Appendix I-12

Greenhouse Gas Assessment

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Our ref: 12567140

02 July 2026

Mr. Darren Fry
Walker Environmental
2800 Thorold Townline Rd
Niagara Falls, ON L2E 6S4

Re: Greenhouse Gas Assessment for the South Landfill Phase 2 Environmental Assessment

Dear Darren Fry,

GHD is pleased to present this Greenhouse Gas Assessment Report (Report) to Walker Environmental (Walker) for the South Landfill Phase 2 (SLF PH2) Environmental Assessment (EA) being developed for submission to the Ontario Ministry of Environment, Conservation, and Parks (MECP). The purpose of the Report is to evaluate the greenhouse gas (GHG) impacts of the proposed South Landfill Phase 2 and assess applicable landfill gas (LFG) end uses and the resulting net GHG emissions. GHD reviewed and integrated the LFG curves which were developed by RWDI using Environment and Climate Change Canada's (ECCC) Landfill Methane Model into the assessment.

The GHG impact of the three project scenarios for use of LFG generated by the SLF PH2 is assessed against the baseline scenario of Ontario's current landfill disposal processes for municipal solid waste generated in Ontario. The GHG emissions were assessed over a 45-year gas generation period of the SLF PH2 (2030 to 2075), with the operational phase of the landfill being approximately 20 years (2030 to 2046 with capping activities until 2048).

The intent of this Report is to provide a planning level assessment of the advantages and disadvantages associated with GHG emissions attributable to the proposed project in accordance with the Environmental Assessment Act and the Approved Amended Terms of Reference for the SLF PH2.

1. Project background

1.1 Scope of work

GHD understands the EA is being conducted for submission to the MECP to assess the potential impacts of the SLF PH2 located at 2800 Thorold Townline Road in the City of Niagara Falls. At present, Walker operates a Resource Management Campus (Campus) at the location, which consists of a comprehensive waste management process founded around the South Landfill. The current South Landfill has been operational since 2009 and has an approved capacity for 17.7 million cubic metres (m^3) of waste. The SLF PH2 is being proposed to expand landfill capacity to approximately 19.8 million m^3 over a 20-year period.

The scope of work covered in this report consists of the following:

– Review RWDI-developed forecast of GHG emissions associated with LFG production using the ECCC LFG Tool.

– Conduct a comparative analysis of up to three LFG end-use project scenarios against a baseline scenario. These are understood to include:
  - **Baseline scenario**: Destroy the LFG in an on-site flare.
  - **Project scenario #1**: Produce renewable natural gas (RNG) for injection into the Enbridge natural gas distribution network.
  - **Project scenario #2**: Sell produced LFG to a neighboring industrial facility for use as a fuel source.
  - **Project scenario #3**: Consume the LFG as a fuel for electricity generation onsite.

The anticipated fill rate for the SLF PH2 is 1.1 million tonnes per year, which includes the solid, non-hazardous municipal waste. Provided in this Report is an assessment of GHG emissions associated with the baseline scenario (on-site flaring of LFG) and project scenarios (selling or consuming LFG generated). The baseline and project scenarios are further detailed in Section 3.3.

In addition to the details provided in this Report, GHD has developed an excel spreadsheet (provided as Attachment 1 to this Report) that summarizes the GHG quantification along with outlining the calculations and assumptions used to quantify the GHG emissions resulting from the baseline and project scenarios.

1.2 Limitations

This report: has been prepared by GHD for Walker Environmental and may only be used and relied on by Walker Environmental for the purpose agreed between GHD and Walker Environmental as set out in section 1.1 of this report.

GHD otherwise disclaims responsibility to any person other than Walker Environmental arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section(s) 3.2 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Walker Environmental and others who provided information to GHD (including Government authorities)], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

Accessibility of documents

If this report is required to be accessible in any other format, this can be provided by GHD upon request and at an additional cost if necessary.

2. Definition of terms

This section provides a summary of common terms that have been used throughout this Report and provides definition, context, and explanation of their importance. The terms used below are not linked specifically to any GHG program and are provided to maintain consistency with the way GHG emissions are assessed for this Report. In some cases, there are specific assumptions that are applicable to the below terms; these assumptions have been further defined in Section 3.1.

Baseline scenario – Scenario that includes the destruction of LFG in an on-site flare.

Biogenic emissions – Emissions which arise from the decomposition of natural materials such as plants or plant materials, animal waste, wood and wood products, charcoal and agricultural residues, biologically derived organic matter in municipal and industrial wastes, landfill gas, bioalcohols, black liquor, sludge digestion gas, or animal- or plant-derived oils[1].

Emission reductions – The GHG emissions that would be reduced or avoided if the respective project scenarios were to be implemented and represents the total GHG emission difference between the baseline and project scenarios.

Fugitive emissions – GHG emissions that are not captured or escape through the landfill cover. These emissions are based on the collection efficiency of the landfill gas collection systems.

GHG emission timeline – GHG emissions in this Report are assessed over a 45-year timeline from 2030 through 2075. This timeline represents the period of the most significant gas generation associated with the SLF PH2. For consistency and an accurate comparison, this timeline applies to both the baseline and project scenarios.

GHG quantification model – The GHG quantification model is model/calculation spreadsheet developed by GHD and used to calculate GHG emissions from each of the major emission sources identified within the baseline and project scenarios. The GHG quantification model also summarizes the emission reduction potential for each Project Scenario compared to the Baseline Scenario.

Global Warming Potential (GWP)[2] – A value that is applied to specific GHG compounds that represents how much heat the compound traps in the atmosphere (relative to carbon dioxide). The GWP's used in this assessment are based on the International Panel on Climate Change (IPCC) Fifth Assessment Report (AR5), as mandated by the Greenhouse Gas Pollution Pricing Act (S.C. 2018, c.12, s. 186), Schedule 3[3].

Grid emission factor – Represents the GHG carbon intensity of the electricity grid and is reflective of how electricity is generated within each geographical grid (i.e. predominantly through renewable sources, fossil fuel sources, or a mix of both). The units are conveyed in tonnes of carbon dioxide equivalent per megawatt hour (tCO_2e/MWh).

Landfill capacity – Based on the proposed design details of the SLF PH2, the site will accept 1,100,000 tonnes of waste over a period of 20 years (2030 to 2050). This provides direct input for the waste emissions calculated in the LFG tool.

Landfill gas (LFG) – LFG typically contains the following compounds at the following approximate concentrations; methane at 50 percent by volume (% v/v), carbon dioxide at 45% v/v, and balance gases (mainly nitrogen) at 5% v/v. LFG is generated from the decomposition of waste materials and may be captured via landfill gas collection and control systems (GCCS).

LFG model – The LFG model uses the Environment and Climate Change Canada's (ECCC) Landfill Methane Modelling Tool[4] to forecast GHG emissions associated with the production of LFG at a landfill site over the GHG emissions timeline. The LFG model is an accepted model that was developed by ECCC in response to the Landfill Methane Regulations. The LFG model was run by the engineering consultant RWDI and input into this assessment by GHD.

Methane destruction emissions – Methane is the predominant compound in LFG (representing on average 50% v/v). Methane destruction emissions represent the GHG emissions that are displaced through the combustion of LFG. Other predominant compounds in LFG (carbon dioxide and balance gases; mainly nitrogen) do not provide a net GHG emission benefit when combusted, therefore they are not quantified.

Project scenarios – Scenarios quantifying the GHG emissions of the potential LFG management options. The three project scenarios are detailed in Section 3.3.

[1] As noted in the Greenhouse Gas Reporting Program (GHGRP) Guidance, section 4.2.7. Source: **https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/facility-reporting/reporting/technical-guidance.html#4.2.7**

[2] IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp. Resource: **https://archive.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_FINAL_full_wcover.pdf**

[3] The Greenhouse Gas Pollution Pricing Act, Schedule 3. **https://laws-lois.justice.gc.ca/eng/acts/G-11.55/page-24.html#h-247148**

[4] Landfill Methane Regulations. Resource: **https://www.canada.ca/en/environment-climate-change/services/managing-reducing-waste/municipal-solid/waste-greenhouse-gases-canada-actions/landfill-methane-regulations.html**

SCADA – Supervisory control and data acquisition. In this Report it applies to the software system that is used to monitor and control an LFG collection system.

South Landfill Phase 2 (SLF PH2) – Proposed **continuation** of South Landfill.

tCO_2e – Tonnes of carbon dioxide equivalent. Represents the standardized units of GHG emissions used in the GHG industry and as the standardized units across the globe.

Waste – Represents the total solid, non-hazardous waste that is disposed of at the landfills in both the baseline and project scenarios.

3. Quantification methodology

GHD defined baseline and project scenarios to quantify the GHG emissions associated with the current practice of destroying the LFG in an on-site flare at SLF PH2 (baseline scenario) and different potential LFG selling and consuming options (project scenarios). The GHG quantification of the baseline scenario with comparison to each project scenario will demonstrate the GHG emissions, positive or negative, associated with the project.

A focused set of assumptions have been established to ensure that an accurate and representative comparison can be made between the baseline and project scenarios. GHD has taken a conservative approach related to the assumptions and associated quantification of GHG emissions. GHD has utilized emission factors and default values that are believed to be the most conservative and representative of actual and proposed conditions for the baseline and project scenarios, respectively.

3.1 Baseline and project scenarios

The baseline and project scenarios are quantified to provide an estimation of the GHG emissions associated with each scenario. Provided below is a summary of the GHG emission types that are quantified and compared for both the baseline and project scenarios:

1. **Baseline scenario**: Destroy the LFG in an on-site flare.
2. **Project scenario #1**: Produce RNG for injection into the Enbridge natural gas distribution network.
3. **Project scenario #2**: Sell produced LFG to a neighboring industrial facility for use as a fuel source.
4. **Project scenario #3**: Consume the LFG as a fuel for electricity generation onsite.

For each of the scenarios, GHD considered only emissions which fell within the project boundary, which was determined to be from the time of generation (i.e., disposal of waste) through to the end-use of LFG. Only direct emissions from the project site were considered and emissions associated with the consumption of fuel alternatives (i.e., RNG, electricity generation, etc.) were excluded from the assessment.

Figure's 1 through 4 demonstrate the project boundary for each scenario (baseline and project scenarios). Only operations within the project boundary were evaluated as part of this study.

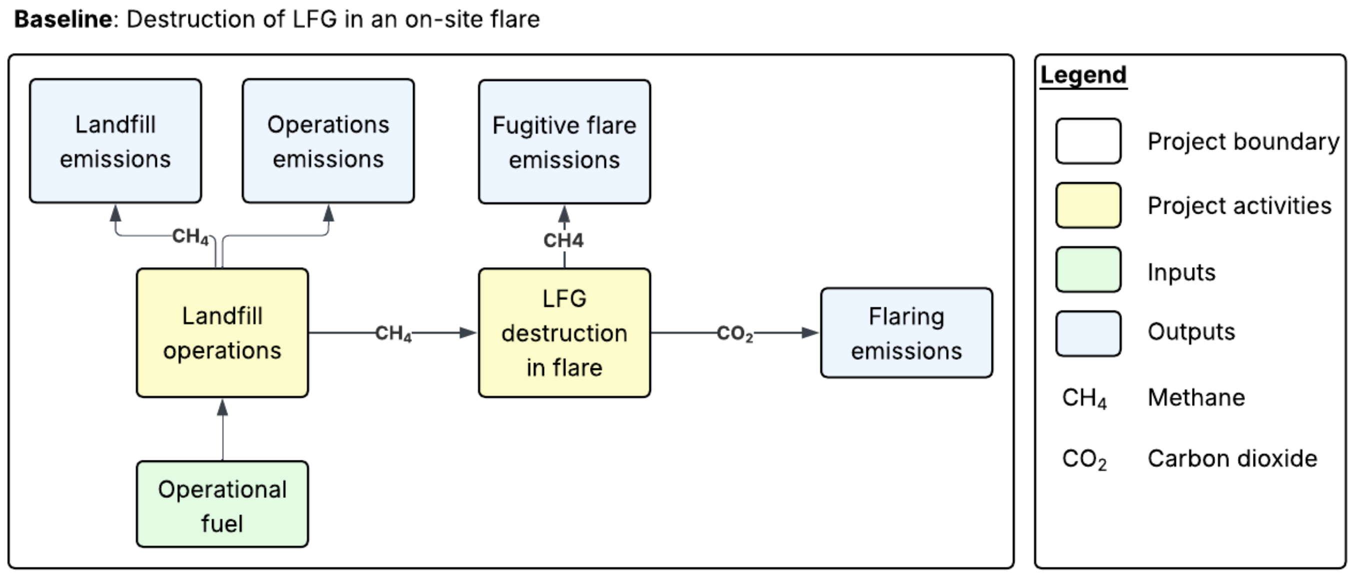

Figure 1 ***Baseline scenario project boundary***

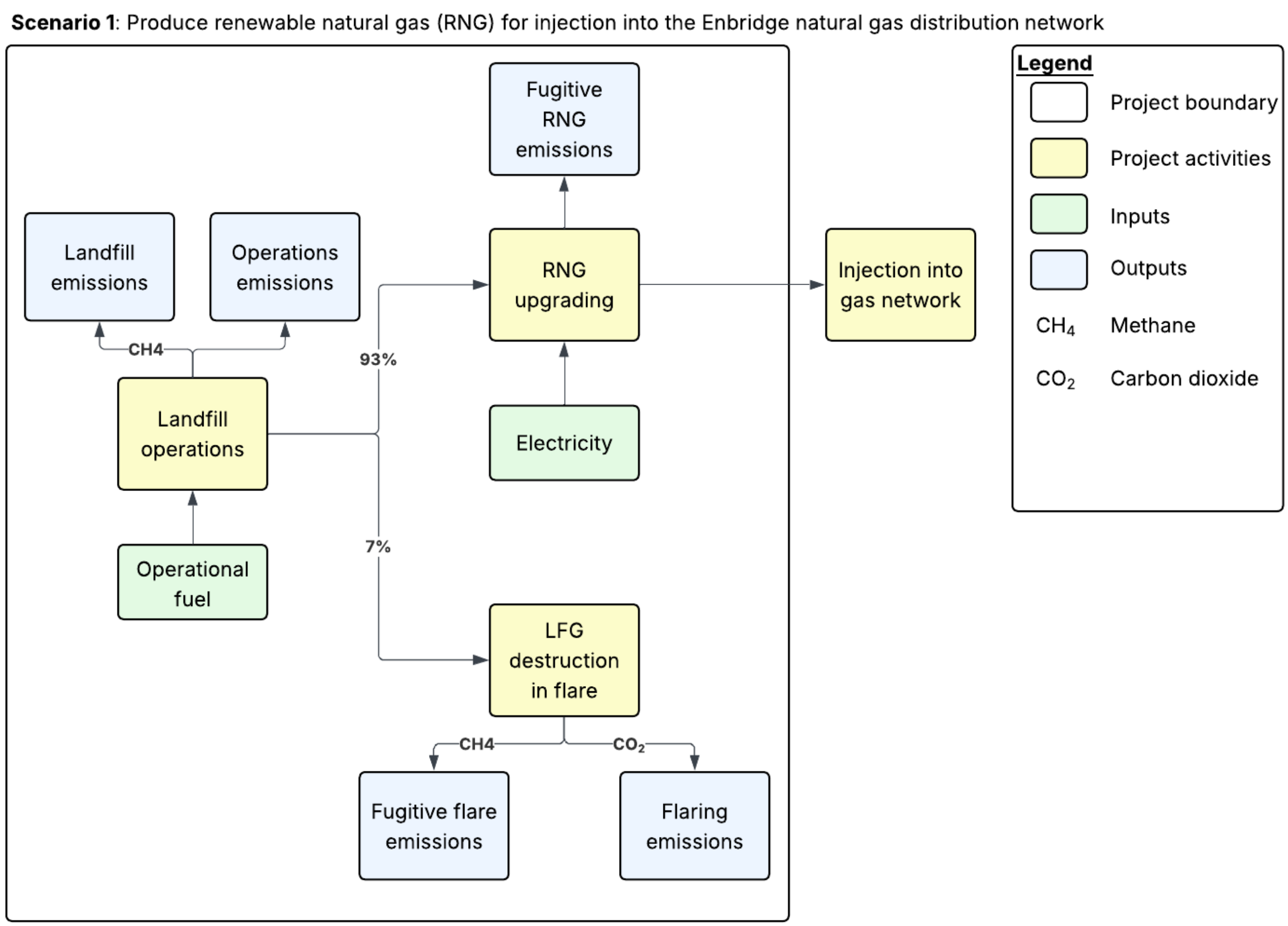

Figure 2 ***Project scenario #1 project boundary***

Scenario 2: Sell produced LFG to a neighbouring industrial facility for use as a fuel source.

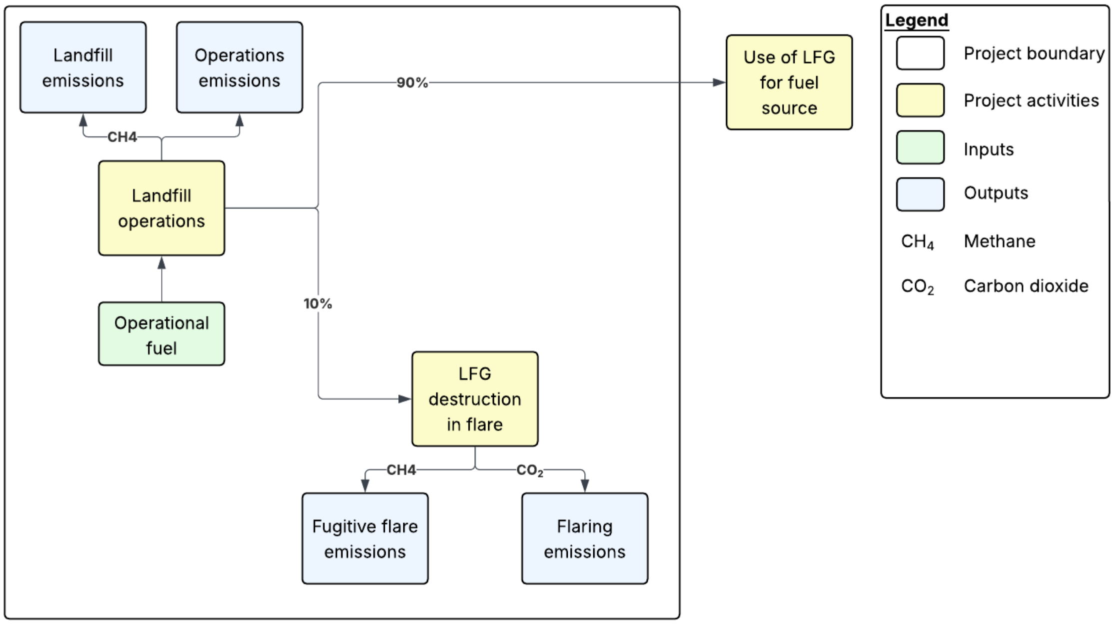

Figure 3 ***Project scenario #2 project boundary***

Scenario 3: Consume LFG as a fuel for electricity generation onsite

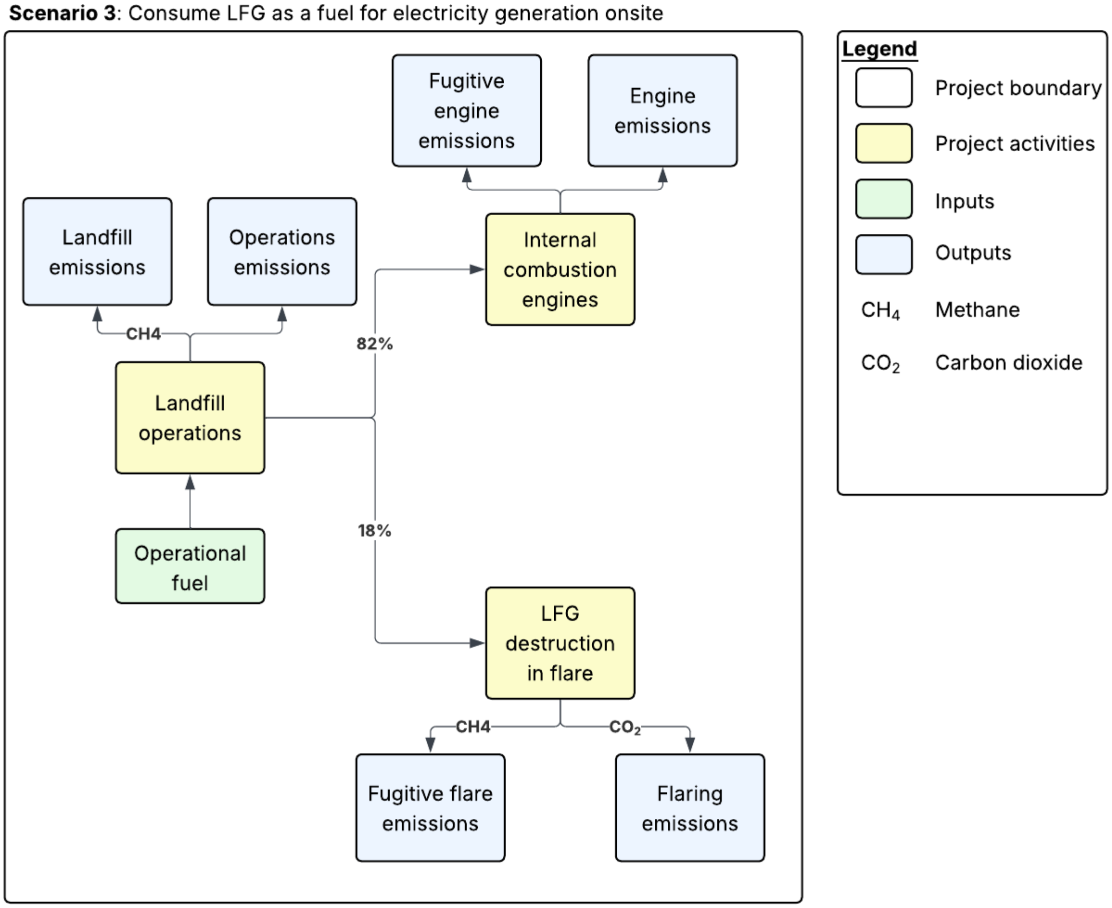

Figure 4 ***Project scenario #3 project boundary***

Across the scenarios, specific GHG emissions were assessed and accounted for. These included:

Scope 1 (direct emissions):

- Stationary combustion: Carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O)
- Methane released from the landfill into the atmosphere: CH_4
- Fugitive emissions from flare, engine, RNG equipment: CH_4
- Facility emissions from routine operations: CO_2, CH_4, N_2O

Scope 2 (indirect emissions):

- Electricity consumption from routine operations: CO_2, CH_4, N_2O
- Additional electricity consumption from additional operations: CO_2, CH_4, N_2O

Beyond the above noted list of GHG emission types, it is assumed that there will be additional types of GHG emissions that will be equivalent or negligible across both the baseline and project scenarios:

- Fuel consumption emissions associated with operating and maintaining flaring systems or alternative processing systems.
- Leachate collection and processing emissions.
- N_2O emissions from the production and collection of LFG.

The magnitude of the above noted emissions are not anticipated to change significantly from the baseline to the project scenarios.

The baseline and project scenarios both involve assumptions and estimates, therefore detailed quantification or assertion of the exact GHG emissions from each scenario cannot be provided, rather a magnitude estimation of GHG emissions for comparison purposes has been provided to accompany the EA.

3.2 Assumptions

Conservative assumptions were established to ensure accurate comparison of the baseline and project scenarios. In addition to being conservative, GHD also ensured that each assumption was representative of the current and forecasted conditions based on the information currently available. Provided below is an overview of the main assumptions which apply to both the baseline and project scenarios. Assumptions that apply to specific scenarios have been listed based on the scenario that they apply to:

- **Annual inflation** – Some emission factors, default values, and GWPs used in the calculations may change over time, however it is impossible to predict what these changes will be. Therefore, it is assumed for comparison purposes that the current values applied for the emission factors and default values will remain constant over the GHG emission timeline.
- **Blower use** – In discussion with Walker personnel, it was noted that due to a difference in the size of the GCCS with SLF PH2, an additional blower would be required for the site. As the specifics of the blower capacity, type, model, etc. are not yet defined it was assumed that the blower would be a 400-horsepower motor and be operational from the time of landfilling (2030) through the end of the GHG emissions timeline (2075). Other assumptions include that the blower would have an overall efficiency rating of 95.8% and would be operational at all hours of the day throughout the entire year.
- **Electricity consumption from site operations** – The landfill site is anticipated to consume electricity at the same rate as was noted in 2025, which corresponds to an approximate GHG emissions rate of 13 tCO_2e/year[5]. This electricity consumption information was collected from Walker's 2025 Sustainability Report and assumes that operations across the site remain the same for existing processes over the lifetime of the study. As the current landfill operations cease, it is anticipated that the SLF PH2 operations will take the same level of effort as current operations. Emissions associated with additional electricity consumption due to the presence of additional operations and/or increased flows have been accounted for separately. Electricity is consumed at landfills for a

[5] Walker provided data for just landfilling operations

variety of operations, including leachate/condensate pumping, blowers for the LFG collection system, SCADA system operation, scales, and for administrative and operations buildings.

- **Emissions from site operations** – The landfill requires various types of equipment to ensure the waste disposed at the site is placed appropriately and compacted. Tippers are used at landfill sites to unload the waste from tippable trailers and heavy-duty compactors and bulldozers are used to place and compact the waste. Additional equipment is also required for the application of daily cover material (i.e. soil) in addition to excavators, rollers, soil compactors, and bulldozers. GHD was provided estimated GHG emissions associated with fossil fuel use across sites (both stationary and mobile) and notes an approximate emissions output of 1,711 tCO_2e/year[5]. For the purposes of this study, it was assumed that the emissions rate would remain the same across the GHG emissions timeline and that operations and processes would not significantly alter. It is assumed the same equipment would be used as is currently in operation at the South Landfill. It has also been assumed that the emissions associated with site operations only apply to the period of time where waste is actively being filled or where there are anticipated closure activities ongoing (2030 – 2048) and therefore have not been calculated after cell closure is complete.
- **Landfill daily cover** – It is assumed that the daily cover for the landfills in the baseline and project scenarios will consist of non-hazardous waste soil material. This material is assumed to not have any significant GHG emissions and is excluded from the evaluation.
- **LFG emissions from current operations –** For the purposes of this assessment, LFG emissions arising from current operations (i.e., current South Landfill filling and capping operations), including any emissions associated with LFG leakage, flare leakage, etc. have been excluded from this assessment. Emissions quantified under this study focus on the emissions arising from operations occurring at site during the SLF PH2 operations only.
- **Waste composition** – It is assumed that the waste composition disposed in the baseline and the project scenarios would be the same. This assumption aids in comparing the landfill waste related emissions from each of the landfill sites in each scenario. It has also been assumed that the waste composition consists of a 70% (by weight) putrescible fraction. This assumption was developed based on a waste composition audit Walker conducted in 2012 of waste received at the South Landfill in Niagara. One of the actions in the MECP's A Made-in-Ontario Environment Plan states "Develop a proposal to ban food waste from landfill and consult with key partners such as municipalities, businesses and the waste industry". However, until any new organics policy is in place, the current waste composition data will be used for the purposes of this Report.
- **Waste tonnage** – It is assumed that the waste tonnage will not change in the baseline and project scenarios. In addition, it is assumed that the waste tonnage will not change from year-to-year through the established 20-year waste disposal timeframe (2030 to 2048).

The stated assumptions allow the Report to be focused on conservative values that are also representative of the current and proposed conditions. In addition, the application of the assumptions for both the baseline and project scenario aid in providing a more accurate comparison. Additional assumptions are defined for the baseline and project scenarios individually.

3.3 Baseline scenario

The baseline scenario consists of the destruction of LFG in an on-site flare. The SLF PH2 is assumed to have an LFG collection system that will only flare LFG through the GHG emission timeline. For accuracy of comparison, GHD only analyzed the amount of waste slated for disposal as part of the SLF PH2 and did not include the emissions from the existing waste-in-place at the site (e.g. South Landfill Phase 1).

Emissions quantified for the baseline scenario include the following:

- Emissions associated with waste degradation and LFG production, not captured by the GCCS.
- Emissions associated with use of an additional blower on-site to move LFG to destruction or use zones.
- Emissions associated with fugitives from the on-site flaring of LFG.
- Emissions associated with electricity consumption from the grid (assumed that an equivalent amount of electricity would be required for the disposal of an equivalent amount of waste at the SLF PH2).

– Emissions from site operations (assumed that an equivalent amount of equipment for site operations would be required for the disposal of an equivalent amount of waste at the SLF PH2).

Biogenic emissions which were calculated but not included in the total emissions output include:

– Emissions associated with on-site flaring of LFG.

3.4 Project scenarios

Three different project scenarios were considered as part of the GHG assessment for the SLF PH2:

1. Produce RNG for injection the Enbridge natural gas distribution network.
2. Sell produced LFG to a neighboring industrial facility for use as a fuel source.
3. Consume the LFG as a fuel for electricity generation onsite (assume internal combustion [IC] engines with heat recovery)

Flaring is included in each of the project scenarios as O. Reg. 232/98 as amended, requires LFG collection at a landfill of this size (e.g. greater than 1.5 million m^3). In addition, the utilization methods for LFG are not always operational and when there is downtime, the alternative method of flaring is used.

Each project scenario represents a potential LFG management/utilization option for the SLF PH2 LFG.

3.4.1 Project scenario #1

In this project scenario, Walker will upgrade the LFG on site to RNG and will sell the RNG to Enbridge for injection into their natural gas distribution network. Emissions quantified for project scenario #1 included the following:

– Emissions associated with converting LFG to RNG, including fugitive emissions.
– Emissions associated with the electricity requirement for converting LFG to RNG.
– Emissions associated with use of an additional blower on-site to move LFG to destruction or use zones.
– Emissions associated with waste degradation and LFG production, not captured by the GCCS.
– Emissions associated with fugitive from the on-site flaring of LFG.
– Emissions associated with electricity consumption from the grid (assumed that an equivalent amount of electricity would be required for the disposal of an equivalent amount of waste at the SLF PH2).
– Emissions from site operations (assumed that an equivalent amount of equipment for site operations would be required for the disposal of an equivalent amount of waste at the SLF PH2).

Biogenic emissions which were calculated but not included in the total emissions output include:

– Emissions associated with on-site flaring of LFG.

As an additional consideration, the GHG model has also estimated the avoided emissions associated with use of RNG downstream. These emissions are a supplementary consideration and are not removed from the GHG emissions balance as end-use of this fuel is unknown at the time of this study, however for a full understanding of the GHG emissions impact, can be considered.

3.4.2 Project scenario #2

In this scenario, Walker will sell their produced LFG to a neighbouring industrial facility that they may use it as a fuel source. Emissions quantified for project scenario #2 include the following:

– Emissions associated with waste degradation and LFG production, not captured by the GCCS.
– Emissions associated with use of an additional blower on-site to move LFG to destruction or use zones.
– Emissions associated with fugitive from the on-site flaring of LFG.

– Emissions associated with electricity consumption from the grid (assumed that an equivalent amount of electricity would be required for the disposal of an equivalent amount of waste at the SLF PH2).
– Emissions from site operations (assumed that an equivalent amount of equipment for site operations would be required for the disposal of an equivalent amount of waste at the SLF PH2).

Biogenic emissions which were calculated but not included in the total emissions output include:

– Emissions associated with on-site flaring of LFG.

As an additional consideration, the GHG model has also estimated the downstream emissions associated with the combustion of LFG in IC engines at the industrial facility. These emissions are a supplementary consideration and are not included in the GHG emissions balance as they fall outside of the operational boundary of Walker's facilities, however for a full understanding of the GHG emissions impact, can be considered.

3.4.3 Project scenario #3

In this project scenario, Walker will consume the produced LFG as a fuel source for electricity generation at site, assuming IC engines with heat recovery. Emissions to be quantified for project scenario #3 include the following:

– Emissions associated with waste degradation and LFG production, not captured by the GCCS.
– Emissions associated with use of an additional blower on-site to move LFG to destruction or use zones.
– Emissions associated with fugitives from the on-site flaring of LFG.
– Emissions associated with fugitives from the engine destruction of LFG.
– Emissions associated with electricity consumption from the grid (assumed that an equivalent amount of electricity would be required for the disposal of an equivalent amount of waste at the SLF PH2).
– Emissions from site operations (assumed that an equivalent amount of equipment for site operations would be required for the disposal of an equivalent amount of waste at the SLF PH2).

Biogenic emissions which were calculated but not included in the total emissions output include:

– Emissions associated with on-site flaring of LFG.
– Emissions associated with the engine destruction of LFG.

Based on GHD's understanding and in review with Walker, it is assumed that there are no other significant emissions sources that exist in either the baseline or project scenarios that have not been included in the GHG assessment for the purposes of this Report. Therefore, the focus of the GHG assessment remains on the major emissions sources previously noted and the associated quantification methodologies that are available for each.

3.5 Quantification approach

There are many different methods available for quantifying GHG emissions from each of the major emissions sources identified. GHD has taken a conservative approach to quantifying GHG emissions and has utilized emission factors, default values, and GWPs that are believed to be the most representative of actual and proposed conditions for the baseline and project scenarios, respectively.

GHD utilized a significant portion of publicly available data for the quantification of GHG emissions. Reputable publicly available sources were selected based on jurisdictional relevance (i.e. the NIR and MECP Guideline for Quantification, Reporting and Verification of Greenhouse Gas Emissions for Ontario emission factors and defaults). GHD also assessed available data from the following sources:

– Walker was used as a resource for first-hand information (e.g. site operations equipment details, and landfill electricity consumption).
– Ontario-specific emission factors and parameters were applied where appropriate.
– Estimated values from online sources were also used (e.g. fuel efficiencies of landfill equipment).

– Where data or information was unavailable, conservative assumptions or estimates based on surrogate parameters were used.

Where publicly available sources outlined a range of emission factors or defaults, GHD assessed the data as follows:

1. Overall appropriateness of the value based on site-specific conditions and assumptions.
2. Level of conservativeness.

Notably, the accuracy of the use of publicly available and well-referenced data improves the accuracy and certainty in the emissions calculations. Conservative assumptions and approaches were used where required. Further details regarding each of values applied and the associated references are provided in Attachment 1.

GHD used the available data to develop a GHG quantification model. The GHG quantification model was used to calculate emissions from each of the major emission sources identified within each of the scenarios detailed in Sections 3.2 and 3.3. The GHG quantification model also summarizes the emission reduction potential for each project scenario compared to the baseline scenario.

Global Warming Potentials (GWPs) for each GHG type were applied to quantify total GHG emissions in tCO_2e.

The quantification was completed in accordance with the ISO 14064-2 standard: *Specification with guidance at the project level for quantification, monitoring, and reporting of greenhouse gas emission reductions or removal enhancements*.

3.5.1 Landfill gas generation quantification

The LFG tool uses the ECCC Landfill Methane Modelling Tool to forecast GHG emissions associated with the production of LFG at a landfill site. The LFG tool therefore provides an accurate representation of the methane generated in the baseline scenario and project scenarios.

RWDI provided GHD with the completed ECCC Landfill Methane Modelling Tool. Using this information, GHD input the values of projected LFG production and methane emissions annually over the GHG emission timeline into the GHG quantification model. RWDI performed four modelling scenarios, once for each stage associated with the SLF PH2. Per RWDI modeling, the four stages of operation were assumed to be as follows:

– Stage 1: Waste placement starting in 2030, assuming a four-year waste acceptance period and two years of capping activities post stage closure.
– Stage 2: Waste placement starting in 2034, assuming a four-year waste acceptance period and two years of capping activities post stage closure.
– Stage 3: Waste placement starting in 2038, assuming a four-year waste acceptance period and two years of capping activities post stage closure.
– Stage 4: Waste placement starting in 2042, assuming a four-year waste acceptance period and two years of capping activities post stage closure.

It is noted that the same model and stages of operation as listed here were used within the Air Quality DIA.

For the LFG model, RWDI has assumed a consistent waste acceptance rate for all stages of 858,000 tonnes per year, assuming 70% putrescible waste. The LFG tool produces the following output parameters that are used as inputs in the subsequent GHG quantification model:

– Total waste in place (tonnes).
– Methane generation (no diversion) as tonnes/year.
– Methane generation (no diversion) as m^3 methane/year.
– Methane generation (no diversion) as scfm methane/year.

The parameters collected from the LFG tool were summed across each of the stages to give a total methane generation rate for the entire project at stated waste acceptance rates. Parameters set in the LFG tool which were used to complete the calculations for LFG production at the site have been provided in Table 1.

Table 1 Assessment parameters used in the LFG tool

Parameter	Value	Unit	Applicable scenario	Source
Methane correction factor (MCF)	1	N/A	All	ECCC Landfill Methane Modelling Tool
Methane content in landfill gas (% CH4)	50%	Percentage		
Molar ratio of CH4:C	1.33	mol CH_4/mol C		
Methane density (@25 C and 1 atm)	0.656	kg/m^3		
Annual precipitation	967	mm		
Decay rate (k)	Weighted average	N/A		
Waste composition	Default	N/A		

3.5.2 GHG quantification model

The LFG tool provided the annual methane production volumes for the SLF PH2, which GHD then input into the GHG quantification model. These results were then used to quantify the GHG emission sources that were dependent on the results of the LFG tool (e.g., methane destruction emissions, fugitive emissions and emissions associated with LFG utilization).

3.5.3 Biogenic emissions

Biogenic emissions are defined as GHG emissions and volatile organic compounds (VOCs) which are released into the atmosphere from biological sources and natural processes, rather than from human activities like burning fossil fuels. Per the GHG Protocol, biogenic emissions are to be accounted for separately from direct sources of emissions which are generated through the combustion of fossil fuels. Further, under the federal Greenhouse Gas Reporting Program (GHGRP) and ECCC Technical guidance, emissions "CO_2 emissions from the combustion of biomass fuels [must be reported] under Biomass Combustion Emissions, and these should not be included in the emission totals for the facility. Any CH_4 and N_2O emissions should be reported… under Waste or Wastewater Emissions in the case of waste incineration and landfill/anaerobic digester gas flaring processes, and these emissions must be included in the facility totals." [6].

Landfill sites generate mass amounts of biogenic emissions from the decomposition of natural materials (food wastes, wood products, etc.) which is what makes up LFG. Under O. Reg. 232/98, landfill sites are required to install and maintain GCCS systems which collect and direct LFG to processing facilities (i.e., flare or other LFG utilization equipment). While these systems are effective, they are not absolute, and collection efficiency is typically estimated (as noted in Section 3.5.4) as about 85%. Destruction of methane collected from GCCS systems occurs through activities such as flaring or IC engine combustion. In these scenarios, the collected methane is considered to be converted to carbon dioxide and is therefore attributed as a biogenic emission source. Per the GHGRP Guidelines, biogenic emissions are to be calculated and disclosed but not included in the emissions total.

Therefore, emissions from the destruction of methane in flares and engines are considered biogenic and have been quantified, but not included in emissions totals.

3.5.4 Landfill gas collection system efficiency and methane release emissions

The SLF PH2 is planned to be filled in four stages, each containing five cells to be filled over a period of approximately one year before intermediate cover is applied. The final cap is generally applied to each stage as it is completed,

[6] Government of Canada. Reporting greenhouse gas emisisons data: technical guidance. Section 4.2.7. Source: **https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/facility-reporting/reporting/technical-guidance.html#4.2.7**

approximately every five (5) years. SLF PH2 LFG collection system (or GCCS) will consist of both horizontal and vertical collection wells, allowing LFG collection to begin within two-to-three years of operation of the site. As a result, the collection efficiency at the SLF PH2 is anticipated to be 85%, which is also consistent with LFG collection efficiencies which are used for reporting purposes at Walker's similarly designed and operated South Landfill.

The collection rate is denoted as the annual LFG or methane that is not collected by the GCCS system and is lost to the atmosphere. This is methane released directly and is included in reporting totals.

3.5.5 Appliance and utilization destruction efficiencies

Destruction devices are used to combust LFG from the LFG collection systems, however, the destruction devices are not capable of destroying LFG at 100% efficiency. Therefore, the destruction efficiencies applied in the GHG quantification model for each scenario are provided in Table 2.

Table 2 Destruction device efficiencies[7]

Applicable scenario	Eligible destruction device	Efficiency (fraction)	Source
Baseline scenario	Flare	0.9806	Walker 2024 NPRI reporting
Project scenario #1	Flare	0.9806	
Project scenario #2	Flare	0.9806	
Project scenario #3	Flare IC Engine	Flare – 0.9806 IC Engine – 0.9720%	

The destruction efficiencies presented in Table 2 are representative of each of the LFG utilization devices in each scenario. The destruction efficiency values themselves represent the degree of combustion through each device (i.e. a value of 1.000 would represent complete combustion or 100% efficiency).

3.5.6 Uptime

3.5.6.1 Flare

The flare uptime represents the percentage of the year that the flare is anticipated to operate (i.e. 100% represents 24 hours a day for 365 days). This percentage is intended to encompass flare downtime that may occur through each year related to but not limited to maintenance, high oxygen concentrations, low methane concentrations, testing, and operational alarms. Flares are typically designed to operate under a broad range of conditions when compared to utilization engines or other stationary combustion devices, therefore assuming a relatively high flare uptime is common. In discussion with Walker personnel, it was determined that there are very few days where no LFG processing is occurring as they employ multiple flares across their sites and if one is down for maintenance, the LFG is directed to another. Therefore, a conservative flare uptime of 99.5% was assumed, which represents the highest range of annual uptime. Table 3 presents the uptime associated with each scenario and LFG utilization device.

3.5.6.2 Other equipment

Similar to the flare uptime, the utilization uptime represents the percentage of the year that the utilization device is anticipated to operate (i.e. 100% represents 24 hours a day for 365 days). For all scenarios using LFG utilization devices, uptimes were estimated and applied based on Walker's experience as a landfill owner/operator and Canada's largest landfill gas utilization project developer. GHD has assumed that during downtime periods with LFG utilization devices that the flare will be used. Table 3 presents the uptime associated with each scenario and LFG utilization device.

[7] US EPA AP-42 Compilation of Air Pollutant Emission Factors, Chapter 2.4 Municipal Solid Waste Landfills. Final Nov. 1998 and Draft Oct. 2008, and Landfill Methane Outreach Program (LMOP) LandGEM V302, May 2005.

Table 3 Uptime assumptions per scenario

Scenario	Flare	RNG generation facility	Piping	IC engines	Total
Baseline scenario	99.5%	0%	0%	0%	100%
Project scenario #1	7%	93%	0%	0%	100%
Project scenario #2	10%	0%	90%	0%	100%
Project scenario #3	18%	0%	0%	82%	100%

For RNG generation facility (applicable to project scenario #1), the average uptime of the facility is 93%. It is noted by Walker through discussions that while the uptime of the facility is relatively high, the processing of LFG to RNG is less efficient that could be in it's current form (note upgrades to the facility are being undertaken in 2026 to improve this), with approximately 30%-35% of LFG intended for RNG being redirected to the flare or regenerative thermal oxidizer. In the GHG quantification model, this is accounted for as additional LFG being sent to the flare in addition to the scheduled uptime.

3.5.7 Fugitive emissions

Fugitive emissions are described as emissions which are released directly to the atmosphere from various points along the production lifecycle. In the case of landfill emissions, they are considered as leakage points where LFG being sent for alternative processing or flaring is being missed, primarily due to equipment destruction efficiencies (where less than 100% of the LFG can be processed) or losses in the system.

Further, fugitive emissions were applied based on equipment uptime. For example, in scenario #1 the flare is anticipated to have a destruction efficiency of 0.9806, which leads to an assumed fugitive emissions rate of 0.0194. This fugitive emissions rate is only applied to the proportion of LFG which is being sent to the flare, which as noted in Table 3, is 7% of the time.

Across the baseline and project scenarios, fugitive emissions are assumed at the rates as noted in Table 5.

Table 4 Fugitive emission rates per scenario

Scenario	Equipment	Destruction efficiency	Fugitive emission rate	Source/note
Baseline scenario	Flare	0.9806	0.0194	Destruction efficiency provided by Walker.
Project scenario #1	Flare	0.9806	0.0194	Destruction efficiency provided by Walker.
	RNG equipment	0.90	0.10	Provided by Walker based on RNG fugitive data.
Project scenario #2	Flare	0.9806	0.0194	Destruction efficiency provided by Walker.
	Piping	N/A	N/A	Assumed no losses from system
Project scenario #3	Flare	0.9806	0.0194	Destruction efficiency provided by Walker.
	IC engine	0.9702	0.0298	Destruction efficiency provided by Walker.

3.5.8 Emissions from site operations (scope 1)

As stated in Section 3.2, there is a governing assumption related to the emissions from site operations. It has been established that the emissions from site operations are generally equivalent between the baseline and project scenarios. Therefore, GHD has assumed an annual emissions output of 1,711 tCO_2e/year as provided by Walker. These emissions have been denoted as scope 1 emissions in the GHG quantification model.

Note that emissions are anticipated only as they relate to the years of waste filling operations (i.e., during active acceptance of waste and capping activities) and emissions for years outside of the active filling and capping were considered negligible.

GHG emissions from site operations associated with on-site fuel use can vary depending on the technology used, types of operations, types of vehicles, types of construction equipment etc. However, the magnitude of emissions associated with site operations are often very similar. When emissions from site operations are calculated during actual operations, there is generally a low level of uncertainty as the emissions are based on total quantities of fossil fuels (e.g. gasoline or diesel) combusted. The equations used to calculate the emissions are also straight forward, as they are based on total fuel consumption and a reference emission factor for that specific fossil fuel type. Accuracy of the GHG emissions estimates can be improved through tracking and measurement of site-specific data (i.e. fuel use for each individual piece of equipment), if applicable, or estimates based on operations at similar facilities. Tracking of energy use through third-party meters or invoicing provides the highest level of verifiable, and reliable data (such as natural gas and electricity invoices).

3.5.9 Emissions from electricity consumption (scope 2)

Electricity usage (i.e. total MWh) is assumed to be equivalent in both the baseline and project scenarios. As noted in Section 3.2, it is assumed that the site will continue to operate as normal over the lifetime of the SLF PH2, with the same electricity consumption from the start of operations through the end of operations. As such, GHD has utilized the 2025 electricity emissions as provided by Walker staff for the landfill emissions. Therefore, GHD has assumed an annual emissions output of 1,743 tCO_2e/year for all years across the GHG emissions timeline. These emissions have been denoted as scope 2 emissions in the GHG quantification model.

Additional emissions were assumed to be required to support the addition of another blower on-site for the SLF PH2 GCCS. This blower was assumed to be a 400 horsepower engine with a 95.8% efficiency rating. Further, it was assumed that the blower would run at all periods of the day throughout the GHG emissions timeline.

GHD assumed that emission factors related to the grid electricity will remain constant over the GHG emission timeline of the SLF PH2. Grid emission factors in Ontario will change over time, however, it is very difficult to accurately forecast this reduction over the 50-year GHG emission timeline of the assessment and emissions are assumed to remain stagnant.

3.5.10 Emissions from electricity consumption for LFG upgrading to RNG

LFG processing consists of upgrading the LFG to produce RNG that could be sold and injected into Enbridge's natural gas distribution network. Processing of the LFG occurs in a closed system and consists of concentrating LFG gas through a multi-stage process that removes contaminants including CO_2, sulphurs, oxygen, nitrogen concentrations to achieve a RNG gas quality that meets or exceeds Enbridge's gas quality specifications.

The main emissions generated from the processing of LFG into RNG are applicable to the consumption of electricity during the processing. GHD used the output flow of LFG (m^3 CH_4/year) from the LFG tool in combination with assumed operating parameters, to determine the volume of LFG that would be supplied to the RNG facility. Walker provided an expected production intensity value of 37.82 kWh/GJ which was converted using standard conversions to kWh/m^3 CH_4. This value (2.099 kWh/m^3 CH_4) was then used to assess the total electricity required annually to process LFG.

Grid factors used to calculate the expected emissions from the GHD then applied the grid emission factor for Ontario from Table 5 to calculate emissions from electricity consumption for LFG processing.

Table 5 Grid electricity emission factors

Emission Factor	Reference	Reference Value	Units
Ontario Grid electricity emission factor	Environment Canada NIR	59	g CO_2e/kWh consumed

3.5.11 Avoided or downstream emissions

Avoided or downstream emissions are emissions which are outside of the project boundary and are not the direct responsibility of the site. These represent emissions which are the result of activities occurring on site but which are not carried out or in the control of the site operators.

For example, in project scenario #2, emissions occur downstream at the GM facility when LFG is processed as a fuel source, however these emissions occur outside of the Walker facility and are not attributable to Walker's GHG emissions inventory as a scope 1 (or direct emission) source. Per the GHG Protocol guidance, GHG emissions impacts are to be assessed for scope 1 or scope 2 emissions only. Therefore, emissions associated with the combustion of LFG as a fuel source may be estimated as downstream emissions.

Consideration has been given in the GHG quantification model to these emissions as they are important to understand the overall impact of scenarios. Specifically, it is critical to view the entire life-cycle of emissions rather than just what is happening at the Walker site, as emissions don't disappear from operation but rather are shifted from one party to another. In practice, avoided emissions can be removed from the GHG impact while downstream emissions would be added to the GHG impact.

3.5.11.1 Emissions from displacing fossil fuels

For project scenario #1, GHD used the LFG tool output of LFG recovery (m^3/year) in combination with assumed operating parameters; methane composition, and methane energy content to determine the amount of energy in giga joules (GJ) that would be generated by the RNG upgrading equipment.

GHD assumed this energy directly displaces the energy consumed elsewhere through Enbridge's pipeline as RNG. Walker provided GHD with their RNG carbon intensity of 16.43 gCO2e/GJ energy produced. To quantify the avoided emissions, GHD assumed a natural gas carbon intensity of 67 gCO2e/GJ[9]. For the purposes of this study, the carbon intensity was assumed to encompass the generation, transportation and combustion emissions. The difference in emissions from the RNG produced was used to quantify the total displacement of fossil fuels.

3.5.11.2 Emissions from combustion of LFG off-site

Project scenario #2 assumes that a proportion of LFG produced is sent to GM for use as a fuel in combustion. As these emissions occur outside of the boundary of the Walker site, they were not considered as part of the core generation of emissions. However, as previously stated there are emissions associated with the combustion of LFG for fuel. To quantify these emissions, GHD assumed that GM utilizes IC engines with the same uptime and destruction efficiency as the engines operated by Walker.

3.5.11.3 Emissions from displacing grid electricity with renewable electricity

Renewable electricity generation associated with LFG utilization varies depending on the LFG utilization engines and conversion efficiency located at the site along with the collection efficiency of the associated LFG collection systems.

GHD quantified emissions from displacing grid electricity with renewable electricity using the LFG recovery rate in standard cubic feet per minute (scfm) calculated by the LFG tool. The average electricity production rate (scfm/MW) was assumed to be based on an IC engine with heat recovery. The IC engine assumed for installation was the Gas

[9] ECCC, Fuel LCA Model Methodology, Appendix B, Milestone 3: Methodology for Low Carbon Fuel Pathways and Default Carbon Intensities, 8.1 RNG from Landfill Gas (LFG), Table 69

Generator Set G3520C by CAT[11] for project scenario #3. In addition, multiple other values were applied to quantify the emissions including; engine run-time assumptions and electricity grid emissions factors.

The electricity emission factors used for electricity consumption (Table 5) were used for the quantification of emissions displaced from renewable electricity generation.

4. Quantification results and discussion

Using the quantification methodology as outlined in Sections 3, GHD has estimated the relevant GHG emissions associated with each scenario. The emissions have been broken down into emission categories, which are representative of the type of emission source. Categories have been noted as follows:

- Fugitive emissions – Represent emissions arising from process leakage or losses (see Section 0)
- Landfill emissions – Represent the biogenic emissions (see Section 3.5.3)
- LFG use emissions – Represent emissions arising from destruction or LFG use equipment which produces it's own GHG emissions with operation (see Section 3.5.5)
- Site operations – Represents emissions related to typical site operation and additional fuel requirements as necessary (see Sections 3.5.8, 3.5.9, and 3.5.10)
- Avoided or downstream emissions – Represent emissions that are the result of off-site activities. Avoided emissions represent emissions which would be removed from the emissions totals, downstream emissions represent emissions which would be added to the emissions totals (see Section 3.5.11).

Table 6 below outlines the estimated GHG emissions for each scenario by emission source. Emission totals are presented for the GHG emission timeline of the SLF PH2 (2030-2075).

Table 6 Comparison of GHG emissions output by scenario (tCO_2e)

Emission category	Baseline scenario	Project scenario #1	Project scenario #2	Project scenario #3
Fugitive emissions	**282,333**	**116,753**	**28,233**	**384,962**
– Flaring	282,333	28,779	28,233	50,820
– RNG	N/A	87,974	N/A	N/A
– IC engine	N/A	N/A	N/A	334,142
Methane released from landfill	**2,568,217**	**2,568,217**	**2,568,217**	**2,568,217**
Site operations	**38,841**	**98,156**	**38,841**	**38,841**
– Scope 1 site operations	30,798	30,798	30,798	30,798
– Scope 2 site operations	598	598	598	598
– Blower energy	7,445	7,445	7,445	7,445
– RNG (electricity)	N/A	59,314	N/A	N/A
Total emissions	**2,889,391**	**2,783,126**	**2,635,292**	**2,992,020**
Avoided or downstream emissions				
– Avoided emissions	N/A	-837,736	N/A	-2,878

[11] **https://www.cat.com/en_US/products/new/power-systems/electric-power/gas-generator-sets/18483554.html**

Emission category	Baseline scenario	Project scenario #1	Project scenario #2	Project scenario #3
– Downstream emissions (fugitive from IC engine use)	N/A	N/A	336,741	N/A
Biogenic emissions				
– Downstream (IC engine use)	N/A	N/A	1,247,338	N/A
– Destruction emissions	1,391,202	552,985	139,819	1,388,138
• Flare	1,391,202	552,985	139,819	251,675
• Engine	N/A	N/A	N/A	1,136,463

The emissions in each category can be presented as either positive or negative based on whether or not the emission category is resulting in the release of emissions to the atmosphere (e.g., combustion of diesel fuel for transportation would be positive), or the emission category is mitigating/reducing emissions that would have otherwise been emitted (e.g., mitigating the direct release of LFG to the atmosphere through combustion would be negative). Provided below is a summary of each of the emission categories and justification for whether or not the emissions are presented as positive or negative. Note that positive values are added to the total emissions balance, while negative are removed from the emissions balance.

- Fugitive emissions (positive)
  - Emissions from process leakage (i.e., due to destruction efficiency) or system losses (i.e., leakage in the system). These emissions are considered to be positive, meaning they contribute to increased emissions under the emissions balance.
- Methane released from landfill (positive)
  - Emissions from the landfill which are captured by the GCCS system. These are considered positive as they contribute to increased emissions under the emissions balance.
- Emissions from site operations (positive) (scope 1)
  - The emissions from site operations are attributed to the combustion of fossil fuels or use of electricity which utilizes fossil fuels for its generation, therefore these emissions represent a positive value in the baseline and project scenarios.
- Emissions from electricity consumption (including LFG processing) (positive) (scope 2)
  - Electricity consumption from the grid is carbon intensive based on the grid emission factor that is applied for the jurisdiction, therefore these emissions represent a positive value in the baseline and project scenarios.
- Avoided emissions (negative)
  - The combustion of LFG to generate renewable electricity displaces grid electricity that would have normally been generated through the use of fossil fuels or other carbon intensive practices (based on the grid emission factors). Therefore, these emissions represent a negative value (or removal) in the applicable project scenarios.
  - The upgrading of LFG to RNG displaces natural gas downstream that would have been used by a consumer. Therefore, these emissions represent a negative value (or removal) in the applicable project scenarios.
- Downstream emissions – fugitive only (positive)
  - A net positive contribution to the GHG emissions balance arising from the use of LFG downstream in combustion processes (e.g., use in IC engines and fugitive emissions from this process). Estimated based on standard assumptions. Represent a net increase in GHG emissions.

Emissions which are not included in the net quantification as they represent biogenic emissions include:

– Downstream emissions – destruction emissions
– Destruction emissions – flare and IC engine use

Based on the above, we can add together the positive and negative categories of each scenario to obtain a holistic picture of the GHG emissions impact that each scenario will have. Table 7 provides the summary of the net GHG emissions for each scenario

Table 7 Net GHG emissions comparison

Emission category	Baseline scenario	Project scenario #1	Project scenario #2	Project scenario #3
Total emissions (not including avoided/downstream)	2,889,391	2,783,126	2,635,292	2,992,020
Net GHG emissions	2,889,391	1,945,390	3,002,033	2,989,142

Net emissions output for LFG utilization at the Walker site for SLF PH2 ranges from a maximum of 3,002,033 tCO_2e (project scenario #2) to a minimum of 1,945,390 tCO_2e (project scenario #1). The variation in range is a result of two primary factors:

1. Differences in the destruction efficiencies associated with equipment used within the scenario.
2. Impacts from avoided emissions, reducing net emissions outlook

Through a utilization of LFG on site for alternative purposes, GHG emissions may be variable. This variability does not recommend one utilization method over the other and use of LFG in any capacity is overall beneficial.

5. Closing

This Report provides an evaluation of the GHG emission impacts that the proposed SLF PH2 will have depending on LFG utilization. The GHG emission estimates in this Report are based on modelled LFG generation from the SLF PH2.

This Report accompanies the EA for the SWLF that also includes an Air Quality Assessment completed by RWDI. GHD has completed this Report independent of the Air Quality Assessment. The Air Quality Assessment provides a more pointed understanding of the air quality emissions from the SLF PH2 that pertain to specific compounds generated from the degradation of waste within the SLF Ph2 (e.g. NMOCs, VOCs, ethane, octane, etc.) along with the core components of LFG (i.e. methane and carbon dioxide).

However, the GHG emission estimates contained in this Report and the results of the Air Quality Assessment are both based on a similar foundation that consists of modelling the anticipated LFG generation from the SLF PH2 over the GHG emission timeline. GHD used the results of the ECCC Landfill Methane Modelling Tool as run by RWDI to inform the GHG quantification model. As such, GHD has determined that the GHG emissions forecasted within this letter report are consistent with the associated LFG generation estimates provided in the Air Quality Assessment. As a result, the GHG emission estimates provided in this Report provide an accurate representation of the proposed conditions at the SLF PH2 based on the information available at the date of issuance.

Please do not hesitate to contact GHD if you have questions or require any additional information.

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