	140 55%	50 60%	**30** 73%
CEMS	150 75%	**40** 96%	35 94%	200 33%	60 60%	**20** 74%

By way of context, continuous discharge monitoring data based on CEMS compiled from early 2024 to mid-2025 shows historical baseline averages of 76 mg/dscm for HCl and 70 mg/dscm for SO_2. Under the Operational Certificate monitoring requirements, interim discharge limits for HCl are based on SO_2 concentrations rather than directly measured HCl concentrations.

While these results stem from short-term trials and serve as a preliminary assessment, they demonstrate a measurable improvement in abatement performance relative to the historical baseline for all evaluated trials.

To accurately interpret these results, the performance data must be analyzed alongside the operational feed rates and constraints unique to each chemical reagent:

- Standard hydrated lime: Tested at a feed rate of 210 kg/hr, which represents a substantial increase above the facility's typical operating feed rate of approximately 115 kg/hr maintained since mid-2025.
- SPS lime: Tested at a steady operational delivery rate of 200 kg/hr. This reagent demonstrated high operational robustness, contingent upon necessary upgrades to the fly ash handling systems.

- Sodium bicarbonate: Tested at a feed rate of around 320 to 390 kg/hr. This trial's performance was influenced by the granulometry of the specific lot tested, rather than inherent limitations of the compound itself. Due to unforeseen delivery issues, the resulting increase in particle size restricted the available specific surface area, thereby understating the potential contaminant removal efficiency of the reagent. This suggests that site-specific preparation, such as on-site milling, could significantly enhance its efficacy.

For a more comprehensive analysis of the trials results, **Appendix D1** presents detailed daily graphs illustrating reagent feed rates alongside inlet and stack acid gas concentrations.

4.1.4.2 OPERATIONAL IMPACT CONSIDERATIONS

Beyond the performance metrics summarized in Table 7, each reagent has qualitative operational impacts that also need to be considered.

Removal efficiency: All reagents effectively mitigated HCl, although sodium bicarbonate demonstrated lower efficiency. This is likely attributable to the non-optimal specific surface area of the product used in the trial rather than the compound itself. Standard hydrated lime demonstrated significant limitations in addressing inlet acid gas concentration spikes. For SO_2 mitigation, conventional hydrated lime proved the least efficient option, whereas SPS lime demonstrated improvement and sodium bicarbonate delivered the highest performance.

Reagent consumption: High removal efficiencies require reagent consumption exceeding the historical baseline of 120 kg/hr, which places additional strain on existing downstream infrastructure.

Fly ash production: While increasing lime-based sorbents increase fly ash production, sodium-based reagents generate up to 50% less residue thanks to higher stoichiometric efficiency and lighter reaction byproducts. This advantage is supported by industry literature, Veolia operational experience, and preliminary trial observations, though long-term mass balance verification is recommended.

Capital investment: Implementing reagent solutions requires capital investment for upstream injection infrastructure (storage silos, day bins, and dosing systems). In addition, SPS lime deployment may necessitate redesign of downstream components and fly ash conveying systems to accommodate increased loads. The use of sodium bicarbonate requires a very fine particle size not commercially available and may require a pre-injection milling stage.

Operational controls: Measurement precision at low concentrations revealed that the facility's current CEMS lacks accuracy for readings around 10 mg/dscm. To sustain discharge at these levels, enhancing the reliability of the continuous monitoring equipment is essential.

4.1.5 Summary of Findings and Recommendations – Long Term Trials

While short-term trial findings were insufficient to establish limits based on best operational performance and reagent mix, the one-month testing campaign on the current hydrated lime system provided a clear baseline of achievable emissions.

By adjusting the HCl discharge target set point to 30 mg/dscm, daily averages were successfully maintained below 35 mg/dscm, with a maximum peak of approximately 40 mg/dscm recorded (refer to **Appendix D1**). Incorporating an appropriate margin, an achievable HCl discharge limit of 45 mg/dscm can be recommended.

Additionally, these operational adjustments demonstrated a positive impact on SO_2 discharge quantities. When combined with the continuous tracking of daily metrics gathered since mid-2025, this supports the recommendation of an achievable SO_2 discharge limit set at 120 mg/dscm.

This process control modification is now integrated into operations. The adjustment made to the HCl control set-point, using the current lime configuration, led to a 17% decline in SO_2 discharge and a 52% decrease in HCl discharge (based on data from late June to early September 2026) compared to 2024 to mid-2025 discharge rates. The only operational impacts of increasing the hydrated lime feed rate are a rise in fly-ash generation and increased lime consumption.

4.1.6 Recommendations

Initial evaluations indicate that while the current hydrated lime configuration has been optimized to its maximum safe potential, achieving immediate emission reductions without damaging plant equipment, it represents a transition strategy. While effective under baseline conditions, its performance during raw-gas concentration peaks highlights the need for more flexible long-term solutions.

To achieve deeper, more consistent emission reductions while maintaining continuous operational reliability, further investigations into alternative and supplementary solutions are recommended. Future studies should focus on two main pillars:

- Technical & Equipment Challenges: Addressing operational hurdles identified during preliminary trials, including the pneumatic conveying of SPS lime fly ash, the development of robust neutralization protocols for sodium-based ash, and the replacement of CEMS analyzers. Upgrading CEMS instrumentation is essential to ensure measurement precision at lower concentration ranges; market inquiries and vendor quotes for high-precision analyzers are already underway.
- Exploration of Solutions: Evaluating flexible, technico-economically viable abatement strategies. This includes assessing a bi-reagent configuration (utilizing standard lime for baseline operation and high-performance reagent when necessary), re-testing sodium bicarbonate with optimized particle sizing, and remaining open to other emerging reagents or technologies.

Further comprehensive assessments involving extended testing durations are essential to fully validate these performance limits and finalize the long-term operational strategy.

4.2 NO_x Management and NH_3 Optimization

Ammonia discharge monitoring is important to prevent the discharge of unreacted ammonia, which can contribute to secondary particulate formation, and to minimize ammonia wasting. To support ongoing compliance and system optimization, Metro Vancouver monitors ammonia use

through routine system monitoring and maintenance activities and operation of the LN system (ammonia injection directly into the furnaces). The Waste-to-Energy Facility also has ammonia slip analyzers for additional monitoring capabilities.

On March 19-20, 2026, testing was conducted to optimize the existing NO_x reduction systems at the Waste-to-Energy Facility. The objective of the testing program was to evaluate opportunities to improve NO_x reduction performance and ammonia utilization.

During the two days of testing, test runs were performed on Unit 3 to collect and analyze data to determine impacts to NO_x emissions over different LN settings and selective non catalytic reduction (SNCR) injection lance positions. The testing found that optimizing the location of ammonia injection/flowrate did not significantly reduce the resultant NO_x emissions. However, optimization of ammonia injection was shown to reduce the use of ammonia by 13%. A reduction in ammonia use consequently reduces the amount of unreacted ammonia discharge.

Further reductions in NO_x emissions are limited by the physical capacity of the existing process, which prevents more aggressive ammonia injection. However, historical data analysis indicates that the current process tuning is highly effective at preventing concentration spikes and maintaining steady-state performance.

Following completion of the testing program, historical NO_x emissions data were reviewed to establish a discharge limit that could be achieved on a consistent basis. Based on the results of this review, a NO_x discharge limit of 150 mg/dscm (24-hour average) was determined to be reliably achievable at the Waste-to-Energy Facility. Evaluation of historical discharge data and operating conditions demonstrated that historic periodic NO_x spikes resulting in discharge concentrations higher than 150 mg/dscm (24-hour average) could be avoided through process control measures.

4.3 N_2O Cylinder Explosion Analysis and CO Exceedance Implications

Continuous monitoring data from the Waste-to-Energy Facility between January 1, 2024, and April 30, 2026, were analyzed to identify and characterize explosion events attributed to N_2O cylinders within the furnaces. This analysis was undertaken to better understand the contribution of short-duration combustion disturbances to reported 30-minute CO exceedances and to assess whether a portion of exceedance events may be attributable to non-controllable short-duration events that are not representative of overall facility performance.

By combining real time operating data with operator logbook records, a data-supported definition of an explosion event was developed. Explosion events were characterized as short-duration CO spikes (>1,500 mg/dscm) occurring within a ±4-minute window and preceded by a rapid furnace pressure increase (>5 mmH_2O). Application of this definition indicated a general increase in explosion frequency over the assessment period, as seen in Figure 6, with an increase in frequency observed in summer 2025 and spring 2026.

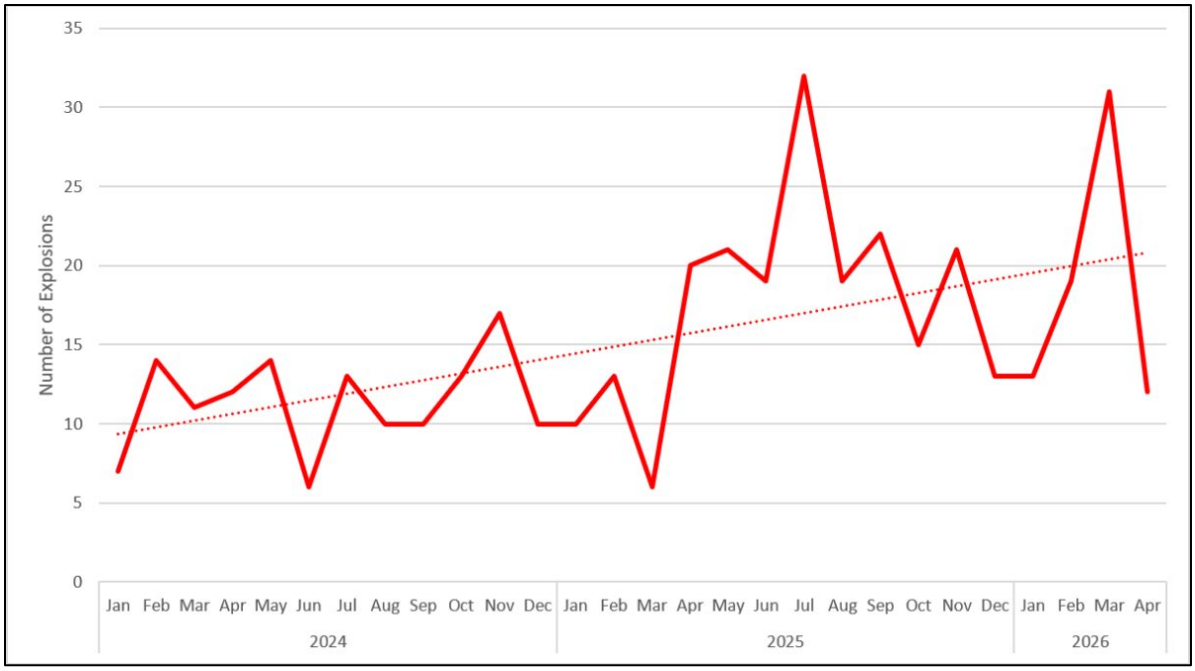


Figure 6: Estimated N2O Cylinder Explosions per Month

The analysis showed that explosion events typically produce substantially higher CO concentrations than other types of CO exceedance events, although elevated CO concentrations generally persist for less than five minutes.

Explosion event timestamps were subsequently mapped against reported 30-minute CO exceedances to assess the extent to which short-duration explosion activity may contribute to reported exceedance events. Approximately 15% of reported 30-minute CO exceedances were associated with explosion activity between January 2024 and April 2026. While explosion events remain a minority contributor to reported exceedances overall, their contribution appears to be increasing, as shown on Figure 7.

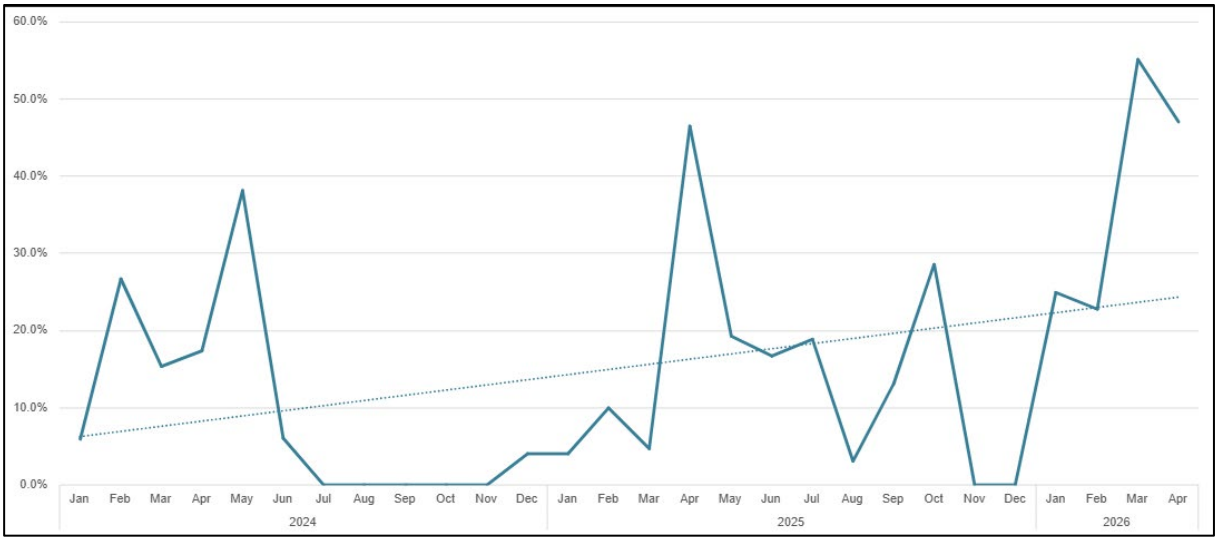


Figure 7: % of 30-Minute CO Exceedances Attributed to N_2O Cylinder Explosions

A supplementary CO spike analysis was also completed to evaluate the contribution of short-duration CO excursions beyond those meeting the N_2O cylinder explosion criteria. The analysis used the same temporal window and event-identification methodology as the explosion analysis, with the pressure criterion removed and the CO threshold reduced to 700 mg/dscm in consultation with the Operator. Identified CO spike event timestamps were subsequently compared against reported 30-minute CO exceedances to quantify their contribution to exceedance events. Between January 2024 and April 2026, 251 of 670 reported 30-minute CO exceedances (37.5%) were associated with identified CO spike activity, inclusive of explosion events (15%). Figure 8 presents the monthly percentage of reported 30-minute CO exceedances associated with CO spike events.

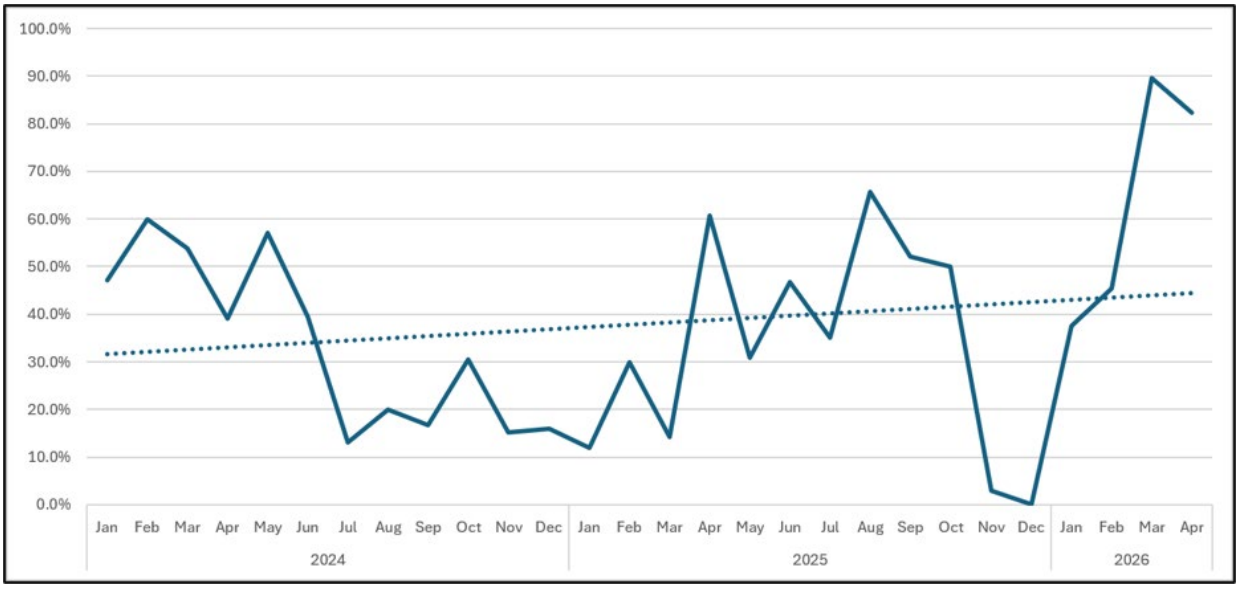


Figure 8: Percentage to 30-Minute CO Exceedances Attributed to CO Spikes

The results suggest that explosion frequency, and consequently CO spike frequency, is increasing and is associated with measurable operational impacts. Further, an increasing proportion of reported 30-minute CO exceedance events are attributable to short-duration CO spikes over time.

Air modelling of the CO exceedances determined under worst case conditions that the ground level concentration of CO during these events at the maximum point of impingement was six times lower than the ambient air quality objective and does not present a public health risk.

4.3.1 Natural Gas Effectiveness Analysis

CO discharge can be used as an indicator for incomplete combustion. So, when a CO spike is observed in the Waste-to-Energy Facility's control room, the operators generally turn on the natural gas burners in the units to promote a better combustion environment. In general, natural gas intervention by the operator does not appear to impact how quickly CO concentrations drop after an explosion. Review of individual events illustrated that CO concentrations typically declined below 500 mg/dscm within one or two minutes of the peak concentration, regardless of whether natural gas was used.

Between January 2024 and April 2026, an estimated 48,500 m³ of excess natural gas consumption was attributed to operator interventions following explosion events. As discussed above, review of individual events indicated that CO concentrations typically declined below 500 mg/dscm within one or two minutes of the peak concentration regardless of whether natural gas was used. Excess natural gas consumption associated with these interventions exhibited variability between months and a generally increasing trend over time. However, this represents only 0.65% of total natural gas use over the same period. While relatively small in comparison to overall natural gas use, this still amounts to approximately 95 tonnes CO_2e of greenhouse gas discharge. If natural gas consumption is extrapolated across all CO spike events, as defined above, an estimated 300,000 m³ excess was used between January 2024 and April 2026. This is equivalent to approximately 5% of total natural gas consumption over the study period, or roughly 590 tonnes CO_2e[2] of greenhouse gas discharge.

4.3.2 Summary of Findings

Continuous monitoring data and operator records were used to develop a data-supported methodology for identifying suspected N_2O cylinder explosions. Application of the methodology indicated that explosion frequency appears to be increasing.

15% of reported 30-minute CO exceedances were associated with suspected N_2O cylinder explosions. A broader assessment of short-duration CO spike events, including explosion-related events, found that 37.5% of reported exceedances were linked to these short duration events. The proportion of 30-minute CO exceedances attributable to these short-duration CO spikes is increasing, indicating a growing influence of these events on reported compliance performance.

[1] CO_2e emissions were estimated using the Government of Canada's 2025 emission factor for marketable natural gas in British Columbia (1,966 g CO_2/m³ natural gas).

Air modelling of the CO exceedances determined under worst case conditions that the ground level concentration of CO during these events at the maximum point of impingement was six times lower than the ambient air quality objective and does not present a public health risk.

5 Proposed Discharge Limits

5.1 Methodologies

To establish technically sound, achievable, and protective discharge limits, Metro Vancouver conducted a comprehensive evaluation of historical facility data, process capabilities, and full-scale trial results. The methodology applied across all monitored parameters relies on a dual analytical approach:

- Statistical Analysis of Historical Discharge: Continuous discharge monitoring data and historical stack testing results were statistically analyzed (Section 3.4) to establish baseline performance and evaluate current compliance margins across all parameters.
- Empirical Trial: For HCl, SO_2 and NO_x, historical trends were used in addition to findings from the recent full-scale trials campaign (Section 4). This allowed evaluation of actual removal efficiencies against continuous discharge monitoring system measurement capabilities and operational constraints.
- Statistical Derivation of the Upper Prediction Limits (UPLs): The purpose of the statistical analysis was to develop upper prediction limits (UPLs) for selected air emission parameters. The UPLs were developed to characterize historical facility performance and to inform Metro Vancouver's evaluation of reasonable parameter-specific limits for potential inclusion in the Waste-to-Energy Facility Operational Certificate (**Appendix E**).
- For arsenic, polychlorinated biphenyls, polycyclic aromatic hydrocarbons, chlorophenols, chromium, and hydrogen fluoride, the proposed discharge limits were set at four times (4x) the UPL.

Metro Vancouver has implemented changes to current control technologies and optimized process automation, based on trial findings for all noted revised parameters. Metro Vancouver will propose revised improved limits for HCl and SO_2 which will be implemented integrating new control technologies and updated process automation, once additional by trial findings are completed during the Engagement period. These modifications will require longer-term capital investment in the Waste-to-Energy Facility.

5.2 Proposed Discharge Limits

Table 8 presents the proposed discharge limits for the Waste-to-Energy Facility's Operational Certificate, based on the research and analysis provided in the above sections.

Table 8: Proposed Discharge Limits

Stack Emission Parameters	Sampling and Analysis Frequency	Current Discharge Limit	Proposed Discharge Limit	Comments
Rate of Flue Gas Discharge	Continuous and Four times per year	N/A	N/A	
Oxygen, % of Dry Air	Continuous and record ½ hr average values for concentration adjustments	N/A	N/A	
Total Particulate Matter	Four times per year	9 mg/dscm	9 mg/dscm	
Lead	N/A	N/A	48 µg/dscm	New
Arsenic	N/A	N/A	9.2 µg/dscm	New
Chromium	N/A	N/A	40 µg/dscm	New
Lead, Arsenic, Chromium	Four times per year	Sum of Lead, Arsenic, Chromium 64 µg/dscm	Sum of Lead, Arsenic, Chromium 60 µg/dscm	Reduced
Cadmium	Four times per year	7 µg/dscm	7 µg/dscm	
Total Mercury	Four times per year	20 µg/dscm	15 µg/dscm	Reduced
Dioxins and Furans (PCDD/PCDF) TEQ	Annually	0.08 ng/dscm	0.06 ng/dscm	Reduced
Hydrogen Chloride (HCl)	Continuous and record ½ hr and 24-hour average values	55 mg/dscm 1-hr (interim)	45 mg/dscm 1-hr	Reduced; No response limits proposed.
Hydrogen Fluoride (HF)	Four times per year	1 mg/dscm	0.52 mg/dscm	
Sulphur Dioxide (SO_2)	Continuous and record ½ hr and 24-hour average values	200 mg/dscm 24-hr (interim)	120 mg/dscm 24-hr	Reduced
Nitrogen Oxides (NO_x)	Continuous and record ½ hr and 24 hours average values	190 mg/dscm 24-hr	150 mg/dscm 24-hr	Reduced: No response limits proposed.
Carbon Monoxide (CO)	Continuous and record ½ hr and 24-hour average values	50 mg/dscm 24-hr	50 mg/dscm 24-hr	
Total Hydrocarbons (THC)	Continuous and record ½ hr and 24-hour average values	10 mg/dscm 24-hr	10 mg/dscm 24-hr	
Opacity	Continuous and record one minute average values for inspections	5%	5%	
Polycyclic Aromatic Hydrocarbons (PAH)	Annually	5 µg/dscm	1.3 µg/dscm	Reduced
Polychlorinated Biphenyls (PCBs)	Annually	1 µg/dscm	0.4 µg/dscm	Reduced
Chlorophenols	Annually	1 µg/dscm	0.29 µg/dscm	Reduced
Chlorobenzene	Annually	1 µg/dscm	1 µg/dscm	

5.3 Proposed Approach to Establishing Final Discharge Limits

Upgrading Monitoring Capabilities
To measure and operate at lower emission levels, higher precision instrumentation is required. Metro Vancouver is procuring new CEMS analyzers capable of monitoring HCl and SO_2 at lower detection ranges than the current equipment allows.

Investigating Alternative Reagents and Technologies
Based on initial trial findings, Metro Vancouver is considering potential avenues for further testing, subject to operational feasibility. This may include trying sodium bicarbonate with an optimized particle size, assessing bi-reagent systems for targeted injection during high raw-gas concentration events, or studying other commercially available reagents not evaluated during initial trials.

Next Steps
In parallel with technical evaluations, engineering assessments will be conducted to define necessary physical facility modifications, operational impacts, and associated capital and operating expenditure requirements.

The final proposed discharge limits will be provided at the end of the engagement period. Metro Vancouver will integrate these technical and financial findings to propose final discharge limits including an anticipated schedule for achieving them as part of the final submission.

5.4 Proposed approach for Carbon Monoxide 30 Minute Exceedances

The Operational Certificate includes 30-minute response limits intended to prompt operator action when combustion conditions deteriorate. However, the analysis presented in Section 4.3identified a distinct class of short-duration CO spike events, including suspected N_2O cylinder explosions, that are operationally different from sustained combustion upsets. These events typically last less than five minutes and return to baseline conditions without operator intervention.

Because the current compliance metric is based on a rolling 30-minute average, short-duration CO spikes can disproportionately influence reported exceedances despite representing only a small fraction of the time period. Analysis indicates that the contribution of these short-duration events to reported 30-minute CO exceedances is increasing.

The PHRA included an assessment of the potential impacts of short-duration CO exceedances on human health (see Section 7). Using the highest 5-minute CO concentrations recorded in the CEMS data as inputs to the PHRA model, the assessment found the ground level concentrations of CO were well below the health based standards and posed no undue risk to human health for receptors located both in the immediate vicinity of the Waste-to-Energy Facility and throughout the wider region.

To better align the response limit with controllable operating conditions, Metro Vancouver proposes that any CO spike that returns below the 30-minute response limit within 5 minutes of exceeding the 30-minute response limit should not be included in the calculation of the number of annual response limit exceedance hours. This approach would allow short-duration transient disturbances to be screened from the 30-minute averaging calculation while maintaining the existing response framework for sustained combustion issues that can be influenced through operator action.

The proposed approach would:

- Maintain focus on operator response to controllable combustion conditions;
- Reduce the influence of short-duration transient events that are not representative of normal facility performance;
- Better align reported exceedances with underlying operational performance; and
- Avoid unnecessary natural gas consumption associated with responding to events that typically resolve independently.

Figure 9 shows a representative short-duration CO spike event and its influence on the 30-minute averaging period.

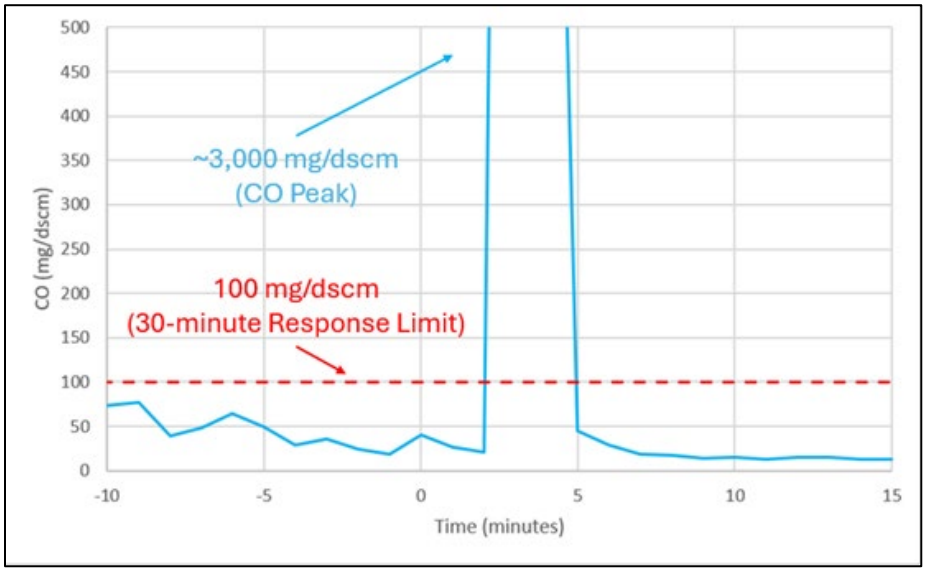


Figure 9: Typical CO Spike from N_2O Cylinder Explosion

6 Proposed Additional Monitoring

6.1 Discharge Monitoring

Building upon the Waste-to-Energy Facility's baseline CEMS and stack testing, Metro Vancouver proposes enhancing the Waste-to-Energy Facility discharge monitoring program. The proposed enhancements consider monitoring approaches in place in other jurisdictions as well as local conditions. For many of the new proposed monitoring parameters, limited data is available on

discharge values, and as such no discharge limits are proposed, but data would be submitted as part of regular environmental reporting, and analysis of the data would be included in future public health risk assessments.

- Condensable Particulates: Addition of condensable particulates as part of regular stack testing.
- Dioxins / Furans: Expanding current testing to annual stack testing on all three lines. In addition, long-term sampling will be performed annually per line, rotating by one quarter each year to determine any seasonal variation in dioxin/furans emissions. Tack testing will be conducted during the extended sampling periods.
- Startup and Shutdown: tack testing during startup and shutdown to characterize startup and shutdown emissions would be conducted on an annual basis for one combustion line.
- Free NH_3: Adding continuous CEMS stack monitoring to measure unreacted ammonia emissions and optimize ammonia use.

Additional monitoring upgrades are presented in Table 9.

Table 9: Proposed Discharge Monitoring Upgrades

Parameter / Monitoring Assessment	Monitoring Approach	Technology (as applicable)	Monitoring Process	Frequency of Monitoring/ Analysis	Comment/ Purpose
Condensable Particulates	Stack testing	n/a	Batch	Quarterly	Informative
Dioxins / Furans	Stack testing	n/a	Batch	Annually on all three lines	Change from single line annually to all three lines annually for discharge limit compliance
	Continuous Sampling	Analyzer	Continuous	- Conduct an extended period of continuous sampling on the same operating criteria as CEMS data collection. Performed for each operating line annually. -Start date of the sampling event would progress by a quarter each year to quantify seasonal variations in waste composition if any. - Stack testing and continuous sampling would be completed during the same period for each line for comparison of results.	- To determine if stack testing data is representative of overall emission, propose continuous sampling over an extended period each year. - Continuous sampling would be conducted for a portion of the year, rather than the full year to reduce financial impacts, while providing data to determine if stack test results are representative of overall emissions. - Informative
Start-Up and Shutdown[1]	Stack testing	n/a	Batch	Annually on one line	Informative
Free NH_3	Stack CEMS	Analyzer	Continuous	Continuous	Informative

[1] See Table 9 for a list of all parameters included in start-up and shutdown testing.

6.2 Additional Monitoring Methods Considered

Additional monitoring methods implemented in other jurisdictions were evaluated but are not proposed at this time. The rationale for excluding these methods is provided below.

6.2.1 Dioxins and Furans – Additional Stack Testing and Continuous Long-Term Sampling

Continuous long-term sampling of dioxins and furans is required in many European countries and is also implemented at Durham York. However, stack testing at the Waste-to-Energy Facility has consistently demonstrated that emissions are below the Operational Certificate discharge limits.

Metro Vancouver proposes to move to annual stack testing for dioxins and furans for all three lines with the addition of long-term continuous sampling of each combustion line as indicated above. This approach will show whether short duration stack testing results are comparable to continuous monitoring and determine if there is season variability in results.

The European and Durham York standard is two stack tests per year and continuous sampling over the entire year. This approach compared to Metro Vancouver's proposed approach would add approximately $500,000 per year in costs and. given the consistent and extremely low discharge values for dioxins and furans. is not expected to add substantial value to the monitoring program.

6.2.2 Mercury – Continuous Sampling

Continuous Hg sampling has recently become a requirement at many European waste-to-energy facilities. However, there has been limited application of this technology at North American waste-to-energy facilities, and inconsistent analyser performance has been reported where it has been implemented. While continuous Hg sampling is not proposed at this time, it may be reconsidered in the future.

6.2.3 Particulates – Continuous Sampling

At present, continuous opacity monitoring is used as a surrogate indicator for particulate emissions and to verify that quarterly stack testing results are representative of normal operating conditions. This approach has been demonstrated to be effective; therefore, continuous particulate sampling is not proposed at this time.

6.2.4 Hydrogen Fluoride – Continuous Sampling

HF stack test results at the Waste-to-Energy Facility have consistently been measured in low concentrations and would be considered in compliance with European standards. Further, continuous monitoring of HF is uncommon at comparable facilities in North America. HF has also not been identified as a contaminant of potential concern (COPC) in the community, and in the airshed. Continuous HF monitoring is not proposed at this time.

6.3 Startup and Shutdown Monitoring

Under standard operating conditions, CEMS measures when waste is actively burning under stable thermal conditions. Stack testing similarly is required to be conducted under isokinetic or stable thermal operating conditions. To characterize emissions across transient operational states, Metro Vancouver proposes establishing stack testing protocols dedicated to monitoring emissions during planned startup and shutdown phases, based in part on the European Best Available Techniques (BAT 18 and BAT 5 / BREF WI 2019).

- These testing activities occur outside of normal operating conditions. Monitoring takes place when the furnace is using auxiliary burners during unit startup and temperature ramp-up, stabilized thermal hold periods, or during unit shutdown and post-waste burnout cooling.
- The proposed testing protocol is designed for characterization and concentration emission estimation, compliance tracking with no formal discharge limit aligned with European regulation.

Table 10: Proposed Startup and Shutdown Emissions Testing Program

Methodology	Contaminants Monitored	Testing Frequency	Units[1]
Stack testing	NO_x, CO, THC, HCl, HF, SO_2, Particulate Matter, Dioxins/Furans, PCB, PAHs, Chlorobenzenes, Chlorophenols, Hg, Cd, Sum of Pb-As-Cr	1 line per year	mg/dscm (uncorrected for O_2)

Notes:
[1] The 11% O_2 correction factor is adapted to normal operating conditions for incineration. During startup and shutdown, furnaces run with high excess air, with high oxygen levels (> 15–18% O_2). Applying the standard correction formula under these diluted conditions mathematically increases concentration values. Following European practices, emissions during these periods are reported as non-corrected concentrations, providing a realistic estimate of actual emissions.

6.4 Ambient Air Monitoring

Metro Vancouver is reinstalling the ambient air monitoring station adjacent to the Waste-to-Energy Facility (S150 station). The station is near predicted MPOI in the air quality dispersion modelling study. The station includes the following continuously monitored parameters:

- HCl
- SO_2
- NO_x
- $PM_{2.5}$
- PM_{10}

Data from the station will be available to the public on the internet as part of Metro Vancouver‘s AirMap website.

Summary of the S150 data would be included as part of annual environmental monitoring reporting.

7 PHRA Updates

Metro Vancouver will undertake updated air quality dispersion modelling and Public Health Risk Assessment (PHRA) every five years using the latest CEMS and stack test data. The PHRAs would consider current facility discharges and any changes in ambient air quality objectives and the data from the S150 monitoring station. The recommendations from the PHRAs would be integrated into requirements for the Waste-to-Energy Facility.

8 Access to Data

8.1 Current Approach on Access to Data

The Operational Certificate establishes requirements for public access to emissions and operational data from the Waste-to-Energy Facility. The facility is monitored through both continuous emissions monitoring systems and periodic manual stack testing programs. Monitoring results, testing reports, and other operational information are reported to BC ENV and are made publicly available through a variety of reporting mechanisms, as described below.

Metro Vancouver maintains a public website (https://metrovancouver.org/services/solid-waste/waste-to-energy-facility) that includes all the information required by the Operational Certificate, as well as any additional information (reports, documents, plans, etc.) concerning the Waste-to-Energy Facility. These include:

- Real-time CEMS data relative to discharge data;
- Manual stack test discharge data;
- Fly ash and bottom ash analytical data;
- Complaint information and corresponding response from Metro Vancouver;
- Links to the facility National Pollutant Release Inventory and Greenhouse Gas data;
- Studies on PHRA, air dispersion modelling, and ambient air monitoring; and
- Miscellaneous operational information.

This data is also reported to the Zero Waste Committee and various agencies.

8.2 Proposed Approach on Access to Data

While Metro Vancouver's approach to publishing environmental monitoring data is one of the most transparent among waste-to-energy facilities in North America, emissions data is not readily searchable by the public. Those seeking information on specific trends or historical results must manually review multiple reports to compile the information or request the data specifically from Metro Vancouver.

To enhance accessibility and usability of environmental performance data, Metro Vancouver will update the Internet Publication Plan to specify the development of an online tool to allow users to query emissions data by selecting specific parameters and time periods. The website will include a disclaimer indicating that the data is provided for user convenience and may be pending

completion of quality assurance and quality control processes at the time of access. Emissions data would be available alongside data from a new ambient air monitoring station at the Waste-to-Energy Facility, enabling users to compare facility emissions data with real-time ambient air concentrations measured immediately adjacent to the Waste-to-Energy Facility. Data collected after the updated Operational Certificate is issued would be available through the tool, while data from before the update to the Operational Certificate would continue to be available through static reports on the website.

Providing public access to historical and real-time Waste-to-Energy Facility emissions data would enhance transparency, accountability, and accessibility of environmental information including emissions data, trends, and historical monitoring results.

As described in Section 2.4, some jurisdictions in Europe maintain online, publicly searchable continuous emissions monitoring data and annual discharge data, either voluntarily or to meet a regulatory requirement. In North America there are limited examples of this level of data accessibility, with certain facilities publishing real-time emissions data on a voluntary basis only. Launching a public tool to provide easy access to current and historical emissions data would strengthen Metro Vancouver's leadership in emissions data transparency across North America and align its approach with that of leading European jurisdictions.

9 Air Dispersion Modelling

Air dispersion modelling provides a link between discharge of emissions from sources at the Waste-to-Energy Facility to ambient air concentrations, which are then used to access facility impact on public health. In addition, predicted ambient air concentrations are compared against air quality standards and objectives to access compliance.

Air dispersion modelling was conducted to predict ambient concentrations of criteria air contaminants (CACs), metals, dioxins and furans, VOCs and other contaminants. The CACs evaluated include particulate matter less than 2.5 µm in diameter ($PM_{2.5)}$, CO, SO_2, and NO_x. The metals, VOCs and other contaminants evaluated include HCl, HF, total dioxins and furans, cadmium, Hg, lead, arsenic, Cr, the sum of lead, arsenic and chromium, PAHs, PCBs, CP, and CB. These are the contaminants that are listed in the Operational Certificate.

9.1 Emission Scenarios

Six scenarios were considered for this study:

- **Current Operational Certificate Scenario:** Represents continuous operation at the maximum emission limits authorized under the current Operational Certificate. As the Waste-to-Energy Facility does not typically operate at permitted limits, this scenario represents a conservative assessment of current permitted operations.
- **Proposed Operational Certificate Scenario**: Represents continuous operation at the proposed emission limits under the proposed Operational Certificate. As the Waste-to-Energy Facility would not typically operate at these limits, this scenario represents a conservative assessment of future permitted operations.

- **Current Operations Scenario**: Represents typical Waste-to-Energy Facility operations using recent available CEMS data and stack testing results.
- **Startup Scenario:** Represents operation of two boilers under typical conditions while a third boiler undergoes startup. Emission rates were developed using startup stack testing and CEMS data.
- **Shutdown Scenario:** Represents operation of two boilers under typical conditions while a third boiler undergoes shutdown. Emission rates were developed using shutdown stack testing and CEMS data.

9.2 Air Dispersion Modelling Assessment Methodology

The air dispersion modelling assessment was completed in accordance with the BC Air Quality Dispersion Modelling Guideline (AGDMG - ENV, 2022) using the CALMET/CALPUFF modelling system. A detailed modelling plan was developed in collaboration with and approved by the BC ENV and health authorities prior to commencement of the assessment. Modelling was conducted to predict ambient concentrations at a comprehensive network of gridded and discrete sensitive receptors (including 261 sensitive receptors), throughout the study area. Predicted concentrations were compared with Metro Vancouver Ambient Air Quality Objectives (MV AAQOs), British Columbia Ambient Air Quality Objectives (BC AAQO), Canadian Ambient Air Quality Standards (CAAQS), and, where local criteria were unavailable, objectives from Alberta and Ontario.

Various aspects of modelling methodology are summarized in Table 11. Methodology and results of air dispersion modelling are provided in **Appendix B**.

Table 11: Summary of Air Dispersion Modelling Methodology

Parameter	Description
Air Dispersion Modelling Objectives	• Provide required inputs for PHRA • Assess compliance against ambient air quality objectives and standards
Study Area and Model Domain	• 50 km x 50 km covering Lower Fraser Valley
Dispersion Modelling System	• CALMET (v.6.5.0) /CALPUFF (v.7.2.1)
Dispersion Modelling Years	• 2019-2023
Meteorological Inputs	• ENV's mesoscale prognostic data at 1.33 km resolution • Surface meteorological data from Metro Vancouver's meteorological network
CALMET Resolution	• 250 m, 10 vertical layers
Model Receptors	• Gridded receptors according to the AQDMG • 261 discrete receptors representing sensitive population locations
Cumulative Effects	• Assessed through addition of ambient background concentrations from representative Metro Vancouver ambient monitoring network for the period of 2022-2024.
Modelled Contaminants	• CACs: $PM_{2.5}$, SO_2, NO_2, CO • Metals: cadmium, Hg, lead, arsenic, chromium, the sum of lead, arsenic and chromium • Other: HCl, HF, total dioxins and furans, PAHs, PCBs, chlorophenols and chlorobenzenes
Model Outputs	• Ambient air concentrations and deposition rates (to inform PHRA)

9.2.1 Air Dispersion Modelling Results

Maximum predicted concentrations of CACs, metals, VOCs and other contaminants were compared with applicable ambient air quality objectives and standards.

For CACs, predicted concentrations of $PM_{2.5}$, CO, and annual SO_2 were below their respective objectives in all modelled scenarios.

Predicted 1-hour SO_2 concentrations under the Current Operations, Startup, and Shutdown scenarios, were below the applicable objectives and standards. Predicted SO_2 concentrations exceeded the1-hour MV AAQO in the Operational Certificate and Proposed Operational Certificate scenarios, while the 1-hour SO_2 CAAQS was exceeded in the Operational Certificate scenario, only. These scenarios assume continuous operation at maximum permitted emission limits throughout the five-year modelling period and are therefore conservative representations of Waste-to-Energy Facility performance.

For NO_2, predicted 1-hour and annual concentrations from the Waste-to-Energy Facility emissions alone were below the applicable MV AAQOs in all modelled scenarios. Exceedances were predicted only after the addition of ambient background concentrations. Background NO_2 concentrations alone account for approximately 92% of the 1-hour objective and exceed the annual objective. As a result, the predicted NO_2 exceedances are primarily attributable to regional background air quality conditions rather than emissions from the Waste-to-Energy Facility.

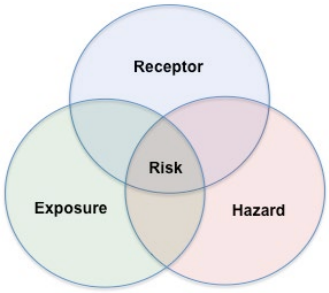
For metals, VOCs and other contaminants, predicted concentrations were below their respective assessment criteria for all contaminants evaluated except HCl and PAHs. Predicted 1-hour HCl concentrations exceeded the applicable objective in all modelled scenarios; however, the exceedances were localized to areas within approximately 470 m of the Waste-to-Energy Facility and occurred infrequently. Predicted exceedance frequencies were generally less than 0.1% in any given year and less than 0.03% over the five-year modelling period.

Predicted concentrations of PAHs exceeded the applicable Ontario Ambient Air Quality Criterion for 24-hour and annual averaging periods, under the Current Operational Certificate and Proposed Operational Certificate scenarios. The 24-hour criterion was also exceeded under the Shutdown scenario. No PAH exceedances were predicted under the Current Operations Scenario, which is considered representative of typical Waste-to-Energy Facility operations. Note that as the Operational Certificate only limits the total PAHs and not the individual PAH components, the total PAH concentrations were conservatively compared with the Ontario AAQC for benzo(a)pyrene.

Note that the assessment incorporates conservative assumptions in emissions development, background concentrations, and dispersion modelling to provide a protective evaluation of potential air quality impacts. In particular, the background concentrations include emissions from the existing operations of the Waste-to-Energy Facility. Comparisons with ambient monitoring data at S150 station indicate that model predictions are substantially higher than the observed conditions, indicating that the assessment provides a robust margin of conservatism and a protective evaluation of potential future air quality impacts.

Overall, the modelling results indicate that Waste-to-Energy Facility emissions contribute a relatively small increment to ambient concentrations of the Lower Fraser Valley for most contaminants. Predicted exceedances were generally associated with conservative maximum-permitted emission scenarios, elevated regional background concentrations, or localized areas immediately surrounding the facility. The modelling results presented in this assessment along with additional data on predicted ambient concentration and deposition rates provide inputs required for the companion PHRA.

10 Public Health Risk Assessment Report Findings



The PHRA was completed in consultation with Vancouver Coastal Health and the Fraser Health Authority to ascertain whether or not the operations of the Waste-to-Energy Facility pose a risk to human health and to inform the proposed discharge limits.

The PHRA used the air dispersion modelling maximum point of impingement ground level air quality results to determine whether or not a potential risk to public health may exist. The Waste-to-Energy Facility predicted airborne concentrations were assessed in isolation (Facility Alone) and, with the baseline, monitored air contaminant concentrations to provide the predictions of potential health risk to the public. In addition, contaminant depositions to local soil were assessed over a 20-year loading period to determine if a multi-media risk assessment was warranted.

The PHRA included:

- Conducting an updated review of the world-wide peer-reviewed scientific literature published since 2018 on the potential health effects that one could expect from living or working or engaged in proximity to the Metro Vancouver Waste-to-Energy Facility. This review was conducted using the PUBMED and Google Scholar databases. It built off the previous Waste-to-Energy Facility health impact literature reviews conducted for Metro Vancouver. The focus was to ensure that the scope of the PHRA was on the correct COPC exposure pathways and potential health outcomes.
- The air quality dispersion modelling results provided baseline/ambient concentrations of COPCs from the Lower Fraser Valley Air Quality Monitoring Network, modelled concentrations and deposition of contaminants of potential concern under the existing Operational Certificate discharge limits, including startup and shutdown conditions, and ground level airborne concentrations of contaminants of potential concern under the proposed discharge limits, and in particular for SO_2 and HCl.

This PHRA assessed both the short-term (Startup/Shutdown) and long-term (normal operations) potential exposure of the public to release of contaminants from the Waste-to-Energy Facility. It involved both a review of the existing scientific literature on contaminant release, exposure and long-term deposition of contaminants from such facilities and the PHRA. The complete PHRA Report is found in **Appendix C**.

10.1 Public Health Risk Assessment Methodology

A PHRA is the scientific approach to determining if a population's exposure to contaminants released to the environment could pose an undue risk to health. This approach is based on decades of research and the development of standard protocols and approaches to assessing risk.

All contaminants have the potential to interact with people, but it is the level, route and duration of exposure that determine if it could cause harm to health. For a potential undue risk to exist from discharge from the Waste-to-Energy Facility, one must understand:

- The nature in which people use the surrounding environment, for work, living and recreational purposes (receptors);
- The extent to which people may come into contact with the emitted contaminants (exposure); and
- The contaminants must be present at a high enough level to pose a risk to these people (hazard).

It is a combination of these elements that determine if an unacceptable risk to human health may exist.

The Ministry of Environment and Parks has published the *British Columbia Guidance for Prospective Human Health Risk Assessment* (2022) that was used as the primary guidance document for the conduct of the Public Health Risk Assessment. In addition, the Public Health Risk Assessment incorporated direction from *Health Canada's Guidance for Evaluating Human Health Effects in Impact Assessment: Human Health Risk Assessment* (2023).

This risk assessment follows the general risk assessment paradigm of:

- Problem Formulation; Exposure Assessment; Toxicity/Hazard Assessment; Risk Characterization

10.2 PHRA Modelling Results

10.2.1 Tier 1 Risk Assessment Results

There is no question that the Waste-to-Energy Facility releases contaminants into the air. However, the results of the risk assessment determined that:

- For the majority of the Criteria Air Contaminants, the facility does not pose an undue risk to anyone at the MPOI for $PM_{2.5}$, CO, HCl, HF even at the existing Permitted Operational Certificate discharge limits. The Operational Project Alone levels confirm that these contaminants do not pose an undue risk.
- For SO_2, the Current Operational Certificate Permitted levels are marginally above the concentration ratio benchmark of 1.0. However, the Current Operational discharges are below the acceptable benchmark. The lowering of the Proposed Operational Certificate Permitted levels also result in an acceptable Concentration Ratio of <1.0. Therefore, the

Operational Certificate discharge limits should be lowered to those proposed and do not result in an unacceptable risk to human health.

- The secondary particulate matter levels were an order of magnitude lower than the predicted primary $PM_{2.5}$ modelled levels at the MPOI and had no effect on the resulting $PM_{2.5}$ Concentration Ratios. Therefore, secondary particulate matter from the release of SO_2 emissions from the Waste-to-Energy Facility do not pose an undue risk to human health.
- Air modelling of the short-term spike CO exceedances determined under worst case conditions that the ground level concentration of CO during these events at the MPOI was six times lower than the ambient air quality objective and does not present a public health risk.
- Overall, all of the additional contaminants considered do not pose a risk to human health, whether under the Current Operational Certificate Permitted levels, the Proposed Operational Certificate Permitted levels or certainly the Current Operational levels at the MPOI when considering the existing background concentrations in air. Their Concentration Ratios were all below 1.0. The exception to this was the PAHs that were modelled in the Current Operational Certificate Permitted that had a Concentration Ratio above 1.0. However, the Concentration Ratio for the Current Operations Facility Alone level and in combination with the Background levels were below the benchmark of 1.0. In addition, the lowering of the emissions under the Proposed Operational Certificate Permitted limits would ensure that the Concentration Ratio for PAHs would be acceptable and should be adopted by the Waste-to-Energy Facility. Therefore, PAHs were not carried forward into the Tier 2 risk assessment.
- NO_2 levels require further evaluation under the Tier 2 Risk Assessment.

10.2.2 Tier 2 Risk Characterization of Nitrogen Dioxide Emissions from the Waste-to-Energy Facility

Nitrogen dioxide is a non-threshold contaminant that needs to be given serious consideration in any combustion facility health risk assessment. Exposure to NO_2 in our everyday environment has been demonstrated to elicit adverse health impacts, the most significant of which is the potential to exacerbate asthmatic episodes in adults and children. The PHRA concludes that although the Waste-to-Energy Facility is a source of ground level NO_2, it does not pose an undue public health risk based on the following lines of evidence:

- Over the past 40 years the facility emissions of NO_2 have seen a dramatic decrease in their discharge limits and operational discharge of NO_2. The most significant decrease in release was seen in 2014 after the introduction of new air pollution control technology into the system.
- The Waste-to-Energy Facility accounts for only 0.5% of the total emissions of NO_2 in the Lower Fraser Valley airshed in 2025.
- The measured ambient air concentrations at the fence line of the facility (S150 station) and the closest ambient air monitoring station Burnaby South (T018) in 2022 were higher than the predicted contribution from the Waste-to-Energy Facility modelled NO_2

concentrations at these stations. Given that this is an active facility, then the existing ambient air monitoring stations results are inclusive of the contribution of the Waste-to-Energy Facility emissions. The ambient air concentrations of NO_2 at these monitoring stations either meet or marginally exceed the Metro Vancouver Ambient Air Quality Objectives.

- The modelled percentile concentrations of NO_2 from the Waste-to-Energy Facility under the Proposed Operational Certificate Permitted Discharge Limit, and more importantly for the Current Operations scenario are below the Ambient Air Quality Objective at all times (100^{th} percentile).

10.3 Recommendations

Based on the findings of the PHRA, the following recommendations are made for future monitoring and assessment:

1. Conduct annual startup and shutdown stack test monitoring of all contaminants to establish a trend in the emissions in comparison to the routine operations emissions from the facility (See Section 6.3).

2. Re-establish the S150 Air Monitoring Station at the fence line of the facility. The MPOI for Criteria Air Contaminants are located near the fenceline for the 1-hr and 24-hr values and would provide the best indicator for the potential influence the facility is having on the airshed. Contaminants should include NO_2, SO_2, HCl, and $PM_{2.5.}$ This data should be included as part of the annual environmental monitoring reporting for the facility. There would be no need to install additional air monitoring stations in the area (See Section 6.4).

3. Conduct an updated air quality dispersion modelling and PHRA every five years using the latest CEMS and stack test data. This would confirm the effectiveness of the lowering of the SO_2 and HCl. It would also assist in the tracking of the other contaminants. It should include any changes in ambient air quality objectives and include the data from the S150 monitoring station. The Waste-to-Energy Facility should be required to implement any recommendations of the updated PHRA (See Section 7).

Based on the findings of the deposition of contaminants to soil over 20 years there would be no need to conduct soil or vegetation sampling in the area surrounding the Waste-to-Energy Facility.

10.4 Conclusions

It was concluded that the current emissions of contaminants from the Waste-to-Energy Facility do not pose a public health risk. The findings of this PHRA are consistent with the findings of 2018 report and the past three decades of peer-reviewed scientific literature and government reports on facilities around the world.

The PHRA recommends that that the Proposed Operational Certificate Permitted Discharge Limits for the Waste-to-Energy Facility be adopted by Metro Vancouver. In addition, annual startup and shutdown stack testing monitoring of all contaminants should be conducted, re-

establishment of the S150 station fence line air monitoring station should be conducted and every five years the air quality modelling and public health risk assessment should be conducted.

11 Proposed Public Consultation and Engagement Plan

For consideration by the Ministry of Environment and Parks, the following outlines the Public Consultation and Engagement Plan. Following provincial approval of the Public Consultation and Engagement Plan, Metro Vancouver will complete engagement prior to submitting final proposed emission limits and additional monitoring activities to the BC ENV for consideration.

Metro Vancouver will collect, track, and analyze all feedback received, maintaining records of correspondence, inquiries, and responses. Input received may inform revisions to the proposed emissions limits and environmental monitoring opportunities. Following completion of the engagement process, Metro Vancouver will prepare an engagement summary report documenting feedback received and a description of how key issues were considered. Engagement and reporting are expected to conclude within five months of approval of the Public Consultation and Engagement Plan.

Engagement will focus on seeking feedback on:

- Proposed emission limits for the Waste-to-Energy Facility Operational Certificate;
- Proposed additional environmental monitoring opportunities; and
- Any other questions, concerns, or comments raised by First Nations, stakeholders, interested organizations, or members of the public.

Metro Vancouver will provide information on:

- Overall environmental performance of the Waste-to-Energy Facility;
- PHRA conclusions; and
- Conclusions from the recent study, “Analysis of the Potential Dispersion and Deposition Effects of Particulate Matter Emissions from the Metro Vancouver Waste-to-Energy Facility on the Surrounding Environment.”

Engagement Objectives

1. Reach, engage, and hear from interested parties to receive feedback on proposed updated emissions limits and potential additional environmental monitoring activities for the Waste-to-Energy Facility Operational Certificate.
2. Engage in meaningful dialogue to identify potential concerns and opportunities related to Waste-to-Energy Facility emissions.
3. Identify feedback to support any updates to proposed emission limits.
4. Support informed engagement and share engagement outcomes including a summary of feedback and how Metro Vancouver is responding.
5. Continue to learn how audiences want to stay informed about Waste-to-Energy Facility updates and engagement opportunities.

Audiences

Engagement audiences will include:

- First Nations
- Metro Vancouver member jurisdictions and adjacent regional districts
- Provincial and federal health authorities
- Waste and recycling industry representatives
- Relevant government agencies
- Organizations and individuals with a demonstrated interest in the Waste-to-Energy Facility
- Owners and tenants of properties adjacent to the Waste-to-Energy Facility and within approximately 500 metres of the facility property boundary, including businesses and buildings located across the Fraser River within 300 metres of the facility.
- Subscribers to Metro Vancouver's Solid Waste Services mailing list
- Social media audiences

Methods

Metro Vancouver will notify interested parties and promote engagement opportunities and invite feedback through:

- Notification letters
- Email communications (e-blasts) describing the engagement opportunity and how to provide feedback
- Social media channels promoting the engagement opportunity
- Information and engagement materials posted on the Metro Vancouver website
- Offering meetings on request

First Nations Engagement

Metro Vancouver's First Nations engagement strategy will follow a collaborative government-to-government approach with First Nations whose territories and interests include all or part of the project area. Engagement activities may include:

- Written correspondence to share project information and seek input on interests and concerns, including formal engagement letters, update letters, and emails.
- Meetings with First Nations to discuss the project and understand interests and concerns.
- Sharing technical, environmental, archaeological, and other project-related reports and materials for review and comment.
- Reporting back to First Nations on engagement outcomes, including:
    - A summary of interests and concerns raised
    - Metro Vancouver's responses
    - How feedback was incorporated

Reporting

Following completion of engagement activities, Metro Vancouver will prepare an engagement summary report that documents:

- The engagement process and activities undertaken;
- Participation by interested groups and the public;
- Key themes and feedback received;
- First Nations feedback (to be reported based on direction from each individual Nation engaged);
- Metro Vancouver's responses to feedback, including rationale; and
- How feedback influenced proposed updates to emission limits and additional environmental monitoring opportunities.

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Appendices

- Appendix A – Operational Certificate
- Appendix B – Air Quality Monitoring Report
- Appendix C – Public Health Risk Assessment Report
- Appendix D – Operational Testing and Analysis Data
    - D1 – Acid Gas Trials
    - D2 - NO_x and NH_3 testing data
    - D3 - N_2O cylinder explosion analysis and CO spike analysis
- Appendix E – Statistical Analysis of Historical Discharge Limit Parameters

Appendix A: Operational Certificate

MINISTRY OF ENVIRONMENT AND PARKS

OPERATIONAL CERTIFICATE

107051

Under the Provisions of the Environmental Management Act

GREATER VANCOUVER SEWERAGE AND DRAINAGE DISTRICT

4730 Kingsway, 27th Floor, Metrotower III
Burnaby, BC V5H 0C6

is authorized to discharge contaminants to the air from a waste to energy facility located at 5150 Riverbend Drive, Burnaby, British Columbia, subject to the terms and conditions listed below. Contravention of any of these conditions is a violation of the *Environmental Management Act* and may lead to prosecution.

1. AUTHORIZED DISCHARGES

1.1 Mass Burn Incinerator/Boilers

This section applies to the discharge of air contaminants from three separate **Mass Burn Incinerators/Boilers** from a common support stack containing three individual flues. The site reference number for this discharge is E300670.

1.1.1 The maximum combined rate of discharge is 72 cubic metres per second, resulting from the combustion of a maximum of 310,000 tonnes per year (moist weight as received) of waste.

1.1.2 The authorized discharge period is continuous.

Date issued: December 15, 2016
Date amended: September 23, 2025
(most recent)

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Authorizations - Communities, IPM & AgriFood

1.1.3 The characteristics of the discharge must be equivalent to or better than:

Parameter	Units[1]	Interim Discharge Limits[2][3]			Discharge Limits[3]		Response Limits[4]
		24-hr average[5]	4-hr average[6]	1-hr average	24-hr average[5]	Approved Test Method[7]	1/2-hr average[8]
Total Particulate Matter[9]	mg/dscm	-	-	-	-	9	-
Opacity	%	-	-	5	-	-	5
Carbon Monoxide (CO)	mg/dscm	-	55	-	50	-	100
Hydrogen Chloride (HCl)	mg/dscm	-	-	55[10]	10	-	60
Hydrogen Fluoride (HF)	mg/dscm	-	-	-	-	1.0	-
Sulphur Dioxide (SO_2)	mg/dscm	200	-	-	50	-	190
Nitrogen Oxides (NO_x)	mg/dscm	350	-	-	190	-	350
Total Hydrocarbons (THC)	mg/dscm	-	-	Manual Stack Test limit of 40[11]	10	-	20
Total Dioxins and Furans (as PCDD/F TEQ)[12]	ng/dscm	-	-	-	-	0.08	-
Cadmium (Cd)	µg/dscm	-	-	-	-	7	-
Mercury (Hg)[13]	µg/dscm	-	-	-	-	20	-
Sum of Lead (Pb), Arsenic (As), Chromium (Cr)	µg/dscm	-	-	-	-	64	-
Chlorophenols	µg/dscm	-	-	-	-	1	-
Chlorobenzenes	µg/dscm	-	-	-	-	1	-

Date issued: December 15, 2016
Date amended: September 23, 2025
(most recent)

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Polycyclic Aromatic Hydrocarbons (PAHs)	µg/dscm	-	-	-	-	5	-
Polychlorinated Biphenyls (PCBs)	µg/dscm	-	-	-	-	1	-

1. dscm = dry standard cubic metre, corrected to 11% oxygen
2. Interim Discharge Limits will apply until and including the following dates, at which point the
   Discharge Limits and Response Limits will apply:
   a. Opacity – December 31, 2017
   b. CO – December 31, 2016 (Discharge Limit) and December 31, 2018 (Response Limit)
   c. HCl – as per subparagraph 1.1.11 of this Operational Certificate
   d. SO2 – as per subparagraph 1.1.11 of this Operational Certificate
   e. NOx – December 31, 2017 (Response Limit)
   f. THC – December 31, 2018 (Discharge and Response Limits)
3. Discharge Limits are the criteria for compliance determination of each discharge parameter listed in the column, subject to Note 2 above.
4. Response limits are the threshold requiring the Operational Certificate Holder to take immediate action to bring down the discharge levels to the applicable discharge limits specified in this section. The response limits are expressed as ½ hour (block) average values measured by approved continuous emission monitors. The Operational Certificate Holder is required to demonstrate the response action(s) implemented by record keeping.
5. Interim Discharge Limits are daily average values, calculated as the arithmetic average of valid continuous emissions monitoring system (CEMS) data. Discharge Limits are 24-hour (daily block) averages.
6. Calculated as the arithmetic average of 4 hours of data from a CEMS.
7. Determined by a test method approved by the Director. A single manual stack test result is the average of a minimum of three test runs.
8. Calculated as the arithmetic average of ½ hour block of data from a CEMS.
9. Total particulate matter (filterable portion only) is determined by EPA Test Method 5 or an alternative method approved by the Director.
10. Continuous monitoring of SO_2 will be used as a surrogate for emission monitoring of acid gases, such as HCl and HF.
11. Monitored as total hydrocarbons (measured as methane).
12. PCDD (polychlorinated dibenzo-p-dioxins) & PCDF (polychlorinated dibenzofurans) will be expressed in dioxin toxicity equivalent value (dioxin TEQ) as defined in the *Hazardous Waste Regulation*.

Date issued: December 15, 2016
Date amended: September 23, 2025
(most recent)

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for Director, *Environmental Management Act*
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13. Mercury determined by EPA Test Method 29 or an alternative method approved by the Director.

1.1.4 Notwithstanding the requirements of 1.1.3, the emission standards specified in 1.1.3 are not applicable to start up and shut down periods as defined by section 3.6.

1.1.5 The authorized works are a refuse bunker, three mass burn incinerators/boilers each equipped with an independent feed chute, integrated furnace/boiler, Covanta Low NO_x System, selective non-catalytic NO_x reduction system, lime scrubber, activated carbon injection system and three baghouses, fans, heaters, ash handling and treatment systems, turbo generator, air cooled condenser or steam vent, a common support stack (with three individual flues), and related appurtenances approximately located as shown on the attached Site Plan.

1.1.6 The authorized works must be complete and in operation while discharging.

1.1.7 The location of the facilities from which the discharge originates, and the point of discharge is Lot 1, District Lot 167, Group 1, New Westminster District, Plan 72187.

1.1.8 A furnace temperature of 980 degrees Celsius must be maintained for a minimum residence time of one second when unburned solid waste is present in a combustion chamber. The secondary combustion zone temperature for each incinerator unit must be monitored and reported for compliance purposes based on a minimum one-hour average reference temperature of 800 degrees Celsius, which correlates to a combustion zone temperature of 980 degrees Celsius.

1.1.9 The Operational Certificate Holder must ensure that under no circumstances solid waste is continued to be fed to an incinerator/boiler when an authorized parameter response limit is exceeded for a period of more than 4 hours uninterrupted per

parameter per unit; moreover, the cumulative duration of operation in such conditions over one calendar year must be less than 60 hours per parameter per unit.

1.1.10 The Operational Certificate Holder must continuously monitor additional discharge parameters including, but not limited to, volumetric flowrate, oxygen, and carbon dioxide in the flue gases for operational and emissions reporting purposes.

1.1.11 By September 23, 2026, the Operational Certificate Holder will cause one or more Qualified Professionals to prepare and submit to the Director the following information to facilitate the Director's decision on discharge limits for HCl and SO_2:

(a) Review of all current emissions levels in clause 1.1.3 in addition to HCl and SO_2.
(b) Results of testing of potential facility operational modifications to support reduction of discharge limits for emissions in clause 1.1.3.
(c) A Public Health Risk assessment in consultation with Vancouver Coastal Health and the Fraser Health Authority which will inform the discharge limits.
(d) A proposal for draft revised discharge limits listed in clause 1.1.3.
(e) A public consultation plan for draft revised discharge limits for Director's approval.
(f) A review of emission reporting and public access to data, including any recommendations for improvement.

1.1.12 Within five (5) months of the date of Director's approval of the public consultation plan submitted pursuant to section 1.1.11(e), the Operational Certificate Holder will submit its proposed final discharge limits for the Director's decision.

1.2 Closed-Circuit Cooling Tower

This section applies to the discharge of air contaminants from a Closed-Circuit Cooling Tower. The site reference number for this discharge is E300671.

1.2.1 The maximum rate of discharge is 70 m^3/s.

1.2.2 The authorized discharge period is continuous.

1.2.3 The characteristics of the discharge must be equivalent to or better than typical air discharge from a closed-circuit cooling tower including water vapour and mist containing dissolved minerals naturally present in water and water conditioning additives for pH and algae growth control.

1.2.4 The authorized works are a closed-circuit cooling tower, exhaust vents, and related appurtenances approximately located as shown on the attached Site Plan.

1.2.5 The authorized works must be complete and in operation while discharging.

1.2.6 The location of the facilities from which the discharge originates and the point of discharge is the same as Section 1.1.7 above.

1.3 Lime Silo

This section applies to the discharge of air contaminants from a Lime Silo. The site reference number for this discharge is E300672.

1.3.1 The maximum rate of discharge is 1.0 m^3/s.

1.3.2 The authorized discharge period is intermittent.

1.3.3 The characteristics of the discharge must be equivalent to or better than:

Total particulate matter,
maximum (estimated): 0.012 tonnes per year

1.3.4 The authorized works are a lime silo, a dust collector, and related appurtenances approximately located as shown on the attached Site Plan.

1.3.5 The authorized works must be complete and in operation while discharging.

1.3.6 The location of the facilities from which the discharge originates and the point of discharge is the same as Section 1.1.7 above.

1.4 Activated Carbon Silo

This section applies to the discharge of air contaminants from an Activated Carbon Silo. The site reference number for this discharge is E300673.

1.4.1 The maximum rate of discharge is 1.0 m^3/s.

1.4.2 The authorized discharge period is intermittent.

1.4.3 The characteristics of the discharge must be equivalent to or better than:

Total particulate matter,
maximum (estimated): 0.00035 tonnes per year

1.4.4 The authorized works are an activated carbon silo, a filter vent, and related appurtenances approximately located as shown on the attached Site Plan.

1.4.5 The authorized works must be complete and in operation while discharging.

1.4.6 The location of the facilities from which the discharge originates and the point of discharge is the same as Section 1.1.7 above.

1.5 Fly Ash Silo

This section applies to the discharge of air contaminants from a Fly Ash Silo. The site reference number for this discharge is E300674.

1.5.1 The maximum rate of discharge is 2.0 m^3/s.

1.5.2 The authorized discharge period is continuous.

1.5.3 The characteristics of the discharge must be equivalent to or better than:

Total particulate matter,
maximum (estimated): 0.098 tonnes per year

1.5.4 The authorized works are a fly ash silo, dust collector, and related appurtenances approximately located as shown on the attached Site Plan.

1.5.5 The authorized works must be complete and in operation while discharging.

1.5.6 The location of the facilities from which the discharge originates and the point of discharge is the same as Section 1.1.7 above.

1.6 Emergency Power Generator

This section applies to the discharge of air contaminants from a standby Emergency Power Generator. The site reference number for this discharge is E300675.

1.6.1 The maximum rate of discharge is 2.0 m^3/s.

1.6.2 The authorized discharge period is limited to necessary emergency and maintenance operation.

1.6.3 The characteristics of the discharge must be equivalent to or better than typical emissions from an emergency power generator utilizing low sulphur diesel fuel.

1.6.4 The authorized works are a standby emergency power generator and related appurtenances approximately located as shown on the attached Site Plan.

1.6.5 The authorized works must be complete and in operation while discharging.

1.6.6 The location of the facilities from which the discharge originates and the point of discharge is the same as Section 1.1.7 above.

2. GENERAL REQUIREMENTS

2.1 Maintenance of Works and Emergency Procedures

The authorized works must be inspected regularly and maintained in good working order. In the event of an emergency or condition beyond the control of the Operational Certificate Holder which prevents effective operation of the authorized works or leads to an unauthorized discharge, the Operational Certificate Holder must take appropriate remedial action and notify the Director immediately. The Director may reduce or suspend operations to protect the environment until the authorized works have been restored and/or corrective steps taken to prevent unauthorized discharges.

2.2 Bypasses

Any bypass of the authorized works is prohibited unless the approval of the Director is obtained and confirmed in writing.

2.3 Plans - Works

Plans and specifications of the works authorized in Sections 1.1, 1.2, 1.3, 1.4, 1.5, and 1.6 must be submitted to the Director upon request. For

any material modifications to the authorized works, a qualified professional must certify that the works have been constructed in accordance with the certified design before discharge commences.

2.4 Process Modifications

The Director must be notified prior to implementing material changes to any process that adversely affects the quality and/or quantity of the discharge from the facility to a material extent. Despite notification under this section, permitted levels must not be exceeded.

2.5 Non-compliance Response and Reporting

Unless otherwise instructed in writing by the Director, the Operational Certificate Holder must immediately notify the Director or designate of any non-compliance with the requirements of this Operational Certificate and take appropriate remedial action.

Written reporting of non-compliance events must be included in the monthly reports and must include, but not necessarily be limited to:

- all relevant test results, operational data, etc. related to the noncompliance;
- an explanation of the most probable cause(s) of the noncompliance; and
- remedial action planned and/or taken to prevent similar noncompliance(s) in the future.

A summary of non-compliance events for the calendar year must be included in the annual reports.

2.6 General Notification

Any notifications to the Director or designate must be by email, and accompanied by phone (currently Surrey regional office, 604-582-5200) for incidents that occur during normal business hours (typically Monday to Friday, between 08:30 and 16:30). Email acknowledgement or

personal phone contact with ministry staff is required for notification to be considered to have occurred.

2.7 Standard Conditions

For the administration of this Operational Certificate all gaseous volumes must be converted to standard conditions of 293.15 K and 101.325 kPa with zero percent moisture and 11% oxygen.

2.8 Authorized Fuels and Wastes

The authorized wastes for the Mass Burn Incinerators/Boilers are municipal solid waste authorized by an approved waste management plan pursuant to Section 24 of the Environmental Management Act and any wastes authorized prior to January 1, 2015. Natural gas may be used as an auxiliary fuel as required.

Other wastes may be authorized as fuel subject to management of the waste not conflicting with any regulation. Such wastes may be approved or prohibited in writing by the Director, or approved pursuant to the following protocol:

1. Prior to usage of the proposed waste, submit written notification to the Director identifying the proposed material. A report must accompany this notification which must contain the following:

   a. records detailing analyses and written descriptions establishing the composition, source, and quality of the proposed waste;
   b. proposed feed rate of the waste in tonnes per hour with a maximum daily feed quantity; and
   c. documentation supporting that disposal of the proposed waste does not conflict with requirements of any regulation.

2. No earlier than ten business days after submitting the report required by (1) above, the Operational Certificate Holder must conduct a demonstration trial utilizing the proposed waste at the

maximum proposed feed rate. The demonstration trial must meet the following requirements:

a. site storage and handling of the proposed waste must be conducted in such a manner so as to effectively control fugitive emissions;
b. the duration of the demonstration trial must be a maximum of 96 hours;
c. emissions monitoring must be conducted to determine the concentration of the parameters listed in Section 1.1.3. Emissions monitoring results must show that processing of the proposed waste does not cause a statistically significant increase in emissions concentrations for the parameters listed in Section 1.1.3;
d. fly ash and bottom ash monitoring must be conducted to determine the concentrations of the parameters included in the fly ash and bottom ash management plans. Fly ash and bottom ash monitoring results must show that processing the proposed waste does not cause statistically significant increase in concentrations of parameters listed in fly ash and bottom ash management plans; and
e. following completion of the trial, all information collected during the trial including all field data, calculations, operating parameters, measurements, etc., must be submitted to the Director. The submission must include a thorough evaluation of the trial data in a report prepared by a qualified professional.

The Director may at any time request additional information if warranted for the protection of human health or the environment.

Considering this protocol and any other relevant information, the Director may provide authorization for the Operational Certificate Holder to commence utilization of the proposed waste up to the maximum tested feed rate.

2.9 Waste Handling and Storage

Waste must be protected against weather elements to prevent pollution from leachate, odour, litter, or dust emissions during handling and storage.

The Operational Certificate Holder must implement necessary housekeeping procedures to eliminate sources and potential sources of attraction for vermin and vectors.

Waste delivered to the facility by truck must be discharged directly into the refuse bunker. Waste loads delivered to the facility by truck may be periodically discharged onto a dedicated paved area adjacent to the refuse bunker to facilitate waste load inspections and waste audits.

Unloading and storage of bulk waste delivered by trucks must be managed in an area with appropriate ventilation and odour control.

2.10 Future Recycling or Beneficial Use

The Director may require an evaluation of the potential to:

- recycle or beneficially use certain residues from the combustion process; or
- re-use, recycle, or recover certain resources.

2.11 Fugitive Emission Control

Fugitive odour, particulate, etc. emissions created within the facility must be suppressed. If air quality becomes a concern, the Director may require additional control measures on emission sources.

2.12 Ash Management

2.12.1 Fly ash and bottom ash must be managed and disposed of at a facility acceptable to the Director, or beneficially used as acceptable to the Director. Recoverable materials such as ferrous metal pieces should be recovered from bottom ash.

2.12.2 A Fly Ash Management Plan must be submitted by August 15, 2017. The Fly Ash Management Plan must be acceptable to the Director and may be amended in writing by the Director. The Fly Ash Management Plan must include proposed sampling and analytical

protocols, sampling frequency, results interpretation process, protocols for interpreting anomalous data, and other related information. Fly ash management must be conducted according to the Fly Ash Management Plan.

2.12.3 A Bottom Ash Management Plan must be submitted by August 15, 2017. The Bottom Ash Management Plan must be acceptable to the Director and may be amended in writing by the Director. The Bottom Ash Management Plan must include proposed sampling and analytical protocols, sampling frequency, results interpretation process, protocols for interpreting anomalous data, and other related information. Bottom ash management must be conducted according to the Bottom Ash Management Plan.

2.13 Action Plan Review and Update

The Operational Certificate Holder must conduct a review acceptable to the Director of an Action Plan for Review of Environmental Performance of the Metro Vancouver Waste to Energy Facility (Action Plan) to assess current environmental technology using principles outlined in the ministry Determining Best Achievable Technology Standards policy. The Action Plan must be reviewed and updated at least each 5 years from issuance of this Operational Certificate, with the next review and update required by December 15, 2021. Actions recommended as part of each review must be incorporated into the Action Plan.

2.14 Environmental Management System

The Operational Certificate Holder must ensure that an Environmental Management System (EMS) equivalent to or exceeding ISO 14001 continues to be implemented to ensure continual environmental improvement and compliance with discharge requirements through the use of effective operating procedures, training, and maintenance practices. This system must include: operating the equipment within its designed capabilities; preventing occurrences of abnormal operating conditions in all areas of the facility; and enhancing the capabilities to manage or mitigate/correct such abnormal operating conditions for the

protection of the environment and human health. The Operational Certificate Holder must ensure the EMS is updated annually and kept available for inspection.

2.15 Emergency Response Plan

The Operational Certificate Holder must ensure that an Emergency Response Plan is maintained that describes the procedures to be taken to prevent or mitigate any spills, unauthorized discharge of contaminants to the air, or deposit of deleterious substance to the receiving environment. The Emergency Response Plan must be immediately implemented if there is a discharge/deposit, or any risk of a discharge/deposit, of a deleterious substance to the receiving environment. The Operational Certificate Holder must ensure that the Emergency Response Plan is updated annually and kept available for inspection.

2.16 Start Up / Shut Down Evaluation

The Operational Certificate Holder must undertake an Evaluation of emissions that occur during facility start up and shut down events. The Evaluation should characterize contaminant emissions, including emissions of trace organics, through emissions monitoring and any other relevant sources of information to quantify or predict emissions occurring during start up and shut down conditions. The Evaluation must be completed and a report acceptable to the Director submitted by June 15, 2018.

2.17 Evaluation of Contaminant Dispersion and Public Health Risk Assessment

The Operational Certificate Holder must retain an independent qualified professional to undertake an evaluation of the potential surface deposition of contaminants from the operation of the facility. The Evaluation must include:

- characterization of contaminant emissions using site specific monitoring data, scientific literature review, and any other relevant sources of information, to determine potential environmental and health effects for all air contaminants of potential concern including dioxins and furans;
- updated and comprehensive site-specific air dispersion modelling to evaluate potential impacts on the local and regional air quality, and the potential for atmospheric deposition of air contaminants;
- a comprehensive public health risk assessment that takes into consideration multiple pathways of exposure and potentially sensitive receptors within the area of impact, and that covers long-term normal operation of the facility as well as short-term conditions anticipated at start up, shutdown, or during an upset;
- an assessment of the existing regional air quality monitoring network and program to confirm its appropriateness and effectiveness in assessing potential impacts from facility emissions; and
- based on the preceding, an assessment of the effectiveness of the monitoring requirements made in this Operational Certificate, and recommendations for sampling or evaluation of receptors such as soil, vegetation, or other media.

The independent qualified professional must have expertise in air quality, air dispersion modelling, and human health risk assessment. Input from the provincial health authorities must be solicited, and the final report must be provided to them for informational purposes. The Evaluation must be completed and a report acceptable to the Director submitted by December 15, 2018.

3. MONITORING AND REPORTING REQUIREMENTS

3.1 Waste and Ash Monitoring

In a manner acceptable to the Director, the Operational Certificate Holder must ensure the following are monitored and recorded:

3.1.1 Record measured weight of waste received, waste processed, and natural gas burned per day, per month, and per year.

3.1.2 Record estimated bulk weight (and estimated % moisture) of treated bottom ash and treated fly ash destined for disposal or beneficial use per month and per year.

3.2 Spill Reporting

All spills to the environment (as defined in the Spill Reporting Regulation) must be reported immediately in accordance with the Spill Reporting Regulation. Notification must be via the Provincial Emergency Program, currently at 1-800-663-3456.

3.3 Discharge Monitoring for Section 1.1

The Operational Certificate Holder must ensure the discharge is monitored as follows:

Parameter for Stack E300670	**Sampling and Analysis Frequency**[1]
Rate of Discharge[2], m^3/s	Continuous & Four times per year
Total Particulate Matter, mg/m^3	Four times per year
Opacity[3], %	Continuous[3,4] & record one minute average values for inspections
Oxygen[6], % of dry air	Continuous[3,4] & record ½ hr average values for concentration adjustments
Carbon Monoxide (CO) , mg/m^3	Continuous[3,4] & record ½ hr and 24 hour average values
Hydrogen Chloride (HCl), mg/m^3	Continuous[3,4] & record ½ hr and 24 hour average values
Hydrogen Fluoride (HF), mg/m^3	Four times per year
Sulphur Dioxide (SO_2), mg/m^3	Continuous[3,4] & record ½ hr and 24 hour average values
Nitrogen Oxides (NOx), mg/m^3	Continuous[3,4] & record ½ hr and 24 hour average values
Total Hydrocarbons (THC), mg/m^3	Continuous[3,4] & record ½ hr and 24 hour average values
PCDD & PCDF TEQ, pg/ m^3	Annually[5]
Total Mercury, mg/m^3	Four times per year
Polychlorinated Biphenyls (PCBs), mg/m^3	Annually[5]
Chlorophenols, mg/m^3	Annually[5]
Chlorobenzene, mg/m^3	Annually[5]
Lead, mg/m^3	Four times per year

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Arsenic, mg/m^3	Four times per year
Cadmium, mg/m^3	Four times per year
Chromium, mg/m^3	Four times per year
Polycyclic Aromatic Hydrocarbons (PAH) , mg/m^3	Annually[5]

1. For those parameters with continuous monitoring requirements, compliance with Section 1.1 discharge requirements must be verified with continuous monitoring data (with a QA/QC program satisfactory to the Director) collected during normal operating periods, excluding start up and shut down periods described in Section 3.6. Other than instrument errors, all collected data admissible under a QA/QC program must be recorded and reported. The Director may amend the above monitoring requirements when the Operational Certificate Holder is able to demonstrate to the Director that an alternative compliance monitoring method/requirement is equal to or better than the above requirements.
2. The rate of flue gas discharge must be adjusted to dry standard conditions. The rate of flue gas discharge must be reported as daily average values, calculated as the arithmetic average of valid CEMS data.
3. The required data capture rate for (CEMS) specified above must be 90% of the operating hours per quarter and 95% of the operating hours per annum. The monthly CEMS compliance data report must include % up time for CEMS. The statistic must be extended to annual reports.
4. The CEMS data (½ hour and 24 hour averages) for the above parameters must include maximum, minimum and average for the day, month and year and % of time out of compliance. The specified CEMS data may not be available for all parameters prior to December 31, 2017.
5. Monitoring conducted once per year on one incinerator/boiler.

3.4 Emission Control Device Record Keeping

The Operational Certificate Holder must ensure performance records are maintained for all emission control devices in conjunction with manufacturer specifications. The records must include inspection and maintenance records, amounts of reagents such as lime, carbon, ammonia, phosphoric acid, etc. used, and frequency and duration of any period when an emission control device is not fully operational, along with appropriate description of each malfunction, and the corrective measure(s) taken in each case.

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Authorizations - Communities, IPM & AgriFood

3.5 Secondary Combustion Zone Temperature Monitoring Requirements

In a manner acceptable to the Director, the Operational Certificate Holder must ensure the secondary combustion zone temperature (or equivalent surrogate temperature) is monitored and recorded continuously in degrees Celsius at a suitable location in the secondary combustion zone of the incinerator.

3.6 Start Up and Shut Down Period

The start up and shut down period for the incinerator/boilers must be no more than 5 hours each. During this period, emission data recorded by CEMS may be excluded from regulatory emission calculations. Start up periods may exclude times when the auxiliary burners are in service but waste has not yet been introduced into the boiler. The start up period commences when the feed chute damper is open and waste is charged to the stoker. The start up period will be deemed to be over when the boiler steam flow is greater than 30 tonnes per hour for at least 15 minutes but in any case not longer than five hours. After the start up period, all air emission discharge requirements specified in Section 1.1 are applicable even during periods when feed rates are being adjusted for any reasons other than start up or shut down. Auxiliary burner(s) are to be used during start-up, shutdown, upset conditions, and at any other times as necessary to maintain the secondary combustion zone temperature. Instances in which the auxiliary burner(s) availability impacts the secondary combustion zone temperature must be noted in the monthly operating report. The shut down period commences when waste is no longer being charged to the stoker. The shut down period will be deemed to be over when the auxiliary gas burners are shut down after combustion of waste is complete or when the facility has transitioned back to a start up period.

The Director may amend the exclusion of CEMS emission data based upon a review of discharge data and actual start up and shut down operations of the incinerator/boilers.

3.7 Modification of Monitoring Requirements and/or Treatment Works

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for Director, *Environmental Management Act*
Authorizations - Communities, IPM & AgriFood

Based on monitoring results and any other pertinent information obtained in connection with the discharges, the Director may amend the monitoring requirements, and/or require the Operational Certificate Holder to take additional measures, and/or provide additional treatment works to reduce the impact on the environment and human health from discharges to the receiving environment.

3.8 Sampling Location and Techniques

All sampling and monitoring locations, techniques, and equipment must be acceptable to the Director. Sampling and monitoring data, including the stack flow rate, must be accompanied by process data relevant to the operation of the source of the emissions and the performance of the pollution abatement equipment involved in the testing.

Discrete stack sampling must be done under actual operating conditions when the Operational Certificate Holder is able to properly document that these conditions represent a period of normal operation. The following parameters must be reported for the test period:

a. boiler steam production expressed as kg/h or kJ/h;
b. boiler secondary combustion zone temperature or an appropriate surrogate expressed in degrees Celsius; and
c. the estimated rates of waste and fuels, as-fired into the boiler during each compliance test period.

3.9 Continuous Emission Monitoring Systems

Continuous emission monitoring systems (CEMS) must be installed, operated, and maintained according to applicable standards. The Operational Certificate Holder must record and maintain for each CEMS information including: performance range, specifications, and calibration data; availability (expressed as a monthly percentage of facility operating hours); maintenance and calibration work performed; and results of any independent audits and responses to such audits.

3.10 Sampling and Analytical Procedures

Sampling is to be carried out in accordance with the procedures described in the "British Columbia Field Sampling Manual", 2013 Edition, or most recent edition, or by suitable alternative procedures as authorized by the Director.

Analyses are to be carried out in accordance with procedures described in the "British Columbia Laboratory Manual (2015 Edition)", or the most recent edition, or by suitable alternative procedures as authorized by the Director.

Copies of the above manuals are currently available on the Ministry web page at https://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/laboratory-standards-quality-assurance.

3.11 Reporting Requirements

3.11.1 Source Testing Reporting

The Operational Certificate Holder must submit a report in electronic format to the Director, within 60 days of the completion of the actual source testing, with the exception of testing for chlorophenols, chlorobenzenes, polycyclic aromatic hydrocarbons, hydrocarbons, polychlorinated biphenyls, and/or total dioxins and furans, in which case source testing results must be submitted within 90 days of the actual source testing. In addition to the contaminants specified in Section 3.3, the Operational Certificate Holder must report all individual metals that are part of the metals analytical methodology.

3.11.2 Monthly Report

The Operational Certificate Holder must publish a Monthly Report and notify the Director of the publication within 45 days following each month end. The Monthly Report must, at a minimum, include:

- CEMS data tabulations;
- CEMS performance data;
- identification and responses to discharge contaminant exceedances and response limits;
- instances of the combustion temperature falling below the required minimum, and responses;
- identification and any responses to start up, shut down, process upset, bypass, and emergency/spill events;
- identification of instances in which the auxiliary burner(s) availability impacts the secondary combustion zone; and
- any complaints received and responses.

A detailed plan for, and example of, the proposed contents of the Monthly Report identifying and illustrating the minimum information to be included must be submitted to the Director by June 15, 2017. The plan for the Monthly Report must be acceptable to and may be amended in writing by the Director, and must be implemented by the Operational Certificate Holder. The existing format for the monthly report must continue to be used until such time that the plan for the Monthly Report is implemented.

3.11.3 **Annual Report**

The Operational Certificate Holder must publish an Annual Report for the preceding calendar year and notify the Director of the publication by March 31 of each year. The Annual Report must, at a minimum, include:

- summaries, in general, of information contained in the Monthly Reports;
- summaries of CEMS and manual stack test emissions data;
- CEMS calibration data;
- summaries/interpretation of compliance and complaints information;
- overview of plant performance;
- operational information such as quantities of waste processed, estimated amounts of fly ash and bottom ash or other residues generated and their processing or disposal method;

- summary of operation, performance, and maintenance of emissions control devices; and
- evaluation of monitoring programs.

A detailed plan for the proposed contents of the Annual Report identifying the minimum information to be included must be submitted to the Director by June 15, 2017. The plan for the Annual Report must be acceptable to and may be amended in writing by the Director, and must be implemented by the Operational Certificate Holder.

3.11.4 **Upgrade Implementation Report**

The Operational Certificate Holder must publish an annual report outlining the status of facility upgrades to meet interim discharge limits as specified in Section 1.1.3. The report must be submitted to the Director by March 1 of each year and may be included in the Annual Report. The Upgrade Implementation Report must, at a minimum, include:

- detailed description of the facility upgrades project planned activities and deliverables for the entire project presented in a Gantt chart format or in another format acceptable to the Director;
- detailed description of activities completed, and deliverables achieved in the previous 12 months;
- detailed description of planned activities presented in monthly increments for the next 12 months;
- identification of any project risk(s) or project change(s) that could negatively impact the upgrades project completion and meeting of interim discharge limits, including supporting rationale and proposed mitigating and/or corrective actions, as applicable.

3.11.5 **Internet Publication Plan**

A public internet website must be established for the facility that must include, at a minimum:

- manual stack test emissions data;
- real-time CEMS data relative to the emissions limits included in Section 1.1.3 of this Operational Certificate;
- fly ash and bottom ash analytical data;
- links to facility National Pollutant Release Inventory and Greenhouse Gas data published by the associated regulatory agency;
- compliance and complaints information and response;
- relevant operational and incident information and response;
- additional opportunities for dialogue with the community where appropriate;
- the Fly Ash Management Plan and Bottom Ash Management Plan submitted in accordance with Section 2.12, the Start Up/Shut Down Evaluation submitted in accordance with Section 2.16, the Contaminant Dispersion Evaluation and Health Risk Assessment submitted in accordance with Section 2.17; and
- any other relevant additional information such as reports, documents, plans, links, etc. concerning the facility.

An Internet Publication Plan for the website must be submitted to the Director by June 15, 2017. The plan should identify the minimum information and required timelines, retention, etc. for publication and should consider the interests of the public, agencies, and concerned stakeholders. The plan must be acceptable to and may be amended in writing by the Director, and must be implemented by the Operational Certificate Holder.

The Operational Certificate Holder must track and consider all stakeholder feedback received following implementation of the Internet Publication Plan. The feedback, the Operational Certificate Holder's response to the feedback, and any changes to the Internet Publication Plan must be included in the Annual Report.

3.11.6 **Stakeholder Comments**

The Operational Certificate Holder must record and consider all stakeholder comments on the publication of operational data and the content, structure, and publication of reports, plans, etc. The

comments and Operational Certificate Holder's response must be included in publicly available content.

3.11.7 **Record Keeping Requirements**

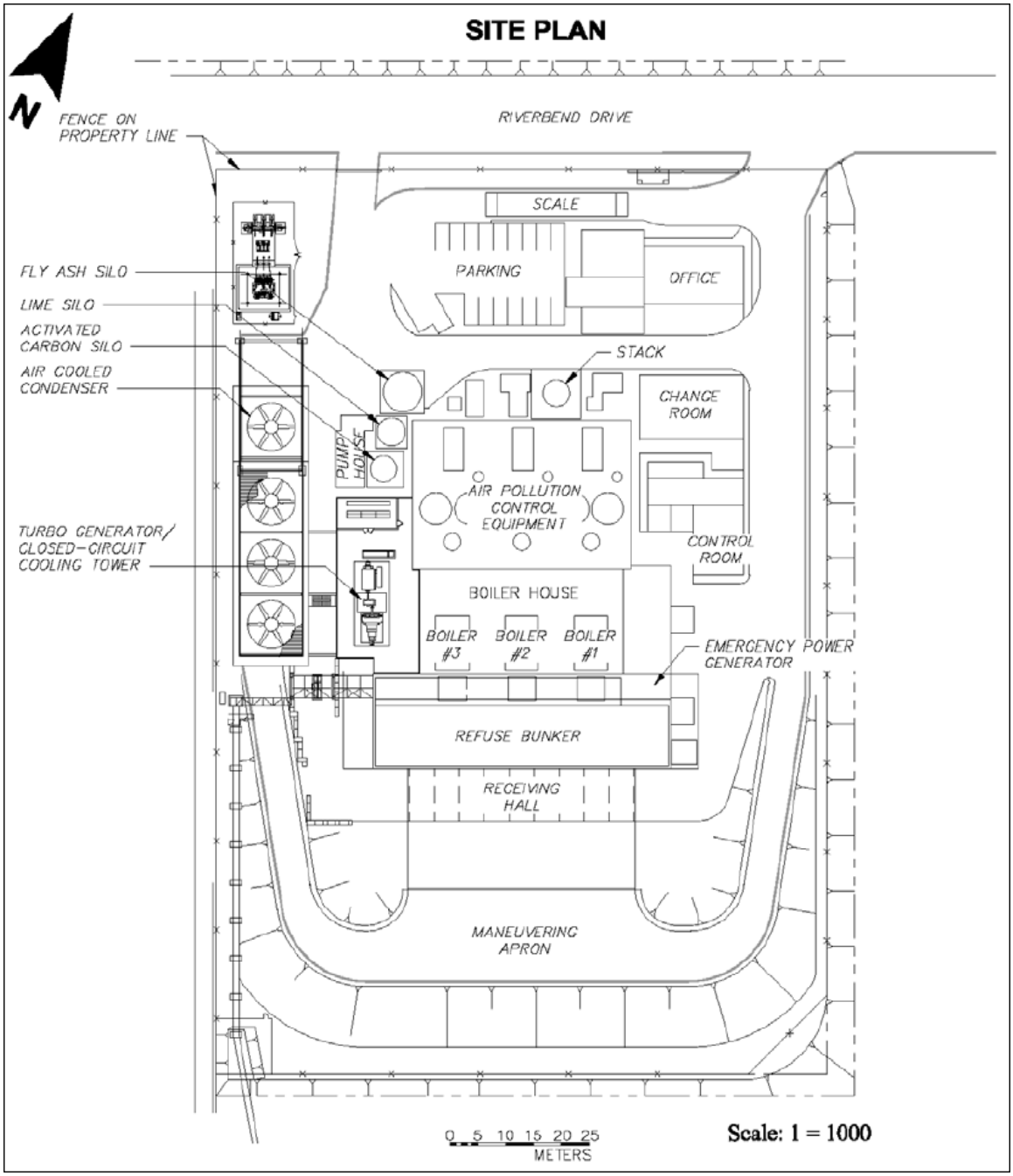
Maintain all records including emission testing results, data of analysis, reports, and continuous emission results and calibration records for continuous monitors required under this Operational Certificate as long as reasonably practical. Data published according to the requirements of this Operational Certificate must be retained for a minimum of 20 years from the date of publishing.

4. PUBLICATION OF DOCUMENTS

The Ministry of Environment and Climate Change Strategy publishes Regulatory Documents on its website for the purpose of research, public education and to provide transparency in the administration of environmental laws. The Operational Certificate holder acknowledges that the Province may publish any Regulatory Documents submitted by the Operational Certificate holder excluding information that would be exempted from disclosure if the document was disclosed pursuant to a request under section 5 of the *Freedom of Information and Protection of Privacy Act*, and the Operational Certificate holder consents to such publication by the Province.

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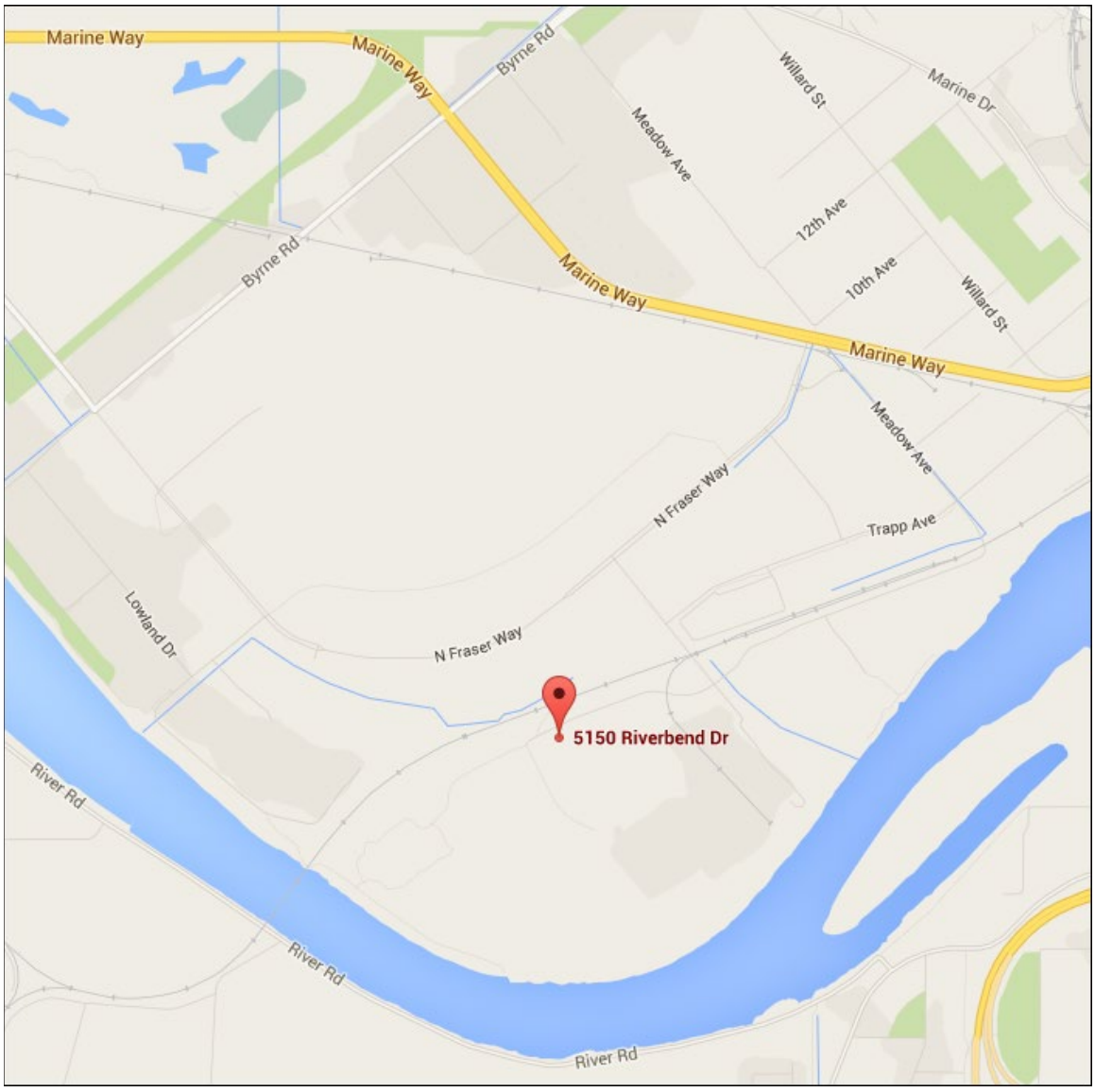
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LOCATION MAP



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Appendix B: Air Quality Monitoring Report

REPORT

METRO VANCOUVER WASTE-TO-ENERGY FACILITY

BURNABY, BC

AIR DISPERSION MODELLING STUDY

RWDI #2600812

September 22, 2026

SUBMITTED TO

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EXECUTIVE SUMMARY

The Metro Vancouver Waste-to-Energy Facility (the "Facility") is located at 5150 Riverbend Drive in Burnaby, British Columbia (BC), and combusts municipal solid waste. The Facility is owned and operated by the Greater Vancouver Sewage and Drainage District and is regulated under BC Ministry of Environment and Parks (ENV) Operational Certificate (OC) 107051 (the Current OC). The current OC authorizes and limits the discharge of contaminants from three separate mass burn incinerators/boilers (the "Boilers") through a common support stack containing three individual flues (the "Boiler Stack").

Study Objectives

Under the amended OC issued, September 23, 2025, a public health risk assessment (PHRA) is required in consultation with Vancouver Coastal and Fraser Health. An air dispersion modelling assessment was completed to support the PHRA and to inform the development of proposed emission limits, as also required to support a proposed amended OC (the Proposed OC). A companion report prepared by Ollson Environmental Health Management addresses the PHRA.

Predicted ambient concentrations of criteria air contaminants (CACs), metals, volatile organic compounds (VOCs) and other contaminants were assessed in this study. The CACs evaluated include particulate matter less than 2.5 µm in diameter ($PM_{2.5}$), carbon monoxide (CO), sulphur dioxide (SO_2), and nitrogen oxides (NO_x). The metals, VOCs and other contaminants evaluated include hydrogen chloride (HCl), hydrogen fluoride (HF), total dioxins and furans, cadmium, mercury, lead, arsenic, chromium, the sum of lead, arsenic and chromium, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), chlorophenols, and chlorobenzenes.

Additional modelling results, including ambient air concentrations and deposition rates, were provided to Ollson Environmental Health Management as input to the companion PHRA. These results are not presented in this report.

Emission Scenarios

Five scenarios were considered for this study:

- **Current OC Scenario:** Represents continuous operation at the maximum emission limits authorized under the Current OC. As the Facility does not typically operate at permitted limits, this scenario represents a conservative assessment of current permitted operations.
- **Proposed OC Scenario**: Represents continuous operation at the proposed emission limits under the Proposed OC. As the Facility would not typically operate at these limits, this scenario represents a conservative assessment of future permitted operations.
- **Current Operations Scenario**: Represents typical Facility operations using recent available continuous emissions monitoring system (CEMS) data and stack testing results.
- **Startup Scenario:** Represents operation of two Boilers under typical conditions while a third Boiler undergoes startup. Emission rates were developed using startup stack testing and CEMS data.

- **Shutdown Scenario:** Represents operation of two Boilers under typical conditions while a third Boiler undergoes shutdown. Emission rates were developed using shutdown stack testing and CEMS data.

Methodology

The air dispersion modelling assessment was completed in accordance with the BC Air Quality Dispersion Modelling Guideline (ENV, 2022a) using the CALMET/CALPUFF modelling system. A detailed modelling plan was developed in collaboration with and approved by the relevant regulatory agencies and health authorities prior to commencement of the assessment.

CALPUFF was used to simulate Facility emissions over a 50 km by 50 km study area surrounding the Facility. Five years of meteorological data (2019 through 2023) were used in the analysis. Ambient background concentrations were developed using available monitoring data from Metro Vancouver monitoring stations for the period 2022 through 2024.

Predicted concentrations were evaluated at a comprehensive network of gridded and discrete sensitive receptors throughout the study area. Predicted concentrations were compared with Metro Vancouver Ambient Air Quality Objectives (MV AAQOs), BC AAQO, Canadian Ambient Air Quality Standards (CAAQS), and, where local criteria were unavailable, objectives from Alberta and Ontario.

Results

Maximum predicted concentrations of CACs, metals, VOCs and other contaminants were compared with applicable ambient air quality objectives and standards in Tables E-1 and E-2.

For CACs, predicted concentrations of $PM_{2.5}$, CO, and annual SO_2 were below their respective objectives in all modelled scenarios.

Predicted 1-hour SO_2 concentrations exceeded the MV AAQO in the Current OC and Proposed OC scenarios, while the 1-hour SO_2 CAAQS was exceeded in the Current OC scenario, only. These scenarios assume continuous operation at maximum permitted emission limits throughout the five-year modelling period and are therefore conservative representations of Facility performance. Under the Current Operations, Startup, and Shutdown scenarios, predicted SO_2 concentrations were below the applicable objectives and standards.

For NO_2, predicted 1-hour and annual concentrations from Facility emissions alone were below the applicable MV AAQOs in all modelled scenarios. Exceedances were predicted only after the addition of ambient background concentrations. Background NO_2 concentrations alone account for approximately 92% of the 1-hour objective and exceed the annual objective. As a result, the predicted NO_2 exceedances are primarily attributable to regional background air quality conditions rather than Facility emissions.

For metals, VOCs and other contaminants, predicted concentrations were below their respective assessment criteria for all contaminants evaluated except HCl and PAHs. Predicted 1-hour HCl concentrations exceeded the applicable objective in all modelled scenarios; however, the exceedances were localized to areas within approximately 470 m of the Facility and occurred infrequently. Predicted exceedance frequencies were generally less than 0.1% in any given year and less than 0.03% over the five-year modelling period.

Predicted concentrations of PAHs exceeded the applicable Ontario Ambient Air Quality Criterion for 24-hour and annual averaging periods, under the Current OC and Proposed OC scenarios. The 24-hour criterion was also exceeded under the Shutdown scenario. No PAH exceedances were predicted under the Current Operations Scenario, which is considered representative of typical Facility operations. Note that the PAH criteria are for benzo(a)pyrene as a surrogate for total PAHs, however as the OC only limits the total PAHs and not the individual PAH components, the total PAH concentrations were compared with these criteria conservatively.

The assessment incorporates conservative assumptions in emissions development, background concentrations, and dispersion modelling to provide a protective evaluation of potential air quality impacts. In particular, the background concentrations include emissions from the existing Facility operations. Comparisons with ambient monitoring data at S150 indicate that model predictions are substantially higher than the observed conditions, indicating that the assessment provides a robust margin of conservatism and a protective evaluation of potential future air quality impacts.

Overall, the modelling results indicate that Facility emissions contribute a relatively small increment to ambient concentrations of the Lower Fraser Valley for most contaminants. Predicted exceedances were generally associated with conservative maximum-permitted emission scenarios, elevated regional background concentrations, or localized areas immediately surrounding the Facility. The modelling results presented in this assessment along with additional data on predicted ambient concentration and deposition rates provide inputs required for the companion PHRA.

Table E-1: Maximum predicted concentrations for Criteria Air Contaminants for all scenarios, over the study area

Air Contaminant	Averaging Period	Background (µg/m³) [1]	Maximum Predicted Concentrations under Various Scenarios (µg/m³)										Ambient Objective (µg/m³)	Jurisdiction of Objectives
			Current OC		Proposed OC		Current Operations		Startup		Shutdown			
			Without Background	With Background	Without Background	With Background	Without Background	With Background	Without Background	With Background	Without Background	With Background		
$PM_{2.5}$	24-hour	16.2	0.86	17.11	0.86	17.11	0.09	16.33	0.07	16.31	0.08	16.32	25	MV AAQO
	Annual	6.3	0.17	6.44	0.17	6.44	0.02	6.28	0.02	6.28	0.02	6.28	8 [2]	MV AAQO
Carbon Monoxide (CO)	1-hour	469.5	126.61	596.15	126.61	596.15	54.45	523.99	65.03	534.57	141.90	611.44	14,900	MV AAQO
	8-hour	435.7	36.50	472.20	36.50	472.20	15.70	451.40	18.75	454.45	40.93	476.63	5,700	MV AAQO
Sulphur Dioxide (SO_2)	1-hour	7.1	**506.43**	**513.51**	**303.86**	**310.93**	137.73	144.80	135.32	142.39	105.81	112.89	183	MV AAQO
	99th percentile, D1HM; averaged over 3 consecutive years and then max. over the 3-year averages	7.1	**201.89**	**208.96**	121.13	128.20	60.46	67.53	59.23	66.30	46.46	53.54	170	CAAQS 2025
	Annual	0.8	3.84	4.60	2.30	3.07	1.24	2.00	1.23	1.99	0.97	1.73	10.5	MV AAQO and CAAQS
Oxides of Nitrogen (NO_X) (Assumes 100% Conversion to NO_2; Background and Objectives for NO_2)	98th percentile, D1HM; averaged over 3 consecutive years and then max. over the 3-year averages	73.0	**91.36**	**164.35**	72.19	**145.18**	55.84	**128.83**	53.29	**126.28**	52.88	**125.87**	79 for NO_2	MV AAQO and CAAQS
	Annual	25.0	2.50	**27.46**	1.98	**26.94**	1.63	**26.59**	1.57	**26.53**	1.57	**26.53**	22.6 for NO_2	MV AAQO
Nitrogen Dioxide (NO_2) (Converted from NO_X) [3]	98th percentile, D1HM; averaged over 3 consecutive years and then max. over the 3-year averages	73.0	68.50	**141.49**	59.20	**132.19**	48.41	**121.40**	46.53	**119.52**	46.34	**119.33**	79	MV AAQO and CAAQS
	Annual	25.0	2.23	**27.19**	1.77	**26.73**	1.47	**26.43**	1.41	**26.37**	1.41	**26.37**	22.6	MV AAQO

Notes: *D1HM – Daily 1-Hour Maximum; MV AAQO – Metro Vancouver Air Quality Objectives; BC AAQO – BC Ambient Air Quality Objectives; CAAQS – Canadian Ambient Air Quality Standards,*

[1] 98th Percentile except for all annual averages and 1-hour SO_2 (99th percentile), according to the BC Air Quality Dispersion Modelling Guideline.

[2] There is also a planning annual objective goal of 6 µg/m³.

[3] Under Guidance for NO_2 Dispersion Modelling in British Columbia (BC ENV, 2022b), ambient NO_2 background is added to the model results *after* they are converted to NO_2.

[4] Values that exceed the applicable objectives are shown in bold text**.**

Table E-2: Maximum predicted concentrations for Metals, VOCs and other non-CAC substances for all scenarios, over the study area

Air Contaminant	Averaging Period	Background (µg/m³) [1]	Maximum Predicted Concentrations under Various Scenarios (µg/m³)										Ambient Objective (µg/m³)	Jurisdiction of Objectives
			Current OC		Proposed OC		Current Operations		Startup		Shutdown			
			Without Background	With Background	Without Background	With Background	Without Background	With Background	Without Background	With Background	Without Background	With Background		
Hydrogen Chloride (HCl)	1-hour	2.1	**139.3**	**141.4**	**113.9**	**116.0**	**103.4**	**105.4**	**84.1**	**86.2**	**89.7**	**91.7**	*75*	AAAQO
Hydrogen Fluoride (HF)	1-hour	N/A	2.5	2.5	1.3	1.3	0.1	0.1	0.1	0.1	0.1	0.1	*4.9*	AAAQO
Total Dioxins and Furans (as PCDD/F TEQ)	24-hour	N/A	1.95E-08	1.95E-08	1.46E-08	1.46E-08	1.38E-10	1.38E-10	7.06E-10	7.06E-10	1.96E-10	1.96E-10	0.1	Ontario AAQC
Cadmium (Cd)	24-hour	N/A	1.71E-03	1.71E-03	1.71E-03	1.71E-03	3.41E-05	3.41E-05	2.97E-05	2.97E-05	5.16E-05	5.16E-05	*0.025*	Ontario AAQC
	Annual	N/A	1.34E-04	1.34E-04	1.34E-04	1.34E-04	3.18E-06	3.18E-06	2.80E-06	2.80E-06	4.89E-06	4.89E-06	*0.005*	Ontario AAQC
Mercury (Hg)	24-hour	N/A	4.88E-03	4.88E-03	3.66E-03	3.66E-03	1.72E-05	1.72E-05	3.97E-05	3.97E-05	4.99E-05	4.99E-05	*2*	Ontario AAQC
Sum of Lead (Pb), Arsenic (As), Chromium (Cr)	1-hour	N/A	1.62E-01	1.62E-01	1.52E-01	1.52E-01	1.01E-02	1.01E-02	8.64E-03	8.64E-03	8.54E-03	8.54E-03	*1.5*	AAAQO
Lead (pb)	1-hour	N/A	-	-	1.22E-01	1.22E-01	4.12E-03	4.12E-03	3.88E-03	3.88E-03	3.31E-03	3.31E-03	*1.5*	AAAQO
Arsenic (As)	1-hour	N/A	-	-	2.28E-02	2.28E-02	1.54E-03	1.54E-03	1.59E-03	1.59E-03	1.33E-03	1.33E-03	*0.1*	AAAQO
	Annual	N/A	-	-	1.73E-04	1.73E-04	1.39E-05	1.39E-05	1.44E-05	1.44E-05	1.21E-05	1.21E-05	*0.01*	AAAQO
Chromium (Cr)	1-hour	N/A	-	-	1.01E-01	1.01E-01	4.44E-03	4.44E-03	3.17E-03	3.17E-03	3.91E-03	3.91E-03	*1*	AAAQO
Polycyclic Aromatic Hydrocarbons (PAHs) [3]	24-hour	N/A	**1.22E-03**	**1.22E-03**	**3.22E-04**	**3.22E-04**	2.90E-05	2.90E-05	2.88E-05	2.88E-05	**7.63E-05**	**7.63E-05**	5.0E-05	Ontario AAQC
	Annual	N/A	**9.59E-05**	**9.59E-05**	**2.53E-05**	**2.53E-05**	2.70E-06	2.70E-06	2.72E-06	2.72E-06	7.24E-06	7.24E-06	1.0E-05	Ontario AAQC
Polychlorinated Biphenyls (PCBs)	24-hour	N/A	2.44E-04	2.44E-04	9.08E-05	9.08E-05	1.65E-06	1.65E-06	1.10E-06	1.10E-06	1.10E-06	1.10E-06	*0.15*	Ontario AAQC
	Annual	N/A	1.92E-05	1.92E-05	7.14E-06	7.14E-06	1.54E-07	1.54E-07	1.04E-07	1.04E-07	1.04E-07	1.04E-07	*0.035*	Ontario AAQC

Notes: AAAQO – Alberta Environment and Parks Ambient Air Quality Objectives (adopted from Texas); Ontario AAQC – Ontario Ambient Air Quality Criteria (Health Limiting Effect)

[1] Values that exceed the applicable objectives are shown in bold text.

[2] A background value of "NA" indicates no monitoring data available for that contaminant. In this case, a background value of zero (0) has been assumed for modelling purposes.

[3] These criteria are for benzo(a)pyrene as a surrogate for total PAHs, however as the OC only limits the total PAHs and not the individual PAH components, the total PAH concentrations were compared with these criteria, conservatively.

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APPENDICES

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Appendix B: CALMET & CALPUFF – Model Settings
Appendix C: Concentration Contours and Exceedance Plots

VERSION HISTORY

Index	Date	Pages	Author(s)
DRAFT	July 24, 2026	All	Jeff Lundgren M.Sc.
DRAFT Rev 1	August 7, 2026	All	Golnoosh Bizhani, Ph.D.
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DRAFT Rev 3	August 28, 2026	All	Golnoosh Bizhani, Ph.D.
DRAFT Rev 4	September 11, 2026	All	Golnoosh Bizhani, Ph.D.
Final	September 22, 2026	-	-

REPORT SIGNATURES

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1 INTRODUCTION

The Metro Vancouver Waste-to-Energy Facility ("the Facility") is located at 5150 Riverbend Drive in Burnaby, British Columbia (BC), and combusts municipal solid waste. The Facility is owned and operated by the Greater Vancouver Sewerage and Drainage District and is regulated under BC Ministry of Environment and Parks (ENV) Operational Certificate 107051 ("the Current OC"), most recently amended on September 23, 2025. The Current OC authorizes and limits the discharge of contaminants from three separate mass burn incinerators/boilers (the "Boilers") from a common support stack containing three individual flues (the "Boiler Stack").

Under the amended OC issued September 23, 2025, a Public Health Risk Assessment (PHRA) must be completed in consultation with Vancouver Coastal and Fraser Health. An air dispersion modelling assessment was completed to support the PHRA, and to inform the development of proposed emission limits, as also required to support a proposed amended OC ("the Proposed OC"). A companion report prepared by Ollson Environmental Health Management addresses the PHRA component.

The assessment evaluates both Facility-only and cumulative concentrations (where applicable through the inclusion of ambient background concentrations) to support comparison with relevant air quality objectives and standards.

Predicted ambient concentrations of criteria air contaminants (CACs), metals, volatile organic compounds (VOCs) and other contaminants were assessed in this air quality study. The CACs of interest include: particulate matter with particle diameter of less than 2.5 µm ($PM_{2.5}$), carbon monoxide (CO), sulphur dioxide (SO_2), and nitrogen oxides (NO_X). The metals, VOCs and other contaminants of interest in this study are: hydrogen chloride (HCl), hydrogen fluoride (HF), total dioxins and furans, cadmium (Cd), mercury (Hg), lead (Pb), arsenic (As), Chromium (Cr), the sum of lead (Pb), arsenic (As) and chromium (Cr), chlorophenols, chlorobenzenes, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs). Note that the current OC has emission limits for total particulate matters (TPM), and consequently stack tests report TPM and not $PM_{2.5}$. To be more conservative, all emissions of TPM were assumed to be $PM_{2.5}$, and modelling was only performed for $PM_{2.5}$, as it has the more stringent objective compared to TPM and PM_{10}.

The air dispersion modelling was completed in accordance with the BC Air Quality Dispersion Modelling Guideline (ENV, 2022a, "the Guideline") using the CALMET/CALPUFF modelling system. A detailed modelling plan was developed in collaboration with and approved by the relevant regulatory agencies and health authorities prior to commencement of the assessment.

Air dispersion modelling was performed using the CALMET/CALPUFF modelling system over a 50 km by 50 km study area. Five scenarios were assessed in this study: one representing maximum permitted operations under the current OC; one representing maximum permitted operations under the proposed OC; one representing current typical operations; one including a boiler startup; and one including a boiler shutdown.

Predicted concentrations for all modelled scenarios were compared with applicable ambient air quality objectives and standards where available. Additional modelling results including ambient air concentrations and deposition rates were also provided to Ollson Environmental Health Management as input for the updated PHRA.

1.1 Project Operations, Emission Sources and Modelled Scenarios

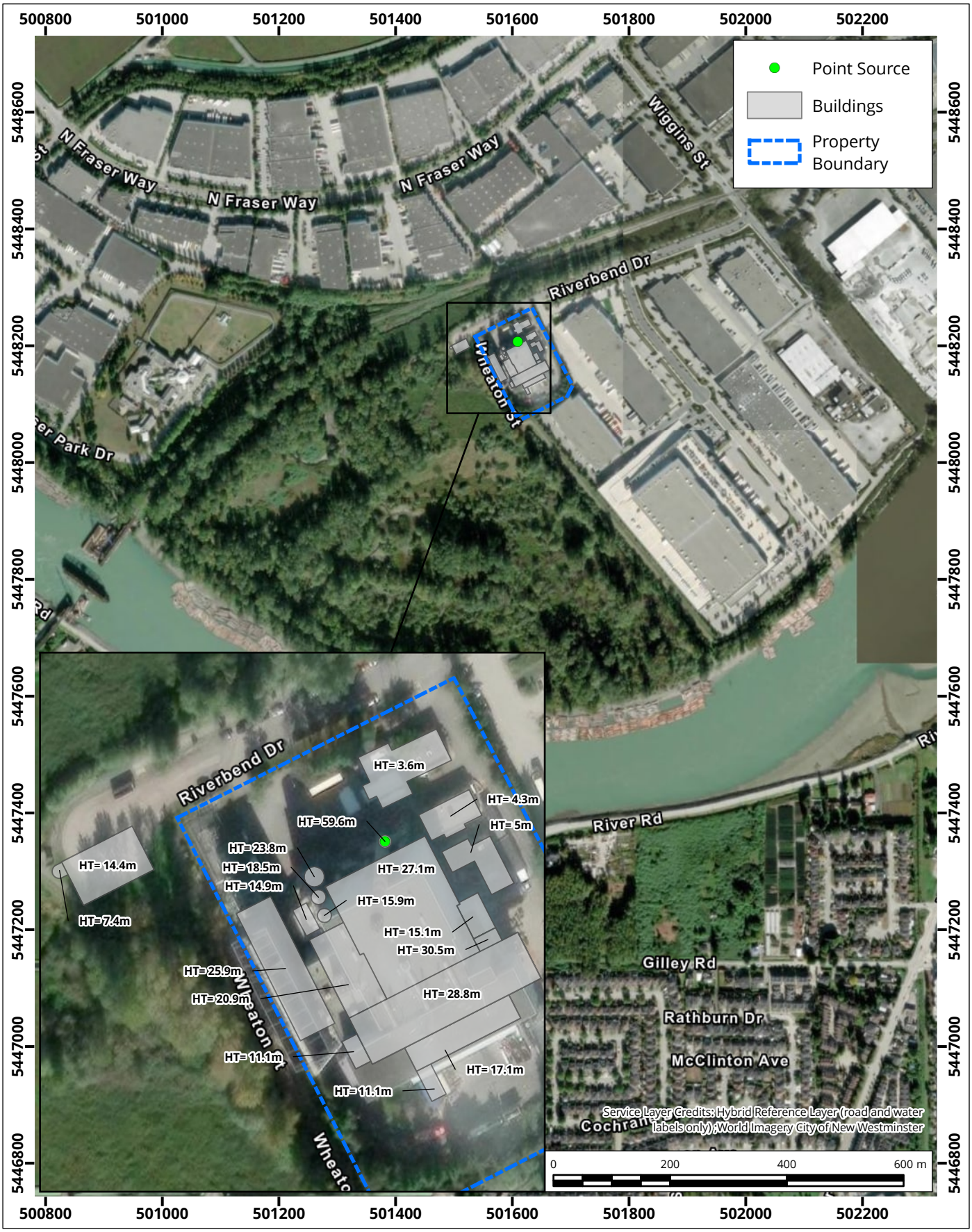
The Facility is permitted to incinerate a maximum of 310,000 tonnes waste (wet weight) per year. The authorized discharge period is continuous. Emissions from the waste incineration are discharged through the Boiler Stack. The Facility location, surrounding area, prominent nearby buildings, and the Boiler Stack are shown in **Figure 1-1**.

Five scenarios were assessed for this study:

- **Current OC Scenario:** Continuous emissions at current limits prescribed in the current OC were considered in this scenario. As the facility does not typically emit at permitted limits, this scenario represents a conservative emissions scenario under the current OC.
- **Proposed OC Scenario:** Continuous emissions at the Proposed OC limits were considered in this scenario. As the facility will not typically emit at permitted limits, this scenario represents a conservative future emissions scenario.
- **Current Operations Scenario:** Typical emissions from recent continuous emissions monitoring systems (CEMS) and stack test data, where available, were used to develop emission rates for this scenario.

  Even though this scenario is more realistic than the Current OC Scenario, the Operations Scenario is still considered conservative as it included the Boilers as continuous sources.
- **Startup Scenario:** This scenario considered emissions from one boiler starting up added to normal operation of the other two boilers as defined in the Current Operations Scenario. A series of stack tests of a boiler starting up were completed from November 28-30, 2017 (A. Lanfranco, 2017) to obtain emission rates for this scenario. Emission rates for contaminants of interest that were not included in the stack test were obtained from CEMS data during known start up times.

  The boiler starting up was modelled as a constant point source representing the maximum emissions measured during testing. Because a start up is a transient condition that in reality will always blend back into normal operations, model predictions from this scenario will always be greater than or equal to concentrations from the Current Operations Scenario.
- **Shutdown Scenario**: This scenario considered emissions from one boiler shutting down added to normal operation of the other two boilers as defined in the Current Operations Scenario. A series of stack tests of a boiler shutting down were completed from November 28-30, 2017 (A. Lanfranco, 2017) to obtain emission rates for this scenario. Emission rates for pollutants of interest that were not included in the stack test were obtained from CEMS data during known shut down times.



Facility Location, Modelled Buildings and Sources

True North

Map Projection: NAD 1983 UTM Zone 10N

Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

Project #: 2600812

Drawn by: PIP	Figure: 1-1
Approx. Scale:	1:9,000
Date Revised: Sep 22, 2026	

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx

2 METHODOLOGY

The air dispersion modelling study was conducted using the CALMET-CALPUFF dispersion modelling suite (Version 7) which is the recommended model under the Guideline for studies of this type. A detailed modelling plan was developed in consultation with and approved by the ENV. The model plan is provided in **Appendix A**. Details about the modelling are presented in this section.

2.1 Contaminants and Ambient Air Quality Objectives

This study focuses on contaminants for which there are ambient air quality criteria. Ambient air quality objectives (AAQOs) are developed by environment and health authorities. These objectives are based on scientific studies that consider the influence of the contaminant on such receptors as humans, wildlife, vegetation, as well as aesthetic qualities such as visibility. Where there are no MV or BC ENV air quality objectives, objectives from other jurisdictions (Ontario and Alberta) were considered. All the AAQOs and the source jurisdiction that were considered in this study are listed in **Table 2-1**. Note that statistical metrics prescribed by the criteria may differ from those used to calculate model results. This approach was taken to maintain consistency across the study, while preserving the original intent of each metric.

Table 2-1: Ambient Air Quality Objectives

Air Contaminant	Averaging Period	Criteria [1] (µg/m³)	Jurisdiction of Other Criteria	Statistical Metric Used for Modelling [2]
Total Particulate Matter (TPM) [3]	24-hour	120	BC Ambient Air Quality Objectives (BC AAQO)	--
	Annual	60	BC AAQO	--
Particulate Matter Less than or Equal to 10 Microns (PM_{10}) [3]	24-hour	50	Metro Vancouver Ambient Air Quality Objective (MV AAQO)	--
	Annual	20	MV AAQO	--
Particulate Matter Less than or Equal to 2.5 Microns ($PM_{2.5}$)	24-hour	25	MV AAQO	98th percentile 24-hour block averages in each year, maximum over 2019-2023
	Annual	8 (6) [4]	MV AAQO	Annual average of hourly concentrations over one year, maximum over 2019-2023
Carbon Monoxide (CO)	1-hour	14,900	MV AAQO	Maximum of 1-hour concentrations over 2019-2023
	8-hour	5,700	MV AAQO	Maximum of 8-hour block averages over 2019-2023
Hydrogen Chloride (HCl)	1-hour	75	Alberta Environment and Parks Ambient Air Quality Objectives (AAAQO)	Maximum of 1-hour concentrations over 2019-2023
Hydrogen Fluoride (HF)	1-hour	4.9	AAAQO	Maximum of 1-hour concentrations over 2019-2023

Air Contaminant	Averaging Period	Criteria [1] ($\mu g/m^3$)	Jurisdiction of Other Criteria	Statistical Metric Used for Modelling [2]
Sulphur Dioxide (SO_2)	1-hour	170	Canadian Ambient Air Quality Standards (CAAQS)	Maximum of [99th percentile of D1HM concentration in each year, averaged over each three-year period (2019-2021; 2020-2022; 2021-2023)]
	1-hour	183	MV AAQO	Maximum of 1-hour concentrations over 2019-2023
	Annual	10.5	MV AAQO	Annual average of hourly concentrations over one year, maximum over 2019-2023
Nitrogen Oxides (NO_x) (Objective for NO_2)	1-hour	79	MV AAQO	Maximum of [98th percentile of D1HM concentration in each year, averaged over each three-year period (2019-2021; 2020-2022; 2021-2023)]
	Annual	22.6	MV AAQO	Annual average of hourly concentrations over one year, maximum over 2019-2023
Total Dioxins and Furans (as PCDD/F TEQ)	24-hour	0.1 (pg TEQ/m^3)	Ontario Ambient Air Quality Criteria (Health Limiting Effect) (Ontario AAQC)	Maximum of 24-hour block average values over 2019-2023
Cadmium (Cd)	24-hour	0.025	Ontario AAQC	Maximum of 24-hour block average values over 2019-2023
	Annual	0.005	Ontario AAQC	Maximum of annual averages over 2019-2023
Mercury (Hg)	24-hour	2	Ontario AAQC	Maximum of 24-hour block average values over 2019-2023
Lead (Pb)	1-hour	1.5	AAAQO	Maximum of hourly Concentrations over 2019-2023
Arsenic (As)	1-hour	0.1	AAAQO	Maximum of hourly Concentrations over 2019-2023
	Annual	0.01	AAAQO	Maximum of annual averages over 2019-2023

Air Contaminant	Averaging Period	Criteria [1] (µg/m³)	Jurisdiction of Other Criteria	Statistical Metric Used for Modelling [2]
Chromium (Cr)	1-hour	1	AAAQO	Maximum of hourly Concentrations over 2019-2023
Sum of Pb, As and Cr	1-hour	1.5	AAAQO for Lead is used	Maximum of hourly Concentrations over 2019-2023
Chlorophenols	--	--	(Assessed in PHRA)	--
Chlorobenzenes	--	--	(Assessed in PHRA)	--
Polycyclic Aromatic Hydrocarbons (PAHs) [5]	24-hour	0.00005	Ontario AAQC	Maximum of 24-hour block average values over 2019-2023
	Annual	0.00001	Ontario AAQC	Maximum of annual averages over 2019-2023
Polychlorinated Biphenyls (PCBs)	24-hour	0.15	Ontario AAQC	Maximum of 24-hour block average values over 2019-2023
	Annual	0.035	Ontario AAQC	Maximum of annual averages over 2019-2023

Notes:

[1] If there are no Metro Vancouver or BC objectives for the air contaminant to be modelled, then criteria from other jurisdictions (e.g., Alberta, Ontario) have been used to put predicted ambient contaminant concentrations in perspective.

[2] Statistical metrics prescribed by the criteria may differ from those used to calculate model results. This approach maintains framework consistency while preserving the original intent of each metric. Block averages are calculated over non-overlapping intervals (e.g., 365 24-hour average values per year), as opposed to rolling averages that use a continuous sliding window (e.g., a 24-hour average recalculated every hour).

[3] For modelling, all particulate matter was conservatively assumed to be $PM_{2.5}$. Only $PM_{2.5}$ was modelled as it has more stringent criteria compared to TPM and PM_{10}.

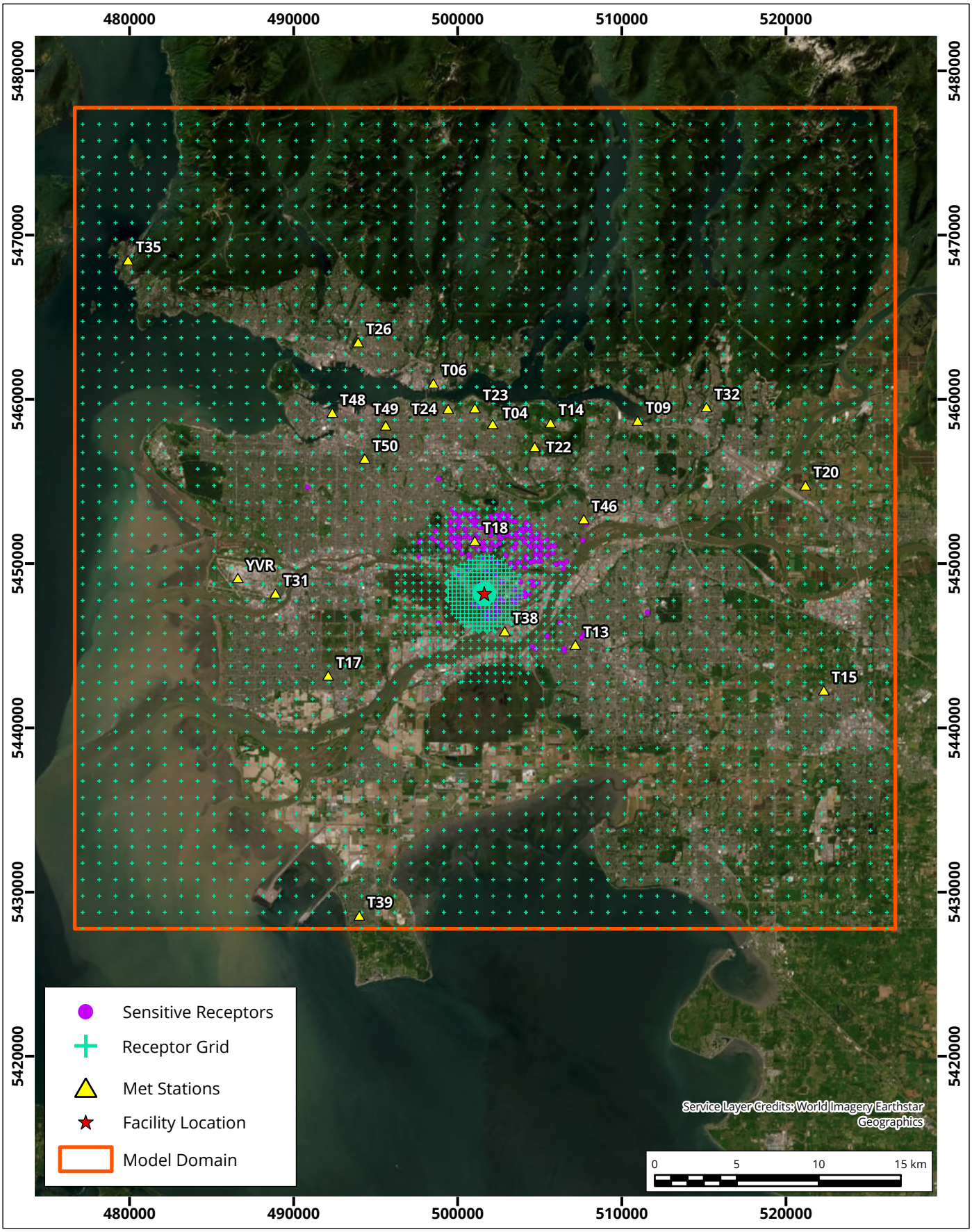
[4] Metro Vancouver's annual $PM_{2.5}$ planning goal of 6 µg/m³ is a longer term aspirational target to support continuous improvement.

[5] These criteria are for benzo(a)pyrene as a surrogate for total PAHs, however as the OC only limits the total PAHs and not the individual PAH components, the total PAH concentrations were compared with these criteria, conservatively.

2.2 Spatial and Temporal Boundaries

The Facility is located on complex terrain and is within 0.5 km of the Fraser River. Due to the surrounding land use cover and terrain, complex flow needed to be considered for this air quality assessment. Modelling was performed on a 50 km by 50 km study area around the Facility, as illustrated in **Figure 2-1**. A zoomed in image of the surrounding area is illustrated in **Figure 2-2.** The study area is slight offset to the North and West (the facility is not in the exact middle). This was done to avoid including the United States in the study area, and to have more of the domain over the eastern Fraser Valley where populations reside and less over the open water to the west. Any potential air quality effects from the Boilers are expected to occur within this study area.

Five years of hourly meteorological data was used, from January 1, 2019 to December 31, 2023, as included in the approved modelling plan. The meteorological data inputs to the model consists of observations made at several MV weather stations within the study area, and three-dimensional outputs from the BC ENV province wide Weather Research and Forecasting (WRF) mesoscale meteorological simulations that are recommended by the Guideline for use in CALMET.



Study Area, Receptors, and Meteorological Stations used for Dispersion Modelling

True North

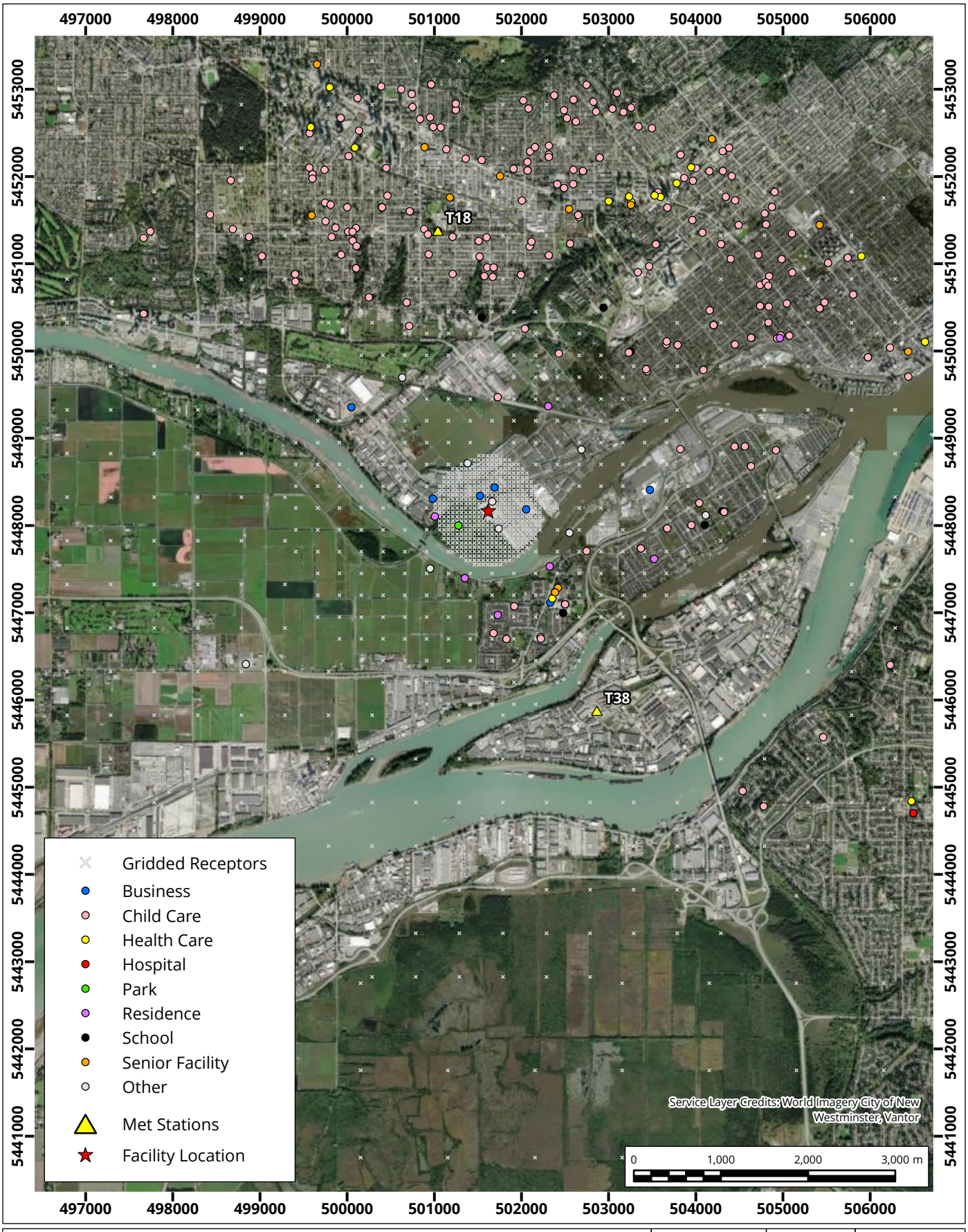
Map Projection: NAD 1983 UTM Zone 10N

Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

Project #: 2600812

Drawn by: PIP	Figure: 2-1
Approx. Scale:	1:320,000
Date Revised:	Sep 22, 2026

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Receptors and Meteorological Stations within 5km of Facility used for Dispersion Modelling

True North

Map Projection: NAD 1983 UTM Zone 10N

Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

Project #: 2600812

Drawn by: PIP	Figure: 2-2
Approx. Scale:	1:60,000
Date Revised: Sep 22, 2026	

Map Document: C:\Work\ingFolder\Jobs_AMER\P2600812\P2600812.aprx

2.3 Emission Estimation

The three boilers are the emissions sources that must be assessed under the OC. Representative values from the OC, stack tests, and CEMS data were used to model the Boiler Stack for the various scenarios. The methodology for each scenario is described in this section.

Five scenarios were assessed in this study, one representing maximum permitted operations under the current OC; one representing maximum permitted operations under the proposed OC, one representing typical operations, one representing typical operations with one boiler starting up, and one representing typical operations with one boiler shutting down.

Note that the OC has a limit for TPM. No limit for PM_{10} or $PM_{2.5}$ are stated in the OC. Consequently, stack tests only measure TPM. As a conservative assumption, all PM was assumed to be $PM_{2.5}$, and only $PM_{2.5}$ was modelled.

No adjustments were made to the emissions for any of the averaging periods (e.g., the same emission rate was used for the 1-hour results as the annual results).

As no size fraction data were available, all particulate matter was assumed to be $PM_{2.5}$.

The emission rates are summarized in **Table 2-2**.

Table 2-2: Emission Rates for Each Scenario

Pollutant	Total Emission Rate for Combined Operations (g/s) [1]				
	Current OC	Proposed OC	Current Operations	Startup	Shutdown
$PM_{2.5}$ [2]	0.65	0.65	0.06	0.05	0.05
Carbon Monoxide (CO)	3.60	3.60	1.54	1.83	4.00
Hydrogen Chloride (HCl)	3.96	3.24	2.91	2.37	2.53
Hydrogen Fluoride (HF)	0.07	3.60E-02	3.60E-03	3.41E-03	2.55E-03
Sulphur Dioxide (SO_2)	14.40	8.64	3.88	3.81	2.98
Oxides of Nitrogen (NO_X) as expressed in Nitrogen Dioxides	13.68	10.80	7.44	7.09	7.04
Total Dioxins and Furans (as PCDD/F TEQ)	5.76E-09	4.32E-09	4.03E-11	2.06E-10	5.73E-11
Cadmium (Cd)	5.04E-04	5.04E-04	9.99E-06	8.67E-06	1.51E-05
Mercury (Hg)	1.44E-03	1.08E-03	5.04E-06	1.16E-05	1.46E-05
Sum of Lead (Pb), Arsenic (As), Chromium (Cr)	4.61E-03	4.32E-03	2.85E-04	2.44E-04	2.41E-04
Lead (Pb)	-	3.46E-03	1.16E-04	1.09E-04	9.33E-05
Arsenic (As)	-	6.48E-04	4.35E-05	4.47E-05	3.74E-05
Chromium (Cr)	-	2.88E-03	1.25E-04	8.92E-05	1.10E-04
Chlorophenols	7.20E-05	2.16E-05	1.44E-07	3.89E-06	2.05E-06
2,4,6-Trichlorophenol (Trichlorophenols as surrogate)	-	-	8.17E-07	1.83E-06	1.09E-06
2,3,4,6-Tetrachlorophenol (Tetrachlorophenols as surrogate)	-	-	8.17E-07	1.02E-06	7.70E-07
Pentachlorophenol	-	-	8.17E-07	4.91E-06	2.96E-06
Chlorobenzenes	7.20E-05	7.20E-05	2.08E-06	3.05E-05	4.08E-05
1,2-Dichlorobenzene (Trichlorobenzenes as surrogate)	-	-	2.14E-06	1.80E-05	2.75E-05
1,2,4-Trichlorobenzene (Trichlorobenzenes as surrogate)	-	-	2.14E-06	1.80E-05	2.75E-05
1,2,4,5-Tetrachlorobenzene (Tetrachlorobenzenes as surrogate)	-	-	9.79E-07	1.36E-05	1.14E-05

Pollutant	Total Emission Rate for Combined Operations (g/s) [1]				
	Current OC	Proposed OC	Current Operations	Startup	Shutdown
Pentachlorobenzene	-	-	8.17E-07	3.72E-06	4.33E-06
Hexachlorobenzene	-	-	1.63E-07	8.23E-07	5.69E-07
Polycyclic Aromatic Hydrocarbons (PAHs)	3.60E-04	9.50E-05	8.49E-06	8.42E-06	2.23E-05
Benz[a]anthracene	-	-	3.27E-07	3.08E-07	3.08E-07
Benzo[a]pyrene	-	-	1.64E-07	1.55E-07	2.03E-07
Benzo[b]fluoranthene	-	-	4.05E-07	3.15E-07	3.15E-07
Benzo[j]fluoranthene, Benzo[b]fluoranthene as surrogate	-	-	4.05E-07	3.15E-07	3.15E-07
Benzo[k]fluoranthene	-	-	5.99E-07	4.45E-07	4.45E-07
Chrysene	-	-	3.27E-07	3.08E-07	3.08E-07
Dibenz[a,h]anthracene	-	-	1.63E-07	1.54E-07	1.55E-07
Benzo[g,h,i]perylene	-	-	1.31E-06	1.01E-06	1.04E-06
Indeno[1,2,3-c,d]pyrene	-	-	1.65E-07	1.55E-07	1.55E-07
Naphthalene	-	-	4.96E-05	6.41E-05	8.90E-05
Polychlorinated Biphenyls (PCBs)	7.20E-05	2.68E-05	4.82E-07	3.22E-07	3.22E-07

Note:

[1] The emission rates shown in this table represent combined emissions from all three boilers emitted through the Boiler Stack.

[2] All PM was assumed to be $PM_{2.5}$.

2.3.1 Current OC Scenario

The current limits enforced in the OC were considered in this scenario. A Discharge Limit that was in effect as of September 23, 2025 was used, otherwise the Interim Discharge Limit was used. These limits and the maximum combined flow rate in the current OC (72 m^3/s) were evenly distributed among the three Boilers. The Boilers were modelled as a single point source with constant emission rates.

No adjustments were made to the emissions for any of the averaging periods (e.g., the same emission rate was used for the 1-hour results as the annual results). As the facility does not typically emit at full capacity, this scenario represents a conservative emissions scenario.

2.3.2 Proposed OC Scenario

The proposed limits for a proposed amended OC were considered in this scenario. All contaminants with the exception of particulate matter, CO, cadmium and Chlorobenzenes have reduced discharge limits. There are additional individual limits for lead, arsenic and chromium as well. The Boilers were modelled as a single point source with constant emission rates. The maximum combined flow rate in the current OC (72 m^3/s) were evenly distributed among the three Boilers.

No adjustments were made to the emissions for any of the averaging periods (e.g., the same emission rate was used for the 1-hour results as the annual results). As the facility is not expected to typically emit at full capacity, this scenario represents a conservative emissions scenario.

2.3.3 Current Operations Scenario

Typical emissions from recent continuous emissions monitoring systems (CEMS) and stack test data conducted by A. Lanfranco & Associates Inc., where available, were considered in this scenario:

- For CO, NO_X, and SO_2: The median of hourly emission rates based on 2025 CEMS data was used.
- For PM and metals, and HF: Average of emission rates based on quarterly stack tests from 2024-2025 were used.
- For all other contaminants: Average of emission rates based on stack tests from 2025 were used.

Where a contaminant of interest was not detected in a stack test, the detection limit was used in lieu of other data. This scenario is more realistic than the Current and Proposed OC Scenarios; however, the Current Operations Scenario is still conservative as it includes the Boilers as continuous sources.

2.3.4 Startup and Shutdown Scenarios

These scenarios represent typical periods when one boiler is undergoing startup or shutdown. Emission rates for these conditions were developed using data from a series of stack tests conducted between November 28 and 30, 2017 (A. Lanfranco, 2017).

For pollutants not included in the stack testing program, emission rates were derived from CEMS data collected during documented startup and shutdown events in 2017. The emissions data were obtained from the Startup/Shutdown Test Report prepared by HDR (HDR, 2018).

For modelling purposes, a boiler undergoing startup or shutdown was represented as a constant point source operating at the maximum measured emission rate at all times. For the combined stack under the startup and shutdown scenarios, emission rates of one boiler from starting up or shutting down event were combined with two boilers from the typical operations as described under Current Operations Scenario.

Since the startup and shutdown events are temporary and ultimately return to normal operations, the maximum short-term concentrations predicted for these scenarios (e.g., the annual maximum 1-hour concentration) are inherently equal to or greater than those predicted under the Current Operations Scenario. Normal operation of the other two boilers is defined in the Current Operations Scenario.

2.4 Dispersion Modelling

Dispersion modelling was conducted for each of the five emission scenarios described above. The dispersion modelling methodology is consistent with the Guideline. A detailed dispersion modelling plan was developed in consultation with and approved by the BC ENV. The model plan is provided in **Appendix A**.

As the topography around the Facility is spatially varied, resulting in complex wind flow patterns, a refined dispersion model, capable of simulating complex wind flow patterns was selected. Specifically, the CALPUFF model in full three-dimensional CALMET mode was used. CALMET is a meteorological pre-processor that develops hourly three-dimensional meteorological fields of wind and temperature used to drive pollutant transport and dispersion within CALPUFF. CALPUFF is a multi-layer, multi-species, non-steady-state puff dispersion model. It simulates the influences of time- and space-varying meteorological conditions on pollutant transport, transformation and deposition. CALPUFF was used to predict ambient concentrations for the pollutants of interest in this study. CALPUFF was also used to predict deposition rates for the PHRA.

Two separate runs of CALPUFF were carried out. For ambient concentration results, dry deposition and wet deposition were disabled for all pollutants to be more conservative. For deposition rate results provided for the PHRA, dry deposition and wet deposition were enabled for all pollutants.

2.4.1 CALMET

A 50 km x 50 km model domain approximately centred on the Facility was used for CALMET and CALPUFF. Grid cells were spaced at 250 m.

CALMET (version 6.5.0) 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 observations at multiple meteorological stations, as well as prognostic meteorological model output (WRF), 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 summary of CALMET model inputs is provided in below. More detailed information is provided in **Appendix B**.

Table 2-3: Summary of CALMET Setup

Parameter	Period of Record (start/end date)
Meteorological Model	CALMET Version 6.5.0
Modeling Period	January 1, 2019 to December 31, 2023
Domain Size	50 km x 50 km, approximately centered on the Project
Grid Resolution	250 m
Vertical Resolutions	10 layers at 20, 40, 80, 160, 300, 600, 1000, 1500, 2200 and 3000 m
Prognostic Data	WRF at 1.33 km resolution, provided by ENV
Surface Meteorology	From Metro Vancouver meteorological network – see Table B.2 of **Appendix B** and **Figure 2-1**
Terrain Elevations	Canadian Digital Elevation Model (at 0.75 arc-second)
Land Cover Data	2020 Land Cover of Canada

The CALMET model performance was assessed by reviewing various model outputs and, where possible, comparing to observations, as per the modelling guideline. This analysis is provided in **Appendix B**.

2.4.2 CALPUFF

The CALMET output (five years of hourly three-dimensional meteorological fields) was used as input to the CALPUFF dispersion model (version 7.2.1). CALPUFF was run over the full CALMET domain (50 km by 50 km study area).

2.4.2.1 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 Guideline. All receptors were modelled at a flagpole height of 1.5 metres above ground for ambient concentrations and at ground level (0 metres above ground) for deposition rates (used in the PHRA).

Receptor spacing for the Cartesian grid is as follows:

- 20-m spacing along the Facility property line;
- 50-m spacing within 500 m of the Facility;
- 250-m spacing within 2 km of the Facility and over all residential areas within the model domain;
- 500-m spacing within 5 km of the Facility; and
- 1,000-m spacing for the remainder of the study area.

In addition to the nested grid, 261 locations were defined as sensitive receptors. Other than the sensitive receptors that were considered in the 2018 air quality assessment for the facility, additional sensitive receptors were identified and included in the model based on input from stakeholders, Metro Vancouver, Vancouver Coastal and Fraser Health Authority and BC ENV. These sensitive receptors include schools, child care facilities, senior care facilities, health care facilities, hospitals, businesses, residences, parks and other sensitive uses such as community centres and farms. The sensitive receptor locations are shown in **Figure 2-1** and **Figure 2-2**.

Terrain elevations for all receptors included as input to the CALPUFF model were extracted from Canadian Digital Elevation Data (https://open.canada.ca/data/en/dataset/7f245e4d-76c2-4caa-951a-45d1d2051333). The 2020 land cover data (https://open.canada.ca/data/en/dataset/ee1580ab-a23d-4f86-a09b-79763677eb47) was used for the geophysical data in CALMET.

2.4.2.2 Technical Dispersion Options

All technical options relating to the CALPUFF dispersion model were set according to the Guideline or to model defaults. These include parameters and options such as the calculation of plume dispersion coefficients, the plume path coefficients used for terrain adjustments, and building downwash methodology. A list of the non-default technical options is included in **Appendix B**.

2.4.2.3 Particle Size and Deposition Parameters

For PM related species (i.e., PM and components thereof), the particle size distributions recommended by the Guideline were used.

A unit emission rate was modelled for VOC and other non-CAC contaminants for the deposition model run.

For deposition results, deposition rates for metals were pro-rated from PM results and deposition rates for VOCs, and other non-CAC contaminant were pro-rated from the generic pollutant with unit emission rate.

2.4.2.4 Point Source Parameters

For all modelled scenarios the Boiler Stack was modelled as a single point source in CALPUFF. There are three openings in the Boiler Stack – one associated with each boiler. For concentration runs with deposition turned off, constant unit emission rate was modelled then concentrations were pro-rated for each contaminant for their respective total Boiler Stack emission rate. For deposition runs, the actual emission rates of SO_2, and PM species were used in the CALPUFF input file. For other contaminants, unit emission rate approach was used.

Stack parameters for the boiler stack including stack height, stack diameter, and exit velocity are summarized for each scenario in **Table 2-4**. Exit temperatures for Current and Proposed OC Scenarios and Current Operations Scenario were taken from stack tests during typical operations. Exit temperatures were determined from the start up and shut down stack tests, then the most conservative value was used for the other scenarios. Stack height and diameter were provided by Metro Vancouver. Stack exit velocities were calculated based on the flow rates, which were taken from the Current OC for both Current and Proposed OC Scenarios, from CEMS data for the Current Operations Scenario, and from the startup and shutdown stack tests for the remaining scenarios.

Table 2-4: Modelled Point Source Stack Parameters for each of the Emission Streams in the Boiler Stack

Model Scenario	Current and Proposed OC	Current Operations	Startup	Shutdown
Stack Height (m)	60.0			
Stack Diameter (m)	1.25			
Exit Flow (Sm^3/s; per boiler)	24.0	18.4	18.3	18.7
Exit Velocity (m/s; per boiler)	28.4	21.8	21.6	21.9
Exit Temperature (°C)	153	153	151.0	147.0
Number of Boilers routed to the Boiler Stack	3 operating at full, permitted capacity	3 operating at typical capacity	3: 2 operating at typical capacity, and 1 starting up	3: 2 operating at typical capacity, and 1 shutting down

2.4.2.5 Building Effects

Buildings located close to stacks may influence the dispersion of emissions. The effect of large buildings and structures that are part of the Facility on the modelled point sources was incorporated using the Building Profile Input Program Plume Rise Model Enhancement (BPIP-PRIME) algorithm. The algorithm explicitly treats the trajectory of the plume near the building and uses the position of the plume relative to the building to calculate interactions with the building wake. On-site building heights were estimated from site plan. The buildings included in the model are shown in **Figure 1-1**.

2.4.2.6 Post-Processing of Model Results

Hourly flagpole-level concentrations were predicted for each emissions scenario run at each receptor. Post-processing of hourly model results was conducted to determine required results for comparison with AAQOs over various averaging periods.

2.4.2.7 Derived Total Modelled Deposition

To calculate total $PM_{2.5}$ deposition flux the POSTUTIL post-processor was used to combine the PM sub- species. The POSTUTIL post-processor was also used to add wet and dry deposition rates together. The CALPOST post-processors were then used to extract required metrics from the resulting binary files.

The maximum results from each of the scenarios were selected for each contaminant, averaging period and receptor.

2.4.2.8 Representative Background Concentrations

The Guideline requires that representative background concentrations be added to concentrations predicted by dispersion modelling to account for other emission sources in the study area.

As per the Guideline, the background concentrations to be added to the maximum predicted concentrations in a Level 3 assessment, such as this one, are determined as follows:

1-Hour averaging period

- SO_2 – use the 99th percentile of daily maximum 1-hour (D1HM) values
- NO_2 – use the 98th percentile of D1HM values
- Other pollutants (in this case, HCl) – use the 98th percentile from the screened hourly data set

24-Hour averaging period

- Use the 98th percentile of 24-hour values from screened data set

Annual average

- Annual mean from the screened or unscreened hourly data set over a year

The methodology used for short term averaging periods 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 and the maximum predicted concentration might only occur once during the modelled period.

For this study, background concentrations for the criteria air contaminants (CACs) and HCl were based on three years (2022 to 2024) of hourly ambient air quality observations from the MV stations including North Delta station (T13), Burnaby South station (T18) and New Westminster station (T46). No screening was performed to exclude data that were impacted by forest fires. Data for NO_2 and $PM_{2.5}$ were available for all these three stations, while CO, SO_2 and HCl concentrations were available at T18 only. The NO_2 data for T46 station in 2024 does not meet the 75% completeness criterion, therefore, only 2022 and 2023 NO_2 data were included for T46. The 98th percentile (except for SO_2) or 99th percentile (for SO_2) of the entire monitoring period was calculated for each short-term background concentration.

The average value of the entire monitoring period was calculated for each annual background concentration. Block averages were used to calculate background for the 8-hour and 24-hour averaging periods, and they were only used if the data were more than 75% complete in each of the 8-hour and 24-hour periods (e.g., 24-hour periods with less than 18 hours of valid data were not included). Block averages are calculated over non-overlapping intervals (e.g., 365 24-hour average values per year), as opposed to rolling averages that use a continuous sliding window (e.g., a 24-hour average recalculated every hour). Averages of the background concentrations from the three stations were then used to determine the cumulative predictions.

No background was considered for any other contaminants due to the lack of monitoring data.

Table 2-5: Representative Background Concentrations

Air Contaminant	Averaging Period	Background (µg/m³)	Statistical Metrics [1]
PM_{10}	24-hour	23.0	98th percentile of 24-hour block averages
	Annual	8.9	Annual mean of hourly concentrations
$PM_{2.5}$	24-hour	16.2	98th percentile of 24-hour block averages
	Annual	6.3	Annual mean of hourly concentrations
Carbon Monoxide (CO)	1-hour	469.5	98th percentile of hourly concentrations
	8-hour	435.7	98th percentile of 8-hour block averages
Sulphur Dioxide (SO_2)	1-hour	7.1	99th percentile of D1HM concentrations
	Annual	0.8	Annual mean of hourly concentrations
Nitrogen Dioxide (NO_2)	1-hour	73.0	98th percentile of D1HM concentrations
	Annual	25.0	Annual mean of hourly concentrations
HCl	1-hour	2.1	98th percentile of hourly concentrations

Note: [1] Block averages are calculated over non-overlapping intervals (e.g., 365 24-hour average values per year), as opposed to rolling averages that use a continuous sliding window (e.g., a 24-hour average recalculated every hour).

2.4.2.9 NO_X to NO_2 Conversion

According to the BC modelling guideline, the first and most conservative method of estimating NO_2 is to assume 100% conversion of NO_X into NO_2. If a more accurate estimate is desired, the ambient ratio method (ARM2) or the ozone limiting method may be used. The ambient ratio method is recommended in areas where representative NO_X and NO_2 ambient monitoring data are available. For this assessment, ARM2 was used to provide a more realistic estimate for the conversion of NO_X to NO_2 based on the empirically derived conversion formula, which was developed using the ambient hourly NO and NO_2 monitoring data, provided in the Guidance for NO_2 Dispersion Modelling in British Columbia (the NO_2 Guidance - ENV, 2022b). Coefficients for urban sites were selected given the nature of the surroundings of the Project.

Further to the above equation, the NO_2/NO_X ratio is constrained to a maximum value of 0.9 and a minimum value of 0.2, according to the NO_2 Guidance.

Chemical transformations in CALPUFF (e.g., RIVAD scheme with ISORROPIA) were not used to obtain NO_2 from NO_X. The steps to obtain NO_2 are summarized below:

1. Unit emission rates were modelled in CALPUFF to produce generic model concentrations;
   POSTUTIL was used to generate NO_X concentrations using NO_X emission rate;
   NO_X model concentrations were converted to NO_2 using the urban ARM2 curve by the postprocessor CALNO2. This produced NO_2 model concentrations;
2. As required by the NO_2 guidance, ambient background concentrations of NO_2 were added to model concentrations *after* they were converted to NO_2.

3 DISPERSION MODELLING RESULTS

This section describes predicted model concentrations in the study area, and comparisons to applicable AAQOs. Predicted concentrations at maximum point of impingement (MPOI) for all CACs and for all scenarios, with- and without ambient background, are presented in **Table 3-1**. Predicted MPOI concentrations for metals, VOCs and other non-VOC contaminants for all scenarios, with- and without ambient background, are presented in **Table 3-2**.

For all modelled contaminants except CO, the predicted MPOI concentration was associated with the Current OC Scenario. For CO, the highest concentration was expected from the Shutdown Scenario, however, predicted concentrations for all modelled scenarios were below their respective AAQOs.

Note that the available Operational Certificate limits and stack test data report particulate matter only as TPM and do not distinguish between particle size fractions (e.g., PM_{10} or $PM_{2.5}$). Accordingly, all particulate emissions were conservatively assumed to consist entirely of $PM_{2.5}$ for the purposes of this assessment. Under this assumption, the $PM_{2.5}$ predictions represent a conservative assessment of particulate matter impacts; therefore, separate PM_{10} and TPM modelling results are not presented.

Among CACs, the predicted MPOI concentrations including ambient background were below the respective criteria for all contaminants except for 1-hour SO_2 (both metrics), and 1-hour and annual NO_2. Modelling results for SO_2 and NO_x are discussed in greater detail in **Sections 3.1** and **3.2**, respectively.

For metals, VOCs, and other non-CAC contaminants, the predicted MPOI concentrations were below the respective criteria, except for 1-hour HCl and 24-hour and annual PAHs. The predicted concentration of HCl exceeds the 1-hour objective in all scenarios. Modelling results for HCl are discussed further in **Section 3.3**. The predicted concentrations of PAH exceed the 24-hour objective for the Current OC, Proposed OC and Shut Down scenarios, and the annual objective for the Current OC and Proposed OC scenarios. The model results indicate that there will be no exceedances of PAHs under Current Operations scenario. PAH results are discussed further in **Section 3.4**. Note that the PAH criteria are for benzo(a)pyrene as a surrogate for total PAHs, however as the OC only limits the total PAHs and not the individual PAH components, the total PAH concentrations were compared with these criteria, conservatively

Predicted values that are above the applicable AAQOs are highlighted in bold in both tables.

Concentration contours of SO_2, NO_2, $PM_{2.5}$, HCl and PAH as well as the exceedance plots where applicable for all scenarios are provided in **Appendix C.**

As demonstrated in the contour plots, all predicted exceedances (with the exception of NO_2 and PAH) are confined to areas in close proximity to the Facility, and concentrations decrease rapidly with increasing distance from the source. For NO_2, predicted exceedances are mainly attributed to the elevated background concentrations. NO_2 results are discussed further in **Section 3.2**.

It is important to note that the predicted concentrations should be interpreted as conservative estimates of potential air quality impacts. Background concentrations used in the assessment were derived from ambient monitoring data and therefore already include contributions from existing Facility operations, as well as other regional emission sources. Consequently, adding modelled Facility concentrations to these background values likely overestimates actual ambient concentrations. In addition, the conservative assumptions applied in both emissions development and dispersion modelling provide a cautious assessment of potential impacts. This is supported by comparisons with ambient monitoring data at S150, which shows that the measured concentrations were substantially lower than the modelled concentrations for all modelled scenarios. The comparison indicates that the modelling approach provides a conservative representation of air quality conditions and likely overpredicts actual ambient concentrations in the study area. This is further discussed in **Section 3.5.**

Table 3-1: Maximum predicted concentrations for CACs over the study area, for all modelled scenarios

Air Contaminant	Averaging Period	Background (µg/m³) [1]	Maximum Predicted Concentrations under Various Scenarios (µg/m³)										Ambient Objective (µg/m³)	Jurisdiction of Objectives
			Current OC		Proposed OC		Current Operations		Startup		Shutdown			
			Without Background	With Background	Without Background	With Background	Without Background	With Background	Without Background	With Background	Without Background	With Background		
$PM_{2.5}$	24-hour	16.2	0.86	17.11	0.86	17.11	0.09	16.33	0.07	16.31	0.08	16.32	25	MVAAQO
	Annual	6.3	0.17	6.44	0.17	6.44	0.02	6.28	0.02	6.28	0.02	6.28	8 [2]	MVAAQO
Carbon Monoxide (CO)	1-hour	469.5	126.61	596.15	126.61	596.15	54.45	523.99	65.03	534.57	141.90	611.44	14,900	MVAAQO
	8-hour	435.7	36.50	472.20	36.50	472.20	15.70	451.40	18.75	454.45	40.93	476.63	5,700	MVAAQO
Sulphur Dioxide (SO_2)	1-hour	7.1	**506.43**	**513.51**	**303.86**	**310.93**	137.73	144.80	135.32	142.39	105.81	112.89	183	MVAAQO
	99th percentile, D1HM; averaged over 3 consecutive years and then max. over the 3-year averages	7.1	**201.89**	**208.96**	121.13	128.20	60.46	67.53	59.23	66.30	46.46	53.54	170	CAAQS 2025
	Annual	0.8	3.84	4.60	2.30	3.07	1.24	2.00	1.23	1.99	0.97	1.73	10.5	MVAAQO and CAAQS
Oxides of Nitrogen (NO_x) (Assumes 100% Conversion to NO_2; Background and Objectives for NO_2)	98th percentile, D1HM; averaged over 3 consecutive years and then max. over the 3-year averages	73.0	**91.36**	**164.35**	72.19	**145.18**	55.84	**128.83**	53.29	**126.28**	52.88	**125.87**	79 for NO_2	MVAAQO and CAAQS
	Annual	25.0	2.50	**27.46**	1.98	**26.94**	1.63	**26.59**	1.57	**26.53**	1.57	**26.53**	22.6 for NO_2	MVAAQO
Nitrogen Dioxide (NO_2) (Converted from NO_X) [3]	98th percentile, D1HM; averaged over 3 consecutive years and then max. over the 3-year averages	73.0	68.50	**141.49**	59.20	**132.19**	48.41	**121.40**	46.53	**119.52**	46.34	**119.33**	79	MVAAQO and CAAQS
	Annual	25.0	2.23	**27.19**	1.77	**26.73**	1.47	**26.43**	1.41	**26.37**	1.41	**26.37**	22.6	MVAAQO

Notes: *D1HM – Daily 1-Hour Maximum; MVAAQO – Metro Vancouver Air Quality Objectives; BCAAQO – BC Ambient Air Quality Objectives; CAAQS – Canadian Ambient Air Quality Standards*

[1] 98th Percentile except for all annual averages and 1-hour SO_2 (99th percentile), according to the BC modelling guideline.

[2] There is also a planning annual objective goal of 6 µg/m³.

[3] Under Guidance for NO_2 Dispersion Modelling in British Columbia (BC ENV, 2022b) ambient NO_2 background is added to the model results *after* they are converted to NO_2.

[4] Values that exceed the applicable objectives are shown in bold text.

Table 3-2: Maximum predicted concentrations for Metals, VOCs and other non-CAC contaminants for over the study area, for all modelled scenarios

Air Contaminant	Averaging Period	Background (µg/m³) [3]	Maximum Predicted Concentrations under Various Scenarios (µg/m³) [2]										Ambient Objective (µg/m³)	Jurisdiction of Objectives [1]
			Current OC		Proposed OC		Current Operations		Startup		Shutdown			
			Without Background	With Background	Without Background	With Background	Without Background	With Background	Without Background	With Background	Without Background	With Background		
Hydrogen Chloride (HCl)	1-hour	2.1	**139.3**	**141.4**	**113.9**	**116.0**	**103.4**	**105.4**	**84.1**	**86.2**	**89.7**	**91.7**	*75*	AAAQO
Hydrogen Fluoride (HF)	1-hour	N/A	2.5	2.5	1.3	1.3	0.1	0.1	0.1	0.1	0.1	0.1	*4.9*	AAAQO
Total Dioxins and Furans (as PCDD/F TEQ)	24-hour	N/A	1.95E-08	1.95E-08	1.46E-08	1.46E-08	1.38E-10	1.38E-10	7.06E-10	7.06E-10	1.96E-10	1.96E-10	0.1	Ontario AAQC
Cadmium (Cd)	24-hour	N/A	1.71E-03	1.71E-03	1.71E-03	1.71E-03	3.41E-05	3.41E-05	2.97E-05	2.97E-05	5.16E-05	5.16E-05	*0.025*	Ontario AAQC
	Annual	N/A	1.34E-04	1.34E-04	1.34E-04	1.34E-04	3.18E-06	3.18E-06	2.80E-06	2.80E-06	4.89E-06	4.89E-06	*0.005*	Ontario AAQC
Mercury (Hg)	24-hour	N/A	4.88E-03	4.88E-03	3.66E-03	3.66E-03	1.72E-05	1.72E-05	3.97E-05	3.97E-05	4.99E-05	4.99E-05	*2*	Ontario AAQC
Sum of Lead (Pb), Arsenic (As), Chromium (Cr)	1-hour	N/A	1.62E-01	1.62E-01	1.52E-01	1.52E-01	1.01E-02	1.01E-02	8.64E-03	8.64E-03	8.54E-03	8.54E-03	*1.5*	AAAQO for Lead
Lead (pb)	1-hour	N/A	-	-	1.22E-01	1.22E-01	4.12E-03	4.12E-03	3.88E-03	3.88E-03	3.31E-03	3.31E-03	*1.5*	AAAQO
Arsenic (As)	1-hour	N/A	-	-	2.28E-02	2.28E-02	1.54E-03	1.54E-03	1.59E-03	1.59E-03	1.33E-03	1.33E-03	*0.1*	AAAQO
	Annual	N/A	-	-	1.73E-04	1.73E-04	1.39E-05	1.39E-05	1.44E-05	1.44E-05	1.21E-05	1.21E-05	*0.01*	AAAQO
Chromium (Cr)	1-hour	N/A	-	-	1.01E-01	1.01E-01	4.44E-03	4.44E-03	3.17E-03	3.17E-03	3.91E-03	3.91E-03	*1*	AAAQO
Polycyclic Aromatic Hydrocarbons (PAHs) [4]	24-hour	N/A	**1.22E-03**	**1.22E-03**	**3.22E-04**	**3.22E-04**	2.90E-05	2.90E-05	2.88E-05	2.88E-05	**7.63E-05**	**7.63E-05**	*5.0E-05*	Ontario AAQC
	Annual	N/A	**9.59E-05**	**9.59E-05**	**2.53E-05**	**2.53E-05**	2.70E-06	2.70E-06	2.72E-06	2.72E-06	7.24E-06	7.24E-06	*1.0E-05*	Ontario AAQC
Polychlorinated Biphenyls (PCBs)	24-hour	N/A	2.44E-04	2.44E-04	9.08E-05	9.08E-05	1.65E-06	1.65E-06	1.10E-06	1.10E-06	1.10E-06	1.10E-06	*0.15*	Ontario AAQC
	Annual	N/A	1.92E-05	1.92E-05	7.14E-06	7.14E-06	1.54E-07	1.54E-07	1.04E-07	1.04E-07	1.04E-07	1.04E-07	*0.035*	Ontario AAQC

Notes:

[1] *AAAQO – Alberta Environment and Parks Ambient Air Quality Objectives (adopted from Texas); Ontario AAQC – Ontario Ambient Air Quality Criteria (Health Limiting Effect)*

[2] Values that exceed the applicable objectives are shown in bold text.

[3] A background value of "N/A" indicates no monitoring data available for that contaminant. In this case, a background value of zero (0) has been assumed for modelling purposes.

[4] These criteria are for benzo(a)pyrene as a surrogate for total PAHs, however as the OC only limits the total PAHs and not the individual PAH components, the total PAH concentrations were compared with these criteria, conservatively.

3.1 SO_2 Results

Predicted SO_2 concentrations at MPOI are summarized in **Table 3-1**. Contour plots for 99th percentile D1HM SO_2 concentrations for Current and Proposed OC scenarios are shown in **Figure 3-1.**

Additional contour plots are shown in **Appendix C** (**Figures C.1** and **C.3** for Current OC Scenario, **Figures C.14** and **C.15** for Proposed OC Scenario**, Figures C.24** and **C.25** for Current Operations Scenario, **Figure C.31** and **C.32** for Startup Scenario, **Figure C.38** and **C.39** for Shutdown Scenario).

Model predictions for maximum 1-hour SO_2 with ambient concentrations included were within MV AAQO of 183 µg/m^3 under Current Operation, Startup and Shutdown scenarios. Exceedances were predicted in both the Current OC and Proposed OC scenarios. For these scenarios, the predicted concentrations from the Facility alone also exceed the criteria. However, it should be noted that both the Current OC and Proposed OC scenarios are conservative as the Facility was assumed to operate at full capacity throughout the modelling period.

The predicted 99th percentile D1HM SO_2 concentrations with ambient concentrations included, were also below CAAQS of 170 µg/m^3 under Current Operations, Startup and Shutdown and the Proposed OC scenarios. Exceedances were predicted for the Current OC Scenario. The MPOI occurs close to the fenceline and the exceedance zone extends to approximately 370 m to the west of the Facility. For this scenario, the predicted concentration from the Facility alone also exceeds the criteria. However, it should be noted that the Current OC Scenario is conservative as it assumes that the Facility operates at full capacity throughout the modelling period.

As shown in **Figure 3-1**, under the Proposed OC limits, predicted impacts from the Facility are reduced substantially in both magnitude and geographical extent. Under this scenario, exceedances of the 1-hour CAAQS are no longer predicted.

The predicted annual SO_2 concentrations with ambient concentrations included are all below the criteria of 10.5 µg/m^3, with the highest concentrations predicted over the model domain up to 44% of the criteria under the Current OC Scenario.

For SO_2, number of excursions of the 1-hour MV AAQO (i.e., number of hours where the predicted hourly concentration with background at a given receptor is greater than the numerical value of 183 µg/m^3) are provided for each modelled year and for the duration of the modelling period in **Table 3-3**. For the Current OC Scenario, predicted frequencies of excursions are less than 0.2% in 2022, and 0.07% for the duration of modelling period. These are further decreased to 0.07% for 2022 and less than 0.02% for the duration of the modelling period for the Proposed OC Scenario.

Similarly, number of excursions of the 1-hour SO_2 CAAQS (i.e., number of days where the predicted D1HM concentration with background at a given receptor is greater than the numerical value of 170 µg/m^3) are provided for each modelled year and for the duration of the modelling period in **Table 3-4**. Contour plot showing count of excursions is shown in **Figure C.2**. For the Current OC Scenario, predicted frequencies of excursions are less than 5% in 2022, and less than 2% for most of the duration of the modelling period. No excursions are predicted for the Proposed OC Scenario.

Table 3-3 Maximum Number of Excursions of the 1-hour SO_2 MV AAQO of 183 µg/m³ [1,2]

Scenario	2019	2020	2021	2022	2023	2019-2023
Current OC Scenario	4 (0.05%)	3 (0.03%)	1 (0.01%)	17 (0.19%)	6 (0.07%)	26 (0.06%)
Proposed OC Scenario	0 (0%)	1 (0.01%)	0 (0%)	6 (0.07%)	1 (0.01%)	7 (0.02%)

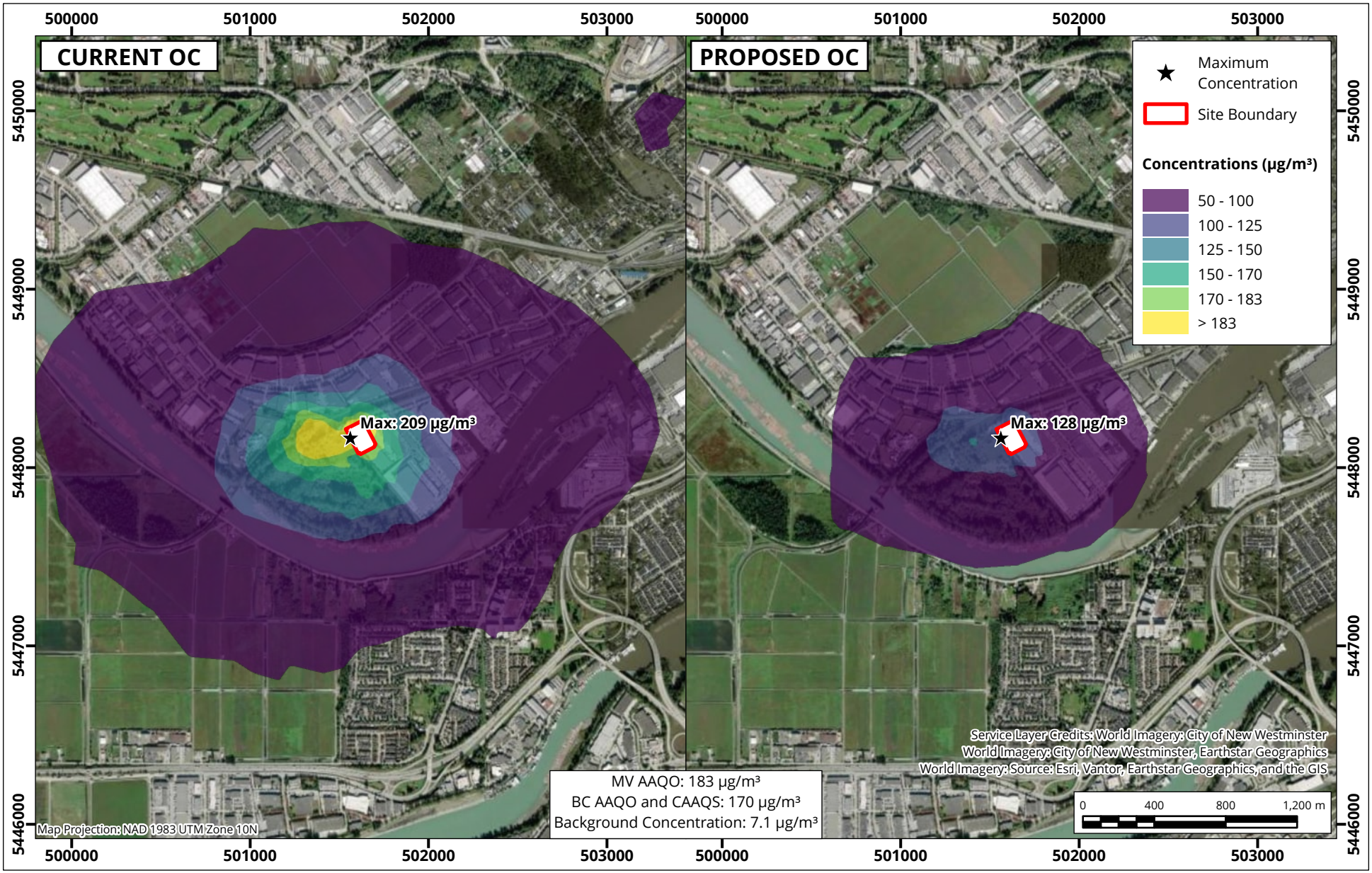
Notes:
[1] Number of excursions: number of hours where the predicted hourly concentration is greater than 183 µg/m³ for a given receptor.
[2] Percentages are calculated by dividing the number of excursions in each year (or the 5-year period) to the number of hours in that year (or 5-year period).

Table 3-4 Maximum Number of Excursions of the 1-hour SO_2 CAAQS of 170 µg/m³ [1,2]

Scenario	2019	2020	2021	2022	2023	2019-2023
Current OC Scenario	6 (1.6%)	3 (0.8%)	1 (0.3%)	15 (4.1%)	5 (1.4%)	24 (1.3%)
Proposed OC Scenario	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Notes:
[1] Number of excursions: number of days where the predicted D1HM concentration is greater than 170 µg/m³ for a given receptor.
[2] Percentages are calculated by dividing the number of excursions in each year (or the 5-year period) to the number of days in that year (or 5-year period).

It should be noted that the assessment was intentionally developed using conservative assumptions for both emissions and dispersion modelling to provide a cautious evaluation of potential air quality impacts. As discussed further in Section 3.5, a comparison of model predictions with ambient monitoring data qualitatively demonstrates the conservatism inherent in the assessment, particularly for short-term predictions. Accordingly, the predicted exceedances for the Current OC and Proposed OC scenarios should be interpreted as indicators of worst potential impacts under conservative assumptions, simultaneous highest allowed emissions and worst dispersion conditions, rather than predictions of the magnitude or frequency of concentrations expected under typical operating conditions. Accordingly, future measured concentrations are expected to remain substantially lower than the model predictions.



Comparison of 1-hour SO_2 Concentrations Current vs. Proposed OC (with Background)

Metric: Maximum of [99th percentile of D1HM concentration in each year, averaged over each three year period (2019-2021; 2020-2022; 2021-2023)]

True North

Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

Project #: 2600812

Drawn by: PIP	Figure: 3-1
Approx. Scale:	1:30,000
Date Revised: Sep 22, 2026	

Map Document: C:\WorkingFolder\Jobs\AMER\P2600812\P2600812.aprx

3.2 NO_2 Results

Predicted NO_2 concentrations at MPOI are summarized in **Table 3-1**. Contour plots are shown in **Appendix C** (**Figures C.4** and **C.6** for Current OC Scenario, **Figures C.16** and **C.18** for Proposed OC Scenario**, Figures C.26** and **C.28** for Current Operations Scenario, **Figures C.33** and **C.35** for Startup Scenario, **Figures C.40** and **C.42** for Shutdown Scenario).

For 1-hour NO_2 (ARM2) results, the predicted 98th percentile D1HM concentrations from Facility emissions alone, were below the MV AAQO of 79 µg/m^3 under all modelled scenarios. When background concentrations were included, the maximum predicted concentrations exceeded the 1-hour MV AAQO objective for all scenarios. The MPOIs occur close to the west of the Facility at a distance of approximately 225 m. It is noteworthy that background concentrations alone (based on 98th percentile of monitored data) account for approximately 92% of the objective, indicating that the predicted exceedances are largely driven by regional background NO_2 levels rather than Facility emissions. Contour plots showing count of excursions for different scenarios are shown in **Figures C.5**, **C.17**, **C.27**, **C.34** and **C.41** for the modelled scenarios.

Similarly, for the annual NO_2 (ARM2), the predicted annual NO_2 concentrations from Facility emissions alone, were well below the MV AAQO of 22.6 µg/m^3 under all modelled scenarios. The predicted maximum annual NO_2 concentrations among all scenarios was only 2.23 µg/m^3, less than 10% of the objective. The annual background concentrations for NO_2 is 25 µg/m^3, already exceeding the objective of 22.6 µg/m^3. Therefore, modelled annual NO_2 concentrations with background exceed the objective over the whole domain for all modelled scenarios.

3.3 HCl Results

Predicted HCl concentrations at MPOI are summarized in **Table 3-2**. Contour plots are shown in **Appendix C** (**Figure C.9** for Current OC Scenario, **Figure C.19** for Proposed OC Scenario**, Figure C.29** for Current Operations Scenario, **Figure C.36** for Startup Scenario, **Figure C.43** for Shutdown Scenario).

The maximum predicted 1-hour HCl both from Facility alone and with ambient concentrations included were above AAAQO of 75 µg/m^3 under all modelled scenarios. The exceedances however are localized and confined to a distance of approximately 470 m from the Facility. The MPOI occurs to the west of the Facility.

The number of excursions of the 1-hour HCl AAAQO (i.e., number of hours where the predicted hourly concentration with background at a given receptor is greater than the numerical value of 75 µg/m^3) are also analyzed and provided for each modelled year and for the duration of the modelling period in **Table 3-5**. Results show that despite the exceedances in all modelled scenarios, the frequency of exceedances is limited to less than 0.1% for all modelled years and scenarios. If the duration of modelling period is considered, the predicted frequencies of excursion remain below 0.03% for all modelled scenarios. Contour plot showing count of excursions are shown in **Figures C.10**, **C.20**, **C.30**, **C.37** and **C.44**, for the modelled scenarios.

Table 3-5 Maximum Number of Excursions of the 1-hour HCl AAAQO of 75 µg/m³ [1,2]

Scenario	2019	2020	2021	2022	2023	2019-2023
Current OC Scenario	0 (0%)	1 (0.01%)	0 (0%)	7 (0.08%)	2 (0.02%)	9 (0.021%)
Proposed OC Scenario	0 (0%)	1 (0.01%)	0 (0%)	5 (0.06%)	1 (0.01%)	6 (0.014%)
Current Operations Scenario	0 (0%)	0 (0%)	0 (0%)	4 (0.05%)	1 (0.01%)	4 (0.009%)
Startup Scenario	0 (0%)	0 (0%)	0 (0%)	2 (0.02%)	0 (0%)	2 (0.005%)
Shutdown Scenario	0 (0%)	0 (0%)	0 (0%)	2 (0.02%)	0 (0%)	2 (0.005%)

Notes:
[1] Number of excursions: number of hours where the predicted hourly concentration is greater than 75 µg/m³ for a given receptor.
[2] Percentages are calculated by dividing the number of excursions in each year (or the 5-year period) to the number of hours in that year (or 5-year period).

3.4 PAH Results

Predicted PAHs concentrations at MPOI are summarized in **Table 3-2**. Contour plots are shown in **Appendix C** (**Figures C.11** and **C.13** for Current OC Scenario, **Figures C.21** and **C.23** for Proposed OC Scenario and **Figure C.45** for Shutdown Scenario).

Note that as the OC only limits the total PAHs and not the individual PAH components, the total PAH concentrations were conservatively compared with the Ontario AAQC for benzo(a)pyrene.

The maximum predicted 24-hour PAHs were above Ontario AAQC of 5.0E-05 µg/m³ for the Current OC, Proposed OC and Shutdown scenarios. For Current OC Scenario, the exceedances extend to over 20 km from the Facility. For the Proposed OC Scenario however, exceedances are limited to approximately 9 km from the Facility. No exceedances are predicted for the Current Operations and Startup scenarios. For the Shutdown scenario, localized exceedances within approximately 560 m from the Facility were predicted. The MPOI locations occur close to the Facility at approximately 20 m from the fenceline for all scenarios.

The predicted annual PAHs concentrations were predicted to be below Ontario AAQC of 1.0E-05 µg/m³ under Current Operation, Startup and Shutdown scenarios. Exceedances predicted for the Current OC and Proposed OC scenarios extend to distances of around 7 km and 2 km from the Facility, respectively. The MPOI locations occur approximately 270 m from the Facility.

The number of excursions of the 24-hour PAHs Ontario AAQC (i.e. number of days where the predicted daily concentration with background at a given receptor is greater than the numerical value of 5.0E-05 µg/m³) are also analyzed and provided for each modelled year and for the duration of the modelling period in **Figures C.12**, **C.22** and **C.46**.

3.5 Comparison of Modelling Results with Monitored Concentrations

As noted above, the predicted concentrations should be interpreted as conservative estimates of potential air quality impacts. The conservative assumptions and methodology applied in both emissions development and dispersion modelling provide a cautious assessment of potential impacts. Moreover, background concentrations used in the assessment were derived from ambient monitoring data and therefore already include contributions from Facility operations.

Consequently, adding modelled facility concentrations to these background values likely overestimates actual future ambient concentrations. This is supported by comparison of model predictions with ambient monitoring data at the fenceline monitoring station, S150, located at the northwestern corner of the facility, as shown in **Table 3-6**.

Note that this comparison does not serve as model performance evaluation as the modelling assessment was not designed or calibrated for that purpose. Rather, it is provided as a qualitative demonstration of the conservatism inherent in the assessment.

Importantly, the differences between the modelled and observed concentrations should not be interpreted as a discrepancy in model performance. The assessment was not designed to reproduce measured concentrations or to evaluate model performance. Rather, it was developed to estimate upper-bound concentrations by combining conservative emission assumptions with worst-case meteorological conditions. Accordingly, differences between modelled and observed concentrations are consistent with the conservative and risk-evaluation nature of the assessment.

Monitoring data from 2021-2022 was analyzed by WSP (WSP, 2024). The WSP report presents For SO_2 and HCl, for 1-hour averaging period, maximum reading over the 2021-2022 period from the WSP report is provided in **Table 3-6**. For 1-hour NO_2, 98th percentile of D1HM in each year, maximum over two years is provided. For 24-hour averaging period maximum of 24-hour averages over the two years is provided. For annual averaging period, maximum of annual average concentration over 2021-2022 is provided in in **Table 3-6**.

Model predictions presented in in **Table 3-6** were extracted for the fenceline receptor closest to the location of S150, for the Current Operations Scenario, using the same statistical metrics shown in **Table 2-1**, and include ambient background concentrations.

Note that model predictions for 1-hour averaging period present the worst-case dispersion conditions at each receptor (in this case, near S150), including rare and extreme meteorological conditions that limit dispersion or direct the plume towards the receptor. These infrequent conditions are unlikely to occur concurrently with the conservative emission rates assumed in the modelling. As a result, the predicted short-term concentrations are substantially higher than the maximum concentrations measured at S150. While predictions for longer averaging periods remain conservative, they are less influenced by short-term meteorological extremes and are therefore more consistent with observed ambient concentrations.

Accordingly, future measured concentrations are expected to remain substantially lower than the model predictions, as the assessment intentionally combines conservative emission assumptions with worst-case meteorological conditions that are unlikely to occur in practice.

Table 3-6 Comparison of Concentrations Measured at S150 and Modelled at the Nearest Receptor (Including Background) [1]

Contaminant	Averaging period	Observed Concentration at S150 (µg/m³) [2]	Modelled Concentration at S150 (µg/m³) [3,4]		
			Current OC	Proposed OC	Current Operations
Sulphur Dioxide (SO_2)	1-Hour	18.1	461	279	130
	Annual	0.6	2.0	1.5	1.1
Nitrogen Dioxide (NO_2) (ARM2)	98th perc. D1HM	92.1	134	125	116
	Annual	26.1	25.6	25.5	25.4
Hydrogen Chloride (HCl)	1-Hour	4.2	127	104	94
	24-Hour	2.6	12.1	10.2	9.4
	Annual	0.6	1.0	0.9	0.9

Notes:

[1] Comparison with observed concentrations is provided to illustrate the conservatism inherent in the assessment and is not a model performance evaluation.

[2] Observed concentrations at Station S150 were obtained from Table 7-1 of WSP Report (WSP, 2024), based on 2021-2022 monitoring data.

[3] Background concentrations (shown in **Table 2-5**) were added to the modelled concentrations.

[4] Statistical metrics for modelled concentrations are presented in **Table 2-1**.

4 SUMMARY AND CONCLUSIONS

An air dispersion modelling assessment was completed for the Metro Vancouver Waste-to-Energy Facility using the CALMET/CALPUFF modelling system in accordance with the BC Air Quality Dispersion Modelling Guideline and the modelling plan that was developed in consultation with approved by ENV for this Facility.

Five scenarios were assessed for this study:

- **Current Operational Certificate Scenario:** representing maximum permitted operations, 24 hours a day, each day of the year. Continuous emissions prescribed in the Current OC were considered in this scenario.
- **Proposed Operational Certificate Scenario:** representing maximum proposed future operations, 24 hours a day, each day of the year. Continuous emissions prescribed in the proposed Operational Certificate were considered in this scenario.
- **Current Operations Scenario:** representing typical operations. Typical emissions from the most recent CEMS and stack test data were considered in this scenario.
- **Startup Scenario:** representing typical operations for two boilers and one boiler starting up. Emission rates were developed using stack tests conducted during boiler startup times.
- **Shutdown Scenario:** representing typical operations for two boilers and one boiler shutting down. Emission rates were developed using stack tests conducted during boiler shutting down.

CO and $PM_{2.5}$: All predicted concentrations including ambient background were below their respective ambient air quality objectives for all modelled scenarios.

SO_2: Predicted maximum 1-hour SO_2 concentrations exceeded the Metro Vancouver Air Quality Objective (183 µg/m³) in the Current OC and Proposed OC scenarios. Predicted concentrations (99^{th} percentile D1HM) also exceeded the 1-hour SO_2 CAAQS (170 µg/m³) in the Current OC scenario. For all other scenarios and averaging periods, predicted SO_2 concentrations were below the applicable objectives and standards. Where exceedances were predicted, they were localized to areas within 370 m of the Facility and occurred infrequently, with predicted excursion frequencies less than 0.2% in any year and 0.06% over the full five-year modelling period for the Current OC Scenario and 0.07% in any year and less than 0.02% over the full five-year period for the Proposed OC Scenario.

NO_2: Predicted cumulative concentrations of NO_2 were dominated by high background concentrations in the region. Background NO_2 concentrations alone account for approximately 92% of the 1-hour objective and exceed the annual objective. Predicted 1-hour and annual NO_2 concentrations from Facility emissions alone were below the applicable Metro Vancouver Air Quality Objectives in all modelled scenarios. Predicted exceedances occurred only after the addition of ambient background concentrations. As such, the predicted NO_2 exceedances are primarily attributable to regional background air quality conditions rather than Facility emissions. Facility contributions to annual NO_2 concentrations were less than 10% of the applicable objective in all scenarios.

HCl: Predicted 1-hour HCl concentrations exceeded the applicable Alberta Ambient Air Quality Objective (75 µg/m³) in all modelled scenarios. The exceedances were confined to areas in close proximity to the Facility, generally within approximately 470 m of the source. Despite the exceedances, the frequency of excursions was low, with predicted exceedance frequencies generally less than 0.1% in any given year and less than 0.03% over the full modelling period.

Metals, VOCs and other non-CAC Contaminants: Predicted concentrations of metals, VOCs and other non-CAC contaminants were below their respective assessment criteria for all contaminants evaluated, with the exception of PAHs. Exceedances of the 24-hour and annual PAH criteria were predicted under the Current OC and Proposed OC scenarios. The 24-hour criterion was also exceeded under the Shutdown Scenario. No PAH exceedances were predicted under the Current Operations Scenario, which is considered representative of typical Facility operations. Note that as the OC only limits the total PAHs and not the individual PAH components, the total PAH concentrations were conservatively compared with the Ontario AAQC for benzo(a)pyrene.

Overall, the assessment indicates that Facility emissions contribute a relatively small increment to ambient concentrations for most contaminants. Predicted exceedances were generally associated with conservative maximum-permitted emission scenarios, elevated regional background concentrations, or were localized to areas in close proximity to the Facility. Comparison of modelled results with ambient monitoring data at S150 indicate that model predictions are substantially higher than the observed conditions, indicating that the assessment provides a robust margin of conservatism and a protective evaluation of potential future air quality impacts.

The modelling results including ambient concentration and deposition rates were provided to Ollson Environmental Health Management to support the companion PHRA.

5 STATEMENT OF LIMITATION

This report entitled "Air Dispersion Modelling Study, Metro Vancouver Waste-to-Energy Facility" was prepared by RWDI AIR Inc. ("RWDI") for HDR Corporation ("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 the 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 the 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

A. Lanfranco & Associates Inc. (A. Lanfranco). 2017. Waste to Energy Facility: Start Up and Shut Down Emissions Report: November 2017 Survey $PM_{2.5}$ 36 pp.

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WSP. 2024. Waste-to-Energy Facility Ambient Air Monitoring Program Assessment, 2021-2022 Summary. May 27, 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: *2026-09-04*

Facility Name, Company, Location (Lat, Long): *Metro Vancouver Waste-to-Energy Facility, 5150 Riverbend Drive, Burnaby, BC: 49.1864°N, 122.9779°W*

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

Ministry Contact Name: *Ben Weinstein*

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

A level 3 (comprehensive) assessment is proposed. Although the Waste-to-Energy Facility (WTEF) has only a single emission source, the modelling effort must include multiple operating scenarios and provide detailed results that will be sufficient to inform a comprehensive Public Health Risk Assessment (PHRA) and to compare with regional ambient air quality monitoring. Modelling will be performed using multiple years of meteorology.

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:

Yes.

This model plan follows a similar methodology to the previous dispersions modelling study performed in 2018-2020 in support of the facility Operating Certificate 107051 issued in 2016 (last amended 2025). The approach is similar but has been updated in instances where the BC Ministry of Environment and Parks (BC ENV) Dispersion Modelling guidance has changed and/or available supporting data has been updated.

The modelling will be done in accordance with the British Columbia Air Quality Dispersion Modelling Guideline (BC AQDMG) (BC ENV, July 2022) and the Guidance for NO2 Dispersion Modelling in British Columbia (BC NO2 modelling guideline) (BC ENV, July 2022).

The CALNO2 post-processor for NO2 modelling will be used; the processor was developed in coordination with BC ENV and is consistent with modelling guidance in BC. The ambient ratio method - ARM2 option will be used in CALNO2, using ARM2 curves from Appendix A of the BC NO2 modelling guideline.

Upper air meteorological data will be derived from an updated Weather Research Forecast (WRF) dataset developed by the province of BC for the years 2019 to 2023, inclusive. Surface meteorological observations will be taken from all Metro Vancouver stations within the model domain for years 2019 to 2023, to match the WRF data period.

PROJECT DESCRIPTION AND GEOGRAPHIC SETTING

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

The facility incinerates waste received onsite and generates electricity. The facility is authorized to incinerate 310,000 tonnes of waste (wet weight) per year and operate continuously. The operational certificate (OC) authorizes and limits emissions from three mass burn incinerators/boilers which have a common exhaust stack. Emissions from waste incineration are discharged through the common stack.

The purpose of the dispersion modelling study is to support an application for an amended operational certificate. Modelled outputs will be used for a PHRA.

Provide a description of the following:

- Terrain characteristics within domain: flat terrain or complex terrain (i.e., will complex flow need to be considered?)
- Dominant land cover: urban, rural, industrial, agricultural, forested, rock, water, grassland

The modelling will be performed using the CALPUFF dispersion model and so complex flow will be considered. The facility is located in southern Burnaby. The terrain within approximately 15km of the facility is relatively flat and is elevated towards the north – from the North Shore Mountains north of Vancouver, to Golden Ears Provincial Park farther east.

The land cover around the facility is mixed including urban, agricultural, industrial, water and shrubland. The facility is located 500m away from the Fraser River.

DISPERSION MODEL

<u>Selected Dispersion Model:</u>

- List model(s) and version to be used (see Section 2).
- *CALPUFF - Version 7.2.1*
- *CALMET - Version 6.5.0*

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

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

<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.

- *N/A*

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

  - *See Figure 1 for CALMET domain map with locations of surface meteorological stations. No data from upper air stations will be used.*

  - anticipated grid resolution:____*250m*____ (m)

  - number of grids in X and Y direction (NX = __*200*____ ,NY = ___*200*____*)*

  - vertical levels (m):
    __0___,__20___,__40___,__80___,__160___,__300___,__600___,__1000___,__1500___,__2200___ ,__3000__

AERMOD and Receptors

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

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

CALPUFF and Receptors

If the CALPUFF model is used, provide the following:

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

  Receptor locations in CALPUFF will be set according to the BC Guidelines as follows:

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

Sensitive receptors such as daycares, schools, hospitals, senior care facilities, recreational areas, residential areas and businesses will be considered in the assessment. In addition to the sensitive receptors that were considered in the 2018 air quality assessment for the facility, additional sensitive receptors will be included based on input from stakeholders, Metro Vancouver, Vancouver Coastal Health Authority, Fraser Health Authority and BC ENV. A list of sensitive receptors included thus far is attached as Appendix A.

See Figure 2 for a map of the CALPUFF domain, gridded receptors and sensitive receptors. The receptor IDs from Figure 2 can be referenced to the table in Appendix A.

A flagpole receptor height of 1.5 m will be used to assess airborne concentrations.

A flagpole receptor height of 0 m will be used to assess depositions.

PLANNED MODEL OUTPUT: AIR QUALITY ASSESSMENT NEEDS

Output Requirements for

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

- Air Quality: concentrations, depositions, visibility, fogging, icing, other (specify)
- *Concentrations and wet and dry depositions*

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 air quality parameters (maximums, exceedance frequencies, annual averages) showing locations of maximum short and long term average air quality parameters
- tables of maximum short and long term average air quality parameters ~~(locations and associated meteorological conditions)~~
- tables of air quality parameters at select receptors of interest (maximums, frequency distributions)
- tables of air quality parameters under abnormal emission situations (~~upsets,~~ start-up*/shut-down*)
- ~~output spatial scale: near-field (<10 km), local (<50 km), regional (>50 km)~~
- special output required for vegetation, health risk or visibility assessments
- other (specify):
- *All of the above will be provided with the exception of the following:*
    - *Meteorological conditions associated with maximum results will be reviewed as part of the QA/QC for the assessment. They will not be presented in tables for all results.*
    - *Results will not be split up into near-field, local or regional effects; spatial distributions of predicted concentrations across the whole model domain will be provided.*

EMISSION SOURCES AND CHARACTERISTICS

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

See Figure 3.

The operational certificate for the WTEF authorizes the discharge of air contaminants from three separate mass burn incinerators/boilers from a common support stack containing three individual flues. The common stack will be represented as a single point source in the dispersion model.

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.

Five scenarios will be assessed:

1. *Operational Certificate Scenario*
2. *Proposed Operational Certificate Scenario*
3. *Current Operations Scenario*
4. *Startup Scenario*
5. *Shutdown Scenario*

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)
E300670 - mass burn incinerator/boilers common exhaust stack	*P*	• *TPM* • *PM_{10}* • *$PM_{2.5}$ (filterable and condensable)* • *Carbon Monoxide (CO)* • *Hydrogen Chloride (HCl)* • *Hydrogen Fluoride (HF)* • *Sulphur Dioxide (SO_2)* • *Nitrogen Oxides (NO_x)* • *Total Hydrocarbons (THC)* • *Total Dioxins and Furans (as PCDD/F TEQ)* • *Cadmium (Cd)* • *Mercury (Hg)* • *Sum of Lead (Pb), Arsenic (As), Chromium (Cr)* • *Chlorophenols* • *Chlorobenzenes* • *Polycyclic Aromatic Hydrocarbons (PAHs)* • *Polychlorinated Biphenyls (PCBs)*	_*X*__approved/proposed emission limits: *Existing and proposed emissions for the amended operational certificate.* ___manufacturer specifications ___emission factors _*X*__CEM: *Emissions from CEMS during normal operation.* ___modelled emission rates _*X*__stack sample: *Emissions from stack testing during start-up/shut-down operations.* ___other (specify)

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

Source Emission Rate Variability

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

No.

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

For the Current Operations Scenario, typical emissions will be determined from CEMS/stack test data. Median values from the CEMS dataset will be used to represent normal emissions.

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

No batch processes.

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.

Startup and shutdown scenarios will be modelled. These are transient processes that may occur at any time for less than 5 hours each. Stack testing emissions from 2017 will be used to determine the modelled emissions during start-up and shutdown.

The modelling will be conducted to include the potential for a given startup or shutdown cycle to occur on any hour of the year. Though startup and shutdown are temporary transient conditions, these scenarios will be run with the emissions applied to every hour of the year.

A summary table of the emissions for each scenario is provided below.

Contaminant	Emission Rate (g/s; per boiler)*					Total Emission Rate (g/s; combined operations)				
	Current OC	Proposed OC	Current Operations	Startup	Shutdown	Current OC	Proposed OC	Current Operations	Startup	Shutdown
$PM_{2.5}$	2.16E-01	2.16E-01	1.94E-02	8.61E-03	1.40E-02	6.48E-01	6.48E-01	5.81E-02	4.73E-02	5.28E-02
Carbon Monoxide (CO)	1.20E+00	1.20E+00	5.12E-01	8.10E-01	2.98E+00	3.60E+00	3.60E+00	1.54E+00	1.83E+00	4.00E+00
Hydrogen Chloride (HCl)	1.32E+00	1.08E+00	9.72E-01	4.29E-01	5.84E-01	3.96E+00	3.24E+00	2.91E+00	2.37E+00	2.53E+00
Hydrogen Fluoride (HF)	2.40E-02	1.20E-02	1.20E-03	1.01E-03	1.50E-04	7.20E-02	3.60E-02	3.60E-03	3.41E-03	2.55E-03
Sulphur Dioxide (SO_2)	4.80E+00	2.88E+00	1.29E+00	1.23E+00	3.93E-01	1.44E+01	8.64E+00	3.88E+00	3.81E+00	2.98E+00
Oxides of Nitrogen (expressed as NO2)	4.56E+00	3.60E+00	2.48E+00	2.12E+00	2.08E+00	1.37E+01	1.08E+01	7.44E+00	7.09E+00	7.04E+00
Total Dioxins and Furans (as PCDD/F TEQ)	1.92E-09	1.44E-09	1.34E-11	1.80E-10	3.05E-11	5.8E-09	4.32E-09	4.03E-11	2.06E-10	5.73E-11
Cadmium (Cd)	1.68E-04	1.68E-04	3.33E-06	2.01E-06	8.42E-06	5.0E-04	5.04E-04	9.99E-06	8.67E-06	1.51E-05
Mercury (Hg)	4.80E-04	3.60E-04	1.68E-06	8.24E-06	1.12E-05	1.4E-03	1.08E-03	5.04E-06	1.16E-05	1.46E-05
Sum of Lead (Pb), Arsenic (As), Chromium (Cr)	1.54E-03	1.44E-03	9.50E-05	5.37E-05	5.07E-05	4.6E-03	4.32E-03	2.85E-04	2.44E-04	2.41E-04
Lead (Pb)	-	1.15E-03	3.87E-05	3.21E-05	1.59E-05	-	3.46E-03	1.16E-04	1.1E-04	9.33E-05
Arsenic (As)	-	2.16E-04	1.45E-05	1.58E-05	8.42E-06	-	6.48E-04	4.35E-05	4.5E-05	3.74E-05
Chromium (Cr)	-	9.60E-04	4.18E-05	5.68E-06	2.66E-05	-	2.88E-03	1.25E-04	8.9E-05	1.10E-04
Chlorophenols	2.40E-05	7.20E-06	4.81E-08	3.79E-06	1.95E-06	7.2E-05	2.16E-05	1.44E-07	3.89E-06	2.05E-06
Chlorobenzenes	2.40E-05	2.40E-05	6.92E-07	2.91E-05	3.94E-05	7.2E-05	7.20E-05	2.08E-06	3.05E-05	4.08E-05
Polycyclic Aromatic Hydrocarbons (PAHs)	1.20E-04	3.17E-05	2.83E-06	2.77E-06	1.67E-05	3.6E-04	9.50E-05	8.49E-06	8.42E-06	2.23E-05
Polychlorinated Biphenyls (PCBs)	2.40E-05	8.93E-06	1.61E-07	3.17E-10	6.79E-10	7.2E-05	2.68E-05	4.82E-07	3.22E-07	3.22E-07

Notes:

- *In the 'per boiler' columns, the emission rates for the Startup and Shutdown scenarios only show the emissions for the boiler that is starting up or shutting down. For combined operations, total emissions = startup/shutdown emissions for one stack plus emissions from the Current Operations Scenario for the other two stacks.*
- *The Proposed OC now explicitly includes Lead and Arsenic, as opposed to the sum of Lead, Arsenic and Cadmium, as well as Chromium. The emission rates for Lead, Arsenic and Chromium for the Current Operations, Start-up and Shut-down scenarios are also included for reference.*

The stack parameters for each scenario are provided below. Flow rates are provided in both standard and actual conditions. Standard conditions are taken as 293.15°K and 101.325 mb as per section 2.7 of the WTEF Operational Certificate amended September, 2025. Exit velocity for modelling will be calculated using the actual flow corrected from standard to actual conditions based on the stack exit temperature.

The correction from reference (standard) conditions to actual condition is given by the ideal gas law. Equating the two conditions and removing the constants provides the following:

$$\frac{P_{ref} \times V_{ref}}{T_{ref}} = \frac{P_{act} \times V_{ref}}{T_{act}}$$

Where:

P_{ref} and P_{act} are the pressures at reference and actual conditions, respectively;

T_{ref} and T_{act} are the absolute temperatures at reference and actual conditions, respectively; and,

V_{ref} and V_{act} are the volumes at reference and actual conditions, respectively;

Dividing both sides by time to convert volume to flow rate gives:

$$\frac{P_{ref} \times Q_{ref}}{T_{ref}} = \frac{P_{act} \times Q_{ref}}{T_{act}}$$

Where Q_{ref} and Q_{act} are the volumetric flow rates at reference and actual conditions, respectively.

Solving for Q_{act}:

$$Q_{act} = Q_{ref} x \frac{P_{ref}}{P_{act}} x \frac{T_{act}}{T_{ref}}$$

The WTE is located close to sea level and on average P_{act} will be approximately equal to P_{ref}, so in this case the equation simplifies to:

$$Q_{act} = Q_{ref} x \frac{T_{act}}{T_{ref}}$$

The difference in pressure due to the height of the stack itself has also been considered negligible.

Stack Parameters for Each Scenario

Stack Parameter	Scenario				
	Current OC	Proposed OC	Current Operations	Startup	Shutdown
Stack Height (m)	60.0				
Stack Diameter (m)	1.25				
Exit Flow @ Standard (Sm3/s; per boiler)	24.0	24.0	18.4	18.3	18.7
Exit Temperature (°C)	153	153	153	151	147
Exit Flow @ Actual (m3/s; per boiler)	34.9	34.9	26.7	26.5	26.8
Exit Velocity @ Actual (m/s; per boiler)	28.4	28.4	21.8	21.6	21.9
Configuration of Point Sources Emitting from Boiler Stack	3 operating at full, permitted capacity	3 operating at full, proposed capacity	3 operating at typical capacity	3: 2 operating at typical capacity, and 1 starting up	3: 2 operating at typical capacity, and 1 shutting down

BASELINE CONCENTRATION

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

  __*X*___monitoring data (Section 8.1.1 and 8.1.2)

  _____establish monitoring program (Section 8.1.3)

  _____modelled sources (Section 8.1.5)

  _____other method (describe)

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

Representative Air Quality Measurements

Station Name (Lat./Long./ or indicate on map)	Period of Record (start/end date)	Contaminants Measured
Burnaby South (T18)	*2022, 2023, 2024*	*SO2,* *NO2,* *CO,* *PM10,* *PM2.5,* *HCl*
North Delta (T13)	*2022, 2023, 2024*	*NO2,* *PM2.5*
New Westminster (T46)	*2022, 2023, 2024*	*NO2,* *PM2.5*

- 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.
- *N/A*

- 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).*

- *Baseline values will be based on measurements taken at T18, T13 and T46 stations that lie approximately 3 km north, 6 km southeast and 7.5 km northeast of the facility. The stations are operated by Metro Vancouver and have been sited to provide measurements that are representative of the surrounding area and are not unduly influenced by nearby industrial sources. For NO2 and PM2.5 a baseline value that is averaged over the three surrounding stations will be used in the assessment.*

- 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).
- *98th percentile of daily1-hour maximum values will be presented.*
- If the Monte Carlo method (Section 3.3.2.1, *GUIDANCE FOR NO_2 DISPERSION MODELLING IN BRITISH COLUMBIA*) is applied for NO_2 baseline, submit the computer code used to generate results.

- *N/A*

A table of background values is provided below. All Values in µg/m^3. For NO_2 and $PM_{2.5}$, the average across all stations is also provided. All values calculated according to Section 8.1.4 of the BC AQDMG as quoted in the table footnotes. Note that no values were screened out from the hourly data.

*Note that the guidance in Section 8.1.4 offers no specific guidance on use of multiple years, only on use of multiple stations. The guidance states only that "*Choosing an appropriate single value from a year's worth of monitoring data is problematic*" and "*a conservative value should be used to establish baseline levels*"*

To that end, the percentiles used to select short term averages from the hourly data at each station were applied over all three years of data, as opposed to year by year. This includes all the years in the calculation and the 98th ptile over the whole period will be equal or higher than the average of the 98 ptile foreach year. Note also that the averaging dictated by Section 8.1.4 does not always align with the form of the associated objective. For example, the background for 24-hr PM10 is based on a percentile, but the objective is not.

For any model parameters not included in the table, background concentrations will be taken as 0.

Representative Background Concentrations from Metro Vancouver Station Data

Station	Species	Averaging Time			
		1 hr	8-hr [5]	24 hr [4]	Annual [6]
Burnaby South (T18)	SO_2	7.1 [1]		2.0	0.8
	NO_2	68.1 [2]		44.5	22.1
	CO	469.5 [3]	435.7	424.7	229.4
	PM_{10}	26.4 [3]		23.0	8.9
	$PM_{2.5}$	18.0 [3]		15.8	5.8
	HCl	2.1 [3]		1.6	0.6
North Delta (T13)	NO_2	72.4 [2]		43.9	21.5
	$PM_{2.5}$	17.2 [3]		15.7	6.0
New Westminster (T46)	NO_2	78.4 [2]		49.5	31.3
	$PM_{2.5}$	19.9 [3]		17.1	7.0
Average over all stations [7]	NO_2	73.0		46.0	25.0
	$PM_{2.5}$	18.4		16.2	6.3

1) *99th percentile of daily maximum 1-h values from the screened hourly data set.*
2) *98th percentile of daily maximum 1-h values from the screened hourly data set.*
3) *98th percentile from the screened hourly data set.*
4) *98th percentile of the 24-h (daily) values from the screened hourly data set*
5) *98^{th} percentile of block 8-hr average from the screened hourly data set*
6) *From screened hourly data over all three years*
7) *From BCAQMG, page 72: If there is more than one representative monitoring site…the representative baseline value would be the arithmetic average of the 1-h, 24-h and annual average values obtained for each site.*

BUILDING DOWNWASH

- Potential for building downwash. Please provide rationale if building downwash is not modelled.
- *Building downwash will be modelled.*
- If building downwash included, provide a site map to indicate buildings to be processed by BPIP-PRIME, and complete the following Table:
- *See Figure 3 for buildings that will be included in the modelling. The input file for BPIP is also provided as a separate attachment.*

Source Height (m)	Distance from the Source to the Nearest Building (m)	Building Length (m)	Building Height (m)	Building Width (m)
E300670: 60 m	*Emission source is directly beside building (approximately 3 m)*	*70 m*	*27 m*	*40 m*

GEOPHYSICAL DATA INPUT

Topography and Land Use Data

- Terrain data (specify source of data) and an elevation map for the model domain:
  Canadian Digital Elevation Model Data at a resolution of 0.75 seconds (~20m) from GeoGratis.
- Land use data (specify source of data) and a land use map for the model domain:
  GeoGratis Canadian Land Cover

Please see Figure 4 for the domain elevation and Figure 5 for the land use..

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 based on land use from the BC model guideline will be used.

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:

See Figure 1 for the locations of the surface stations that will be used.

Data for all stations is from Metro Vancouver. Data from all stations spans 1/1/2019 to 31/12/2023 i.e. 5 years except for station T6 for which data ends in November 2023. Most of the data is over 99% complete. Missing data will be treated as per the guidance in the BC AQDMG.

Calm wind percent has not been provided since it is only applicable to AERMOD modelling as per the BC AQDMG.

Surface Met Data and Location (lat/long or indicate on map)	Anemometer Height (m)	Parameters
T4 *Burnaby – Kensington Park*	*13.5*	*WS, WD, T, RH*
T6 *N. Vancouver – 2nd Narrows*	*11.9*	*WS, WD, T, RH*
T9 *Port Moody*	*12.8*	*WS, WD, T, RH*
T13 *North Delta*	*18.3*	*WS, WD, T, RH*
T14 *Burnaby Mountain*	*29.8*	*WS, WD, T, RH*
T15 *Surrey East*	*16.9*	*WS, WD, T, RH*
T17 *Richmond South*	*12.5*	*WS, WD, T, RH*
T18 *Burnaby South*	*19.9*	*WS, WD, T, RH, P*
T20 *Pitt Meadows*	*10.1*	*WS, WD, T, RH, P*
T22 *Burnaby – Burmount*	*10.0*	*WS, WD, T*

Surface Met Data and Location (lat/long or indicate on map)	Anemometer Height (m)	Parameters
T23 *Burnaby – Capitol Hill*	*10.0*	*WS, WD, T, RH*
T24 *Burnaby North*	*10.0*	*WS, WD, T, RH*
T26 *N.Vancouver – Mahon Park*	*14.2*	*WS, WD, T, RH, P*
T31 *Richmond – Airport*	*10.3*	*WS, WD, T, RH, P*
T32 *Coquitlam*	*24.0*	*WS, WD, T, RH, P*
T35 *Horseshoe Bay*	*10.0*	*WS, WD, T, RH*
T38 *Annacis Island*	*10.0*	*WS, WD, T, RH*
T39 *Tsawwassen*	*10.8*	*WS, WD, T, RH*
T46 *New Westminster*	*17.3*	*WS, WD*
T48 *Vancouver – Templeton*	*21.3*	*WS, WD, T, RH*
T49 *Vancouver – Portside*	*9.9*	*WS, WD, T, RH*
T50 *Vancouver – Clark Drive*	*12.4*	*WS, WD, T, RH*

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
4 *WS – scalar wind speed, WD – wind direction, T – temperature, RH – relative humidity, P - pressure*

Upper-Air Meteorological Data

If upper air meteorological data are used provide the following:

N/A

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

[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:

We are using the newest BC Province Wide WRF. The updated WRF data covers the entire province at 4km with higher resolution subdomains in areas of particular interest, including the lower mainland. The subdomain covering the lower mainland including Metro Vancouver that will be used for CALMET is 1.333km resolution. Details are available from BC ENV.

- Mesoscale Meteorological Model (Name\Version\Model Configuration):
- Model Output Provider: *BC ENV*
- Domain (attach a map showing the horizontal extent):
- Horizontal and Vertical Grid Resolution and Height of Each Vertical Level:
- Data Period (start/end date): *January 1, 2019 to December 31, 2023.*
- Four Dimensional Data Assimilation is applied (Yes or No):

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

- AERMET/AERMOD: *N/A*
  - 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: *CALMET will be used using surface stations and NWP data.*
  - NWP only, or
  - Surface station and NWP, or
  - Surface station, upper air sounding, and NWP, or
  - Other (specify):

TREATMENTS

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

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

ARM2 will be used with the urban area coefficients since the WTEF is located in Burnaby which is an urban area. The model domain is primarily made up of urban landuse, especially within the areas 10-15km away from the WTEF in all directions. Although the outer portions of the model domain consist of water and forest, it is more important to select an ARM2 curve developed for conditions characteristic of the centre of the domain and its surrounding area.

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

NOx->NO2 conversion will be done using the specific CALNO2 processor that has the BC ENV ARM2 curve coefficients embedded in the code.

_____OLM:

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

_____PVMRM (for AERSCREEN and AERMOD only):

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

Chemical Transformation:

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

Particle Deposition:

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

Stagnation:

- Provide an estimate of the frequency of stagnation based on local meteorological data if available. If AERMOD is proposed, provide methodology on how stagnation periods will be treated (see Section 10.2).
- *Not provided since using CALPUFF.*

Shore/Coastal Effects:

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

Shore/coastal effects will be included because the CALMET micrometeorological module uses the underlying land use in the calculation for boundary layer depth and stability. Parameterization of the thermal internal boundary layer (TIBL) at scales smaller than the grid spacing of 250m is not required, so the sub-grid scale TIBL option with an external coastline file will not be used.

Plume Condensation (Fogging) and Icing:

- Indicate if this will be included (Section 10.6).
- *Not included.*

QUALITY MANAGEMENT PROGRAM

Model Input Data

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

The plots and data listed below will be reviewed as part of the QA/QC process for geophysical data, surface meteorology and WRF data.

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

Model Output Data

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

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

The tests in section 9.1.1, 9.1.2 and 9.1.3 of the BC AQDMG will be performed except:

- *the tests related to NWP output in section 6.1 and the last bullet in section 9.1.3 (checking CALMET-generated wind fields with and without NWP output) will not be performed since the WRF data is QA'ed is being provided by BC ENV.*
- *example spatial plots of mixing heights for different stability regimes will also be reviewed.*
- terrain, land use
- *QA output files extracted using PRTMET will be reviewed – terrain contours and landuse map*
- sources (locations and elevation) and emission characteristics
- *QA output file showing point source location will be checked to ensure the source is modelled at the correct location in the domain*
- meteorological data (locations) and tests to confirm proper processing of the raw meteorological data (units, parameters)
- *QA output file extracted using PRTMET will be reviewed – surface station locations. Timeseries of winds including wind roses and temperatures will be reviewed and compared to raw data. Daytime and nighttime mixing heights will be reviewed.*
- receptor locations and elevations
- *QA output file of receptor locations will be reviewed*

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 vector plots extracted using PRTMET will be reviewed for calm hours to check for channelling of winds with respect to nearby terrain*
- wind roses at selected locations and elevations (annual, seasonal)

- *Wind roses of co-located WRF, station observations and CALMET output for select locations will be compared qualitatively to ensure reasonable agreement. Note that with 22 inputs stations it would require 66 wind roses to include every WRF/obs/CALMET triplet, which is excessive. As such this evaluation will be limited to a reduced set of the stations. In the previous study wind roses of CALMET versus observations for T13,T18,T22 and T38 were presented (WRF wind roses were not shown previously but will be this time). Those stations will be included along with 2 or 3 additional stations depending on results.*
- frequency distributions of various meteorological parameters (annual, seasonal) such as PG-stability class and mixing heights
- *Frequency distributions of PG class will be reviewed. Frequency distributions of mixing heights typically aren't reviewed but spatial plots over the domain for select hours are reviewed*
- plots of hourly average parameters such as temperature, mixing height, and precipitation at key locations (seasonal and annual)
- *Plots of meteorological parameters will be reviewed*

Model Performance Evaluation

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

The WTEF has a fenceline monitor – station S150. Data from this station will be reviewed and compared to the dispersion modelling results to determine if monitored values are higher or lower than modelled values. Ambient monitoring data are available from stations located nearby as discussed previously in the model plan. However, it's important to note that these data reflect cumulative ambient concentrations from emission sources throughout Burnaby, not solely from the facility. As such, they are not appropriate for evaluating model results that isolate emissions from the facility alone.

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:_____



Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx

Model Domain and Meteorological Stations

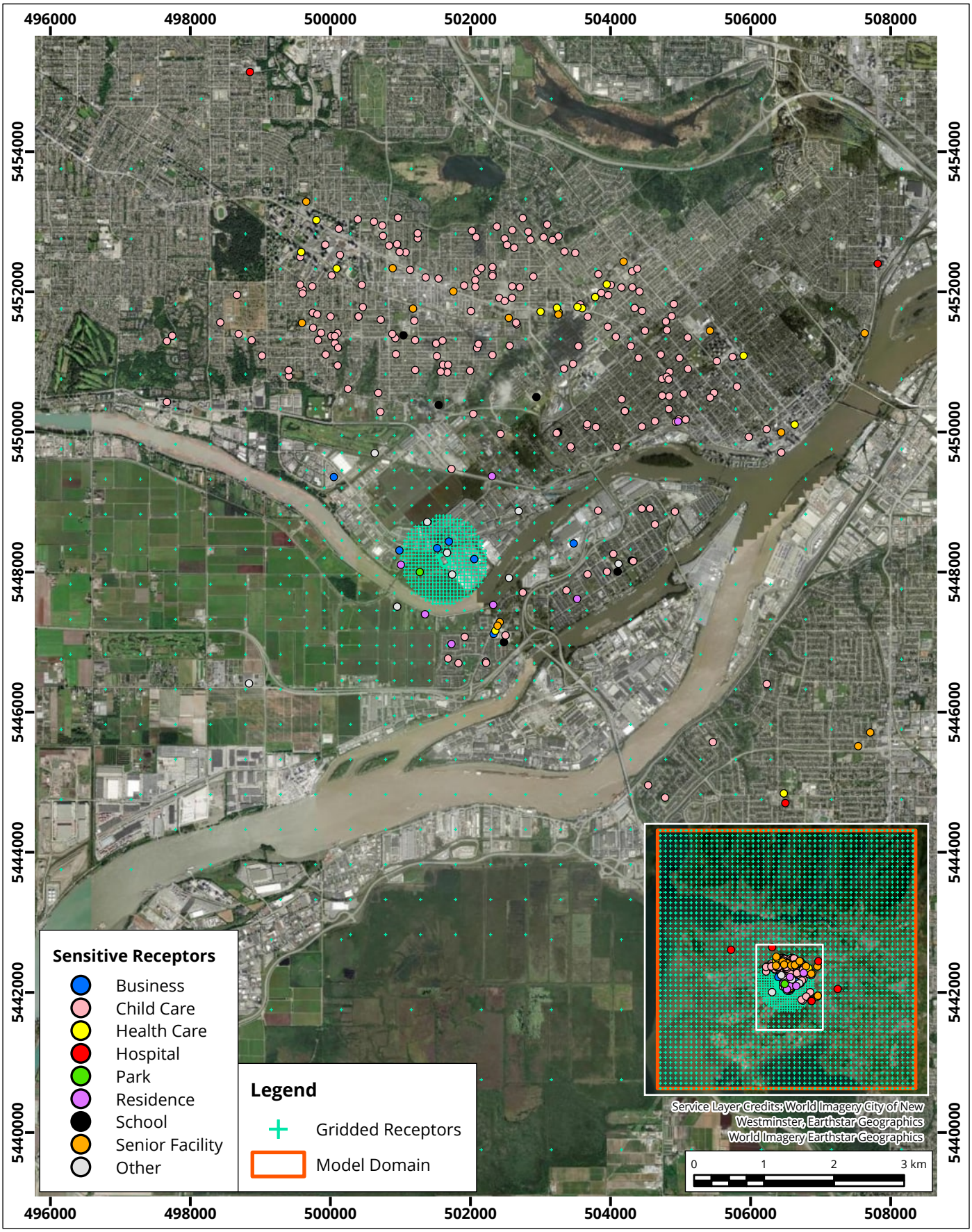
True North

Map Projection: NAD 1983 UTM Zone 10N

Waste-To-Energy Facility - Burnaby, British Columbia

Project #: 2600812

Drawn by:	PIP	Figure:	1
Approx. Scale:		1:320,000	
Date Revised:		Feb 13, 2026	



Model Domain and Receptors

True North

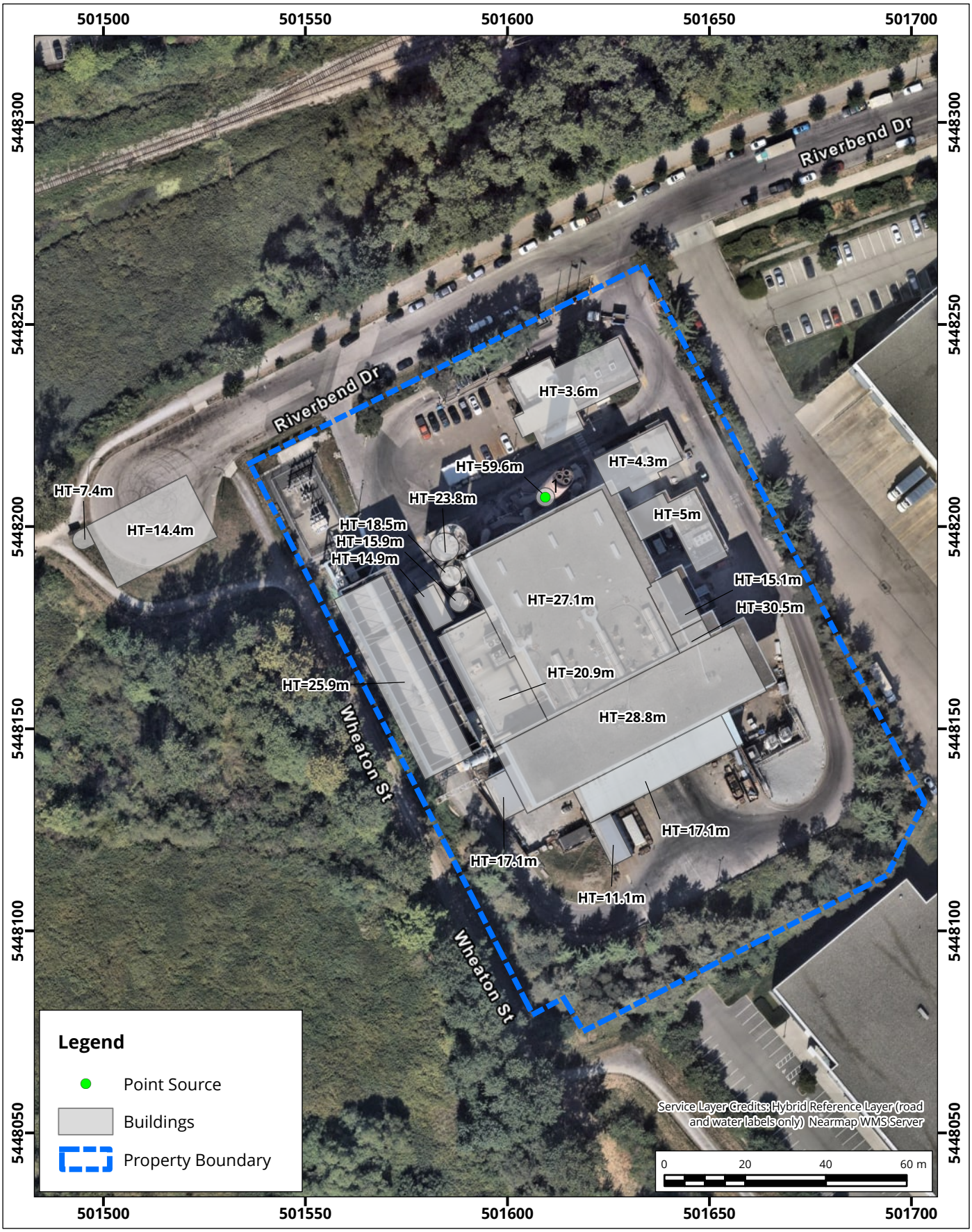
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Waste-To-Energy Facility - Burnaby, British Columbia

Project #: 2600812

Drawn by:	PIP	Figure:	2
Approx. Scale:		1:75,000	
Date Revised:		Apr 9, 2026	

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Modelled Significant Source, Buildings, and Property Boundary

True North

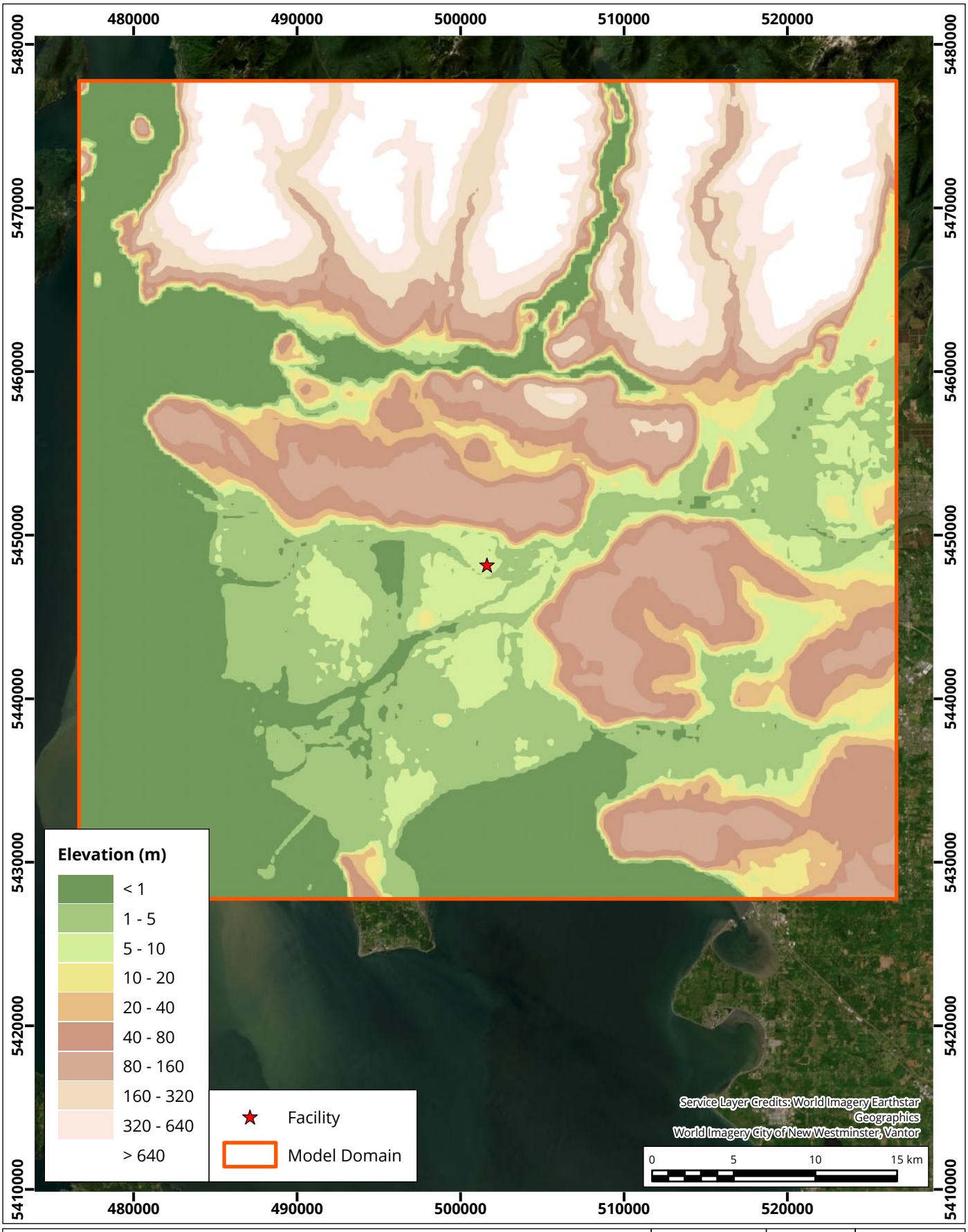
Map Projection: NAD 1983 UTM Zone 10N

Waste-To-Energy Facility - Burnaby, British Columbia

Project #: 2600812

Drawn by:	PIP	Figure:	3
Approx. Scale:			1:1,300
Date Revised:			Mar 7, 2026

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Elevation within Model Domain

True North

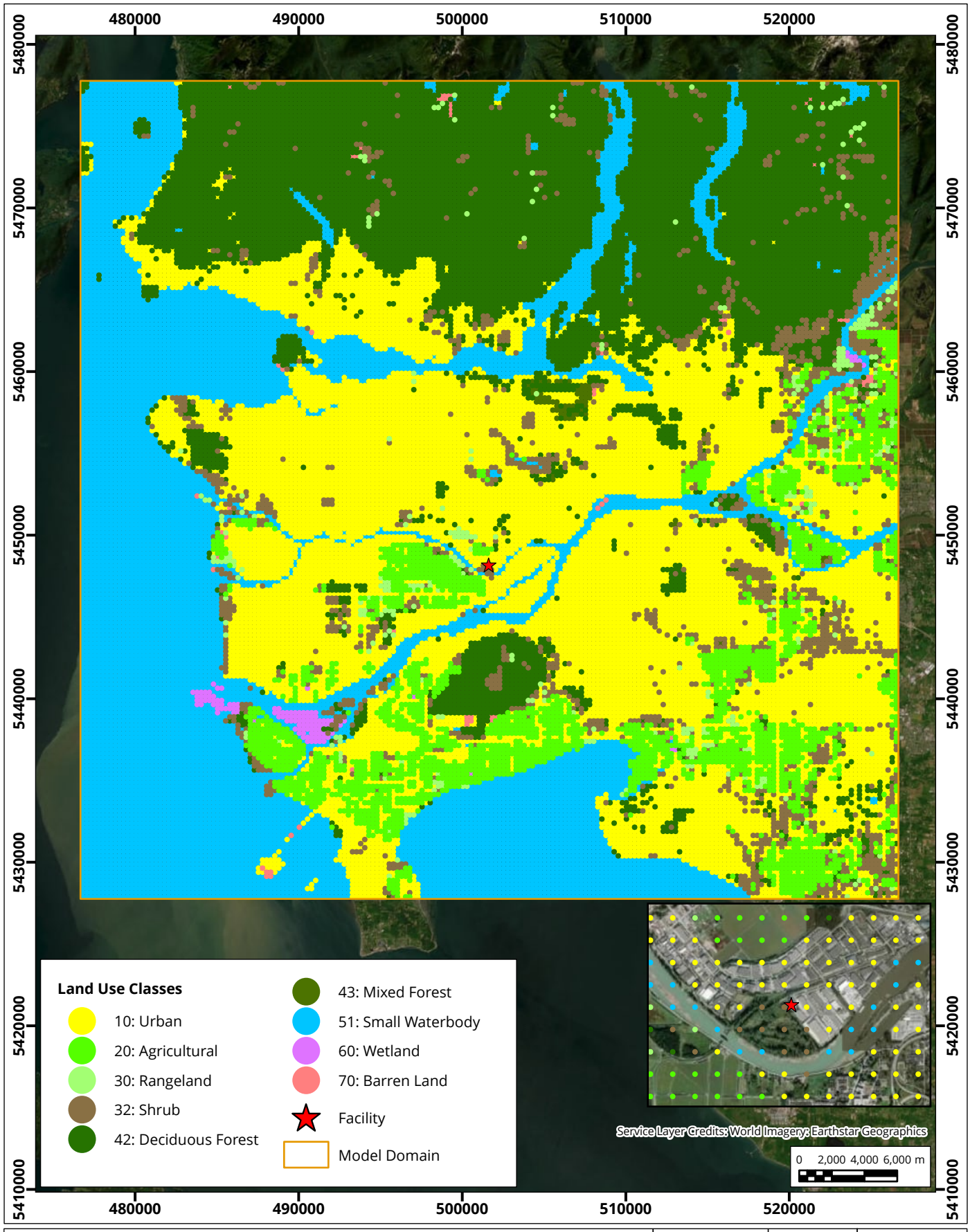
Map Projection: NAD 1983 UTM Zone 10N

Waste-To-Energy Facility - Burnaby, British Columbia

Project #: 2600812

Drawn by:	PIP	Figure:	4
Approx. Scale:	1:320,000		
Date Revised:	May 15, 2026		

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Land Use Classes within Model Domain

True North

Map Projection: NAD 1983 UTM Zone 10N

Waste-To-Energy Facility - Burnaby, British Columbia

Project #: 2600812

Drawn by:	PIP	Figure:	5
Approx. Scale:	1:320,000		
Date Revised:	May 15, 2026		

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx

APPENDIX B

B.1 INTRODUCTION

This Appendix provides details on CALMET settings, inputs and results. Representative CALMET outputs are shown and briefly discussed to demonstrate CALMET's performance is consistent with expected meteorological conditions. CALMET settings and inputs were consistent with the Air Dispersion Modelling Plan and the BC Air Dispersion Modelling Guideline (ENV, 2022).

In order to provide three-dimensional hourly meteorological input into CALPUFF, the BC regulatory model, CALMET (Scire et al, 2000), was run for a five-year period from January 1, 2019, to December 31, 2023, over a 50 km by 50 km modelling domain, with input from local hourly meteorological observations from the Metro Vancouver monitoring network and mesoscale meteorological modelling fields provided BC ENV.

CALMET horizontal domain resolution was set at 250 m. In the vertical direction, 10 layers were chosen, from the surface to 3000m, with the top of the layers set as 20, 40, 80, 160, 300, 600, 1000, 1500, 2200 and 3000 m above ground level.

CALMET was initialized for the five-year model period using the Weather Research and Forecasting (WRF) model. The WRF model is a mesoscale, numerical, weather prediction system designed to serve both atmospheric research and operational forecasting needs. It represents the latest numerical weather forecasting model to be adopted by the United States National Weather Service and by the United States military and private meteorological services. The ENV WRF dataset for 2019 - 2023, with a 1.33-km resolution was obtained from ENV (https://www2.gov.bc.ca/gov/content/environment/air-land-water/air/air-quality-management/modelling/wrf-data). In the absence of observed hourly upper air soundings in the vicinity of the Project, the WRF fields also provided upper meteorological information to the modelling. Surface observations were taken from the Metro Vancouver meteorological network and added to the model.

The summary of CALMET model input datasets and setup is provided in Table B.1 and discussed in more details in Section B.2.

The CALMET model performance was assessed by reviewing various model outputs and, where possible, comparing to observations, as per MV Modelling protocol. This analysis is presented in Section B.3.

Output from CALMET provided the meteorological fields required by CALPUFF (version 7.2.1). CALPUFF switches were set according to model defaults and the BC AQDMG. All non-default settings are summarized in Section 0.

Table B.1 Summary of CALMET Setup

Parameter	Period of Record (start/end date)
Meteorological Model	CALMET Version 6.5.0
Modeling Period	January 1, 2019 to December 31, 2023
Domain Size	50 km x 50 km, approximately centered on the Project
Grid Resolution	250 m
Vertical Resolutions	10 layers at 20, 40, 80, 160, 300, 600, 1000, 1500, 2200 and 3000 m
Prognostic Data	WRF at 1.33 km resolution, provided by ENV
Surface Meteorology	From Metro Vancouver meteorological network – see Table B.2 and Figure B.2
Terrain Elevations	Canadian Digital Elevation Model
Land Cover Data	2020 Land Cover of Canada

B.2 CALMET INPUTS

B.2.1 Terrain

The terrain elevation characterization information used as input into the CALMET model was obtained from Canadian Digital Elevation Model Data at a resolution of 0.75 seconds (~20m) from Open Canada (https://open.canada.ca/data/en/dataset/7f245e4d-76c2-4caa-951a-45d1d2051333). The land cover characterization information used as input into CALMET was obtained from 2020 Land Cover of Canada (https://open.canada.ca/data/en/dataset/ee1580ab-a23d-4f86-a09b-79763677eb47) and corrected manually for known issues such as urban vs forest coverage or waterways and continuity of waterways. The terrain elevation and land use information for the study area used as input into the CALMET model are illustrated in Figure B.1 and Figure B.2.

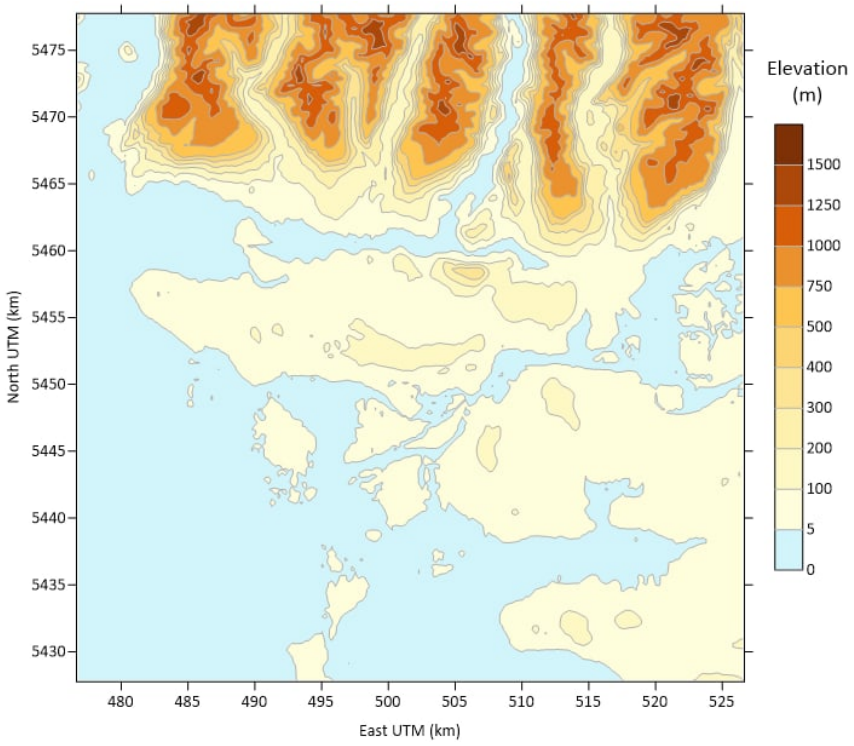


Figure B.1: Terrain Elevations in CALMET Domain

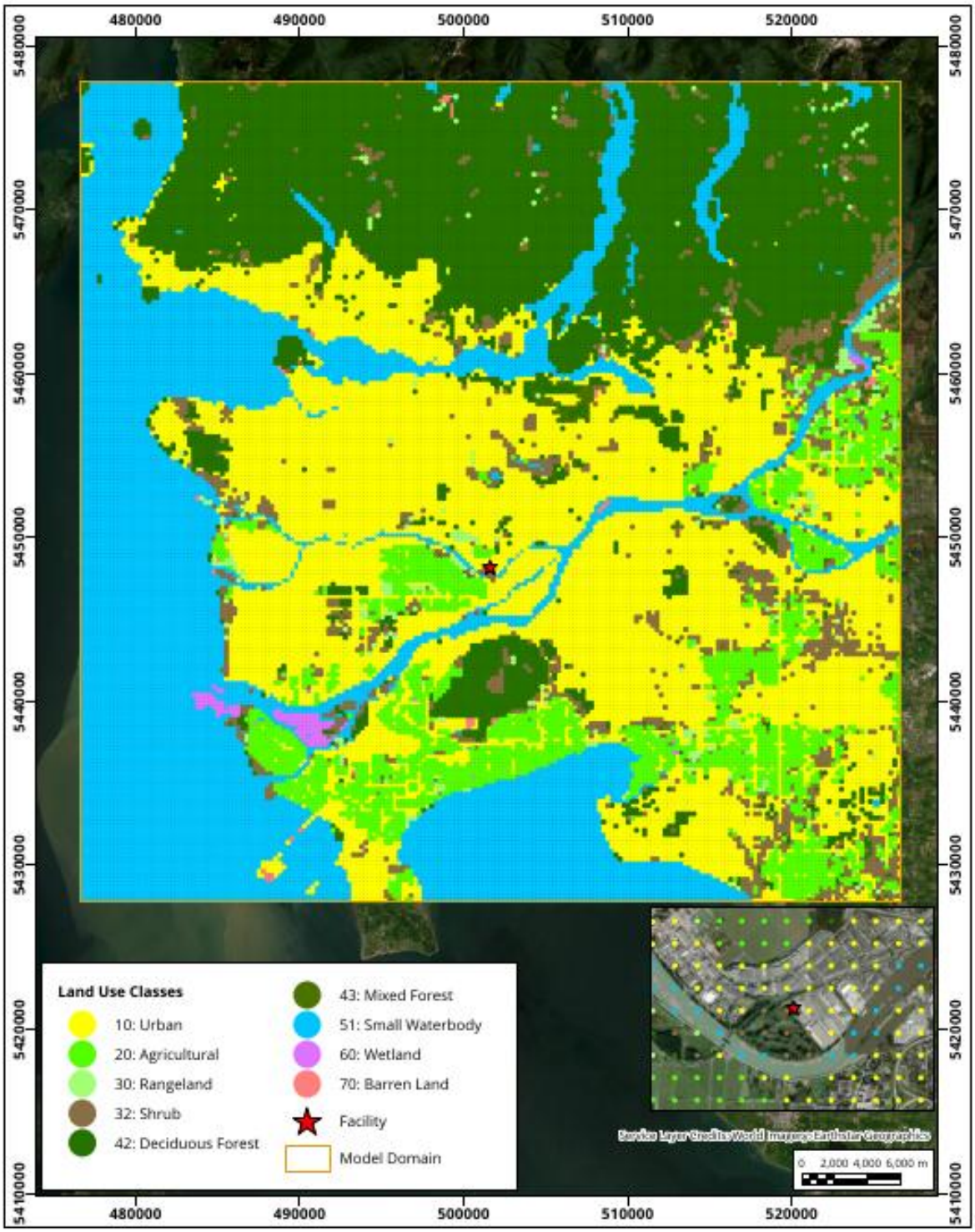


Figure B.2: Land Use in CALMET Domain

B.2.2 Geophysical Parameters

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. To represent the seasonally dependent geophysical parameters more accurately in the CALMET model, five seasons were specified as per the BC AQDMG (ENV, 2022):

- Season 1: Mid-summer with lush vegetation (June to August)
- Season 2: Autumn with cropland that has not yet been harvested (September and October)
- Season 3: Winter with freezing temperatures, no snow on ground (November to March)
- Season 4: Winter with sub-freezing temperatures, snow cover on ground (Not used as these conditions are infrequent in Project location)
- Season 5: Transitional spring with partially green short annuals (April and May)

All geophysical parameters were defined by land cover characterization type and seasonal category based on the BC modelling guideline. A 2D map of the gridded land use categories is provided in Figure B.2.

B.2.3 Surface Meteorology

Surface meteorological data from the MV network were obtained from Metro Vancouver, and used in the CALMET model, as well as data from the ECCC station at the Vancouver Airport (YVR). A total of 22 surface stations were used in the CALMET model as presented in Table B.2. The locations of the surface meteorological stations are shown in Figure B.3.

Table B.2: Surface Meteorological Data Stations in CALMET

Surface Met Data Station	Period of Record (start/end date)	Parameter(s) used in modelling
T4 - Burnaby – Kensington Park	January 1, 2019/December 31, 2023	Temperature, wind speed, wind direction, and relative humidity
T6 - North Vancouver – Second Narrows	January 1, 2019/December 31, 2023	Temperature, wind speed, wind direction, and relative humidity
T9 - Port Moody	January 1, 2019/December 31, 2023	Temperature, wind speed, wind direction, and relative humidity
T13 - North Delta	January 1, 2019/December 31, 2023	Temperature, wind speed, wind direction, and relative humidity
T14 - Burnaby Mountain	January 1, 2019/December 31, 2023	Temperature, wind speed, wind direction, and relative humidity
T15 - Surrey East	January 1, 2019/December 31, 2023	Temperature, wind speed, wind direction, and relative humidity
T17 - Richmond South	January 1, 2019/December 31, 2023	Temperature, wind speed, wind direction, and relative humidity
T18 - Burnaby South	January 1, 2019/December 31, 2023	Temperature, wind speed, wind direction, relative humidity, and pressure
T20 - Pitt Meadows	January 1, 2019/December 31, 2023	Temperature, wind speed, wind direction, relative humidity, and pressure
T22 - Burnaby–Burmount	January 1, 2019/December 31, 2023	Temperature, wind speed, and wind direction
T23 - Burnaby–Capitol Hill	January 1, 2019/December 31, 2023	Temperature, wind speed, wind direction, and relative humidity
T24 - Burnaby North	January 1, 2019/December 31, 2023	Temperature, wind speed, wind direction, and relative humidity
T26 - North Vancouver–Mahon Park	January 1, 2019/December 31, 2023	Temperature, wind speed, wind direction, relative humidity, and pressure
T31 - Richmond Airport	January 1, 2019/December 31, 2023	Temperature, wind speed, wind direction, relative humidity, and pressure
T32 - Coquitlam	January 1, 2019/December 31, 2023	Temperature, wind speed, wind direction, relative humidity, and pressure
T35 - Horseshoe Bay	January 1, 2019/December 31, 2023	Temperature, wind speed, wind direction, and relative humidity
T38 - Annacis Island	January 1, 2019/December 31, 2023	Temperature, wind speed, wind direction, and relative humidity
T39 - Tsawwassen	January 1, 2019/December 31, 2023	Temperature, wind speed, wind direction, and relative humidity
T46 - New Westminster	January 1, 2019/December 31, 2023	Wind speed, wind direction
T48 – Vancouver - Templeton	January 1, 2019/December 31, 2023	Temperature, wind speed, wind direction, and relative humidity
T49 – Vancouver - Portside	January 1, 2019/December 31, 2023	Temperature, wind speed, wind direction, and relative humidity
T49 – Vancouver - Clark Drive	January 1, 2019/December 31, 2023	Temperature, wind speed, wind direction, and relative humidity
Vancouver International Airport	January 1, 2019/December 31, 2023	Temperature, wind speed, wind direction, relative humidity, and pressure



Figure B.3: Surface Meteorological Stations used in CALMET

B.2.4 Model Switch Settings

All modelling switches were set according to the AQDMG and the Model Plan. A list of non-default options and the rationale for the selected setting is provided in Table B.3.

Table B.3: Non-Default CALMET Model Switch Settings.

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)
RMIN2	4	-1	Used to ensure extrapolation of all surface stations for IEXTRP = -4
IPROG	0	14	Used WRF prognostic model output for initial guess field
RMAX1	NA	10	Maximum radius of influence over land in the surface layer.
RMAX2	NA	10	Maximum radius of influence over land aloft
RMAX3	NA	10	Maximum radius of influence over water
TERRAD	NA	3	Identified from main terrain feature of influence Accounts for complex terrain that is very close; Edmonds to Burnaby Mountain Area is 6 km, divided by 2.
R1	NA	1	Complex, mixed terrain. Influence of observations limited to near the stations.
R2	NA	1	No upper air data, but R2 is still used when surface stations extrapolated aloft
RPROG	NA	0	Not used since IPROG = 14
KBAR	NZ	10	Level (1 to NZ) up to which barriers apply
XBAR, YBAR, XEBAR, YEBAR	NA	0, 0, 0, 0	Not used since NBAR = 0
IRHPROG	0	1	3D relative humidity from prognostic data
ITPROG	0	1	3D temperature from surface stations
NUMTS	5	22	Allow all surface stations to be included for temperature interpolation
JWAT1	-	99	No over water temperature interpolation used
JWAT2	-	99	No over water temperature interpolation used

B.3 RESULTS

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

B.3.1 Surface Winds

Windroses display the combined frequency distribution of wind speed and direction at a given location. The modelled (CALMET) windroses for the entire model period (2019 – 2023) at WTE Facility are shown in Figure B.4. Seasonal (based on CALMET seasons) windroses are presented in Figure B.5. Winds are predominantly from the East–northeast, followed by the East and West.

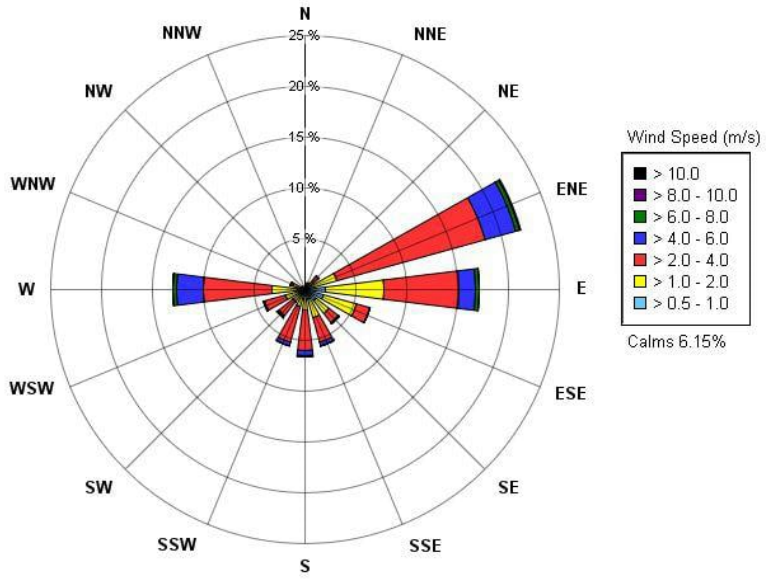
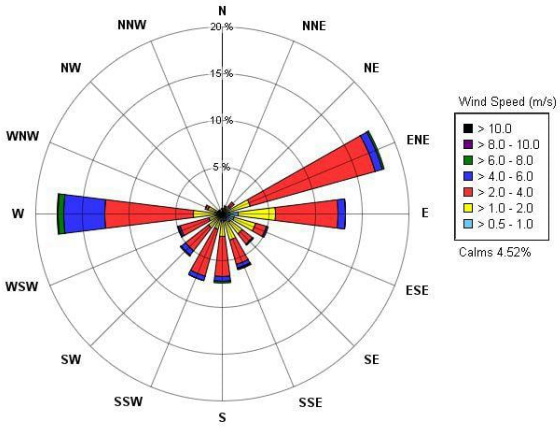
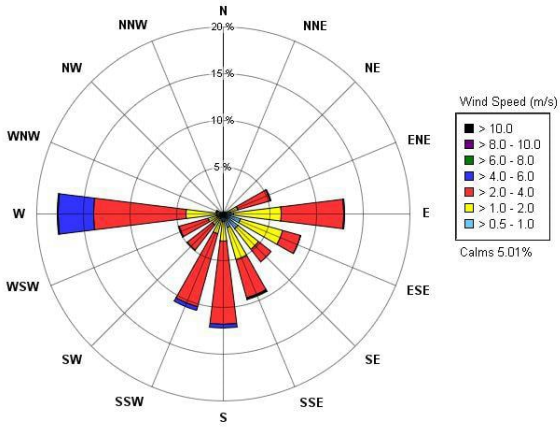


Figure B.4: CALMET Wind Roses for the Model Period (2019 – 2023) at WTE Facility

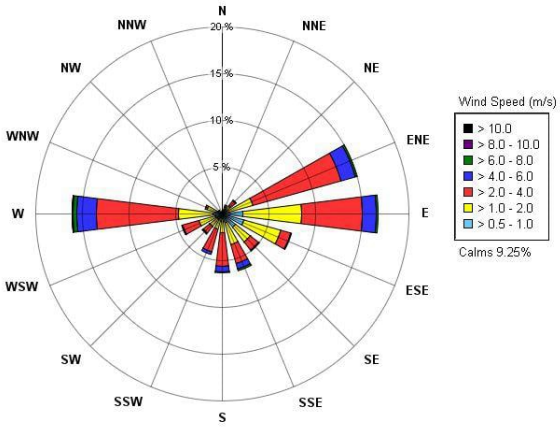
Spring (April – May)



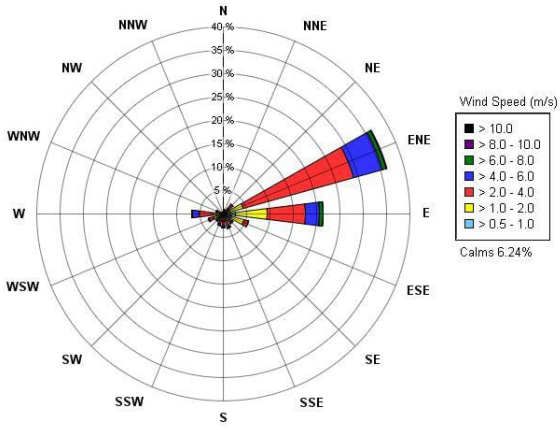
Summer (June – August)



Fall (September – October)



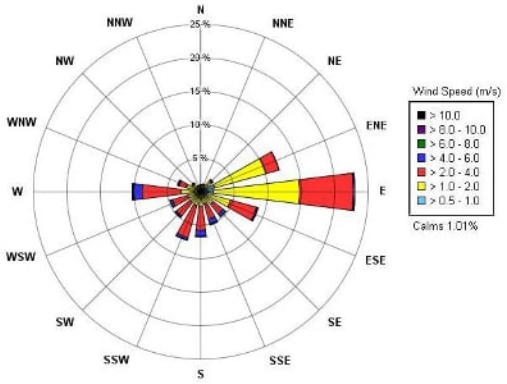
Winter (November – March)



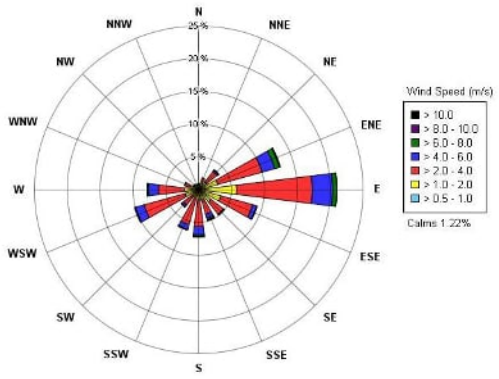
Frequency of Counts by Wind Direction (%)

Figure B.5: Seasonal CALEMT Wind Roses for the Model Period (2019 – 2023) at WTE Facility

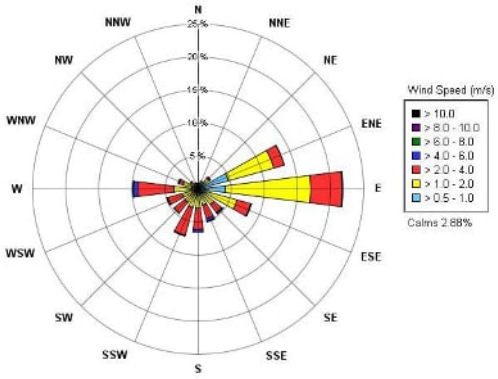
CALMET is designed to match the observations that have been assimilated in the modelling at the observation sites. Wind roses based on modelled winds should therefore closely match wind roses based on observations, as long as the modelled wind roses are extracted at model grid points matching the locations of the meteorological stations. In complex terrain situations, even a small location departure may cause additional terrain-driven winds and differences in the modelled wind roses. Note that CALEMT the CALMET should be a 'blend' of the observed and WRF winds. The observations, WRF, and CALMET wind roses at selected stations are shown in Figure B.6. The observations and CALMET wind roses illustrate a close match at all selected stations. The WRF wind roses also show good agreement with both the observations and CALMET results at T13 - North Delta, while differences are observed at the other stations. These differences may reflect the 1.33 km resolution of the WRF model, as local variations in wind speed and direction can occur within the area represented by a single WRF grid cell.



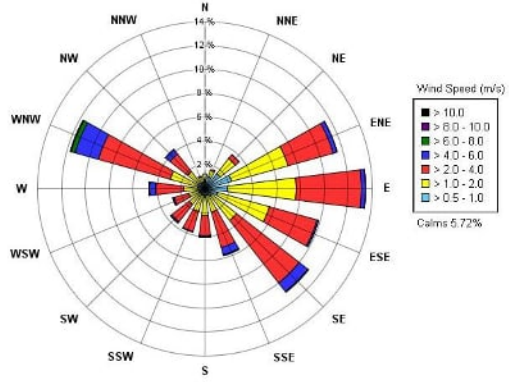
Observed



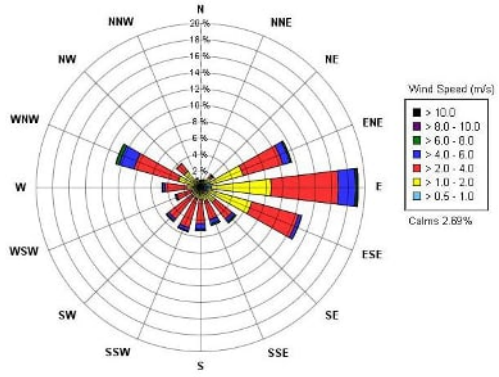
Modelled (WRF)
T13 – North Delta



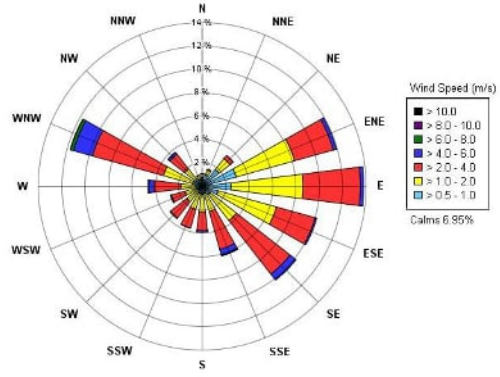
Modelled (CALMET)



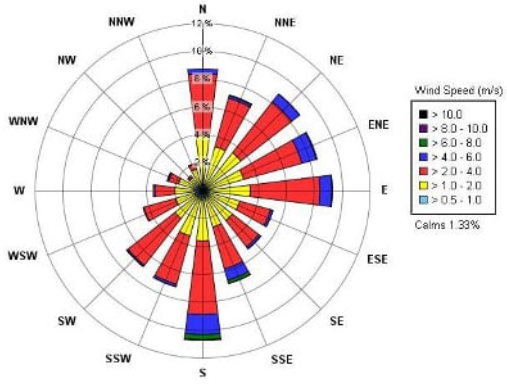
Observed



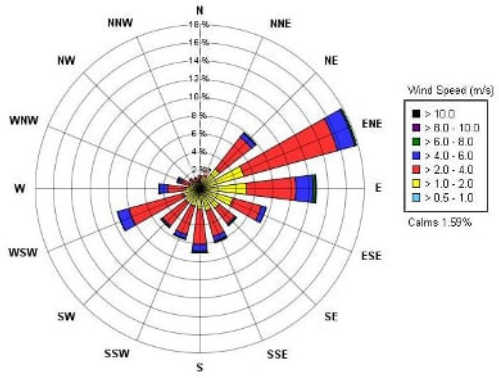
Modelled (WRF)
T17 – Richmond South



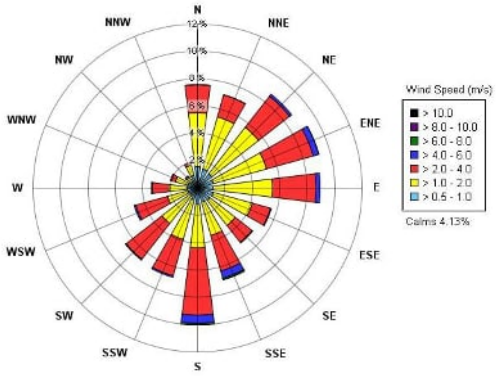
Modelled (CALMET)



Observed

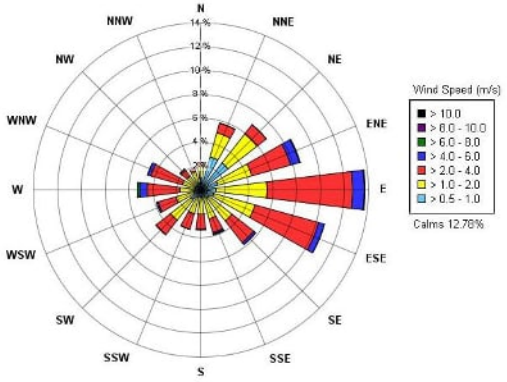


Modelled (WRF)

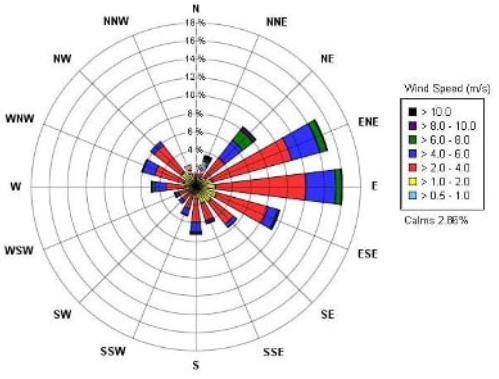


Modelled (CALMET)

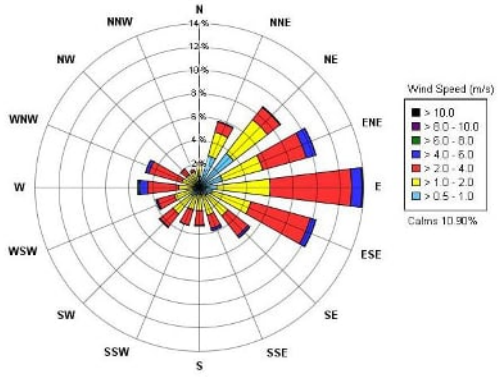
T18 – Burnaby North



Observed



Modelled (WRF)



Modelled (CALMET)

T22 – Burnaby-Burmount

Figure B.6: Observed and Modelled Annual Wind Roses at T13 - North Delta, T17 - Richmond South, T18 - Burnaby North, and T22 – Burnaby-Burmount (2019-2023).

B.3.2 Pasquill-Gifford Stability Class

In CALMET, the Pasquill-Gifford stability scheme is used to classify atmospheric stratification in the boundary layer over land. These 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 and lower wind speeds which means that boundary layer turbulence is generated mostly through thermal buoyancy and less so by mechanical wind shear. Stable conditions are primarily associated with night-time cooling that results in the suppression of buoyant turbulence and prevalence of near surface temperature inversions. Neutral conditions are mostly associated with high wind speeds or overcast sky conditions and boundary layer mixing driven mostly by mechanical wind shear.

The frequency distributions of CALMET-derived Pasquill-Gifford stability classes for the WTE Facility, as well as the T13 - North Delta, T17 - Richmond South, T18 - Burnaby South, and T22 - Burnaby–Burmount stations are shown in Figure B.7. For all listed locations, the most frequent stability class is Class F stable, followed by class D neutral, while the unstable class A is the least frequent. This is typical of most locations in BC. Unstable classes occur only during warm clear weather in daytime so their occurrence is limited to a lesser fraction of hours during the warmest months. The stable classes occur mostly at night during cooler weather. They dominate during winter and can occur during other periods as well. Neutral classes can occur day or night during at any time of year given higher wind speeds.

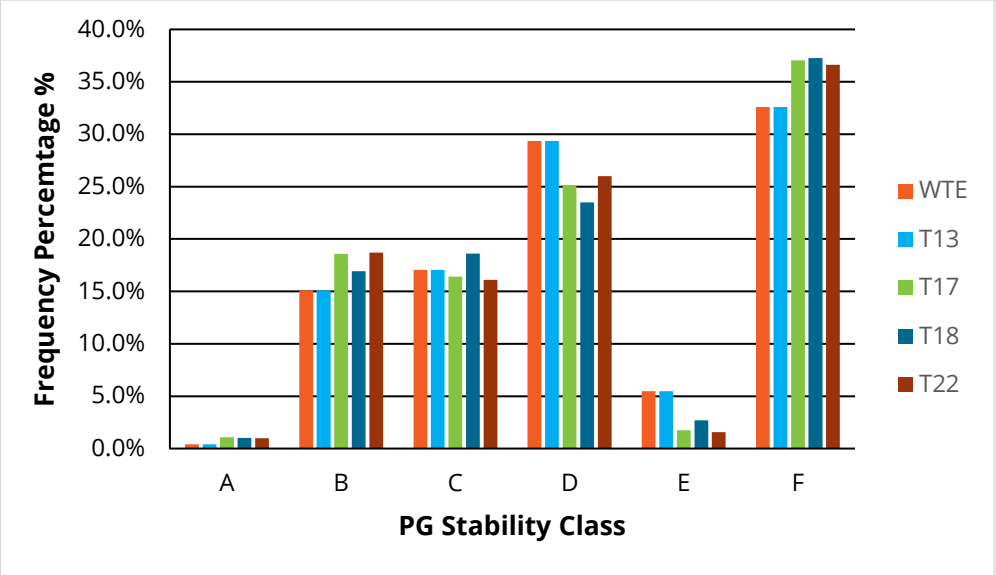
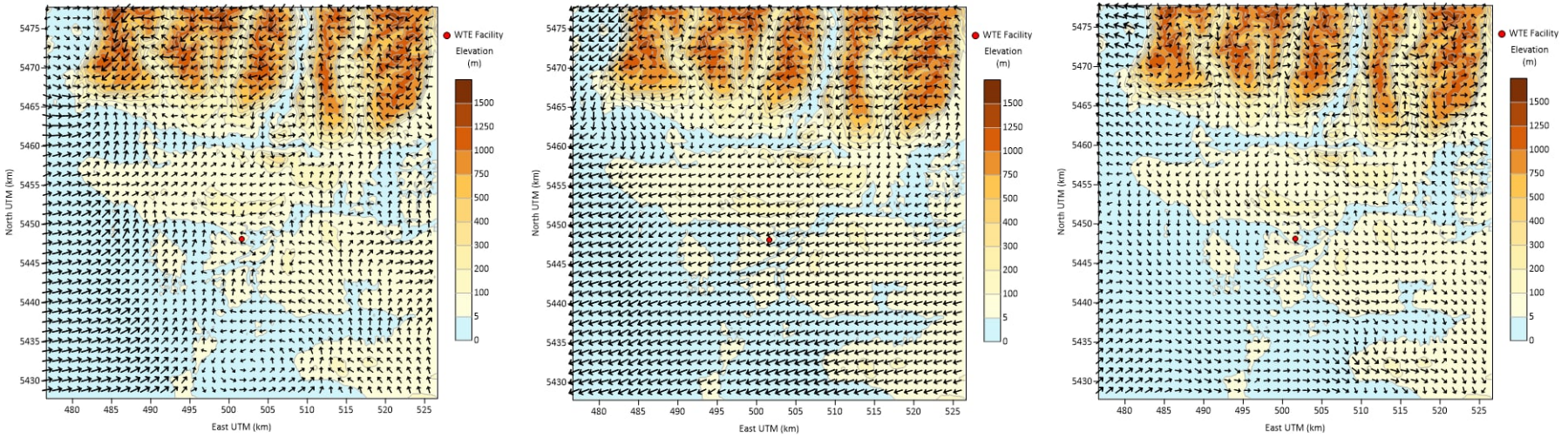


Figure B.7: Frequency of modelled Pasquill-Gifford stability classes

B.3.3 Modelled Wind Fields

Winds in the study area result from a combination of large-scale synoptic patterns, thermal circulations (land-sea breezes), and terrain driven circulations (upslope during daytime, downslope and channeling during nighttime). WRF winds, at 1.33 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 1.33 km). CALMET refines the terrain effects further at the finer scale of 250 m used in the current modelling.

Modelled wind fields vector plots are illustrated in Figure B.8, for representative unstable, neutral, and stable conditions.



Unstable
June 12, 2021 15:00

Neutral
November 11, 2023 00:00

Stable
October 7, 2020 00:00

Figure B.8: Modelled Wind Fields at 10 m Above Ground Level during Unstable, Neutral, and Stable Conditions

B.3.4 Mixing Heights

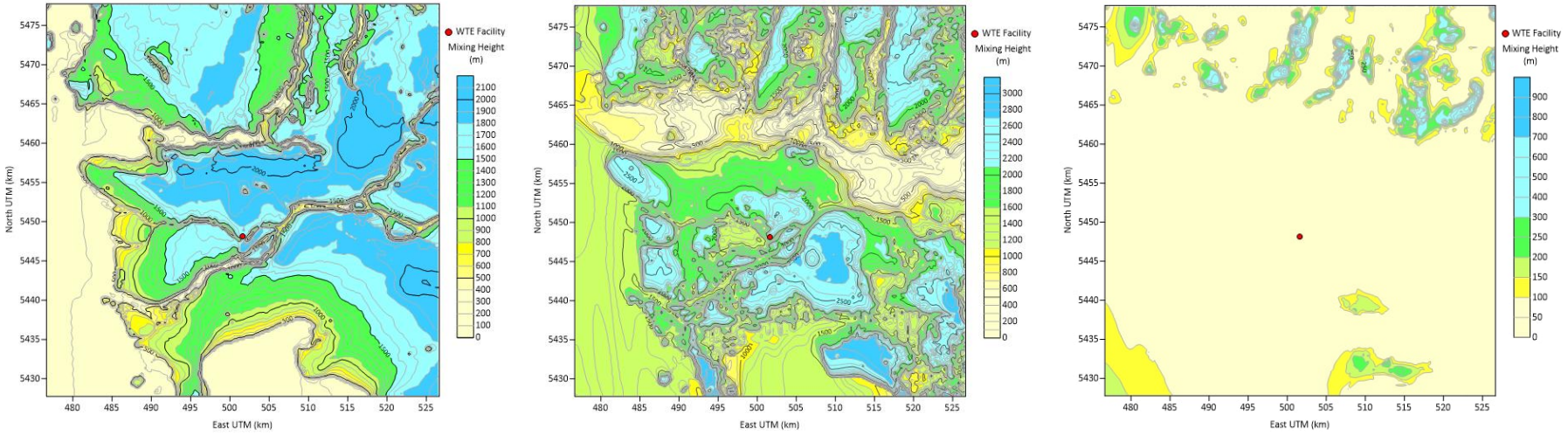
Mixing heights are estimated in CALMET through methods that are based on either surface heat flux (thermal turbulence) and vertical temperature profiles, or friction velocities (mechanical turbulence). Table B.4 shows the average modelled mixing heights by Pasquill-Gifford stability class. The highest 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 F), when both convective and mechanical turbulence are at their lowest.

The spatial distribution of mixing heights under unstable, neutral, and stable conditions is shown in Figure B.9. 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 at the WTE Facility, as well as the T13 - North Delta, T17 - Richmond South, T18 - Burnaby South, and T22 - Burnaby–Burmount stations are shown in Figure B.10, for a typical summer day (August 10, 2023) and a typical winter day (January 1, 2023). 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.

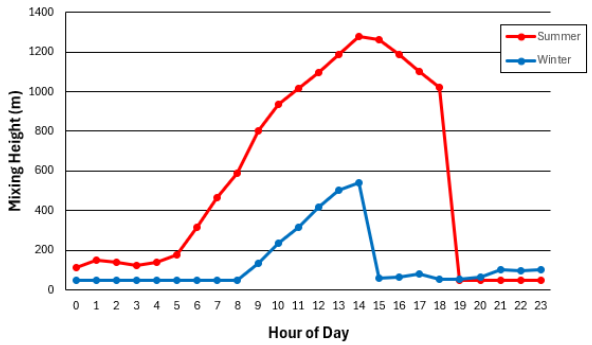
Table B.4: Average Modelled Mixing Height by Pasquill-Gifford Stability Class (in m)

Station	A	B	C	D	E	F
WTE Facility	779	753	664	455	259	81
T13 North Delta	1,058	833	616	430	377	82
T17 Richmond South	913	748	550	411	389	79
T18 Burnaby South	1,089	859	625	427	327	72
T22 Burnaby-Burmount	1,104	922	678	457	316	78

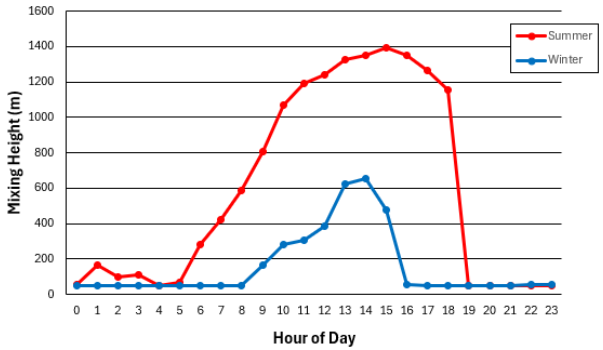


Unstable	**Neutral**	**Stable**
June 12, 2021 15:00	November 11, 2023 00:00	October 7, 2020 00:00

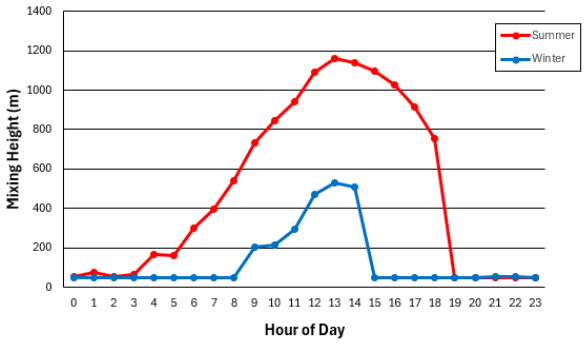
Figure B.9: Modelled Mixing Heights during Unstable, Neutral and Stable Atmospheric Conditions



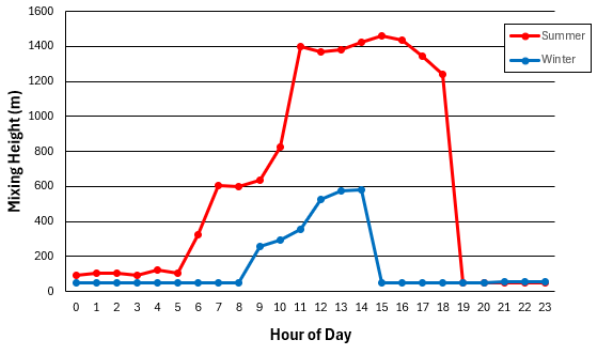
WTE Facility



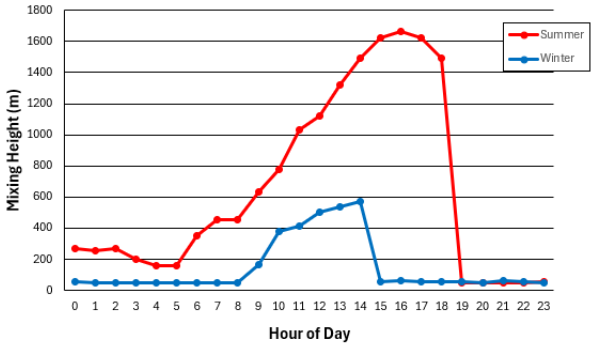
T13 North Delta



T17 Richmond South



T18 Burnaby South



T22 Burnaby-Burmount

Figure B.10: Diurnal Variation of Modelled Mixing Height for a Typical Summer Day (August 10, 2023), and a Typical Winter Day (January 1, 2023)

B.3.5 Precipitation

CALMET interpolates rainfall rates predicted by WRF (no observations). Modelled monthly precipitation patterns at the WTE Facility, as well as the T13 - North Delta, T17 - Richmond South, T18 - Burnaby South, and T22 - Burnaby–Burmount stations are illustrated in Figure B.11. The least amount of precipitation is expected to occur in the summer months from May to August, and the greatest amount of precipitation is expected to occur in in the winter months from November to January.

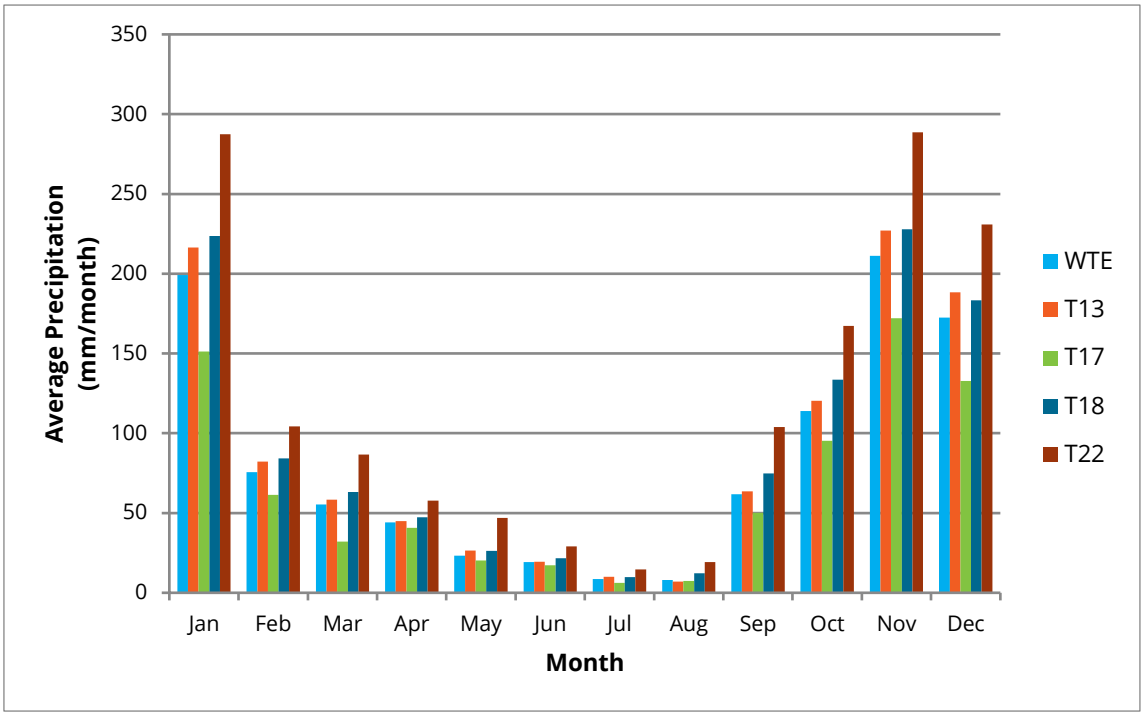


Figure B.11: Monthly Distribution of Averaged Modelled Precipitation

B.4 CALPUFF INPUTS

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 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 non-default technical options is shown in Table B.5.

Table B.5: Non-default CALPUFF Model Switch Settings

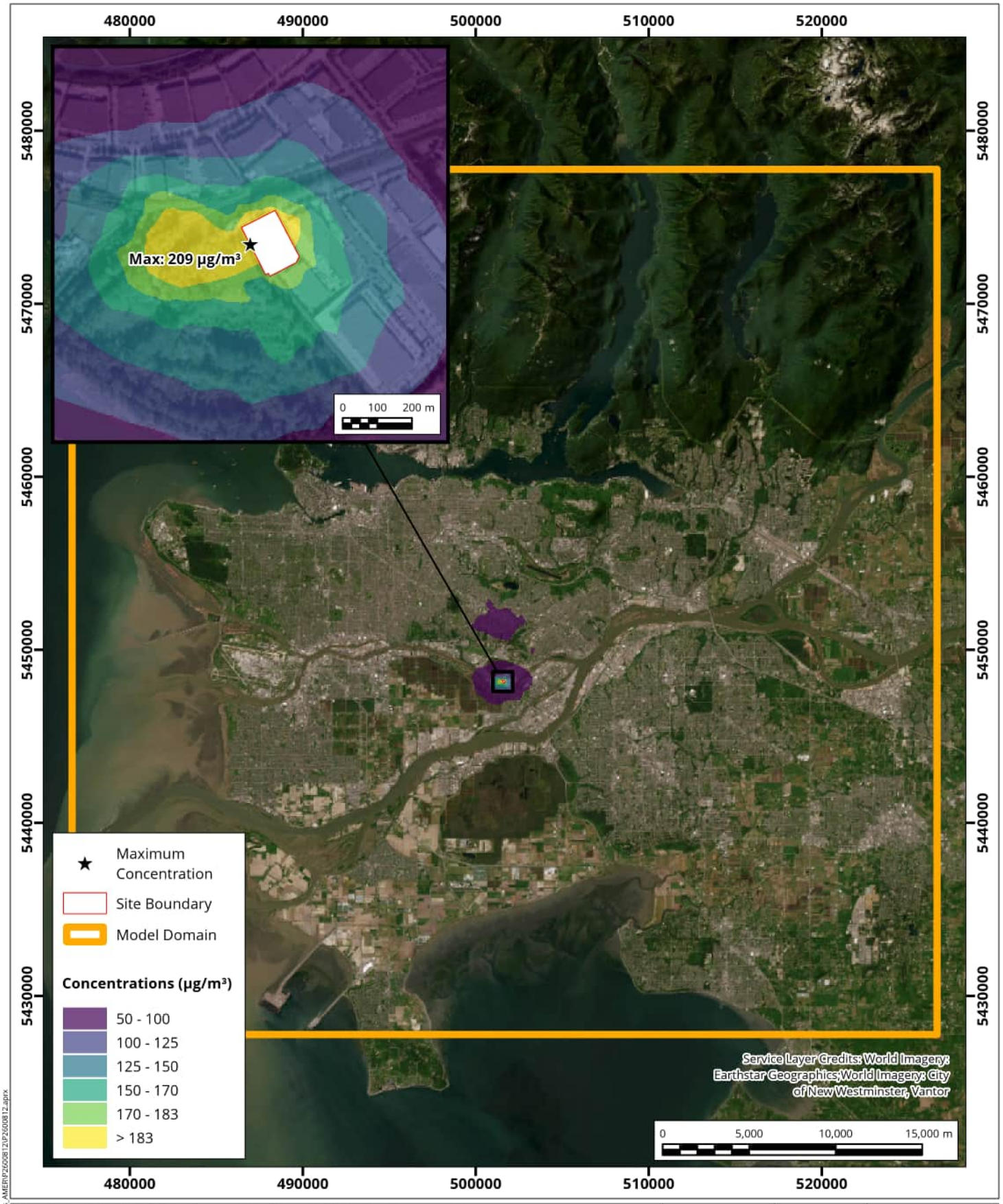
Parameter	Default	Project	Comments
MBDW	1	2	PRIME method used to stimulate building downwash
MCHEM	1	6	This switch affects contaminants involved in chemical transformation (SO2, NOx, NO2, PM, etc.). For this assessment, a unit emission rate was modelled in CALPUFF and results were scaled for all modelled contaminants, based on their corresponding emission rates. This switch, therefore, does not affect model results.
MDISP	3	2	Near-field dispersion coefficients internally calculated from sigma-v, sigma-w using micrometeorological variables as recommended by guidelines
MREG	1	0	Do not test options specified to see if they conform to United States Environmental Protection Agency regulatory values

APPENDIX C

List of Contour Plots in Appendix C

Note: All concentration contours include all modelled sources and background (if applicable).

Current OC Scenario	
Figure C.1	Predicted D1HM SO_2 Concentrations (With Background) – Scenario: Current OC
Figure C.2	Maximum Annual Count of D1HM SO_2 Excursions – Scenario: Current OC
Figure C.3	Predicted Annual SO_2 Concentrations (With Background) – Scenario: Current OC
Figure C.4	Predicted D1HM NO_2 Concentrations (With 98^{th}p Background) – Scenario: Current OC
Figure C.5	Maximum Annual Count of D1HM NO_2 Excursions – Scenario: Current OC
Figure C.6	Predicted Annual NO_2 Concentrations (With Background) – Scenario: Current OC
Figure C.7	Predicted 24-Hour $PM_{2.5}$ Concentrations (With Background) – Scenario: Current OC
Figure C.8	Predicted Annual $PM_{2.5}$ Concentrations (With Background) – Scenario: Current OC
Figure C.9	Predicted 1-Hour HCl Concentrations (With Background) – Scenario: Current OC
Figure C.10	Maximum Annual Count of 1-Hour HCl Excursions – Scenario: Current OC
Figure C.11	Predicted 24-Hour PAHs Concentrations (Without Background) – Scenario: Current OC
Figure C.12	Maximum Annual Count of 24-Hour PAHs Excursions – Scenario: Current OC
Figure C.13	Predicted Annual PAHs Concentrations (Without Background) – Scenario: Current OC
Proposed Operational Certificate Scenario	
Figure C.14	Predicted D1HM SO_2 Concentrations (With Background) – Scenario: Proposed OC
Figure C.15	Predicted Annual SO_2 Concentrations (With Background) – Scenario: Proposed OC
Figure C.16	Predicted D1HM NO_2 Concentrations (With 98^{th}p Background) – Scenario: Proposed OC
Figure C.17	Maximum Annual Count of D1HM NO_2 Excursions – Scenario: Proposed OC
Figure C.18	Predicted Annual NO_2 Concentrations (With Background) – Scenario: Proposed OC
Figure C.19	Predicted 1-Hour HCl Concentrations (With Background) – Scenario: Proposed OC
Figure C.20	Maximum Annual Count of 1-Hour HCl Excursions – Scenario: Proposed OC
Figure C.21	Predicted 24-Hour PAHs Concentrations (Without Background) – Scenario: Proposed OC
Figure C.22	Maximum Annual Count of 24-Hour PAHs Excursions – Scenario: Proposed OC
Figure C.23	Predicted Annual PAHs Concentrations (Without Background) – Scenario: Proposed OC
Current Operations Scenario	
Figure C.24	Predicted D1HM SO_2 Concentrations (With Background) – Scenario: Current Operations
Figure C.25	Predicted Annual SO_2 Concentrations (With Background) – Scenario: Current Operations
Figure C.26	Predicted D1HM NO_2 Concentrations (With 98^{th}p Background) – Scenario: Current Operations
Figure C.27	Maximum Annual Count of D1HM NO_2 Excursions – Scenario: Current Operations
Figure C.28	Predicted Annual NO_2 Concentrations (With Background) – Scenario: Current Operations
Figure C.29	Predicted 1-Hour HCl Concentrations (With Background) – Scenario: Current Operations
Figure C.30	Maximum Annual Count of 1-Hour HCl Excursions – Scenario: Current Operations
Startup Scenario	
Figure C.31	Predicted D1HM SO_2 Concentrations (With Background) – Scenario: Startup
Figure C.32	Predicted Annual SO_2 Concentrations (With Background) – Scenario: Startup
Figure C.33	Predicted D1HM NO_2 Concentrations (With 98^{th}p Background) – Scenario: Startup
Figure C.34	Maximum Annual Count of D1HM NO_2 Excursions – Scenario: Startup
Figure C.35	Predicted Annual NO_2 Concentrations (With Background) – Scenario: Startup
Figure C.36	Predicted 1-Hour HCl Concentrations (With Background) – Scenario: Startup
Figure C.37	Maximum Annual Count of 1-Hour HCl Excursions – Scenario: Startup
Shutdown Scenario	
Figure C.38	Predicted D1HM SO_2 Concentrations (With Background) – Scenario: Shutdown
Figure C.39	Predicted Annual SO_2 Concentrations (With Background) – Scenario: Shutdown
Figure C.40	Predicted D1HM NO_2 Concentrations (With 98^{th}p Background) – Scenario: Shutdown
Figure C.41	Maximum Annual Count of D1HM NO_2 Excursions – Scenario: Shutdown
Figure C.42	Predicted Annual NO_2 Concentrations (With Background) – Scenario: Shutdown
Figure C.43	Predicted 1-Hour HCl Concentrations (With Background) – Scenario: Shutdown
Figure C.44	Maximum Annual Count of 1-Hour HCl Excursions – Scenario: Shutdown
Figure C.45	Predicted 24-Hour PAHs Concentrations (Without Background) – Scenario: Shutdown
Figure C.46	Maximum Annual Count of 24-Hour PAHs Excursions – Scenario: Shutdown



Predicted D1HM SO_2 Concentrations (With Background)
Scenario: Current OC

Metric: Maximum of [99th percentile of D1HM concentration in each year, averaged over each three year period (2019-2021; 2020-2022; 2021-2023)]

Map Projection: NAD 1983 UTM Zone 10N

Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

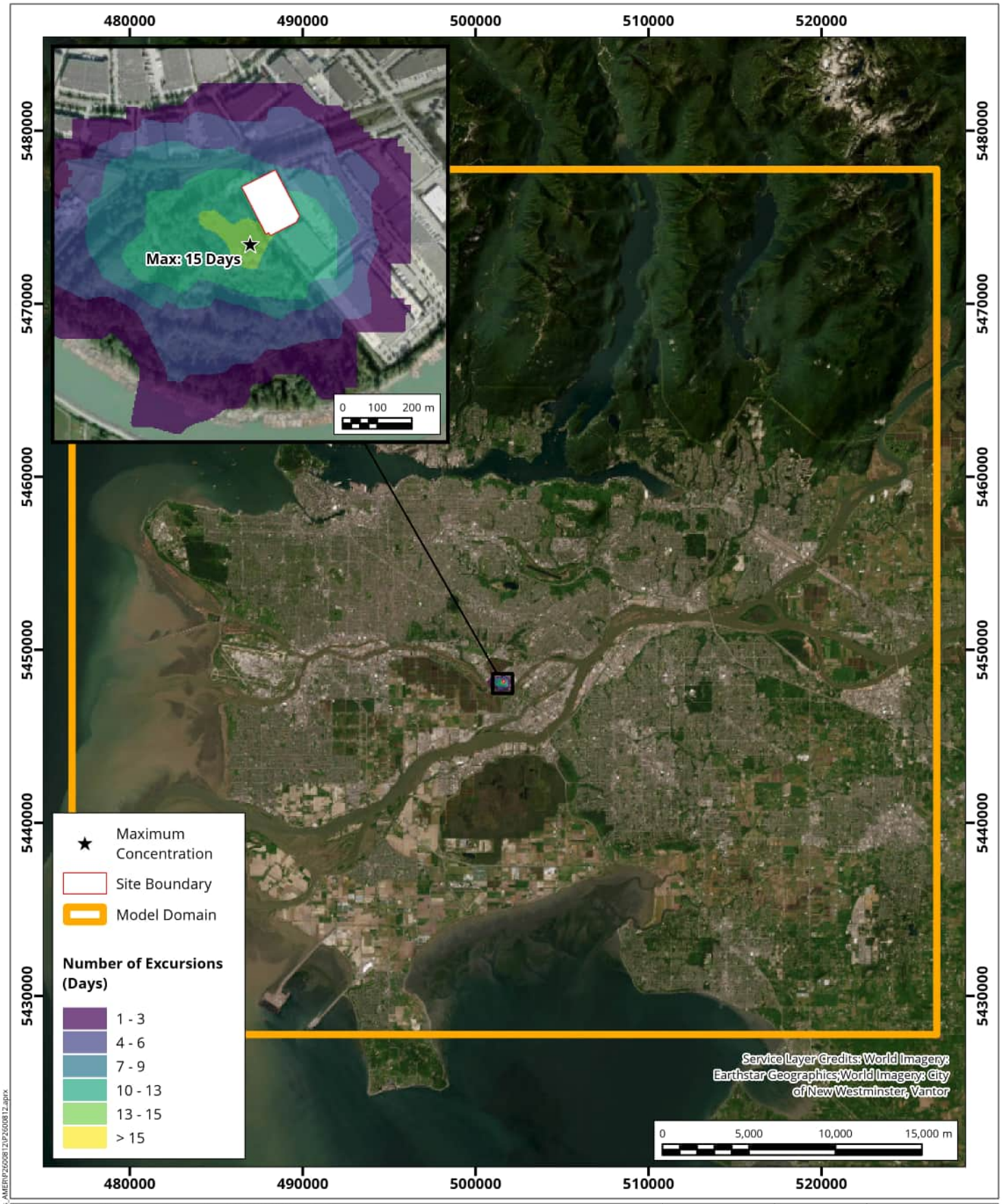
True North

MV AAQO: 183 µg/m³
BC AAQO and CAAQS: 170 µg/m³
Background Concentration: 7.1 µg/m³

Project #: 2600812

Drawn by: PIP	Figure: C.01
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Maximum Annual Count of D1HM SO_2 Excursions
Scenario: Current OC

D1HM Concentration including Background > CAAQS of 170 µg/m³

Map Projection: NAD 1983 UTM Zone 10N

Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

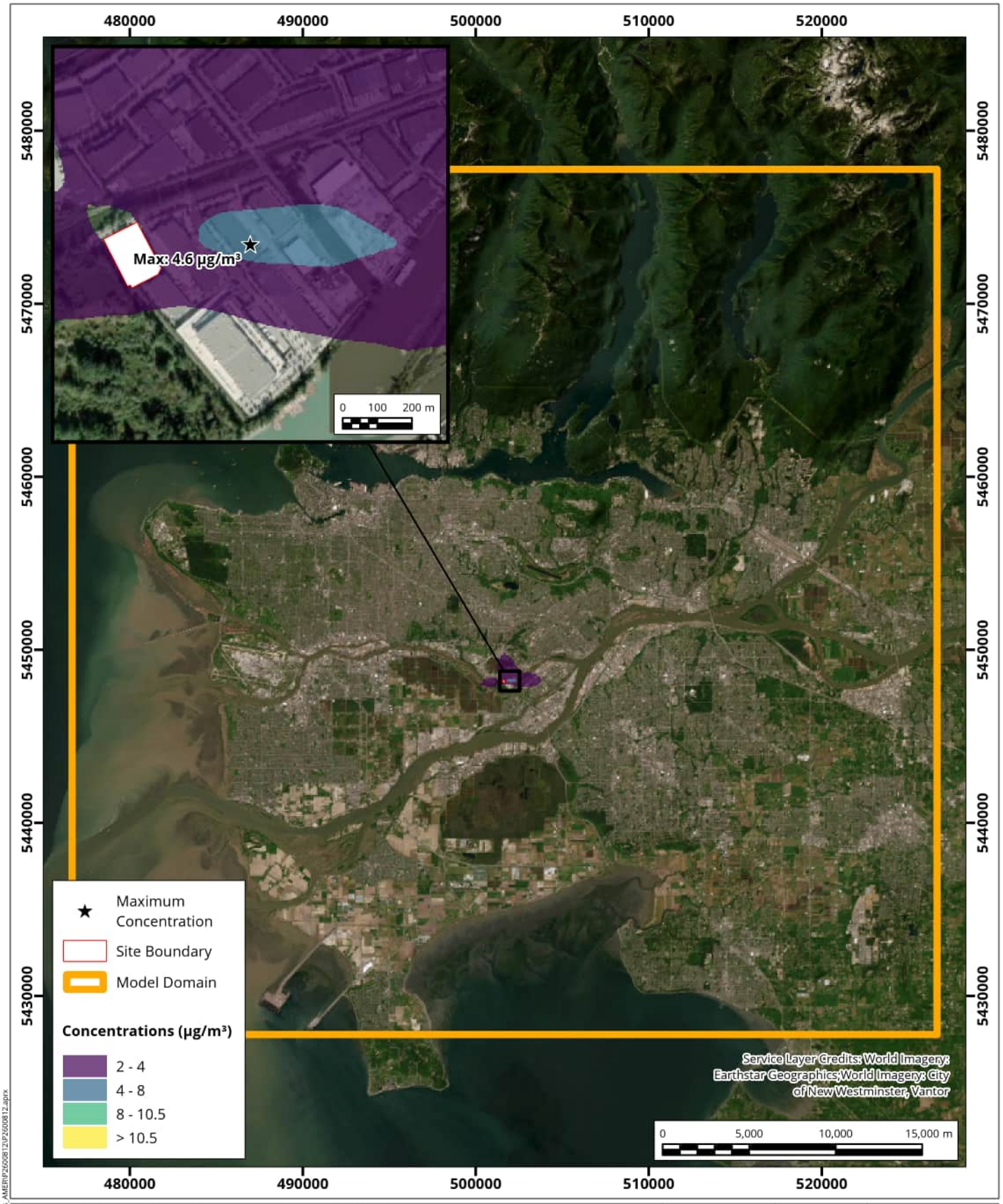
True North

MV AAQO: 183 µg/m³
BC AAQO and CAAQS: 170 µg/m³
Background Concentration: 7.1 µg/m³

Project #: 2600812

Drawn by: PIP	Figure: C.02
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Predicted Annual SO_2 Concentrations (With Background)
Scenario: Current OC

Metric: Annual average of hourly concentrations over one year, maximum over 2019-2023

Map Projection: NAD 1983 UTM Zone 10N

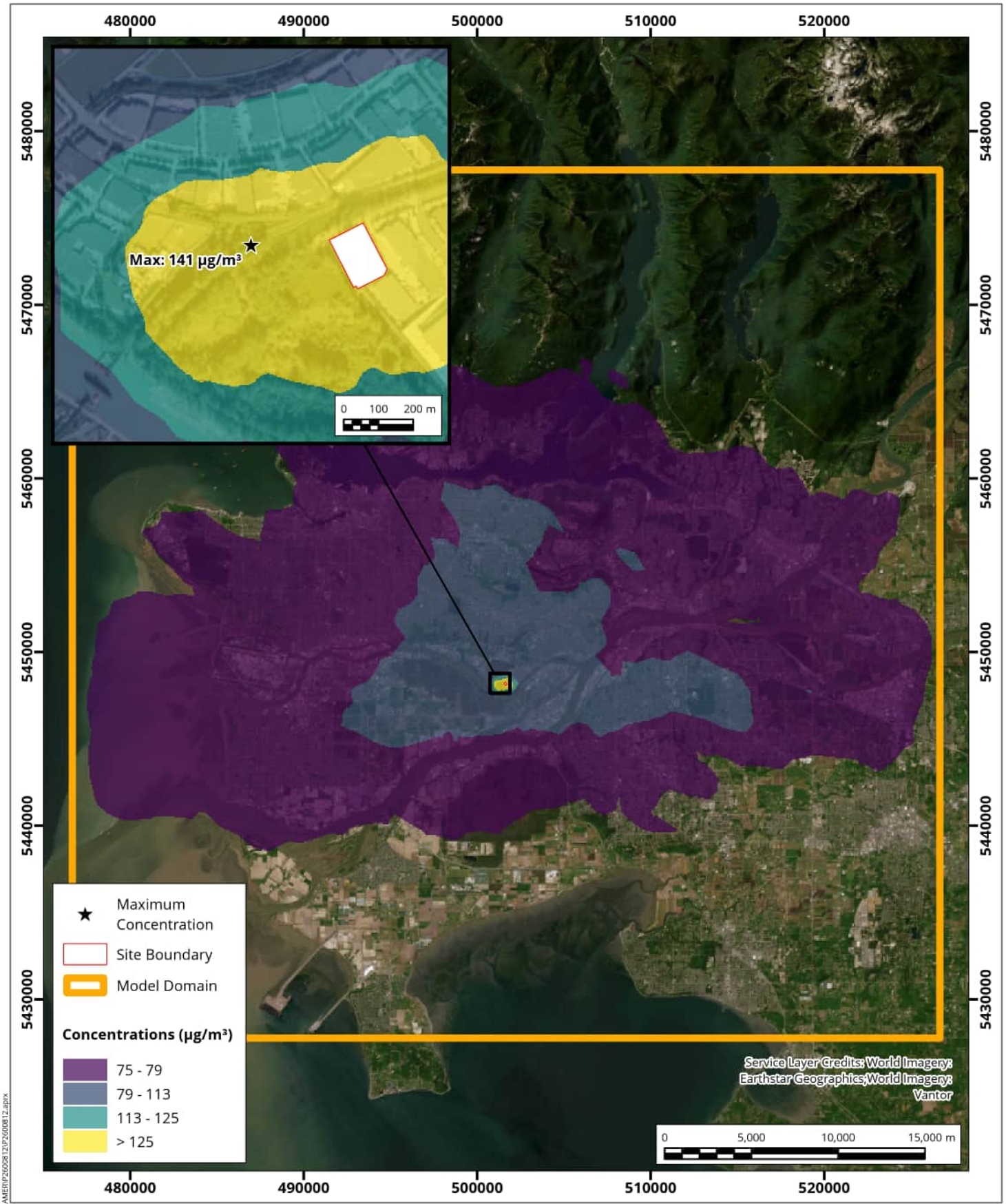
Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

True North

MV AAQO, BC AAQO and CAAQS: 10.5 µg/m³
Background Concentration: 0.8 µg/m³
Project #: 2600812

Drawn by: PIP	Figure: C.03
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working Folder\Jobs_AMER\P2600812\P2600812.aprx



Predicted D1HM NO_2 Concentrations (With 98thp Background)
Scenario: Current OC

Metric: Maximum of [98th percentile of D1HM concentration in each year, averaged over each three year period (2019-2021; 2020-2022; 2021-2023)]

Map Projection: NAD 1983 UTM Zone 10N

Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

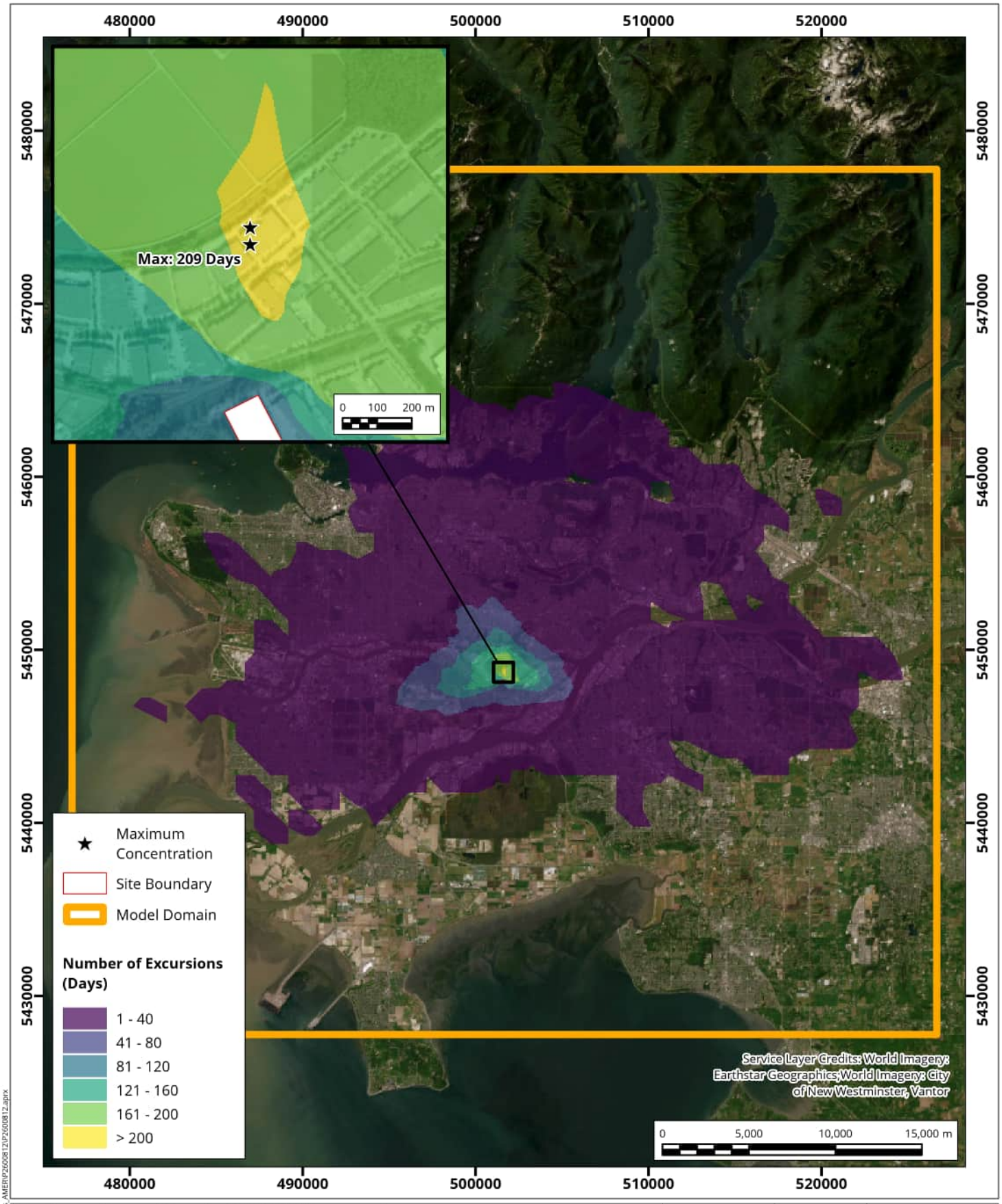
True North

BC AAQO: 113 µg/m³
MV AAQO and CAAQS: 79 µg/m³
Background Concentration: 73 µg/m³

Project #: 2600812

Drawn by: PIP	Figure: C.04
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Maximum Annual Count of D1HM NO_2 Excursions
Scenario: Current OC

D1HM Concentration (including 98thp Background) > MV AAQO of 79 µg/m^3

Map Projection: NAD 1983 UTM Zone 10N

Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

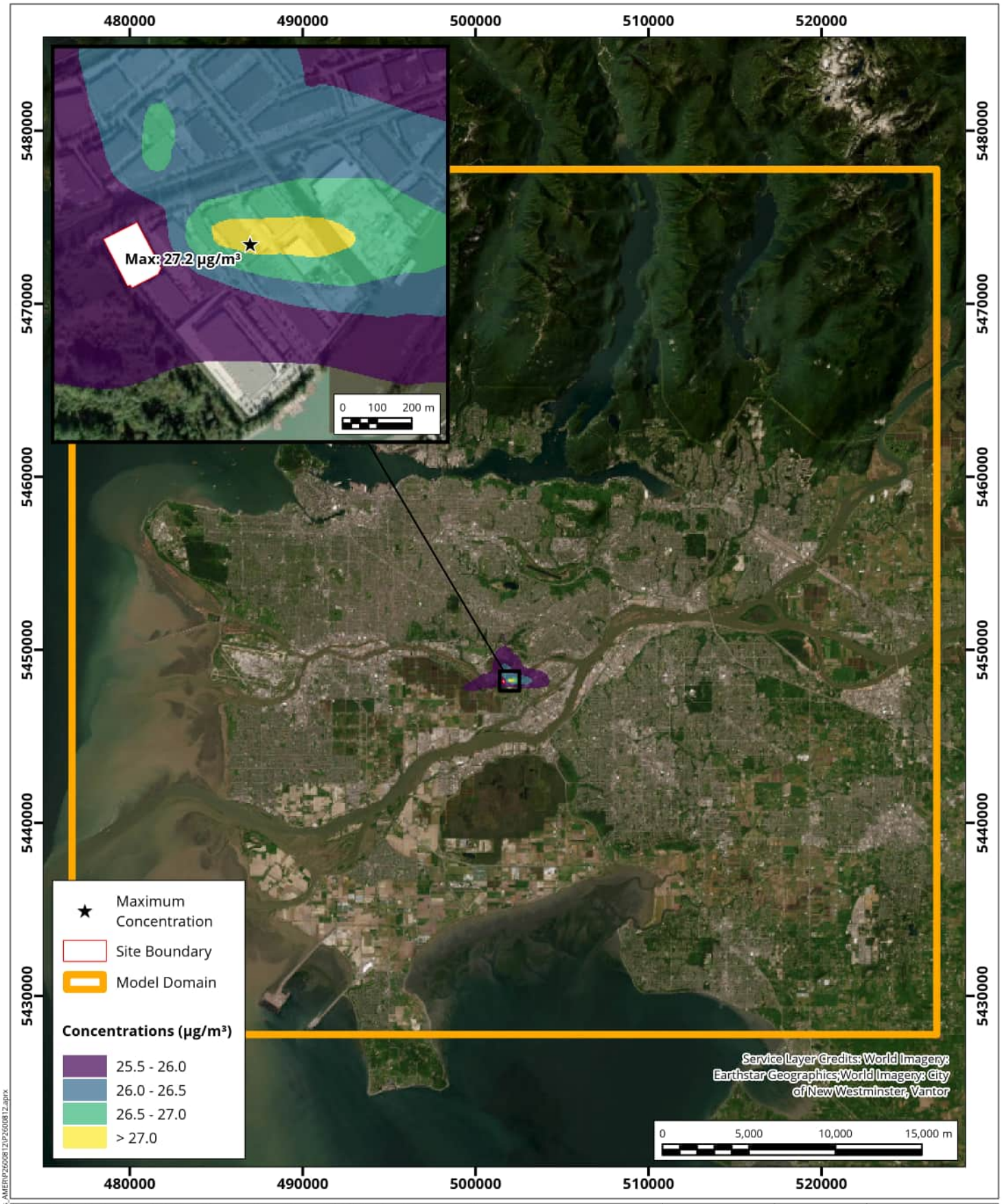
True North

BC AAQO: 113 µg/m^3
MV AAQO and CAAQS: 79 µg/m^3
Background Concentration: 73 µg/m^3

Project #: 2600812

Drawn by: PIP	Figure: C.05
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Predicted Annual NO_2 Concentrations (With Background)
Scenario: Current OC

Metric: Annual average of hourly concentrations over one year, maximum over 2019-2023

Map Projection: NAD 1983 UTM Zone 10N

Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

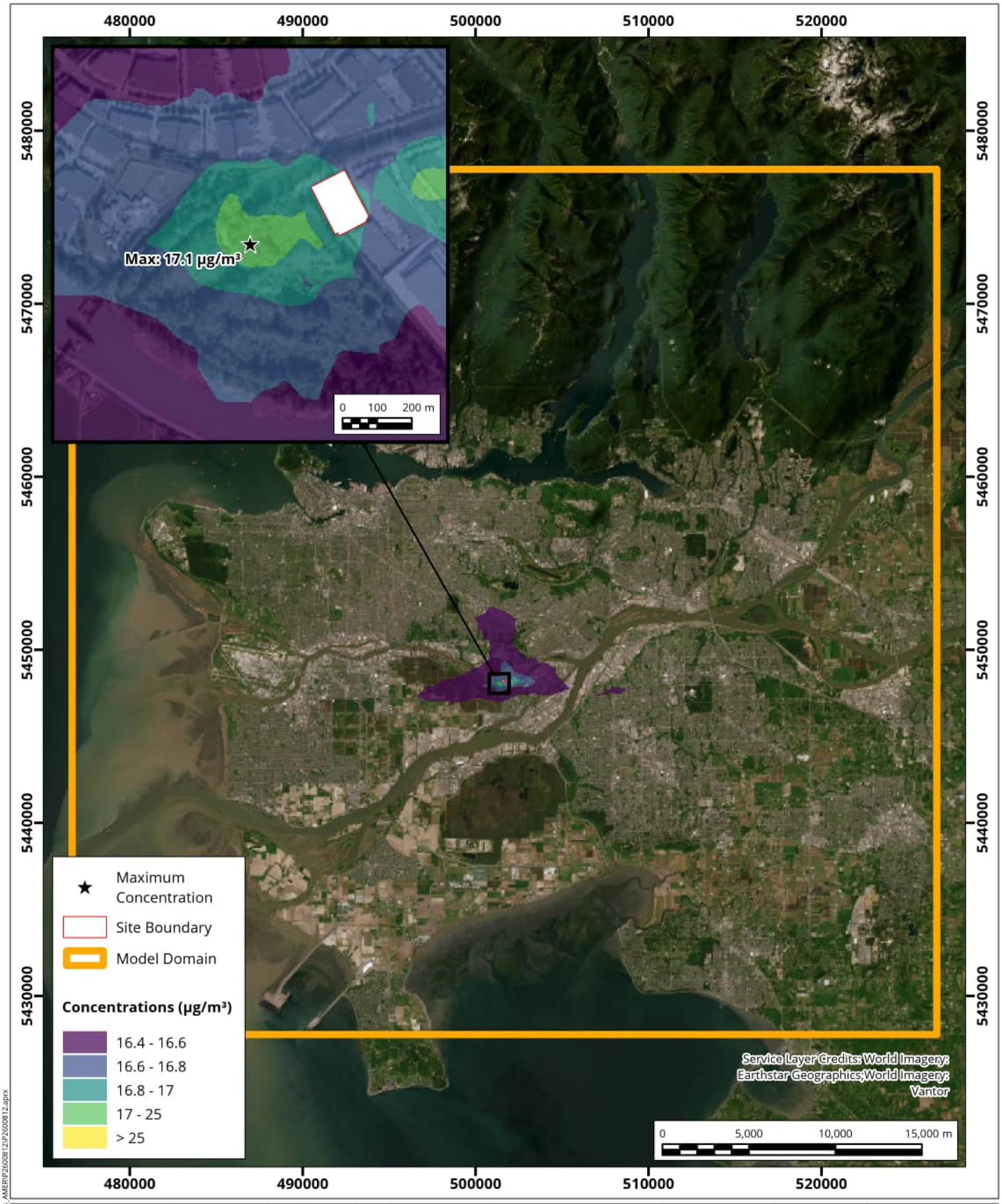
True North

BC AAQO: 32 µg/m³
MV AAQO and CAAQS: 22.6 µg/m³
Background Concentration: 25 µg/m³

Project #: 2600812

Drawn by: PIP	Figure: C.06
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working Folder\Jobs_AMER\P2600812\P2600812.aprx



Predicted 24-Hour $PM_{2.5}$ Concentrations (With Background)
Scenario: Current OC

Metric: 98th percentile 24-hour block averages in each year, maximum over 2019-2023

Map Projection: NAD 1983 UTM Zone 10N

Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

True North

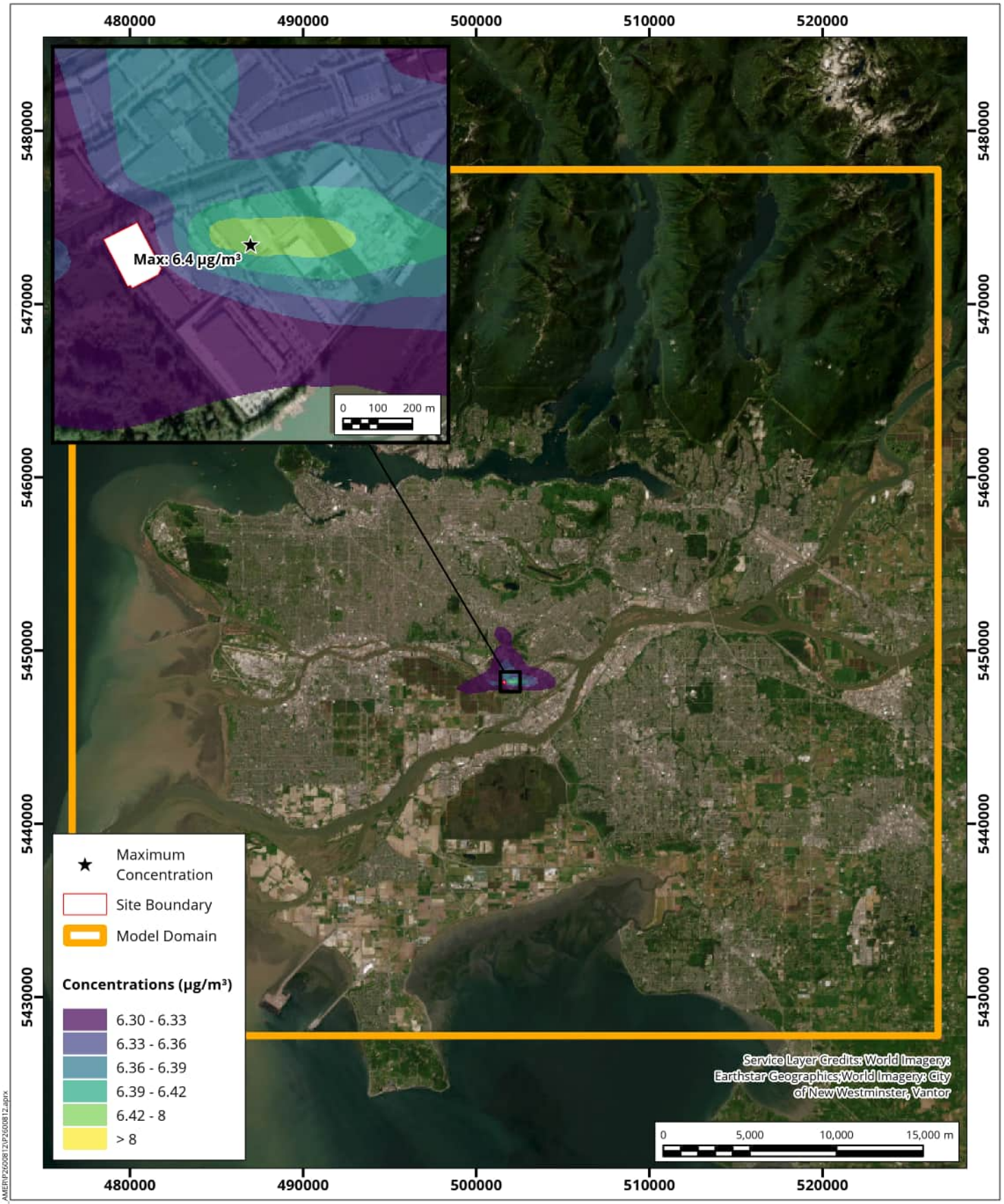
MV AAQO and BC AAQO: 25 µg/m³

Background Concentration: 16.2 µg/m³

Project #: 2600812

Drawn by: PIP	Figure: C.07
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working Folder\Jobs_AMER\P2600812\P2600812.aprx



Predicted Annual $PM_{2.5}$ Concentrations (With Background)
Scenario: Current OC

Metric: Annual average of hourly concentrations over one year, maximum over 2019-2023

Map Projection: NAD 1983 UTM Zone 10N

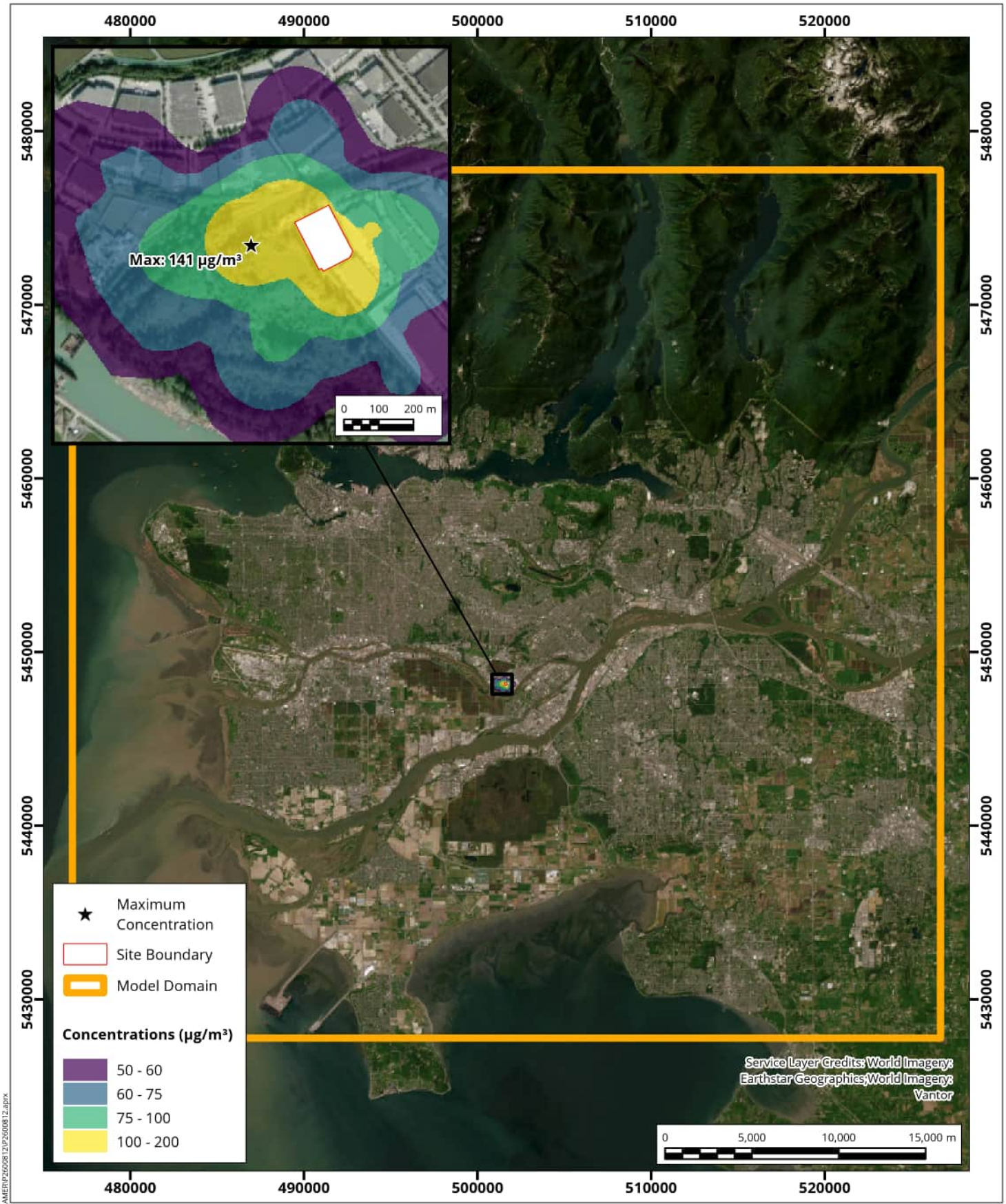
Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

True North

MV AAQO and BC AAQO: 8 µg/m³
Background Concentration: 6.3 µg/m³
Project #: 2600812

Drawn by: PIP	Figure: C.08
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Predicted 1-Hour HCl Concentrations (With Background)
Scenario: Current OC

Metric: Maximum of 1-hour concentrations over 2019-2023

True North

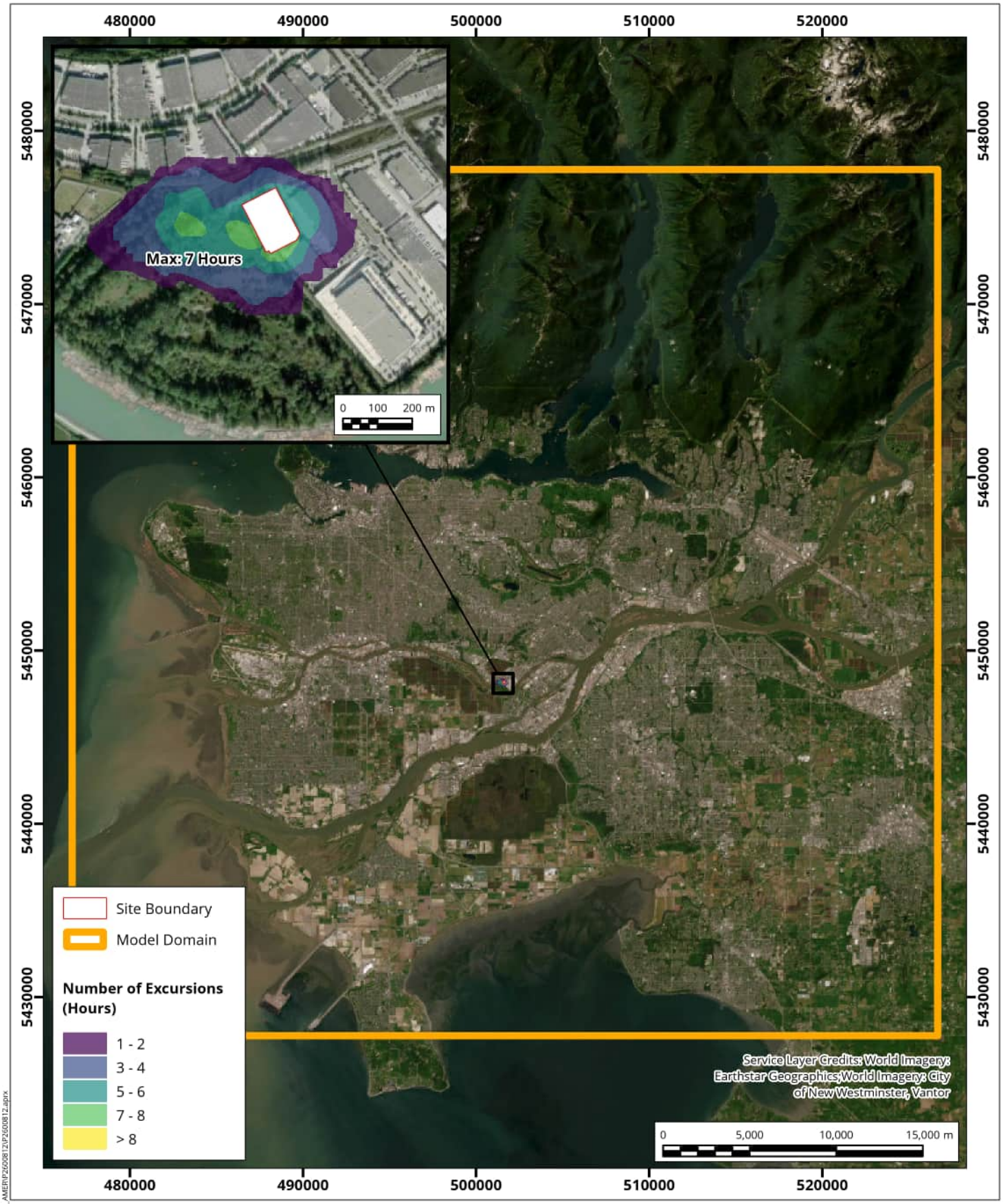
AAAQO: 75 µg/m³
Background Concentration: 2.1 µg/m³

Map Projection: NAD 1983 UTM Zone 10N
Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

Project #: 2600812

Drawn by: PIP	Figure: C.09
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Maximum Annual Count of 1-Hour HCl Excursions
Scenario: Current OC

Concentration including Background > AAAQO of 75 µg/m³

True North

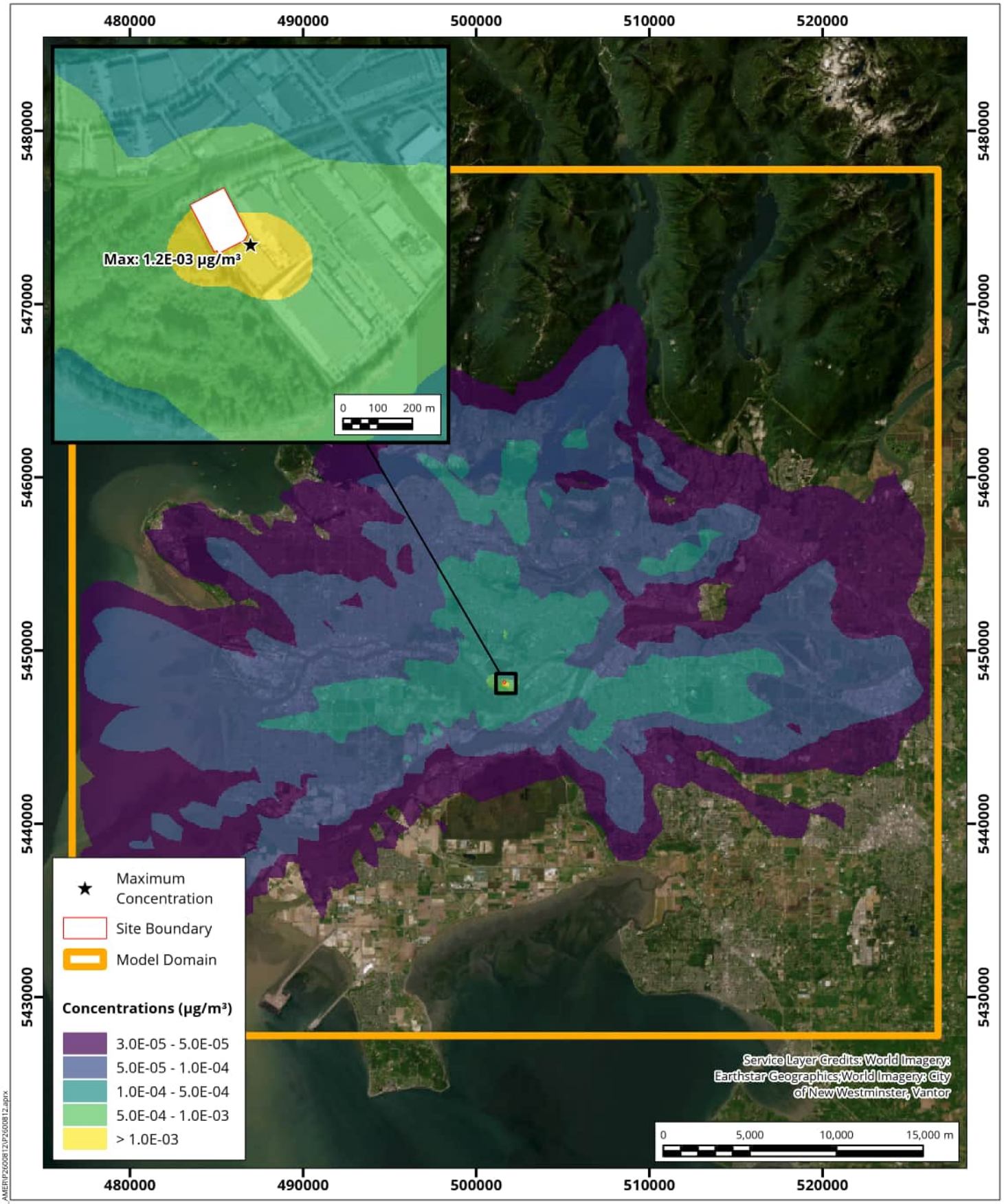
AAAQO: 75 µg/m³
Background Concentration: 2.1 µg/m³

Map Projection: NAD 1983 UTM Zone 10N
Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

Project #: 2600812

Drawn by: PIP	Figure: C.10
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Predicted 24-Hour PAHs Concentrations (Without Background)
Scenario: Current OC

Metric: Maximum of 24-hour block average values over 2019-2023

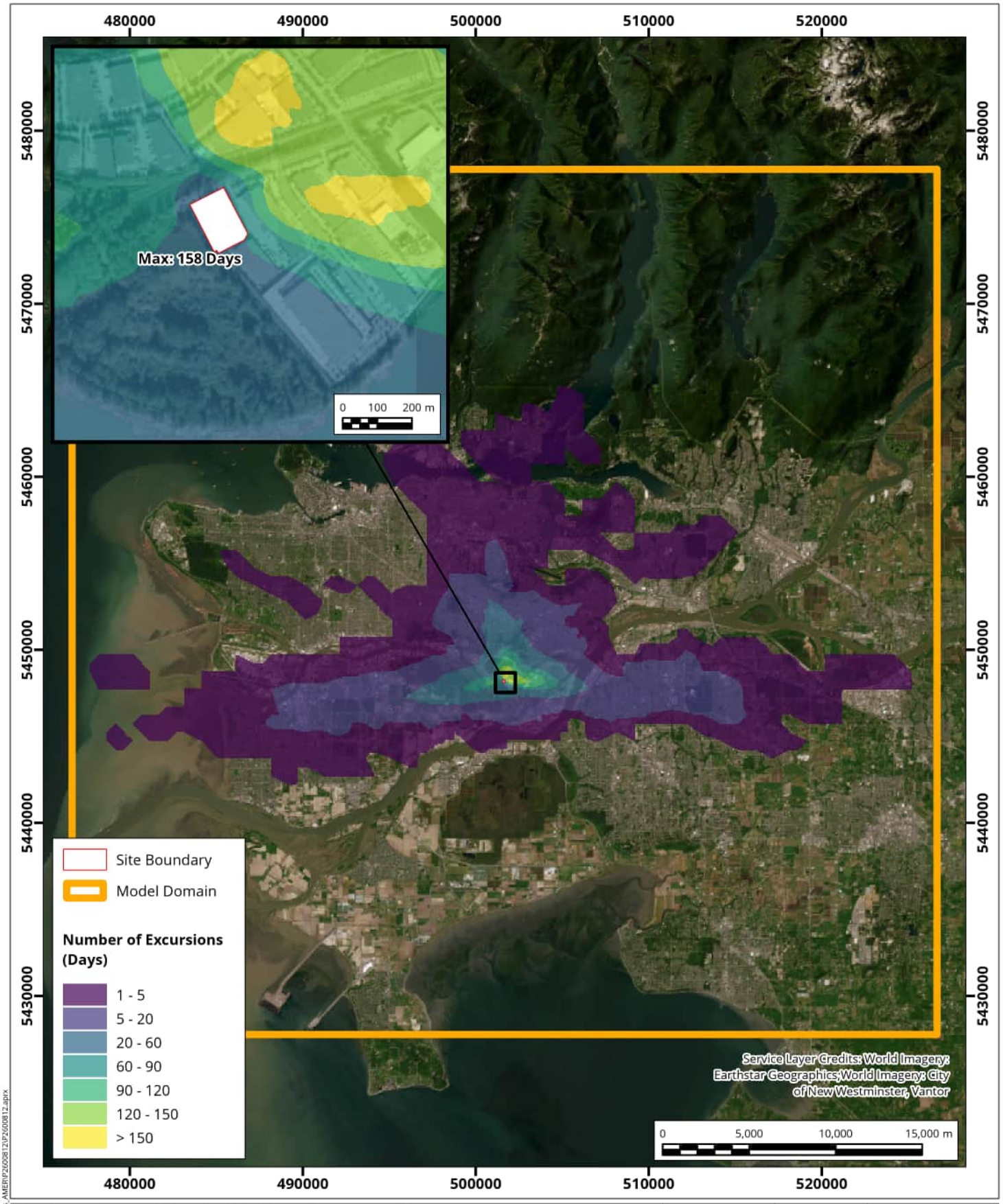
True North

Drawn by: PIP	Figure: C.11
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Projection: NAD 1983 UTM Zone 10N
Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

OAAQC: 5E-05 µg/m³
Project #: 2600812

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Maximum Annual Count of 24-Hour PAH Excursions
Scenario: Current OC

Concentration Without Background > OAAQC of 5E-05 µg/m³

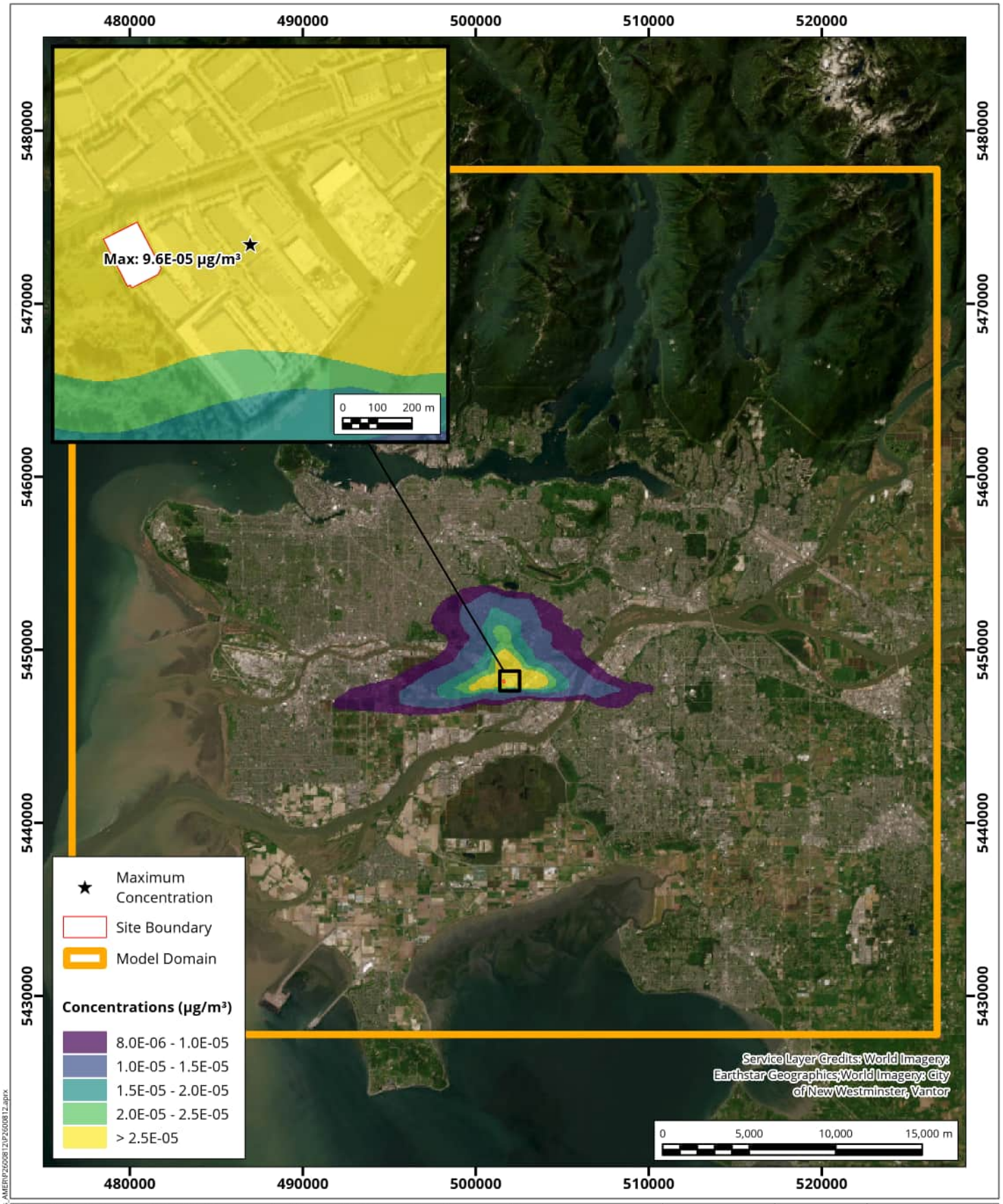
True North

Drawn by: PIP	Figure: C.12
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Projection: NAD 1983 UTM Zone 10N
Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

OAAQC: 5E-05 µg/m³
Project #: 2600812

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Predicted Annual PAHs Concentrations (Without Background)
Scenario: Current OC

Metric: Annual average of hourly concentrations over one year, maximum over 2019-2023

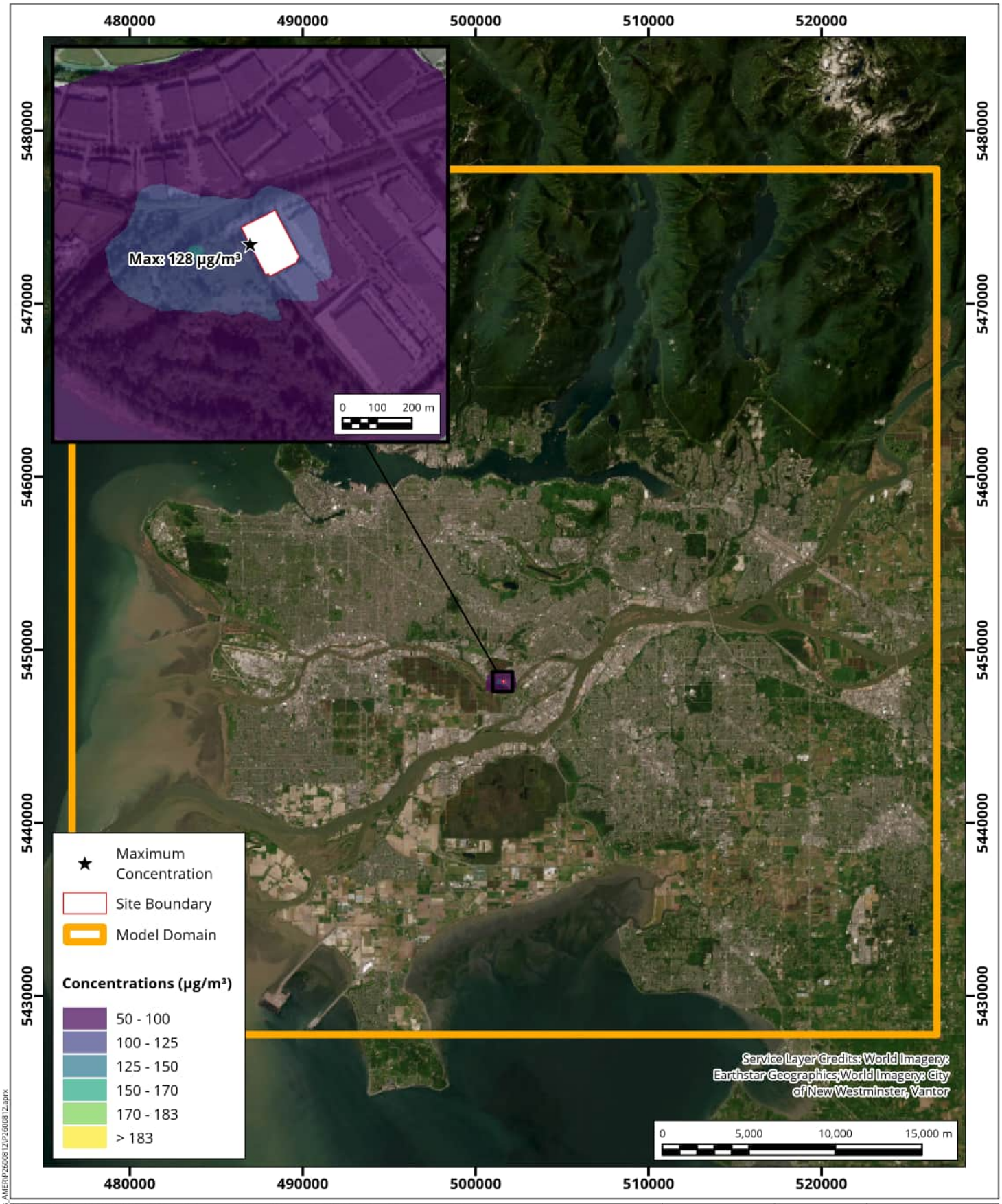
Map Projection: NAD 1983 UTM Zone 10N
Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

True North

OAAQC: 1E-05 µg/m³
Project #: 2600812

Drawn by: PIP	Figure: C.13
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Predicted D1HM SO_2 Concentrations (With Background)
Scenario: Proposed OC

Metric: Maximum of [99th percentile of D1HM concentration in each year, averaged over each three year period (2019-2021; 2020-2022; 2021-2023)]

Map Projection: NAD 1983 UTM Zone 10N

Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

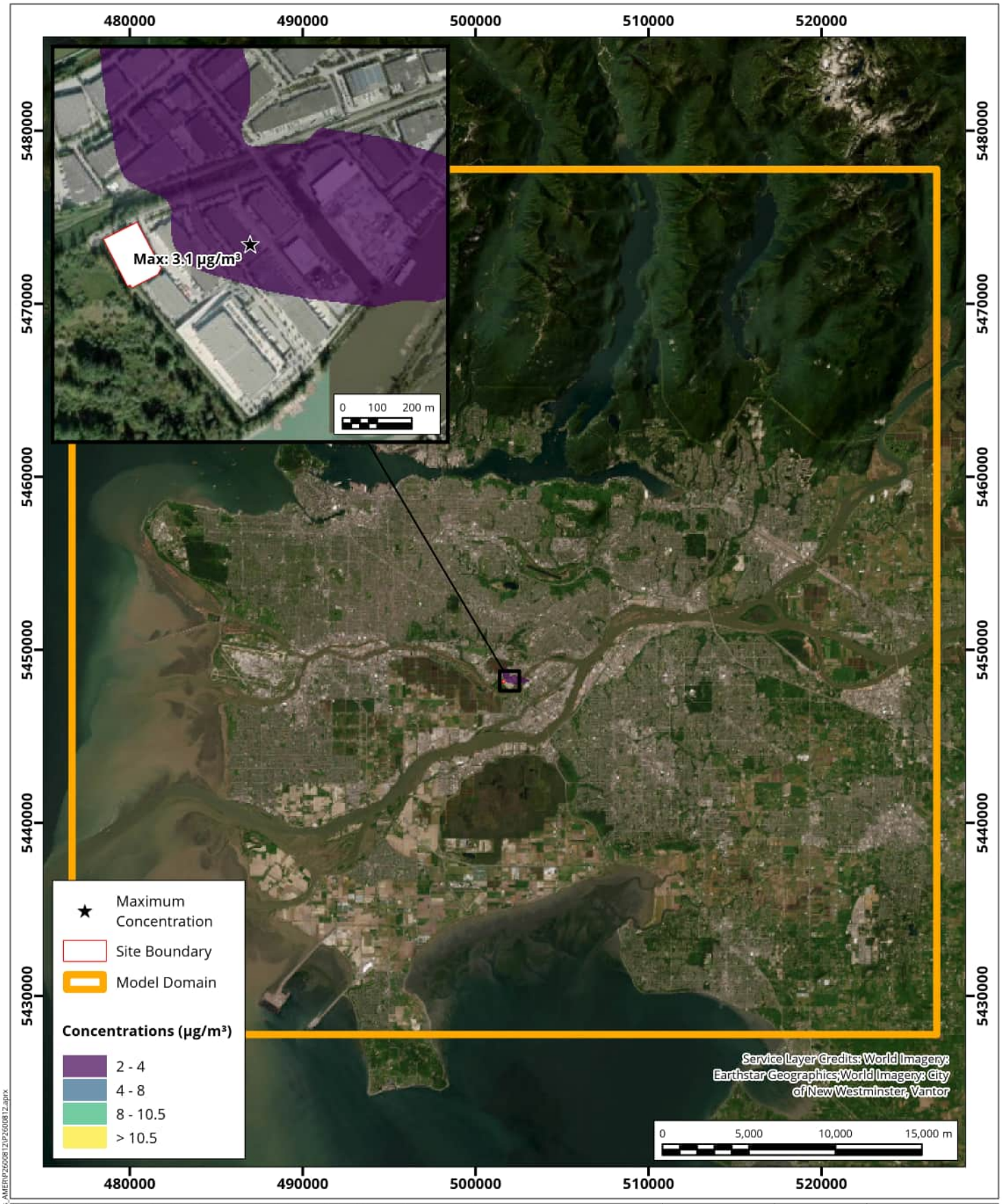
True North

MV AAQO: 183 µg/m³
BC AAQO and CAAQS: 170 µg/m³
Background Concentration: 7.1 µg/m³

Project #: 2600812

Drawn by: PIP	Figure: C.14
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working Folder\Jobs_AMER\P2600812\P2600812.aprx



Predicted Annual SO_2 Concentrations (With Background)
Scenario: Proposed OC

Metric: Annual average of hourly concentrations over one year, maximum over 2019-2023

Map Projection: NAD 1983 UTM Zone 10N

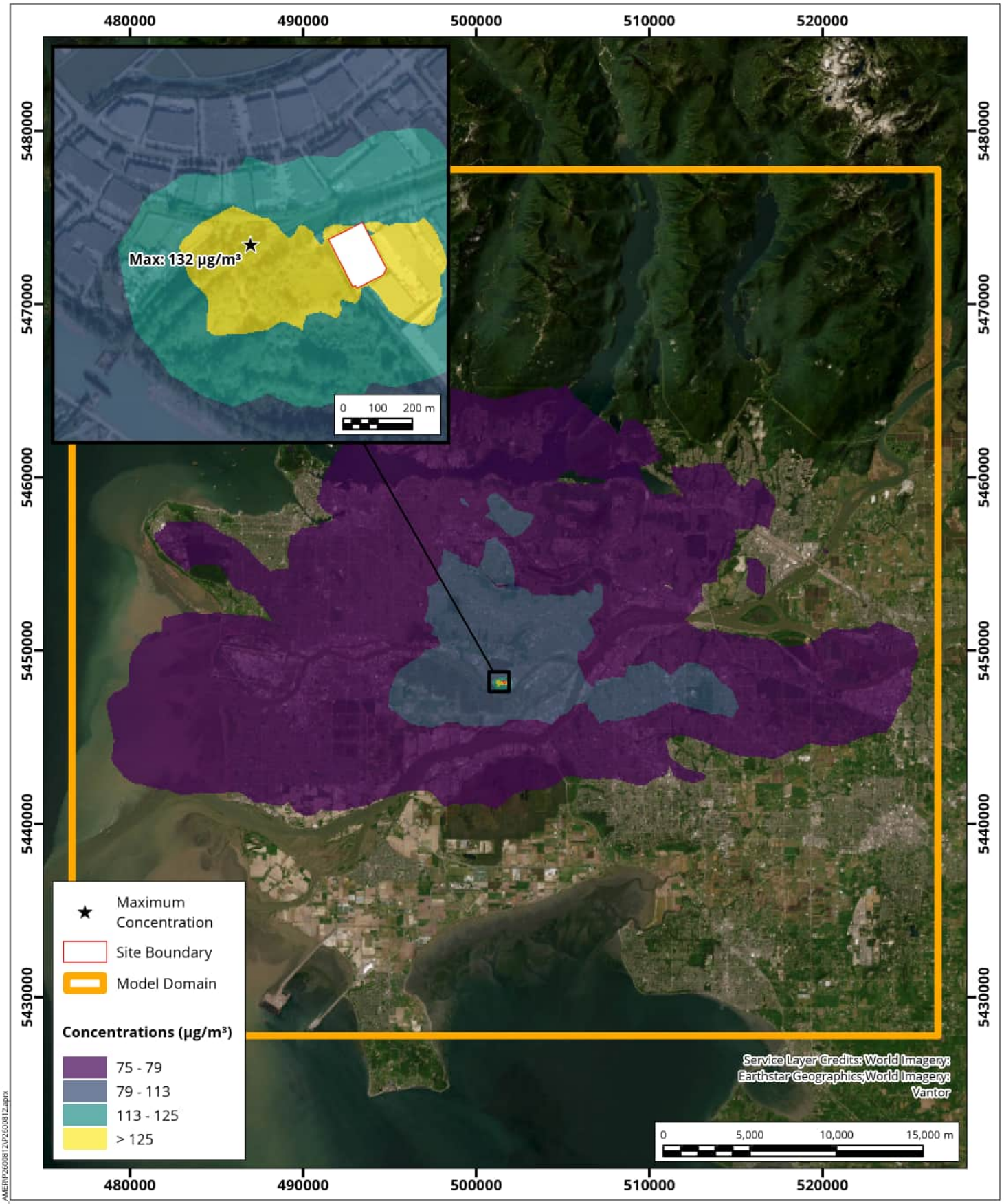
Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

True North

MV AAQO, BC AAQO and CAAQS: 10.5 µg/m³
Background Concentration: 0.8 µg/m³
Project #: 2600812

Drawn by: PIP	Figure: C.15
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Predicted D1HM NO_2 Concentrations (With 98thp Background)
Scenario: Proposed OC

Metric: Maximum of [98th percentile of D1HM concentration in each year, averaged over each three year period (2019-2021; 2020-2022; 2021-2023)]

Map Projection: NAD 1983 UTM Zone 10N

Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

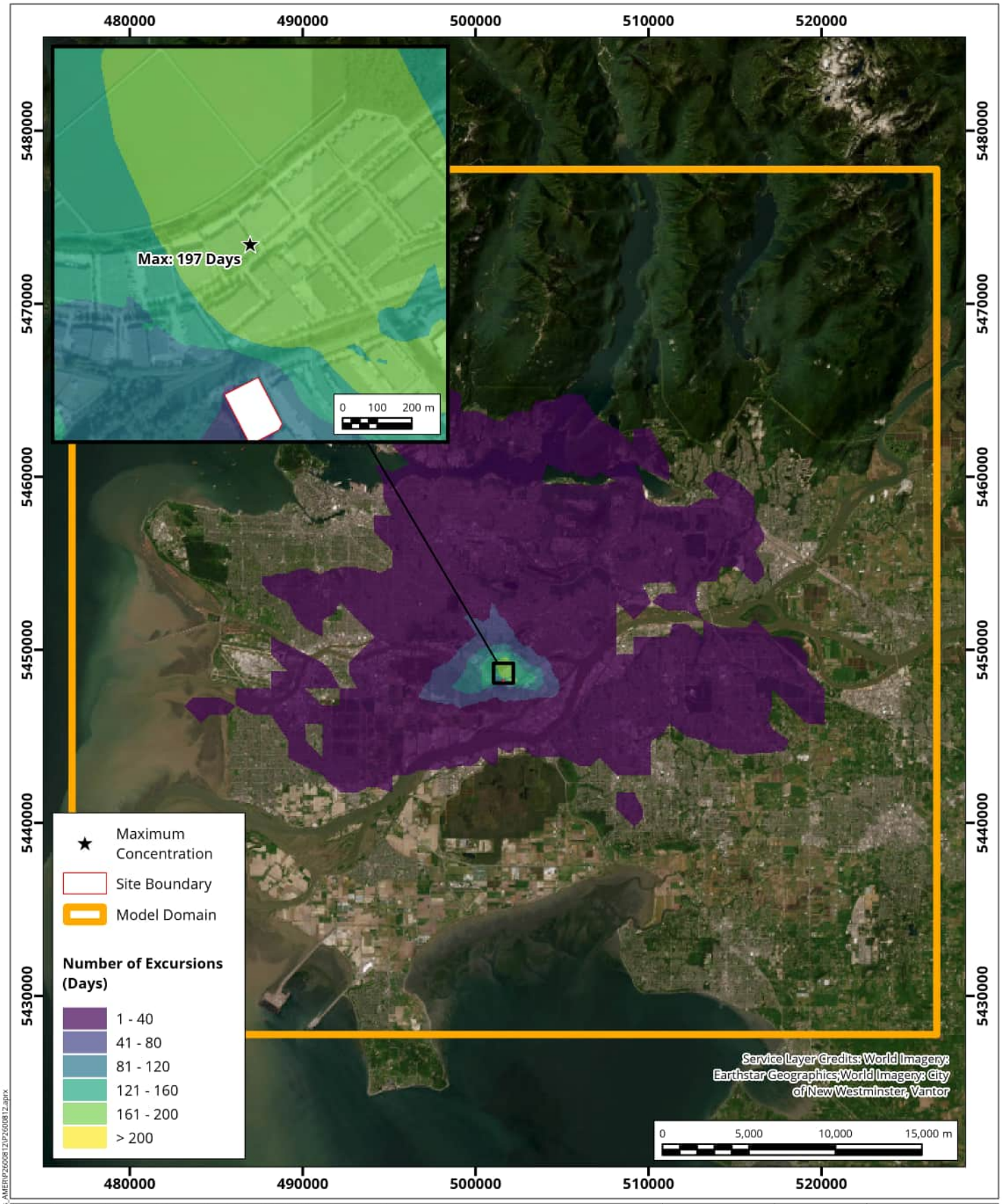
True North

BC AAQO: 113 µg/m³
MV AAQO and CAAQS: 79 µg/m³
Background Concentration: 73 µg/m³

Project #: 2600812

Drawn by: PIP	Figure: C.16
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working Folder\Jobs_AMER\P2600812\P2600812.aprx



Maximum Annual Count of D1HM NO_2 Excursions
Scenario: Proposed OC

D1HM Concentration (including 98thp Background) > MV AAQO of 79 µg/m^3

Map Projection: NAD 1983 UTM Zone 10N

Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

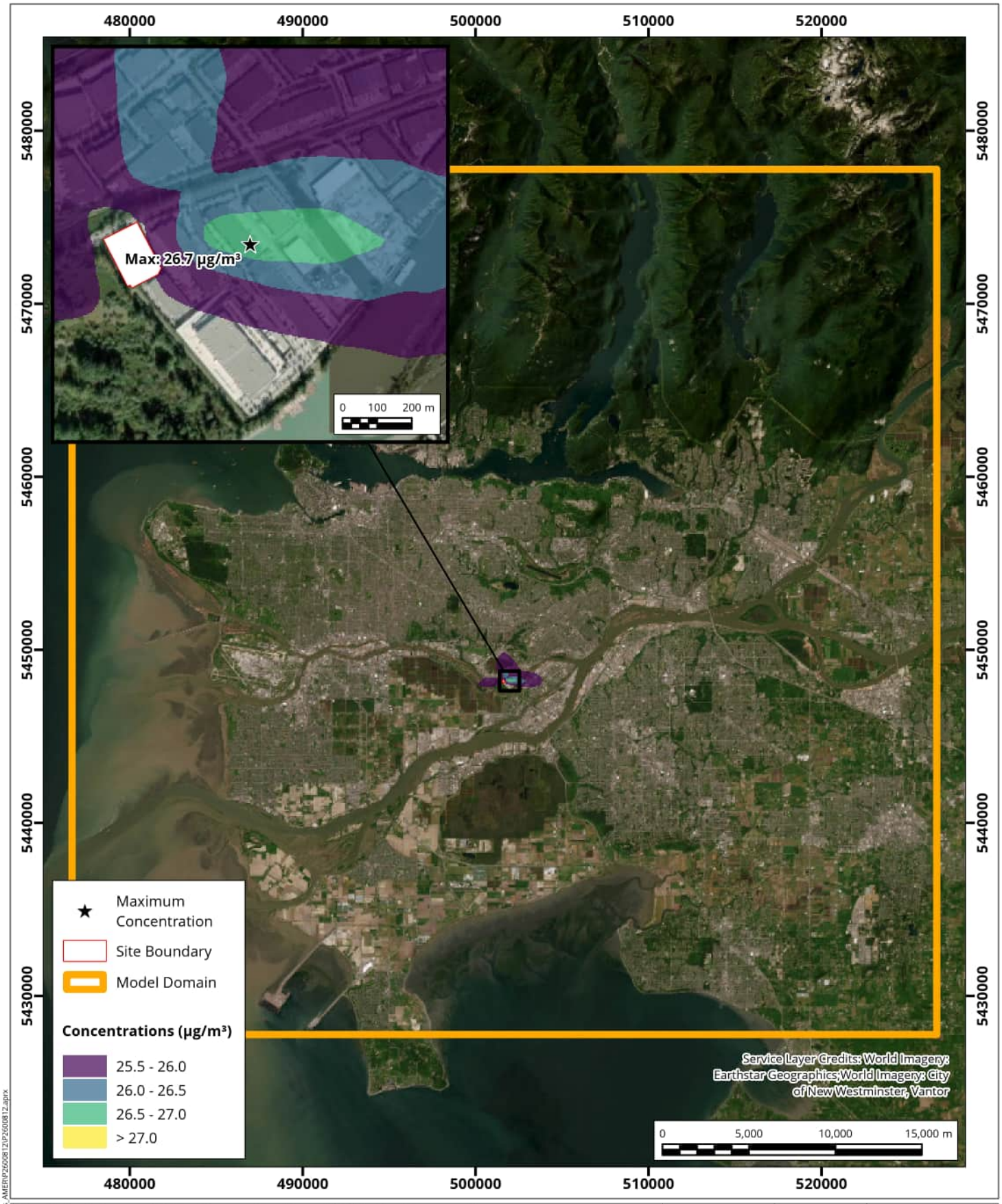
True North

BC AAQO: 113 µg/m^3
MV AAQO and CAAQS: 79 µg/m^3
Background Concentration: 73 µg/m^3

Project #: 2600812

Drawn by: PIP	Figure: C.17
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Predicted Annual NO_2 Concentrations (With Background)
Scenario: Proposed OC

Metric: Annual average of hourly concentrations over one year, maximum over 2019-2023

Map Projection: NAD 1983 UTM Zone 10N

Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

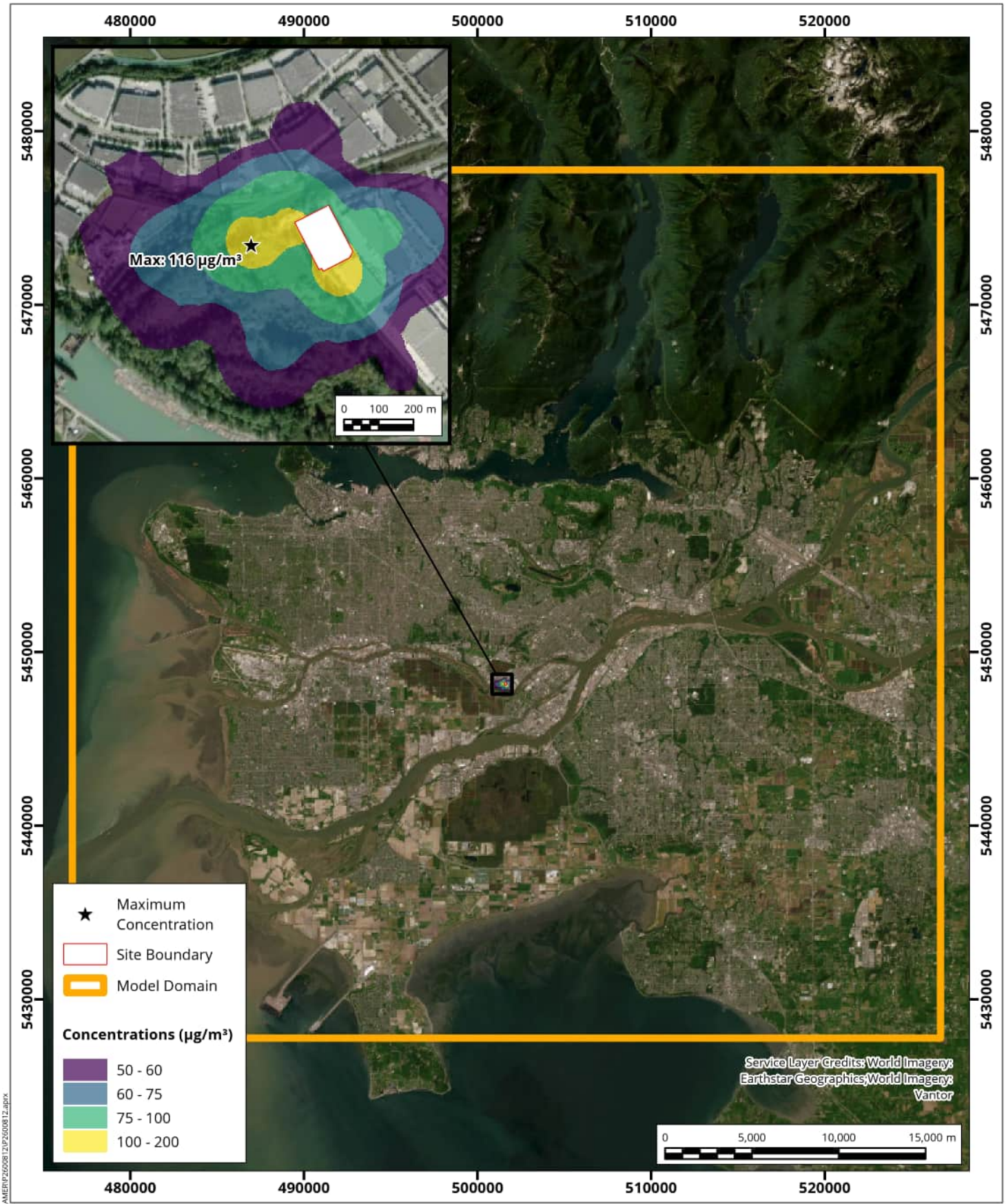
True North

BC AAQO: 32 µg/m³
MV AAQO and CAAQS: 22.6 µg/m³
Background Concentration: 25 µg/m³

Project #: 2600812

Drawn by: PIP	Figure: C.18
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working Folder\Jobs_AMER\P2600812\P2600812.aprx



Predicted 1-Hour HCl Concentrations (With Background)
Scenario: Proposed OC

Metric: Maximum of 1-hour concentrations over 2019-2023

True North

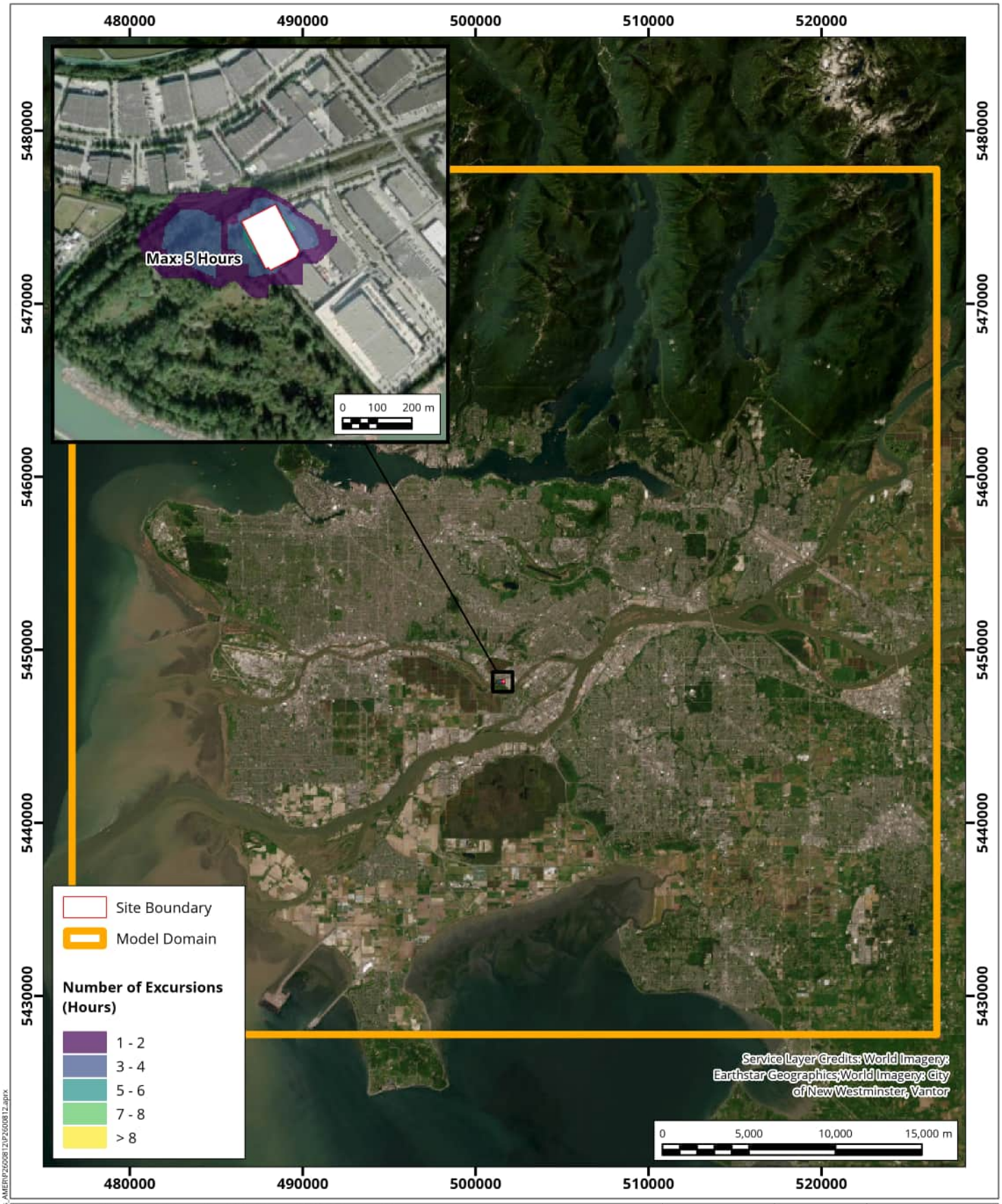
AAAQO: 75 µg/m³
Background Concentration: 2.1 µg/m³

Map Projection: NAD 1983 UTM Zone 10N
Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

Project #: 2600812

Drawn by: PIP	Figure: C.19
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Maximum Annual Count of 1-Hour HCl Excursions
Scenario: Proposed OC

Concentration including Background > AAAQO of 75 µg/m³

True North

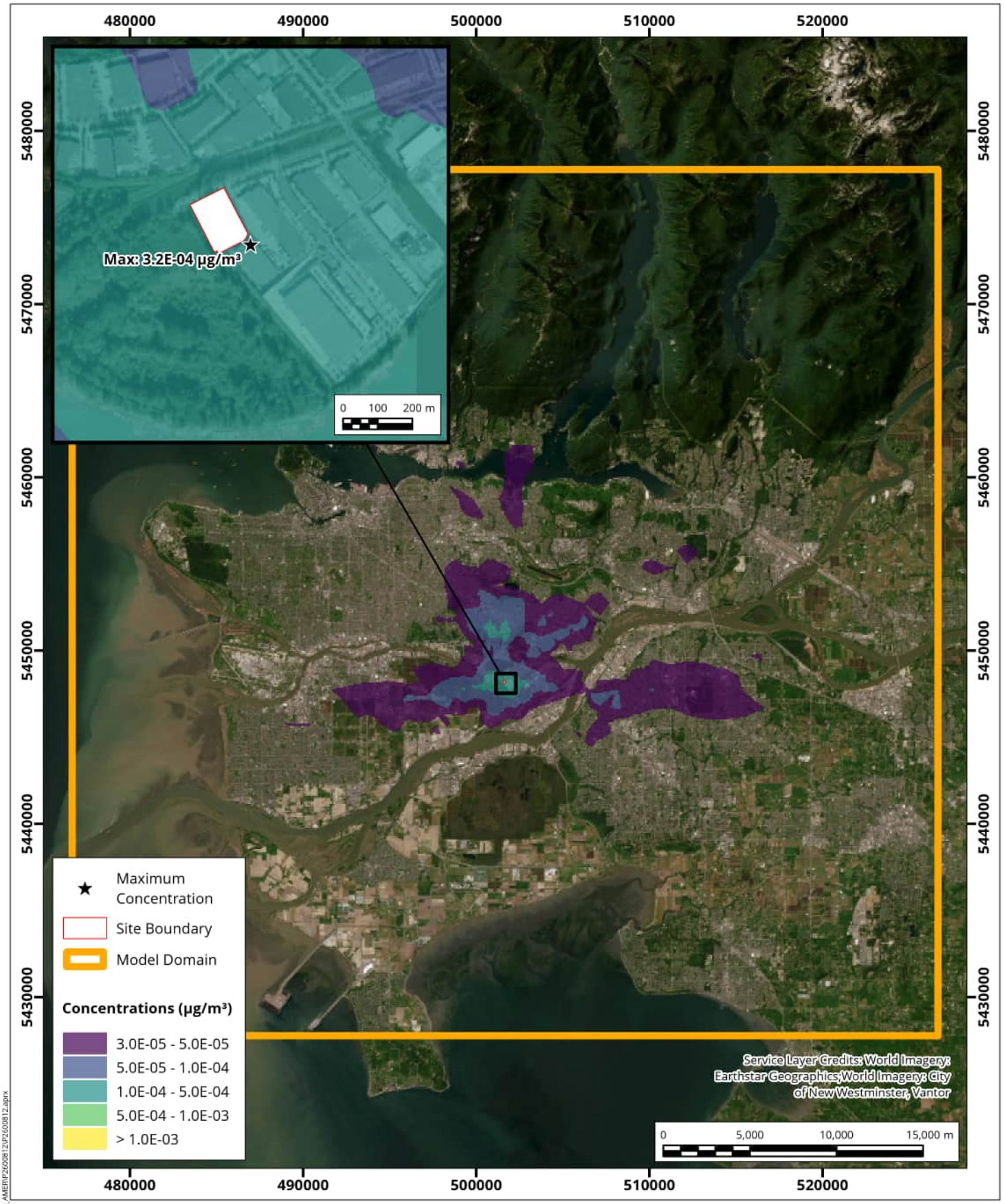
AAAQO: 75 µg/m³
Background Concentration: 2.1 µg/m³

Map Projection: NAD 1983 UTM Zone 10N
Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

Project #: 2600812

Drawn by: PIP	Figure: C.20
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Predicted 24-Hour PAHs Concentrations (Without Background)
Scenario: Proposed OC

Metric: Maximum of 24-hour block average values over 2019-2023

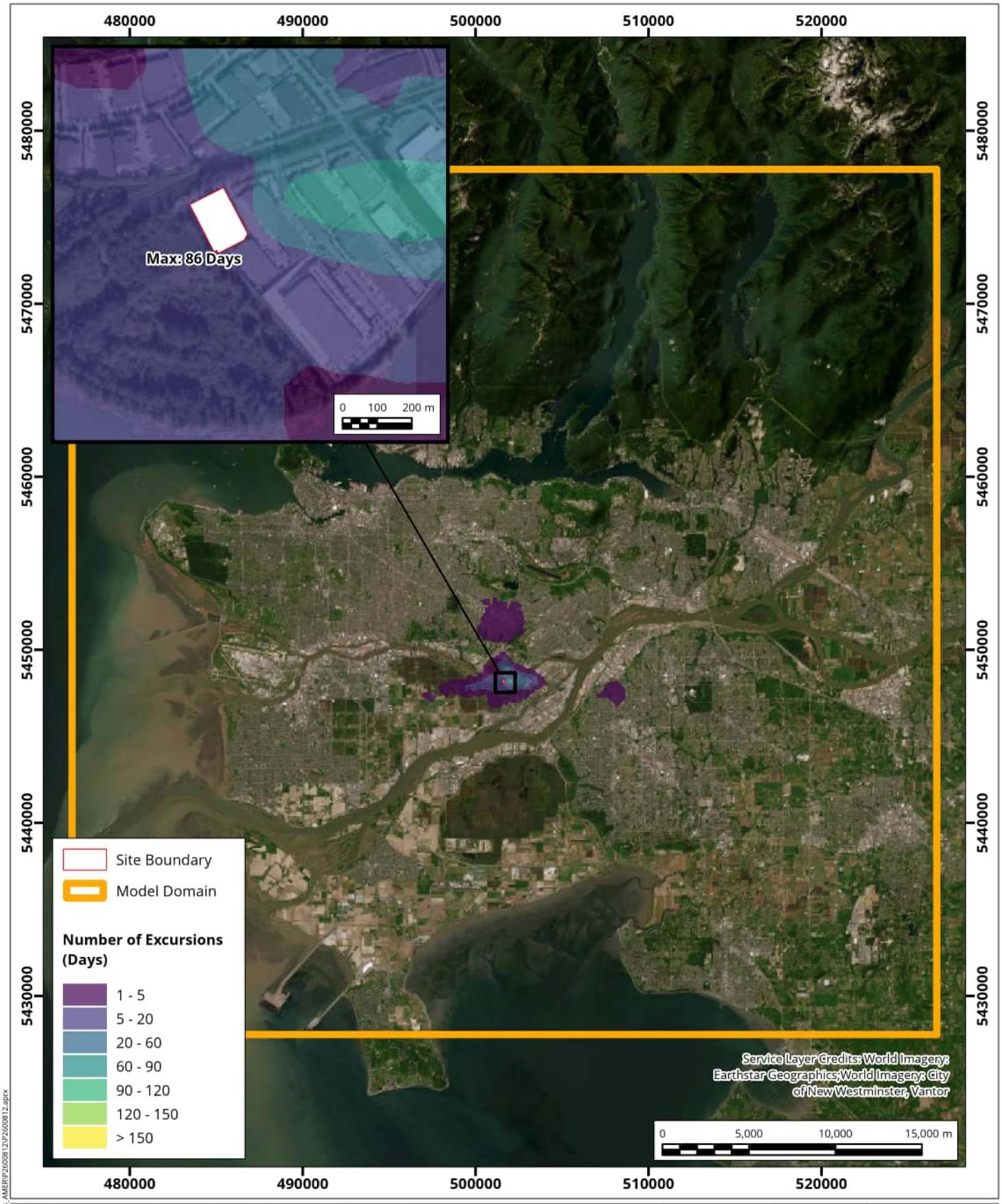
True North

Drawn by: PIP	Figure: C.21
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Projection: NAD 1983 UTM Zone 10N
Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

OAAQC: 5E-05 µg/m³
Project #: 2600812

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Maximum Annual Count of 24-Hour PAH Excursions
Scenario: Proposed OC

Concentration Without Background > OAAQC of 5E-05 µg/m³

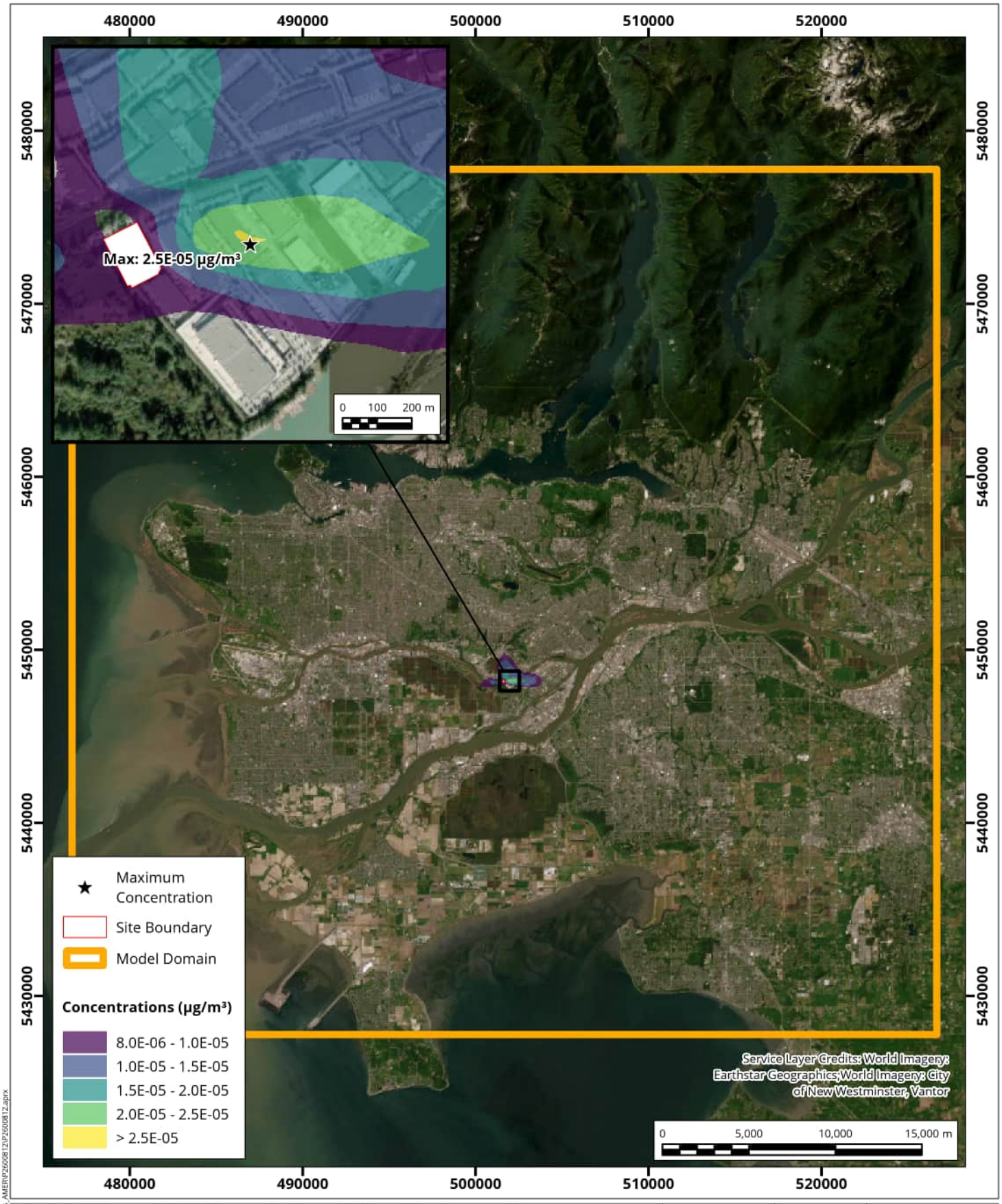
Map Projection: NAD 1983 UTM Zone 10N
Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

True North

OAAQC: 5E-05 µg/m³
Project #: 2600812

Drawn by: PIP	Figure: C.22
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Predicted Annual PAHs Concentrations (Without Background)
Scenario: Current OC

Metric: Annual average of hourly concentrations over one year, maximum over 2019-2023

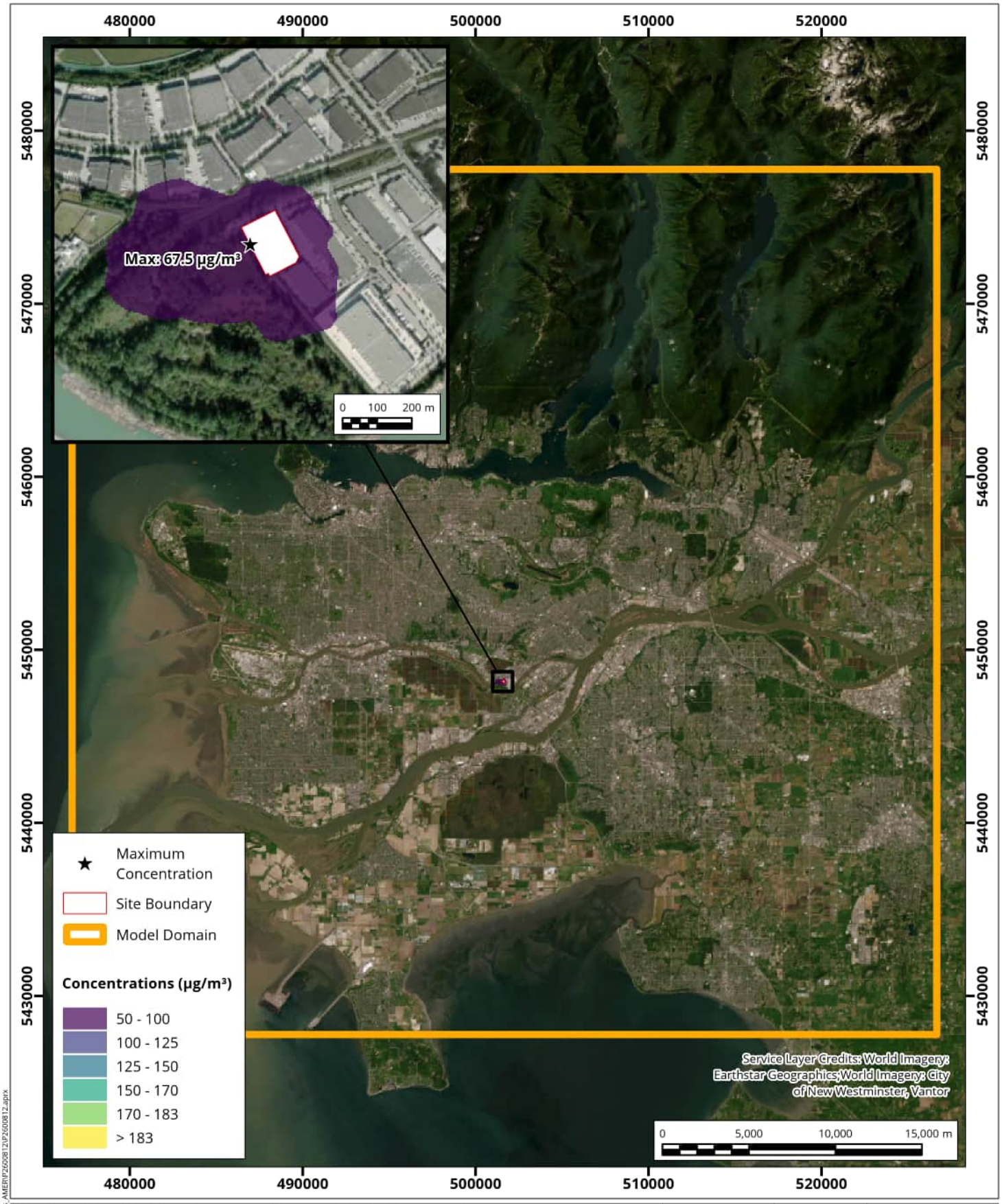
Map Projection: NAD 1983 UTM Zone 10N
Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

True North

OAAQC: 1E-05 µg/m³
Project #: 2600812

Drawn by: PIP	Figure: C.23
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Predicted D1HM SO_2 Concentrations (With Background)
Scenario: Current Operations

Metric: Maximum of [99th percentile of D1HM concentration in each year, averaged over each three year period (2019-2021; 2020-2022; 2021-2023)]

Map Projection: NAD 1983 UTM Zone 10N

Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

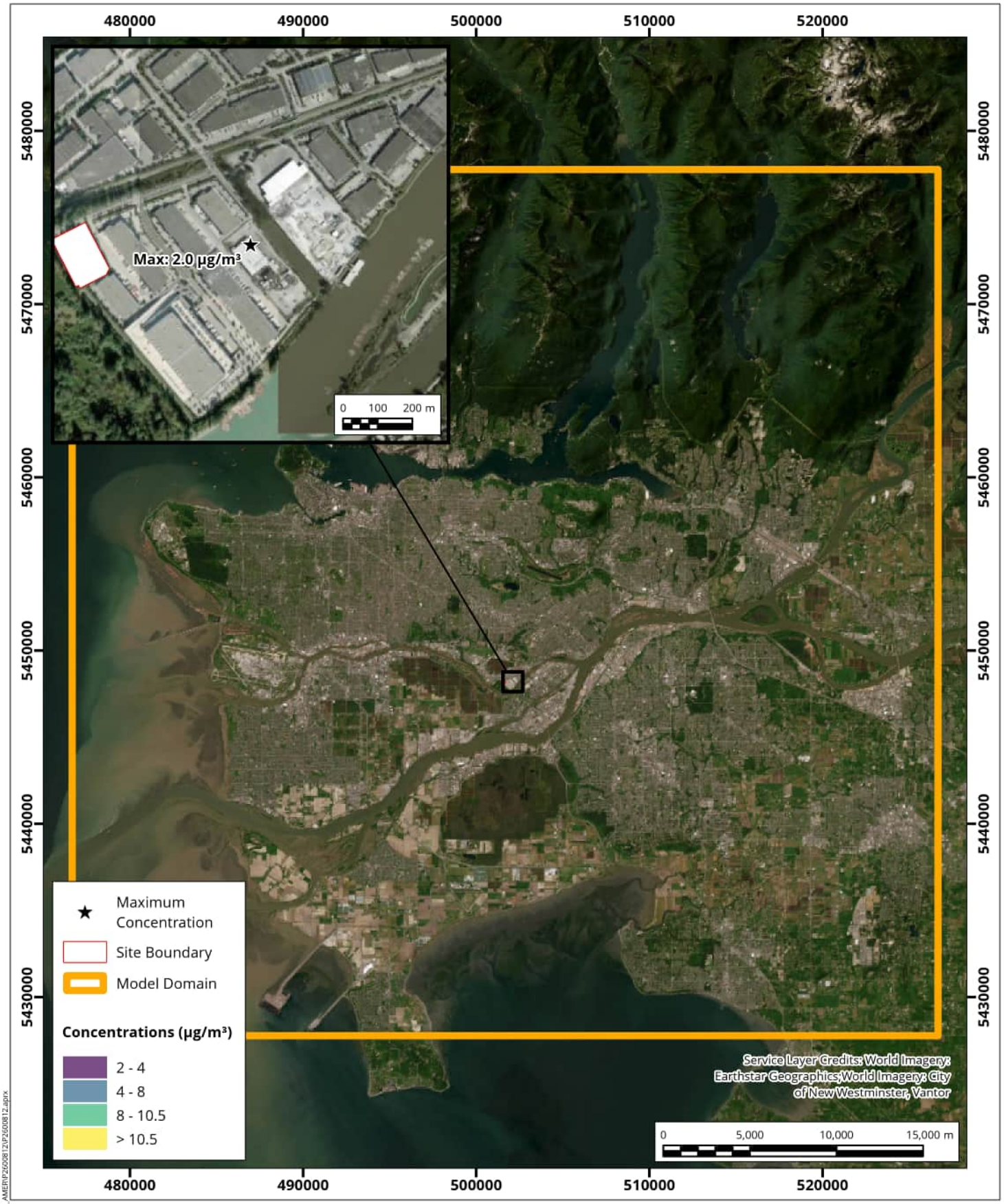
True North

MV AAQO: 183 µg/m³
BC AAQO and CAAQS: 170 µg/m³
Background Concentration: 7.1 µg/m³

Project #: 2600812

Drawn by: PIP	Figure: C.24
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working Folder\Jobs_AMER\P2600812\P2600812.aprx



Predicted Annual SO_2 Concentrations (With Background)
Scenario: Current Operations

Metric: Annual average of hourly concentrations over one year, maximum over 2019-2023

Map Projection: NAD 1983 UTM Zone 10N

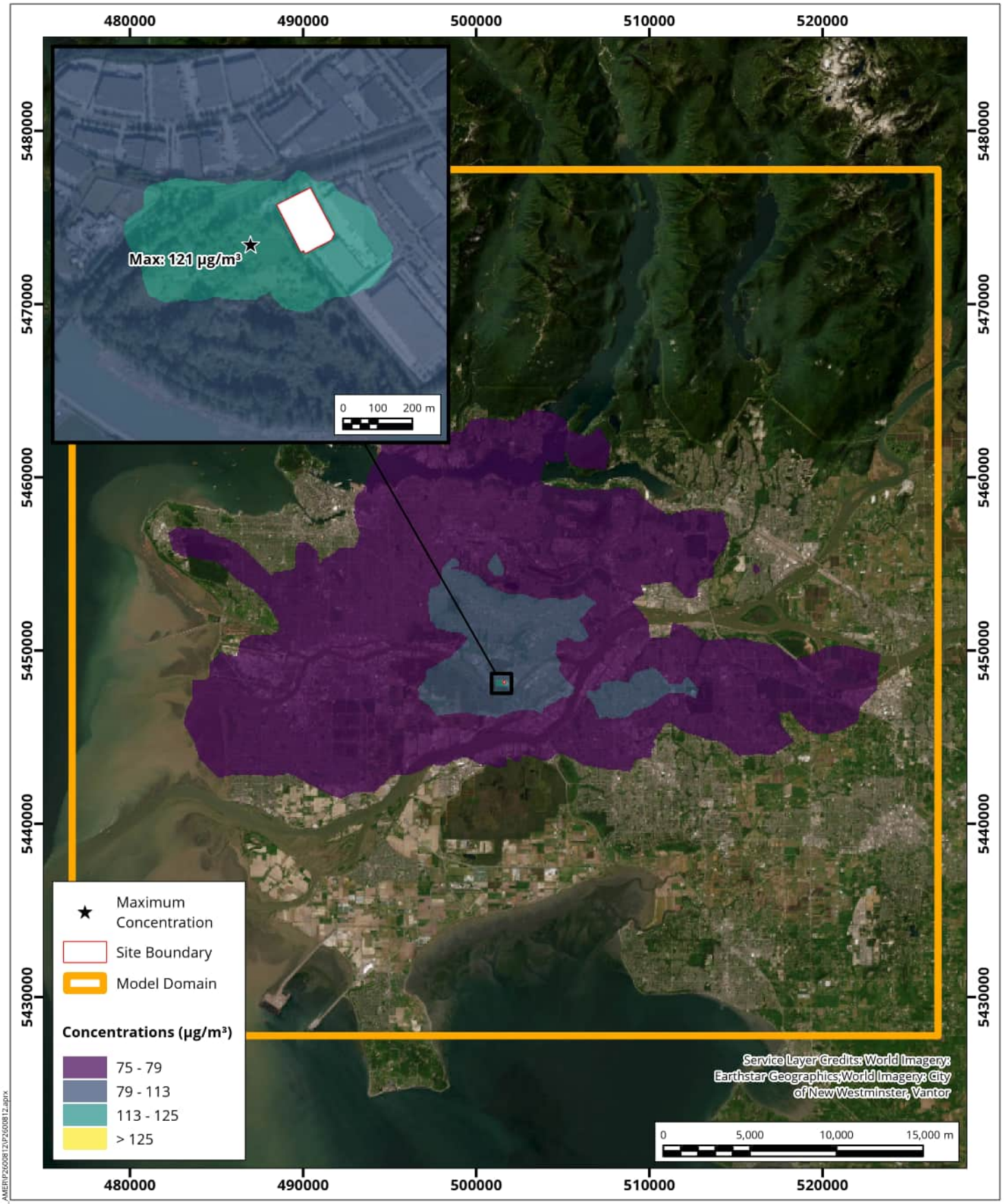
Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

True North

MV AAQO, BC AAQO and CAAQS: 10.5 µg/m³
Background Concentration: 0.8 µg/m³
Project #: 2600812

Drawn by: PIP	Figure: C.25
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Predicted D1HM NO_2 Concentrations (With 98thp Background)
Scenario: Current Operations

Metric: Maximum of [98th percentile of D1HM concentration in each year, averaged over each three year period (2019-2021; 2020-2022; 2021-2023)]

Map Projection: NAD 1983 UTM Zone 10N

Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

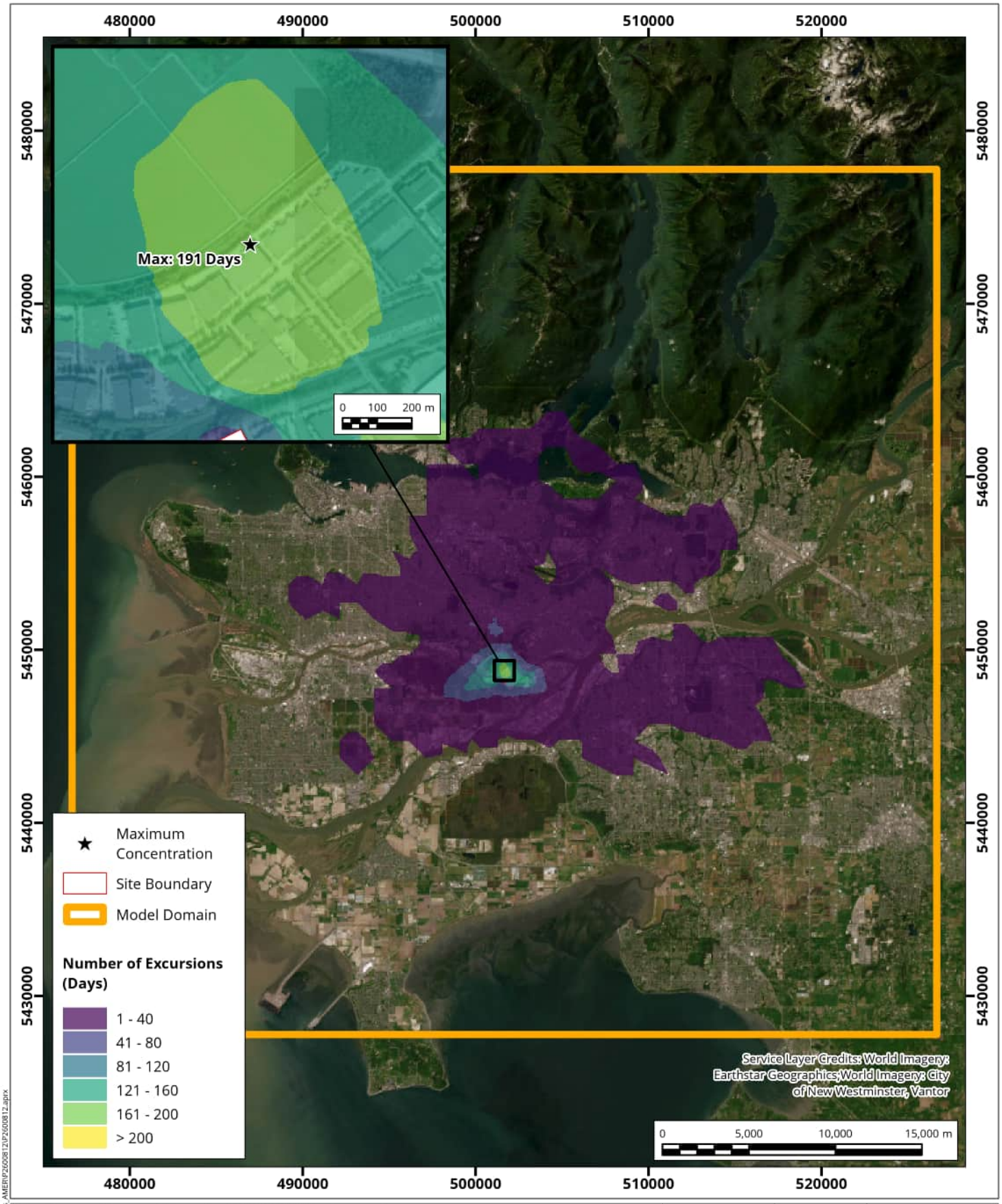
True North

BC AAQO: 113 µg/m³
MV AAQO and CAAQS: 79 µg/m³
Background Concentration: 73 µg/m³

Project #: 2600812

Drawn by: PIP	Figure: C.26
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working Folder\Jobs_AMER\P2600812\P2600812.aprx



Maximum Annual Count of D1HM NO_2 Excursions
Scenario: Current Operations

D1HM Concentration (including 98thp Background) > MV AAQO of 79 µg/m^3

Map Projection: NAD 1983 UTM Zone 10N

Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

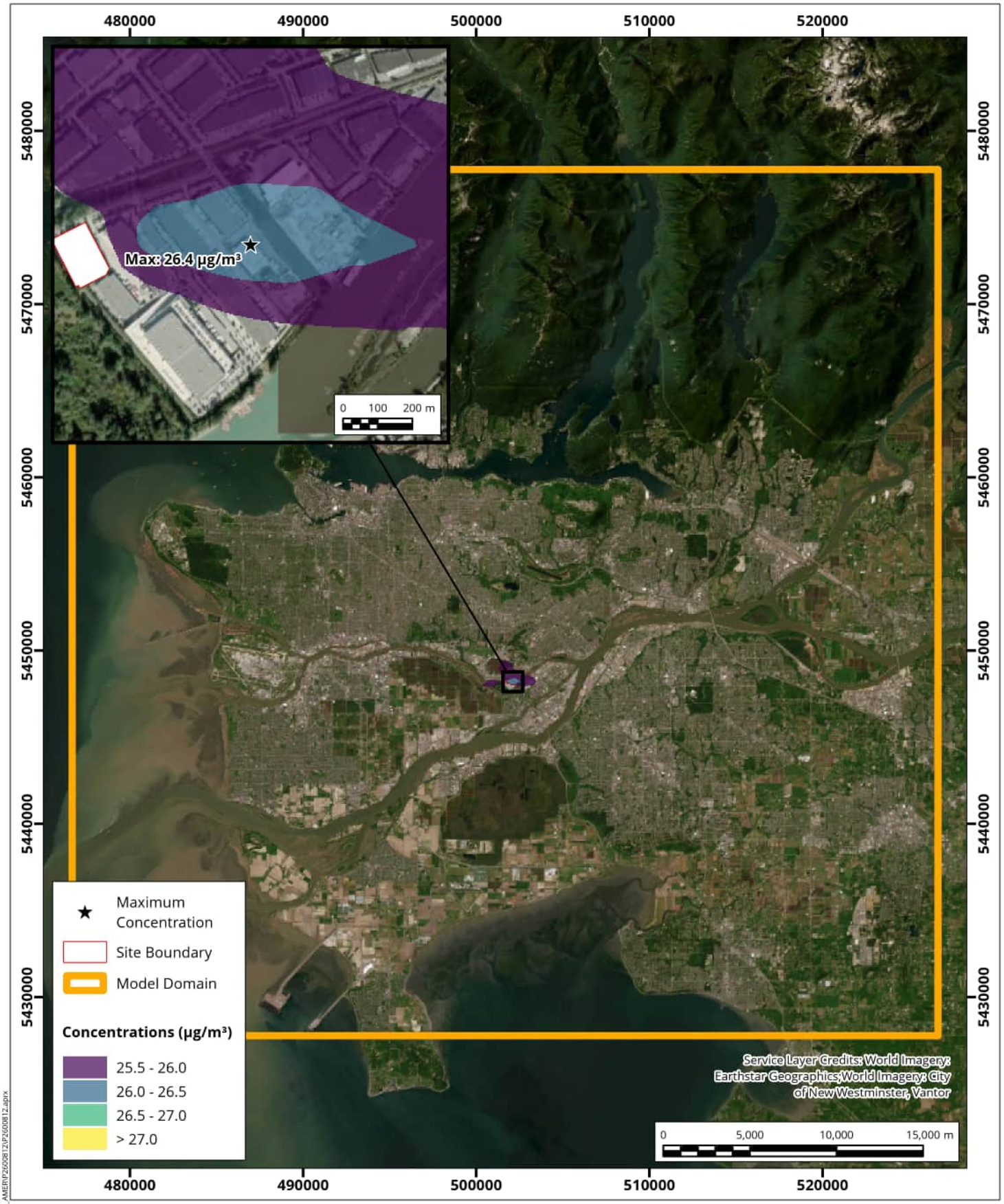
True North

BC AAQO: 113 µg/m^3
MV AAQO and CAAQS: 79 µg/m^3
Background Concentration: 73 µg/m^3

Project #: 2600812

Drawn by: PIP	Figure: C.27
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Predicted Annual NO_2 Concentrations (With Background)
Scenario: Current Operations

Metric: Annual average of hourly concentrations over one year, maximum over 2019-2023

Map Projection: NAD 1983 UTM Zone 10N

Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

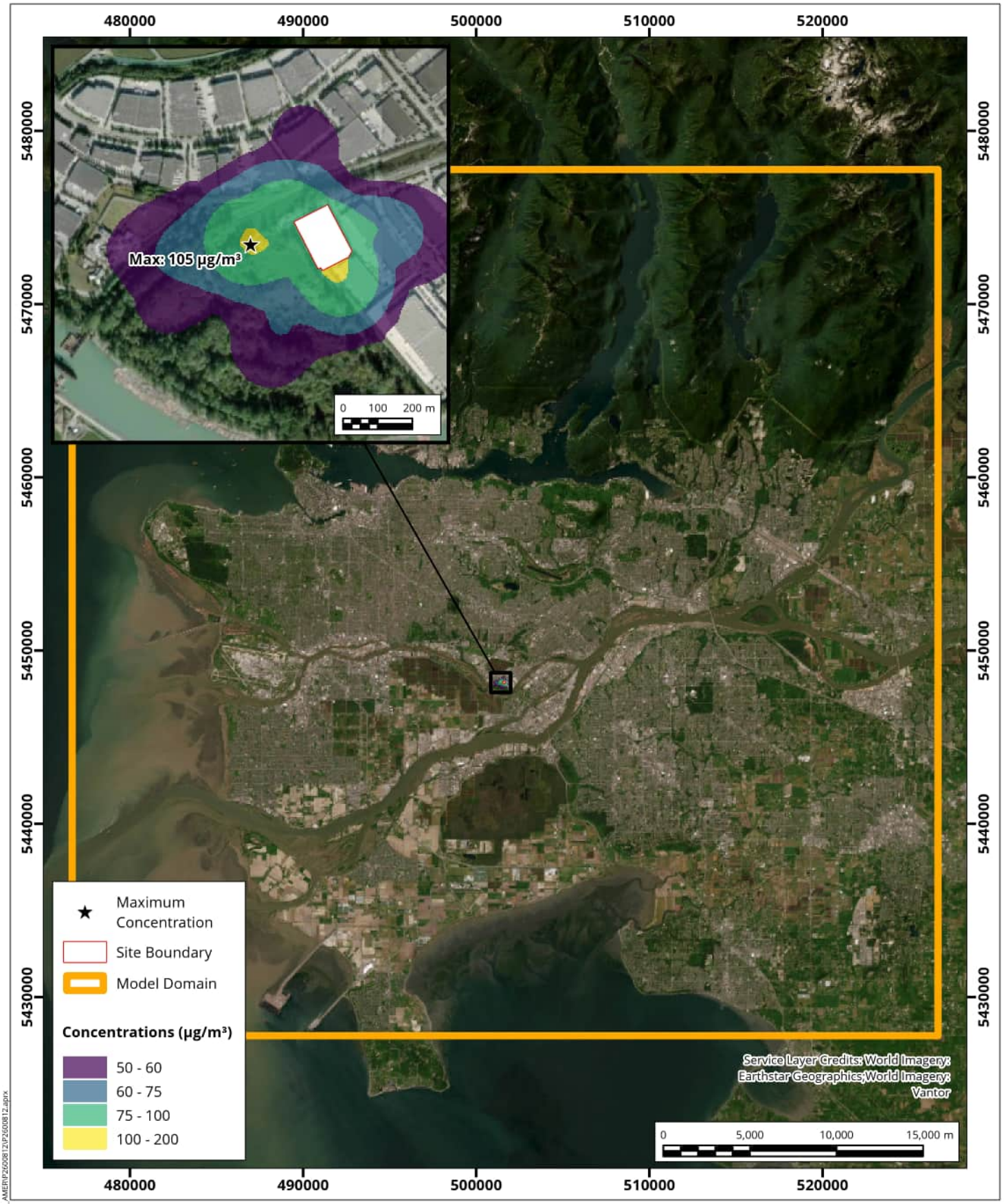
True North

BC AAQO: 32 µg/m³
MV AAQO and CAAQS: 22.6 µg/m³
Background Concentration: 25 µg/m³

Project #: 2600812

Drawn by: PIP	Figure: C.28
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working Folder\Jobs_AMER\P2600812\P2600812.aprx



Predicted 1-Hour HCl Concentrations (With Background)
Scenario: Current Operations

Metric: Maximum of 1-hour concentrations over 2019-2023

True North

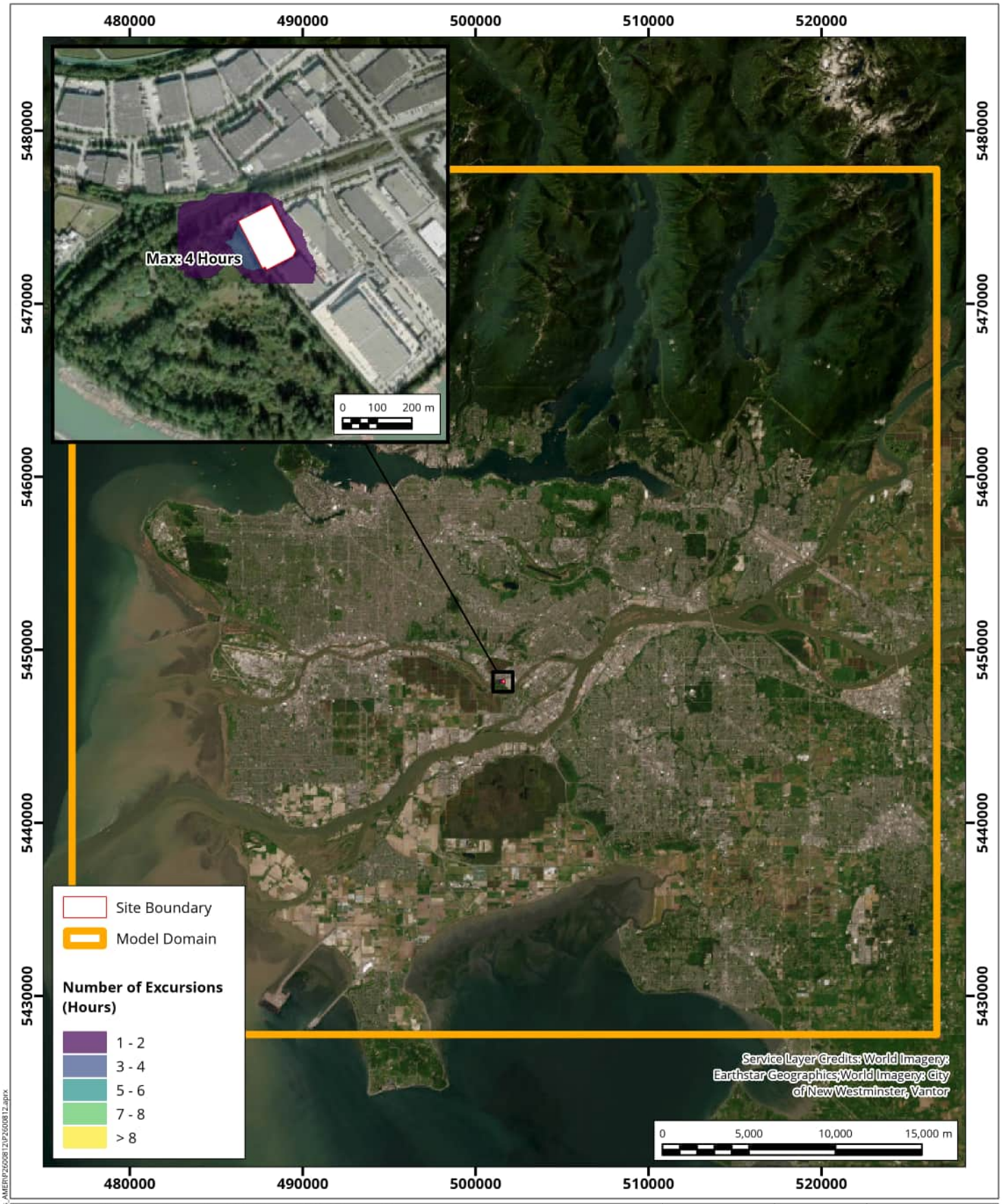
AAAQO: 75 µg/m³
Background Concentration: 2.1 µg/m³

Map Projection: NAD 1983 UTM Zone 10N
Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

Project #: 2600812

Drawn by: PIP	Figure: C.29
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Maximum Annual Count of 1-Hour HCl Excursions
Scenario: Current Operations

Concentration including Background > AAAQO of 75 µg/m³

True North

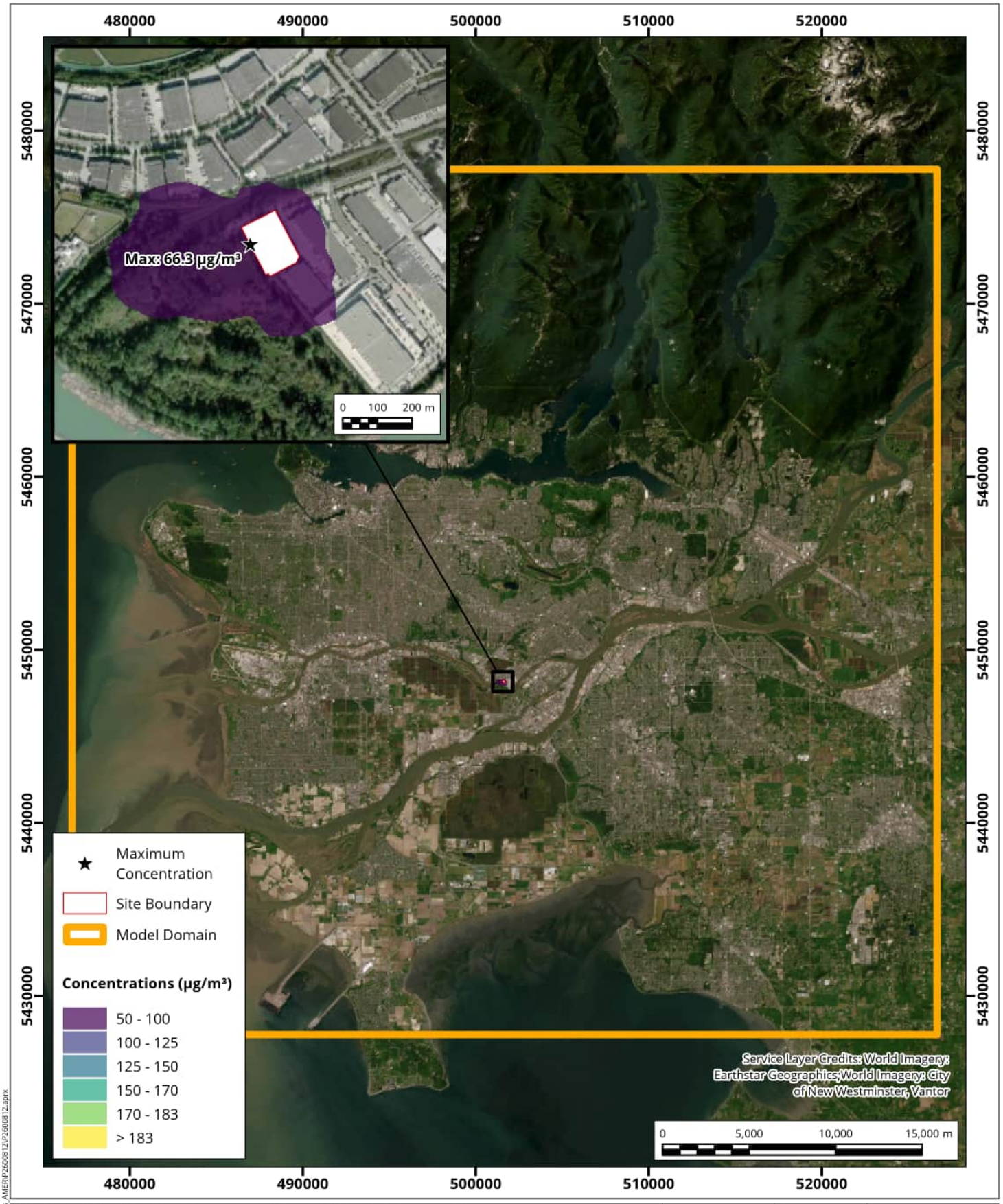
AAAQO: 75 µg/m³
Background Concentration: 2.1 µg/m³

Map Projection: NAD 1983 UTM Zone 10N
Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

Project #: 2600812

Drawn by: PIP	Figure: C.30
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Predicted D1HM SO_2 Concentrations (With Background)
Scenario: Startup

Metric: Maximum of [99th percentile of D1HM concentration in each year, averaged over each three year period (2019-2021; 2020-2022; 2021-2023)]

Map Projection: NAD 1983 UTM Zone 10N

Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

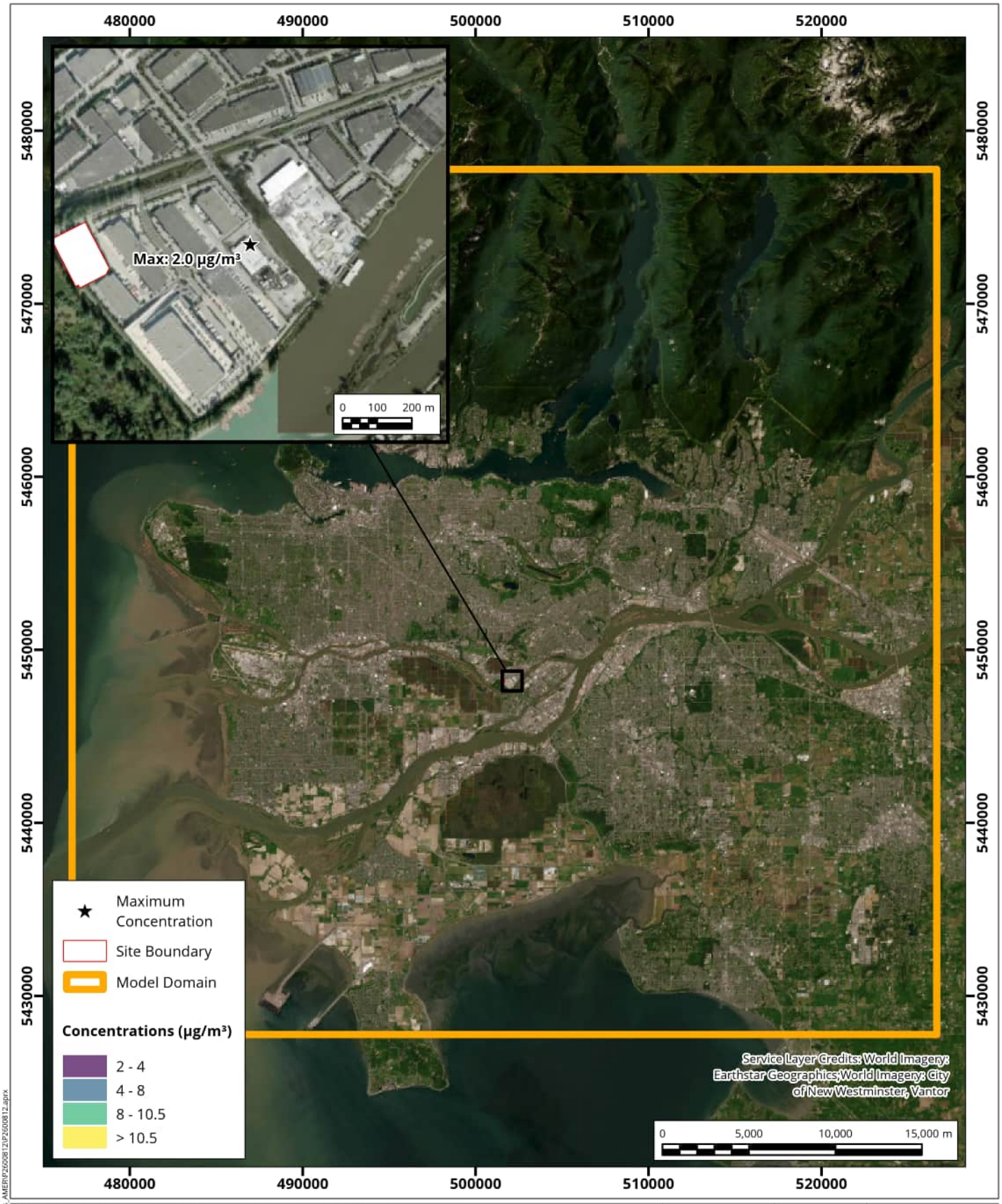
True North

MV AAQO: 183 µg/m³
BC AAQO and CAAQS: 170 µg/m³
Background Concentration: 7.1 µg/m³

Project #: 2600812

Drawn by: PIP	Figure: C.31
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working Folder\Jobs_AMER\P2600812\P2600812.aprx



Predicted Annual SO_2 Concentrations (With Background)
Scenario: Startup

Metric: Annual average of hourly concentrations over one year, maximum over 2019-2023

Map Projection: NAD 1983 UTM Zone 10N

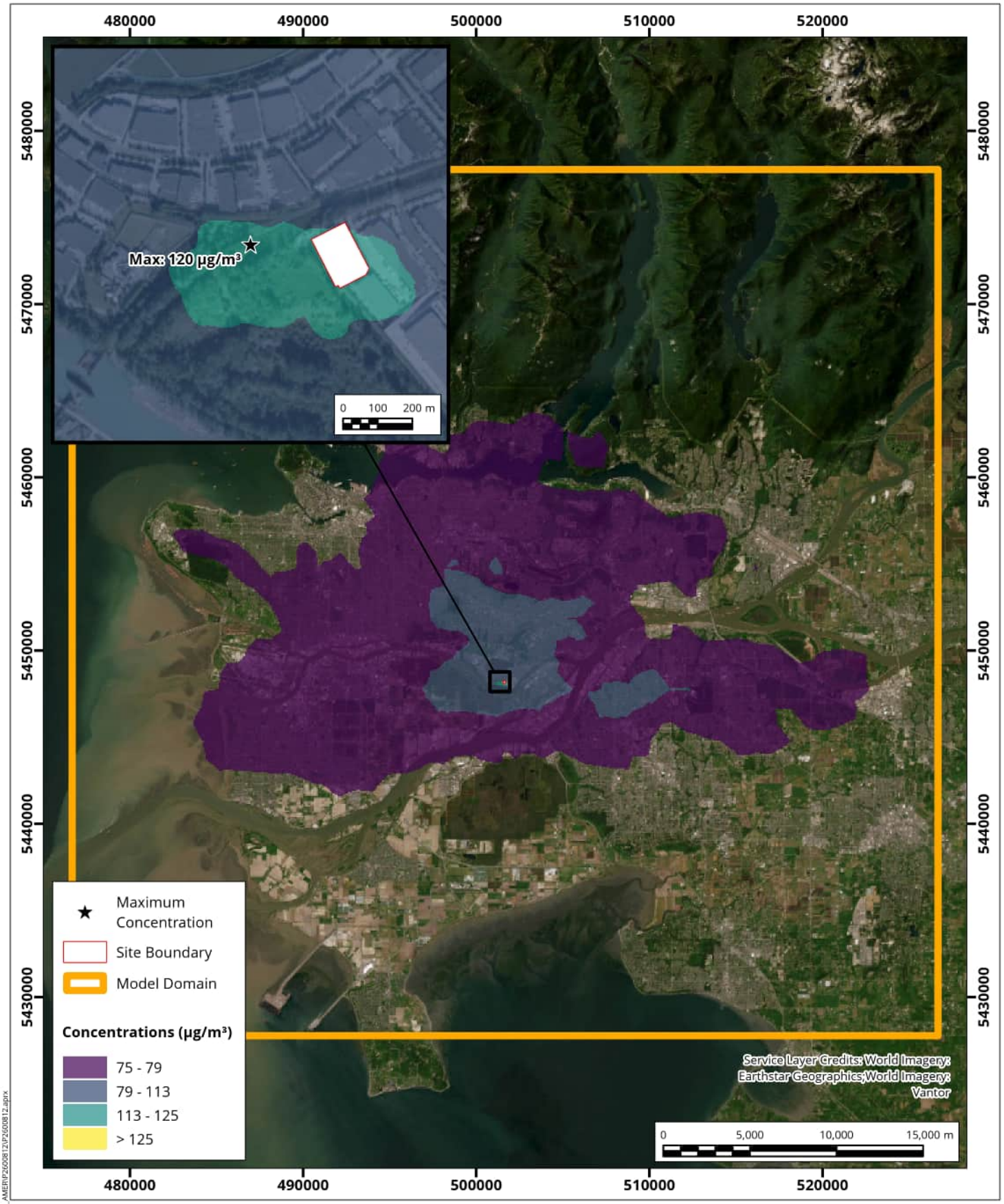
Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

True North

MV AAQO, BC AAQO and CAAQS: 10.5 µg/m³
Background Concentration: 0.8 µg/m³
Project #: 2600812

Drawn by: PIP	Figure: C.32
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Predicted D1HM NO_2 Concentrations (With 98thp Background)
Scenario: Startup

Metric: Maximum of [98th percentile of D1HM concentration in each year, averaged over each three year period (2019-2021; 2020-2022; 2021-2023)]

Map Projection: NAD 1983 UTM Zone 10N

Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

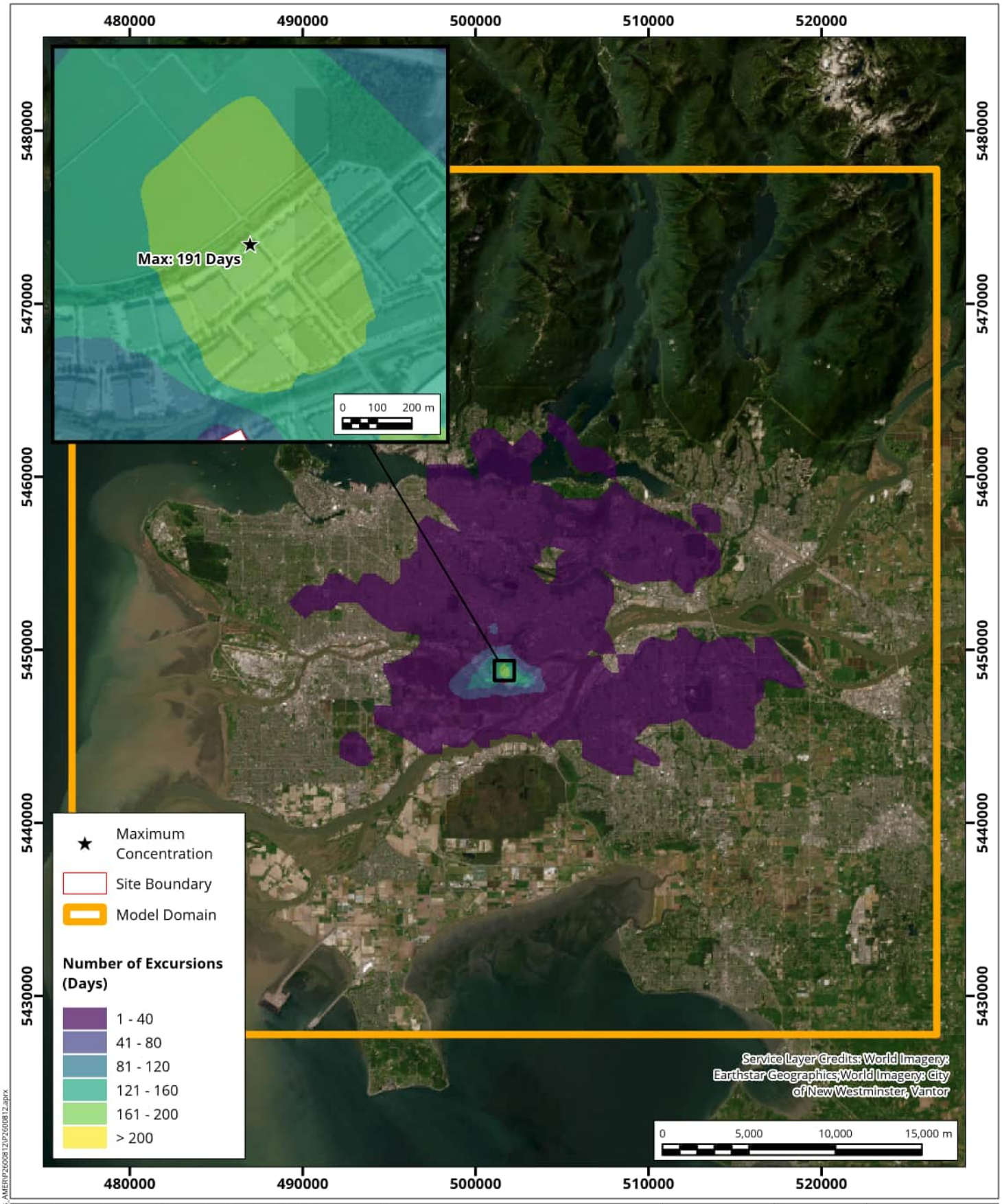
True North

BC AAQO: 113 µg/m³
MV AAQO and CAAQS: 79 µg/m³
Background Concentration: 73 µg/m³

Project #: 2600812

Drawn by: PIP	Figure: C.33
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working Folder\Jobs_AMER\P2600812\P2600812.aprx



Maximum Annual Count of D1HM NO_2 Excursions
Scenario: Startup

D1HM Concentration (including 98thp Background) > MV AAQO of 79 µg/m^3

Map Projection: NAD 1983 UTM Zone 10N

Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

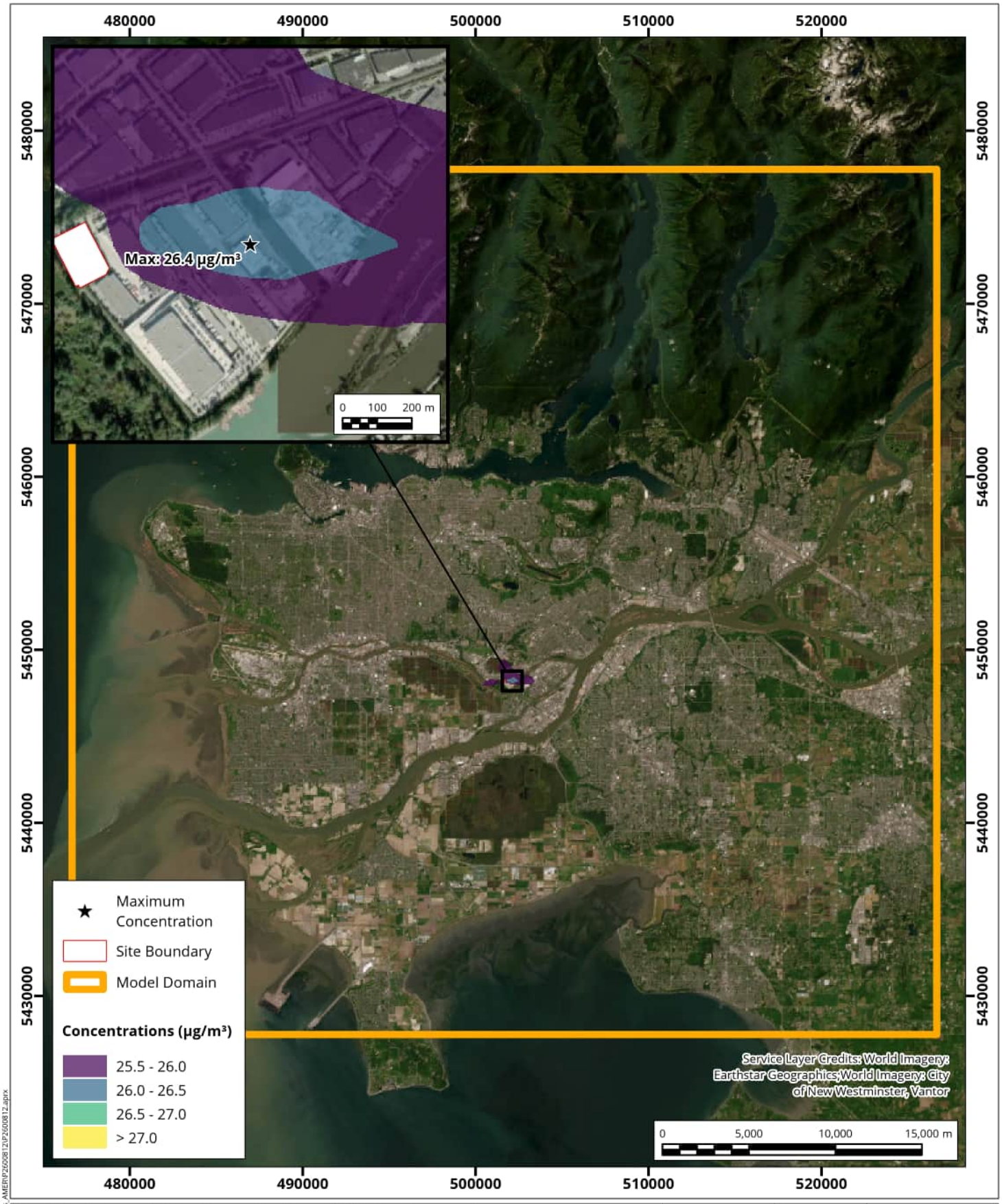
True North

BC AAQO: 113 µg/m^3
MV AAQO and CAAQS: 79 µg/m^3
Background Concentration: 73 µg/m^3

Project #: 2600812

Drawn by: PIP	Figure: C.34
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Predicted Annual NO_2 Concentrations (With Background)
Scenario: Startup

Metric: Annual average of hourly concentrations over one year, maximum over 2019-2023

Map Projection: NAD 1983 UTM Zone 10N

Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

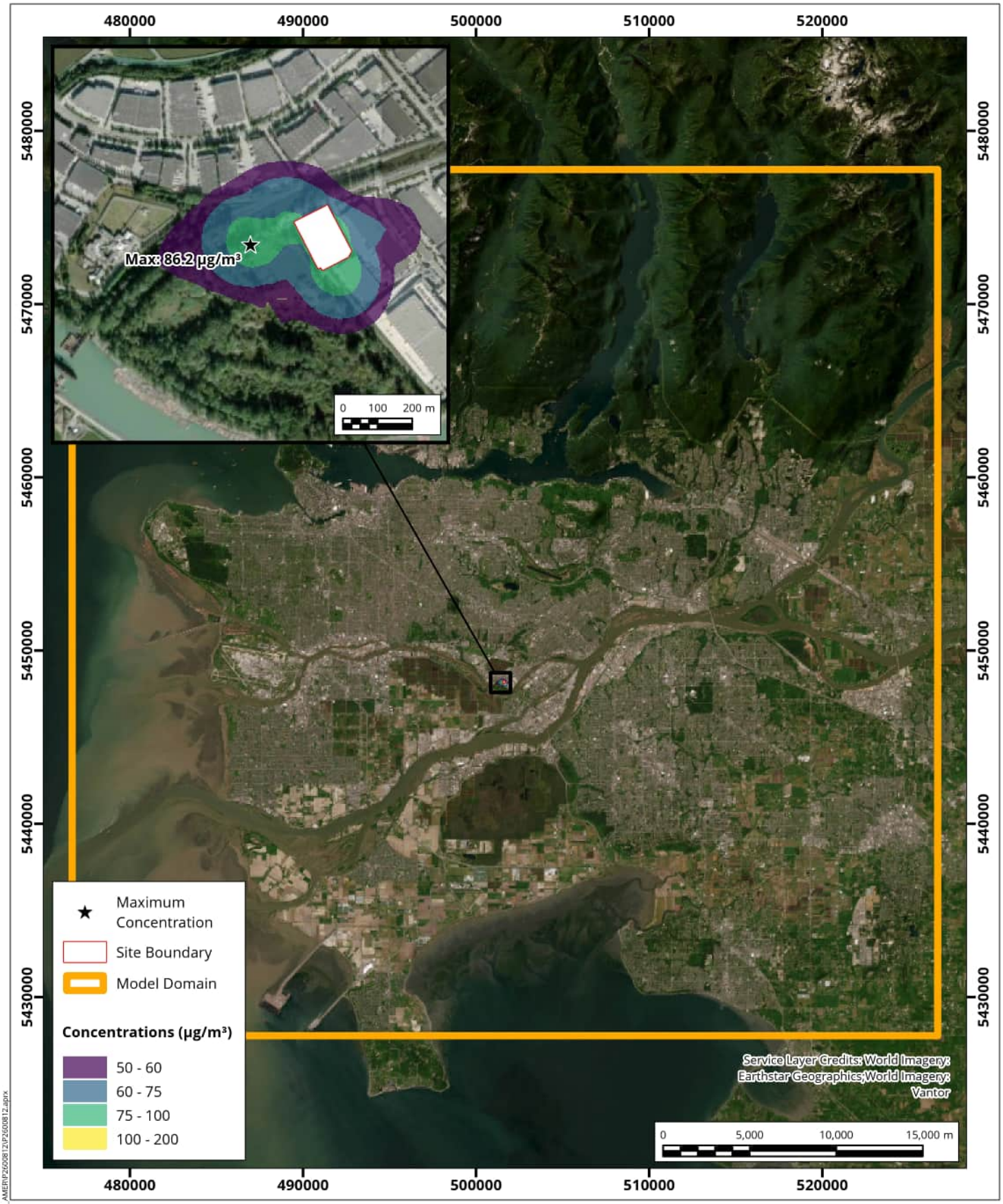
True North

BC AAQO: 32 µg/m³
MV AAQO and CAAQS: 22.6 µg/m³
Background Concentration: 25 µg/m³

Project #: 2600812

Drawn by: PIP	Figure: C.35
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working Folder\Jobs_AMER\P2600812\P2600812.aprx



Predicted 1-Hour HCl Concentrations (With Background)
Scenario: Startup

Metric: Maximum of 1-hour concentrations over 2019-2023

True North

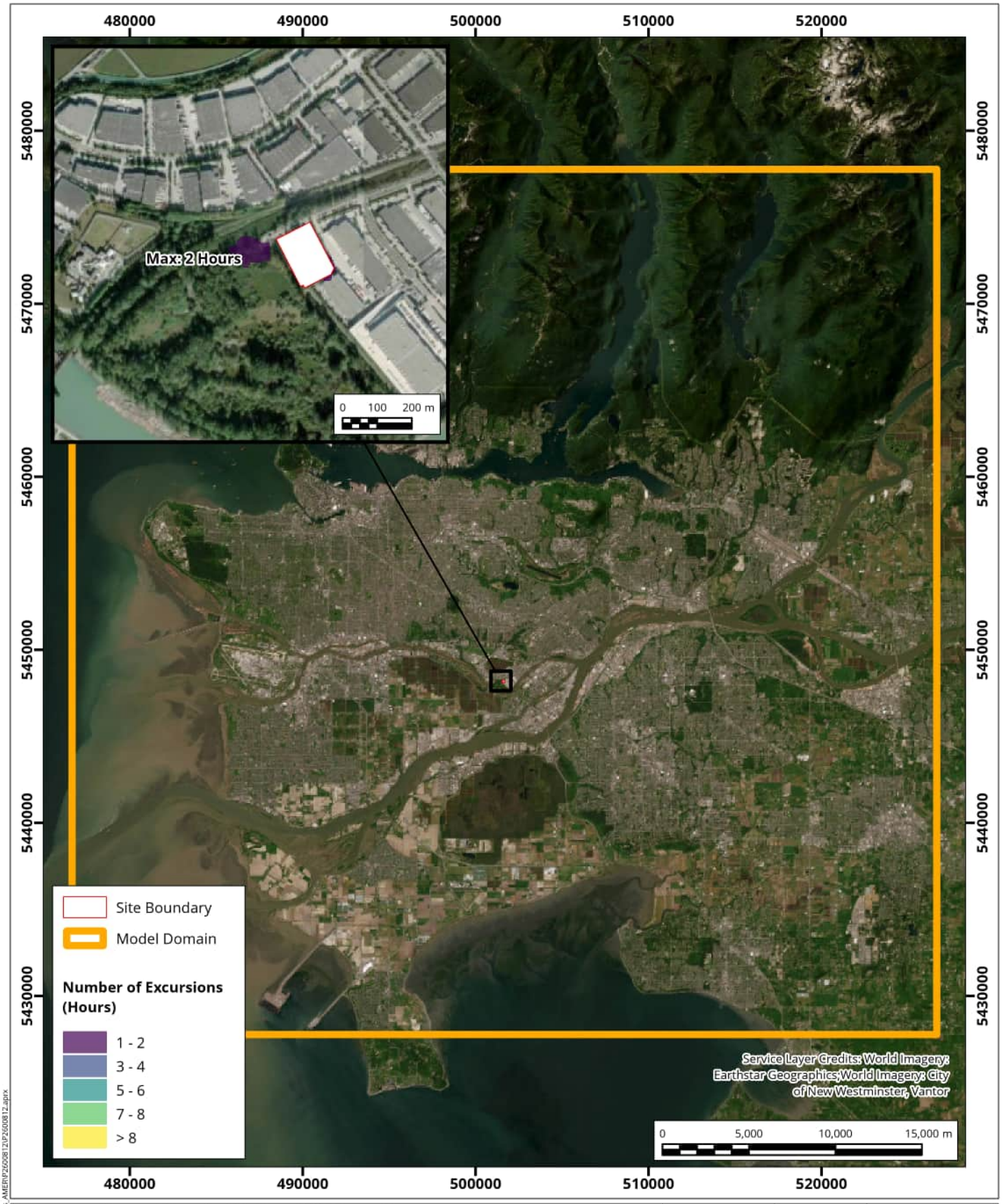
AAAQO: 75 µg/m³
Background Concentration: 2.1 µg/m³

Map Projection: NAD 1983 UTM Zone 10N
Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

Project #: 2600812

Drawn by: PIP	Figure: C.36
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Maximum Annual Count of 1-Hour HCl Excursions
Scenario: Startup

Concentration including Background > AAAQO of 75 µg/m³

True North

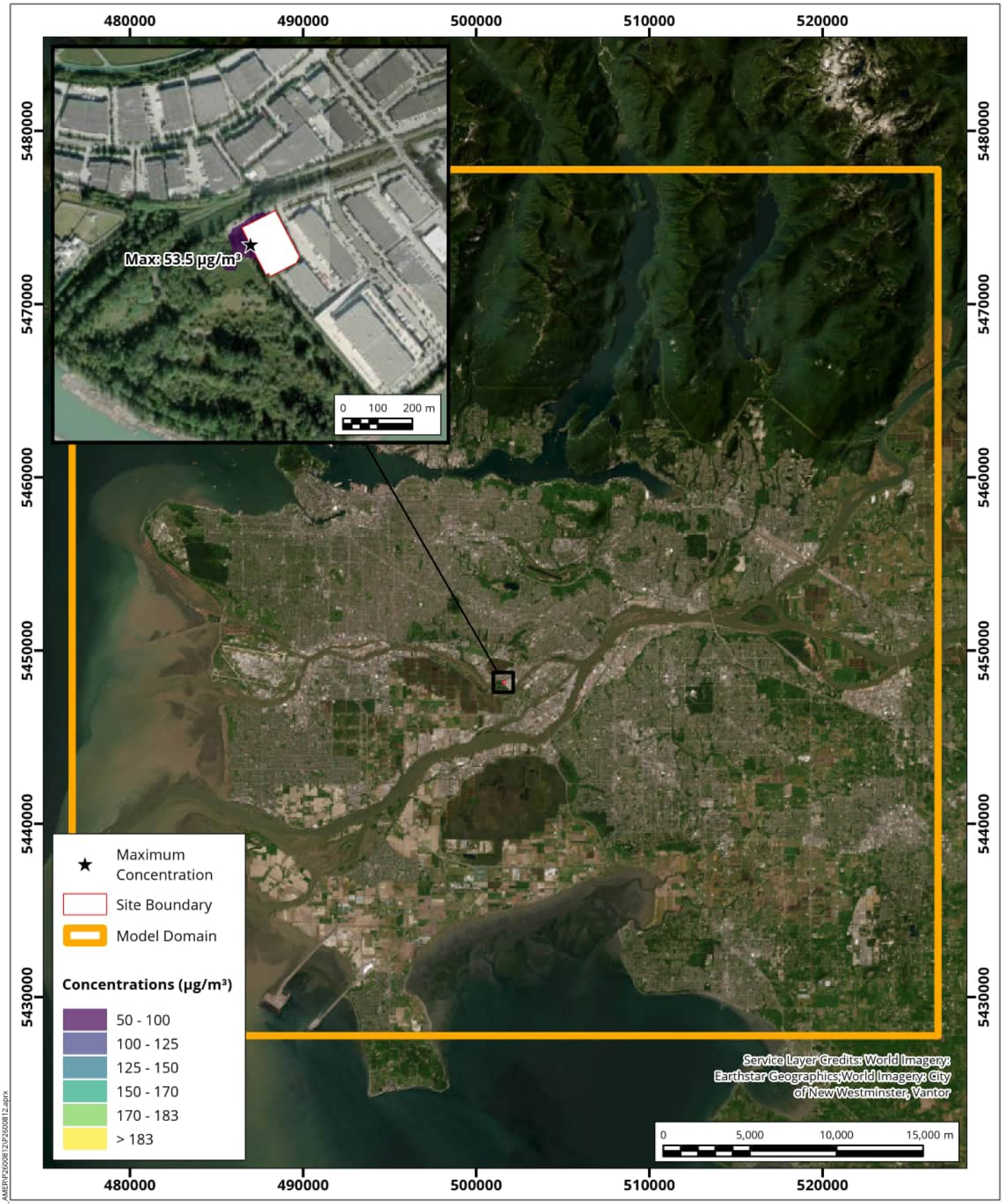
AAAQO: 75 µg/m³
Background Concentration: 2.1 µg/m³

Map Projection: NAD 1983 UTM Zone 10N
Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

Project #: 2600812

Drawn by: PIP	Figure: C.37
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Predicted D1HM SO_2 Concentrations (With Background)
Scenario: Shutdown

Metric: Maximum of [99th percentile of D1HM concentration in each year, averaged over each three year period (2019-2021; 2020-2022; 2021-2023)]

Map Projection: NAD 1983 UTM Zone 10N

Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

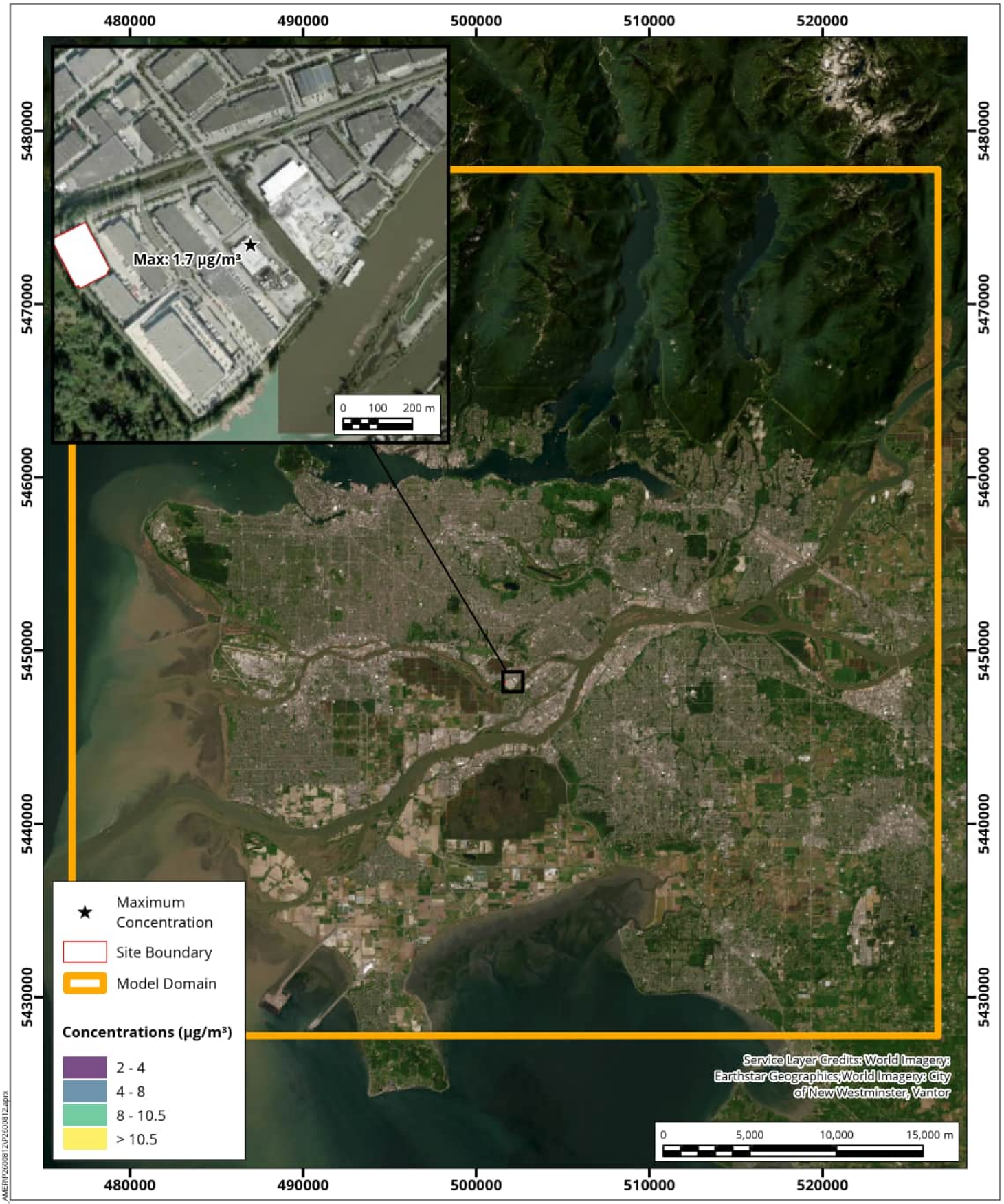
True North

MV AAQO: 183 µg/m³
BC AAQO and CAAQS: 170 µg/m³
Background Concentration: 7.1 µg/m³

Project #: 2600812

Drawn by: PIP	Figure: C.38
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working Folder\Jobs_AMER\P2600812\P2600812.aprx



Predicted Annual SO_2 Concentrations (With Background)
Scenario: Shutdown

Metric: Annual average of hourly concentrations over one year, maximum over 2019-2023

Map Projection: NAD 1983 UTM Zone 10N

Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

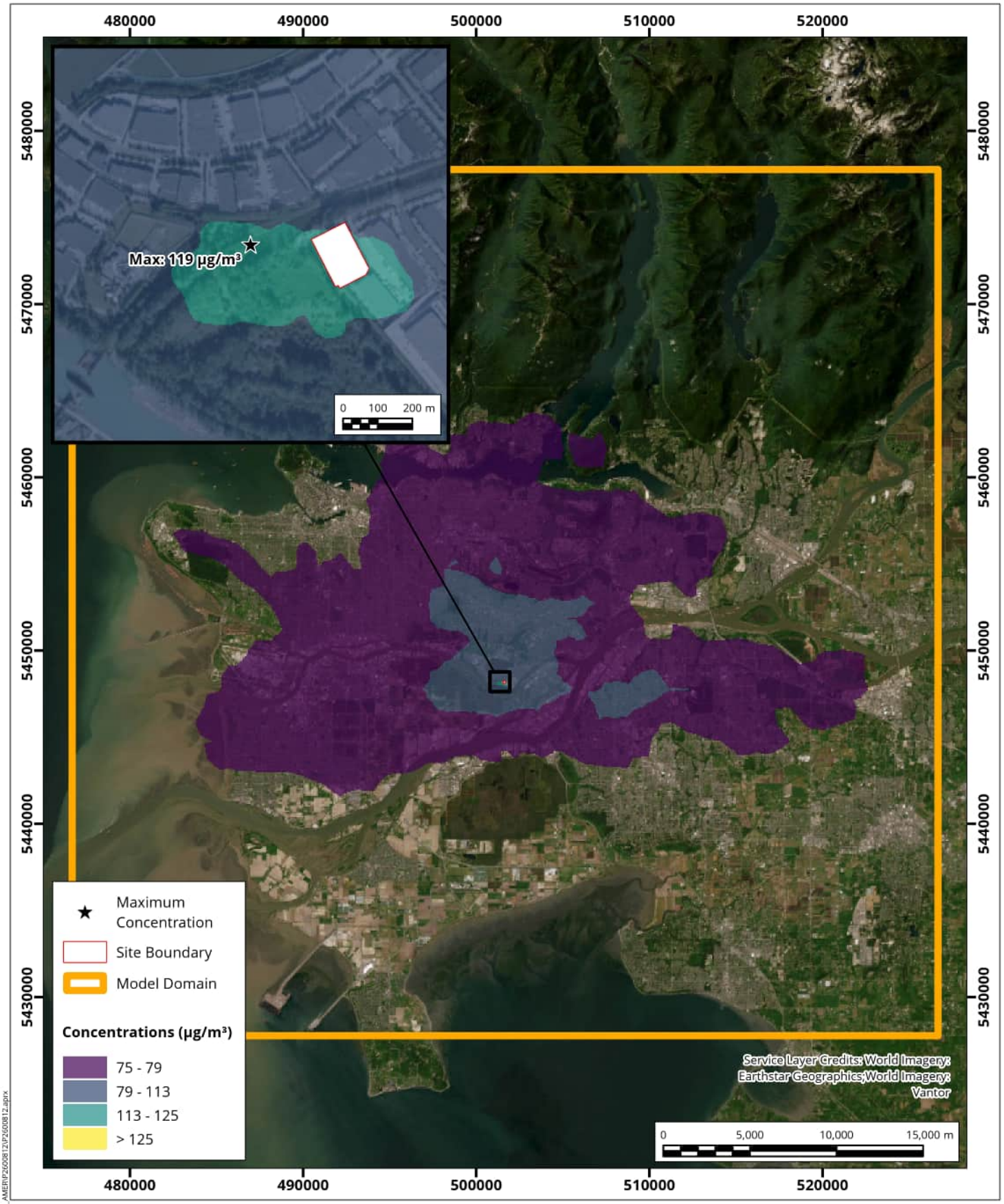
True North

MV AAQO, BC AAQO and CAAQS: 10.5 µg/m³
Background Concentration: 0.8 µg/m³

Project #: 2600812

Drawn by: PIP	Figure: C.39
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working Folder\Jobs_AMER\P2600812\P2600812.aprx



Predicted D1HM NO_2 Concentrations (With 98thp Background)
Scenario: Shutdown

Metric: Maximum of [98th percentile of D1HM concentration in each year, averaged over each three year period (2019-2021; 2020-2022; 2021-2023)]

Map Projection: NAD 1983 UTM Zone 10N

Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

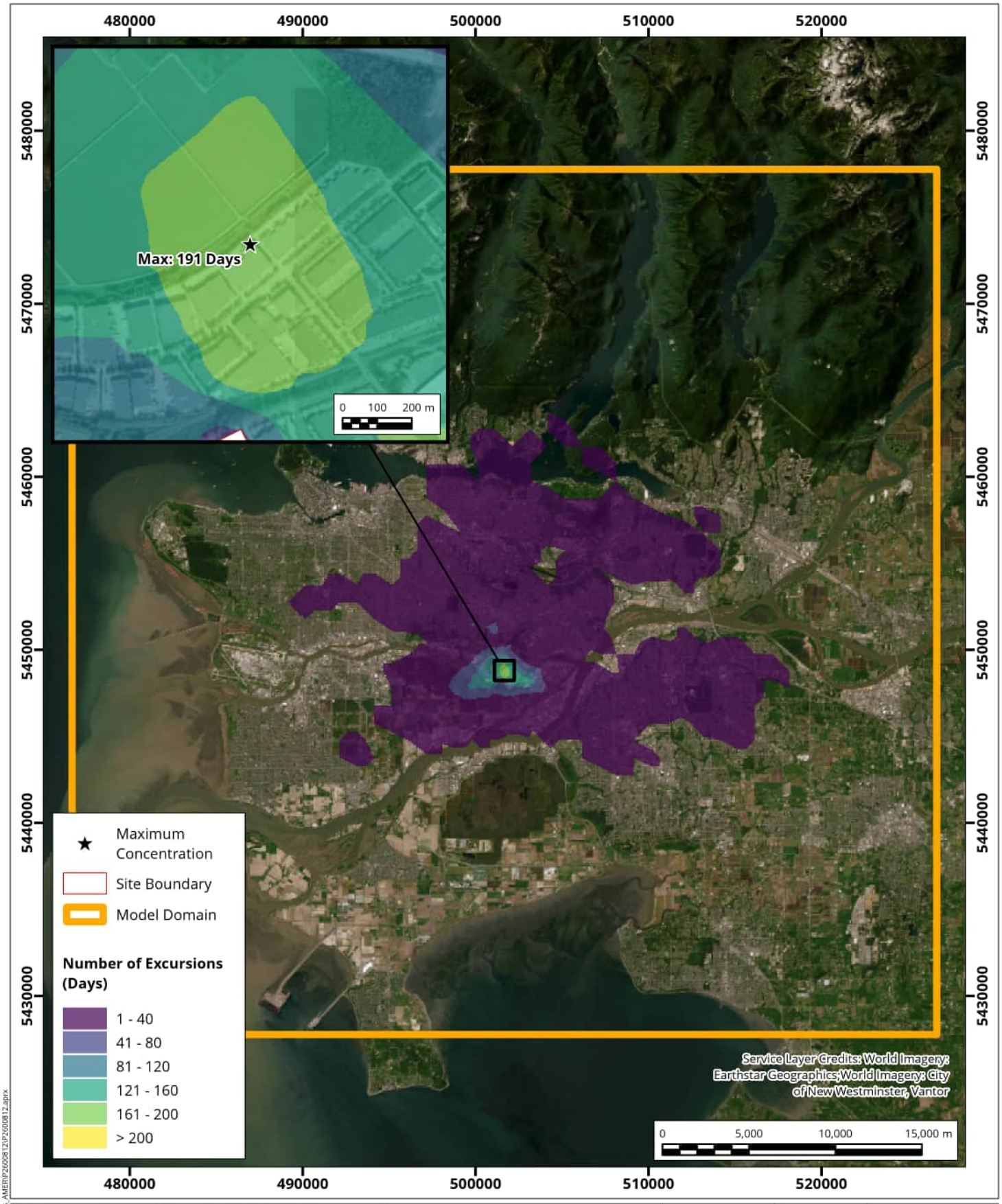
True North

BC AAQO: 113 µg/m³
MV AAQO and CAAQS: 79 µg/m³
Background Concentration: 73 µg/m³

Project #: 2600812

Drawn by: PIP	Figure: C.40
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working Folder\Jobs_AMER\P2600812\P2600812.aprx



Maximum Annual Count of D1HM NO_2 Excursions
Scenario: Shutdown

D1HM Concentration (including 98thp Background) > MV AAQO of 79 µg/m^3

Map Projection: NAD 1983 UTM Zone 10N

Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

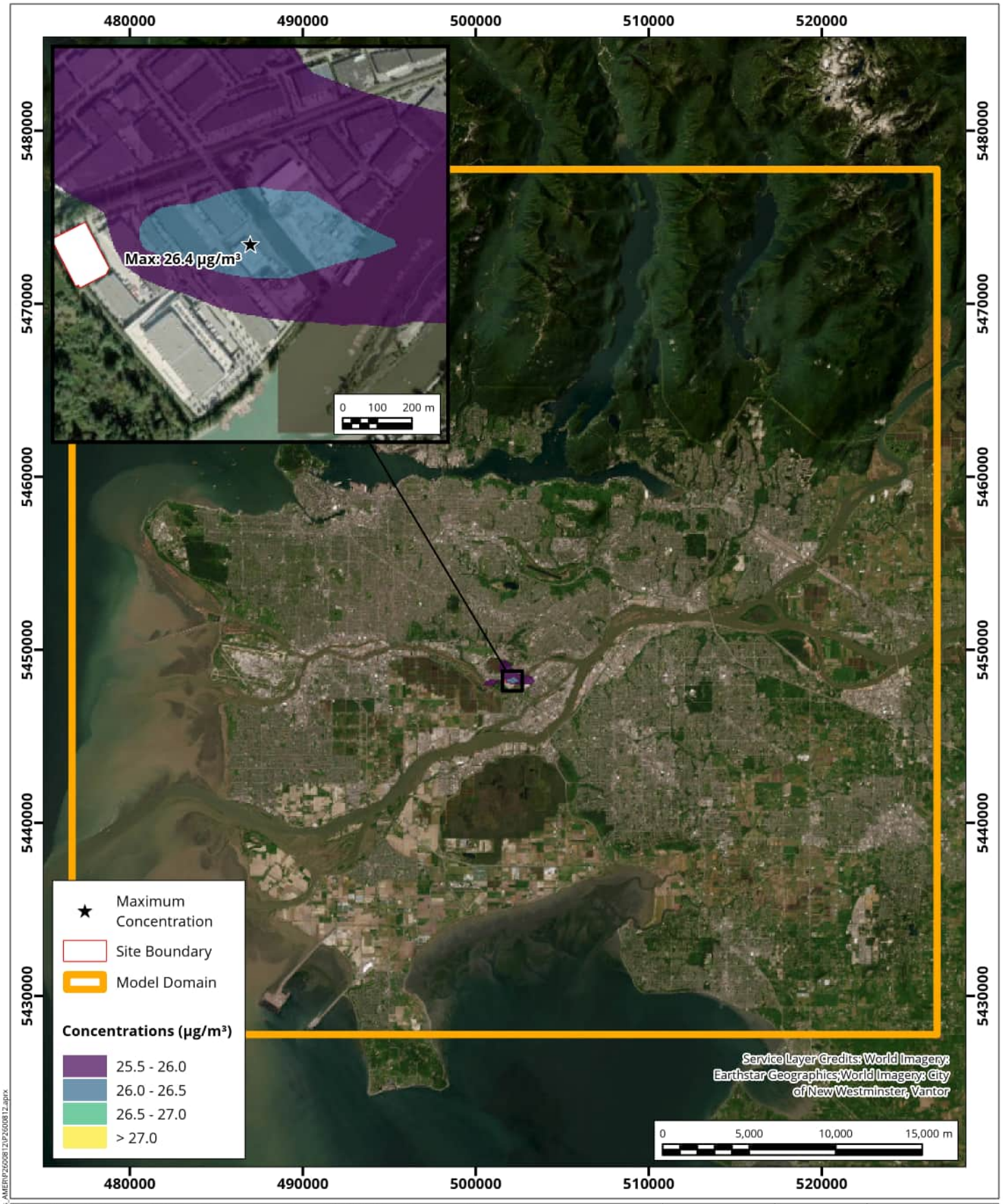
True North

BC AAQO: 113 µg/m^3
MV AAQO and CAAQS: 79 µg/m^3
Background Concentration: 73 µg/m^3

Project #: 2600812

Drawn by: PIP	Figure: C.41
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Predicted Annual NO_2 Concentrations (With Background)
Scenario: Shutdown

Metric: Annual average of hourly concentrations over one year, maximum over 2019-2023

Map Projection: NAD 1983 UTM Zone 10N

Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

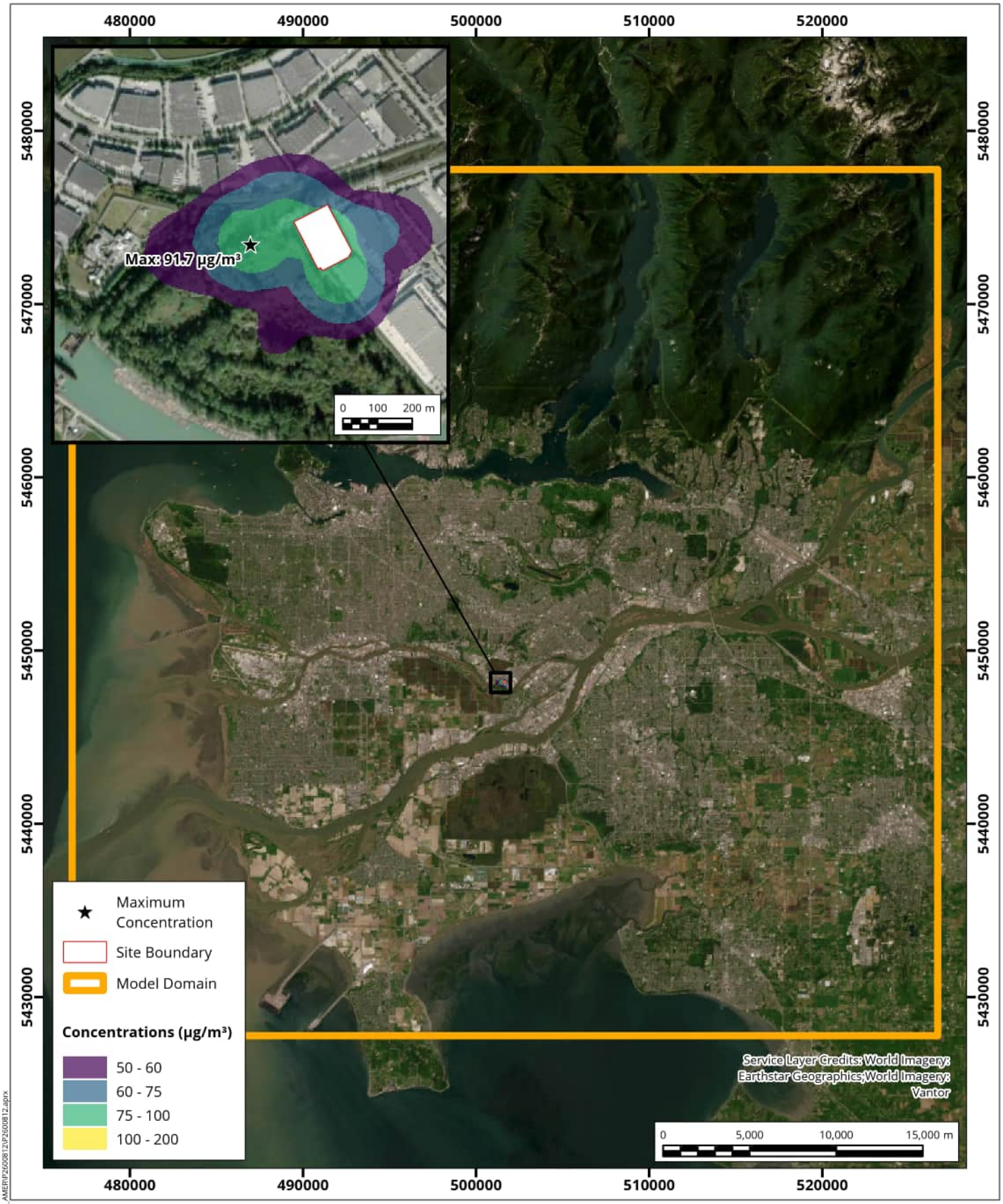
True North

BC AAQO: 32 µg/m³
MV AAQO and CAAQS: 22.6 µg/m³
Background Concentration: 25 µg/m³

Project #: 2600812

Drawn by: PIP	Figure: C.42
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working Folder\Jobs_AMER\P2600812\P2600812.aprx



Predicted 1-Hour HCl Concentrations (With Background)
Scenario: Shutdown

Metric: Maximum of 1-hour concentrations over 2019-2023

True North

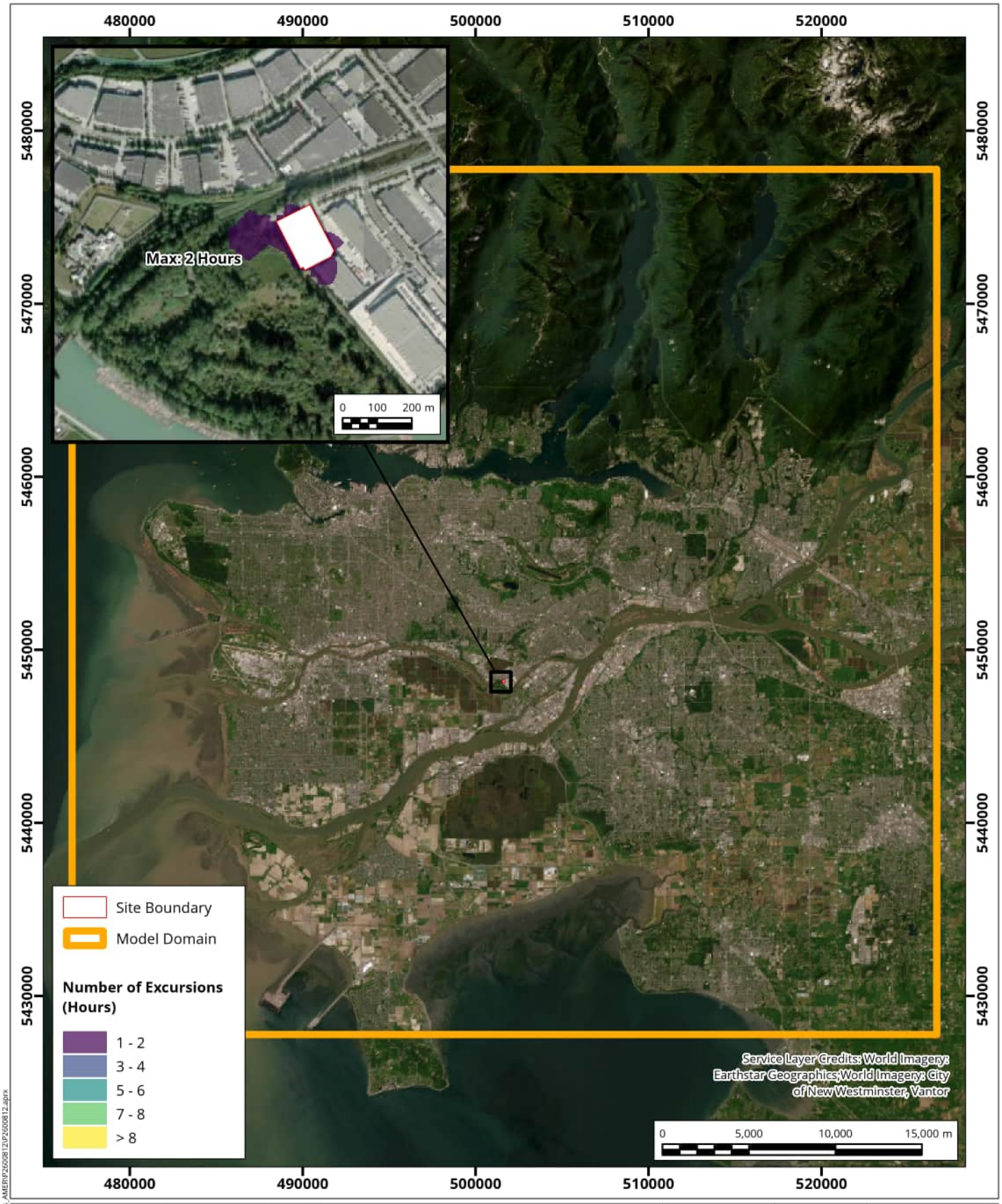
AAAQO: 75 µg/m³
Background Concentration: 2.1 µg/m³

Map Projection: NAD 1983 UTM Zone 10N
Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

Project #: 2600812

Drawn by: PIP	Figure: C.43
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Maximum Annual Count of 1-Hour HCl Excursions
Scenario: Shutdown

Concentration including Background > AAAQO of 75 µg/m³

Map Projection: NAD 1983 UTM Zone 10N

Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

True North

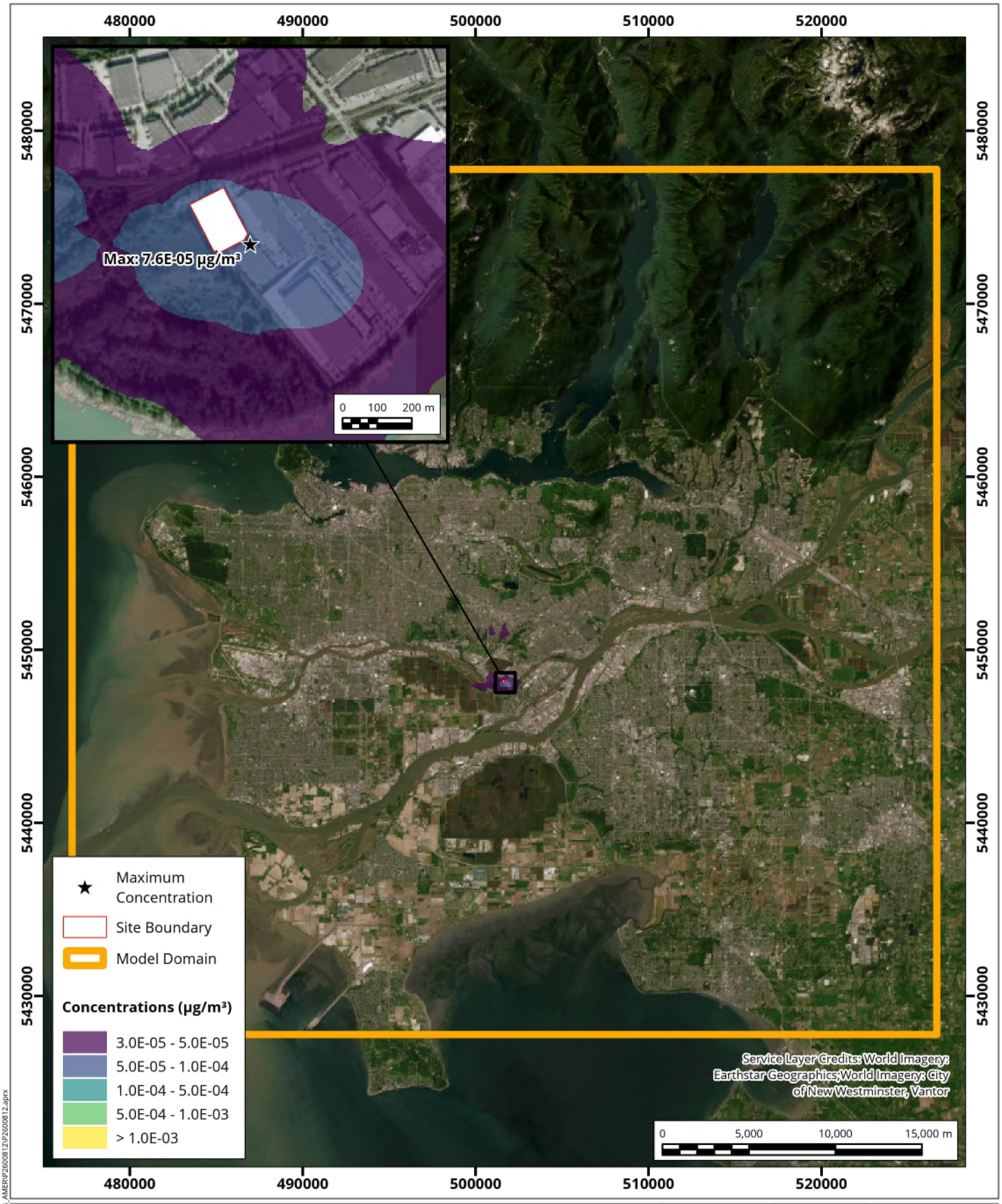
AAAQO: 75 µg/m³

Background Concentration: 2.1 µg/m³

Project #: 2600812

Drawn by: PIP	Figure: C.44
Approx. Scale:	1:300,000
Date Revised:	Aug 6, 2026

Map Document: C:\Working\Folder\Jobs_AMER\P2600812\P2600812.aprx



Predicted 24-Hour PAHs Concentrations (Without Background)
Scenario: Shutdown

Metric: Maximum of 24-hour block average values over 2019-2023

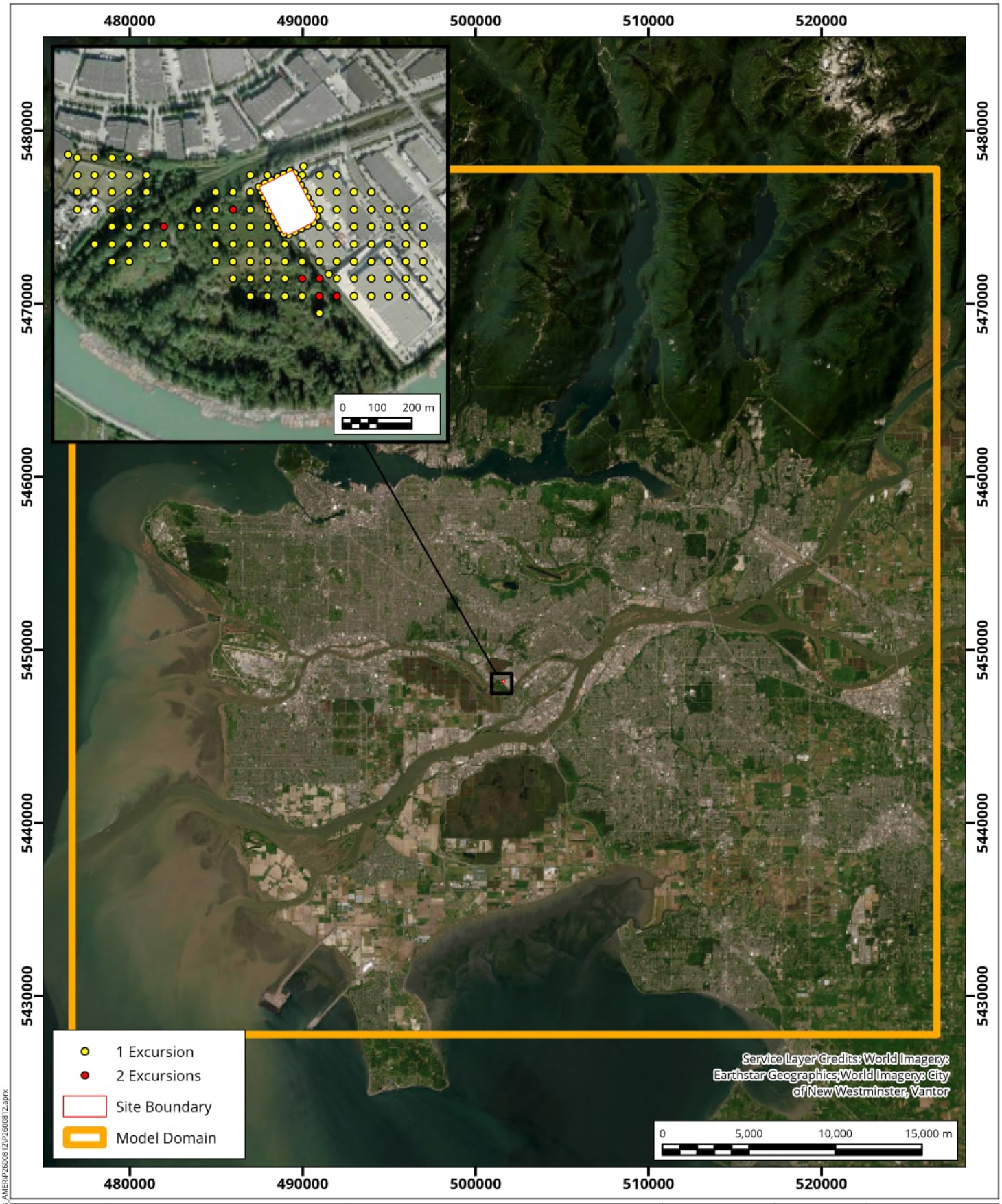
Map Projection: NAD 1983 UTM Zone 10N
Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

True North

OAAQC: 5E-05 µg/m³
Project #: 2600812

Drawn by: PIP	Figure: C.45
Approx. Scale:	1:300,000
Date Revised:	Aug 28, 2026

Map Document: C:\WorkingFolder\Jobs_AMER\P2600812\P2600812.aprx



Maximum Annual Count of 24-Hour PAH Excursions
Scenario: Shutdown

Concentration Without Background > OAAQC of 5E-05 µg/m^3
*** Receptors with predicted concentration above the criteria are shown.**

Map Projection: NAD 1983 UTM Zone 10N
Metro Vancouver Waste-To-Energy Facility - Burnaby, British Columbia

True North

OAAQC: 5E-05 µg/m^3
Project #: 2600812

Drawn by: PIP	Figure: C.46
Approx. Scale:	1:300,000
Date Revised:	Aug 28, 2026

Map Document: C:\WorkingFolder\Jobs_AMER\P2600812\P2600812.aprx

Appendix C: Public Health Risk Assessment Report

Metro Vancouver

Waste-to-Energy Facility
Public Health Risk Assessment

Prepared for:

Metro Vancouver

Chris Allan, P.Eng.
Director, Solid Waste Operations
Metro Vancouver
Metrotower III, 4515 Central Boulevard
Burnaby, BC V5H 0C6

September 23, 2026

OLLSON
Environmental Health Management

Executive Summary

The Greater Vancouver Sewerage and Drainage District is the owner of the Metro Vancouver Waste-to-Energy Facility located in Burnaby, British Columbia. It is a mass burn combustion facility designed to process 750 tonnes per day (tpd) (approximately 240,000 tonnes per year) of municipal solid waste (municipal solid waste). Located at 5150 Riverbend Drive, Burnaby, began operation in 1988 and has been in commercial operation since then. The Waste-to-Energy Facility has been operated and maintained on the Metro Vancouver's behalf by a number of private third-party operators since the start of operations, currently Veolia Environmental (Veolia) is the operator.

On September 23, 2025, the Ministry of Environment and Parks issued an amendment to Operational Certificate 107051 for the Waste-to-Energy Facility that contains the emissions discharge limits and performance requirements for air pollution control equipment for various contaminants. It requires that a Public Health Risk assessment be conducted in consultation with Vancouver Coastal Health and the Fraser Health Authority which will inform the discharge limits.

The objectives of the current Public Health Risk Assessment are:

- Conduct an updated review of the world-wide peer-reviewed scientific literature published since 2018 on the potential health effects that one could expect from living or working or engaged in proximity to the Metro Vancouver Waste-to-Energy Facility. This review was conducted using the PUBMED and Google Scholar databases. It builds on the previous Waste-to-Energy Facility health impact literature reviews conducted for Metro Vancouver. The results ensure that the scope of the Public Health Risk Assessment is focused on the correct contaminants of potential concern (COPC), exposure pathways and potential health outcomes.
- Update the Public Health Risk Assessment based on new air quality dispersion modelling being conducted by RWDI in 2026. This will include existing baseline/ambient concentrations of COPC from the Lower Fraser Valley Air Quality Monitoring Network, modeled concentrations and deposition of contaminants of potential concern under the existing Operational Certificate discharge limits, including start-up and shut-down conditions, and ground level airborne concentrations of contaminants of potential concern under newly proposed emission limits, in particular for sulphur dioxide (SO_2) and hydrogen chloride (HCl).
- Consider potential new approaches to evaluating the potential health impacts of the emissions of the non-threshold non-carcinogenic criteria air contaminants (CACs; e.g., nitrogen dioxide and fine particulate matter).
- Conduct an updated review of the toxicity reference values to be used within the Public Health Risk Assessment.

This Public Health Risk Assessment assessed both the short-term (Start-Up/Shutdown) and long-term (normal operations) potential exposure of the public to release of contaminants from the Waste-to-Energy Facility. It involved both a review of the existing scientific literature on contaminant release, exposure and long-term deposition of contaminants from such facilities and the Public Health Risk Assessment. Based on the findings of the Public Health Risk Assessment, recommendations for potential additional ambient air monitoring are discussed.

This report was prepared as part of the broader undertaking to satisfy the requirements of the Operational Certificate. The Air Dispersion Modelling Study, prepared by RWDI (2026), to support the Public Health Risk Assessment was prepared under separate cover. In addition, further technical details of the Waste-to-Energy Facility around found in the Metro Vancouver Proposed Operational Certificate Discharge Limits: Metro Vancouver Waste-to-Energy Facility (HDR, 2026).

Findings of the Literature Review

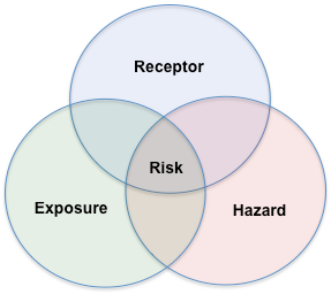
The updated review of the literature is consistent with the findings of previously published scientific research and suggests that modern, well-maintained Waste-to-Energy facilities, such as the Metro Vancouver Waste-to-Energy Facility, that are operated within compliance with air quality emissions standards in general do not pose an unacceptable risk to people living or working in the vicinity of waste-to-energy facilities. The literature review did not identify any contaminants that are not being assessed in this Public Health Risk Assessment. If anything, this Public Health Risk Assessment contains a more extensive list of contaminants for evaluation than was reported in the scientific literature. Risk assessment, human biomonitoring, and epidemiological studies conclude that there are unlikely to be significant adverse health effects on populations living and working near Waste-to-Energy facilities.

Public Health Risk Assessment Methodology

Public health risk assessment is the scientific approach to determining if a population's exposure to contaminants released to the environment could pose an undue risk to health. This approach is based on decades of research and the development of standard protocols and approaches to assessing risk.

All contaminants have the potential to interact with people, but it is the level, route and duration of exposure that determine if it could cause harm to health. For a potential undue risk to exist from emissions from the Waste-to-Energy Facility, one must understand:

- The nature in which people use the surrounding environment, for work, living and recreational purposes (receptors);
- The extent to which people may come into contact with the emitted contaminants (exposure); and
- The contaminants must be present at a high enough level to pose a risk to these people (hazard).



It is a combination of these elements that determine if an unacceptable risk to human health may exist.

The British Columbia Ministry of Health has published the *British Columbia Guidance for Prospective Human Health Risk Assessment* (2022) that was used as the primary guidance document for the conduct of the Public Health Risk Assessment. In addition, the Public Health Risk Assessment incorporated direction from *Health Canada's Guidance for Evaluating Human Health Effects in Impact Assessment: Human Health Risk Assessment* (2023).

Results of the Public Health Risk Assessment

As expected, the highest ground level concentrations of contaminants were predicted for the Current OC Permitted Scenario. This is the maximum concentration of contaminants that can be emitted from the Waste-to-Energy Facility. There was a considerable decrease of maximum ground level contaminant concentrations for the Current Operational Scenario, or the actual emissions that come from the facility. This is because the Waste-to-Energy Facility routinely emits considerably less of each contaminant than limited by the permit. An evaluation of the Proposed OC Permitted Discharge Limits was also conducted.

The following conclusions were reached:

- For the majority of the Criteria Air Contaminants that the Facility does not pose an undue risk to anyone at the MPOI for $PM_{2.5}$, carbon monoxide (CO), hydrogen chloride (HCl), hydrogen fluoride (HF) even at the existing Permitted OC discharge limits. The Operational Project Alone levels confirm that these contaminants do not pose an undue risk to public health.
- For sulphur dioxide (SO_2) the Current OC Permitted levels are marginally above the concentration ratio benchmark of 1.0. However, the Current Operational discharges are below the acceptable benchmark. The lowering of the Proposed OC Permitted levels also result in an acceptable Concentration Ratio of <1.0. Therefore, the OC discharge limits should be lowered to those proposed and do not result in an unacceptable risk to human health.
- The secondary particulate matter levels were an order of magnitude lower than the predicted primary $PM_{2.5}$ modeled levels at the MPOI and had no effect on the resulting $PM_{2.5}$ Concentration Ratios. Therefore, secondary particulate matter from the release of SO_2 emissions from the Waste-to-Energy Facility do not pose an undue risk to human health.
- Overall, all of the additional contaminants considered do not pose an unacceptable risk to human health, whether under the Current OC Permitted levels, the Proposed OC Permitted levels or certainly the Current Operational levels at the MPOI when considering the existing background concentrations in air. Their Concentration Ratios were all below 1.0. The exception to this was the PAHs that were modelled in the Current OC Permitted that had a Concentration Ratio above 1.0. However, the Concentration Ratio for the Current Operations Facility Alone level and in combination with the Background levels were below the benchmark of 1.0. In addition, the lowering of the emissions under the Proposed OC Permitted limits would ensure that the Concentration Ratio for PAHs would be acceptable and should be adopted by the Waste-to-Energy Facility. Therefore, PAHs especially with the Proposed OC Permitted limits do not pose an undue risk to human health.
- Nitrogen dioxide (NO_2) levels require further evaluation under the Tier 2 Risk Assessment.

Nitrogen Dioxide Tier 2 Risk Assessment Conclusions

The Public Health Risk Assessment concludes that although the Waste-to-Energy Facility is a source of ground level NO_2, it does not pose an undue public health risk based on the following lines of evidence:

- Over the past 40 years the Facility emissions of NO_2 have seen a dramatic decrease in their Discharge Limits and operational discharge of NO_2. The most significant decrease in release were seen in 2014 after the introduction of new air pollution control technology into the system.
- The Waste-to-Energy Facility accounts for only 0.5% of the total emissions of NO_2 in the Lower Fraser Valley airshed in 2025.
- The measured ambient air concentrations at the fence line of the Facility (S150) and the closest ambient air monitoring station Burnaby South (T018) in 2022 were higher that the predicted contribution from the Waste-to-Energy Facility modeled NO_2 concentrations at these stations. Given that this is an active facility then the existing ambient air monitoring stations results are inclusive of the contribution of the Waste-to-Energy Facility emissions. The ambient air concentrations of NO_2 at these monitoring stations either meet or marginally exceed the Metro Vancouver Ambient Air Quality Objectives.
- The modeled percentile concentrations of NO_2 from the Waste-to-Energy Facility under the Proposed OC Permitted Discharge Limit, and more importantly for the Current Operations scenario are below the Ambient Air Quality Objective at all times (100^{th} percentile).
- Overall, the emitted NO_2 Waste-to-Energy Facility emission do not pose an undue risk to human health.

Recommendations

Section 6 of the Metro Vancouver Proposed Operational Certificate Discharge Limits: Metro Vancouver Waste-to-Energy Facility (HDR, 2026) report provides the additional monitoring that is being committed to, in part based on the results of the Public Health Risk Assessment.

Based on the findings of the Public Health Risk Assessment, the following recommendations are made for future monitoring and assessment:

1. Conduct annual start-up and shutdown stack test monitoring of all contaminants to establish a trend in the emissions in comparison to the routine operations emissions from the Facility. The specifics of this monitoring are expanded on in the Operational Certificate overarching report.
2. Adopted the Proposed Operational Certificate new emissions discharge limits.
3. Re-establish the S150 Air Monitoring Station at the fence line of the Facility. The MPOI for Criteria Air Contaminants are located near the fenceline for the 1-hr and 24-hr values and would provide the best indicator for the potential influence the Facility is having on the airshed. Contaminants should include NO_2, SO_2, HCl, and $PM_{2.5}$. This data should be included as part of the annual environmental monitoring reporting for the Facility. There would be no need to install additional air monitoring stations in the area.
4. Conduct an updated air quality dispersion modelling and provide the results, such that a Public Health Risk Assessment is conducted every five years using the latest CEMS and stack test data. This would confirm the effectiveness of the lowering of the SO_2 and HCl. It would also assist in the tracking of the other contaminants. It should include any changes in ambient air quality objectives and include the data from the S150 monitoring station. The

Waste-to-Energy Facility should be required to implement any recommendations of the updated Public Health Risk Assessment.

Based on the findings of the deposition of contaminants to soil over 20 years there would be no need to conduct soil or vegetation sampling in the area surrounding the Waste-to-Energy Facility.

Conclusions

Based on the results of the ambient air quality monitoring and PHRA, current emissions of contaminants from the Waste-to-Energy Facility do not pose a public health risk. The findings of this PHRA are consistent with the findings of a 2018 report and the past three decades of peer-reviewed scientific literature and government reports on facilities around the world.

The PHRA recommends that that the draft proposed discharge limits presented in this report be included in the Waste-to-Energy Facility Operational Certificate. In addition, annual startup and shutdown stack testing should be conducted, the ambient air monitoring station adjacent to the Waste-to-Energy Facility should be re-established, and every five years air quality modelling and a PHRA should be conducted.

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1 Introduction

The Greater Vancouver Sewerage and Drainage District is the owner of the Metro Vancouver Waste-to-Energy Facility located in Burnaby, British Columbia. It is a mass burn combustion facility designed to process 750 tonnes per day (tpd) (approximately 240,000 tonnes per year) of municipal solid waste (municipal solid waste). Located at 5150 Riverbend Drive, Burnaby, began operation in 1988 and has been in commercial operation since then. The Waste-to-Energy Facility has been operated and maintained on the Metro Vancouver's behalf by a number of private third-party operators since the start of operations, currently Veolia Environmental (Veolia) is the operator.

On September 23, 2025, the Ministry of Environment and Parks issued an amendment to Operational Certificate 107051 for the Waste-to-Energy Facility that contains the emissions discharge limits and performance requirements for air pollution control equipment for various contaminants. The Operational Certificate requires the following be undertaken:

> 1.1.11 By September 23, 2026, the Operational Certificate Holder will cause one or more Qualified Professionals to prepare and submit to the Director the following information to facilitate the Director's decision on discharge limits for HCl and SO_2:
>
> (a) Review of all current emissions levels in clause 1.1.3 in addition to HCl and SO_2.
>
> (b) Results of testing of potential facility operational modifications to support reduction of discharge limits for emissions in clause 1.1.3.
>
> (c) A Public Health Risk assessment in consultation with Vancouver Coastal Health and the Fraser Health Authority which will inform the discharge limits.
>
> (d) A proposal for draft revised discharge limits listed in clause 1.1.3.
>
> (e) A public consultation plan for draft revised discharge limits for Director's approval.
>
> (f) A review of emission reporting and public access to data, including any recommendations for improvement.

Metro Vancouver has retained HDR Corporation (HDR) to undertake the tasks required by the Operational Certificate. Ollson Environmental Health Management (OEHM) has been retained by HDR to lead the Public Health Risk Assessment.

In 2018, OEHM and HDR completed a Public Health Risk Assessment for the Waste-to-Energy Facility under the previous Operational Certificate. The overall conclusions of the 2018 Public Health Risk Assessment were:

> *All contaminant concentrations were below their respective health-based benchmarks for the Operations, Start-up and Shutdown Scenarios and required no further evaluation. This means that the current emissions from the facility do not pose a health risk to people.*
>
> *For the very conservative Permitted Scenario, the maximum concentrations of 1-hr nitrogen dioxide, 1-hr hydrogen chloride and 24-hr total polycyclic aromatic hydrocarbons immediately adjacent to the facility were above the respective background guidelines for a couple of hours a year.*
>
> *Further spatial, temporal and toxicological exposure evaluation to the maximum predicted concentrations of all three of these contaminants close to the facility revealed that they do not pose an undue public health risk for those living, working or engaged in recreational activity surrounding the facility. Based on these results, additional monitoring of contaminants in air, soil, water, vegetation or other environmental media are not recommended. Although there were minor temporal exceedances of the Permitted Scenario these Operational Certificate limits are reasonable, do not result in a public health risk and therefore no changes to the Operational Certificate limits are recommended. The findings of the Public Health Risk Assessment are consistent with the past two decades of peer-reviewed scientific literature and government reports.*

The objectives of the current Public Health Risk Assessment are:

- Conduct an updated review of the world-wide peer-reviewed scientific literature published since 2018 on the potential health effects that one could expect from living or working or engaged in proximity to the Metro Vancouver Waste-to-Energy Facility. This review was conducted using the PUBMED and Google Scholar

databases. It builds on the previous Waste-to-Energy Facility health impact literature reviews conducted for Metro Vancouver. The results ensure that the scope of the Public Health Risk Assessment is focused on the correct contaminants of potential concern (COPC), exposure pathways and potential health outcomes.

- Update the Public Health Risk Assessment based on new air quality dispersion modelling being conducted by RWDI in 2026. This will include existing baseline/ambient concentrations of COPC from the Lower Fraser Valley Air Quality Monitoring Network, modeled concentrations and deposition of contaminants of potential concern under the existing Operational Certificate discharge limits, including start-up and shut-down conditions, and ground level airborne concentrations of contaminants of potential concern under newly proposed emission limits, in particular for sulphur dioxide (SO_2) and hydrogen chloride (HCl).
- Consider potential new approaches to evaluating the potential health impacts of the emissions of the non-threshold non-carcinogenic criteria air contaminants (CACs; e.g., nitrogen dioxide and fine particulate matter).
- Conduct an updated review of the toxicity reference values to be used within the Public Health Risk Assessment.

This Public Health Risk Assessment assessed both the short-term (Start-Up/Shutdown) and long-term (normal operations) potential exposure of the public to release of contaminants from the Waste-to-Energy Facility. It involved both a review of the existing scientific literature on contaminant release, exposure and long-term deposition of contaminants from such facilities and the Public Health Risk Assessment. Based on the findings of the Public Health Risk Assessment, recommendations for potential additional ambient air monitoring are discussed.

This report was prepared as part of the broader undertaking to satisfy the requirements of the Operational Certificate. The Air Dispersion Modelling Study, prepared by RWDI, to support the Public Health Risk Assessment was prepared under separate cover. In addition, further technical details of the Waste-to-Energy Facility around found in the Metro Vancouver Proposed Operational Certificate Discharge Limits: Metro Vancouver Waste-to-Energy Facility (HDR, 2026).

2 Overview of the Metro Vancouver Waste-to-Energy Facility

The Waste-to-Energy Facility is located in a commercial/industrial area of south Burnaby, British Columbia, Canada on a 1.8-hectare site near the Fraser River. The Waste-to-Energy Facility commenced operation in 1988 and has been in commercial operation since that time. It has been operated and maintained on the Corporation's behalf by a number of contractors.

The Waste-to-Energy Facility consists of three identical, mass burn type combustion units and currently processes approximately 240,000 tonnes per year of municipal solid waste, or approximately 25% of the residual municipal solid waste managed by Metro Vancouver. This volume of waste processing was similar in 2018 and not expected to change in the coming years. Each combustion train consists of a feed hopper/chute, a stoker grate and a waterwall boiler. Municipal solid waste is stored in a bunker and fed into each feed hopper using an overhead refuse crane.

Heat is recovered from the combustion process in the form of superheated steam. The steam is used to generate approximately 23 megawatts of gross electrical power at full load using a steam turbine and electric generator. All of the electricity generated by the Waste-to-Energy Facility is sold to B.C. Hydro under a power purchase agreement. Approximately 3 megawatts of electrical power is purchased directly from B.C. Hydro to satisfy the in-house load required to operate the Waste-to-Energy Facility. The Waste-to-Energy Facility is also able to export steam through a dedicated turbine extraction port. The Waste-to-Energy Facility previously sold steam to an adjacent paper facility operated by Norampac. Steam export was discontinued in 2011 due to the closure of the steam host facility, but Metro Vancouver is currently developing a district energy system to supply heat and hot water to nearby neighbourhoods.

The flue gases from each combustion unit are treated in an air pollution control system prior to discharge to the atmosphere. The existing air pollution control system equipment on each unit consists of a heat recovery unit, a dry hydrated lime scrubber, and a multi-compartment fabric filter baghouse. The air pollution control system heat recovery unit, referred to as the primary economizer, is used to cool the flue gases leaving the boiler and provides a second means of preheating the boiler feed water. Hydrated lime and activated carbon are injected into the dry scrubber to reduce acid gases and emissions of mercury (Hg) and dioxins and furans, respectively.

The baghouse removes particulates from the flue gas including fly ash from the combustion process and by-products from the dry scrubber. An induced draft fan is located downstream of each baghouse and is used to maintain a negative draft through the combustion and air pollution control system train. The cleaned flue gas is discharged from the ID fan through a dedicated flue inside a common concrete stack. In 2014, a Low Nitrogen Oxide (NO_X) (or LN™) technology consisting of staged combustion air and aqueous ammonia injection into each furnace was installed. Figure 1 provides a representative cross section of the Waste-to-Energy Facility.

Table 1 provides an overview of the current emission control systems employed by the Facility.

Table 1. Current Emissions Control Systems

System	Primary Controlled Contaminants
Good Combustion Management (Residence Time, Furnace temperature, O_2)	CO, Dioxins and Furans, Organics
Ammonia Injection (LN™)	NOx
Dry scrubber (Hydrated Lime Addition)	Acid Gases (SO_2, HCl, HF)
Dry Scrubber (Power Activated Carbon)	Mercury, Dioxins and Furans, Heavy Metals
Baghouse	Particulates, Dioxins and Furans, Heavy Metals, Acid Gases (SO_2, HCl, HF)

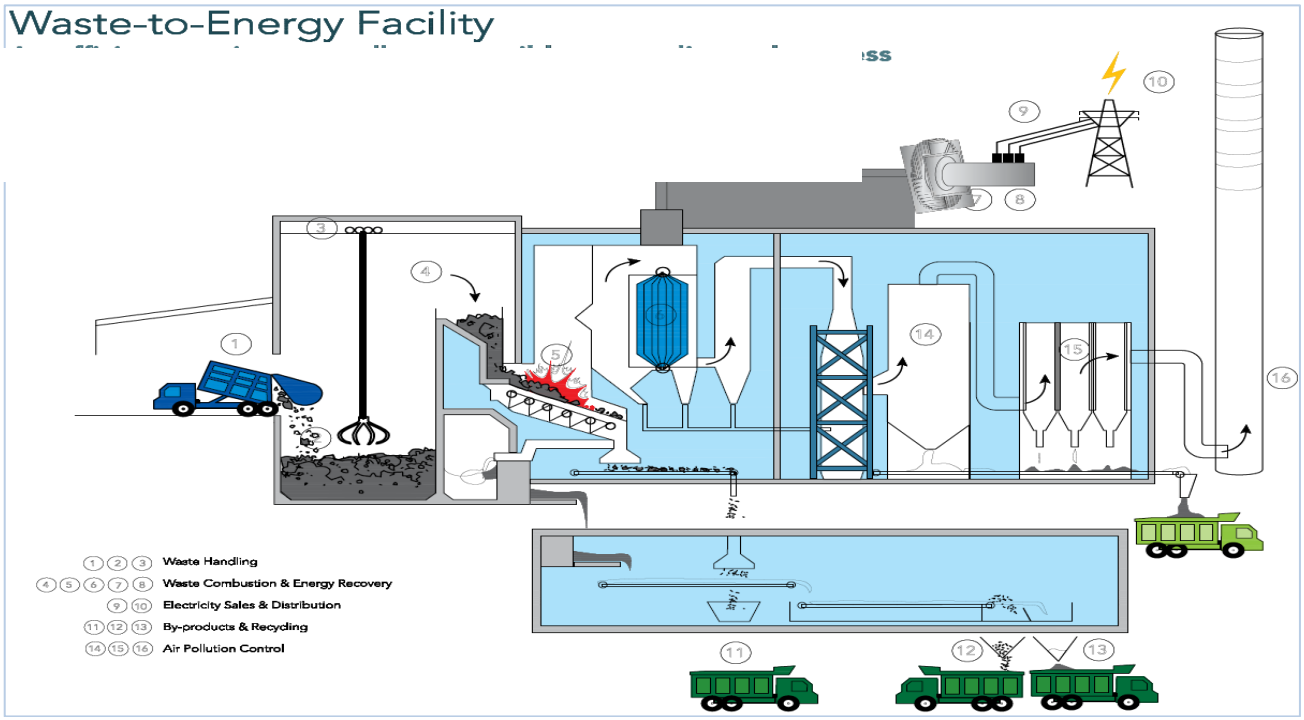


Figure 1. Schematic of the Metro Vancouver Waste-to-Energy Facility

By-products from the combustion process include bottom ash from the boiler system and fly ash from the air pollution control system, which are stored and disposed separately. Ferrous metal is recovered from the bottom ash using a belt magnet positioned perpendicular to the bottom ash conveyor on each combustion unit. Bottom ash and recovered ferrous metals are stored temporarily in a bunker and loaded out with an overhead ash crane.

A non-ferrous metal recovery system was installed in 2018. Bottom ash is batch fed to this system using the ash crane and recovers both non-ferrous metals and an incremental amount of additional ferrous metal. Fly ash is collected in hoppers beneath the dry scrubber and baghouse and conveyed pneumatically to a storage silo. Phosphoric acid is added to the bottom ash to stabilize metal constituents before being loaded into covered trailers. Fly ash is conditioned with water and phosphoric acid in a pugmill to reduce dusting and stabilize metals. Given that the ash material is handled under strict regulations and is not emitted to the environment, it is not being considered in this assessment.

The Facility operates under stringent contaminant emission discharge limits that have been updated over the years. Compliance with these limits are demonstrated through two types of emissions monitoring that are employed by the Waste-to-Energy Facility. The first is an in-stack continuous emissions monitoring and continuous opacity monitoring systems, as well as applicable operating parameters. The air quality related parameters that are continuously monitored for compliance purposes include:

- Stack temperature
- Stack gas oxygen (O_2) concentration
- Stack gas sulfur dioxide (SO_2) concentration
- Stack gas hydrogen chloride (HCl)
- Stack gas nitrogen oxides (NO_x) concentration
- Stack gas carbon monoxide (CO) concentration
- Stack gas total hydrocarbons (THC) concentration
- Opacity (as a surrogate for particulate matter)
- Furnace temperature

The second is quarterly stack testing conducted for a number of constituents and annually for another set of pollutants. The quarterly testing includes:

- Particulate matter (filterable)
- Hydrogen fluoride
- Seventeen (17) metals

The annual testing includes:

- Dioxins and furans (PCDD/F)
- Polychlorinated biphenyl (PCB)
- Polycyclic aromatic hydrocarbons (PAH)
- Hexachlorobenzenes (HCB)
- Chlorobenzene (CB)
- Chlorophenols (CP)

As compared to other facilities located in North America and Europe, the quarterly stack testing is a greater frequency than most facilities. Typically, the Waste-to-Energy Facility facilities have a requirement for annual or semi-annual stack testing (e.g. Durham York Energy Centre and many facilities in the United States).

The results of both the continuous monitoring and the quarterly stack testing from were used in the Air Dispersion Modelling Assessment (RWDI, 2026) to predict ground level airborne concentrations of contaminants surrounding the Waste-to-Energy Facility. In addition, Metro Vancouver has spent significant effort over the past year to ascertain the best approach for reducing sulphur dioxide and hydrogen chloride emissions from the Facility.

3 Literature Review of Potential Health Impacts Living in Proximity to Waste-to-Energy Facilities

A number of comprehensive scientific literature reviews have been conducted in this field over the past decade. In 2014, Metro Vancouver commissioned a study "*Literature Review of Potential Health Risk Issues Associated with New Waste-to-Energy Facilities*" (Intrinsik, 2014). This review focused on Public Health Risk Assessments, human biomonitoring studies and epidemiological studies for those living in close proximity to modern waste-to-energy facilities such as the Metro Vancouver Waste-to-Energy Facility. The definition of a modern waste-to-energy facility is not tied to a specific construction date. Rather, modern facilities are generally characterized by advanced air pollution control systems, strong maintenance records, continuous emissions monitoring, and compliance with applicable regulatory emission limits. Details of emission limits in other Canadian facilities, the United States and the European Union are provided in the Metro Vancouver Proposed Operational Certificate Discharge Limits report (HDR,2026). Although there is variation between these jurisdictions this literature review considers Waste-to-Energy Facilities operation in all three of them to be modern facilities. Less is known about the emission limits and standards in Asian countries. For those facilities where research has been conducted, they were scrutinized but still included in the results of this review.

The Metro Vancouver Waste-to-Energy Facility, while constructed in 1988, has received multiple improvements over its life resulting in reduced emissions compared to when originally constructed. In addition, the Metro Vancouver Waste-to-Energy Facility operates under modern, updated, British Columbia Ministry of Environment air emissions limits and is therefore considered a modern waste-to-energy facility in the context of this literature review. Based on these criteria, the Metro Vancouver Waste-to-Energy Facility can be considered a modern facility.

The overall conclusion from the 2014 report was:

> *"Out of the 21 peer-reviewed articles included for detailed review, 14 were risk assessments, 3 were human biomonitoring studies, and 4 were epidemiological studies. Although there were some limitations and uncertainties associated with each of the studies, over all these articles best represented the available scientific knowledge on modern WTE facilities and potential health impacts. The results from these studies collectively indicate that there are no unacceptable health risks to residents living in the immediate vicinity of a modern, well- maintained and properly operated WTE facility equipped with the best available pollution control technologies."*

The Metro Vancouver 2014 review built on the comprehensive reviews undertaken for Ontario in "*Halton Region Energy-from-Waste Literature Review*" (Jacques Whitford, 2007) and the Durham Region "*Review of International Best Practices of Environmental Surveillance for Energy-From-Waste Facilities Literature Review of Waste-to-Energy Issues"* (Jacques Whitford, 2009). The findings of these reports are consistent with the the Metro Vanouver (2014) review. A key finding of the Jacques Whitford (2009) report was:

> *"It is concluded from the scientific literature that an ongoing soil monitoring program would not be required for the proposed Durham/York EFW facility to ensure the protection of human or environmental health. This conclusion was reached on the basis that a modern incineration facility that employs current pollution control technology should not impact local soil quality."*

This conclusion was reached after review of numerous soil monitoring programs around waste-to-energy facilities indicate that loading of contaminants (including dioxins and furans) did not occur above background conditions.

In 2017, Metro Portland as part of their long-term strategic planning effort for municipal solid waste commissioned a *Literature Review of waste-to-energy Issues* (HDR, 2017). This review included an update to the health literature

from the Metro Vancouver review (Intrinsik, 2014) and issues surrounding environmental monitoring for impacts. It concluded:

> *"Overall, the published scientific literature on potential health concerns living in proximity to WTE facilities indicates that modern facilities with appropriate air pollution control technology can be safely sited."*

The conclusion of the 2018 literature review commissioned by Metro Vancouver was:

> *"The updated review of the literature is consistent with the findings of previous published scientific research and results in the field, and taken together suggest that it is unlikely that the Waste-to-Energy Facility would adversely impact health of nearby receptors (people)."*

Over the past decade, comprehensive literature reviews consistently conclude that modern, well-maintained waste-to-energy facilities, with stringent air quality emissions standards do not pose an unacceptable health risk to nearby residents.

An updated literature search was undertaken for this Public Health Risk Assessment and it included a search for peer-reviewed scientific studies and review articles assessing the potential health impacts for those living near waste-to-energy facilities. Given the large volume of literature available on the subject and building upon the previous literature review from 2018, the search date was restricted to papers published between 2018 and 2026.

The literature review was conducted using PubMed database and Google Scholar with the search terms:

- Waste-to-Energy
- Health
- Incineration
- Municipal Solid Waste Incineration

The literature search identified a total of 990 records (PubMed 730, Google Scholar 260). Articles selected for retrieval based on title totaled 74 articles (Pub Med 52, Google Scholar 22). Next, abstracts were reviewed and articles were screened against exclusion criteria and removed accordingly.

The exclusion criteria consisted of papers with:

- Consideration in the previous literature review. All studies published earlier than 2018 were excluded as they would have been captured in previous literature reviews. However, papers published after 2018, which contained analytical data or results collected prior to 2018 were included provided the paper wasn't considered in the previous literature review.
- Hazardous waste incinerators as opposed to municipal solid waste incinerators
- Occupational exposure
- No discussion about health or risk
- Public perception of waste-to-energy facilities
- Exposure pathway ingestion only
- Non-English papers

Figure 2 shows the number of articles included at each step of the process.

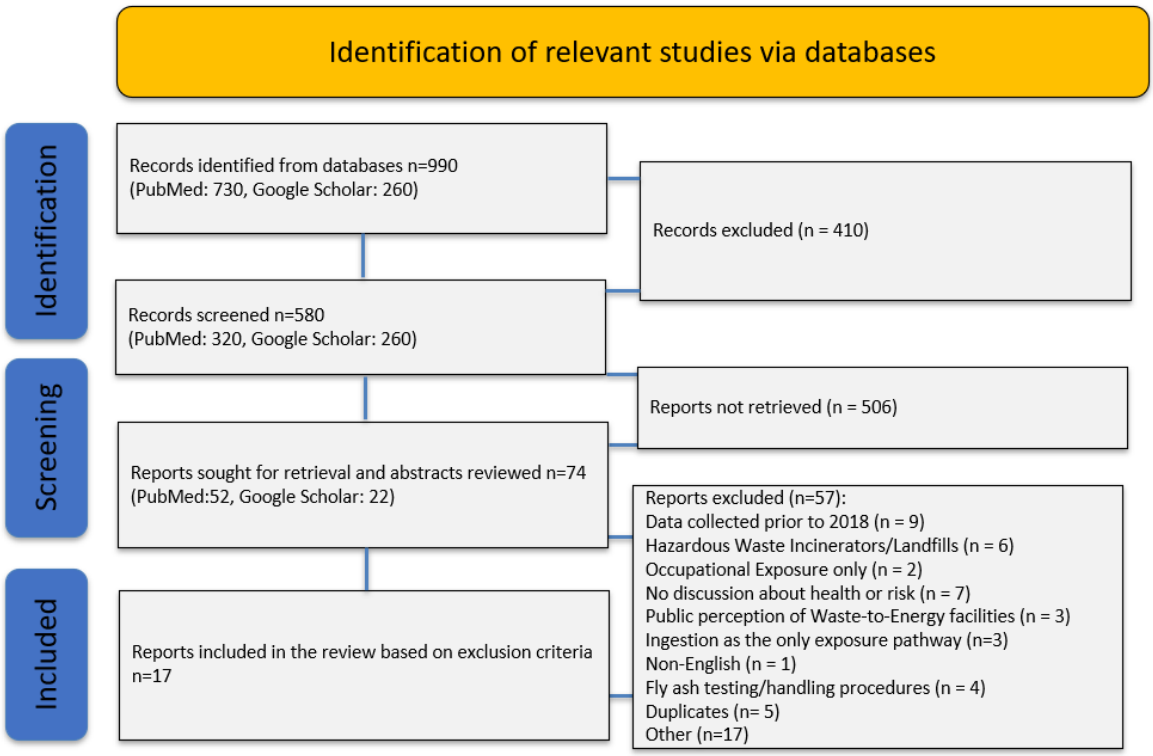


Figure 2. Flow chart detailing the number of articles selected at each phase of identification, screening, and inclusion in the Waste-to-Energy Facility literature review.

The abstract review yielded 17 total papers, which are presented below organized by systematic reviews, epidemiological and human biomonitoring studies, and public health risk assessments. A summary of these peer-reviewed articles is found in Table 1 and discussed below.

Systematic Reviews:

Cole-Hunter et al. (2020) The health impacts of waste-to-energy emissions: a systematic review of the literature. Environmental Research Letters. 15:123006

This review summarizes the current evidence of potential health effects of exposure to waste to energy/refuse derived fuel. The studies reviewed included two epidemiological studies, five environmental monitoring studies, seven risk assessments, and five life-cycle assessments. The nations represented in the studies include China, Slovakia, the UK, Italy, Spain, Canada, and Singapore. The limited evidence suggests that well-designed and operated waste-to-energy facilities (that could include using sorted feedstock (refuse derived feed)) are critical to reduce potential adverse health (cancer and non-cancer) impacts, due to lower hazardous combustion-related emissions and appropriate emissions limits, compared to landfill.

de Titto E, Savino A. (2019) Environmental and health risks related to waste incineration. Waste Management Research. 10:976-986.

This mini review focused on research published on the impact to human health from living near waste-to-energy facilities. The papers included in this review were published between 1999 and mid-2018 and included epidemiological, risk assessment, and biomonitoring studies. The studies spanned the globe including papers from Germany, Belgium, Japan, Portugal, France, Spain, the UK, and China. The authors found no studies indicating that modern-technology waste incineration plants (which would include the Metro Vancouver Waste-to-Energy

Facility), which comply with the legislation on emissions, are a cancer risk factor or have adverse effects on reproduction or development.

Tait et al. (2020) The health impacts of waste incineration: a systematic review Australia New Zealand Journal of Public Health. 44: 40-48.

This review focused on peer-reviewed epidemiological studies that investigate the health effects of waste incineration. The papers included in this review were dated 2002 to 2017 and were organized into external measurements (air, soil, water, food), internal measurements (toxin levels in urine, blood), and health effects (cancer, reproductive health, and overall health). Overall, authors identified some possible associations between older waste incinerators without updated emission control systems and updated air emission permitted levels as is the case with the Metro Vancouver Waste-to-Energy Facility, and adverse health outcomes including certain cancers, respiratory effects, and adverse birth outcomes. The authors state that "improvements in incinerator technologies may mean these results will not accurately represent the health consequences of exposure to current incinerators".

Negri et al. (2020) Health effects of living near an incinerator: A systematic review of epidemiological studies, with focus on last generation plants. Environmental Research 184:109305.

This review focused on epidemiological evidence of the health effects of waste-to-energy facilities. The search yielded 63 studies and the health endpoints selected were cancer, cardio-cerebrovascular diseases, respiratory diseases, pregnancy outcomes, and congenital anomalies. The findings suggest there is no association between incinerators and cancer, cardio-cerebrovascular diseases, respiratory diseases, and pregnancy outcomes. Generally, studies showed no association with waste-to-energy facilities and congenital anomalies, however, there were associations reported in a few studies for specific types of congenital anomalies for older waste-to-energy facilities. This would not include the Metro Vancouver Waste-to-Energy Facility. Overall, evidence suggests that if there were any increases in congenital anomalies for older waste-to-energy facilities, they would be modest at most.

Campo et al. (2019) A systematic review of biomonitoring of individuals living near or working at solid waste incinerator plants. Critical Reviews in Toxicology. 49 (6):476-519.

This review focused on peer-reviewed biomonitoring primary literature related to exposure and effects of waste-to-energy facility contaminants for those living in the surrounding area and waste-to-energy facility workers. The relevant contaminants that were selected include dioxins, metals, PAHs, and volatile organic compounds and their associated biomarkers. In total, 132 papers were selected published between 2001 and 2010 and span the world (European Union (EU): Belgium, Germany, Italy, Portugal, Slovakia etc, Americas: Brazil, USA, Asia: China, Japan, South Korea). The levels of the biomarkers in the general population living near modern waste-to-energy facilities were, in most studies, in the range of the reference values, showing no or very scarce impact of waste-to-energy facilities emissions on internal dose of the contaminants considered.

Bottini (2025). Residential exposure to municipal solid waste incinerators and health effects: a systematic review with meta-analysis. BMC Public Health. 25:1989.

Researchers conducted a systematic review of waste-to-energy facilities and health effects and found that, while there were slight indications of increased cardiovascular and respiratory hospitalizations and a possible association with non-Hodgkin lymphoma, generally overall evidence remains weak.

Epidemiological Studies:

Ghosh et al. (2019) Fetal growth, stillbirth, infant mortality and other birth outcomes near UK municipal waste incinerators; retrospective population-based cohort and case-control study. Environment International. 122: 151-158

This epidemiological study investigated the incidence of adverse birth outcomes near waste-to-energy facilities in the UK. The health endpoints included fetal growth, stillbirth, infant mortality, and others. The authors found no evidence that exposure to PM_{10} from, or living near to, a waste-to-energy facility operating to current EU standards was associated with harm for any of the outcomes investigated.

Biomonitoring:

The following three studies are all human biomonitoring studies of the waste-to-energy facility in Turin, Italy.

Lamiceli et al. (2020) Biomonitoring of the adult population in the area of Turin waste incinerator: Baseline levels of polycyclic aromatic hydrocarbon metabolites. Environmental Research. 181:108903

This biomonitoring study investigated the prevalence of polycyclic aromatic hydrocarbons (PAH) biomarkers and established their baseline levels for subsequent studies. The specific biomarkers measured in urine samples were ten monohydroxy-PAHs (OH-PAHs) representing the primary metabolites of naphthalene (NAP), fluorene (FLU), phenanthrene (PHE), and pyrene (PYR). Concentrations of 1-OH-NAP, 9-OH-FLU, 1-,2-,3, 4-OH-PHE, and 1-OH-PYR were significantly lower in subjects living near the waste-to-energy facility compared to those living in the town of Turin, with differences between the two groups in the range of 13-31%. Concentrations of OH-PAHs assessed in this study may be considered indicative of the background exposure to PAHs for adult population living in an urban and industrialized area and reflect lifestyle choices such as smoking as opposed to proximity to the waste-to-energy facility.

Ruggieri et al. (2019) Human biomonitoring health surveillance for metals near a waste-to energy incinerator: The 1-year post-operam study. Chemosphere. 225:839-848

This biomonitoring study assessed the temporal and spatial trends of exposure to 18 metals for subjects living around the waste-to-energy facility in Turin, Italy. Researchers measured the concentration of metals in the urine of 380 adults (186 exposed and 194 unexposed based on proximity to the Waste-to-Energy). Researchers found that most metals decreased in concentration over time, except for Chromium that increased in concentration over time for subjects near the waste-to-energy facility. Generally, the concentration of metals was within their established reference ranges even after one year of waste-to-energy facility operations.

Lamiceli et al. (2022) The longitudinal biomonitoring of residents living near the waste incinerator of Turin: Polycyclic Aromatic Hydrocarbon metabolites after three years from the plant start-up. Environmental Pollution. 314: 120199

This biomonitoring study is a follow-up to the above study and assessed changes in the PAH biomarker level temporally, approximately 3 years after the waste-to-energy facility became operational. Researchers found that urinary PAH metabolite concentrations in residence living near the Turin waste-to-energy facility did not increase three years after plant start-up when compared to baseline measurements. Temporal trends in PAH exposure were primarily associated with lifestyle and behavioral factors rather than residence near the waste-to-energy facility. Overall, the findings suggested that sustained operation of the facility did not contribute to increased internal PAH exposure in the monitored population during the study period.

Human Health Risk Assessments

Huang et al. (2024) Health risk assessment of municipal solid waste incineration emissions based on regression analysis. Eco-Environment & Health. 3:338-346

This original research article examined the potential human health effects associated with the operation of 96 waste-to-energy facilities in China. The risk assessment metrics employed were hazard indices (HI) and cancer risks (CR) and spatial distribution of contaminants emitted from the waste-to-energy facility were modelled using the Weather Research and Forecasting (WRF) model and California Puff (CALPUFF). Researchers found that, for the entire

study area, the average HI was 2.95E-03 and the average CR was 3.43E-7, below the acceptable threshold of 1.0 and 1.0E-6, respectively.

Fan et al. (2024) Probabilistic human health risk assessment of PCDD/Fs near municipal solid-waste incinerator using Monte Carlo analysis coupled with triangular fuzzy numbers. Ecotoxicology Environment Safety 1:116203.

This original research article involved collecting PCDD/Fs samples around a waste-to-energy facility in China. Air and soil samples were collected from 2016 to 2018 at two sample locations less than 1.5 km from the waste-to-energy facility and two sample locations 3 – 10 km from the facility. Researchers found that the carcinogenic and non-carcinogenic risk values of PCDD/Fs exposed to residents in nearby areas were acceptable, with hazard index (HI) values lower than 1.0 and a total carcinogenic risk lower than 1.0E-6.

Rovira et al. (2018) Concentrations of trace elements and PCDD/Fs around a municipal solid waste incinerator in Girona (Catalonia, Spain). Human health risks for the population living in the neighborhood. Science of the Total Environment. 630: 34-45.

This original research article involved the collection of soil (8) and air (4) samples around the waste-to-energy facility in Catalonia, Spain in 2015 and 2016. A suite of metals and PCDD/Fs were analyzed and compared to reference values to assess exposure and health risks, both carcinogenic and non-carcinogenic, for the population living around the facility. The study found no significant differences in air concentrations with respect to distance or wind direction from the waste-to-energy facility. Researchers found that in soils, no significant changes were detected for any metal or PCDD/F between the 2015 and 2016 sampling campaigns. In air however, several metals were measured at significantly higher levels in 2016 than in 2015. No explanation was provided with respect to the cause of the higher measured metal concentrations. Non-carcinogenic risks were below the safety limit (Hazard Quotient (HQ) / Concentration Ration (CR) <1) and carcinogenic risks were within acceptable ranges.

Li et al (2018). The health risk levels of different age groups of residents living in the vicinity of municipal solid waste incinerator posed by PCDD/Fs in atmosphere and soil. Science of the Total Environment. 631-632:81-91.

This original research article involved sampling air and soil to evaluate the potential health effects of PCDD/Fs on residents living in the vicinity of a waste-to-energy facility located in China. The carcinogenic risk (CR) of PCDD/Fs in the surrounding atmosphere and soil for three age ranges (children, teens, and adults) were all less than 1.00E-05, suggested that the potential cancer risk is at acceptable levels. The non-carcinogenic risk values for the three age groups were all lower than 1, indicating that no obvious non-carcinogenic effects occurred.

Boré et al (2020). Monitored air pollutants from waste-to-energy facilities in China: Human health risk, and buffer distance assessment. Atmospheric Pollution Research. 13, 7: 101484.

This risk assessment investigated air contaminants from 510 waste-to-energy facilities in China to evaluate human health risks and assess the adequacy of existing buffer distances. Using monitored emission data for criteria contaminants (PM, SO_2, NO_x, CO, HCl) and heavy metals, combined with plume dispersion modeling, the authors quantified non-cancer (hazard index, HI) and cancer risks (CR) from inhalation exposure. The hazard index (HI) assessment included Cd, As, Cr, Ni, Pb, and Hg, whereas the cancer risk (CR) included Cd, As, Cr, and Ni. Researchers found that, while national emissions showed a declining trend from 2015 to 2020 for PM, SO_2, and CO, at 1 km downwind from the facility, the average HI (1.06) slightly exceeded the recommended safety threshold (1.00), and the average lifetime cancer risk (5.69 E-3) exceeded acceptable levels (1E-4). The researchers suggest that the buffer distance should be increased to 1.5 km downwind to better protect surrounding communities in China. It is unknown as to how the concentrations of these contaminants compared to that of the Metro Vancouver Waste-to-Energy Facility emissions, and what the background levels of contaminants were in the vicinity of the waste-to-

energy facilities. However, it points to the need for the public health risk assessment to determine the potential risks for waste-to-energy facilities.

3.1 Limitations of the Literature Review

This literature review was limited by several factors including:

- This literature review was not a meta-analysis or a Cochrane Systematic Review, which are far more rigorous in their methodology and undertaking. Instead, using similar principles it was conducted to provide a scan of the available literature that is readily accessible and provides insight into potential adverse health outcomes for those living around currently operating Waste-to-Energy Facilities.
- The published health research was primarily from European and Asian countries, with limited studies focusing on North America or more specifically Canada. Therefore, caution should be exercised in an over interpretation of the findings in relation to the Metro Vancouver Waste-to-Energy Facility. It is unknown, and not reported in the literature, what emission limits are in place in the Asian-based studies. It is possible that they have similar emission limits to North America or the EU. However, it is equally possible that their emission limits may be higher. This was beyond the scope of this literature review and all studies were included regardless.
- The most common contaminants investigated were dioxins/furans and metals. Only two papers selected specifically focused on NO_x, HCl, and SO_2.
- The definition of what a modern waste-to-energy facility is in regard to age, maintenance and emission limits. Several studies noted that modern facilities tended to be associated with fewer health impacts but did not specify the age restrictions to be considered modern. Therefore, it is difficult to interpret this finding within the context of the Metro Vancouver Waste-to-Energy Facility. That said, the distinction is that facilities reported on since 2018 in the literature tend to examine levels of emissions that were measured from 2010 onwards that continue to be in operation, therefore a facility constructed or in operation in 2010 and onward or continue to be in operation during the investigation period were considered.
- There are difference between air emission standards across different jurisdictions. While each country or area has its own air emission standards, generally the EU standards are very similar to the Metro Vancouver Waste-to-Energy facility for most parameters however, it is important to note that the EU standards are slightly more stringent than the Metro Vancouver Waste-to-Energy facility for HCl, SO_2, and NO_x. Conversely, the United States Environmental Protection Agency (USEPA) standards are generally similar or less stringent when compared to the Metro Vancouver Waste-to-Energy facility standards. It is important to interpret the results of the literature within the context of the specific country/area of operation and the emission standards to which they follow. The Metro Vancouver Proposed Operational Certificate Discharge Limits report (HDR, 2026) provides further details of these limits across Canada, the US and the EU.
- The specific air pollution control technologies used at the facilities were not reported in most of the studies except for the Turin plant which uses baghouse filtration, selective catalytic reduction for NO_x treatment, and activated carbon for dioxins/furans treatment. The Metro Vancouver Waste-to-Energy facility employs a very similar multi-stage air pollution control system including fabric filtration, dry reagent injection for acid gases, activated carbon injection for dioxins/furans and metals, and NO_x controls.
- A number of the studies investigated both the epidemiological evidence of potential increase in cancer incidence rates for those living around Waste-to-Energy Facilities and many included prospective risk

assessments of the potential incremental lifetime cancer risks based on contaminant air concentrations. Epidemiological and risk assessment evidence does not demonstrate an association between waste-to-energy facilities and cancer. However, the available epidemiological evidence is limited by the long latency period of many cancers, relatively short operating history of modern facilities (20-30 years). Hence the reason the prospective risk assessment studies on potential incremental lifetime cancer risk should be more relied on.

3.2 Conclusions of the Literature Review

The updated review of the literature is consistent with the findings of previously published scientific research and suggests that modern, well-maintained Waste-to-Energy facilities such as the Metro Vancouver Waste-to-Energy Facility that are operated within compliance with air quality emissions standards in general do not pose an unacceptable risk to people living or working in the vicinity of waste-to-energy facilities. The literature review did not identify any contaminants that are not being assessed in this Public Health Risk Assessment. If anything, this Public Health Risk Assessment contains a more extensive list of contaminants for evaluation than was reported in the scientific literature. Risk assessment, human biomonitoring, and epidemiological studies conclude that there are unlikely to be significant adverse health effects on populations living and working near Waste-to-Energy facilities.

Table 2. Literature Review Summary

Citation	Title	Year	Country of study	Study Type	Type of Facility	Type of Contaminant	Health Endpoint	Conclusion
Cole-Hunter et al. (2020) The health impacts of waste-to-energy emissions: a systematic review of the literature. Environmental Research Letters. 15:123006	The health impacts of waste-to-energy emissions: a systematic review of the literature.	2020	Multiple	Literature review	Waste-to-Energy using refuse derived fuel	Multiple	Multiple	Review of literature suggests that well-designed and operated waste-to-energy facilities are critical to reduce potential adverse health (cancer and non-cancer) impacts, due to lower hazardous combustion- related emissions, compared to landfill or unsorted incineration.
de Titto E, Savino A. (2019) Environmental and health risks related to waste incineration. Waste Management Research. 10:976-986.	Environmental and health risks related to waste incineration	2019	Multiple	Mini review	Modern waste-to-energy	Multiple	Cancer, Reproductive health and fetal development	No evidence that modern-technology, well-functioning plants that comply with legislation on emissions are a cancer risk factor or have adverse effects on reproduction or development
Tait et al. (2020) The health impacts of waste incineration: a systematic review Australia New Zealand Journal of Public Health. 44: 40-48.	The health impacts of waste incineration: a systematic review	2020	Multiple	Systematic review	Modern waste-to-energy	PAHs, PCDD/Fs, Metals	Cancer and Reproductive health	Older incinerator technology and infrequent maintenance schedules have been strongly linked with adverse health effects. More recent incinerators have fewer reported ill effects.
Negri et al. (2020) Health effects of living near an incinerator: A systematic review of epidemiological studies, with focus on last generation plants. Environmental Research 184:109305.	Health effects of living near an incinerator: A systematic review of epidemiological studies, with focus on last generation plants	2020	Multiple	Review of epidemiological studies	Modern waste-to-energy (last generation plants)	PM, PCDD/Fs, Metals, CO, HCl NOx, SO_2	Cancer, Cardiocerebrovascular disease, respiratory disease, pregnancy outcomes, and congenital anomalies	Huge reductions in waste-to-energy facilities' emissions occurred over time, and results of older studies cannot be directly generalized to modern plants. Direct evidence from third generation plants is scarce. The overall evidence suggests that, if there were any adverse outcomes for older waste-to-energy facilities, they were modest at most.
Campo et al. (2019) A systematic review of biomonitoring of individuals living near or working at solid waste incinerator plants.	A systematic review of biomonitoring of individuals living near or working at solid waste	2019	Multiple	Systematic review	Modern waste-to-energy	PCDD/Fs, Metals, PAHs, VOCs	N/A – biomonitoring	In the selected studies, the levels of biomarkers in the public living near modern waste-to-energy facilities were within the range of acceptable reference values. The results suggest that living near at waste-to-energy facility does not meaningfully

Citation	Title	Year	Country of study	Study Type	Type of Facility	Type of Contaminant	Health Endpoint	Conclusion
Critical Reviews in Toxicology. 49 (6):476-519.	incinerator plants							increase exposure to the investigated biomarkers.
Ghosh et al. (2019) Fetal growth, stillbirth, infant mortality and other birth outcomes near UK municipal waste incinerators; retrospective population-based cohort and case-control study. Environment International. 122: 151-158	Fetal growth, stillbirth, infant mortality and other birth outcomes near UK municipal waste incinerators; retrospective population-based cohort and case-control study	2019	UK	Epidemiological study	Municipal waste incinerators	PM_{10}	Fetal growth, stillbirth, and infant mortality	This study did not find any evidence that exposure to PM10 from, or living near to, a waste-to-energy facility operating to current EU standards was associated with harm for any of the outcomes investigated. Results should be generalizable to other waste-to-energy facilities operating to similar standards.
Lamiceli et al. (2020) Biomonitoring of the adult population in the area of Turin waste incinerator: Baseline levels of polycyclic aromatic hydrocarbon metabolites. Environmental Research. 181:108903	Biomonitoring of the adult population in the area of Turin waste incinerator: Baseline levels of polycyclic aromatic hydrocarbon metabolites.	2020	Italy	Biomonitoring	Modern waste-to-energy	PAH	N/A - biomonitoring	Concentrations of OH-PAHs assessed in this study may be considered indicative of the background exposure to PAHs for adult population living in an urban and industrialized area.
Ruggieri et al. (2019) Human biomonitoring health surveillance for metals near a waste-to energy incinerator: The 1-year post-operam study. Chemosphere. 225:839-848	Human biomonitoring health surveillance for metals near a waste-to energy incinerator: The 1-year post-operam study.	2019	Italy	Biomonitoring	Modern waste-to-energy	Metals	N/A - biomonitoring	The concentration of most metals (with the exception of chromium) was within their established reference ranges even after one year of the Turin waste-to-energy operations.
Lamiceli et al. (2022) The longitudinal biomonitoring of residents living near the waste incinerator of Turin: Polycyclic Aromatic Hydrocarbon	The longitudinal biomonitoring of residents living near the waste incinerator of Turin:	2020	Italy	Biomonitoring	Modern waste-to-energy	PAH	N/A - biomonitoring	Researchers found that urinary PAH metabolite concentrations in residence living near the Turin incinerator waste-to-energy facility did not increase three years after plant start-up when compared to baseline measurements.

Citation	Title	Year	Country of study	Study Type	Type of Facility	Type of Contaminant	Health Endpoint	Conclusion
metabolites after three years from the plant start-up. Environmental Pollution. 314: 120199	Polycyclic Aromatic Hydrocarbon metabolites after three years from the plant start-up.							
Huang et al. (2024) Health risk assessment of municipal solid waste incineration emissions based on regression analysis. Eco-Environment & Health. 3:338-346	Health risk assessment of municipal solid waste incineration emissions based on regression analysis.	2024	China	Risk assessment	96 total waste-to-energy facilities at different levels of modernity	None	Carcinogenic and non-carcinogenic health effects	Researchers studied air contaminants from 510 waste to energy facilities in China and found that, for the entire study area, the average HI was 2.95E-03 and the average CR was 3.43E-7, below the acceptable threshold of 1.0 and 1.0E-6, respectively.
Fan et al. (2024) Probabilistic human health risk assessment of PCDD/Fs near municipal solid-waste incinerator using Monte Carlo analysis coupled with triangular fuzzy numbers. Ecotoxicology Environment Safety 1:116203.	Probabilistic human health risk assessment of PCDD/Fs near municipal solid-waste incinerator using Monte Carlo analysis coupled with triangular fuzzy numbers.	2024	China	Risk assessment	Municipal solid waste incinerator	PCDD/Fs	Carcinogenic and non-carcinogenic health effects	Researchers studied PCDD/F surrounding one waste-to-energy facility and found that the carcinogenic and non-carcinogenic risk values of PCDD/Fs exposed to residents in nearby areas were acceptable, with hazard index (HI) values lower than 1.0 and a total carcinogenic risk lower than 1.0E-6.
Rovira et al. (2018) Concentrations of trace elements and PCDD/Fs around a municipal solid waste incinerator in Girona (Catalonia, Spain). Human health risks for the population living in the neighborhood. Science of the Total Environment. 630: 34-45.	Concentrations of trace elements and PCDD/Fs around a municipal solid waste incinerator in Girona (Catalonia, Spain). Human health risks for the population living in the neighborhood.	2018	Spain	Risk assessment	Municipal solid waste incinerator	PCDD/Fs	Carcinogenic and non-carcinogenic health effects	Researchers studied PCDD/Fs around a waste-to-energy facility in Spain and found that non-carcinogenic risks were below the safety limit (Hazard Quotient (HQ) <1) and carcinogenic risks were within acceptable ranges.
Li et al (2018). The health risk levels of different age groups	The health risk levels of different age	2018	China	Risk assessment	Municipal solid waste incinerator	PCDD/Fs	Carcinogenic and non-	Researchers studied PCDD/Fs around a waste-to-energy facility in China and found that the carcinogenic risk (CR) were less

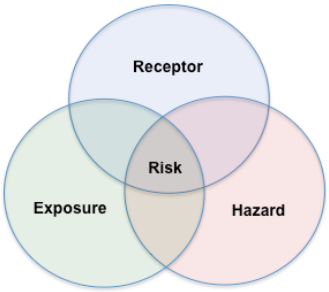
Citation	Title	Year	Country of study	Study Type	Type of Facility	Type of Contaminant	Health Endpoint	Conclusion
of residents living in the vicinity of municipal solid waste incinerator posed by PCDD/Fs in atmosphere and soil. Science of the Total Environment. 631-632:81-91.	groups of residents living in the vicinity of municipal solid waste incinerator posed by PCDD/Fs in atmosphere and soil.						carcinogenic health effects	than 1.00E-05 and the non-carcinogenic risk was lower than 1, both findings suggest the risk is at an acceptable level.
Boré et al (2020). Monitored air pollutants from waste-to-energy facilities in China: Human health risk, and buffer distance assessment. Atmospheric Pollution Research. 13, 7: 101484.	Monitored air contaminants from waste-to-energy facilities in China: Human health risk, and buffer distance assessment.	2020	China	Risk assessment	Multiple waste-to-energy facilities	PM, SO_2, NO_x, CO, HCl, and metals.	Carcinogenic and non-carcinogenic health effects	Researchers studying air emissions from a waste-to-energy facility in China found that at 1 km downwind from the facility, the average HI (1.06) slightly exceeded the recommended safety threshold (1.00), and the average lifetime cancer risk (5.69 E-3) exceeded acceptable levels (1E-4).
Bo et al (2022). Characteristics, correlations and health risks of PCDD/Fs and heavy metals in surface soil near municipal solid waste incineration plants in Southwest China. Environmental Pollution. 298:118816	Characteristics, correlations and health risks of PCDD/Fs and heavy metals in surface soil near municipal solid waste incineration plants in Southwest China	2022	China	Risk assessment	Municipal solid waste incinerator	PCDD/F Metals	Carcinogenic and non-carcinogenic health effects	Researchers investigated the presence and health risks of PCDD/F and metals surrounding waste-to-energy facilities and found that the carcinogenic and non-carcinogenic risks of PCDD/F and metals (except for Ni) were within acceptable levels.
Bottini (2025). Residential exposure to municipal solid waste incinerators and health effects: a systematic review with meta-analysis. BMC Public Health. 25:1989	Residential exposure to municipal solid waste incinerators and health effects: a systematic review with meta-analysis.	2025	Italy	Systematic Review	Modern waste-to-energy	Multiple	Multiple	Researchers conducted a systematic review of waste-to-energy facilities and health effects and found that, while there were slight indications of increased cardiovascular and respiratory hospitalizations and a possible association with non-Hodgkin lymphoma, generally overall evidence remains weak.

4 Methodology for the Public Health Risk Assessment

Public health risk assessment is the scientific approach to determining if a population's exposure to contaminants released to the environment could pose an undue risk to health. This approach is based on decades of research and the development of standard protocols and approaches to assessing risk.

All contaminants have the potential to interact with people, but it is the level, route and duration of exposure that determine if it could cause harm to health. For a potential undue risk to exist from emissions from the Waste-to-Enery Facility, one must understand:

- The nature in which people use the surrounding environment, for work, living and recreational purposes (receptors);
- The extent to which people may come into contact with the emitted contaminants (exposure); and
- The contaminants must be present at a high enough level to pose a risk to these people (hazard).



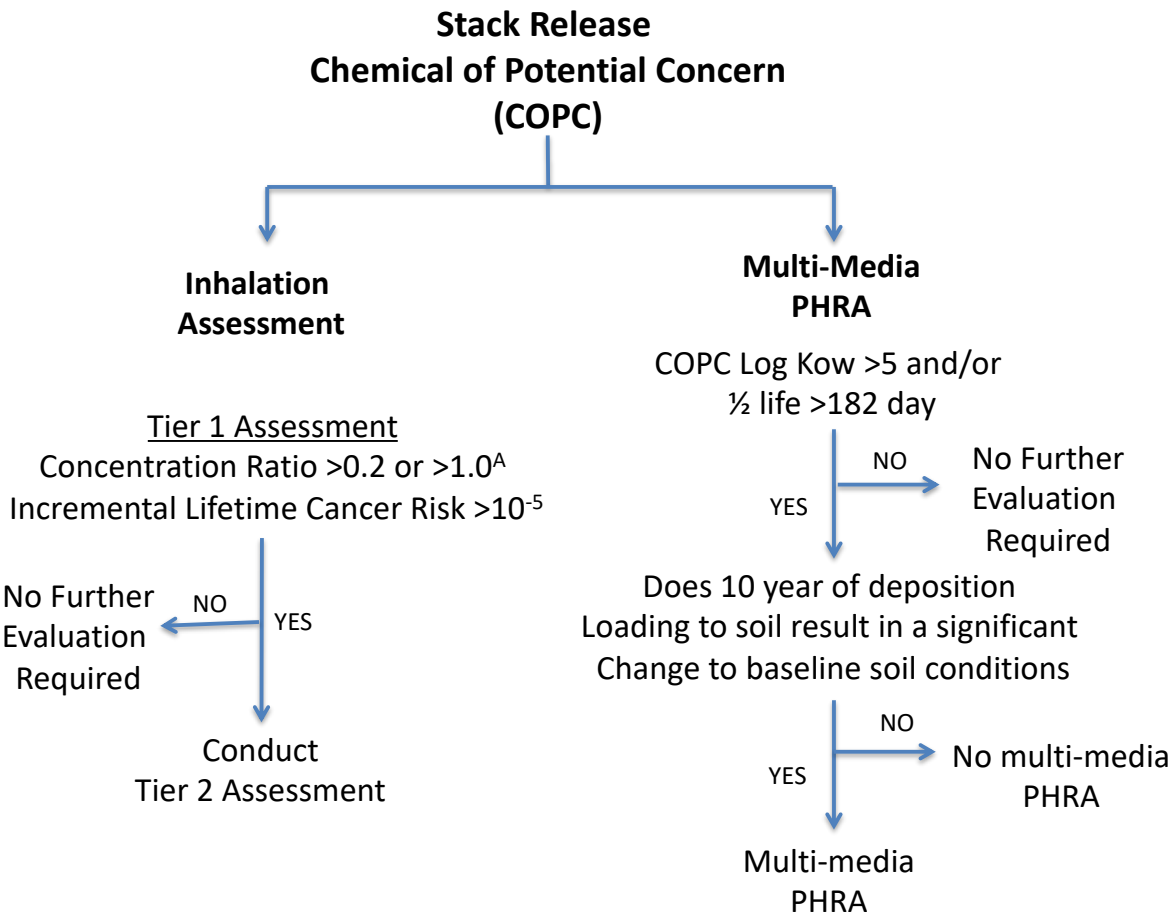
It is a combination of these elements that determine if an unacceptable risk to human health may exist.

The British Columbia Ministry of Health has published the *British Columbia Guidance for Prospective Human Health Risk Assessment* (2022) that was used as the primary guidance document for the conduct of the Public Health Risk Assessment. In addition, the Public Health Risk Assessment incorporated direction from *Health Canada's Guidance for Evaluating Human Health Effects in Impact Assessment: Human Health Risk Assessment* (2023).

This risk assessment follows the general risk assessment paradigm of:

- Problem Formulation; Exposure Assessment; Toxicity/Hazard Assessment; Risk Characterization

Figure 3 provides a flow diagram of the process by which the inhalation and the multi-media risk assessments was conducted. The details of how the Tier 2 Assessment is conducted are provided in Section 8.2.



A. Concentration Ratio of >0.2 for contaminants with no Background air concentrations.
Concentration Ratio of >1.0 for contaminants with Background air concentrations.

Figure 3. Public Health Risk Assessment Framework for Metro Vancouver Waste-to-Energy Facility

5 Problem Formulation

5.1 Site Characterization

The Waste-to-Energy Facility is located at 5150 Riverbend Drive, Burnaby, British Columbia. In operation since 1988, the Waste-to-Energy Facility is a mass burn facility processing approximately 240,000 tonnes of municipal solid waste annually, or roughly 25% of the garbage requiring disposal from the Metro Vancouver region. For almost 40 years, the facility has made regular operational improvements and upgrades to its air pollution control technology. It routinely operates below the Operational Certificate emission discharge limits.

5.2 Air Dispersion Modeling Scenarios

The Operational Certificate describes a number of emission scenarios that were specified for the original 2018 Public Health Risk Assessment, including start-up/shutdown/upset conditions and normal long-term operations of the facility. The primary pathway of potential concern for human exposure to emissions of the Facility is from airborne emissions from the stack. The only contaminant emissions from the facility are through the stack and there are no significant direct emissions or discharges from the Waste-to-Energy Facility to soil, surface water or groundwater. Air emissions have the potential to impact local ground level concentrations of contaminants in the air and deposit into soil. Table 3 provides the Public Health Risk Assessment project scenarios.

Table 3. Project Scenarios Evaluated in the Public Health Risk Assessment

Project Scenario	Case	Description
Existing Conditions	Baseline	The yearly 98th percentile, averaged over the most recently available three (3) years of ambient data, years were used to determine baseline air quality for 1-hour, 8-hour and 24-hour averaging periods. Annual average was determined as the mean for all hours of the year, averaged over all three years. Baseline was selected from available observation data from existing stations in the Metro Vancouver network. The Metro Vancouver air quality monitoring stations – Burnaby South (T18), North Delta (T13), and New Westminster (T46) – were used to provide baseline concentrations. In addition, two years of fenceline monitoring data is available from the Waste-to-Energy Facility.
Operational	Operational Certificate Permitted Levels	The Operational Certificate discharge limits were modeled for the Waste-to-Energy Facility over a 10- and 20-year period for 1-hour, 24-hour, and annual averaging periods.
	Operational Annual Performance Data	Annual stack test and CEM data were used to model mean operational performance of the Waste-to-Energy Facility over a 10- and 20-year period for 1-hour, 24-hour, and annual averaging periods. It also includes the incorporation of the number of typical start-up/shut-down events and emissions on an annual basis.
Start-Up	Start-up	Measured contaminant emissions from the start-up testing were modeled for short-term exposure. It presents maximum 1-hour concentrations at ground level. The 2018 start-up Metro Vancouver Waste-to-Energy Facility stack test data was used in this scenario. In addition, the anticipated frequency of start-up events over the course of a year was incorporated into the air quality analysis.
Shutdown	Shutdown	Measured contaminant emissions from the start-up testing were modeled for short-term exposure. It presents maximum 1-hour concentrations at ground level. The 2018 shut-down Metro Vancouver Waste-to-Energy Facility stack test data was used in this scenario. In addition, the anticipated frequency of start-up events over the course of a year was incorporated into the air quality analysis. It involves having two boilers still in operation and a single boiler being removed from operation (e.g., either starting up or shutting down)
Proposed Emissions Limits	Updated Authorized Discharges	The proposed new Operational Certificate discharge limits will be modeled for the Waste-to-Energy Facility over a 10- and 20- year period for 1-hour, 24-hour, and annual averaging periods.

RWDI was retained by HDR to complete the Air Dispersion Modelling Study (RWDI, 2026). The Air Dispersion Modeling Plan, that detailed the approach to conducting the study, was approved by the Ministry of Environment and Parks (June 11, 2026). Predicted ground level air concentrations of contaminants required by the Operational Certificate were assessed; including criteria air contaminants, metals, dioxins and furans, and volatile organic compounds (Table 4).

The air dispersion modelling assessment was completed in accordance with the BC Air Quality Dispersion Modelling Guideline (ENV, 2022) using the CALMET/CALPUFF modelling system. CALPUFF was used to simulate Facility emissions over a 50 km by 50 km study area surrounding the Facility. Five years of meteorological data (2019 through 2023) were used in the analysis. Predicted concentrations were evaluated at a comprehensive network of gridded and discrete sensitive receptors throughout the study area.

For each scenario the Facility resulting ground level contaminant concentrations (1.5 m for inhalation and 0 m for deposition) were evaluated as the Facility Alone and then the Facility + Background. The baseline ambient air concentrations are from Lower Fraser Valley Air Quality Monitoring Network. In addition, Metro Vancouver operated the S150 – Metro Vancouver Waste-to-Energy Facility air monitoring station from the fall of 2020 until mid-2023, monitoring for HCl, NO_2 and SO_2. This monitoring station was located near ground level near the previously predicted 2018 maximum point of impingement (MPOI - the location of the highest modelled 1-hour contaminant concentration) of these contaminants from the Facility. The results for HCl, NO_2, SO_2 from this station are also evaluated. Given that it is an operating facility, it already contributes to the local ambient air monitoring results. Therefore, this approach of adding modeled facility emission to the existing ambient baseline air concentrations is a more conservative approach for an existing facility than that of a proposed new build facility.

The scenarios allow for predicting the contaminant concentrations that are experienced by people living and working in the vicinity of the Waste-to-Energy Facility.

Metro Vancouver is required as part of the amended Operational Certificate to review all current contaminant emission levels, including with respect to SO_2 and HCl. In addition, Metro Vancouver assessed the potential for lowering discharge limits for all contaminants included in the amended Operational Certificate. The proposed reductions to emission limits were modelled, and the corresponding change in ambient air concentrations were included in the in the Public Health Risk Assessment.

From a temporal standpoint there is no expiration date on the Operational Certificate for the Facility. Therefore, a 20-year operational period, under the Operational Certificate permitted emissions conditions was used to assess the long-term potential cumulative effects of operations. The 20–year timeframes were selected given that it is unlikely that the facility may operate without additional upgrades or maintenance to its air pollution control system or revision of its Operational Certificate beyond a 20-year time frame. Loading deposition of persistent and bioaccumulative contaminants onto soil in the environment was conducted over 20 years.

There are no accident or malfunction scenarios given that if the plant is not operating within its prescribed discharge limits it undergoes shut-down. There are no uncontrolled releases of contaminants of potential concern to the environment beyond that during shut-down conditions.

5.2.1 Contaminants of Potential Concern

The contaminants of potential concern for the Facility are those that are governed by the Operational Certificate. This includes all contaminants that have discharge limits and require monitoring in the

Operational Certificate as these have been identified as those contaminants that are: the most toxic, released at the highest levels, or of particular concern to the public. The literature review supports that these are the primary contaminants for evaluation from any waste-to-energy facility. Although not in the Operational Certificate, secondary particulate formation, as $PM_{2.5}$ is also included in the assessment. In addition, these are the common contaminants of potential concern that have emission limits in other facilities in Canada, the United States and across the European Union. A report summarizing emission limits in other jurisdictions was prepared under separate cover Proposed Operational Certificate Discharge Limits: Metro Vancouver Waste-to-Energy Facility (HDR, 2026).

Table 4 is the table of contaminants of potential concern that require continuous emissions monitoring (CEM) or annual stack testing for compliance and their associated discharge limits.

Table 4. Contaminants of Potential Concern and Discharge Limits from the Operational Certificate

Parameter	Units[1]	Interim Discharge Limits[2][3]			Discharge Limits[3]		Response Limits[4]
		24-hr average[5]	4-hr average[6]	1-hr average	24-hr average[5]	Approved Test Method[7]	1/2-hr average[8]
Total Particulate Matter[9]	mg/dscm	-	-	-	-	9	-
Opacity	%	-	-	5	-	-	5
Carbon Monoxide (CO)	mg/dscm	-	55	-	50	-	100
Hydrogen Chloride (HCl)	mg/dscm	-	-	55[10]	10	-	60
Hydrogen Fluoride (HF)	mg/dscm	-	-	-	-	1.0	-
Sulphur Dioxide (SO2)	mg/dscm	200	-	-	50	-	190
Nitrogen Oxides (Nox)	mg/dscm	350	-	-	190	-	350
Total Hydrocarbons (THC)	mg/dscm	-	-	Manual Stack Test limit of 40[11]	10	-	20
Total Dioxins and Furans (as PCDD/F TEQ) [12]	ng/dscm	-	-	-	-	0.08	-
Cadmium (Cd)	µg/dscm	-	-	-	-	7	-
Mercury (Hg) [13]	µg/dscm	-	-	-	-	20	-
Sum of Lead (Pb), Arsenic (As), Chromium (Cr)	µg/dscm	-	-	-	-	64	-
Chlorophenols	µg/dscm	-	-	-	-	1	-
Chlorobenzenes	µg/dscm	-	-	-	-	1	-
Polycyclic Aromatic Hydrocarbons (PAHs)	µg/dscm	-	-	-	-	5	-
Polychlorinated biphenyl (PCBs)	µg/dscm	-	-	-	-	1	-

1. dscm = dry standard cubic meter, corrected to 11% oxygen
2. Interim Discharge Limits will apply until and including the following dates, at which point the Discharge Limits and Response Limits will apply:
a. Opacity – December 31, 2017
b. CO – December 31, 2016 (Discharge Limit) and December 31, 2018 (Response Limit)
c. HCl – as per subparagraph 1.1.11 of this Operational Certificate
d. SO2 – as per subparagraph 1.1.11 of this Operational Certificate
e. Nox – December 31, 2017 (Response Limit)
f. THC – December 31, 2018 (Discharge and Response Limits)
3. Discharge Limits are the criteria for compliance determination of each discharge parameter listed in the column, subject to Note 2 above.
4. Response limits are the threshold requiring the Operational Certificate Holder to take immediate action to bring down the discharge levels to the applicable discharge limits specified in this section. The response limits are expressed as ½ hour (block) average values measured by approved continuous emission monitors. The Operational Certificate Holder is required to demonstrate the response action(s) implemented by record keeping.
5. Interim Discharge Limits are daily average values, calculated as the arithmetic average of valid continuous emissions monitoring system (CEMS) data. Discharge Limits are 24-hour (daily block) averages.
6. Calculated as the arithmetic average of 4 hours of data from a CEMS.
7. Determined by a test method approved by the Director. A single manual stack test result is the average of a minimum of three test runs.
8. Calculated as the arithmetic average of ½ hour block of data from a CEMS.
9. Total particulate matter (filterable portion only) is determined by EPA Test Method 5 or an alternative method approved by the Director.
10. Continuous monitoring of SO2 will be used as a surrogate for emission monitoring of acid gases, such as HCl and HF.
11. Monitored as total hydrocarbons (measured as methane).
12. PCDD (polychlorinated dibenzo-p-dioxins) & PCDF (polychlorinated dibenzofurans) will be expressed in dioxin toxicity equivalent value (dioxin TEQ) as defined in the *Hazardous Waste Regulation*.
13. Mercury determined by EPA Test Method 29 or an alternative method approved by the Director.

It is acknowledged that the Operational Certificate Discharge Limits provide some grouping of contaminant constituents for reporting compliance, and that further refinement is required for the risk assessment. Table 5 provides the contaminants of potential concern for the Public Health Risk Assessment.

The characterization of persistence and bioaccumulation is provided in detail within Environment Canada's Existing Substances Program and the Health Canada and Environment Canada's Domestic Substances List Categorization, under the Canadian Environmental Protection Act and is consistent with the BC Ministry of Health guidance (BC Health, 2022).

Persistence refers to the length of time a contaminant resides in the environment and is measured by its half-life. This is the time required for the quantity of a contaminant to diminish or degrade to half of its original amount within a particular environment or medium. For the purposes of this Public Health Risk Assessment, a contaminant was considered persistent if its half-life in soil is greater than or equal to (≥) six months (182 days).

Bioaccumulation is a general term used to describe the process by which contaminants are accumulated in an organism directly from exposure to water, soil, or through consumption of food containing the substances. A contaminant's potential to bio-accumulate is related to its octanol-water partition coefficient (Kow). The Kow refers to the ratio of distribution of a substance in octanol compared to that in water. For the purposes of this risk assessment, a contaminant was considered bioaccumulative if its Log Kow is greater than or equal to five.

Therefore, contaminants of potential concern retained for consideration of deposition in the PHRA have:

- A half-life in soil greater than or equal to six months; and/or
- Log Kow greater than or equal to five.

As indicated in Figure 2, if there is no predicted significant increase in baseline soil concentration through 20 years of contaminant deposition from the Waste-to-Energy Facility, then a multi-media risk assessment will not be undertaken for that individual contaminant at that receptor location. However, if the modeling results determine that there is a significant loading of Waste-to-Energy Facility contaminants into the soil (e.g., above that of standard analytical error) and above soil quality guideline then a limited multi-media risk assessment will be completed. This would involve the evaluation of the soil ingestion, dermal contact and particulate inhalation pathways. Given that there are no water discharges from the facility and that drinking water is on municipal supply these additional pathways of exposure were not evaluated.

Table 5. Contaminants of potential concern for the PHRA

Discharge Limit Parameter	PHRA COPC	Inhalation Assessment	Consideration for Deposition
Total Particulate Matter (TPM)	$PM_{2.5}$	✓	
Opacity	Not health based, not included in PHRA		
Carbon Monoxide (CO)	Carbon Monoxide (CO)	✓	
Hydrogen Chloride (HCl)	Hydrogen Chloride (HCl)	✓	
Hydrogen Fluoride (HF)	Hydrogen Fluoride (HF)	✓	
Sulphur Dioxide (SO_2)	Sulphur Dioxide (SO_2)	✓	
Nitrogen Oxides (NO_x)	Nitrogen Dioxide (NO_2)	✓	
Total Hydrocarbons (THC)	Not health based, not included in PHRA		
Total Dioxins and Furans (as PCDD/F TEQ)	PCDD/F TEQ	✓	✓
Cadmium (Cd)	Cadmium (Cd)	✓	✓
Mercury (Hg)	Mercury (Hg)	✓	✓
Sum of Lead (Pb), Arsenic (As), Chromium (Cr)	Lead (Pb), Arsenic (As), and Chromium (Cr) evaluated individually	✓	✓
Chlorophenols	2,4,6-Trichlorophenol; 2,3,4,6-Tetrachlorophenol Pentachlorophenol	✓	✓
Chlorobenzenes	1,2-Dichlorobenzene; 1,2,4 –Trichlorobenzene 1,2,4,5-Tetrachlorobenzene; Pentachlorobenzene Hexachlorobenzene	✓	✓
Polycyclic Aromatic Hydrocarbons (PAHs)	Benzo(a)pyrene TEQ for carcinogenic PAHs and naphthalene	✓	✓
Polychlorinated Biphenyls (PCBs)	Total PCB	✓	✓

5.3 Receptor Characterization

The facility is surrounded by mixed land use including:

- Urban,
- Agricultural,
- Industrial/Commercial, and
- Fraser River.

Selection of potential receptor locations was done in consort with the air quality dispersion modeling. Although the area surrounding the Waste-to-Energy Facility is largely industrial and commercial, there are local residential and agricultural land uses (primarily cranberry farming) in the area. There is also the Burnaby Youth Custody Services Center located directly to the west of the Facility, which was treated as a residential receptor. Sensitive receptors were selected based on potential vulnerable populations.

The original 29 sensitive receptor locations from the 2018 Public Health Risk Assessment were retained in this assessment. Numerous additional sensitive receptors have been added in the current Public Health Risk Assessment. These include additional receptors in the growing neighbourhood to the south of the Waste-to-Energy Facility and the Fraser River. It also includes filling in some of the gaps from the 2018 Public Health Risk Assessment. At the direction of Metro Vancouver this included all senior facilities, health care facilities, childcare and schools within a 5-kilometer radius to the Facility. A total of 260 sensitive receptors are included in the air model results, including for residential neighborhoods, childcare facilities, schools, senior facilities, hospitals, health care facilities, businesses and recreational areas (Figure 4). The

list of sensitive receptors and their locations are found in Appendix A. The complete set of results would comprise 100s of pages. Instead, the results are available in the event that they are needed in the future.

From previous literature reviews, the maximum point of impingement (MPOI) of contaminants at ground level from waste-to-energy facilities typically occur within <1 km to 2 km from facilities. In fact, the modelled MPOI for the 2018 Public Health Risk Assessment was within 500 meters of the Waste-to-Energy Facility. However, sensitive receptors several kilometers from the Waste-to-Energy Facility have been included in the Public Health Risk Assessment. Although the Public Health Risk Assessment study area is smaller than the overall air quality model domain, it will capture those with greatest exposure that act as surrogates for other lesser affected areas. Note that the businesses and individual homes were not selected because of their use/type but rather were selected to simply be representative of a nearby geographical area.

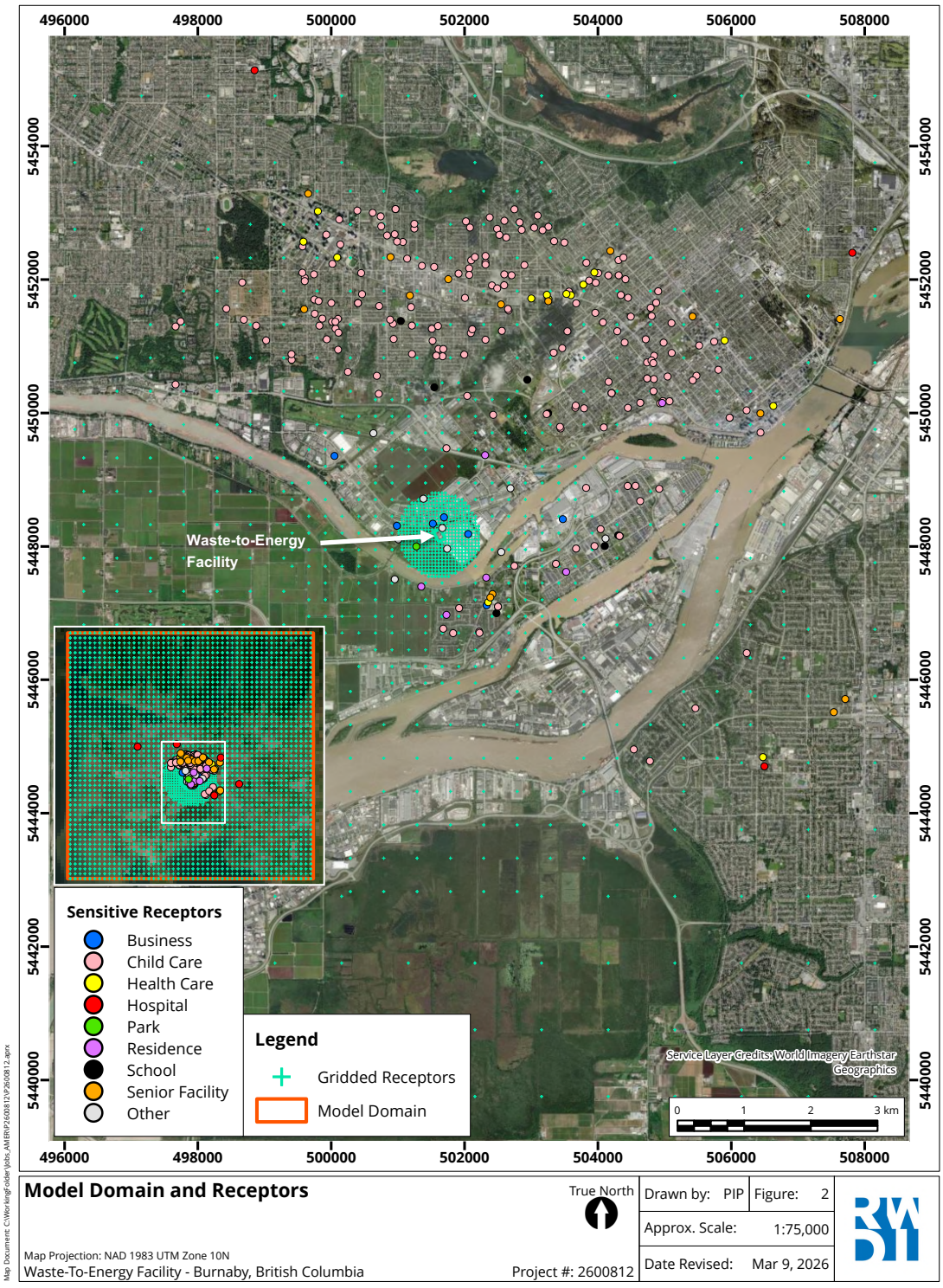


Figure 4. Special Receptor Locations and Grid Spacing for Air Quality Modeling.

6 Exposure Assessment

The exposure assessment determines the degree to which people come into contact with airborne concentrations of contaminants released from the Waste-to-Energy Facility. This includes consideration of age, physiological parameters (e.g., inhalation rate, body weight) and duration of exposure. The following receptors will be considered as if they are all located at the maximum point of impingement (MPOI):

- Commercial/Industrial workers from nearby facilities;
- Youth Correctional Facility residents;
- Local residents;
- School/daycare staff and pupils;
- Hospital staff and patients;
- Recreational users of parks; and,
- Agricultural workers.



The primary exposure pathway for contaminants of potential concern from the Waste-to-Energy Facility will be ground level airborne inhalation. All other routes of exposure, for example – soil ingestion, dermal contact, food ingestion – have been demonstrated in other Public Health Risk Assessments and post-construction monitoring programs of waste-to-energy facilities to be insignificant, including for the Durham York Energy Centre (Ollson et al., 2014; Durham York EFW HHRA; 2008). The literature review confirmed that the primary exposure pathway of concern for waste-to-energy facilities is inhalation of airborne contaminants.

The Inhalation assessment focuses on the use of the airborne concentrations at the MPOI. The Public Health Risk Assessment conservatively assumed that one lives at the MPOI 24 hours a day, throughout their lifetime. This is means that if the ground level concentrations are not impacting an ever present individual than it is a conservative approach to interpreting potential health risks than the *British Columbia Guidance for Prospective Human Health Risk Assessment* (2022) approach to assessing individual life stages of receptors and time activity patterns, including:

- Toddlers (non-carcinogenic)
- Lifetime (carcinogenic)
- Adult Commercial/Industrial Workers (non-carcinogenic / carcinogenic)

It includes evaluation of both acute (short-term) and chronic (long-term) inhalation assessment of exposure. Ground level airborne concentrations of contaminants are provided for acute (1-hr and 24-hr) and chronic (annual average) by the air quality dispersion model at the MPOI, in addition, levels at the local ambient air quality stations were also evaluated.

6.1 Tier 1 Exposure Assessment

The Tier 1 exposure assessment assumes that an exposed individual lives at the predicted MPOI, 24 hours a day for an entire 80-year lifespan. Even if the MPOI occurs in the residential area, this is a highly conservative approach, because an individual is very unlikely to spend their entire life in one location, and the Waste-to-Energy Facility is similarly unlikely to operate in its current configuration for 80 years.

However, if there is no undue risk at the MPOI for this ever-present individual, then there would not be an increased risk for any of the other Sensitive Receptors (Figure 1).

The Tier 1 assessment includes consideration of health risks due to acute (short-term; 1-hr and 24-hr) and chronic (long-term; annual average) exposures to ground-level airborne concentrations of contaminants of potential concern. There was no time apportionment for the MPOI and hence it is protective of all life stages.

6.2 Tier 2 Exposure Assessment

The Tier 2 risk assessment involved understanding of the frequency of exceedances through the use of percentile data provided by the air quality dispersion modeling.

6.3 Statistical Metrics

Table 6 provides a summary of the metrics used for establishing baseline concentrations and what metric was selected for use in the modeling of Waste-to-Energy Facility emissions, along with the corresponding averaging period. The reason for the varying statistical evaluation involves those contaminants that have requirements under the Metro Vancouver or the Canadian Ambient Air Quality Criteria for evaluation. For the remaining it is the practice to evaluate reasonable worst case scenario air levels at the MPOI.

Table 6. Statistical Metrics used in Deriving the Air Quality Modeled Concentrations

Contaminant	Averaging Period	Metrics Used for Background	BG Stations [1]	Background Concentration	MV AAQO	Metric for the Objective	Metric used for Model Results
NO_2	1-hour	98th percentile of D1HM values over 2022-2024	Burnaby South (T18) North Delta (T13) New Westminster (T46)	73.0	79	98th percentile of the daily maximum 1-hour (D1HM) concentration in each year, averaged over three consecutive years	Maximum of [98th percentile of D1HM concentration in each year, averaged over each three year period (2019-2021; 2020-2022; 2021-2023)]
	Annual	Average of hourly values in each year, maximum over 2022-2024		25.0	22.6	Annual average of 1-hour concentrations over one year	Annual average of hourly concentrations over one year, maximum over 2019-2023
SO_2	1-hour - MV	99th percentile of D1HM values over 2022-2024	Burnaby South (T18)	7.1	183	Maximum of 1-hour concentrations	Maximum of 1-hour concentrations over 2019-2023
	1-hour - CAAQS				170 [2]	99th percentile of the D1HM concentrations in each year, averaged over three consecutive years	Maximum of [99th percentile of D1HM concentration in each year, averaged over each three year period (2019-2021; 2020-2022; 2021-2023)]
	Annual	Average of hourly values in each year, maximum over 2022-2024		0.8	10.5	Annual average of 1-hour concentrations over one year	Annual average of hourly concentrations over one year, maximum over 2019-2023
CO	1-hour	98th percentile of hourly values over 2022-2024	Burnaby South (T18)	470	14,900	Maximum of 1-hour concentrations	Maximum of 1-hour concentrations over 2019-2023
	8-hour	98th percentile of 8-hour block average values over 2022-2024		436	5,700	Maximum of 8-hour rolling average concentrations	Maximum of 8-hour block averages over 2019-2023
$PM_{2.5}$	24-hour	98th perecentile of 24-hour block averages over 2022-2024	Burnaby South (T18) North Delta (T13) New Westminster (T46)	16.2	25	Maximum of 24-hour rolling average concentrations	98th percentile of D1HM concentration in each year, maximum over 2019-2023
	Annual	Average of hourly values in each year, maximum over 2022-2024		6.3	8	Annual average of 1-hour concentrations over one year	Annual average of hourly concentrations over one year, maximum over 2019-2023
PM_{10}	1-hour	98th perecentile of 24-hour block averages over 2022-2024	Burnaby South (T18)	23.0	50	Maximum of 24-hour rolling average concentrations	--
	24-hour	98th perecentile of 24-hour block averages over 2022-2024		8.9	20	Annual average of 1-hour concentrations over one year	--
HCl	1-hour	98th percentile of hourly values over 2022-2024	Burnaby South (T18)	2.1	--	--	Maximum of hourly values over 2019-2023
	24-hour	98th percentile of 24-hour block averages over 2022-2024		1.6	--	--	Maximum of 24-hour block average values over 2019-2023
	Annual	Average of hourly values in each year, maximum over 2022-2024		0.6	--	--	Annual average of hourly concentrations over one year, maximum over 2019-2023
All other contaminants	1-hour (if applicable)	Conversion from 24-hour values to 1 hr values	--	--	--	--	Maximum of hourly values over 2019-2023
	24-hour (if applicable)	Maximum of 24-hour block averages over 2022-2024	--	--	--	--	Maximum of 24-hour block average values over 2019-2023
	Annual (if applicable)	Average of hourly values over 2022-2024	--	--	--	--	Annual average of hourly concentrations over one year, maximum over 2019-2023

1. Values are calculated for each station, then averaged over applicable stations.
2. CAAQs 2025

6.4 Contaminants of Potential Concern Concentrations

Figure 5 provides the location of the air quality monitoring stations used in assessment. This includes the three closest ambient air monitoring stations to the Waste-to-Energy Facility (T018, T013, and T046). In addition, the Public Health Risk Assessment examined data from the S150 air monitoring station established on the northwest fence line of the facility.

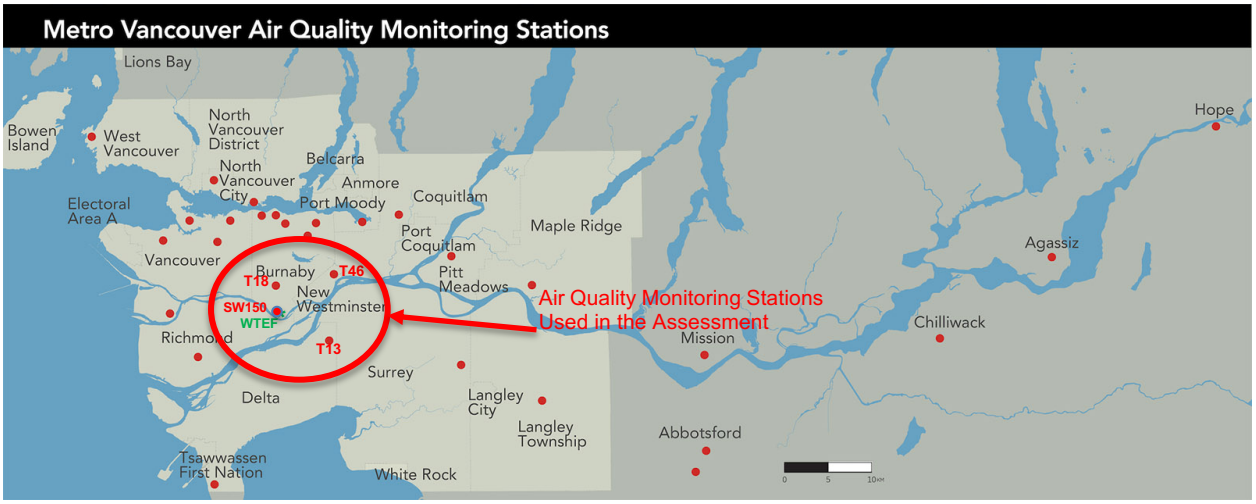


Figure 5. Location of the Ambient Air Monitoring Stations in relation to the Waste-to-Energy Facility. Stations T18, T46, T13 and SW150 were used in this assessment.

Table 7 provides an overview of the baseline concentrations of the criteria air contaminants in the local airshed from 2022 to 2024. The Burnaby South (T18) station provides the most comprehensive list of contaminants of potential concern to be evaluated in the risk assessment (NO_2, SO_2, HCl, $PM_{2.5}$, metals, PAHs). In addition, Metro Vancouver installed a new monitoring station S150 – Metro Vancouver Waste-to-Energy Facility air monitoring station near the fence line of the Waste-to-Energy Facility from the fall of 2020 till mid-2023 (NO_2, SO_2, HCl). This station best represents the impact that the Waste-to-Energy Facility is having at a location close to the modelled MPOI.

The levels of NO_2, SO_2 and HCl at S150 were similar to those at the Burnaby South (T18) station, the closest to the Facility. In addition, it can be seen that the levels of NO_2 were similar across the stations and highest at T046. This suggests that the Waste-to-Energy Facility is not having a considerable impact on the local air quality immediately adjacent to the Facility for these contaminants.

Table 7. Baseline Ambient Air Quality Concentrations at Air Quality Monitoring Stations Near the Waste-to-Energy Facility in 2022 (note these are not the baseline concentrations used in the modeling and are for illustration purposes).

Air Monitoring Station	HCL			NO2		SO2	
	1 hr	24 hr	Annual Average	1 hr	Annual Average	1 hr	Annual Average
	ug/m3						
S150	4.2	2.6	0.6	79.4	26.1	18	0.6
T013				76.6	21.5		
T018	7.0	2.5	0.6	69.6	22.1	8.9	0.7
T046				82.2	31.3		

Airborne COPC concentrations were reported in the Air Dispersion Modeling Study (RWDI, 2026). Table 8 provides the COPC concentrations for the 1-hr, 24-hr and annual average concentrations for the criteria air contaminants and Table 9 for the remaining contaminants at the MPOI for the five scenarios evaluated, including background concentrations where available. The potential for impact of these concentrations on health is provided in Section 8 Risk Characterization.

Background concentrations were obtained for the criteria air contaminants from the Metro Vancouver Burnaby South (T018), New Westminster (T046) and North Delta (T018 stations, while the metals and PAHs were obtained from the T018 station. Given that the Waste-to-Energy Facility volatile organic compound and halogen acid gases that are not routinely monitoring at air stations, no baseline or background concentrations could be obtained for these contaminants.

The Permitted emissions scenario resulted in the highest predicted ground-level concentrations of contaminants of potential concern. This is not unexpected, as this scenario represents upper limits at which the facility is permitted to operate. In contrast, Operations emissions scenario resulted in predicted ground level concentrations of contaminants of potential concern at the MPOI that were typically far less than those under the Permitted Scenario. For example, dioxin and furan (PCDD/F) concentrations at the MPOI were four (4) orders of magnitude lower for the Operations Scenario. The exception was NO_2, where concentrations predicted for the Operations scenario were approximately 90% of those predicted for the Permitted Scenario.

A major focus of the *"Evaluation of Contaminant Dispersion and Public Health Risk Assessment"* required by the Operational Certificate was to determine how Start-up and Shutdown conditions at the Waste-to-Energy Facility affect emission levels, ground level COPC concentrations, and associated human health risk. Of key interest was how these start-up and shutdown conditions would impact predicted PCDD/F emissions and exposure relative to the Operations scenario. Relative to the Operations scenario, results for the Shutdown scenario show only a slight increase in PCDD/F concentrations at the MPOI, while Start-up conditions resulted in a two orders of magnitude concentration increase. However, the concentrations predicted for the Operations, Start-up and Shutdown scenarios all remained below those predicted for the Permitted Scenario. Similar trends were seen for the other organic contaminants and the metals. In 2025, there were an average of 44 warm shutdowns (duration of <5 hours) and 22 cold shutdowns (> 5 hrs) across the 3 units. Given that the infrequency of these shutdown/start-ups and that their emissions were similar to the Operational scenario they are considered to not have and increase over operations on local air quality.

Table 8. Concentrations of Criteria Air Contaminants at the Maximum Point of Impingement.

Air Contaminant	Averaging Period	Background (µg/m3)	Modelled MPOI under Different Scenarios									
			Current OC Permitted		Proposed OC Permitted		Current Operational		Start-up Boiler + Other 2 boilers		Shut-down Boiler + Other 2 boilers	
			Project Alone (µg/m3)	Project + Background (µg/m3)	Project Alone (µg/m3)	Project + Background (µg/m3)	Project Alone (µg/m3)	Project + Background (µg/m3)	Project Alone (µg/m3)	Project + Background (µg/m3)	Project Alone (µg/m3)	Project + Background (µg/m3)
$PM_{2.5}$	24-hour	16.2	0.9	17	0.86	17	0.09	16	0.07	16	0.08	16
$PM_{2.5}$	Annual	6.3	0.2	6.4	0.17	6.4	0.02	6	0.02	6	0.02	6
Carbon Monoxide (CO)	1-hour	470	127	596	127	596	54	524	65	535	142	611
Carbon Monoxide (CO)	8-hour	436	37	472	37	472	16	451	19	454	41	477
Hydrogen Chloride (HCl)	1-hour	2.1	139	141	114	116	103	105	84	86	90	92
Hydrogen Chloride (HCl).2	24-hour	1.6	13	15	11	13	10.0	12	8.1	10	8.6	10
Hydrogen Chloride (HCl)	Annual	0.6	1.1	2	0.86	1.5	0.93	2	0.76	1	0.82	1
Hydrogen Fluoride (HF)	1-hour	N/A	2.5		1.3		0.12		0.12		0.090	
Sulphur Dioxide (SO_2)	1-hour	7.1	202	209	121	128	60	68	59	66	46	54
Sulphur Dioxide (SO_2)	24-hour	2.0	49	51	29	31	13	15	13	15	10	12
Sulphur Dioxide (SO_2)	Annual	0.8	3.8	4.6	2.3	3.1	1.2	2	1.2	2	0.97	2
Nitrogen Dioxide (NO_2) (Converted from NO_X)	1-hour	73	69	141	59	132	48	121	47	120	46	119
Nitrogen Dioxide (NO_2) (Converted from NO_X)	Annual	25	2.2	27	1.8	27	1.5	26	1.4	26	1.4	26

Table 9. Ground level airborne predicted Concentrations of Contaminants at the Maximum Point of Impingement.

Air Contaminant	Averaging Period	Background (µg/m3)	Modelled MPOI under Different Scenarios									
			Current OC Permitted		Proposed OC Permitted		Current Operational		Start-up Boiler + Other 2 boilers		Shut-down Boiler + Other 2 boilers	
			Project Alone (µg/m3)	Project + Background (µg/m3)	Project Alone (µg/m3)	Project + Background (µg/m3)	Project Alone (µg/m3)	Project + Background (µg/m3)	Project Alone (µg/m3)	Project + Background (µg/m3)	Project Alone (µg/m3)	Project + Background (µg/m3)
Total Dioxins and Furans (as PCDD/F TEQ)	24-hour		2.0E-08		0.00		1.4E-10		7.1E-10		2.0E-10	
Total Dioxins and Furans (as PCDD/F TEQ)	Annual		1.5E-09		1.2E-09		1.3E-11		6.7E-11		1.9E-11	
Cadmium (Cd)	1-hour	0.011	1.8E-02	2.8E-02	0.02	0.028	3.5E-04	1.1E-02	3.1E-04	1.1E-02	5.35E-04	1.1E-02
Cadmium (Cd)	24-hour	0.004	1.7E-03	6.1E-03	1.7E-03	0.006	3.4E-05	4.4E-03	3.0E-05	4.4E-03	5.16E-05	4.4E-03
Cadmium (Cd)	Annual	0.001	1.3E-04	8.2E-04	1.3E-04	0.001	3.2E-06	6.8E-04	2.8E-06	6.8E-04	4.89E-06	6.9E-04
Mercury (Hg)	1-hour		5.1E-02		3.8E-02		1.8E-04		4.1E-04		5.18E-04	
Mercury (Hg)	24-hour		4.9E-03		3.7E-03		1.7E-05		4.0E-05		4.99E-05	
Mercury (Hg)	Annual		3.8E-04		2.9E-04		1.6E-06		3.7E-06		4.73E-06	
Sum of Lead (Pb), Arsenic (As), Chromium (	1-hour		1.6E-01		0.15		1.0E-02		8.6E-03		8.54E-03	
Lead (Pb)	1-hour	0.038			1.2E-01	0.16	4.1E-03	4.2E-02	3.9E-03	4.1E-02	3.31E-03	4.1E-02
Lead (Pb)	24-hour	0.015			1.2E-02	0.027	4.0E-04	1.6E-02	3.7E-04	1.6E-02	3.19E-04	1.6E-02
Lead (Pb)	Annual	0.004			9.2E-04	0.004	3.7E-05	3.6E-03	3.5E-05	3.6E-03	3.02E-05	3.6E-03
Arsenic (As)	1-hour	0.029			0.02	0.052	1.5E-03	3.0E-02	1.6E-03	3.0E-02	1.33E-03	3.0E-02
Arsenic (As)	24-hour	0.012			2.2E-03	0.014	1.5E-04	1.2E-02	1.5E-04	1.2E-02	1.28E-04	1.2E-02
Arsenic (As)	Annual	0.00031			1.7E-04	0.0005	1.4E-05	3.3E-04	1.4E-05	3.3E-04	1.21E-05	3.2E-04
Chromium (Cr)	1-hour	0.0092			0.10	0.11	4.4E-03	1.4E-02	3.2E-03	1.2E-02	3.91E-03	1.3E-02
Chromium (Cr)	24-hour	0.0038			9.8E-03	0.014	4.3E-04	4.2E-03	3.1E-04	4.1E-03	3.77E-04	4.1E-03
Chromium (Cr)	Annual	0.0009			7.7E-04	0.0016	4.0E-05	9.2E-04	2.9E-05	9.1E-04	3.57E-05	9.2E-04
Chlorophenols	1-hour		2.5E-03		7.6E-04		5.1E-06		1.4E-04		7.27E-05	
Pentachlorophenol	1-hour						2.9E-05		1.7E-04		1.05E-04	
Pentachlorophenol	24-hour						2.8E-06		1.7E-05		1.01E-05	
Pentachlorophenol	Annual						2.6E-07		1.6E-06		9.59E-07	
Chlorobenzenes	1-hour		3E-03		2.5E-03		7.4E-05		1.1E-03		1.45E-03	
Pentachlorobenzene	1-hour						2.9E-05		1.3E-04		1.54E-04	
Pentachlorobenzene	Annual						2.6E-07		1.2E-06		1.40E-06	
Hexachlorobenzene	1-hour						5.8E-06		2.9E-05		2.02E-05	
Hexachlorobenzene	Annual						5.2E-08		2.7E-07		1.85E-07	
Polycyclic Aromatic Hydrocarbons (PAHs)	24-hour	1.2E-04	1E-03	1.3E-03	3.2E-04	4.5E-04	2.9E-05	1.5E-04	2.9E-05	1.5E-04	7.63E-05	2.0E-04
Polycyclic Aromatic Hydrocarbons (PAHs)	Annual	2.5E-05	1E-04	1.2E-04	2.5E-05	5.1E-05	2.7E-06	2.8E-05	2.7E-06	2.8E-05	7.24E-06	3.2E-05
Polychlorinated Biphenyls (PCBs)	1-hour	N/A	3E-03		9.4E-04		1.7E-05		1.1E-05		1.14E-05	
Polychlorinated Biphenyls (PCBs)	24-hour	N/A	2E-04		9.1E-05		1.6E-06		1.1E-06		1.10E-06	
Polychlorinated Biphenyls (PCBs)	Annual	N/A	2E-05		7.1E-06		1.5E-07		1.0E-07		1.04E-07	

The new Proposed Operational Certificate limits resulted in lower ground level airborne concentrations of COPCs compared to current permitted emissions. Overall, the concentrations of contaminants decreased at the ground level MPOI by approximately one third. The most dramatic decrease was seen for SO_2 where the Proposed OC Permitted limit would result in approximately 2/3 lower ground level concentrations at the MPOI than the current Permitted Limits. In addition, there are proposed limits for the individual metals of lead, arsenic and chromium. In all cases the Proposed OC Limits MPOI concentrations remain above the current Operational levels.

A review of the 2018 air modeling results with the current results for the same scenarios shows that the concentrations of contaminants are the same order of magnitude for each of the averaging times. This is to be expected as there has not been any dramatic changes or upgrades to either the feedstock of waste or the air pollution control technology.

The Literature Reviews suggest that the maximum ground level point of impingement (MPOI) for modern waste to energy facilities typically occur less than 1 km from facilities. The MPOI for the Waste-to-Energy Facility differs based on averaging time used to assess ground level concentrations, but in all cases occurs very near the facility (Table 10). Table 10 provides the MPOI distances and directions for those contaminants that required further evaluation in the Tier 2 assessment. The furthest MPOI was for the annual average concentration of NO_2 at a distance of 415 m from the Waste-to-Energy Facility to the east of the facility in the commercial/industrial park. RWDI (2026) provides the isopleths and the MPOI for these contaminants.

A review of the 2018 air modeling results indicated that the MPOIs were in a similar range and direction, and in all cases similar to the current assessment under 500 m from the Facility.

Table 10. Maximum Point of Impingement Distances and Direction from the Waste-to-Energy Facility Property

Air Contaminant	Avg Period	MPOI under Different Scenarios Distance and Direction from the Facility									
		Current OC Permitted		Proposed OC Permitted		Current Operational		Start-up Boiler + Other 2 boilers		Shut-down Boiler + Other 2 boilers	
		MPOI Distance	Direction	MPOI Distance	Direction	MPOI Distance	Direction	MPOI Distance	Direction	MPOI Distance	Direction
Hydrogen Chloride (HCl)	1-hour	140 m	W Fenceline	140 m	W Fenceline	140 m	W Fenceline	140 m	W Fenceline	140 m	W Fenceline
Sulphur Dioxide (SO_2)	1-hour	0m	W Fenceline	0m	W Fenceline	0m	WFenceline	0m	W Fenceline	0m	W Fenceline
Nitrogen Dioxide (NO_2) (Converted from NO_x)	1-hour	225 m	NW Fenceline	225 m	NW Fenceline	120 m	SW Fenceline	175 m	NW Fenceline	175 m	NW Fenceline
	Annual	265 m	E Fenceline	265 m	E Fenceline	415 m	E Fenceline	415 m	E Fenceline	415	E Fenceline

COPC concentrations at these MPOI locations are used to characterize human exposure in the Tier 1 Public Health Risk Assessment. The evaluation of the MPOI provide a conservative estimate of exposure for surrounding land uses. Although the MPOI was located close to the Waste-to-Energy Facility, special receptors out several kilometers from the Waste-to-Energy Facility have been included in the Public Health Risk Assessment but the results are available upon request.

6.5 Multi-Media Exposure Pathway Risk Assessment Evaluation of Deposition of Contaminants of Potential Concern

6.5.1 Review of Soil Sampling Surrounding the Waste-to-Energy Facility and Other Similar Facilities

The Literature Review suggests that the primary exposure pathway for contaminants of potential concern from modern waste-to-energy facilities is ground level airborne inhalation. Numerous Public Health Risk Assessments and post-construction monitoring programs for other modern facilities have demonstrated no significant health risk associated with other routes of exposure such as soil ingestion, dermal contact, and food ingestion. There has not been a requirement to conduct soil testing as part of the Operational Certificate for the Metro Vancouver Waste-to-Energy Facility. This is common across many similar facilities across North America and Europe.

Durham York Energy Centre Soils Testing Program

The Durham York Energy Centre (DYEC) is a 140,000 tonnes per year waste-to-energy facility located in Clarington, Ontario. It first began processing waste in February 2015, with full commercial operations being achieved in January 2016. As part of its Environmental Compliance Approval the facility conducts a Soils Testing Plan every three years. The purpose of the sampling is to:

- Quantify background contaminant concentrations in the area.
- Monitor emission dispersion of EFW-related soil contaminants in nearby residential areas.
- Ensure ongoing environmental management of the site.
- Quantify any measurable concentrations resulting from emissions from the DYEC, including validating the predicted concentrations from the Human Health and Ecological Risk Assessment (HHERA), conducted during the 2009 Residual Waste Environmental Assessment (EA) Study, for predicted soil contaminant loading over the life of the facility.

Monitoring locations include:

- An upwind site at the Courtice Water Pollution Control Plant, approximately 1 kilometre from the EFW site.
- A downwind site near Baseline Road and Rundle Road in Clarington, approximately 2.5 kilometres from the EFW site.
- A third station is located inside the property line of the DYEC.

The baseline soil concentrations for metals, PAHs and PCDD/F was conducted in 2013. Yearly sampling was conducted in 2015, 2016, and 2017. The facility currently conducts soil sampling every three years, which occurred in 2020 and 2023, with the latest round of sampling scheduled for 2026.

The concentration of contaminants are benchmarked against the Ontario Ministry of Environment, Conservation and Parks Table 1 "Full Depth Background Site Condition Standards". The soil standards in Table 1 are background values derived from the Ontario Typical Range values for the land uses indicated and are considered representative of upper limits of typical province-wide background concentrations in soils that are not contaminated by point sources.

Over the years, the soil sampling reports have indicated that there has not been an impact on local soil from the operation of the facility.

The following are the conclusions provided in the latest 2023 report:

- The soil sampling grid established at the upwind sampling location was constructed by RWDI personnel based on a previously established metal T-fence post benchmark installed at the southeast corner of the grid outline. The soil sampling grid established at the downwind location was left in place from the previous sample collection efforts.
- Overall, concentrations of metals observed at the upwind and downwind soil sampling locations in 2023 were generally comparable to historical concentrations.
- Concentrations of dioxins and furans in soil have increased at both the upwind and downwind sampling locations relative to historical levels but are not interpreted to be attributed to facility emissions. Given that the concentrations slightly increased in both the up wind and downwind locations it is believe to be from other background sources or analytical error. No specific cause for this increase was discussed in the report.
- The observed concentrations of the analyzed contaminants for the Upwind and Downwind sample aliquots satisfied the Table 1 criteria of the MECP Standards.

The following recommendations are respectfully submitted:

- The contingency plan [additional testing], per the Soil Testing Plan, does not need to be implemented at this time.
- Soil sampling should continue to follow the established three (3) year schedule. As such, the next soil sampling event is currently scheduled to be undertaken in 2026.

Overall, the Durham York Energy Centre soils testing program has demonstrated that the facility has not impact the local soils through deposition of airborne contaminants released over the past decade. This program has established that the Human Health Risk Assessment (2009) conducted for the facility accurately predicted that there would not be significant deposition of contaminants in surrounding soils as a result of facility operations.

Metro Vancouver Analysis of the Potential Dispersion and Deposition Effects of Particulate Matter Emissions from the Metro Vancouver Waste-to-Energy Facility on the Surrounding Environment – March 2026

Specific to the Metro Vancouver Waste-to-Energy Facility a deposition and soil sampling report was prepared in 2026. It concluded that particulate accumulation on a warehouse roof near the Waste-to-Energy Facility is not attributable to air emissions from the facility, and that metal and dioxin and furan concentrations in nearby environmental media are not significantly influenced by facility air emissions.

Metro Vancouver commissioned the study following concerns from the owner of a warehouse near the Waste-to-Energy Facility about material accumulating on the warehouse roof. The study aimed to examine the potential for deposition of particulate matter from the facility into the surrounding environment. The full report, *Analysis of the Potential Dispersion and Deposition Effects of Particulate Matter Emissions from the Metro Vancouver Waste-to-Energy Facility on the Surrounding Environment*, is available on the Metro Vancouver website (https://metrovancouver.org/services/solid-waste/Documents/metro-van-wtef-deposition-report-final.pdf).

Multiple lines of evidence were used to investigate the warehouse owner's concerns:

- Evaluation of the Waste-to-Energy Facility operations to determine potential sources of particulate emissions
- Modelling of predicted particulate and metal and dioxin and furan deposition rates
- Investigating metals and dioxins and furans concentrations, and particle size and morphology from 52 sample locations on rooftops, streets and soils both near to, and at other in similarly industrially zoned neighborhoods far from the Waste-to-Energy Facility

The study found that neither the size, morphology and metal composition of the particles on a stack testing filter nor the fly ash from the Waste-to-Energy Facility match the size, morphology and metal composition of the samples from the warehouse roof or other sampled roofs.

Additionally, metal and dioxin and furan concentrations on the nearby warehouse roof, other nearby roofs, in roadside dust, and in soils near the Waste-to-Energy Facility are not significantly impacted by emissions from the Waste-to-Energy Facility. Metals and dioxins and furans concentrations both near the Waste-to-Energy Facility and in the other locations sampled are within the appropriate levels for industrial activity, which is consistent with the uses of all the locations sampled.

These results were consistent with the Metro Vancouver Public Health Risk Assessment (2018) conducted for the Waste-to-Energy Facility, which predicted that there would not be significant deposition of contaminants in surrounding soils as a result of facility operations.

6.5.2 Evaluation of Deposition of Airborne Contaminants to Soil surrounding Metro Vancouver Waste-to-Energy Facility

To determine if this is the case for the Waste-to-Energy Facility, deposition of contaminants of potential concern to soil over a 20-year period were calculated. This is a standard approach for such facilities, as outlined in the Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities (UEPEA, 2005). Details on the methodology and calculation for deposition of persistent and bioaccumulative contaminants of potential concern are provided in Appendix B.

The first step in assessing deposition for Waste-to-Energy Facility emissions was determination of background concentrations of contaminants of potential concern in soil. Where possible, British Columbia background soil concentrations were obtained from the BC Ministry of the Environment (MENV). However, a number of contaminants do not have analytical data for background available for BC, so Ontario background soil concentrations were obtained from Ontario Ministry of the Environment, Conservation and Parks (MECP), Ontario Regulation 153/04. In addition, Ontario MECP provides default contaminant analytical reporting limits (RL), which were used for evaluation of the significance of soil loading of contaminants of potential concern.

Table 11 provides the predicted deposition of contaminants of potential concern to soil at the MPOI over a 20-year period for the Permitted scenario, as well as percentage change in loading relative to background levels. 20-year deposition of Waste-to-Energy Facility emissions resulted in changes from background soil levels typically less than 10%, with the exception mercury could have almost a doubling of baseline. However, soil loading of each contaminant was either at (mercury) or well below (all other contaminants of potential concern) the analytical reporting limits.

Only a minor decrease in soil deposition was seen between the existing Permitted emissions and that of the proposed Permitted OC emissions deposition. For the Operations scenario demonstrated that the

Waste-to-Energy Facility contaminant deposition is in most cases orders of magnitude less than the permitted scenarios and would be <1% of background soil concentrations.

This means that after 20 years of Waste-to-Energy Facility emissions deposition in soil at the MPOI, the change in contaminant concentration would be analytically insignificant, and likely not detectable even for the existing Permitted scenario emissions. This indicates that there would be no appreciable increase in human health risk due to deposited contaminant. In addition, an increase in all other multi-media pathway (e.g., vegetation, Fraser River, vegetables, or fish) would depend on an appreciable increase in contaminant concentrations in soil (USEPA, 2005).

The results of the deposition analysis for the Waste-to-Energy Facility are consistent with those found in the scientific peer-reviewed literature. No appreciable or analytically detectable increase in soil contaminant concentrations was predicted, even under the existing or proposed permitted OC scenarios indicating that the only significant exposure pathway for Waste-to-Energy Facility Public Health Risk Assessment is ground-level inhalation of airborne contaminants of potential concern.

This is also consistent with the findings of the recently conducted Metro Vancouver Analysis of the Potential Dispersion and Deposition Effects of Particulate Matter Emissions from the Metro Vancouver Waste-to-Energy Facility on the Surrounding Environment – March 2026

Following the Public Health Risk Assessment Framework methodology (Figure 1), it was concluded that no multi-media Public Health Risk Assessment was required.

Table 11. 20-year Deposition of Contaminants of Potential Concern to Soil from the Permitted Scenario at the Maximum Point of Impingement

Parameter	Description /Surrogate	Ontario MOE Soil RL	Ontario Soil Bkgrd	BC Soil Bkgrd	Background Data Source	Current OC Permit Limit			Proposed OC Permit Limit			Current Operational		
						Soil Concentration Facility ONLY	% Change from Background	Soil Loading Concentration Relative to Reporting Limit (RL)	Soil Concentration Facility ONLY	% Change from Background	Soil Loading Concentration Relative to Reporting Limit (RL)	Soil Concentration Facility ONLY	% Change from Background	Soil Loading Concentration Relative to Reporting Limit (RL)
		mg/kg	mg/kg	mg/kg		mg/kg soil			mg/kg soil			mg/kg soil		
2,3,7,8-TCDD Equivalent	Total Diozins and Furans expressed as2,3,7,8-TCDD Equivalent	5.40E-07	0.000007			4.1E-07	5.9%	<RL	3.1E-07	4.4%	<RL	9.0E-11	0.0013%	<RL
Cadmium (Cd)		1	1	0.8	Burnaby Report	6.6E-02	8.3%	<RL	6.6E-02	8.3%	<RL	1.4E-05	0.0017%	<RL
Mercury (Hg)	Total modeled as (inorganic) - divalent Mg2+	0.1	0.16	0.33		1.6E-01	48.1%	At RL	0.1	36.1%	<RL	5.8E-06	0.0018%	<RL
Lead (Pb)	Sum of Lead, Arsenic and Chromium applied to Each Metal	10	45	80.74		1.1	1.3%	<RL	0.80	1.0%	<RL	2.8E-04	0.0003%	<RL
Arsenic (As)		1	11	5.7		3.8E-02	0.7%	<RL	5.4E-03	0.1%	<RL	3.8E-06	0.0001%	<RL
Chromium (Cr)		5	67	14.1	SALM data (average Burnaby north and	2.5E-02	0.2%	<RL	1.6E-02	0.1%	<RL	7.1E-06	0.0001%	<RL
Total Chlorophenols	Total Chlorophenols (except pentachlorolphenol) modeled as 2,4,6-Trichlorophenol	0.1	0.1			4.8E-06	0.005%	<RL	1.43E-06	0.001%	<RL	1.7E-09	0.000002%	<RL
Pentachlorophenol		0.1	0.1									2.8E-09	0.000003%	<RL
Total Chlorobenzenes	Total Chlorobenezes (except pentachlorobenzene modeled as hexachlorobeneze	0.05	0.05			3.4E-04	0.7%	<RL	3.42E-04	0.7%	<RL	3.6E-08	0.000072%	<RL
Pentachlorobenzene		0.05	0.05									2.4E-08	0.000049%	<RL
Total PAHs	Total PAHs Modelled as Benzo(a)pyrene	0.05	0.05	0.063	Data received from BCMOE	6.8E-04	1.1%	<RL	1.79E-04	0.3%	<RL	5.0E-07	0.0008%	<RL
Total PCB	Modelled as AROCLOR 1254	0.3	0.3			5.1E-03	1.7%	<RL	1.9E-03	0.6%	<RL	1.1E-06	0.0004%	<RL

7 Hazard Assessment

All contaminants (anthropogenic and natural) have the potential to induce toxicological effects in people; however, it is the contaminant concentration, the route of exposure, the duration of exposure, and the inherent toxicity of the contaminant that determines the level of effect.

Toxicity Reference Values (TRVs) are defined as doses of carcinogenic and non-carcinogenic contaminants that people can be exposed to without developing unacceptable health effects. Both non-carcinogenic (threshold) and carcinogenic (non-threshold) exposure to contaminants were evaluated. For contaminants that have the potential to elicit both endpoints, they were assessed as such.

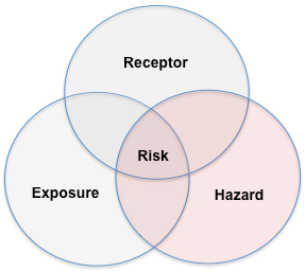
In accordance with the BC Ministry of Environment and Parks Risk Assessment Guidance (2022) TRVs were selected, where available, from the primary sources and if necessary secondary sources:

- Primary sources–- Health Canada TRVs (Health Canada, 2010a, 2018b); US EPA IRIS; or WHO Air Quality Guidelines; and,
- Secondary sources–- Netherlands National Institute of Public Health and the Environment (RIVM); ATSDR; TRVs published by other Canadian provincial/territorial or American state-level government agencies such as the Texas Commission on Environmental Quality (TCEQ) Environmental Screening Levels (ESLs).

In addition, the toxicity of a contaminant depends on whether the exposure is acute (short-term) or chronic (long-term) in duration and TRVs need to be differentiated accordingly. This is particularly true for the inhalation exposure pathway.

Acute: The amount or dose of a contaminant that can be tolerated without evidence of adverse health outcomes on a short-term basis. These limits are routinely applied to conditions in which exposures extend from minutes through several hours or several days only (ATSDR, 2006). For the PHRA, acute risks will be evaluated based upon 1- or 24-hour inhalation exposure periods. Acute exposures are applicable only for non-carcinogenic endpoints.

Chronic: The amount of a contaminant that is expected to be without health outcomes, even when exposure occurs continuously or regularly over extended periods, possibly lasting for periods of at least a year, and possibly extending over an entire lifetime (ATSDR, 2006). For the PHRA, chronic inhalation exposures will be evaluated on an annual basis for non-carcinogens and over a 10-year exposure period for carcinogenic contaminants.



The following are the types of TRVs that were sourced for the contaminants of potential concern.

Reference Concentration (RfC): an RfC can be defined as the acceptable level of an airborne contaminant for which the primary route of exposure is inhalation (i.e., inhalation no observed adverse effect level (NOAEL) or lowest observed adverse effect level (LOAEL) with uncertainty factors applied). It is expressed as a concentration of the contaminant in air (i.e., µg/m^3) and applies only to threshold contaminants.

Regulatory Air Quality Objectives (AQO) concentration (Inhalation): Similar to reference concentrations, regulatory AQOs can either be health based or a combination of regulatory attainment levels that are meant to be as protective as practicable for human health. For this

assessment only health-based benchmarks were be sourced. Benchmarks are acceptable levels of airborne contaminants and are generally expressed as a concentration of contaminant in air (i.e., $\mu g/m^3$) and apply only to threshold contaminants.

Air Quality Objectives (policy based): A number of air quality objectives are often policy based that recognize lowering the objectives to an obtainable airshed level may improve population health. These include the Metro Vancouver Ambient Air Quality Objectives. Further interpretation of these values is discussed in the Risk Characterization Section.

Inhalation Slope Factor/Unit Risk (UR): For substances that are genotoxic (certain carcinogens and germ cell mutagens), the TRV represents an upper bound estimate of the slope between exposure and the occurrence of effect (cancer, in most cases). The slope of the dose-response relationship is referred to as the slope factor (relating to exposure dose) or unit risk (relating to exposure concentration in air).

Air quality inhalation assessments vary in large part from multi-pathway risk assessments in that the majority of TRVs are health-based limits developed by regulatory agencies for 1-hr, 24-hr and annual average exposures. For $PM_{2.5}$, NO_2 and SO_2, the Metro Vancouver Ambient Air Quality Objectives, are at least as stringent as the Canadian Council of Ministers of the Environment Canadian Ambient Air Quality Standards (CAAQs) and were used for evaluation. Note that the Metro Vancouver annual $PM_{2.5}$ objective is lower than the current CAAQs and is aligned with the 2030 limit, while the 24-hour value is lower than the 2025 objective. There is a different statistical form and numerical threshold for the 1-hour SO_2 objective. These are primarily limits that were derived for protection airshed management.

Where possible, RfCs from the United States Environmental Protection Agency or Health Canada were used over benchmarks for annual average concentrations. For other benchmarks, the credible agencies of Ontario Ministry of the Environment Conservation and Parks, Alberta Environment and Texas TCEQs were given priority over other agencies as they have conducted the most comprehensive review of the toxicological literature for contaminants of potential concern.

Table 12 provides the TRVs that were used in the Public Health Risk Assessment. Additional information on contaminants of potential concern toxicology was provided for those contaminants that exceed their applicable benchmark concentrations.

Of note, there are a number of air quality benchmarks that have been reassessed since the completion of the 2018 Public Health Risk Assessment. In most cases, these benchmarks were lowered from those used in the 2018 report. The exception is HCl 1-hr benchmark which has been increased based on more fulsome scientific evaluation. The 2018 report used a 75 ug/m^3 1-hr benchmark based on the Alberta Environment Ambient Air Quality Objective. This value is referenced by Alberta Environment to be based on the Texas TCEQ ESL derived in 1999. However, in 2009 Texas conducted a detailed toxicology review of HCl inhalation exposure and modified their ESL to 190 ug/m^3. Therefore, this more up to date and toxicologically supported 1-hr HCl value was used in this report.

In addition, polycyclic aromatic hydrocarbons the 24-hour and annual ambient quality criteria from Ontario were used as benzo(a)pyrene as a surrogate of total polycyclic aromatic hydrocarbons. Benzo(a)pyrene is used as a surrogate for the total carcinogenicity of PAHs. However, Ontario uses a target incremental lifetime cancer risk of 1E-06, which is an order of magnitude lower that the BC Ministry of Health cancer risk target of 1E-05. Therefore the 24-hour and annual ambient air quality criteria were multiplied by 10 to ensure that the appropriate target cancer risk for British Columbia is achieved. Therefore, the PAH criteria used in the Air Dispersion Modeling Report (RWDI, 2026) is lower than that used by public health.

Table 12. Health-Based Inhalation Benchmarks and Reference Concentrations

Air Contaminant	Averaging Period	Health-Based Standard or RfC (ug/m3)	Critical Effect	Benchmark/RfC	Agency
$PM_{2.5}$	24-hour	25	Health Based	Benchmark	MV AAQO
$PM_{2.5}$	Annual	8	Health Based	Benchmark	MV AAQO
Carbon Monoxide (CO)	1-hour	14,900	carboxyhaemoglobin (COHb) blood level of less than 1%.	RFC	ealth Canada/MV AAQ
Carbon Monoxide (CO)	8-hour	5,700	Health Based	Benchmark	MV AAQO
Hydrogen Chloride (HCl)	1-hour	190	Health Based	Benchmark	TCEQ ESL
Hydrogen Chloride (HCl)	24-hour	20	Health Based	Benchmark	MOE AAQC
Hydrogen Chloride (HCl)	Annual	20	Hyperpasia of the nasal mucosa larynx and trachea	RfC	US EPA
Hydrogen Fluoride (HF)	1-hour	18	Redness of the skin and some burning and irritation of the nose and eyes	Benchmark	TCEQ ESL
	Annual	8.7		Benchmark	TCEQ ESL
Sulphur Dioxide (SO_2)	1-hour	183	effects-based level that is also reflective of technological, economic and societal information	Benchmark	MV AAQO
Sulphur Dioxide (SO_2)	24-hour	125	Respiratory health	Benchmark	AENV AAQO
Sulphur Dioxide (SO_2)	Annual	10.5	effects-based level that is also reflective of technological, economic and societal information	Benchmark	MV AAQO
Nitrogen Dioxide (NO_2) (Converted from NO_x)	1-hour	79	Respiratory Irritation	Benchmark	CAAQS (2020)
Nitrogen Dioxide (NO_2) (Converted from NO_x)	24-hour	NV	Respiratory Irritation	Benchmark	Ontario AAQC
Nitrogen Dioxide (NO_2) (Converted from NO_x)	Annual	22.6	Respiratory Irritation	Benchmark	CAAQS (2020)
Total Dioxins and Furans (as PCDD/F TEQ)	24-hour	1.00E-07	Health Based	Benchmark	Ontario AAQC
Total Dioxins and Furans (as PCDD/F TEQ)	Annual	3.00E-08	health based	benchmark	TCEQ ESL
Cadmium (Cd)	1-hour	0.03	Respiratory	benchmark	ATSDR MRL
Cadmium (Cd)	24-hour	0.025	Respiratory Irritation	benchmark	Ontario AAQC
Cadmium (Cd)	Annual	0.005	Kidney Effects	benchmark	Ontario AAQC
Mercury (Hg)	1-hour	0.6	CNS disturbances in rat offspring	benchmark	CalEPA REL
Mercury (Hg)	24-hour	2	Health Based	benchmark	Ontario AAQC
Mercury (Hg)	Annual	0.3	Neurotoxicity	RfC	US EPA
Sum of Lead (Pb), Arsenic (As), Chromium (Cr)	1-hour	1.5	Health-Based on Pb Exposure	Benchmark	ENV AAQO / TCEQ ESL
Lead (Pb)	1-hour	1.5	Impairment of hematopoietic system	Benchmark	AENV AAQO
Lead (Pb)	24-hour	0.5	Neurological effects in children	Benchmark	Ontario AAQC
Lead (Pb)	Annual	0.2	Blood lead levels	benchmark	Ontario AAQC
Arsenic (As)	1-hour	0.1	Decreased fetal weight in mice	Benchmark	AENV AAQO
Arsenic (As)	24-hour	0.3	Irritation, sensitization, immune suppression, teratogenesis, genotoxicity and carcinogenicity in exposed individuals	Benchmark	Ontario AAQC
Arsenic (As)	Annual	0.01	health based cancer risk	Benchmark	AENV AAQO
Chromium (Cr)	1-hour	1	Health Based	Benchmark	TCEQ ESL
Chromium (Cr)	24-hour	0.5	Health Based	Benchmark	Ontario AAQC
Chromium (Cr)	Annual	60	Kidney effects in humans	RfC	RIVM
Chlorophenols	1-hour	5	Eye and upper respiratory tract irritation; CNS impairment; and cardiac system impairment	Benchmark	Surrogate TCEQ ESL
Pentachlorophenol	1-hour	5	Eye and upper respiratory tract irritation; CNS impairment; and cardiac system impairment	Benchmark	TCEQ ESL
Pentachlorophenol	24-hour	20	Health Based	Benchmark	Ontario AAQC
Pentachlorophenol	Annual	0.5	Cardiac system impairment	Benchmark	TCEQ ESL
Chlorobenzenes	1-hour	0.25	Health Based	Benchmark	TCEQ ESL
Pentachlorobenzene	1-hour	1000	Health Based	Benchmark	TCEQ ESL
Pentachlorobenzene	Annual	100	Health Based	Benchmark	TCEQ ESL
Hexachlorobenzene	1-hour	0.25	Health Based	Benchmark	TCEQ ESL
Hexachlorobenzene	Annual	0.025	Health Based	Benchmark	TCEQ ESL
Polycyclic Aromatic Hydrocarbons (PAHs)	1-hr	0.5	Health Based	Benchmark	TCEQ ESL
Polycyclic Aromatic Hydrocarbons (PAHs)	24-hour	5.00E-04	Health Based Cancer Risk B(a)P	Benchmark	Ontario AAQC
Polycyclic Aromatic Hydrocarbons (PAHs)	Annual	3.00E-04	Health Based Cancer Risk B(a)P	Benchmark	AENV AAQO
Polychlorinated Biphenyls (PCBs)	1-hour	0.1	Health Based	Benchmark	TCEQ ESL
Polychlorinated Biphenyls (PCBs)	24-hour	0.15	Health Based	Benchmark	Ontario AAQC
Polychlorinated Biphenyls (PCBs)	Annual	0.035	Health Based	Benchmark	Ontario AAQC

Seven of the contaminants of potential concern were also determined to be carcinogenic (Table 13). Unit Risk (UR), otherwise known as cancer slope factors, were sourced from the USEPA and Health Canada. These URs were used to calculate the incremental lifetime cancer risks (ILCR) for contaminants of potential concern (Table 13).

Table 13. Inhalation Unit Risks / Cancer Slope Factors

Air Contaminant	Carcinogenic Unit Risk (ug/m3)-1	Agency
Cadmium (Cd)	9.8E-03	Health Canada
Arsenic (As)	4.3E-03	USEPA IRIS
Chromium (CR)	1.1E-02	Health Canada
Chlorophenols	3.1E-06	USEPA IRIS
Chlorobenzenes	4.6E-04	USEPA IRIS
Hexachlorobenzene	4.6E-04	USEPA IRIS
Total PAHs (as B(a)P	6.0E-04	USEPA IRIS

7.1 Non-Threshold Non-Carcinogenic Contaminants

It is acknowledged that there are a limited number of the criteria air contaminants, namely nitrogen dioxide (NO_2) and fine particulate matter ($PM_{2.5}$), that exhibit non-threshold non-carcinogenic health endpoints. However, there is no set regulatory approach to assessing these effects, as acknowledged by British Columbia the Ministry of the Environment (2022):

> *"Regulatory agencies have not established defined levels of acceptable risk for several common non-carcinogenic non-threshold COPCs. The discussion of the significance of predicted health effects and interpretation of the HHRA results is used to determine if the project risks are acceptable."*

The two criteria air contaminants that are known non-threshold non-carcinogenic contaminants emitted from the Waste-to-Energy Facility are NO_2 and $PM_{2.5}$. This means that there is no threshold or "safe criteria" below which no adverse health effects may occur. There is some speculation that SO_2 may also be included in this group of contaminants; however, given that facility emissions were within the benchmarks SO_2 was not considered further as a non-threshold contaminant.

Table 14 illustrates the potential adverse health outcomes associated with exposure to these contaminants. The exposure time and duration are also important to understand, as acute health impacts typically include inflammation of the pulmonary system (e.g., asthmatic response), whereas chronic exposure may result in potential cardio-pulmonary disease and even premature mortality.

Table 14. Non-Threshold Non-Carcinogenic

Contaminant	Health Outcome	Reference
$PM_{2.5}$	strongly associated with mortality and other human health endpoints, such as hospitalization for cardio-pulmonary disease	WHO 2003; Health Canada 2021
NO_2	Asthmatic response, cardio-pulmonary distress, chronic disease and up to and including mortality	Health Canada 2016

There are a number of Health Canada reports that describe the relationship between exposure and increasing probability of adverse health impacts at a population level. These documents on exposure levels and adverse health outcomes will be relied on throughout the assessment.

7.1.1 Multiple Line of Evidence Approach to Risk Characterization of NO_2

Given that there is little to no regulatory guidance on assessing the potential non-carcinogenic non-threshold risk posed by these contaminants, a multiple lines of evidence approach was used to understand the risk that these contaminants pose. Collectively, these lines of evidence allow for a determination to what extent the Waste-to-Energy Facility emissions pose a potential risk to public health.

8 Risk Characterization

The inhalation risk characterization was conducted in a Tiered approach, as detailed below.

8.1 Tier 1 Risk Characterization Non-Carcinogenic Risk Assessment at Maximum Point of Impingement

The Tier 1 risk characterization assumes that an exposed individual lives at the MPOI, 24 hours a day for an entire 80-year lifespan.

For non-carcinogenic contaminants of potential concern, the modeled ground level COPC concentrations were divided by the appropriate benchmark or RfC concentration.

$$\text{Concentration Ratio (CR)} = \frac{\text{Air Concentration (ug/m}^3\text{)}}{\text{RfC or Benchmark (ug/m}^3\text{)}}$$

This was done to evaluate both acute (1-hour and 24-hour) and chronic (annual) ground level air concentrations predicted at the MPOI. The resulting unitless Concentration Ratios (CR) were benchmarked against the acceptable value of 1.0 for contaminants that included baseline concentrations for a complete exposure and 0.2 for those contaminants that do not have associated baseline air concentrations. This is in accordance with both BC Health (2022) and Health Canada (2023) guidance.

If the modeled air concentrations are less than the threshold "acceptable" health-based regulatory air quality objectives or RfCs, then no undue risk to exposure individuals would be predicted (CR<1 if background air quality values are available; or CR<0.2 if background air quality values are not available and only Facility emissions are assessed). Where available, the background ambient air concentrations for contaminants of potential concern were added to predicted concentrations associated with Waste-to-Energy Facility emissions.

8.1.1 Risk Characterization of the Criteria Air Contaminants

Table 15 provides the Concentration Ratios for all scenarios for the criteria air contaminants. This table includes the modelling results for the Project Alone and then combines the Project Alone with the Background (Project + Background) airborne concentrations at the MPOI.

The baseline/background concentration ratio results are available for the criteria air contaminants, with the exception of hydrogen fluoride. The concentration ratios for CO, HCl and SO_2 were well below the benchmark of 1.0. The $PM_{2.5}$ concentration ratios were higher but still remain below 1.0.

The Background 1-hour NO_2 ambient air concentrations averaged across the three Metro Vancouver monitoring stations evaluated closest to the Waste-to-Energy Facility are at or marginally above a level that exceeds the Metro Vancouver Ambient Air Quality Objectives. This was anticipated given that the objectives were recently lowered, after the 2018 Public Health Risk Assessment, from a 1 hr averaging time of 113 ug/m^3 to 79 ug/m^3 and the annual average of 32 ug/m^3 to 22.6 ug/m^3, respectively.

The concentration ratio results for all permitted and operational scenarios, including the addition to baseline existing air quality are also provided in Table 15. The Concentration Ratios for $PM_{2.5}$, Carbon Monoxide are below their target of 1.0, including with the addition of the Background concentrations, even for the Permitted scenario. Hydrogen Fluoride did not have and existing background concentration and its Concentration Ratio was below the appropriate benchmark of 0.2. Examination of the predicted Concentration Ratios reveal that the actual Operational Facility emissions are predicted to be at least an

order of magnitude lower than that of the Permitted Scenario. Start-up and Shut-down predicted concentrations at the MPOI for these contaminants are consistent with the Operations scenario and similarly below that of the Permitted Scenario. Therefore, these contaminants were not carried forward into a Tier 2 risk assessment.

For HCl all scenarios result in a Concentration Ratio of <1.0 when added to the Background concentrations for each of the averaging periods. Note that the Facility alone is predicted to be the dominant source of HCl, which as shown in Table 15 was predicted to be far greater than the existing Background levels. The introduction of Proposed Permit condition lowering the HCl emissions would bring the Concentration Ratios in line with the existing Operational predictions. Regardless, the predicted concentrations of HCl do not pose a potential adverse health risk to the public. Therefore, HCl was not required to be carried forward into the Tier 2 risk assessment.

The predicted existing Permitted 1-hour emissions of SO_2 from the Facility alone resulted in a Concentration Ratio slightly greater than 1.0. However, the Operational Concentration Ratios both for the Project Alone and including Background were well below 1.0. The lowering of the Proposed Permit condition of the Facility alone 1-hour Concentration Ratios to below the acceptable benchmark of 1.0. Therefore, the SO_2 under existing Operational Conditions and the Proposed Permit conditions would not pose an adverse health risk to the public and it was not carried forward into the Tier 2 risk assessment. Instead, the Public Health Risk Assessment concludes that the SO_2 Operational Certificate Discharge Limit should be lowered to the Proposed OC limit.

In addition, SO_2 released from the Waste-to-Energy Facility has the potential to form secondary particulate matter ($PM_{2.5}$) as it is oxidized in the atmosphere into sulfate. This can contribute to the overall $PM_{2.5}$ concentration in the air. RWDI modelled the SO_2 secondary particulate matter contribution at the MPOI. This was done as any concentration of secondary particulate formation further from the MPOI would be lower. Therefore, the MPOI can be used as a surrogate for all other locations. Table 16 provides both the modelled airborne secondary $PM_{2.5}$ concentrations and the resulting Concentration Ratios. The secondary particulate matter levels were an order of magnitude lower than the predicted primary $PM_{2.5}$ modeled levels at the MPOI and had no effect on the resulting $PM_{2.5}$ Concentration Ratios. Therefore, secondary particulate matter from the release of SO_2 emissions from the Waste-to-Energy Facility do not pose an undue risk to human health.

The Background Concentration Ratios for both the 1-hour and Annual average NO_2 levels were already at, or just above, the acceptable benchmark of 1.0. For the annual average the predicted concentrations of NO_2 slightly increase the Concentration Ratio from 1.1 to 1.2. However, the 1-hr predictions across all scenarios resulted in an increase in Concentration Ratios from 1.0 to between 1.5 to 1.8. The Proposed Permitted ground level predictions for 1-hour NO_2 were lower; however, provide little change to these predictions. The potential effect of NO_2 is carried forward into the Tier 2 Risk Analysis.

Table 15. Concentration Ratios for Criteria Air Contaminants at the Maximum Point of Impingement

Air Contaminant	Averaging Period	Health-Based Standard or RfC (ug/m3)	Background	Modelled MPOI under Different Scenarios									
				Current OC Permitted		Proposed OC Permitted		Current Operational		Start-up Boiler + Other 2 boilers		Shut-down Boiler + Other 2 boilers	
			CR	CR Project Alone	CR Project + Background	CR Project Alone	CR Project + Background	CR Project Alone	CR Project + Background	CR Project Alone	CR Project + Background	CR Project Alone	CR Project + Background
$PM_{2.5}$	24-hour	25	0.65	0.03	0.684	0.03	0.68	0.0034	0.65	0.0027	0.65	0.0031	0.65
$PM_{2.5}$	Annual	8	0.78	0.022	0.805	0.02	0.80	0.0023	0.79	0.0019	0.78	0.0021	0.79
Carbon Monoxide (CO)	1-hour	14,900	0.03	0.008	0.040	0.01	0.04	0.0037	0.035	0.0044	0.036	0.010	0.04
Carbon Monoxide (CO)	8-hour	5,700	0.08	0.006	0.083	0.01	0.08	0.0028	0.079	0.0033	0.080	0.0072	0.08
Hydrogen Chloride (HCl)	1-hour	190	0.01	0.73	0.74	0.60	0.61	0.54	0.55	0.44	0.45	0.47	0.48
Hydrogen Chloride (HCl).2	24-hour	20	0.08	0.67	0.75	0.55	0.63	0.50	0.58	0.41	0.48	0.43	0.51
Hydrogen Chloride (HCl)	Annual	20	0.03	0.053	0.084	0.04	0.07	0.046	0.077	0.038	0.069	0.041	0.07
Hydrogen Fluoride (HF)	1-hour	18		0.14				0.0069		0.0068		0.0050	
Sulphur Dioxide (SO_2)	1-hour	183	0.04	**1.1**	**1.1**	0.66	0.70	0.33	0.37	0.32	0.36	0.25	0.29
Sulphur Dioxide (SO_2)	24-hour	125	0.02	0.39	0.41	0.23	0.25	0.11	0.12	0.10	0.12	0.082	0.10
Sulphur Dioxide (SO_2)	Annual	10.5	0.07	0.37	0.44	0.22	0.29	0.12	0.19	0.12	0.19	0.092	0.16
Nitrogen Dioxide (NO_2) (Converted from NO_X)	1-hour	79	**1**	**0.9**	**1.8**	0.75	**1.7**	0.6	**1.5**	0.59	**1.5**	0.59	**1.5**
Nitrogen Dioxide (NO_2) (Converted from NO_X)	Annual	22.6	**1.1**	0.10	**1.2**	0.08	**1.2**	0.06	**1.2**	0.06	**1.2**	0.06	**1.2**

Table 16. Secondary Particulate Air Concentrations and Concentration Ratios at the MPOI

Scenario	Current OC		Proposed OC		Current Operations	
Averaging Period	24hr	Annual	24hr	Annual	24hr	Annual
Health-Based Standard	25	8	25	8	25	8
$PM_{2.5}$ MPOI Conc. (µg/m3)	0.86	0.17	0.86	0.17	0.09	0.02
Concentration Ratio	0.035	0.022	0.035	0.022	0.003	0.002
Sec_$PM_{2.5}$ Conc (µg/m3) at $PM_{2.5}$ MPOI location	0.93	0.20	0.91	0.19	0.18	0.03
Concentration Ratio	0.037	0.025	0.036	0.024	0.007	0.004
Total $PM_{2.5}$ MPOI Conc.	1.8	0.37	1.8	0.36	0.26	0.05
Concentration Ratio	0.072	0.046	0.071	0.046	0.011	0.006

8.1.2 Waste-to-Energy Facility Emission Scenario Risk Characterization for the Additional Contaminants

The Concentration Ratios for the remaining contaminants, including dioxins and furans, metals, VOC, PAHs and PCBs are provided in Table 17.

For the majority of contaminants, the Project Alone modelled concentrations in Current OC Permitted, Proposed OC Permitted scenario were below a benchmark of 0.2 (i.e., without consideration of Background concentrations). However, the 1-hour Cadmium, 1-hour Arsenic and 24-hour PAHs were above their benchmark CR of 0.2. Regardless, when the Facility + Background concentrations ratios were considered for Cadmium and Arsenic then they do not pose an unacceptable risk under the Proposed OC Permit conditions and a benchmark of 1.0. For PAHs the Current OC Permitted condition for the Project + Background was above the benchmark of 1.0.

However, by lowering the Proposed OC Permitted discharge limit the PAHs would be acceptable and below 1.0 (including background). These are all for the Waste-to-Energy Facility operating exactly at their Current OC Permitted Condition or at lower Proposed OC Permitted Conditions. In all cases, the Facility operates well below this discharge limits. As shown in Table 16, the Concentration Ratios are orders of magnitude for all scenarios and all time periods than their respective benchmarks of either 0.2 (without inclusion of Background) or certainly with the inclusion of Background of a benchmark of 1.0.

Therefore, these contaminants do not pose an undue risk to human health, for even an individual that would hypothetically live at the maximum point of impingement. Therefore, none of these contaminants were carried forward into the Tier 2 risk assessment.

Table 17. Concentration Ratios (CR) for Contaminants of Potential Concern at the Maximum Point of Impingement

Air Contaminant	Averaging Period	Health-Based Standard or RfC (ug/m3)	Background	Modelled MPOI under Different Scenarios									
				Current OC Permitted		Proposed OC Permitted		Current Operational		Start-up Boiler + Other 2 boilers		Shut-down Boiler + Other 2 boilers	
			CR	CR Project Alone	CR Project + Background	CR Project Alone	CR Project + Background	CR Project Alone	CR Project + Background	CR Project Alone	CR Project + Background	CR Project Alone	CR Project + Background
Total Dioxins and Furans (as PCDD/F TEQ)	24-hour	1.00E-07		0.20		0.15		1.4E-03		6.7E-04		2.0E-03	
Total Dioxins and Furans (as PCDD/F TEQ)	Annual	3.00E-08		5.1E-02		3.8E-02		4.3E-04		1.0E+04		6.2E-04	
Cadmium (Cd)	1-hour	0.03	0.4	0.59	0.94	0.59	0.94	1.2E-02	0.36	9.9E-04	0.36	1.8E-02	3.7E-01
Cadmium (Cd)	24-hour	0.025	0.2	6.8E-02	0.24	6.8E-02	0.2	1.4E-03	0.18	1.1E-04	0.18	2.1E-03	1.8E-01
Cadmium (Cd)	Annual	0.005	0.1	2.7E-02	0.16	2.7E-02	0.2	6.4E-04	0.14	8.2E-02	0.14	9.8E-04	1.4E-01
Mercury (Hg)	1-hour	0.6		8.4E-02		6.3E-02		3.0E-04		6.6E-05		8.6E-04	0.0E+00
Mercury (Hg)	24-hour	2		2.4E-03		1.8E-03		8.6E-06		1.9E-06		2.5E-05	0.0E+00
Mercury (Hg)	Annual	0.3		1.3E-03		9.6E-04		5.4E-06		2.9E-02		1.6E-05	0.0E+00
Sum of Lead (Pb), Arsenic (As), Chromium (Cr)	1-hour	1.5		0.11		0.10		6.7E-03		2.6E-03		5.7E-03	
Lead (Pb)	1-hour	1.5	0.03			8.1E-02	0.11	2.7E-03	2.8E-02	2.5E-04	0.03	2.2E-03	
Lead (Pb)	24-hour	0.5	0.03			2.3E-02	0.05	7.9E-04	3.2E-02	7.1E-05	0.03	6.4E-04	
Lead (Pb)	Annual	0.2	0.02			4.6E-03	0.02	1.8E-04	1.8E-02	7.9E-03	0.02	1.5E-04	
Arsenic (As)	1-hour	0.1	0.3			0.23	0.52	1.5E-02	0.30	1.5E-03	0.30	1.3E-02	
Arsenic (As)	24-hour	0.3	0.04			7.3E-03	0.05	5.0E-04	4.0E-02	4.8E-05	0.04	4.3E-04	
Arsenic (As)	Annual	0.01	0.03			1.7E-02	0.05	1.4E-03	3.3E-02	3.2E-01	0.03	1.2E-03	
Chromium (Cr)	1-hour	1	0.01			0.10	0.11	4.4E-03	1.4E-02	3.1E-04	0.01	3.9E-03	
Chromium (Cr)	24-hour	0.5	0.01			2.0E-02	0.03	8.6E-04	8.4E-03	5.8E-05	0.01	7.5E-04	
Chromium (Cr)	Annual	60	1.5E-05			1.3E-05	2.7E-05	6.7E-07	1.5E-05	2.3E-06	1.52E-05	6.0E-07	
Chlorophenols	1-hour	5		5.1E-04		1.5E-04		1.0E-06		3.5E-05		1.5E-05	
Pentachlorophenol	1-hour	5						5.8E-06		3.4E-06		2.1E-05	
Pentachlorophenol	24-hour	20						1.4E-07		8.4E-07		5.1E-07	
Pentachlorophenol	Annual	0.5						5.2E-07		3.2E-06		1.9E-06	
Chlorobenzenes	1-hour	0.25		1.0E-02		1.0E-02		2.9E-04		4.3E-03		5.8E-03	
Pentachlorobenzene	1-hour	1000						2.9E-08		1.3E-07		1.5E-07	
Pentachlorobenzene	Annual	100						2.6E-09		1.2E-08		1.4E-08	
Hexachlorobenzene	1-hour	0.25						2.3E-05		1.2E-04		8.1E-05	
Hexachlorobenzene	Annual	0.025						2.1E-06		1.1E-05		7.4E-06	
Polycyclic Aromatic Hydrocarbons (PAHs)	24-hour	5.00E-04	0.25	2.4	**2.7**	0.64	0.89	5.8E-02	0.31	5.8E-02	0.31	1.5E-01	0.40
Polycyclic Aromatic Hydrocarbons (PAHs)	Annual	3.00E-04	0.08	0.32	0.40	8.4E-02	0.17	9.0E-03	9.3E-02	9.1E-03	0.09	2.4E-02	0.11
Polychlorinated Biphenyls (PCBs)	1-hour	0.1		2.5E-02		9.4E-03		1.7E-04		1.1E-04		1.1E-04	
Polychlorinated Biphenyls (PCBs)	24-hour	0.15		1.6E-03		6.1E-04		1.1E-05		7.3E-06		7.3E-06	
Polychlorinated Biphenyls (PCBs)	Annual	0.035		5.5E-04		2.0E-04		4.4E-06		3.0E-06		3.0E-06	

8.1.3 Tier 1 Carcinogenic Risk Assessment at Maximum Point of Impingement

The modelled concentrations of carcinogenic contaminants of potential concern in air at the MPOI were multiplied by their unit risk / inhalation slope factor to provide an estimate of the incremental lifetime cancer risk (ILCR).

$$\text{Incremental lifetime Cancer risk} = \text{Air Concentration } (ug/m^3) \times \text{Unit Risk } (ug/m^3)^{-1}$$

The result is a unitless probability expressing the potential increase in cancer cases that could manifest due to the exposure to the Facility emissions. The ILCR was benchmarked against the acceptable level of 1 potential additional cancer case in an exposed population of 100,000 (i.e., 1E-05 or 0.00001). ILCRs at the MPOI under the Tier 1 assessment were not time activity pattern adjusted.

Risk estimates for all carcinogenic contaminants of potential concern are provided in Table 18. ILCRs for all seven contaminants in the Permitted and Operational scenario were <1E-05, or 1 additional cancer case in 100,000 people exposed. Therefore, results indicate that the Waste-to-Energy Facility does not pose an undue cancer risk to those in the vicinity of the facility.

Table 18. Incremental Lifetime Cancer Risk of Contaminants of Potential Concern Exposure at the Maximum Point of Impingement

Air Contaminant	Current OC Permitted	Proposed OC Permitted	Current Operational	Start-up Boiler + Other 2 boilers	Shut-down Boiler + Other 2 boilers
	ILCR	ILCR	ILCR	ILCR	ILCR
Cadmium (Cd)	1.32E-06	1.32E-06	3.12E-08	2.74E-08	4.79E-08
Arsenic (As)		7.42E-07	5.96E-08	6.20E-08	5.22E-08
Chromium (Cr)		8.44E-06	4.39E-07	3.17E-07	3.93E-07
Chlorophenols	7.85E-09	2.35E-09	1.59E-11	4.27E-10	2.25E-10
Chlorobenzenes	1.16E-06	1.16E-06	3.39E-08	4.98E-07	6.66E-07
Hexacholorbenzene			2.40E-11	1.22E-10	8.49E-11
Total PAHs as B(a)P	5.76E-08	1.52E-08	1.62E-09	1.63E-09	4.34E-09

8.1.4 Conclusion of the Tier 1 Risk Assessment

There is no question that the Waste-to-Energy Facility releases contaminants into the air. However, the results of the risk assessment determined that:

- For the majority of the Criteria Air Contaminants that the Facility does not pose an undue risk to anyone at the MPOI for $PM_{2.5}$, carbon monoxide (CO), hydrogen chloride (HCl), hydrogen fluoride (HF) even at the existing Permitted OC discharge limits. The Operational Project Alone levels confirm that these contaminants do not pose an undue risk.
- For sulphur dioxide (SO_2) the Current OC Permitted levels are marginally above the concentration ratio benchmark of 1.0. However, the Current Operational discharges are below the acceptable

benchmark. The lowering of the Proposed OC Permitted levels also result in an acceptable Concentration Ratio of <1.0. Therefore, the OC discharge limits should be lowered to those proposed and do not result in an unacceptable risk to human health.

- The secondary particulate matter levels were an order of magnitude lower than the predicted primary $PM_{2.5}$ modeled levels at the MPOI and had no effect on the resulting $PM_{2.5}$ Concentration Ratios. Therefore, secondary particulate matter from the release of SO_2 emissions from the Waste-to-Energy Facility do not pose an undue risk to human health.
- Overall, all of the additional contaminants considered do not pose an unacceptable risk to human health, whether under the Current OC Permitted levels, the Proposed OC Permitted levels or certainly the Current Operational levels at the MPOI when considering the existing background concentrations in air. Their Concentration Ratios were all below 1.0. The exception to this was the PAHs that were modelled in the Current OC Permitted that had a Concentration Ratio above 1.0. However, the Concentration Ratio for the Current Operations Facility Alone level and in combination with the Background levels were below the benchmark of 1.0. In addition, the lowering of the emissions under the Proposed OC Permitted limits would ensure that the Concentration Ratio for PAHs would be acceptable and should be adopted by the Waste-to-Energy Facility. Therefore, PAHs were not carried forward into the Tier 2 risk assessment.
- Nitrogen dioxide (NO_2) levels require further evaluation under the Tier 2 Risk Assessment.

8.2 Tier 2 Risk Characterization of Nitrogen Dioxide Emissions from the Waste-to-Energy Facility

The only contaminant that requires further Tier 2 evaluation in this Public Health Risk Assessment is nitrogen dioxide (NO_2). This is not unexpected given that the Metro Vancouver Ambient Air Quality Objectives, which are identical to the Canada Ambient Air Quality Standards, were appropriately lowered in by Metro Vancouver in 2024. Table 19 provides the Metro Vancouver Ambient Air Quality Objectives and the appropriate statistical derivation of ambient air quality to be assessed against the objective.

Table 19. Metro Vancouver Ambient Air Quality Objectives for Nitrogen Dioxide

Nitrogen Dioxide (NO_2)	Ambient Air Quality Objective (ug/m^3)	Statistical Basis
1-hour	79	Achievement based on annual 98th percentile of the daily maximum 1-hour concentration averaged over three consecutive years.
Annual	22.6	Achievement based on annual average of 1-hour concentrations over one year.

The AAQOs are intended to drive continuous improvement in air quality and, in turn, protect health and the environment across the country. However, it is recognized that NO_2 is considered to be a non-threshold contaminant, which means there is unlikely a level at which no health risks exist. The AAQOs recognize that incremental reductions in ambient concentrations of NO_2 will directly lead to health benefits to Canadians.

The NO_2 existing Background concentration across Metro Vancouver, for both the 1-hour and annual average concentrations are already at the AAQO limit and result in a Concentration Ratio of 1.0 or 1.1. Therefore, the modeling of any incremental increase of NO_2 from a facility would increase the overall loading

of NO_2 in the airshed (Table 20). The following are observations of the predicted NO_2 concentrations at the MPOI:

- For the Annual average NO_2 predictions of the Facility Alone at the MPOI are only 10% of that of the existing Background concentrations and results in an increase of only 0.1 in the Concentration Ratios, when Background is included.
- The Concentration Ratios of Facility Alone at the MPOI approach 1.0 for the Current OC Permitted level, would decrease to a CR=0.75 for the Proposed OC Permitted limit, while the Current Operational and Start-up/Shut-down are lower at CR=0.6. However, these levels when combined with the Background take the Concentration Ratios marginally above 1. This requires further evaluation.

Table 20. Concentration Ratios of NO2 at the MPOI for the Waste-to-Energy Facility.

Air Contaminant	Averaging Period	Health-Based Standard or RfC (ug/m3)	Background	Modelled MPOI under Different Scenarios									
				Current OC Permitted		Proposed OC Permitted		Current Operational		Start-up Boiler + Other 2 boilers		Shut-down Boiler + Other 2 boilers	
			CR	CR Facility Alone	CR Facility + Background	CR Facility Alone	CR Facility + Background	CR Facility Alone	CR Facility + Background	CR Facility Alone	CR Facility + Background	CR Facility Alone	CR Facility + Background
Nitrogen Dioxide (NO_2) (Converted from NO_X)	1-hour	79	1	0.9	1.8	0.75	1.7	0.6	1.5	0.59	1.5	0.59	1.5
Nitrogen Dioxide (NO_2) (Converted from NO_X)	Annual	22.6	1.1	0.10	1.2	0.08	1.2	0.06	1.2	0.06	1.2	0.06	1.2

The following sections evaluate the significance of the Waste-to-Energy Facility NO_2 emissions in relation to public health.

8.2.1 Toxicological Overview for Short-Term (Acute) exposure to NO_2

In 2016, Health Canada issued the comprehensive Human Health Risk Assessment for Ambient Nitrogen Dioxide (Health Canada, 2016). This document acknowledges that it appears that NO_2 is a non-threshold contaminant. This means that it is possible that exposure to NO_2 does not follow a typical dose-response relationship for non-carcinogenic contaminants where a threshold or an acceptable dose below which effects would not been experienced, especially in sensitive populations.

The most vulnerable or sensitive individuals to NO_2 are adults and children with asthma, or other pre-existing cardiovascular conditions; such as individuals with chronic obstructive pulmonary disease (COPD). There is also indication that the elderly population is more susceptible to NO_2 exposure.

The following are the potential adverse health impacts from exposure to NO_2:

Short-term Respiratory Effects

Studies with asthmatic adults exposed to near-ambient levels of NO_2 have elicited a range of adverse effects, including decreased lung function, increased airway hyperresponsiveness and airway inflammation. Similar effects have also been demonstrated in epidemiology studies of asthmatic children. These studies have also been independently associated with increases in respiratory and asthmatic hospitalizations and emergency room visits. Overall, the evidence indicates a causal relationship between short-term exposure to current ambient NO_2 levels.

Short-term Cardiovascular Effects

The studies on short-term exposure to NO_2 with increased cardiovascular mortality, hospitalization and emergency room visits are often related to other pollutants. The overall evidence is suggestive, but not

sufficient to infer causal relationship between short-term exposures to ambient NO_2 and cardiovascular effects.

Mortality Related to Short-term Exposure

Overall, the associations with total non-accidental, cardiopulmonary, and to a lesser extent cardiovascular and respiratory mortality display strength of association, consistency, and robustness, but lack some aspects of coherence with ambient NO_2 exposure. Health Canda concluded that there is likely a causal relationship between short-term exposure to ambient NO_2 at current levels and these categories of mortality.

Health Canada Input to the Derivation of the Canada Ambient Air Quality Standards

The study by Health Canada was used to support the derivation of the lower CAAQS for NO_2, and in turn the Metro Vancouver AAQOs. In part these recommendations were used to derive the 2020 NO_2 standards and then the lowering of these standards 30% to the current 2025 standards that were adopted by Metro Vancouver as their Ambient Air Quality Objectives. Although OEHM recognizes that that NO_2 is a non-threshold contaminant the Ambient Air Quality Objectives provide a meaningful target to best attempt to protect the health of those living in the region.

8.2.2 Nitrogen Dioxide (NO_2) Reduction in Emissions from the Facility

Nitrogen oxide is always one of the most challenging air contaminants to control in any waste-to-energy facility. Over the almost 40 years of operation, the Waste-to-Energy Facility has seen a significant reduction in the emission of NO_x from the stack. Nitrous oxide emissions from the Waste-to-Energy Facility dropped approximately 60% in 2014 following upgrades to emission control systems (Figure 6). The Facility installed a Selective Non-Catalytic Reduction (SNCR) ($DeNO_x$) in late 2013. The system was designed to utilize the Low NOx (LN) process in combination with an SNCR aqueous ammonia injection system for NO_x reduction. The LN process incorporated modifications to the standard Martin GmbH combustion air system to achieve reductions in NO_x formation. The aqueous ammonia SNCR system supplies nineteen percent (19%) aqueous ammonia solution to a nozzle on each side of the furnace to achieve a further reduction in NO_x. This converts the NO_x into nitrogen gas and water vapour.

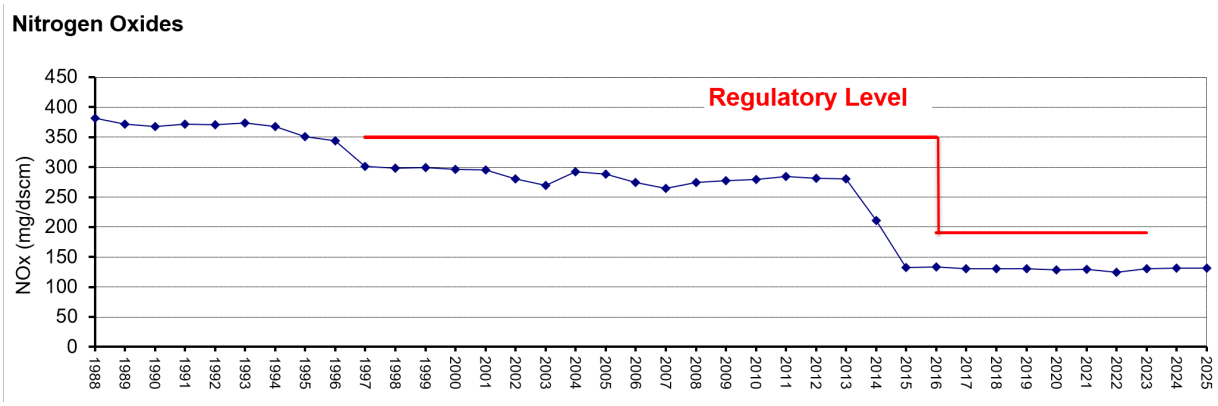


Figure 6. Annual Emission Levels of NO_2 Over the Almost 40 Years of Operation of the Waste-to-Energy Facility. A Significant Reduction of NO_2 Levels was Achieved in 2014 Based on New Emissions Control Technology Being Implemented.

Metro Vancouver has proposed to lower the current Discharge Limit of NO_x from 190 mg/dscm to 150 mg/dscm in the new Operational Certificate. As shown in Table 20 this would result in a decrease in ground level NO_2 Concentration Ratio reduction of 25% for the 1-hour time period and 20% reduction for the Annual average. It is OEHM's understanding through consultation with Metro Vancouver and HDR that it is not technically feasible to achieve a lower emission Discharge Limit for NO_2 below 150 mg/dscm at this time.

8.2.3 Comparison of NO_2 MPOI Modelled Ground Level Concentrations with the Measured Background Concentrations at Air Monitoring Stations

Given that the Waste-to-Energy Facility is already in operation, then it is important to understand what the predicted contribution of the Waste-to-Energy Facility is to the Background air concentrations at the closest ambient air monitoring stations. RWDI provided the predicted modelled concentrations of the Waste-to-Energy Facility at the ambient air monitoring stations T018 (Burnaby South) and the S150 monitoring station that was in operation at the Northwest fence line of the Facility in 2022 (Table 21). It can be seen that the Waste-to-Energy is not predicted to increase the concentrations of NO_2 above Background at these locations. Given that these are actual measured concentrations of NO_2, the Background concentrations of NO_2 at these stations already account for the contribution from the Waste-to-Energy Facility.

Note that the S150 air monitoring station is located at or close to the MPOI for the Facility. The Public Health Risk Assessment conservatively added the modelled predicted Waste-to-Energy Facility MPOI concentrations to the existing Background of the three ambient air monitoring stations used in the assessment to establish the Background concentration of NO_2 in air. Therefore, OEHM believes that this conservatively overestimates the potential influence of the Waste-to-Energy Facility on Background.

Given that the Background NO_2 air concentrations used in this assessment were at the acceptable Benchmark Concentration Ratio it does not appear that the Waste-to-Energy Facility is having an actual substantial impact on the overall airshed and not unduly influencing public health, even at the MPOI in comparison to other air monitoring stations across the regional airshed.

Table 21. Modelled and Measured Background Concentrations for the Permitted Scenario at Air Monitoring Stations T18 and S150 in 2022

Air Contaminant	Averaging Period	Receptor Closest to T18		Receptor Closest to S150	
		Receptor ID# 12		Receptor ID# 1602	
		Predicted Facility Alone	Measured Background at T18	Predicted Facility Alone	Measured Background at S150
		ug/m^3			
Nitrogen Dioxide (NO_2) (Converted from NO_X)	1-hour	24	68	63	86
	Annual	0.43	22	0.58	26

In addition, there was a marginal increase in the concentration of NO_2 between the two air monitoring locations. The S150 station is located not only near the Waste-to-Energy Facility location but also in a heavy commercial/industrial area with considerable heavy-duty vehicles and other facilities, while the T018 Burnaby South air monitoring station is located in a more residential area of the region.

8.2.4 Relative Source Apportionment of the Waste-to-Energy Facility NO_2 Emissions in the Fraser Valley

The Metro Vancouver Proposed Operational Certificate Discharge Limits: Metro Vancouver Waste-to-Energy Facility (HDR, 2026) provide context to the relative emission sources of NO_x in the Lower Fraser

Valley in 2025 (Figure 7). The Waste-to-Energy Facility accounts for 0.5% of the total emissions of nitrogen oxides in the Lower Fraser Valley. Therefore, any additional reduction in emissions would likely have minimal impact on the regional air zone management area.

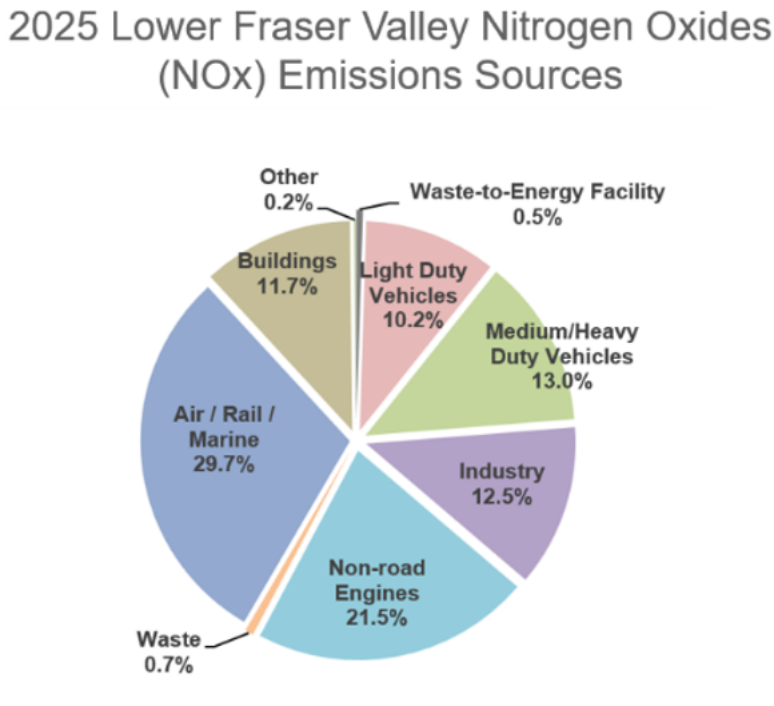


Figure 7. Lower Fraser Valley NO_x Emissions by Source Sector (2025)

8.2.5 Statistical Evaluation of NO_2 Concentrations at the MPOI

For each of the Current OC Permitted, Proposed OC Permitted and the Current Operational scenarios the percentile concentrations of 1-hour NO_2 concentrations at the MPOI (Table 22). Given that it was demonstrated in Table 21 that the modelled 1-hour NO_2 concentrations at S150 were below those that were measured in ambient air, this represents a conservative assessment of the contribution that the Waste-to-Energy Facility could have on the local environment.

If the Waste-to-Energy Facility was operating continuously at its Current OC Permitted Discharge Limits for NO_2, there would be only 0.1% of the hours a year, or 9 hours, where the NO_2 concentrations would exceed the 79 ug/m^3 standard (which is actually meant as a comparison to the annual 98th percentile of the daily maximum 1-hour concentration averaged over three consecutive years). For the Proposed OC Permitted Discharge Limit and the Current Operational scenario would not exceed this limit at any point at the MPOI.

Therefore, this is yet a further line of evidence that NO_2 emissions from the Waste-to-Energy Facility do not pose an undue risk beyond that of those living in other areas in the region, to even someone that would be at the MPOI, 24 hours a day throughout their entire lifetime.

Table 22. Percentile Concentrations of the MPOI NO_2

Percentile	Current OC Permitted	Proposed OC Permitted	Current Operational
	Facility Alone (µg/m3)	Facility Alone (µg/m3)	Facility Alone (µg/m3)
	AAQO = 79 ug/m3		
50	0.82	0.65	0.07
75	6.7	5.3	2.0
90	22	18	13
95	35	27	24
98	64	54	43
99	75	66	57
99.9	**83**	78	73
99.98	**83**	78	73
100	**83**	78	73

8.2.6 Conclusions of the Tier 2 Nitrogen Dioxide Risk Assessment

Nitrogen dioxide is a non-threshold contaminant that needs to be given serious consideration in any combustion facility health risk assessment. Exposure to NO_2 in our everyday environment has been demonstrated to elicit adverse health impacts, the most significant of which is the potential to exacerbate asthmatic episodes in adults and children. The Public Health Risk Assessment concludes that although the Waste-to-Energy Facility is a source of ground level NO_2, it does not pose an undue public health risk based on the following lines of evidence:

- Over the past 40 years the Facility emissions of NO_2 have seen a dramatic decrease in their Discharge Limits and operational discharge of NO_2. The most significant decrease in release were seen in 2014 after the introduction of new air pollution control technology into the system.
- The Waste-to-Energy Facility accounts for only 0.5% of the total emissions of NO_2 in the Lower Fraser Valley airshed in 2025.
- The measured ambient air concentrations at the fence line of the Facility (S150) and the closest ambient air monitoring station Burnaby South (T018) in 2022 were higher that the predicted contribution from the Waste-to-Energy Facility modeled NO_2 concentrations at these stations. Given that this is an active facility then the existing ambient air monitoring stations results are inclusive of the contribution of the Waste-to-Energy Facility emissions. The ambient air concentrations of NO_2 at these monitoring stations either meet or marginally exceed the Metro Vancouver Ambient Air Quality Objectives.
- The modeled percentile concentrations of NO_2 from the Waste-to-Energy Facilty under the Proposed OC Permitted Discharge Limit, and more importantly for the Current Operations scenario are below the Ambient Air Quality Objective at all times (100^{th} percentile).

8.2.7 Nitrous Oxide Cannister

The Operational Certificate includes a 30-minute response limit for Carbon Monoxide (CO) intended to prompt operator action when combustion conditions deteriorate. However, in recent years the Waste-to-Energy Facility has experienced numerous short-duration CO spike events, including suspected N_2O cylinder explosions, that are operationally different from sustained combustion upsets. These events typically last less than five minutes and return to baseline conditions without operator intervention. They may also be accompanied by a temporary reduction in flue gas flow in the affected unit. Further details are found in the Metro Vancouver Proposed Operational Certificate Discharge Limits: Metro Vancouver Waste-to-Energy Facility (HDR, 2026)

Because the current compliance metric is based on a rolling 30-minute average, short-duration CO spikes can disproportionately influence reported exceedances despite representing only a small fraction of the time period. Analysis indicates that the contribution of these short-duration events to reported 30-minute CO exceedances is increasing.

RWDI conducted an additional air quality modeling (Appendix C) based on the following assumptions:

- Peak CO emission rates during these events can reach up to a maximum of 2,990 g/min (49.8 g/s).
- Elevated CO emissions generally persist for only 1 to 5 minutes.
- Stack temperature remains constant throughout the events.
- Process data suggest that flue gas flow may decrease during and/or following certain events. Decrease in flow was conservatively estimated to be up to 30%.
- Only one boiler at a time can go through a spike event.
- Two stacks were assumed to be operating at Current OC conditions (see Tables 2-2 and 2-4 of the RWDI 2026 Facility Study) and one stack was assumed to be operating continuously at spike conditions. This is a very conservative assumption as the spike conditions only last a few minutes at a time.

Air modelling of the maximum release of CO 2,990 g/min during the exceedances determined under even the worst-case release that the ground level concentration of CO during these events at the maximum point of impingement was six times lower than the ambient air quality objective and does not present a public health risk (Table 23). The modelled maximum CO discharge concentration was modeled with the assumption that it was released at this concentration for the full 1-hour period. Consequently, the modelled CO ground level concentration was higher than could be expected under any short duration exceedance.

Table 23. Predicted Modelled Concentration at the MPOI for Carbon Monoxide Spike Scenario

Air Contaminant	Averaging Period	Background (µg/m3)	Predicted Concentration (µg/m3)		Ambient Objective (µg/m3)	Jurisdiction of Objectives
			Without Background	With Background		
Carbon Monoxide (CO)	1-hour	470	1,923	2,392	14,900	Metro Vancouver

9 Uncertainty Analysis

All Public Health Risk Assessments are conducted with the intention of ensuring that a conservative, yet realistic, assessment of the potential risk that a facility emissions poses to public health is achieved. At each step of the process there is inherent uncertainty in the input parameters that may affect the results. The following are areas of uncertainty that were identified in the process and measures taken to ensure that the risk assessment followed regulatory authority best practices.

Guidance Documents Used in Preparation of the Risk Assessment

The Public Health Risk Assessment followed the risk assessment paradigm and best practices as provided in the:

- British Columbia Ministry of Health *British Columbia Guidance for Prospective Human Health Risk Assessment* (2022)
- Health Canada's *Guidance for Evaluating Human Health Effects in Impact Assessment: Human Health Risk Assessment* (2023).

By applying the direction from these documents the risk assessment was conducted in accordance to accepted regulatory practice for conducting risk assessment in British Columbia

Literature Review

It is not standard practice to conduct a literature review for potential health impacts from industrial facility emissions risk assessment. This process allowed the authors to build off of their 20 years of experience in conducting waste-to-energy risk assessments. It confirmed that the contaminants being evaluated in this assessment were consistent with those being investigated by other researchers at similar facilities around the world. The literature review confirmed that this Public Health Risk Assessment includes a larger list of contaminants than typically considered in other global assessments. Perhaps the most significant limitation is that the research articles rarely provide details of the emission rates of contaminants that could be directly compared to that of the Metro Vancouver facility.

Project Scenarios

The assessment considered both the maximum Discharge Limits of contaminants under the existing Operational Certificate and those Discharge Limits being proposed by Metro Vancouver for the new Operational Certificate. These are conservative scenarios to evaluate as for the vast majority of the contaminants the Waste-to-Energy Facility emissions are far less than the permitted limits, with the exception of NO_2.

However, the Start-Up and Shut-Down emissions scenarios were based on the single available stack tests that were completed in 2018. This is an area of uncertainty that should be further evaluated with additional start-up and shut-down stack testing. The 2018 testing identified that emissions during start-up and shut-down were similar or lower than Current Operations levels. In the event that further testing determines that emissions of one or more contaminants are greater than the Current Operational levels then their potential risk at the MPOI should be evaluated.

Receptor Locations

A comprehensive review of the local area and land uses was conducted. The air modeling report has the ability to retrieve the concentrations of all contaminants, for each of the time periods, at 260 discrete special receptor locations. However, all risk characterization was conducted as if an individual at all life stages lived

at the MPOI 24-hours a day, throughout their entire lifetime. This is a conservative analysis given that the concentration of contaminants would be lower beyond the MPOI.

Hazard Assessment

An attempt was made to source toxicologically or health-based reference concentrations or air quality criteria, where available. These values have undergone documented significant toxicological review by the originating regulatory authority and inherently have uncertainty (safety) factors built in. However, some of the air quality regulatory benchmarks do not publish the basis for health protection. In addition, many of the criteria air contaminants (e.g., $PM_{2.5}$ and NO_2) are recognized non-threshold contaminants and their objectives are based on attainment levels and not absolute protection of health. Overall, the Hazard Assessment followed the protocols under the BC MENV risk assessment guidance (2022).

Risk Characterization

The risk characterization involved the assessment of an individual living at the MPOI. It assumed for carcinogenic contaminants that they were exposed to the contaminant MPOI over an 80 year lifespan without any time apportionment. Similarly, the non-carcinogenic contaminants and non-carcinogenic non-threshold contaminants were similarly assessed. Overall, this provides a conservative risk estimation for all of the surrounding special receptors.

Overall Uncertainty Assessment

The Public Health Risk Assessment was conducted in accordance to regulatory guidance, risk assessment best practices and provides a reasonable degree of certainty in its finding and conclusions.

10 Recommendations for Potential Future Monitoring and Assessment

Section 6 of the Metro Vancouver Proposed Operational Certificate Discharge Limits: Metro Vancouver Waste-to-Energy Facility (HDR, 2026) report provides the additional monitoring that is being committed to, in part based on the results of the Public Health Risk Assessment.

Based on the findings of the Public Health Risk Assessment, the following recommendations are made for future monitoring and assessment:

5. Conduct annual start-up and shutdown stack test monitoring of all contaminants to establish a trend in the emissions in comparison to the routine operations emissions from the Facility. The specifics of this monitoring are expanded on in the Operational Certificate overarching report.
6. Adopted the Proposed Operational Certificate new emissions discharge limits.
7. Re-establish the S150 Air Monitoring Station at the fence line of the Facility. The MPOI for Criteria Air Contaminants are located near the fenceline for the 1-hr and 24-hr values and would provide the best indicator for the potential influence the Facility is having on the airshed. Contaminants should include NO_2, SO_2, HCl, and $PM_{2.5.}$ This data should be included as part of the annual environmental monitoring reporting for the Facility. There would be no need to install additional air monitoring stations in the area.
8. Conduct an updated air quality dispersion modelling and provide the results, such that a Public Health Risk Assessment is conducted every five years using the latest CEMS and stack test data. This would confirm the effectiveness of the lowering of the SO_2 and HCl. It would also assist in the tracking of the other contaminants. It should include any changes in ambient air quality objectives and include the data from the S150 monitoring station. The Waste-to-Energy Facility should be required to implement any recommendations of the updated Public Health Risk Assessment.

Based on the findings of the deposition of contaminants to soil over 20 years there would be no need to conduct soil or vegetation sampling in the area surrounding the Waste-to-Energy Facility.

11 Conclusions

The Public Health Risk Assessment, and the associated Air Dispersion Modeling Study were conducted to satisfy reporting requirement in the Operational Certificate (OC) for the Metro Vancouver Waste-to-Energy Facility. As expected, the highest ground level concentrations of contaminants were predicted for the Current OC Permitted Scenario. This is the maximum concentration of contaminants that can be emitted from the Waste-to-Energy Facility. There was a considerable decrease of maximum ground level contaminant concentrations for the Current Operational Scenario, or the actual emissions that come from the facility. This is because the Waste-to-Energy Facility routinely emits considerably less of each contaminant than limited by the permit. An evaluation of the Proposed OC Permitted Discharge Limits was also conducted.

The following conclusions were reached:

- For the majority of the Criteria Air Contaminants that the Facility does not pose an undue risk to anyone at the MPOI for $PM_{2.5}$, carbon monoxide (CO), hydrogen chloride (HCl), hydrogen fluoride (HF) even at the existing Permitted OC discharge limits. The Operational Project Alone levels confirm that these contaminants do not pose an undue risk to public health.
- For sulphur dioxide (SO_2) the Current OC Permitted levels are marginally above the concentration ratio benchmark of 1.0. However, the Current Operational discharges are below the acceptable benchmark. The lowering of the Proposed OC Permitted levels also result in an acceptable Concentration Ratio of <1.0. Therefore, the OC discharge limits should be lowered to those proposed and do not result in an unacceptable risk to human health.
- The secondary particulate matter levels were an order of magnitude lower than the predicted primary $PM_{2.5}$ modeled levels at the MPOI and had no effect on the resulting $PM_{2.5}$ Concentration Ratios. Therefore, secondary particulate matter from the release of SO_2 emissions from the Waste-to-Energy Facility do not pose an undue risk to human health.
- Overall, all of the additional contaminants considered do not pose an unacceptable risk to human health, whether under the Current OC Permitted levels, the Proposed OC Permitted levels or certainly the Current Operational levels at the MPOI when considering the existing background concentrations in air. Their Concentration Ratios were all below 1.0. The exception to this was the PAHs that were modelled in the Current OC Permitted that had a Concentration Ratio above 1.0. However, the Concentration Ratio for the Current Operations Facility Alone level and in combination with the Background levels were below the benchmark of 1.0. In addition, the lowering of the emissions under the Proposed OC Permitted limits would ensure that the Concentration Ratio for PAHs would be acceptable and should be adopted by the Waste-to-Energy Facility. Therefore, PAHs especially with the Proposed OC Permitted limits do not pose an undue risk to human health.
- Nitrogen dioxide (NO_2) levels require further evaluation under the Tier 2 Risk Assessment.

Nitrogen Dioxide Tier 2 Risk Assessment Conclusions

The Public Health Risk Assessment concludes that although the Waste-to-Energy Facility is a source of ground level NO_2, it does not pose an undue public health risk based on the following lines of evidence:

- Over the past 40 years the Facility emissions of NO_2 have seen a dramatic decrease in their Discharge Limits and operational discharge of NO_2. The most significant decrease in release were seen in 2014 after the introduction of new air pollution control technology into the system.
- The Waste-to-Energy Facility accounts for only 0.5% of the total emissions of NO_2 in the Lower Fraser Valley airshed in 2025.
- The measured ambient air concentrations at the fence line of the Facility (S150) and the closest ambient air monitoring station Burnaby South (T018) in 2022 were higher that the predicted contribution from the Waste-to-Energy Facility modeled NO_2 concentrations at these stations. Given that this is an active facility then the existing ambient air monitoring stations results are inclusive of the contribution of the Waste-to-Energy Facility emissions. The ambient air concentrations of NO_2 at these monitoring stations either meet or marginally exceed the Metro Vancouver Ambient Air Quality Objectives.
- The modeled percentile concentrations of NO_2 from the Waste-to-Energy Facility under the Proposed OC Permitted Discharge Limit, and more importantly for the Current Operations scenario are below the Ambient Air Quality Objective at all times (100^{th} percentile).
- Overall, the emitted NO_2 Waste-to-Energy Facility emission do not pose an undue risk to human health.

Based on the results of the ambient air quality monitoring and PHRA, current emissions of contaminants from the Waste-to-Energy Facility do not pose a public health risk. The findings of this PHRA are consistent with the findings of a 2018 report and the past three decades of peer-reviewed scientific literature and government reports on facilities around the world.

The PHRA recommends that that the draft proposed discharge limits presented in this report be included in the Waste-to-Energy Facility Operational Certificate. In addition, annual startup and shutdown stack testing should be conducted, the ambient air monitoring station adjacent to the Waste-to-Energy Facility should be re-established, and every five years air quality modelling and a PHRA should be conducted.

Appendix A

List of Special Receptors

ID	Type	Name	Latitude (°)	Longitude (°)	UTM X (m)	UTM Y (m)
1	Business	Tippet-Richardson	49.188	-122.979	501524	5448340
2	Business	BC Roofing Products	49.186	-122.972	502054	5448185
3	Business	Strip Mall	49.177	-122.968	502330	5447117
4	Business	Vanguard Steel	49.188	-122.986	500984	5448308
5	Residence	River Rd	49.179	-122.981	501350	5447397
6	Residence	Queensborough	49.181	-122.968	502324	5447531
7	Residence	New Westminster	49.197	-122.968	502307	5449367
8	School	Hamilton Elementary	49.176	-122.966	502478	5446999
9	School	Glenwood Elementary	49.206	-122.979	501546	5450385
10	School	Taylor Park Elementary	49.207	-122.960	502941	5450498
11	School	Queen Elizabeth Elementary	49.185	-122.944	504102	5448005
12	School	Burnaby South	49.215	-122.986	501043	5451379
13	School	Connaught Heights Elementary	49.203	-122.955	503253	5449996
14	Child Care	Cranberry Children's Centre	49.182	-122.962	502747	5447707
15	Child Care	Betheny Child Care Centre	49.173	-122.970	502218	5446722
17	Child Care	Burnaby Children's Centres Society	49.201	-122.953	503440	5449768
18	Senior Facility	Seniors Services Society	49.221	-122.976	501755	5452005
19	Senior Facility	Seniors Services Society	49.203	-122.912	506436	5449993
20	Senior Facility	Kennedy Senior Recreation Center	49.162	-122.897	507537	5445515
21	Hospital	RYT Medical Centre	49.155	-122.911	506496	5444703
22	Hospital	Royal Columbian	49.224	-122.893	507815	5452401
23	Hospital	Surrey Memorial Hospital	49.176	-122.841	511561	5447028
24	Hospital	Burnaby Hospital	49.249	-123.016	498850	5455137
25	Hospital	BC Womens and Childrens Hospital	49.244	-123.126	490865	5454626
26	Other	Burnaby Youth Custody Centre	49.186	-122.986	501006	5448104
27	Other	RichBerry Cranberry Farm	49.180	-122.987	500952	5447507
28	Other	Farm	49.191	-122.981	501382	5448715
29	Other	Riverway Golf Course	49.200	-122.991	500632	5449696
30	School	Queensborough Middle School	49.186	-122.941	504303	5448166
31	Business	Garibaldi Glass	49.189	-122.977	501691	5448436
32	Residence	Queensborough Neighbourhood	49.181	-122.952	503523	5447617
33	Senior Facility	Hamilton Village Senior Care Centre	49.178	-122.967	502418	5447285
34	Business	Amazon Distribution Centre	49.197	-122.999	500048	5449356
35	Business	Costco Business Centre	49.188	-122.952	503473	5448408
36	Other	Tree Island	49.184	-122.965	502550	5447916
37	Residence	Hamilton Village	49.176	-122.976	501728	5446973
38	Child Care	Aline Before and After School Daycare	49.208	-122.991	500683	5450557
39	Other	Roadside Dust/Soil Sampling	49.187	-122.977	501665	5448275
40	Other	Roadside Dust/Soil Sampling	49.184	-122.976	501738	5447964
41	Park	Terimus Park	49.185	-122.982	501276	5448000
42	Other	Intersection of Meadow and Trapp	49.193	-122.963	502688	5448871
43	Residence	New Westminster Residence	49.204	-122.932	504963	5450149
44	Child Care	St. Barnabas Daycare Society	49.208	-122.925	505477	5450558
45	Child Care	St. Matthews Day Care Society	49.223	-122.941	504308	5452291
46	Child Care	Playwest Kids Out-Of-School Care	49.205	-122.942	504204	5450298
47	Child Care	Klub Kelvin Out-Of-School Care	49.211	-122.930	505106	5450899
48	Child Care	St. Alban's The Martyr Day Care	49.224	-122.940	504382	5452330
49	Child Care	Burnaby French Language Preschool	49.230	-122.991	500621	5453000
50	Child Care	Hillview Parent Participation Preschool	49.210	-123.008	499407	5450797
51	Child Care	Absorbent Minds Montessori Ltd.	49.218	-122.995	500401	5451647
52	Child Care	Bethany Child Care Centre	49.173	-122.970	502223	5446703
53	Child Care	Bee House Montessori Day Care I	49.218	-122.995	500401	5451647
54	Child Care	Happy Learning Child Care Centre	49.201	-122.953	503430	5449791
55	Child Care	Maywood Neighbourhood Care	49.223	-123.000	500017	5452234
56	Child Care	Stride Avenue Neighbourhood Care	49.211	-122.954	503335	5450903
57	Child Care	Hamilton Out Of School Care	49.177	-122.966	502500	5447097
58	Child Care	Quality Family Day Care	49.207	-122.934	504838	5450508
59	Child Care	Dedic Family Day Care	49.212	-122.932	504985	5451053
60	Child Care	Little Hearts Family Child Care	49.230	-122.987	500964	5453056

61	Child Care	Kool Catz Family Child Care	49.230	-122.987	500964	5453056
62	Child Care	Qe Clubhouse & Kids Borough	49.186	-122.941	504324	5448156
63	Child Care	Pomegranate Childcare	49.218	-123.000	500001	5451648
64	Child Care	Academics Prekindergarten Royal City	49.212	-122.921	505743	5451069
65	Child Care	Happy Bird Daycare	49.221	-122.943	504156	5452061
66	Child Care	Little Hat Daycare	49.223	-122.971	502099	5452288
67	Child Care	Riverside Childcare	49.185	-122.950	503672	5447967
68	Child Care	Ask Or Imagine Christian Children's Center	49.226	-122.964	502625	5452630
69	Child Care	Abc Academy - Children's Learning Center Ltd	49.209	-122.920	505805	5450647
70	Child Care	Fantastic Kidz Childcare	49.218	-123.003	499747	5451701
71	Child Care	1St Step Montessori Inc - Sunbury Hall	49.156	-122.934	504779	5444781
72	Child Care	Springtree Montessori School	49.223	-122.968	502314	5452253
73	Child Care	Debbie's Daycare On Main	49.157	-122.938	504538	5444957
74	Child Care	Golden Sunshine Daycare Centre	49.207	-122.935	504737	5450517
75	Child Care	Little Blossom Daycare	49.218	-122.994	500401	5451647
76	Child Care	Inspirations Montessori School	49.211	-122.999	500103	5450948
77	Child Care	Early Learning Childcare Centre	49.224	-122.968	502314	5452353
78	Child Care	Forest City Children's Centre	49.222	-122.979	501544	5452189
79	Child Care	Growing Hands Childcare Centre	49.210	-122.934	504842	5450857
80	Child Care	Little Blossom Daycare - I/T Program	49.219	-122.994	500462	5451780
81	Child Care	Sakura Childcare The Third	49.222	-122.972	502068	5452167
82	Child Care	Gummy Bears Child Care	49.229	-122.972	502020	5452872
83	Child Care	Abc Academy-Children's Learning Center Ltd-Uptown New West	49.212	-122.924	505518	5451011
84	Child Care	Foccus Kids Family Child Care	49.214	-122.965	502559	5451231
85	Child Care	Metrotown Daycare	49.218	-123.003	499811	5451677
86	Child Care	Precious Early Years Childcare	49.210	-122.935	504736	5450757
87	Child Care	Eminent Stars Daycare Ltd	49.215	-123.015	498875	5451308
88	Child Care	Angels Playhouse Infant And Toddler Childcare Centre(Rumble)	49.215	-122.983	501210	5451309
89	Child Care	Pink Bunny Daycare Ltd	49.193	-122.937	504563	5448907
90	Child Care	We Care Childcare - Children's Learning Centre	49.208	-122.931	505044	5450546
91	Child Care	Boo Boo Daycare	49.228	-122.983	501246	5452764
92	Child Care	Heartland Montessori Child Care	49.182	-122.954	503370	5447738
93	Child Care	Angel Wings Daycare Center	49.221	-122.947	503868	5451984
94	Child Care	Tiny Hoppers Early Learning Queensborough	49.193	-122.948	503822	5448876
95	Child Care	Happy Family Child Care	49.203	-122.948	503792	5450070
96	Child Care	Gummy Bears Child Care	49.223	-122.968	502314	5452224
97	Child Care	Abc Childcare	49.223	-122.960	502897	5452217
98	Child Care	Wonderworld Montessori Academy-Metrotown	49.225	-123.006	499569	5452497
99	Child Care	Momentos De Ninos Childcare Ltd	49.211	-122.978	501607	5450959
100	Child Care	Marlbrough Neighbourhood Care	49.228	-122.990	500750	5452797
101	Child Care	Little Wonderland Childcare	49.219	-122.933	504904	5451824
102	Child Care	Polka Dot Fine Art & Education	49.198	-122.976	501728	5449471
103	Child Care	A + Child Care Centre	49.221	-122.963	502705	5452064
104	Child Care	Marlborough Early Years Care	49.229	-122.990	500741	5452946
105	Child Care	Burnaby Montessori School Ltd	49.224	-122.984	501138	5452313
106	Child Care	South Slope Day Care	49.214	-122.999	500064	5451264
107	Child Care	Angels Playhouse Daycare Society (Sperling Ave)	49.221	-122.964	502595	5452077
108	Child Care	Bright Beginnings Fine Arts Preschool Ltd	49.215	-122.987	500926	5451337
109	Child Care	Kiddie Club Infant Toddler Childcare	49.228	-122.961	502825	5452857
110	Child Care	Wild Dream Educare	49.176	-122.974	501918	5447074
111	Child Care	Ic Early Learning Center	49.227	-122.989	500837	5452660
112	Child Care	Just B4 Queensborough	49.186	-122.941	504324	5448155
113	Child Care	Nubo Kids Center	49.217	-122.963	502659	5451536
114	Child Care	Happy Smile Childcare Centre	49.221	-122.941	504311	5452063
115	Child Care	Tree House Infant And Toddler Daycare	49.221	-123.005	499603	5452026
116	Child Care	Open Mind Childcare	49.218	-122.950	503673	5451644
117	Child Care	Wonderful Childcare Centre	49.210	-122.977	501670	5450850
118	Child Care	A & B Childcare Centre	49.224	-122.970	502155	5452337
119	Child Care	Little Neighbourhood Childcare	49.219	-122.940	504343	5451768
120	Child Care	E2 Childcare	49.215	-122.999	500101	5451410

121	Child Care	Burnaby Lakeview Daycare	49.220	-122.964	502593	5451914
122	Child Care	Stride Early Years Care	49.212	-122.952	503465	5450971
123	Child Care	Kiddie Castle Daycare	49.206	-122.934	504833	5450327
124	Child Care	Inspirations Montessori School - Irmin	49.215	-122.988	500883	5451399
125	Child Care	Sakura Childcare The Annex	49.220	-123.018	498665	5451956
126	Child Care	Opus Daycare - Nelson	49.208	-122.997	500250	5450616
127	Child Care	Queensborough ymca Kids Club	49.187	-122.945	504040	5448258
128	Child Care	Ic Early Learning Center (Nelson)	49.230	-122.995	500391	5453033
129	Child Care	Tweedsmuir After School Studio	49.205	-122.942	504204	5450297
130	Child Care	Gym Bears Child Care	49.226	-122.985	501074	5452563
131	Child Care	Baby Smile Childcare	49.216	-122.946	503960	5451501
132	Child Care	Little Seedlings Daycare Centre	49.214	-122.941	504289	5451225
133	Child Care	Willowbrae Academy River District	49.207	-123.032	497665	5450427
135	Child Care	Angels Playhouse Daycare Society (Clinton St)	49.213	-122.987	500935	5451108
136	Child Care	Pearl Childcare	49.227	-122.987	500952	5452679
137	Child Care	Bw Childcare	49.212	-122.940	504400	5451056
138	Child Care	Ready Set Grow Children's Centre	49.205	-122.942	504204	5450297
139	Child Care	Apple Island Childcare	49.223	-122.947	503826	5452250
140	Child Care	Little Sparrows Academy Corporation	49.211	-122.973	501995	5450874
141	Child Care	Aurostar Montessori Children Centre (Delta)	49.170	-122.915	506231	5446401
142	Child Care	Hummingbird Learning House	49.211	-122.983	501211	5450883
143	Child Care	Little Charm Daycare	49.214	-122.999	500109	5451204
144	Child Care	Starlight Child Care Ltd.	49.202	-122.918	505975	5449929
145	Child Care	Creative Kids Family Child Care	49.185	-122.946	503949	5448005
146	Child Care	A1 Suncrest Daycare	49.213	-123.013	499023	5451087
147	Child Care	Baby Angel Early Learning Inc	49.216	-123.002	499867	5451414
148	Child Care	Blue Castle Kidz Academy	49.215	-122.930	505103	5451347
149	Child Care	Marin Learning Center	49.205	-122.990	500712	5450287
150	Child Care	Blessed Generations Academy - Canada Way, Burnaby	49.218	-122.933	504873	5451652
151	Child Care	Early Steps Highgate	49.219	-122.951	503566	5451820
152	Child Care	Pioneering Minds Childcare Ltd	49.205	-122.972	502039	5450256
153	Child Care	Little Oak Childcare Centre (Stride Burnaby)	49.214	-122.951	503542	5451224
154	Child Care	Little Melody	49.217	-123.022	498427	5451562
155	Child Care	Angels Playhouse Daycare Society (6Th Ave)	49.203	-122.939	504449	5450076
156	Child Care	Kids Academy Family Daycare	49.193	-122.939	504445	5448905
157	Child Care	Apple Island Childcare	49.221	-123.004	499741	5452077
158	Child Care	Joyful Harmony Child Care	49.228	-122.966	502487	5452760
159	Child Care	A & B Early Learning Centre	49.228	-122.971	502080	5452779
160	Child Care	Ludus Montessori Children's House	49.228	-122.955	503257	5452790
161	Child Care	Burnaby-South Childcare Centre	49.218	-122.972	502006	5451725
162	Child Care	Aloha Childcare Centre	49.214	-122.971	502093	5451197
163	Child Care	Hey Bears Child Care	49.211	-122.978	501574	5450859
164	Child Care	Edmonds Childcare Centre	49.222	-122.945	504004	5452095
165	Child Care	Hand In Hand Child Care	49.217	-122.990	500718	5451602
166	Child Care	Ciping Daycare	49.214	-122.971	502115	5451254
167	Child Care	Little Scholars Childcare Centre	49.228	-122.958	503044	5452777
168	Child Care	Little Innovators Daycare	49.211	-123.008	499403	5450881
169	Child Care	Angel Smile Child Care	49.221	-123.005	499603	5451976
170	Child Care	Neo Academy	49.215	-123.031	497741	5451372
172	Child Care	Premier Montessori Metrotown	49.229	-122.998	500119	5452901
173	Child Care	Gold Key Childcare Center	49.228	-122.983	501246	5452835
174	Child Care	Hula Bears Child Care	49.213	-123.001	499932	5451104
175	Child Care	Inspirations Montessori School Newwest	49.200	-122.912	506438	5449706
176	Child Care	Jeewoo Daycare	49.215	-122.944	504075	5451357
177	Child Care	Little Town Childcare Centre - 1	49.222	-123.006	499567	5452102
178	Child Care	Educare 2 Childcare Centre	49.230	-122.962	502747	5453052
179	Child Care	A & B Daycare	49.227	-122.956	503169	5452739
180	Child Care	Merseyside Early Learning Centre Inc.	49.193	-122.932	504919	5448863

181	Child Care	First Path Childcare	49.223	-122.981	501360	5452205
182	Child Care	Acg Early Learning Center #1	49.222	-122.994	500448	5452097
183	Child Care	Somewhere To "Grow" Montessori Childcare Centre	49.207	-122.935	504737	5450517
184	Child Care	Jellybean Park Junior Campus	49.227	-123.001	499926	5452672
185	Child Care	Douglas College Ece Center (New Westminster)	49.203	-122.914	506229	5450039
186	Child Care	South Slope Out Of School Care	49.216	-123.003	499752	5451487
187	Child Care	Dd's Playhouse	49.204	-122.932	504973	5450179
188	Child Care	House Of Angels	49.215	-123.002	499823	5451308
189	Child Care	Rainbows And Unicorns Preschool	49.177	-122.966	502500	5447097
190	Child Care	Bright Star Montessori School Inc	49.215	-123.000	500013	5451368
192	Child Care	Clinton Neighbourhood Care	49.213	-122.979	501520	5451082
193	Child Care	Champlain Heights Community Centre Preschool	49.214	-123.032	497665	5451296
195	Child Care	In-Joy Montessori Children's Centre	49.217	-122.964	502651	5451559
196	Child Care	Jellybean Park International Campus	49.226	-122.998	500136	5452526
197	Child Care	Learning Tree Montessori Day Care	49.173	-122.975	501828	5446699
198	Child Care	Kiddocare Infant/Toddler Centre	49.216	-122.934	504806	5451452
199	Child Care	Graham Montessori School	49.202	-122.918	505975	5449929
200	Child Care	Discovery Childcare Centre	49.216	-122.938	504492	5451444
201	Child Care	Amy's Family Day Care	49.229	-122.964	502597	5452881
202	Child Care	Suncrest Neighbourhood Care	49.215	-123.018	498689	5451397
203	Child Care	A & C Family Daycare	49.226	-122.986	500987	5452568
204	Child Care	Smart Baby Family Child Care	49.174	-122.977	501680	5446766
205	Child Care	Little Stars Daycare	49.229	-122.967	502376	5452931
206	Child Care	Angels Playhouse Infant & Toddler Child Care Centre	49.217	-122.984	501198	5451587
207	Child Care	Montessori Minds Childcare Centre Ltd #2	49.204	-122.930	505073	5450176
208	Child Care	Happy Feet Childcare Centre	49.213	-122.968	502313	5451097
209	Child Care	Bear Paws Child Care	49.221	-122.972	502070	5452069
210	Child Care	Fraser Montessori Daycare	49.204	-122.932	504933	5450144
211	Child Care	Bright Eyes Academy Inc @ Brooke	49.163	-122.925	505461	5445574
213	Child Care	Dragon's Grove	49.203	-122.956	503231	5449983
214	Child Care	Caring Daycare	49.218	-122.939	504451	5451727
215	Child Care	Fraser Montessori Daycare	49.203	-122.967	502428	5449972
216	Child Care	St. Francis De Sales Parish Before & After School Care	49.220	-122.967	502410	5451912
217	Child Care	St. Francis De Sales Preschool	49.220	-122.966	502489	5451869
218	Child Care	Twelfth Avenue Neighbourhood Care	49.217	-122.934	504790	5451576
219	Child Care	123 A Child's World	49.213	-122.935	504717	5451104
220	Child Care	Growing Minds Child Care Centre	49.220	-122.946	503967	5451952
221	Child Care	Little School House Daycare	49.207	-122.926	505421	5450489
222	Child Care	Fraser Montessori Daycare Inc	49.201	-122.944	504087	5449783
223	Child Care	Seeds And Roots Montessori	49.207	-122.943	504159	5450466
224	Child Care	Kiddie Club Childcare Center	49.227	-122.965	502522	5452669
225	Child Care	Pamela's Little Promises	49.211	-122.977	501680	5450958
226	Child Care	Ewen Childcare Centre	49.191	-122.936	504634	5448679
227	Child Care	Neville Childcare	49.214	-122.979	501509	5451262
228	Child Care	Cartwheels & Crayons Childcare	49.204	-122.936	504634	5450152
229	Child Care	Bear's House Child Care	49.215	-122.999	500062	5451367
230	Child Care	C.J.'S School Age Fun Daycare	49.226	-122.954	503342	5452574
231	Child Care	Kathy's Licensed Child Care Centre	49.226	-122.952	503496	5452554
232	Child Care	Supernova Montessori Childcare	49.221	-122.939	504413	5452004
233	Child Care	Kiddie Club Childcare Center	49.227	-122.961	502856	5452744
234	Child Care	Windsor ymca Kids Club	49.222	-122.974	501909	5452089
235	Child Care	Precious Early Years Childcare Inc.	49.203	-122.950	503662	5450078
236	Child Care	Precious Early Years Childcare Centre	49.204	-122.950	503667	5450110
237	Child Care	Precious School Years Childcare	49.210	-122.934	504803	5450787
238	Child Care	Buckingham Tots Child Care Center	49.229	-122.957	503096	5452959
239	Child Care	Dandelion Daycare Centre	49.215	-122.978	501600	5451303
240	Child Care	Precious Early Years Childcare	49.210	-122.934	504830	5450747

241	Health Care	Hamilton Village Health Centre	49.177	-122.968	502354	5447163
242	Health Care	North Delta Public Health Unit	49.156	-122.911	506474	5444841
243	Health Care	Integrated Wellness Medical Clinic	49.224	-122.999	500089	5452332
244	Health Care	Mango Medical Clinic	49.226	-123.006	499582	5452567
245	Health Care	Pacific Heights Health Centre	49.204	-122.909	506630	5450104
246	Health Care	Care Point Medical Clinic - New Westminster	49.213	-122.919	505900	5451086
247	Health Care	Edmonds Health Centre	49.222	-122.946	503946	5452106
248	Health Care	Kingsway Medical Clinic	49.220	-122.948	503780	5451923
249	Health Care	Sea Cliff Medical	49.219	-122.951	503595	5451765
250	Health Care	New Canadian Clinic	49.219	-122.952	503527	5451784
251	Health Care	Highgate Medical Clinic	49.218	-122.955	503258	5451709
252	Health Care	Total Life Care Medical	49.219	-122.956	503234	5451771
253	Health Care	Middlegate Medical Centre	49.218	-122.959	503001	5451716
254	Senior Facility	Hamilton High Street Residence	49.178	-122.967	502386	5447234
255	Senior Facility	Fair Haven Homes Burnaby Lodge	49.217	-123.006	499594	5451555
256	Senior Facility	Willingdon Care Centre	49.232	-123.005	499654	5453286
257	Senior Facility	The Poppy Residences	49.224	-122.988	500888	5452336
258	Senior Facility	Concordia Court	49.219	-122.984	501179	5451761
259	Senior Facility	Robert Nimi Nikkei Home	49.217	-122.965	502547	5451627
260	Senior Facility	Mulberry PARC	49.218	-122.955	503255	5451675
261	Senior Facility	AgeCare Harmony Court	49.225	-122.943	504185	5452430
262	Senior Facility	Thornebridge Gardens Retirement Residence	49.216	-122.926	505419	5451445
263	Senior Facility	AgeCare Royal City	49.215	-122.895	507629	5451408
264	Senior Facility	Columbus Lodge Delta	49.164	-122.894	507708	5445711
265	Health Care	Metrotown Urgent and Primary Care Centre	49.230	-123.003	499800	5453023
266	Other	Queensborough Community Centre	49.186	-122.944	504114	5448118

Appendix B

Deposition Calculations

The following sections present the equations used to calculate the concentrations used in the Public Health Risk Assessment. Generally, the equations and the terms explained. Unless otherwise stated, the equations presented are found in US EPA (2005). In cases where values used were based on site specific quantities, rationale for use of these values is provided below. Where known standards or default values (as presented in US EPA, 2005) were adopted, these values are given in brackets.

Soil Concentration

Contaminant concentrations in soil are calculated by summing the various wet and dry as well as vapour and particle phase deposition of contaminants to the soil. The US EPA (2005) guideline includes three different deposition equations, one for standard (non-carcinogenic) contaminants, and two for carcinogenic contaminants. The equation used for each contaminant depends on the type of contaminant and duration of exposure. For this study, the long-term exposure results in the requirement for only one of the carcinogenic equations to be used in the model. The non-carcinogenic equation is a variation of the first carcinogenic equation, calculating the highest 1-year annual average soil concentration; which typically occurs at the end of the operating life of the emission source (US EPA, 2005).

Carcinogen – soil concentration averaged over exposure duration

$$C_s = \frac{\left(\frac{D_S \times tD - C_{stD}}{ks}\right) + \left(\frac{C_{stD}}{ks}\right) \times (1 - \exp[-ks \times (T_2 - tD)])}{(T_2 - T_1)} + C_{sBackground}$$

For T1<tD<T2 – (exposure duration greater than operating lifetime of the emission source):

$$C_s = \frac{D_s \times [1 - \exp(-ks \times tD)]}{ks}$$

Non-Carcinogens – maximum annual average soil concentration

Where:			Units
Cs	=	average contaminant soil concentration over exposure duration	mg/kg soil
Ds	=	deposition term; discussed below	mg contaminant/kg soil/yr
T_1	=	time period at the beginning of combustion	0 years
ks	=	contaminant soil loss constant due to all processes; discussed below	yr^{-1}
tD	=	time period over which deposition occurs	10 yr
C_{stD}	=	soil concentration at time tD (equivalent to C_s for non-carcinogens)	mg/kg
T_2	=	length of exposure duration (applicable for carcinogens only)	80 yr

The deposition term (Ds) is calculated as follows:

$$D_s = \left[\frac{100 \times Hg_{factor} \times Q}{Z_s \times BD}\right] \times D_{loading}$$

Where: Units

Ds	=	deposition term	mg CoPC/kg soil/yr
100	=	units conversion factor	mg-m^2/kg-cm^2
$Hg_{factorDS}$	=	mercury factor for deposition; discussed below	unitless
Q	=	CoPC emission rate; discussed previously	g/s
Zs	=	soil mixing zone depth	cm
BD	=	soil bulk density (1.5 g/cm^3)	g soil/cm^3 soil
$D_{loading}$	=	loading of deposition based on modelling output, CoPC-specific	(g/m^2/yr)

The $Hg_{factorDS}$ for deposition is 1.0 for all CoPCs, with the following exceptions:
0.0 for Hg^0 (i.e., 0.482 * 0.0)
0.47236 for Hg^{2+} (i.e., 0.482 * 0.98)
0.00964 for MHg (i.e., 0.482 * 0.02)

A soil mixing zone depth (Zs) of 10 cm has been selected for this assessment, based on contaminant distribution in soils and root uptake zones. The deposition loading terms $D_{loading}$ are determined by air modelling of the site of a reference particulate and vapour and are applied to the other CoPC's based on contaminant classification as determined during the air modelling. US EPA (2005) outlines several mechanisms which result in the removal of contaminants from the soil. These methods may or may not occur simultaneously and have varying amounts of significance depending on the type of contaminant. The total rate at which a contaminant is lost from the soil is referred to as the soil loss constant (ks). I

$$ks = ks_g + ks_e + ks_r + ks_l + ks_v$$

Where:			Units
ks	=	CoPC soil loss constant due to all processes	yr^{-1}
ksg	=	CoPC loss constant due to biotic and abiotic degradation; discussed below	yr^{-1}
kse	=	CoPC loss constant due to soil erosion (=0)	yr^{-1}
ksr	=	CoPC loss constant due to surface runoff; discussed below	yr^{-1}
ksl	=	CoPC loss constant due to leaching; discussed below	yr^{-1}
ksv	=	CoPC loss constant due to volatilization (=0)	yr^{-1}

The CoPC loss constant (ks_g) represents the rate of contaminant degradation in the soils based on biotic and abiotic degradation. This represents the loss of a given contaminant by processes which do not include leaching. Abiotic degradation can include photolysis, hydrolysis, and redox reactions as well as metabolic pathways under biologic conditions. Lyman et al. (1982) states that degradation rates can be assumed to follow first order kinetics in a homogeneous media.

The loss constant due to surface runoff can be estimated using the following equation, US EPA (2005):

$$ks_r = \frac{RO}{\theta_{sw} \times Z_s} \times \left(\frac{1}{1 + \left(Kd_s \times {BD}/{\theta_{sw}} \right)} \right)$$

Where: Units

Where:			Units
ks_r	=	CoPC loss constant due to surface runoff; discussed below	yr^{-1}
RO	=	average annual surface runoff from pervious areas; discussed below	cm/yr
θ_{sw}	=	soil volumetric water content (0.2)	mL/cm
Z_s	=	soil mixing zone depth (discussed previously) (10cm)	cm
Kd_s	=	soil/water partition coefficient; CoPC-specific	mL water/g soil

BD	=	soil bulk density (1.5 g/cm3)	g soil/cm^3 soil

The average annual surface runoff from pervious areas (RO) was 150 cm/yr, based on precipitation and evapotranspiration rates and a 2013 Agricultural Canada Report. Losses of soil CoPCs due to leaching (ksl) depend on the amount of water available to generate leachate and soil properties. The recommended equation for calculating ksl (US EPA, 2005) is as follows:

$$ks_l = \frac{P + I - RO - E_V}{\theta_{sw} \times Z_s \times \left[1 + \left(BD \times {Kd_s}/{\theta_{sw}}\right)\right]}$$

Where:			Units
ks_l	=	CoPC loss constant due to leaching	yr^{-1}
P	=	average annual precipitation	cm/yr
I	=	average annual irrigation	cm/yr
RO	=	average annual surface runoff from pervious areas	cm/yr
E_v	=	average annual evapotranspiration	cm/yr
θ_{sw}	=	soil volumetric water content (0.2 mL/cm^3)	mL/cm^3
Z_s	=	soil mixing zone depth; discussed previously	Cm
BD	=	soil bulk density (1.5 g/cm^3)	g soil/cm^3 soil
Kd_s	=	soil/water partition; CoPC-specific	cm^3 water/g soil

The following climatological data was used in the assessment:

Variable	Site Value (cm)	Reference
P	195.2	City of Burnaby Average Monthly Precipitation Data, Environment Canada
I	0	No irrigation
RO	150	Agriculture and Agri-Food Canada, "Annual Unit Runoff in Canada, January 2013
E_v	34.0	Annual evapotranspiration, NASA's Moderate Resolution Imaging Spectroradiometer (MODIS), University of Montana Numerical Terradynamic Simulation Group

Contaminant of Potential Concern	ks_g (yr^{-1})	k_{Ds} mL water/g soil	k_{ow}	$C_{S\ background}$ (µg/g)	
Total Dioxins and Furans (as PCDD/F TEQ)					
2,3,7,8-TCDD Equivalent	3.00E-02	3.89E+04	6.31E+06	7.00E-06	Ontario MECP Rationale for the Development of Soil and Ground Water Standards for Use at Contaminated Sites In Ontario 2011
Metals					
Cadmium (Cd)	0	75	1.00E+01	0.8	Metro Vancouver 1992 Soil and Vegetation Report
Mercury (Hg) (inorganic) - divalent MH2+	0	1.00E+03	6.10E-01	0.33	Metro Vancouver 1992 Soil and Vegetation Report
Lead (Pb)	0	900	5.37E+00	80.74	Metro Vancouver 1992 Soil and Vegetation Report
Arsenic (As)	0	29	4.79E+00	5.7	Metro Vancouver 1992 Soil and Vegetation Report
Chromium (Cr)	0	19	1.70E+00		BC SALM data (average Burnaby north and Burnaby Lake, 0-10 cm)
Chlorophenols					
2,4,6-Trichlorophenol	3.61E+00	7.60E-01	5.01E+03	0.1	Ontario MECP Rationale for the Development of Soil and Ground Water Standards for Use at Contaminated Sites In Ontario 2011
Pentachlorophenol	1.42E+00	1.20E+00	1.26E+05	0.1	Ontario MECP Rationale for the Development of Soil and Ground Water Standards for Use at Contaminated Sites In Ontario 2011
Chlorobenzenes					
Pentachlorobenzene	7.30E-01	1.21E+03	1.48E+05	0.05	Ontario MECP Rationale for the Development of Soil and Ground Water Standards for Use at Contaminated Sites In Ontario 2011
Hexachlorobenzene	1.20E-01	1.10E+02	2.00E+05		
Polycyclic Aromatic Hydrocarbons (PAHs)					
Benzo(a)pyrene TEQ for carcinogenic PAHs	5.50E-01	1.60E+05	1.00E+06	0.062875	Supplemental Data received from BCMOE (average of all locations provided)
Polychlorinated Biphenyls (PCBs)					
Total PCB (AROCLORAROperational CertificateLOR 1254)	3.00E-02	2.45E+04	3.16E+06	0.3	Ontario MECP Rationale for the Development Of Soil and Ground Water Standards for Use at Contaminated Sites In Ontario 2011

1 All k values obtained from the 2005 HHRAP Database (USEPA)

Appendix C

Air Dispersion Model Memo Short Duration Carbon Monoxide Spike Events

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V6H 3V9

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MEMORANDUM

DATE:	2026-09-14	**RWDI Reference No.:** 2600812
TO:	Karina Rogers	karina.rogers@hrdinc.com
CC:	Mathhew Sawycky	Matthew.Sawycky@rwdi.com
FROM:	Golnoosh Bizhani	Golnoosh.Bizhani@rwdi.com
RE:	**Short-Duration Carbon Monoxide Emissions Spike Events – Air Dispersion Study – Rev. 1 Metro Vancouver Waste-to-Energy Facility**	

RWDI was retained to assess the potential off-site air quality impacts associated with short-duration carbon monoxide (CO) emission spikes at the Metro Vancouver Waste-to-Energy (WTE) Facility and determine whether the resulting ground-level concentrations could exceed applicable air quality criteria.

The WTE Facility periodically experiences short-duration CO emission spikes associated with pressurized canister discharge events. These events are characterized by brief increases in CO emissions, typically lasting between one and five minutes, and may be accompanied by a temporary reduction in flue gas flow in the affected unit.

This memorandum provides details of the assessment undertaken by RWDI, assumptions, modelling scenario, dispersion modelling approach, and the resulting predicted ground-level CO concentrations associated with a conservative CO excursion scenario.

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MODELLED SCENARIO

Review of operating data by HDR [1] indicated that:

- Peak CO emission rates during these events can reach up to a maximum of 2,990 g/min (49.8 g/s).
- Elevated CO emissions generally persist for only 1 to 5 minutes.
- Stack temperature remains constant throughout the events.
- Process data suggest that flue gas flow may decrease during and/or following certain events. Decrease in flow was conservatively estimated to be up to 30%.
- Only one boiler at a time can go through a spike event.

MODEL PARAMETERS AND METHODS

Modeling was conducted using CALMET/CALPUFF modelling system with methodology and approach consistent with the methodology used for the air dispersion modelling for the WTE Facility completed in support of the Operational Certificate (OC) Amendment (RWDI 2026 Facility Study)[2].

Modelling domain, model period, meteorology, modelled receptors, receptors, background concentrations, CALPUFF control input file settings (with the exception of source parameters), and postprocessing methods were all similar to the RWDI 2026 Facility Study.

Two stacks were assumed to be operating at Current OC conditions (see Tables 2-2 and 2-4 of the RWDI 2026 Facility Study) and one stack was assumed to be operating continuously at spike conditions. This is a very conservative assumption as the spike conditions only last a few minutes at a time.

Modelled source parameters are summarized in **Table 1** below.

1 Email communication with HDR, Veolia, Metro Vancouver and Ollson Environmental Health Management, Consolidated on Aug 31, 2026, with emission rates updated on Sept 11, 2026.

2 RWDI. 2026. Air Dispersion Modelling Study, Metro Vancouver Waste-to-Energy Facility. September 11, 2026.

Table 1: Model Parameters for CO Spike Modelling Scenario

Source Parameters	2 Boilers Operating under Current OC Conditions [1]	1 Boiler under CO Spike Conditions [2,3]
Stack Diameter (m)	1.25	
Stack Height (m)	60	
Temperature (°C)	153	
Flow Rate (Sm^3/s)	24	16.8 (30% less than the Current OC scenario)
Velocity (m/s)	28.4	19.9
CO Emission Rate (g/s)	1.2 (per boiler)	49.8

Notes:
[1] Emission rates and stack parameters for the two stacks operating under OC conditions were taken from Tables 2-2 and 2-4 of RWDI 2026 Facility Study for Current OC scenario.
[2] For CO spike conditions, the CO emission rate was based on the maximum recorded CO loading over 5-minute intervals, i.e. 2,990 g/min.
[3] CO spike events last only a few minutes at a time, however they were conservatively modelled as continuous.

RESULTS

The maximum predicted off-site concentrations are summarized in **Table 2** below.

The modelling results demonstrate that the predicted off-site impacts associated with a CO spike event remain substantially below the applicable Metro Vancouver 1-hour ambient objective for CO (approximately 16% of the objective).

Based on the assessed scenario, short-duration CO spike events are not expected to result in adverse off-site air quality impacts or exceedances of applicable air quality criteria, even under the conservative assumptions applied in the modelling.

Table 2: Predicted Modelled Concentrations for CO Spike Modelling Scenario

Air Contaminant	Averaging Period	Background ($\mu g/m^3$) [1]	Predicted Concentration ($\mu g/m^3$)		Ambient Objective ($\mu g/m^3$)	Jurisdiction of Objectives
			Without Background	With Background		
Carbon Monoxide (CO)	1-hour	470	1,923	2,392	*14,900*	Metro Vancouver

Note:
[1] Taken from Table 2-5 of the 2026 Facility Study (RWDI, 2026)

CLOSING

RWDI completed air dispersion modelling to evaluate the potential off-site air quality impacts associated with short-duration CO emission spike events at the WTE Facility. The modelling was based on the highest observed CO emission rate associated with a canister discharge event, a reduced stack flow rate reflective of observed operating conditions during and/or immediately after a spike event, and a conservative assumption that the elevated emission rate persisted for a full model period. It was assumed that only one boiler experiences a spike event at any time.

The modelling results indicate that the maximum predicted 1-hour CO concentration, including background concentrations, was 2,392 µg/m³, which is well below the Metro Vancouver 1-hour ambient objective of 14,900 µg/m³. Accordingly, the assessed CO spike scenario is not expected to result in exceedances of applicable air quality criteria or adverse off-site air quality impacts.

We trust that this memorandum satisfies your current information requirements regarding CO emission spike events associated with canister discharges at the Metro Vancouver Waste-to-Energy Facility. Should additional information, clarification, or further assessment be required, please do not hesitate to contact the sender.

STATEMENT OF LIMITATIONS

This memorandum entitled "Short-Duration Carbon Monoxide Emissions Spike Events – Air Dispersion Study – Rev. 1, Metro Vancouver Waste-to-Energy Facility" was prepared by RWDI AIR Inc. ("RWDI") for HDR Corporation ("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 the 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 the 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.

Appendix D: Operational Testing and Analysis Data

D.1 Acid Gas Trials

D1.1 Detailed Schedule for Acid Gas Operational Trials

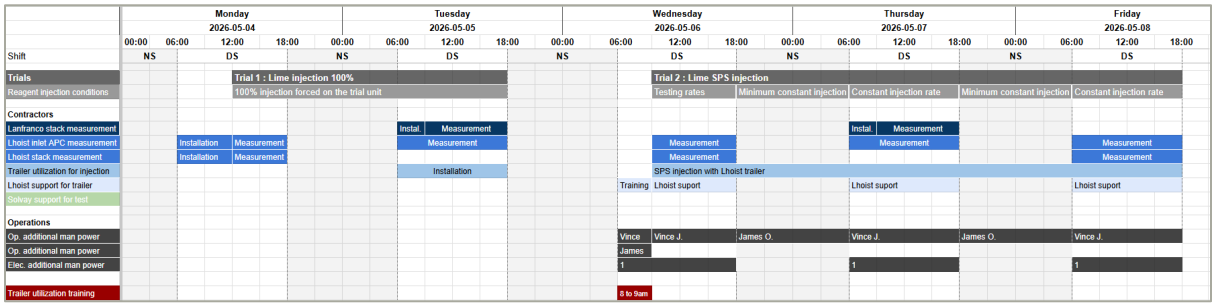


Figure D1: Schedule for May 4th to May 8th Acid Gas Trials

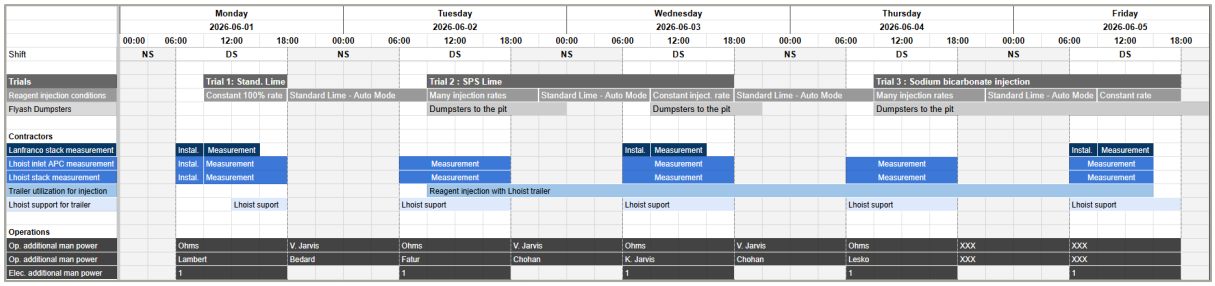
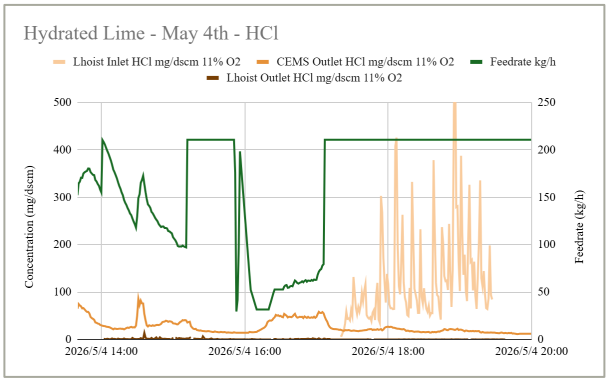
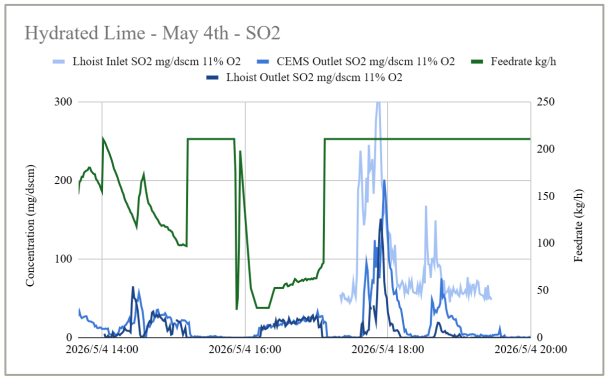
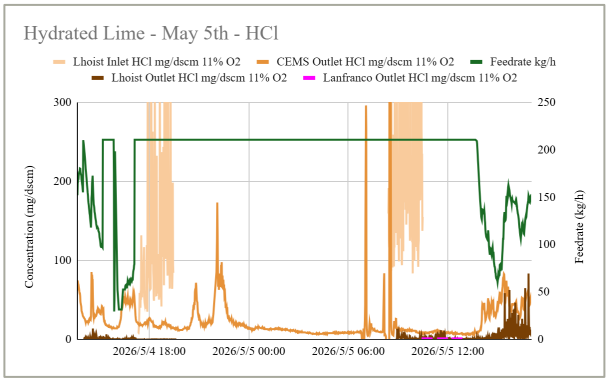


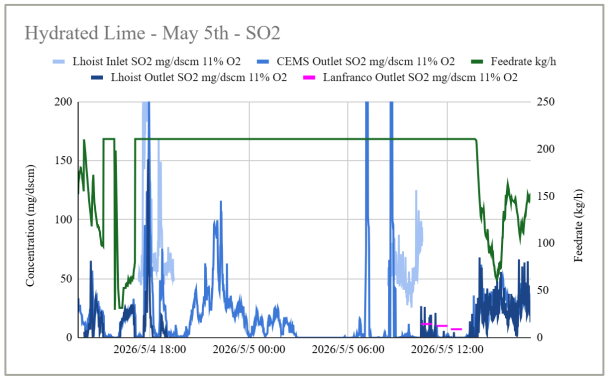
Figure D2: Schedule for June 1st to June 5th Acid Gas Trials

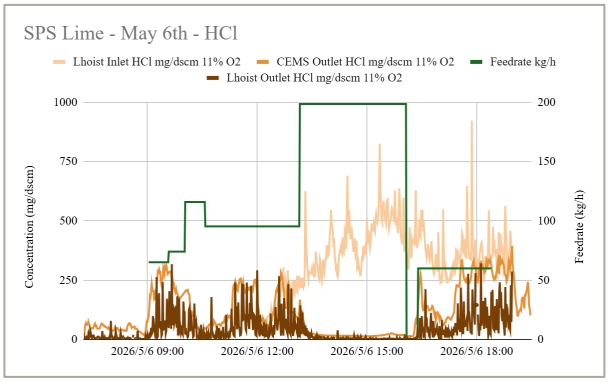
D.1.2 Acid Gas Operational Trials – Minutes Emissions Data (HCl and SO_2)

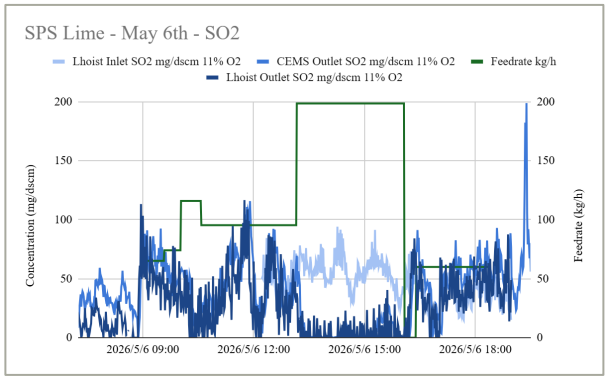


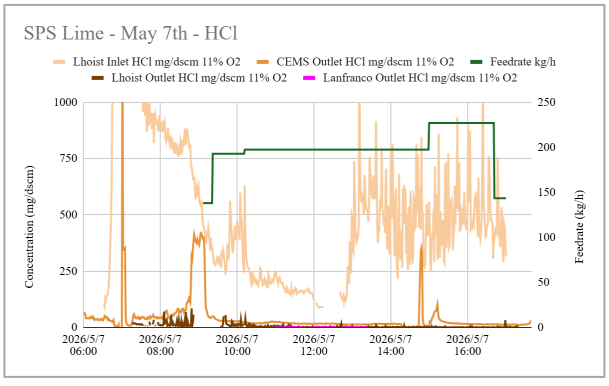


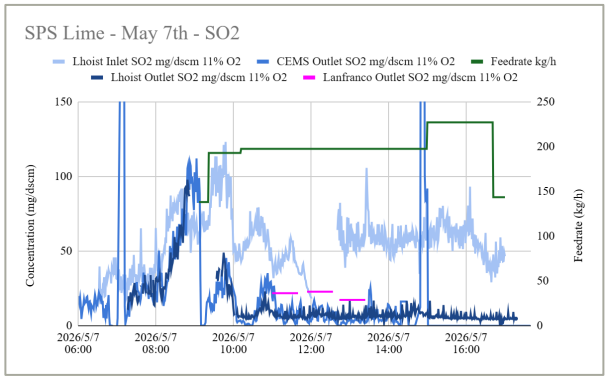


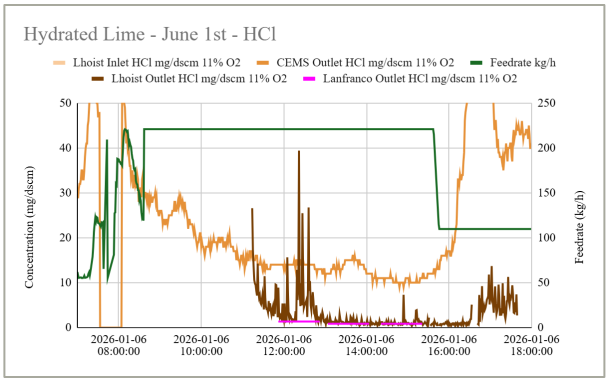


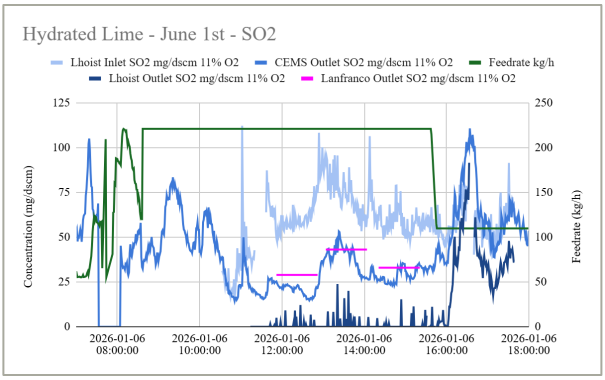


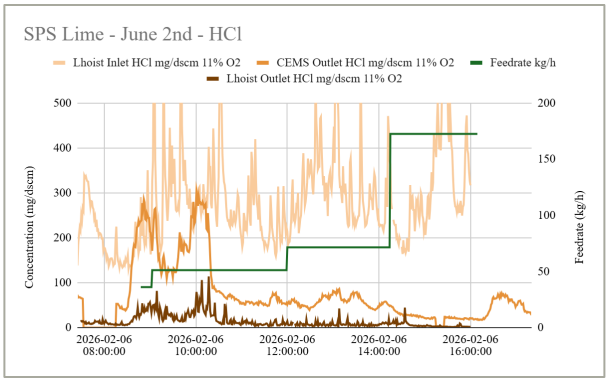


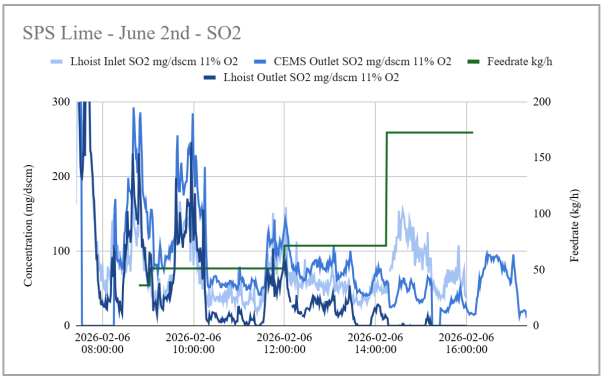


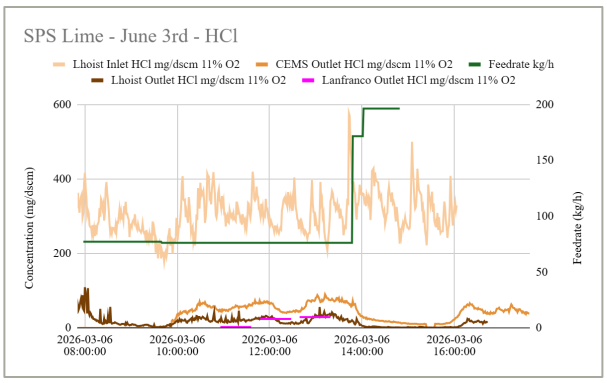


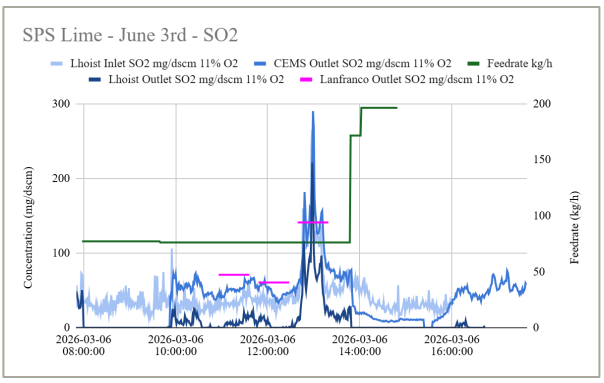

Hydrated Lime - June 1st - HCl
Lhoist Inlet HCl mg/dscm 11% O2
CEMS Outlet HCl mg/dscm 11% O2
Feedrate kg/h
Lhoist Outlet HCl mg/dscm 11% O2
Lanfranco Outlet HCl mg/dscm 11% O2
Concentration (mg/dscm)
Feedrate (kg/h)
2026-01-06 08:00:00
2026-01-06 10:00:00
2026-01-06 12:00:00
2026-01-06 14:00:00
2026-01-06 16:00:00
2026-01-06 18:00:00

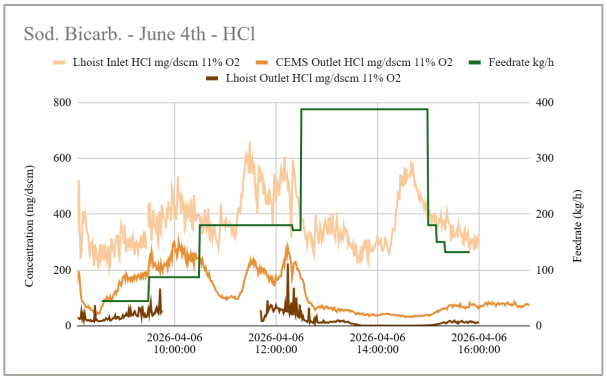

Hydrated Lime - June 1st - SO2
Lhoist Inlet SO2 mg/dscm 11% O2
CEMS Outlet SO2 mg/dscm 11% O2
Feedrate kg/h
Lhoist Outlet SO2 mg/dscm 11% O2
Lanfranco Outlet SO2 mg/dscm 11% O2
Concentration (mg/dscm)
Feedrate (kg/h)
2026-01-06 08:00:00
2026-01-06 10:00:00
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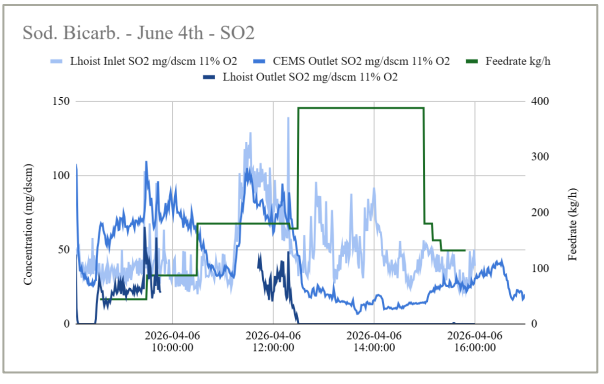

SPS Lime - June 2nd - HCl
Lhoist Inlet HCl mg/dscm 11% O2
CEMS Outlet HCl mg/dscm 11% O2
Feedrate kg/h
Lhoist Outlet HCl mg/dscm 11% O2
Concentration (mg/dscm)
Feedrate (kg/h)
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2026-02-06 10:00:00
2026-02-06 12:00:00
2026-02-06 14:00:00
2026-02-06 16:00:00


SPS Lime - June 2nd - SO2
Lhoist Inlet SO2 mg/dscm 11% O2
CEMS Outlet SO2 mg/dscm 11% O2
Feedrate kg/h
Lhoist Outlet SO2 mg/dscm 11% O2
Concentration (mg/dscm)
Feedrate (kg/h)
2026-02-06 08:00:00
2026-02-06 10:00:00
2026-02-06 12:00:00
2026-02-06 14:00:00
2026-02-06 16:00:00


SPS Lime - June 3rd - HCl
Lhoist Inlet HCl mg/dscm 11% O2
CEMS Outlet HCl mg/dscm 11% O2
Feedrate kg/h
Lhoist Outlet HCl mg/dscm 11% O2
Lanfranco Outlet HCl mg/dscm 11% O2
Concentration (mg/dscm)
Feedrate (kg/h)
2026-03-06 08:00:00
2026-03-06 10:00:00
2026-03-06 12:00:00
2026-03-06 14:00:00
2026-03-06 16:00:00


SPS Lime - June 3rd - SO2
Lhoist Inlet SO2 mg/dscm 11% O2
CEMS Outlet SO2 mg/dscm 11% O2
Feedrate kg/h
Lhoist Outlet SO2 mg/dscm 11% O2
Lanfranco Outlet SO2 mg/dscm 11% O2
Concentration (mg/dscm)
Feedrate (kg/h)
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2026-03-06 10:00:00
2026-03-06 12:00:00
2026-03-06 14:00:00
2026-03-06 16:00:00


Sod. Bicarb. - June 4th - HCl
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CEMS Outlet HCl mg/dscm 11% O2
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Lhoist Outlet HCl mg/dscm 11% O2
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2026-04-06 16:00:00


Sod. Bicarb. - June 4th - SO2
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CEMS Outlet SO2 mg/dscm 11% O2
Feedrate kg/h
Lhoist Outlet SO2 mg/dscm 11% O2
Concentration (mg/dscm)
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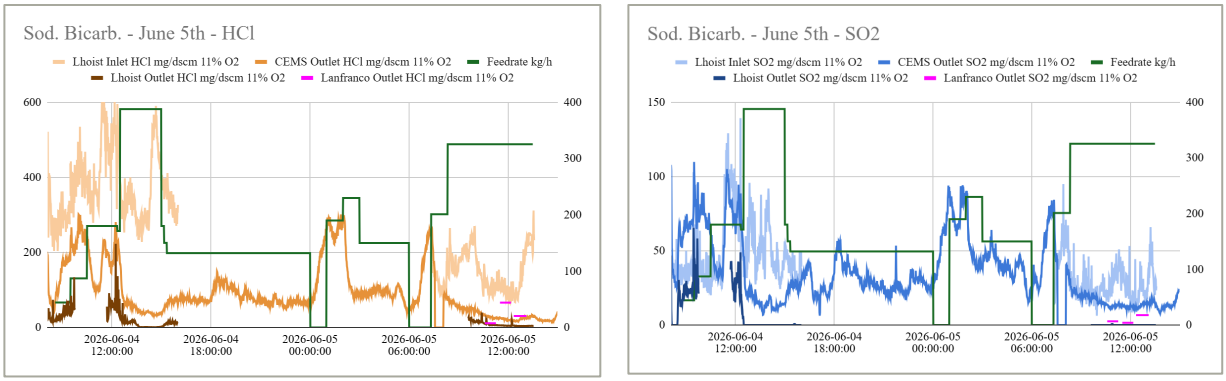


Figure D3: Minutes Inlet and Emissions Data during Acid Gas Operational Trials (HCl and SO_2)

D.1.3 Additional Acid Gas Operational Trials – Daily Emissions Data (HCl and SO_2)

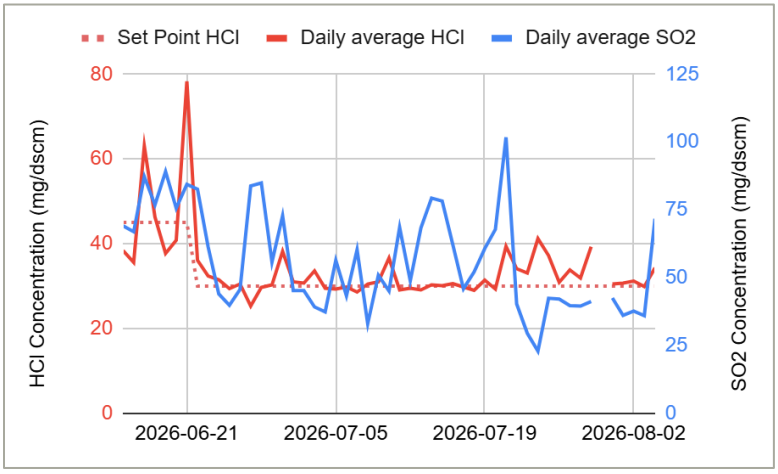


Figure D4: Unit 1 Daily Emissions Data (HCl and SO_2)

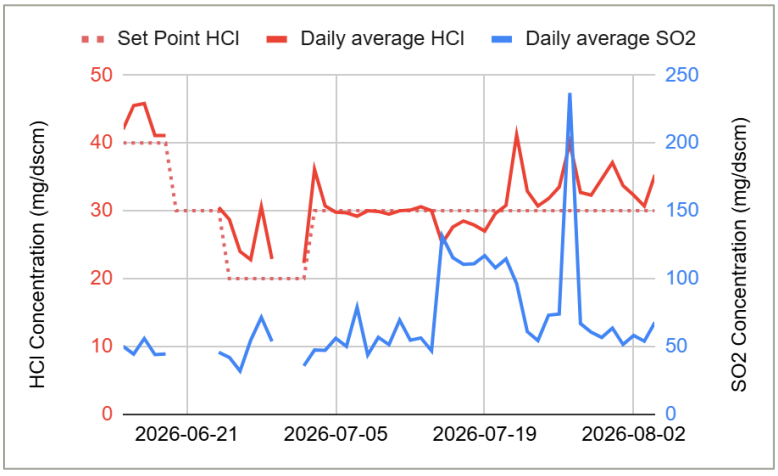


Figure D5: Unit 2 Daily Emissions Data (HCl and SO_2)

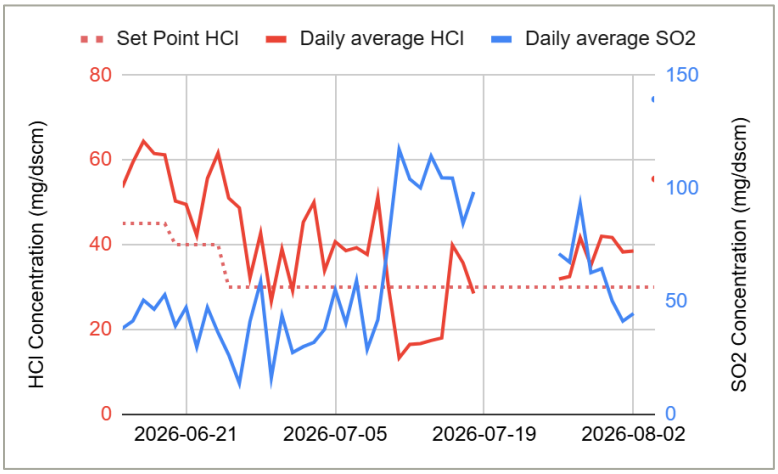


Figure D6: Unit 3 Daily Emissions Data (HCl and SO_2)

D.2 NOx Management and NH_3 Optimization Testing Results

D.2.1 LN Operation without SNCR - Day 1 and 2

lance position	LN Setpoin %	Ammonia l/hr	Steam flow kg/hr	rnace ter oC	CO mg/Nm3	NOx mg/Nm3	NOx reduction %	UFA Nm3/h	Total OFA m3/hr	LN Flow m3/hr	% LN airflow % of OFA
Upper	0.0	0.0	38,282	921	30	252	0%	17,569	15,087	2,180	14%
Upper	0.0	0.0	37,516	886	16	268	0%	24,709	14,981	2,270	15%
Upper	0.0	0.0	37,803	905	17	287	0%	23,960	15,032	2,357	16%
Upper	0.0	0.1	36,853	887	20	325	0	18,966	16,896	2,271	14%
Upper	2.8	0.0	37,576	885	23	337	0%	19,588	16,858	2,278	14%
Upper	3.1	0.0	37,609	884	23	339	0%	19,378	16,866	2,277	13%
Upper	14.6	0.7	37,672	890	28	250	21%	27,375	8,886	2,187	25%
Upper	25.1	2.5	37,953	894	31	199	28%	27,466	9,979	2,187	22%
Lower	0.0	0.0	37,695	888	20	310	0%	18,380	18,139	2,184	12%
Lower	50.0	1.1	38,093	941	15	186	31%	20,356	15,079	3,611	24%
Lower	75.0	0.1	38,251	941	19	190	29%	21,930	15,065	5,437	36%
Lower	75.0	0.6	37,380	917	39	186	42%	19,454	16,814	6,037	36%
Lower	100.0	3.8	37,998	936	17	178	34%	20,507	15,050	7,261	48%
Lower	100.0	0.3	34,110	896	35	228	30%	28,767	14,385	6,861	48%

D.2.2 LN Operation with SNCR – Day 1 (Lower SNCR Positions)

Time	LN Setpoint %	Ammonia l/hr	Steam flow kg/hr	Furnace temp oC	CO mg/Nm3	NOx mg/Nm3	NOx reduction %	UFA Nm3/h	Total OFA m3/hr	LN Flow m3/hr	% LN airflow % of OFA
9:48	0	0	38,282	921	30	252	Unabated	17,569	15,087	2,180	14%
10:00	0	20	38,327	901	11	224	14%	18,449	15,085	2,187	14%
10:11	0	40	38,323	896	10	179	31%	18,664	15,083	2,189	15%
10:21	0	60	38,289	903	13	148	43%	20,637	15,097	2,221	15%
10:31	0	80	38,437	916	11	99	62%	19,792	15,104	2,211	15%
10:41	0	0	37,516	886	16	268	Unabated	24,709	14,981	2,270	15%
		cems purge issue			No CEMS data - test paused						
12:53	25	2	37,953	894	31	199	26%	27,466	9,979	2,187	22%
13:03	25	20	38,146	886	25	163	39%	27,656	11,299	2,168	19%
13:13	25	40	38,705	919	42	138	49%	22,687	13,300	2,154	16%
13:23	25	60	37,805	922	19	119	56%	21,251	15,005	2,195	15%
13:34	25	80	38,370	921	18	91	66%	20,872	15,077	2,185	14%
13:44	50	1	38,093	941	15	186	31%	20,356	15,079	3,611	24%
13:54	50	20	38,139	950	26	136	50%	20,309	15,053	3,639	24%
14:05	50	40	37,732	933	23	115	57%	24,538	15,018	3,618	24%
14:15	50	60	38,287	941	39	88	67%	22,619	15,065	3,609	24%
14:25	50	80	38,163	939	25	76	72%	21,461	15,043	3,607	24%
14:40	75	0	38,251	941	19	190	29%	21,930	15,065	5,437	36%
14:51	75	20	37,581	921	20	163	39%	25,094	14,964	5,390	36%
14:59	75	40	38,539	951	16	107	60%	19,239	15,078	5,418	36%
15:13	75	60	38,093	948	17	82	70%	19,119	15,051	5,442	36%
15:24	76	80	38,300	944	16	68	75%	19,306	15,062	5,467	36%
15:35	100	4	37,998	936	17	178	34%	20,507	15,050	7,261	48%
15:44	100	20	38,276	957	30	128	52%	20,519	15,095	7,196	48%
15:55	100	40	37,965	948	29	91	66%	22,221	15,057	7,217	48%
16:06	100	60	38,340	954	27	70	74%	21,463	15,093	7,237	48%
16:16	100	80	37,876	934	61	60	78%	22,973	15,042	7,256	48%
16:25	0	0	37,803	905	17	287	unabated	23,950	15,032	2,357	16%

D.2.3 LN Operation with SNCR – Day 2 (Upper SNCR Positions)

LN Setpoint %	Ammonia 0.0	Steam flow 0.0	Furnace temp oC	CO mg/Nm3	NOx 0.0	NOx reduction %	UFA 0.0	Total OFA 0.0	LN Flow 0.0	% LN airflow % of OFA
0	0	36,853	887	20	325	unabated	18,956	16,696	2,271	14%
0	20	36,190	870	20	259	18%	21,292	13,535	2,259	17%
0	40	36,056	858	26	214	33%	25,042	12,113	2,277	19%
0	60	35,573	844	28	180	43%	28,689	6,567	2,201	34%
0	80	37,552	877	23	138	56%	28,844	6,743	2,199	33%
upset periods - combustion control - waste feed										
15	1	37,672	890	28	250	21%	27,375	8,886	2,187	25%
25	20	37,451	890	29	216	32%	28,232	8,439	2,180	26%
25	40	36,106	883	29	177	44%	29,971	6,060	2,196	36%
25	60	37,032	890	24	140	56%	29,170	6,137	2,190	36%
37	80	33,753	837	21	144	55%	29,321	5,789	2,194	38%
50	0	32,880	835	27	301	5%	30,000	5,657	2,205	39%
50	20	37,625	895	91	165	48%	27,290	9,902	2,507	25%
50	40	38,074	917	78	133	58%	22,821	12,533	2,915	23%
50	60	37,658	922	38	135	58%	20,664	16,201	3,892	24%
49	80	37,704	908	47	129	59%	19,956	16,516	3,956	24%
7	0	37,695	888	20	310	unabated	18,380	18,139	2,184	12%
75	1	37,380	917	39	186	42%	19,454	16,814	6,037	36%
75	20	37,669	972	34	177	45%	20,025	18,744	6,750	36%
75	40	37,647	967	28	139	57%	20,442	18,545	6,704	36%
75	60	37,526	981	60	113	65%	19,771	18,715	6,753	36%
89	80	36,529	956	54	116	64%	21,940	19,492	7,206	37%
100	0	34,110	896	35	228	30%	28,767	14,385	6,861	48%
100	20	36,332	920	24	185	43%	24,818	14,737	7,074	48%
100	40	35,041	882	24	175	46%	26,733	11,245	5,459	49%
100	60	33,775	847	25	140	57%	28,696	5,629	2,761	49%
91	80	30,781	822	25	157	51%	30,576	4,069	2,307	57%
3	0	37,576	885	23	337	unabated	19,588	16,858	2,278	14%
3	0	37,609	884	23	339	unabated	19,378	16,866	2,277	13%

D.2.3 LN Operation with SNCR – Day 2 (Comparison Between Upper and Lower Positions)

	LN Setpoint %	Ammonia l/hr	Steam flow kg/hr	Furnace temp oC	CO mg/Nm3	NOx mg/Nm3	NOx reduction %	UFA Nm3/h	Total OFA m3/hr	LN Flow m3/hr	% LN airflow % of OFA
50% LN Setting/ 30 L/hr ammonia - upper and then lower ports											
upper	50	30	37,880	933	18	154	52%	19,415	16,331	3,937	24%
lower	50	30	37,635	903	25	147	54%	21,692	15,230	3,626	24%

D.3 N2O Cylinder Explosion Analysis

D.3.1 Example Explosion Events

Example	Date	Time	Unit	Operator Note
1	July 23, 2026	18:36	1	“Furnace explosion; CO spike ~2400 mg/dscm, O2 drop observed”
2	June 20, 2026	16:28	1	“Explosion event; short-duration CO spike to ~2200 mg/dscm”

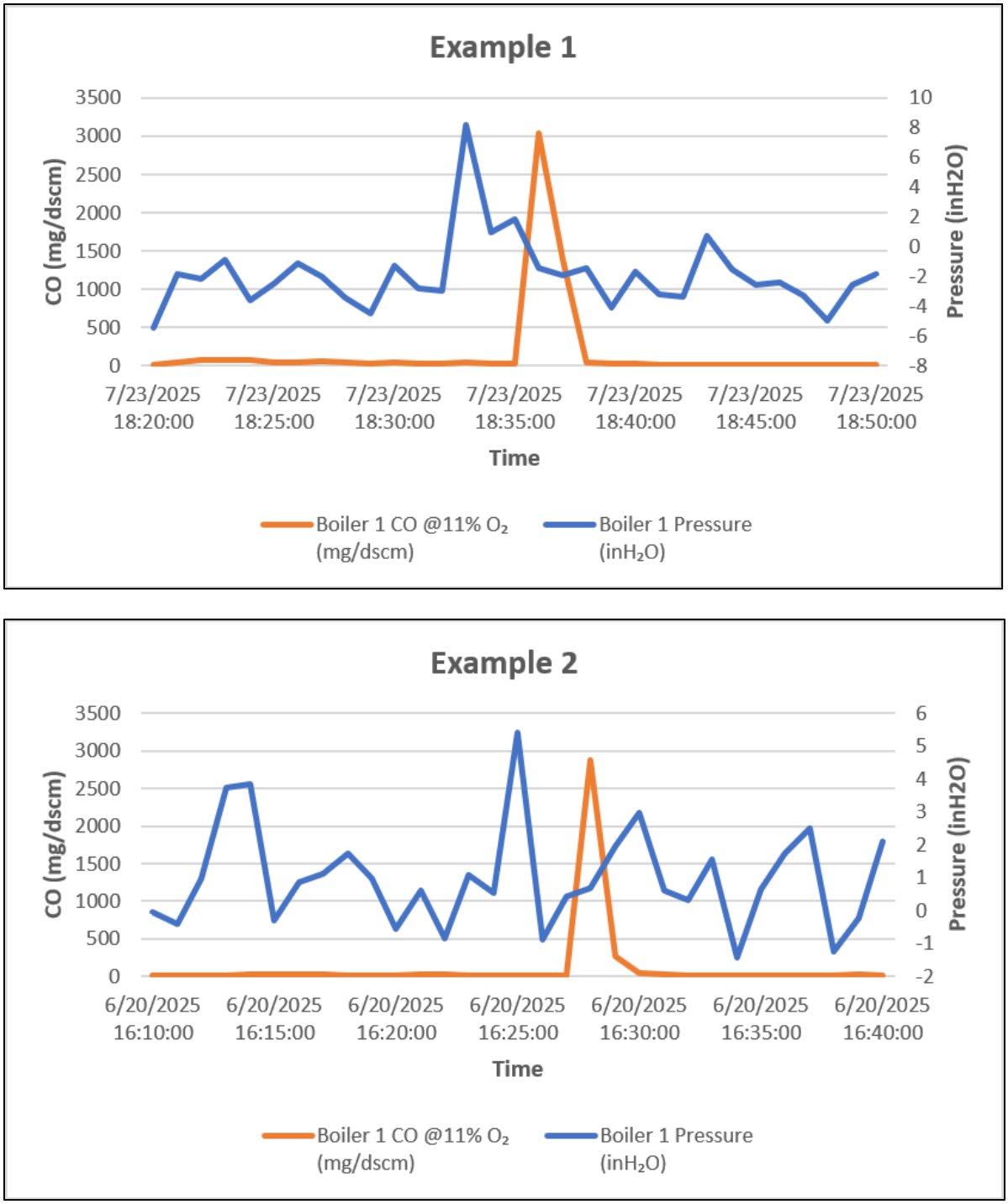


Figure D6: Example N2O Cylinder Explosion Events

D.3.2 N2O Cylinder Analysis Summary Table

Year	Month	Unit	N_2O Cylinder Explosions	CO Spikes	Shutdown Hours	Operational Hours	Explosions per Hour	CO Spikes per Hour
2024	Jan	1	1	18	77.94	666.06	0.002	0.027
2024	Jan	2	6	36	7.36	736.64	0.008	0.049
2024	Jan	3	0	19	67.17	676.83	0.000	0.028
2024	Feb	1	8	24	56.78	639.22	0.013	0.038
2024	Feb	2	3	36	39.56	656.44	0.005	0.055
2024	Feb	3	3	21	80.25	615.75	0.005	0.034
2024	Mar	1	10	38	17.89	726.11	0.014	0.052
2024	Mar	2	1	58	33.38	710.62	0.001	0.082
2024	Mar	3	0	17	2.5	741.5	0.000	0.023
2024	Apr	1	6	37	305.01	414.99	0.014	0.089
2024	Apr	2	4	85	16.03	703.97	0.006	0.121
2024	Apr	3	2	44	2.07	717.93	0.003	0.061
2024	May	1	5	24	26.49	717.51	0.007	0.033
2024	May	2	3	79	16.08	727.92	0.004	0.109
2024	May	3	6	48	22.18	721.82	0.008	0.066
2024	Jun	1	2	47	90.44	629.56	0.003	0.075
2024	Jun	2	1	82	20.49	699.51	0.001	0.117
2024	Jun	3	3	56	44.8	675.2	0.004	0.083
2024	Jul	1	5	42	119.72	624.28	0.008	0.067
2024	Jul	2	2	66	135.13	608.87	0.003	0.108
2024	Jul	3	6	42	87.77	656.23	0.009	0.064
2024	Aug	1	6	22	6.36	737.64	0.008	0.030
2024	Aug	2	1	78	34.82	709.18	0.001	0.110
2024	Aug	3	3	16	10.2	733.8	0.004	0.022
2024	Sep	1	5	30	58.48	661.52	0.008	0.045
2024	Sep	2	2	76	22.14	697.86	0.003	0.109
2024	Sep	3	3	34	330.67	389.33	0.008	0.087
2024	Oct	1	5	34	91.09	652.91	0.008	0.052
2024	Oct	2	4	72	370.12	373.88	0.011	0.193
2024	Oct	3	4	64	40.51	703.49	0.006	0.091
2024	Nov	1	11	62	88.47	631.53	0.017	0.098
2024	Nov	2	1	56	84.98	635.02	0.002	0.088
2024	Nov	3	5	44	61.12	658.88	0.008	0.067
2024	Dec	1	3	24	133.78	610.22	0.005	0.039
2024	Dec	2	3	45	5.09	738.91	0.004	0.061
2024	Dec	3	4	33	1.68	742.32	0.005	0.044
2025	Jan	1	2	18	117.56	626.44	0.003	0.029
2025	Jan	2	6	32	126.67	617.33	0.010	0.052
2025	Jan	3	2	8	437.31	306.69	0.007	0.026
2025	Feb	1	7	23	153.8	518.2	0.014	0.044
2025	Feb	2	3	19	4.35	667.65	0.004	0.028
2025	Feb	3	3	30	1.75	670.25	0.004	0.045
2025	Mar	1	2	33	60.71	683.29	0.003	0.048
2025	Mar	2	3	60	141.42	602.58	0.005	0.100
2025	Mar	3	1	26	12.61	731.39	0.001	0.036
2025	Apr	1	8	26	67.2	652.8	0.012	0.040

Year	Month	Unit	N_2O Cylinder Explosions	CO Spikes	Shutdown Hours	Operational Hours	Explosions per Hour	CO Spikes per Hour
2025	Apr	2	8	82	99.21	620.79	0.013	0.132
2025	Apr	3	4	25	81.46	638.54	0.006	0.039
2025	May	1	4	21	384.17	359.83	0.011	0.058
2025	May	2	12	103	62.56	681.44	0.018	0.151
2025	May	3	5	31	70.32	673.68	0.007	0.046
2025	Jun	1	9	45	64.41	655.59	0.014	0.069
2025	Jun	2	4	56	380.97	339.03	0.012	0.165
2025	Jun	3	6	55	37.65	682.35	0.009	0.081
2025	Jul	1	9	37	76.95	667.05	0.013	0.055
2025	Jul	2	11	125	66.87	677.13	0.016	0.185
2025	Jul	3	12	60	140.33	603.67	0.020	0.099
2025	Aug	1	7	45	101.53	642.47	0.011	0.070
2025	Aug	2	5	109	79.36	664.64	0.008	0.164
2025	Aug	3	7	53	143.22	600.78	0.012	0.088
2025	Sep	1	8	26	127.21	592.79	0.013	0.044
2025	Sep	2	11	104	90.84	629.16	0.017	0.165
2025	Sep	3	3	26	447.43	272.57	0.011	0.095
2025	Oct	1	8	36	213.76	530.24	0.015	0.068
2025	Oct	2	4	37	436.82	307.18	0.013	0.120
2025	Oct	3	3	29	351.23	392.77	0.008	0.074
2025	Nov	1	8	34	50.67	669.33	0.012	0.051
2025	Nov	2	5	44	158.95	561.05	0.009	0.078
2025	Nov	3	8	44	51.18	668.82	0.012	0.066
2025	Dec	1	5	18	115.08	628.92	0.008	0.029
2025	Dec	2	5	31	58.7	685.3	0.007	0.045
2025	Dec	3	3	17	48.85	695.15	0.004	0.024
2026	Jan	1	6	18	16.13	727.87	0.008	0.025
2026	Jan	2	4	17	162.87	581.13	0.007	0.029
2026	Jan	3	3	18	98.02	645.98	0.005	0.028
2026	Feb	1	6	18	113.71	558.29	0.011	0.032
2026	Feb	2	9	34	82.78	589.22	0.015	0.058
2026	Feb	3	4	21	185.54	486.46	0.008	0.043
2026	Mar	1	9	22	181.88	562.12	0.016	0.039
2026	Mar	2	12	40	135.55	608.45	0.020	0.066
2026	Mar	3	10	31	52.98	691.02	0.014	0.045
2026	Apr	1	4	9	398.76	321.24	0.012	0.028
2026	Apr	2	4	43	294.57	425.43	0.009	0.101
2026	Apr	3	4	23	286.79	433.21	0.009	0.053

D.3.3 Natural Gas Effectiveness Graphs

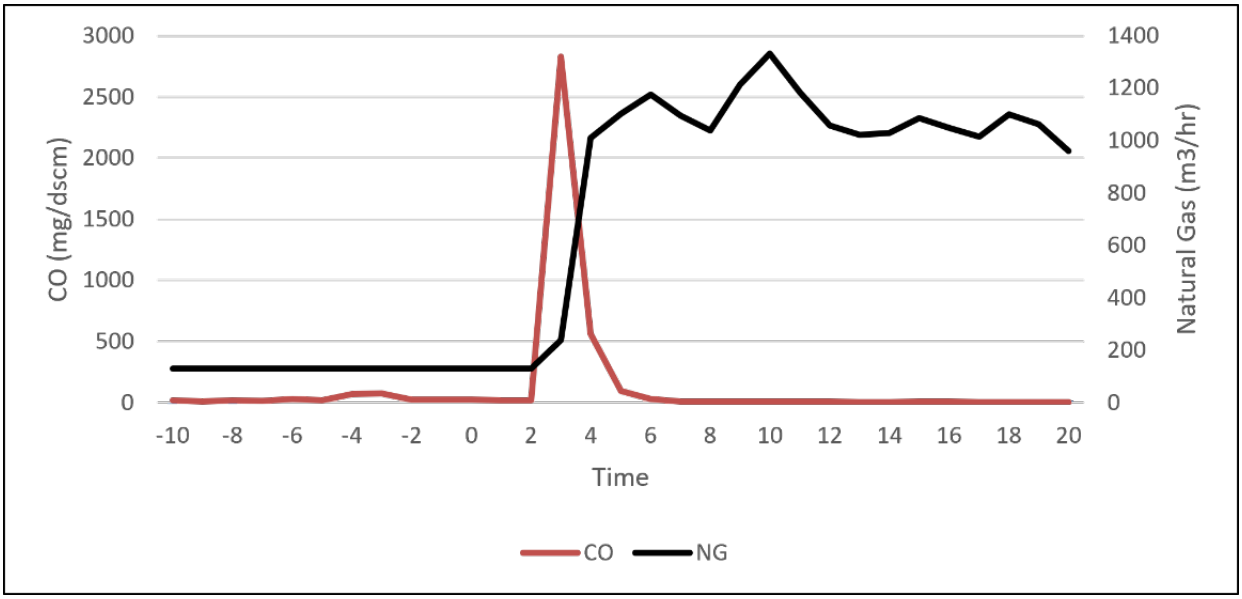


Figure D7: Operator Intervention with Natural Gas

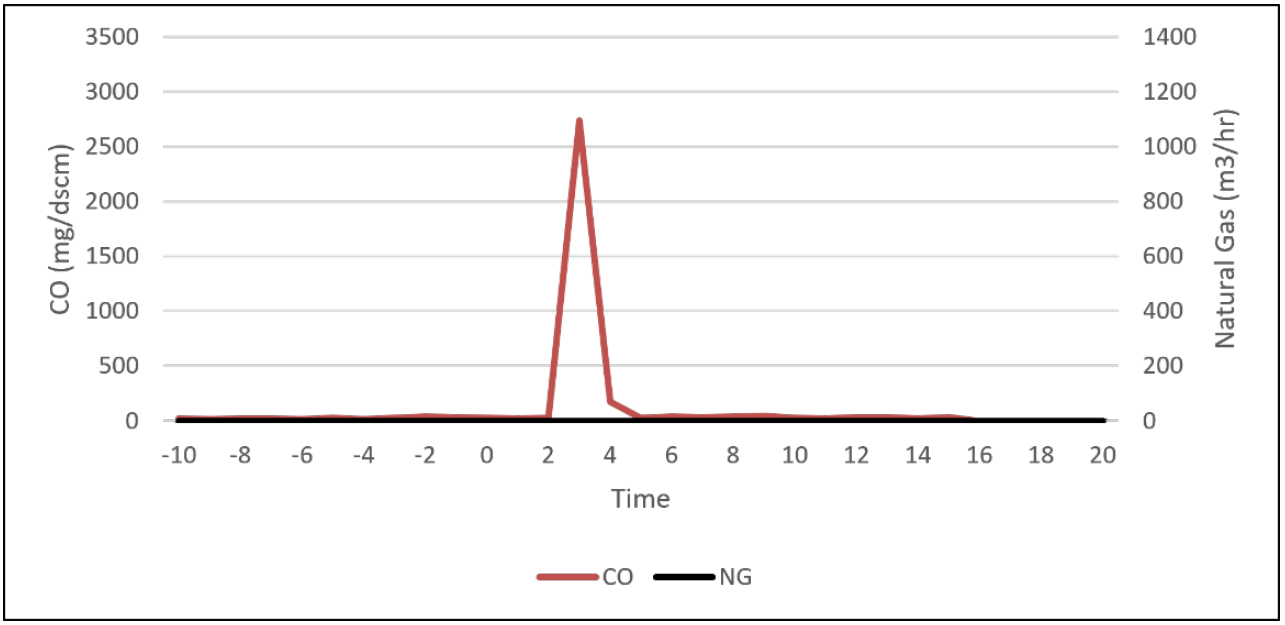


Figure D8: No Operator Intervention with Natural Gas

Appendix E: Statistical Analysis of Historical Discharge Limit Parameters

Metro Vancouver WTEF

Air Quality Upper Prediction Limits

Purpose and Scope

The statistical analyses summarized in this report pertain to historical stack testing results for Units 1, 2, and 3 at the Metro Vancouver Waste-to-Energy Facility (WTEF).

The purpose of the statistical analysis is to develop upper prediction limits (UPLs) for selected air emission parameters. The UPLs were developed to characterize historical facility performance and to inform Metro Vancouver's evaluation of reasonable parameter-specific limits for potential inclusion in the WTEF Operational Certificate.

Prior to estimating the UPLs, a preliminary data analysis was conducted using descriptive statistics, goodness-of-fit tests, statistical outlier tests, tests for spatial variability among the three units, seasonality tests, autocorrelation tests, and trend analyses. These analyses were conducted to evaluate the characteristics of the historical datasets and to select an appropriate statistical method for each parameter. Detailed statistical tables and supporting plots are provided separately from this memorandum.

Stack Emissions Data Review

The statistical analysis includes historical stack testing results for 14 air emission parameters measured at Units 1, 2, and 3. Depending on the parameter, the available period of record extends from Q1 2009 through Q4 2025. Sample sizes range from 10 observations for several annually tested organic parameters to 63 observations for cadmium, lead, and combined lead, arsenic, and chromium.

Reporting units, periods of record, number of observations, number of non-detects, percentage of non-detects, descriptive statistics, and recommended distributions are summarized in **Table 1**.

Table 1: Summary of Historical WTEF Stack Testing Data

Parameter	Unit	n	No. NDs	Date Range	Mean	Median	Min.	Max.
Arsenic	mg/dscm	60	0	2021-02-01 to 2025-11-01	0.00067	0.00053	0.00024	0.0023
Cadmium	mg/dscm	63	0	2020-11-01 to 2025-11-01	0.00027	0.00013	0.00006	0.0033
Chlorobenzenes	ug/dscm	10	0	2016-01-01 to 2025-01-01	0.31	0.3	0.033	0.59
Chlorophenols	ug/dscm	10	0	2016-01-01 to 2025-01-01	0.014	0.0067	0.0023	0.072
Chromium	mg/dscm	60	0	2021-02-01 to 2025-11-01	0.0018	0.0011	0.00011	0.016
Dioxins and Furans	ng/Sm3@ 11% O2	17	2	2009-01-01 to 2025-01-01	0.0012	0.0007	0.00002	0.0042
Hydrogen Fluoride	mg/dscm	60	0	2021-02-01 to 2025-11-01	0.036	0.014	0.001	0.13
Lead	mg/dscm	63	0	2020-11-01 to 2025-11-01	0.0023	0.0014	0.00039	0.01
Lead, Arsenic and Chromium	mg/dscm	63	0	2020-11-01 to 2025-11-01	0.0049	0.0041	0.0014	0.024
Mercury	mg/dscm	60	0	2021-02-01 to 2025-11-01	0.00024	0.000056	0.00002	0.0023
Particulate	mg/dscm	60	0	2021-02-01 to 2025-11-01	1.2	0.86	0.03	5

Parameter	Unit	n	No. NDs	Date Range	Mean	Median	Min.	Max.
Polychlorinated Biphenyls	ug/dscm	10	0	2016-01-01 to 2025-01-01	0.012	0.013	0.0001	0.024
Polycyclic Aromatic Hydrocarbons	ug/dscm	10	0	2016-01-01 to 2025-01-01	0.11	0.096	0.029	0.19
Total Hydrocarbons	mg/dscm	36	0	2023-02-01 to 2025-11-01	3.7	3.4	2.3	6.1

Dioxins and furans were the only parameter group containing censored observations, with two non-detects among 17 observations. All other parameter groups contained detected concentrations. The datasets for most metals and other parameters tested quarterly contain between 36 and 63 observations. The annually tested chlorobenzenes, chlorophenols, polychlorinated biphenyls, and polycyclic aromatic hydrocarbons datasets contain 10 observations each.

Results from Units 1, 2, and 3 were pooled by parameter under the assumption that concentrations measured at the three units, when pooled, provide an estimate of facility-wide operating conditions for the evaluated parameters. Pooling the results increases the available sample size and allows the UPLs to reflect the range of concentrations observed among the three units.

The historical datasets were screened for statistical outliers using Dixon's outlier test or Rosner's outlier test, depending on the number of detected observations available for each parameter. Dixon's test was used for sample sizes smaller than 25, and Rosner's test was used for sample sizes of 25 or greater. Both tests were conducted using detected concentrations and a significance level of 1 percent.

Statistical outliers are observations that may not be representative of the population from which they are sampled. However, Dixon's and Rosner's tests assume normally distributed data and may identify upper-tail observations in skewed or nonparametric datasets. Accordingly, observations identified by these tests were reviewed as part of the exploratory analysis but were not excluded solely because they were identified as statistical outliers.

This consideration is particularly important for the annually tested parameters, for which only 10 observations were available, and for dioxins and furans, for which 17 observations were available. With these sample sizes, there is limited information available to determine whether an individual high observation represents a separate population rather than the upper end of regular operating variability. Removing an observation could also materially affect the fitted distribution and calculated UPL. Therefore, all available observations, including observations identified as potential statistical outliers, were retained in the datasets used to calculate the UPLs.

The exploratory analysis also included tests for spatial variability among the three units, seasonality, autocorrelation, and trends over time. These analyses were used to provide context for the pooled historical datasets and to identify characteristics that may warrant continued review as additional stack testing results become available. No observations were excluded or adjusted based on the results of these tests. The full set of exploratory tables and plots, including trend tests, outlier tests, and goodness-of-fit tests, are presented in **Appendix A** and **Appendix B** respectively.

Statistical Methodology

The historical data were fit to known distribution models using goodness-of-fit tests. The distributions evaluated included normal, lognormal, and gamma distributions. Nonparametric methods were used where the data did not adequately support a parametric distribution.

Arsenic, cadmium, chlorophenols, hydrogen fluoride, and mercury were treated as nonparametric. Chromium, lead, and total hydrocarbons were assigned lognormal distributions. Chlorobenzenes, dioxins and furans, combined lead, arsenic, and, particulate, polychlorinated biphenyls, and polycyclic aromatic hydrocarbons were assigned gamma distributions.

Dioxins and furans were the only parameter group containing non-detects. The final UPL for dioxins and furans was calculated using the gamma distribution and the Kaplan-Meier estimate. The remaining UPLs were calculated using the applicable parametric or nonparametric method for uncensored datasets.

Based on the assigned distributions and the observed historical data, UPLs were computed for the 14 parameters of interest. The UPL represents a statistical estimate of the maximum concentration expected for the next sample from the population represented by the historical dataset. The 99 percent UPL is calculated so that, under the selected distribution and associated assumptions, there is 99 percent confidence that the next observation will not exceed the UPL. The UPLs therefore provide parameter-specific estimates of the upper concentrations expected during the next stack testing event, assuming operating conditions remain consistent with those represented by the historical data.

Background Upper Prediction Limits

The selected 99 percent UPLs are presented in **Table 2**. The table also presents the number of observations, recommended distribution, maximum observed concentration, and existing or proposed limit for each parameter. The UPLs were developed to inform Metro Vancouver's evaluation of reasonable parameter-specific limits for potential inclusion in the WTEF Operational Certificate. Additional detailed UPL results are presented in **Appendix C**.

Table 2: Historical WTEF Air Quality Upper Prediction Limits

Constituent	Unit	n	No. NDs	Max	Recommended Distribution	Confidence Level	UPL
Arsenic	mg/dscm	60	0	0.0023	Nonparametric	0.99	0.0023
Cadmium	mg/dscm	63	0	0.0033	Nonparametric	0.99	0.0033
Chlorobenzenes	ug/dscm	10	0	0.59	Gamma	0.99	1.3
Chlorophenols	ug/dscm	10	0	0.072	Nonparametric	0.99	0.072
Chromium	mg/dscm	60	0	0.016	Lognormal	0.99	0.010
Dioxins and Furans	ng/Sm3@ 11% O2	17	2	0.0042	Gamma	0.99	0.0074
Hydrogen Fluoride	mg/dscm	60	0	0.13	Nonparametric	0.99	0.13
Lead	mg/dscm	63	0	0.01	Lognormal	0.99	0.011

Constituent	Unit	n	No. NDs	Max	Recommended Distribution	Confidence Level	UPL
Lead, Arsenic and Chromium	mg/dscm	63	0	0.024	Gamma	0.99	0.015
Mercury	mg/dscm	60	0	0.0023	Nonparametric	0.99	0.0023
Particulate	mg/dscm	60	0	5	Gamma	0.99	5.3
Polychlorinated Biphenyls	ug/dscm	10	0	0.024	Gamma	0.99	0.093
Polycyclic Aromatic Hydrocarbons	ug/dscm	10	0	0.19	Gamma	0.99	0.33
Total Hydrocarbons	mg/dscm	36	0	6.1	Lognormal	0.99	7.2

The UPLs for arsenic, cadmium, chlorophenols, hydrogen fluoride, and mercury are equal to their respective maximum observed concentrations because nonparametric methods were selected for these parameters.

For most parameters assigned gamma or lognormal distributions, the selected UPL is greater than the corresponding maximum observed concentration. The calculated UPLs for chromium and combined lead, arsenic, and chromium are exceptions. The lognormal UPL for chromium is 0.0102 mg/dscm compared with a maximum observed concentration of 0.01586 mg/dscm. The gamma UPL for combined lead, arsenic, and chromium is 0.0149 mg/dscm compared with a maximum observed concentration of 0.02423 mg/dscm.

These results can occur because a parametric UPL is estimated from the fitted distribution and is not constrained to exceed every observation. An isolated observation in the upper tail of the dataset may therefore exceed the calculated UPL. Both maximum observations were retained in their respective datasets and included in the fitted distributions.

Upward trends were identified for hydrogen fluoride and total hydrocarbons, with a less pronounced upward trend observed for arsenic. Hydrogen fluoride and total hydrocarbons also exhibited positive autocorrelation. These results indicate that the more recent concentrations may not be fully independent of preceding observations and may reflect sustained changes over time rather than isolated sampling events. The UPLs for these parameters should therefore be interpreted with consideration of the observed temporal patterns. Hydrogen fluoride, total hydrocarbons, and arsenic should continue to be evaluated as additional stack testing results become available, and their UPLs should be updated if the trends persist.