CITY OF TEMISKAMING SHORES
NEW WASTE MANAGEMENT CAPACITY
ENVIRONMENTAL ASSESSMENT STUDY REPORT
TECHNICAL SUPPORT DOCUMENT:

AIR QUALITY

Submitted to:
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FOREWORD

As of January 1, 2015, we have changed our company name from AMEC Environment & Infrastructure, a Division of AMEC Americas Limited to Amec Foster Wheeler Environment & Infrastructure, a Division of Amec Foster Wheeler Americas Limited (Amec Foster Wheeler). This reflects the combination of our parent company, AMEC plc, and Foster Wheeler AG. This name change is administrative in nature and we assure you that we will continue to maintain the current resources, contracts or other existing services you have with Amec Foster Wheeler. We will continue to provide the same quality of services and the same dedicated team of consultants, project managers, engineers and scientists. Our focus remains on delivering projects safely and successfully for you. You can find more information on Amec Foster Wheeler at www.amecfw.com.

EXECUTIVE SUMMARY

The City of Temiskaming Shores was formed in January 2004 through the amalgamation of the towns of Haileybury and New Liskeard and Township of Dymond into a single tier municipality. The City has two existing landfill sites: the New Liskeard Landfill (formerly the Town of New Liskeard Landfill) and the Haileybury Landfill (formerly the Town of Haileybury Landfill).

The New Liskeard Landfill, located approximately 3 kilometres west of the former Town of New Liskeard off of Rockley Road, has been used for landfilling since 1916 (Earth Tech, 2009). The Haileybury Landfill, located approximately 9 km southwest of the former Town of Haileybury off of Highway 11 along Dump Road, has been in operation since 1975 (Earth Tech, 2009).

Prior to amalgamation, the New Liskeard Landfill received waste only from the former Town of New Liskeard, while the Haileybury Landfill received waste from the former Town of Haileybury, the former Town of Dymond, the Town of Cobalt, and from residents of Firstbrooke and Lorrain Townships (Earth Tech, 2009). The New Liskeard Landfill reached its approved landfill capacity in June 2009, and is currently no longer accepting waste. Currently, the Haileybury Landfill accepts landfill waste from the City of Temiskaming Shores and the Town of Cobalt.

Based on waste generation projections (AMEC, 2010), the Haileybury Landfill is expected to reach its approved landfill capacity by mid-2016. As such, the City's draft Solid Waste Management Master Plan (WMMP) identified the provision of additional landfill capacity to facilitate long-term waste disposal as the second key objective in establishing a sustainable solid waste management program for the City of Temiskaming Shores (Earth Tech, 2009). Through the EA process, the City evaluated different ways to manage waste and ultimately selected landfilling. Subsequently, the City evaluated different methods (locations) for managing waste through landfilling. The selected preferred alternative is the expansion of the New Liskeard Landfill (the Project).

Amec Foster Wheeler has completed a study of the potential air quality effects of the Project as a technical support document (TSD) in support of the environmental assessment (EA). The Air Quality Assessment requires quantification of the potential air emissions from site activities, the prediction of off-site effects using dispersion modelling, and the comparison of the results to applicable air quality criteria in order to determine whether potential adverse effects on the environment and human health exist. Air emissions sources from the Project are expected to include landfill gases, fugitive dusts, and exhaust from diesel-fueled equipment.

AERMOD, a Gaussian dispersion model, was considered to be the most appropriate model for assessment as it is capable of handling multiple sources of varying types such as point, area, and volume sources. The input data required for AERMOD includes five years of regional, hourly meteorological data, terrain elevations for the site and vicinity, and the characteristics of the buildings and emission sources at the project site. The model uses these input parameters to predict the resultant air concentrations at off-site locations (receptors), and is capable of predicting these effects for each of the relevant averaging times.

In addition, the potential greenhouse gas (GHG) emissions from the landfill were assessed for comparison with the Canadian and Ontario GHG Inventory for discussion of the significance of these emissions.

The findings of the Air Quality Assessment are as follows:

- The predicted air concentraitons at all sensitive points of receptions were found to be less than the respective Ambient Air Quality Criteria (AAQC) for all effects assessment indicators; these indicators are the key substances expected to be emitted from the Project that include particulate matter (TSP, PM_{10}, and $PM_{2.5}$), landfill gases, and the criteria air contaminants nitrogen oxides, sulphur dioxide, and carbon monoxide;
- The cumulative effects, defined for the purpose of the air quality assessement as the sum of the modelled effect of the landfill expansion, the original landfill and the existing baseline air concentration, were found to be less than the respective AAQC for all effects assessment indicators at all sensitive points of reception;
- There is a potential for fugitive dust to result in an occasional exceedance of the AAQC for PM_{10} and $PM_{2.5}$ AAQC along the eastern property boundary. The modelled results in excess of the desirable ambient air quality were found at the property boundary of the Project where there is no current human activity, and where there are no human receptors. For $PM_{2.5}$, it was determined that the frequency of exceedance of an AAQC was 1.8%, and for PM_{10} this frequency was 0.3% of the time. This finding should be considered in the context of the conservative nature of the emission rate estimation, the definition of the maximum emission scenarion, and the conservative predictions of the AERMOD modelling for low level fugitive sources of this nature; and
- Odour effects are not expected to be significant at sensitive receptors located in the vicinity of the landfill.

These findings are based upon the implementation of effective mitigation and operational controls will be implemented that include:

- A fugitive dust best management plan (DBMP) will be prepared to identify all potential sources of fugitive dusts, outline mitigative measures that will be employed to control dust generation, and detail the inspection and recordkeeping required to demonstrate that fugitive dusts are being effectively managed;
- The DBMP will be consistent with industry best management practices and Ontario Ministry of the Environment and Climate Change (MOECC) requirements, to ensure that these management practices and active mitigation are effective in mitigating the activities which may generate fugitive dusts;
- Management plans for the contol of litter and odour will also be developed and implemented, either as stand-alone plans or combined with the DBMP into a site-wide plan that encompasses all air emissions that have the potential to cause off-site effects if not adequately managed;

- A preventive maintenance program will be employed that encompasses all diesel-fired engines in order to minimize potential NO_2 effects;
- Air emissions from diesel combustion associated with mobile heavy equipment operations will be controlled through use of low sulphur diesel and the use of equipment that meets Transport Canada off road vehicle emission requirements; and
- Potential longer term effects of climate change on the landfill operating environment will continue to be monitored through assessment of trends in site wind, temperture and precipitation data from the nearest climate monitoring station.

The proposed measures are based on current international best management practices, are predictably effective, and are not prone to failure.

The management plans should include opportunities for adaptive management, in which the intensity of the control measures may need to be increased if site inspections and monitoring indicate that current measures are insufficient to prevent off-site effects.

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GLOSSARY AND ABBREVIATIONS

AAQC	Ambient Air Quality Criteria
AERMOD	an MOECC approved atmospheric dispersion model
Amec Foster Wheeler	Amec Foster Wheeler Environment & Infrastructure
ARM	Ambient Ratio Method for nitrogen dioxide
CAAQS	Canadian Ambient Air Quality Standards
CAZ	Contaminant Attenuation Zone
CCME	Canadian Council of Ministers of the Environment
CEPA	Canadian Environmental Protection Act
CH_4	methane
cm	centimetres
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CWS	Canada Wide Standards
DBMP	Dust Best Management Plan
EA	Environmental Assessment
g/s	grams per second
g/hp-hr	grams per horsepower-hour
GHG	greenhouse gas
GRI	Global Reporting Index
GWP	global warming index
ha	hectare (1 ha = 10,000 m2 = 2.47 acres)
H_2S	hydrogen sulphide
HNO_3	nitric acid
IPCC	International Panel on Climate Change
kg	kilogram
km	kilometre
km/h	kilometres per hour
ktonne	kilotonne
ktonne/year	kilotonne per year
LFG	landfill gas
m	metre
m/s	metre per second
mm	millimetre
mm^3	million cubic metres
MOECC	Ministry of the Environment and Climate Change
NA	not applicable
NAD 83	North American Datum 1983

NAPS	National Air and Pollution Surveillance
ND	non-detect
NMOC	non-methane organic compounds
NO	nitric oxide
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
NONROAD	U.S. EPA model for the estimation of tailpipe emissions from non-road vehicles
N_2O	nitrous oxide
O. Reg.	Ontario Regulation
OU	odour unit
PM	particulate material
$PM_{2.5}$, PM_{10}	particulate matter less than 2.5 or 10 micrometres in diameter
PM_{TOT}	total particulate matter
POI	point of impingement
ppb	parts per billion
ppm	parts per million
Project	Proposed expansion of the New Liskeard Landfill
SO_x	sulphur oxides
SO_2	sulphur dioxide
SO_3	sulphur trioxide
TSD	technical support document
TSP	Total Suspended Particulate (particles typically less the 44 µm)
U.S. EPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
°C	degrees Celsius
µm	Micrometre (1 µm = one millionth of a metre)
$\mu g/m^3$	micrograms per cubic metre
VOC	volatile organic compound
WBCSD	World Business Council for Sustainable Development (WBCSD)
WRI	World Resources Institute (WRI)
WMMP	Waste Management Master Plan

1.0 INTRODUCTION AND PROJECT OVERVIEW

The City of Temiskaming Shores was formed in January 2004 through the amalgamation of the towns of Haileybury and New Liskeard and Township of Dymond into a single tier municipality. The City has two existing landfill sites: the New Liskeard Landfill (formerly the Town of New Liskeard Landfill) and the Haileybury Landfill (formerly the Town of Haileybury Landfill). The locations of these landfills are identified on Figure 1.1.

The New Liskeard Landfill, located approximately 3 kilometres (km) west of the former Town of New Liskeard off of Rockley Road, has been used for landfilling since 1916 (Earth Tech, 2009). The Haileybury Landfill, located approximately 9 km southwest of the former Town of Haileybury off of Highway 11 along Dump Road, has been in operation since 1975 (Earth Tech, 2009).

Prior to amalgamation, the New Liskeard Landfill received waste only from the former Town of New Liskeard, while the Haileybury Landfill received waste from the former Town of Haileybury, the former Town of Dymond, the Town of Cobalt, and from residents of Firstbrooke and Lorrain Townships (Earth Tech, 2009). The New Liskeard Landfill reached its approved landfill capacity in June 2009, and is currently no longer accepting waste. Currently, the Haileybury Landfill accepts landfill waste from the City of Temiskaming Shores and the Town of Cobalt.

Based on waste generation projections (AMEC, 2010), the Haileybury Landfill is expected to reach its approved landfill capacity by mid-2016. As such, the City’s draft Solid Waste Management Master Plan (WMMP) identified the provision of additional landfill capacity to facilitate long-term waste disposal as the second key objective in establishing a sustainable solid waste management program for the City of Temiskaming Shores (Earth Tech, 2009). Through the environmental assessment (EA) process, the City evaluated different ways to manage waste and ultimately selected landfilling. Subsequently, the City evaluated different methods (locations) for managing waste through landfilling. The selected preferred alternative is the expansion of the New Liskeard Landfill (the Project).

The New Liskeard Landfill is situated approximately 1 km west of Highway 11 along the north side of Rockley Road in Dymond Township. The legal description of the landfill property is the west half of Lot 5, Concession 2 of the former Town of New Liskeard (MOECC, 2007). This site is located approximately 3 km west of the former Town of New Liskeard, as shown on Figure 1.1.

The total property area is 32 hectares (ha), of which approximately 5 ha have been landfilled.

The Project property access is from the south gate located along Rockley Road. A series of granular haul roads have been constructed on the New Liskeard Landfill site, one running from the gate adjacent to the west property boundary, one running south and east of the landfill and one running over the capped landfill area towards the previous disposal area.

A detailed history of landfilling activities is provided in the Feasibility Study (AMEC, 2010).

This technical support document (TSD) has been prepared by Amec Foster Wheeler Environment & Infrastructure (Amec Foster Wheeler) and is one of a series of technical reports to support the EA for the Project.

1.1 Overview of the Project

The major proposed Project components are expected to include those common to the operation of a municipal non-hazardous solid waste landfill, and are expected to include:

- Waste haul trucks travelling along site roads to working face;
- Deposition of waste materials, compaction, bulldozing, and grading activities at the working face;
- Stockpiling of clean cover materials, with loading of daily cover material into haul trucks and transport to the working face; and
- Facility support activities, with vehicular traffic from small vehicles or pick-up trucks.

The proposed landfill expansion will be spread over five waste disposal cells. For the purposes of the Air Quality Assessment, it is assumed that the construction of the proposed landfill expansion will begin from the south end at Cell 1. The project will progress sequentially through Cell 1 through Cell 5 (i.e., south to north). The activities associated with the landfill expansion are expected to occur over a 45-year period and be divided into four phases as follows.

- Phase 1 Construction (Year 1), includes the construction of Cell 1 base and associated perimeter access roads, swales, and drainage ditches (including the appropriate sediment and erosion protection measures);
- Phase 2 Operations (Years 2 to 20), includes landfilling at actives cells (1 through 5) and concurrent development of cells (2 through 5) and subsequent closure of cells (1 through 4) as they reach the designed final contours;
- Phase 3 Closure (Years 20 to 21), includes closure of Cell 5 and placement of final capping and cover; and
- Phase 4 Post-Closure (Years 21 to 45), includes post-closure monitoring (groundwater).

Due to the small volumes of waste anticipated and the size of the landfill, there is no landfill gas collection system proposed.

1.2 Air Quality

Amec Foster Wheeler has completed a study of the potential air quality effects of the Project. The Air Quality Assessment required the prediction of off-site effects using dispersion modelling, and the comparison of the results to applicable air quality criteria in order to determine whether potential adverse effects on the environment and human health exist.

The objectives of the Air Quality Assessment are as follows:

- Identify the key substances that are expected to be emitted during the construction, operation, closure and post-closure phases;
- Prepare estimates of the air emissions from the significant sources identified;
- Employ dispersion modelling to predict the resultant air quality effects on ambient air in the vicinity;
- Detail mitigative measures, if required, to reduce emission rates such that resultant off-site air quality effects are the Ontario Ambient Air Quality Criteria (AAQC); and
- Provide a discussion of the significance of potential air quality effects.

The Air Quality Assessment also presents a forecast for greenhouse gas (GHG) emissions as a result of the Project.

2.0 METHODOLOGY

2.1 Spatial Boundaries

2.1.1 Site Study Area

The Site Study Area encompasses the lands owned by the City that lie adjacent to the New Liskeard Landfill site, which is located on the west ½ of Lot 5, Concession 2 within the City of Temiskaming Shores, in the District of Temiskaming. It corresponds to the direct footprint of the on-site Project components. It has a total site area of 2.61 ha.

2.1.2 Site-Vicinity Study Area

The Site-Vicinity Study Area this includes the existing 5 ha landfill footprint plus the additional 2.61 ha proposed expansion and the lands in the vicinity of the Site with a buffer of 500 metre (m).

2.1.3 Extended Study Area

The air quality Extended Study Area is defined as an area that extends approximately 10 km from the main Project emission sources, as illustrated in Figure 2.1. It is not expected that the effects of the Project would be measurable beyond the Extended Study Area.

A Sub-Extended Study Area was selected for the Air Quality Assessment that generally corresponds to the area in the vicinity of the Project where the potential air quality effects of the Project are expected to occur, and can be predicted or measured with a reasonable degree of accuracy. This subarea is defined as an area that extends approximately 2 km from the main Project emission sources (Figure 2.2).

2.2 Temporal Boundaries

The temporal boundaries of the EA will span all phases of the Project, including the operations, closure, and post-closure phases. Initial construction will begin with preparation of Cell 1 in Year 1, and waste receiving is projected to start in Year 2. Subsequent construction of landfill cells will occur concurrent with landfilling, with the closure of Cell 5 beginning in Year 20.

2.3 Selection of Effects Assessment Indicators

Ambient air quality may be affected by one or more of the Project components, and the effect assessment indicators selected are detailed in Table 2.1. The indicators are the predicted off-site ground level air concentrations for each of the key substances deemed significant in terms of the aggregate site-wide emission rate and the resultant modelled concentration being greater than the existing baseline.

Table 2.1: Effects Assessment Indicators Selected for Air Quality

Effect Assessment Indicator	Rationale for Selection
Suspended particulate matter ($PM_{TOT.}$), PM_{10}, and fine particulate matter ($PM_{2.5}$)	Indicators selected are the key emissions of the Project
Sulphur oxides (SO_x), mainly as sulphur dioxide (SO_2)	
Nitrogen dioxide (NO_2)	
Carbon monoxide (CO)	
Landfill Gases (Vinyl Chloride, Hydrogen Sulphide, Benzene, Acrylonitrile)	
Odour	

Note: particulate matter total, PM_{TOT}; particulate matter less than 2.5 or 10 micrometres in diameter, PM2.5 and PM10, respectively.

2.4 Prediction of Effects

2.4.1 Methodology

Amec Foster Wheeler has completed an assessment of the potential air quality effects of this proposed Project in accordance with generally accepted Air Quality Assessment methodologies.

The Air Quality Assessment methodology involved the following distinct steps:

- Identify the significant emissions sources associated with the Project;
- Identify the key substances released to the atmosphere from the identified sources;
- Determine the baseline ambient air quality conditions in the absence of the Project for each of the key substances;
- Identify the relevant regulatory air quality standards and criteria, and establish the appropriate assessment criteria for the site in Ontario;
- Outline mitigative measures for the site that would maintain site emissions at a level that would not result in off-site effects;
- Develop a maximum emission scenario for the proposed landfill expansion, for each of the key substances using appropriate estimation methods and established data sources;
- Prepare a source summary table that identifies all sources at Project site which may release one or more of the key substances to the atmosphere in significant quantities and the corresponding pollutants and emission rates;
- Perform the air dispersion modelling using the U.S. Environmental Protection Agency (U.S. EPA) AERMOD model, a dispersion model approved for use in Ontario;

- Provide a qualitative and quantitative analysis of the significant of modeled effects, and the effects of landfill expansion, with comparison of the dispersion modelling output to the assessment criteria; and
- Provide a qualitative discussion of the significance of nuisance effects of non-modelled effects.

2.4.2 Dispersion Model Selection

AERMOD, a sixth generation Gaussian dispersion model, was considered to be the most appropriate model for assessment as it is capable of handling multiple sources of varying types including area and volume sources. The input data required for AERMOD includes five years of local, hourly meteorological data, terrain elevations for the site and vicinity, and the characteristics of the buildings and emission sources at the project site. The model uses these input parameters to predict the resultant air concentrations at off-site locations (receptors), and is capable of predicting these effects for each of the relevant averaging times.

2.4.3 Dispersion Modelling Input Parameters

Wind is a critical parameter in the dispersion of contaminants. The wind direction determines the primary direction of dispersion. At low wind speeds (or calm conditions), concentrations tend to be higher due to poor mixing and dispersion. Increasing wind speed has the effect of decreasing air concentrations of contaminants through enhanced dispersion and mixing. For particulates, this enhanced dispersion can be offset by increased emissions of particulates due to wind erosion and reduced settling.

The meteorological data used for the AERMOD modelling consisted of five years (1996 to 2000) of surface and upper air meteorological data provided by the Ministry of the Environment and Climate Change (MOECC) from the stations in Sudbury, Ontario and White Lake, Michigan, respectively.

Although the immediate area surrounding the proposed Project does not have significant topographical features such as mountains, valleys, or canyons, the topography was included in the AERMOD modelling. North American Datum 1983 (NAD 83) digital elevation model files (7.5 minute) with 30 m resolution were available for the Project site area.

Receptors were placed around the Project as per the area of modelling coverage specified in Ontario Regulation 419/05 clause 14(1). As per the regulation the receptor density has a finer resolution near the source and a coarser resolution further away. Receptors within the property boundary were removed.

The modelling was done with a combination of area and volume sources to represent the emissions sources at the landfill, specifically:

- The landfill was modelled as an area source for the purposes of predicting off-site effects of odours and landfill gases released during waste decomposition. Each landfill cell was included as a separate area source as the length of time the waste is in the cell will affect the quantity of landfill gas emissions generated. The existing landfill was modelled as a separate area source.
- Exhaust from diesel engines operating on or near the active/working face were modelled as volume sources, which was appropriate as the exhaust discharges at an elevated temperature and there is some associated plume rise.

  There may be a number of various diesel-fueled equipment operating at the site; the maximum emission scenario involved the continuous operation of more than one engine within the immediate vicinity of the working face.

  Although it is possible that some of the engines in use at the landfill would be Environment Canada Tier 4 compliant (EC SOR/2005-32, 2014), the modelling was done using U.S. EPA emission factors for a 2014 fleet that includes older engines and Tier 2 and Tier 3 engines to allow for flexibility in the scheduling of landfill activities to Cell 5.

  For the purposes of the assessment, it was assumed that up to three large pieces of equipment may be in operation in an 80 metre x 80 metre area centred at the active face. The modelling scenario considered Phase 2 (Years 2 to 20) as this scenario would involve vehicles travelling the longest distance from the front gate to the working face, and a working face within close proximity to the eastern property boundary.
- The on-site roadway was modelled as line-area sources, with an initial vertical dimension to account the road dust plume height.
- Material handling and wind erosion associated with the daily cover material was modelled as an area source, assuming there was one large stockpile on the site.

A site plan indicating the location of each of these sources is provided as Figure 5.1.

3.0 ATMOSHPERIC EMISSIONS AND APPLICABLE CRITERIA

The Air Quality Assessment requires comparing the results of the dispersion modelling to applicable air quality criteria in order to determine whether there are potential adverse effects on the environment and human health. Various regulatory agencies set specific target AAQC to be protective of human health and the environment, including Ontario and Canada. The MOECC have set AAQCs and also facility-specific point of impingement (POI) air quality standards (Ontario Regulation, O. Reg. 419/05) for various parameters, including most of the key substances identified for this Air Quality Assessment. The AAQCs are set to determine a desirable concentration for a location, inclusive of all sources and background. The O. Reg. 419/05 standards are used only for facility specific emissions to determine compliance and are used for permitting purposes. In many cases, the AAQC criteria and the O. Reg. 419/05 standards are numerically the same.

For this assessment, it was appropriate to compare the modelled effects to the respective Ontario AAQCs; these AAQCs are not compliance standards, but have been established by the MOECC as targets for desirable ambient air quality in Ontario. The Ontario AAQC limits used for the assessment include limits for different averaging times, depending upon the substance.

Federal air quality criteria exist as well, in the form of the existing Canada Wide Standards (CWS) for particulate matter (respirable particulate matter, $PM_{2.5}$) and the new Canadian Ambient Air Quality Standards (CAAQS) for $PM_{2.5}$ that will come into effect in 2015.

The air quality standards and guidelines applicable to this Project are discussed for each compound or group of compounds in the following sections.

3.1 Air Pollutants Associated with Landfilling

Atmospheric emissions from landfilling activities include landfill gases, fugitive dust sources such as on-site roadways, diesel-fueled equipment operating at the working face, wind erosion, and odour emissions associated with the handling and decomposition of wastes.

The air quality effects of the airborne pollutants may be classified as health effects, environmental effects, or nuisance effects. The health and environmental effects are of significance in the ambient air in general. Nuisance effects, which are not generally expected to result in health or environmental effects, and are considered at locations where people reside or frequent; such locations are deemed ‘sensitive receptors’ for the purposes of air quality studies.

Emissions to the atmosphere of the following parameters are anticipated from the Project activities:

- Total Suspended Particulates (TSP);
- Fine particualte matter less than 10 microns: PM_{10};
- Fine particulate matter less the 2.5 microns: $PM_{2.5}$;
- Oxides of nitrogen (NO_x), reported as nitrogen dioxide (NO_2);

- Sulphur dioxide (SO_2) resulting from sulphur in the diesel fuel;
- Carbon monoxide (CO);
- Odour;
- Landfill Gases (Vinyl Chloride, Hydrogen Sulphide, Benzene and Acrylonitrile as surrogates); and
- Greenhouse gases

A summary of potential environmental effects of the Project on the atmospheric environment is presented in Table 3.1. Greenhouse gases and climate change aspects are addressed in Section 6.

Although volatile organic compounds are released as a by-product of fuel combustion from the on-site equipment and vehicles, the overall volatile organic compound (VOC) emissions from these sources are expected to be very minor. The site mitigation measures include an Engine Maintenance Program for the generators, trucks, and mobile equipment which will minimize fuel use and combustion emissions, thereby reducing potential air quality effects.

Table 3.1: Potential Environmental Effects on the Atmospheric Environment

Potential Interactions	Description and Rationale	Associated Parameter(s)
Change in Air Quality	The Project has the potential to affect air quality through emissions of air pollutants associated with landfill operations, materials movement, vehicle and heavy equipment operation.	Ambient Air Concentrations, in $\mu g/m^3$ for: • Particulate Matter (TSP, PM_{10}, and $PM_{2.5}$) • Nitrogen dioxide (NO_2) • Sulphur Dioxide (SO_2) • Carbon monoxide (CO) • Landfill gases Odour
Change in GHG Emissions	The Project has the potential to release GHGs associated with landfill operations, and with vehicle and heavy equipment operation.	Annual GHG emissions, reported in tonnes of carbon dioxide equivalent (CO_2e)

3.1.1 Particulate Matter

Particulate matter, which consists primarily of fugitive dusts, is generated from a variety of activities at landfills, including material handling and road dust from on-site traffic. Airborne particles are categorized as primary (being emitted directly from the source into the atmosphere) and secondary (being formed in part by chemical and physical transformations). Particles can be chemically inert or active. Even if inert, they may adsorb chemically active substances or they may combine to form chemically active species.

It has been generally accepted since the 1970's that there is an association between respiratory health and high levels of particulate pollution. What has not been clear until more recently is that adverse health effects also occur at ambient concentrations that are routinely experienced today in North America and Western Europe. Historically, the standards were developed for the full range of particle sizes that stay airborne (typically particles less than 44 micrometres (µm)) to be protective of visibility impairment. As the scientific data evolved, it was found that the correlation between health effects and particulate was stronger at smaller particle sizes. Standards were then developed for particles with diameters of less than 10 µm and, more recently, those standards have been superseded by standards for particles sizes less than 2.5 µm.

TSP are generally considered to be in the particle size range of up to 44 µm in aerodynamic diameter, and includes the smaller particle size fractions PM_{10} and $PM_{2.5}$. It is emphasized that that these particle size fractions are not separate compounds, nor are they additive. The smaller particle sizes are a subset of the large particulate matter size fractions. The standard and AAQC for total particulate matter of 120 micrograms per cubic metre (µg/m^3) (24-hour averaging time) is based upon potential effects on visibility.

The PM_{10} size fraction is also generally associated with dusts generated by mechanical activities and road dust. The MOECC has not set an AAQC for PM_{10}. In the AAQC listing (MOECC, 2012b), MOECC suggest value for PM_{10} of 50 µg/m^3 for the 24-hour averaging time, and identified as an 'interim' AAQC.

Respirable particle $PM_{2.5}$, with particles sizes less than 2.5 micron in diameter, are produced during the combustion of fuels for power generation and equipment operation. The federal criteria are detailed in the *Canadian Environmental Protection Act* (CEPA), and the Canadian Ambient Air Quality Standards that replaced the Canada Wide Standards for $PM_{2.5}$ in 2015. The CAAQS for $PM_{2.5}$ were established at 28 µg/m^3 for the 24-hour averaging time, and 10 µg/m^3 for the annual averaging time; these CAAQS will decrease in 2020 to 27 µg/m^3 for the 24-hour averaging time, and 8.8 µg/m^3 for the annual averaging time.

The potential exists for fugitive dust generated by landfilling activities to lead to reduced air quality, impaired visibility, and deposition in the surrounding area. The proximity of the site to populated areas of Temiskaming Shores and residences in the area increases the likelihood that, if unmitigated, dust may become a nuisance to residents in the community and cause material discomfort or interfere with the enjoyment of normal use of property.

3.1.2 Nitrogen Oxides

Nitrogen oxides are classified in Canada as a criteria air contaminant, and are released as constituents of the combustion exhaust from diesel-fueled vehicles operating at the landfill.

There are more than six forms of oxides of nitrogen; nitric oxide (NO) and NO_2 are the predominant forms found in air emissions and the most significant air pollutants. NO is a colourless gas and NO_2 is a red-brown gas and contributes to the formation of photochemical smog. Only NO, NO_2 and N_2O are found in significant amounts in the atmosphere. Collectively they are known as NO_x and are expressed as the equivalent mass concentration of NO_2.

NO_2 acts as an acute irritant and in equal concentration is more injurious than NO. Increased airway resistance is experienced at a concentration of 1 parts per million (ppm) for 15 minutes. NO does not remain stable for long periods in the atmosphere, and oxidizes to NO_2 over time. Nitrogen dioxide in the atmosphere is considered a harmful air pollutant and therefore EC and the MOECC have set AAQC. There are no AAQC for NO or N_2O, though the latter is a greenhouse gas and ozone depleter. In the atmosphere, NO_2 is hydrolyzed to form HNO_3 or nitric acid, a compound estimated to form 40% of acid rain.

Emissions of NO_x are of concern in locations where, in the presence of sunlight, they combine with man-made or natural VOCs to form photochemical smog, containing ozone. In locations where there are already significant existing emissions of NO_x and volatile organic compounds, particularly in warm summer months, smog conditions that last days or weeks can be detrimental to human health, crop and vegetation growth and health.

Since NO_2 has adverse effects at much lower concentrations than NO, and NO converts to NO_2 in ambient air, the standard and AAQC for nitrogen oxides is based on the health effects of NO_2. In the assessment of ambient air quality, NO_2, not NO_x, is the reference contaminant; NO_x AAQCs and Schedule 3 standards with 1-hour and 24-hour averaging times should only be compared to monitored NO_2 data.

The AAQC for NO_2 are set as 400 µg/m^3 for a 1-hour averaging time, and 200 µg/m^3 for a 24-hour averaging time. The AAQC considers all sources of NO_X emissions, and are based upon potential health effects of exposure to NO_2.

3.1.3 Sulphur Oxides

Sulphur oxides are also classified in Canada as a criteria air contaminant, and released as constituents of the combustion exhaust from diesel-fueled vehicles operating at the landfill.

Sulphur oxides, or SO_x, comprise SO_2, sulphur trioxide (SO_3) and solid sulphate forms. SO_2 is a non-flammable, non-explosive colourless gas. In connection with fuel burning, where the majority is in the form of SO_2, SO_x is normally expressed in terms of the equivalent mass concentration of SO_2 and sometimes as total sulphur. Sulphur oxide, or SO, has an odour threshold limit of 0.47 to 3.0 ppm, and has pungent irritating odour above 3 ppm. SO_x compounds are substantial contributors to acid rain and also precursors to the formation of secondary fine particulate matter. SO_2 is irritating to the eyes and respiratory system above 5 ppm (exposure for 10 minutes), in the form of higher airway resistance. The effects of SO_2 on human health with respect to the short term (acute) respiratory effects have been extensively studied. No clear evidence of long term or chronic effects is apparent.

Ontario has AAQC for the 1-hour, 24-hour, and annual averaging times SO_2; the AAQC are based upon potential health effects of SO_2, as well as potential effects on vegetation.

3.1.4 Carbon Monoxide

Carbon monoxide is another Criteria Air Contaminant that is present in the combustion exhaust.

CO is a colourless, odourless, tasteless gas, which is produced primarily through the combustion of fossil fuels as a result of incomplete combustion. Over 75% of the CO produced in Ontario is from the transportation sector and 25% is due to the combined effect of power generation, buildings, heating and industrial operations. Exposures at 100 ppm or greater can be dangerous to human health, and larger exposures can lead to significant toxicity of the central nervous system and heart. Ontario AAQC exist for the 1-hour and 8-hour averaging times and are all based upon potential health effects. CO is generally not considered to be a key pollutant from landfill operations.

3.1.5 Landfill Gases

Landfill gas is produced by the biological decomposition of putrescible, organic waste materials placed in a landfill and subjected to anaerobic conditions. Landfill gas is a moist, odorous gas that consists of approximately 40% to 45% carbon dioxide and 50% to 55% methane by volume. Landfill gas also contains trace constituents such as hydrogen sulphide, mercaptans, vinyl chloride and numerous other volatile compounds (VOCs), generally at concentrations of 1% by volume.

The rate of landfill gas produced during decomposition depends on the interrelationship of factors such as the composition of the waste material, age, temperature, moisture content, pH and quantity and quality of available nutrients and microbial populations. The length of time that a landfill may generate gas can be in excess of 50 years. The concerns with landfill gas are:

- Methane gas creates an explosive hazard under certain conditions (concentrations ranging from 5% to 15% by volume in air);
- Landfill gas will reduce or replace a portion of the natural atmosphere in enclosed structures, thus creating health hazards due to an oxygen deficient environment; and
- There is a potential for health effects due to the presence of trace compounds.

The generated landfill gas has two methods of emanating from a landfill site: emission of the landfill gas to the atmosphere either under controlled release conditions (designed venting and/or collection structures) or uncontrolled conditions (venting through the landfill cover), and/or the migration of the landfill gas within the surrounding subsurface until a venting location is encountered.

The decomposition of organic matter deposited in landfills generates landfill gas. Once the landfill gas (LFG) generation reaches steady state under anaerobic conditions, methane (CH_4) and carbon dioxide (CO_2) are the primary constituents of landfill gas, and are produced during anaerobic; the release of these compounds from solid waste landfills is widely acknowledged to contribute to climate change and global warming, but are not of significance on a local scale when considering effects on ambient air quality. The anaerobic decomposition is a slow process, and wastes buried in a landfill may produce landfill gas for 20 to 30 years.

The quantity and exact composition generated depends upon a number of factors, such as the types and age of the waste buried, the quantity and types of organic matter in waste, the moisture content, and the temperature of the waste.

Landfill gas contains a small amount of non-methane organic compounds (NMOC). This NMOC fraction contains a number of VOCs, reduced sulphur compounds, GHG, and compounds associated with stratospheric ozone depletion.

Of the NMOC fraction, vinyl chloride is considered by many jurisdictions as the contaminant of most concern in the LFG, and has low ambient air quality standards and guidelines. As such, vinyl chloride is frequently used in Air Quality Assessments as an indicator of off-site effects as the assessment criteria is the most stringent of the common LFG constituents. In addition the off-site effects of Benzene and Acrylonitrile (NMOC fraction) have been assessed due to the low AAQC 24-hour average standards (which are based upon potential health effects).

Hydrogen sulphide was similarly used as an indicator of the potential for off-site effects, as it has AAQC for both the 10-minute and 24-hour averaging times; the 10-minute average AAQC is based upon the potential for odorous effects, and the 24-hour average AAQC is based upon potential health effects.

3.1.6 Odour

There are several sources at the landfill that may release odour to the atmosphere. Odour emissions that result in detectable concentrations at sensitive receptors have the potential to cause nuisance effects depending upon the intensity of the odour, the frequency that people are subjected to the odour, the character or type of odour (putrid, earthy, sweet), the duration of each odour exposure or event, and the location of the sensitive receptor. Landfill gas odours contain reduced sulphur compounds, such as hydrogen sulphide (H_2S), which give the odour its characteristically unpleasant smell.

3.1.7 Litter

Litter is generally considered to be a potential nuisance effect (visual effect), and predominantly consists of paper products and light plastic materials (bags, sheets) that are blown off-site from vehicles delivering waste or carried from working faces by winds.

3.2 Air Quality Assessment Criteria

A summary of the AAQCs for the target parameters is provided in Table 3-2; the AAQC for all applicable averaging times are shown.

The sources at the landfill are not subject to the requirements under O. Reg. 419/05, therefore the potential effects predicted by dispersion modelling were compared to the AAQCs in order to assess the significance of the effects.

The AAQCs are criteria that are defined by the MOECC as a desirable concentration of a contaminant in air, based on protection against adverse effects on health or the environment. The term “ambient” is used to reflect general air quality independent of location or source of a contaminant. AAQCs are used in environmental studies using ambient air monitoring data, to assess general air quality in a community and also in annual reporting on air quality across the province (MOECC, 2012b).

As such, if the ambient concentrations are below the AAQCs, the air quality would not be considered to be adversely affected by air pollutants. The AAQCs are set in a conservative manner, and short term exceedances in an urban environment are not unusual.

Table 3.2: Ontario Ambient Air Quality Criteria (AAQC)

Parameter	CAS Number	Averaging Time	Ambient Air Quality Criteria ($\mu g/m^3$)
TSP	NA	24-hour	120
		Annual	60
PM_{10}	NA	24-hour	50 (Interim)
$PM_{2.5}$	NA	24-hour	28
		Annual	8.8
Nitrogen Oxides (as NO_2)	10102-44-0	1-hour	400
		24-hour	200
Sulphur Dioxide SO_2	7446-09-5	1-hour	690
		24-hour	275
		Annual	55
Carbon Monoxide CO	630-08-0	1-hour	36,200
		8-hour	15,700
Vinyl Chloride	75-01-4	24-hour	1
		Annual	0.2
Hydrogen Sulphide	7783-06-5	24-hour	7
		10-minute	13
Acrylonitrile	107-13-1	24-hour	0.6
		Annual	0.12
Benzene	71-43-2	24-hour	2.3
		Annual	0.45

Note: not applicable (NA), there is no CAS Number for particulate matter.

In 2015, the Canada Wide Standards for $PM_{2.5}$ were replaced by the Canadian Ambient Air Quality Standards; these new standards were used in the assessment.

3.2.1 Odour

Although odour is a nuisance, numerical criteria for odour assessments can be established to allow for discussions of the intensity of odour effects and the consequential likelihood that odours will cause an adverse effect.

Odour are quantified in terms of odour units, with one odour unit defined as the number of dilutions with clean air needed for an odorous gas to be detectable by 50% of the population, and non-detectably by the other 50%.

Odour effects generally fall into one of three categories: non-detectable and therefore no effects, detectable but infrequently and at low enough intensity that no adverse effect is realized, and levels at which the odours are considered offensive and cause a nuisance effect. Although only approximations, each of these categories can be roughly correlated with numerical odour units. This is useful for discussions of the severity of potential effects. It is conservative to consider the aggregate effect of all site odours at receptors, as the odours are distinct in character.

The model was used to estimate peak, or 10-minute average odour concentrations at sensitive receptors in the vicinity, based upon 1-hour average odour emission rates from various sources at the landfill during normal, continuous or semi-continuous activities.

Upset conditions, or abnormal discharges, cannot be accurately assessed through dispersion modelling, but are expected to be highly infrequent if the landfill is operated following best management practices.

Odour-modelling guideline values should not be interpreted as a 'pass or fail'. The evaluation of the potential for objectionable or offensive effects must be on the basis of probability. The conservative nature of the emission estimates should be considered in discussions of the predicted concentrations from the model.

3.2.2 Litter

Litter has the potential to become a nuisance, and thereby cause an adverse effect. At wind speed exceeding 5 metres per second (m/s), it can be expected that paper litter may be carried from the site; this threshold wind speed is lower than the average wind speed measured at the Sudbury Airport. Effective litter control measures are therefore necessary to prevent litter from being carried off-property and depositing in the vicinity.

4.0 EXISTING ENVIRONMENTAL CONDITIONS

4.1 Meteorological Data

Given that local meteorological conditions, specifically temperature, precipitation, wind speed, and wind direction, will affect the likely degree and extent of potential Project effects, these parameters are relevant to discussions of dust and other potential air quality effects.

A summary of the baseline climate conditions based on published sources has been developed and provided below. Climate data was obtained from the Environment Canada's National Climate Data and Information Archive as Climate Normals (1981-2010) for the station at Earlton Airport; the station is approximately 23 km from the Project site. The location of the Sudbury Airport is also provided as there was no wind data for Earlton Airport in the Climate Normals.

In general, the climate in the Extended Study Area may be described as humid continental, with warm summers and long, cold, snowy winters (Koppen, 2013). The station identification, including latitude and longitude, are presented in Table 4.1.

Table 4.1: Environment Canada Weather Stations

Station	Station ID	Latitude (N)	Longitude (W)
Earlton Airport	6072225	47°42'00.0"	79°51'00.0"
Sudbury Airport	6068150	47°37'32.0"	80°47'52.0"

Source: Environment Canada, 2014

The daily average temperatures are summarized in Table 4.2, along with the daily maximum and minimum to illustrate the range of temperatures that may be experienced each month. The average annual temperature is 2.6 degrees Celsius (ºC). As illustrated, there is an appreciable seasonal variation in temperature, with extremely cold winter temperatures and warm summers.

Table 4.2: Earlton Airport Station Daily Average Temperature (°C)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daily Average Temperature	-16.2	-13.3	-6.7	2.6	10.4	15.6	18.3	16.8	12	5.1	-2.7	-10.9
Daily Maximum	-10	-6.5	-0.5	8.5	17.2	22.3	24.8	23.2	17.9	10	1.4	-5.8
Daily Minimum	-22.4	-20.1	-12.9	-3.3	3.5	8.8	11.8	10.4	6.1	0.3	-6.7	-16

Source: Environment Canada, 2014

The monthly mean precipitation data is summarized in Table 4.3. On average, 786.3 millimetres (mm) of precipitation occurs annually, with 576.5 mm of this total falling as rain. Most precipitation occurs in June, July, August, and September. An extreme precipitation event of 99.1 mm of daily rainfall was recorded in June 1957.

Table 4.3: Earlton Airport Station Monthly Mean Precipitation

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total Annual
Rainfall (mm)	4.2	3.4	18	39.6	70.9	79	84.4	80.8	86.5	70	30.6	9.3	576.5
Snowfall (cm)	46.9	38.3	34.1	15.7	1.7	0.2	0	0	0.3	5.6	34.8	44.8	222.4
Precipitation (mm)	47.2	39.9	50.7	54.7	72.7	79.2	84.4	80.8	86.7	75.6	63.8	50.5	786.3
Days with Precipitation >=0.2 mm	16.8	13	12.4	11.3	12.5	13.8	14.2	12.5	13.8	15.1	17.1	16.9	169.4

Source: Environment Canada, 2014
Note: centimetre (cm)

A summary by month of Climate Normal wind speed and wind direction data for Sudbury Airport is provided in Tables 4.4 and 4.5, for the 30-year period from 1981 to 2010 (Environment Canada 2014); there was no appropriate wind data set for Earlton Airport. The winds are predominantly from the north during the winter and southwest during the summer months. The average wind speed ranges from 11.3 kilometres per hour (km/h) in July to 15.9 km/h in April.

Table 4.4: Sudbury Airport Station Wind Speed (km/h)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average	14.8	14.9	15.3	15.9	14.4	12.6	11.3	11.7	13.2	14.3	15.1	14.4
Maximum Hourly	82	89	87	90	72	87	77	64	71	84	89	80
Maximum Gust	109	113	115	137	103	126	121	129	105	102	122	119

Source: Environment Canada, 2014

Table 4.5: Sudbury Airport Station Most Frequent Monthly Wind Direction

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Direction	N	N	N	N	N	SW	SW	SW	SW	S	S	SW

Source: Environment Canada, 2014
Note: north (N), southwest (SW), south (S)

Wind speed and direction summary data for Sudbury Airport are shown as a wind rose in Figure 4.1. A windrose is a type of frequency distribution plot that shows the wind speed and direction data in one plot. Each colour in the plot represents a wind speed range, and each segment extending out from the centre represents the frequency that wind is blowing from that direction. This is the wind speed and direction data used for the dispersion modelling.

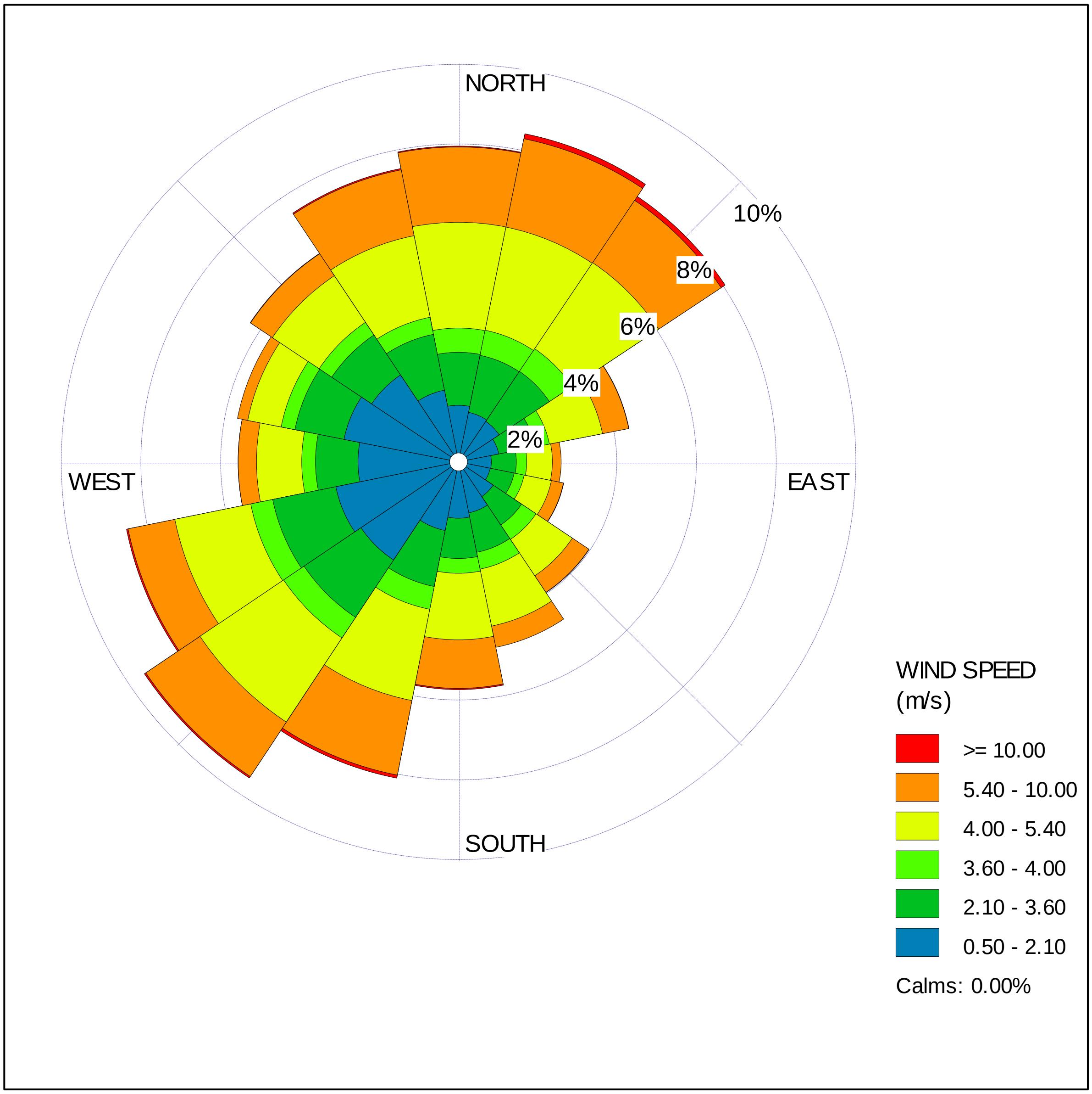

Figure 4.1: Windrose for Sudbury Airport (1996-2000)

Source: MOECC, 2014

4.2 Air Quality

Background air quality in the Extended Study Area is expected to be good, given the absence of nearby large urban centres. However, air quality will be influenced by long range transport of air emissions from the south and also by natural sources, such as volatile organic emissions from vegetation and forest fires.

4.3 Monitoring Networks

Baseline air quality data for air pollutants anticipated from the operations associated with landfilling was obtained from the Environment Canada National Air Pollution Surveillance (NAPS) Network pollutant database.

The NAPS Network operates a number of monitoring stations across the country. The NAPS Network reports background air chemistry data that is collected for various gases, PM, as well as various VOCs and semi-volatile organic compounds. A number of NAPS stations operate within a reasonable distance of the Project site, including Sudbury, North Bay, and Rouyn-Noranda (Table 4.6). The NAPS stations also constitute part of the Ontario MOECC Ambient Air Monitoring Network and are Air Quality Health Index stations.

Table 4.6: Environment Canada NAPS / MOECC Air Quality Monitoring Stations

Station	Station ID	Latitude (N)	Longitude (W)
Sudbury	77219	46°28'32.5"	80°57'46.6"
North Bay	75010	46°19'23.5"	79°26'57.4"
Rouyn-Noranda	05064	48°14'2.8"	78°58'58.1"

Source: Environment Canada, 2008

The air quality in Sudbury may be more influenced by urban populations relative to the remoteness of the Site Study Area; the data for these stations is therefore considered to be conservative when used as baseline for the current project.

4.3.1 Particulate Matter

A summary of available $PM_{2.5}$ air quality monitoring data collected by the MOECC and Environment Canada is provided in Table 4.7; the 90th percentile data for the 24-hour averaging time was used to estimate baseline $PM_{2.5}$ for the 24-hour averaging time, and the annual average (mean) was used to estimate the baseline concentration for annual averaging time.

TSP and PM_{10} are no longer routinely monitored at either NAPS or MOECC stations, therefore it was assumed that the baseline PM_{10} is twice the $PM_{2.5}$ concentration, and the baseline TSP is twice the PM_{10}; this assumption is frequently used, and supported by an Environment Canada study of particulate monitoring data at 14 sites in Canada between 1986 and 1994 (EC, 2000).

Table 4.7: Background $PM_{2.5}$ at NAPS / MOECC Stations

Parameter		Station	2009	2010	2011	2012	2013	Average
$PM_{2.5}$ (µg/m^3)	90th Percentile (24-hour averaging time)	Sudbury	7	8	8	9	11	10.2
		Rouyn-Noranda	12	13	12	11	11	
	Mean (annual averaging time)	Sudbury	3	4	4	4	6	5.5
		Rouyn-Noranda	7	7	7	6	7	

Source: MOECC, 2009-2013

4.3.2 Nitrogen Dioxide

The baseline NO_2 at the Project site is reasonably estimated using NO_2 concentrations measured at Sudbury and North Bay as part of the NAPS network for the 5-year period 2009-2013 are presented in Table 4.8.

Table 4.8: Background NO_2 at NAPS / MOECC Stations

Parameter		Station	2009	2010	2011	2012	2013	Average
NO_2 (ppb)	90th Percentile (1hr-Average)	Sudbury	ND	ND	ND	ND	16	16.3ppb (33.2 µg/m³)
		North Bay	20	18	17	14	13	
	90th Percentile (24hr-Average)	Sudbury	ND	ND	ND	ND	14	14.2ppb (28.8 µg/m³)
		North Bay	18	15	15	12	11	

Source: MOECC, 2009-2013
Note: ND – not determined (no measurements taken)

4.3.3 Sulphur Dioxide

The ambient SO_2 concentrations measured at Sudbury and Rouyn-Noranda as part of the NAPS network for the 5-year period 2009-2013 are presented in Table 4.9; the estimation of baseline SO_2 at the Project Site using this data is reasonable, as the monitoring stations are sited in similar northern communities.

Table 4.9: Background SO_2 at NAPS / MOECC Stations

Parameter		Station	2009	2010	2011	2012	2013	Average
SO_2 (ppb)	90th Percentile (24-hour averaging time)	Sudbury	3	4	4	4	8	5.3 ppb (14.9 µg/m^3)
		Rouyn-Noranda	6	7	5	6	6	
	90th Percentile (1-hour averaging time)	Sudbury	2	2	2	2	8	3.3 ppb (9.3 µg/m3)
		Rouyn-Noranda	5	4	3	3	2	
	Mean (annual averaging time)	Sudbury	1	1	1	1	1	1.9 ppb (5.4 µg/m^3)
		Rouyn-Noranda	3	3	2	2	2	

Source: MOECC, 2009-2013

4.3.4 Baseline Summary

The Project site is located a few kilometres outside New Liskeard in the City of Temiskaming Shores, and there may be a some influence from nearby sources of air emissions that include small and mid-sized industrial facilities to the southeast, public highways and roads, and small residential developments; this influence is expected to be less than what would be found in and around large urban centres or near major industrial facilities. Miller Minerals operates a quarry and lime plant approximately 6 km to the southeast, and other mining and quarrying operations are present within 10 km to the west and southwest. There would be particulate emissions associated with the mining and quarrying activities, and although these facilities are located beyond the Sub-Extended Study Area, a portion of these emissions may be carried longer distances and contribute to the baseline concentrations in the vicinity of the Project. This would be particularly true of the smaller particle size fraction $PM_{2.5}$, and to a lesser extent PM_{10}. The use of baseline concentrations from a number of surrounding monitoring sites is anticipated to take into account contributions from industries of this nature.

Air quality in the Extended Study Area would also be influenced by long range transport of air emissions from the south and also by natural sources, such as volatile organic emissions from vegetation or particulate from natural fires. Air quality at the urban sites in Sudbury and Sault Ste. Marie may be more influenced by urban populations than the Project site, therefore the use of data for these stations may be conservative when used as baseline for the Extended Study Area. There are no available monitoring or air sampling data for carbon monoxide, vinyl chloride, or hydrogen sulphide that would be reasonable to use as baseline.

The background concentrations considered for the assessment are summarized in Table 4.10.

Table 4.10: Extended Study Area Baseline Concentrations

Compound	CAS Number	Averaging Time	Air Quality Criterion (µg/m³)	Baseline Concentration (µg/m³)	Reference for Baseline Concentration
Total Suspended Particulate (TSP)	NA	24-hour	120	40.8	TSP = $PM_{2.5}$ Baseline * 4
		Annual	60	22.0	TSP = $PM_{2.5}$ Baseline * 4
PM_{10}	NA	24-hour	50	20.4	PM_{10} = $PM_{2.5}$ Baseline * 2
$PM_{2.5}$	NA	24-hour	28	10.2	Average of 5 years of hourly and 90th percentile $PM_{2.5}$ data at Sudbury, and Rouyn-Noranda.
		Annual	8.8	5.5	
Nitrogen Oxides (NO_x, as NO_2)	10102-44-0	1-hour	400	33.2	Average of 5 years of 90th percentile data at Sudbury and North Bay.
		24-hour	200	28.8	
Sulphur Dioxide (SO_2)	7446-09-5	1-hour	690	9.3	Average of 5 years of hourly and 90th percentile SO_2 data at Sudbury, and Rouyn-Noranda.
		24-hour	275	14.9	
		Annual	55	5.4	
Carbon Monoxide (CO)	630-08-0	1-hour	36,200	None available and not expected to be significant.	
		8-hour	15,700		
Vinyl Chloride (VC)	75-01-4	24-hour	1	None available and not expected to be significant.	
		Annual	0.2		
Hydrogen Sulphide	7783-06-5	24 -hour	7	None available and not expected to be significant.	
		10-minute	13		
Acrylonitrile	107-13-1	24-hour	0.6	None available and not expected to be significant	
		Annual	0.12		

Compound	CAS Number	Averaging Time	Air Quality Criterion (μg/m^3)	Baseline Concentration (μg/m^3)	Reference for Baseline Concentration
Benzene	71-43-2	24-hour	2.3	None available and not expected to be significant	
		Annual	0.45		

Source: Environment Canada, 2008

5.0 PREDICTION OF EFFECTS

The Project's Construction Phase will include site preparation and construction of landfill infrastructure (specifically Cell 1). However, construction activities will be part of the Project's Operation Phase due to simultaneous and sequential activities (i.e., filling of an active cell and construction of the next cell and then closure of the previous cell).The environmental effects assessment considered the sources of air emissions that are associated with the active construction and operation activities of the Project. As well, to be conservative, the maximum operating scenario was developed based on the maximum material and truck movements

Similar equipment will be used during the construction and operation activities, and particulate matter (dust) is the major emission. Vehicle travel on the 725 m unpaved section of Rockley Road can also be a contributor to particulate emissions. The Project's emissions will be managed through a fugitive dust best management plan (DBMP).

5.1 Sources of Air Emissions and Emission Rate Estimation

The following emission sources were identified for the Project and included in the dispersion modelling assessment:

- Landfill working face;
- Landfill cover;
- Existing (closed) Landfill;
- Site roadway; and
- Cover stockpile.

The emission estimates from the sources identified have been presented in the form of Source Summary and Emission Summary tables (Appendix I); these tables provide data on all emission sources at the facility that may discharge one or more of the target contaminants, the predicted off-site effects from the dispersion modelling, and a comparison of the predicted effects to the respective AAQC. The locations of the emission sources on the Project site layout are shown on Figure 5.1.

A summary of the emission calculation methodologies, emission factors used, and the associated calculations, are provided in Appendix II. Calculations are shown for all emission sources, including roadways, material handling, and landfill gas emissions. The dispersion modelling was completed to allow for comparison with the AAQCs; for this reason fugitive dusts and exhaust from diesel-fueled equipment were quantified and included in the modelling.

Emission factors were used to estimate fugitive dust emissions associated with on-site activities; these factors relate the quantity of particulate matter emitted from a source to a measure of activity such as the distance traveled by a vehicle, the quantity of material handled, or the duration of the activity. For certain fugitive dust sources, particulate emissions are also dependent upon specific, or local, physical characteristics of a site, such as silt loading or content, moisture content, wind speed, or the weight of the vehicle traveling on a roadway.

The published factors are generally for uncontrolled emissions. For controlled emission rates, which would be applicable when dust abatement or suppression measures have been implemented, a control efficiency term is added to the emission rate estimate. This control efficiency may be used to reduce the emission rates, based upon expected or documented efficiencies of the abatement technique. The control efficiency used for road dust corresponds to regular watering of unpaved roads during dry periods, good road maintenance, and speed limit restrictions (20 km/hr limit).

Emission factors were also used to estimate combustion gases exhausted from the diesel engines (TSP, PM_{10}, $PM_{2.5}$, NO_2, SO_2, CO).

The odour emissions associated with the landfill gas were estimated using the Ontario conservative “upper range” odour concentration of 10,000 odour unit (OU) per cubic metre of landfill gas. Potential odour at the working face was also taken into account in the modelling assessment (MOECC, 1992).

5.2 Operating Scenarios and Dispersion Modelling

The Air Quality Assessment encompasses the sources of air emissions that are associated with the operation of the landfill. A maximum emission scenario was developed, and the dispersion model was used to predict the off-site effects (in µg/m^3) of TSP, PM_{10}, $PM_{2.5}$, NO_2, SO_2, CO, vinyl chloride, hydrogen sulphide, benzene, acrylonitrile and odour, for each of the relevant averaging times.

The AAQC assessment considered total NO_x emissions, but in order to compare against the ambient NO_2 standard, the model was run using the appropriate U.S. EPA NO to NO_2 atmospheric chemistry algorithms with the Tier 2 Ambient Ratio Method (ARM) with the recommended default NO/NO_x ratios.

Dispersion modelling for particulate matter was done considering plume depletion; particle size distributions and particulate density were estimated using the emission factors and particle size data published by the U.S. EPA.

The dispersion modelling was used to predict the maximum off-site effects for a given pollutant, which is termed the maximum POI; the POI for each key substance was compared to the respective AAQC.

In addition to modelling to determine maximum off-site effects (POI concentrations), a number of nearby sensitive receptors were identified to assess potential effects at locations where human activity is expected. Each of the receptors identified is a residence. The key sensitive receptors and locations are provided in Table 5.1. The predicted air quality effects at each of these receptors was assessed.

Table 5.1: Sensitive Receptor Description and Location

Receptor ID	Description	UTM Coordinates (x(m),y(m))	
POR01	Residence on North Side of Rockley Road (150 m southeast of landfill boundary)	597256.87 m E	5262533.15 m N
POR02	Residence on South Side of Rockley Road (255 m east of landfill boundary)	597124.90 m E	5262384.18 m N
POR03	884048 Hwy 65 (790 m east of landfill boundary)	597795.72 m E	5263141.42 m N
POR04	884114 Hwy 65 (485 m northeast of landfill boundary)	597318.52 m E	5263627.46 m N
POR05	Residence on Petes Dam Road (750 m north of landfill boundary)	596797.93 m E	5264013.30 m N

Note: Universal Transverse Mercator (UTM)

The dispersion modelling conducted to assess potential nuisance effects associated with landfill odour was done considering the 10-minute averaging time; the odour effects were predicted at the sensitive receptors (residences) identified in Table 5.1. The 1-hour average odour concentrations predicted by the model were multiplied by a conversion factor of 1.65 for the 10-minute averaging time, as per the guidance of the MOECC. The odour modelling assessment was prepared in accordance with the Methodology for Modelling Assessments of Contaminants with 10-Minue Average Standards and Guidelines under O.Reg 419/05 (MOECC Technical Bulletin, April 2008).

In accordance with the Air Dispersion Modelling Guideline for Ontario (MOECC, 2009a), when determining the maximum 1-hour average concentrations, the eight highest hours per modelling year were discarded in order to remove the effects of potential meteorological anomalies on the modelling results. For assessment of the 24-hour average concentrations, the first highest 24-hour average per modelling year was discarded as a meteorological anomaly.

Modelling was completed to allow for assessment against the Ontario AAQC.

5.3 Overview of Predicted Residual Environmental Effects

The results of the dispersion modelling are presented in Tables 5.2 to 5.4 as the maximum off-property modelled concentrations. Table 5.2 presents the aggregate site-wide emission rates for all contaminants from all sources (mobile and stationary), with comparison to the Ontario AAQCs.

The Project was assessed against the Ontario AAQCs. The AAQCs are set as air quality objectives, or desirable air quality, and are used to consider all sources as well as background air quality. As such, the AAQCs are not standards

Table 5.2 provides a summary of results of the full AAQC assessment. The table results reflect the maximum predicted concentrations considering all site emission sources (stationary and mobile), and also present the maximum cumulative concentration for each parameter in terms of the sum of the modelled and the baseline concentrations. The specific air quality results at the maximum of the sensitive receptors in the Extended Study Area are shown in Table 5.3.

There were no exceedances of vinyl chloride, hydrogen sulphide, NO_2, SO_2, or CO predicted off-property, as all ground level air concentrations were determined to be lower than the respective AAQC for all averaging times.

The modelling output for the AAQC scenarios are depicted in Figures 5.2 to 5.8, with the predicted ambient concentration isopleths (lines of equal concentration) for PM_{tot}, PM_{10}, $PM_{2.5}$ (both maximum 24-hour and annual), NO_2 (both 24- and 1-hour), and hydrogen sulphide (24-hour) shown.

The shapes of the isopleths indicate the location of effects, which vary with direction and distance, as a result of source locations, meteorological conditions and receptor elevation. The model assesses the effect of topography on dispersion; therefore nearby receptors at elevated heights typically have higher concentrations than receptors at the same distance from a source but located at lower elevation.

Table 5.2: Emission Summary Table with Comparison to Ontario AAQCs

Compounds	CAS Number	Facility Emission Rate (g/s)	Model Used	Averaging Period (hr - unless noted otherwise)	Ontario AAQC ($\mu g/m^3$)	Limiting Effect	Modelled POI Concentration ($\mu g/m^3$)	% of AAQC	Baseline Concentration ($\mu g/m^3$)	Cumulative Concentration (Modelled + Baseline) ($\mu g/m^3$)	% of Criteria
Total Particulate (TSP)	NA	0.28	AERMOD	24	120	visibility	113.2	94.4%	40.8	154.0	128.4%
			AERMOD	annual	60		13.8	22.9%	22.0	35.8	59.6%
PM_{10}	NA	0.10	AERMOD	24	50	health	58.9	117.8%	20.4	79.3	158.6%
$PM_{2.5}$	NA	0.06	AERMOD	24	27	health	46.8	173.3%	10.2	57.0	211.1%
			AERMOD	annual	8.8		5.6	64.0%	5.5	11.1	126.5%
Nitrogen Dioxide (NO_2)	10102-44-0	0.75	AERMOD	1	400	health	317.1	79.3%	33.2	350.3	87.6%
		0.19	AERMOD	24	200		35.5	17.8%	28.8	64.3	32.2%
Carbon Monoxide (CO)	630-08-0	0.80	AERMOD	1	36200	health	376.0	1.0%	NA	376.0	1.0%
			AERMOD	8	15700		83.0	0.5%	NA	83.0	0.5%
Sulfur Dioxide (SO_2)	7446-09-5	0.059	AERMOD	24	275	health and vegetation	3.5	1.3%	14.9	18.4	6.7%
		0.0147	AERMOD	1	690		31.3	4.5%	9.3	40.6	5.9%
			AERMOD	annual	55		0.44	0.8%	5.4	5.8	10.6%
Vinyl Chloride	75-01-4	8.75E-04	AERMOD	24	1	health	0.21	20.7%	NA	0.21	20.7%
			AERMOD	annual	0.2		0.037	18.7%	NA	0.037	18.7%
Hydrogen sulphide (H_2S)	7783-06-4	2.35E-03	AERMOD	24	7	health	0.557	8.0%	NA	0.56	8.0%
		2.35E-03	AERMOD	10-min	13	odour	2.02	15.5%	NA	2.02	15.5%
Acrylonitrile	107-13-1	6.40E-04	AERMOD	24	0.6	health	0.15	25.3%	NA	0.15	25.3%
			AERMOD	annual	0.12		0.027	22.9%	NA	0.03	22.9%
Benzene	71-43-2	2.84E-04	AERMOD	24	2.3	health	0.07	2.9%	NA	0.07	2.9%
			AERMOD	annual	0.45		0.01	2.7%	NA	0.01	2.7%

Notes:
The modelled concentrations account for meteorological anomalies, as per MOE Guidance, except for hydrogen sulphide, vinyl chloride, and annual averages where the maximum concentrations were reported.

For $PM_{2.5}$, the 2015 CAAQS is 28 $\mu g/m^3$, and the 2020 CAAQS will be 27 $\mu g/m^3$. CAAQS will also come into effect for the annual averaging period.
The annual averages were those averaged over 5-years; since the POIs were notably lower than the AAQCs, the maximum for each individual year was not determined.
The PM_{10} AAQC is an interim value.

Table 5.3: Emission Summary Table with Maximum Concentration at Sensitive Receptor

Compounds	CAS Number	Facility Emission Rate (g/s)	Model Used	Averaging Period (hr - unless noted otherwise)	Ontario AAQC (μg/m³)	Maximum Concentration at POR (μg/m³)	Receptor ID	Baseline Concentration (μg/m³)	Cumulative Concentration (Modelled + Baseline) (μg/m³)	% of Criteria
Total Particulate (TSP)	NA	0.28	AERMOD	24	120	8.7	POR-01	40.8	49.5	41.3%
			AERMOD	annual	60	0.5	POR-01	22.0	22.5	37.5%
PM_{10}	NA	0.10	AERMOD	24	50	4.8	POR-01	20.4	25.2	50.5%
$PM_{2.5}$	NA	0.06	AERMOD	24	27	3.9	POR-01	10.2	14.1	52.2%
			AERMOD	annual	8.8	0.22	POR-01	5.5	5.7	65.0%
Nitrogen Dioxide (NO_2)	10102-44-0	0.75	AERMOD	1	400	135	POR-02	33	168.5	42.1%
		0.19	AERMOD	24	200	5.9	POR-02	28.8	34.7	17.3%
Carbon Monoxide (CO)	630-08-0	0.80	AERMOD	1	36200	153	POR-02	NA	153.4	0.4%
			AERMOD	8	15700	21	POR-02	NA	21.3	0.1%
Sulfur Dioxide (SO_2)	7446-09-5	0.059	AERMOD	24	275	0.6	POR-02	14.9	15.5	5.6%
		0.0147	AERMOD	1	690	13.3	POR-02	9.3	22.6	3.3%
			AERMOD	annual	55	1.48E-02	POR-01	5.4	5.4	9.8%
Vinyl Chloride	75-01-4	8.75E-04	AERMOD	24	1	0.070	POR-02	NA	0.07	7.0%
			AERMOD	annual	0.2	3.91E-03	POR-02	NA	0.004	2.0%
Hydrogen sulphide (H_2S)	7783-06-5	2.35E-03	AERMOD	24	7	0.19	POR-02	NA	0.19	2.7%
		2.35E-03	AERMOD	10-min	13	1.11	POR-02	NA	1.11	8.5%
Acrylonitrile	107-13-1	6.40E-04	AERMOD	24	0.6	0.05	POR-02	NA	0.05	8.5%
			AERMOD	annual	0.12	2.861E-03	POR-02	NA	0.003	2.4%
Benzene	71-43-2	2.84E-04	AERMOD	24	2.3	0.02	POR-02	NA	0.02	1.0%
			AERMOD	annual	0.45	0.0013	POR-02	NA	0.0013	0.3%

Notes:

The modelled concentrations account for meteorological anomalies, as per MOE Guidance, except for hydrogen sulphide and vinyl chloride where the maximum concentrations were reported.

For $PM_{2.5}$, the 2015 CAAQS is 28 μg/m³, and the 2020 CAAQS will be 27 μg/m³. CAAQS will also come into effect for the annual averaging period.

The annual averages were those averaged over 5-years; since the POIs were notably lower than the AAQCs, the maximum for each individual year was not determined.

The PM10 AAQC is an interim value.

Fugitive dusts are one of the most significant emissions from the site and a high potential for causing off-site effects unless effective mitigation is implemented at the various sources. As summarized in Table 5.2, PM_{10} and $PM_{2.5}$ show potential exceedances of the AAQC at the property boundary for the Project, but not at any sensitive receptors. The potential AAQC exceedances are limited to an area along the eastern site boundary and the modelled concentrations decrease to below the AAQCs within 82 m of the property boundary. The modelled concentrations are at a level that is also typical of many landfill sites in Ontario.

The potential for NO_2 exceedances also exists should too many large engines operate simultaneously in close proximity. For the purposes of the assessment, it was assumed that up to three large pieces of equipment may be in operation in an 80 metre x 80 metre area centred at the active face.

These predicted levels should be considered in the context of the conservative nature of the assessment and the frequency at which exceedances are modelled. The assessment is conservative in terms of the emission rate estimates reflecting the maximum emission scenario, and in terms of the modelling which predicts effects from the worst-case meteorological conditions over five years of meteorological data.

An analysis of the frequency of AAQC exceedances was performed to determine how many days out of the five-year modelling period that the predicted 24-hour average concentrations were greater than the respective AAQC. For $PM_{2.5}$, it was determined that at the most impacted receptor, the AAQC was exceeded 33 days or 1.8% of the time. For PM_{10} the AAQC, at the most impacted receptor, was exceeded 6 days or 0.3% of the time. The most impacted receptor is located along the property boundary. The frequency analysis at the most impacted receptor is presented in Table 5.4.

Table 5.4: PM_{10} and $PM_{2.5}$ Frequency Analysis at the Most Impacted Receptor

Parameter	Maximum Off-Site Concentration (μg/m^3)	Number of Days of Exceedance	Frequency of Exceedance
PM_{10}	58.9	6 days in 5 years	0.3%
$PM_{2.5}$	46.8.0	33 days in 5 years	1.8%

5.4 Cumulative Effects on Air Quality

Project effects on air quality are, for the most part, expected to be limited to the Site-Vicinity Study Area, and in most cases to the immediate vicinity of the landfill. In the case of total particulate matter, the potential air quality effects decrease quickly with distance from the Project and much of the particulate mass will generally settle within approximately 100 m from the source.

For this purpose of this assessment, the cumulative effects on ambient air quality may be considered as the sum of the incremental Project effect (as determined by the dispersion modelling) and the existing baseline concentration in the Site-Vicinity Study Area, as presented in Table 5.3.

The baseline concentrations, as noted above, include contributions from natural and anthropogenic sources in the local area, with some long range transport to the Project site.

The cumulative concentration for each of the indicators was well below the AAQC at each of the sensitive points of reception identified, suggesting that cumulative effects are not expected to be significant.

Some exceedances along the property boundary are predicted for TSP, PM_{10}, $PM_{2.5}$, and NO_2, however these cumulative concentrations decrease to below the desirable AAQCs within approximately 150 m of the property boundary.

As noted in the previous section, there were no exceedances of vinyl chloride, hydrogen sulphide, SO_2, or CO predicted off-property, as all ground level air concentrations were determined to be lower than the respective AAQC for all averaging times. Even with the inclusion of background levels of SO_2, this cumulative effect is still below the respective AAQCs. For vinyl chloride, hydrogen sulphide, benzene, acrylonitrile and carbon monoxide, there is not expected to be significant baseline concentrations present, and the modelled effects from landfill operations would be dominant.

An analysis of the frequency of maximum AAQC exceedances including baseline concentrations was performed to determine how many days out of the five-year modelling period that the predicted 24-hour average concentrations were greater than the respective AAQC. For $PM_{2.5}$, it was determined that (at the most impacted receptor) the AAQC was exceeded 168 days or 9.2% of the time. For PM_{10}, the AAQC (at the most impacted receptor) was exceeded 67 days or 3.7% of the time. For TPM, the AAQC (at the most impacted receptor) was exceeded 16 days or 0.9%. The most impacted receptors are located along the east property boundary and in close proximity to the working face, there is no human activity in these areas. The results at sensitive receptors do not exceed the AAQC. The frequency analysis at the most impacted receptor is presented in Table 5.5, the elimination of meteorological anomalies was not considered in this analysis.

Table 5.5: TPM, PM_{10} and $PM_{2.5}$ Frequency Analysis Cumulative

Parameter	Maximum Reportable Off-Site Concentration (µg/m^3)	Number of Days of Exceedance	Frequency of Exceedance	Receptor Location
PM_{10}	79.3	67 days in 5 years	3.7%	East Property Boundary
$PM_{2.5}$	57.0	168 days in 5 years	9.2%	East Property Boundary
TPM	153.0	16 days in 5 years	0.9%	East Property Boundary

5.5 Nuisance Effects (Odour and Litter)

There is the potential for odorous effects from landfilling operations to result in a nuisance to humans that live, or may be present, in the vicinity of the landfill. Landfill gas odours are caused primarily by the presence of hydrogen sulfide and mercaptans that are often found at trace quantities in landfill gas. These compounds may be detected by sense of smell at very low concentrations (i.e., 0.005 ppm and 0.001 ppm for hydrogen sulphide and mercaptans, respectively).

Odorous emissions from the working face and the landfill cover were quantified and modelled in order to assess the potential for such effects to occur as a result of the Project.

The maximum predicted odour concentration at the property boundary during Phase 2 of the Project suggest that odour may be at detectable levels; however, there are no human receptors at this location. The maximum concentrations (as per MOECC guidance) at all sensitive receptors are shown in Table 5.5. These values may be compared to an odour concentration of 1 OU/m^3, which is the level at which 50% of the population would perceive an odour. Although 1 OU/m^3 is not a standard, it is sometimes a useful metric in discussions of predicted odour effects. The results indicate that the maximum results at receptors POR01 and POR02 are only marginally above the 1 OU/m^3 level and less than levels which are often used for assessment of other municipal infrastructure. For POR01 there are only 37 hours that exceed 1 OU/m^3 out of a 5 year MET set or 0.08%. For POR02 there are only 57 hours that exceed 1 OU/m^3 out of a 5 year MET set or 0.13%. Therefore the exceedances are not significant. Mitigation to control particulate emissions from the active face will also help to control and mitigate odours. Mitigation has not been factored into the odour modelling therefore these results are considered conservative.

Table 5.6: Potential Odour Effects

Receptor ID	Maximum 10-minute Odour Effect (OU/m^3)
POR01	1.1
POR02	1.4
POR03	0.3
POR04	0.4
POR05	0.4

Note: odour unit per cubic metre (OU/m^3)

Litter will be managed through best practices, with mitigation measures discussed in Section 7.0.

5.6 Landfill Gases and Subsurface Migration

The generated landfill gas has two methods of emanating from a landfill site: emission of the landfill gas to the atmosphere either under controlled release conditions (designed venting and/or collection structures) or uncontrolled conditions (venting through the landfill cover), and/or the migration of the landfill gas within the surrounding subsurface until a venting location is encountered.

Gas migration in the subsurface soil is governed by the same principles as groundwater flow. The migration of landfill gas is dependent on the soil conditions at the landfill site, the landfill gas generation rate, the landfill site design, and weather conditions throughout the year. A perched water table or frost layer will impact the distance of landfill gas migration and affect the location(s) of landfill gas venting from the soil to atmosphere, since the boundary layer will create a reduced exfiltration area for the gas.

The risk of a landfill gas explosion is generally associated with subsurface migration of landfill gas into enclosed, subsurface structures located on or near the site. If landfill gas is allowed to accumulate in these areas, explosive concentrations of methane could develop. Accumulation of landfill gas within an enclosure could also create an environment that is toxic and oxygen deficient and, therefore, hazardous.

O. Reg. 232/98 provides threshold criteria for landfill gas concentrations at new or expanding landfill sites. The criteria outlined in O. Reg. 232/98 provide a basis for assessing the potential impacts due to methane gas migration. The concentration limits specified in the Regulation are:

- Less than 2.5 by volume in air (vol %) in the subsurface at the property boundary;

- Less than 1.0 vol % in any on-site building, and in the area immediately outside the foundation if the building or structure is accessible to any person or contains electrical equipment or a potential source of ignition; and,
- Less than 0.05 vol % in any off-site building, and in the area immediately outside the foundation if the building or structure is accessible to any person or contains electrical equipment or a potential source of ignition.

O. Reg. 232/98 and Revised Regulations of Ontario 1990, Regulation 347 (General – Waste Management) ("Regulation 347") under the Environmental Protection Act (EPA) were amended in June 2008 and resulted in requirements for LFG collection and flaring (burning), or use, for new, expanding and operating landfills larger than 1.5 million m^3. The new regulations amend the existing requirements for control of the atmospheric emissions of landfill gas in Section 15 of O. Reg. 232/98 (in place since 1998) primarily by changing the landfill size trigger to 1.5 million m^3 and applying the requirements to operating sites, in addition to new or expanding landfills.

The regulations also provide for submission of a report, if appropriate, showing that a landfill does not generate gas of significant concern and that landfill gas facilities may not be needed.

The concentration level at which methane has the potential to explode is called the Explosive Limit. Methane is explosive when mixed with air at concentrations between 5% vol % and 15 vol %. At concentrations below 5 vol % and above 15 vol %, methane is not explosive. Therefore, the Lower Explosive Limit (LEL) of methane is 5 vol % and the Upper Explosive Limit (UEL) is 15 vol %. Methane is lighter than air and is likely to dissipate unless trapped inside enclosed spaces.

The MOE developed a Guideline for Assessing Methane Hazards from Landfill Sites, dated November 1987, known as Procedure D-4-1. Section 2.1 of Procedure D-4-1 states the following:

> *2.1 Methane cannot cause an explosion unless it accumulates to a concentration above its lower explosive limit (LEL) in an enclosed space where it can be ignited.*

In accordance with Procedure D-4-1, methane cannot cause an explosion unless it enters an enclosed space and accumulates to a concentration above its LEL, and has a high enough entry rate and high enough accumulation time, such that the methane concentration will be still above the LEL after dilution by ventilation of the enclosed space.

Procedure D-4-1 considers that methane concentrations in air (or in an enclosed space) greater than 20% LEL (equivalent to 1 vol % methane) may be associated with still higher concentrations, exceeding the LEL. Therefore, methane concentrations greater than 20% LEL warn of conditions which could potentially be hazardous in enclosed structures and gas control systems should be designed to maintain methane concentrations below this level.

Landfill gas monitoring of potential subsurface migration, and the development of a Contingency Plan to address migration, is discussed in Section 8.0.

6.0 GREENHOUSE GASES AND CLIMATE CHANGE IMPACTS

6.1 Change in Greenhouse Gas Emissions

This section documents the methods, data and assumptions that have been used to evaluate the predicted GHG emissions from the Project. This exercise included:

- Definition of the GHG reporting framework and organizational boundaries using established reporting protocols;
- Quantification of GHG emissions from the facility using approved methodologies as defined above considering the proposed landfill expansion; and
- Comparison of estimated GHG emissions to provincially and federally reported GHG emissions to evaluate these emissions / effects.

It is important to note that the data used to estimate the GHG emissions are based on the current Project description and information available; as there was no projected fuel use or other data available at the time of writing, the GHG emissions for mobile sources were estimated based upon emission factors obtained from the U.S. EPA NONROAD model; NONROAD is a model developed for estimating tailpipe emissions from non-road vehicles.. Any comparison to future project reporting program requirements must be validated once actual fleet activities, fuel consumption and landfill emissions are accurately defined and quantified.

The Project will include components and activities that will contribute to GHG emissions, such as diesel-fuelled vehicle and landfill equipment tailpipe emissions, and GHGs released from the decomposition of landfill wastes as landfill gases.

The potential environmental effect associated with GHG emissions is the contribution to global climate change on a regional and global level.

6.2 GHG Assessment Framework

The World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI) GHG Protocol (WBCSD/WRI 2004) has been adopted by the Global Reporting Initiative (GRI) and provides guidance for preparing corporate or project GHG inventories and general procedures for estimating GHG emissions. This is built on the following concepts:

- Relevance: To ensure the inventory appropriately reflects the GHG emissions of the company;
- Completeness: To account for and report on all GHG emission sources and activities within the chosen inventory boundary and to disclose any specific exclusions;
- Consistency: To use consistent methodologies to allow for meaningful comparisons of emissions over time;

- Transparency: Disclosure of any relevant assumptions and making appropriate references to the accounting and calculation methodologies and data sources used; and
- Accuracy: Ensuring that the quantification of GHG emissions is systematically neither over nor under actual emissions and that uncertainties are reduced as far as practicable.

The Protocol also introduces the concept of direct and indirect emissions and scopes for GHG emission inventory under three broad categories, as follows:

- Scope 1 - Direct GHG emissions: Carbon emissions occurring from sources that are owned or controlled by the company (e.g., emissions from combustion in owned or controlled boilers, furnaces and vehicles, process and fugitive emissions, transportation of material on-site).
- Scope 2 - Electricity indirect GHG emissions: Carbon emissions from the generation of purchased electricity, heat or steam consumed by the company.
- Scope 3 - Other indirect GHG emissions: Carbon emissions which are a consequence of a company's activities, but occur from sources not owned or controlled by the company (e.g., emissions from waste, the extraction and production of purchased materials; and employee travel to and from work).

An operational boundary defines the scope of direct and indirect emissions for operations that fall within a company's established organizational boundary. The selected operational boundary is then uniformly applied to identify and categorize included emissions at each operational level.

In Canada, GHG emissions above certain thresholds are required to be reported to Environment Canada; for annual emissions this threshold is currently 50,000 tonnes CO_2e.

Study Boundary

An organizational boundary for the GHG assessment was developed for the Project using an operational control approach and is based on source categories from the GHG Protocol (2004) required under the GHG reporting guidelines for Environment Canada. These are shown in Table 6.1.

Table 6.1: Source Categories Included in GHG Assessment

Source Category	Environment Canada	Included in EA
Scope 1 – Direct emissions	Required	Yes
Scope 2 – Indirect (purchased energy)	Optional	No
Scope 3 – Other indirect	No	No

Source: Environment Canada, 2014

For this Project, only Scope 1 GHG emissions have been considered. These are defined as those GHG emissions produced as a direct result of an activity (including auxiliary activities) occurring within the operational Project boundary and that are owned or controlled by the City, and that pertain to the landfill expansion Project.

The Scope 1 GHG emission sources considered in this study include:

- Consumption of fuel (diesel or gasoline) by on-site equipment that is projected to include one or more of a compactor, excavator, loader, bulldozers, and grader) and support equipment (e.g., waste trucks, pick-up trucks); and
- Emissions from the solid waste landfilled.

Definitions

The following definitions have been used in this assessment:

Carbon dioxide equivalent (CO_2e): A unit of measure used to allow the addition of, or the comparison between, gases that have different global warming potentials (GWPs). Since many GHGs exist and their GWPs vary, the emissions are added in a common unit, CO_2e. To express GHG emissions in units of CO_2e, the quantity of a given GHG (expressed in units of mass) is multiplied by its GWP.

Global warming potential (GWP): Calculated as the ratio of the time-integrated radiative forcing (i.e. the amount of heat-trapping potential, measured in units of power per unit of area, such as watts per square metre) that would result from the emission of 1 kilogram (kg) of a given GHG to that from the emission of 1 kg of CO_2. For this assessment the 100-year GWP values from the IPCC Fifth Assessment Report have been used and values for GHGs arising from this Project are shown in Table 6.2.

Table 6.2: Global Warming Potentials (GWPs)

Greenhouse Gas	Formula	CAS Number	100 year GWP
Carbon dioxide	CO_2	124-38-9	1
Methane	CH_4	74-82-8	28
Nitrous oxide	N_2O	10024-97-2	265

Source: IPCC, 2013

Direct emissions: Releases from sources that are located within the Project boundary and that are owned or controlled by the municipality.

Total facility emissions: Emissions calculated as the sum total mass of each of the gases or gas species multiplied by their respective GWP.

6.3 Emissions Sources and Estimation Methods

The IPCC suggests that the most effort for quantifying emissions should be spent on those sources that are the most critical (i.e., those that make up the largest quantity are responsible for the greatest increase or decrease, or have the highest level of uncertainty associated with them). Using the organizational boundary as defined above the emissions sources assessed in this assessment are shown in Table 6.3. Details on the calculation methodology used for the various source categories follow.

Table 6.3: Included GHG Emissions Sources

Source	Equipment	Carbon Source
Landfill Fleet	Major equipment (compactor, dozer, excavator, loader, grader, pick-up trucks, and waste haul trucks)	Diesel fuel
Waste	Landfilled materials	Material decay

The purpose of this GHG assessment is to quantify the difference in GHG emissions between the scenario in which the landfill expansion proceeds and the 'no-build' scenario which would result in zero GHG emissions at the site; should landfilling or waste disposal occur on an alternate site, there would be associated GHG emissions; however, these GHGs are not considered for the purpose of this assessment.

Landfill Fleet Emissions

This category refers to any direct releases of CO_2, CH_4 and N_2O resulting from fuel combustion used for the on-site transportation of substances, materials or products used in the production process (EC, 2012). The fleet emissions were calculated assuming all equipment was operating 40 hours per week.

For this assessment, the GHGs were estimated from the proposed engine sizes, operating times, and emission factors obtained from the U.S. EPA NONROAD model. The more accurate approach based upon fuel consumption could not be used as there were no forecast fuel usage data available.

The total fuel-based GHG emission is calculated as:

$$CO_2e \text{ emissions (tonnes)} = CO_2\,(t) + CH_4\,(t) \times GWP(CH_4) + N_2O\,(t) \times GWP\,(N_2O)$$

, where the relevant GWPs and the individual components are calculated from the total annual operating hours, engine size, and NONROAD emission factor, in units of g/hp-hr, for each GHG component and each vehicle or diesel-fuelled equipment that is used.

$$\text{GHG component emission (tonnes)} = \text{Annual operating hours} \times EF\,(g/hp\text{-}hr) \times \text{Engine Size (hp)}$$

Solid Waste Emissions

GHGs emissions from the landfill due to waste decomposition were estimated using the U.S. EPA LandGEM Landfill Gas Emissions Model Version 3.02 and the projected tonnage disposed of at the landfill over the life of the Project (Years 2 to 20).

6.4 Overview of Predicted Environmental Effects

The estimated GHG emissions for the Project are presented in Table 6.4 for Year 21 (2039), the year determined to release the maximum GHG emissions. The graph presented as Figure 6.1 shows the landfill and fleet GHG emissions, in kiloTonnes per year (kiloTonne/year), with the peak in Year 21 (2039).

Table 6.4: Project GHG Emissions

	GHG Emissions CO_2e (kiloTonne/year)		
	Tailpipe	**Landfill**	**Total GHG Emissions**
2020	3.15	3.08	6.22
2025	3.15	6.32	9.47
2030	3.15	9.04	12.19
2035	3.15	11.35	14.50
2039	3.15	12.96	16.11

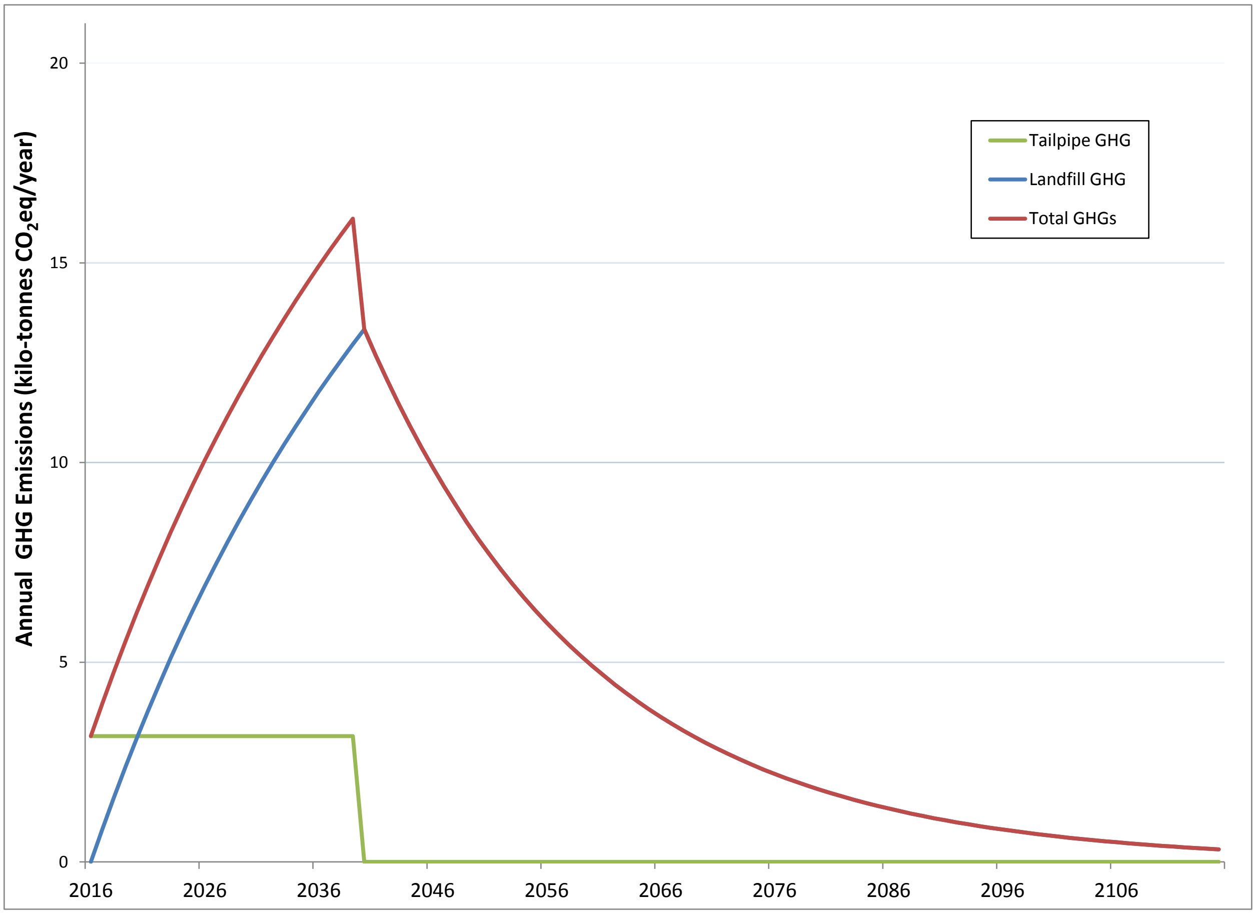

Figure 6.1: Annual Project GHG Emissions

This maximum of 16.1 kilotonnes CO_2e in forecast GHG emissions associated with the Project for the maximum year (Year 21) represents less than 0.01%of the 2012 GHG emissions inventory for Ontario (167 million tonnes, MTonnes CO_2e), and 0.002% of the 699 MTonnes CO_2e in the overall Canadian GHG Inventory for 2012.

Table 6.5: 2039 GHG Emissions Contribution by Source Group

	GHG Emissions (ktonne)	Percentage Contribution
Fleet	3.15	19.6
Landfill	12.96	80.4
Total	16.11	100%

6.5 Effects of the Project on Climate Change

Since the predicted greenhouse gas emissions from the Project are minor in comparison to Ontario, Canadian and global emissions, the Project will have no appreciable effect on current estimates of future global climate change.

6.6 Effects of Climate Change on the Project

While the project scale is such that adaptation to climate change over the project lifetime is not a specific requirement, there are a number of meteorological influences, which if modified significantly with changing climate, could potentially impact the project environment. These include wind speed and precipitation and the effects would be more related to an increase in the frequency of occurrence of extreme events. Table 6.6 indicates the climatic parameter, type of effect and the mitigation measures which could be implemented. It is anticipated that the proponent would continue to monitor changes in climate conditions over the project lifetime and adapt dust or leachate management plans as required.

Table 6.6: Effects of Climate Change on the Project

Climate Parameter	Project Impact	Mitigation Measure
Precipitation	Increased precipitation causing increased leachate	Continued monitoring of precipitation amount, cover status and leachate volume
Wind Speed	Increased potential for fugitive dust or litter	Cover and road maintenance

7.0 MITIGATION MEASURES

The principal air quality elements of concern emitted from the Project will be dust and landfill gases associated with the following sources:

- Road dust associated with haul trucks transporting waste to the cells;
- Fugitive dusts generated in the are of the working face; and
- Landfill gases generated by decomposition of the deposited wastes.

A DBMP will be prepared for the landfill operations to identify all potential sources of fugitive dusts, outline mitigative measures that will be employed to control dust generation, and detail the inspection and recordkeeping required to demonstrate that fugitive dusts are being effectively managed. The DBMP will be consistent with industry best management practices and MOECC requirements, to ensure that these management practices and active mitigation are effective. This will include:

- Dust emissions from roads will be controlled through the application of water should visible dust or silt be identified.
- Water spray onto exposed soils may also be needed to mitigate dusts.
- Upon closure, all exposed soil areas will be revegetated and progressive reclamation will be used wherever practicable.
- All site roadways will be maintained in good condition, with regular inspections and timely repairs completed to minimize the silt loading on the roads. The road maintenance procedures will be incorporated into the DBMP plan. A speed limit will also be enforced to reduce road dusts from trucks travelling to the working face. The unpaved stretch of Rockley Road can be sprayed with chemical surfactants to diminish particulate emissions during vehicle travel. Alternatively the road can be paved.

The proposed dust control measures are based on current international best management practices, are predictably effective and are not prone to failure. The DBMP includes opportunities for adaptive management, in which the intensity of the control measures may need to be increased if site inspections and monitoring indicate that current measures are insufficient to prevent off-site dust effects.

Air emissions associated with diesel-fuelled vehicles and equipment will be controlled through use of:

- Low sulphur diesel, as required by Environment Canada's Sulpher in Diesel Fuel Regulation;
- Equipment meeting applicable Transport Canada off-road vehicle emission requirements, as these regulations and associated emission limits are phased-in; and

- Effective equipment maintenance via a preventative maintenance program.

Litter effects will be minimize through best management practices that would require all loads to be secured to prevent litter along roadways to landfill, and would require litter fences installed if blowing litter is identified as an issue once the landfill begins receiving wastes.

A summary of mitigation measures is provided in Table 7.1.

Given that the Project GHG direct emissions are primarily due to the diesel-fueled engines and landfill gases, mitigation measures would be most effectively related to these two activities. Measures to mitigate the Project's energy use and associated GHG emissions from such activities may include:

- Landfill equipment and vehicles will be regularly maintained and serviced to maximize operational efficiency;
- The use of lower emission equipment and fuels will be investigated;
- The distances vehicles travel on-site will be minimized to the extent possible through planning; and
- GHG emissions will be inventoried annually to identify reporting requriements (if any), and potential opportunities to reduce emissions.

Table 7.1: Summary of Mitigation Measures

Project Phase	Issue / Concern / Interaction	Mitigation Measure	Description / Commitment	Standard
Construction/ Operations	Airborne particulates from Fugitive Dust Emissions	Dust Best Management Plan (DBMP)	The DBMP will ensure effective fugitive dust management to mitigate potential off-site effects of the particulate matter and trace metals present on the particulate. The DBMP will detail the following measures: watering frequency, visual monitoring, inspection, record keeping, responsibility, training, complaint response, and corrective actions. If further mitigation is required at specific locations (e.g., working face), dedicated water sprays will be employed. Travel surfaces will be maintained to minimize silt (fine material), and a site speed limit will be enforced. Dust generation on the unpaved stretch of Rockley Road can be controlled through the use of chemical surfactants for suppression, or alternatively, paving the road.	Maintain TSP, PM_{10} and $PM_{2.5}$ concentrations below AAQC at off-site receptors.
Construction/ Operations	Exhaust from generators, trucks and mobile equipment	Engine Maintenance program	A preventive maintenance program will be employed that encompasses all pollution control equipment and diesel-fired engines.	Maintain air quality below Ontario ambient air quality criteria (AAQC) for NO_2, SO_2, CO, and particulate matter at off-site receptors.

Table 7.1: Summary of Mitigation Measures

Project Phase	Issue / Concern / Interaction	Mitigation Measure	Description / Commitment	Standard
Construction/ Operations	Exhaust from trucks and off-road mobile equipment	Equipment compliant with Transport Canada vehicle emission requirements	Emission reductions achieved through the use of current equipment that complies with Transport Canada's off-road engine emission criteria.	Transport Canada Off-Road Compression-Ignition Engine Emission Regulations (SOR/2005-32).
Construction/ Operations	SO_2 emissions from diesel fuel use	Use of low sulphur fuel (15 ppm sulphur)	Low sulphur fuels will be used in off-road diesel engines; this will reduce the sulphur dioxide emissions from all sources and the resultant off-site air concentrations.	Environment Canada Sulphur in Diesel Fuel Regulation limiting fuel sulphur content to less than 15 ppm for off-road engines (SOR/2002-254).
Construction/ Operations	GHG emissions from diesel fuel use	Regular service and maintenance of vehicles,	Overall efficiency will be maximized through the regular maintenance and service of vehicles	Transport Canada Off-Road Compression-Ignition Engine Emission Regulations (SOR/2005-32).
Construction/ Operations	Litter	Best practices for managing landfill	Measures to prevent wind-blown litter will be detailed in documented procedures.	Prevent nuisance effect of litter.
Construction/ Operations	Odour, explosive, and oxygen replacement hazards from landfill gas	Collection and utilization of methane	Progressive implementation of landfill gas collection and utilization	

8.0 RECOMMENDED MONITORING

The findings of the Air Quality Assessment identified the potential for fugitive dusts and litter to result in off-site effects, if these are not adequately controlled through site practices and active mitigation.

In line with monitoring at other landfills, it is recommended that visual monitoring, in the form of routine site inspections following a prescribed checklist developed as part of the dust and litter management plans, be carried out on a daily basis to ensure that fugitive dusts and litter are adequately controlled, and to allow for implementation of additional mitigation as warranted.

Table 8.1: Recommended Ambient Air Monitoring

Parameter	Monitoring Method	Standard	Frequency / Timeframe	Location
Litter and Fugitive Dusts	Visual Inspections	Maintain TSP, PM_{10} and $PM_{2.5}$ concentrations below AAQC at off-site receptors.	Daily and weekly.	Inspections to be carried out along roadways, at working face, and along property boundary.

In addition to monitoring for potential effects associated with litter and fugitive dusts from the landfill, there will also be monitoring of subsurface landfill gases (specifically methane) within on-site structures and via gas monitoring probes installed around both the closed landfill and the new landfill. The main concern associated with subsurface landfill gas is migration away from the landfill footprint.

Based on the requirements of O. Reg 232/98, all structures on-site are equipped with full-time gas monitoring devices. In addition, it is also proposed that the generation of landfill gas be measured at the source and at each property boundary. This monitoring would have to be completed through dedicated gas monitoring probes and monitored at least twice a year concurrently with the water quality monitoring programs. The landfill gas probes should be monitored using a Landtec GEM 2000 (or equivalent) portable monitoring device capable of recording methane (% by volume CH_4), carbon dioxide (% by volume CO_2), oxygen (% by volume O_2) and balance gases. In addition, the progressive implementation of landfill gas collection and utilization will occur on-site which may serve to reduce the release of landfill gases to atmosphere.

Should subsurface gas migration away from the landfill footprint be confirmed, possible contingency measures would include the installation of vertical extraction wells or horizontal collectors to capture the gas and control the migration. The wells and/or collectors would be connected to the existing landfill gas extraction system and the migrating gas would be managed with the remainder of the landfill gases. The current status of contingency plans will be reviewed annually as part of the reporting process. Proposed contingency actions will be implemented if necessary in consultation with the MOECC District Office. The status of the contingency plans will be reviewed annually as part of the reporting process, and proposed contingency actions will be implemented, if necessary, in consultation with the MOECC District Office.

9.0 CONCLUSIONS

Amec Foster Wheeler has completed a study of the potential air quality effects of the City of Temiskaming Shores Landfill Expansion Project as a TSD in support of the EA.

The Air Quality Assessment requires quantification of the potential air emissions from site activities, the prediction of off-site effects using dispersion modelling, and the comparison of the results to applicable air quality criteria in order to determine whether potential adverse effects on the environment and human health exist. Air emissions sources from the Project are expected to include landfill gases, fugitive dusts, and exhaust from diesel-fueled equipment.

In addition, the potential GHG emissions from the landfill were assessed for comparison with the Canadian and Ontario GHG Inventory for discussion of the significance of these emissions.

The findings of the Air Quality Assessment are as follows:

- The predicted air concentraitons at all sensitive points of receptions were found to be less than the respective AAQC for all effects assessment indicators;
- The cumulative effects, defined for the purpose of the air quality assessement as the sum of the modelled effect of the landfill and the existing baseline air concentration, were found to be less than the respective AAQC for all effects assessment indicators at all sensitive points of reception;
- There is a potential for fugitive dust to result in an occasional exceedance of the AAQC for PM_{10} and $PM_{2.5}$ AAQC along the eastern property boundary.

  These modelled results in excess of the desirable ambient air quality were found at the property boundary of the Project where there is no current human activity, and where there are no human receptors.

  For $PM_{2.5}$, it was determined that the frequency of exceedance of an AAQC was 1.8%, and for PM_{10} this frequency was 0.3% of the time.

  This finding should be considered in the context of the conservative nature of the emission rate estimation, the definition of the maximum emission scenario, and the conservative predictions of the AERMOD modelling for low level fugitive sources of this nature; and
- Odour effects are not expected at sensitive receptors located in the vicinity of the landfill.

GHG emissions from the Project were deemed to be negligible in terms of the overall Canadian and Ontario GHG inventory. These findings are based upon the implementation of effective mitigation and operational controls will be implemented that include:

- A fugitive dust BMP will be prepared to identify all potential sources of fugitive dusts, outline mitigative measures that will be employed to control dust generation, and detail the inspection and recordkeeping required to demonstrate that fugitive dusts are being effectively managed;

The DBMP will be consistent with industry best management practices and Ontario MOECC requirements, to ensure that these management practices and active mitigation are effective in mitigating the activities which may generate fugitive dusts;

- Management plans for the contol of litter and odour will also be developed and implemented, either as stand-alone plans or combined with the DBMP into a site-wide plan that encompasses all air emissions that have the potential to cause off-site effects if not adequately managed;
- A preventive maintenance program will be employed that encompasses all diesel-fired engines in order to minimize potential NO_2 effects; and
- Air emissions from diesel combustion associated with mobile heavy equipment operations will be controlled through use of low sulphur diesel and the use of equipment that meets current Transport Canada off road vehicle emission requirements.

The proposed measures are based on current international best management practices, are predictably effective, and are not prone to failure.

The management plans should include opportunities for adaptive management, in which the intensity of the control measures may need to be increased if site inspections and monitoring indicate that current measures are insufficient to prevent off-site effects.

10.0 CLOSING

This TSD was prepared for the City of Temiskaming Shores for specific purpose addressed herein. The quality of information, conclusions and estimates contained herein is consistent with the level of effort involved in Amec Foster Wheeler's services and based on: i) information available at the time of preparation, ii) data supplied by outside sources, and iii) the assumptions, conditions and qualifications set forth in the report. This TSD is intended to be used by the City of Temiskaming Shores only, subject to the terms and conditions of its contract with Amec Foster Wheeler. Any other use of, or reliance on, this report by a third party other than those expressly noted in this report is at that party's sole risk. This TSD has been prepared in accordance with generally accepted engineering practice. No other warranty, expressed or implied, is made.

Written by: Linda Lattner, P.Eng.
Senior Air Quality Engineer

Signature: Date: August 23, 2016

Written by: Mano Narayanan, P. Eng.
Senior Air Quality Engineer

Signature: Date: August 23, 2016

Reviewed by: Steve Lamming, Ph.D. EP
Principal, Air Quality

Signature: Date: August 23, 2016

11.0 REFERENCES

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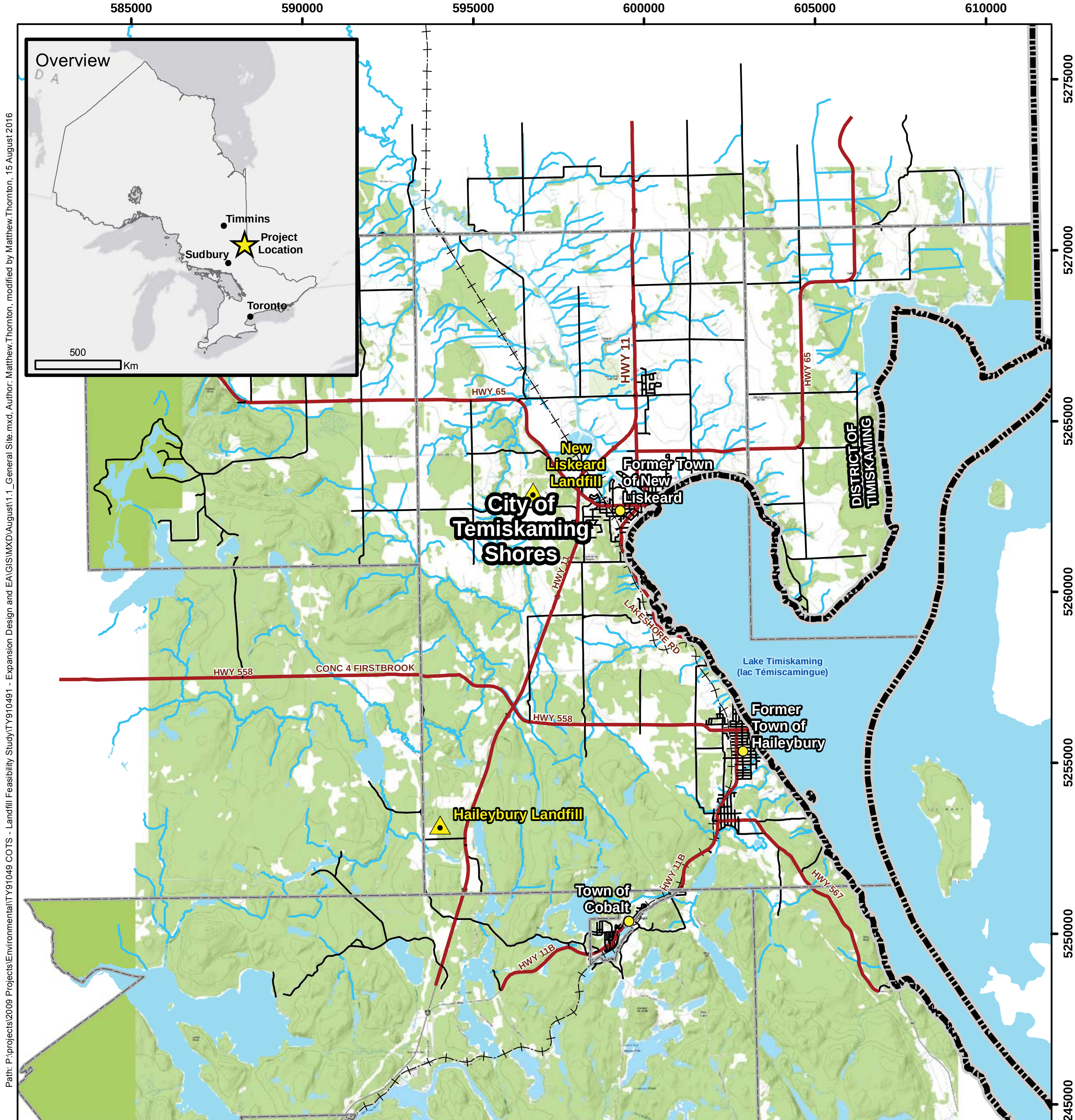
FIGURES



LEGEND

- Existing Landfill Locations
- Regional Communities
- District of Timiskaming Boundary
- City of Temiskaming Shores Boundary
- Highway / Major Roads
- Local Roads
- Railway
- Watercourse
- Waterbody
- Wooded Area

NOTES:
- Background image extracted from ESRI World Topo Map.
- All base data on this map was extracted form Land Information
- Geonames extracted from Geobase.

0 3 6 9 12 Kilometres

Datum & Projection: NAD 1983 UTM Zone 17N

N E S W

Temiskaming Shores

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**TECHNICAL SUPPORT DOCUMENT: AIR QUALITY
NEW WASTE MANAGEMENT CAPACITY
TEMISKAMNG SHORES, ONTARIO**

General Site Location

PROJECT N°:TY910491	**FIGURE: 1.1**
SCALE: 1:150,000	DATE: August 2016

Path: P:\projects\2009 Projects\Environmental\TY91049 COTS - Landfill Feasibility Study\TY910491 - Expansion Design and EA\GIS\MXD\August\6.1_SitePlan.mxd, Author: Matthew.Thornton, modified by Matthew.Thornton, 15 August 2016

LEGEND

- Property Boundary
- Contaminant Attenuation Zone
- Approximate Domestic Solid Waste Boundary
- Site (Proposed Landfill Expansion Area)
- Local Roads

NOTES:
- Background image extracted from ESRI World Topo Map.
- All base data on this map was extracted form Land Information
- Geonames extracted from Geobase.

TECHNICAL SUPPORT DOCUMENT: AIR QUALITY
NEW WASTE MANAGEMENT CAPACITY
TEMISKAMNG SHORES, ONTARIO

Proposed Site Plan

Datum & Projection: NAD 1983 UTM Zone 17N

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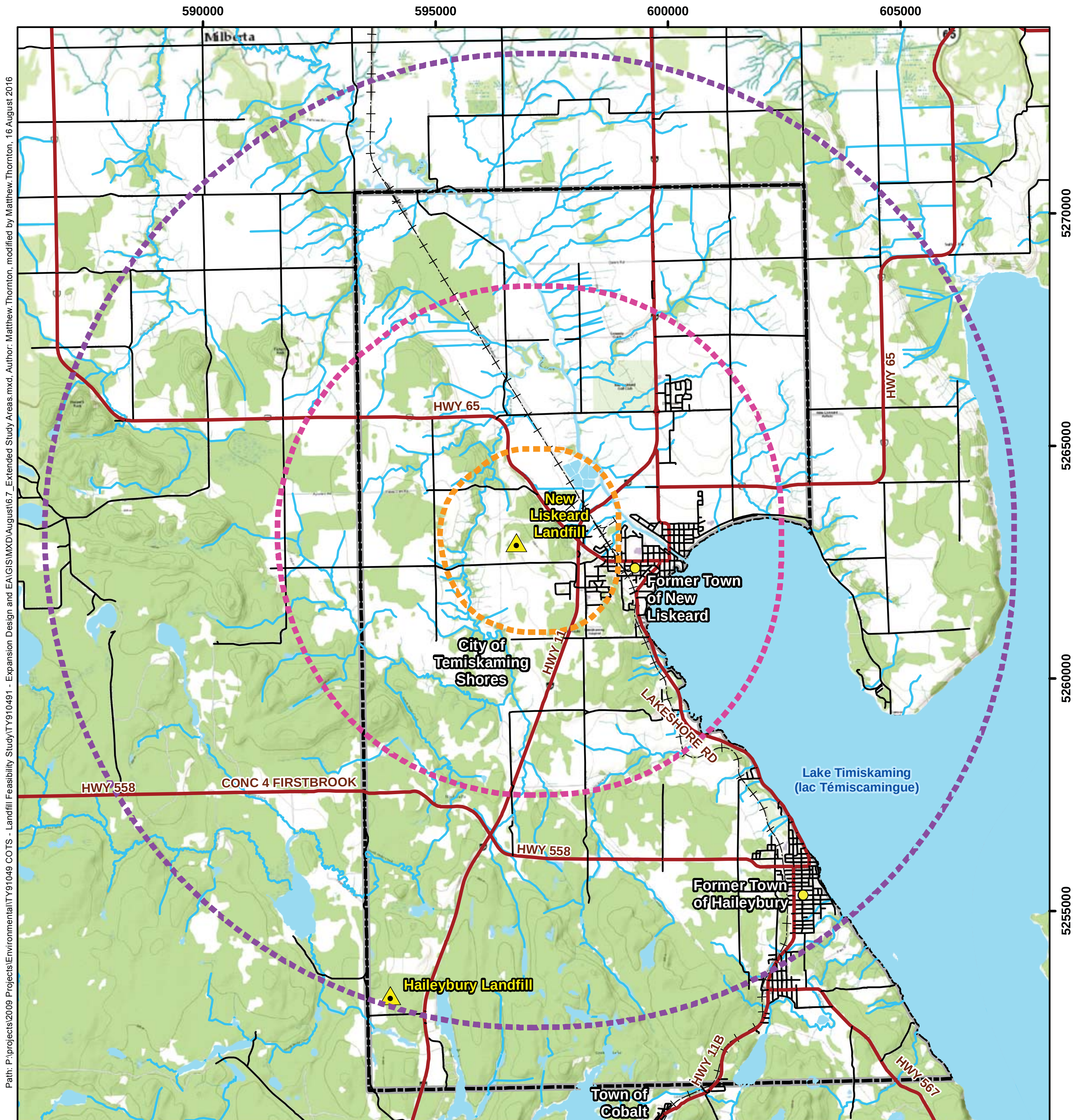
PROJECT N^{o}:TY910491	**FIGURE: 2.1**
SCALE: 1:5,000	DATE: August 2016



LEGEND

- Existing Landfill Locations
- Groundwater Study Area (1.5 km Buffer)
- Noise Study Area (5 km Buffer)
- Atmospheric Study Area (10 km Buffer)
- Municipal Boundary (City of Temiskaming Shores)
- Highway / Major Roads
- Local Roads
- Railway
- Watercourse
- Waterbody
- Wooded Area

NOTES:
- Background image extracted from ESRI World Topo Map.
- All base data on this map was extracted form Land Information
- Geonames extracted from Geobase.

Datum & Projection:
NAD 1983 UTM Zone 17N

0 2.5 5 7.5 10 Kilometres

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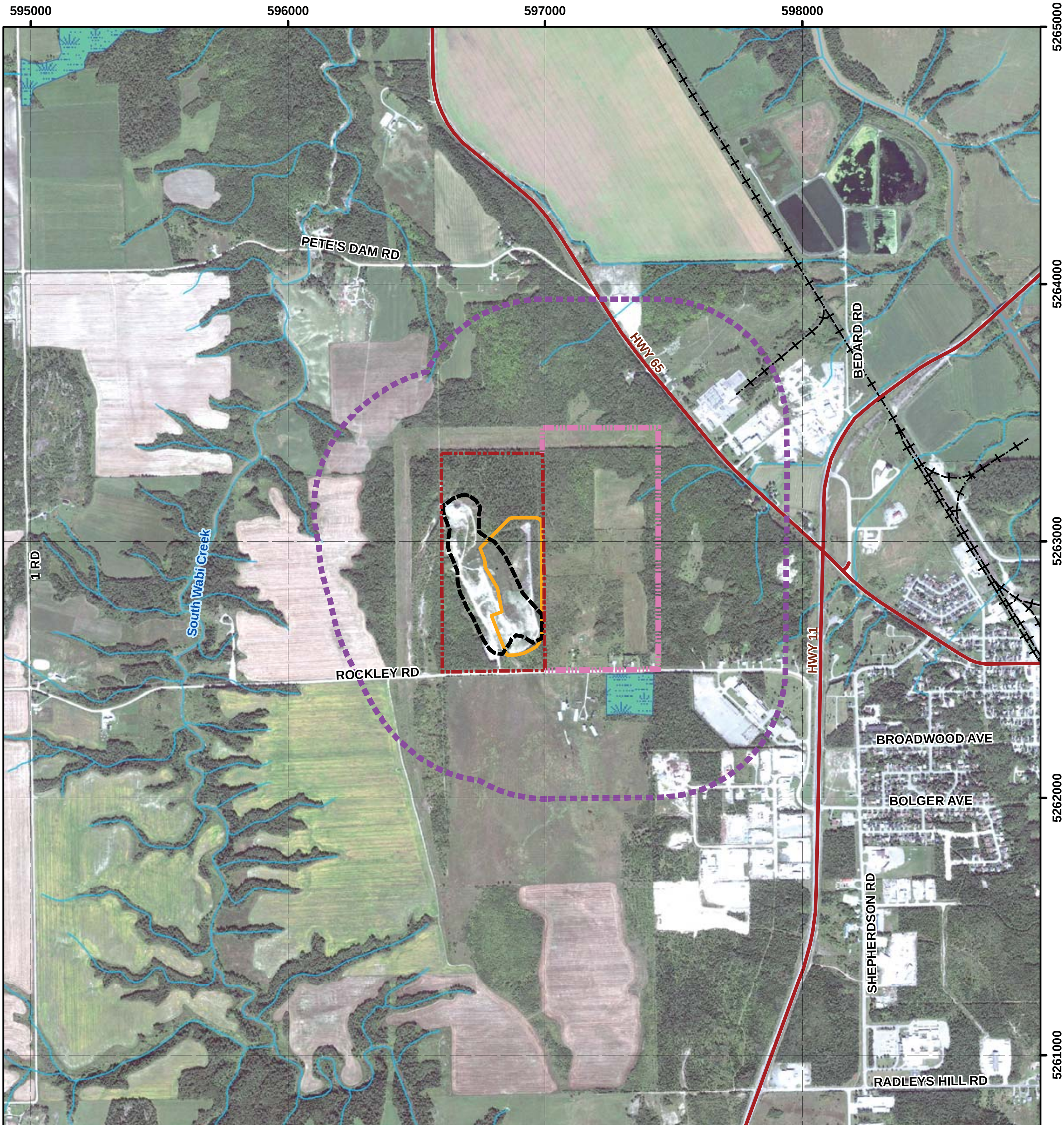
TECHNICAL SUPPORT DOCUMENT: AIR QUALITY
NEW WASTE MANAGEMENT CAPACITY
TEMISKAMNG SHORES, ONTARIO

Extended Study Areas

PROJECT N^{o}:TY910491	**FIGURE: 2.2**
SCALE: 1:110,000	DATE: August 2016



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LEGEND

- Property Boundary
- Contaminant Attenuation Zone
- Approximate Domestic Solid Waste Boundary
- Site (Proposed Landfill Expansion Area; Site Study Area)
- Site-vicinity Study Area (500 m Buffer)
- Highway / Major Roads
- Railway
- Watercourse
- Wetland

NOTES:
- Background image extracted from ESRI World Topo Map.
- All base data on this map was extracted form Land Information
- Geonames extracted from Geobase.

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TECHNICAL SUPPORT DOCUMENT: AIR QUALITY
NEW WASTE MANAGEMENT CAPACITY
TEMISKAMNG SHORES, ONTARIO

Site Study Area and Site-vicinity Study Area

Datum & Projection: NAD 1983 UTM Zone 17N

0 0.5 1 1.5 2 Kilometres

N E S W

PROJECT N^{o}:TY910491	**FIGURE: 2.3**
SCALE: 1:20,000	DATE: August 2016

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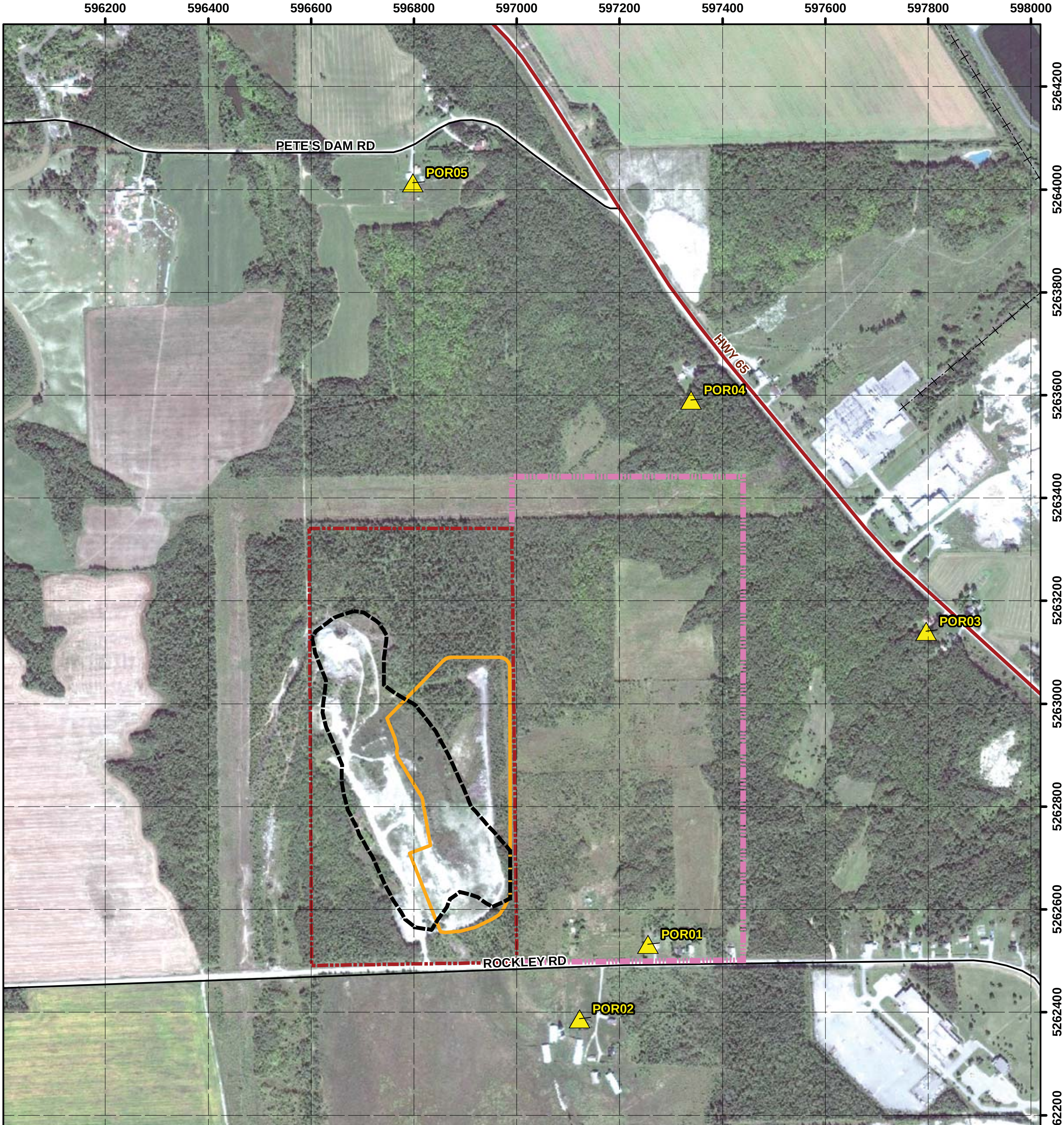

LEGEND

- Receptor (labelled with ID)
- Property Boundary
- Contaminant Attenuation Zone
- Highway / Major Roads
- Local Roads
- Approximate Solid Waste Boundary
- Site (Proposed Landfill Expansion Area)

0 0.2 0.4 0.6 0.8 1 Kilometers

NOTES:
- Background image extracted from ESRI World Topo Map.
- All base data on this map was extracted form Land Information
- Geonames extracted from Geobase.
- Figure to be reviewed with the Air Quality Technical Support Document.

Datum & Projection:
NAD 1983 UTM Zone 17N

N E S W

TECHNICAL SUPPORT DOCUMENT: AIR QUALITY
NEW WASTE MANAGEMENT CAPACITY
TEMISKAMNG SHORES, ONTARIO

Receptor Locations (Air Quality)

PROJECT N^{o}:TY910491	**FIGURE: 5.1**
SCALE: 1:10,000	DATE: August 2016

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LEGEND

- Property Boundary
- Contaminant Attenuation Zone
- Approximate Domestic Solid Waste Boundary
- Site (Proposed Landfill Expansion Area)
- Highway / Major Roads
- Local Roads
- Railway

Modelled Concentration

- < 10 μg/m³
- 10 - 40 μg/ m³
- 40 - 80 μg/m³
- > 80 μg/m³

0 0.25 0.5 0.75 1 Kilometres

NOTES:
- Background image extracted from ESRI World Topo Map.
- All base data on this map was extracted form Land Information
- Geonames extracted from Geobase.
- Figure to be reviewed with the Air Quality Technical Support Document.

Datum & Projection:
NAD 1983 UTM Zone 17N

N W E S

Temiskaming Shores

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TECHNICAL SUPPORT DOCUMENT: AIR QUALITY
NEW WASTE MANAGEMENT CAPACITY
TEMISKAMNG SHORES, ONTARIO

Total Suspended Particulate Matter Isopleth (24-hour Averaging Time)

PROJECT N°:TY910491	**FIGURE: 5.2**
SCALE: 1:10,000	DATE: August 2016

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LEGEND

- Property Boundary
- Contaminant Attenuation Zone
- Approximate Domestic Solid Waste Boundary
- Site (Proposed Landfill Expansion Area)
- Highway / Major Roads
- Local Roads
- Railway

Modelled Concentrations

- 5 - 10 µg/ m^3
- 10 - 20 µg/ m^3
- 20 - 30 µg/m^3
- 30 - 50 µg/m^3
- > 50 µg/m^3

0 0.25 0.5 0.75 1 Kilometres

NOTES:
- Background image extracted from ESRI World Topo Map.
- All base data on this map was extracted form Land Information
- Geonames extracted from Geobase.
- Figure to be reviewed with the Air Quality Technical Support Document.

Datum & Projection: NAD 1983 UTM Zone 17N

N E S W

TECHNICAL SUPPORT DOCUMENT: AIR QUALITY
NEW WASTE MANAGEMENT CAPACITY
TEMISKAMNG SHORES, ONTARIO

Particulate Matter PM_{10} Isopleth (24-hour Averaging Time)

PROJECT N^o:TY910491	**FIGURE: 5.3**
SCALE: 1:10,000	DATE: August 2016

Path: P:\projects\2009 Projects\Environmental\TY91049 COTS - Landfill Feasibility Study\TY910491 - Expansion Design and EA\GIS\MXD\August\7.4_PM 2.5 Isopleth_24.mxd, Author: Matthew.Thornton, modified by Matthew.Thornton, 16 August 2016

LEGEND

- Property Boundary
- Contaminant Attenuation Zone
- Approximate Domestic Solid Waste Boundary
- Site (Proposed Landfill Expansion Area)
- Highway / Major Roads
- Local Roads
- Railway

Model Concentration

- 5 - 17 µg/ m^3
- 17 - 28 µg/m^3
- > 28 µg/m^3

0 0.25 0.5 0.75 1 Kilometres

NOTES:
- Background image extracted from ESRI World Topo Map.
- All base data on this map was extracted form Land Information
- Geonames extracted from Geobase.
- Figure to be reviewed with the Air Quality Technical Support Document.

Datum & Projection:
NAD 1983 UTM Zone 17N

N W E S

Temiskaming Shores

amec foster wheeler

TECHNICAL SUPPORT DOCUMENT: AIR QUALITY
NEW WASTE MANAGEMENT CAPACITY
TEMISKAMNG SHORES, ONTARIO

Particulate Matter $PM_{2.5}$ Isopleth (24-hour Averaging Time)

PROJECT N°:TY910491	**FIGURE: 5.4**
SCALE: 1:10,000	DATE: August 2016

LEGEND

- Property Boundary
- Contaminant Attenuation Zone
- Approximate Domestic Solid Waste Boundary
- Site (Proposed Landfill Expansion Area)
- Highway / Major Roads
- Local Roads
- Railway

Modelled Concentrations

- 1 - 2 µg/ m^3
- 2 - 3.3 µg/ m^3
- 3.3 - 5.6 µg/ m^3

0 0.25 0.5 0.75 1 Kilometres

NOTES:
- Background image extracted from ESRI World Topo Map.
- All base data on this map was extracted form Land Information Geobase.
- Geonames extracted from Geobase.
- Figure to be reviewed with the Air Quality Technical Support Document.

Datum & Projection: NAD 1983 UTM Zone 17N

N W E S

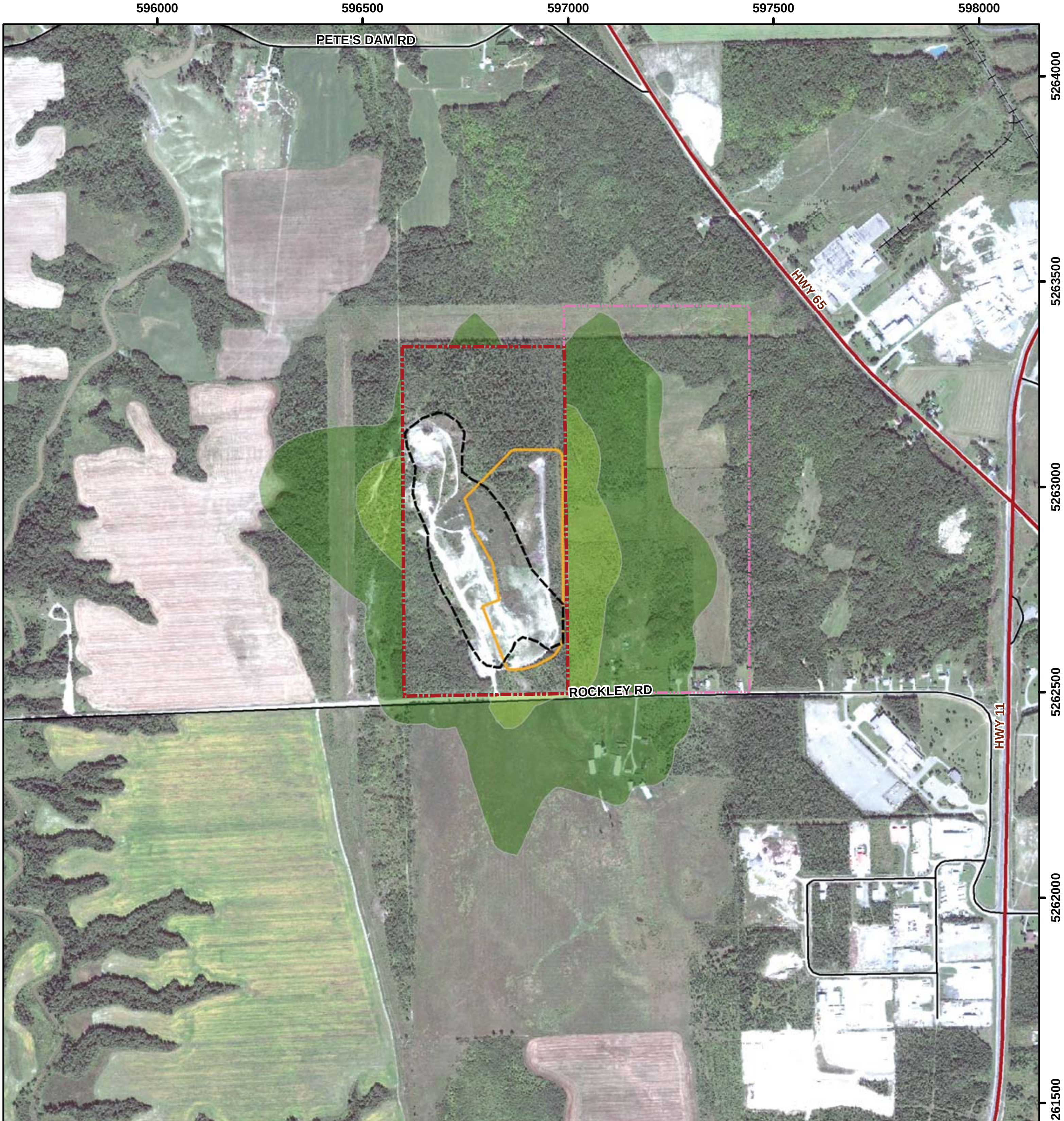
Temiskaming Shores

amec foster wheeler

TECHNICAL SUPPORT DOCUMENT: AIR QUALITY
NEW WASTE MANAGEMENT CAPACITY
TEMISKAMNG SHORES, ONTARIO

Particulate Matter $PM_{2.5}$ Isopleth (Annual Average)

PROJECT N^o:TY910491	**FIGURE: 5.5**
SCALE: 1:10,000	DATE: August 2016



Path: P:\projects\2009 Projects\Environmental\TY91049 COTS - Landfill Feasibility Study\TY910491 - Expansion Design and EA\GIS\MXD\August\7.6_Landfill Gas_24.mxd, Author: Matthew.Thornton, modified by Matthew.Thornton, 17 August 2016

LEGEND

- Property Boundary
- Contaminant Attenuation Zone
- Approximate Domestic Solid Waste Boundary
- Site (Proposed Landfill Expansion Area)
- Highway / Major Roads
- Local Roads
- Railway

Modelled Concentrations

- 0.05 - 0.1 µg/ m^3
- 0.1 - 0.2 µg/m^3

0 0.25 0.5 0.75 1 Kilometres

NOTES:
- Background image extracted from ESRI World Topo Map.
- All base data on this map was extracted form Land Information
- Geonames extracted from Geobase.
- Figure to be reviewed with the Air Quality Technical Support Document.

Datum & Projection: NAD 1983 UTM Zone 17N

N W E S

Temiskaming Shores

amec foster wheeler

TECHNICAL SUPPORT DOCUMENT: AIR QUALITY NEW WASTE MANAGEMENT CAPACITY TEMISKAMNG SHORES, ONTARIO

Landfill Gas (Hydrogen Sulphide) Isopleth (24-hour Averaging Time)

PROJECT N^o:TY910491	FIGURE: 5.6
SCALE: 1:12,500	DATE: August 2016

Path: P:\projects\2009 Projects\Environmental\TY91049 COTS - Landfill Feasibility Study\TY910491 - Expansion Design and EA\GIS\MXD\August\7.7_NO2 Isopleth_24.mxd, Author: Matthew.Thornton, modified by Matthew.Thornton, 17 August 2016

LEGEND

- Property Boundary
- Contaminant Attenuation Zone
- Approximate Domestic Solid Waste Boundary
- Site (Proposed Landfill Expansion Area)
- Highway / Major Roads
- Local Roads
- Railway

Modelled Concentration

- 1 - 5 µg/ m^3
- 5 - 10 µg/m^3
- 10 - 20 µg/m^3
- 20 - 40.8 µg/m^3

0 0.25 0.5 0.75 1 Kilometres

NOTES:
- Background image extracted from ESRI World Topo Map.
- All base data on this map was extracted form Land Information
- Geonames extracted from Geobase.
- Figure to be reviewed with the Air Quality Technical Support Document.

Datum & Projection: NAD 1983 UTM Zone 17N

N E S W

Temiskaming Shores

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TECHNICAL SUPPORT DOCUMENT: AIR QUALITY
NEW WASTE MANAGEMENT CAPACITY
TEMISKAMNG SHORES, ONTARIO

Nitrogen Dioxide (NO_2) Isopleth (24-hour Averaging Time)

PROJECT N^o:TY910491	**FIGURE: 5.7**
SCALE: 1:10,000	DATE: August 2016

Path: P:\projects\2009 Projects\Environmental\TY91049 COTS - Landfill Feasibility Study\TY910491 - Expansion Design and EA\GIS\MXD\August\7.8_NO2 Isopleth_1.mxd, Author: Matthew.Thornton, modified by Matthew.Thornton, 17 August 2016

LEGEND

- Property Boundary
- Contaminant Attenuation Zone
- Approximate Domestic Solid Waste Boundary
- Site (Proposed Landfill Expansion Area)
- Highway / Major Roads
- Local Roads
- Railway

Modelled Concentration

- 1 - 50 µg/ m^3
- 50 - 100 µg/ m^3
- 100 - 200 µg/ m^3
- 200 - 366.8 µg/ m^3
- > 366.8 µg/m^3

0 0.25 0.5 0.75 1 Kilometres

NOTES:
- Background image extracted from ESRI World Topo Map.
- All base data on this map was extracted form Land Information
- Geonames extracted from Geobase.
- Figure to be reviewed with the Air Quality Technical Support Document.

Datum & Projection: NAD 1983 UTM Zone 17N

N E S W

Temiskaming Shores

amec foster wheeler

TECHNICAL SUPPORT DOCUMENT: AIR QUALITY
NEW WASTE MANAGEMENT CAPACITY
TEMISKAMNG SHORES, ONTARIO

Nitrogen Dioxide (NO_2) Isopleth (1-hour Averaging Time)

PROJECT N°:TY910491	**FIGURE: 5.8**
SCALE: 1:10,000	DATE: August 2016

APPENDIX I

EMISSION SUMMARY TABLES

B1: Source Summary Table

Category	Emission Source / Activity	Source ID	Emission Estimation Methodology	Total Particulate Matter g/s	PM_{10} g/s	$PM_{2.5}$ g/s	Odour OU/s	LFG (vinyl chloride) g/s	LFG (hydrogen sulphide) g/s	LFG (acrylonitrile)	LFG (benzene)
Landfill	Landfill	Active Face					688				
Materials Handling	cover material onto active landfill	Active Face	Ontario Interim Guide	4.3E-05	2.0E-05	3.0E-06					
	cover material into haul truck at cover stockpile	Cover Stockpile	US EPA AP-42	9.3E-03	4.4E-03	6.5E-04					
	dozing at active face	Active Face	US EPA AP-42	1.3E-01	2.6E-02	1.4E-02					
Roadways	to landfill active face	Main Road	US EPA AP-42 Section 13.2.2 (unpaved roads)	0.0649	0.018	0.0018					
Exposed Areas	Landfill	Landfill Area	US EPA AP-42 Sections 11.9 and 13.2.5, Australian NPI	0.007	0.003	0.001	440	8.21E-04	2.21E-03	6.01E-04	2.67E-04
	Cover Material Stockpile	Cover Stockpile		0.028	0.014	0.0056					
Existing Landfill	Landfill	Existing Landfill	US EPA AP-42 Sections 11.9 and 13.2.5, Australian NPI				29.0	5.40E-05	1.45E-04	3.95E-05	1.76E-05
Vehicular Tailpipe Emissions	HDDV (waste hauler, pick up truck)	Main Road	MOBILE 6.2C	8.38E-06	8.38E-06	7.72E-06					
	Dozers	Active Face	US EPA NONROAD Model	0.0048	0.005	0.005					
	Compactors	Active Face		0.0059	0.006	0.006					
	Loader	Active Face		0.0095	0.010	0.009					
	Articulated Truck	Road from Active Face to Cover Stockpile		0.0066	0.0066	0.0064					
	Earth Mover / Grader	Active Face		0.0039	0.0039	0.0038					
	Excavator	Active Face		0.0033	0.0033	0.0032					
Total Emission Rate				**0.276**	**0.099**	**0.056**	**1,156**	**8.75E-04**	**2.35E-03**	**6.40E-04**	**2.84E-04**

B1: Source Summary Table

Category	Emission Source / Activity	Source ID	Emission Estimation Methodology	NOx - 1hr g/s	NOx - 24hr g/s	SO2 - 1 hr g/s	SO2 - 24hr g/s	CO - 8 hr g/s
Landfill	Landfill	Active Face						
Materials Handling	cover material onto active landfill	Active Face	Ontario Interim Guide					
	cover material into haul truck at cover stockpile	Cover Stockpile	US EPA AP-42					
	dozing at active face	Active Face	US EPA AP-42					
Roadways	to landfill active face	Main Road	US EPA AP-42 Section 13.2.2 (unpaved roads)					
Exposed Areas	Landfill	Landfill Area	US EPA AP-42 Sections 11.9 and 13.2.5, Australian NPI					7.05E-03
	Cover Material Stockpile	Cover Stockpile						
Existing Landfill	Landfill	Existing Landfill	US EPA AP-42 Sections 11.9 and 13.2.5, Australian NPI					4.64E-04
Vehicular Tailpipe Emissions	HDDV (waste hauler, pick up truck)	Main Road	MOBILE 6.2C	8.94E-04	2.98E-04	6.93E-05	2.31E-05	1.73E-01
	Dozers	Active Face	US EPA NONROAD Model	0.2605	6.51E-02	0.0095	0.0024	0.1028
	Compactors	Active Face				0.0116	0.0029	0.1257
	Loader	Active Face		0.3563	8.91E-02	0.0100	0.0025	0.1892
	Articulated Truck	Road from Active Face to Cover Stockpile				0.0134	0.0033	0.1063
	Earth Mover / Grader	Active Face				0.0076	0.0019	0.0555
	Excavator	Active Face		0.1312	3.28E-02	0.0065	0.0016	0.0446
Total Emission Rate				**0.749**	**0.19**	**0.059**	**1.47E-02**	**0.80**

APPENDIX II

EMISSION CALCULATIONS

C1: Landfill Activity Data

Project Aspect	Description	Units of Measure	Quantity	Source
Operating Hours	Schedule		Tues-Sat, 40 h/week	Tuesday through Saturday 40 hours per week (52 weeks a year), AMEC email 18Sept2014
	Total Days/Year		260	
	Total Hours / Year		2080	
Waste Received	See Waste Summary attached			
Annual Daily Cover	Cover	m^3/year	5,800	
		m^3/day	22	
Total Landfill Area	area	sq.metres.	109,000	
Landfill Working Faces	area	sq.metres.	625	
Clean Fill	Soil Type			
	silt content (cover)	wt %	9	US EPA AP-42 Table 13.2.4-1
	moisture content (cover)	wt %	12	
Residential waste hauler	Quantity		2	King Cobra Rear Packer waste density 260 kg/m3
	Model		estimate	
	Capacity	yd3	32.0	
	Tare Weight	tonnes	8.7	
	Payload	tonnes	6.6	
	Engine Type			
	Net Power			
	Gross Power	hp	350.0	
	Height	metres	3.7	
	Width	metres	2.8	
Dozers	Quantity		2	CAT D8 Dozer Specifications
	Model		D8	
	Weight	tons	42.6	
	Engine Type			
	Gross Power	hp	328.0	
	Height	metres	3.6	
	Width (with blade)	metres	3.9	

C1: Landfill Activity Data

Project Aspect	Description	Units of Measure	Quantity	Source
Compactors	Quantity		1	Cat 826 Specifications
	Model		826	
	Weight	tons	40.7	
	Engine Type			
	Gross Power	hp	401.0	
	Net Power	hp	354.0	
	Height (to top of cab)	metres	4.2	
	Height (to exhaust)	metres	3.7	
	Width (with blade)	metres	4.5	
Loader	Quantity		1	Cat 966 Loader Specifications
	Model		966	
	Capacity	cu. yard	2	
	Weight	tons	27.6	
	Engine Type			
	Net Power	hp	262	
	Gross Power	hp	286	
	Height (to exhaust)	metres	3.6	
	Width (with blade)	metres	3.5	
Articulated Truck	Quantity		1	CAT740B Specifications
	Model		CAT740B	
	Capacity	cu. yard	31.4	
	Tare Weight	tons	38.0	
	Payload	tons	43.5	
	Engine Type			
	Net Power	hp	484	
	Gross Power	hp	489	
	Height (to exhaust)	metres	4.1	
	Width	metres	3.5	

C1: Landfill Activity Data

Project Aspect	Description	Units of Measure	Quantity	Source
Earth Mover / Grader	Quantity		1	Cat 140M3 Specifications
	Model		140M	
	Net Power		272	
	Gross Power			
	Weight	tons	23.0	
	Height (to cab)	metres	3.3	
	Width	metres	2.5	
Pickup Truck	Quantity		2	
	Model			
	Net Power			
	Gross Power			
	Weight (GVWR)	tonnes		
	Weight (Curb)	tonnes		
	Height	metres		
	Width	metres		
Excavator	Quantity		1	Cat 140M3 Specifications
	Model		CAT330L	
	Net Power		222	
	Gross Power		236	
	Weight	tons	37.2	
	Height (to cab)	metres	3.6	
	Width	metres	3.3	

C2: Quantities of Waste

Year	Total Compacted Volume (m^3)	Total Solid Waste Tonnage (metric tonnes)	Total Uncompacted Waste (m^3)	Total Cumulative Compacted Volume (m^3)
1997	NA	NA	NA	NA
1998	NA	NA	NA	NA
1999	NA	NA	NA	NA
2000	7,563	3,592	16,806	7,563
2001	6,646	3,157	14,769	14,209
2002	6,230	2,959	13,844	20,439
2003	5,250	2,494	11,667	25,689
2004	4,546	2,159	10,102	30,235
2005	5,414	2,572	12,032	35,649
2006	8,349	3,966	18,554	43,998
2007	9,151	4,347	20,335	53,149
2008	8,755	4,159	19,456	61,904
2009	10,373	4,927	23,051	72,277
2010	10,370	4,926	23,045	82,648
2011	10,484	4,980	23,297	93,131
2012	10,597	5,034	23,549	103,729
2013	10,711	5,088	23,801	114,439
2014	10,824	5,141	24,053	125,263
2015	10,937	5,195	24,305	136,201
2016	11,051	5,249	24,557	147,251
2017	11,164	5,303	24,809	158,415
2018	11,277	5,357	25,061	169,693
2019	11,391	5,411	25,313	181,084
2020	11,504	5,464	25,565	192,588
2021	11,618	5,518	25,817	204,205
2022	11,731	5,572	26,069	215,936
2023	11,844	5,626	26,321	227,781
2024	11,958	5,680	26,573	239,738
2025	12,071	5,734	26,825	251,809
2026	12,184	5,788	27,077	263,994
2027	12,298	5,841	27,329	276,292
2028	12,411	5,895	27,580	288,703
2029	12,525	5,949	27,832	301,227
2030	12,638	6,003	28,084	313,865
2031	12,751	6,057	28,336	326,617
2032	12,865	6,111	28,588	339,482
2033	12,978	6,165	28,840	352,460
2034	13,091	6,218	29,092	365,551
2035	13,205	6,272	29,344	378,756
2036	13,318	6,326	29,596	392,074
2037	13,432	6,380	29,848	405,506
2038	13,545	6,434	30,100	419,051
2039	13,658	6,488	30,352	432,709
2040	13,772	6,542	30,604	446,481
2041	13,885	6,595	30,856	460,366
2042	13,998	6,649	31,108	474,364
2043	14,112	6,703	31,360	488,476
2044	14,225	6,757	31,612	502,701
2045	14,339	6,811	31,864	517,040
2046	14,452	6,865	32,116	531,492
2047	14,565	6,919	32,367	546,057
2048	14,679	6,972	32,619	560,736
2049	14,792	7,026	32,871	575,528
2050	14,905	7,080	33,123	590,434

C3: Landfill Gas, Odour, Vinyl Chloride, Hydrogen Sulphide , Acrylonitrile, Benzene, Carbon Monoxide Emissions

Odour Generation and Release

The odour generation and release rate associated with Landfill Gases was estimated assuming that the landfill gas has an odour concentration of 10,000 OU/m^3. This estimation method is recommended in the Ontario Interim Guide to Estimate and Assess Landfill Air Impacts, 1992, as a conservative manner to estimate odours.

Table C3.1: Odour, Vinyl Chloride, Hydrogen Sulphide , Acrylonitrile, Benzene, Carbon Monoxide Emissions associated with Landfill Gas Generation

Scenario	Year	LFG Cells	LFG Generation		LFG Odour Concentration	Odour Generation	VC Emission Rate		H2S Emission Rate		Acrylonitrile Emission Rate		Benzene Emission Rate		Carbon Monoxide		Landfill Area m^2 (Active and Closed Cells)
			(ft^3/min)	(m^3/s)	(OU/m^3)	(OU/s)	(m^3/s)	g/s	(m^3/s)	g/s	(m^3/s)	g/s	(m^3/s)	g/s	m3/s	g/s	
1	2	1	22.1	0.0104	10,000	104	7.62E-08	1.95E-04	3.76E-07	5.24E-04	6.58E-08	1.43E-04	1.98E-08	6.34E-05	1.46E-06	1.67E-03	26120.3
2	7	1,2	45.5	0.0215	10,000	215	1.57E-07	4.00E-04	7.73E-07	1.08E-03	1.35E-07	2.93E-04	4.08E-08	1.30E-04	3.00E-06	3.44E-03	36983.6
3	12	1,2,3	65.1	0.0307	10,000	307	2.24E-07	5.73E-04	1.10E-06	1.54E-03	1.93E-07	4.19E-04	5.83E-08	1.86E-04	4.30E-06	4.92E-03	54405
4	17	1,2,3,4	81.6	0.0385	10,000	385	2.81E-07	7.19E-04	1.39E-06	1.93E-03	2.43E-07	5.26E-04	7.32E-08	2.34E-04	5.39E-06	6.17E-03	76117.7
5	21	1,2,3,4,5	93.2	0.0440	10,000	440	3.21E-07	8.21E-04	1.58E-06	2.21E-03	2.77E-07	6.01E-04	8.36E-08	2.67E-04	6.16E-06	7.05E-03	93578.5
Existing	21	Existing	6.138	0.0029	10,000	28.95	2.11E-08	5.40E-05	1.04E-07	1.45E-04	1.82E-08	3.95E-05	5.50E-09	1.76E-05	4.05E-07	4.64E-04	

C3: Landfill Gas, Odour, Vinyl Chloride, Hydrogen Sulphide , Acrylonitrile, Benzene, Carbon Monoxide Emissions

Vinyl Chloride and Hydrogen Sulphide Generation and Release

The Landgem model output was used to estimate the vinyl chloride and H_2S emissions as constituents of the landfill gas.

				ppmv	%
VC Molecular Weight	62.50	g/g-mol	H2S Concentration	36	0.0036
H2S Molecular Weight	34.08	g/g-mol	VC Concentration	7.3	0.00073
Acrylonitrile Molecular Weight	53	g/g-mol	Acrylonitrile	6.3	0.00063
Benzene Molecular Weight	78.11	g/g-mol	Benzene	1.9	0.00019
Carbon Monoxide	28	g/g-mol	CO	140	0.014

Landfill Gas Generation by Cell and Year

Cell	Year	LFG ft3/min	Cell	Year	LFG ft3/min	Cell	Year	LFG ft3/min
1	2	22.14	2	2		3	2	
	7	22.24		7	23.26		7	
	12	17.32		12	23.36		12	24.38
	17	13.49		17	18.19		17	24.47
	21	11.04		21	14.89		21	20.04
Cell	Year	LFG ft3/min	Cell	Year	LFG ft3/min	Cell	Year	LFG ft3/min
4	2		5	2		ALL	2	
	7			7		1,2,3,4,5	7	
	12			12			12	
	17	25.49		17			17	
	21	26.90		21	20.36		21	93.23

Odour Generation by Cell and Year

Cell	Year	OU/s	Cell	Year	OU/s	Cell	Year	OU/s
1	2	104.49	2	2		3	2	
	7	104.96		7	109.77		7	
	12	81.74		12	110.23		12	115.04
	17	63.66		17	85.85		17	115.50
	21	52.12		21	70.29		21	94.56
Cell	Year	OU/s	Cell	Year	OU/s	Cell	Year	OU/s
4	2		5	2		ALL	2	
	7			7		1,2,3,4,5	7	
	12			12			12	
	17	120.32		17			17	
	21	126.96		21	96.08		21	440.02

C3: Landfill Gas, Odour, Vinyl Chloride, Hydrogen Sulphide , Acrylonitrile, Benzene, Carbon Monoxide Emissions

H2S Generation by Cell and Year

Cell	Year	H2S g/s	Cell	Year	H2S g/s	Cell	Year	H2S g/s
1	2	5.24E-04	2	2020		3	2020	
	7	5.26E-04		2025	5.50E-04		2025	
	12	4.10E-04		2030	5.53E-04		2030	5.77E-04
	17	3.19E-04		2035	4.31E-04		2035	5.79E-04
	21	2.61E-04		2039	3.52E-04		2039	4.74E-04
Cell	Year	H2S g/s	Cell	Year	H2S g/s	Cell	Year	H2S g/s
4	2		5	2020		ALL 1,2,3,4,5	2020	
	7			2025			2025	
	12			2030			2030	
	17	6.03E-04		2035			2035	
	21	6.37E-04	2039		4.82E-04		2039	2.21E-03

VC Generation by Cell and Year

Cell	Year	VC g/s	Cell	Year	VC g/s	Cell	Year	VC g/s
1	2	1.95E-04	2	2		3	2	
	7	1.96E-04		7	2.05E-04		7	
	12	1.52E-04		12	2.06E-04		12	2.15E-04
	17	1.19E-04		17	1.60E-04		17	2.15E-04
	21	9.72E-05		21	1.31E-04		21	1.76E-04
Cell	Year	VC g/s	Cell	Year	VC g/s	Cell	Year	VC g/s
4	2		5	2		ALL 1,2,3,4,5	2	
	7			7			7	
	12			12			12	
	17	2.24E-04		17			17	
	21	2.37E-04		21	1.79E-04		21	8.21E-04

Acrylonitrile Generation by Cell and Year

Cell	Year	Acry g/s	Cell	Year	Acry g/s	Cell	Year	Acry g/s
1	2	1.43E-04	2	2		3	2	
	7	1.43E-04		7	1.50E-04		7	
	12	1.12E-04		12	1.50E-04		12	1.57E-04
	17	8.69E-05		17	1.17E-04		17	1.58E-04
	21	7.11E-05		21	9.59E-05		21	1.29E-04
Cell	Year	Acry g/s	Cell	Year	Acry g/s	Cell	Year	Acry g/s
4	2		5	2		ALL 1,2,3,4,5	2	
	7			7			7	
	12			12			12	
	17	1.64E-04		17			17	
	21	1.73E-04		21	1.31E-04		21	6.01E-04

C3: Landfill Gas, Odour, Vinyl Chloride, Hydrogen Sulphide , Acrylonitrile, Benzene, Carbon Monoxide Emissions

Benzene Generation by Cell and Year

Cell	Year	Benzene g/s	Cell	Year	Benzene g/s	Cell	Year	Benzene g/s
1	2	6.34E-05	2	2		3	2	
	7	6.37E-05		7	6.66E-05		7	
	12	4.96E-05		12	6.69E-05		12	6.98E-05
	17	3.86E-05		17	5.21E-05		17	7.01E-05
	21	3.16E-05		21	4.26E-05		21	5.74E-05
Cell	Year	Benzene g/s	Cell	Year	Benzene g/s	Cell	Year	Benzene g/s
4	2		5	2		ALL	2	
	7			7		1,2,3,4,5	7	
	12			12			12	
	17	7.30E-05		17			17	
	21	7.70E-05		21	5.83E-05		21	2.67E-04

CO Generation by Cell and Year

Cell	Year	CO g/s	Cell	Year	CO g/s	Cell	Year	CO g/s
1	2	1.67E-03	2	2		3	2	
	7	1.68E-03		7	1.76E-03		7	
	12	1.31E-03		12	1.77E-03		12	1.84E-03
	17	1.02E-03		17	1.38E-03		17	1.85E-03
	21	8.35E-04		21	1.13E-03		21	1.52E-03
Cell	Year	CO g/s	Cell	Year	CO g/s	Cell	Year	CO g/s
4	2		5	2		ALL	2	
	7			7		1,2,3,4,5	7	
	12			12			12	
	17	1.93E-03		17			17	
	21	2.03E-03		21	1.54E-03		21	7.05E-03

C4: Odour - Working Face

Working Landfill Face Odour Generation

A literature survey was conducted in order to obtain data to allow estimation of the odour generated at the active, or working face, of landfills. This survey resulted in a conservative estimate of 1.1 $OU/m^2/s$ to be used for the landfill working face.

The active face is 25 metres x 25 metres.

Table C4.1: Odour Emissions from Active Faces (resulting from scraping)

Total Area (m^2)	Odour Generation per unit Area ($OU/m^2/s$)	Odour Emission Rate (OU/s)
625	1.1	687.5

C5: Road Dust Emissions

Table C5.1 Road Dust Estimates

Road Segment ID	Road Description / Activity	Length of Segment	Vehicle Description	Hourly Return Trips	Vehicle Weight	W mean weight	Paved / Unpaved	VKT		Emission Factors (kg/VKT)			Hours per Day	Emission Rate					
														TSP		PM_{10}		$PM_{2.5}$	
		(m)			(tonnes)	(tons)		(km/day)	(km/hr)	TSP	PM_{10}	$PM_{2.5}$		(kg/hr)	(g/s)	(kg/hr)	(g/s)	(kg/hr)	(g/s)
1	Access Road to Working Face	769.6	Waste Hauler	2	12.0	13.3	unpaved	24.63	3.08	0.1944	0.0525	0.0052	8	0.199	0.055	0.054	0.015	0.005	0.0015
2	Pick up trucks	769.6	Pick Up Trucks	1	0.0	0.0	unpaved	6.16	0.77	0.0000	0.0000	0.0000	8	0.000	0.000	0.000	0.000	0.000	0.0000

Movement of cover from stockpile to working face were not included in the modelling, as these trips are either irregular in occurrence, limited in number, or alternate trips to those detailed in the summary table above.

Mean vehicle weight = average of empty and loaded truck weight

The length of segment was estimated to be a maximum of 835 metres for haul trucks bringing waste to cell 5 (2036-2039).

It was assumed that, at most, one pick up truck would drive the perimeter of the site each hour.

Road dust emissions are controlled by using both an on-site speed limit, road maintenance and watering, road maintenace, therefore both control factors are incorporated into the calculated emission rate

C5: Road Dust Emissions

Predictive Emission Factor Equation for Unpaved Roadways

$$E = k \times \left(\frac{s}{12}\right)^{a}\left(\frac{W}{3}\right)^{b}$$

US EPA AP-42 Chapter 13.2.2, Equation 1a

k,a,b = empirical constants

s = silt content (%)

W = average vehicle weight (tons)

1 lb/VMT = 281.9 g/VKT

Table C5.2 Unpaved Road Parameters

Constant	Units of Measure	PM_{30}	PM_{10}	$PM_{2.5}$	
k	lb/VMT (1)	4.9	1.5	0.15	
a	-	0.7	0.9	0.9	
b	-	0.45	0.45	0.45	
s	%	6.4	6.4	6.4	
Conversion factor	lb/VMT to g/VKT (2)	281.9	281.9	281.9	
Control Efficiency	%	44%	44%	44%	(limited on-site speed, road maintenance)
		80%	80%	80%	(watering, road maintenance)

(1) "lb/VMT" means pounds per vehicle mile travelled.

(2) "g/VKT" means grams per vehicle kilometre

Table C5.3 Vehicle Weights

Vehicle Class	Weight (tonnes)	
	No Load	Load
pickup trucks	0.0	0.0
haul truck	9	15

C6: Aggregate Handling

Unloading of Cover Material onto Landfill

Particulate emissions from unloading and spreading cover material were estimated using the method recommended in the Ontario Interim Guide to Estimate and Assess Landfill Air Impacts, 1992, according to Equation C6.1. The particle size distribution (PSD) reported in US EPA AP-42 Section 13.2.4 Aggregate Handling and Storage Piles was assumed to be a representative of the distribution in the cover material.

$$ER\,(kg/hr) = 0.0009 \times \left[\frac{\left(\frac{s}{5}\right) \times \left(\frac{u_2}{2.2}\right) \times \left(\frac{H}{1.5}\right)}{\left(\frac{m}{2}\right)^2 \times \left(\frac{Y}{4.6}\right)^{0.33}} \right] \times Q$$

Equation C6.1

Table C6.1: Emissions from Application of Cover Material at Working Face

Year / Scenario	Particle Size	Annual Cover Applied (m3)	Annual Operating Hours	Cover Applied (tonnes/hr)	Silt Content (%)	Wind Speed U_2 (m/s)	Drop Height (m)	Moisture Content (%)	Device Capacity (m3)	PSD (%)	Emission Factor (kg/tonne)	1-hr Average Emission Rate (kg/hr)	1-hr Average Emission Rate (g/s)	24-hr Average Emission Rate (g/s)
Maximum	TSP	5,800	2,080	4.5	9	5.1	2	12	11.4	100%	1.03E-04	4.6E-04	1.3E-04	4.3E-05
	PM_{10}									47%	4.85E-05	2.2E-04	6.0E-05	2.0E-05
	$PM_{2.5}$									7%	7.22E-06	3.2E-05	9.0E-06	3.0E-06

s = silt content (%)

u_2 = wind velocity at 2 m, an average wind speed of 5.1 m/s was used to determine if aggregate handling was significant.

H = fall distance (m) m = moisture content of cover (%)

Y (capacity of device (m^3)) = 25 tonnes / 2.2 g/cm^3 * 1000 kg/tonne * 1000 g/kg * 1 cm3/$1E^{-6}$ m^3

Q = material handled per hour (tonnes/hr)

Cover material density 1600 kg/m3 http://www.pedosphere.com/resources/bulkdensity/triangle.cfm?284,297

Filling of Trucks with Cover Material at Stockpile by Excavator

Truck loading by power shovel (batch drop), US EPA AP-42 Section 11.9, Table 11.9-4, Overburden

Emission Factor 0.018 kg PM/Mg material

Table C6.2: Emissions from Filling of Trucks with Cover Material at Stockpile

Year / Scenario	Particle Size	Annual Cover Applied (tonnes)	Annual Operating Hours	Cover Applied (tonnes/day)	Particle Size Multiplier	Emission Factor (kg/tonne)	1-hr Avereage Emission Rate (kg/hr)	Hours per day	24-hr Average Emission Rate (kg/hr)	24-hr Average Emission Rate (g/s)
Maximum	TSP	5,800	2,080	22.3	100%	0.018	0.402	2	0.03346	0.00929
	PM_{10}				47%	0.0085	0.189		0.01573	0.00437
	$PM_{2.5}$				7%	0.0013	0.028		0.00234	0.00065

Assume all cover loaded to truck in one hour

C7: Bulldozer Activity

Particulate matter emissions from the movement of bulldozers on cover material was estimated using the methodology outlined in US EPA Section 11.9, Table 11.9-2, Bulldozing on Material other than Coal (Overburden).

$$\boxed{TSP\ EF(kg/hr) = 2.6 \times \left(\frac{(s)^{1.2}}{(M)^{1.3}} \right)}$$

$$\boxed{PM_{10}\ EF(kg/hr) = 0.34 \times \left(\frac{(s)^{1.5}}{(M)^{1.4}} \right)}$$

$$\boxed{PM_{2.5}\ EF\ (kg/hr) = 0.105 \times TSP}$$

s = silt content (%)
M = moisture content (%)

Table C7.1: Particulate Emissions from Bulldozers Activity

Year / Scenario	Particle Size	Number of Bulldozers or Equivalent	Silt Content (%)	Moisture Content (%)	Emission Rate			Hours per Day	24-hr Average Emission Rate
					per Dozer (kg/hr)	total (kg/hr)	total (g/s)		total (g/s)
Maximum	TSP	2	9	12	1.44	2.87	0.80	4	0.133
	PM_{10}				0.28	0.57	0.16		0.026
	$PM_{2.5}$				0.15	0.30	0.08		0.014

Included emissions from two of one dozers, one grader, and one compactor (3 units)

C8: Landfill Open Face Wind Erosion

Wind Erosion - Average Hour

An average value for wind erosion from open areas and stockpiles of 0.4 kg/ha/h (3,504 kg/ha/year) was used for the assessment (SPCC (1986)). This approach was used to avoid overestimating the disturbed areas that would be susceptible to wind erosion.

This estimated average value is more conservative in nature than the estimated wind erosion of overburden or graded areas at surface coal mine (AP-42 Section 11.9), which estimates that the annual losses from wind erosion are 0.85 Mg/ha/year (or 0.097 kg/ha/hr).

Average Wind Erosion from Exposed Areas (kg/ha/hr)			Average Wind Erosion from Exposed Areas ($g/m^2/s$)		
TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
0.40	0.20	0.08	1.1E-05	5.6E-06	2.2E-06

Location	Total Area (m^2)	Total Area (ha)	Emissions (kg/hr)			Emissions (g/s)		
			TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
active face of landfill	625	0.1	0.03	0.01	0.005	0.007	0.003	0.001
cover material stockpile	2,500	0.3	0.10	0.05	0.020	0.028	0.014	0.006

It should be noted that the particulate emissions from disturbed, or active, stockpiles, may be significantly higher during periods of high winds. However the emission rate during such events decreases quickly as the particulate matter on the surface that is susceptible to the wind is finite. Such episodes or events are best managed by on-site practices such as water application and modified activity at stockpiles during high wind events.

The use of the current emission factors for wind erosion in the U.S. EPA's AP-42 document would require hourly input of emission values. In addition, that factor only applies to a limited number of hours above a high wind speed threshold. For these reasons, a more practical approach was used to avoid modelling a different emission value for each hour of meteorological data. An average value based on the emission factor for coal mines was used. Since this factor would lead to higher wind erosion because coal dust related wind erosion is more likely to occur than asphalt, limestone, or overburden type soil related wind erosion, that approach is considered conservative. In addition, wind erosion is only expected to significantly occur when the wind speed exceeds 10 m/s. The emissions from the wind erosion from the landfill open face were modelled without adjusting the emission rate based on wind speed, essentially assuming that emissions are occurring at all times and under all conditions, but in reality when the wind speed drops below 10 m/s the effects of wind erosion are diminished. This approach is considered conservative.

C9: Tailpipe Emissions

Vehicle Type	Engine Power (hP)	Emission Factors							Units	Emission Rate (g/s/vehicle)						
		TSP	PM_{10}	$PM_{2.5}$	NOx	SO2	CO2	CO		TSP	PM_{10}	$PM_{2.5}$	NOx	SO2	CO2	CO
Residential waste hauler	350	0.039	0.039	0.036	1.59	0.13	1410.80	0.63	g/mile	1.02E-05	1.02E-05	9.35E-06	4.12E-04	3.38E-05	3.64E-01	1.62E-04
Dozers	328	0.21	0.21	0.20	2.86	0.10	536.27	1.13	g/hp-hr	0.019	0.019	0.019	0.260	0.010	48.860	0.103
Compactors	401	0.21	0.21	0.20	2.86	0.10	536.27	1.13	g/hp-hr	0.023	0.023	0.023	0.318	0.012	59.735	0.126
Loader	286	0.48	0.48	0.46	4.48	0.13	624.51	2.38	g/hp-hr	0.038	0.038	0.037	0.356	0.010	49.614	0.189
Articulated Truck	489	0.19	0.19	0.19	1.95	0.10	536.34	0.78	g/hp-hr	0.026	0.026	0.026	0.266	0.013	72.853	0.106
Earth Mover / Grader	272	0.21	0.21	0.20	2.15	0.10	536.25	0.73	g/hp-hr	0.015	0.015	0.015	0.163	0.008	40.517	0.055
Pickup Truck	0	0.017	0.017	0.015	0.25	0.0056	0.56	598.60	g/mile	4.82E-06	4.82E-06	4.45E-06	7.08E-05	1.62E-06	1.61E-04	1.73E-01
Excavator	236	0.20	0.20	0.19	2.00	0.10	536.28	0.68	g/hp-hr	0.013	0.013	0.013	0.131	0.0065	35.156	0.045

Vehicle Type	Number of Vehicles	Emission Rate 1-hr, 8-hr (g/s)				Emission Rate 24-hr (g/s)					Emission Rate Annual (tonnes/year)
		NOx	SO2	CO2	CO	TSP	PM_{10}	$PM_{2.5}$	NOx	SO2	CO2
Residential waste hauler	2	8.23E-04	6.77E-05	n/a	3.24E-04	6.77E-06	6.77E-06	6.23E-06	2.74E-04	2.26E-05	5.458
Dozers	1	0.260	0.010	n/a	0.103	0.0048	0.0048	0.0047	0.0651	0.0024	365.867
Compactors	1	0.318	0.012	n/a	0.126	0.0059	0.0059	0.0057	0.0796	0.0029	447.294
Loader	1	0.356	0.010	n/a	0.189	0.0095	0.0095	0.0092	0.0891	0.0025	371.507
Articulated Truck	1	0.266	0.013	n/a	0.106	0.0066	0.0066	0.0064	0.0664	0.0033	545.527
Earth Mover / Grader	1	0.163	0.008	n/a	0.055	0.0039	0.0039	0.0038	0.0407	0.0019	303.391
Pickup Truck	1	7.08E-05	1.62E-06	n/a	0.173	1.61E-06	1.61E-06	1.48E-06	2.36E-05	5.39E-07	0.001
Excavator	1	0.131	0.006	n/a	0.045	0.0033	0.0033	0.0032	0.0328	0.0016	263.249

Industrial vehicles include heavy earth moving and construction equipment and a range of miscellaneous vehicles such as forklifts and mobile airport equipment. Industrial vehicles also include road-transport vehicle such as cars and goods vehicles, when used on rough terrain, steep grades or poorly graded tracks.

Assume equipment at landfill operating 8 hours per day, 2080 hours per year
Assume residential waste haulers travelling 15 minutes per hour on-site; all other vehicles assumed to be in use for 8 hours per day.
PickUp Truck assumed to travel 1.5 km (0.93 mile) per hour during each of 8 hours of landfill operations.
Waste hauler assumed to travel 1.67 km (1.04 mile) per hour during each of 8 hours of landfill operations.

Sample Calc:
TSP- Residential Waste Hauler
0.039 g/mile, Mobile 6.2C heavy duty diesel vehicle 2020
PickUp Truck assumed to travel 1.5 km (0.93 mile) per hour during each of 8 hours of landfill operations.
g/mile x 0.93 mile/hr / 3600 s/hr
1.02E-05 g/s/vehicle
Emission rate 24hr
g/s/vehicle x # of vehicles x 8hr / 24hrs
6.77E-06 g/s/24hr

C9: Tailpipe Emissions
Output from US EPA NONROAD MODEL

Range	HP	SCC	EQUIP	Fuel Type	PM exhaust	PM10 exhaust	PM25 exhaust	NOx exhaust	SO2 exhaust	CO2 exhaust	CO exhaust
300 < HP <= 600	600	2270002069	Crawler Tractor/Dozers	Diesel	0.21	0.21	0.20	2.86	0.10	536.27	1.13
175 < HP <= 300	300	2270002036	Excavators	Diesel	0.20	0.20	0.19	2.00	0.10	536.28	0.68
175 < HP <= 300	300	2270002048	Graders	Diesel	0.21	0.21	0.20	2.15	0.10	536.25	0.73
300 < HP <= 600	600	2270002051	Off-highway Trucks	Diesel	0.19	0.19	0.19	1.95	0.10	536.34	0.78
175 < HP <= 300	300	2270002066	Tractors/Loaders/Backho	Diesel	0.48	0.48	0.46	4.48	0.13	624.51	2.38

Mobile6.2C Heavy Duty Diesel Vehicles - Emission Factors (g/mile)

Year	TSP	PM10	PM2.5	NOx	SO2	CO	CO2
2020	0.0393	0.0393	0.0362	1.593	0.131	0.628	1410.8
2025	0.0299	0.0299	0.0276	0.878	0.131	0.435	1410.8
2030	0.026	0.026	0.024	0.579	0.131	0.347	1410.8
2035	0.0236	0.0236	0.0218	0.453	0.131	0.292	1410.8
2039	0.0236	0.0236	0.0218	0.453	0.131	0.292	1410.8

Mobile6.2C Light Duty Diesel Vehicles - Emission Factors (g/mile)

Year	TSP	PM10	PM2.5	NOx	SO2	CO	CO2
2020	0.0167	0.0167	0.0154	0.245	0.0056	0.559	598.6
2025	0.0122	0.0122	0.0113	0.171	0.0056	0.487	598.6
2030	0.0093	0.0093	0.0086	0.121	0.0056	0.433	598.6
2035	0.0093	0.0093	0.0086	0.116	0.0056	0.433	598.6
2039	0.0093	0.0093	0.0086	0.116	0.0056	0.433	598.6

Project GHG Emissions

Summary

	GHG Emissiosn CO2-eq (kiloTonne/year)				
	Tailpipe	Landfill	Total GHG Emissions	% of Ontario 2012 GHG	% of Canada 2012 GHG
2020	3.15	3.08	6.22	0.0037%	0.00089%
2025	3.15	6.32	9.47	0.0057%	0.00135%
2030	3.15	9.04	12.19	0.0073%	0.00174%
2035	3.15	11.35	14.50	0.0087%	0.00207%
2039	3.15	12.96	16.11	0.01%	0.00230%
100 Year Total	75.52	442.26	517.78		

Summary of GHG Emissions by Source

Year		Tailpipe GHG CO_2-eq Emissions (kTonne)	Landfill GHG CO_2-eq Emissions (kTonne)	Total GHGs CO_2-eq Emissions (kTonne)	Waste Tonnage MTonne	GHG Intensity tonne CO2eq / MTonne Waste
1	2016	3.1	0.000	3.1	5249	0.5995
2	2017	3.1	0.815	4.0	5303	0.7471
3	2018	3.1	1.599	4.7	5357	0.8858
4	2019	3.1	2.352	5.5	5411	1.0163
5	2020	3.1	3.078	6.2	5464	1.1390
6	2021	3.1	3.776	6.9	5518	1.2545
7	2022	3.1	4.449	7.6	5572	1.3631
8	2023	3.1	5.097	8.2	5626	1.4652
9	2024	3.1	5.722	8.9	5680	1.5614
10	2025	3.1	6.325	9.5	5734	1.6518
11	2026	3.1	6.906	10.1	5788	1.7370
12	2027	3.1	7.468	10.6	5841	1.8171
13	2028	3.1	8.011	11.2	5895	1.8926
14	2029	3.1	8.536	11.7	5949	1.9637
15	2030	3.1	9.043	12.2	6003	2.0306
16	2031	3.1	9.534	12.7	6057	2.0936
17	2032	3.1	10.010	13.2	6111	2.1529
18	2033	3.1	10.470	13.6	6165	2.2089
19	2034	3.1	10.917	14.1	6218	2.2615
20	2035	3.1	11.350	14.5	6272	2.3112
21	2036	3.1	11.770	14.9	6326	2.3579
22	2037	3.1	12.178	15.3	6380	2.4020
23	2038	3.1	12.575	15.7	6434	2.4436
24	2039	3.1	12.961	16.1	6488	2.4827
25	2040	0	13.336	13.3	0	n/a

Project GHG Emissions

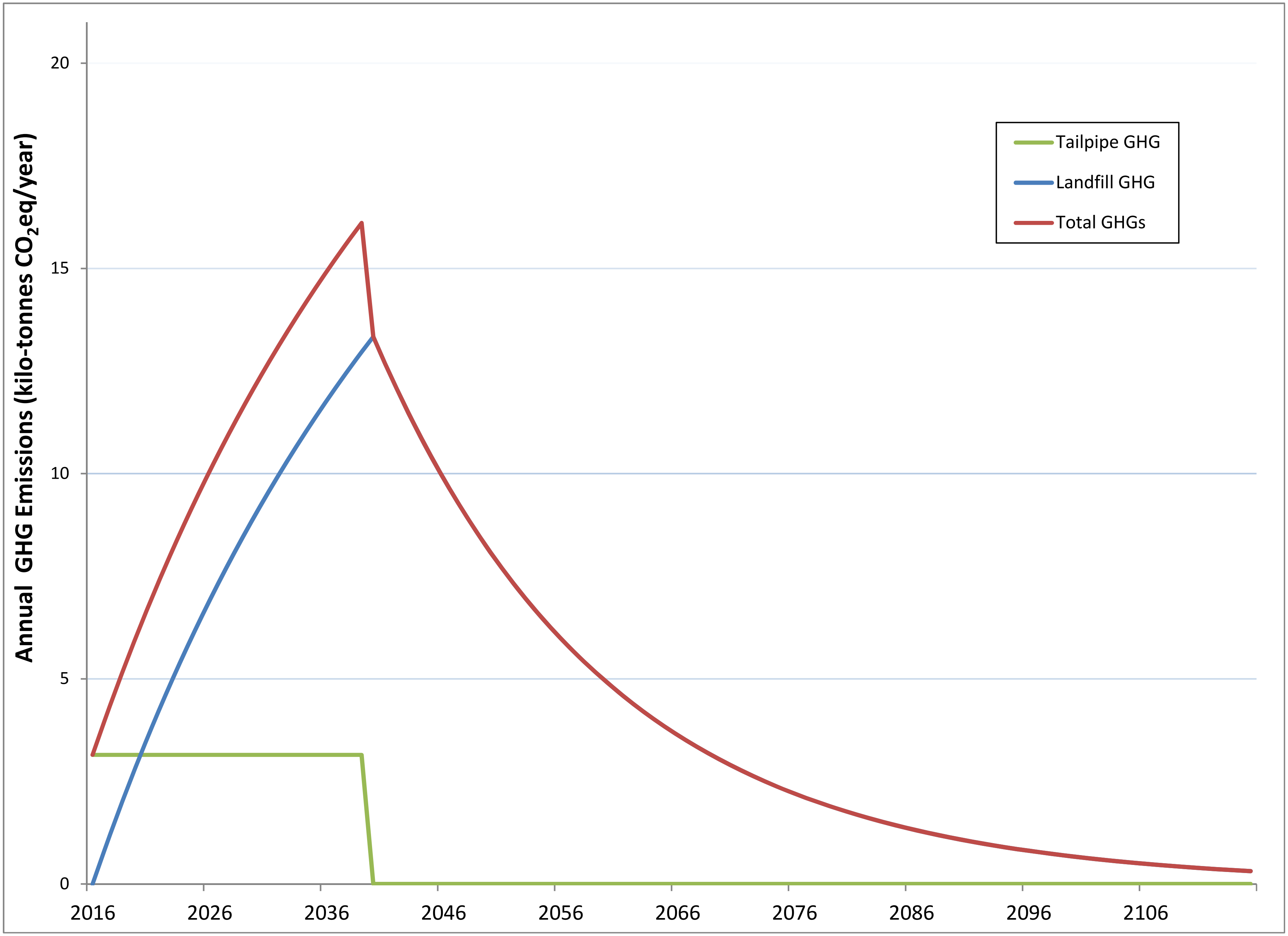
Summary of GHG Emissions by Source

Year		Tailpipe GHG	Landfill GHG	Total GHGs	Waste Tonnage	GHG Intensity
		CO_2-eq Emissions (kTonne)	CO_2-eq Emissions (kTonne)	CO_2-eq Emissions (kTonne)	MTonne	tonne CO2eq / MTonne Waste
26	2041	0	12.685	12.7	0	n/a
27	2042	0	12.067	12.1	0	n/a
28	2043	0	11.478	11.5	0	n/a
29	2044	0	10.918	10.9	0	n/a
30	2045	0	10.386	10.4	0	n/a
31	2046	0	9.879	9.9	0	n/a
32	2047	0	9.398	9.4	0	n/a
33	2048	0	8.939	8.9	0	n/a
34	2049	0	8.503	8.5	0	n/a
35	2050	0	8.089	8.1	0	n/a
36	2051	0	7.694	7.7	0	n/a
37	2052	0	7.319	7.3	0	n/a
38	2053	0	6.962	7.0	0	n/a
39	2054	0	6.622	6.6	0	n/a
40	2055	0	6.299	6.3	0	n/a
41	2056	0	5.992	6.0	0	n/a
42	2057	0	5.700	5.7	0	n/a
43	2058	0	5.422	5.4	0	n/a
44	2059	0	5.157	5.2	0	n/a
45	2060	0	4.906	4.9	0	n/a
46	2061	0	4.667	4.7	0	n/a
47	2062	0	4.439	4.4	0	n/a
48	2063	0	4.223	4.2	0	n/a
49	2064	0	4.017	4.0	0	n/a
50	2065	0	3.821	3.8	0	n/a
51	2066	0	3.634	3.6	0	n/a
52	2067	0	3.457	3.5	0	n/a
53	2068	0	3.289	3.3	0	n/a
54	2069	0	3.128	3.1	0	n/a
55	2070	0	2.976	3.0	0	n/a
56	2071	0	2.830	2.8	0	n/a
57	2072	0	2.692	2.7	0	n/a
58	2073	0	2.561	2.6	0	n/a
59	2074	0	2.436	2.4	0	n/a
60	2075	0	2.317	2.3	0	n/a
61	2076	0	2.204	2.2	0	n/a
62	2077	0	2.097	2.1	0	n/a
63	2078	0	1.995	2.0	0	n/a
64	2079	0	1.897	1.9	0	n/a
65	2080	0	1.805	1.8	0	n/a
66	2081	0	1.717	1.7	0	n/a
67	2082	0	1.633	1.6	0	n/a
68	2083	0	1.553	1.6	0	n/a
69	2084	0	1.478	1.5	0	n/a
70	2085	0	1.406	1.4	0	n/a

Project GHG Emissions

Summary of GHG Emissions by Source

Year		Tailpipe GHG	Landfill GHG	Total GHGs	Waste Tonnage	GHG Intensity
		CO_2-eq Emissions (kTonne)	CO_2-eq Emissions (kTonne)	CO_2-eq Emissions (kTonne)	MTonne	tonne CO2eq / MTonne Waste
71	2086	0	1.337	1.3	0	n/a
72	2087	0	1.272	1.3	0	n/a
73	2088	0	1.210	1.2	0	n/a
74	2089	0	1.151	1.2	0	n/a
75	2090	0	1.095	1.1	0	n/a
76	2091	0	1.041	1.0	0	n/a
77	2092	0	0.990	1.0	0	n/a
78	2093	0	0.942	0.9	0	n/a
79	2094	0	0.896	0.9	0	n/a
80	2095	0	0.853	0.9	0	n/a
81	2096	0	0.811	0.8	0	n/a
82	2097	0	0.771	0.8	0	n/a
83	2098	0	0.734	0.7	0	n/a
84	2099	0	0.698	0.7	0	n/a
85	2100	0	0.664	0.7	0	n/a
86	2101	0	0.632	0.6	0	n/a
87	2102	0	0.601	0.6	0	n/a
88	2103	0	0.571	0.6	0	n/a
89	2104	0	0.544	0.5	0	n/a
90	2105	0	0.517	0.5	0	n/a
91	2106	0	0.492	0.5	0	n/a
92	2107	0	0.468	0.5	0	n/a
93	2108	0	0.445	0.4	0	n/a
94	2109	0	0.423	0.4	0	n/a
95	2110	0	0.403	0.4	0	n/a
96	2111	0	0.383	0.4	0	n/a
97	2112	0	0.364	0.4	0	n/a
98	2113	0	0.347	0.3	0	n/a
99	2114	0	0.330	0.3	0	n/a
100	2115	0	0.314	0.3	0	n/a


Annual GHG Emissions (kilo-tonnes CO_2eq/year)
20
15
10
5
0
2016
2026
2036
2046
2056
2066
2076
2086
2096
2106
Tailpipe GHG
Landfill GHG
Total GHGs

Project GHG Emissions

Fleet Comparison (Wabush 3 and No-Build Scenarios)

Vehicle Type	Engine Power (hP)	Number in Use Per Hour	Operating Hours	CO2 Emission Factor (g/hp-hr)	CO2 Emission Rate (tonnes/year)	CH4 Emission Rate (tonnes/year)	N2O Emission Rate (tonnes/year)	Total GHG Emissions (tonnes/year CO2-eq)
Residential waste hauler	350	2	2080	536.34	390.46	0.02	0.06	406.55
Dozers	328	1	2080	536.27	365.87	0.02	0.05	370.71
Compactors	401	1	2080	536.27	447.29	0.02	0.07	447.29
Loader	286	1	2080	536.20	318.98	0.02	0.05	318.98
Articulated Truck	489	1	2080	536.34	545.53	0.03	0.08	545.53
Earth Mover / Grader	272	1	2080	536.28	303.41	0.02	0.05	303.41
Pickup Truck	440	2	2080	536.34	490.86	0.02	0.07	490.86
Excavator	236	1	2080	536.28	263.25	0.01	0.04	263.25
							Total	**3146.57**

Diesel Engine Emission Factors

	Emission Factor (kg/kL)	GWP (Fifth Assessment Report)
CO2	2663	1
CH4	0.133	28
N2O	0.4	265

Source: Environment Canada, 2013 National Inventory Report 1990–2011 The Canadian Government's Submission to the UN Framework Convention on Climate Change Greenhouse Gas Sources And Sinks In Canada. Table A8-11 (page 198).

GWP - global warming potential, 2013 IPCC GWPs and Atmospheric Lifetimes

Project GHG Emissions

Landfill Gas GHG Emissions

	CO2-eq (kilo-tonne/year)
2020	3.1
2025	6.3
2030	9.0
2035	11.3
2039	13.0
140 Year Landfill Total	447.6

Methane global warming potential GWP = 28

LandGEM - Landfill Gas Emissions Model, Version 3.02 Output

	Year	Waste Accepted (tonnes/year)	Total landfill gas (tonne/year)	Methane Emissions (tonnes/year)	Carbon monoxide (tonnes/year)	CO2-eq (kilo-tonne/year)
0	2016	5249	0.00	0.00	0.00	0.00
1	2017	5303	108.97	29.11	79.86	0.815
2	2018	5357	213.74	57.09	156.65	1.599
3	2019	5411	314.52	84.01	230.51	2.352
4	2020	5464	411.51	109.92	301.59	3.078
5	2021	5518	504.88	134.86	370.02	3.776
6	2022	5572	594.82	158.88	435.94	4.449
7	2023	5626	681.49	182.03	499.45	5.097
8	2024	5680	765.05	204.35	560.69	5.722
9	2025	5734	845.65	225.88	619.77	6.325
10	2026	5788	923.44	246.66	676.78	6.906
11	2027	5841	998.55	266.72	731.83	7.468
12	2028	5895	1071.12	286.11	785.01	8.011
13	2029	5949	1141.26	304.84	836.42	8.536
14	2030	6003	1209.11	322.97	886.14	9.043
15	2031	6057	1274.76	340.50	934.26	9.534
16	2032	6111	1338.33	357.48	980.85	10.010
17	2033	6165	1399.92	373.93	1025.98	10.470
18	2034	6218	1459.62	389.88	1069.74	10.917
19	2035	6272	1517.52	405.35	1112.18	11.350
20	2036	6326	1573.73	420.36	1153.37	11.770
21	2037	6380	1628.30	434.94	1193.37	12.178
22	2038	6434	1681.34	449.10	1232.23	12.575
23	2039	6488	1732.90	462.88	1270.03	12.961
24	2040	0	1783.07	476.28	1306.80	13.336
25	2041	0	1696.11	453.05	1243.06	12.685
26	2042	0	1613.39	430.95	1182.44	12.067
27	2043	0	1534.71	409.94	1124.77	11.478
28	2044	0	1459.86	389.94	1069.91	10.918
29	2045	0	1388.66	370.93	1017.73	10.386
30	2046	0	1320.93	352.84	968.10	9.879
31	2047	0	1256.51	335.63	920.88	9.398
32	2048	0	1195.23	319.26	875.97	8.939
33	2049	0	1136.94	303.69	833.25	8.503
34	2050	0	1081.49	288.88	792.61	8.089
35	2051	0	1028.74	274.79	753.96	7.694
36	2052	0	978.57	261.39	717.18	7.319
37	2053	0	930.85	248.64	682.21	6.962
38	2054	0	885.45	236.51	648.94	6.622
39	2055	0	842.26	224.98	617.29	6.299
40	2056	0	801.19	214.01	587.18	5.992
41	2057	0	762.11	203.57	558.54	5.700
42	2058	0	724.94	193.64	531.30	5.422
43	2059	0	689.59	184.20	505.39	5.157
44	2060	0	655.96	175.21	480.74	4.906
45	2061	0	623.96	166.67	457.30	4.667
46	2062	0	593.53	158.54	434.99	4.439
47	2063	0	564.59	150.81	413.78	4.223
48	2064	0	537.05	143.45	393.60	4.017
49	2065	0	510.86	136.46	374.40	3.821

Project GHG Emissions

LandGEM - Landfill Gas Emissions Model, Version 3.02 Output

	Year	Waste Accepted (tonnes/year)	Total landfill gas (tonne/year)	Methane Emissions (tonnes/year)	Carbon monoxide (tonnes/year)	CO2-eq (kilo-tonne/year)
50	2066	0	485.94	129.80	356.14	3.634
51	2067	0	462.24	123.47	338.77	3.457
52	2068	0	439.70	117.45	322.25	3.289
53	2069	0	418.26	111.72	306.54	3.128
54	2070	0	397.86	106.27	291.59	2.976
55	2071	0	378.45	101.09	277.36	2.830
56	2072	0	360.00	96.16	263.84	2.692
57	2073	0	342.44	91.47	250.97	2.561
58	2074	0	325.74	87.01	238.73	2.436
59	2075	0	309.85	82.76	227.09	2.317
60	2076	0	294.74	78.73	216.01	2.204
61	2077	0	280.37	74.89	205.48	2.097
62	2078	0	266.69	71.24	195.46	1.995
63	2079	0	253.69	67.76	185.92	1.897
64	2080	0	241.31	64.46	176.86	1.805
65	2081	0	229.54	61.31	168.23	1.717
66	2082	0	218.35	58.32	160.03	1.633
67	2083	0	207.70	55.48	152.22	1.553
68	2084	0	197.57	52.77	144.80	1.478
69	2085	0	187.93	50.20	137.74	1.406
70	2086	0	178.77	47.75	131.02	1.337
71	2087	0	170.05	45.42	124.63	1.272
72	2088	0	161.76	43.21	118.55	1.210
73	2089	0	153.87	41.10	112.77	1.151
74	2090	0	146.36	39.10	107.27	1.095
75	2091	0	139.23	37.19	102.04	1.041
76	2092	0	132.44	35.37	97.06	0.990
77	2093	0	125.98	33.65	92.33	0.942
78	2094	0	119.83	32.01	87.82	0.896
79	2095	0	113.99	30.45	83.54	0.853
80	2096	0	108.43	28.96	79.47	0.811
81	2097	0	103.14	27.55	75.59	0.771
82	2098	0	98.11	26.21	71.90	0.734
83	2099	0	93.33	24.93	68.40	0.698
84	2100	0	88.77	23.71	65.06	0.664
85	2101	0	84.44	22.56	61.89	0.632
86	2102	0	80.33	21.46	58.87	0.601
87	2103	0	76.41	20.41	56.00	0.571
88	2104	0	72.68	19.41	53.27	0.544
89	2105	0	69.14	18.47	50.67	0.517
90	2106	0	65.77	17.57	48.20	0.492
91	2107	0	62.56	16.71	45.85	0.468
92	2108	0	59.51	15.89	43.61	0.445
93	2109	0	56.60	15.12	41.49	0.423
94	2110	0	53.84	14.38	39.46	0.403
95	2111	0	51.22	13.68	37.54	0.383
96	2112	0	48.72	13.01	35.71	0.364
97	2113	0	46.34	12.38	33.97	0.347
98	2114	0	44.08	11.78	32.31	0.330
99	2115	0	41.93	11.20	30.73	0.314
100	2116	0	39.89	10.65	29.23	0.298
101	2117	0	37.94	10.14	27.81	0.284
102	2118	0	36.09	9.64	26.45	0.270
103	2119	0	34.33	9.17	25.16	0.257
104	2120	0	32.66	8.72	23.93	0.244
105	2121	0	31.07	8.30	22.77	0.232
106	2122	0	29.55	7.89	21.66	0.221
107	2123	0	28.11	7.51	20.60	0.210
108	2124	0	26.74	7.14	19.60	0.200
109	2125	0	25.43	6.79	18.64	0.190
110	2126	0	24.19	6.46	17.73	0.181
111	2127	0	23.01	6.15	16.87	0.172
112	2128	0	21.89	5.85	16.04	0.164
113	2129	0	20.82	5.56	15.26	0.156
114	2130	0	19.81	5.29	14.52	0.148

Project GHG Emissions

LandGEM - Landfill Gas Emissions Model, Version 3.02 Output

	Year	Waste Accepted (tonnes/year)	Total landfill gas (tonne/year)	Methane Emissions (tonnes/year)	Carbon monoxide (tonnes/year)	CO2-eq (kilo-tonne/year)
115	2131	0	18.84	5.03	13.81	0.141
116	2132	0	17.92	4.79	13.14	0.134
117	2133	0	17.05	4.55	12.50	0.128
118	2134	0	16.22	4.33	11.89	0.121
119	2135	0	15.43	4.12	11.31	0.115
120	2136	0	14.67	3.92	10.75	0.110
121	2137	0	13.96	3.73	10.23	0.104
122	2138	0	13.28	3.55	9.73	0.099
123	2139	0	12.63	3.37	9.26	0.094
124	2140	0	12.01	3.21	8.81	0.090
125	2141	0	11.43	3.05	8.38	0.085
126	2142	0	10.87	2.90	7.97	0.081
127	2143	0	10.34	2.76	7.58	0.077
128	2144	0	9.84	2.63	7.21	0.074
129	2145	0	9.36	2.50	6.86	0.070
130	2146	0	8.90	2.38	6.52	0.067
131	2147	0	8.47	2.26	6.20	0.063
132	2148	0	8.05	2.15	5.90	0.060
133	2149	0	7.66	2.05	5.61	0.057
134	2150	0	7.29	1.95	5.34	0.055
135	2151	0	6.93	1.85	5.08	0.052
136	2152	0	6.59	1.76	4.83	0.049
137	2153	0	6.27	1.68	4.60	0.047
138	2154	0	5.97	1.59	4.37	0.045
139	2155	0	5.68	1.52	4.16	0.042
140	2156	0	5.40	1.44	3.96	0.040