CLIMATE ACTION RESERVE

Mine Methane Protocol

Version 1.0 for Board Approval
September 10, 2026

Anticipated Effective Date: September 18, 2026

Table of Contents

List of Tables

List of Figures

List of Equations

Abbreviations and Acronyms

ACM	Approved consolidated baseline and monitoring methodology under CDM
CDM	Clean Development Mechanism
CH_4	Methane
CMG	Coal mine gas
CMM	Coal mine methane
CNG	Compressed natural gas
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
CRT	Climate Reserve Tonne
ETS	Emissions Trading System
GHG	Greenhouse gas
HMM	Coal mine methane from horizontal pre-mining
ISO	International Organization for Standardization
IPCC	Intergovernmental Panel on Climate Change
LNG	Liquid natural gas
NMHC	Non-methane hydrocarbon
NOV	Notice of Violation
NOVA/COI	Notification of Verification Activities/Conflict of Interest
PMM	Coal mine methane from post-mining (gob wells)
QA/QC	Quality assurance/quality control
SMM	Coal mine methane from surface pre-mining
SSR	Sources, sinks and reservoirs
UNFCCC	United Nations Framework Convention on Climate Change
VAM	Ventilation air methane
WBCSD	World Business Council for Sustainable Development
WRI	World Resources Institute

1 Introduction

The Climate Action Reserve (Reserve) Mine Methane Protocol provides guidance to account for, report, and verify greenhouse gas (GHG) emission reductions associated with destroying methane from active and abandoned underground mines that would have otherwise been vented to the atmosphere from degasification systems, including drainage systems and ventilation systems. This document outlines the common project activity requirements and guidance for all mine methane projects and is complemented by associated Jurisdiction Modules. Please refer to the applicable Jurisdiction Module for additional requirements.

2 The GHG Reduction Project

2.1 Background

Methane is formed during the same geologic process that converts vegetative matter to coal; coal mining and post-mining processes release this methane from the coal and surrounding rock to the atmosphere. The amount of methane contained in and around a coal seam tends to be correlated with the amount of geologic pressure on the seam, which in turn depends on the seam depth.

When combined with air in concentrations of 5 to 15 percent, methane released by mining activity is explosive within the mine atmosphere. Degasification is therefore an integral and critically important component of the underground mining process. Two primary degasification techniques are available to the operator: ventilation and methane drainage. Methane emissions are vented through mine ventilation shafts or methane drainage wells designed for the express purpose of removing the methane from the mine and venting it to the atmosphere.

Ventilation

The primary purpose of ventilation systems is to (1) dilute the methane in the mine air, and (2) remove the methane from the mine. Clean intake air is drawn into the mine from above ground through intake air shafts and/or horizontal drift entries, where it is channeled through the intake airways to the face, and then through the "returns" to a return air shaft(s) and/or drift entry(ies). The energy needed to move the large quantities of air through the ventilation system is provided by high-powered exhaust mine fans located on the surface at the return air shaft(s). Upon passing up the return air shaft(s) and through the fan, the mine air, including diluted methane, is vented to the atmosphere.

The ventilation systems emit highly dilute concentrations of the methane; typically, the mine air vented from return air shafts is less than 1 percent methane. In this protocol, coal mine methane in mine air emitted through ventilation systems is referred to as ventilation air methane or "VAM."

Methane Drainage

At very gassy mines, ventilation is typically supplemented with methane drainage systems designed to remove methane either in advance of, or behind, the working face. These systems involve drilling boreholes, either from the surface or inside the mine, to drain methane from the coal seam, surrounding strata, or underground workings, thereby reducing the amount of methane that has to be handled by the ventilation system.

There are three main types of drainage systems, which may be employed in isolation or in combination with one another:

- Surface pre-mining boreholes
- Horizontal pre-mining boreholes
- Post-mining (or gob) boreholes

Each of these three system types are described in more detail below. Note that the protocol distinguishes between *coal mine gas* (CMG), which is the gas that comes out of the boreholes before any processing or enrichment and often contains various levels of other compounds (e.g., nitrogen, oxygen, carbon dioxide, hydrogen sulfide, NMHC, etc.) and *coal mine methane* (CMM), which represents only the methane portion of CMG.

Surface Pre-Mining Boreholes

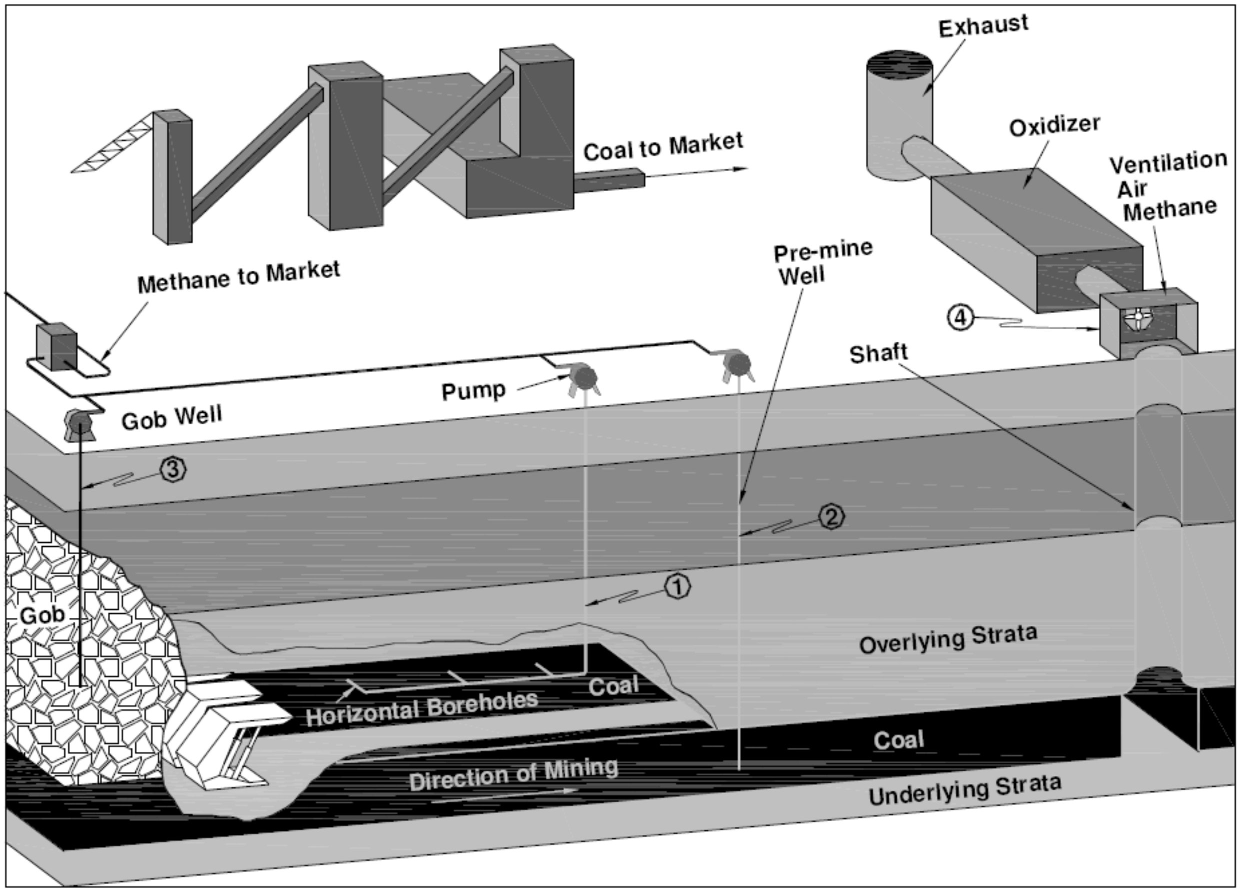
Surface pre-mining boreholes, or wells, are drilled from the surface to unmined portions of the coal seam in advance of mining (see Figure 2.1). They may be vertical, vertical to lateral, or even close to horizontal in their orientation. Surface-to-seam boreholes (otherwise known as surface-drilled directional boreholes) fall into this category. All of these surface pre-mining boreholes collect methane both from the seam itself, as well as from strata lying above the seam. Surface pre-mining wells may be drilled in locations that are not scheduled to be mined through for months or years; sometimes surface pre-mining wells are drilled before the associated mine even opens. Because they are drilled into virgin coal instead of the underground workings, pre-mining surface wells produce a high-quality gas that is uncontaminated with mine air. Typically, gas from these wells is at least 90 percent pure methane. In this protocol, the acronym "SMM" refers to coal mine methane drained from surface pre-mining boreholes.

Horizontal Pre-Mining Boreholes

Horizontal pre-mining boreholes, also referred to as "in-mine" boreholes, are drilled from within the mine (rather than from the surface) into unmined blocks of coal (see Figure 2.1). They are generally 400 to 800 feet in length and are drilled shortly (as opposed to years) before mining occurs. Methane is drained from the boreholes by an in-mine vacuum piping system, which transports the methane to the surface where it may be either vented or captured and utilized. Because horizontal boreholes are drilled directly into the coal seam from the mine, drainage is limited to the methane contained within the seam; methane in the surrounding strata is unaffected. Hence recovery rates tend to be low (10 to 18 percent of the methane that would otherwise have been emitted from the ventilation system), although the gas recovered from horizontal boreholes is generally comparable in purity to methane drained from surface pre-mining boreholes. In this protocol, the acronym "HMM" refers to coal mine methane from horizontal pre-mining boreholes.

Post-Mining Boreholes

Post-mining, or gob, boreholes are drilled from the surface to a point 10 to 50 feet above the coal seam in advance of mining (see Figure 2.1). As mining advances under and past the well, the strata above the coal seam fractures and eventually collapses into the mined out area creating a de-pressurized zone extending up to the well; this zone is called the gob. Methane and other gases from the gob are collected via the gob well. The gob is exposed to the mine air, and hence the methane drained by gob wells is typically less pure than gas recovered by pre-mining boreholes, although it can be high quality early on in the life of the well. In many cases vacuum pumps are used in conjunction with gob wells to enhance gas recovery and to prevent methane from entering the mine's ventilation circuit. However, these pumps may draw in mine air as well as methane, thus exacerbating the contamination of the recovered methane. Gob gas typically has a heating value ranging from 300 to 800 Btus per cubic feet (as compared with approximately 1,000 Btus per cubic foot for pipeline quality natural gas). In this protocol, the acronym "PMM" refers to coal mine methane from post-mining boreholes.



1) Horizontal Pre-Mining 2) Surface Pre-Mining 3) Post-Mining and 4) VAM
Source: U.S. EPA *Identifying Opportunities for Methane Recovery at U.S. Coal Mines: Profiles of Selected Gassy Underground Coal Mines 2002 – 2006*, EPA -430-K-04-003, January 2009, p 2-5.

Figure 2.1. Schematic of Degasification Types

2.2 Project Definition

For the purpose of this protocol, a GHG reduction project (project) is defined as the installation and operation of any device, or set of devices, that result in the destruction of methane gas that would otherwise have been vented to the atmosphere from an underground mine. Eligible mines include coal mines and trona mines. While the protocol document refers to "coal mine methane" throughout, it may be applied to methane released through mining at underground trona mines.

A project must consist of either:

1. Installation and operation of a methane destruction device (or multiple devices) that destroys methane from a methane drainage system at an active underground coal or trona mine
2. Installation and operation of a methane destruction device (or multiple devices) that destroys ventilation air methane at an active underground coal or trona mine
3. Installation and operation of one or more methane destruction devices that destroy methane from an abandoned underground coal mine or eligible abandoned underground trona mine that would otherwise be emitted to the atmosphere.

A single project may not combine destruction of both drainage system and ventilation air methane, except under limited circumstances.[1] However, both drainage projects and VAM projects may be implemented and registered separately at the same mine. In addition, project developers may register multiple projects of the same type at the same mine, e.g., if separate destruction devices are installed at different times.

The protocol does not apply to projects that:

- Operate in surface mines
- Destroy virgin coal bed methane (e.g., methane of high quality extracted from coal seams independently of any mining activities)
- Use CO_2 or any other fluid/gas to enhance CMM drainage before mining takes place
- Occur at flooded abandoned mines or in flooded sections of abandoned mines

Under the terms of this protocol, the Reserve will issue CRTs only for the destruction of methane that would otherwise have been emitted to the atmosphere. Some projects may put captured CMM to beneficial use by using it to generate energy. Projects that use CMM for energy production are eligible under this protocol (since they destroy methane in the process). However, such projects will not receive credit for displacing GHG emissions associated with other fossil fuels that might have been used to produce energy.

2.2.1 Drainage Projects

A drainage project is one that destroys methane that would otherwise be vented to the atmosphere from a methane drainage system. The methane drainage system may use any of the following extraction activities:

- Surface boreholes, including vertical and surface-to-seam directional drilling, located within the boundary of the mine to capture pre-mining CMM
- In-mine underground horizontal boreholes located within the boundary of the mine to capture pre-mining CMM
- Surface gob wells, underground boreholes, gas drainage galleries or other gob gas capture techniques located within the boundary of the mine, including gas from sealed areas, to capture post mining CMM

The borehole(s) that make up each project's drainage system must be defined by the project developer at the time of project submittal. The project developer must also specify what destruction device(s) is/are part of the drainage project. A single project must be explicitly defined and associated with specific boreholes and destruction devices. Multiple drainage projects may be implemented at a single mine, each with its own start date, crediting period, registration, and verification cycle. Each project's drainage system and destruction devices shall be detailed in the project diagram.

If additional boreholes are drilled and/or connected to an existing qualifying project destruction device, this is considered a project expansion. Similarly, if a new or additional destruction device is added to boreholes that are already connected to an existing project destruction device, this is considered a project expansion. If a new borehole or a borehole that is currently venting CMM is connected to a new destruction device, this may be considered a new project or a project expansion. If the project developer chooses to define it as a project expansion, the project start

[1] In some cases, CMM from a drainage system is allowed to supplement a VAM project (see Section 3.4.2). In this case, a single project can consist of both drainage system and VAM methane destruction, as long as the drainage system contribution is limited to supplemental CMM.

date and crediting period remain the same as the original project, and a single verification will cover all activities. If the project developer chooses to define it as a new project, the project will have a new start date and crediting period, and the new project will require separate verification.

2.2.2 Ventilation Air Methane Projects

A ventilation air methane project is one that destroys methane that would otherwise be vented from a ventilation shaft (or multiple shafts). The ventilation shaft(s) and VAM destruction device(s) that make up each VAM project must be defined by the project developer at the time of project submittal. A single project must be explicitly defined and associated with a specific shaft (or multiple shafts that are operating concurrently). Multiple projects may be implemented at a single mine, each with its own start date, crediting period, registration, and verification cycle. Each project's ventilation shaft(s) and VAM destruction device(s) shall be detailed in the project diagram.

If additional VAM destruction equipment is added to a shaft that is part of an existing project, this is considered a project expansion. If VAM destruction equipment is installed at a shaft that is not part of an existing project, this new shaft may be considered a new project or a project expansion. If the project developer chooses to define it as a project expansion, the project start date and crediting period remain the same, and a single verification will cover activities at both shafts. If the project developer chooses to define it as a new project, activities at the new shaft will have a new start date and crediting period and will require separate verification. For a new VAM project, the VAM destruction equipment does not need to be new; it is only the ventilation shaft that must be new.

2.2.3 Non-Qualifying Devices

Non-qualifying devices are devices that destroy CMM but do not meet one or more of the eligibility rules as described in Section 3 and are located at the same mine where eligible project activities are taking place. If there are any non-qualifying devices in operation at a mine, the project developer must include the non-qualifying device(s) in the project's GHG Assessment Boundary (see Section 4) and in the project diagram (see Section 7.1). Subsequent projects implemented at the same mine may exclude the same non-qualifying device(s) from their GHG assessment boundaries. In other words, if methane destruction at a non-qualifying device is accounted for by one project at a mine, it does not need to be accounted for by other projects at the same mine. Refer to the Jurisdiction Module for what devices are non-qualifying devices as a result of common practice.

If any new non-qualifying devices become operational at the mine, these devices must be assigned to a specific project. In the case where a project developer has more than one registered project at a mine, the project developer may choose which project will account for the new non-qualifying device.

In the case where there are multiple projects with different crediting periods at a mine, when the crediting period for a project that includes a non-qualifying device expires, the non-qualifying device must be added to the GHG Assessment Boundary of a project that is still active. Thus, all non-qualifying devices must be properly accounted for in the GHG Assessment Boundary of an active project at the mine over time.

2.3 The Project Developer

The project developer must have clear ownership of the project's GHG reductions established by clear and explicit title. The project developer must sign the Attestation of Title. Refer to the Reserve Offset Program Manual for additional information on meeting this requirement.

Project developers may be mine owners, mine operators, entities that specialize in project development, utilities, independent energy companies, or other entities.

3 Eligibility Rules

Projects that meet the definition of a GHG reduction project in Section 2.2 must fully satisfy the following eligibility rules in order to register with the Reserve.

3.1 Location

Under this protocol, only projects located in countries with a Jurisdiction Module are eligible to register with the Reserve.

3.2 Project Start Date

The project start date shall be defined by the project developer, but must be no more than three months after coal mine methane is first destroyed by the project, regardless of whether sufficient monitoring data is available to report reductions. The start date is defined in relation to the commencement of methane destruction. For projects that involve pre-mine drainage, for example, well-drilling may commence in advance of any methane destruction; in such cases, the start date would be linked to the commencement of methane destruction, not drilling activities.

To be eligible, the project must be submitted to the Reserve no more than 12 months after the project start date.[2] Projects may always be submitted for listing by the Reserve prior to their start date.

3.3 Project Crediting Period

The Reserve will issue Climate Reserve Tonnes (CRTs) for GHG reductions quantified and verified for mine methane projects for an initial crediting period of 10 years following the project start date. The crediting period begins at the project start date regardless of whether sufficient monitoring data is available to verify GHG reductions.

Projects may be eligible for a second crediting period, for a maximum of two, 10-year crediting periods (i.e., for a project lifespan of 20 years), provided that the project meets the eligibility requirements of the current version of the protocol at the time of application.[3]

The Reserve will cease to issue CRTs for GHG reductions if at any point in the future CMM destruction becomes legally required at the project site (See Section 3.4.1). Thus, the Reserve will issue CRTs for GHG reductions quantified and verified according to this protocol for a maximum of two 10-year crediting periods after the project start date, or until the project activity is required by law, whichever comes first.

A change in mine status, including a declaration that the mine is abandoned, shall not by itself terminate the crediting period or render the project ineligible, provided that the project continues to satisfy all applicable requirements of this protocol.

[2] Projects are considered submitted when the project developer has fully completed and filed the appropriate project submittal documentation, available on the Reserve's website.
[3] Refer to the Reserve Program Manual for the deadline to submit for a renewed crediting period.

3.4 Additionality

The Reserve strives to register only projects that yield surplus GHG reductions that are additional to what would have occurred in the absence of a carbon offset market.

Projects must satisfy the following tests to be considered additional:

1. The Legal Requirement Test
2. The Performance Standard Test

3.4.1 The Legal Requirement Test

A project passes the Legal Requirement Test when there are no laws, statutes, rules, regulations, ordinances, court orders, governmental agency actions, enforcement actions, environmental mitigation agreements, permitting conditions, permits or other legally binding mandates requiring the abatement of CMM at the project site. Each time a project undergoes verification, including the initial verification, the project developer must sign the Reserve's Attestation of Voluntary Implementation form. Refer to the Reserve Program Manual for additional information on meeting this requirement. Jurisdiction Modules provide additional information related to legal considerations particular to a given jurisdiction.

If an eligible project begins operation at a mine that later becomes subject to a regulation, ordinance or permitting condition that calls for the destruction of coal mine methane, emission reductions may be reported to the Reserve up until the date that the coal mine methane is legally required to be destroyed. If the mine's methane emissions are included under an emissions cap (e.g., under a state or federal emissions trading system (ETS)), emission reductions may likewise be reported to the Reserve until the date that the emissions cap takes effect. Refer to the applicable Jurisdiction Module for further information.

3.4.2 The Performance Standard Test

Projects pass the Performance Standard Test by meeting a performance threshold, i.e., a standard of performance applicable to all coal mine methane destruction projects, established on an *ex-ante* basis by this protocol and supporting Jurisdiction Module.

There are numerous possible management options and end uses for coal mine methane, ranging from venting, to destruction by flares, to injection of the methane into natural gas pipelines. The Performance Standard Test employed by this protocol is based on a national assessment of "common practice" for managing coal mine methane. The performance standard defines those end uses that the Reserve has determined will exceed common practice and therefore generates additional GHG reductions.

Drainage projects at active mines pass the Performance Standard Test if they destroy CMM through any end-use management option, unless otherwise specified in the Jurisdiction Module (e.g., flare, power generation, heat generation, producing CNG/LNG for vehicle use, natural gas pipeline injection, etc.). Projects that destroy CMM from an abandoned underground coal mine pass the Performance Standard Test if they install and operate one or more methane destruction devices that destroy CMM that would otherwise be emitted to the atmosphere.

All VAM projects pass the Performance Standard Test. Such projects may include, but are not limited to, the following end uses for VAM:

- Thermal flow reversal reactors with or without catalysts
- Volatile organic compound concentrators

- Carbureted gas turbines
- Lean-fueled turbines with catalytic combustors that compress the air/methane mixture and then combust it in a catalytic combustor
- Hybrid coal- and ventilation air-fueled gas turbine technology
- Lean-fueled catalytic microturbine technology
- Combustion air for commercial engine and turbine technologies or a coal-fired steam power plant

In some cases, VAM projects may need to supplement VAM with CMM from drainage boreholes, either to increase the concentration of methane flowing into the combustion/oxidation device or to help balance the concentration of methane flowing into the combustion/oxidation device. This supplemental CMM is also eligible as part of a VAM project, as long as the supplemental CMM would not have been used for energy purposes.

The Performance Standard Test is applied at the time a project applies for registration with the Reserve. Once a project is registered, it does not need to be evaluated against future versions of the protocol or the Performance Standard Test for the duration of its first crediting period.

If a project developer wishes to apply for a second crediting period, the project must meet the requirements of the most current version of this protocol, including any updates to the Performance Standard Test.

3.5 Regulatory Compliance

Guidance related to regulatory compliance specific to a given jurisdiction can be found in the relevant Jurisdiction Module. Each time the project is verified, the project developer must sign the Reserve's Attestation of Regulatory Compliance form and report all instances of non-compliance to the verifier. Refer to the Reserve Program Manual for additional information on meeting this requirement.

3.6 Social and Environmental Safeguards

This Protocol includes specific social and environmental safeguards that must be considered in the project design and implemented throughout the project life to help guarantee that the project will have positive environmental and social outcomes. In addition, all projects must comply with the Reserve Program Manual, including the section on regulatory compliance and programmatic environmental and social safeguards. The safeguards in the protocol are intended to respect internal governmental processes, customs, and rights of employees and communities while ensuring projects are beneficial, both socially and environmentally. The sections on monitoring, reporting, and verification (MRV) (Sections 7 and 8) specify the criteria for verification of each of these safeguards and consequences for failure to achieve the minimum thresholds.

The social safeguards requirements include:

1. Labor and Safety: The project developer must attest that the project is in material compliance with all applicable laws, including labor or safety laws. See Section 3.5 Regulatory Compliance for further information.
2. Dispute Resolution: The Reserve holds public comment on all listed projects prior to registration and has an ongoing dispute resolution process. See the Reserve Offset Program Manual and website for further information on programmatic and project specific public consultation and dispute resolution processes. Projects that receive

material complaints will not be registered until a satisfactory dispute resolution plan has been approved.

The environmental safeguards requirements include:

1. Air and Water Quality: The project developer must attest that the project is in material compliance with all applicable laws, including environmental regulations (e.g., air and water quality). See Section 3.5 for further information.
2. Mitigation of Pollutants: Projects must be designed and implemented to mitigate potential releases of pollutants that may cause degradation of the quality of soil, air, surface and groundwater, and project developers must acquire the appropriate local permits prior to installation to prevent violation of all applicable law.

4 GHG Assessment Boundary

The GHG Assessment Boundary delineates the GHG sources, sinks, and reservoirs (SSRs) that shall be assessed by project developers in order to determine the total net change in GHG emissions caused by a coal mine methane project.

This protocol does not account for carbon dioxide emission reductions associated with displacing grid-delivered electricity or fossil fuel use.

Figure 4.1 provides a general illustration of the GHG Assessment Boundary for VAM projects, indicating which SSRs are included or excluded from the boundary.

Figure 4.2 provides a general illustration of the GHG Assessment Boundary for drainage projects, indicating which SSRs are included or excluded from the boundary.

Table 4.1 provides greater detail on each SSR and provides justification for all SSRs and gases that are excluded from the GHG Assessment Boundary. The GHG Assessment Boundary diagram and table presented here apply to all project types; individual SSRs may or may not be relevant depending on the project type.

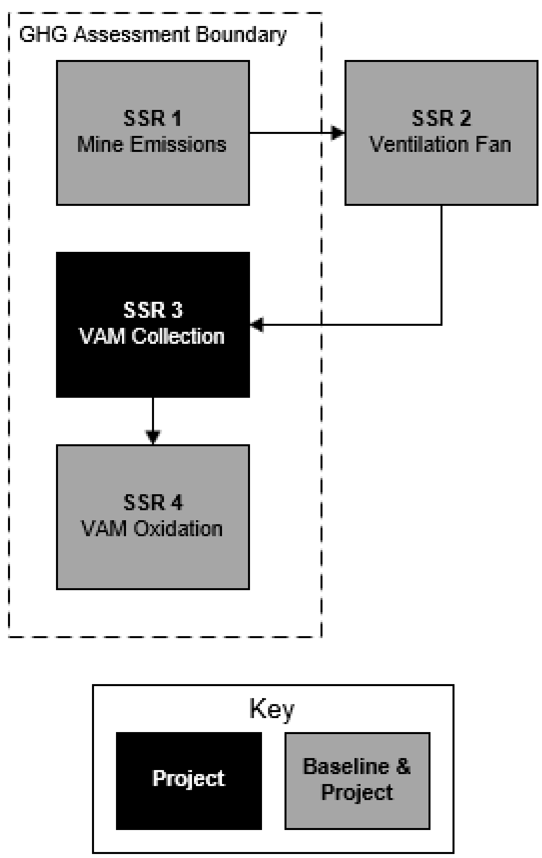


Figure 4.1. Illustration of the GHG Assessment Boundary for VAM Projects

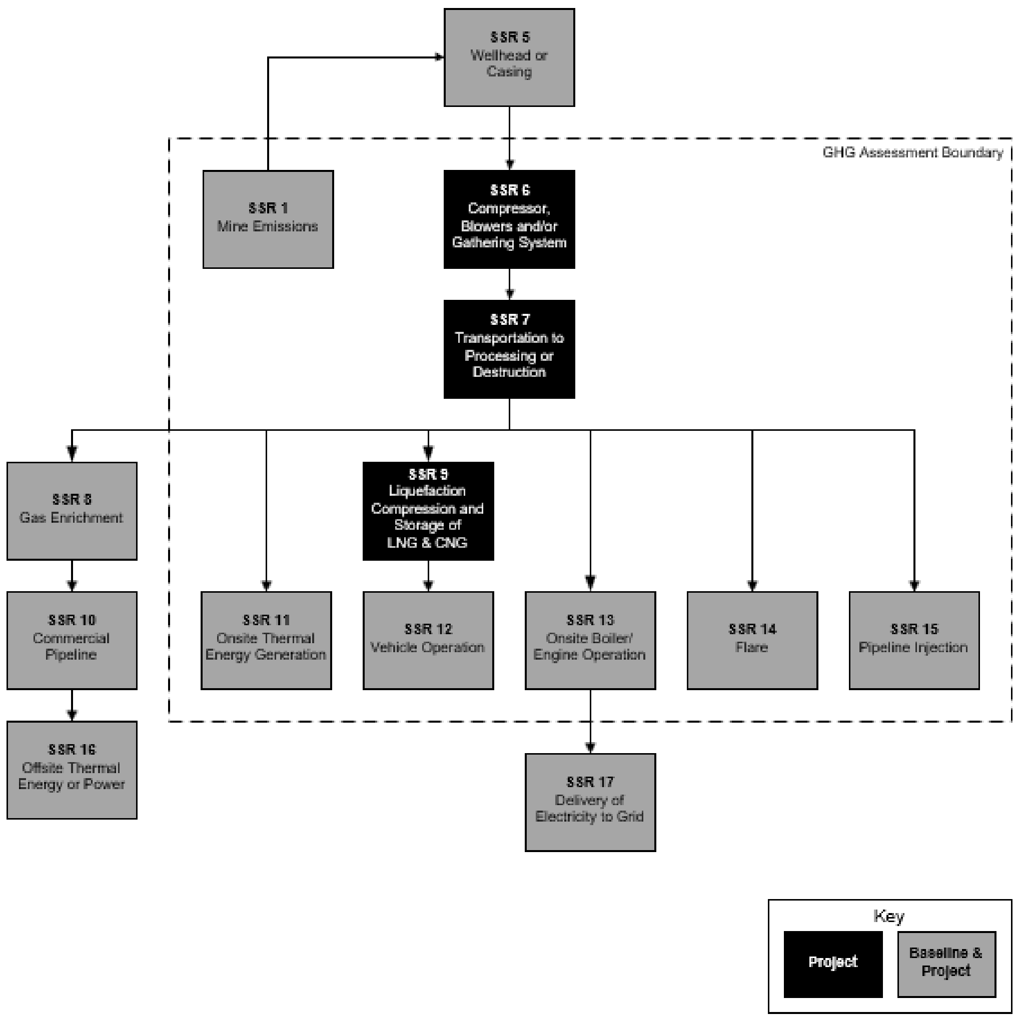


Figure 4.2. Illustration of the GHG Assessment Boundary for Drainage Projects

Table 4.1. Summary of Identified Sources, Sinks, and Reservoirs

SSR	Source	Gas	Relevant to Baseline (B) or Project (P)	Included/ Excluded	Justification/Explanation
1	Emissions as a result of venting	CH_4	B, P	Included	Main emission source of methane from active and abandoned mines. A GHG project will directly affect these emissions. Only the change in CMM emissions release will be taken into account, by monitoring the methane used or destroyed by the project.
2	Ventilation fan	CO_2	n/a	Excluded	Ventilation fan operation will not be affected by the project.
3	VAM collection system	CO_2	P	Included	The VAM collection system will result in increased combustion emissions due to energy consumption from equipment used to drain, compress, blow, and gather VAM.
		CH_4		Excluded	Excluded for simplification. This emission source is assumed to be very small.
		N_2O		Excluded	Excluded for simplification. This emission source is assumed to be very small.
4	VAM oxidation	CO_2	B, P	Included	VAM project will result in increased CO_2 emissions from the oxidation of methane in ventilation air.
		CH_4	P	Included	VAM project will result in CH_4 emissions from non-oxidized CH_4 from the ventilation air stream.
		N_2O	n/a	Excluded	Excluded for simplification. This emission source is assumed to be very small.
	Emissions from NMHC destruction	CO_2	P	Included if >3,500 mg/m^3	VAM project will result in increased CO_2 emissions from the combustion of NMHC in oxidizer (only included if NMHC accounts for more than 3,500 mg/m^3 (wet basis) of extracted ventilation air).
5	Fugitive emissions resulting from casing or wellhead	CH_4	n/a	Excluded	The project is unlikely to affect quantities of methane from this source.
6	Emissions resulting from energy used by compressors, blowers, and/or gathering system	CO_2	P	Included	If any additional equipment is required by the project beyond what is required in the baseline, energy consumption from additional equipment shall be accounted for. Energy used by equipment installed for the safety of the mine shall be excluded.
		CH_4		Excluded	Excluded for simplification. This emission source is assumed to be very small.

SSR	Source	Gas	Relevant to Baseline (B) or Project (P)	Included/ Excluded	Justification/Explanation
		N_2O		Excluded	Excluded for simplification. This emission source is assumed to be very small.
	Fugitive emissions resulting from compressors, blowers, and/or gathering system	CH_4	n/a	Excluded	Excluded for simplification. This emission source is assumed to be very small.
7	Fuel consumption for transport of CMG to processing or destruction equipment	CO_2	P	Included	If any additional equipment is required by the project beyond what is required in the baseline, energy consumption from additional equipment shall be accounted for.
		CH_4		Excluded	Excluded for simplification. This emission source is assumed to be very small.
		N_2O		Excluded	Excluded for simplification. This emission source is assumed to be very small.
	Fugitive emissions from transport of CMG to processing or destruction equipment	CH_4	n/a	Excluded	Excluded for simplification. This emission source is assumed to be very small.
8	Emissions resulting from gas enrichment system	CO_2	n/a	Excluded	The project is unlikely to affect quantities of methane sent to gas enrichment systems, and will therefore not affect energy consumption or fugitive emissions from gas enrichment systems.
		CH_4		Excluded	
		N_2O		Excluded	
9	Emissions resulting from liquefaction, compression, or storage of methane for vehicle fuel	CO_2	P	Included	If any additional equipment is required by the project beyond what is required in the baseline, energy consumption from additional equipment shall be accounted for.
		CH_4		Excluded	Excluded for simplification. This emission source is assumed to be very small.
		N_2O		Excluded	Excluded for simplification. This emission source is assumed to be very small.
10	Fugitive emissions from commercial pipelines	CH_4	n/a	Excluded	The project is unlikely to affect quantities of methane delivered to commercial pipelines, and will therefore not affect fugitive pipeline emissions.

SSR	Source	Gas	Relevant to Baseline (B) or Project (P)	Included/ Excluded	Justification/Explanation
11	Emissions resulting from combustion during on-site thermal energy generation	CO_2	B, P	Included	If CMM is used for on-site thermal energy generation, project will result in increased CO_2 emissions from the destruction of methane to generate energy. This source is also included where CMM is sent to a non-qualifying device to generate energy.
		N_2O		Excluded	Excluded for simplification. This emission source is assumed to be very small.
	Emissions resulting from incomplete combustion during onsite thermal energy generation	CH_4	P	Included	If CMM is used for on-site thermal energy generation, project will result in increased CH_4 emissions from incomplete combustion. This source is also included where CMM is sent to a non-qualifying device to generate energy.
	Emissions from NMHC destruction	CO_2	P	Included if >35,000 mg/m^3	If CMM is used for on-site thermal energy generation, project will result in increased CO_2 emissions from the combustion of NMHC during energy generation (only included if NMHC accounts for more than 35,000 mg/m^3 of CMG). This source is also included where CMM is sent to a non-qualifying device to generate energy.
12	Emissions resulting from combustion during vehicle operation	CO_2	B, P	Included	If CMM is used to produce CNG/LNG to fuel vehicle operation, project will result in increased CO_2 emissions from the destruction of methane in CNG/LNG vehicles. This source is also included where CMM is used for non-qualifying vehicle operation.
		N_2O		Excluded	Excluded for simplification. This emission source is assumed to be very small.
	Emissions resulting from incomplete combustion during vehicle operation	CH_4	P	Included	If CMM is used to produce CNG/LNG to fuel vehicle operation, project will result in increased CH_4 emissions from incomplete combustion. This source is also included where CMM is used for non-qualifying vehicle operation.
	Emissions from NMHC destruction	CO_2	P	Included if >35,000 mg/m^3	If CMM is to produce CNG/LNG to fuel vehicle operation, project will result in increased CO_2 emissions from the combustion of NMHC during vehicle operation (only included if NMHC accounts for more than 35,000 mg/m^3 of CMG). This source is also included where CMM is used for non-qualifying vehicle operation.

SSR	Source	Gas	Relevant to Baseline (B) or Project (P)	Included/ Excluded	Justification/Explanation
13	Emissions resulting from combustion during on-site electricity generation	CO_2	B, P	Included	If CMM is used for on-site power generation, project will result in increased CO_2 emissions from the destruction of methane to generate power. This source is also included where CMM is sent to a non-qualifying device for electricity generation.
		N_2O		Excluded	Excluded for simplification. This emission source is assumed to be very small.
	Emissions resulting from incomplete combustion during on-site electricity generation	CH_4	P	Included	If CMM is used for on-site power generation, project will result in increased CH_4 emissions from incomplete combustion. This source is also included where CMM is sent to a non-qualifying device for electricity generation.
	Emissions from NMHC destruction	CO_2	P	Included if >35,000 mg/m^3	If CMM is used for on-site power generation, project will result in increased CO_2 emissions from the combustion of NMHC during power generation (only included if NMHC accounts for more than 35,000 mg/m^3 of CMG). This source is also included where CMM is sent to a non-qualifying device for electricity generation.
14	Emissions resulting from combustion during flaring	CO_2	B, P	Included	If CMM is sent to a flare, project will result in increased CO_2 emissions from the destruction of methane in flare. This source is also included where CMM is sent to a non-qualifying device for flaring.
		N_2O		Excluded	Excluded for simplification. This emission source is assumed to be very small.
	Emissions resulting from incomplete combustion during flaring	CH_4	P	Included	If CMM is sent to a flare, project will result in increased CH_4 emissions from incomplete combustion. This source is also included where CMM is sent to a non-qualifying device for flaring.
	Emissions from NMHC destruction	CO_2	P	Included if >35,000 mg/m^3	If CMM is sent to a flare, project will result in increased CO_2 emissions from the combustion of NMHC in flare (only included if NMHC accounts for more than 35,000 mg/m^3 of CMG).
15	Emissions resulting from methane combustion from pipeline injection	CO_2	B,P	Included	If CMM is sent to a natural gas pipeline, project will result in increased CO_2 emissions from the destruction of methane. This source is also included where CMM is sent to a non-qualifying device for injection.

SSR	Source	Gas	Relevant to Baseline (B) or Project (P)	Included/ Excluded	Justification/Explanation
		N_2O		Excluded	Excluded for simplification. This emission source is assumed to be very small.
	Emissions resulting from the incomplete methane combustion from pipeline injection	CH_4	B,P	Included	If CMM is sent to a natural gas pipeline, project will result in increased CH_4 emisions from incomplete combustion.
16	Emissions resulting from offsite thermal or power generation	CO_2	n/a	Excluded	The project is unlikely to affect quantities of methane delivered through pipelines to offsite thermal or power generation equipment, and will therefore not affect emissions from such equipment.
		N_2O			
	Emissions resulting from incomplete combustion during off-site thermal energy or power generation	CH_4			
17	Delivery of electricity to grid	CO_2	n/a	Excluded	This protocol does not cover displacement of GHG emissions from the use of CMM for grid-connected electricity generation.
		CH_4			
		N_2O			
	Project construction and decommissioning emissions	CO_2	n/a	Excluded	Excluded for simplification. This emission source is assumed to be very small.
		CH_4			
		N_2O			

5 Quantifying GHG Emission Reductions

ER
Equation 5.1 GHG Emission Reductions

Emission Reductions = Baseline Emissions – Project Emissions

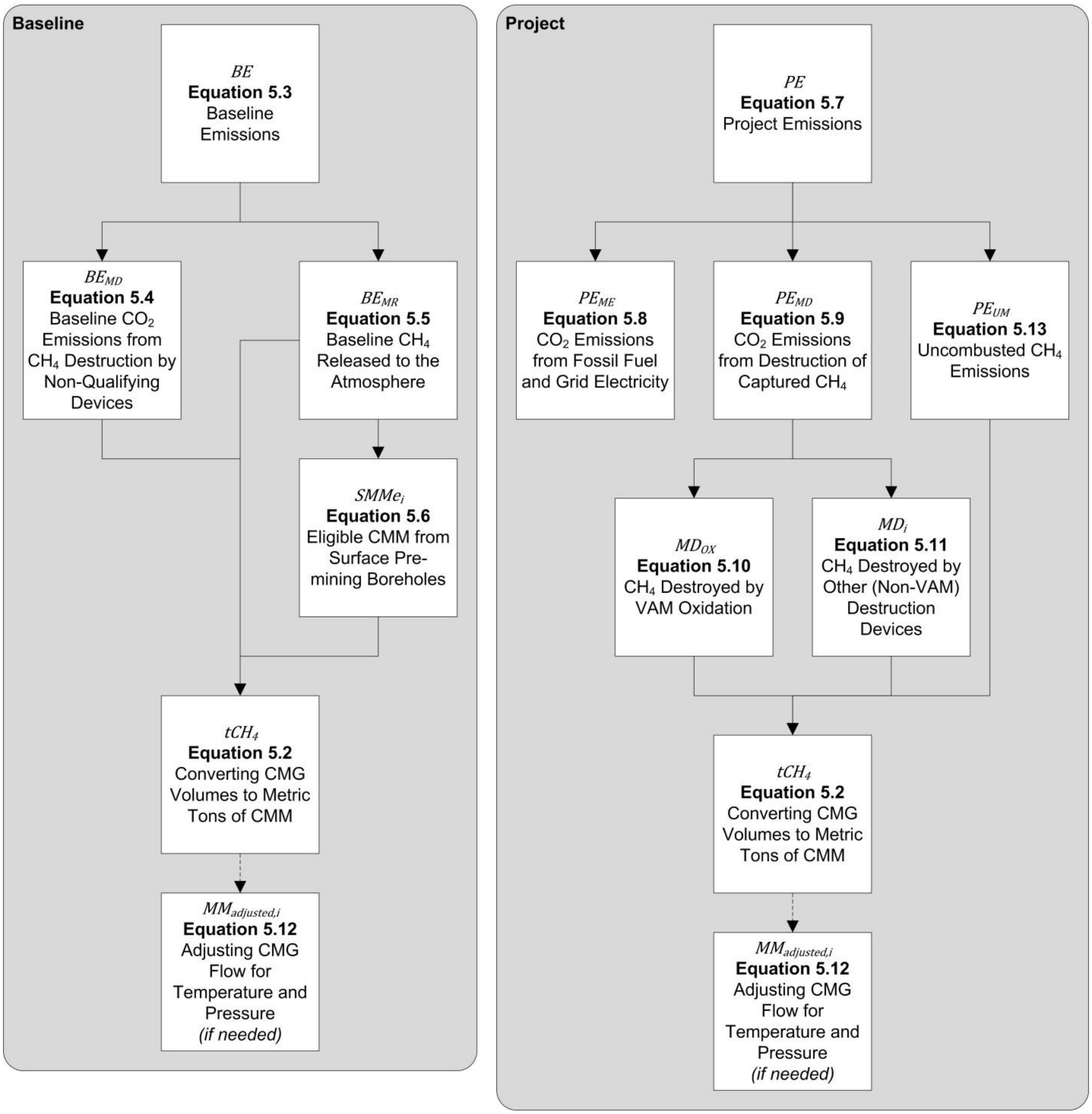


Figure 5.1. Organizational Chart for Equations in Section 5

GHG emission reductions from a coal mine methane project are quantified by comparing actual project emissions to baseline emissions at the mine. Baseline emissions are an estimate of the GHG emissions from sources within the GHG Assessment Boundary (see Section 4) that would have occurred in the absence of the coal mine methane project. Project emissions are actual

GHG emissions that occur at sources within the GHG Assessment Boundary. Project emissions must be subtracted from the baseline emissions to quantify the project's total net GHG emission reductions (Equation 5.1).

GHG emission reductions must be quantified and verified. The length of time over which GHG emission reductions are quantified and verified is called the "reporting period."

Equation 5.1. GHG Emission Reductions

$$ER = BE - PE$$

Where,			Units
ER	=	GHG emission reductions of the project activity during the reporting period	tCO_2e
BE	=	Baseline emissions during the reporting period	tCO_2e
PE	=	Project emissions during the reporting period	tCO_2e

The calculations provided in this protocol are derived from internationally accepted methodologies.[4] Project developers shall use the calculation methods provided in this protocol to determine baseline and project GHG emissions in order to quantify GHG emission reductions.

Equation 5.2 provides guidance for calculating the mass of methane from the independently measured parameters of gas volume and methane concentration. Note that Equation 5.2 distinguishes between *coal mine gas* (CMG), which is the gas that comes out of the boreholes before any processing or enrichment and often contains various levels of other compounds (e.g., nitrogen, oxygen, carbon dioxide, hydrogen sulfide, NMHC, etc.) and *coal mine methane* (CMM), which represents only the methane portion of CMG.

Throughout the protocol, it is assumed that measured quantities of coal mine gas are converted to metric tons of methane using the following three parameters:

- Measured methane concentration of the coal mine gas
- Volume of gas, corrected to standard conditions (60°F and 1 atm)
- Density of methane at standard conditions (60°F and 1 atm)

[4] The Reserve's GHG reduction calculation method for CMM projects is derived from the UNFCCC approved consolidated methodology under the Kyoto Protocol's Clean Development Mechanism (ACM0008/Version 6), and also draws from Greenhouse Gas Services Methodology for Coal Mine Methane and Abandoned Mine Methane Capture and Destruction Projects (Version 1.1), the U.S. EPA Inventory of U.S. GHG Emissions and Sinks 1990-2007, California Air Resources Board Compliance Offset Protocol Mine Methane Capture Projects (November 2014), and the 2006 IPCC Guidelines for National GHG Inventories.

Equation 5.2. Converting CMG Volumes to Metric Tons of CMM

$$tCH_4 = (0.0423 \times 0.000454) \times \sum_t scfCMG_t \times \%CH_{4t}$$

Where,			Units
tCH_4	=	Total quantity of CMM	tCH_4
t	=	Time interval for which flow and concentration measurements are aggregated (daily)	
$\%CH_{4t}$	=	The average methane fraction of the CMG in time interval t as measured	scf CH_4/scf
$scfCMG_t$	=	Total volume of coal mine gas in time interval t, as measured (see Equation 5.12 for additional guidance on adjusting the CMG flow for temperature and pressure)	scf CMG
0.0423	=	Density of methane	lb CH_4/scf CH_4
0.000454	=	tCH_4/lb CH_4	t/lb

5.1 Quantifying Baseline Emissions

Total baseline emissions must be estimated by calculating and summing the expected baseline emissions for all relevant SSRs (as indicated in Table 4.1) using Equation 5.3 and the supporting equations presented below.

Equation 5.3. Baseline Emissions

$$BE = BE_{MD} + BE_{MR}$$

Where,			Units
BE	=	Baseline emissions during the reporting period	tCO_2e
BE_{MD}	=	Baseline emissions from destruction of methane during the reporting period	tCO_2e
BE_{MR}	=	Baseline emissions from release of methane into the atmosphere during the reporting period	tCO_2e

Baseline emissions from CMM release or destruction may be associated with four different stages of mining activity:

1. Surface pre-mining: boreholes are drilled from the surface to unmined portions of the coal seam in advance of mining. CMM drained from surface pre-mining boreholes is represented as SMM in the equations below.

2. Horizontal pre-mining: boreholes are drilled horizontally from within the mine into unmined blocks of coal shortly before mining occurs (also referred to as in-mine boreholes). CMM drained from horizontal pre-mining boreholes is represented as HMM in the equations below.

3. Ventilation during mining through required ventilation systems. CMM collected from ventilation systems is represented as VAM in the equations below.

4. Post-mining: boreholes are drilled from the surface to a point 10 to 50 feet above the coal seam in advance of mining. As mining advances under and past the well, the strata above the coal seam collapses into the mined out area creating a de-pressurized zone extending up to the well; this zone is called the gob. CMM drained from post-mining boreholes is represented as PMM in the equations below.

5.1.1 Calculating Baseline Carbon Dioxide Emissions from Methane Destruction

Depending on the mine, some CMM may be destroyed in the baseline through flaring, oxidation, power generation, heat generation, etc., in non-qualifying destruction devices (see Section 2.2.3). Baseline emissions estimates must include the estimated CO_2 emissions from the destruction of CMM in non-qualifying devices, calculated using Equation 5.4.

The amount of CMM destroyed in the baseline by a non-qualifying destruction device (variables $SMM_{BL,i}$, $HMM_{BL,i}$, $PMM_{BL,i}$ and $VAM_{BL,i}$ in Equation 5.4) is established by calculating and comparing:

1. The actual amount of SMM, HMM, PMM and VAM destroyed by the non-qualifying destruction device during the reporting period; and
2. The amount of SMM, HMM, PMM and VAM destroyed by the non-qualifying destruction device over the three year period prior to the implementation of the project (or however long the non-qualifying destruction device has been operational, whichever is shorter), averaged according to the length of the reporting period. For example, if the reporting period is three months, then the three-year historical amount must be divided by 12 to derive the average amount of destruction in a three-month period.

The higher of either (1) or (2) must be used for $SMM_{BL,i}$, $HMM_{BL,i}$, $PMM_{BL,i}$ and $VAM_{BL,i}$ in Equation 5.4 (and

Equation 5.5 in the next section).

Baseline emissions estimates must also include the CO_2 emissions from the destruction of non-methane hydrocarbons (NMHC) in non-qualifying devices, if NMHC comprise more than 35,000 mg/m^3 (measured on a wet basis at standard conditions) of extracted CMG or more than 3,500 mg/m^3 (measured on a wet basis at standard conditions) of extracted ventilation air.

If a non-qualifying destruction device in operation at the mine that was shut down less than one year prior to the project start date – or if a non-qualifying device is shut down at any point during the project's crediting period – the project developer must still account for the device in the baseline calculations, using the historical destruction amount calculated in (2), above. If the device was shut down more than one year before the project start date, it does not need to be accounted for in the baseline calculations.

If there is no destruction of methane in the baseline, then BE_{MD} = 0.

5.1.1.1 Treatment of CMM Sent to Non-Qualifying Devices

At some mines, the baseline may involve sending some CMM to a destruction device and could therefore be considered a "non-qualifying device."

For the case of pipeline injection in the baseline scenario, on-site CMM destruction projects are unlikely to affect the quantity of CMM delivered to pipelines (due to the likely physical and temporal separation of these activities), emissions associated with pipelines are excluded from the GHG Assessment Boundary, and do not need to be accounted for in the baseline or the project emission calculations.

If a mine that has historically sent CMM to a destruction device ceases to do so, CMM from that drainage system (i.e., SMM, HMM, or PMM) is not eligible for emission reductions, even if CMM is sent to an otherwise eligible destruction device. Furthermore, if a project mine begins to send CMM to a non-qualifying device while a CMM project is still ongoing, CMM from that drainage system will also be deemed ineligible from that point in time forward.

Where CMM is routed through a pipeline, gathering system, gas processing or upgrading facility, or other downstream pathway, the project developer must include within the GHG Assessment Boundary all project-attributable emissions necessary to quantify net GHG reductions, including material emissions from collection, compression, processing, upgrading, transport, delivery, and destruction or beneficial use, as applicable.

Equation 5.4. Baseline CO_2 Emissions from CH_4 Destruction by Non-Qualifying Devices

$$BE_{MD} = \left(2.75 + r \times CEF_{NMHC}\right) \times \sum_i \left(SMM_{BL,i} + VAM_{BL,i} + HMM_{BL,i} + PMM_{BL,i}\right)$$

Where,			Units
BE_{MD}	=	Baseline emissions from destruction of methane in the reporting period	tCO_2e
i	=	Use of methane (flaring, power generation, heat generation, etc.). Uses must include all non-qualifying devices	

$SMM_{BL,i}$	=	CMM from surface pre-mining that would have been captured, sent to and destroyed by use i in the baseline scenario in the reporting period	tCH_4
$VAM_{BL,i}$	=	VAM that would have been captured, sent to and destroyed by use i in the baseline scenario in the reporting period	tCH_4
$HMM_{BL,i}$	=	CMM from horizontal pre-mining that would have been captured, sent to and destroyed by use i in the baseline scenario in the reporting period	tCH_4
$PMM_{BL,i}$	=	Post-mining CMM that would have been captured, sent to and destroyed by use i in the baseline scenario in the reporting period	tCH_4
2.75	=	CO_2 emission factor for combusted methane[5]	tCO_2e/tCH_4
CEF_{NMHC}	=	CO_2 emission factor for combusted non methane hydrocarbons	$tCO_2e/tNMHC$
R	=	Relative mass proportion of NMHC compared to methane	

With:

$$r = {PC_{NMHC}}/{PC_{CH_4}}$$

Where,			Units
r	=	Relative mass proportion of NMHC compared to methane	
PC_{NMHC}	=	NMHC concentration (in mass) in extracted CMG or ventilation air, measured on a wet basis	mg/m^3
PC_{CH4}	=	Concentration (in mass) of methane in extracted CMG or ventilation air, measured on wet basis at standard conditions (60°F and 1 atm)	mg/m^3

5.1.2 Calculating Baseline Methane Emissions

Baseline emissions must include the methane that would have been emitted to the atmosphere in the absence of the project activity. Baseline emissions of methane are calculated by summing the total amount of methane *actually destroyed* by all qualifying and non-qualifying devices during the reporting period, and subtracting the amount that would have been destroyed in the baseline, as determined in Section 5.1.1. The difference between the actual amount of methane destroyed and what would have been destroyed determines how much methane would have been released.

In

[5] Use the molar mass of CO_2 and CH_4 to calculate tCO_2e/tCH_4 (44/16 = 2.75).

Equation 5.5, actual methane destruction at all qualifying devices (those installed as part of the project to destroy methane) and non-qualifying devices must be accounted for. For qualifying devices, baseline values for methane destruction (i.e., $SMM_{BL,i}$, $HMM_{BL,i}$, $PMM_{BL,I}$, *and* $VAM_{BL,i}$) will be zero.

Baseline methane emissions from surface pre-mining (SMM) are quantified only during reporting periods in which the emissions *would have occurred* (i.e., when the borehole is mined through). Thus, baseline methane emissions from SMM must be determined according to the amount of *eligible* CMM that has been destroyed, as defined in Section 5.1.2.1.

If a qualifying device for a VAM project uses CMM to supplement the flow of VAM, the supplemental CMM must be accounted for in

Equation 5.5 according to its source (*SMM*, *HMM* or *PMM*) if VAM flow and supplemental CMM flow are monitored separately, or directly through $VAM_{PJ,i}$ if only the resulting enriched flow is monitored.

Any methane that is still vented in the project scenario is not accounted for in the project emissions or baseline emissions, since it is vented in both scenarios. Similarly, the methane that is injected into natural gas pipeline in the project scenario is not accounted for in the project emissions or baseline emissions, since it is injected in both scenarios.

Equation 5.5. Baseline CH_4 Released to the Atmosphere

$$BE_{MR} = GWP_{CH_4} \times \left[\begin{array}{l} \sum_i \left(SMMe_i - SMM_{BL,i}\right) + \sum_i \left(HMM_{PJ,i} - HMM_{BL,i}\right) \\ + \sum_i \left(PMM_{PJ,i} - PMM_{BL,i}\right) + \sum_i \left(VAM_{PJ,i} - VAM_{BL,i}\right) \end{array} \right]$$

Where,			<u>Units</u>
BE_{MR}	=	Baseline methane emissions avoided by the project activity in the reporting period	tCO_2e
i	=	Use of methane (flaring, power generation, heat generation, etc.). *Uses must include all qualifying and non-qualifying devices*	
$SMMe_i$	=	*Actual* amount of CMM from surface pre-mining captured, sent to and destroyed by use i for the reporting period. For qualifying devices, only the *eligible* amount shall be quantified (see Section 5.1.2.1)	tCH_4
$SMM_{BL,i}$	=	CMM from surface pre-mining that would have been captured, sent to and destroyed by use i in the baseline scenario in the reporting period, as determined in Section 5.1.1	tCH_4
$HMM_{PJ,i}$	=	*Actual* amount of CMM from horizontal pre-mining captured, sent to and destroyed by use i in the reporting period	tCH_4
$HMM_{BL,i}$	=	CMM from horizontal pre-mining that would have been captured, sent to and destroyed by use i in the baseline scenario in the reporting period, as determined in Section 5.1.1	tCH_4
$PMM_{PJ,i}$	=	*Actual* amount of post-mining CMM captured, sent to and destroyed by use i in the project activity in the reporting period	tCH_4
$PMM_{BL,i}$	=	Post-mining CMM that would have been captured, sent to and destroyed by use I in the baseline scenario in the reporting period, as determined in Section 5.1.1	tCH_4
$VAM_{PJ,i}$	=	*Actual* amount of VAM sent to and destroyed by use i in the project activity in the reporting period. In the case of oxidation, $VAM_{PJ,i}$ is equivalent to MM_{OX} defined in Section 5.2.2	tCH_4
$VAM_{BL,i}$	=	VAM that would have been captured, sent to and destroyed by use i in the baseline scenario in the reporting period, as determined in Section 5.1.1	tCH_4
GWP_{CH4}	=	Global warming potential of methane[6]	tCO_2e/tCH_4

[6] Refer to the Reserve Program Manual and most recent policy memo for the appropriate GWP values.

5.1.2.1 Determining Eligible SMM

To determine the amount of baseline SMM that is eligible to be quantified in a given reporting period, project developers shall identify what boreholes within the bounds of active coal extraction were "mined through" during the reporting period. The most current mine plan shall be used to identify these boreholes.

Baseline SMM emissions are quantified only when the endpoint of the borehole is mined through. If the mine plan calls for mining past rather than through the borehole, then quantification is allowed once the linear distance between the endpoint of the borehole and the working face that will pass nearest the endpoint of the borehole has reached an absolute minimum.

For the purposes of this protocol, mined through is defined as any of the following:

- The working face intersects the endpoint of the borehole
- The working face passes directly underneath the bottom of the borehole, as long as the endpoint of the borehole is within a -50 meter to +150 meter vertical range of the mined coal seam
- The working face intersects the plane of the borehole
- The working face passes both underneath and to the side of the borehole (which will happen when the bottom of the borehole lies above a block of coal that will be left unmined as a pillar)

Once a borehole is mined through, SMM from that borehole that was captured and destroyed by a qualifying device in previous reporting periods may be reported and quantified for the current reporting period (as a component of $SMMe_i$ in

Equation 5.5). $SMMe_i$ is calculated as the sum of SMM captured and destroyed by qualifying devices from wells mined through in the current reporting period ($SMMpre_e$), plus SMM captured and destroyed by qualifying devices from wells that were mined through in previous reporting periods ($SMMpost_e$) – see Equation 5.6.

Equation 5.6. Eligible CMM from Surface Pre-mining Boreholes

$$SMMe_i = SMMpre_e + SMMpost_e$$

Where,			Units
SMMe$_i$	=	Actual amount of CMM from surface pre-mining captured, sent to and destroyed by use i that is *eligible* for quantification in the reporting period	tCH_4
SMMpre$_e$	=	Actual amount of CMM destroyed by qualifying devices from surface pre-mining boreholes that were mined through during the current reporting period	tCH_4
SMMpost$_e$	=	Actual amount of CMM destroyed by qualifying devices in the current reporting period from surface pre-mining boreholes that were previously mined through	tCH_4

And:

$$SMMpre_e = \sum_{w_1} \left(SMM_{w_1} \right)$$

Where,			Units
SMMw$_1$	=	Total actual amount of CMM captured and destroyed from well w_1 from the project start date through the end of the current reporting period	tCH_4
w1	=	The set of wells mined through during the current reporting period	

And:

$$SMMpost_e = \sum_{w_2} \left(SMM_{w_2} \right)$$

Where,			Units
SMMw$_2$	=	Actual amount of CMM captured and destroyed from well w_2 during the current reporting period	tCH_4
w2	=	The set of wells mined through prior to the current reporting period	

For example, at a mine in which five surface pre-mining wells had been drilled and whose reporting period is 12 months long, if all five wells are mined through in year 4, then in years 1 to 3 the eligible CMM from surface pre-mining would be zero. In year 4 it would be the cumulative volume for the previous three years plus the volume extracted in year 4. In year 5, it would only be the volume extracted in year 5.

5.2 Quantifying Project Emissions

Project emissions must be quantified at a minimum on an annual, *ex-post* basis. As shown in Equation 5.7, project emissions equal the sum of:

- CO_2 emissions from energy used to collect, process, transport and destroy CMM/VAM
- CO_2 emissions from CMM/VAM destroyed in qualifying and non-qualifying destruction devices
- Uncombusted CH_4 emissions from qualifying and non-qualifying destruction devices

Equation 5.7. Project Emissions

$$PE = PE_{ME} + PE_{MD} + PE_{UM}$$

Where,			Units
PE	=	Project emissions during the reporting period	tCO_2e
PE_{ME}	=	Project emissions from energy required for methane collection, transport, and combustion during the reporting period	tCO_2e
PE_{MD}	=	Project emissions from methane destroyed during the reporting period	tCO_2e
PE_{UM}	=	Project emissions from uncombusted methane during the reporting period	tCO_2e

5.2.1 Project Emissions from Energy Required for Methane Collection, Transport, and Combustion

Included in the GHG Assessment Boundary are carbon dioxide emissions resulting from fossil fuel combustion and/or use of grid-delivered electricity for on-site equipment that is used for:

- VAM collection
- Compressors, blowers and/or CMM gathering systems
- Transporting CMM to on-site combustion
- Liquefaction, compression and storage of liquid natural gas (LNG) or compressed natural gas (CNG) created from CMM
- Transporting CMM to boilers/engines for power generation
- Transporting CMM to a flare
- Collection, compression, processing, upgrading, transport, delivery, or other routing of CMM to a downstream destruction or beneficial-use pathway.

If the project utilizes fossil fuel or grid electricity to power equipment necessary for performing the above processes, the resulting project carbon dioxide emissions shall be calculated per Equation 5.8 below. Note that fossil fuel or grid electricity to power equipment installed for the safety of the mine shall be excluded, as that equipment is not within the GHG Assessment Boundary of the project.

Equation 5.8. CO_2 Emissions from Fossil Fuel and Grid Electricity

$$PE_{ME} = \left(CONS_{ELEC,PJ} \times CEF_{ELEC}\right) + \frac{\left(CONS_{HEAT,PJ} \times CEF_{HEAT} + CONS_{FossFuel,PJ} \times CEF_{FossFuel}\right)}{1000}$$

Where,			Units
PE_{ME}	=	Project emissions from energy required for methane collection, transport, and combustion during the reporting period	tCO_2e
$CONS_{ELEC,PJ}$*	=	Additional electricity consumption for destruction of methane during the reporting period, if any	MWh
CEF_{ELEC}	=	CO_2 emission factor of electricity used by mine during the reporting period [7]	tCO_2/MWh
$CONS_{HEAT,PJ}$	=	Additional heat consumption for destruction of methane during the reporting period, if any	volume
CEF_{HEAT}	=	CO_2 emissions factor of heat used by mine during the reporting period; see Appendix A for guidance on deriving emission factor	kg CO_2/ volume
$CONS_{FossFuel,PJ}$	=	Additional fossil fuel consumption for destruction of methane during the reporting period, if any	volume
$CEF_{FossFuel}$	=	CO_2 emission factor of fossil fuel used by mine during the reporting period[8]	kg CO_2/ volume
1/1000	=	Conversion of kg to metric tons	

* If total electricity being generated by project activities is $\geq$ the additional electricity consumption, then $CONS_{ELEC,PJ}$ shall not be accounted for in the project emissions and shall be omitted from the equation above.

5.2.2 Project Emissions from Destruction of Captured Methane

When CMM/VAM is burned in a flare, heat or power plant, or oxidized in an oxidation unit, or routed to an eligible downstream destruction or beneficial-use pathway, carbon dioxide emissions are released and must be accounted for. In addition, if NMHC comprise more than 35,000 mg/m^3 (measured on a wet basis at standard conditions) of extracted CMG or more than 3,500 mg/m^3 (measured on a wet basis at standard conditions) of extracted ventilation air, carbon dioxide emissions from combustion of NMHC must also be accounted for.

Equation 5.9 must be used to calculate carbon dioxide emissions from destruction of captured methane at qualifying and non-qualifying devices or through eligible end-use management options, as applicable.

Note: Although baseline methane emissions from surface pre-mining are accounted for only when they are eligible (i.e., after the borehole is mined through), carbon dioxide emissions resulting from the destruction of surface pre-mining CMM must be accounted for in the period during which the destruction occurs, using Equation 5.9.

[7] Refer to the Jurisdiction Module for emission factors.
[8] Refer to the Jurisdiction Module for emission factors.

Equation 5.9. CO_2 Emissions from Destruction of Captured CH_4

$$PE_{MD} = \left(MD_{OX} + MD_i\right) \times \left(2.75 + r \times CEF_{NMHC}\right)$$

With:

$$r = {PC_{NMHC}} \Big/ {PC_{CH_4}}$$

Where,			Units
PE_{MD}	=	Project emissions from methane destroyed during the reporting period	tCO_2e
MD_i[9]	=	Methane destroyed by all qualifying and non-qualifying devices during the reporting period	tCH_4
MD_{OX}	=	Methane destroyed through oxidation during the reporting period	tCH_4
2.75	=	CO_2 emission factor for combusted methane	tCO_2/tCH_4
CEF_{NMHC}	=	CO_2 emission factor for combusted NMHC[10]	tCO_2/tNMHC
r	=	Relative mass proportion of NMHC compared to methane	
PC_{NMHC}	=	NMHC concentration (in mass) in extracted CMG or ventilation air, measured on a wet basis at standard conditions (60°F and 1 atm)	mg/m^3
PC_{CH4}	=	Concentration (in mass) of methane in extracted CMG or ventilation air, measured on wet basis at standard conditions	mg/m^3

For each end-use destruction device (qualifying and non-qualifying), the amount of gas destroyed depends on the efficiency of combustion for that destruction device. For VAM project destruction devices, Equation 5.10 must be used to quantify the methane destroyed by oxidation, which accounts for the destruction efficiency of the oxidation unit on a continuous basis. For drainage project destruction devices, Equation 5.11 must be used to quantify the methane destroyed for each qualifying and non-qualifying device.

Using Equation 5.11, project developers have the option to use either the default methane destruction efficiencies provided in Appendix A, or site-specific methane destruction efficiencies. Site specific destruction efficiencies for each qualifying or non-qualifying device must be determined by a source-test service provider accredited by a state or local agency. If the project developer chooses to use site-specific destruction efficiencies, the destruction device shall be source tested at least annually and the destruction efficiency updated accordingly.

[9] MD_i includes methane from all SMM sent to qualifying devices, not just eligible SMM.

[10] Because concentrations of different NMHC components may vary over time, the appropriate emission factor shall be obtained through annual analysis of captured gas from each drainage system type.

Equation 5.10. CH_4 Destroyed by VAM Oxidation

$$MD_{OX} = MM_{OX} - PE_{OX}$$

Where,			Units
MD_{OX}	=	Methane destroyed through oxidation during the reporting period	tCH_4
MM_{OX}	=	Methane measured sent to oxidizer during the reporting period	tCH_4
PE_{OX}	=	Project emissions of non-oxidized CH_4 from oxidation of the VAM stream during the reporting period	tCH_4

And:

$$MM_{OX} = VAM_{flow.rate,y} \times time_y \times PC_{CH_4.VAM} \times D_{CH_4}$$

Where,			Units
$VAM_{flow.rate,y}$	=	Average flow rate of ventilation air entering the oxidation unit during period y corrected if needed for inlet flow gas pressure and temperature ($P_{VAMinflow}$ and $T_{VAMinflow}$ respectively) per Equation 5.12	scfm
$time_y$	=	Time during which VAM unit is operational during period y	m
$PC_{CH4.VAM}$	=	Concentration of methane in the ventilation air entering the oxidation unit corrected if needed for pressure and temperature in the vicinity of the methane analyzer	scf/scf
D_{CH4}	=	Density of methane under standard conditions	tCH_4/scf

And:

$$PE_{OX} = VAM_{exhaust\ volume,y} \times PC_{CH4,exhaust} \times D_{CH4}$$

Where,			Units
$VAM_{exhaust\ volume,y}$	=	Total volume of methane leaving the oxidation unit during period *y*	scf
$PC_{CH4.exhaust}$	=	Concentration of methane in the ventilation air exhaust corrected if needed for pressure and temperature in the vicinity of the methane analyzer ($P_{VAManalyzer\ inflow}$, $T_{VAManalyze\ rinflow}$, $P_{VAMnalyzer\ exhaust}$, and $T_{VAManalyzer\ exhaust}$)	scf/scf
D_{CH4}	=	Density of methane under standard conditions	tCH_4/scf

And either

$$VAM_{exhaust\ volume,y} = VAM_{exhaust\ flow\ rate,y} \times time_y$$

Or,

$$VAM_{exhaust\ volume,y} = \left(VAM_{flow\ rate,y} \times time_y\right) + \left(CA_{flow\ rate,z} \times time_z\right)$$

Where, Units:

$VAM_{exhaust\ flow\ rate,y}$	=	Average metered flow rate of the ventilation air exhaust leaving the oxidation unit during period y, corrected if needed for inlet flow gas pressure and temperature	scfm
$CA_{flow\ rate,z}$	=	Flow rate[a] of additional cooling air added to VAM destruction system after metering point for VAMflow rate (equal to zero if the project is a closed system in which VAM intake flow is equal to exhaust gas flow)	scfm
$time_z$	=	Subset of time, *z,* during which the air intake system is operational within the time period *y*[b]	m

Equation 5.11. CH_4 Destroyed by Other (Non-VAM) Destruction Devices

$$MD_i = \sum_i MM_i \times DE_i$$

Where, Units

MD_i	=	Methane destroyed by all qualifying and non-qualifying devices i during the reporting period	tCH_4
MM_i	=	Methane measured sent to use i during the reporting period	tCH_4
DE_i	=	Efficiency of methane destruction device i; site specific or default destruction efficiencies by destruction device[11]	%

If gas flow metering equipment provides the actual flow rate or volume instead of a flow rate or volume adjusted to standard conditions, then *MMi* in Equation 5.11 must be adjusted according to Equation 5.12 below.

[11] Project developers have the option to use either the default methane destruction efficiencies provided, or site-specific methane destruction efficiencies as provided by a state or local agency accredited source test service provider, for each of the combustion devices used in the project.

Equation 5.12. Adjusting CMG Flow for Temperature and Pressure

Important: Apply the following equation only if the CMG flow metering equipment does not internally correct for temperature and pressure.

$$MM_{adjusted,i} = MM_{unadjusted,i} \times \frac{520}{T} \times \frac{P}{1}$$

Where,			Units
$MM_{adjusted,i}$	=	Adjusted volume of CMG collected for the given time interval at utilization type i, adjusted to 60°F and 1 atm	scf/unit time
$MM_{unadjusted,i}$	=	Unadjusted volume of CMG collected for the given time interval at utilization type i	scf/unit time
T	=	Measured temperature of the CMG for the given time period (°R = °F + 460)	°R
P	=	Measured pressure of the CMM for the given time interval	atm

5.2.3 Project Emissions from Uncombusted Methane

Not all of the methane sent to the flare, oxidizer, heat or power generation unit, or eligible end-use management pathway will be combusted; a small amount will escape to the atmosphere. These emissions are calculated using Equation 5.13.

As in Equation 5.11, project developers again have the option to use either the default methane destruction efficiencies provided in Appendix A, or site-specific methane destruction efficiencies in Equation 5.13. If the project developer chooses to use site specific destruction efficiencies in Equation 5.11, they must use the same destruction efficiencies in Equation 5.13.

Equation 5.13. Uncombusted CH_4 Emissions

$$PE_{UM} = \left[GWP_{CH_4} \times \sum_i MM_i \times \left(1 - DE_i\right) \right] + PE_{OX} \times GWP_{CH_4}$$

Where,			Units
PE_{UM}	=	Project emissions from uncombusted methane during the reporting period	tCO_2e
GWP_{CH4}	=	Global warming potential of methane	tCO_2e/tCH_4
i	=	The set of all qualifying and non-qualifying devices	
MM_i	=	Methane measured sent to use i during the reporting period	tCH_4
DE_i	=	Efficiency of methane destruction in use i; see Appendix A for default destruction efficiencies by destruction device[12]	%
PE_{OX}	=	Project emissions of non-oxidized methane from oxidation of the VAM stream during the reporting period	tCH_4

[12] Project developers have the option to use either the default methane destruction efficiencies provided, or site specific methane destruction efficiencies as provided by a state or local agency accredited source test service provider, for each of the combustion devices used in the project.

6 Project Monitoring

The Reserve requires a Monitoring Plan to be established for all monitoring and reporting activities associated with the project. The Monitoring Plan will serve as the basis for verification bodies to confirm that the monitoring and reporting requirements in this section and Section 7 have been and will continue to be met, and that consistent, rigorous monitoring and record-keeping is ongoing at the project site. The Monitoring Plan must cover all aspects of monitoring and reporting contained in this protocol and must specify how data for all relevant parameters in Table 6.1 (below) will be collected and recorded.

At a minimum the Monitoring Plan shall stipulate the frequency of data acquisition; a record keeping plan (see Section 7.3 for minimum record keeping requirements); the frequency of instrument cleaning, inspection, field check and calibration activities; and the role of individuals performing each specific monitoring activity. The Monitoring Plan should include QA/QC provisions to ensure that data acquisition and meter calibration are carried out consistently and with precision. The Monitoring Plan shall also contain a detailed diagram of the coal mine gas collection and destruction system, including the placement of all meters and equipment that affect SSRs within the GHG Assessment Boundary (see Figure 4.1 and Figure 4.2).

Finally, the Monitoring Plan must include procedures that the project developer will follow to ascertain and demonstrate that the project at all times passes the Legal Requirement Test (Section 3.4.1).

Project developers are responsible for monitoring the performance of the project and ensuring that the operation of CMM destruction devices is consistent with the manufacturer's recommendations for each piece of equipment.

6.1 Monitoring Requirements

For drainage projects, the drainage systems and methane destruction devices must be monitored with measurement equipment that directly meters:

- The total flow of CMG from each drainage system defined as part of a project, measured continuously and recorded every 15 minutes or totalized and recorded at least daily, adjusted for temperature and pressure

- The flow of CMG delivered to each destruction device (unless otherwise allowed by Section 6.1.1), measured continuously and recorded every 15 minutes or totalized and recorded at least daily, adjusted for temperature and pressure

- The fraction of methane in the CMG from each drainage system, measured continuously and recorded every 15 minutes and averaged at least daily

For VAM projects, monitoring requirements include:

- The total inlet flow entering the oxidation unit, measured continuously and recorded every two minutes to calculate average flow per hour

- The fraction of methane in the ventilation air entering the oxidation unit and in the exhaust gas, measured continuously and recorded every two minutes to calculate average methane concentration per hour

- If required in order to standardize the flow rate, the temperature and pressure in the vicinity of the flow meter, measured continuously and recorded at least every hour to calculate hourly pressure and temperature.

- If required in order to correct methane concentration readings, the temperature and pressure in the vicinity of the methane analyzer, measured continuously and recorded at least every hour to calculate hourly pressure and temperature.

For abandoned underground mine projects, the methane collection systems and methane destruction devices must be monitored with measurement equipment that directly meters:

- The total flow of CMG from each methane collection system defined as part of a project, measured continuously and recorded every 15 minutes or totalized and recorded at least daily, adjusted for temperature and pressure;

- The flow of CMG delivered to each destruction device, measured continuously and recorded every 15 minutes or totalized and recorded at least daily, adjusted for temperature and pressure; and

- The fraction of methane in the CMG from each methane collection system, measured continuously and recorded every 15 minutes and averaged at least daily.

All flow data collected must be corrected for temperature and pressure at standard conditions (60°F and 1 atm).

Equation 5.12 must be applied if flow metering equipment does not make this correction automatically. Depending on the methane analyzer technology used, methane concentration data may or may not need to be corrected for temperature and pressure. If the methane analyzer technology used requires adjustment for temperature and pressure, then concentration data must also be corrected to 60°F and 1 atm.

For both VAM projects and drainage projects, NMHC content of the CMG shall be determined on an annual basis by a full gas analysis using a gas chromatograph at an ISO 17025 accredited lab or a lab that has been certified by an accreditation body conformant with ISO 17025[13] to perform test methods appropriate for NMHC content analysis.[14] Separate gas samples shall be collected from each drainage system or ventilation shaft within the project definition by a third-party technician. The sample shall be taken upstream of the destruction device(s).

Operational activity of the CMM drainage systems and the destruction devices shall be monitored and documented at least hourly to ensure actual methane destruction. GHG reductions will not be accounted for during periods in which the destruction device is not operational. For flares, operation is defined as thermocouple readings above 500°F. For all other destruction devices, the means of demonstration shall be determined by the project developer and subject to verifier review and professional judgment.

6.1.1 Arrangement of CMG Metering Equipment

For drainage projects and abandoned underground mine projects, the CMG from each drainage system or methane collection system (i.e., surface pre-mining boreholes, horizontal pre-mining boreholes, or post-mining boreholes) must be monitored separately prior to interconnection with other CMG sources. The volumetric gas flow, methane concentration, temperature, and pressure shall be monitored and recorded separately for each drainage system.

In addition, the flow of gas to each destruction device must be monitored separately for each destruction device, except under certain conditions. Specifically, if all destruction devices are of identical efficiency and verified to be operational throughout the reporting period, a single flow meter may be used to monitor gas flow to all destruction devices. Otherwise, the destruction efficiency of the least efficient destruction device shall be used as the destruction efficiency for all destruction devices monitored by this meter.

If a project using a single meter to monitor gas flow to multiple destruction devices has any periods when not all destruction devices downstream of a single flow meter are operational, methane destruction from the set of downstream devices during these periods will only be eligible provided that the verifier can confirm all of the following requirements and conditions are met:

a. The destruction efficiency of the least efficient downstream destruction device in operation shall be used as the destruction efficiency for all destruction devices downstream of the single meter; and
b. All devices are either equipped with valves on the input gas line that close automatically if the device becomes non-operational (requiring no manual intervention), or designed in

[13] Such as the American Industrial Hygiene Association (AIHA), the American Association for Laboratory Accreditation (A2LA) and the National Environmental Laboratory Accreditation Program (NELAP).
[14] For example, NIOSH method number 1550 for portable gas chromatography.

such a manner that it is physically impossible for gas to pass through while the device is non-operational; and

c. For any period during which one or more downstream destruction devices are not operational, it must be documented that the remaining operational devices have the capacity to destroy the maximum gas flow recorded during the period.

6.2 Instrument QA/QC

Monitoring instruments[15] shall be inspected, cleaned, and calibrated according to the following schedule.

All gas flow meters[16] and continuous methane analyzers must be:

- Cleaned and inspected on a quarterly basis, with the activities and results documented by site personnel. Cleaning and inspection may occur more frequently at the project developer's discretion, but must, at a minimum, follow the manufacturer's recommendations.

- Field checked for calibration accuracy by an appropriately trained individual or a third-party technician with the percent drift documented, using either a portable instrument or manufacturer specified guidance, at the end of – but no more than two months prior to or after – the end date of the reporting period.[17] If a portable calibration instrument is used for field checks, the portable instrument shall be maintained and calibrated per the manufacturer's specifications, and calibrated at least annually by the manufacturer or at an ISO 17025 accredited laboratory. For portable methane analyzers, the portable instrument must be field calibrated to a known sample gas prior to each use.

- Calibrated by the manufacturer or a third-party calibration service at the frequency recommended by the manufacturer. If the manufacturer does not specify a recommended calibration schedule, then no calibrations are required, unless a field check reveals a difference of +/- 5% or more.

    - Flow meter calibrations shall be documented to show that the meter was calibrated to a range of flow rates corresponding to the flow rates expected at the mine.
    - Methane analyzer calibrations shall be documented to show that the calibration was carried out to the range of conditions (temperature and pressure) corresponding to the range of conditions as measured at the mine.

If the field check on a piece of equipment reveals a difference of +/- 5% or more between the value measured by the portable calibration instrument and the value measured by the monitoring instrument, calibration by the manufacturer or a third-party calibration service is required for that piece of equipment.

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[15] If separate instruments are used for monitoring temperature and pressure, these instruments must also meet the specified QA/QC guidelines.

[16] Field checks and calibrations of flow meters shall assess the volumetric output of the flow meter.

[17] Instead of performing field checks, the project developer may have equipment calibrated by the manufacturer or a third-party calibration service per manufacturer's guidance, at the end of, but no more than two months prior to or after, the end date of the reporting period to meet this requirement.

For the interval between the last successful field check/calibration and any field check/calibration event revealing accuracy outside the +/- 5% threshold, all data from that meter or analyzer must be scaled according to the following procedure based on the results of the calibration report from the manufacturer or third-party service provider. These adjustments must be made for the entire period from the last successful field check/calibration until such time as the meter is properly calibrated and in place.

1. For calibrations that indicate an underestimation of emission reductions, the metered values must be used without correction.

2. For calibrations that indicate an overestimation of emission reductions, the metered values must be adjusted based on the greatest calibration drift recorded at the time of calibration.

For example, if a project conducts field checks quarterly during a year-long reporting period, then only three months of data will be subject at any one time to the penalties above. However, if the project developer feels confident that the meter does not require field checks or calibration more than annually, then failed events will accordingly require the adjustments above to be applied to the entire year's data. Further, frequent calibration may minimize the total accrued drift (by zeroing out any error identified), and result in smaller overall deductions.

In order to provide flexibility in verification, data monitored up to two months after a field check may be verified. As such, the end date of the reporting period must be no more than two months after the latest successful field check. A field check conducted up to two months after the end date of a reporting period is also acceptable to confirm the accuracy of the equipment during the reporting period. Note that while a field check completed outside of the 12 month reporting period may be used, only the 12 months of data specified as the reporting period can be verified.

Project developers have the option to use either the default methane destruction efficiencies provided in the protocol, or the site-specific methane destruction efficiencies as provided by a state- or local agency-accredited source test service provider, for any of the destruction devices used in the project, performed on an annual basis. Device-specific source testing shall include at least three test runs, with the accepted final value being one standard deviation below the mean of the measured efficiencies.

6.3 Missing Data

In situations where the flow rate or methane concentration monitoring equipment is missing data, the project developer shall apply the data substitution methodology provided in Appendix B. If for any reason the destruction device or eligible end-use management pathway monitoring equipment is inoperable (for example, the thermocouple on the flare), then no emission reductions can be credited for the period of inoperability.

6.4 Monitoring Parameters

Prescribed monitoring parameters necessary to calculate baseline and project emissions are provided in Table 6.1.

Table 6.1. Coal Mine Methane Project Monitoring Parameters

Eq. #	Parameter	Description	Data Unit	Measurement Frequency	Calculated (c) Measured (m) Reference (r) Operating records (o)	Comment
5.4 5.5	$SMM_{BL,i}$	CMM from surface pre-mining that would have been captured, sent to and destroyed by use i in the baseline scenario in the reporting period	tCH_4	Estimated at start of project and calculated annually, if non-qualifying destruction device is still in place	c, m	The higher of the two calculated values is used
5.4 5.5	$HMM_{BL,i}$	CMM from horizontal pre-mining that would have been captured, sent to and destroyed by use i in the baseline scenario in the reporting period	tCH_4	Estimated at start of project and calculated annually, if non-qualifying destruction device is still in place	c, m	The higher of the two calculated values is used
5.4 5.5	$PMM_{BL,i}$	Post-mining CMM that would have been captured, sent to and destroyed by use i in the baseline scenario in the reporting period	tCH_4	Estimated at start of project and calculated annually, if non-qualifying destruction device is still in place	c, m	The higher of the two calculated values is used
5.4 5.5	$VAM_{BL,i}$	VAM that would have been captured, sent to and destroyed by use i in the baseline scenario in the reporting period	tCH_4	Estimated at start of project and calculated annually, if non-qualifying destruction device is still in place	c, m	The higher of the two calculated values is used
5.4 5.9	CEF_{NMHC}	CO_2 emission factor for combusted non methane hydrocarbons (various)	tCO_2e/ tNMHC	Annually	m	To be obtained through analysis of the fractional composition of captured gas
5.4 5.9	PC_{CH4}	Concentration (in mass) of methane in extracted CMG or ventilation air , measured on wet basis	mg/m^3	Continuous	m	To be measured on wet basis
5.4 5.9	PC_{NMHC}	NMHC concentration (in mass) in extracted CMG or ventilation air	mg/m^3	Annually	m	Based on full gas analysis by a certified gas lab using a gas chromatograph

Eq. #	Parameter	Description	Data Unit	Measurement Frequency	Calculated (c) Measured (m) Reference (r) Operating records (o)	Comment
5.5 5.6	$SMMe_i$	CMM from surface pre-mining captured, sent to and destroyed by use i for the reporting period. For qualifying devices, only the *eligible* amount may be quantified	tCH_4	Every reporting period	c, m	Only includes SMM from boreholes that have been “mined through” and SMM destroyed by non-qualifying devices (excluding SMM sent to pipeline)
5.5	$HMM_{PJ,i}$	CMM from horizontal pre-mining captured, sent to and destroyed by use i in the reporting period	tCH_4	Continuous	m	Includes metered HMM destroyed by both eligible and non-qualifying devices
5.5	$VAM_{PJ,i}$	VAM sent to and destroyed by use i in the project activity in the reporting period. In the case of oxidation, $VAM_{PJ,i}$ is equivalent to MM_{OX} defined in Section 5.2.2	tCH_4	Continuous	m	Includes metered VAM destroyed by both eligible and non-qualifying devices
5.5	$PMM_{PJ,i}$	CMM from post-mining captured, sent to and destroyed by use i in the project activity in the reporting period	tCH_4	Continuous	m	Includes metered PMM destroyed by both eligible and non-qualifying devices
5.6	$SMMpre_e$	CMM destroyed by qualifying devices in the current reporting period from surface pre-mining boreholes that were mined through during the current reporting period	tCH_4	Every reporting period	m	
5.6	$SMMpost_e$	CMM destroyed by qualifying devices in the current reporting period from surface pre-mining boreholes that were previously mined through	tCH_4	Every reporting period	m	
5.6	$SMMw_1$	CMM captured and destroyed from well w_1 from the project start date through the end of the current reporting period	tCH_4	Every reporting period	m	
5.6	w_1	The set of wells mined through in current reporting period		Every reporting period	o	
5.6	$SMMw_2$	CMM captured from well w_2 during the current reporting period	tCH_4	Every reporting period	m	

Eq. #	Parameter	Description	Data Unit	Measurement Frequency	Calculated (c) Measured (m) Reference (r) Operating records (o)	Comment
5.6	w_2	The set of wells mined through prior to the current reporting period		Every reporting period	o	
5.8	$CONS_{ELEC,PJ}$	Additional electricity consumption for destruction of methane, if any	MWh	Every reporting period	o	From electricity use records
5.8	$CONS_{HEAT,PJ}$	Additional heat consumption destruction of methane	volume	Every reporting period	o	From purchased heat records
5.8	$CONS_{FossFuel,PJ}$	Additional fossil fuel consumption for destruction of methane	volume	Every reporting period	o	From fuel use records
5.8	CEF_{ELEC}	CO_2 emissions factor of electricity used by mine	tCO_2/ MWh	Every reporting period	r	See eGRID
5.8	CEF_{HEAT}	CO_2 emissions factor of heat used by mine	kg CO_2/ volume	Every reporting period	c	See Jurisdiction Module
5.8	$CEF_{FossFuel}$	CO_2 emissions factor of fossil fuel used by mine	kg CO_2/ volume	Every reporting period	r	See Jurisdiction Module
5.9	MD_i	Methane destroyed by all qualifying and non-qualifying devices	tCH_4	Every reporting period	c	
5.10	$VAM_{flow.rate,y}$	Average flow rate of ventilation air entering the oxidation unit during period y	scfm	Continuous	m, c	Readings taken every two minutes to calculate average hourly flow
5.10	$time_y$	Time during which VAM unit is operational during period y	m	Continuous		Readings taken every two minutes to calculate average hourly flow
5.10	D_{CH4}	Density of methane under standard conditions	tCH_4/scf		r	Density of methane under standard conditions (60ºF and 1 atm) = 0.0423 lb/scf
5.10	D_{CH4}	Density of methane under standard conditions	tCH_4/scf		r	Density of methane under standard conditions (60ºF and 1 atm) = 0.0423 lb/scf
5.10	$P_{VAMinflow}$	Pressure of ventilation air entering the oxidation unit	atm	Continuous	m	Readings taken at least every hour to calculate hourly pressure
5.10	$T_{VAMinflow}$	Temperature of ventilation air entering the oxidation unit (ºR = ºF + 460)	ºR	Continuous	m	Readings taken at least every hour to calculate hourly temperature
5.10	$PC_{CH4,VAM}$	Concentration of methane in the ventilation air entering the oxidation unit	scf/scf	Continuous	m	Readings taken at least every two minutes and used to calculate average methane concentration per hour

Eq. #	Parameter	Description	Data Unit	Measurement Frequency	Calculated (c) Measured (m) Reference (r) Operating records (o)	Comment
5.10	$PC_{CH4,exhaust}$	Concentration of methane in the ventilation air exhaust	scf/scf	Continuous	m	Readings taken at least every two minutes (either average over two minutes or instantaneous) and used to calculate average methane concentration per hour
5.10	$P_{VAManalyzerinflow}$	Pressure of ventilation air in the vicinity of the VAM methane analyzer at inlet	atm	Continuous	m	If methane analyzer technology requires adjustment for pressure and temperature and the use of $P_{VAMinflow}$ is inappropriate, readings shall be taken in the vicinity of the inlet VAM methane analyzer at least every hour to calculate hourly pressure
5.10	$T_{VAManalyzerinflow}$	Temperature of ventilation air entering the oxidation unit in the vicinity of the VAM methane analyzer	ºR	Continuous	m	If methane analyzer technology requires adjustment for pressure and temperature and the use of $T_{VAMinflow}$ is inappropriate, readings shall be taken in the vicinity of the inlet VAM methane analyzer at least every hour to calculate hourly temperature
5.10	$P_{VAManalyzerexhaust}$	Pressure of exhaust gases in the vicinity of the VAM methane analyzer at inlet	atm	Continuous	m	If methane analyzer technology requires adjustment for pressure and temperature, readings shall be taken in the vicinity of the exhaust VAM methane analyzer at least every hour to calculate hourly pressure
5.10	$T_{VAManalyzerexhaust}$	Temperature of exhaust gases exiting the oxidation unit in the vicinity of the VAM methane analyzer	ºR	Continuous	m	If methane analyzer technology requires adjustment for pressure and temperature, readings shall be taken in the vicinity of the exhaust VAM methane analyzer at least every hour to calculate hourly temperature
5.11 5.13	MM_i	Methane measured sent to use i	tCH_4	Continuous	m	Flow meters will record gas volumes, pressure and temperature
5.11 5.13	Eff_i	Efficiency of methane destruction through use i		Annually	m or r	See Appendix A

Eq. #	Parameter	Description	Data Unit	Measurement Frequency	Calculated (c) Measured (m) Reference (r) Operating records (o)	Comment
5.12	*MMadjusted ,i*	Adjusted volume of CMG collected for the given time interval at use i	scf/unit time	Every reporting period	c	Adjusted to standard conditions (60°F and 1 atm)
5.12	*MMunadjust ed,i*	Unadjusted volume of CMG collected for the given time interval at use i	scf/unit time	Continuously	m	If flow meters do not internally correct for temperature and pressure
5.12	*T*	Measured temperature of CMG for the given time period (ºR = ºF + 460)	ºR	Continuously	m	Measured to adjust the flow of CMG. No separate monitoring of temperature is necessary when using flow meters that automatically adjust flow volumes for temperature and pressure
5.12	*P*	Measured pressure of the CMG for the given time interval	atm	Continuously	m	Measured to adjust the flow of CMG. No separate monitoring of pressure is necessary when using flow meters that automatically adjust flow volumes for temperature and pressure

7 Reporting Parameters

This section provides requirements and guidance on reporting rules and procedures. A priority of the Reserve is to facilitate consistent and transparent information disclosure by project developers. Project developers must submit verified emission reduction reports to the Reserve annually at a minimum.

7.1 Project Documentation

Project developers must provide the following documentation to the Reserve in order to list a coal mine methane project.

- Project Submittal form
- Project diagram: diagram that illustrates how the project is defined and includes the location, quantity and type of boreholes, ventilation shafts, abandoned underground mine methane collection systems, eligible destruction devices and non-qualifying destruction devices within the project GHG Assessment Boundary, as well as placement of monitoring equipment

Project developers must provide the following documentation each reporting period in order for the Reserve to issue CRTs for quantified GHG reductions:

- Verification Report
- Verification Opinion
- Signed Attestation of Title form
- Signed Attestation of Voluntary Implementation form
- Signed Attestation of Regulatory Compliance form
- Project Data Report (PDR)
- Environmental and Social Safeguards Evaluation Form
- Sustainable Development Goals (SDG) Tool

At a minimum, the above project documentation (except for the project diagram) will be available to the public via the Reserve's online registry. Further disclosure and other documentation may be made available by the project developer on a voluntary basis. Project submittal forms can be found on the protocol webpage.

7.1.1 Project Data Report

A Project Data Report (PDR) is a required document for reporting information about a project. The document must be submitted for every verification period. A PDR template has been developed by the Reserve and is available on the Reserve's website. The template is organized to assist in ensuring all requirements of the protocol are addressed. PDRs are intended to serve as the main project document that thoroughly describes how the project meets eligibility requirements, discusses the quantification methodologies utilized top generate project estimates, and outlines how the project complies with terms for additionality. PDRs must be of professional quality and free of incorrect citations, missing pages, incorrect project references, etc.

7.1.2 Documentation of Project Expansions

If a project expands to include boreholes, ventilation shafts, abandoned underground mine methane collection systems, or destruction devices beyond what was included in the project as defined by the project developer at the time of listing (see Section 2.2), the project developer must submit an updated project diagram to the Reserve.

Similarly, if any new non-qualifying device becomes operational at the mine – or if an existing non-qualifying device at a mine is assigned to a different active project (see Section 2.2.3) – the project developer must submit an updated project diagram for the project to which the device is assigned.

7.2 Joint Project Verification

Because the protocol allows for multiple projects at a single mine site, project developers have the option to hire a single verification body to verify multiple projects at a mine through a "joint project verification." This may provide economies of scale for the project verifications and improve the efficiency of the verification process. Joint project verification is only available as an option for a single project developer; joint project verification cannot be applied to multiple projects registered by different project developers at the same mine.

Under joint project verification, each project, as defined by the protocol and the project developer, is submitted, listed, and registered separately in the Reserve system. Furthermore, each project requires its own separate verification process and Verification Opinion (i.e., each project is assessed by the verification body separately as if it were the only project at the mine). However, all projects may be verified together by a single site visit to the mine. Furthermore, a single Verification Report may be filed with the Reserve that summarizes the findings from multiple project verifications.

Finally, the verification body may submit one Notification of Verification Activities/Conflict of Interest (NOVA/COI) Assessment form that details and applies to all of the projects at a single mine that it intends to verify.

If, during joint project verification, the verification activities of one project are delaying the registration of another project, the project developer can choose to forego joint project verification and submit separate verification reports. There are no additional administrative requirements of the project developer or the verification body if a joint project verification is terminated.

Regardless of whether the project developer chooses to verify multiple projects through a joint project verification or pursue verification of each project separately, the documents and records for each project must be retained according to this section.

7.3 Record Keeping

For purposes of independent verification and historical documentation, project developers are required to keep all information outlined in this protocol through the end of verification of the project's final reporting period in the final crediting period. This information will not be publicly available, but may be requested by the verifier or the Reserve.

System information the project developer should retain includes:

- All data inputs for the calculation of GHG reductions, including all required sampled data
- Copies of mine operating permits, air, water, and land use permits; Notices of Violations (NOVs); and any administrative or legal consent orders related to project activities dating

back at least three years prior to the project start date; and for each subsequent year of project operation[18]
- Copies of mine plans and mine ventilation plans submitted to a government agency throughout the crediting period
- Executed Attestation of Regulatory Compliance related to the project
- Flow meter information (model number, serial number, manufacturer's calibration procedures)
- Methane monitor information (model number, serial number, calibration procedures)
- Destruction device monitor information (model number, serial number, calibration procedures)
- Field checks and calibration results for all meters
- Corrective measures taken if meter does not meet performance specifications
- Destruction device monitoring data (for each destruction device)
- Project flow and methane concentration data
- Emission reduction calculations
- Verification records and results from each verification
- All maintenance records relevant to the project monitoring equipment and destruction devices
- For abandoned underground mine projects, records demonstrating the mine's abandoned status, the eligibility of methane collection systems, and delivery of CMM to any eligible end-use management pathway, including records sufficient to demonstrate ultimate destruction or beneficial use.

7.4 Reporting Period & Verification Cycle

7.4.1 Reporting Period

The reporting period is the length of time over which GHG emission reductions from project activities are quantified. Project developers must report GHG reductions resulting from project activities during each reporting period. A reporting period may not exceed 12 months in length, except for the initial reporting period, which may cover up to 24 months. The Reserve accepts verified emissions on a sub-annual basis, should the project developer choose to have a sub-annual reporting period and verification schedule (e.g., quarterly or semi-annually). A project's initial reporting period must begin on the project's start date. Reporting periods must be contiguous; there can be no time gaps in reporting during the crediting period of a project once the initial reporting period has commenced.

7.4.2 Verification Periods

The verification period is the length of time over which GHG emission reductions from project activities are verified. The initial verification period is limited to one reporting period of up to 24 months of data. Subsequent verification periods may cover up to two reporting periods, with a maximum of 24 months of data (i.e., 12 months of data per reporting period). CRTs will not be issued for reporting periods that have not been verified. For any reporting period that ends prior to the end of the verification period (i.e., year 1 of a 2-year verification period), an interim monitoring report[19] must be submitted to the Reserve no later than six months following the end of the relevant reporting period. The interim monitoring report shall contain a summary of emission reductions, description of QA/QC activities, and description of any potential

[18] Note that these documentation requirements are for activities and equipment related to the project and the mine where the project is located.

[19] A template interim monitoring report is available on the protocol webpage. Project developers may submit their own monitoring report as long as it covers the required information.

nonconformances, data errors, metering issues, or material changes to the project. All mandatory sections of the interim monitoring reports must be verified in the subsequent verification.

To meet the verification deadline, the project developer must have the required verification documentation (See Section 7.1) submitted within 12 months of the end of the verification period. The end date of any verification period must correspond to the end of a reporting period.

7.4.3 Verification Site Visit Schedule

A site visit must occur during the initial verification, and at least once every two reporting periods thereafter. A reporting period may be verified without a new site visit if the following requirements are met:

1. A new site visit occurred in conjunction with the previous reporting period;
2. The current verification is being conducted by the same verification body that conducted the site visit for the previous verification; and
3. There have been no significant changes in data management systems, equipment, or personnel since the previous site visit.

The above requirements apply regardless of whether the verification period contains one or two reporting periods. The Reserve maintains the discretion to require a new site visit for a reporting period despite satisfaction of the above requirements. For example, the approval of a significant variance during the reporting period could be considered grounds for denial of the option to forego a site visit for the verification.

8 Verification Guidance

This section provides verification bodies with guidance on verifying GHG emission reductions from coal mine methane projects developed to the standards of this protocol. This verification guidance supplements the Reserve's Verification Program Manual and describes verification activities in the context of coal mine methane destruction projects.

Verification bodies trained to verify coal mine methane projects must conduct verifications to the standards of the following documents:

- Reserve Program Manual
- Reserve Verification Program Manual
- Reserve Coal Mine Methane Protocol (this document)
- Climate Action Reserve Jurisdiction Module (project location dependent)
- Any applicable errata and clarifications to the Mine Methane Protocol
- Any applicable policy memos issued by the Reserve

The Reserve's Program Manual, Verification Program Manual, and project protocols are designed to be compatible with each other and are available on the Reserve's website at http://www.climateactionreserve.org.

In cases where the Program Manual and/or Verification Program Manual differ from the guidance in this protocol, this protocol takes precedent. The Jurisdiction Module is complementary to this protocol; however, in the case that they differ the Jurisdiction Module takes precedence.

Only ISO-accredited verification bodies trained by the Reserve for this project type are eligible to verify coal mine methane project reports. Verification bodies approved under other project protocol types are not permitted to verify coal mine methane projects. Information about verification body accreditation and Reserve project verification training can be found in the Verification Program Manual.

8.1 Standard of Verification

The Reserve's standard of verification for coal mine methane projects is the Mine Methane Protocol (this document), the Reserve Program Manual, and the Verification Program Manual. To verify a coal mine methane project developer's project report, verification bodies apply the guidance in the Verification Program Manual and this section of the protocol to the standards described in Section 2 through 7 of this protocol. Sections 2 through 7 provide eligibility rules, methods to calculate emission reductions, performance monitoring instructions and requirements, and procedures for reporting project information to the Reserve.

8.2 Monitoring Plan

The Monitoring Plan serves as the basis for verification bodies to confirm that the monitoring and reporting requirements in Section 6 and Section 7 have been met, and that consistent, rigorous monitoring and record-keeping is ongoing at the project site. Verification bodies shall confirm that the Monitoring Plan covers all aspects of monitoring and reporting contained in this protocol and specifies how data for all relevant parameters in Table 6.1 are collected and recorded.

8.3 Verifying Project Eligibility

Verification bodies must affirm a coal mine methane project's eligibility according to the rules described in this protocol. The table below outlines the eligibility criteria for a coal mine methane project. This table does not represent all criteria for determining eligibility comprehensively; verification bodies must also look to Section 3 and the verification items list in Table 8.2.

Table 8.1. Summary of Eligibility Criteria

Eligibility Rule	Eligibility Criteria	Frequency of Rule Application
Start Date	Projects must be submitted for listing no more than 12 months after the project start date	Once during initial verification of each crediting period
Location	Countries with an approved Jurisdiction Module	Once during initial verification of each crediting period
Performance Standard	▪ Drainage projects: the project destroys CMM through any end use destruction system other than injection into a natural gas pipeline for off-site consumption ▪ All VAM projects	During initial verification of each crediting period
Legal Requirement Test	Signed Attestation of Voluntary Implementation form and monitoring procedures that lay out procedures for ascertaining and demonstrating that the project passes the Legal Requirement Test	Every verification
Regulatory Compliance	Project must be in material compliance with all applicable laws, and submit a signed Attestation of Regulatory Compliance form	Every verification
Exclusions	▪ Surface coal mines ▪ Coal bed methane destruction ▪ Use of CO_2 or other fluid/gas to enhance methane drainage before mining takes place ▪ Flooded mines or parts of mines ▪ Pipeline injection for drainage projects	Every verification

8.4 Core Verification Activities

The Mine Methane Protocol provides explicit requirements and guidance for quantifying GHG reductions associated with the destruction of coal mine methane. The Verification Program Manual describes the core verification activities that shall be performed by verification bodies for all project verifications. They are summarized below in the context of a coal mine methane project, but verification bodies shall also follow the general guidance in the Verification Program Manual.

Verification is a risk assessment and data sampling effort designed to ensure that the risk of reporting error is assessed and addressed through appropriate sampling, testing, and review. The three core verification activities are:

1. Identifying emissions sources, sinks and reservoirs
2. Reviewing GHG management systems and estimation methodologies
3. Verifying emission reduction estimates

Identifying emission sources, sinks, and reservoirs
The verification body reviews for completeness the sources, sinks, and reservoirs identified for a project, such as VAM and CMM destruction system energy use, fuel consumption from transport of the gas, combustion and destruction from various qualifying and non-qualifying destruction devices, and emissions from the incomplete combustion of methane.

Reviewing GHG management systems and estimation methodologies
The verification body reviews and assesses the appropriateness of the methodologies and management systems that the mine operator uses to gather data on methane collected and destroyed and to calculate baseline and project emissions.

Verifying emission reduction estimates
The verification body further investigates areas that have the greatest potential for material misstatements and then confirms whether or not material misstatements have occurred. This involves site visits to the project to ensure the systems on the ground correspond to and are consistent with data provided to the verification body. In addition, the verification body recalculates a representative sample of the performance or emissions data for comparison with data reported by the project developer in order to double-check the calculations of GHG emission reductions.

8.5 Mine Methane Verification Items

The following tables provide lists of items that a verification body needs to address while verifying a coal mine methane project. The tables include references to the section in the protocol where requirements are further described. The table also identifies items for which a verification body is expected to apply professional judgment during the verification process. Verification bodies are expected to use their professional judgment to confirm that protocol requirements have been met in instances where the protocol does not provide (sufficiently) prescriptive guidance. For more information on the Reserve's verification process and professional judgment, please see the Verification Program Manual.

Note: These tables shall not be viewed as a comprehensive list or plan for verification activities, but rather guidance on areas specific to coal mine methane projects that must be addressed during verification.

8.5.1 Project Eligibility and CRT Issuance

Table 8.2 lists the criteria for reasonable assurance with respect to eligibility and CRT issuance for coal mine methane projects. These requirements determine if a project is eligible to register with the Reserve and/or have CRTs issued for the reporting period. If any one requirement is not met, either the project may be determined ineligible or the GHG reductions from the reporting period (or sub-set of the reporting period) may be ineligible for issuance of CRTs, as specified in Sections 2, 3, and 6.

Table 8.2. Eligibility Verification Items

Protocol Section	Eligibility Qualification Item	Apply Professional Judgment?
2.2 - 2.2.2	Verify that the project meets the definition of a CMM project and is properly defined as either drainage project or VAM project	No

Protocol Section	Eligibility Qualification Item	Apply Professional Judgment?
2.2.3	Confirm all non-qualifying devices have been properly accounted for within project's GHG Assessment Boundary	No
2.3	Verify ownership of the reductions by reviewing Attestation of Title	No
2.2.1 - 2.2.3, 7.1.1	If there are new destruction devices, boreholes, shafts or a project crediting period expiration at the mine, verify that project expansions have been completed, properly defined and documented to account for these changes	No
3.1	Verify that the project only consists of activities at a single coal mine or Category III gassy underground trona mine operating within the U.S. or its territories	No
3.2	Verify eligibility of project start date	No
3.2	Verify accuracy of project start date based on operational records	Yes
3.3	Verify that project is within its 10-year crediting period	No
3.4.1	Confirm execution of the Attestation of Voluntary Implementation form to demonstrate eligibility under the Legal Requirement Test	No
3.4.1	Verify that the project monitoring plan contains procedures for ascertaining and demonstrating that the project passes the Legal Requirement Test at all times	Yes
3.4.2	Verify that the project meets the appropriate Performance Standard Test for the project type	No
3.4.2	If VAM project uses supplemental CMM, verify that supplemental CMM is eligible	No
3.5	Verify that project activities comply with applicable laws by reviewing any instances of non-compliance provided by the project developer and performing a risk-based assessment to confirm the statements made by the project developer in the Attestation of Regulatory Compliance form	Yes

8.5.2 Quantification of GHG Emission Reductions

Table 8.3 lists the items that verification bodies shall include in their risk assessment and re-calculation of the project's GHG emission reductions. These quantification items inform any determination as to whether there are material and/or immaterial misstatements in the project's GHG emission reduction calculations. If there are material misstatements, the calculations must be revised before CRTs are issued.

Table 8.3. Quantification Verification Items

Protocol Section	Quantification Item	Apply Professional Judgment?
4	Verify that SSRs included in the GHG Assessment Boundary correspond to those required by the protocol and those represented in the project diagram for the reporting period	No
5.1	Verify that the project developer correctly accounted for methane destruction in the baseline scenario	No

Protocol Section	Quantification Item	Apply Professional Judgment?
5.1	Verify that baseline emissions for non-qualifying devices were calculated according to the protocol	No
5.1.2.1	Verify definition of mined through was properly applied to SMM boreholes	No
5.2.2	Verify NMHC concentration of CMG is either below project-specific threshold or, if above, CO_2 emissions from NMHC combustion are accounted for in project emissions	No
5.2.1	Verify that the project developer correctly quantified and aggregated electricity use	Yes
5.2.1	Verify that the project developer correctly quantified and aggregated fossil fuel use	Yes
5.2.1	Verify that the project developer correctly quantified and aggregated heat consumption	Yes
Equation 5.8, Jurisdiction Module	Verify that the project developer applied the correct emission factors for fossil fuel combustion and grid-delivered electricity	No
Equation 5.11, Appendix A	Verify that the project developer applied the correct methane destruction efficiencies	No
Equation 5.11	If the project developer used source test data in place of the default destruction efficiencies (Appendix A), verify accuracy and appropriateness of data and calculations	Yes
6.1	Verify that monitoring meets the requirements of the protocol; if it does not, verify that a variance has been approved for monitoring variations	No
6.1	Verify that NMHC samples were properly collected and analyzed	No
6.1, 6.1.1	Verify that destruction devices were operational during the reporting period, or that guidance in Section 6.1.1 was properly applied	Yes
6.2	Verify that all gas flow meters and continuous methane analyzers adhered to the inspection, cleaning, and calibration schedule specified in the protocol; if they do not, verify that a variance has been approved for monitoring variations or that adjustments have been made to data per the protocol requirements	No
6.2	Verify that any portable calibration instruments were calibrated at least annually by the manufacturer or at an ISO 17025 accredited lab	No
6.2	If any piece of equipment failed a calibration check, verify that data from that equipment was scaled according to the failed calibration procedure for the appropriate time period	No
6.3, Appendix B	If used, verify that data substitution methodology was properly applied	No
n/a	If any variances were granted, verify that variance requirements were met and properly applied	Yes

8.5.3 Risk Assessment

Verification bodies will review the following items in Table 8.4 to guide and prioritize their assessment of data used in determining eligibility and quantifying GHG emission reductions.

Table 8.4. Risk Assessment Verification Items

Protocol Section	Item that Informs Risk Assessment	Apply Professional Judgment?
6	Verify that the project monitoring plan is sufficiently rigorous to support the requirements of the protocol and proper operation of the project	Yes
6	Verify that the methane destruction equipment was operated and maintained according to manufacturer specifications	Yes
6	Verify that appropriate monitoring equipment is in place to meet the requirements of the protocol	No
6	Verify that the individual or team responsible for managing and reporting project activities are qualified to perform this function	Yes
6	Verify that appropriate training was provided to personnel assigned to project-related duties	Yes
6	Verify that all contractors are qualified for project-related duties if relied upon by the project developer. Verify that there is internal oversight to assure the quality of the contractor's work	Yes
6	If field checks are performed by an individual that is not a third-party technician, verify the competency of the individual to perform the field check and the accuracy of the field check procedure	Yes
7.3	Verify that all required records have been retained by the project developer	No

8.6 Completing Verification

The Verification Program Manual provides detailed information and instructions for verification bodies to finalize the verification process. It describes completing a Verification Report, preparing a Verification Statement, submitting the necessary documents to the Reserve, and notifying the Reserve of the project's verified status.

As stated in Section **Error! Reference source not found.**, project developers may choose to have a verification body conduct multiple project verifications at a single mine under a joint project verification. The verification body must verify the emission reductions entered into the Reserve system for each project and upload a unique Verification Statement for each project within the joint verification. The verification body can prepare a single Verification Report that contains information on all of the projects, but this must also be uploaded to every project under the joint verification.

9 Glossary of Terms

Active mine	Active mines include mine works that are actively ventilated by the mine operator. For the purposes of this protocol, government agency designated “intermittent” mines are also considered active mines, unless otherwise stated in the Jurisdiction Module.
Abandoned mine	A mine where all mining activity including mine development and mineral production have ceased, mine personnel are not present in the mine workings, and mine ventilation fans are no longer operative.[20] lMines are declared “abandoned” from the date when ventilation is discontinued.
Baseline emissions	Baseline emissions represent the GHG emissions within the GHG Assessment Boundary that would have occurred in the absence of the GHG reduction project.
Coal bed methane (CBM)	A generic term for methane originating in coal seams that is drained from virgin coal seams and surrounding strata. CBM is unrelated to mining activities.
Coal mine gas (CMG)	Gas from drainage systems before any processing or enrichment that often contains various levels of other components (e.g., nitrogen, oxygen carbon dioxide, hydrogen sulfide, NMHC, etc.).
Coal mine methane (CMM)	Methane contained in coal and surrounding strata that is released because of mining activity. For the purposes of this protocol, CMM also refers to the methane gas that is released because of mining activity at Category III gassy underground trona mines. CMM includes methane released from abandoned underground coal mines as a result of prior mining activity.
Drainage system	A term used to encompass the entirety of the equipment that is used to drain the gas from underground and collect it at a common point, such as a vacuum pumping station. In this protocol, methane drainage systems include surface pre-mining, horizontal pre-mining, and post-mining.
Eligible end use	For the purposes of this protocol, all end uses or end-use management pathways that result in the destruction, oxidation, or beneficial use of methane.
Gob	Also referred to as goaf, it is the collapsed area of strata produced by the removal of coal and artificial supports behind a working coalface. Strata above and below the gob are de-stressed and fractured by the mining activity.
Intermittent	Mines placed in intermittent status by relevant government agency, as a result of being seasonally idled for more than 90 days, are not considered abandoned. To maintain intermittent status, facilities and equipment such as the mine office, surface, and underground power systems, the main mine fan, and underground coal haulage systems

[20] UN Economic and Social Council, Economic Commission for Europe, Committee on Sustainable Energy, Glossary of Coal Mine Methane Terms and Definitions, July 2008.

	must remain intact. Under this protocol, intermittent mines are considered active mines and are eligible.
Joint project verification	Project verification option where a project developer hires a verification body to verify multiple projects at a mine.
Longwall mine	An underground mining type that uses at least one longwall panel during coal excavation.
Mined through	When the linear distance between the endpoint of the borehole and the working face that will pass nearest the endpoint of the borehole has reached an absolute minimum. Coal mine methane from surface pre-mining boreholes shall not be quantified in the baseline until the endpoint of the borehole is mined through.
Mine	An area of land and all structures, facilities, machinery tools, equipment, shafts, slopes, tunnels, excavations, and other property, real or personal, placed upon, under, or above the surface of such land by any person, used in, or to be used in, or resulting from, the work of extracting minerals. The mine boundaries are defined by the mine area as permitted by the state in which the mine is located.
Non-qualifying destruction device	A methane destruction device that does not meet one or more of the eligibility rules as described in Section 3 (e.g., operational start date, regulatory requirement, injection into natural gas pipeline) and is located at the same mine where eligible project activities are taking place.
Oxidizer	For the purposes of this protocol, the term oxidizer refers to technology for destruction of ventilation air methane with or without utilization of thermal energy and/or with or without a catalyst.
Project diagram	A diagram of the mine that illustrates the location, quantity, and type of boreholes, ventilations shafts, eligible destruction devices and non-qualifying destruction devices within a project's GHG Assessment Boundary. The project diagram must be updated and submitted to the Reserve whenever a project expansion occurs.
Project emissions	Project emissions are actual GHG emissions that occur within the GHG Assessment Boundary as a result of project activities. Project emissions are calculated at a minimum on an annual, *ex-post* basis.
Qualifying destruction device	A methane destruction device that meets the eligibility rules for a CMM project as described in Section 3.
Room and pillar mine	An underground mining type that uses square or rectangular pillars of coal during excavation, laid out in a checkerboard fashion. Pillars typically range in size from 60 feet by 60 feet to 100 feet by 100 feet and rooms are typically 20 feet wide and a few thousand feet long
Reporting period	Specific time period of project operation for which the project developer has calculated and reported emission reductions and is seeking verification and registration. The reporting period must be no longer than 12 months.

Standard conditions	Under this protocol, standard conditions are defined as 60ºF and 1 atm.
Ventilation air methane (VAM)	Coal mine methane that is mixed with the ventilation air in the mine that is circulated in sufficient quantity to dilute methane to low concentrations for safety reasons (typically below 1 percent).
Ventilation system	A system that is used to control the concentration of methane and other deleterious gases within mine working areas. Ventilation systems consist of powerful fans that move large volumes of air through the mine workings to dilute methane concentrations. All underground coal mines in the U.S. are required to develop and maintain ventilation systems.
Verification cycle	The Reserve requires verification of coal mine methane projects annually, but does not require verifications to be completed on specific dates. Project developers select the reporting period to be verified. Thus, each project has a unique verification cycle that begins the first time a project is verified, occurs at least annually, and ends once the crediting period expires or the project is no longer eligible, whichever happens first.
Year	For the purposes of this protocol, year refers to a 12 month period of the project's crediting period, not a calendar year.

10 References

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Appendix A Emission Factor Tables

If available, the official source tested methane destruction efficiency shall be used in place of the default methane destruction efficiency. Project developers have the option to use either the default methane destruction efficiencies provided, or the site-specific methane destruction efficiencies as provided by a state or local agency accredited source test service provider, for each of the combustion devices used in the project, performed on an annual basis.

Table A.1. Default Destruction Efficiencies for Combustion Devices

Destruction Device	Destruction Efficiency
Open Flare	0.96
Enclosed Flare	0.995
Lean-burn Internal Combustion Engine	0.936
Rich-burn Internal Combustion Engine	0.995
Boiler	0.98
Microturbine or Large Gas Turbine	0.995
Upgrade and Use of Gas as CNG/LNG Fuel	0.95
Upgrade and Injection into Natural Gas Pipeline	0.98**

Source: The default destruction efficiencies for enclosed flares and electricity generation devices are based on a preliminary set of actual source test data provided by the Bay Area Air Quality Management District. The default destruction efficiency values are the lesser of the twenty fifth percentile of the data provided or 0.995. These default destruction efficiencies may be updated as more source test data is made available to the Reserve.

** The Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories gives a standard value for the fraction of carbon oxidized for gas destroyed of 99.5% (Reference Manual, Table 1.6, page 1.29). It also gives a value for emissions from processing, transmission and distribution of gas which would be a very conservative estimate for losses in the pipeline and for leakage at the end user (Reference Manual, Table 1.58, page 1.121). These emissions are given as 118,000kgCH_4/PJ on the basis of gas consumption, which is 0.6%. Leakage in the residential and commercial sectors is stated to be 0 to 87,000kgCH_4/PJ, which equates to 0.4%, and in industrial plants and power station the losses are 0 to 175,000kg/CH_4/PJ, which is 0.8%. These leakage estimates are compounded and multiplied. The methane destruction efficiency for landfill gas injected into the natural gas transmission and distribution system can now be calculated as the product of these three efficiency factors, giving a total efficiency of (99.5% * 99.4% * 99.6%) 98.5% for residential and commercial sector users, and (99.5% * 99.4% * 99.2%) 98.1% for industrial plants and power stations. [21]

Equation A.1. Calculating Heat Generation Emission Factor ($EF_{heat,y}$)

$$EF_{heat,y} = \frac{EF_{CO_2,i}}{Eff_{heat}} \times \frac{44}{12}$$

Where,			Units
$EF_{heat,y}$	=	Emission factor for heat generation	kg CO_2/volume
$EF_{CO2,i}$	=	CO_2 emission factor of fuel used in heat generation	kg C/volume
Eff_{heat}	=	Boiler efficiency of the heat generation (either measured efficiency, manufacturer nameplate data for efficiency, or 100%)	%
44/12	=	Carbon to carbon dioxide conversion factor	

[21] GE AES Greenhouse Gas Services, Landfill Gas Methodology, Version 1.0 (July 2007).

Appendix B Data Substitution Guidelines

This appendix provides guidance on calculating emission reductions when data integrity has been compromised due to missing data points. No data substitution is permissible for equipment such as thermocouples which monitor the proper functioning of destruction devices. Rather, the methodologies presented below are to be used only for the methane concentration and flow metering parameters, including temperature and pressure data.

The Reserve expects that projects will have continuous, uninterrupted data for the entire reporting period. However, the Reserve recognizes that unexpected events or occurrences may result in brief data gaps.

The following data substitution methodology may be used only for flow and methane concentration data gaps that are discrete, limited, non-chronic, and due to unforeseen circumstances. Data substitution can only be applied to methane concentration *or* flow readings, but not both simultaneously. If data is missing for both parameters, no reductions can be credited. The methodology may also be used for missing temperature and pressure data (which is used to adjust flow rate). However, the methodology must be applied to both parameters simultaneously, regardless of if data is available for one or the other. In other words: if either temperature or pressure data is missing, the project developer must use the following methodology to substitute data for both parameters over the same time interval.

Further, substitution may only occur when two other monitored parameters corroborate proper functioning of the destruction device and system operation within normal ranges. These two parameters must be demonstrated as follows:

1. Proper functioning can be evidenced by thermocouple readings for flares, energy output for engines, etc.
2. For methane concentration substitution, flow rates during the data gap must be consistent with normal operation.
3. For flow substitution, methane concentration rates during the data gap must be consistent with normal operations.

If corroborating parameters fail to demonstrate any of these requirements, no substitution may be employed. If the requirements above can be met, the following substitution methodology maybe applied:

Duration of Missing Data	Substitution Methodology
Less than six hours	Use the average of the four hours of normal operations immediately before and following the outage
Six to 24 hours	Use the 90% lower or upper confidence limit of the 24 hours of normal operations prior to and after the outage, whichever results in greater conservativeness
One to seven days	Use the 95% lower or upper confidence limit of the 72 hours of normal operations prior to and after the outage, whichever results in greater conservativeness
Greater than one week	No data may be substituted and no credits may be generated

The lower confidence limit should be used for both methane concentration and flow readings, as this will provide the greatest conservativeness.

Acknowledgements

Workgroup

The Mine Methane Protocol was modified from the U.S. Coal Mine Methane Project Protocol Version 1.1. The list of workgroup members below comprises all individuals and organizations who have assisted in developing and updating various versions of the Coal Mine Methane Project Protocol.

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