Federal Offset Protocol: Reducing Manure Methane Emissions

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Canada's Greenhouse Gas Offset Credit System

Environment and Climate Change 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* to provide an incentive to implement 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 federal or provincial pricing mechanisms for GHG emissions.

Canada's GHG Offset Credit System consists of:

- the *Canadian Greenhouse Gas Offset Credit System Regulations* (the Regulations), which establish the system, implement the operational aspects and set the 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 Canada's GHG Offset Credit System Public Registry

Only projects following a federal offset protocol included in the Compendium and meeting all requirements outlined in the Regulations can generate GHG reductions for which federal offset credits may be issued under the Regulations.

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1.0 Introduction

Methane emissions from livestock manure are primarily generated by anaerobic decomposition of organic matter in liquid manure in an anaerobic storage structure. Implementation of manure treatment systems (MTS) for liquid manure can reduce these methane emissions by reducing the amount of manure methane produced during storage.

The *Reducing Manure Methane Emissions* federal offset protocol is intended for use by a proponent implementing a project that treats eligible manure with one or more eligible MTS in order to generate greenhouse gas (GHG) emission reductions for which federal offset credits may be issued under the *Canadian Greenhouse Gas Offset Credit System Regulations* (the Regulations). The following are eligible project MTS:

- a chemical treatment system that acidifies the manure
- a mechanical treatment system that separates the manure into solid and liquid outputs
- an anaerobic digestion system that allows for the recovery and destruction of manure methane

The proponent must follow the quantification methodology and requirements set out in this protocol, including those to quantify and report GHG emission reductions generated by eligible project activities. The requirements contained in this protocol are part of the Regulations and must be read in conjunction with provisions in the Regulations.

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.

A project that uses biogas produced by an anaerobic digestion system instead of fossil fuels to produce energy may also generate GHG emission reductions from fossil fuel displacement (that is, fuel switching). However, when the GHG emission reductions are from sources that are subject to a federal or provincial pricing mechanism for GHG emissions, GHG emission reductions from fossil fuel displacement are not additional and are not eligible for federal offset credit issuance.

The proponent is also 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*.

Adjacent destruction facility

means a facility adjacent to the manure treatment site where biogas produced by a project anaerobic digestion (AD) manure treatment system (MTS) is combusted and methane (CH_4) is destroyed in an eligible destruction device.

Anaerobic digestion manure treatment system (AD MTS)

means an MTS engineered to maximize anaerobic CH_4 production (for example, through controlled heating, mixing and/or the addition of enzymes) and capture CH_4 for energy generation, including all equipment operated for the treatment of eligible manure and associated outputs such as a digester, treated manure storage, biogas purification systems, and eligible destruction devices.

Anaerobic storage

means the storage of liquid manure under anaerobic conditions for more than 24h in a storage structure with a depth equal to or more than 1 m, such as an earthen basin or lagoon, a tank, a deep pit, or under-barn storage structure.

Biogas

means a gaseous mixture consisting primarily of CH_4 and biogenic carbon dioxide (CO_2), that is produced by the anaerobic decomposition of organic matter (for example, in liquid manure) in an anaerobic storage structure or by treatment of organic matter in an AD MTS.

Biogas can be used directly as a fuel, for example, to generate heat or electricity, or may be upgraded to meet the standards for injection into a natural gas network as renewable natural gas (RNG).

Biogenic CO_2

means CO_2 resulting from the decomposition of manure and the destruction of manure CH_4.

Biogenic CO_2 is considered to be part of the natural carbon cycle.

Chemical manure treatment system (chemical MTS)

means an MTS in which a chemical agent, such as a strong acid, is added to the manure, including all equipment operated for the treatment of eligible manure and associated outputs such as acidification tanks and treated manure storage.

Eligible destruction device

means a device, listed in Table 1, that combusts biogas produced by a project AD MTS, destroys manure CH_4 and converts it into biogenic CO_2 to generate greenhouse gas (GHG) emission reductions.

Feedstock

means any organic material treated by a project MTS, such as eligible manure, non-eligible manure, crop residues, and food industry organic waste.

Global warming potential (GWP)

means a metric representing the ability of a GHG to trap heat in the atmosphere compared to CO_2, as set out in Schedule 3 to the Act.

Livestock operation

means the facility, including the land and buildings, used for the raising of livestock and the storage of livestock liquid and solid manure.

Liquid manure

means livestock excreta containing less than 20% of dry matter content by mass, which may include added water and/or organic or inorganic bedding material such as straw or sand.

Liquid treated manure

means eligible manure treated by a project MTS and containing less than 20% of dry matter content by mass, which may include the acidified manure from a chemical MTS, the liquid output of a mechanical MTS, or the liquid output of an AD MTS.

The liquid output of an AD MTS, also known as digestate, may be composed of treated manure plus other treated feedstock when the project MTS treats other feedstock in addition to eligible manure.

Manure methane (manure CH_4)

means the CH_4 portion of biogas produced by the anaerobic decomposition of liquid manure stored in an anaerobic storage structure or by the treatment of manure in an AD MTS.

Manure treatment site

means the area where a project MTS and all supporting buildings and infrastructure are located.

Eligible manure or treated manure storage structures and eligible destruction devices may be located outside of the manure treatment site, such as at the site of other livestock operations or at an adjacent destruction facility.

Manure treatment system (MTS)

means a system preventing the emission of eligible manure CH_4 to the atmosphere, by reducing manure CH_4 production during storage and by converting manure CH_4 into biogenic CO_2 in the case of an AD MTS.

Mechanical manure treatment system (mechanical MTS)

means an MTS separating the liquid and solid phases of eligible manure by mechanical means such as a filter, press, centrifuge, or other mechanical separation method, including all equipment operated for the treatment of eligible manure and associated outputs and liquid or solid treated manure storage.

Project site

means the area, contiguous or non-contiguous, where all storage sites, the manure treatment site, supporting buildings and infrastructure related to CH_4 destruction, and any adjacent destruction facilities are located as part of a project.

Project MTS

means all AD MTS, chemical MTS or mechanical MTS installed and operated in a project.

Regulations

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

Solid manure

means livestock excreta which contains at least 20% of dry matter content by mass due to the loss of moisture by evaporation or the presence of organic or inorganic bedding material.

Solid treated manure

means eligible manure treated by a project MTS and containing at least 20% of dry matter content by mass, which may include the coarse solid and fine solid phases from a mechanical MTS.

Storage site

means the area where a storage structure is used to store eligible manure in the baseline scenario, or solid or liquid treated manure from a project MTS for a period of more than 24 hours.

The storage site may be adjacent or not to the manure treatment site.

Treated manure

means both liquid treated manure and solid treated manure.

Under-barn storage

means the storage of liquid manure in a structure located below a slatted floor in an enclosed animal confinement facility; often used for swine.

Under-barn storage is considered as anaerobic storage if depth is equal to or more than 1 m.

3.0 Baseline scenario

3.1 Baseline conditions

For a project to be eligible under this protocol, at least one of the following baseline conditions must be met at the project site:

- Any livestock operation raising any type of livestock was established at least 3 years before the project start date and has continuously managed liquid manure in anaerobic storage for at least 3 years before the project start date; or

- Any dairy cattle or swine livestock operation established less than 3 years before the project start date has managed liquid manure in anaerobic storage before the project start date

In addition, for any livestock operation, the following baseline conditions must be met for at least 10 years before the project start date or, if the livestock operation was established less than 10 years before the project start date, since its establishment:

- The biogas produced from anaerobic storage of liquid manure was not recovered, combusted, or treated in any way, including by biofilters
- Liquid manure was not treated by a chemical MTS
- Liquid manure was not treated by a mechanical MTS or an AD MTS, notwithstanding that the liquid output after treatment by such an MTS operating during the project is considered as eligible manure, as per Section 4.2

3.2 Determining the baseline scenario

The baseline scenario for a project implemented following this protocol is the release of manure CH_4 to the atmosphere from anaerobic storage of eligible manure. GHG emissions from the anaerobic storage of eligible manure that would have occurred in the absence of the project (baseline scenario) are quantified using a dynamic baseline approach, as per Section 8.1.1.

In addition, where an AD MTS is part of a project and produces biogas eligible for fossil fuel displacement, as per Section 4.4, and the proponent chooses to quantify the resulting GHG emission reductions for federal offset credit issuance, the proponent must determine the type and the annual amount of fossil fuels that would have been used in the baseline scenario. The proponent must quantify these baseline scenario GHG emissions as per Section 8.1.2.

4.0 Project scenario

4.1 Project conditions

To be eligible under this protocol, a project must meet the following project conditions:

- Within the project site, eligible manure is treated by at least one MTS of the types listed in Section 4.3
- Each project MTS has been installed and operated on or after January 1, 2017

A project MTS may treat any feedstock, but only eligible manure can generate GHG emission reductions from anaerobic storage under this protocol.

Structures storing eligible manure may have been installed and operated prior to January 1, 2017.

4.2 Eligible manure

Manure that is to be treated in a project must meet the following conditions to be considered as eligible manure under this protocol:

- Manure is liquid and sourced from a livestock operation meeting the applicable baseline conditions in Section 3.1
- Liquid manure was not mixed with any other organic or inorganic material before storage, except for animal bedding
- If liquid manure is treated by an MTS that is not part of the project (for example, installed prior to January 1, 2017), the liquid output of manure after treatment by that MTS is considered as eligible manure

4.3 Eligible project activities

Eligible project activities are the treatment of eligible manure using one or more of the following MTS types that are installed and operated within the project site:

- **A chemical MTS** where a chemical agent is added to the eligible manure to prevent manure CH_4 production under anaerobic storage, and meeting the following requirements:
    - Eligible manure is acidified to continuously maintain a pH of 5.5 or less
    - Acidification is achieved via the addition of sulfuric acid exclusively

  After the end of the reporting period, the acidified treated manure storage structure is emptied, and the acidified treated manure is land applied within 2 months.

  The chemical agent used in a chemical MTS may be added to the eligible manure in the storage structure or prior to the eligible manure entering the storage structure.

  Systems where the chemical agent is added post-storage, such as during land application, are not eligible under this protocol.

- **A mechanical MTS** where eligible manure is separated by mechanical means into:
    - solid treated manure that is subsequently stored aerobically, producing low levels of manure CH_4 emissions
    - liquid treated manure with lower organic content that is subsequently stored anaerobically, resulting in lower levels of manure CH_4 emissions than raw manure

  A mechanical MTS may consist of any type of mechanical separation system, from a system allowing only the separation of coarse solids to a system allowing the separation of fine solids (also known as nutrient recovery systems).

  A mechanical MTS may use chemicals, such as flocculants, to improve the efficiency of separation by mechanical means.

- **An AD MTS** where manure CH_4 is converted into biogenic CO_2 by producing and combusting biogas, resulting in lower levels of CH_4 emissions during the subsequent anaerobic storage of liquid treated manure, and meeting the following requirements:
    - The manure CH_4 is destroyed by combusting the biogas in one or more of the eligible destruction devices listed in Table 1
    - Eligible destruction devices may have been installed and operated prior to January 1, 2017

- Eligible destruction devices may be located at an adjacent destruction facility provided that they are not a flare (open or enclosed)

An AD MTS may receive and treat feedstock from more than one source, including eligible manure from more than one livestock operation (also known as a centralized digester or hub-and-spoke AD).

Covered manure storage structures with passive CH_4 production and capture are not considered AD MTS and not eligible under this protocol.

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 a gas.
Enclosed flare	A device with an insulated cylinder stack surrounding a burner manifold and combustion/cooling air louvers that combusts 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 (for example, 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 (for example, a generator producing electricity).
Station for direct injection of upgraded biogas into a natural gas network[1]	A device that monitors and prepares upgraded biogas 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 biogas prior to transport and injection into a natural gas network	A device that compresses or liquefies upgraded biogas for transport to a station for its injection into a natural gas network (see above).

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

If the proponent is not the owner of the project MTS, or any part of the project MTS, the proponent must have an agreement with the owner to ensure:

- the proponent and verification body can access the project MTS and can obtain all data and information needed for ensuring compliance with requirements in the protocol
- requirements in subsection 4(3) and paragraphs 8(1)(b) and 8(1)(c) of the Regulations are met

4.4 Eligible biogas for displacement of fossil fuels

The biogas produced by a project AD MTS and destroyed in an eligible destruction device generating energy may displace fossil fuels.

If a project AD MTS treats other feedstocks in addition to eligible manure, biogas produced by all feedstocks can generate GHG emission reductions from the displacement of fossil fuels under this protocol, if the conditions are met. However, only eligible manure can generate GHG emission reductions from anaerobic storage.

The biogas produced by the project AD MTS and used to displace fossil fuels is eligible to generate GHG emission reductions under this protocol, provided the following conditions are met:

- The biogas is displacing fossil fuels combusted in equipment present and in operation at the project site, including any adjacent destruction facility, during the 3 years preceding the project start date
- The biogas is displacing fossil fuels that are not subject to federal or provincial pricing mechanisms for GHG emissions
- The biogas is not used to produce RNG for injection into a natural gas network

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 law (including regulations), municipal by-laws, or any other legally binding mandates. This includes legal requirements to control the release of manure biogas or to treat all or a portion of manure to reduce GHG emissions from the livestock operation or for odour or pollutant control (for example, requirements to use biofilters or chemical treatments).

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, federal offset credits can only be issued for GHG emission reductions 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

GHG emission reductions from sources that are subject to a federal or provincial pricing mechanism for GHG emissions are not eligible for federal offset credits.

6.0 General requirements

6.1 Project start date

The start date of a project corresponds to the first day eligible manure enters the project MTS to be treated.

6.2 Project site location and geographic boundaries

The proponent must document the location and geographic boundaries of the project site and prepare a site plan. The site plan must show and clearly label:

- the location of all the components of the project site, including:
  - the manure treatment site
  - all storage sites, including storage sites outside of the manure treatment site
  - any adjacent destruction facility where the CH_4 from the biogas produced by the project MTS is destroyed, if applicable
- the location and arrangement of all project MTS components, which may include:
  - treated manure storage structures
  - equipment to treat manure
  - biogas treatment, purification and upgrading equipment
  - eligible destruction devices, including those located at an adjacent destruction facility
  - biogas measuring devices
  - fossil fuel and/or electricity meters
  - any other equipment associated with the sources, sinks and reservoirs (SSRs) within the project GHG boundary (Section 7.0)
- the location and arrangement of all MTS that are not part of the project, but from which liquid treated manure is eligible manure for the project
- the flow of raw manure and intermediary treated manures between MTS, if applicable

The geographic boundary of the project site must be established as per the Regulations.

6.3 Environmental and social safeguards

6.3.1 Compliance with applicable environmental legal requirements

The proponent must ensure that the project activities and the project site comply with all applicable laws, including regulations, municipal by-laws, operating permits, and other

applicable legal requirements, such as those related to minimizing odour, emergency venting, protecting air and water quality, and managing nutrients from manure.

The proponent must also ensure that any output of the project MTS is disposed of in accordance with all applicable legal requirements, including from relevant federal, provincial, or territorial regulations, and municipal by-laws. Disposal includes, but is not limited to, land application and discharge into water bodies.

6.3.2 Safeguards for land application of acidified liquid treated manure

Acidified liquid treated manure from a chemical MTS will have a lower pH and a higher nitrogen content than untreated manure. To prevent negative impacts[2] from land application of acidified liquid treated manure, the proponent must ensure that all lands receiving acidified liquid treated manure during a reporting period are covered by a crop nutrient management plan or similar fertilizer management document completed by a Professional Agrologist (P.Ag.) or Certified Crop Advisor (CCA). The plan or document must:

- consider soil pH and include measures to monitor soil pH over time
- include measures to manage soil pH for lands receiving acidified liquid treated manure if recommended by the P.Ag or CCA based on factors such as soil type and crop agronomic guidelines
    - Measures include adjustments to manure application rates and the use of soil amendments
- ensure that the nitrogen content of acidified liquid treated manure is accounted for and supplemental fertilizer amounts are adjusted accordingly

The proponent must ensure that recommendations in the crop nutrient plan or similar fertilizer management document for managing soil acidification risks and nitrogen content are implemented.

7.0 Project GHG boundary

The project GHG boundary (Figure 1) contains the SSRs that must be included or excluded by the proponent in the baseline and project scenarios to determine the GHG emission reductions generated by the project.

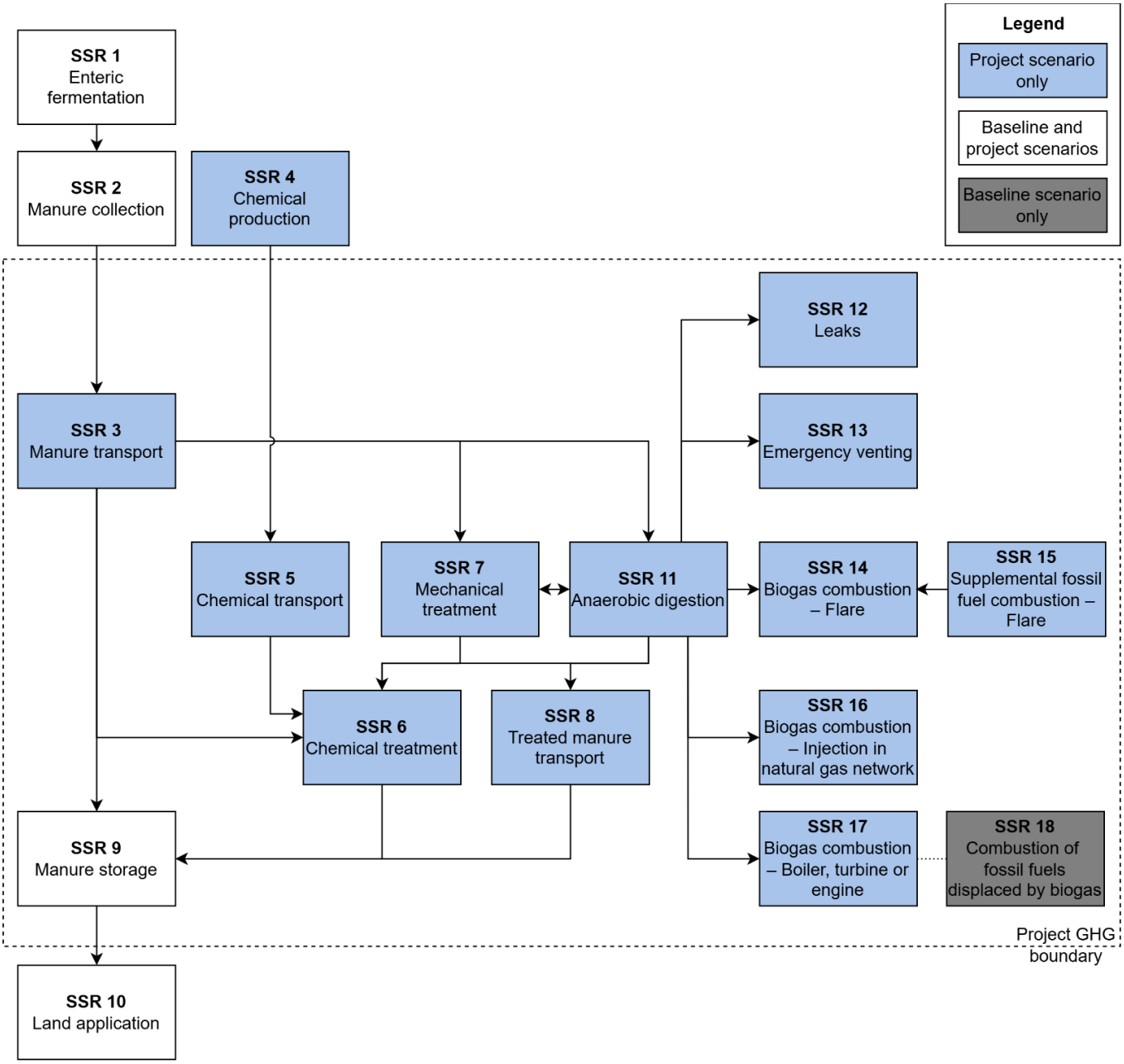
Table 2 provides additional details on the SSRs identified for the baseline and project scenarios, as well as justification for their inclusion or exclusion in the quantification of GHG emission reductions. The proponent must assess each of the “included” SSRs that are relevant to the baseline and project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

Three GHGs are relevant to the SSRs in this protocol: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Biogenic CO_2 is excluded from the quantification of GHG emission

[2] Land application of acidified liquid treated manure has the potential to cause soil acidification which may negatively affect soil health and/or crop production.

reductions under this protocol, that is, biogenic CO_2 from SSR 9, SSR 12, SSR 13, SSR 14, SSR 16 and SSR 17.[3]

Figure 1: Illustration of the project GHG boundary



[3] This is consistent with the Intergovernmental Panel on Climate Change (IPCC). 2001. Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, Chapter 5 (Waste) (PDF), and Canada's national GHG inventory.

Table 2: Details on baseline and project scenario SSRs

SSR	Title	Description	Type	Baseline or project scenario	GHG	Included or excluded
1	Enteric fermentation	Enteric fermentation of the feed consumed by livestock.	Related	Baseline (B1) Project (P1)	CH_4	**Excluded:** The difference in GHG emissions between the baseline and project scenarios is assumed to be negligible.
2	Manure collection	Combustion of fossil fuels or consumption of grid electricity for the operation of the eligible manure collection system.	Related	Baseline (B2) Project (P2)	CO_2 CH_4 N_2O	**Excluded:** The difference in GHG emissions between the baseline and project scenarios is assumed to be negligible.
3	Manure transport	Combustion of fossil fuels in vehicles used to transport eligible manure to the storage or treatment site.	Controlled	Project (P3)	CO_2 CH_4 N_2O	**Included:** Quantified based on fossil fuels usage, using Equation 7.
4	Chemical production	Combustion of fossil fuels and process emissions for the production of chemicals used in a project chemical MTS.	Affected	Project (P4)	CO_2 CH_4 N_2O	**Excluded:** GHG emissions from this source are assumed to be negligible.
5	Chemical transport	Combustion of fossil fuels in vehicles used to transport chemicals from the point of retail to the site of the project chemical MTS.	Controlled	Project (P5)	CO_2 CH_4 N_2O	**Included:** Quantified based on fossil fuels usage, using Equation 7.
6	Chemical treatment	Combustion of fossil fuels or consumption of grid electricity for the operation of the project chemical MTS.	Fossil fuels: Controlled Electricity: Related	Project (P6)	CO_2 CH_4 N_2O	**Included:** Quantified based on energy usage, using Equation 7 and/or Equation 8.

SSR	Title	Description	Type	Baseline or project scenario	GHG	Included or excluded
7	Mechanical treatment	Combustion of fossil fuels or consumption of grid electricity for the operation of the project mechanical MTS.	Fossil fuels: Controlled Electricity: Related	Project (P7)	CO_2	**Included:** Quantified based on energy usage, using Equation 7 and/or Equation 8.
					CH_4	
					N_2O	
8	Treated manure transport	Combustion of fossil fuels in vehicles used to transport treated manure to the storage site or direct land application.	Controlled	Project (P8)	CO_2	**Included:** Quantified based on fossil fuels usage, using Equation 7.
					CH_4	
					N_2O	
9	Manure storage	Eligible manure or treated manure decomposition during storage.	Controlled	Baseline (B9) Project (P9)	CH_4	**Included:** Quantified for eligible manure using Equation 2 or Equation 3, and for treated manure, as per Section 8.2.3.
					N_2O	**Included:** For solid treated manure using Equation 21 or Equation 22. **Excluded:** For liquid treated manure, GHG emissions from this source are not expected to increase in the project scenario compared to the baseline scenario.
10	Land application	Combustion of fossil fuels in equipment used to apply eligible manure or	Related	Baseline (B10)	CO_2	**Excluded:** GHG emissions from this source are not expected to increase
					CH_4	

SSR	Title	Description	Type	Baseline or project scenario	GHG	Included or excluded
		treated manure to the land and emissions from eligible manure or treated manure decomposition in the soil.		Project (P10)	N_2O	in the project scenario with a mechanical or AD MTS compared to the baseline scenario. Any risk of increased N_2O emissions from land application of acidified treated manure is addressed through safeguards prescribed in Section 6.3.2.
11	Anaerobic digestion	Combustion of fossil fuels or consumption of grid electricity for the operation of the project AD MTS.	Fossil Fuels: Controlled Electricity: Related	Project (P11)	CO_2	**Included:** Quantified based on energy usage, using Equation 7 and/or Equation 8.
					CH_4	
					N_2O	
12	Leaks	Release of biogas due to continuous leaks in the AD MTS.	Controlled	Project (P12)	CH_4	**Included:** Quantified based on a default or site-specific rate, using Equation 10.
					N_2O	**Excluded:** N_2O emissions from biogas leaks are assumed to be negligible.
13	Emergency venting	Release of biogas due to emergency venting.	Controlled	Project (P13)	CH_4	**Included:** Quantified based on a default or site-specific rate, using Equation 13.
					N_2O	**Excluded:** N_2O emissions from this source are assumed to be negligible.
14		Combustion of biogas in an open or	Controlled		CH_4	**Included:** Quantified based on the

SSR	Title	Description	Type	Baseline or project scenario	GHG	Included or excluded
	Biogas combustion – Flare	enclosed flare, as set out in Table 1.		Project (P14)	N_2O	incomplete destruction of CH_4 and the generation of N_2O from the combustion of biogas in a flare, using Equation 14.
15	Supplemental fossil fuel combustion – Flare	Combustion of supplemental fossil fuels to support the operation of an open or enclosed flare.	Controlled	Project (P15)	CO_2 CH_4 N_2O	**Included:** Quantified based on combustion of supplemental fossil fuels in a flare, using Equation 17.
16	Biogas combustion – Injection in natural gas network	Combustion of upgraded biogas after its injection into a natural gas network with or without compression or liquefaction, as set out in Table 1.	Controlled	Project (P16)	CH_4 N_2O	**Included:** Quantified based on the incomplete destruction of CH_4 and the N_2O emissions generated from the combustion of biogas in an eligible destruction device, using Equation 14.
17	Biogas combustion – Boiler, turbine or engine	Combustion of biogas in a boiler, turbine or internal combustion engine, as set out in Table 1.	Controlled	Project (P17)	CH_4 N_2O	**Included:** Quantified based on the incomplete destruction of CH_4 and the N_2O emissions generated from the combustion of biogas in an eligible destruction device, using Equation 14.
18	Combustion of fossil fuels displaced by biogas	GHG emissions from the combustion of fossil fuels in the baseline scenario	Controlled	Baseline (B18)	CO_2 CH_4	**Included:** Quantified for fossil fuels displaced by eligible biogas, as per

SSR	Title	Description	Type	Baseline or project scenario	GHG	Included or excluded
		that are displaced by eligible biogas produced in the project scenario.			N_2O	Section 4.4, based on the volume of fossil fuels that would have been needed to produce the amount of energy generated by CH_4 from the eligible biogas produced by the project AD MTS using Equation 4.

8.0 Quantification methodology

This section contains the quantification methodology that the proponent must follow to quantify baseline and project scenario GHG emissions and subsequently, the GHG emission reductions generated by the project.

Baseline scenario GHG emissions are the GHG emissions from the SSRs within the project GHG boundary that would likely have occurred in the absence of the project from the business-as-usual management of the same amount of eligible manure treated in the project scenario. Baseline scenario GHG emissions are quantified based on GHG emissions from the anaerobic storage of eligible manure, and, if applicable, GHG emissions that would have occurred in the absence of the project from the combustion of fossil fuels displaced by eligible biogas, as per Section 8.1.

Project scenario GHG emissions are the GHG emissions from the SSRs within the project GHG boundary that are generated from the eligible project activities, and quantified as per Section 8.2.

The GHG emission reductions generated by the project are quantified by deducting the project scenario GHG emissions from the baseline scenario GHG emissions, as per Section 8.4.

The quantification of both the baseline and project scenario GHG emissions must include all the GHG emissions that were likely to occur in the absence of the project (baseline scenario) and did occur (project scenario) during a reporting period. The proponent must report the sub-totals in tonnes of CO_2 equivalent (t CO_2e) for each full or partial calendar year of the reporting period to support issuance of the offset credits by calendar year.

For an aggregation of projects, the proponent must quantify GHG emission reductions for each project separately. Subsequently, the GHG emission reductions for each project are to be summed together to determine the GHG emission reductions for the aggregation of projects. The proponent must report the sub-totals of each project within the aggregation in tonnes of CO_2 equivalent (t CO_2e) for each full or partial calendar year of the reporting period to support issuance of the offset credits by calendar year.

Some emission factors and other reference values used in the quantification methodology are provided in the *Emission Factors and Reference Values* document.[4] Raw data must be converted to align with the units presented in the quantification methodology, if necessary.

8.1 Baseline scenario GHG emissions

The proponent must use Equation 1 and the subsequent equations in Section 8.1 to quantify the baseline scenario GHG emissions for each full or partial calendar year covered by the reporting period, based on the included SSRs as set out in Table 2.

The baseline scenario GHG emissions are quantified using a dynamic baseline approach based on eligible manure that is treated in the project scenario.

Equation 1: Baseline scenario GHG emissions for a calendar year covered by the reporting period

$$BE_C = \left(\sum_{i}^{n} BSE_{i,C}\right) + FDE_C$$

Parameter	Description	Units
BE_C	Baseline scenario GHG emissions for a calendar year covered by the reporting period	t CO_2e
$BSE_{i,C}$	Baseline scenario CH_4 emissions from the anaerobic storage of eligible manure from livestock operation, i, for a calendar year covered by the reporting period, as per Equation 2 or Equation 3 (SSR B9)	t CO_2e
FDE_C	Baseline scenario GHG emissions from the combustion of fossil fuels displaced by eligible biogas for a calendar year covered by the reporting period, as per Equation 4 (SSR B18)	t CO_2e
i	Livestock operation	unitless
n	Number of livestock operations from which eligible manure is sourced during a calendar year covered by the reporting period. If BSE is quantified as per Equation 3, n = 1	unitless
C	Calendar year	unitless

[4] To be used along with federal offset protocols, the *Emission Factors and Reference Values* document contains general and protocol-specific emission factors and other reference values that are needed for the quantification of GHG emission reductions.

8.1.1 Baseline scenario CH_4 emissions from the anaerobic storage of eligible manure

To quantify baseline scenario CH_4 emissions from the anaerobic storage of eligible manure, the proponent must use the equation of one of the following two options:

- Option 1: **Equation 2**, which is **based on the volatile solids (VS) content** of the eligible manure, measured as per Section 9.1.2; or
- Option 2: **Equation 3**, which is **based on the number of livestock,** as per Section 9.1.3, if the project meets the following conditions:
  - The project MTS treats eligible manure from a single livestock operation.
  - Eligible manure is not treated by an MTS that is not part of the project.
  - If the project MTS includes an AD system, no feedstock other than eligible manure from the livestock operation is treated by the project MTS (that is, no co-digestion).

In all cases, the proponent must derive a site-specific methane conversion factor (MCF), determined as per Section 9.1.5.

Equation 2: Baseline scenario CH_4 emissions from anaerobic storage of eligible manure based on VS content for a calendar year covered by the reporting period

$$\mathrm{BSE_{i,C}} = \sum_{\mathrm{m}}^{\mathrm{M}} (\mathrm{QM_{i,m}} \times \mathrm{VS_{source,i,m}}) \times \mathrm{B_{0,l}} \times \mathrm{MCF_C} \times \frac{\rho_{\mathrm{CH4}}}{1000} \times \mathrm{GWP_{CH4}}$$

Parameter	Description	Units
$\mathrm{BSE_{i,C}}$	Baseline scenario CH_4 emissions from the anaerobic storage of eligible manure from livestock operation, i, for a calendar year covered by the reporting period (SSR B9)	t CO_2e
$\mathrm{QM_{i,m}}$	Quantity of eligible manure from livestock operation, i, treated by the project MTS in the project scenario for month, m, as per Sections 9.1.1 and 9.3	t
$\mathrm{VS_{source,i,m}}$	VS content of eligible manure from livestock operation, i, treated by the project MTS in the project scenario for month, m, before mixing with any other organic material, as per Sections 9.1.2 and 9.3	kg VS/t manure
$\mathrm{B_{0,l}}$	Maximum CH_4 producing potential for manure from livestock type, l, as set out in the *Emission Factors and Reference Values* document. If the livestock operation, i, includes more than one livestock type, B_0 must correspond to the livestock type producing the largest quantity of eligible manure.	m^3 CH_4/kg VS
$\mathrm{MCF_C}$	Site-specific methane conversion factor for a calendar year covered by the reporting period, as per Section 9.1.5	unitless
ρ_{CH4}	Reference density of CH_4 = 0.656	kg CH_4/m^3 CH_4

1000	Conversion factor, kilograms to tonnes	kg/t
GWP_{CH4}	GWP of CH_4, as set out in Schedule 3 to the Act	unitless
M	Number of months during a calendar year covered by the reporting period	unitless
m	Month	unitless
i	Livestock operation	unitless
l	Livestock type, as set out in the *Emission Factors and Reference Values* document	unitless
C	Calendar year	unitless

Equation 3: Baseline scenario CH_4 emissions from anaerobic storage of eligible manure based on the number of livestock for a calendar year covered by the reporting period

$$BSE_{i,C} = \sum_{l}^{L} \left(LHC_{l,C} \times VS_{rate,l} \times B_{0,l} \times D_{l,C}\right) \times MCF_C \times \frac{\rho_{CH4}}{1000} \times GWP_{CH4}$$

Parameter	Description	Units
$BSE_{i,C}$	Baseline scenario CH_4 emissions from the anaerobic storage of eligible manure from livestock operation, i, for a calendar year covered by the reporting period (SSR B9)	t CO_2e
$LHC_{l,C}$	Average number of livestock from livestock type, l, producing eligible manure treated by the project MTS, for a calendar year covered by the reporting period, as per Sections 9.1.3 and 9.3	head
$VS_{rate,l}$	VS excretion rate for a livestock type, l, producing eligible manure treated by the project MTS for a calendar year covered by the reporting period, as set out in the *Emission Factors and Reference Values* document	kg VS/head/day
$B_{0,l}$	Maximum CH_4 producing potential for manure from livestock type, l, as set out in the *Emission Factors and Reference Values* document	m^3 CH_4/kg VS
$D_{l,C}$	Number of days of eligible manure production for livestock type, l, during a calendar year covered by the reporting period, as per Sections 9.1.3 and 9.3	day
MCF_C	Site-specific methane conversion factor for a calendar year covered by the reporting period, as per Section 9.1.5	unitless
ρ_{CH4}	Reference density of CH_4 = 0.656	kg CH_4/m^3 CH_4

1000	Conversion factor, kilograms to tonnes	kg/t
GWP_{CH4}	GWP of CH_4, as set out in Schedule 3 to the Act	unitless
L	Number of livestock types from which eligible manure is sourced for a calendar year covered by the reporting period	unitless
l	Livestock type as set out in the *Emission Factors and Reference Values* document	unitless
i	Livestock operation	unitless
C	Calendar year	unitless

8.1.2 Baseline scenario GHG emissions from the combustion of fossil fuels displaced by eligible biogas

If the project includes an AD MTS that produces eligible biogas for displacement of fossil fuels and the proponent chooses to quantify the resulting GHG emission reductions for credit issuance, they must use Equation 4 to quantify baseline scenario GHG emissions from the combustion of fossil fuels displaced by eligible biogas.

Equation 4: Baseline scenario GHG emissions from combustion of fossil fuels displaced by eligible biogas for a calendar year covered by the reporting period

$$FDE_C = \sum_{i}^{n} \left[\begin{matrix} \left(FD_{i,C} \times EF_{CO_2,i}\right) + \left(FD_{i,C} \times EF_{CH_4,i} \times GWP_{CH_4}\right) \\ +\left(FD_{i,C} \times EF_{N_2O,i} \times GWP_{N_2O}\right) \end{matrix} \right] \div 1000$$

Parameter	Description	Units
FDE_C	Baseline scenario GHG emissions from the combustion of fossil fuels displaced by eligible biogas for a calendar year covered by the reporting period (SSR B18)	t CO_2e
$FD_{i,C}$	Volume of fossil fuel, i, displaced by eligible biogas and used in the baseline scenario for a calendar year covered by the reporting period, as per Equation 5	m^3
$EF_{CO_2,i}$	CO_2 emission factor for fossil fuel, i, as set out in the *Emission Factors and Reference Values* document	kg CO_2/m^3
$EF_{CH_4,i}$	CH_4 emission factor for fossil fuel, i, as set out in the *Emission Factors and Reference Values* document	kg CH_4/m^3
GWP_{CH_4}	GWP of CH_4, as set out in Schedule 3 to the Act	unitless
$EF_{N_2O,i}$	N_2O emission factor for fossil fuel, i, as set out in the *Emission Factors and Reference Values* document	kg N_2O/m^3
GWP_{N_2O}	GWP of N_2O, as set out in Schedule 3 to the Act	unitless

1000	Conversion factor, kilograms to tonnes	kg/t
n	Number of fossil fuels displaced by eligible biogas	unitless
i	Fossil fuel displaced by eligible biogas	unitless
C	Calendar year	unitless

The volume of fossil fuels that would have been used in the baseline scenario to generate the equivalent amount of energy as the combustion of eligible biogas must be calculated using Equation 5. However, if the value of $FD_{i,C}$, obtained from Equation 5, is higher than the highest annual volume of fossil fuels used during the 3 years before the project start date, the proponent must use this highest annual volume as the value of $FD_{i,C}$ in Equation 4.

Equation 5: Volume of fossil fuel displaced by eligible biogas for a calendar year covered by a reporting period

$$\mathrm{FD_{i,C}} = \mathrm{BGD_C} \times \left(\frac{\mathrm{HHV_{BG}}}{\mathrm{HHV_{FF,i}}}\right)$$

Parameter	Description	Units
$\mathrm{FD_{i,C}}$	Volume of fossil fuel, i, displaced by eligible biogas and used in the baseline scenario for a calendar year covered by the reporting period	m^3
$\mathrm{BGD_C}$	Volume of biogas eligible for displacement of fossil fuels in the project scenario for a calendar year covered by the reporting period, as per Sections 9.1.6 and 9.3	m^3
$\mathrm{HHV_{BG}}$	Higher heating value of biogas produced by the project AD MTS, as set out in the *Emission Factors and Reference Values* document	MJ/m^3
$\mathrm{HHV_{FF,i}}$	Higher heating value of fossil fuel, i, displaced by eligible biogas, as set out in the *Emission Factors and Reference Values* document	MJ/m^3
i	Fossil fuel displaced by eligible biogas	unitless
C	Calendar year	unitless

If eligible biogas has been upgraded to the standards required to be RNG, the proponent must use the applicable higher heating value for RNG, as set out in the *Emission Factors and Reference Values* document, for the parameter HHV_{BG} in Equation 5.

If eligible biogas has not been upgraded to the standards required to be RNG, the proponent must use the higher heating value for biogas regardless of the CH_4 composition of the biogas, as set out in the *Emission Factors and Reference Values* document, for the parameter HHV_{BG} in Equation 5.

Despite the previous provision, the proponent may determine a project-specific higher heating value for eligible biogas by measuring the energy density of the biogas following the requirements for fuel heat content monitoring set out in Section 2.D.3 of the latest available version of *Canada's Greenhouse Gas Quantification Requirements / Greenhouse Gas Reporting Program*, and corrected to standard conditions.

8.2 Project scenario GHG emissions

The proponent must use Equation 6 and the subsequent equations in Section 8.2 to quantify the project scenario GHG emissions for each full or partial calendar year covered by the reporting period, based on the included SSRs, as set out in Table 2.

The project scenario GHG emissions correspond to the GHG emissions from, as applicable:

- the use of fossil fuels or electricity, quantified as per Section 8.2.1, for:
  - the transport of eligible manure from the livestock operation to the project MTS (SSR P3)
  - the transport of chemicals (that is, sulfuric acid) necessary for the operation of a project chemical MTS, from the retail site to the project MTS (SSR P5)
  - the transport of solid and liquid treated manure from the project MTS to the storage site (SSR P8)
  - the operation of the project MTS, including the treatment equipment, the biogas purification system, and the destruction device (SSR P6, SSR P7 and SSR P11)
- sources specific to a project AD MTS, quantified as per Section 8.2.2:
  - leaks occurring at any point in the project AD MTS, with the exclusion of tanks, platforms receiving feedstock, treated manure storage structures and eligible destruction devices (SSR P12)
  - emergency venting where biogas is released to the atmosphere, indicated by a zero or near zero flow to all the eligible destruction devices simultaneously when biogas storage is at maximum capacity (SSR P13)
  - incomplete destruction of CH_4 and generation of N_2O from the combustion of biogas in eligible destruction devices (SSR P14, SSR P16 and SSR P17)
  - supplemental fossil fuels used to support the operation of a flare (SSR P15)
- the storage of liquid and solid treated manure (SSR P9), quantified as per Section 8.2.3

Equation 6: Project scenario GHG emissions for a calendar year covered by the reporting period

$$PE_C = FF_C + EL_C + ADE_C + LTM_C + STM_C$$

Parameter	Description	Units
PE_C	Project scenario GHG emissions for a calendar year covered by the reporting period	t CO_2e
FF_C	GHG emissions from the combustion of fossil fuels for the transport of eligible manure (SSR P3), chemicals (SSR P5) and treated manure (SSR P8) and the operation of the	t CO_2e

	project MTS (SSR P6, SSR P7 and SSR P11) for a calendar year covered by the reporting period, as per Equation 7	
EL_C	GHG emissions from the use of grid electricity for the operation of the project MTS for a calendar year covered by the reporting period, as per Equation 8 (SSR P6, SSR P7 and SSR P11)	t CO_2e
ADE_C	GHG emissions specific to a project AD MTS from leaks (SSR P12), emergency venting (SSR P13), the incomplete destruction of CH_4 and the generation of N_2O from the combustion of biogas in eligible destruction device(s) (SSR P14, SSR P16 and SSR P17), and the combustion of supplemental fossil fuels to support the operation of a flare (SSR P15) for a calendar year covered by the reporting period, as per Equation 9	t CO_2e
LTM_C	CH_4 emissions from the anaerobic storage of liquid treated manure in the project scenario for a calendar year covered by the reporting period, as per Equation 18 or Equation 20 (SSR P9)	t CO_2e
STM_C	GHG emissions from the storage of solid treated manure in the project scenario for a calendar year covered by the reporting period, as per Equation 21 or Equation 22 (SSR P9)	t CO_2e
C	Calendar year	unitless

8.2.1 Project scenario GHG emissions from fossil fuels combustion and energy usage

The proponent must use Equation 7 to quantify the GHG emissions from the combustion of fossil fuels used for the transport of eligible manure, chemicals, and treated manure as well as from the operation of the project MTS for a calendar year covered by the reporting period. For the GHG emissions from transport, the volume of fossil fuels consumed ($FF_{i,C}$) is determined using the total transport distance and vehicle energy consumption data.

The proponent must use Equation 8 to quantify the GHG emissions from the use of grid electricity for the operation of the project MTS for a calendar year covered by the reporting period.

If both fossil fuels and grid electricity are used for the operation of the project MTS, the proponent must use the summation of Equation 7 and Equation 8 as the total GHG emissions for SSR P6, SSR P7 and SSR P11 for reporting purposes, as per Section 11.0.

Equation 7: GHG emissions from the combustion of fossil fuels for the transport of eligible manure, chemicals and treated manure and the operation of the project MTS for a calendar year covered by the reporting period

$$FF_C = \sum_i^n \left[\begin{matrix} \left(FF_{i,C} \times EF_{CO_2,i}\right) + \left(FF_{i,C} \times EF_{CH_4,i} \times GWP_{CH_4}\right) \\ +\left(FF_{i,C} \times EF_{N_2O,i} \times GWP_{N_2O}\right) \end{matrix} \right] \div 1000$$

Parameter	Description	Units
FF_C	GHG emissions from the combustion of fossil fuels for the transport of eligible manure (SSR P3), chemicals (SSR P5) and treated manure (SSR P8), and the operation of the project MTS (SSR P6, SSR P7 and SSR P11) for a calendar year covered by the reporting period	t CO_2e
$FF_{i,C}$	Volume of the type of fossil fuel, i, consumed by mobile and/or stationary equipment for the transport of eligible manure, chemicals, and treated manure and the operation of the project MTS, for a calendar year covered by the reporting period, as per Section 9.3	m^3
$EF_{CO_2,i}$	CO_2 emission factor for fossil fuel, i, as set out in the *Emission Factors and Reference Values* document	kg CO_2/m^3
$EF_{CH_4,i}$	CH_4 emission factor for fossil fuel, i, as set out in the *Emission Factors and Reference Values* document	kg CH_4/m^3
GWP_{CH_4}	GWP of CH_4, as set out in Schedule 3 to the Act	unitless
$EF_{N_2O,i}$	N_2O emission factor for fossil fuel, i, as set out in the *Emission Factors and Reference Values* document	kg N_2O/m^3
GWP_{N_2O}	GWP of N_2O, as set out in Schedule 3 to the Act	unitless
1000	Conversion factor, kilograms to tonnes	kg/t
n	Number of fossil fuels displaced by eligible biogas	unitless
i	Fossil fuel displaced by eligible biogas	unitless
C	Calendar year	unitless

Equation 8: GHG emissions from the use of grid electricity for the operation of the project MTS for a calendar year covered by the reporting period

$$EL_C = \frac{GridEL \times EF_{EL,GHG}}{1000}$$

Parameter	Description	Units
$\mathrm{EL_C}$	GHG emissions from the use of grid electricity for the operation of the project MTS for a calendar year covered by the reporting period (SSR P6, SSR P7 and SSR P11)	t CO_2e
GridEL	Grid electricity consumed by the project MTS for a calendar year covered by the reporting period, as per Section 9.3	MWh
$\mathrm{EF_{EL,GHG}}$	Emission factor for the electricity consumption GHG emission intensity for the grid of the project's province or territory, as set out in the *Emission Factors and Reference Values* document	kg CO_2e/MWh
1000	Conversion factor, kilograms to tonnes	kg/t

8.2.2 Project scenario GHG emissions specific to a project AD MTS

If the project includes an AD MTS, the proponent must use Equation 9 to quantify GHG emissions specific to the project AD MTS in the project scenario.

Equation 9: GHG emissions specific to a project AD MTS for a calendar year covered by the reporting period

$$\mathrm{ADE_C} = \mathrm{LK_C} + \mathrm{EV_C} + \mathrm{DBG_C} + \mathrm{FF_{Flare,C}}$$

Parameter	Description	Units
$\mathrm{ADE_C}$	GHG emissions specific to a project AD MTS from leaks (SSR P12), emergency venting (SSR P13), the incomplete destruction of CH_4 and the generation of N_2O from the combustion of biogas in eligible destruction device(s) (SSR P14, SSR P16 and SSR P17), and the combustion of supplemental fossil fuels to support the operation of a flare (SSR P15) for a calendar year covered by the reporting period	t CO_2e
$\mathrm{LK_C}$	GHG emissions from leaks from the project AD MTS for a calendar year covered by the reporting period, as per Equation 10	t CO_2e
$\mathrm{EV_C}$	GHG emissions from emergency venting of biogas from the project AD MTS for a calendar year covered by the reporting period, as per Equation 13	t CO_2e
$\mathrm{DBG_C}$	GHG emissions from the incomplete destruction of CH_4 and the generation of N_2O from the combustion of biogas in the eligible destruction device(s) for a calendar year covered by the reporting period, as per Equation 14	t CO_2e

$FF_{Flare,C}$	GHG emissions from the combustion of supplemental fossil fuels to support the operation of a flare for a calendar year covered by the reporting period, as per Equation 17	t CO_2e
C	Calendar year	unitless

The proponent must use Equation 10 to quantify GHG emissions from leaks from the project AD MTS.

Equation 10: GHG emissions from leaks from the project AD MTS for a calendar year covered by the reporting period

$$LK_C = \sum_{i}^{n} (DM_{i,C}) \times LR \times \frac{\rho_{CH_4}}{1000} \times GWP_{CH_4}$$

Parameter	Description	Units
LK_C	GHG emissions from leaks from the project AD MTS for a calendar year covered by the reporting period (SSR P12)	t CO_2e
$DM_{i,C}$	Volume of CH_4 delivered to an eligible destruction device, i, for a calendar year covered by the reporting period, as per Equation 11	m^3 CH_4
LR	Leak rate for the project AD MTS = 0.05[5], or 0.005[6] if leak surveys are conducted as per Section 9.1.7	unitless
ρ_{CH_4}	Reference density of CH_4 = 0.656	kg CH_4/m^3 CH_4
GWP_{CH_4}	GWP of CH_4, as set out in Schedule 3 to the Act	unitless
1000	Conversion factor, kilograms to tonnes	kg/t
n	Number of eligible destruction devices	unitless
i	Eligible destruction device	unitless
C	Calendar year	unitless

[5] Leak rate from median values in Wechselberger, V., Reinelt, T., Yngvesson, J., Scharfy, D., Scheutz, C., Huber-Humer, M., & Hrad, M. (2023). Methane losses from different biogas plant technologies. Waste Management, 157, 110–120. doi.org/10.1016/j.wasman.2022.12.012; and in Liebetrau, J., Reinelt, T., Agostini, A., & Linke, B. (2017). Methane emissions from biogas plants (37; IEA Bioenergy Task, p. 52). IEA Bioenergy.

[6] Leak rate from the maximum values in Baldé, H., Wagner-Riddle, C., MacDonald, D., & VanderZaag, A. (2022). Fugitive methane emissions from two agricultural biogas plants. Waste Management, 151, 123–130. doi.org/10.1016/j.wasman.2022.07.033; in Wechselberger, V., Reinelt, T., Yngvesson, J., Scharfy, D., Scheutz, C., Huber-Humer, M., & Hrad, M. (2023). Methane losses from different biogas plant technologies. Waste Management, 157, 110–120. doi.org/10.1016/j.wasman.2022.12.012; and in Liebetrau, J., Reinelt, T., Agostini, A., & Linke, B. (2017). Methane emissions from biogas plants (37; IEA Bioenergy Task, p. 52). IEA Bioenergy.

Equation 11: CH_4 delivered to eligible destruction devices for a calendar year covered by the reporting period

$$DM_{i,C} = \sum_{t}^{n} (BG_{i,t} \times MC_{i,t})$$

Parameter	Description	Units
$DM_{i,C}$	Volume of CH_4 delivered to an eligible destruction device, i, for a calendar year covered by the reporting period	m^3 CH_4
$BG_{i,t}$	Corrected volume of biogas produced by the project AD MTS and delivered to an eligible destruction device, i, during measurement period, t, as per Section 9.3 if automatically corrected or as per Equation 12 if not automatically corrected	m^3 biogas
$MC_{i,t}$	Average CH_4 content of the biogas delivered to the eligible destruction device, i, during measurement period, t, as per Section 9.3	m^3 CH_4/m^3 biogas
n	Number of measurement periods in a calendar year covered by the reporting period	unitless
t	Measurement period	unitless
i	Eligible destruction device	unitless
C	Calendar year	unitless

All flow meter data must be corrected to the reference temperature and pressure conditions. If a 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 12. Equation 12 is not needed if the flow meter automatically corrects the volume.

Equation 12: Volume of biogas produced by the project AD MTS delivered to an eligible destruction device, corrected to reference conditions

$$BG_{i,t} = BG_{UC,i,t} \times \frac{T_{ref}}{T_{i,t}} \times \frac{P_{i,t}}{P_{ref}}$$

Parameter	Description	Units
$BG_{i,t}$	Corrected volume of biogas produced by the project AD MTS and delivered to eligible destruction device, i, during measurement period, t	m^3 biogas
$BG_{UC,i,t}$	Uncorrected volume of biogas produced by the project AD MTS and delivered to eligible destruction device, i, during measurement period, t, as per Section 9.3	m^3 biogas

$T_{i,t}$	Measured temperature of the biogas produced by the project AD MTS and delivered to eligible destruction device, i, during the measurement period, t, as per Section 9.3	K
T_{ref}	Reference temperature of the biogas = 298.15 K	K
$P_{i,t}$	Measured pressure of the biogas produced by the project AD MTS and delivered to eligible destruction device, i, during the measurement period, t, as per Section 9.3	kPa
P_{ref}	Reference pressure of the biogas = 101.325 kPa	kPa
t	Measurement period	unitless
i	Eligible destruction device	unitless

In the event of an emergency venting where biogas from the project AD MTS is released to the atmosphere, the proponent must use Equation 13 to quantify the corresponding CH_4 emissions (SSR P13).

Equation 13: GHG emissions from emergency venting of biogas from the project AD MTS for a calendar year covered by the reporting period

$$EV_C = (BD + BG_{V7} \times TV) \times MC_{V7} \times \frac{\rho_{CH_4}}{1000} \times GWP_{CH_4}$$

Parameter	Description	Units
EV_C	GHG emissions from emergency venting of biogas from the project AD MTS for a calendar year covered by the reporting period (SSR P13)	t CO_2e
BD	Estimated volume of stored biogas vented to the atmosphere, as per Section 9.1.8	m^3 biogas
BG_{V7}	Average flow of biogas produced by the project AD MTS during the 7 days preceding the emergency venting event, measured as the sum of $BG_{i,t}$ for all eligible destruction devices, as per Section 9.3	m^3 biogas/h
TV	Duration of emergency venting event	h
MC_{V7}	Average CH_4 content of the biogas produced by the project AD MTS during the 7 days preceding the emergency venting event, measured as the average of $MC_{i,t}$, for all eligible destruction devices, as per Section 9.3	m^3 CH_4/m^3 biogas
ρ_{CH_4}	Reference density of CH_4 = 0.656	kg CH_4/m^3 CH_4
GWP_{CH_4}	GWP of CH_4, as set out in Schedule 3 to the Act	unitless

1000	Conversion factor, kilograms to tonnes	kg/t
C	Calendar year	unitless

The proponent must use Equation 14 to quantify GHG emissions from the incomplete destruction of CH_4 and the generation of N_2O from the combustion of biogas in eligible destruction devices (SSR P14 – flare, SSR P16 – injection in natural gas network and SSR P17 – boiler, turbine or engine), for each calendar year covered by the reporting period.

Equation 14: GHG emissions from the incomplete destruction of CH_4 and the generation of N_2O from the combustion of biogas in eligible destruction device(s) for a calendar year covered by the reporting period

$$DBG_C = IDM_C + CBG_C$$

Parameter	Description	Units
DBG_C	GHG emissions from the incomplete destruction of CH_4 and the generation of N_2O from the combustion of biogas in the eligible destruction device(s) for a calendar year covered by the reporting period (SSR P14, SSR P16 and SSR P17)	t CO_2e
IDM_C	CH_4 emissions from the incomplete destruction of CH_4 in the eligible destruction device(s), for a calendar year covered by the reporting period, as per Equation 15	t CO_2e
CBG_C	N_2O emissions from the combustion of biogas in the eligible destruction device(s) for a calendar year covered by the reporting period, as per Equation 16	t CO_2e
C	Calendar year	unitless

Equation 15: CH_4 emissions from the incomplete destruction of CH_4 in the eligible destruction device(s) for a calendar year covered by the reporting period

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

Parameter	Description	Units
IDM_C	CH_4 emissions from the incomplete destruction of CH_4 in the eligible destruction device(s), for a calendar year covered by the reporting period (SSR P14, SSR P16 and SSR P17)	t CO_2e
$DM_{i,C}$	Volume of CH_4 delivered to an eligible destruction device, i, for a calendar year covered by the reporting period, as per Equation 11	m^3 CH_4

$DE_{CH_4,i}$	CH_4 destruction efficiency of eligible destruction device, i, as set out in the *Emission Factors and Reference Values* document or specific to the device	unitless
ρ_{CH_4}	Reference density of CH_4 = 0.656	kg CH_4/m^3 CH_4
GWP_{CH_4}	GWP of CH_4, as set out in Schedule 3 to the Act	unitless
1000	Conversion factor, kilograms to tonnes	kg/t
n	Number of eligible destruction devices	unitless
i	Eligible destruction device	unitless
C	Calendar year	unitless

The amount of CH_4 destroyed in each eligible destruction device is dependent on the CH_4 destruction efficiency for each device (DE_{CH4}). The *Emission Factors and Reference Values* document sets out default CH_4 destruction efficiencies that the proponent must use for each eligible destruction device in the project.

Despite the previous provision, the proponent may 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 reporting period, and include at least 3 test runs, with the accepted final value being one standard deviation below the mean of the measured efficiencies.

Equation 16: N_2O emissions from the combustion of biogas in the eligible destruction device(s) for a calendar year covered by the reporting period

$$CBG_C = \sum_{i}^{n} (DM_{i,C}) \times \frac{\rho_{CH_4}}{1000} \times \frac{EF_{BG,N_2O}}{1000} \times GWP_{N_2O}$$

Parameter	Description	Units
CBG_C	N_2O emissions from the combustion of biogas in the eligible destruction device(s) for a calendar year covered by the reporting period (SSR P14, SSR P16 and SSR P17)	t CO_2e
$DM_{i,C}$	Volume of CH_4 delivered to an eligible destruction device, i, for a calendar year covered by the reporting period, as per Equation 11	m^3 CH_4
EF_{BG,N_2O}	N_2O emission factor for the combustion of biogas, as set out in the *Emission Factors and Reference Values* document	kg N_2O/t CH_4
ρ_{CH_4}	Reference density of CH_4 = 0.656	kg CH_4/m^3 CH_4
1000	Conversion factor, kilograms to tonnes	kg/t

GWP_{N_2O}	GWP of N_2O, as set out in Schedule 3 to the Act	unitless
n	Number of eligible destruction devices	unitless
i	Eligible destruction device	unitless
C	Calendar year	unitless

If a project AD MTS includes an open or enclosed flare, the proponent must use Equation 17 to quantify the GHG emissions from supplemental fossil fuels combusted to support the operation of the flare for each calendar year covered by the reporting period, which corresponds to SSR P15.

Equation 17: GHG emissions from the combustion of supplemental fossil fuels to support the operation of a flare for a calendar year covered by the reporting period

$$FF_{Flare,C} = \sum_{i}^{n} \left[\begin{array}{c} \left(FF_{supp,i,C} \times EF_{CO_2,i}\right) \\ + \left(FF_{supp,i,C} \times FF_{CH_4,i} \times \rho_{CH_4} \times (1 - DE_{CH_4}) \times GWP_{CH_4}\right) \\ + \left(FF_{supp,i,C} \times EF_{N_2O,i} \times GWP_{N_2O}\right) \end{array} \right] \div 1000$$

Parameter	Description	Units
$FF_{Flare,C}$	GHG emissions from the combustion of supplemental fossil fuels to support the operation of a flare for a calendar year covered by the reporting period (SSR P15)	t CO_2e
$FF_{supp,i,C}$	Volume of supplemental fossil fuel, i, consumed by a flare for a calendar year covered by the reporting period, as per Section 9.3	m^3
$EF_{CO_2,i}$	CO_2 emission factor for supplemental fossil fuel, i, as set out in the *Emission Factors and Reference Values* document	kg CO_2/m^3
$FF_{CH_4,i}$	Average CH_4 content of supplemental fossil fuel, i, obtained from the supplier	m^3 CH_4/m^3
ρ_{CH_4}	Reference density of CH_4 = 0.656	kg CH_4/m^3 CH_4
DE_{CH_4}	CH_4 destruction efficiency of the flare, as set out in the *Emission Factors and Reference Values* document or specific to the device	unitless
GWP_{CH_4}	GWP of CH_4, as set out in Schedule 3 to the Act	unitless
$EF_{N_2O,i}$	N_2O emission factor for supplemental fossil fuel, i, as set out in the *Emission Factors and Reference Values* document	kg N_2O/m^3
GWP_{N_2O}	GWP of N_2O, as set out in Schedule 3 to the Act	unitless
1000	Conversion factor, kilograms to tonnes	kg/t

n	Number of supplemental fossil fuels	unitless
i	Supplemental fossil fuel	unitless
C	Calendar year	unitless

8.2.3 Project scenario GHG emissions from the storage of treated manure

The proponent must quantify project scenario GHG emissions from the storage of liquid and solid treated manure streams, based on the storage type, as set out in the *Emission Factors and Reference Values* document. If the project includes more than one project MTS, the proponent must include all treated manure streams entering a storage type.

Treated manure that is temporarily stored for less than 24h may be excluded from the quantification.

8.2.3.1 CH_4 emissions from the storage of liquid treated manure

The proponent must quantify CH_4 emissions from the storage of liquid treated manure in the project scenario in accordance with the quantification method used for the baseline scenario CH_4 emissions from the anaerobic storage of eligible manure, as follows:

- If the proponent quantifies baseline scenario CH_4 emissions from the anaerobic storage of eligible manure **based on its VS content** (Option 1 with Equation 2 as per Section 8.1.1), they must use Equation 18 to quantify project scenario CH_4 emissions from the storage of liquid treated manure based on the **VS content of the liquid treated manure**
    - If the project includes a chemical MTS and the storage of acidified liquid treated manure, the proponent must use the value of VS_{Source} from Equation 2 as the value of VS_{LTM} in Equation 18

- If the proponent quantifies baseline scenario CH_4 emissions from the anaerobic storage of eligible manure **based on the number of livestock** (Option 2 with Equation 3 as per Section 8.1.1), they must use Equation 20 to quantify project scenario CH_4 emissions from the storage of liquid treated manure based on the **project-specific MTS efficiency rate** determined as per Section 9.1.4
    - If the project includes a chemical MTS and the storage of acidified liquid treated manure, the project MTS efficiency rate is not project-specific and the proponent must instead select the CF_{MCF} value for Liquid – Anaerobic storage, acidified, as set out in the *Emission Factors and Reference Values* document, as the value of Eff_{MTS} in Equation 20

Equation 18: CH_4 emissions from the anaerobic storage of liquid treated manure based on VS content for a calendar year covered by the reporting period

$$LTM_C = \sum_{m}^{M} \left(QLTM_m \times VS_{LTM,m}\right) \times B_{0,Average} \times MCF_C \times CF_{MCF,S} \times \frac{\rho_{CH4}}{1000} \times GWP_{CH_4}$$

Parameter	Description	Units
LTM_C	CH_4 emissions from the anaerobic storage of liquid treated manure in the project scenario for a calendar year covered by the reporting period (SSR P9)	t CO_2e
$QLTM_m$	Quantity of liquid treated manure sent to anaerobic storage during the month, m, as per Sections 9.1.1 and 9.3	t
$VS_{LTM,m}$	VS measured from the liquid treated manure stored anaerobically, for the month, m, as per Sections 9.1.2 and 9.3	kg VS/t manure
$B_{0,Average}$	Weighted average of the maximum CH_4 producing potential for treated manure, as per Equation 19, for projects treating manure from more than one livestock operation. For projects with one livestock operation, use the B_0 value set out in the *Emission Factors and Reference Values* document corresponding to the main livestock type, l, raised at the livestock operation	m^3 CH_4/kg VS
MCF_C	Site-specific methane conversion factor for a calendar year covered by the reporting period, as per Section 9.1.5	unitless
$CF_{MCF,s}$	MCF correction factor for liquid treated manure sent to a storage type, s, as set out in the *Emission Factors and Reference Values* document	unitless
ρ_{CH4}	Reference density of CH_4 = 0.656	kg CH_4/m^3 CH_4
1000	Conversion factor, kilograms to tonnes	kg/t
GWP_{CH_4}	GWP of CH_4, as set out in Schedule 3 to the Act	unitless
M	Number of months during a calendar year covered by the reporting period	unitless
m	Month	unitless
s	Type of liquid treated manure storage	unitless
C	Calendar year	unitless

Equation 19: Weighted average of the maximum CH_4 producing potential for projects treating manure from more than one livestock operation

$$B_{0,Average} = \sum_{i}^{n} \left[B_{0,i} \times \frac{QM_i}{QM_{Total}} \right]$$

Parameter	Description	Units
$B_{0,Average}$	Weighted average of the maximum CH_4 producing potential for treated manure	m^3 CH_4/kg VS
$B_{0,i}$	Maximum CH_4 producing potential for treated manure for a livestock operation, i, as set out in the *Emission Factors and Reference Values* document. If the livestock operation, i, includes more than one livestock type, B_0 must correspond to the livestock type producing the largest quantity of eligible manure	m^3 CH_4/kg VS
QM_i	Quantity of eligible manure from livestock operation, i, treated by the project MTS in the project scenario for a calendar year covered by the reporting period, as per Sections 9.1.1 and 9.3	t
QM_{Total}	Total quantity of eligible manure treated by the project MTS in the project scenario for a calendar year covered by the reporting period, as per Sections 9.1.1 and 9.3	t
n	Number of livestock operations from which eligible manure is sourced during a calendar year covered by the reporting period.	unitless
i	Livestock operation	unitless

Equation 20: CH_4 emissions from the anaerobic storage of liquid treated manure based on number of livestock for a calendar year covered by the reporting period

$$LTM_C = \sum_{l}^{L} \left(LHC_{l,C} \times VS_{rate,l} \times B_{0,l} \times D_{l,C}\right) \times (1 - Eff_{MTS}) \times MCF_C \times \frac{\rho_{CH4}}{1000} \times GWP_{CH_4}$$

Parameter	Description	Units
LTM_C	CH_4 emissions from the anaerobic storage of liquid treated manure in the project scenario for a calendar year covered by the reporting period (SSR P9)	t CO_2e
$LHC_{l,C}$	Average number of livestock from livestock type, l, producing eligible manure treated by the project MTS, for a calendar year covered by the reporting period, as per Sections 9.1.3 and 9.3	head
$VS_{rate,l}$	VS excretion rate for a livestock type, l, producing eligible manure treated by the project MTS for a calendar year covered by the reporting period, as set out in the *Emission Factors and Reference Values* document	kg VS/head/day

$B_{0,l}$	Maximum CH_4 producing potential for manure from livestock type, l, as set out in the *Emission Factors and Reference Values* document	m^3 CH_4/kg VS
$D_{l,C}$	Number of days of eligible manure production for livestock type, l, during a calendar year covered by the reporting period, as per Sections 9.1.3 and 9.3	day
Eff_{MTS}	Project-specific MTS efficiency rate as per Section 9.1.4 or, for a chemical MTS, instead use the value of CF_{MCF} from liquid anaerobic storage, acidified, as set out in the *Emission Factors and Reference Values* document	unitless
MCF_C	Site-specific methane conversion factor for a calendar year covered by the reporting period, as per Section 9.1.5	unitless
ρ_{CH4}	Reference density of CH_4 = 0.656	kg CH_4/m^3 CH_4
1000	Conversion factor, kilograms to tonnes	kg/t
GWP_{CH_4}	GWP of CH_4, as set out in Schedule 3 to the Act	unitless
L	Number of livestock types from which eligible manure is sourced for a calendar year covered by the reporting period	unitless
l	Livestock type as set out in the *Emission Factors and Reference Values* document	unitless
C	Calendar year	unitless

8.2.3.2 GHG emissions from the storage of solid treated manure

The proponent must use Equation 21 to quantify the GHG emissions from the storage of solid treated manure in the project scenario based on default emission factors for all types of solid treated manure storage. Despite this provision, the proponent may use Equation 22 to quantify the GHG emissions from the storage of the solid treated manure based on its VS content, if the following conditions are met:

- The proponent quantifies baseline scenario CH_4 emissions from manure storage based on VS content of the eligible manure (Option 1 with Equation 2 as per Section 8.1.1)
- The storage type is static piles or other types of composting
- The proponent measures VS content of the treated manure prior to mechanical separation, when the project activity consists of an AD MTS followed by a mechanical MTS, as per Section 9.1.2

Equation 21: GHG emissions from the storage of solid treated manure based on default emission factors for a calendar year covered by the reporting period

$$STM_C = \sum_{s}^{S} \left[\left(\frac{QSTM_{s,C} \times EF_{TM,CH_4,s}}{1000} \times GWP_{CH_4} \right) + \left(\frac{QSTM_{s,C} \times EF_{TM,N_2O,s}}{1000} \times GWP_{N_2O} \right) \right]$$

Parameter	Description	Units
STM_C	GHG emissions from the storage of solid treated manure in the project scenario for a calendar year covered by the reporting period (SSR P9)	t CO_2e
$QSTM_{s,C}$	Quantity of solid treated manure sent to a storage type, s, for a calendar year covered by the reporting period, as per Section 9.3	t wet treated manure
$EF_{TM,CH_4,s}$	Storage CH_4 emission factor for solid treated manure sent to a storage type, s, as set out in the *Emission Factors and Reference Values* document	kg CH_4/t wet treated manure
$EF_{TM,N_2O,s}$	Storage N_2O emission factor for solid treated manure sent to a storage type, s, as set out in the *Emission Factors and Reference Values* document	kg N_2O/t wet treated manure
1000	Conversion factor, kilograms to tonnes	kg/t
GWP_{CH_4}	GWP of CH_4, as set out in Schedule 3 to the Act	unitless
GWP_{N_2O}	GWP of N_2O, as set out in Schedule 3 to the Act	unitless
S	Number of solid treated manure storage types	unitless
s	Type of solid treated manure storage	unitless
C	Calendar year	unitless

Equation 22: GHG emissions from the storage of solid treated manure based on VS content for a calendar year covered by the reporting period

$$STM_C = \sum_{s}^{S} \left(STM_{CH_4,s,C} \right) + \left[\sum_{m}^{M} (QSTM_{s,m}) \times \frac{EF_{TM,N_2O,s}}{1000} \times GWP_{N_2O} \right]$$

Parameter	Description	Units
STM_C	GHG emissions from the storage of solid treated manure in the project scenario for a calendar year covered by the reporting period (SSR P9)	t CO_2e
$STM_{CH_4,s,C}$	CH_4 emissions from solid treated manure sent to a storage type, s, for a calendar year covered by the reporting period, as per Equation 23	t CO_2e

$QSTM_{s,m}$	Quantity of solid treated manure sent to storage, s, during the month, m, as per Section 9.3	t wet treated manure
$EF_{TM,N_2O,s}$	Storage N_2O emission factor for solid treated manure sent to a storage type, s, as set out in the *Emission Factors and Reference Values* document	kg N_2O/t wet treated manure
GWP_{N_2O}	GWP of N_2O, as set out in Schedule 3 to the Act	unitless
1000	Conversion factor, kilograms to tonnes	kg/t
S	Number of solid treated manure storage types	unitless
s	Type of solid treated manure storage	unitless
M	Number of months during a calendar year covered by the reporting period	unitless
m	Month	unitless
C	Calendar year	unitless

Equation 23: CH_4 emissions from the storage of solid treated manure based on VS content for a calendar year covered by the reporting period

$$STM_{CH_4,s,C} = \sum_{m}^{M} (QSTM_m \times VS_{STM,m}) \times B_{0,Average} \times 0.02 \times \frac{\rho_{CH_4}}{1000} \times GWP_{CH_4}$$

Parameter	Description	Units
$STM_{CH_4,s,C}$	CH_4 emissions from solid treated manure sent to a storage type, s, for a calendar year covered by the reporting period	t CO_2e
$QSTM_m$	Quantity of solid treated manure sent to storage for the month, m, as per Section 9.3	t wet treated manure
$VS_{STM,m}$	VS of the solid treated manure from the project mechanical MTS for the month, m, as per Equation 24	kg VS/t manure
$B_{0,Average}$	Weighted average of the maximum CH_4 producing potential for treated manure, as per Equation 19	m^3 CH_4/kg VS
0.02	Methane conversion factor for solid treated manure, adapted from the Intergovernmental Panel on Climate Change (IPCC)[7]	unitless
ρ_{CH4}	Reference density of CH_4 = 0.656	kg CH_4/m^3 CH_4

[7] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 10, Table 10.17

1000	Conversion factor, kilograms to tonnes	kg/t
$\mathrm{GWP}_{\mathrm{CH_4}}$	GWP of CH_4, as set out in Schedule 3 to the Act	unitless
M	Number of months during a calendar year covered by the reporting period	unitless
m	Month	unitless
s	Type of solid treated manure storage	unitless
C	Calendar year	unitless

Equation 24: VS of the solid treated manure from the project mechanical MTS

$$\mathrm{VS}_{\mathrm{STM,m}} = \mathrm{VS}_{\mathrm{LM,pre,m}} - \mathrm{VS}_{\mathrm{LTM,m}}$$

Parameter	Description	Units
$\mathrm{VS}_{\mathrm{STM,m}}$	VS of the solid treated manure from the project mechanical MTS for the month, m	kg VS/t manure
$\mathrm{VS}_{\mathrm{LM,pre,m}}$	VS measured from the eligible manure or liquid treated manure pre mechanical MTS for the month, m, as per Section 9.1.2 and 9.3	kg VS/t manure
$\mathrm{VS}_{\mathrm{LTM,m}}$	VS measured from the liquid treated manure stored anaerobically, that is, post mechanical MTS, for the month, m, as per Section 9.3	kg VS/t manure
m	Month	unitless

8.3 Leakage

A project in which the quantity of manure produced in the project scenario is reduced compared to the baseline scenario (for example, due to a reduction in livestock number) would pose a leakage risk if GHG emission reductions were quantified based on historical manure quantities. This form of leakage is avoided in this protocol by quantifying GHG emissions in the baseline scenario based on the quantity of manure that is treated in the project scenario (that is, using a dynamic baseline approach) to ensure functional equivalency between the baseline and project scenarios.

As a result, there is no leakage discount factor (which corresponds to variable C_i in the formula in subsection 20(2) of the Regulations) to be applied for the quantification of GHG emission reductions generated by a project implemented following this protocol.

8.4 Project GHG emission reductions

The proponent must use Equation 25 to quantify the GHG emission reductions (ER_C) generated by the project, which correspond to the GHG reductions determined in accordance with section 20 of the Regulations.

Equation 25: Project GHG emission reductions for a calendar year covered by the reporting period

$$ER_C = BE_C - PE_C$$

Parameter	Description	Units
ER_C	Project GHG emission reductions for a calendar year covered by the reporting period	t CO_2e
BE_C	Baseline scenario GHG emissions for a calendar year covered by the reporting period, as per Equation 1	t CO_2e
PE_C	Project scenario GHG emissions for a calendar year covered by the reporting period, as per Equation 6	t CO_2e
C	Calendar year	unitless

9.0 Measurement and data

9.1 Data collection

If the proponent quantifies baseline scenario CH_4 emissions from the anaerobic storage of eligible manure based on its VS content (Option 1 with Equation 2 as per Section 8.1.1), they must measure:

- the mass of eligible manure and treated manure as per Section 9.1.1
- VS content as per Section 9.1.2

If the proponent quantifies baseline scenario CH_4 emissions from the anaerobic storage of eligible manure based on the number of livestock (Option 2 with Equation 3 as per Section 8.1.1), they must determine:

- the number of livestock and days of eligible manure production as per Section 9.1.3
- the project-specific MTS efficiency rate as per Section 9.1.4

Regardless of the option chosen to quantify baseline scenario CH_4 emissions from the anaerobic storage of eligible manure, the proponent must:

- determine the methane conversion factor (MCF) as per Section 9.1.5
- measure the volume of biogas eligible for displacement of fossil fuels, if applicable, as per Section 9.1.6
- conduct leak surveys, if applicable, as per Section 9.1.7

- estimate the volume of biogas emitted to the atmosphere during emergency venting, if applicable, as per Section 9.1.8

9.1.1 Mass of eligible manure and treated manure

The proponent must measure the quantity of eligible manure and treated manure by volume or wet weight.

If eligible manure or treated manure is measured by volume, the volume must be converted to mass. A density of 1 tonne/m^3 must be used for eligible manure and for liquid treated manure. The density of the solid treated manure from a mechanical MTS must be measured every 3 months and the average density must be used to convert volume to mass.

9.1.2 VS content

The proponent must determine the VS content monthly as follows:

- **Eligible manure** – in each source of eligible manure before mixing with any other non-eligible manure or organic material
    - Eligible manure from different livestock operations may be pooled before determining VS content if the livestock operations all raise the same livestock type as listed for parameters VS_{rate} and B_0 in the *Emission Factors and Reference Values* document
- **Treated manure** – in liquid treated manure from the project MTS, except for acidified treated manure

In addition to the two VS content measures above, if the proponent uses Equation 22 to quantify project scenario GHG emissions from the storage of solid treated manure stored in static piles or composted, and if the project activity consists of an AD MTS followed by a mechanical MTS, the proponent must determine the VS content of the treated manure from the AD MTS and prior to entering the mechanical MTS and use it in Equation 24. The VS content of manure must be determined as follows:

- Samples must be taken from well-mixed eligible manure before treatment by the project MTS
- Samples must be taken from well-mixed liquid treated manure before entering anaerobic storage and, if applicable, prior to entering the project mechanical MTS
- The VS content of each sample must be analyzed in triplicate following a recognized standard, such as the American Public Health Association (APHA) Standard Methods for the Examination of Water and Wastewater[8]

9.1.3 Number of livestock and days of eligible manure production

The proponent must count the number of days eligible manure was produced and the number of livestock each day to support parameters $LHC_{l,C}$ and $D_{l,C}$.

[8] 2540 solids. (2017). In Standard Methods for the Examination of Water and Wastewater (24th ed.). American Public Health Association. DOI 10.2105/SMWW.2882.030

For $D_{l,C}$ the proponent must count the number of days in a calendar year that eligible manure treated by the project MTS was produced for each livestock type, l. Livestock types and their descriptions are set out in the *Emission Factors and Reference Values* document.

$LHC_{l,C}$ represents an average number of livestock for each livestock type, l, producing eligible manure treated by the project MTS. The proponent must, therefore, count the number of livestock for each livestock type, l, producing eligible manure treated by the project MTS each day eligible manure is produced by the livestock in a calendar year. The daily count must be averaged over the number of days eligible manure was produced by livestock type, l ($D_{l,C}$).

9.1.4 Project-specific MTS efficiency rate

The proponent must determine a project-specific MTS efficiency rate by determining the VS content of samples taken before and after treatment by the project MTS, as follows:

- Samples must be taken from well-mixed eligible manure before treatment by the project MTS, for a minimum of 3 evenly distributed times (samplings) during each 12-month period within the reporting period
- Samples must be taken from well-mixed liquid treated manure after treatment by the project MTS and before entering anaerobic storage
    - Samples from liquid treated manure must be taken after samples from eligible manure, after a period of time equivalent to the retention time in the project mechanical or AD MTS
- The VS content of each sample must be analyzed in triplicate following a recognized standard, such as the American Public Health Association (APHA) Standard Methods for the Examination of Water and Wastewater[8], and the 3 values must be averaged to determine a single value for the VS content of the sample
- For each sampling, i, (minimum of 3 times) the VS content of eligible manure at sampling, i, ($VS_{before\ MTS,i}$) and the VS content of treated manure at sampling, i, ($VS_{after\ MTS,i}$) must be used with Equation 26 to determine the project-specific MTS efficiency rate for sampling, i ($Eff_{MTS,i}$)
- The final project-specific MTS efficiency value (Eff_{MTS}) is one standard deviation below the mean of the 3 or more $Eff_{MTS,i}$ values obtained from Equation 26. This final project-specific MTS efficiency value is applied in Equation 20 to each calendar year within the applicable 12-month sampling period

Equation 26: Efficiency rate for the project MTS

$$\mathrm{Eff}_{\mathrm{MTS,i}} = \frac{\left(\mathrm{VS}_{\mathrm{before\ MTS,i}} - \mathrm{VS}_{\mathrm{after\ MTS,i}}\right)}{\mathrm{VS}_{\mathrm{before\ MTS,i}}}$$

Parameter	Description	Units
$\mathrm{Eff}_{\mathrm{MTS,i}}$	Project-specific MTS efficiency rate for sampling, i	unitless
$\mathrm{VS}_{\mathrm{before\ MTS,i}}$	VS in eligible manure before treatment by the project MTS, at sampling, i, as per Section 9.3	kg/t manure

$VS_{after\ MTS,i}$	VS in liquid treated manure after treatment by the project MTS, at sampling, i, as per Section 9.3	kg/t manure
i	Sampling (n ≥ 3)	unitless

9.1.5 Methane conversion factor (MCF)

The proponent must determine a single site-specific MCF to be used in both the baseline and project scenarios. The site-specific MCF must be determined each calendar year covered by the reporting period following the method in Annex 10A.3 of the IPCC 2019 guidelines[9] and the following requirements for determining input values:

- Monthly air temperature must be sourced from the Government of Canada's historical weather data using information from the weather station nearest to the manure treatment site[10] during a calendar year covered by a reporting period
- If the project includes one or more livestock operations with an under-barn storage structure, the MCF must be determined using treated manure temperature instead of air temperature
- Manure removal from anaerobic storage structure and timing must be set using one of two options:
    - **Option a:** As a default, removal is set at twice per year in May and October regardless of historical practice at the livestock operation
    - **Option b:** The proponent may set removal to once per year if they can demonstrate manure removal occurred annually at the livestock operation for 3 years prior to the project start date
- The selected option including the manure removal frequency and timing must remain the same in both the baseline and project scenarios
- Storage emptying efficiency must be set to 85%
- For all other parameters, the default values provided by the IPCC 2019 guidelines must be used

A single MCF must be determined for the whole project site in the following situations:

- The project site includes one or more livestock operation(s) and the manure removal frequency does not vary across livestock operations
- The project site includes one livestock operation with a single under-barn storage structure

In all other cases, the proponent must determine multiple MCF values as follows:

- One MCF value for each manure removal frequency within the project site
- One MCF value for each under-barn storage within the project site

If the proponent must determine multiple MCF values, a single average site-specific MCF must be determined for each calendar year covered by the reporting period. For a single livestock operation with multiple under-barn storages, a simple average of the MCF for each under-barn

[9] 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Section 10 (PDF).
[10] Historical Data - Climate - Environment and Climate Change Canada (weather.gc.ca)

storage structure must be used for the livestock operation. For a project site that includes multiple livestock operations, a weighted average must be used based on the quantity of manure treated as per Equation 27.

Equation 27: Site-specific MCF for a project site including multiple livestock operation for a calendar year covered by the reporting period to be used in both the baseline and project scenarios

$$\mathrm{MCF_C} = \sum_{u}^{n} \left[\mathrm{MCF_u} \times \frac{\mathrm{QM_{u,C}}}{\mathrm{QM_{Total}}} \right]$$

Parameter	Description	Units
$\mathrm{MCF_C}$	Site-specific MCF for a calendar year covered by the reporting period	unitless
$\mathrm{MCF_u}$	MCF determined for a specific removal frequency or under-barn storage, u	unitless
$\mathrm{QM_{u,C}}$	Quantity of manure treated by the project MTS in the project scenario for a specific removal frequency or under-barn storage, u, for a calendar year covered by the reporting period	t
$\mathrm{QM_{Total}}$	Total quantity of eligible manure treated by the project MTS in the project scenario for a calendar year covered by the reporting period	t
n	Number of different removal frequencies or under-barn storages requiring a unique MCF for a calendar year covered by the reporting period	unitless
u	Removal frequency or under-barn storage requiring a unique MCF	unitless
C	Calendar year	unitless

9.1.6 Volume of biogas eligible for displacement of fossil fuels

If the proponent quantifies GHG emissions from the combustion of fossil fuels displaced by eligible biogas using Equation 4, they must measure the volume of eligible biogas using measuring devices as per Section 9.2.4.2.

9.1.7 Leak surveys

To use a leak rate (LR) of 0.005 in Equation 10, the proponent must conduct leak surveys according to the following requirements:

- Leak surveys must be conducted a minimum of every 4 months during each calendar year

- Each leak survey must consist of extensive leak detection on the digester and associated gas piping up to the inlet of eligible destruction devices
- Measuring devices used for CH_4 leak detection must follow the requirements specified in Section 9.2.4.6
- For each leak survey:
    - no leaks were detected; or
    - one or more leaks were detected but were repaired as demonstrated by a follow-up survey within 30 days of the initial survey showing that the leak is no longer detectable

When carrying out the leak surveys, a leak is defined as one of the following:

- A reading of at least 500 ppmv of CH_4 concentration on a measuring device listed in Section 9.2.4.6
- A release of any CH_4 concentration detected by means of an auditory method, an olfactory method, or a visual method

If the requirements above for using a leak rate of 0.005 are not met, the proponent must use a leak rate of 0.05 in Equation 10.

9.1.8 Emergency venting

The proponent must estimate the volume of biogas accumulated in the digester or in a secondary storage structure (that is, biogas bladder) that was vented to the atmosphere during an emergency venting event. If direct measurement is not possible, the volume of stored biogas may be determined by an engineering estimate.

9.2 Measuring devices

All measuring devices listed in this section must be operated according to the manufacturer's specifications.

9.2.1 General measuring devices

If the proponent quantifies baseline scenario CH_4 emissions from the anaerobic storage of eligible manure based on the VS content (Option 1 with Equation 2 as per Section 8.1.1), they must use a measuring device to measure the quantity of eligible manure treated by the project MTS by weight or volume, such as with a flow meter, a truck scale or a volumetric sensor.

The quantity of grid electricity used for the operation of the project MTS must be measured by permanent meters or determined using purchase records.

For projects including one or more under-barn storage structure(s), temperature must be measured daily at mid-depth of the treated manure in the under-barn storage structure(s) and averaged to obtain a monthly average temperature.

9.2.2 Measuring devices specific to a project chemical MTS

If the project includes a project chemical MTS, the proponent must use a portable pH meter that directly measures pH in the treated manure storage at least daily.

9.2.3 Measuring devices specific to a project mechanical MTS

If the project includes a project mechanical MTS and if the proponent quantifies baseline scenario CH_4 emissions from the anaerobic storage of eligible manure based on the VS content (Option 1 with Equation 2 as per Section 8.1.1), the proponent must use the following measuring devices:

- a flow meter or a scale to measure all treated manure types by volume or weight at the frequency set out in Table 3
- for treated solid manure measured by volume, a density meter providing measurements every 3 months and averaged over the reporting period

9.2.4 Measuring devices specific to a project AD MTS

9.2.4.1 Treated manure measuring devices

If the project includes a project AD MTS and if the proponent quantifies baseline scenario CH_4 emissions from the anaerobic storage of eligible manure based on the VS content (Option 1 with Equation 2 as per Section 8.1.1), the proponent must use a flow meter or a scale to measure treated manure by volume or weight at the frequency set out in Table 3.

9.2.4.2 Biogas flow meters

For any project AD MTS, the proponent must use a permanent flow meter that directly and separately measures the volume of biogas produced by the project MTS and delivered to each individual eligible destruction device at the frequency set out in Table 3.

9.2.4.3 Biogas temperature and pressure gauges

If the flow meter of a project AD MTS automatically corrects the biogas volume to the reference temperature and pressure conditions set out in Equation 12, no additional temperature and pressure gauges are required.

If the flow meter does not automatically correct the biogas volume, the proponent must use permanent temperature and pressure gauges to measure temperature and pressure at the same measurement frequency as the uncorrected volume of biogas (Section 9.3). Biogas temperature and pressure must be measured under the same conditions (wet or dry basis) as the biogas volume.

The biogas volume data must be corrected from measured temperature and pressure conditions to the reference temperature and pressure conditions using Equation 12.

9.2.4.4 Methane analyzers

For any project AD MTS, the proponent must use a permanent or portable methane analyzer (for example, gas chromatographs) that directly measures the CH_4 content in the biogas on a volumetric basis at the frequency set out in Table 3.

9.2.4.5 Arrangement of biogas measuring devices

Flow meters and methane analyzers must be arranged in such a way as to ensure the data is representative of the biogas produced and combusted in the project.

For a project with multiple eligible destruction devices:

- flow meters must be placed to separately measure the volume of biogas produced from within the project site and delivered to each individual eligible destruction device
- if the biogas is delivered to the eligible destruction devices from a common manifold or header pipe upstream of the destruction devices, one methane analyzer may be placed to measure the CH_4 content of the biogas at that common manifold or header pipe
- if the biogas is delivered to each eligible destruction device from a separate manifold or header pipe, a methane analyzer is required upstream of each individual eligible destruction device

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

- measure the volume and CH_4 content of the biogas before the introduction of any supplemental fossil fuels
- measure the volume and CH_4 content of the biogas produced from within the project site separately from any other fuels sources prior to the combustion of the biogas in eligible destruction devices at adjacent facilities

Measuring devices must be arranged such that biogas CH_4 content is measured under the same conditions (wet or dry basis) as biogas 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 (biogas 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. Other devices or equipment that could change the biogas composition by volume must not separate a methane analyzer and a flow meter.

9.2.4.6 Leak detection

To conduct leak surveys as per Section 9.1.7, the proponent must use a measuring device for leak detection that:

- meets the specification set out in Section 6 of Method 21[11] of the Environmental Protection Agency of the United States (EPA)
- in the case of an optical gas-imaging measuring device, is capable of imaging CH_4 at the leak definition concentration specified in Section 9.1.7, and is operated in accordance with the requirements of Section 8.3 of the EPA Method 21

[11] The method of the Environmental Protection Agency of the United States entitled Method 21 — Determination of Volatile Organic Compound Leaks, set out in Appendix A-7 to Part 60 of Title 40, chapter I of the Code of Federal Regulations of the United States.

9.3 Measurement method and frequency

Table 3 identifies the parameters in the quantification methodology set out in Section 8.0 that must be measured and provides details regarding measurement method and frequency.

Table 3: Measurement method and frequency for measured parameters

Parameter	Description	Units	Measurement method and frequency	Equations
QM_i	Quantity of eligible manure from livestock operation, i, treated by the project MTS.	t	Measured continuously by volume or weight, recorded at least once every 15 minutes during the operational period of the MTS, and summed for each month in each calendar year covered by the reporting period. **or** If the eligible manure is transported by truck to the MTS site, measured by volume or weight for each truck load.	2, 19
VS_{source}	VS content of eligible manure from livestock operation, i, that is treated by the project MTS before mixing with any other organic material.	kg VS / t manure	Measured monthly at a minimum and upon change in eligible manure source as per Section 9.1.2.	2
D_l	Number of days of eligible manure production for livestock type, l.	day	Determined at the end of the calendar year as per Section 9.1.3	3, 20
LHC_l	Average number of livestock from livestock type, l, producing eligible manure treated by the project MTS.	head	Counted each day eligible manure treated by the project MTS is produced day and averaged as per section 9.1.3.	3, 20
BGD	Volume of biogas eligible for displacement of fossil fuels.	m^3	Measured continuously, recorded at least every hour and summed for each calendar year covered by the reporting period. **or**	5

Parameter	Description	Units	Measurement method and frequency	Equations
			Quantified as per Equation 12 if flow meter does not automatically correct volume.	
FF_i	Volume of the type of fossil fuel, i, consumed by mobile and/or stationary equipment for the transport of eligible manure, chemicals, and treated manure, and for the operation of the project MTS.	m^3	Calculated from fossil fuels purchase records and/or equipment specifications and summed for each calendar year covered by the reporting period.	7
$GridEL$	Grid electricity consumed by the project MTS.	MWh	Measured using meter and summed for each calendar year covered by the reporting period. **or** Calculated from electricity purchase records and/or equipment specifications and summed for each calendar year covered by the reporting period.	8
$BG_{i,t}$	Corrected volume of biogas produced by the project AD MTS and delivered to eligible destruction device, i, during a measurement period, t.	m^3 biogas	Measured continuously and recorded every measurement period. The measurement period can be a maximum of 1h. **or** Quantified as per Equation 12 if flow meter does not automatically correct volume.	11
$MC_{i,t}$	Average CH_4 content of the biogas delivered to the eligible destruction device, i, during measurement period, t.	m^3 CH_4 /m^3 biogas	Measured continuously and averaged over the measurement period. The measurement period can be a maximum of 1h.	11

Parameter	Description	Units	Measurement method and frequency	Equations
$BG_{UC,i,t}$	Uncorrected volume of biogas produced by the project AD MTS and delivered to eligible destruction device, i, during measurement period, t.	m^3 biogas	Measured continuously and recorded every measurement period. The measurement period can be a maximum of 1h.	12
T_t	Measured temperature of the biogas produced by the project AD MTS for the measurement period, t.	K	Measured continuously and recorded every measurement period if flow meter does not automatically correct volume. The measurement period can be a maximum of 1h but must be the same frequency as for BG_{UC}.	12
P_t	Measured pressure of the biogas produced by the project AD MTS for the measurement period, t.	kPa	Measured continuously and recorded every measurement period if flow meter does not automatically correct volume. The measurement period can be a maximum of 1h but must be the same frequency as for BG_{UC}.	12
$FF_{supp,i}$	Volume of supplemental fossil fuel, i, consumed by a flare.	m^3	Calculated from fossil fuels purchase records and/or equipment specifications and summed for each calendar year covered by the reporting period.	17
$QLTM$	Quantity of liquid treated manure sent to anaerobic storage.	t	Measured continuously by volume or weight, recorded at least once every 15 minutes and summed for each calendar year covered by the reporting period. **or** If the treated manure is transported by truck to the storage site, measured by volume or weight for each truck load.	18
VS_{LTM}	VS measured from liquid treated manure stored anaerobically.	kg VS/t manure	Measured monthly at a minimum and upon a change of 5% or more in eligible manure composition (based	18, 24

Parameter	Description	Units	Measurement method and frequency	Equations
			on livestock type l) or a change in source of other organics.	
$QSTM$	Quantity of solid treated manure sent to storage.	t wet treated manure	Measured continuously by volume or weight, recorded at least once every 15 minutes and summed for each calendar year covered by the reporting period. **or** If the treated manure is transported by truck to the storage site, measured by volume or weight for each truck load.	21, 22, 23
$VS_{LM,pre}$	VS measured from the eligible manure or liquid treated manure pre mechanical MTS.	kg VS/t manure	Measured monthly at a minimum and upon a change of 5% or more in eligible manure composition (based on livestock type, l) or a change in source of other organics.	24
$VS_{before\ MTS,i}$	VS content of eligible manure of the sample, i, before treatment by the project MTS.	kg/t manure	Measured a minimum of 3 evenly distributed times during each 12-month period within the reporting period as per Section 9.1.4.	26
$VS_{after\ MTS,i}$	VS content of liquid treated manure of the sample, i, after treatment by the project MTS.	kg/t manure	Measured a minimum of 3 evenly distributed times during each 12-month period within the reporting period as per Section 9.1.4.	26

9.4 Quality assurance and quality control

The proponent must have documented quality assurance and quality control (QA/QC) procedures and must implement them to ensure that all measurements and calculations are made in accordance with this protocol and can be verified.

All measuring devices listed in Section 9.2, except for grid electricity meters and leak detection measuring devices operated by a third party certified for that purpose, 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.

The measurement accuracy of all these measuring devices must be within a ± 5% accuracy range. When the measurement accuracy of a measuring device exceeds the ± 5% range, the

appropriate corrective actions must be taken on the device, in accordance with the manufacturer specifications.

After the corrective actions, the measuring device must be rechecked for accuracy. If the measurement 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 2 months after the accuracy check conducted following the corrective actions. If the measuring device was manufactured with no possibility of calibration, it must be replaced no more than 2 months after the accuracy check conducted following the corrective actions.

When the measurement accuracy of a measuring device, except for a leak detection measuring device, indicates a reading outside of a ± 5% accuracy range, the following conditions must be followed 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
    - An under-reporting means a value indicated by the project measuring device is more conservative than the value indicated by the equipment used for accuracy checks
- 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
    - An over-reporting means a value indicated by the project measuring device is less conservative than the value indicated by the equipment used for accuracy checks

When the measurement accuracy of a leak detection measuring device indicates a reading outside of a ± 5% accuracy range, any leak survey conducted during the period from the last time the leak detection device showed a reading within ± 5% accuracy until the device shows a return to ± 5% accuracy, is considered as not meeting the requirements as per Section 9.1.7.

All measuring devices listed in Section 9.2, except for grid electricity meters, leak detection measuring devices operated by a third party certified for that purpose and portable pH meters, must be 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. However, if the device is factory calibrated and the manufacturer specifies that no recalibration is required, the factory calibration then needs to be validated on-site by either the manufacturer or a certified third party in accordance with the manufacturer specified frequency or every 5 years, whichever is more frequent.

For portable pH meters, the user must perform a calibration daily or in accordance with the manufacturer specified frequency, whichever is more frequent.

9.5 Missing data

If a measuring device fails to produce data as required in Sections 9.1, 9.2 and 9.3, missing data may be substituted following the requirements in this section. If missing data cannot be

substituted as per the applicable requirements, no GHG emission reductions can be quantified for the issuance of offset credits for the period during which data is missing.

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

- 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_2e, 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_2e

9.5.1 Missing data from a biogas measuring device

The proponent may substitute missing data from a biogas measuring device (that is, flow meter or methane analyzer) only if the operational status of the eligible destruction devices can be demonstrated in accordance with the requirements in Section 9.6.3.1 during the period of missing data. In addition, missing data from a flow meter or methane analyzer may only be substituted in accordance with the following conditions:

- Biogas volume data may be substituted when CH_4 content data is not missing, and the methane analyzer is demonstrated to be functioning properly
- CH_4 content data may be substituted when biogas volume data is not missing, and the flow meter is demonstrated to be functioning properly

For a project with biogas volume or CH_4 content data missing for a period of up to 7 consecutive days, the proponent must use the appropriate substitution method set out in Table 4 to substitute the data.

For data missing for more than 7 consecutive days, only the data for the period of up to 7 days may be substituted. No data may be substituted for the period after the 7th consecutive day, and no GHG emission reductions may be quantified for the issuance of offset credits for that period.

Table 4: Missing data substitution methods for biogas measuring devices

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.

9.5.2 Missing data from VS content

The proponent may substitute missing data from monthly VS content sampling in eligible manure or treated manure, as per Section 9.1.2, only if the following two conditions are met:

- No change in the following attributes occurred since the previous test for which VS content data is available:
    - Source of eligible manure, if missing manure VS content data
    - Source and composition of feedstock, if missing treated manure VS content data
- VS data from the month prior to the month of the missing VS content data is available

If the conditions for substitution listed above are met, the proponent may use the appropriate VS content value (that is, eligible manure or treated manure) from the month prior to the month of the missing VS content data to use in Equation 2 ($VS_{Source,i,m}$) if missing data from eligible manure VS content, or in Equation 18 and Equation 24 ($VS_{LTM,m}$) if missing data from treated manure VS content.

If the conditions for substitution listed above are not met, no GHG emission reductions from anaerobic storage (SSR 9) can be quantified for the issuance of offset credits for the period during which data is missing. The proponent must set the value of $VS_{Source,i,m}$ in Equation 2 and the value of $VS_{LTM,m}$ in Equation 18 and Equation 24 to zero. GHG emissions from all other SSRs must continue to be quantified as per Section 8.0.

The proponent may not substitute missing data from VS content sampling required for defining a project-specific MTS efficiency rate, as per Section 9.1.4.

9.5.3 Missing data from pH measurement for a project chemical MTS

For a project including a chemical MTS with pH data missing for a period of up to 7 consecutive days, the proponent must 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.

After the 7^{th} consecutive day of missing pH data, the project chemical MTS is considered not operational as per Section 9.6.1, and no missing data may be substituted for that period.

9.6 Operational status of a project MTS

9.6.1 Operational status of a project chemical MTS

The proponent must monitor and record pH according to Section 9.2.2.

A project chemical MTS is considered operational if the daily average pH is:

- 5.5 or less; or
- above 5.5 for up to 7 consecutive days maximum

If a project chemical MTS is considered not operational for 1 month or more in the period of May to October, the project chemical MTS is considered operational again once the two following conditions are met:

- The treated manure storage has been emptied

- The average daily pH after emptying is at or below 5.5

In all other cases (that is, not operational for less than 1 month in the period of May to October, or not operational for any amount of time from November to April), the project chemical MTS is considered operational again once the two following conditions are met:

- Additional sulfuric acid has been added to the anaerobic storage to correct the pH
- The average daily pH after sulfuric acid addition is at or below 5.5

If during any period of time a project chemical MTS is considered not operational, the system is not functioning properly or is not operated in accordance with the manufacturer specifications, or its operational status cannot be confirmed, no GHG emission reductions can be quantified for the issuance of offset credits for this period.

9.6.2 Operational status of a project mechanical MTS

For a project mechanical MTS, the proponent must monitor and record an indicator of operational status appropriate for the system using a monitoring instrument in accordance with the manufacturer specifications, such as manure input, motor speed, system pressure, or temperature.

If during any period of time a project mechanical MTS or the monitoring instrument is not functioning properly or not operated in accordance with the manufacturer specifications, or the operational status cannot be confirmed, no GHG emission reductions can be quantified for the issuance of offset credits for this period.

9.6.3 Operational status of a project AD MTS

For a project AD MTS, the proponent must monitor and record an indicator of operational status appropriate for the system in accordance with the manufacturer specifications, such as biogas production, digester temperature, or pH.

If during any period of time a project AD MTS, including an eligible destruction device, or the monitoring instrument is not functioning properly or not operated in accordance with the manufacturer specifications, or the operational status cannot be confirmed, no GHG emission reductions can be quantified for the issuance of offset credits for this period.

9.6.3.1 Operational status of eligible destruction devices

For a project AD MTS, the proponent must monitor and record the operational status of all eligible destruction devices by using, for each destruction device, a monitoring instrument that records the operational status at least once per hour.

For a flare (open or enclosed), the operational status must be determined based on data from a thermocouple. For the flare to be considered operational, the thermocouple must indicate that the flare temperature meets or exceeds 260˚C (the minimum temperature for CH_4 destruction).

For all other eligible destruction devices listed in Table 1, the destruction device monitoring instrument must monitor and record an indicator of operational status appropriate for the destruction device such as energy output.

Requirements for the operational status of eligible destruction devices apply to all eligible destruction devices located within the project site, including those located at an adjacent destruction facility.

In cases where biogas is combusted in an eligible destruction device located at an adjacent destruction facility, the proponent must obtain the monitoring data demonstrating the operational status of the eligible destruction device; otherwise, no GHG emission reductions generated with this device can be quantified for the issuance of offset credits.

10.0 Records

In addition to the record keeping requirements specified in the Regulations and to the documents required in Section 11.0, the proponent must keep records of all data and information that support the implementation of the project and verification, including invoices, contracts, metered results, calculations, databases, photographs, equipment maintenance, accuracy checks and calibration records. The records must be kept and retained at the location and for the period of time specified in the Regulations.

10.1 General records

The proponent must keep records of the information about any eligible project MTS, measuring devices, monitoring instruments and meters located at the project site, including adjacent destruction facilities.

10.1.1 Project site

The proponent must keep a record of the information about the project site, including:

- documentation indicating the type and depth of storage used to store eligible manure before the project start date, including engineering design documents or nutrient management plans, for each livestock operation
- for livestock operations established at least 3 years before the project start date, photographs or operational logs demonstrating the use of anaerobic storage to store eligible manure during the 3 years prior to the project start date
- documentation, such as photographs, demonstrating that during the 10 years before the project start date or, if the livestock operation was established less than 10 years before the project start date, since its establishment:
    - manure storage was not fitted with equipment to recover and destroy manure CH_4
    - eligible manure was not treated by a chemical MTS before entering anaerobic storage
    - eligible manure was not treated by a mechanical or an AD MTS that is no longer in operation during the project.
- documentation related to all operating permits and authorizations for the project site and the project MTS, including their effective dates and any details related to manure treatment, as well as environmental impact assessments if applicable

- a copy of the agreement between the proponent and the owner of the project MTS, or any part of the project MTS, if applicable

10.1.2 Eligible manure

The proponent must keep a record of the information about the eligible manure treated by the project MTS, including:

- documentation indicating the type of livestock producing eligible manure, as per the types listed in the *Emission Factors and Reference Values* document
- documentation, such as standard operating procedures, demonstrating that manure was collected as liquid manure and that no organic material, other than animal bedding, was added to or mixed with the manure before storage
- for a project MTS located outside of the livestock operation site, documentation demonstrating eligible manure was transported from the livestock operation to the project MTS, such as trucking receipts
- documentation of any legal requirement related to manure management and applicable to the project site that may impact manure eligibility, such as but not limited to operating permit, manure handling plans or nutrient management plans

10.1.3 Project activities

The proponent must keep a record of the information about the project activities, including:

- an engineering plan or technical sketch or sheet of all equipment treating eligible manure in the project MTS, such as digester, press, centrifuge or acidification tank
- manufacturer specifications for the operation and maintenance of the project MTS, including the maximum quantity of feedstock that can be treated by the MTS
- data indicating the operational status of each project MTS and records demonstrating that the equipment is operating according to the manufacturer specifications
- documentation describing the type of storage for all treated manure types exiting the project MTS

10.1.4 Measuring devices and monitoring instruments

The proponent must keep a record of the information about the measuring devices and monitoring instruments in the project, including:

- for meters measuring grid electricity consumed by the project MTS, except for meters under the control of a grid electricity supplier, and for leak detection measuring devices operated by a third party certified for that purpose:
    - documentation describing each grid electricity meter used, including the meter model number or serial number
    - manufacturer specifications for the operation and maintenance of each meter
    - documentation demonstrating the proper functioning of each meter in accordance with the manufacturer specifications

- for leak detection measuring devices operated by a third party certified for that purpose:
    - CH_4 detection limits

    - name and certification of the third party operating the devices

- for a portable pH meter:
    - device type, model number, and/or serial number
    - manufacturer specifications for the operation, maintenance and calibration
    - the maintenance records, including records of accuracy checks
    - documentation describing the corrective measures applied if the meter fails to meet the requirements for measurement accuracy
    - calibration records that indicate calibration date, time and results

- for all other measuring devices and monitoring instruments:
    - documentation describing their installation and operation, including:
        - device type, model number, and/or serial number
        - manufacturer specifications for the operation, maintenance and calibration
        - documentation describing the location and arrangement
        - documentation indicating the proper functioning in accordance with the manufacturer specifications
    - the maintenance records for each measuring device and monitoring instrument, 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, or as applicable the on-site validation certificates and/or other records, which indicate calibration or calibration validation date, time, and results from either the manufacturer or a third-party certified for that purpose for each measuring device or meter

10.1.5 Quantification

The proponent must keep a record of the information used for the quantification of the GHG emission reductions generated by the project, including:

- all measured data, as per Table 3
- standard operating procedures and sampling logbooks for VS content sampling in eligible and treated manure
- documentation showing the number of livestock and days of eligible manure production for each livestock type, l, as per Section 9.1.3, if the proponent quantifies baseline scenario CH_4 emissions based on the number of livestock (Option 2 with Equation 3 as per Section 8.1.1)
- average monthly air temperature sourced from Government of Canada's historical weather data using information from the nearest weather station[10], if applicable
- records showing manure removal date for 3 years before the project start date
- metered quantities or purchase records that indicate the quantity of grid electricity consumed by the project MTS, or documentation describing equipment electricity consumption and time of usage, if applicable
- purchase records that indicate the quantity and types of fossil fuel consumed by the project MTS, vehicles for the transportation of eligible manure or treated manure and

sulfuric acid, or documentation describing mileage, vehicle class, and standard fuel consumption rate, if applicable

10.2 Records specific to a project chemical MTS

The proponent must keep a record of the information about the project chemical MTS and the acidified liquid treated manure, including:

- all information and data in addition to that in Section 10.1.5 and used to support the quantification of the GHG emission reductions, including:
    - data on sulfuric acid quantity used to treat eligible manure such as purchase records or measurement records
    - documentation indicating the distance between the chemical retail point and the manure treatment site and the category of vehicles used to transport chemicals used in the project MTS
    - acidified liquid treated manure pH data
- documentation, such as standard operating procedures, demonstrating the location and depth for pH measurement in manure storage structures
- documentation indicating the location of all land receiving acidified liquid treated manure during the reporting period

10.3 Records specific to a project mechanical MTS

The proponent must keep a record of the information about the project mechanical MTS, including:

- all information and data in addition to that in Section 10.1.5 and used to support the quantification of the GHG emission reductions, including solid treated manure density data, if quantity is measured by volume

10.4 Records specific to a project AD MTS

The proponent must keep a record of the information about the project AD MTS, including:

- an engineering plan or technical sketch or sheet of all eligible destruction devices, including the localization of measuring devices and monitoring instruments
- all information and data in addition to that in Section 10.1.5 and used to support the quantification of the GHG emission reductions, including:
    - all biogas volume data, corrected to the reference temperature and pressure conditions, either automatically or using Equation 12
    - all biogas CH_4 content data, if applicable
    - all uncorrected biogas volume data, if a flow meter does not automatically correct volume
    - measured temperature and pressure data for the biogas, if a flow meter does not automatically correct volume
    - records or documentation supporting the estimation of stored biogas vented to the atmosphere in case of an emergency venting

- documentation demonstrating the sale of any biogas to be used for energy generation at the project site, including adjacent destruction facility as applicable, biogas directly injected into a natural gas network, and/or biogas compressed or liquefied prior to transport and injection into a natural gas network, and including the actual quantities sold during the reporting period, if applicable
- the testing data and documentation pertaining to the project-specific higher heating value for eligible biogas, if applicable
- data, operating procedures and sampling logbook pertaining to the leak surveys, if applicable, as per Sections 9.1.7 and 9.2.4.6
- details about eligible destruction devices, including:
    - documentation describing eligible destruction devices
    - manufacturer specifications for the operation and maintenance of eligible destruction devices
    - the testing data and documentation pertaining to the device-specific destruction efficiency for eligible destruction devices, if applicable
    - data indicating the operational status of eligible destruction devices along with evidence that the equipment is operating according to the manufacturer specifications

If applicable, the proponent must keep a record of the information about the displacement of fossil fuels by eligible biogas, as per Sections 3.2 and 4.4, including:

- documentation demonstrating that an energy-generating device combusting fossil fuels was:
    - in operation at the project site, including adjacent destruction facilities, for at least 3 years before the project start date
    - replaced by or converted to an eligible destruction device combusting biogas produced by the project AD MTS
- documentation, such as purchase invoice, indicating the type and quantity of fossil fuel historically combusted by the device replaced by or converted to an eligible destruction device during the 3 years before the project start date.
- metered quantities of eligible biogas having displaced fossil fuels.

11.0 Reporting

In addition to the reporting requirements specified in the Regulations, the proponent must include the following in project reports.

In the initial project report, the proponent must include:

- for each livestock operation, the type and depth of manure storage structures, and whether the eligible manure is treated by an MTS that is not part of the project or was treated by an MTS before the project start date
- a description of the eligible project activities undertaken for each full or partial calendar year of the reporting period
- the first day eligible manure enters the project MTS to be treated, such as the commissioning date (project start date)
- the type(s) of MTS in operation on the project site

- the maximum capacity of the project MTS and, for a mechanical MTS, the separation efficiency as provided by the manufacturer

In any project report, the proponent must include:

- the option chosen to quantify baseline scenario CH_4 emissions from the anaerobic storage of eligible manure, as per Section 8.1.1
- if the proponent quantifies baseline scenario CH_4 emissions based on the number of livestock (Option 2 with Equation 3 as per Section 8.1.1), a description of how the conditions for using this quantification method are met, as per Section 8.1.1

- for a project chemical MTS:
    - data indicating the operational status of the project chemical MTS, as per Sections 9.2.2 and 9.6.1
    - a copy of the crop nutrient plan or similar fertilizer management document completed by a Professional Agrologist (P.Ag.) or Certified Crop Advisor (CCA) for all lands receiving acidified liquid treated manure during the reporting period, as per Section 6.3.2 including the name, title, and contact details of the Professional Agrologist or Certified Crop Advisor signing the plan or similar document
    - confirmation that recommendations in the crop nutrient plan or similar fertilizer management document for managing soil acidification risks and nitrogen content have been implemented
    - the date after the end of the reporting period on which the acidified treated manure storage structure is fully emptied to the extent operationally feasible and the acidified treated manure is land applied

- for a project mechanical MTS:
    - data indicating the operational status of the project mechanical MTS, as per Section 9.6.2

- for a project AD MTS:
    - data indicating the operational status of the project AD MTS and the eligible destruction device(s), as per Section 9.6.3
    - data and information used for determination of the leak rate, as per Sections 9.1.7 and 9.2.4.6
    - data and information used for determination of the CH_4 emissions vented to the atmosphere in case of an emergency venting event, as per Section 9.1.8
    - if the project includes displacement of fossil fuels by eligible biogas, a description of how each requirement outlined in Section 4.4 is met

- the quantified GHG emissions for each SSR included in the baseline and project scenarios, in t CO_2e, for each full or partial calendar year covered by the reporting period as well as the measured and collected data needed for the quantification as per the method and frequency prescribed for applicable parameters in Table 3
- the periods during which missing data was substituted and the method of substitution used as per Section 9.5
- any under or over reported values and the corrective actions taken as per Section 9.4