# Federal Offset Protocol: Landfill Methane Recovery and Destruction

**Version 1.1**
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Canada's Greenhouse Gas Offset Credit System

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Canada

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# Foreword

Canada's Greenhouse Gas (GHG) Offset Credit System is established under Part 2 of the *Greenhouse Gas Pollution Pricing Act* (GGPPA) to provide an incentive to undertake projects that result in domestic GHG reductions that would not have been generated in the absence of the project, that go beyond legal requirements and that are not subject to carbon pollution pricing mechanisms.

Canada's GHG Offset Credit System consists of:

- The *Canadian Greenhouse Gas Offset Credit System Regulations* (the Regulations), which establish the system, implement operational aspects and set general requirements applicable to all project types;
- Federal offset protocols, included in the *Compendium of Federal Offset Protocols* (the Compendium), each containing requirements for project implementation and methods for quantifying GHG reductions for a given project type; and
- The Credit and Tracking System (CATS) to register offset projects, issue and track offset credits, and share key information through a public registry.

Only projects following a federal offset protocol included in the Compendium and meeting all requirements outlined in the Regulations can generate offset credits under the Regulations.

# Document revision history

| Version number | Publication date | Summary of changes |
|---|---|---|
| 1.1 | February 24, 2023 | The approach for the destruction efficiency values for destruction devices was modified regarding the use of either default values or device-specific values (Section 8.2).<br>Eligibility is no longer restricted to landfills designed and constructed by landfill cells but is now inclusive of landfills not designed and constructed by landfill cells (Section 4.1).<br>Some provisions in the protocol were clarified or streamlined without changing the scope and intent. |
| 1.0 | June 8, 2022 | Initial version of the protocol. |

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# 1.0 Introduction

Methane ($CH_4$) emissions from landfills are generated by the anaerobic decomposition of organic material in the buried waste. The installation of a landfill gas (LFG) recovery and destruction system enables the landfill $CH_4$ to be converted into biogenic carbon dioxide ($CO_2$), instead of allowing it to be passively released to the atmosphere.

The *Landfill Methane Recovery and Destruction* protocol is intended for use by a proponent undertaking a project to actively recover and destroy LFG to generate offset credits under the *Canadian Greenhouse Gas Offset Credit System Regulations* (the Regulations). The requirements contained in this protocol are part of the Regulations and must be read in conjunction with provisions in the Regulations.

The proponent must follow the methodology and requirements set out in this protocol, including those to quantify and report greenhouse gas (GHG) emission reductions generated by eligible project activities. This protocol is designed to ensure a project generates GHG emission reductions that are real, additional, quantified, verified, unique and permanent. The protocol is also developed in accordance with the principles of ISO 14064-2:2019 *Greenhouse gases – Part 2 – Specification with guidance at the project level for quantification, monitoring and reporting greenhouse gas emission reductions or removal enhancements* to ensure reported GHG emission reductions generated as a result of implementing a project are relevant, complete, consistent, accurate, transparent, and conservative.

GHG emission reductions generated by a project under this protocol can only result from avoided $CH_4$ emissions achieved through the active recovery of LFG from within the project site and its destruction in an eligible destruction device, which can include open and enclosed flares, boilers, turbines, internal combustion engines, stations for the direct injection of upgraded LFG into a natural gas network, or stations for the compression or liquefaction of upgraded LFG prior to its transport and injection into a natural gas network.

Projects that use the recovered LFG to generate energy or heat may reduce their GHG emissions from fossil fuel combustion. While this activity is encouraged, GHG emission reductions from fossil fuel displacement (i.e. fuel switching) are not additional, as the emission sources are subject to carbon pollution pricing, therefore, they are not included in the quantification of GHG emission reductions under this protocol. Proponents may be able to generate credits for this activity under other crediting mechanisms, such as the *Clean Fuel Regulations*. However, proponents are responsible for ensuring that any GHG emission reductions credited under Canada’s GHG Offset Credit System are unique, that is, they are not credited under another offset program or another GHG reduction mechanism.

# 2.0 Terms and definitions

***Act***

means the *Greenhouse Gas Pollution Pricing Act* *(GGPPA).*

***Active recovery***

means the recovery of LFG by a system, which includes gas collection wells, connective piping, blowers, and other technologies, creating a pressure gradient to actively extract LFG. This does not include passive venting.

***Adjacent facility***

means a facility adjacent to the landfill site where landfill $CH_4$ is destroyed in an eligible destruction device owned by an end user or the proponent.

***Biogenic carbon dioxide ($CO_2$)***

means $CO_2$ emissions resulting from the decomposition or destruction of organic material, including those produced from the destruction of landfill $CH_4$; they are considered to be a natural part of the carbon cycle.

***Destruction***

means the combustion of LFG and the resulting conversion of landfill $CH_4$ into biogenic $CO_2$.

***Eligible destruction device***

means a device, listed in Table 1, that can destroy landfill $CH_4$ and generate offset credits.

***Global Warming Potential (GWP)***

means a metric representing the ability of a GHG to trap heat in the atmosphere compared to $CO_2$, as provided in Column 2 of Schedule 3 to the Act.

***Landfill***

means an identifiable area of public or private land where waste is or has been intentionally placed above or below ground for permanent disposal.

***Landfill cell***

means a unique and discrete section of a landfill designed and constructed to contain a volume of waste.

***Landfill gas (LFG)***

means a mixture of gases resulting from the decomposition of organic material disposed of in a landfill comprised primarily of $CH_4$, biogenic $CO_2$, and other compounds in low concentrations.

***Landfill methane (landfill $CH_4$)***

means the $CH_4$ portion of LFG, generated by the anaerobic decomposition of organic material disposed of in a landfill.

***Landfill site***

means an identifiable area of public or private land where a landfill and all supporting buildings and infrastructure are located.

***Project site***

means the area of the landfill site from which LFG is actively recovered and the area where it is destroyed in the eligible destruction device(s) that may include portions of an adjacent facility, if applicable.

***Regulations***

means the *Canadian Greenhouse Gas Offset Credit System Regulations.*

# 3.0 Baseline scenario

## 3.1 Baseline condition

The following baseline condition must apply in the baseline scenario in order for a project to be eligible under this protocol.[1]

- Within the project site, LFG has never been actively recovered prior to the project start date.

# 4.0 Project scenario

## 4.1 Project conditions

The following project conditions must apply in the project scenario in order for a project to be eligible under this protocol.[2]

- Within the project site, the LFG is actively recovered and destroyed in one or more eligible destruction devices listed in Table 1.
- For landfills that are designed and constructed by landfill cells, the project site consists of a minimum of one landfill cell.
- For landfills that are not designed and constructed by landfill cells, the project site consists of a minimum of one clearly delineated discrete section of the landfill.
- The active LFG recovery system is installed and operated on or after January 1, 2017.

## 4.2 Eligible project activities and equipment

Eligible project activities include the:

- Installation and operation of an active LFG recovery system within the project site.
- Treatment, purification and/or upgrading of LFG actively recovered from within the project site.
- Operation of eligible destruction device(s) for the destruction of LFG actively recovered from within the project site.
    - Only the destruction devices listed in Table 1 below are considered eligible under this protocol.
    - The project must use a minimum of one eligible destruction device.
    - Eligible destruction devices can be installed for the purposes of the project, or can have been installed and operated prior to January 1, 2017.
    - Flares (open and enclosed) must be located within the landfill site.
    - Eligible destruction devices other than a flare may be located at an adjacent facility.
        - In cases where an eligible destruction device in a project is located at an adjacent facility and owned by an end user, the proponent must have an agreement with the end user to ensure no offset credits issued for the GHG emission reductions generated by the project will be claimed by the end user,

[1] The baseline scenario consists of the relevant SSRs referred to in Section 7.0 Project GHG boundary.
[2] The project scenario consists of the relevant SSRs referred to in Section 7.0 Project GHG boundary.

and no credits will be attributed under another GHG reduction mechanism to the end user for the GHG emission reductions generated by the project.

*Table 1: Eligible destruction devices*

| Type | Description |
|---|---|
| Open flare | A device with a pilot flame at the top of a vertical stack that is exposed to atmosphere that combusts and destroys a gas. |
| Enclosed flare | A device with an insulated cylinder stack surrounding a burner manifold and combustion/cooling air louvers that combusts and destroys a gas. |
| Boiler | A device that combusts a fuel in order to heat a fluid, such as water or leachate, generating vapour that provides thermal energy for various purposes. |
| Turbine (micro or large) | A device that compresses air to combust with a fuel in order to produce expanding gas that turns turbine blades, generating mechanical energy that can be harnessed by a load (e.g. a generator producing electricity). |
| Internal combustion engine (stationary or mobile) | A device that compresses and combusts an air-fuel mixture in a cylinder in order to produce expanding gas that moves a piston and crankshaft, generating rotary mechanical energy that can be harnessed by a load (e.g. a generator producing electricity). |
| Station for direct injection of upgraded LFG into a natural gas network[3] | A device that monitors and prepares upgraded LFG for injection into a natural gas network; this can include odourizing the gas, metering the flow, regulating the pressure, and monitoring the chemical composition prior to injection. |
| Station for compression or liquefaction of upgraded LFG prior to transport and injection into a natural gas network | A device that compresses or liquefies upgraded LFG for transport to a station for its injection into a natural gas network (see above). |

[3] Upgraded LFG injected into a natural gas network is considered to be destroyed once it is delivered to a station for direct injection or a station for compression or liquefaction.

# 5.0 Additionality

## 5.1 Legal additionality

GHG emission reductions generated by a project must not occur as a result of federal, provincial or territorial regulations, municipal by-laws, or any other legally binding mandates such as operating permits. This includes legal requirements to recover and destroy all or a portion of LFG from the landfill to reduce GHG emissions from the landfill or control of the release of LFG for reasons such as safety precautions (to reduce potential for an explosion) or odour control.

A project at a landfill site with a legal requirement to recover and destroy any portion of its LFG is not considered to be additional and, therefore, is not eligible for registration.

If at any time after project registration the GHG emission reductions generated by the project become required by law or the result of a legal requirement, the GHG emission reductions will no longer be additional and, therefore, can only be quantified and offset credits can only be generated up to the date immediately preceding the date on which the law or the legal requirement comes into force.

## 5.2 Provincial or federal pricing mechanisms for GHG emissions

Any emission sources that are included in an industrial facility's GHG emissions reported under a federal, provincial or territorial pricing mechanism for GHG emissions are not eligible for offset credits. This includes on-site landfills at covered facilities under the federal Output-Based Pricing System.

# 6.0 General requirements

## 6.1 Project start date

The start date of a project corresponds to the first day that LFG actively recovered from within the project site is destroyed in an eligible destruction device. In the case of the injection of upgraded LFG into a natural gas network, the LFG is considered to be destroyed once it is delivered to a station for direct injection or a station for compression or liquefaction.

## 6.2 Project location and geographic boundaries

The proponent must document and report the location and geographic boundaries of the project site and submit a site plan. The site plan must show where the project site is situated with respect to the landfill site and any adjacent facilities, including the delineation of relevant landfill cells or discrete landfill sections. The site plan must also show the location and arrangement of all the project components associated with LFG recovery and destruction, including the active recovery system within the project site; treatment, purification and upgrading equipment; eligible destruction devices; measuring devices; and any other equipment associated with the GHG sources, sinks and reservoirs (SSRs) within the project GHG boundary (Section 7.0).

The geographic boundary of the project site cannot change after the first reporting period, but project activities can expand within the boundary. Any changes to the site plan must be communicated as specified in the Regulations.

## 6.3 Environmental and social safeguards

The proponent must ensure that the project activities comply with any operating permits, municipal by-laws or regulations applicable to the landfill site, including those related to minimizing odour, and ensuring the safe operation of all systems within the project site.

# 7.0 Project GHG boundary

The project GHG boundary (Figure 1) contains the eligible project activities and the GHG SSRs that must be assessed by the proponent in order to determine the GHG emission reductions generated by the project relative to the baseline scenario.

Table 2 provides additional details on the SSRs identified for the baseline and project scenarios, as well as justification for their inclusion or exclusion in the quantification of GHG emission reductions. The proponent must assess each of the “included” SSRs that are relevant to the specific activities taking place in the baseline and project scenarios.

Three GHGs are relevant to the SSRs in this protocol: carbon dioxide ($CO_2$), methane ($CH_4$), and nitrous oxide ($N_2O$). $CO_2$ emissions from the decomposition of organic material and destruction of landfill $CH_4$ are considered biogenic and are excluded from the quantification of GHG emissions in this protocol.

*Figure 1: Illustration of the project GHG boundary*

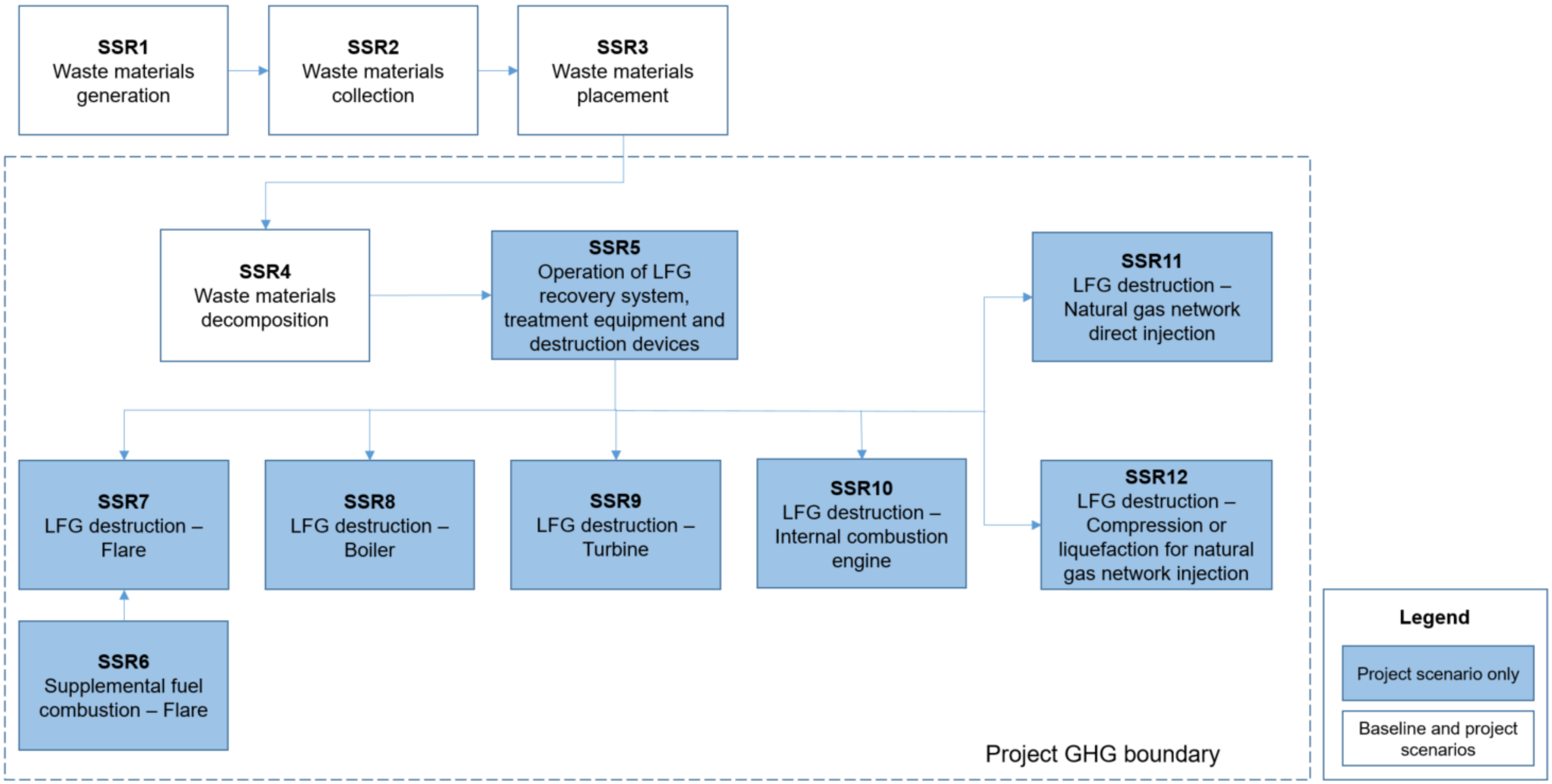

*Table 2: Details on baseline and project scenario SSRs*

| SSR | Title | Description | Type | Baseline or project scenario | GHG[4] | Included or excluded |
|---|---|---|---|---|---|---|
| 1 | Waste materials generation | Generation of waste materials before their collection and placement into the landfill. | Related | Baseline (B1)<br>Project (P1) | $CO_2$<br>$CH_4$<br>$N_2O$ | **Excluded:** GHG emissions from this source are assumed to be the same in both the baseline and project scenarios. |
| 2 | Waste materials collection | Combustion of fossil fuels for vehicles used to collect waste materials and transport them to the landfill site. | Related | Baseline (B2)<br>Project (P2) | $CO_2$<br>$CH_4$<br>$N_2O$ | **Excluded:** GHG emissions from this source are assumed to be the same in both the baseline and project scenarios. |
| 3 | Waste materials placement | Combustion of fossil fuels to operate equipment for the handling and placement of waste materials into the landfill. | Related | Baseline (B3)<br>Project (P3) | $CO_2$<br>$CH_4$<br>$N_2O$ | **Excluded:** GHG emissions from this source are assumed to be the same in both the baseline and project scenarios. |
| 4 | Waste materials decomposition | Generation of LFG from the anaerobic decomposition of waste materials in the landfill. | Controlled | Baseline (B4) | $CH_4$ | **Included:** Quantified based on landfill $CH_4$ actively recovered in the project scenario, using Equation 2. |
| | | | | | $N_2O$ | **Excluded:** $N_2O$ emissions from anaerobic decomposition are not significant.[5] |

[4] Biogenic $CO_2$ emissions from SSR 4, SSR 7, SSR 8, SSR 9, SSR 10, SSR 11 and SSR 12 are not quantified. This is consistent with the Intergovernmental Panel on Climate Change (IPCC). 2001. *Good Practise Guidance and Uncertainty Management in National Greenhouse Gas Inventories, Chapter 5 (Waste)*.(PDF).
[5] The IPCC does not provide a methodology to quantify $N_2O$ emissions from landfills as this emission source is not significant. This is consistent with IPCC. 2006. *Guidelines for National Greenhouse Gas Inventories, Volume 5: Waste, Chapter 3: Solid Waste Disposal. IPCC National Greenhouse Gas Inventories Programme.*(PDF)

| SSR | Title | Description | Type | Baseline or project scenario | GHG[4] | Included or excluded |
|---|---|---|---|---|---|---|
| | | | | Project (P4) | $CH_4$ | **Included:** Quantified based on undestroyed landfill $CH_4$ following the destruction of LFG in the eligible destruction device(s), using Equation 9. |
| | | | | | $N_2O$ | **Excluded:** $N_2O$ emissions from anaerobic decomposition are not significant. |
| 5 | Operation of LFG recovery system, treatment equipment and destruction devices | Combustion of fossil fuels or consumption of grid electricity for the operation of the active LFG recovery system, treatment equipment, and destruction devices[6] | Fossil Fuels: Controlled<br><br>Electricity:<br>Related | Project (P5) | $CO_2$ | **Included:** Quantified using Equation 6 and Equation 7. |
| | | | | | $CH_4$ | |
| | | | | | $N_2O$ | |
| 6 | Supplemental fuel combustion – Flare | Combustion of supplemental fossil fuel to support the operation of an open or enclosed flare. | Controlled | Project (P6) | $CO_2$ | **Included:** Quantified based on combustion of supplemental fossil fuel in a flare, using Equation 8. |
| | | | | | $CH_4$ | |
| | | | | | $N_2O$ | |
| 7 | LFG destruction – Flare | Destruction of LFG in an open or enclosed flare, as identified in Table 1. | Controlled | Project (P7) | $CH_4$ | **Included:** Quantified based on undestroyed landfill $CH_4$ and $N_2O$ from the destruction of LFG in a flare, using Equation 10. |
| | | | | | $N_2O$ | |
| 8 | LFG destruction – Boiler | Destruction of LFG in a boiler, as identified in Table 1. | Controlled | Project (P8) | $CH_4$ | **Included:** Quantified based on undestroyed landfill $CH_4$ and $N_2O$ from the destruction of LFG in a boiler, using Equation 10. |
| | | | | | $N_2O$ | |

[6] This SSR captures emissions from operating project components such as blowers; equipment for LFG treatment and purification; destruction devices (other than a flare); equipment for the conveyance of LFG to an adjacent facility; equipment for the upgrading, compression or liquefaction, and injection of upgraded LFG into a natural gas network.

| SSR | Title | Description | Type | Baseline or project scenario | GHG[4] | Included or excluded |
| --- | --- | --- | --- | --- | --- | --- |
| 9 | LFG destruction – Turbine | Destruction of LFG in a turbine, as identified in Table 1. | Controlled | Project (P9) | $CH_4$<br>$N_2O$ | **Included:** Quantified based on undestroyed landfill $CH_4$ and $N_2O$ from the destruction of LFG in a turbine, using Equation 10. |
| 10 | LFG destruction – Internal combustion engine | Destruction of LFG in an internal combustion engine, as identified in Table 1. | Controlled | Project (P10) | $CH_4$<br>$N_2O$ | **Included:** Quantified based on undestroyed landfill $CH_4$ and $N_2O$ from the destruction of LFG in an internal combustion engine, using Equation 10. |
| 11 | LFG destruction – Natural gas network direct injection | Destruction of upgraded LFG after its direct injection into a natural gas network, as identified in Table 1. | Related | Project (P11) | $CH_4$<br>$N_2O$ | **Included:** Quantified based on undestroyed landfill $CH_4$ and $N_2O$ from the destruction of LFG after its direct injection into a natural gas network, using Equation 10. |
| 12 | LFG destruction – Compression or liquefaction for natural gas network injection | Destruction of upgraded LFG after its compression or liquefaction, transport and injection into a natural gas network, as identified in Table 1. | Related | Project (P12) | $CH_4$<br>$N_2O$ | **Included:** Quantified based on undestroyed landfill $CH_4$ and $N_2O$ from the destruction of LFG after its compression or liquefaction, transport and injection into a natural gas network, using Equation 10. |

# 8.0 Quantification methodology

This section contains the quantification methodology that must be followed to quantify baseline and project scenario GHG emissions, which are subsequently used to quantify the GHG emission reductions generated by a project.

Raw data must be converted to align with the units presented in the quantification methodology, if necessary. Schedule A provides the reference condition values that must be applied to complete the quantification. Emission factors that must be used are provided in the *Emission Factors and Reference Values* document and may also need to be converted to align with the units presented in the quantification methodology. The proponent must use the most recent version of the *Emission Factors and Reference Values* document.

Baseline scenario GHG emissions are the GHG emissions that would have occurred in the absence of a project, quantified based on SSRs within the project GHG boundary. Project scenario GHG emissions are the actual GHG emissions that occur from SSRs within the project GHG boundary.

The GHG emission reductions generated by the project are quantified by deducting the project scenario GHG emissions from the baseline scenario GHG emissions as outlined in Section 8.3.

The quantification of both baseline and project scenario GHG emissions must include all the GHG emissions that occurred during the reporting period, and must include sub-totals in tonnes of $CO_2$ equivalent (t $CO_2$e) for each full or partial calendar year to support issuance of the resulting offset credits by calendar year.

## 8.1 Baseline scenario GHG emissions

The proponent must follow the quantification methodology below to quantify the baseline scenario GHG emissions for each full or partial calendar year covered by the reporting period, based on the included SSRs outlined in Table 2.

This protocol quantifies the baseline scenario GHG emissions through the use of a dynamic baseline approach based on measurements made in the project scenario instead of modelling the GHG emissions generated by the landfill in the baseline scenario. This means that the baseline scenario GHG emissions are quantified based on the quantity of landfill $CH_4$ that is actively recovered in the project scenario, which may vary over time.

*Equation 1: Baseline scenario GHG emissions*

$$BE_C = CH_4REC_{PR} \text{ x } (1 - OX)$$

Where,

| | | | Units |
|---|---|---|---|
| $BE_C$ | = | Baseline scenario GHG emissions during a calendar year covered by the reporting period | *t $CO_2$e* |
| $CH_4REC_{PR}$ | = | Quantity of landfill $CH_4$ recovered by the active LFG recovery system during a calendar year covered by the reporting period, as per Equation 2 (SSR B4) | *t $CO_2$e* |

| | | | |
|---|---|---|---|
| $OX$ | = | Factor for the oxidation of landfill $CH_4$ by bacteria in soil or materials covering the waste | - |
| $C$ | = | Calendar year | - |

Baseline scenario GHG emissions are quantified based on the presumption that the landfill $CH_4$ actively recovered in the project scenario would have been passively released to the atmosphere in the baseline scenario. Oxidation of landfill $CH_4$ emissions must be accounted for in the baseline scenario. If a non-geomembrane cover system or other $CH_4$ oxidation technology is present, it can be presumed that the landfill $CH_4$ would have been subject to oxidation by bacteria in the soil or materials covering the waste prior to being released to the atmosphere. If a geomembrane covers the entire landfill area and no $CH_4$ oxidation technology is present, it can be presumed that the landfill $CH_4$ would not have been subject to oxidation.

Oxidation of landfill $CH_4$ emissions must be accounted for in the following manner:

- A $CH_4$ oxidation factor of 0% can only be used for landfills with a geomembrane covering the entire landfill area and no $CH_4$ oxidation technology.
- A $CH_4$ oxidation factor of 10% must be used for all other landfills, including those with a non-geomembrane cover system or other $CH_4$ oxidation technology.[7]

Equation 2 and Equation 3 must be used to quantify the quantity of landfill $CH_4$ recovered by the active LFG recovery system for each full or partial calendar year covered by the reporting period.

*Equation 2: Quantity of landfill $CH_4$ attributed to the anaerobic decomposition of waste recovered by the active LFG recovery system (SSR B4)*

$$CH_4REC_{PR} = \left[\frac{\sum_i^n (Q_i) \text{ x } \rho_{CH_4}}{1000}\right] \text{x } GWP_{CH_4}$$

| Where, | | | Units |
|---|---|---|---|
| $CH_4REC_{PR}$ | = | Quantity of landfill $CH_4$ recovered by the active LFG recovery system during a calendar year covered by the reporting period (SSR B4) | *t $CO_2$e* |
| $Q_i$ | = | Volume of landfill $CH_4$ delivered to eligible destruction device, i, during a calendar year covered by the reporting period, as per Equation 3 | *$m^3$ $CH_4$* |
| $\rho_{CH_4}$ | = | Reference density of $CH_4$, as set out in Schedule A – Reference condition values | *kg $CH_4$/$m^3$ $CH_4$* |
| $GWP_{CH_4}$ | = | GWP of $CH_4$, as provided in Column 2 of Schedule 3 to the Act | - |
| $1000$ | = | Conversion factor, kilograms to tonnes | *kg/t* |
| $n$ | = | Number of eligible destruction devices | - |

[7] IPCC. 2001. Good Practise Guidance and Uncertainty Management in National Greenhouse Gas Inventories, Chapter 5 (Waste). (PDF).

| | | | |
|---|---|---|---|
| $i$ | = | Eligible destruction device | - |

*Equation 3: Volume of landfill $CH_4$ delivered to an eligible destruction device*

$$Q_i = \sum_{t}^{n} (LFG_{i,t} \times LFG_{CH_4,t})$$

| Where, | | | Units |
|---|---|---|---|
| $Q_i$ | = | Volume of landfill $CH_4$ delivered to eligible destruction device, i, during a calendar year covered by the reporting period | *$m^3$ $CH_4$* |
| $LFG_{i,t}$ | = | Corrected volume of LFG delivered to eligible destruction device, i, during measurement period, t, as per automatic correction or Equation 4 | *$m^3$ LFG* |
| $LFG_{CH_4,t}$ | = | Average $CH_4$ content of the LFG during measurement period, t | *$m^3$ $CH_4$/$m^3$ LFG* |
| $n$ | = | Number of measurement periods in a calendar year covered by the reporting period | - |
| $t$ | = | Measurement period | - |

All flow meter data must be corrected to the reference temperature and pressure conditions set out in Schedule A – Reference condition values. If the flow meter does not automatically correct the measured volume to the reference temperature and pressure conditions, the proponent must quantify the corrected volume following Equation 4. Equation 4 is not needed if the flow meter automatically corrects the volume.

*Equation 4: Volume of LFG delivered to an eligible destruction device, corrected to reference condition*

$$LFG_{i,t} = LFG_{UC} \times \frac{T_{ref}}{T_m} \times \frac{P_m}{P_{ref}}$$

| Where, | | | Units |
|---|---|---|---|
| $LFG_{i,t}$ | = | Corrected volume of LFG delivered to eligible destruction device, i, during measurement period, t | *$m^3$ LFG* |
| $LFG_{UC}$ | = | Uncorrected volume of LFG delivered to eligible destruction device, i, during measurement period, t | *$m^3$ LFG* |
| $T_m$ | = | Measured temperature of the LFG for the measurement period, t | *K* |
| $T_{ref}$ | = | Reference temperature of the LFG, as set out in Schedule A – Reference condition values | *K* |
| $P_m$ | = | Measured pressure of the LFG for the measurement period, t | *kPa* |
| $P_{ref}$ | = | Reference pressure of the LFG, as set out in Schedule A – Reference condition values | *kPa* |

## 8.2 Project scenario GHG emissions

The proponent must follow the quantification methodology below to quantify the project scenario GHG emissions for each full or partial calendar year covered by the reporting period, based on the included SSRs outlined in Table 2.

The project scenario GHG emissions correspond to the GHG emissions attributed to energy inputs into the active LFG recovery system, treatment equipment, and destruction devices (other than a flare); supplemental fossil fuel used to support the operation of a flare; and the destruction of LFG in the eligible destruction device(s).

*Equation 5: Project scenario GHG emissions*

$$PE_C = FF_{GHG} + EL_{GHG} + FF_{supp,GHG} + LFG_{GHG}$$

Where,

| | | | Units |
|---|---|---|---|
| $PE_C$ | = | Project scenario GHG emissions during a calendar year covered by the reporting period | *t $CO_2$e* |
| $FF_{GHG}$ | = | Quantity of GHG emissions attributed to the use of fossil fuels for the operation of the active LFG recovery system, treatment equipment, and destruction devices during a calendar year covered by the reporting period, as per Equation 6 (SSR P5) | *t $CO_2$e* |
| $EL_{GHG}$ | = | Quantity of GHG emissions attributed to the use of grid electricity for the operation of the active LFG recovery system, treatment equipment, and destruction devices during a calendar year covered by the reporting period, as per Equation 7 (SSR P5) | *t $CO_2$e* |
| $FF_{supp,GHG}$ | = | Quantity of GHG emissions attributed to the use of supplemental fossil fuels to support the operation of a flare during a calendar year covered by the reporting period, as per Equation 8 (SSR P6) | *t $CO_2$e* |
| $LFG_{GHG}$ | = | Quantity of GHG emissions attributed to the destruction of LFG in the eligible destruction device(s) during a calendar year covered by the reporting period, as per Equation 10 (SSR P7, SSR P8, SSR P9, SSR P10, SSR P11, SSR P12) | *t $CO_2$e* |
| $C$ | = | Calendar year | - |

Equation 6 and Equation 7 quantify the GHG emissions from the operation of the active LFG recovery system, treatment equipment, and destruction devices during each full or partial calendar year covered by the reporting period, which correspond to SSR P5. The proponent must use the appropriate equation(s) dependent on the energy inputs required for the operation of the active LFG recovery system, treatment equipment, and destruction devices; these can include blowers, equipment for LFG treatment and purification, destruction devices (other than flares), equipment for the conveyance of LFG to an adjacent facility, and/or equipment for the upgrading, compression or liquefaction, and injection of upgraded LFG into a natural gas network. If both fossil fuels and grid electricity are used for these purposes, the proponent must use the summation of Equation 6 and Equation 7 to quantify SSR P5.

*Equation 6: Quantity of GHG emissions attributed to the use of fossil fuels for the operation of the active LFG recovery system, treatment equipment, and destruction devices (SSR P5)*

$$FF_{GHG} = \sum_{j}^{m} \left[ \frac{\left(FF_j \text{ x } EF_{CO_2,j}\right) + \left(FF_j \text{ x } EF_{CH_4,j} \text{ x } GWP_{CH_4}\right) + \left(FF_j \text{ x } EF_{N_2O,j} \text{ x } GWP_{N_2O}\right)}{1000} \right]$$

Where,

| | | | Units |
|---|---|---|---|
| $FF_{GHG}$ | = | Quantity of GHG emissions attributed to the use of fossil fuels for the operation of the active LFG recovery system, treatment equipment, and destruction devices during a calendar year covered by the reporting period (SSR P5) | *t $CO_2$e* |
| $FF_j$ | = | Volume of fossil fuel, j, consumed by the active LFG recovery system, treatment equipment, and destruction devices during a calendar year covered by the reporting period | *$m^3$* |
| $EF_{CO_2,j}$ | = | $CO_2$ emission factor for fossil fuel, j, as set out in the *Emission Factors and Reference Values* document | *kg $CO_2/m^3$* |
| $EF_{CH_4,j}$ | = | $CH_4$ emission factor for fossil fuel, j, as set out in the *Emission Factors and Reference Values* document | kg $CH_4/m^3$ |
| $GWP_{CH_4}$ | = | GWP of $CH_4$, as provided in Column 2 of Schedule 3 to the Act | - |
| $EF_{N_2O,j}$ | = | $N_2O$ emission factor for fossil fuel, j, as set out in the *Emission Factors and Reference Values* document | *kg $N_2O/m^3$* |
| $GWP_{N_2O}$ | = | GWP of $N_2O$, as provided in Column 2 of Schedule 3 to the Act | - |
| 1000 | = | Conversion factor, kilograms to tonnes | *kg/t* |
| m | = | Number of types of fossil fuels | - |
| j | = | Type of fossil fuel | - |

*Equation 7: Quantity of GHG emissions attributed to the use of grid electricity for the operation of the active LFG recovery system, treatment equipment, and destruction devices (SSR P5)*

$$EL_{GHG} = \frac{EL \text{ x } EF_{EL,GHG}}{1000}$$

| Where, | | | Units |
|---|---|---|---|
| $EL_{GHG}$ | = | Quantity of GHG emissions attributed to the use of grid electricity for the operation of the active LFG recovery system, treatment equipment, and destruction devices during a calendar year covered by the reporting period (SSR P5) | *t $CO_2$e* |
| $EL$ | = | Grid electricity consumed by the active LFG recovery system, treatment equipment, and destruction devices during a calendar year covered by the reporting period | *MWh* |
| $EF_{EL,GHG}$ | = | GHG consumption intensity emission factor for grid electricity from the project jurisdiction, as set out in the *Emission Factors and Reference Values* document | *kg $CO_2$e/MWh* |
| $1000$ | = | Conversion factor, kilograms to tonnes | *kg/t* |

Equation 8 quantifies the GHG emissions from supplemental fossil fuel used to support the operation of a flare during each full or partial calendar year covered by the reporting period, which corresponds to SSR P6. Equation 8 is not needed if the project does not include a flare as a destruction device.

*Equation 8: Quantity of GHG emissions attributed to the use of supplemental fossil fuel to support the operation of a flare (SSR P6)*

$$FF_{supp,GHG} = \sum_{j}^{m} \left[ \frac{(FF_{supp,j} \text{ x } EF_{CO_2,j}) + (FF_{supp,j} \text{ x } FF_{CH_4,j} \text{ x } \rho_{CH_4} \text{x } (1 - DE_{CH_4}) \text{ x } GWP_{CH_4}) + (FF_{supp,j} \text{ x } EF_{N_2O,j} \text{ x } GWP_{N_2O})}{1000} \right]$$

| Where, | | | Units |
|---|---|---|---|
| $FF_{supp,GHG}$ | = | Quantity of GHG emissions attributed to the use of supplemental fossil fuels to support the operation of a flare during a calendar year covered by the reporting period (SSR P6) | *t $CO_2$e* |
| $FF_{supp,j}$ | = | Volume of supplemental fossil fuel, j, consumed by a flare during a calendar year covered by the reporting period | *$m^3$* |
| $EF_{CO_2,j}$ | = | $CO_2$ emission factor for supplemental fossil fuel, j, as set out in the *Emission Factors and Reference Values* document | *kg $CO_2$/$m^3$* |
| $FF_{CH_4,j}$ | = | Average $CH_4$ content of supplemental fossil fuel, j, obtained from the supplier | *$m^3$ $CH_4$/$m^3$* |
| $\rho_{CH_4}$ | = | Reference density of $CH_4$, as set out in Schedule A – Reference condition values | *kg $CH_4$/$m^3$ $CH_4$* |
| $DE_{CH_4}$ | = | $CH_4$ destruction efficiency of the flare, as set out in Table 3 or specific to the device | - |

| | | | |
|---|---|---|---|
| $GWP_{CH_4}$ | = | GWP of $CH_4$, as provided in Column 2 of Schedule 3 to the Act | - |
| $EF_{N_2O,j}$ | = | $N_2O$ emission factor for supplemental fossil fuel, j, as set out in the *Emission Factors and Reference Values* document | *kg $N_2O/m^3$* |
| $GWP_{N_2O}$ | = | GWP of $N_2O$, as provided in Column 2 of Schedule 3 to the Act | - |
| $1000$ | = | Conversion factor, kilograms to tonnes | *kg/t* |
| $m$ | = | Number of types of supplemental fossil fuels | - |
| $j$ | = | Type of supplemental fossil fuel | - |

Equation 9 and Equation 10 must be used to quantify GHG emissions due to the destruction of LFG in the eligible destruction device(s) during each full or partial calendar year covered by the reporting period. Equation 9 determines the undestroyed landfill $CH_4$ generated from the anaerobic decomposition of waste and released to atmosphere from the eligible destruction device(s), corresponding to SSR P4. This value is then accounted for within Equation 10, which quantifies the GHG emissions from the destruction of LFG in the eligible destruction device(s), corresponding to SSR P7, SSR P8, SSR P9, SSR P10, SSR P11, and SSR P12.

*Equation 9: Quantity of undestroyed landfill $CH_4$ generated from the anaerobic decomposition of waste and released to atmosphere based on the destruction efficiency of the eligible destruction device(s) (SSR P4)*

$$CH_4UND = \left[ \sum_{i}^{n} \left[ Q_i \times \left(1 - DE_{CH_4,i}\right) \right] x \frac{\rho_{CH_4}}{1000} \right] \times GWP_{CH_4}$$

| Where, | | | Units |
|---|---|---|---|
| $CH_4UND$ | = | Quantity of undestroyed landfill $CH_4$ released to atmosphere during a calendar year covered by the reporting period based on the destruction efficiency of the eligible destruction device(s) (SSR P4) | *t $CO_2e$* |
| $Q_i$ | = | Volume of landfill $CH_4$ delivered to eligible destruction device, i, during a calendar year covered by the reporting period, as per Equation 3 | *$m^3$ $CH_4$* |
| $DE_{CH_4,i}$ | = | $CH_4$ destruction efficiency of eligible destruction device, i, as set out in Table 3 or specific to the device | - |
| $\rho_{CH_4}$ | = | Reference density of $CH_4$, as set out in Schedule A – Reference condition values | *kg $CH_4/m^3$ $CH_4$* |
| $GWP_{CH_4}$ | = | GWP of $CH_4$, as provided in Column 2 of Schedule 3 to the Act | - |
| $1000$ | = | Conversion factor, kilograms to tonnes | *kg/t* |
| $n$ | = | Number of eligible destruction devices | - |
| $i$ | = | Eligible destruction device | - |

The amount of landfill $CH_4$ destroyed in each eligible destruction device is dependent on the $CH_4$ destruction efficiency for each device ($DE_{CH4}$). Table 3 sets out default $CH_4$ destruction efficiencies that can be used by the proponent for each eligible destruction device in the project. The proponent may also determine a device-specific destruction efficiency for each eligible destruction device in the project. Testing for the device-specific destruction efficiency must be conducted each full or partial calendar year, and include at least three test runs, with the accepted final value being one standard deviation below the mean of the measured efficiencies.

*Table 3: Default $CH_4$ destruction efficiencies by eligible destruction device ($DE_{CH4}$)*

| **Eligible destruction device** | **Efficiency ($DE_{CH4}$)[8]** |
|---|---|
| Open Flare | 0.96 |
| Enclosed Flare | 0.995 |
| Boiler | 0.98 |
| Turbine (micro or large) | 0.995 |
| Internal Combustion Engine (stationary or mobile) | 0.936 |
| Station for direct injection of upgraded LFG into a natural gas network | 0.98 |
| Station for compression or liquefaction of upgraded LFG prior to transport and injection into a natural gas network | 0.95 |

Equation 10 must be used to quantify the quantity of undestroyed landfill $CH_4$ and generated $N_2O$ emissions from the destruction of LFG in the eligible destruction device(s) during each full or partial calendar year covered by the reporting period.

*Equation 10: Quantity of GHG emissions attributed to the destruction of LFG in the eligible destruction device(s) (SSR P7, SSR P8, SSR P9, SSR P10, SSR P11, SSR P12)*

$$LFG_{GHG} = [CH_4UND] + \left[\sum_{i}^{n}\left(\frac{Q_i \text{ x } \rho_{CH_4}}{1000} \text{ x } \frac{EF_{LFG,\,N_2O,i}}{1000}\right) \times GWP_{N_2O}\right]$$

Where, Units

| | | | |
|---|---|---|---|
| $LFG_{GHG}$ | = | Quantity of GHG emissions attributed to the destruction of LFG in the eligible destruction device(s) during a calendar year covered by the reporting period (SSR P7, SSR P8, SSR P9, SSR P10, SSR P11, SSR P12) | *t $CO_2$e* |
| $CH_4UND$ | = | Quantity of undestroyed landfill $CH_4$ released to atmosphere during a calendar year covered by the reporting period based on the destruction efficiency of the eligible destruction device(s), as per Equation 9 (SSR P4) | *t $CO_2$e* |

[8] Destruction efficiencies are referenced from Quebec's *Regulation respecting landfill methane reclamation and destruction projects eligible for the issuance of offset credits*. These values also align with most other landfill $CH_4$ offset protocols from other systems.

| | | | |
|---|---|---|---|
| $Q_i$ | = | Volume of landfill $CH_4$ delivered to eligible destruction device, i, during a calendar year covered by the reporting period, as per Equation 3 | *$m^3$ $CH_4$* |
| $\rho_{CH_4}$ | = | Reference density of $CH_4$, as set out in Schedule A – Reference condition values | *kg $CH_4$/$m^3$ $CH_4$* |
| $EF_{LFG,\,N_2O,i}$ | = | $N_2O$ emission factor for the destruction of LFG in eligible destruction device, i, as set out in the *Emission Factors and Reference Values* document | *kg $N_2O$/t $CH_4$* |
| $1000$ | = | Conversion factor, kilograms to tonnes | *kg/t* |
| $GWP_{N_2O}$ | = | GWP of $N_2O$, as provided in Column 2 of Schedule 3 to the Act | - |
| $n$ | = | Number of eligible destruction devices | - |
| $i$ | = | Eligible destruction device | - |

## 8.3 GHG emission reductions

The GHG emission reductions (ER), determined in accordance with Equation 11, correspond to the GHG reductions generated by a project, determined in accordance with section 20 of the Regulations.

*Equation 11: GHG emission reductions*

$$ER_C = BE_C - PE_C$$

| Where, | | | Units |
|---|---|---|---|
| $ER_C$ | = | GHG emission reductions during a calendar year covered by the reporting period | *t $CO_2$e* |
| $BE_C$ | = | Baseline scenario GHG emissions during a calendar year covered by the reporting period, as per Equation 1 | *t $CO_2$e* |
| $PE_C$ | = | Project scenario GHG emissions during a calendar year covered by the reporting period, as per Equation 5 | *t $CO_2$e* |
| $C$ | = | Calendar year | - |

# 9.0 Measurement and data

## 9.1 Measuring devices

The proponent must ensure the appropriate measuring devices are installed and operated as per the requirements in Section 9.0.

### 9.1.1 Flow meters

The LFG recovery and destruction system must include permanent flow meters that directly and separately measure the volume of LFG actively recovered from within the project site and delivered to the individual eligible destruction device(s). The volume of any fossil fuels used for the operation of the active LFG recovery system, treatment equipment, or eligible destruction devices must be measured by permanent flow meters or determined using purchasing records. Volume data must be converted into cubic metres ($m^3$) to align with the quantification methodology presented in Section 8.0.

### 9.1.2 Temperature and pressure gauges

If a flow meter automatically corrects the LFG volume to the reference temperature and pressure conditions set out in Schedule A – Reference condition values, no additional temperature and pressure gauges are required.

If a flow meter does not automatically correct the LFG volume, permanent temperature and pressure gauges must be installed to measure temperature and pressure at the same measurement frequency as the uncorrected volume of LFG (Section 9.2). LFG temperature and pressure must be measured under the same conditions (wet or dry basis) as the LFG volume.

The LFG volume data must be corrected from measured temperature and pressure conditions to the reference temperature and pressure conditions set out in Schedule A – Reference condition values by using Equation 4.

### 9.1.3 Methane analyzers

The active LFG recovery system must include permanent methane analyzers (e.g. gas chromatographs) that directly measure the $CH_4$ content in the LFG on a volumetric basis.

### 9.1.4 Arrangement of measuring devices

Flow meters and methane analyzers must be arranged in such a way as to ensure the data is representative of the LFG actively recovered and destroyed by the project.

- **Flow meters:** Must be placed to separately measure the volume of LFG actively recovered from within the project site and delivered to the individual eligible destruction device(s).
- **Methane analyzers**: For a project with multiple eligible destruction devices, if the LFG is delivered to the eligible destruction devices from a common manifold or header upstream of the destruction devices, one methane analyzer can be placed to measure the $CH_4$ content of the LFG at that common manifold or header pipe. If the LFG is delivered to each eligible destruction device from separate manifolds or header pipes, a separate methane analyzer is required upstream of each individual destruction device.

Additionally, flow meters and methane analyzers must be placed to:

- Measure the volume and $CH_4$ content of the LFG actively recovered from within the project site separately from any other LFG recovered from within the landfill;
- Measure the volume and $CH_4$ content of the LFG before the introduction of any supplemental fossil fuel;
- Measure the volume of supplemental fossil fuel prior to its introduction; and
- Measure the volume and $CH_4$ content of the LFG actively recovered from within the project site separately from any other fuel sources prior to the destruction of the LFG in the eligible destruction device(s) at an adjacent facility.

Measuring devices should be arranged such that LFG $CH_4$ content is measured under the same conditions (wet or dry basis) as LFG volume, temperature and pressure. However, a moisture-removing component may separate a methane analyzer and a flow meter where the methane analyzer is placed upstream of the moisture-removing component ($CH_4$ content measured on a wet basis), and the flow meter is placed downstream of the moisture-removing component (LFG volume measured on a dry basis). A moisture-removing component must not separate a methane analyzer and flow meter in any other configuration other than previously described. No other devices or equipment that could change the LFG composition by volume may separate a methane analyzer and a flow meter.

## 9.2 Measurement frequency

Table 4 identifies the measurement frequency of the parameters that must be measured in order to gather the data required to quantify GHG emissions reductions generated by a project.

*Table 4: Measurement frequency for measured parameters for a landfill $CH_4$ recovery and destruction project*

| Parameter | Description | Units | Measurement frequency | Equations |
|---|---|---|---|---|
| $LFG_{i,t}$ | Corrected volume of LFG delivered to eligible destruction device, i, during measurement period, t | $m^3$ LFG | Measured continuously with volume recorded every measurement period. The measurement period can be a maximum of 15 minutes.<br>**or**<br>Quantified as per Equation 4 if flow meter does not automatically correct volume. | 3, 4 |
| $LFG_{CH_4,t}$ | Average $CH_4$ content of the LFG during measurement period, t | $m^3$ $CH_4$/$m^3$ LFG | Measured continuously with $CH_4$ content averaged over the measurement period. The measurement period can be a maximum of 15 minutes. | 3 |
| $LFG_{UC}$ | Uncorrected volume of LFG delivered to eligible destruction device, i, during measurement period, t | $m^3$ LFG | Measured continuously with volume recorded every measurement period. The measurement period can be a maximum of 15 minutes. | 4 |

| Parameter | Description | Units | Measurement frequency | Equations |
|---|---|---|---|---|
| $T_m$ | Measured temperature of the LFG for the measurement period, t | K | Measured continuously with value recorded every measurement period if flow meter does not automatically correct volume. The measurement period can be a maximum of 15 minutes but must be the same frequency as for $LFG_{UC}$. | 4 |
| $P_m$ | Measured pressure of the LFG for the measurement period, t | kPa | Measured continuously with value recorded every measurement period if flow meter does not automatically correct volume. The measurement period can be a maximum of 15 minutes but must be the same frequency as for $LFG_{UC}$. | 4 |
| $FF_j$ | Volume of fossil fuel, j, consumed by the active LFG recovery system, treatment equipment, and destruction devices during a calendar year covered by the reporting period | $m^3$ | Measured continuously with volume recorded at least once every 15 minutes and summed for each calendar year covered by the reporting period.<br>**or**<br>Calculated from fossil fuel purchasing records and/or equipment specifications and summed for each calendar year covered by the reporting period. | 6 |
| EL | Grid electricity consumed by the active LFG recovery system, treatment equipment, and destruction devices during a calendar year covered by the reporting period | MWh | Measured using meter and summed for each calendar year covered by the reporting period.<br>**or**<br>Calculated from electricity purchasing records and/or equipment specifications and summed for each calendar year covered by the reporting period. | 7 |
| $FF_{supp,j}$ | Volume of supplemental fossil fuel, j, consumed by a flare during a calendar year covered by the reporting period | $m^3$ | Measured continuously with volume recorded at least once every 15 minutes and summed for each calendar year covered by the reporting period.<br>**or**<br>Calculated from fossil fuel purchasing records and/or equipment specifications and summed for each calendar year covered by the reporting period. | 8 |

## 9.3 Quality assurance and quality control

Quality assurance and quality control procedures must be implemented to ensure that all measurements and calculations have been made correctly and can be verified.

All flow meters and methane analyzers must be:

- Checked for accuracy by following manufacturer specifications at least once each calendar year, with the last occurring no more than 2 months before or after the end of the reporting period; and
- Calibrated by the manufacturer or by a third party certified for that purpose and following manufacturer specifications, in accordance with the manufacturer specified frequency or every 5 years, whichever is more frequent.

The measurement accuracy of all measuring devices must show that the measuring device provides a reading that is within a ± 5% accuracy range. When the accuracy of the measuring device deviates from the ± 5% range, the appropriate corrective action(s) must be taken, in accordance with the manufacturer specifications.

After the corrective action(s), the measuring device must be rechecked for accuracy. If the accuracy of the measuring device is still not within the ± 5% range, the measuring device must be calibrated by the manufacturer or by a third party certified for that purpose and following manufacturer specifications, no more than two months after the end of the reporting period.

When the measurement accuracy of a measuring device indicates a reading outside of a ± 5% accuracy range, the following rules must be applied for the entire period from the last time the measuring device showed a reading within ± 5% accuracy until the measuring device shows a return to ± 5% accuracy:

- When the inaccuracy of the measuring device indicates an under-reporting, the measured values must be used without correction.
- When the inaccuracy of the measuring device indicates an over-reporting, the measured values must be corrected by the percentage that the accuracy of the measuring device deviated from the ± 5% range.

## 9.4 Missing data

If a measuring device fails to produce data as required in Section 9.2, missing data may be substituted using the methodology in this section. If missing data is not substituted using the methodology below, no GHG emission reductions can be quantified for the period during which data is missing.

Missing data from a measuring device may only be substituted if the following two conditions are met during the period of missing data:

- The operational status of the eligible destruction device(s) can be demonstrated in accordance with the requirements in Section 9.5; and
- The proper functioning of the thermocouple or destruction device monitoring instrument(s) referred to in Section 9.5 can be demonstrated with the appropriate data.

Missing data from a flow meter or methane analyzer may only be substituted in accordance with the following rules:

- LFG volume data may be substituted when $CH_4$ content data is not missing and the methane analyzer is demonstrated to be functioning properly; or
- $CH_4$ content data may be substituted when LFG volume data is not missing and the flow meter is demonstrated to be functioning properly.

For a project with LFG volume or $CH_4$ content data missing for a period of up to seven consecutive days, the appropriate substitution method from Table 5 may be employed to substitute the data.

In the event that periods of missing data occur more than once during the reporting period, data may be substituted for:

- No more than 5% of the GHG emission reductions for the reporting period, if the GHG emission reductions are less than 100,000 tonnes of $CO_2$e; or
- No more than 2% of the GHG emission reductions for the reporting period, if the GHG emission reductions are equal to or greater than 100,000 tonnes of $CO_2$e.

*Table 5: Missing data substitution methods*

| Missing data period | Substitution method |
|---|---|
| Less than 6 consecutive hours | Use the average of the 4 hours immediately prior to **and** after the missing data period. |
| 6 to less than 24 consecutive hours | Use the 95% upper or lower confidence limit of the 72 hours prior to **or** after the missing data period, whichever results in greater conservativeness. |
| 1 to 7 consecutive days | Use the 90% upper or lower confidence limit of the 72 hours prior to **or** after the missing data period, whichever results in greater conservativeness. |
| More than 7 consecutive days | No data may be substituted after the 7$^{th}$ consecutive day, and no GHG emission reductions may be quantified. |

## 9.5 Operational status of eligible destruction devices

The operational status of the eligible destruction device(s) must be monitored with a destruction device monitoring instrument and recorded at least hourly to ensure LFG destruction is occurring.

For a flare (open or enclosed), the operational status must be determined based on data from a thermocouple. The thermocouple must indicate that the flare temperature meets or exceeds 260˚C, the minimum combustion temperature for $CH_4$. If the temperature is below 260˚C, no GHG emission reductions can be quantified for the period during which the temperature remains below 260˚C.

For boilers, turbines, internal combustion engines, stations for the direct injection of upgraded LFG into a natural gas network, or stations for the compression or liquefaction of upgraded LFG prior to its transport and injection into a natural gas network, a destruction device monitoring instrument must monitor and measure an indicator of operational status (e.g. energy output). If the operational status is not monitored and an indicator is not measured, no GHG emission reductions can be quantified for the period during which monitoring data is not measured.

In cases where LFG is destroyed in an eligible destruction device located at an adjacent facility and owned by an end user, monitoring data demonstrating the operational status of the eligible destruction device must be made available to the proponent, otherwise the GHG emission reductions can not be included in the quantification.

If an eligible destruction device, thermocouple or other destruction device monitoring instrument is not operating or functioning properly in accordance with the manufacturer specifications, no GHG emission reductions can be quantified for the period during which they are not operating or functioning properly.

# 10.0 Records

In addition to the record keeping requirements in the Regulations, the proponent must retain records that support the implementation of a project under this protocol, including invoices, contracts, metered results, maintenance records, calculations, databases, photographs, and calibration records, at the location and for the period of time specified in the Regulations. These records apply to any eligible destruction devices, measuring devices or meters located at the landfill site or adjacent facility, if applicable. Additional records include:

- Documentation demonstrating the quantity of waste in place and/or waste received/disposed per year at the landfill.
- Documentation related to all operating permits for the landfill site, including their effective dates and any details related to LFG recovery and destruction.
- Documentation related to project design considerations for the installation and safe operation of the active LFG recovery system and the eligible destruction device(s).
- Documentation demonstrating the installation date of the active LFG recovery system and eligible destruction device(s) and the first day LFG actively recovered from within the project site is destroyed in the eligible destruction device(s).
- Documentation demonstrating the geographic boundaries of the active LFG recovery system within the project site.
- A copy of any agreements between the proponent and an end user of the LFG stating that no offset credits issued for the GHG emission reductions generated by the project will be claimed by the end user, and no credits will be attributed under another GHG reduction mechanism to the end user for the GHG emission reductions generated by the project.
- A copy of the agreement/contract in place for the sale of any LFG to be destroyed at the landfill site or adjacent facility, directly injected into a natural gas network, and/or compressed or liquefied prior to transport and injection into a natural gas network.
- Documentation demonstrating the sale of any LFG to be destroyed at the landfill site or adjacent facility, directly injected into a natural gas network, and/or compressed or liquefied prior to transport and injection into a natural gas network, including the actual quantities sold during the reporting period.
- Documentation providing details of the landfill cover system and $CH_4$ oxidation technologies in place, including the proportion of the landfill area that is covered and the installation date for all landfill covers (by landfill cell or discrete section, if applicable) and $CH_4$ oxidation technologies.
- Details about the eligible destruction device(s) including:
    - Documentation describing the eligible destruction device(s) included in the project.
    - Manufacturer specifications for the operation and maintenance of the eligible destruction device(s) included in the project.
    - If applicable, the testing data and documentation pertaining to the device-specific destruction efficiency for the eligible destruction device(s) included in the project.

    - Documentation describing the location and arrangement of the eligible destruction device(s), including if an eligible destruction device is located at an adjacent facility.
    - Data indicating the operational status of the eligible destruction device(s) along with evidence that the equipment is operating according to the manufacturer specifications.
- Details of fossil fuel and/or electricity consumed.
    - For meters under control of the proponent, this includes:
        - Documentation describing all fossil fuel and/or electricity meters used, including the meter model number or serial number.
        - Manufacturer specifications for the maintenance and calibration of each meter.
        - Documentation indicating the proper functioning of each meter in accordance with the manufacturer specifications.
    - For meters that are not under control of the proponent:
        - Reasonable efforts must be made to obtain documentation describing all fossil fuel and/or electricity meters used and demonstrating that manufacturer specifications for maintenance and calibration have been met during the reporting period.
    - Documentation describing the location and arrangement of all fossil fuel and/or electricity meters.
    - Metered quantities or purchase records that indicate the quantity and types of fossil fuel and/or quantity of electricity consumed by the project.
- Details about the measuring devices including:
    - Documentation describing the device type, model number and/or serial number for each measuring device included in the project, including flow meters, methane analyzers, temperature or pressure gauges, thermocouples, and/or destruction device monitoring instruments.
    - Manufacturer specifications for the maintenance and calibration of each measuring device included in the project.
    - Documentation describing the location and arrangement of all measuring devices included in the project.
    - Documentation indicating the proper functioning of each measuring device included in the project in accordance with the manufacturer specifications.
- The maintenance records for the active LFG recovery system, destruction devices and measuring devices, including records of accuracy checks.
- Documentation describing the corrective measures applied if a measuring device or meter fails to meet the requirements for measurement accuracy.
- The calibration certificates and/or other records from either the manufacturer or a third-party certified for that purpose for each measuring device or meter which indicate calibration date, time, and results.
- All information and data used to support the quantification of the GHG emission reductions including:
    - All uncorrected LFG volume data, if a flow meter does not automatically correct volume.
    - Measured temperature and pressure data for the LFG, if a flow meter does not automatically correct volume.
    - All LFG volume data, corrected to the reference temperature and pressure conditions as set out in Schedule A – Reference condition values, either automatically or using Equation 4.
    - All LFG $CH_4$ content data.

# 11.0 Reporting requirements

In addition to the reporting requirements specified in the Regulations, the proponent must report the quantified GHG emissions for each SSR included in the baseline and project scenarios in t $CO_2$e for each full or partial calendar year covered by the reporting period.

# Schedule A

## Reference condition values

| Parameter | Description | Value | Units | Reference source |
|---|---|---|---|---|
| $T_{ref}$ | Reference temperature of the LFG | 298.15 | K | Physical constant |
| $P_{ref}$ | Reference pressure of the LFG | 101.325 | kPa | Physical constant |
| $\rho_{CH_4}$ | Reference density of $CH_4$ (at $T_{ref}$ and $P_{ref}$ conditions) | 0.656 | $kg/m^3$ | Physical constant |