

REPORT**Air Quality Existing Conditions and Impact Assessment***W12A Landfill Expansion EA, City of London, Ontario*

Submitted to:

Mike Losee, Division Manager, Solid Waste Management

City of London
300 Dufferin Avenue
PO Box 5035
London, Ontario
N6A 4L9

Submitted by:

Golder Associates Ltd.

1931 Robertson Road, Ottawa, Ontario, K2H 5B7, Canada

+1 613 542 0029

1648176

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1 e-copy City of London

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APPENDICES**APPENDIX A**

Background Air Quality

APPENDIX B

Emission Calculations

APPENDIX C

Dispersion Modelling

Acronyms and Glossary of Terms

Term / Acronym	Definition
AAQC	Ambient Air Quality Criteria
CAAQC	Canadian Ambient Air Quality Criteria (Federal)
CCME	Canadian Council of Ministers of the Environment
CEPA	<i>Canadian Environmental Protection Act</i>
C ₂ H ₃ Cl	Vinyl Chloride
CH ₄	methane
CO	Carbon monoxide
CO ₂	Carbon dioxide
CO ₂ e	Carbon dioxide equivalent
D/T	Dilution Threshold
EA	Environmental Assessment
EASR	Environmental Assessment Study Report
ECA	Environmental Compliance Approval
ECCC	Environment and Climate Change Canada
EPA	<i>Environmental Protection Act</i>
ESDM	Emission Summary & Dispersion Modelling
GHG	Greenhouse gas
GHGRP	Greenhouse Gas Emissions Reporting Program
H ₂ S	Hydrogen Sulphide
HSW	Household Special Waste
LFG	Landfill gas
LGCCS	Landfill gas collection & control system
MECP	Ministry of the Environment, Conservation and Parks
MRF	Material Recovery Facility
NAAQOs	National Ambient Air Quality Objectives
NAPS	National Air Pollution Surveillance Network
NO ₂	Nitrogen dioxide
NO _x	Oxides of nitrogen
N ₂ O	Nitrous Oxide
O. Reg.	Ontario Regulation
O ₃	Ozone

Term / Acronym	Definition
PM ₁₀	Particles nominally smaller than 10 µm in aerodynamic diameter
PM _{2.5}	Particles nominally smaller than 2.5 µm in aerodynamic diameter
POI	Point-of-Impingement
SO ₂	Sulphur dioxide
SPM	Suspended particulate matter (also Total Suspended Particulate or TSP)
ToR	Terms of Reference
TSD	Technical Support Document
US EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds

UNITS

Unit	Definition
Am ³ /hr	Actual cubic metre per hour
g/s	Grams per second
km	kilometre
Kt/yr	Kilotonnes per year
m	Metres
masl	Metres above sea level
OU/m ³	Odour units per cubic metre
OU/s	Odour units per second
µg/m ³	Micrograms per cubic metre
µm	Micrometres (also microns), one-millionth of a metre
scfm	Standard cubic feet per minute
Tonnes/yr	Tonnes per year

1.0 INTRODUCTION

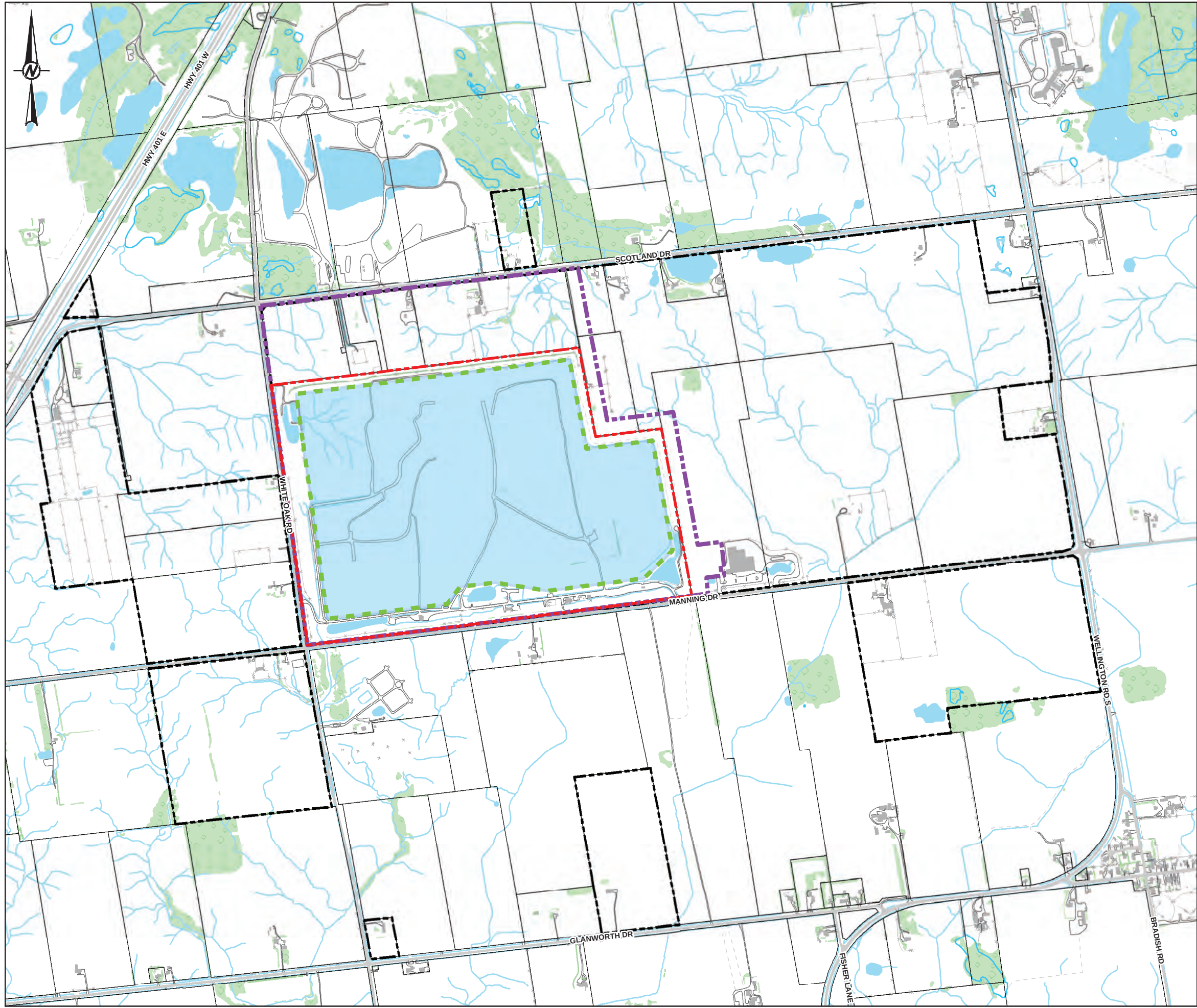
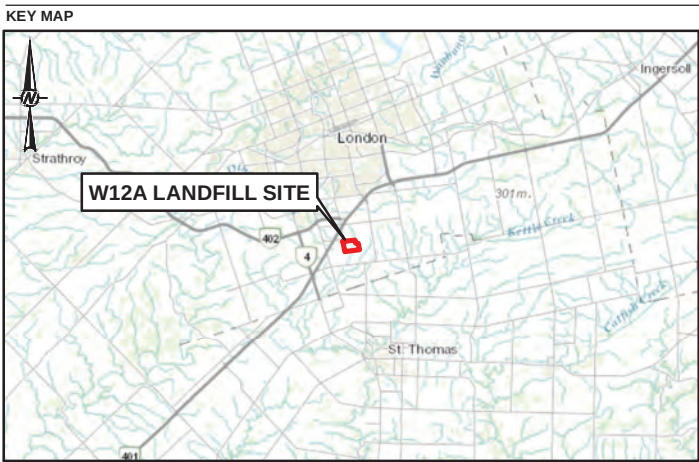
The City of London is proposing an expansion of the existing W12A Landfill site (the Project) located at 3502 Manning Drive, part of Lots 18, 19 and 20 of Concession 6 in the former Township of Westminster, in the south end of the City of London, Ontario.

Figure 1 presents the Project site location. The environment is considered in broad terms to include the natural, social, cultural, and economic aspects of the environment. This document presents the air quality component (a sub-component of Atmosphere) existing conditions and impact assessment for the Environment Assessment (EA) of the proposed W12A Landfill expansion. This work has been conducted in accordance with the requirements set out in the approved Amended Terms of Reference (ToR), dated February 2019 and the work plan, dated December 2019 prepared following commencement of the EA and circulated to the Ministry of the Environment, Conservation and Parks (MECP).

This report is a supporting document to the Environmental Assessment Study Report (EASR).

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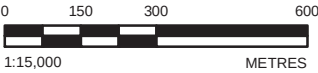


SCALE 1:750,000

LEGEND	
	WATERCOURSE
	DRIVEWAY
	FENCELINE
	TRAIL
	BUILDING FOOTPRINT
	WOODED AREA
	WATERBODY
	CITY OWNED PROPERTY
	EXISTING PROPERTY BOUNDARY
	PROPOSED PROPERTY BOUNDARY
	EXISTING APPROVED LIMIT OF WASTE
	PROPOSED LIMIT OF WASTE

REFERENCE(S)
1. DATA PROVIDED BY THE CITY OF LONDON.
2. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: UTM ZONE 17 VERTICAL DATUM: CGVD28

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CLIENT CORPORATION OF THE CITY OF LONDON			
PROJECT ENVIRONMENTAL ASSESSMENT OF THE PROPOSED W12A LANDFILL EXPANSION: AIR QUALITY AND ODOUR			
TITLE SITE LOCATION PLAN			
CONSULTANT 	CLIENT	YYYY-MM-DD	2020-08-19
	DESIGNED	----	----
	PREPARED	JEM	----
	REVIEWED	----	----
	APPROVED	----	----
PROJECT NO. 1648176	PHASE 0020	REV. A	FIGURE 1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 28mm

2.0 METHODOLOGY

The general approach used for assessing the atmospheric effects of the proposed undertaking, and documented in this assessment, supports the philosophy of the EA as a planning and decision-making process and conforms to the general methodology presented in the approved Amended ToR. The specific study methods used in the assessment are described in the following sections.

2.1 Study Area

For the purposes of the air quality and odour assessment, there are two study areas, as follows:

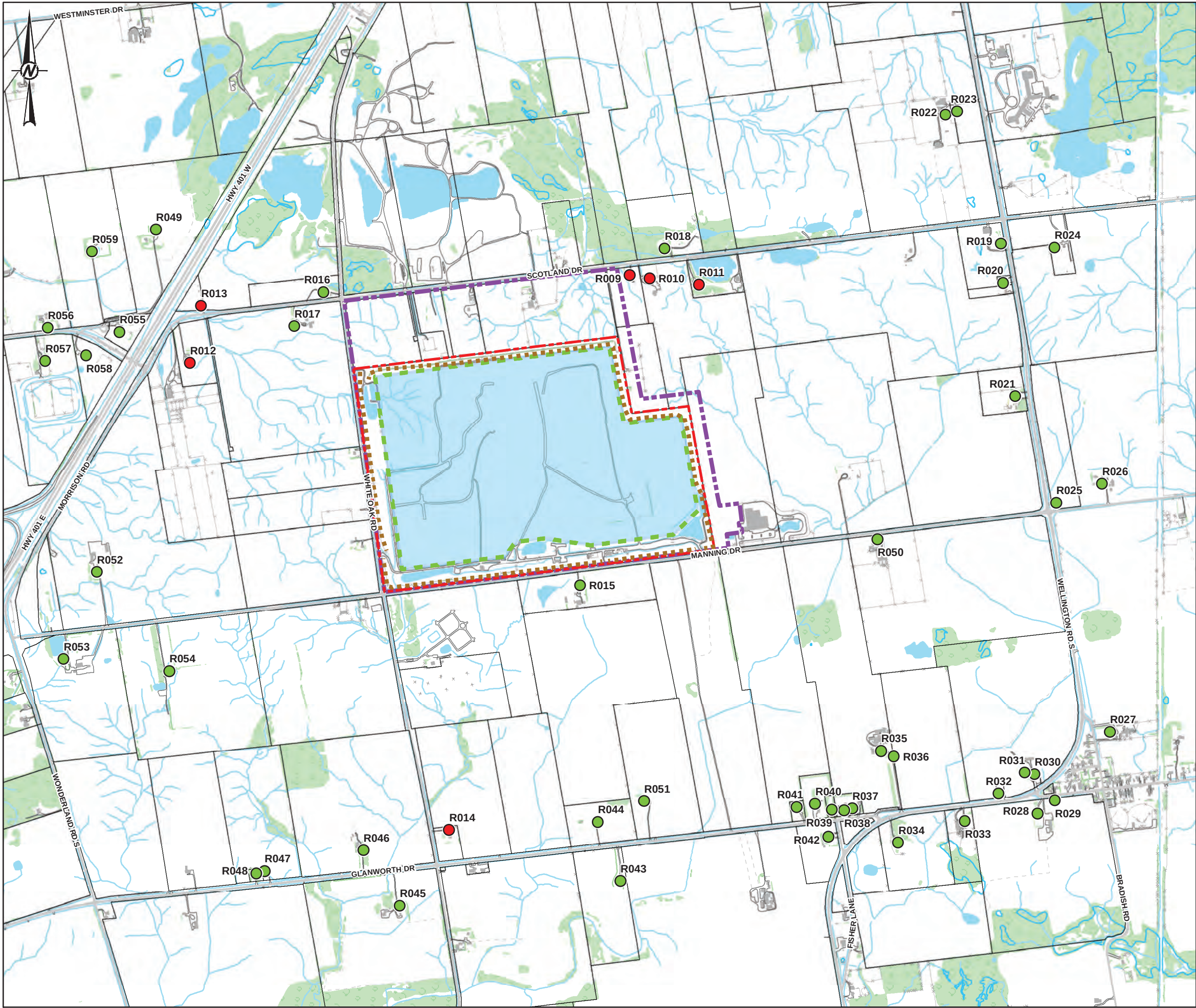
Site Area – The existing W12A Landfill Site, located at 3502 Manning Drive and adjacent lands where landfill expansion will occur.

Site-vicinity Study Area – The lands in the area immediately adjacent to the Site Area that have the potential to be directly affected by the landfill expansion and activities with the Site Area. The extent of the Site-vicinity Study Area will be determined for each of the environmental components. For most environmental components, a Site-vicinity Study Area of 500 metres (m) from the Site Area is appropriate. Air (health-related compounds) and dust emissions are required to meet provincial requirements at and beyond the landfill site boundary. Air dispersion modelling to demonstrate compliance with provincial requirements has been carried out in accordance with the MECP modelling guidelines (MECP, 2017), which includes the use of a receptor grid that meets the requirements of s.14 of Ontario Regulation (O. Reg.) 419/05. Odour emissions are required to meet provincial requirements at off-site sensitive receptors. Odour emissions may travel further than 500 m but any effects are expected to be within 1.5 kilometres (km) of the Site Area.

The locations of the closest sensitive receptors in all wind directions have been identified and reviewed for inclusion in the air dispersion model. Sensitive receptor locations were identified using the MECP definition in section 30(8) of O. Reg. 419/05 and the definition of “human receptors” in MECP guidance document “Methodology for Modeling Assessments of Contaminants with 10 Minute Average Standards and Guidelines under O. Reg. 419/05” (MECP, 2016). Specifically, locations where “human activities regularly occur” or that meet any of the following definitions:

- a health care facility
- a senior citizens’ residence or long-term care facility
- a child care facility
- an educational facility
- a dwelling
- a place where discharges of a contaminant may cause a risk to human health

Consideration was given to receptors that are greater than 1.5 km from the Study Area but limited to the closest sensitive receptors for a given wind direction. Sensitive receptors included in the air quality and odour assessment are illustrated on Figure 2. The majority of the sensitive receptors identified were dwellings. Several of these receptors are owned by the City but have been included in the assessment if they are still occupied.

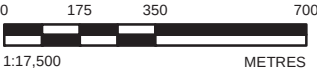


LEGEND

- CITY OWNED PROPERTY - EXISTING
- NON-CITY OWNED PROPERTY - EXISTING
- WATERCOURSE
- DRIVEWAY
- FENCELINE
- TRAIL
- APPROXIMATE BERM LOCATION
- BUILDING FOOTPRINT
- WOODED AREA
- WATERBODY
- EXISTING PROPERTY BOUNDARY
- PROPOSED PROPERTY BOUNDARY
- EXISTING APPROVED LIMIT OF WASTE
- PROPOSED LIMIT OF WASTE

REFERENCE(S)
1. DATA PROVIDED BY THE CITY OF LONDON.
2. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: UTM ZONE 17 VERTICAL DATUM: CGVD28

DRAFT



CLIENT CORPORATION OF THE CITY OF LONDON			
PROJECT ENVIRONMENTAL ASSESSMENT OF THE PROPOSED W12A LANDFILL EXPANSION: AIR QUALITY AND ODOUR			
TITLE SENSITIVE RECEPTOR LOCATIONS			
CONSULTANT 	YYYY-MM-DD	2020-08-19	
	DESIGNED	----	
	PREPARED	JEM	
	REVIEWED	----	
PROJECT NO. 1648176	PHASE 0020	REV. A	FIGURE 2

2.2 Timeframe

The air quality and odour assessments focus on the operations phase of the project. During the post-closure phase, the only anticipated activities potentially related to emissions to the air are ongoing leachate collection and treatment, landfill gas (LFG) management, site performance monitoring, and maintenance. Once, the landfill operational activities have ceased, a final landfill cover will be in place and the LFG management system will be operating over the whole landfill; therefore, the overall emissions from the Project during the post-closure phase will be less than during the operational phase.

2.3 Indicator Compounds

The assessment of air quality focuses on predicting changes in the concentrations of indicator compounds. These indicator compounds represent compounds that are typically emitted from landfills, have the highest potential to cause adverse and/or non-mitigatable effects, and for which air quality criteria exist:

- **Particulate matter:** suspended particulate matter (SPM), particles nominally smaller than 10 µm in diameter (PM₁₀), and particles nominally smaller than 2.5 µm in diameter (PM_{2.5})
- **Combustion gases:** Nitrogen oxides (NO_x) represented by nitrogen dioxide (NO₂), sulphur dioxide (SO₂), and carbon monoxide (CO)
- **Other Indicator Compounds:** hydrogen sulphide (H₂S), vinyl chloride (C₂H₃Cl), odour (expressed as whole odour (OU/m³))

These compounds are associated with various landfill operations. Particulate matter is typically associated with airborne dust from vehicles travelling on on-Site paved roads and unpaved roads/haul routes, as well as material loading and unloading activities. Products of combustion (NO₂, SO₂ and CO) are associated with the exhaust from on-Site vehicles. Emissions of hydrogen sulphide and vinyl chloride are the result of breakdown of waste material within the landfill. To determine air quality impacts, the air quality predicted to result from the emissions from the proposed undertaking will be compared to existing ambient air quality objectives and criteria limits for the above compounds.

Ozone (O₃) has been identified as an indicator for the project because although it will not be directly emitted as a result of the project works and activities, it will be used to calculate NO₂ in the effects assessment. Ozone is not emitted directly into atmosphere but is associated with the reaction of NO_x and Volatile Organic Compounds (VOCs) (MECP 2018).

Odour represented as an odour threshold value (OTV) and described as “odour units” (OU/m³), is the primary method used in Ontario to quantify the presence of odorous compounds in air. The concentration of whole odour can be measured at a facility and evaluated through the use of an odour panel. The panel is exposed to the odorant at various dilution thresholds (D/T). Due to the variability in human perception of odour, the point at which 50 percent of the panel can detect the odour is used as the threshold odour concentration. An odour unit (OU) is the number of dilutions required to reduce the odour to its detection threshold and is the emission variable used in dispersion modelling.

An odour concentration (as an OU) is not an indicator of the offensiveness of a particular odour. Offensiveness is a subjective factor that varies by individual, thus has not been considered in this analysis.

2.4 Applicable Guidelines

The relevant air quality criteria used for screening the air quality effects of the Project include the Ontario criteria and federal standards and objectives where provincial guidelines are not available. The MECP has set guidelines related to ambient air concentrations that are summarized in *Ontario's Ambient Air Quality Criteria* (AAQC) document (MECP 2018). The Ontario AAQCs are characterized as desirable ambient air concentrations, they are an indicator of the air quality in an area. They are not regulatory limits and therefore can be exceeded. The Ontario AAQCs are used for screening the air quality effects in environmental assessments, for studies using ambient air monitoring data, and for assessment of general air quality in a community or across the province (MECP 2018).

There are two sets of federal objectives and criteria: the National Ambient Air Quality Objectives (NAAQOs) and the Canadian Ambient Air Quality Standards (CAAQSS) (formerly National Ambient Air Quality Standards (NAAQS)). Similar to the Ontario AAQCs, the NAAQOs are benchmarks that can be used to facilitate air quality management on a regional scale and provide goals for outdoor air quality that protect public health, the environment, or aesthetic properties of the environment (CCME 1999). The federal government has established the following levels of NAAQOs (Health Canada 1994):

- The maximum **Desirable** level defines the long-term goal for air quality and provides a basis for an anti-degradation policy for unpolluted parts of the country and for the continuing development of control technology.
- The maximum **Acceptable** level is intended to provide adequate protection against adverse effects on soil, water, vegetation, materials, animals, visibility, personal comfort, and well-being.

The CAAQSS have been developed under the *Canadian Environmental Protection Act, 1999*, and include standards for PM_{2.5}, NO₂, SO₂ and ozone that must be achieved by 2020. In 2015 the standard was phased in, with the final standard phase-in date in 2020 (Government of Canada 2013). Like the Ontario AAQCs, the CAAQSS are not regulatory limits and are used as national targets for PM_{2.5}, NO₂, SO₂ and ozone, excluding Quebec (CCME 2014). These more stringent standards were adopted because, as stated by the CCME (emphasis added):

Canadians living in heavily populated and industrialized areas of the country may be exposed to potentially harmful levels of outdoor air pollutants, at concentrations that exceeded established standards. (CCME 2014)

However, the key aspect of “CAAQS Achievement” (i.e., compliance), as stated by the CCME, is (emphasis added):

Achievement of the CAAQS means that the measured air pollutant concentration in an air zone does not exceed the CAAQS numerical value. (CCME 2014)

These values are reported based on a series of monitoring stations located in airsheds across Canada and, in this context, an “air zone” refers to a local or regional sub-region of the established provincial or territorial airsheds. Currently, Southern Ontario and Southern Quebec are treated as a single Airshed (East Central) and Southern Ontario, excluding Hamilton and Sarnia, is designated as a single air zone.

For conservatism in this assessment, the lower of the Ontario AAQCs and the CAAQS, where applicable, were used for comparison to the maximum modelled concentrations. However, comparing the maximum predicted concentrations to the CAAQS standards is not appropriate for the following reasons:

- Neither the Site Area nor the Site-vicinity Study Area represent an “air zone”, the region over which the CCME states that achievement of the CAAQS is to be evaluated/compared.
- There are not heavily populated or industrialized areas located within the Site-vicinity Study Area. Therefore, there is no exposure pathway by which:
 - *Canadians living in heavily populated and industrialized areas of the country may be exposed to potentially harmful levels of outdoor air pollutants, at concentrations that exceeded established standards. (CCME 2014)*

A summary of the applicable Ontario and federal objectives and criteria are listed in Table 1.

For Odour, the MECP uses a guideline of 1 odour unit (OU/m³) based on the 99.5 percentile on a 10-minute time averaging period to assess the potential for nuisance. 1 OU/m³ is the concentration at which 50% of the population can perceive an odour, therefore 1 OU/m³ is typically used as an indicator for the likelihood of nuisance.

3.0 EXISTING CONDITIONS

The environment potentially affected by the Project can be delineated as the combination of the existing background air quality and the contribution from the approved activities at the W12A Landfill. The background air quality represents the existing conditions of air quality before the Project. Sources include industrial facilities, roadways, long range transboundary air pollution, small regional sources and large industrial sources.

Available data can be used to characterize the background air quality within the Site-vicinity Study Area; however, it cannot accurately describe the variations in concentrations that will result from emissions from existing sources at the Site (i.e., existing conditions). The approach used to describe the existing sources is described below.

- The existing air quality was characterized using a combination of existing information and dispersion models.
- Field studies were not undertaken to characterize the existing air quality. Adequate data was available from existing sources to characterize regional air quality and was used to describe background air quality within the Site-vicinity Study Area.
- The existing air quality described in Section 3.1 considers the combination of the background air quality from regional ambient monitoring stations with the modelled existing air quality from the approved sources at the W12A Landfill.

Table 1: Relevant Ambient Air Quality Criteria for Indicator Compounds

Substance	Averaging Period	Ontario Ambient Air Quality Guidelines ^(a) (µg/m ³)	Canadian Ambient Air Quality Standards ^(b) (µg/m ³)	National Ambient Air Quality Standards and Objectives ^(c) (µg/m ³)	
				Desirable	Acceptable
SPM^(d)	24-Hour	120	—	—	120
	Annual	60^(e)	—	60	70
PM₁₀	24-Hour	50^(f)	—	—	—
PM_{2.5}	24-Hour	30 ^(g)	27^(g)	—	—
	Annual	—	8.8	—	—
NO₂	1-Hour	400^(h)	79⁽ⁱ⁾	—	400
	24-Hour	200^(h)	—	—	200
	Annual	—	22.5⁽ⁱ⁾	60	100
SO₂	10 Minute	180	—	—	—
	1-Hour	100	170.34 ^(j)	450	900
	24-Hour	—	—	150	300
	Annual	10	10.5 ^(j)	30	60
CO	1-Hour	36,200	—	15,000	35,000
	8-Hour	15,700	—	6,000	15,000
O₃	1-Hour	165	—	100	160
	8-Hour	—	123.6	—	—
H₂S	10 Minute	13	—	—	—
	24-Hour	7	—	—	—
Vinyl Chloride	24-Hour	1	—	—	—
	Annual	0.2	—	—	—

Notes:

(a) MECP (2018)

(b) CAAQS published in the Canada Gazette Volume 147, No. 21 - May 25, 2013. Final standard phase in date of 2020 used (CCME 2014).

(c) CCME (1999)

(d) SPM in Ontario is defined as Suspended Particulate Matter (<44 µm diameter)

(e) Geometric mean

(f) Interim AAQC and is provided as a guide for decision making (MECP 2018)

(g) Compliance is based on the 98th percentile of the annual monitored data averaged over three years of measurements.(h) Standard is for nitrogen oxides (NO_x) but is based on the health effects of NO₂.(i) Canadian ambient air quality standard for NO₂ is effective from 2025. The 1-hour standard is based on the three-year average of the 98th percentile of the daily maximum 1-hour average concentration.(j) Canadian ambient air quality standard for SO₂ is effective from 2025. The 1-hour standard is based on the three-year average of the 98th percentile of the daily maximum 1-hour average concentration.**Bolded** values represent the criteria used in the assessment.

3.1 Air Quality Monitoring Data

Background air quality was characterised using observations from the Environment and Climate Change Canada (ECCC) National Air Pollution Surveillance Network (NAPS) air quality monitoring stations (ECCC 2019). The closest air quality monitoring station is located at 42 St. Julien Street in London (London Station). Two other NAPS air quality monitoring stations were selected, West Avenue and Homewood in Kitchener (Kitchener Station), and Beasley Park Hamilton Downtown in Hamilton (Hamilton Station). The location of these air monitoring stations is shown on Figure 3.

The Project is located in a rural location; however, it is located adjacent to Highway 401. A wind-rose for the area is provided in Appendix A and indicates that the predominant wind direction is from the south-west. The London Station (NAPS ID 60904) is the closest NAPS station to the Project (approximately 12 km north-east), so it is expected that the Project will experience similar wind patterns and impacts from regional transport of compounds as this station. It is similarly situated near residential areas. All indicator compounds with the exception of CO and SO₂ are monitored at this station.

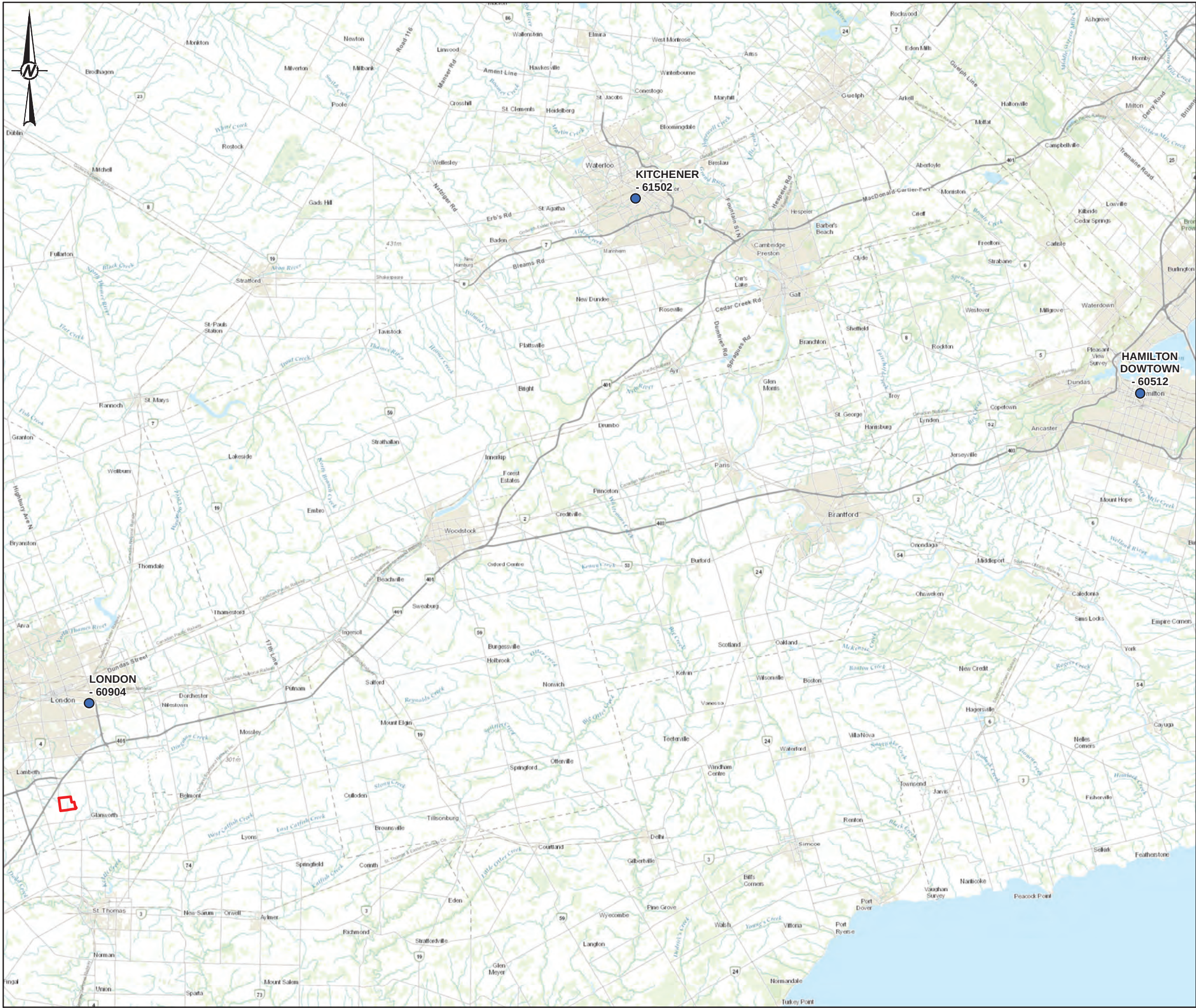
The Kitchener NAPS station (61502) located approximately 87 km away was selected due to Kitchener's similar size, industry and proximity to Highway 401 as London. All indicator compounds with the exception of CO and SO₂ are monitored at this station. The Hamilton station was selected for the CO and SO₂ data as it was the most representative station that monitors these compounds.

There is no monitoring data available for SPM and PM₁₀, however, the background SPM and PM₁₀ concentrations can be estimated from the available PM_{2.5} monitoring results. PM_{2.5} is a subset of PM₁₀, and PM₁₀ is a subset of SPM. Therefore, it is reasonable to assume that the ambient concentrations of SPM will be greater than corresponding PM₁₀ levels, and PM₁₀ concentrations will be greater than the corresponding levels of PM_{2.5}. The mean levels of PM_{2.5} in Canadian locations are found to be about 54% of the PM₁₀ concentrations and about 30% of the SPM concentrations (Lall et al. 2004). By applying this ratio, it is possible to estimate the background SPM and PM₁₀ concentrations for the study area.

Hydrogen sulphide is not measured at any of the above three stations, therefore the 1-hour background concentration was taken from the ECCC's draft screening Assessment for H₂S (ECCC, 2017) and converted to the relevant averaging periods using MECP recommended methodologies in the *Air Dispersion Modelling Guideline for Ontario* (MECP, 2017)

Background air quality data was primarily taken from the London Station as this is the closest site to the Study Area. A copy of the full Background air quality study is included as Appendix A.

The background air quality is provided in Table 2 and compared to the air quality criteria identified in Section 2.4. All background concentrations used in the assessment are below the relevant air quality criteria.



LEGEND

AMBIENT AIR MONITORING STATION

W12A LANDFILL SITE

REFERENCE(S)

1. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: UTM ZONE 17 VERTICAL DATUM: CGVD28

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0 3,900 7,800 15,600
1:400,000 METRES

CLIENT
CORPORATION OF THE CITY OF LONDON

PROJECT
ENVIRONMENTAL ASSESSMENT OF THE PROPOSED W12A
LANDFILL EXPANSION: AIR QUALITY AND ODOUR

TITLE
AIR QUALITY MONITORING STATIONS

CONSULTANT	YYYY-MM-DD	2020-08-19
	DESIGNED	----
	PREPARED	JEM
	REVIEWED	----
	APPROVED	----

PROJECT NO.
1648176

PHASE
0020

REV.
A

FIGURE
3

Table 2: Background Air Quality

Indicator	Averaging Period	Air Quality Criteria ($\mu\text{g}/\text{m}^3$)	Background Concentrations ($\mu\text{g}/\text{m}^3$)	Percentage of Air Quality Criteria (%)
SPM	24-hour	120	45.83	38.2%
	Annual	60	26.85	44.8%
PM ₁₀	24-hour	50	25.46	50.9%
PM _{2.5}	24-hour	27	13.75	50.9%
	Annual	8.8	8.06	91.6%
NO ₂	1-Hour	400/ 79	22.57	5.6%/28.6%
	24-Hour	200	19.87	9.9%
	Annual	32	11.70	52.0%
SO ₂	10-min	180	56.19	31.2%
	1-Hour	100	34.05	34.1%
	24-Hour	150	32.36	21.6%
	Annual	10	9.08	90.8%
CO	1-Hour	15,000	458.10	3.1%
	8-Hour	6,000	572.62	9.5%
O ₃	1-Hour	165	88.31	53.5%
	8-Hour	123.6	105.43	85.3%
H ₂ S	10-min	13	0.84	6.5%
	24-hour	7	0.21	3.0%
Vinyl Chloride	24-Hour	1	0.00382	0.4%
	Annual	0.2	0.00147	0.7%

3.2 Review of Existing Odour Complaints Data

In 2019, a total of 58 odour complaints were received by the City in relation to W12A Landfill. This value is similar to the number of complaints received in 2018 (62 complaints) but higher than in previous years (19 in 2014, 21 in 2015, 17 in 2016, 34 in 2017).

A review of the odour complaint records for the landfill in 2019 was conducted to identify the likelihood that the landfill may have contributed to each odour complaint. This was undertaken through a review of the location from which the complaint was made and corresponding wind direction at the time the complaint was logged. If the area of the complaint did not appear to be reasonably downwind of the W12A Landfill at the time the complaint was logged, it was deemed unlikely that W12A Landfill was a significant contributor to the complaint and thus the corresponding data was not used for further analysis.

Of the 58 odour complaints received in 2019, eight complaints were excluded based on wind direction, leaving 50 complaints that may reasonably be attributed, in whole or in part, to the W12A Landfill. These 50 complaints were received from 30 different reported addresses surrounding the Site with the majority recorded at addresses along the western end of Manning Drive.

Figure 4, below shows the frequency of complaints received for each wind direction. The majority of odour complaints have historically been recorded during times when winds are blowing from the east.

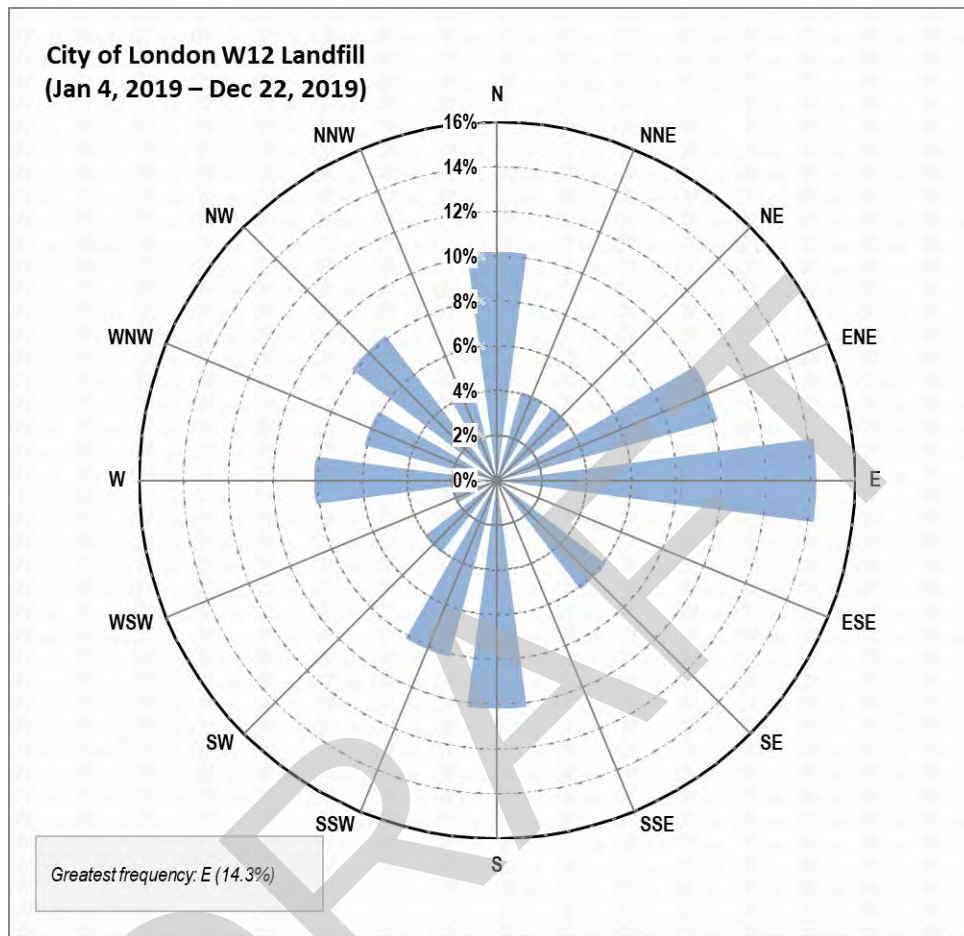


Figure 4: Odour Rose for 2019 Odour Complaints Potentially Attributed to W12A Landfill

3.3 Modelled Air Quality from Existing Sources

As described in Section 3.0, the existing air quality in the Site-vicinity Study Area was described using a combination of background air quality for the region and the modelled air quality resulting from the emissions of approved sources at the existing Site. Existing approved on-Site sources of air emissions include:

- landfill gas generated from waste decomposition
- by-products from combustion of landfill gas in the flare
- traffic, loading and unloading
- on-Site vehicle emissions
- landfill waste receipt activities
- landfill daily and final cover activities

The AERMOD model (Version 19191) was used to predict concentrations at a series of off-Site locations, referred to as receptors. These off-Site receptors included a series of receptors placed at nearby residences (referred to as sensitive receptors and illustrated on Figure 2). Model predictions for most of the indicator compounds are presented as the highest value from any modelled receptor.

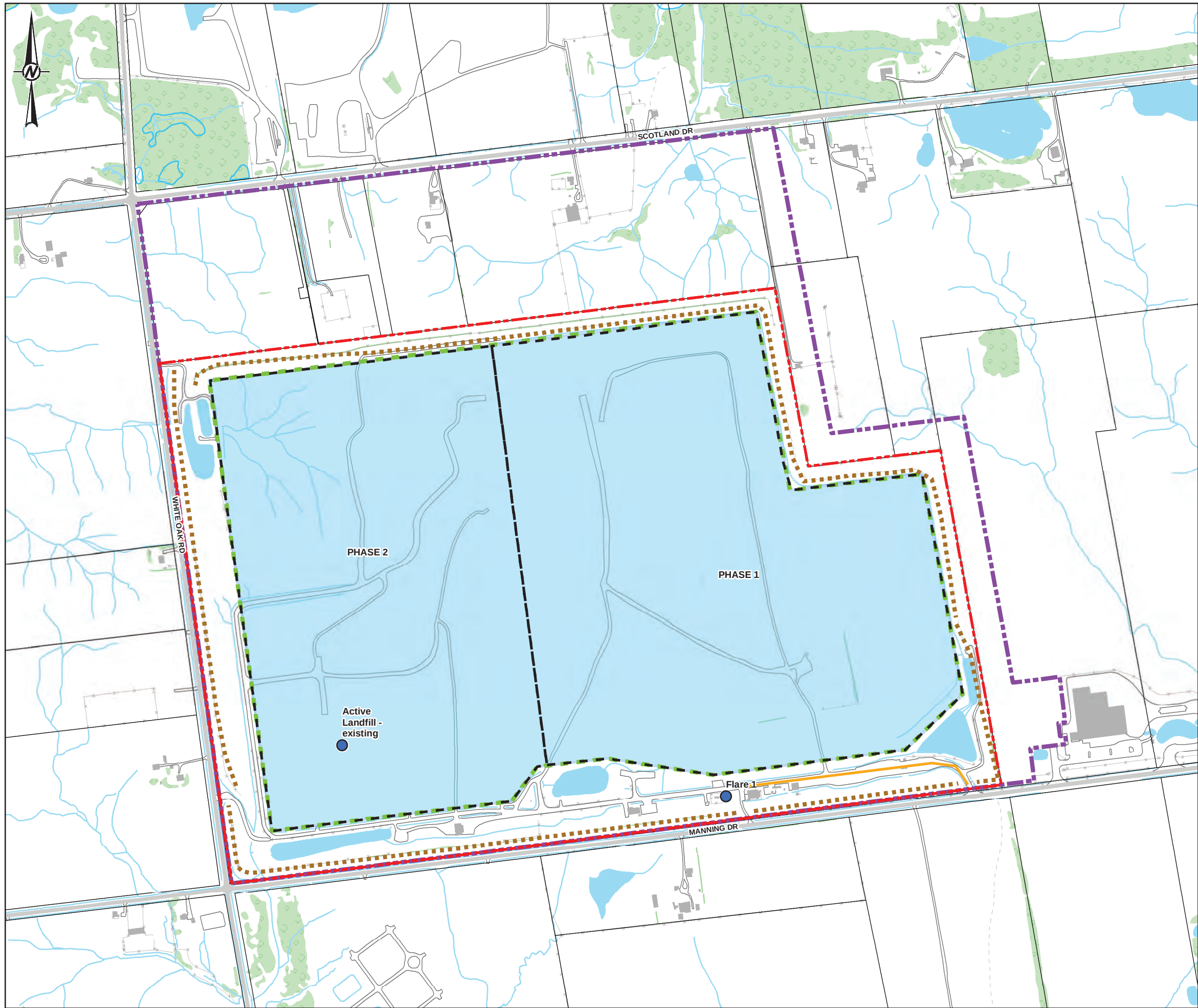
More details regarding the development of emission calculations are provided in Appendix B and additional details regarding the dispersion modelling set-up are provided in Attachment C. The locations of existing Emission Sources are illustrated on Figure 5.

Table 3 lists the emission rates from the W12A Landfill that were used to characterize the air quality in the Site-vicinity Study Area from currently approved sources, based on the emission rate calculations described in Appendix B.

Table 3: Existing Emissions from W12A Landfill

Compound	Units	Emission Rate
SPM	g/s	1.828
PM ₁₀	g/s	0.494
PM _{2.5}	g/s	0.198
NO _x	g/s	0.959
SO ₂	g/s	0.078
CO	g/s	1.612
H ₂ S	g/s	0.020
C ₂ H ₃ Cl	g/s	0.002
Odour	OU/s	5779.04

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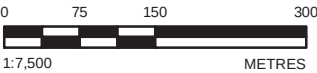


LEGEND

- AIR EMISSION SOURCE
- WATERCOURSE
- DRIVEWAY
- FENCELINE
- TRAIL
- APPROXIMATE BERM LOCATION
- BUILDING FOOTPRINT
- WOODED AREA
- WATERBODY
- EXISTING PROPERTY BOUNDARY
- PROPOSED PROPERTY BOUNDARY
- EXISTING APPROVED LIMIT OF WASTE
- PROPOSED LIMIT OF WASTE
- ROADWAY TYPE**
- DECOMPOSABLE WASTE

REFERENCE(S)
1. DATA PROVIDED BY THE CITY OF LONDON.
2. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: UTM ZONE 17 VERTICAL DATUM: CGVD28

DRAFT



CLIENT CORPORATION OF THE CITY OF LONDON			
PROJECT ENVIRONMENTAL ASSESSMENT OF THE PROPOSED W12A LANDFILL EXPANSION: AIR QUALITY AND ODOUR			
TITLE SITE LAYOUT AND EMISSION SOURCE LOCATION: EXISTING			
	CONSULTANT	YYYY-MM-DD	2020-08-19
	DESIGNED	----	
	PREPARED	JEM	
	REVIEWED	----	
	APPROVED	----	
PROJECT NO. 1648176	PHASE 0020	REV. A	FIGURE 5

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM:
28mm

The predicted model concentrations as a result of the existing approved activities at the W12A Landfill are summarized in Table 4. These numbers represent the maximum predicted concentrations at sensitive receptors.

Table 4: Maximum Predicted Air Quality Concentrations from Existing Approved Activities

Indicator	Averaging Period	Maximum Predicted Concentration - Existing Approved Activities ($\mu\text{g}/\text{m}^3$)
SPM	24-hour	12.01
	Annual	2.15
PM ₁₀	24-hour	5.35
PM _{2.5}	24-hour	1.57
	Annual	0.23
NO ₂ ^(a)	1-hour	119.32
	24-hour	84.60
	Annual	2.87
SO ₂	10-min	0.39
	1-hour	0.24
	24-hour	0.07
	Annual	0.004
CO	½-hour	789.52
	1-hour	657.93
	8-hour	97.09
H ₂ S	10-min	2.58
	24-hour	0.41
C ₂ H ₃ Cl	24-hour	0.034
	Annual	0.006
Odour ^(b)	10-min	0.55

Notes:

(a) NO₂ concentrations are calculated from the predicted NO_x concentrations as described in Attachment C.

(b) Values are in OU/m³ and presented at the 99.5 percentile

(c) In accordance with Ontario guidance (MECP, 2017), meteorological anomalies have been removed when calculating the maximum predicted concentrations.

3.4 Existing Air Quality

The existing air quality conditions against which the Project will be evaluated are a combination of background air quality for the region and the modelled air quality resulting from the emissions of currently approved sources at the existing Site. Table 5 provides a summary of the existing conditions for each of the indicator compounds.

Table 5: Existing Air Quality (background plus currently approved activities)

Indicator	Averaging Period	Background Air Quality ($\mu\text{g}/\text{m}^3$) ⁽¹⁾	Maximum Predicted Concentration – Currently Approved Activities ⁽²⁾ ($\mu\text{g}/\text{m}^3$)	Existing Air Quality ($\mu\text{g}/\text{m}^3$)
SPM	24-hour	45.83	12.01	57.84
	Annual	26.85	2.15	29.00
PM ₁₀	24-hour	25.46	5.35	30.81
PM _{2.5}	24-hour	13.75	1.57	15.32
	Annual	8.06	0.23	8.29
NO _x	1-hour	22.57	119.32	141.89
	24-hour	19.87	84.60	104.47
	Annual	11.70	2.87	14.57
SO ₂	10-minute	56.19	0.39	56.58
	1-hour	34.05	0.24	34.29
	24-hour	32.36	0.07	32.43
	Annual	9.08	0.0035	9.08
CO	½-hour	549.72	789.52	1,339.24
	1-hour	458.10	657.93	1,116.03
	8-hour	572.62	97.09	669.71
H ₂ S	10-min	0.84	2.58	3.42
	24-hour	0.21	0.41	0.62
C ₂ H ₃ Cl	24-hour	0.00382	0.0335	0.037
	Annual	0.00147	0.0057	0.007
Odour ⁽³⁾	10-min	—	0.55	0.55

Notes:

(1) Data from Table 2

(2) Data from Table 4

(3) Values are in OU/m³ and presented at the 99.5%ile

4.0 PROJECT DESCRIPTION

The landfill expansion consists of a vertical expansion over the existing landfill footprint to provide 13.8 million m³ of airspace for waste and daily cover. To accommodate ancillary features and provide additional on-Site buffer width compared to the existing landfill, the northern boundary of the landfill property will be adjacent to Scotland Drive and a 100 m buffer width will be provided on the east side of the landfill footprint and some additional area in the southeast corner to tie into the adjacent MRF property line. This results in a 106.3 ha landfill footprint within a 192.4 ha landfill property, with a highest ridge elevation of waste of 318.43 metres above sea level (masl).

The landfill expansion will be developed sequentially in eight Phases, 1E through 8E. The expansion will commence in Phase 1E in the southwest and in the non-decomposable cell in the southeast, which will involve progressive stripping of the existing cover material from the active area and the placement and compaction of waste and spreading of daily cover soil, compaction and daily covering of the waste. The daily cover will be mostly suitable types of materials incoming to the site on an ongoing basis, supplemented as needed by material from on-Site soil stockpiles. To reduce air emissions (for odour control purposes during landfilling operations and to increase the overall collection of landfill gases), it is proposed that a number of horizontal landfill gas collection pipes will also be installed progressively as waste is placed.

After completion of a cell and moving to the next disposal area (as per the phasing plan), final cover soil will be placed over the waste and revegetated and the vertical landfill gas collection system progressively installed with the final cover. During operations, vehicles will travel on the on-Site perimeter roads and on the haul roads located on the landfill, as well as to and from the soil stockpiles in the north buffer area. There will be ongoing maintenance and monitoring activities. The operations activities during the expansion will basically be a continuation of current site activities both on and adjacent to the existing landfill footprint, with raising of the landfill to reach the design configuration.

It is estimated that the total expanded landfill will theoretically generate a maximum of 4,395 standard cubic feet per minute (scfm) of LFG in 2049 (the year following completion of filling of the expansion), of which typically 50% is methane as noted in the main EA. LFG is collected from completed areas of the landfill using a vertical well system that is connected to an enclosed flare; the existing flare is sized to combust a maximum of approximately 1,700 scfm of LFG. Considering the actual extent of the LFG well extraction system and its current collection efficiency that is expected to be around 60%, analysis indicates that the capacity of the existing flare may be exceeded around year 2027.

The timing for installation of additional flare capacity will depend on the actual operation of the existing flare and its ability to handle the collected gas flow rate. It is proposed to utilize vertical LFG extraction wells with a collection efficiency of 85% to be progressively installed with the construction of final cover following placement of waste to final contours in each Phase.

5.0 IMPACT ASSESSMENT

The effects of the Project on air quality were identified for different phases of the expansion and involved the following three steps:

- Calculating representative emissions rates for each of the significant sources (detailed in Appendix B).
- Carrying out atmospheric dispersion modelling to predict off-Site concentrations of the indicator compounds (detailed in Appendix C).
- Comparison of predicted concentrations to existing conditions and the Applicable Guidelines (Section 2.4).

5.1 Emission Estimation

The method used for calculating and quantifying air emissions resulting from the proposed project involved the following steps:

- **Identifying emissions sources:** Emission sources were identified based on detailed project information provided by the City of London.
- **Calculating emission rates:** Air emission rates were calculated using accepted methods, such as published emission factors, and were based on design activity data provided by the engineering team. Emission rates were conservatively calculated to estimate the release rates into the atmosphere.

The emission estimation methods followed accepted MECP practices including, where applicable, guidance in the Ontario MECP document *Procedure for Preparing an Emission Summary and Dispersion Modelling Report Version 4.1* (MECP, 2018b).

In calculating these emissions, all potential sources for the proposed project were considered; however, only significant sources (i.e., existing daily cover stockpiles) were carried through to Step 2. Sources with emissions rates that were less than 1% of the site-wide emissions were considered insignificant. Additionally, infrequent operations were also considered insignificant (i.e., testing of standby power generators). Details of the specific emissions calculation methods and resulting emissions are provided in Appendix B.

5.2 Identification of Emission Sources

Table 6 outlines the activities (i.e., sources of emissions) that have been assessed as part of the air quality assessment for both the existing scenario and the expansion phases. For sources that were identified and not included in the assessment, the rationale has been presented in the table.

Emissions during normal operations and after expansion are expected to be greater than during the post-operation phase (i.e., closure) because the level of on-Site activities will be greater during the operational phase; therefore, the air emissions and associated effects during the project operational phase represent the greatest potential impacts.

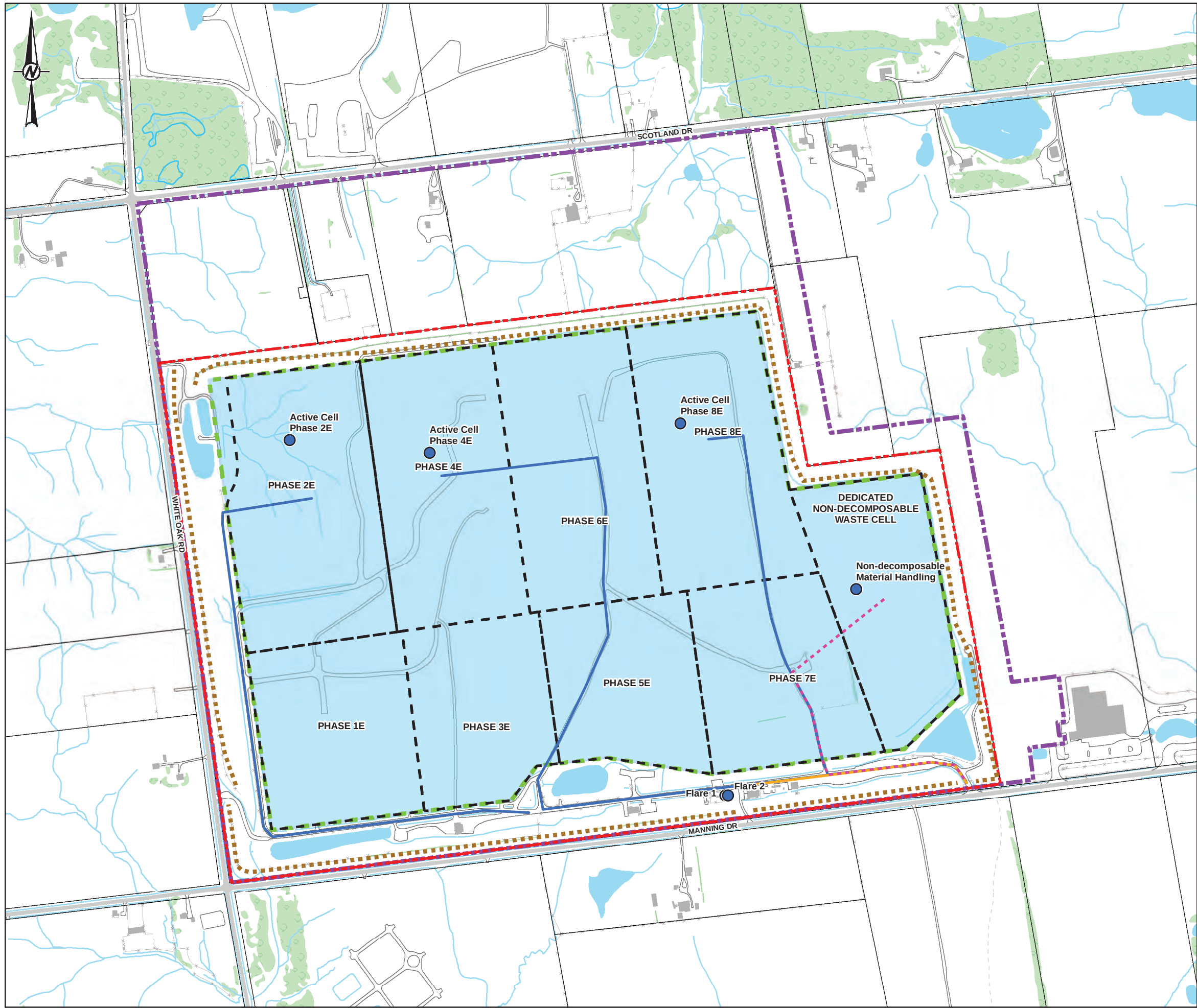
As the project will be conducted in eight phases, consideration was given to identifying the operational phase that results in the “worst case” emissions scenario. Three different phases were considered for this purpose:

- Phase 2E
- Phase 4E
- Phase 8E

These phases were selected as they have the longest on-Site vehicle access routes (i.e., result in largest fugitive dust and vehicle exhaust emissions). The location of Project Emission Sources is illustrated on Figure 6.

For odour, the main sources of emission are the active filling areas. As a result, all eight phases of the site were modelled and the active filling area for each respective phase was placed in the location closest to sensitive receptors, typically close to the site boundary. Emissions from the capped areas of the landfill were also modelled, using the existing landfill footprint. The location of the modelled odour sources is illustrated on Figure 7.

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LEGEND

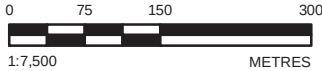
- AIR EMISSION SOURCE
- WATERCOURSE
- DRIVEWAY
- FENCELINE
- TRAIL
- APPROXIMATE BERM LOCATION
- BUILDING FOOTPRINT
- WOODED AREA
- WATERBODY
- EXISTING PROPERTY BOUNDARY
- PROPOSED PROPERTY BOUNDARY
- EXISTING APPROVED LIMIT OF WASTE
- PROPOSED LIMIT OF WASTE

ROADWAY TYPE

- DECOMPOSABLE WASTE
- NON-DECOMPOSABLE
- PHASE 2E, 4E, 8E

REFERENCE(S)
1. DATA PROVIDED BY THE CITY OF LONDON.
2. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: UTM ZONE 17 VERTICAL DATUM: CGVD28

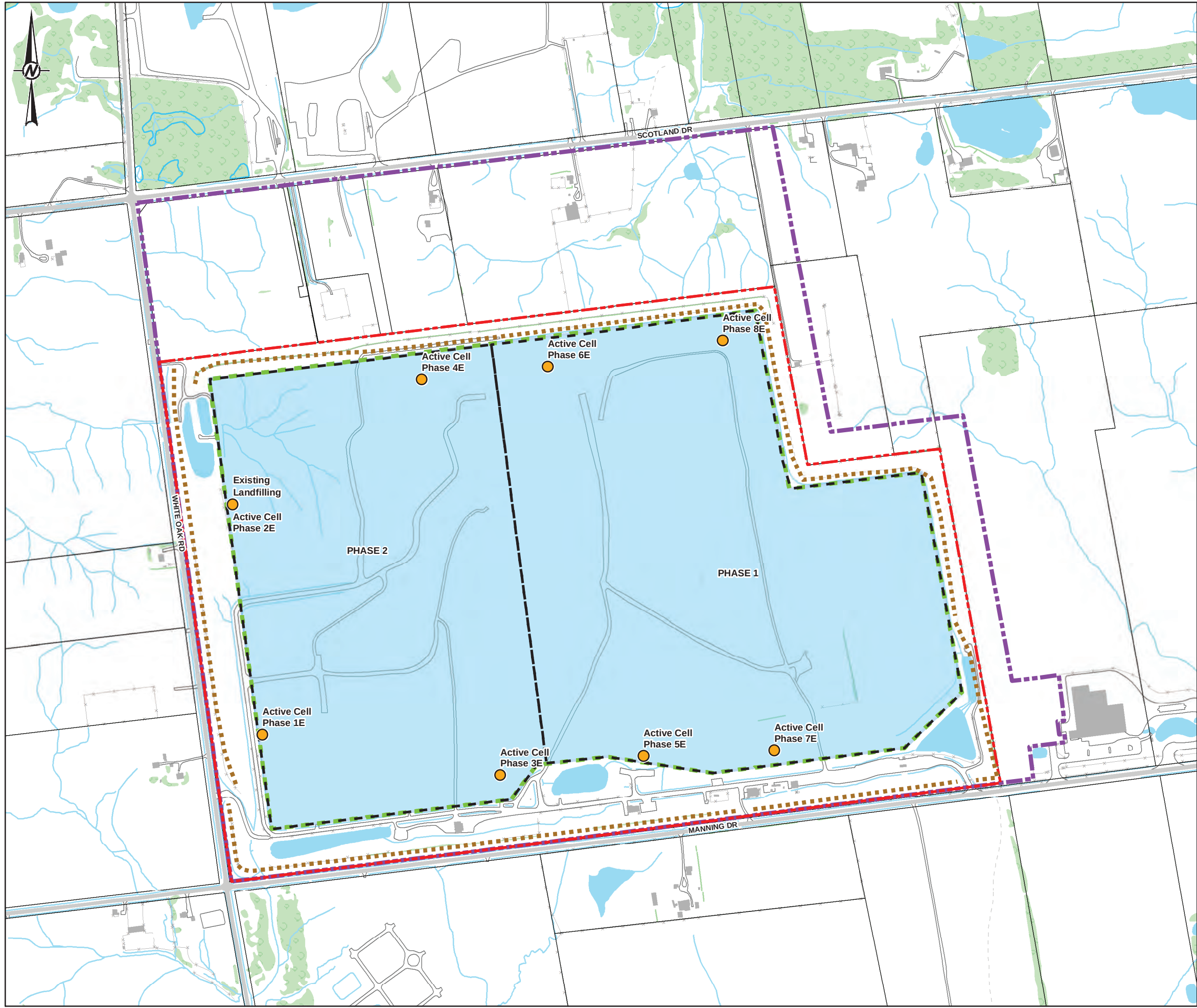
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CLIENT CORPORATION OF THE CITY OF LONDON			
PROJECT ENVIRONMENTAL ASSESSMENT OF THE PROPOSED W12A LANDFILL EXPANSION: AIR QUALITY AND ODOUR			
TITLE SITE LAYOUT AND EMISSION SOURCE LOCATION: EXPANSION			
	CONSULTANT	YYYY-MM-DD	2020-08-19
	DESIGNED	----	----
	PREPARED	JEM	----
	REVIEWED	----	----
	APPROVED	----	----
PROJECT NO. 1648176	PHASE 0020	REV. A	FIGURE 6

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 28mm

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LEGEND

- ODOUR EMISSION SOURCE
- PROPOSED LIMIT OF WASTE (LANDFILL CAP ODOUR EMISSION SOURCE)
- WATERCOURSE
- DRIVEWAY
- FENCELINE
- TRAIL
- APPROXIMATE BERM LOCATION
- BUILDING FOOTPRINT
- WOODED AREA
- WATERBODY
- EXISTING PROPERTY BOUNDARY
- PROPOSED PROPERTY BOUNDARY
- EXISTING APPROVED LIMIT OF WASTE

REFERENCE(S)
1. DATA PROVIDED BY THE CITY OF LONDON.
2. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: UTM ZONE 17 VERTICAL DATUM: CGVD28

DRAFT



CLIENT CORPORATION OF THE CITY OF LONDON		
PROJECT ENVIRONMENTAL ASSESSMENT OF THE PROPOSED W12A LANDFILL EXPANSION: AIR QUALITY AND ODOUR		
TITLE SITE LAYOUT AND EMISSION SOURCE LOCATION: ODOUR		
	CONSULTANT	YYYY-MM-DD 2020-08-19
	DESIGNED	----
	PREPARED	JEM
	REVIEWED	----
	APPROVED	----
PROJECT NO. 1648176	PHASE 0020	REV. A
		FIGURE 7

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 28mm

Table 6: Project Emission Sources

Source Information		Significant	Modelled	Rationale
General Location	Source	(Yes or No)?	(Yes or No)?	
Landfill	Landfill cap	Yes	Yes	—
	Landfill operations (material handling & vehicle exhaust)	Yes	Yes	—
Landfill gas collection & control system (LGCCS)	Enclosed LFG flare (existing)	Yes	Yes	—
	Enclosed LFG flare (proposed)	Yes	Yes	—
	Propane combustion equipment	No	No	Propane is used to ignite the pilot flame on the flare. The pilot flame is not ignited at the same time as the flare is operated with LFG, therefore combustion associated with the pilot flame is not included in the model as it does not represent the worst-case scenario.
Paved & unpaved roads	Vehicle exhaust and fugitive road dust	Yes	Yes	—
Storage piles	On-Site storage piles wind erosion	No	No	Emissions from wind erosion for the piles were calculated but are considered to be negligible in comparison to the other activities occurring on-Site.
Non-decomposable Area	Non-decomposable Area	Yes	Yes	—
Public Drop Off Area	Public Drop Off Area	No	No	These activities are considered to be negligible in comparison to the other activities occurring on-Site.
HSW building	HSW building	No	No	These activities are considered to be negligible in comparison to the other activities occurring on-Site.

Source Information		Significant	Modelled	Rationale
General Location	Source	(Yes or No)?	(Yes or No)?	
Leachate collection system	Leachate collection and treatment	No	No	The leachate is treated off-Site and therefore there are no emissions from on-Site leachate treatment. The Facility does have a capacity for below-grade temporary leachate storage, but it is not anticipated more than a few times per year.
Support activities	Emergency power generator(s)	No	No	The emergency power equipment only operates periodically (rather than continuously) and therefore produces emissions that are negligible relative to the overall emissions from the Site.
	Comfort Heating	No	No	These activities are considered to be negligible in comparison to the other activities occurring on-Site.
	Operational support activities, such as maintenance activities & stormwater ponds	No	No	These activities are considered to be negligible in comparison to the other activities occurring on-Site.

5.3 Emission Summary

Table 7 below summarizes the estimated emission rates for each indicator compound from the Project operations as identified in the previous sections. More details and the emissions per source are provided in Appendix B.

Table 7: Summary of Emission Rates from Project During Operation

Compound	Units	Operational Phase		
		Phase 2E	Phase 4E	Phase 8E
SPM	g/s	2.933	5.062	4.106
PM ₁₀	g/s	0.820	1.643	1.242
PM _{2.5}	g/s	0.311	0.411	0.379
NO _x	g/s	1.287	1.286	1.278
SO ₂	g/s	0.188	0.188	0.188
CO	g/s	1.988	1.988	1.985
H ₂ S	g/s	0.015	0.015	0.015
C ₂ H ₃ Cl	g/s	0.001	0.001	0.001
Odour	OU/s	4458.667	4458.667	4458.667

5.4 Dispersion Modelling

Atmospheric dispersion models were used to predict ground-level concentrations of indicator compounds. The models incorporate the emission rates for each scenario and local atmospheric conditions and terrain.

The AERMOD-PRIME (AERMOD) dispersion model (Version 19191) was used to predict ground-level concentrations for the indicator compounds. The AERMOD modelling system was developed by the United States Environmental Protection Agency (U.S. EPA) and has been adopted in Ontario as the regulatory model recommended by the MECP.

The AERMOD system consists of the dispersion model itself and two pre-processors; the AERMET meteorological pre-processor and the AERMAP terrain pre-processor. The following approved dispersion model and pre-processors were used in the assessment:

- AERMOD dispersion model (v.19191)
- AERMAP surface pre-processor (v.18081)

AERMET was not required since MECP provided a 5-year site-specific pre-processed meteorological dataset (2013-2017).

Results were predicted at the sensitive receptors, identified on Figure 2.

Additional details regarding the dispersion modelling inputs and source characterization are provided in Appendix C.

5.5 Effects Prediction

To determine potential effects of the proposed project on air quality and odour, the predicted concentrations of indicator contaminants were compared to the applicable guidelines identified in Section 2.4.

Background air quality conditions (i.e., the concentrations without any landfill activities) are also presented in Table 8, which are added to the predicted concentrations from the Project to provide the cumulative concentration for each indicator compound.

Maximum predicted concentrations for the expansion scenario (that presents the maximum predicted concentration from Phase 2E, 4E or 8E) at the sensitive receptors are presented in Table 8.

The maximum cumulative concentrations of all indicator compounds are below the relevant guidelines for all indicator compounds, with the exception of NO₂ on a 1-hour basis.

For NO₂, the maximum predicted 1-hour NO₂ concentration is greater than the CAAQS of 79 µg/m³; however, comparison to the CAAQS is not appropriate and the maximum predicted 1-hour NO₂ concentrations above the CAAQS standard is not significant because neither the Site Area nor the Site-vicinity Study Area represent an “air zone”, the region over which the CCME states that achievement of the CAAQS is to be evaluated/compared (Section 2.4).

The predicted 1-hr CAAQS for NO₂ can be calculated within the Site-vicinity Study Area using the model output; however, such a comparison is inherently biased by model input assumptions and is not suitable for comparison to monitoring based values such as the CAAQS that use a 3-year averaging period. The NO₂ emissions inventory for the Project are designed to be conservative and represent a ‘worst-case’ scenario. Project emissions assume all combustion sources (including the flare and heavy-duty truck traffic) operate at their peak intensity/load/capacity for each hour for 1-hr simulations. In reality, individual equipment will be idling or off for varying parts of the workday, which cannot be predicted but will result in lower emissions than currently estimated. The likelihood that all equipment operates simultaneously for an hour or more along with unfavourable weather conditions to produce the maximum concentrations modelled is very low. A less conservative but more appropriate comparison to the Ontario AAQC of 400 µg/m³ for 1-hr NO₂ would result in a maximum predicted concentration that is only about 32% of the relevant criteria.

As such, the predicted compound concentrations associated with the expansion are predicted to meet the relevant air quality criteria.

Table 8: Maximum Predicted Concentrations at the Sensitive Receptors for Proposed Project

Indicator	Averaging Period	Air Quality Criteria ($\mu\text{g}/\text{m}^3$)	Background Conditions ⁽¹⁾ ($\mu\text{g}/\text{m}^3$)	Maximum Predicted Concentration - Proposed Landfill Expansion ($\mu\text{g}/\text{m}^3$)	Cumulative Effect - Proposed Landfill Expansion ($\mu\text{g}/\text{m}^3$)	Percentage of Air Quality Criteria (%)
SPM	24-hour	120	45.83	23.26	69.09	57.6%
	Annual	60	26.85	3.11	29.96	49.9%
PM ₁₀	24-hour	50	25.46	9.36	34.82	69.6%
PM _{2.5}	24-hour	27	13.75	1.14	14.89	55.2%
	Annual	8.8	8.06	0.21	8.27	94.0%
NO ₂	1-hour	400/ 79	22.57	103.63	126.20	31.6%/159.8%
	24-hour	200	19.87	29.52	49.39	24.7%
	Annual	32	11.70	2.48	14.18	63.0%
SO ₂	10-min	180	56.19	1.22	57.41	31.9%
	1-hour	100	34.05	0.74	34.79	34.8%
	24-hour	150	32.36	0.17	32.53	21.7%
	Annual	10	9.08	0.01	9.09	90.9%
CO	1-hour	15,000	458.10	406.73	864.83	5.8%
	8-hour	6,000	572.62	72.16	644.78	10.7%
H ₂ S	10-min	13	0.50	0.52	1.36	10.5%
	24-hour	7	0.50	0.07	0.28	4.0%
C ₂ H ₃ Cl	24-hour	1	0.00334	0.006	0.0094	0.9%
C ₂ H ₃ Cl	Annual	0.2	0.00147	0.0011	0.0025	1.3%
Odour ⁽²⁾	10-min	1	—	0.69	0.69	Below 1 OU/m3

Notes:

⁽¹⁾ Existing conditions as described in Section 3.1

⁽²⁾ Values for odour are in odour units per cubic metre (OU/m³) and presented at the 99.5 percentile

“—” indicates that there is no data available for existing conditions.

5.6 Compliance With Ontario Regulation 419/05

In addition to the assessment of the effects of the Project on ambient air quality and odour, consideration was given to an evaluation of compliance by determining whether an Environmental Compliance Approval (ECA) for air and noise under Section 9 of the Environmental Protection Act could be obtained based on whether the facility is in compliance for those sources regulated under O. Reg. 419/05. At the landfill, this would include landfill gases and materials handling emissions only. All mobile equipment is exempt from compliance requirements under O. Reg. 419/05. In addition, assessment of compliance with O. Reg. 419/05 would not include any consideration of the background air quality. The table below summarizes the estimated emission rates for each indicator compound from the Project operations as identified in the previous sections suitable for assessment against O. Reg. 419/05. More details and the emissions per source are provided in Appendix B.

A modelling grid that satisfies s. 14 O. Reg. 419/05 assessment was used in modelling the indicator compounds. Emissions from tailpipe, bulldozing and road dust were not considered in O. Reg. 419/05 assessment as they can be excluded from modelling as per O. Reg. 524/98 and the ESDM Procedure Document.

Table 9: Summary of O. Reg. 419/05 Emission Rates

Compound	Units	Emission Rates from O. Reg. 419/05 Sources
SPM	g/s	0.307
NO _x	g/s	0.555
SO ₂	g/s	0.188
CO	g/s	0.657
H ₂ S	g/s	0.015
C ₂ H ₃ Cl	g/s	0.001
Odour	OU/s	4458.667

Maximum concentrations at the property boundary and the gridded receptors as per section 14 of O. Reg. 419/05 are presented in Table 10 and were predicted with the AERMOD dispersion model (as described in Section 5.4).

Table 10: Predicted Air Quality Compliance with O. Reg. 419/05

Indicator	Averaging Period	Air Quality Criteria ($\mu\text{g}/\text{m}^3$)	Maximum Predicted POI Concentration ($\mu\text{g}/\text{m}^3$)	Percentage of Air Quality Criteria (%)
SPM	24-hour	120	20.90	17.4%
NO _x	1-hour	400	9.28	2.3%
NO _x	24-hour	200	2.64	1.3%
SO ₂	1-hour	690	3.23	<1%%
SO ₂	24-hour	275	0.93	<1%%
CO	½-hour	6000	13.54	<1%%
H ₂ S	10-min	13	0.5398	4.2%
H ₂ S	24-hour	7	0.0912	1.3%
C ₂ H ₃ Cl	24-hour	1	0.0074	<1%
Odour ⁽¹⁾	10-min	1	0.69	Below 1 OU/m ³

Notes: ⁽¹⁾ Values for odour are in odour units per cubic metre (OU/m³) and presented at the 99.5 percentile at sensitive receptors.

The assessment indicates that the proposed facility will be in compliance with Schedule 3 of O. Reg. 419/05.

6.0 CONSIDERATION OF CLIMATE CHANGE

The potential effects of climate change on infrastructure associated with the Project have been included in this report in an effort to qualitatively assess potential climate change effects. Ways that the project could reduce greenhouse gas (GHG) emissions or remove GHGs from the atmosphere have also been considered.

The activities at the Project that will produce GHGs include the following:

- landfill gas
- stationary combustion emissions from the flare(s)
- on-site transportation fuel combustion emissions
- stationary combustion emissions from natural gas used for comfort heating in the buildings

The GHG emission estimates, where applicable, have followed quantification guidelines for both provincial and federal reporting:

- Federal reporting under Section 46 of the *Canadian Environmental Protection Act*, (CEPA), SC 1999: Greenhouse Gas Emissions Reporting Program (GHGRP).
- Provincial reporting under Ontario's Greenhouse Gas Emissions: Quantification, Reporting, and Verification Regulation, Ontario Regulation 390/18 (O. Reg. 390/18).

6.1 Project Greenhouse Gas Emissions

The following table presents the sources of emissions from the Project, the GHGs emitted, and the corresponding methodology used to estimate emissions.

GHG emissions from on-Site transportation have been estimated using emission factors from Tables 2-2 and 2-6 of Canada's ECCC Document "2019 Canada's Greenhouse Gas Quantification Requirements" dated December 2019 (GHGRP Guidance Document) (ECCC, 2019b). Fuel consumption for the on-Site transportation equipment was estimated using methods in the document titled 'Exhaust and Crankcase Emission Factors for Nonroad Engine Modelling – Compression Ignition NR-009d' dated July 2010 (Crankcase Document) (US EPA, 2010). Stationary combustion emissions from natural gas used for comfort heating were estimated using Equation 2-19 and emission factors from Table 2-4 of the GHGRP Guidance Document. Emissions from the fugitive release and combustion of landfill gas are categorized as "Waste Emissions" under the 2019 GHGRP Guidance Document. There is no prescribed method in the 2019 GHGRP Guidance Document for estimating fugitive methane emitted through the landfill cap or emissions from biomass combustion through the flare and therefore GHG emissions from these sources were estimated using engineering calculations. Fugitive methane that is oxidized in the atmosphere once emitted through the cap has not been taken into consideration for this assessment; however, it is commonly assumed that approximately 10% of the methane from landfill gas oxidizes.

The methods used to estimate GHG emissions from each source are summarized in Table 11 below.

Table 11: GHG Emissions Sources and Methods

Source Category	Emission Sources	Emissions Methodology	GHG
Stationary Combustion	<ul style="list-style-type: none"> Natural Gas 	<ul style="list-style-type: none"> 2019 GHGRP Guidance Document s.2.A.2.c Equation 2-9 2019 GHGRP Guidance Document s.2.B Equation 2-13 	<ul style="list-style-type: none"> Carbon Dioxide (CO₂) Methane (CH₄) Nitrous Oxide (N₂O)
On-site Transportation	<ul style="list-style-type: none"> Diesel Gasoline 	<ul style="list-style-type: none"> 2019 GHGRP Guidance Document s.2.A.1 Equation 2-2 Crankcase Document (Fuel Consumption) 2019 GHGRP Guidance Document s.2.B Equation 2-13 	<ul style="list-style-type: none"> CO₂ CH₄ N₂O
Waste (Landfill Gas)	<ul style="list-style-type: none"> Fugitive LFG 	<ul style="list-style-type: none"> Not prescribed in 2019 GHGRP Guidance Document Engineering Estimate (EE) – Carbon Dioxide/Methane composition of LFG and the amount of LFG lost fugitively 	<ul style="list-style-type: none"> CO₂ CH₄
Waste (Landfill Gas Flare)	<ul style="list-style-type: none"> LFG Combustion 	<ul style="list-style-type: none"> Not prescribed in 2019 GHGRP Guidance Document Engineering Estimate (EE) – Methane composition of LFG, Flare destruction efficiency, conversion of methane to carbon dioxide. N₂O estimated from Western Climate Initiative (WCI) method for LFG Flares 	<ul style="list-style-type: none"> CO₂ CH₄ N₂O

Table 12 and Table 13 summarize the estimated annual GHG emission rates in tonnes per year for each activity at the Project for the existing landfill and the proposed expanded landfill, respectively.

Table 12: Summary of Estimated GHG Annual Emissions from the Existing W12A Landfill

Source	Estimated Annual Emissions [tonnes/yr]			Annual Total [tonnes/yr]
	CO ₂	CH ₄	N ₂ O	CO ₂ e
Landfill Gas	12,635	4,584	0	127,245
LFG Flare	20,346	151	0.039	24,141
Mobile Combustion Emissions (road & non-road vehicles)	8,310	0.240	0.697	8,523
Comfort Heating	169	0.003	0.003	170

Note: CO₂e equals carbon dioxide equivalence, which is the summation of multiplying the emissions of CO₂, CH₄, N₂O by their respective global warming potential of 1, 25, and 298, respectively (IPCC, 2012)

The existing annual emissions were estimated to represent the 2020 year.

Table 13: Summary of Estimated GHG Annual Emissions from the Proposed Expansion of the W12A Landfill in Year 2049

Source	Estimated Annual Emissions [tonnes/yr]			Annual Total [tonnes/yr]
	CO ₂	CH ₄	N ₂ O	CO ₂ e
Landfill	8,870	3,219	0	89,337
LFG Flare	49,043	365	0.095	58,191
Mobile Combustion Emissions (road & non-road vehicles)	10,032	0.290	0.840	10,291
Comfort Heating	169	0.003	0.003	170

The peak annual GHG emissions were predicted to occur in 2049.

6.2 Reportable Greenhouse Gas Emissions

The tables below summarize the reportable GHG emissions under the GHGRP and O. Reg. 390/18. Table 14 and Table 15 present the annual GHG emission rates in tonnes per year for each activity at the Project for the existing landfill and the proposed expanded landfill, respectively. Carbon dioxide from the combustion of biomass is excluded from GHGRP per Schedule 3 s.2(b) of the Notice with respect to reporting of greenhouse gases for 2019 and it is not included in the Reporting Amount per s.6(2) of O. Reg. 390/18. Carbon dioxide from the decomposition of biomass is excluded from GHGRP per Schedule 3 s.2(c) of the Notice with respect to reporting of greenhouse gases for 2019 and from O. Reg. 390/18 per ON.191 of the MECP Guideline for QRV of GHG Emissions, Feb 2020.

Table 14: Summary of Reportable Annual GHG Emissions from the Existing W12A Landfill

Source	Estimated Annual Emissions [tonnes/yr]			Annual Total [tonnes/yr]
	CO ₂	CH ₄	N ₂ O	CO ₂ e
Landfill	—	4,584	0	114,610
LFG Flare	—	151	0.039	3,795
Mobile Combustion Emissions (road & non-road vehicles)	8,310	0.240	0.697	8,523
Comfort Heating	169	0.003	0.003	170

The existing annual emissions were estimated to represent the 2020 year.

Table 15: Summary of Reportable Annual GHG Emissions from the Proposed Expansion of the W12A Landfill in Year 2049

Source	Estimated Annual Emissions [tonnes/yr]			Annual Total [tonnes/yr]
	CO ₂	CH ₄	N ₂ O	CO ₂ e
Landfill	—	3,219	0	80,466
LFG Flare	—	365	0.095	9,148
Mobile Combustion Emissions (road & non-road vehicles)	10,032	0.290	0.840	10,291
Comfort Heating	169	0.003	0.003	170

The peak annual GHG emissions were predicted to occur in 2049.

6.3 Comparison to Provincial and Canadian Totals

Table 16 presents a comparison of the W12A Landfill's existing and proposed expansion GHG emissions to the provincial and Canadian totals. As indicated, the increase in emissions from the existing case to the proposed expansion would have a negligible contribution of less than 0.04% to the Ontario emissions and less than 0.01% to the Canadian emissions; therefore, the Project will have a negligible effect on climate change.

Table 16: Comparison of GHG Emissions from the Project to Ontario and Canadian Emission Totals

Source	Existing Emissions [kt/year CO ₂ e]	Expansion Emissions [kt/year CO ₂ e]	Increase in Emissions [kt/year CO ₂ e]
Project GHG Emissions	160	158	-2
Comparison to Ontario Total	0.10%	0.10%	-0.0013%
Comparison to Canada-wide Total	0.02%	0.02%	-0.0003%
Ontario GHG Emissions (2018)	165,000		
Canada-wide GHG Emissions (2018)	729,000		

7.0 BEST MANAGEMENT PRACTICES AND ADDITIONAL MITIGATION

In determining the air emissions associated with the Project works and activities, consideration was given to those mitigation measures that were considered to be integral to the design and implementation of the works and activities. These mitigation measures, which are considered to be typical and consistent with best practices, were incorporated into the emission estimates presented in Section 5.3, and therefore were incorporated in the effects predictions presented in Section 5.5. The in-design mitigation measures that were included in the air quality and odour assessment are summarized in Table 17.

Table 17: Summary of In-Design Mitigation Incorporated into the Air Quality and Odour Assessment

Mitigation Measure	Mitigation Specifics	Works and Activities Affected	Compound Affected by Mitigation Measure	Project Phase where Mitigation is being Considered
Dust suppressant on paved and unpaved roadways	Application of dust suppressant on unpaved roads on a routine basis	<ul style="list-style-type: none"> Vehicle movements related to initial construction, waste placement and cover placement 	<ul style="list-style-type: none"> SPM PM₁₀ PM_{2.5} 	<ul style="list-style-type: none"> Construction Operation
Paved road entrance and access road	Sweep/clean the roads as required to prevent mud track out on vehicles	<ul style="list-style-type: none"> Vehicle movements 	<ul style="list-style-type: none"> SPM PM₁₀ PM_{2.5} 	<ul style="list-style-type: none"> Construction Operation
Maintenance of on-Site vehicles and equipment	On-Site vehicles and equipment engines will meet Tier 3 emission standards and be maintained in good working order	<ul style="list-style-type: none"> On-Site Vehicles 	<ul style="list-style-type: none"> NO₂ CO SO₂ SPM PM₁₀ PM_{2.5} 	<ul style="list-style-type: none"> Construction Operation
Minimize idling of vehicles on-Site	Minimize idling of vehicles on-Site	<ul style="list-style-type: none"> On-Site vehicles 	<ul style="list-style-type: none"> NO₂ CO SO₂ SPM PM₁₀ PM_{2.5} 	<ul style="list-style-type: none"> Construction Operation
Minimize working face/daily cover	Site will operate with approx. 1500 m ² maximum working face, daily cover of waste is required	<ul style="list-style-type: none"> Landfill 	<ul style="list-style-type: none"> H₂S C₂H₃Cl Odour 	<ul style="list-style-type: none"> Operation
Capping of Landfill	Landfill will be capped and LFG collection system installed and put into operations progressively as Phases of landfilling are completed	<ul style="list-style-type: none"> Landfill 	<ul style="list-style-type: none"> H₂S C₂H₃Cl Odour 	<ul style="list-style-type: none"> Operation Post-closure

8.0 MONITORING

The conceptual air quality monitoring activities for the Project are described below. It is recognized that monitoring will be relevant at all stages of the Project (e.g., operation and post-closure). Moreover, it is recognized that monitoring will likely be a condition of environmental approvals and/or permits, and the final details will be confirmed in the ECA(s) for the Project. The follow-up air quality verification program provided in the following sub-sections contains sufficient detail to allow independent judgment to:

- Verify emission rates, to allow a comparison of actual with predicted effects;
- Confirm effectiveness of mitigation measures, and in doing so determine if alternate mitigation strategies are required; and
- Provide information for use in adaptive management to address potential unforeseen effects.

A follow-up air quality program will assist in determining if the environmental effects of the Project are consistent with predictions reported in this assessment. It can also be used to verify that mitigation measures are effective once implemented and determine whether there is a need for additional mitigation measures. A preliminary follow-up air quality program is provided below. The follow-up air quality verification program is designed to be appropriate to the scale of the Project and the potential effects identified through the EA process.

8.1.1 Initial Scope of the Follow-up Air Quality Activities

Table 18 summarizes the conceptual follow-up air quality verification program for the air quality and odour components. The recommendations identify the general timeframe for follow-up (operations or post-closure phase).

Table 18: Proposed Follow-Up Activities for Air Quality and Odour

Component	Project Phase	Objective	Suggested Program Activity
Air Quality (including odour)	Operations Phase	<ul style="list-style-type: none"> To verify the predicted concentrations of SPM, PM₁₀ and PM_{2.5}. To verify that the mitigation measures considered integral to the Project are being incorporated as planned and are effective. 	<ul style="list-style-type: none"> One time only sampling of unpaved and paved road silt loadings to confirm emission estimates. Review and update of existing fugitive dust management plan and complaints response protocol
		<ul style="list-style-type: none"> To verify that the Odour emission rates used in the assessment were reasonable, but conservative To verify the predicted concentrations of Odour To verify that the mitigation measures considered integral to the Project are being incorporated as planned, and are effective 	<ul style="list-style-type: none"> One time landfill gas sampling early in the expansion to determine actual emission rates from the site of indicator compounds Sampling analysis to include odourous compounds, Vinyl Chloride and Hydrogen sulphide Review and update the odour management plan and complaints response protocol

9.0 OTHER APPROVALS

The Project will require an application for an amendment of the ECA for air and noise under Section 9 of the *Environmental Protection Act*. An application for an ECA for air and noise must include a demonstration that a facility can document compliance with O. Reg. 419/05.

The assessment described in Section 5.6 of this report demonstrates that the W12A Landfill is expected to continue to be able to document compliance with O. Reg. 419/05 following the commencement of the Project.

10.0 CONCLUSION

This report evaluated the potential effects of the proposed Project on air quality and odour. The conclusions of the assessment are highlighted below. Emissions estimates and dispersion modelling were carried out to predict concentrations from all emission sources of the indicator compounds. Anticipated measurable air emissions were identified and evaluated to determine effects. The residual effects were evaluated and it is concluded that they do not result in adverse effects in terms of air quality or odour, as they are all below the relevant guidelines with the exception of NO₂. The maximum predicted concentration of NO₂ is greater than the 2025 1-hour CAAQS. However, as described in Section 5.5, the maximum predicted concentration is significantly less than the less conservative, but still applicable Ontario AAQC for 1-hour NO₂.

A follow-up air quality monitoring program is recommended in accordance with Section 8.0, and subject to the ECA for the W12A Landfill, to:

- Verify the emission rates for air quality indicator compounds.
- Verify that the mitigation measures considered integral to the W12A Landfill are being incorporated as planned, and are effective.

Specifically, one-time sampling for road silt loadings, as well as landfill gas sampling are proposed. In addition, the dust and odour management plans and complaints protocol for the site will be updated and included in the ECA amendment application.

An assessment to demonstrate that the Project can achieve compliance with O. Reg. 419/05 was also completed. Air modelling guidance for the Province of Ontario was followed where appropriate. This assessment demonstrates that the Project can be expected to operate in compliance with s. 20 of O. Reg. 419/05.

11.0 IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

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This report has been prepared for the specific site, design objective, developments and purpose described to Golder by City of London (the City). The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location.

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Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the City in the design of the specific project.

The findings and conclusions of this report are valid only as of the date of this report. If new information is discovered in future work, Golder Associates Ltd. should be requested to re-evaluate the conclusions of this report, and to provide amendments as required.

12.0 REFERENCES

- Alberta Environment and Sustainable Resource Development (2013). Air Quality Model Guideline – Effective October 1st, 2014. ISBN: 978-1-4601-0599-3, Edmonton, Alberta.
- Canadian Council of Ministers of the Environment (CCME) (1999). *Canadian National Ambient Air Quality Objectives: Process and Status*. Available from ceqg-rcqe.ccme.ca/download/en/133/
- Canadian Council of Ministers of the Environment (CCME) (2014). *Canada-Wide Standards for Particulate Matter and Ozone, 2012 Final Report*.
- Environment and Climate Change Canada (ECCC) and Health Canada (2017). *Draft Screening Assessment Hydrogen Sulfide (H₂S), Sodium Sulfide (Na(SH)) and Sodium Sulfide (Na₂S), September 2017*.
- Environment and Climate Change Canada (ECCC) (2019). National Air Pollution Surveillance Program (NAPS). <http://www.ec.gc.ca/rnspa-naps/>
- Environment and Climate Change Canada (ECCC) (2019) 2019 Canada's Greenhouse Gas Quantification Requirements.
- Government of Canada (2013). Canada Gazette Vol 147, 21.
- Government of Canada (2017). Canada Gazette Vol 151, 43.
- Health Canada (1994). National Ambient Air Quality Objectives for Carbon Monoxide. Executive Summary, Desirable, Acceptable and Tolerable Levels. ISBN 0-662-25642-5.
- Intergovernmental Panel on Climate Change (IPCC) (2012) Climate Change 2007: The Physical Science Basis, Working Group 1 contribution to the IPCC Fourth Assessment Report – Errata <http://www.ipcc.ch/report/ar4/wg1/>.
- Lall, R., Kendall., M., Ito, K., Thurston, G.D. (2004) Estimation of Historical Annual PM_{2.5} Exposures for Health Effects Assessment. Atmospheric Environment 38 (2004) 5217 – 5226. Accessed https://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.files/fileID/13226.
- Ministry of the Environment, Conservation and Parks (MECP) (2016). Technical Bulletin: Methodology For Modelling Assessments Of Contaminants With 10-Minute Average Standards And Guidelines For Odour Under O. Reg. 419/05. Standards Development Branch.
- Ministry of the Environment, Conservation and Parks (MECP) (2017). Air Dispersion Modelling Guideline for Ontario, Version 3 – February 2017.
- Ministry of the Environment, Conservation and Parks (MECP) (2018). Ontario's Ambient Air Quality Criteria, PIBS# 6570e01. Standards Development Branch, Environmental Standards and Sciences Division.
- Ministry of the Environment, Conservation and Parks (MECP) (2018a). Air Contaminants Benchmarks List, Version 2.0 – April 2018. Standards Development Branch, Environmental Standards and Sciences Division.

Ministry of the Environment, Conservation and Parks (MECP) (2018b). Procedure For Preparing an Emission Summary and Dispersion Modelling Report, Version 4.1 – March 2018. Ministry of the Environment, Conservation and Parks (MECP) (2019). Air Quality in Ontario 2017 Report.

United States Environmental Protection Agency (US EPA) (2010). Exhaust and Crankcase Emission Factors for Nonroad Engine Modelling – Compression Ignition NR-009d

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Signature Page

Golder Associates Ltd.

Jamie McEvoy
Air Quality Engineer

Katie Armstrong
Senior Air Quality Specialist

JDM/KSA/PAS/PLE/sg

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APPENDIX A

Background Air Quality

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APPENDIX A**Background Air Quality***W12A Landfill Expansion EA, City of London, Ontario*

Submitted to:

Mike Losee, Division Manager, Solid Waste Management

City of London
300 Dufferin Avenue
PO Box 5035
London, Ontario
N6A 4L9

Submitted by:

Golder Associates Ltd.

1931 Robertson Road, Ottawa, Ontario, K2H 5B7, Canada

+1 613 592 9600

1648176

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Distribution List

1 e-copy - City of London

1 e-copy - Golder Associates Ltd.

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1.0 INTRODUCTION

This appendix is part of the Air Quality assessment for the proposed expansion of the W12A Landfill by the City of London. This work has been conducted in accordance with the requirements set out in the approved Amended Terms of Reference (ToR), dated February 2019 and the work plan December 2019 prepared following commencement of the EA and circulated to the Ministry of the Environment, Conservation and Parks (MECP).

1.1 Purpose

This appendix documents the methods, inputs and assumptions that were used to calculate background air quality concentrations for the Site-vicinity Study Area.

2.0 AIR QUALITY MONITORING DATA

Background air quality was characterised using observations from the Environment and Climate Change Canada (ECCC) National Air Pollution Surveillance Network (NAPS) air quality monitoring stations (ECCC 2019). The closest air quality monitoring station is located at 42 St. Julien Street in London (London Station). Two other NAPS air quality monitoring stations were selected, West Avenue and Homewood in Kitchener (Kitchener Station), and Beasley Park Hamilton Downtown in Hamilton (Hamilton Station).

The Project is located in a rural location; however, it is located adjacent to Highway 401. A wind-rose for the area is provided in Appendix A and indicates that the predominant wind direction is from the southwest. The London Station (NAPS ID 60904) is the closest NAPS station to the Project (approximately 12 km northeast), so it is expected that the Project will experience similar wind patterns and impacts from regional transport of compounds as this station. It is similarly situated near residential areas. All air quality indicator compounds with the exception of CO and SO₂ are monitored at this station.

The Kitchener NAPS station (61502) located approximately 87 km away was selected due to Kitchener's similar size, industry, and proximity to Highway 401 as London. All air quality indicator compounds with the exception of CO and SO₂ are monitored at this station. The Hamilton station was selected for the CO and SO₂ data as it was the most representative station that monitors these compounds.

The relative locations of the air quality monitoring stations selected to describe the background air quality are summarized in Table A-1 and presented on Figure A-1.

Table A-1: Location of Air Monitoring Stations

Station	Address	NAPS Station ID	Latitude and Longitude	Distance to the Project (km)	Direction
London	42 St. Julien St.	60904	42.97446, -81.20086	12	North-Northeast
Kitchener	West Avenue and Homewood	61502	43.44383, -80.50381	87	North-Northeast
Hamilton	Elgin & Kelly	60512	43.25778, -79.86167	119	East-Northeast

As shown on the wind rose for London (Figure A-2), the air flow into the London area is predominantly from the southwest.

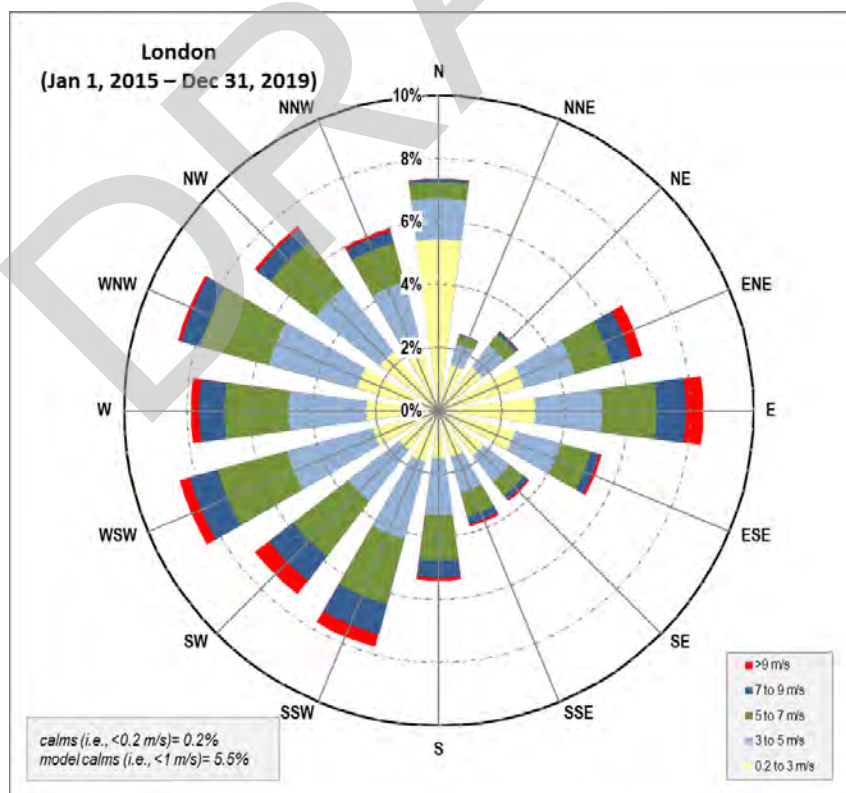


Figure A-2: Five-year Wind Rose for London Ontario

Table A-2 provides a summary of the monitoring data available from the London, Kitchener and Hamilton stations for the period from 2013 through 2017. The London and Kitchener data is used for PM_{2.5}, NO₂, O₃, and Vinyl Chloride while the Hamilton data is used for SO₂ and CO.

There is no monitoring data available for SPM and PM₁₀; however, the background SPM and PM₁₀ concentrations can be estimated from the available PM_{2.5} monitoring results. PM_{2.5} is a subset of PM₁₀, and PM₁₀ is a subset of SPM. Therefore, it is reasonable to assume that the ambient concentrations of SPM will be greater than corresponding PM₁₀ levels, and PM₁₀ concentrations will be greater than the corresponding levels of PM_{2.5}. The mean levels of PM_{2.5} in Canadian locations are found to be about 54% of the PM₁₀ concentrations and about 30% of the TSP concentrations (Lall et al. 2004). By applying this ratio, it is possible to estimate the background SPM and PM₁₀ concentrations for the Site-vicinity Study Area. Hydrogen sulphide is not measured at any of the above three stations, therefore the 1-hour background concentration was taken from the ECCC's draft screening Assessment for H₂S (ECCC, 2017) and converted to the relevant averaging periods using MECP recommended methodologies in the *Air Dispersion Modelling Guideline for Ontario* (MECP, 2017)

Table A-2: Availability of Ambient Air Quality Data

Compound	London Station	Kitchener Station	Hamilton Station
SPM	—	—	—
PM ₁₀	—	—	—
PM _{2.5}	2013-2017	2013-2017	2013-2017
NO ₂	2013-2017	2013-2017	2013-2017
SO ₂	—	—	2013-2017
CO	—	—	2013-2017
O ₃	2013-2017	2013-2017	2013-2017
H ₂ S	—	—	—
C ₂ H ₃ Cl	2014-2017	2013-2017	—

Notes:

"—" indicates that data for the parameter were not available.

Bolded years indicates which station was used for the compound.

2.1 Assessment of Background Air Quality

The continuous monitoring stations listed in Table A-1 were used to reflect the existing conditions in the Site-vicinity Study Area. The existing air quality levels, based on background air concentrations from available monitoring stations, are summarized in the following sections. The available air monitoring data represents the combined effect of emissions from sources near to each of the monitoring stations, as well as the effect of the emissions transported into the region. The emissions transported into the region could be considered to be the 'background air quality', which would be added to dispersion modelling results as part of the impact assessment for the proposed expansion of the W12A Landfill.

Although gaseous monitoring equipment records concentrations in units of parts per million parts (ppm) or parts per billion parts (ppb), regulatory criteria are established on the basis of micrograms per cubic metre ($\mu\text{g}/\text{m}^3$). In this section, monitoring results for gaseous compounds are presented in the units of $\mu\text{g}/\text{m}^3$, to facilitate the comparison of monitoring to criteria. The conversion from ppm to $\mu\text{g}/\text{m}^3$ is unique to each compound, based on the molecular weight of the compound and standard atmospheric conditions (1 atmosphere of pressure and 25°C). In contrast, particulate and metals monitoring equipment records concentrations in units of $\mu\text{g}/\text{m}^3$, allowing for direct comparison to the regulatory criteria.

2.2 Comparison of Monitored Data by Indicator Compound

The 90th percentile of the 1-hour, 8-hour, and 24-hour measurements are typically used to represent the background air quality value when conducting an impact assessment, as this value is exceeded only 10% of the time. The annual average concentration is used for annual background levels (Alberta Environment 2013) and based on the limited measurement data. The average concentration for the shorter time periods provides an indication of what air quality would typically be at the location. The 75th percentile provides an indication of the concentration below which the vast majority of the existing air quality readings occurred. Significant differences between the average and 75th percentile readings provide an indication that the background air quality is dominated by infrequent, but extreme events.

2.2.1 Fine Particulate Matter ($\text{PM}_{2.5}$)

Particulate emissions occur due to anthropogenic activities (such as industrial, transportation, and residential sources) and natural sources. Suspended particulate matter is classified based on its aerodynamic particle size, primarily due to the different health effects that can be associated with particles of different diameters. In Ontario, $\text{PM}_{2.5}$ emissions have been demonstrating a steady decline over time, decreasing by approximately 16% from 2008 to 2017 (MECP 2019).

The 24-hour standard for $\text{PM}_{2.5}$, the Canadian Ambient Air Quality Standard (CAAQS), is calculated as the three year average of the annual 98th percentile of the daily 24-hour average concentrations. The annual CAAQS is based on the annual average concentration averaged over three years of measurements. Table A-3 lists the 24-Hour and Annual $\text{PM}_{2.5}$ ambient monitoring results calculated according to these methodologies.

Table A-3: Summary of 24-Hour and Annual PM_{2.5} Monitoring Results for Comparison to the Canadian Ambient Air Quality Standard

Years	PM _{2.5} Concentration [µg/m ³]			
	London		Kitchener	
	24-Hour (CAAQS = 27 µg/m ³)	Annual (CAAQS = 8.8 µg/m ³)	24-Hour (CAAQS = 27 µg/m ³)	Annual (CAAQS = 8.8 µg/m ³)
2013–2015	22.01	8.72	23.64	8.91
2014–2016	20.21	8.05	22.53	8.55
2015–2017	17.96	7.47	19.54	7.78

The 24-hour CAAQS has not been exceeded at either station. The Annual CAAQS was exceeded at the Kitchener station over the 2013-2015 period but the measurements for the subsequent three year periods have decreased to below the corresponding CAAQS.

2.2.2 Nitrogen Dioxide (NO₂)

NO_x is emitted in two primary forms: nitric oxide (NO) and nitrogen dioxide (NO₂). NO reacts with ozone in the atmosphere to create NO₂. The primary source of oxides of nitrogen (NO_x) in the region is the combustion of fossil fuels. Emissions of NO_x result from the operation of stationary sources such as incinerators, boilers, and generators, as well as the operation of mobile sources such as vehicles, haul trucks, and other equipment.

The annual mean concentrations of NO₂ in Ontario have decreased by 25% from 2008 to 2017 (MECP 2019). None of the monitored values for NO₂ were above the 1-hour or 24-hour Ontario AAQC for NO₂.

Tables A-4 and A-5 below present the 90th percentile and maximum monitored concentrations compared to the 1-hour and 24-hour AAQC.

Table A-4: Summary of the 90th Percentile and Maximum 1-Hour NO₂ Monitoring Results for Comparison to the Ontario AAQC

Station	NO ₂ 1-hour Criteria [µg/m ³]	90 th percentile concentration [µg/m ³]	90 th percentile as a % of the Criteria	Maximum concentration [µg/m ³]	Maximum as a % of the Criteria
London	400	22.57	6%	99.69	25%
Kitchener	400	26.33	7%	114.74	29%

Table A-5: Summary of the 90th Percentile and Maximum 24-Hour NO₂ Monitoring Results for Comparison to the Ontario AAQC

Station	NO ₂ 24-hour Criteria [µg/m ³]	90 th percentile concentration [µg/m ³]	90 th percentile as a % of the Criteria	Maximum concentration [µg/m ³]	Maximum as a % of the Criteria
London	200	19.87	10%	57.76	29%
Kitchener	200	22.57	11%	67.09	34%

The 1-hour CAAQS standards for NO₂ are calculated as the 98th percentile of the daily maximum 1-hour concentrations, averaged over three years of measurements. Table A-6 lists the 1-Hour ambient monitoring results calculated according to this methodology.

Table A-6: Summary of 1-Hour NO₂ Monitoring Results for Comparison to the Canadian Ambient Air Quality Standard

Years	1-Hour NO ₂ [µg/m ³] (CAAQS 1-Hour = 79 µg/m ³)	
	London	Kitchener
2013–2015	70.95	80.98
2014–2016	70.76	75.52
2015–2017	64.84	69.42

The 1-hour CAAQS was exceeded at the Kitchener station over the 2013-2015 period but the measurements for the subsequent three year periods have decreased to below the corresponding CAAQS.

2.2.3 Sulphur Dioxide (SO₂)

The primary source of SO₂ in Ontario is the combustion of fossil fuels in the electricity and smelter sectors. Emissions have decreased significantly due to the phase out of coal-fired generating stations in the province.

The annual mean concentrations of SO₂ in Ontario have decreased by 46% from 2008 to 2017 (MECP 2019).

Tables A-7 through A-9 below present the 90th percentile and maximum monitored concentrations compared to the 10-Minute, 1-hour and Annual AAQC. Out of the chosen stations, SO₂ data is only available at the Hamilton station. SO₂ data for the Hamilton Station is collected on a 1-hour basis, therefore the 1-hour data was converted to a 10-minute basis using MECP conversion factors (MECP, 2017).

Table A-7: Summary of the 90th Percentile and Maximum 10-minute SO₂ Monitoring Results for Comparison to the Ontario AAQC

Station	SO ₂ 10-minute Criteria [µg/m ³]	90 th percentile concentration [µg/m ³]	90 th percentile as a % of the Criteria	Maximum concentration [µg/m ³]	Maximum as a % of the Criteria
Hamilton Downtown	180	56.19 ^(a)	31%	527.28 ^(a)	293%

Notes:

^(a) 10-minute SO₂ concentrations were converted from the corresponding 1-hour SO₂ monitoring results using MECP conversion factors (MECP, 2017)

Table A-8: Summary of the 90th Percentile and Maximum 1-Hour SO₂ Monitoring Results for Comparison to the Ontario AAQC

Station	SO ₂ 1-hour Criteria [µg/m ³]	90 th percentile concentration [µg/m ³]	90 th percentile as a % of the Criteria	Maximum concentration [µg/m ³]	Maximum as a % of the Criteria
Hamilton Downtown	100	34.05	34%	319.56	320%

Table A-9: Summary of the 90th Percentile and Maximum 24-hour SO₂ Monitoring Results for Comparison to the AAQC

Station	SO ₂ 24-hour Criteria [µg/m ³]	90 th percentile concentration [µg/m ³]	90 th percentile as a % of the Criteria	Maximum concentration [µg/m ³]	Maximum as a % of the Criteria
Hamilton Downtown	150	32.36	22%	112.41	75%

The monitored 1 hour and 10-minute measured SO₂ concentrations have been periodically above the Ontario AAQC at the Hamilton Station over the 5 year monitoring period but the 90th percentile of all monitoring data is below the corresponding Ontario AAQCs.

2.2.4 Carbon Monoxide (CO)

Carbon Monoxide is a colourless, odourless, tasteless, and, at high concentrations, toxic gas. It is produced primarily from the incomplete combustion of fossil fuels, as well as natural sources, with approximately 71% of emissions arising from the transportation sector in Ontario (MECP 2019).

Tables A-10 and A-11 below present the 90th percentile and maximum monitored concentrations compared to the 1-hour and 8-hour National Ambient Air Quality Standards and Objectives. Out of the chosen stations, CO data is only available at the Hamilton station. No exceedances of the 1-hour or 8-hour National Ambient Air Quality Standards and Objectives criteria for CO were recorded at the station from 2013 to 2018.

Table A-10: Summary of the 90th Percentile and Maximum 1-Hour CO Monitoring Results for Comparison to the National Ambient Air Quality Standards and Objectives

Station	CO 1-hour Criteria [µg/m³]	90 th percentile concentration [µg/m³]	90 th percentile as a % of the Criteria	Maximum concentration [µg/m³]	Maximum as a % of the Criteria
Hamilton Downtown	15,000	458.10	3%	3321.20	22%

Table A-11: Summary of the 90th Percentile and Maximum 8-Hour CO Monitoring Results for Comparison to the National Ambient Air Quality Standards and Objectives

Station	CO 8-hour Criteria [µg/m³]	90 th percentile concentration [µg/m³]	90 th percentile as a % of the Criteria	Maximum concentration [µg/m³]	Maximum as a % of the Criteria
Hamilton Downtown	6,000	317.41	5%	1188.19	20%

2.2.5 Ozone (O₃)

Ground-level ozone is formed when NO_x and VOCs react in the presence of sunlight. Monitored ground-level ozone records were well below the Ontario 1-hour AAQC at both the London station and the Kitchener station in 2017. Between 2013 - 2018 the maximum 1-hour concentration of O₃ at the London station reached the Ontario AAQC concentration limit of 160 µg/m³; however, the 90th percentile at the London station was well below the Ontario AAQC. At the Kitchener station, between years 2013-2018, the maximum 1-hour concentration of O₃ and 90th percentile was also below the Ontario AAQC.

Currently there is no 8-hour Ontario AAQC for O₃, but there is a Canadian Ambient Air Quality Standard that has been used for comparison to the data. While the maximum 8-hour concentration of O₃ exceeds the standard at the London and Kitchener stations, compliance with the Canadian Ambient Air Quality Standard is based on the fourth highest 8-hour value annually, averaged over a 3-year period. Table A-12 presents a summary of the three year averaging methodology using 8-hour O₃ ambient monitoring results. The Canadian Ambient Air Quality Standard has been exceeded at both the London and Kitchener stations.

Table A-12: Summary of 3-year average for 4th Highest 8-Hour O₃ Value Monitoring Results for Comparison to the CAAQS

Years	8-Hour Ozone [$\mu\text{g}/\text{m}^3$] (CAAQS = 123.6 $\mu\text{g}/\text{m}^3$)	8-Hour Ozone [$\mu\text{g}/\text{m}^3$] (CAAQS = 123.6 $\mu\text{g}/\text{m}^3$)
	London Downtown	Kitchener Downtown
2013 - 2015	131.98	127.96
2014 - 2016	132.96	130.33
2015 - 2017	132.79	129.28

2.2.6 Vinyl Chloride (C₂H₃Cl)

Vinyl Chloride is a volatile organic compound (VOC) and one of the common constituents in landfill gas (LFG). It is formed in the environment when soil organisms break down chlorinated solvents.

Table A-13 below presents the 90th percentile and maximum monitored concentrations compared to the 24-hour and Vinyl Chloride AAQC. No exceedances of the 24-hour or annual AAQC for Vinyl Chloride were recorded at either station from 2013 to 2018.

Table A-13: Summary of the 90th Percentile and Maximum 24-Hour Vinyl Chloride Monitoring Results for Comparison to the Ontario AAQC

Station	Vinyl Chloride 24-hour Criteria [$\mu\text{g}/\text{m}^3$]	90 th percentile concentration [$\mu\text{g}/\text{m}^3$]	90 th percentile as a % of the Criteria	Maximum concentration [$\mu\text{g}/\text{m}^3$]	Maximum as a % of the Criteria
London	1	0.008	<1%	0.016	1.6%
Kitchener	1	0.010	1%	0.015	1.5%

2.2.7 Hydrogen Sulphide (H₂S)

Hydrogen Sulphide is a major odorous component in landfill gas (LFG). LFG and Hydrogen Sulphide is formed from the biodegradation of the municipal solid waste material within the landfill.

Hydrogen sulphide is not measured at any of the three NAPS stations used for background air quality, therefore the 1-hour background concentration was taken from the ECCC's Draft Screening Assessment for H₂S (ECCC, 2017) and converted to the relevant averaging periods using MECP recommended methodologies (MECP, 2017). Table A-14 below summarises the 10-minute and 24-hour average background concentrations used in the assessment.

Table A-14: Summary of Hydrogen Sulphide Concentrations for Comparison to the Ontario AAQC

Indicator Compound	Averaging Period	AAQC Criteria [$\mu\text{g}/\text{m}^3$]	Background Concentration [$\mu\text{g}/\text{m}^3$]	Percentage of Air Quality Criteria
Hydrogen Sulphide	10-minute	13	0.84	6.5%
	24-Hour	7	0.21	3.0%

2.2.8 Summary of Monitored Data by Station

For the London and Kitchener stations, monitoring data for the years 2013 through 2017 (where available) were summarized by indicator compounds for the averaging period relevant to the AAQC. CO and SO₂ data were summarized for the years 2013 through 2017 from the Hamilton Downtown station. To provide an understanding of the variability of the monitoring data, the average, 75th percentile, 90th percentile, and maximum values are summarized in Tables A-15 to A-17. As discussed in the previous sections, the 90th percentile of the 1-hour, 8-hour, and 24-hour measurements is typically used to represent the background air quality value when conducting an impact assessment and the annual average concentration is used for annual background levels (Alberta Environment 2013). The average concentration for the shorter time periods provides an indication of what air quality would typically be at the location. The 75th percentile provides an indication of the concentration below which the vast majority of the existing air quality readings occurred.

Table A-15: Summary of Background Air Quality at London Station (2013 – 2017)^(a) in $\mu\text{g}/\text{m}^3$

Indicator	Averaging Period	Average	75th	90th	Max
SPM ^(b)	24-Hour	26.82	34.11	45.83	99.44
	Annual	26.85	—	—	30.43
PM ₁₀ ^(b)	24-Hour	14.90	18.95	25.46	55.25
	Annual	14.90	18.95	25.46	55.25
PM _{2.5} ^(a)	24-Hour	8.05	10.23	13.75	29.83
	Annual	8.06	—	—	9.13
NO ₂ ^(a)	1-Hour	11.71	15.05	22.57	99.69
	24-Hour	11.70	13.95	19.87	57.76
	Annual	11.70	—	—	13.06
O ₃ ^(a)	1-Hour	55.23	72.61	88.31	160.92
	8-Hour	74.41	87.33	105.43	151.85
C ₂ H ₃ Cl ^(c)	24-Hour	0.00340	0.00477	0.00853	0.0161
	Annual	0.00340	—	—	0.00406

Notes:

"—" indicates that data for the parameter were not available at that station.

(a) Data measured in parts per billion (ppb) or parts per million (ppm), were converted to $\mu\text{g}/\text{m}^3$ assuming standard temperature and pressure (25°C and one atmosphere of pressure).

(b) Data converted from PM_{2.5}.

(c) Data from years 2014-2017

Table A-16: Summary of Background Air Quality at Kitchener Station (2013 – 2017)^(a) in $\mu\text{g}/\text{m}^3$

Indicator	Averaging Period	Average	75th	90th	Max
SPM ^(b)	24-Hour	27.01	35.00	48.75	124.03
	Annual	26.91	—	—	30.92
PM ₁₀ ^(b)	24-Hour	15.01	19.44	27.08	68.90
PM _{2.5} ^(a)	24-Hour	8.10	10.50	14.63	37.21
	Annual	8.07	—	—	9.28
NO ₂ ^(a)	1-Hour	13.07	16.93	28.21	114.74
	24-Hour	13.06	16.62	24.45	67.09
	Annual	13.07	—	—	14.44
O ₃ ^(a)	1-Hour	54.76	70.65	88.31	174.66
	8-Hour	71.95	86.10	102.29	160.68
C ₂ H ₃ Cl ^(c)	24-Hour	0.00376	0.00511	0.00977	0.0153
	Annual	0.00376	—	—	0.00441

“—” indicates that data for the parameter were not available at that station.

(a) Data measured in parts per billion (ppb) or parts per million (ppm), were converted to $\mu\text{g}/\text{m}^3$ assuming standard temperature and pressure (25°C and one atmosphere of pressure).

(b) Data converted from PM_{2.5}.

(c) Data from years 2014-2017

Table A-17: Summary of Background Air Quality at the Hamilton Downtown Station (2013-2017)^(a) in $\mu\text{g}/\text{m}^3$

Indicator	Averaging Period	Average	70th	90th	Max
SO ₂ ^(a)	10-minute ^(b)	14.98	12.97	56.19	164.23
	1-Hour	9.08	7.86	34.05	319.56
	24-hour	9.08	13.79	32.36	60.90
	Annual	9.08	—	—	13.22
CO ^(a)	1-Hour	244.50	343.57	458.10	3321.20
	8-Hour	317.41	415.15	572.62	1188.19

Notes:

“—” indicates that data for the parameter were not available at that station.

(a) Data measured in parts per billion (ppb) or parts per million (ppm), were converted to $\mu\text{g}/\text{m}^3$ assuming standard temperature and pressure (25°C and one atmosphere of pressure).

(b) Data converted from 1-hour average concentrations using MECP methodologies (MECP, 2017)

2.3 Summary of Background Air Quality

This section presents the existing air quality for the Site-vicinity Study Area to be added as background to the dispersion modelling results as part of the impact assessment for the W12A Landfill expansion. The London station is the closest station to the W12A Landfill (approx.12 km), so it is expected to experience similar wind patterns and impacts from transport of compounds into the city as the Project location.

Due to proximity to the Site-vicinity Study Area, and the fact the Site-vicinity Study Area is similarly located close to urban areas adjacent to residential areas, the London station is considered to be the most representative station of the Site-vicinity Study Area, and therefore represents the background for indicator compounds monitored at that station. Table A-18 provides the background air quality values.

Table A-18: Background Air Quality Values (90th Percentile, Average for Annual Only)

Indicator	Averaging Period	Background ($\mu\text{g}/\text{m}^3$)
SPM	24-hour	45.83
	Annual	26.85
PM ₁₀	24-hour	25.46
PM _{2.5}	24-hour	13.75
	Annual	8.06
NO ₂	1-Hour	22.57
	24-Hour	19.87
	Annual	11.70
SO ₂	10-minute	56.19
	1-Hour	34.05
	24-hour	32.36
	Annual	9.08
CO	1-Hour	458.10
	8-Hour	572.62
O ₃	1-Hour	88.31
	8-Hour	105.43
H ₂ S	10-minute	0.84
	24-Hour	0.21
C ₂ H ₃ Cl	24-Hour	0.00853
	Annual	0.00340

3.0 REFERENCES

- Alberta Environment and Sustainable Resource Development (2013). Air Quality Model Guideline – Effective October 1st, 2014. ISBN: 978-1-4601-0599-3, Edmonton, Alberta
- Environment and Climate Change Canada (ECCC) and Health Canada (2017). *Draft Screening Assessment Hydrogen Sulfide (H₂S), Sodium Sulfide (Na(SH)) and Sodium Sulfide (Na₂S), September 2017.*
- Environment and Climate Change Canada (ECCC) (2019). National Air Pollution Surveillance Program (NAPS). <http://www.ec.gc.ca/rnspa-naps/>
- Lall, R., Kendall, M., Ito, K., Thurston, G.D. (2004) Estimation of Historical Annual PM_{2.5} Exposures for Health Effects Assessment. Atmospheric Environment 38 (2004) 5217 – 5226. Accessed https://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display/files/fileID/13226.
- Ministry of the Environment, Conservation and Parks (MECP) (2017). Air Dispersion Modelling Guideline for Ontario, Version 3 – February 2017.
- Ministry of the Environment, Conservation and Parks (MECP) (2019). Air Quality in Ontario 2017 Annual Report

APPENDIX B

Emission Calculations

DRAFT

APPENDIX B**Emission Calculations**

W12A Landfill Expansion EA, City of London, Ontario

Submitted to:

Mike Losee, Division Manager, Solid Waste Management

City of London

300 Dufferin Avenue

PO Box 5035

London, Ontario

N6A 4L9

Submitted by:

Golder Associates Ltd.

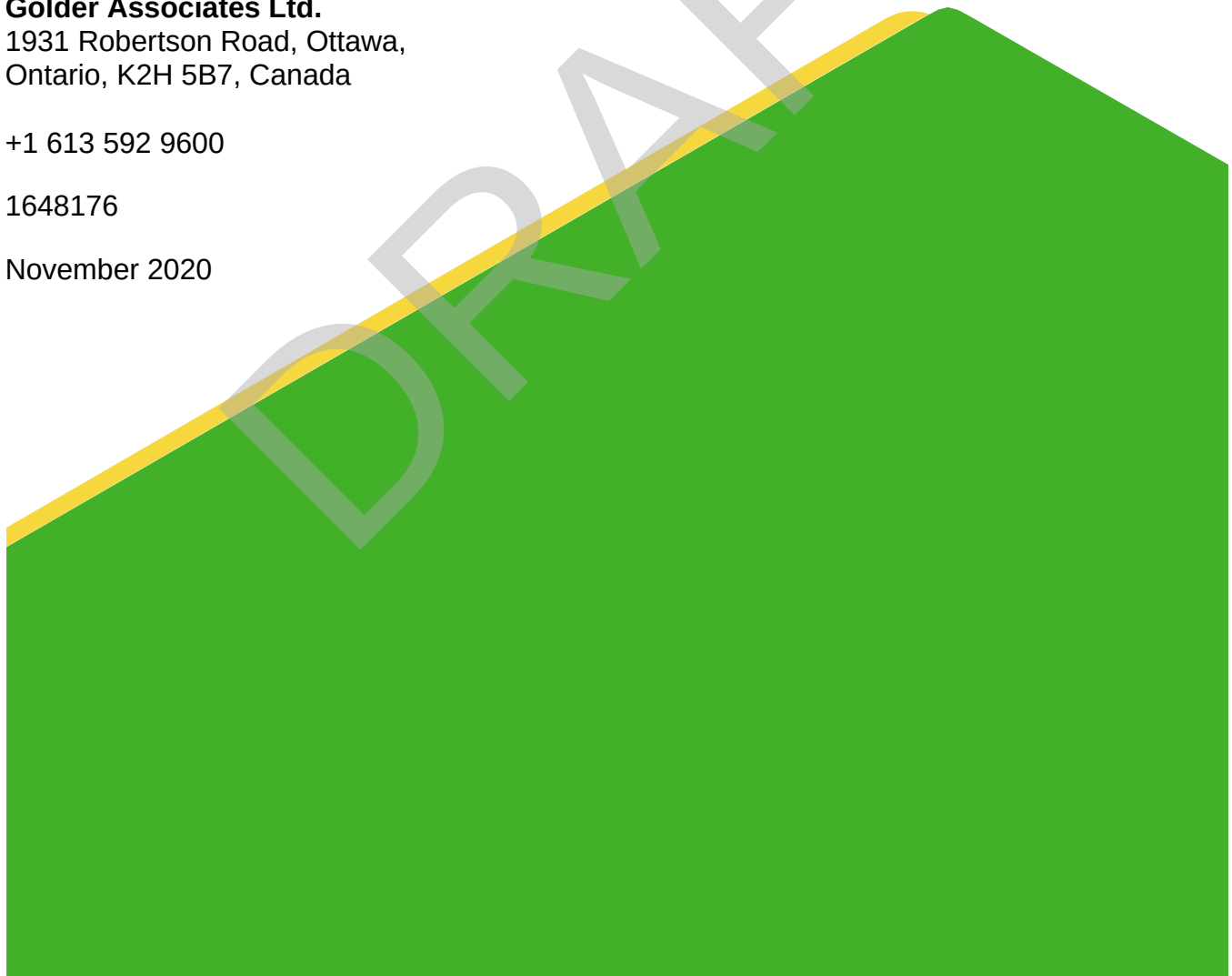
1931 Robertson Road, Ottawa,

Ontario, K2H 5B7, Canada

+1 613 592 9600

1648176

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1.0 INTRODUCTION

This appendix is part of the Air Quality Impact Assessment for the proposed expansion of the existing W12A Landfill site (the Project) located at 3502 Manning Drive, part of Lots 18, 19 and 20 of Concession 6 in the former Township of Westminster, in the south end of the City of London, Ontario.

1.1 Purpose

This appendix documents the methods, input parameters and assumptions that were used to estimate the air emission rates for the Project activities at the landfill. The change associated with the proposed Project is an increase of the permitted volume for disposal at the landfill (landfill airspace) through reconfiguration and vertical expansion. Emission rates of indicator compounds for the existing landfill and the proposed landfill were calculated.

The calculated emission rates were used as inputs for dispersion modelling to predict the indicator compound concentrations resulting from the existing and proposed expanded landfill. The emission estimation methods described within this appendix follow generally accepted practices for conducting Environmental Assessments (EAs) and, where appropriate, guidance in the Ministry of the Environment, Conservation and Parks ESDM Procedure Document (MECP 2018).

2.0 ASSESSMENT OF COMPOUNDS AND ACTIVITIES

Emissions were assessed for activities described in the approved Amended Terms of Reference for Environmental Assessment of the Proposed W12A Landfill Expansion, City of London (Golder February 2019), based on process descriptions and equipment/vehicle specifications provided by the City of London and the Golder design team. Scientifically accepted and well documented emission factors, most notably U.S. AP-42 (U.S. EPA 1995), were also used.

Compounds that will be discharged from the landfill in negligible amounts and/or activities that discharge a compound in a negligible amount were excluded from further analysis.

All potential sources of emissions for the proposed project were identified; however, only significant sources (e.g., emissions from the landfill cap) were carried through to the dispersion modelling assessment. Sources with emissions rates that were less than 1% of the site-wide emissions were considered insignificant. Additionally, infrequent operations were also considered insignificant (e.g., testing of standby power generators). Details of the specific emissions calculation methods and resulting emissions are provided in the following sections.

Table B-1 below provides a summary of the activities for which emissions were calculated in the air quality assessment, as well as a summary of the compounds expected to be released.

Table B-1: Significant Activities at the Proposed W12A Landfill Expansion

Source Information		Significant (Yes or No)?	Modelled (Yes or No)?	Rationale
General Location	Source			
Landfill	Landfill cap	Yes	Yes	—
	Landfill operations – main area (material handling & vehicle exhaust)	Yes	Yes	—
	Landfill operations – Non-decomposable Area (material handling & vehicle exhaust)	Yes	Yes	—
Landfill gas collection & control system (LGCCS)	Enclosed LFG flare (existing)	Yes	Yes	—
	Enclosed LFG flare (proposed)	Yes	Yes	—
	Propane combustion equipment	No	No	Propane is used to ignite the pilot flame on the flare. The pilot flame is not ignited at the same time as the flare is operated with LFG, therefore combustion associated with the pilot flame is not included in the model as it does not represent the worst-case scenario.
Paved & unpaved roads	Vehicle exhaust and fugitive road dust	Yes	Yes	—
Storage piles	On-site storage piles wind erosion	No	No	Emissions from wind erosion for the piles were estimated but are considered to be insignificant in comparison to the other activities occurring on-site as they are less than 1% of the site wide emissions. The daily cover material is received daily and applied directly to the active filling area.

Source Information		Significant (Yes or No)?	Modelled (Yes or No)?	Rationale
General Location	Source			
Public Drop Off Area	Public Drop Off Area	No	No	These activities are considered to be insignificant in comparison to the other activities occurring on-site.
HHW building	HHW building	No	No	These activities are considered to be insignificant in comparison to the other activities occurring on-site.
Leachate collection system	Leachate collection and treatment	No	No	The leachate is treated off-site and therefore there are no emissions from on-site leachate treatment. The Project will have capacity for temporary leachate storage, but it is not anticipated more than a few times per year.
Support activities	Emergency power generator(s)	No	No	The emergency power equipment only operates periodically (rather than continuously) and therefore produces infrequent emissions.
	Comfort Heating	No	No	These activities are considered to be negligible in comparison to the other activities occurring on-site. as they are less than 1% of the site wide emissions.
	Operational support activities, such as maintenance activities & stormwater ponds	No	No	These activities are considered to be insignificant in comparison to the other activities occurring on-site.

2.1 Activities Not Included in Assessment

There are many activities associated with the Project that produce emissions; however, not all activities produce emissions for any or all compounds that are relevant to the overall emissions assessment. All activities that potentially produce emissions were evaluated to determine their relevance; however, only activities that were assessed as relevant were included in the assessment. The following rationale describes why certain activities and/or emissions of certain compounds can be excluded from the assessment, as per the MECP ESDM Procedure Document (MECP 2018):

- The emission rates of certain compounds are very small relative to the overall emissions at the proposed W12A landfill expansion; and
- The emissions of certain sources are known to not be relevant due to the type of operations in the assessment (i.e., activities that are carried out by subcontractors).

Table B-2 lists the activities that were not assessed and the accompanying rationale.

Table B-2: Emissions Not Included in the Assessment

Activity/Compound	Rationale for Excluding from the Assessment
Vehicles on-site used by subcontractors (excluding landfill/earth moving equipment)	This activity is known to not be relevant to the type of operations in this assessment.
Construction and post closure phases for landfill expansion	These activities are considered to be insignificant in comparison to the operational phase of the landfill.
Propane combustion equipment	Propane is used to ignite the pilot flame on the flare. The pilot flame is not ignited at the same time as the flare is operated with LFG, therefore combustion associated with the pilot flame is not included in the model as it does not represent the worst-case scenario.
On-site storage piles	Emissions from wind erosion for the piles were estimated but are considered to be insignificant in comparison to the other activities occurring on-site as they are less than 1% of the site wide emissions. The daily cover material is received daily and applied directly to the active filling area.
Leachate collection	The leachate is treated off-site and therefore there are no emissions from on-site leachate treatment. The Project will have capacity for temporary leachate storage but it is not anticipated more than a few times per year.
Emergency power generator	The emergency power equipment only operates periodically (rather than continuously) and therefore produces infrequent emissions.

Activity/Compound	Rationale for Excluding from the Assessment
Operational support activities, such as maintenance activities & stormwater ponds	The leachate is treated off-site and therefore there are no emissions from leachate treatment on-site. These activities are considered to be negligible in comparison to the other activities occurring on-site.
Comfort Heating	These activities are considered to be negligible in comparison to the other activities occurring on-site. as they are less than 1% of the site wide emissions.
Public Drop Off Area	These activities are considered to be insignificant in comparison to the other activities occurring on-site.
HHW building	These activities are considered to be insignificant in comparison to the other activities occurring on-site.

3.0 DATA SOURCES AND ASSUMPTIONS

Table B-3 to B-4, below, document the assumptions made as part of the estimation of emission rates for Current Operations (Table B-3) and Proposed Expansion Operations (Tables B-4)

Table B-3: Data Sources and Assumptions – Current Conditions

Activity	Parameter	Value	Unit	Notes
Landfill Operations	Landfill area	1,070,000	m ²	Terms of Reference for the Environmental Assessment
	LFG Emissions	3.70x10 ⁷	m ³ /yr	Calculated using the LandGEM model.
	LFG Emissions	4229 (2489)	m ³ /hr (CFM)	
	Collection efficiency	62	%	Estimated to the total LFG LandGEM model for 2020
	Odour concentration	10,000	OU/m ³	Upper range estimate of odour concentration from the MECP's Interim Guide to Estimate and Assess Landfill Air Impacts
	Surface area of daily tipping face	1,500	m ²	Estimate provided by the City of London
	Average daily waste receipt	1,667	Mg/day	Conservatively estimated to 500,000 tonnes/year (approximately 50% more than current average daily rate)
	Depth of daily cover applied	0.15	m	Estimate provided by the City of London
	Density of daily cover	0.80	m	Estimated based on similar landfills

Activity	Parameter	Value	Unit	Notes
	Moisture content of waste	11	%	Misc. fill materials, US EPA AP-42 Section 13.2.4
	Moisture content of daily cover	12	%	Cover, US EPA AP-42 Section 13.2.4
Flare	LFG flow rate to flare	2633 (1550)	m ³ /hr (CFM)	Estimate provided by the City of London
	Methane in landfill gas	50	%	LandGEM
	Operating period	365	days/yr	Number of days in a year
	Inner diameter	2.7	m	Amended Certificate of Approval Air - No. 4183-78XHLX
	Flare height above grade	12.2	m	Amended Certificate of Approval Air - No. 4183-78XHLX
	Flare exit temperature	871	°C	Amended Certificate of Approval Air - No. 4183-78XHLX
	Flare exit flow rate	47	m ³ /s	Information from Comcor
Paved Roads	Average vehicle height	2.98	m	Estimated based on similar landfills
	Average lane width	3.75	m	Estimated based on similar landfills
	Silt loading	7.4	g/m ²	US EPA AP-42 Section 13.2.1, mean silt loading for MSW landfills
	Dust suppressant control efficiency	85	%	Estimated based on dust suppression activities (WGA, 2006)
Unpaved Roads	Average vehicle height	3.5	m	Height of waste hauling trucks
	Average lane width	3.8	m	Estimated based on similar landfills
	Vehicle weights	Various	tonnes	Provided by City of London
	Silt Content	6.4	%	US EPA AP-42 Section 13.2.2, mean silt loading for MSW landfills
	Dust suppressant control efficiency	85	%	Estimated based on dust suppression activities

Table B-4: Data Sources and Assumptions – Expansion

Activity	Parameter	Value	Unit	Notes
Landfill Operations	Landfill area	1,070,000	m ²	Terms of Reference for the Environmental Assessment
	LFG Emissions	6.54E+07	m ³ /yr	Calculated using the LandGEM model
	Collection efficiency	85	%	MECP recommendation
	Odour concentration	10,000	OU/m ³	Upper range estimate of odour concentration from the MECP's Interim Guide to Estimate and Assess Landfill Air Impacts
	Surface area of daily tipping face	1,500	m ²	Estimate provided by the City of London
	Average daily waste receipt	1,667	Mg/day	Conservatively estimated to 500,000 tonnes/year (approximately 50% than current average daily rate)
	Depth of daily cover applied	0.15	m	Estimate provided by the City of London
	Density of daily cover	0.80	m	Estimated based on similar landfills
	Moisture content of waste	11	%	Misc. fill materials, US EPA AP-42 Section 13.2.4
	Moisture content of daily cover	12	%	Cover, US EPA AP-42 Section 13.2.4
Flare 1	LFG flow rate to flare	3744 (2204)	m ³ /hr (CFM)	LandGEM
	Methane in landfill gas	50	%	LandGEM
	Operating period	365	days/yr	Number of days in a year
	Inner diameter	2.7	m	Amended Certificate of Approval Air - No. 4183-78XHLX
	Flare height above grade	12.2	m	Amended Certificate of Approval Air - No. 4183-78XHLX

Activity	Parameter	Value	Unit	Notes
	Flare exit temperature	871	°C	Amended Certificate of Approval Air - No. 4183-78XHLX
	Flare exit flow rate	47	m ³ /s	Information from Comcor
Flare 2	LFG flow rate to flare	2592(1526)	m ³ /hr (CFM)	LandGEM
	Methane in landfill gas	50	%	LandGEM
	Operating period	365	days/yr	Number of days in a year
	Inner diameter	2.7	m	Amended Certificate of Approval Air - No. 4183-78XHLX
	Flare height above grade	12.2	m	Amended Certificate of Approval Air - No. 4183-78XHLX
	Flare exit temperature	871	°C	Amended Certificate of Approval Air - No. 4183-78XHLX
	Flare exit flow rate	33	m ³ /s	Information from Comcor
Paved Roads	Average vehicle height	2.98	m	Estimated based on similar landfills
	Average lane width	3.75	m	Estimated based on similar landfills
	Silt loading	7.4	g/m ²	US EPA AP-42 Section 13.2.1, mean silt loading for MSW landfills
	Dust suppressant control efficiency	85	%	Estimated based on dust suppression activities (WGA, 2006)
Unpaved Roads	Average vehicle height	3.5	m	Height of waste hauling trucks
	Average lane width	3.8	m	Estimated based on similar landfills
	Vehicle weights	Various	tonnes	Provided by City of London
	Silt Content	6.4	%	US EPA AP-42 Section 13.2.2, mean silt loading for MSW landfills
	Dust suppressant control efficiency	85	%	Estimated based on dust suppression activities

4.0 EMISSION CALCULATION METHODOLOGIES

The following sections detail the emission calculation methodology for each source included in the assessment. The emission rates are all in units of grams (g) per second (g/s), with the exception of odour that is in odour units (OU) per second (OU/s), which is required for the dispersion models. The dispersion model assumes the emission rate is constant over an hourly period, which is the smallest time-step within the models used for predictions.

4.1 Landfill Cap

LFG not collected and distributed to the flare may result in fugitive LFG emissions through the landfill cap. LFG constituents and their estimated respective concentrations in the LFG were obtained from the U.S. EPA AP 42 Chapter 2.4 (US. EPA, 2008). Average fugitive LFG emissions per year were estimated using results from the LandGEM model and an 85% capture efficiency by the LGCCS.

The following is a sample calculation for the emission rate of vinyl chloride from the landfill cap for the proposed expansion conditions:

$$ER = \text{conc.} \frac{\mu\text{g}}{\text{m}^3} \times \text{LGF} \frac{\text{m}^3}{\text{yr}} \times \frac{1 \text{ yr}}{365 \text{ days}} \times \frac{1 \text{ day}}{24 \text{ hrs}} \times \frac{1 \text{ hr}}{3,600 \text{ s}} \times \frac{1 \text{ g}}{1,000,000 \mu\text{g}} \times (1 - \text{collection efficiency (\%)})$$

Where:

ER = emission rate (m³/s),

conc. = concentration of the contaminant in the landfill gas (g/m³) obtained from US EPA AP 42 Chapter 2.4 (draft, October 2008),

LFG = average landfill gas emissions per yr. (m³/yr.) (obtained from LandGEM), and
collection efficiency = efficiency of landfill gas collection system (85%)

$$ER = 3627 \frac{\mu\text{g}}{\text{m}^3} \times 65,419,680 \frac{\text{m}^3}{\text{yr}} \times \frac{1 \text{ yr}}{365 \text{ days}} \times \frac{1 \text{ day}}{24 \text{ hrs}} \times \frac{1 \text{ hr}}{3,600 \text{ s}} \times \frac{1 \text{ g}}{1,000,000 \mu\text{g}} \times (1 - 85\%)$$

$$ER = 0.00113 \frac{\text{g}}{\text{s}}$$

Emissions of the remaining indicator compounds were calculated in the same manner presented above.

The odour emissions from the landfill cap were also calculated in the same manner but using an odour emission concentration of 10,000 OU/m³ (MECP, 1992).

The following is a sample calculation for the emission rate of odour from the landfill cap for the proposed expansion conditions:

$$ER = \text{conc.} \frac{\text{OU}}{\text{m}^3} \times \text{LGF} \frac{\text{m}^3}{\text{yr}} \times \frac{1 \text{ year}}{365 \text{ days}} \times \frac{1 \text{ day}}{24 \text{ hrs}} \times \frac{1 \text{ hr}}{3,600 \text{ s}} \times (1 - \text{collection efficiency (\%)})$$

Where:

ER = emission rate (m³/s),

OU = Odour Units

conc. = concentration of the odour in the landfill gas (OU/m³) (MECP, 1992).

LFG = average landfill gas emissions per yr. (m³/yr.) (obtained from LandGEM), and
collection efficiency = efficiency of landfill gas collection system (85%)

$$ER = 10000 \frac{\text{OU}}{\text{m}^3} \times 65,419,680 \frac{\text{m}^3}{\text{yr}} \times \frac{1 \text{ yr}}{365 \text{ days}} \times \frac{1 \text{ day}}{24 \text{ hrs}} \times \frac{1 \text{ hr}}{3,600 \text{ s}} \times \frac{1 \text{ g}}{1,000,000 \text{ } \mu\text{g}} \times (1 - 85\%)$$

$$ER = 3110 \frac{\text{OU}}{\text{s}}$$

4.2 Material Transfer at the Active Area

U.S. EPA AP-42 emission factors were used to calculate the fugitive dust emissions associated with material transfer activities that will occur at the landfill active area, including depositing of waste and application of daily cover (US EPA 2006 and 1998). Odour emissions were estimated based on the working face of other representative landfills in Ontario (City of London, 2018)

The following predictive emissions equation was used in determining the emission factors for material handling:

Fugitive from depositing of waste:

$$EF = k \times 0.0016 \times \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$$

Where:

EF = particulate emission factor (kg/Mg),

k = particle size multiplier for particle size range (see Table B-5),

U = mean wind speed (m/s), and

M = moisture content of material (percent) (%).

Table B-5: Particle Size Assumptions Material Transfer (US EPA, 2006)

Size Range	k
PM _{2.5}	0.053
PM ₁₀	0.35
SPM	0.74

The following is a sample calculation for the SPM emission factor for the depositing of waste in the active area. A mean wind speed of 4.14 m/s was obtained from the pre-processed meteorological data (2013-2018) used in the modelling assessment, along with a moisture content of 12% for municipal solid waste landfill cover soil

$$EF = 0.74 \times 0.0016 \times \frac{\left(\frac{4.14 \text{ m/s}}{2.2}\right)^{1.3}}{\left(\frac{12}{2}\right)^{1.4}}$$

$$EF = 0.000247 \text{ kg/Mg}$$

The following is a sample calculation for the SPM emission rate per drop for a handling rate of 1667 Mg/day.

$$ER = EF \frac{\text{kg}}{\text{Mg}} \times \text{Operation Max Capacity} \frac{\text{Mg}}{\text{day}} \times \frac{1 \text{ hr}}{3,600 \text{ s}} \times \frac{1,000 \text{ g}}{1 \text{ kg}} \times \frac{1 \text{ day}}{\text{hours of operations}}$$

$$ER = \frac{0.000247 \text{ kg}}{\text{Mg}} \times \frac{1667 \text{ Mg}}{\text{day}} \times \frac{1 \text{ hr}}{3,600 \text{ s}} \times \frac{1,000 \text{ g}}{1 \text{ kg}} \times \frac{1 \text{ day}}{12 \text{ hr}}$$

$$ER = 0.00954 \text{ g/s}$$

The emission rates of PM₁₀ and PM_{2.5} were calculated in the same manner as above.

Fugitive Dust from Material Movement (Bulldozing):

SPM

$$EF = \frac{2.6(s)^{1.2}}{(M)^{1.3}}$$

SPM ≤ 10 μm

$$EF = \frac{0.45(s)^{1.5}}{(M)^{1.4}} \times 0.75$$

SPM ≤ 2.5 μm

$$EF = \frac{2.6(s)^{1.2}}{(M)^{1.3}} \times 0.105$$

Where:

EF = particulate emission factor (kg/hr),

s = material silt content (%), and

M = moisture content of material (%).

Table B-6: Assumptions Material Movement (Bulldozing)

Parameter	Value	Reference
Moisture Content (M)	12	US EPA, 2006 – municipal solid waste landfill cover
Silt Content (s)	9	US EPA, 2006– municipal solid waste landfill cover

$$EF(\text{SPM}) = \frac{2.6 (9)^{1.2}}{(12)^{1.3}}$$

$$EF = 1.44 \text{ kg/hr}$$

The following is a sample calculation for the SPM emission rate for material movement.

$$ER = EF \frac{\text{kg}}{\text{hr}} \times \frac{1,000 \text{ g}}{1 \text{ kg}} \times \frac{12 \text{ hours of operations}}{24 \text{ hours}} \times \frac{1 \text{ hr}}{3600 \text{ s}}$$

$$ER = 1.44 \frac{\text{kg}}{\text{hr}} \times \frac{1,000 \text{ g}}{1 \text{ kg}} \times \frac{12 \text{ hours of operations}}{24 \text{ hours}} \times \frac{1 \text{ hr}}{3600 \text{ s}}$$

$$ER = 0.199 \text{ g/s}$$

The emission rates of PM₁₀ and PM_{2.5} were calculated in the same manner as above with the exception of using the specific particle size emission factor equation.

The odour from the material handling operations was determined based on an odour emission rate of 0.898 OU/m²/s based on the working face of other representative landfills in Ontario (City of London, 2018). This emission rate was multiplied by the size of the active area, which was estimated to be 1500 m² (City of London, 2018) The resulting emission rate for odour is 1,347 OU/s.

The following is a sample calculation for the emission rate of odour from the working face for the proposed expansion conditions:

$$ER = \text{conc.} \frac{\text{OU}}{m^2/s} \times \text{Area } m^2$$

Where:

ER = emission rate (m^3/s),

OU = Odour Units

conc. = concentration of the odour in the landfill gas ($\text{OU}/m^2/s$) working face of other representative landfills in Ontario

Area = Surface area of daily working face (m^2)

$$ER = 0.898 \frac{\text{OU}}{m^2/s} \times 1500 m^2$$

$$ER = 1347 \text{ OU/s}$$

4.3 Material Handling – Non-Decomposable Waste

The fugitive dust emissions associated with the activity of depositing non-decomposable waste material into a specific area other than the tipping face were calculated using published emission factors. The operation of depositing non-decomposable waste material in a specific area does not occur in the current existing landfill operations but will in occur in the expansion phases.

Fugitive dust emissions from non-decomposable waste activities were calculated with the same method as presented in Section 4.1 of this appendix and AP-42 emission factors (US EPA 2006 and 1998) were used to calculate the fugitive dust emissions. The following predictive emissions equation was used in determining the emission factors for material handling:

Fugitive dust from depositing of waste:

$$EF = k \times 0.0016 \times \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$$

Where:

EF = particulate emission factor (kg/Mg),

k = particle size multiplier for particle size range,

U = mean wind speed (m/s), and

M = moisture content of material (percent) (%).

Table B-7: Particle Size Assumptions Material Transfer (US EPA, 2006)

Size Range	k
PM _{2.5}	0.053
PM ₁₀	0.35
SPM	0.74

The following is a sample calculation for the SPM emission factor for the depositing of waste in the proposed non-decomposable area. A mean wind speed of 4.14 m/s was obtained from the meteorological data used in the dispersion modelling. A moisture content of 7.4% for non-decomposable waste was used (US EPA, 2006)

$$EF = 0.74 \times 0.0016 \times \frac{\left(\frac{4.14 \text{ m/s}}{2.2}\right)^{1.3}}{\left(\frac{7.4}{2}\right)^{1.4}}$$

$$EF = 0.000431 \text{ kg/Mg}$$

The following is a sample calculation for the SPM emission rate per drop for a handling rate of 150 Mg/hr.

$$ER = EF \frac{\text{kg}}{\text{Mg}} \times \text{Material Handled per day} \frac{\text{Mg}}{\text{day}} \times \frac{1 \text{ hr}}{3,600 \text{ s}} \times \frac{1,000 \text{ g}}{1 \text{ kg}} \times \frac{1 \text{ day}}{\text{hours of operations}}$$

$$ER = \frac{0.000431 \text{ kg}}{\text{Mg}} \times \frac{150 \text{ Mg}}{\text{day}} \times \frac{1 \text{ hr}}{3,600 \text{ s}} \times \frac{1,000 \text{ g}}{1 \text{ kg}} \times \frac{1 \text{ day}}{12 \text{ hr}}$$

$$ER = 0.00150 \text{ g/s}$$

The emission rates of PM₁₀ and PM_{2.5} were calculated in the same manner as above.

Fugitive Dust from Material Movement (Bulldozing):

$$\begin{array}{lll}
 \text{SPM} & \text{SPM} \leq 10 \mu\text{m} & \text{SPM} \leq 2.5 \mu\text{m} \\
 EF = \frac{2.6(s)^{1.2}}{(M)^{1.3}} & EF = \frac{0.45(s)^{1.5}}{(M)^{1.4}} \times 0.75 & EF = \frac{2.6(s)^{1.2}}{(M)^{1.3}} \times 0.105
 \end{array}$$

Where:

EF = particulate emission factor (kg/hr),

s = material silt content (%), and

M = moisture content of material (%).

Table B-8: Assumptions Material Movement (Bulldozing)

Parameter	Value	Reference
Moisture Content (M)	7.4	US EPA 2006 municipal solid waste landfill - Sand
Silt Content (s)	2.6	US EPA 2006 municipal solid waste landfill - Sand

$$EF(\text{SPM}) = \frac{2.6 (2.6)^{1.2}}{(7.4)^{1.3}}$$

$$EF = 0.61 \text{ kg/hr}$$

The following is a sample calculation for the SPM emission rate for the non-decomposable waste material movement.

$$ER = EF \frac{\text{kg}}{\text{hr}} \times \frac{1,000 \text{ g}}{1 \text{ kg}} \times \frac{12 \text{ hours of operations}}{24 \text{ hours}} \times \frac{1 \text{ hr}}{3600 \text{ s}}$$

$$ER = 0.61 \frac{\text{kg}}{\text{hr}} \times \frac{1,000 \text{ g}}{1 \text{ kg}} \times \frac{12 \text{ hours of operations}}{24 \text{ hours}} \times \frac{1 \text{ hr}}{3600 \text{ s}}$$

$$ER = 0.0843 \text{ g/s}$$

The emission rates of PM₁₀ and PM_{2.5} were calculated in the same manner as above with the exception of using the specific particle size emission factor equation.

4.4 Enclosed Flare

The LGCCS was estimated to collect 85% of the LFG produced by the landfill, with the remaining fugitively emitted through the cap. For the existing scenario, the gas collected is combusted using an enclosed flare. Based on an 85% collection efficiency and the outputs from LandGEM, there is approximately 50% methane in the LFG and the flow rate of LFG to the existing flare is 0.99 m³/s. The estimated concentrations of indicator compounds in the LFG were obtained from the U.S. EPA AP 42 Chapter 2.4 (Table 2.4-1) (Draft, October 2008).

The following is a sample calculation for the emission rate of vinyl chloride from the existing flare (Flare 1) for the existing scenario:

$$ER = \text{Landfill Gas flow rate} \frac{\text{m}^3}{\text{s}} \times \text{conc.} \frac{\mu\text{g}}{\text{m}^3} \times \frac{1 \text{ g}}{1,000,000 \mu\text{g}} \times (1 - \text{destruction efficiency (\%)})$$

Where:

ER = emission rate (g/s),

Landfill Gas Flow rate = flow rate of landfill gas to the flare (m³/s),

conc. = concentration of the indicator compound in the landfill gas (μg/m³)

destruction efficiency = amount of the indicator compound that is destroyed during combustion (%) Estimated to be 98% (US EPA, 2008)

$$ER_{\text{vinyl chloride}} = 073 \frac{\text{m}^3}{\text{s}} \times 3627 \frac{\mu\text{g}}{\text{m}^3} \times \frac{1 \text{ g}}{1,000,000 \mu\text{g}} \times (1 - 98 \%)$$

$$ER_{\text{vinyl chloride}} = 0.0000531 \frac{\text{g}}{\text{s}}$$

The emission rate for sulphur dioxide was estimated based on the concentration of compounds containing sulphur (based on the draft US EPA AP 42 Chapter 2.4) multiplied by the number of moles of sulphur in each compound. The following is a sample calculation for the emission rate of reduced sulphur from the Existing Flare (Flare 1) during the existing scenario.

$$ER = \text{conc. of sulphur in the LFG} \frac{\text{m}^3 \text{ S}}{\text{m}^3 \text{ LFG}} \times \text{flow rate} \frac{\text{m}^3 \text{ LFG}}{\text{sec}} \times \frac{1 \text{ mol. K}}{8.3145 \text{ m}^3 \text{ S. PA}} \times \frac{101325 \text{ Pa}}{298.15 \text{ K}} \\ \times \frac{32.1 \text{ gS}}{\text{mol}}$$

$$ER = 40.66 \frac{\text{m}^3 \text{ S}}{1,000,000 \text{ m}^3 \text{ LFG}} \times 0.73 \frac{\text{m}^3 \text{ LFG}}{\text{sec}} \times \frac{1 \text{ mol. K}}{8.3145 \text{ m}^3 \text{ S. PA}} \times \frac{101325 \text{ Pa}}{298.15 \text{ K}} \times \frac{32.1 \text{ g}_s}{\text{mol}}$$

$$ER = 0.039 \frac{\text{g}}{\text{s}}$$

The sulphur dioxide emission rate from the flare was calculated as follows¹:

$$ER = \text{reduced sulphur compounds emission rate} \times \frac{MW_{SO_2}}{MW_S}$$

$$ER = 0.039 \frac{g_s}{s} \times \frac{64.0}{32.1}$$

$$ER = 0.08 \frac{g}{s}$$

Where:

ER = emission rate (g/s)

MW = Molar weight

The following is a sample calculation for the emission rate of combustion by-products (in this case nitrogen oxides) from the flare:

$$ER = \text{flow rate (dscm)} \times \text{percent of methane in LFG(\%)} \times \text{NOx emission factor} \times \text{conversion factors}$$

$$ER = 0.73 \frac{m^3}{s} \times 50\% \text{ CH}_4 \times \frac{631 \text{ kg}}{1,000,000 \text{ dscm of CH}_4} \times 1000 \frac{g}{kg}$$

$$ER = 0.231 \frac{g}{s}$$

4.5 Non-Road Vehicles – Exhaust Emissions

Emission Rates for tailpipe emissions from non-road equipment were calculated using emission factors (US EPA, 2018). Load factors for the non-road equipment were estimated for each piece of equipment based on assumptions for similar equipment. (US EPA, 2002)

Table B-9: Non-Road Equipment

Equipment	Horsepower	# of units
Active Area		
Compactor - Caterpillar 836K	555	1
Compactor - Bomag BC772R10-4	450	1
Crawler Dozer - Caterpillar D8T	310	1
Crawler Dozer - Caterpillar D6R WDA LGP	175	1
Tracked Excavator - Caterpillar 336D	260	1
Rock Truck - Caterpillar 730	365	1
Front End Loader -	178	1

¹ S= sulphur

The following predictive emissions equation was used to determine the combustion emission rates for SPM, CO, and NO_x for the on-site vehicles:

$$ER = EF \times \text{engine horsepower rating} \times \text{load factor} \times \frac{1 \text{ hr}}{3,600 \text{ s}}$$

Where:

ER = emission rate (g/s), and

EF = emission factor (g/hp-hr).

Load factor = utilization factor for the equipment

The following is a sample calculation for the NO_x emissions for the Caterpillar 836K Compactor located at the active area:

$$ER = \frac{0.30 \text{ g}}{\text{hp} - \text{hr}} \times 555 \text{ hp} \times 0.43 \times \frac{1 \text{ hr}}{3,600 \text{ s}}$$

$$ER = 0.0199 \frac{\text{g}}{\text{s}}$$

The emission rates for PM₁₀ and PM_{2.5} were calculated by multiplying SPM emission rate by estimated particle size fraction (US EPA, 1990). The following is a sample calculation for PM₁₀ emissions for Caterpillar 836K Compactor:

$$ER \text{ for SPM} = 0.000663 \frac{\text{g}}{\text{s}}$$

$$ER \text{ for PM}_{10} = 0.000663 \frac{\text{g}}{\text{s}} \times 0.96$$

$$ER \text{ for PM}_{10} = 0.000636 \frac{\text{g}}{\text{s}}$$

The following emissions equation was used to determine the combustion emission factor for SO₂ in grams per horsepower hour (US EPA, 2018):

$$SO_2 = (\text{BSFC} \times 453.6 \times (1 - \text{SO}_{\text{xcnv}}) - \text{HC}) \times 0.01 \times \text{SO}_{\text{xdsl}} \times 2$$

Where:

SO₂ is in g/hp-hr

BSFC = is the in-use adjusted fuel consumption in the lb/hp-hr

453.6 = conversion factor from weight percent to weight fraction

SO_{xcnv} = fraction of fuel sulfur converted to direct PM

HC = the in-use adjusted hydrocarbon emissions in g/hp-hr

0.01 = the conversion factor from weight percent to weight fraction

SO_{xdsl} = the episodic weight percent to weight fraction

2 = the grams of SO₂ formed from a gram of sulfur

The following is a sample calculation for the SO₂ emissions factor for the Caterpillar 836K Compactor located at the active area:

$$SO_2 = \left(0.367 \frac{lb}{hp-hr} \times 453.6 \times (1 - 0.02247) - 0.0080 \right) \times 0.01 \times 0.0015\% \times 2$$

$$\text{Emission Factor for } SO_2 = 0.0000488 \frac{g}{hp-hr}$$

Emission rate sample calculation for SO₂:

$$ER = \frac{0.0000488 g}{hp-hr} \times 555 hp \times 0.43 \times \frac{1 hr}{3,600 s}$$

$$ER = 3.23 \times 10^{-6} \frac{g}{s}$$

Emission rates for non-road vehicles were calculated for each of the active areas where non-road equipment operate. The emission rates from each of the vehicles was summed to give the total emission rate for each contaminant in the active area.

4.6 On-Road Vehicles – Exhaust Emissions

Emission factors for the on-site vehicle exhaust for on-road vehicles were obtained using the U.S. EPA MOVES 2014a emission model.

For roads located on the W12A landfill property, the location, type and length of the road segments was provided by the City of London and is summarized in Table B-10.

Table B-10: W12A Landfill Road Segment Summary

Segment ID	Phase	Road Type	Lanes	Length [m]
B-R1	Current	Paved	2	1577
B-R2	Current	Unpaved	2	155
2-R1	Phase 2	Paved	2	2018
2-R2	Phase 2	Unpaved	2	173
4-R1	Phase 4	Paved	2	847
4-R2	Phase 4	Unpaved	2	1023
8-R1	Phase 8	Paved	2	287
8-R2	Phase 8	Unpaved	2	752
ND-R1	All	Paved	2	288
ND-R2	All	Unpaved	2	442
HHW	All	Paved	2	461

Type, description, and volume of on-road vehicles travelling on the W12A Landfill road segments was provided by the City of London and is summarized in Table B-11:

Table B-11: W12A Landfill On-road Vehicles – Type and Volume of Vehicles

Vehicle Type Description	Average Vehicle Weight (tonnes)	Average Trips per day	Average Trips per hour	Current Maximum Trips per Hour ^(a)	Proposed Maximum Trips per Hour ^(b)
Short Haul Truck	16.23	4.47	0.32	0.56	0.74
Truck Tandem (Triaxle, Dump)	16.23	166.67	11.91	20.71	27.62
Passenger Vehicle (Car or Minivan or pick-up truck)	2.32	74.82	5.34	9.30	12.40

Notes:

^(a) Based on current receipts

^(b) Based on forecasted data

The emission factors developed for the on-road vehicles operated at the facility are provided in the Tables below:

Table B-12: Emission Factors for Waste Trucks Calculated Using MOVES Model

Compound	Emission Factor (g/VKT) ^(a)
SPM	0.0122
PM ₁₀	0.0122
PM _{2.5}	0.0117
NO _x	0.268
SO ₂	0.000583
CO	0.0752

Notes: ^{a)} VKT =vehicle kilometres travelled

TableB-13: Emission Factors for Short Haul Trucks Calculated Using MOVES Model

Compound	Emission Factor (g/VKT) ^(a)
SPM	0.0379
PM ₁₀	0.0379
PM _{2.5}	0.0379
NO _x	0.788
SO ₂	0.000
CO	0.250

Table B-14: Emission Factors for Passenger Vehicles (Gasoline) Calculated Using MOVES Model

Compound	Emission Factor (g/VKT)
SPM	0.000
PM ₁₀	0.000
PM _{2.5}	0.000
NO _x	0.0203
SO ₂	0.000
CO	0.159

The following equation was used to determine the vehicle kilometres travelled per hour (VKT/hr):

$$\frac{\text{VKT}}{\text{hr}} = \frac{\# \text{ of Trucks}}{\text{Hour}} \times \text{Road Length Travelled (km)}$$

The following is a sample calculation for VKT/hr on one segment (BR-1) of the paved roads for the current operations:

$$\frac{\text{VKT}}{\text{hr}} = \frac{21 \text{ Waste Trucks}}{\text{Hour}} \times 1.58 \text{ km}$$

$$\text{VKT/hr} = 65$$

The VKT for each of the road segments was calculated using the equation above. The maximum number of vehicle trips per hour for current existing and proposed phases for each road segment was used in the calculation. Tables B-15 to B-17 list the road segments and VKT/hr for each of the three vehicle types travelling on the roads.

Table B-15: Waste Truck – Road Segment Maximum VKT/hr

Road ID	Description	Vehicles on Segment	Maximum Trips per hour	Segment Length [one way, m]	Maximum VKT/hr
B-R1	Current Paved	Waste Truck	21	1577	65
B-R2	Current Unpaved	Waste Truck	21	155	6
2-R1	Phase 2 Paved	Waste Truck	28	2018	111
2-R2	Phase 2 Unpaved	Waste Truck	28	173	10
4-R1	Phase 4 Paved	Waste Truck	28	847	47
4-R2	Phase 4 Unpaved	Waste Truck	28	1023	57
8-R1	Phase 8 Paved	Waste Truck	28	287	16
8-R2	Phase 8 Unpaved	Waste Truck	28	752	42

Table B-16: Short Haul Truck – Road Segment Maximum VKT/hr

Road ID	Description	Vehicles on Segment	Maximum Trips per hour	Segment Length [one way, m]	Maximum VKT/hr
ND-R1	All Phases Paved	Short Haul	1	288	0.4
ND-R2	All Phases Unpaved	Short Haul	1	442	0.7

Table B-17: Passenger Vehicle (Gasoline) – Road Segment Maximum VKT/hr

Road ID	Description	Vehicles on Segment	Maximum Trips per hour	Segment Length [one way, m]	Maximum VKT/hr
HHW	All Phases Paved	Passenger	12	461	11.4

The following predictive emissions equation was used to determine the exhaust emission rates for on-site vehicles travelling on paved and un-paved roads:

$$ER = EF \times \frac{VKT}{hr} \times \frac{1 \text{ hr}}{3,600 \text{ s}}$$

Where:

ER = emission rate (g/s),

EF = emission factor (g/VKT)

The following is a sample calculation for the total NO_x emissions for Waste Truck exhaust emissions on B-R1 paved road segment for the current phase.

$$ER = \frac{0.268 \text{ g}}{\text{VKT}} \times \frac{65 \text{ VKT}}{\text{hr}} \times \frac{1 \text{ hr}}{3,600 \text{ s}}$$

$$ER = 0.00486 \text{ g/s}$$

Additionally, SPM, PM₁₀ and PM_{2.5}, SO₂, and CO were calculated using the same equation. The exhaust emission rates for unpaved road segments were calculated using the same emissions factor and the same approach to determine the VKT.

4.7 Unpaved Road Dust

The predictive equation referenced in AP42 emission methodologies for unpaved roads (US EPA, 2006b) was used to calculate the fugitive dust emissions from unpaved roadways. The equation accounts for the application of dust suppressant control efficiency. The equation is as follows:

$$EF = \left(k \left(\frac{s}{12} \right)^a \times \left(\frac{W}{3} \right)^b \times 281.9 \right) (1 - \text{control efficiency})$$

Where:

EF = particulate emission factor (g/VKT),

k = empirical constant for particle size range (pounds (lbs) per vehicle mile travelled (VMT)) (see Table B-18),

s = road surface silt content (%) assumed to be 6.4% (as per US EPA AP-42 Section 13.2.2 for MSW landfills),

W = average weight (tons) of the vehicles traveling the road,

a = empirical constant for particle size range (dimensionless) (see Table B-18),

b = empirical constant for particle size range (dimensionless) (see Table B-18),

281.9 = conversion from pounds per vehicle miles travelled to grams per vehicle kilometres travelled, and

control efficiency = reduction of fugitive dust emissions due to dust suppressant use.

Table B-18: Particle Size Assumptions for Unpaved Road Dust

Size Range	k (lb/VMT)	a	b
SPM	4.9	0.7	0.45
PM ₁₀	1.5	0.9	0.45
PM _{2.5}	0.15	0.9	0.45

The following is a sample calculation for SPM for the emission factor for a Waste Truck that will travel road segment BR-2 in the current phase (unpaved road to active area of landfill).

A Waste Truck travelling on this segment will have an average weight of 15.97 tons; vehicle weights were provided by the City of London and are presented in Table B-19.

Table B-19: Road Vehicle Weights

Vehicle Type Description	Average Vehicle Weight (tonnes)	Average Vehicle Weight (tons)
Short Haul Truck	16.23	15.97
Truck Tandem (Triaxle, Dump)	16.23	15.97
Passenger Vehicle (Car or Minivan or pick-up truck)	2.32	2.28

A control efficiency of 85% was selected for unpaved roads to represent the use of dust suppressants.

$$EF = \left(4.9 \left(\frac{6.4}{12} \right)^{0.7} \times \left(\frac{15.97}{3} \right)^{0.45} \times 281.9 \right) (1 - 85\%)$$

$$EF = 238.2 \text{ g/VKT}$$

The following is a sample calculation for the SPM emission rate for vehicles travelling along the BR-2 unpaved road segment in current phase:

$$ER = \frac{238.2 \text{ g}}{\text{VKT}} \times \frac{6 \text{ VKT}}{\text{hr}} \times \frac{1 \text{ hr}}{3600 \text{ s}}$$

$$ER = 0.503 \text{ g/s}$$

The emission rates of PM₁₀ and PM_{2.5} were calculated as presented above.

4.8 Paved Road Dust

Published emission factors were used to calculate the fugitive dust emissions from paved roadways (US EPA, 2011). The following predictive emissions equation was used to determine the fugitive dust emission factor for paved roads:

$$EF = (k(sL)^{0.91} \times (W)^{1.02}) (1 - \text{control efficiency})$$

Where:

EF = particulate emission factor (having units matching the units of k),

k = particle size multiplier for particle size range and units of interest (see Table B-20),

sL = road surface silt loading (g/m²) assumed to be 7.4 (as per US EPA AP-42

Section 13.2.1-3, silt loading for MSW landfills),

W = average weight (tons) of the vehicles traveling the road, and

control efficiency = reduction of fugitive dust emissions due to dust suppression activities.

TableB-20: Particle Size Assumptions for Paved Road Dust (US EPA, 2006)

Size Range	k (g/VKT)
SPM	3.23
PM ₁₀	0.62
PM _{2.5}	0.15

The following is a sample calculation for SPM for the predictive emission factor for a Short Haul Truck that will travel along the road segment ND-R1. The Short Haul Truck will have an average weight of 15.97 tons. A control efficiency of 85% was selected to represent the dust suppression activities at the facility.

$$EF = (3.23 \times (7.4)^{0.91} \times (15.97)^{1.02})(1 - 85\%)$$

$$EF = 283.2 \text{ g/VKT}$$

The following is a sample calculation for the SPM emission rate for vehicles travelling along the same paved road segment:

$$ER = \frac{238.2 \text{ g}}{\text{VKT}} \times \frac{1 \text{ VKT}}{\text{hr}} \times \frac{1 \text{ hr}}{3600 \text{ s}}$$

$$ER = 0.0515 \text{ g/s}$$

The emission rates of PM₁₀ and PM_{2.5} were calculated as presented above.

5.0 REFERENCES

- City of London. 2007. W12A Landfill. MECP *Amended Certificate of Approval Air Number 4183-78XHLX* issue date December 24, 2007.
- City of London. (City of London) 2018. *W12A Landfill Site Odour Management Program* dated August 2018
- Golder Associates Ltd. (Golder) February 2019. Proposed Amended Terms of Reference. Environmental Assessment of the Proposed W12A Landfill Expansion, City of London.
- MECP (Ministry of Environment, Conservation and Parks). 1992. *Interim Guide to Estimate and Assess Landfill Air Impacts* dated October 1992
- MECP (Ministry of Environment, Conservation and Parks). 2018. *Procedure for Preparing an Emission Summary and Modelling Report Guideline A-10 Version 4.1*. PIBs 3614e04.1.
- U.S. Environmental Protection Agency (US EPA). 1995. *Compilation of Air Pollutant Emission Factors*. Volume 1: Stationary Point and Area Sources, Fifth Edition. EPA, Office of Air Quality Planning and Standards. Research Triangle Park, North Carolina. U.S.
- U.S. Environmental Protection Agency (US EPA). 1996. *Compilation of Air Pollutant Emission Factors*. Volume 1: Stationary Point and Area Sources. *Appendix B.2 Generalized Particle Size Distributions*. Document AP-42. U.S. EPA, Office of Air Quality Planning and Standards. Research Triangle Park, North Carolina. U.S.
- U.S. Environmental Protection Agency (US EPA). 1998. *Compilation of Air Pollutant Emission Factors*. Volume 1: Stationary Point and Area Sources. Chapter 11.9.1: *Western Surface Coal Mining*. Document AP-42. U.S. EPA, Office of Air Quality Planning and Standards. Research Triangle Park, North Carolina.
- U.S. Environmental Protection Agency (US EPA). 2002. *Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling NR-005b*. U.S. EPA, Office of Transportation and Air Quality.
- U.S. Environmental Protection Agency (US EPA). 2004. *Compilation of Air Pollutant Emission Factors*. Volume 1: Stationary Point and Area Sources. Chapter 11.19.2: *Crushed Stone Processing and Pulverized Mineral Processing*. Document AP-42. U.S. EPA, Office of Air Quality Planning and Standards. Research Triangle Park, North Carolina.
- U.S. Environmental Protection Agency (US EPA). 2006. *Compilation of Air Pollutant Emission Factors*. Volume 1: Stationary Point and Area Sources. Chapter 13.2.4: *Aggregate Handling and Storage Piles*. Document AP-42. U.S. EPA, Office of Air Quality Planning and Standards. Research Triangle Park, North Carolina. U.S.
- U.S. Environmental Protection Agency (US EPA). 2006b. *Compilation of Air Pollutant Emission Factors*. Volume 1: Stationary Point and Area Sources. Chapter 13.2.2: *Unpaved Roads*. Document AP-42. U.S. EPA, Office of Air Quality Planning and Standards. Research Triangle Park, North Carolina.

- U.S. Environmental Protection Agency (US EPA). 2008. *Compilation of Air Pollutant Emission Factors*. Volume 1: Stationary Point and Area Sources. DRAFT Chapter 2.4: Municipal Solid Waste Landfills. Document AP-42. U.S. EPA, Office of Air Quality Planning and Standards. Research Triangle Park, North Carolina.
- U.S. Environmental Protection Agency (US EPA). 2008. *Compilation of Air Pollutant Emission Factors*. Volume 1: Stationary Point and Area Sources. Section 2.4: *Background Information Document for Updating AP42 Section 2.4 for Estimating Emissions from Municipal Solid Waste Landfills*. Document AP-42. U.S. EPA, Office of Air Quality Planning and Standards. Research Triangle Park, North Carolina. U.S.
- U.S. Environmental Protection Agency (US EPA). 2011. *Compilation of Air Pollutant Emission Factors*. Volume 1: Stationary Point and Area Sources. Chapter 13.2.1: *Paved Roads*. Document AP-42. U.S. EPA, Office of Air Quality Planning and Standards. Research Triangle Park, North Carolina.
- U.S. Environmental Protection Agency (US EPA). 2016 *Multi-scale motor Vehicle and equipment Emission System (MOVES) 2014a modeling software*. U.S. EPA, Office of Transportation and Air Quality.
- U.S. Environmental Protection Agency (US EPA). 2018. *Exhaust and Crankcase Emission Factors for Non-road Compression-Ignition Engines in MOVES2014b*. U.S. EPA, Office of Transportation and Air Quality.

APPENDIX C

Dispersion Modelling

DRAFT

APPENDIX C**Dispersion Modelling***W12A Landfill Expansion EA, City of London, Ontario*

Submitted to:

Mike Losee, Division Manager, Solid Waste Management

City of London

300 Dufferin Avenue

PO Box 5035

London, Ontario

N6A 4L9

Submitted by:

Golder Associates Ltd.

1931 Robertson Road, Ottawa,

Ontario, K2H 5B7, Canada

+1 613 592 9600

1648176

November 2020

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1 e-copy City of London

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1.0 INTRODUCTION

This appendix is part of the Air Quality assessment for the proposed expansion of the W12A Landfill by the City of London. This work has been conducted in accordance with the requirements set out in the approved Amended Terms of Reference (ToR), dated February 2019 and the Work Plan, dated December 2019 prepared following commencement of the EA and circulated to the Ministry of the Environment, Conservation and Parks (MECP).

1.1 Purpose

This appendix documents the methods, inputs and assumptions that were used to carry out the dispersion modelling to predict ground-level concentrations of indicator contaminants resulting from the operations of the existing landfill and the proposed landfill expansion (the Project).

The modelling approach described within this appendix follows generally accepted practices for conducting EAs and, where appropriate, follows MECP guidance (MECP, 2017).

2.0 AIR DISPERSION MODEL

Potential effects to air quality were evaluated with the aid of the latest version of the AERMOD dispersion model (Version 19191). AERMOD was selected for the project since:

- it is recognized by provincial regulators as one which is suitable for this application
- it can evaluate various source configurations and compounds
- it has a technical basis that is scientifically sound, and is in keeping with the current understanding of dispersion in the atmosphere
- it makes predictions that are consistent with observations

AERMOD was developed by the U.S. EPA and consists of the model and two pre-processors: the AERMET meteorological pre-processor and the AERMAP terrain pre-processor. The following approved dispersion model and pre-processors were used in the assessment:

- AERMOD dispersion model (v. 19191)
- AERMAP surface pre-processor (v. 18081)

AERMET was not required since an MECP 5-year pre-processed meteorological dataset (2013-2017) was used.

2.1 Model Inputs

To predict ambient air concentrations with the aid of AERMOD, a series of inputs are required. These inputs can be grouped into categories:

- dispersion meteorological data
- terrain and receptors
- emissions and source configurations

Each of these input categories are discussed separately in the following sections.

2.1.1 Meteorological Data

The MECP, as well as other agencies, recommends that five years of hourly data be used in the model to cover a wide range of potential meteorological conditions. A site-specific MECP pre-processed meteorological dataset for the site was obtained directly from MECP on February 20, 2020. The dataset covers the period of January 1, 2013 to December 31, 2017.

The AERMET pre-processor produced two meteorological data files. The first file contains boundary layer scaling parameters (e.g., surface friction velocity, mixing height, and Monin-Obukhov length) as well as wind speeds, wind directions and temperature at a reference-height (i.e., 10 m). The second file contains one or more levels (a profile) of winds, temperature, and the standard deviation of the fluctuating components of the wind. These files were used directly as inputs to AERMOD.

2.1.2 Terrain

Terrain elevations have the potential to influence air quality concentrations at individual receptors, therefore surrounding terrain data is required when using regulatory dispersion models in both simple and complex terrain situations. Digital terrain data is used in the AERMAP pre-processor to determine the base elevations of receptors, sources and buildings. AERMAP then searches the terrain height and location that has the greatest influence on dispersion for each receptor (U.S. EPA, 2004). This is referred to as the hill height scale. The base elevation and hill height scale produced by AERMAP are directly inserted into the AERMOD input file.

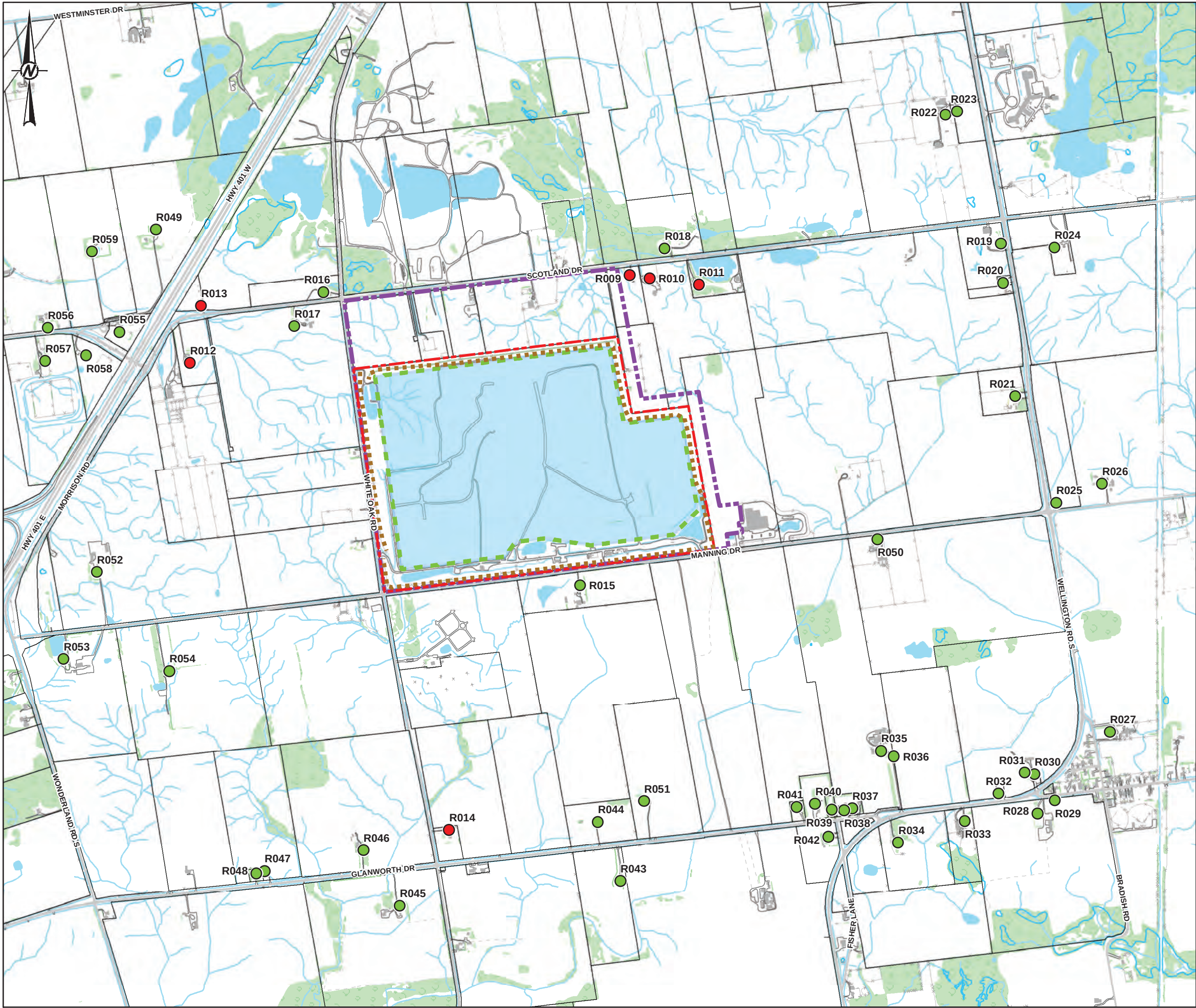
Digital terrain data for the site was obtained from the MECP (GeoTIFF Format) (MECP, 2019). The digital elevation model (CDEM) file used in the modelling was CDEM_DEM_040I.

2.1.3 Receptors

Discrete receptors located off-site at nearby residences (referred to as sensitive receptors) were used for the indicator compounds, illustrated on Figure C-1.

For the assessment of compliance with O. Reg. 419/05, a nested grid of receptors was used for the assessment based on the MECP Dispersion Modelling Guideline (MECP, 2017). Receptors were centered on the sources and placed as follows:

- 20 m spacing within 200 m of all sources of emissions
- 50 m spacing within 300 m of all sources of emissions
- 100 m spacing within 800 m of all sources of emissions
- 200 m spacing within 1,800 m of all sources of emissions
- 500 m spacing within 5,000 m of all sources of emissions.

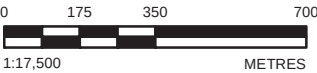


LEGEND

- CITY OWNED PROPERTY - EXISTING
- NON-CITY OWNED PROPERTY - EXISTING
- WATERCOURSE
- DRIVEWAY
- FENCELINE
- TRAIL
- APPROXIMATE BERM LOCATION
- BUILDING FOOTPRINT
- WOODED AREA
- WATERBODY
- EXISTING PROPERTY BOUNDARY
- PROPOSED PROPERTY BOUNDARY
- EXISTING APPROVED LIMIT OF WASTE
- PROPOSED LIMIT OF WASTE

REFERENCE(S)
1. DATA PROVIDED BY THE CITY OF LONDON.
2. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: UTM ZONE 17 VERTICAL DATUM: CGVD28

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CLIENT CORPORATION OF THE CITY OF LONDON			
PROJECT ENVIRONMENTAL ASSESSMENT OF THE PROPOSED W12A LANDFILL EXPANSION: AIR QUALITY AND ODOUR			
TITLE SENSITIVE RECEPTOR LOCATIONS			
CONSULTANT 	YYYY-MM-DD	2020-08-19	
	DESIGNED	----	
	PREPARED	JEM	
	REVIEWED	----	
PROJECT NO. 1648176	PHASE 0020	REV. A	FIGURE C1

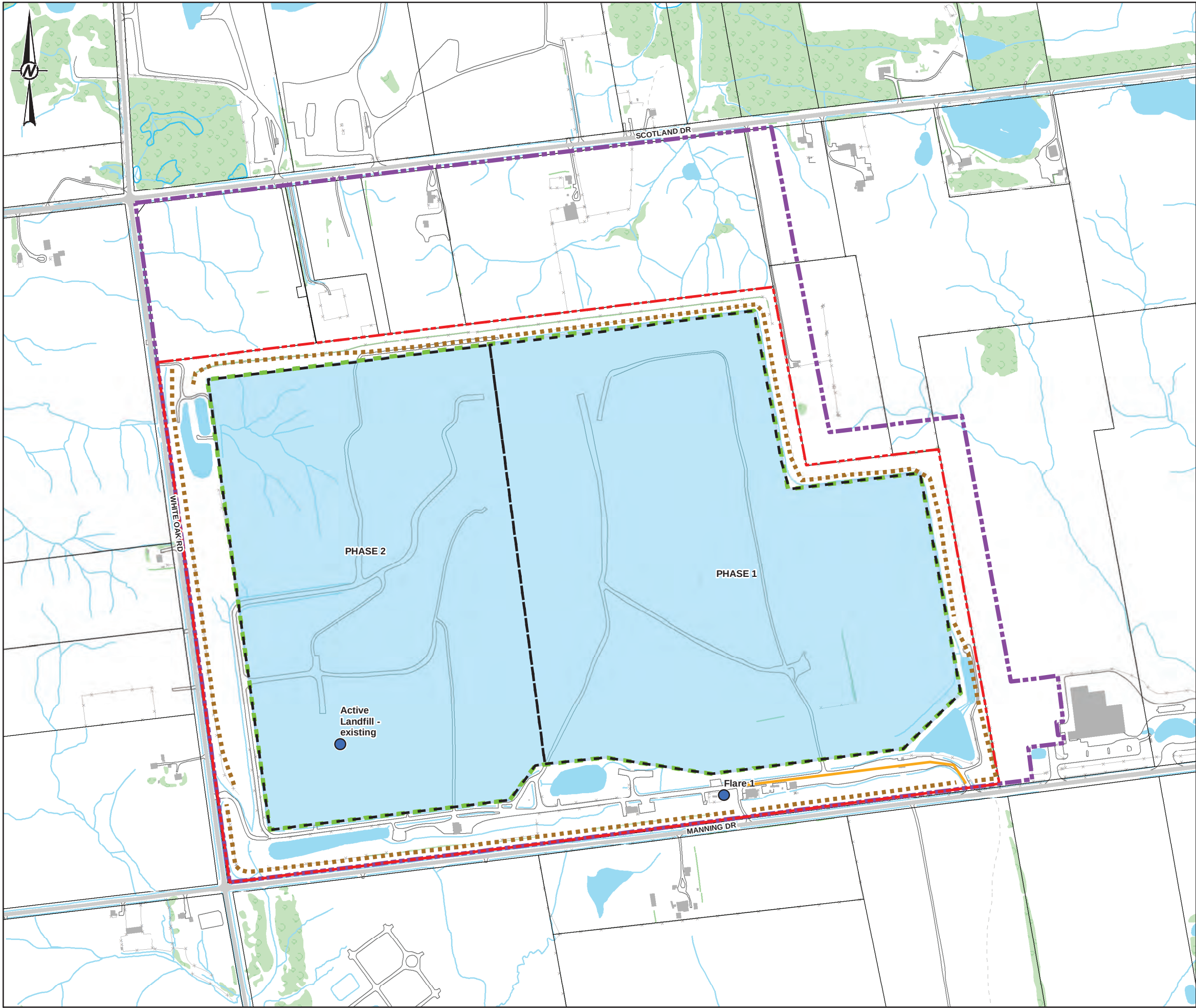
2.1.4 Emission Rates

Hourly emission rates were estimated for the indicator compounds for the W12A Landfill expansion activities (including existing activities) as inputs for the dispersion model. A detailed description of the methodology and sample calculations for determining the emission rates is provided in Appendix B.

2.2 Model Source Configurations

Emission sources that were parameterized in the modelling include the landfill cap, material handling operations in the active area and non-decomposable area, flares, fugitive road dust, and exhaust emissions from road and non-road vehicles for the existing operations and proposed expansion operations.

The model source types that were used in this assessment include: point, area, and volume sources, as described below. Site layout and emission source location figures showing the location of the emission sources for the existing landfill are presented on Figure C-2 and the proposed expansion phases are illustrated on Figure C-3.

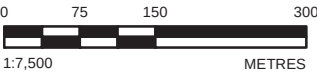


LEGEND

- AIR EMISSION SOURCE
- WATERCOURSE
- DRIVEWAY
- FENCELINE
- TRAIL
- APPROXIMATE BERM LOCATION
- BUILDING FOOTPRINT
- WOODED AREA
- WATERBODY
- EXISTING PROPERTY BOUNDARY
- PROPOSED PROPERTY BOUNDARY
- EXISTING APPROVED LIMIT OF WASTE
- PROPOSED LIMIT OF WASTE
- ROADWAY TYPE**
- DECOMPOSABLE WASTE

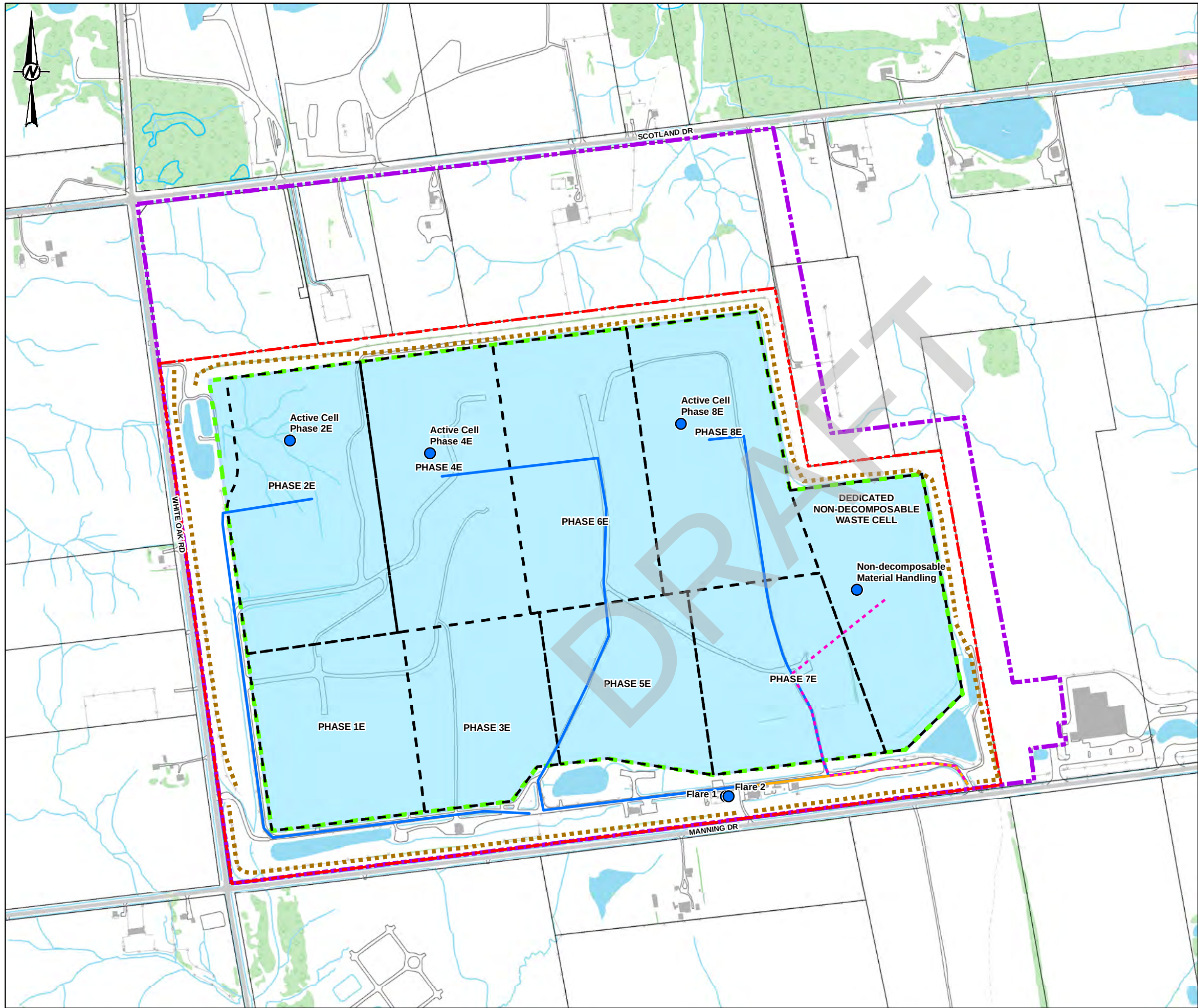
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2. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
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CLIENT CORPORATION OF THE CITY OF LONDON		
PROJECT ENVIRONMENTAL ASSESSMENT OF THE PROPOSED W12A LANDFILL EXPANSION: AIR QUALITY AND ODOUR		
TITLE SITE LAYOUT AND EMISSION SOURCE LOCATION: EXISTING		
	CONSULTANT	YYYY-MM-DD 2020-08-19
	DESIGNED	----
	PREPARED	JEM
	REVIEWED	----
	APPROVED	----
PROJECT NO. 1648176	PHASE 0020	REV. A
		FIGURE C2

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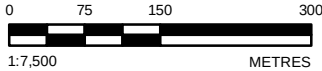
- AIR EMISSION SOURCE
- WATERCOURSE
- DRIVEWAY
- FENCELINE
- TRAIL
- APPROXIMATE BERM LOCATION
- BUILDING FOOTPRINT
- WOODED AREA
- WATERBODY
- EXISTING PROPERTY BOUNDARY
- PROPOSED PROPERTY BOUNDARY
- EXISTING APPROVED LIMIT OF WASTE
- PROPOSED LIMIT OF WASTE

ROADWAY TYPE

- DECOMPOSABLE WASTE
- NON-DECOMPOSABLE
- PHASE 2E, 4E, 8E

REFERENCE(S)
1. DATA PROVIDED BY THE CITY OF LONDON.
2. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: UTM ZONE 17 VERTICAL DATUM: CGVD28

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CORPORATION OF THE CITY OF LONDON

PROJECT
ENVIRONMENTAL ASSESSMENT OF THE PROPOSED W12A
LANDFILL EXPANSION: AIR QUALITY AND ODOUR

TITLE
SITE LAYOUT AND EMISSION SOURCE LOCATION: EXPANSION

CONSULTANT	YYYY-MM-DD	2020-08-19
DESIGNED	----	
PREPARED	JEM	
REVIEWED	----	
APPROVED	----	

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM:
28mm

2.2.1 Point Sources

Point sources are typically used to represent elevated stacks or vents as well as enclosed flares. The existing and proposed second flare are enclosed flares and best represented as a point source (MECP, 2017).

The input parameters for the point sources are provided in Tables C-1 and C-2. The input parameters for the existing flare were obtained from the Environmental Compliance Approval (Air) for the flare (ECA reference 4183-78XHLX, dated December 24, 2007.) and supporting documents from the flare manufacturer. These same input parameters were used for the proposed second flare for the landfill expansion.

Table C-1: Point Source Summary – Existing

Source Description (and ID #)	Stack Height Above Grade [m]	Stack Gas Exhaust Rate (Am ³ /s)	Stack Exit Gas Temp. (°C)	Stack Inner Diameter (m)	UTM Northing (m)	UTM Easting (m)	Indicator Compound	Emission Rate During Operation (g/s)
Enclosed LFG Flare 1 (F1)	12.2	47	871	2.7	481615.8	4747069.9	SPM	8.71E-02
							PM10	8.71E-02
							PM2.5	8.71E-02
							H ₂ S	6.52E-04
							C ₂ H ₃ Cl	5.31E-05
							CO	2.70E-01
							NO _x	2.31E-01
							SO ₂	7.81E-02

Table C-2: Point Source Summary – Expansion

Source Description (and ID #)	Stack Height Above Grade [m]	Stack Gas Exhaust Rate (Am ³ /s)	Stack Exit Gas Temp. (°C)	Stack Inner Diameter (m)	UTM Northing (m)	UTM Easting (m)	Indicator Compound	Emission Rate During Operation (g/s)
Enclosed LFG Flare 1 (F1)	12.2	47	871	2.7	481621	4747069.9	SPM	1.24E-01
							PM10	1.24E-01
							PM2.5	1.24E-01
							H ₂ S	9.27E-04
							C ₂ H ₃ Cl	7.54E-05
							CO	3.83E-01
							NO _x	3.28E-01
							SO ₂	1.11E-01

Source Description (and ID #)	Stack Height Above Grade [m]	Stack Gas Exhaust Rate (Am ³ /s)	Stack Exit Gas Temp. (°C)	Stack Inner Diameter (m)	UTM Northing (m)	UTM Easting (m)	Indicator Compound	Emission Rate During Operation (g/s)
Enclosed LFG Flare 2 (F2)	12.2	32.54	871	2.7	481621	4747069.9	SPM	8.57E-02
							PM10	8.57E-02
							PM2.5	8.57E-02
							H ₂ S	6.42E-04
							C ₂ H ₃ Cl	5.22E-05
							CO	2.65E-01
							NO _x	2.27E-01
							SO ₂	7.68E-02

2.2.2 Area Sources

Area sources are used to model low elevation or ground releases. The landfill cap, operations at the active area; and operations at the non-decomposable waste area were modelled as area sources.

The landfill expansion will be conducted in eight phases. As discussed in Section 5.2 of the main EASR, consideration was given to identifying the operational phase that results in the “worst case” emissions scenario. Three different phases were considered for this purpose:

- Phase 2E
- Phase 4E
- Phase 8E

These phases were selected as they have the longest on-Site vehicle access routes (i.e., result in largest fugitive dust and vehicle exhaust emissions).

For the assessment of the current scenario, the active filling source (FILL) was located within the phase 2 of the current landfill design and it is intended to represent an approximate location of current filling, but closer to the fence line and nearby sensitive receptors for conservatism.

The input parameters for the area sources are provided in Table C-3. The release heights were estimated to be the difference between the Base Elevation in AERMAP and the final (target) elevations.

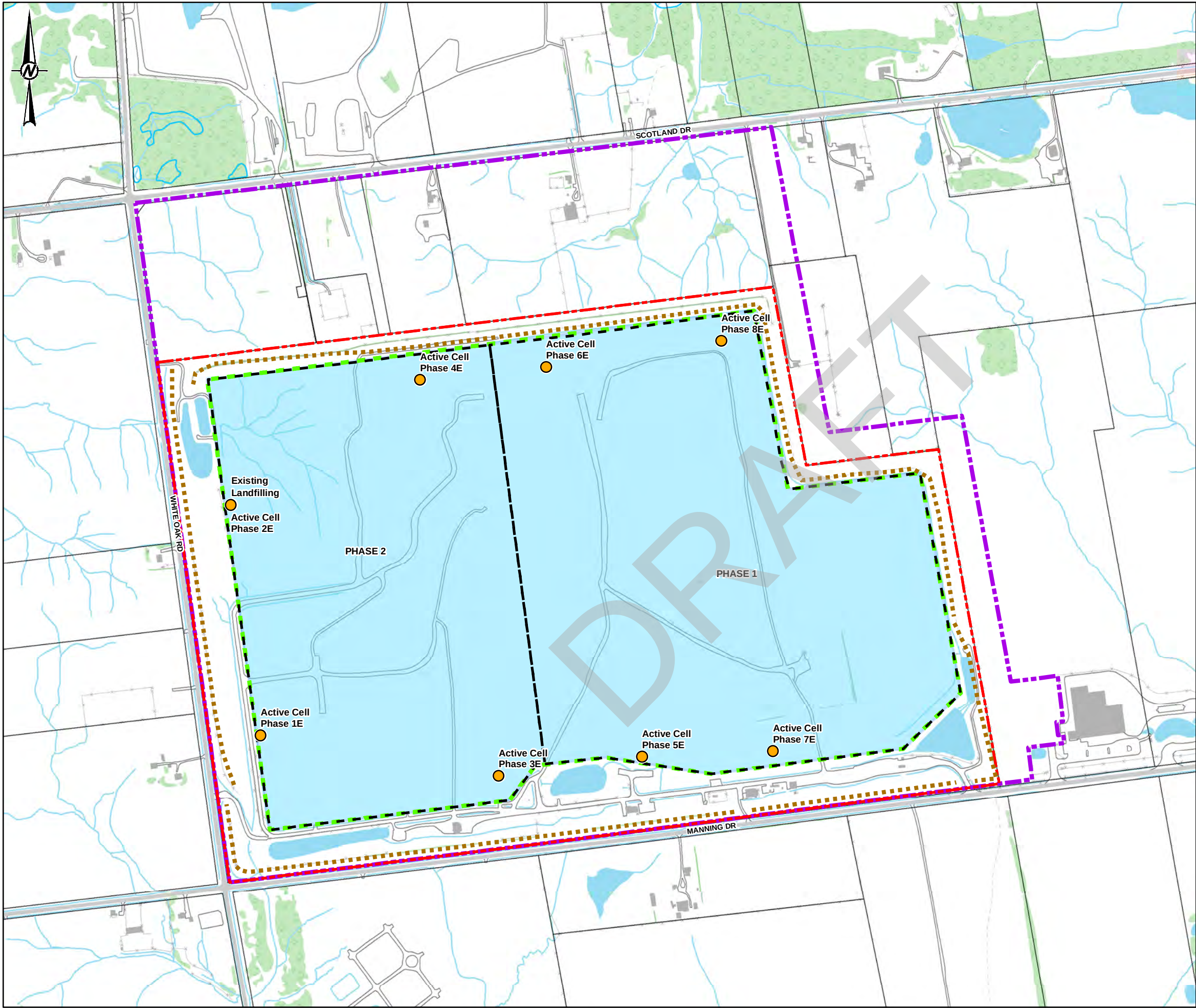
Table C-3: Area Source Summary

Source Description (and ID #)	Release Height Above Grade [m]	Area (m ²)	UTM Northing (m)	UTM Easting (m)	Indicator Compound	Emission Rate During Operation (g/s-m ²)
Existing Landfill Cap (CAP_E)	3	1070000	480734.28	4747009.64	CO	1.16E-08
					H ₂ S	1.85E-08
					C ₂ H ₃ Cl	1.50E-09
Existing Landfill Operations (FILL)	0	1500	480872	4747169	SPM	1.62E-04
					PM ₁₀	5.00E-05
					PM _{2.5}	3.43E-05
					CO	8.85E-04
					NO _x	4.82E-04
Landfill Active Area -Phase 2E (FILL Phase 2E)	13	1500	480770.36	4747760.38	SO ₂	1.26E-08
					SPM	2.42E-01
					PM ₁₀	7.51E-02
					PM _{2.5}	5.15E-02
					CO	1.33E+00
					NO _x	7.22E-01
Landfill Active Area -Phase 4E (FILL Phase 4E)	10	1500	481041.85	4747735.7	SO ₂	1.90E-05
					SPM	2.42E-01
					PM ₁₀	7.51E-02
					PM _{2.5}	5.15E-02
					CO	1.33E+00
					NO _x	7.22E-01
Landfill Active Area -Phase 8E (FILL Phase 8E)	10	1500	481528.99	4747792.86	SO ₂	1.90E-05
					SPM	2.42E-01
					PM ₁₀	7.51E-02
					PM _{2.5}	5.15E-02
					CO	1.33E+00
					NO _x	7.22E-01
Landfill Operations – Non-Decomposable Waste (ND_MH)	3	1000	481869.8	4747470.6	SO ₂	1.90E-05
					SPM	8.58E-02
					PM ₁₀	1.26E-02
					PM _{2.5}	8.95E-03

2.2.2.1 Area Odour Sources

The main sources of odour emission from the Project are the active filling areas. Therefore, in order to identify the maximum emission scenario, all eight phases of the site expansion were modelled, in conjunction with the corresponding active filling area that is located closest to sensitive receptors for each phase (typically closest to the site boundary). Emissions from the capped areas of the landfill were also modelled, using the existing landfill footprint. The location of the modelled odour sources is presented on Figure C-4.

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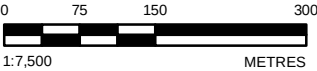


LEGEND

- ODOUR EMISSION SOURCE
- PROPOSED LIMIT OF WASTE (LANDFILL CAP ODOUR EMISSION SOURCE)
- WATERCOURSE
- DRIVEWAY
- FENCELINE
- TRAIL
- APPROXIMATE BERM LOCATION
- BUILDING FOOTPRINT
- WOODED AREA
- WATERBODY
- EXISTING PROPERTY BOUNDARY
- PROPOSED PROPERTY BOUNDARY
- EXISTING APPROVED LIMIT OF WASTE

REFERENCE(S)
1. DATA PROVIDED BY THE CITY OF LONDON.
2. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: UTM ZONE 17 VERTICAL DATUM: CGVD28

DRAFT



CLIENT CORPORATION OF THE CITY OF LONDON			
PROJECT ENVIRONMENTAL ASSESSMENT OF THE PROPOSED W12A LANDFILL EXPANSION: AIR QUALITY AND ODOUR			
TITLE SITE LAYOUT AND EMISSION SOURCE LOCATION: ODOUR			
	CONSULTANT	YYYY-MM-DD	2020-08-19
	DESIGNED	----	
	PREPARED	JEM	
	REVIEWED	----	
	APPROVED	----	
PROJECT NO. 1648176	PHASE 0020	REV. A	FIGURE C-4

The modelling heights for each source are presented in Table C-4. The release heights were estimated to be the difference between the Base Elevation in AERMAP and the final (target) elevations.

Table C-4: Odour Sources Modelling Heights

Source Description (and ID #)	Base Elevation in AERMAP [masl]	Target Elevation [masl]	Release Height [m]
CAP_E (Cap Existing)	273.0	276	3.0
CAP_EX (Cap Expansion)	273.0	296	23.0
ACT_FILL (active filling)	275.7	280	4.3
Landfill Active Area -Phase 1E ACT_1E	275.7	283	7.3
Landfill Active Area -Phase 2E ACT_2E	278.0	283	5.0
Landfill Active Area -Phase 3E ACT_3E	276.0	286	10.0
Landfill Active Area -Phase 4E ACT_4E	280.9	288	7.1
Landfill Active Area -Phase 5E ACT_5E	275.0	287	12.0
Landfill Active Area -Phase 6E ACT_6E	281.0	290	9.0
Landfill Active Area -Phase 7E ACT_7E	279.1	284	4.9
Landfill Active Area -Phase 8E ACT_8E	280.0	288	8.0

The input parameters for the area sources are provided in Table C-5.

Table C-5: Odour Area Source Summary

Source Description (and ID #)	Release Height Above Grade [m]	Area (m ²)	UTM Northing (m)	UTM Easting (m)	Emission Rate During Operation (g/s-m ²)
Existing Landfill Cap (CAP_E)	3	1070000	480734.28	4747009.64	4.14E-03
CAP_EX (Cap Expansion)	23	1070000	480734.28	4747009.64	2.89E-03
ACT_FILL (active filling)	4	1500	480660.13	4747633.95	8.98E-01
Landfill Active Area -Phase 1E ACT_1E	7	1500	480717.21	4747186.09	8.98E-01
Landfill Active Area -Phase 2E ACT_2E	5	1500	480659.63	4747633.23	8.98E-01
Landfill Active Area -Phase 3E ACT_3E	10	1500	481179.10	4747107.14	8.98E-01
Landfill Active Area -Phase 4E ACT_4E	7	1500	481026.66	4747875.67	8.98E-01
Landfill Active Area -Phase 5E ACT_5E	12	1500	481457.08	4747145.07	8.98E-01
Landfill Active Area -Phase 6E ACT_6E	9	1500	481271.00	4747900.44	8.98E-01
Landfill Active Area -Phase 7E ACT_7E	5	1500	481711.46	4747155.67	8.98E-01
Landfill Active Area -Phase 8E ACT_8E	8	1500	481610.69	4747951.45	8.98E-01

2.2.3 Volume Sources

Volume sources are used to model releases from a variety of industrial sources that cannot be classified as a point or area source. The roads at the W12A Landfill have been modelled following the line volume source approach (MECP, 2017). This includes modelling the roads as a series of individual volume sources creating a line that follows the road (US EPA, 2012).

The roads were divided into separated contiguous volume sources with a release height of 2.98 m, which was calculated by multiplying the assumed height of the vehicles (3.5 m) by 1.7 and dividing by 2 as per the MECP and USEPA Guidance (MECP, 2017, USEPA, 2012). The roads are assumed to be 7.6 m wide (for 2 lanes). The emission rate for the entire road segment was divided between the volume sources for the entire segment including both lanes. The roads were modelled using this approach for both the existing and proposed landfill scenarios. The road segments are depicted on Figure C-2 (Existing Scenario) and C-3 (Expansion Scenario). The parameters used in the modelling are identified in Table C-6.

Table C-6: Volume Source Summary

Source Description (and ID #)	Release Height Above Grade [m]	Plume Height [m]	Plume Width [m]	Indicator Compound	Emission Rate per Road Segment (g/s)	# of AERMOD Sources in Road Segment	Emission Rate Per Model Source (g/s)
Paved Road Segment – Current (BR-1)	2.98	5.95	13.6	SPM	0.9175	59	1.56E-02
				PM ₁₀	0.1763		2.99E-03
				PM _{2.5}	0.0428		7.26E-04
				SO ₂	1.06E-05		1.79E-07
				CO	1.36E-03		2.31E-05
				NO _x	0.0049		8.24E-05
Unpaved Road Segment – Current (BR-2)	2.98	5.95	13.6	SPM	0.5035	7	7.19E-02
				PM ₁₀	0.1359		1.94E-02
				PM _{2.5}	0.0136		1.94E-03
				SO ₂	1.04E-06		1.48E-07
				CO	1.34E-04		1.91E-05
				NO _x	0.0005		6.81E-05
Paved Road Segment – Phase 2E (2R-1)	2.98	5.95	13.6	SPM	1.5657	75	2.09E-02
				PM ₁₀	0.3008		4.01E-03
				PM _{2.5}	0.0184		2.45E-04
				SO ₂	1.80E-05		2.41E-07
				CO	2.33E-03		3.10E-05
				NO _x	0.0083		1.11E-04
Unpaved Road Segment – Phase 2E (2R-2)	2.98	5.95	13.6	SPM	0.7522	7	1.07E-01
				PM ₁₀	0.2031		2.90E-02
				PM _{2.5}	0.0203		2.90E-03
				SO ₂	1.55E-06		2.21E-07
				CO	2.00E-04		2.85E-05
				NO _x	0.0007		1.02E-04
Paved Road Segment – Phase 4E (4R-1)	2.98	5.95	13.6	SPM	0.6567	32	2.05E-02
				PM ₁₀	0.1262		3.94E-03
				PM _{2.5}	0.0182		5.68E-04
				SO ₂	7.57E-06		2.37E-07
				CO	9.76E-04		3.05E-05
				NO _x	0.0035		1.09E-04
Unpaved Road	2.98	5.95	13.6	SPM	4.4470	39	1.14E-01
				PM ₁₀	1.2006		3.08E-02
				PM _{2.5}	0.1202		3.08E-03

Source Description (and ID #)	Release Height Above Grade [m]	Plume Height [m]	Plume Width [m]	Indicator Compound	Emission Rate per Road Segment (g/s)	# of AERMOD Sources in Road Segment	Emission Rate Per Model Source (g/s)
Segment – Phase 4E (4R-2)				SO ₂	9.15E-06		2.35E-07
				CO	1.18E-03		3.03E-05
				NO _x	0.0042		1.08E-04
Paved Road Segment – Phase 8E (8R-1)	2.98	5.95	13.6	SPM	0.2228	12	1.86E-02
				PM ₁₀	0.0428		3.57E-03
				PM _{2.5}	0.0181		1.51E-03
				SO ₂	2.57E-06		2.14E-07
				CO	3.31E-04		2.76E-05
				NO _x	0.0012		9.84E-05
Unpaved Road Segment – Phase 8E (8R-2)	2.98	5.95	13.6	SPM	3.2687	29	1.13E-01
				PM ₁₀	0.8825		3.04E-02
				PM _{2.5}	0.0884		3.05E-03
				SO ₂	6.73E-06		2.32E-07
				CO	8.68E-04		2.99E-05
				NO _x	0.0031		1.07E-04
Paved Road Segment – All Phases (ND-R1)	2.98	5.95	13.6	SPM	0.0027	12	2.27E-04
				PM ₁₀	0.0005		4.39E-05
				PM _{2.5}	0.0002		1.87E-05
				SO ₂	0.00E+00		0.00E+00
				CO	2.96E-05		2.47E-06
				NO _x	0.0001		7.77E-06
Unpaved Road Segment – All Phases (ND-R2)	2.98	5.95	13.6	SPM	0.0515	17	3.03E-03
				PM ₁₀	0.0139		8.19E-04
				PM _{2.5}	0.0014		8.22E-05
				SO ₂	0.00E+00		0.00E+00
				CO	4.55E-05		2.68E-06
				NO _x	0.0001		8.43E-06
Paved Road Segment – All Phases (HHW)	2.98	3.4	13.6	SPM	0.0220	18	1.22E-03
				PM ₁₀	0.0042		2.35E-04
				PM _{2.5}	0.0011		6.17E-05
				SO ₂	0.00E+00		0.00E+00
				CO	5.06E-04		2.81E-05
				NO _x	0.0001		3.58E-06

2.3 Options to be used in the AERMOD Model

The options that were used in the AERMOD model are summarized in Table C-7 below.

Table C-7: Options Used in the AERMOD Model

Modelling Parameter	Description	Used in the Assessment?
DFAULT	Specifies that regulatory default options will be used.	Yes
CONC	Specifies that concentration values will be calculated.	Yes
EMISFACT HROFDY	Specifies that variable emissions are in use for variable emissions type "Hour-of-day"	Yes (see table C-8)
OLM	Specifies that the non-default Ozone Limiting Method for NO ₂ conversion will be used.	No
DDPLETE	Specifies that dry deposition will be calculated.	Yes
WDPLETE	Specifies that wet deposition will be calculated.	Yes
FLAT	Specifies that the non-default option of assuming flat terrain will be used.	No, the model will use elevated terrain as detailed in the AERMAP output.
NOSTD	Specifies that the non-default option of no stack-tip downwash will be used.	No
AVERTIME	Time averaging periods calculated.	1-hr, 8-hr, 24-hr, Annual
URBANOPT	Allows the model to incorporate the effects of increased surface heating from an urban area on pollutant dispersion under stable atmospheric conditions.	No
URBANROUGHNESS	Specifies the urban roughness length (m).	No, site specific urban roughness values were incorporated into the AERMET processing.

The variable emissions by hour of day option in AERMOD was applied for road segments where the volume of vehicle traffic on road segments varies significantly over the course of the day. Table C-8 lists the road segments and scaling factor applied to emissions.

Table C-8: Road Segments Variable Emissions Scaling Factors

Roads	Hour of Day	Scaling Factor
BR-1 BR-2 2R-1 2R-2 4R-1 4R-2 8R-1 8R-2	6:00-7:00	0.0005
	7:00-8:00	0.35
	8:00-9:00	0.63
	9:00-10:00	0.78
	10:00-11:00	1.00
	11:00-12:00	0.95
	12:00-13:00	0.75
	13:00-14:00	0.71
	14:00-15:00	0.59
	15:00-16:00	0.24
	16:00-17:00	0.005
	17:00-18:00	0.004
	18:00-19:00	0.002
	19:00-6:00	0.000

AERMOD has the ability to model both wet and dry deposition; however, modelling deposition results in plume depletion, which reduces predicted ground level concentrations. The required inputs are particle diameter, mass fraction and particle density. The following table presents particle data from the Existing Landfill Operations source.

Table C-9: Source Parameters for Gas and Particle Deposition

Sources	Particle Diameter [microns]	Mass Fraction [0 to 1]	Particle Density [g/cm ³]
FILL FILL_2E FILL_4E FILL_8E MH_ND	0.50	0.10	2.65
	5.00	0.10	2.65
	20.00	0.80	2.65
HHW 2_R1 4_R1 8_R1 ND_R1 BR_1	0.50	0.03	2.65
	5.00	0.16	2.65
	20.00	0.81	2.65
2_R2 4_R2 8_R2 ND_R2 BR_R2	0.50	0.03	2.65
	5.00	0.24	2.65
	20.00	0.73	2.65
F1 F2	0.50	1.00	1.00
	5.00	0.00	1.00
	20.00	0.00	1.00

2.4 Time Average Conversions

The smallest time scale that AERMOD predicts is a 1-hour average value. There are instances when criteria are based on shorter averaging times, and in these cases a conversion factor, recommended by the MECP, for conversion from a 1-hour averaging period to the applicable averaging period less than 1-hour was used (MECP, 2017).

An example is given below for converting from a 1-hour averaging period to a 10-minute averaging period, which is required for odour modelling:

$$\begin{aligned} F &= \left(\frac{t_1}{t_0} \right)^n \\ &= \left(\frac{60}{10} \right)^{0.28} \\ &= 1.65 \end{aligned}$$

Where:

F = the factor to convert from the averaging period t_1 output from the model (MECP assumes AERMOD predicts true 60 minute averages) to the desired averaging period t_0 (assumed to be 10-minutes in the example above), and

n = the exponent variable; in this case the MECP value of $n = 0.28$ is used for conversion.

For averaging periods greater than 1-hour, the AERMOD output was used directly.

3.0 REFERENCES

- MECP (Ministry of the Environment, Conservation and Parks). 2017. *Air Dispersion Modelling Guideline for Ontario, Version 3.0*. PIBS: 5165e03, Toronto, Ontario
- MECP (Ministry of the Environment, Conservation and Parks) . 2016. *Methodology for Modelling Assessments of Contaminants with 10-Minute Average Standards and Guidelines under O.Reg. 419/05*. Technical Bulletin.
- United States Environmental Protection Agency (U.S. EPA). 2004. *Users Guide for the AERMOD Terrain Preprocessor (AERMAP)*. EPA-454/B-03-003. Office of Air Quality Planning and Standards. Emissions, Monitoring, and Analysis Division. Research Triangle Park, North Carolina.
- United States Environmental Protection Agency (U.S. EPA). 2012. *Haul Road Workgroup Final Report*. Office of Air Quality Planning and Standards. Research Triangle Park, North Carolina.

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