Landfill Project Offset Reporting Protocol

GHG Emission Reductions Associated with Collecting and Managing Methane From Landfills

Version 2.1

October, 2.1 DRAFT
2008

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Table of Contents

Version 2.1 DRAFT

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List of Tables

Version 2.1 DRAFT

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List of Figures

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List of Equations

Abbreviations and Acronyms

Version 2.1 DRAFT

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ARB CAA	The Climate Action Registry Reporting Online Tool California
California Registry	Environmental Quality Act
CARROT CEQA	Methane
	California Integrated Waste Management Board Condensed
CH.	Natural Gas Carbon dioxide
CIWMB CNG CO,	Emission Guidelines
	Environmental Protection Agency
EG	Greenhouse Gas
EPA	Intergovernmental Panel on Climate Change
GHG	Liquefied Natural Gas
IPCC	Mega gram (1,000,000 grams or one tonne)
LNG	Municipal solid waste
MG	Nitrous oxide
MSW	National Environmental Policy Act
N,O	National Emission Standards for Hazardous Air Pollutants
NEPA	Natural Gas
NESHAP	Non-methane organic compounds
NG	New Source Performance Standards
NMOC	New Source Review
NSPS	Prevention of Significant Deterioration Quality
NSR	Assurance/Quality Control Resources Conservation
PSD	and Control Act Volatile organic compound
QA/QC	
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VOC	
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1 Introduction

Version 2.1 DRAFT

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The California Climate Action Registry's (California Registry) Landfill Greenhouse Gas Project Offset Reporting Protocol – for collecting and managing methane in landfills – provides guidance to account for and report greenhouse gas (GHG) emissions reductions associated with installing a gas collection system at a landfill and managing the collected methane. These include reductions due to the destruction of methane in combustion devices, and the offsetting of fossil fuel due to beneficial uses, that lead to the destruction/conversion of methane, which include, but are not limited to, landfill gas-to-electrical generation, direct use of landfill gas, compressed natural gas/liquefied natural gas (CNG/LNG) production and development of biofuels. Registering GHG reductions calculated from the offsetting of fossil fuels are discussed separately from the flaring of methane.

Established by the California Legislature in 2000 as a non-profit, public/private partnership, the Registry runs a voluntary GHG registry called the Climate Action Reserve (Reserve). Its purpose is to promote and facilitate the measurement, monitoring and reduction of GHG emissions. Participants in the program account for and certify their GHG emissions according to the California Registry's protocols.

Project developers that install landfill gas capture and manage this gas through destruction/conversion and other management technologies can use this document to register GHG reductions with the California Registry. This protocol addresses the management of GHG through the combustion or conversion of methane as well as fossil fuel displacement through landfill gas to energy projects. It provides eligibility rules, methods to calculate reductions, performance-monitoring instructions, and procedures for reporting project information to the California Registry. Additionally, all project reports receive annual, independent verification by California Air Resources Board - and California Registry-approved certifiers. Guidance for verifiers to certify reductions is provided in the corresponding Landfill Project Certification Protocol.

This project protocol facilitates the creation of GHG emissions reductions determined in a complete, consistent, transparent, accurate, and conservative manner, while incorporating relevant sources.[1]

Project developers must comply with all local, state, and federal municipal solid waste (MSW) , air and water quality regulations in order to register GHG reductions with the California Registry. To register GHG reductions with the California Registry, project developers are not required to take an annual entity-level GHG inventory of their MSW operations.

1.1 Document organization

The California Registry's landfill project protocol has the following sections:

- The GHG Reduction Project
- Project Eligibility
- The Project Boundary
- GHG Reductions Calculation Methods
- Project Monitoring
- Reporting Parameters
- Glossary of Terms

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[1] See the WRI/WBCSD GHG Protocol for Project Accounting (Part I, Chapter 4) for a description of GHG accounting principles.

2 The GHG Reduction Project

Most municipal solid waste in the United States is deposited in landfills, where bacteria decompose the organic material. A product of both the bacterial decomposition and oxidation of solid waste is landfill gas, which is composed of methane (CH_4) and carbon dioxide (CO_2) in approximately equal concentrations, as well as smaller amounts of non-methane volatile organic compounds (NMVOC), nitrogen (N_2), oxygen (O_2) and other trace gases. If not collected and managed in processes that lead to the destruction of methane and toxic contaminants, over time, this landfill gas could be released to the atmosphere. Managing of landfill gas includes destruction/conversion of methane in combustion devices, and the offsetting of fossil fuel due to beneficial uses, that lead to the destruction/conversion of methane, which include, but are not limited to, landfill gas-to-electrical generation, direct use of landfill gas, CNG/LNG production and development of biofuels. In the United States, the US EPA has concluded that landfills are the largest source of anthropogenic emissions of CH_4, accounting for 25 percent of total CH_4 emissions.[2] However, the solid waste industry has made significant efforts to reduce their GHG emissions over the past 20 years.[3]

There is considerable uncertainty regarding the actual amount of fugitive methane emissions from landfills. This issue will be addressed in a future protocol that directly addresses fugitive landfill methane emissions. Instead, this protocol addresses the methane that is captured and managed in excess of any regulatory requirements that includes the displacement of fossil fuels from landfill gas to energy and the manufacturing of chemical products derived from landfill gas, such as the production of biofuels. The CCAR will develop protocols to encourage increased methane capture and destruction efficiency as a separate protocol in the future as more information becomes available on the procedures to be used to measure such reductions.

2.1 Project definition

For the purpose of this protocol, the GHG reduction project is the installation of a landfill gas control system for capturing and managing methane that commences operation on or after January 1, 1990.

This protocol is designed to act in concert with the Kyoto Protocol, the EPA's Climate Leaders Program, the GE AES Greenhouse Gas Services Landfill Gas Methodology and the California Assembly Bill (AB) 32, Global Warming Solutions Act. AB 32 codifies the state's goal by requiring that the state's global warming emissions be reduced to 1990 levels by 2020. Landfills which began reducing their GHG emissions after 1990 are eligible to register for GHG reductions under this protocol. This installation date is consistent with the baseline period under AB 32 and will prevent older projects, which have already achieved methane reductions, from being penalized for being proactive. Landfills are the only industry whose 2004 GHG emissions are already below the 1990 baseline.

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[2] U.S. Environmental Protection Agency, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005, EPA-430-R-07-002 (April 2007).
[3] The updated Draft California Greenhouse Gas Inventory, developed by the Air Resources Board (August 2007), shows significant improvement in fugitive methane emission control at landfills within the state of California.

Captured landfill gas could be managed on-site, transported for off-site use (e.g., through gas distribution or transmission pipeline), used to power vehicles or used to manufacture chemicals products for commercial purposes (e.g., manufacturing methanol, sulfur, carbon dioxide and ethanol) as long as the methane is effectively managed in a manner that leads to its destruction. The isolation and recycling of landfill gas chemicals into the commercial market place displaces fossil fuels as well as increases the combustion efficiency of landfill gas to energy projects.

Regardless of how project developers take advantage of the captured landfill gas, for the project to be eligible to register GHG reductions under this protocol, the ultimate fate of the methane must be the destruction or the displacement of fossil fuels or chemical products through the use of landfill gas.

GHG Reductions Resulting From Flared Landfill Gas

The landfill gas collection system typically consist of wells, pipes, blowers, caps and other technologies that enable or enhance the collection of landfill gas and convey it to a management system that leads to destruction of methane and toxic air contaminants. At some landfills, a flare will be the only management device where landfill gas is destroyed.[4]

GHG Reductions Resulting From Fossil Fuel Offsets

The amount of carbon dioxide that, in the absence of the project activity, is generated from combusting fossil fuels is considered a reduction under this protocol. For projects that install energy or process heat technologies that combust landfill gas, such as turbines, reciprocating engines, boilers, heaters, or kilns, these devices will be where landfill gas is destroyed. Direct use arrangements which entail the piping of landfill gas to be destroyed by an industrial end user at an off-site location are also an eligible approach to destruction of the landfill gas.[5] Most projects that produce energy or process heat also include a flare in their design to destroy gas during periods when the gas utilization project is down for repair or maintenance. Other projects include the conversion of the landfill gas to a vehicle fuel or chemical product, which would also be an eligible approach for reductions; provided the methane is destroyed or converted into something other than methane. For these projects, the GHG reductions will be a combination of the amount of methane destroyed or converted plus the additional GHG reduction benefit from the displacement of fossil fuels or chemical products. In addition to reducing methane, the installation and operation of a landfill gas collection and destruction system could impact anthropogenic carbon dioxide and methane emissions associated with the consumption of electricity and fossil fuels. Depending on the project's particular circumstances, this effect could either increase or decrease operational GHG emissions. Section IV, The GHG Assessment Boundary, delineates the scope of the accounting framework.

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[4] Flares which are used as a combustion device under this protocol must be of the enclosed type. Open flares are not eligible combustion devices under this protocol.

[5] For direct use agreements, between the project developer and the end user of the landfill gas (i.e. industrial client purchasing the landfill gas from the project developer), a mechanism must be built into a legally binding agreement to assure that the GHG offset credits will not be double counted.

2.2 The project developer

Project developers could be landfill owners/operators. However, they could also include other entities, such as third-party aggregators. Ownership of the GHG reductions should be established by clear and explicit title.

2.3 Additional GHG reduction activities in the solid waste sector

The California Registry recognizes that project developers could implement a variety of GHG reduction activities associated with the collection, transportation, sorting, recycling and disposal of solid waste. Installing technology to capture and combust methane from landfills is but one of many GHG emissions reduction projects that could occur within the solid waste sector.

Converting landfill gas to energy as well as producing chemical products constitutes better than business-as -usual practices and is discussed further in Section III, Eligibility Rules. Furthermore, producing power for the electricity grid (and thus displacing fossil-fueled power plant GHG emissions) is a complementary and better than business-as-usual GHG project activity to destroying/converting methane gas from landfills, and is included within this protocol's accounting framework.

Landfill operations that utilize anaerobic bioreactor technologies are not eligible to use this protocol, as it is unclear what effects the bioreactor may have on the net total and temporal distribution of fugitive methane emissions relative to project baseline conditions. As defined by the EPA, a bioreactor is any MSW landfill or portion of a MSW landfill with a minimum average moisture content of at least 40 percent by weight that is re-circulating leachate, or an MSW landfill or portion of a MSW landfill that is adding any liquid other than leachate (leachate includes landfill gas condensate) in a controlled fashion to accelerate or enhance the anaerobic biodegradation of the waste. [5]

The California Registry anticipates that separate project protocols may be developed in the future to spur incentives to facilitate emission reduction opportunities in the solid waste sector, including composting, anaerobic digestion, recycling and waste to energy that would balance and compliment the Landfill Project Protocol..

[5] 40 CFR 63.1990 and 40 CFR 258.28a

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3 Eligibility Rules

Project developers using this protocol must satisfy the following eligibility rules to register reductions with the California Registry. These criteria only apply to projects that meet the definition of a GHG reduction project as defined in this protocol.

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Eligibility Rule I:	Additionality	→	*Meet performance standard*
		→	*Exceed regulatory requirements*
Eligibility Rule II:	Location	→	*U.S. landfill*
Eligibility Rule III:	Project Start Date	→	*January 1, 1990*

Eligibility Rule I:	Location	*U. S. landfill*
Eligibility Rule II:	Project Operation Start Date	*January 1, 2001*
Eligibility Rule III:	Additionality	*Meet performance standard* *Exceed reaulatorv reauirements*

3.1 Location

All projects located at landfill operations in the United States are eligible to register reductions with the California Registry. The scope of the analysis of landfill practices that formed the basis of the Performance Standard (111.3) covered landfill operations in the United States. Therefore, the California Registry will estimate GHG reductions from all U.S.-based projects that follow the guidance in this protocol in the same manner.

The California Registry anticipates that this protocol could be applicable internationally. The calculation procedure is consistent with international practices and, considering its rigor, the Performance Standard could apply to regions outside of the U.S. However, at this time, reductions from international projects are not eligible to be registered with the California Registry.

3.2 Project start date

California Senate Bill 1771 (Sher) created the California Registry in September of 2000 to serve as a platform to record and register GHG reduction activities, among other things. This sent a signal to GHG-emitting entities, including landfill operators, that project activities could receive recognition for their carbon value. The establishment of the California Registry to support GHG reduction activities is the basis for the project start date criterion.

Projects that began operating before being listed with the California Registry, but after January 1, 2001, are considered pre-existing projects. Pre-existing projects will be eligible to become listed with the Reserve for a period of 12 months from the effective date of this protocol (version 2.1). This is to ensure that the Reserve is providing "early actors" (those that implemented a GHG reduction project prior to a project protocol being available for their project activity) enough time to list their project", Pre-existing projects that fail to list within this 12-month period, however, will be considered non-additional and excluded from eligibility. Projects that began operating before January 1, 2001 are not eligible to register reductions according to this

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[6] A project is considered "listed" when the project developer has created an account with the Reserve, submitted the required Project Submission Form and related required documents, paid the project submission fee, and the Reserve has approved the project for listing.

protocol. For the California Registry's purpose, the commencement of operation means a constructed system that is capturing and destroying methane gas from the landfill operation.

3.3 Additionality

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The Registry strives to support only projects that yield surplus GHG reductions, which are additional to what might otherwise have occurred. That is, the reductions are above and beyond business-as-usual – the baseline case (e.g., for beneficial uses). Project developers satisfy the "additionality" eligibility rule by passing two tests:

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1. The Performance Standard Test, and
2. The Regulatory Test.

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3.3.1 The Performance Standard Test. Project developers pass the Performance Standard Test by meeting a program-wide performance threshold – i.e., a standard of performance applicable to all landfill projects, established on an ex-ante basis. The performance threshold represents "better than business-as-usual", for beneficial uses. Beneficial uses may include, but are not

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limited to the generation of renewable energy as well as additional safeguards concerning protection of the public health. If the project meets the threshold, then it exceeds what would happen under the business-as-usual scenario and generates surplus/additional GHG reductions.

For this protocol, the California Registry uses a technology-specific threshold; sometimes also referred to as a practice-based threshold, where it serves as "best-practice standard" for managing landfill gas fugitive emissions. By installing a landfill gas collection and destruction system at a landfill that is not required to do so by regulations, which explicitly mandates landfill gas collection and control, a project developer passes the Performance Standard Test.[6] In addition, by recycling the by-products of organic degradation, displacing fossil fuels, a project developer passes the Performance Standard Test. The first determinant of additionality is whether there is already collection and destruction of landfill gas at the proposed project site. There are three possible scenarios under which the practice-based performance threshold is applied:

1. If the landfill is not currently collecting and destroying/converting any landfill gas, the project is considered additional.[7]

2. If the landfill began collecting and destroying/converting landfill gas before New Source Performance Standards (NSPS) or Emission Guidelines (EG) or state or local air quality requirements that are authorized under the federal Clean Air Act, which is the only authority for regulation of GHGs, then the project is considered additional.

a. 3. For the addition of a new project at a landfill operation where the landfill is currently collecting and destroying/converting landfill gas, only projects which begin operation after January 1, 2008 are eligible to register reductions under this protocol. Also, two other conditions must be met for the new project. Landfills currently collecting and destroying landfill gas to comply with NSPS & EG regulations are not eligible to register new projects with the California Registry. Also, Landfills currently collecting and destroying landfill gas to comply with NSPS & EG regulations are not eligible to register GHG reductions associated with the early installation of gas control systems during landfill expansion into new cells.

b. Only the landfill gas destroyed beyond that resulting from the existing non-additional collection and destruction system is considered additional (i.e. those reductions resulting from the implementation of the GHG reduction project). [8]

c. Second, the new GHG project may be designed to be entirely separate from the existing collection system or it may be integrated as a continuous extension of the existing collection system. In the case of where the GHG project is integrated into use the existing collection system, a separate piping system and independent flow control monitor must be installed at the control device.

These conditions will ensure that the reductions resulting from the GHG project can be accounted for separately from current collection and destruction.

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[6] Landfills which collected and destroyed landfill gas before NSPS & EG regulations required them to do so are eligible to account for GHG reductions associated with the early installation of gas control systems for the landfill as a whole or during landfill expansion into new cells for any eligible years.

[7] For landfills that are currently collecting and venting, but not combusting landfill gas, the installation of a landfill gas destruction device is an eligible project activity.

[8] Landfills which are currently collecting and destroying/converting landfill gas to comply with NSPS & EG regulations are not eligible to account for GHG reductions associated with the early installation of gas control systems during landfill expansion into new cells for years when they are required to achieve this control.

The California Registry defined this Performance Standard based upon an evaluation of landfill practices in the United States. A summary of the performance standard analysis is provided in Appendix A.

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All projects that pass this test are eligible to register reductions with the California Registry for the lifetime of the project-crediting period, even if the Performance Standard Test changes during mid-period. As stated in Section VII, Reporting Parameters, the project-crediting period is ten years or until failure of the regulatory additionality test.

The California Registry will periodically re-evaluate the appropriateness of the Performance Standard Threshold by updating the market penetration analysis in appendix A. The California Registry recognizes the importance of waste diversion and recycling programs. Therefore, as part of its periodic assessments of the Performance Threshold, the California Registry will use a stakeholder process to evaluate whether implementation of this protocol has resulted in negative environmental effects, such as increased emissions of criteria pollutants and/or methane. The assessment will pay particular attention to the status of other GHG reduction project protocols including composting, anaerobic digestion, recycling and waste to energy which would act to balance and complement the Landfill Project Reporting Protocol. If it is determined that negative environmental effects have occurred, the California Registry will identify and implement revisions to the protocol to prevent such effects from occurring in the future, or may suspend implementation of the protocol if necessary.

3.3.2 The Regulatory Test.

All greenhouse gas reduction projects are subject to a regulatory test to ensure that the emission reductions achieved would not have occurred in the absence of the project due to federal, state or local CAA regulations. [9] The monitoring plan (see Section VI) must incorporate into the monitoring procedures a mechanism for ensuring and demonstrating that the project at all times passes The Regulatory Test. The [preferred/required] method for demonstrating compliance with the Regulatory Test is a regulatory audit, performed on an [annual/biannual/periodic] basis. [In addition, an executive-level representative must formally attest to compliance with the Regulatory Test on an annual basis for the project to be verified.]

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[9] Federal, State and local regulations information sourced from U.S. EPA Climate Leader's *Draft Offset Protocol – Landfill Methane Collection and Combustion.* October 2006.

3.3.2.1 Federal Regulations. There are several EPA regulations for MSW landfills that have a bearing on the eligibility of methane collection and combustion projects as voluntary GHG reduction projects. These regulations include:

• NSPS for MSW Landfills, codified in 40 CFR 60 Subpart WWW – Targets landfills that commenced construction or made modifications after May 1991.

• Emission Guidelines (EG) for MSW Landfills, codified in 40 CFR 60 Subpart Cc or 40 CFRG2 Subpart GGG (Federal Plan for the EG) – Targets existing landfills that commenced construction before May 30, 1991, but accepted waste after November 8, 1987.

• NESHAP, codified in 40 CFR 63 Subpart AAAA – Regulates HAP emissions at NSPS and EG landfills.

These regulations require control of non-methane organic compounds (NMOC) from landfills according to certain size and emission thresholds. In most cases, activities to reduce NMOC will also lead to a reduction in CH_4 emissions, as gas collection and combustion is a common NMOC management technique employed at regulated landfills.

Landfills with a design capacity of at least 2.5 million megagrams and 2.5 million cubic meters of municipal solid waste (MSW) are subject to the NSPS or EG. Landfills above the design capacity size cutoff must calculate their annual NMOC emissions using equations or procedures in the NSPS or EG rules. The landfill must install a gas collection and control system within 30 months after the first annual NMOC emissions rate report in which the emission rate equals or exceeds 50 Mg/yr. A landfill is subject to the NESHAP if the design capacity is at least 2.5 million megagrams and 2.5 million cubic meters of municipal solid waste, and it has estimated uncontrolled emissions equal to or greater than 50 Mg/yr NMOC as calculated according to Section 60.754(a) of the NSPS or EPA approved Federal, state or tribal plan.

Landfills smaller than 2.5 million megagrams or 2.5 million cubic meters of waste, and those landfills not defined as MSW landfills, such as landfills that contain only construction and demolition material or industrial waste, are not usually subject to NSPS, EG or NESHAP.

3.3.2.2 State and Local Regulations, Ordinances and Permitting Requirements. All states are required by the CAA and Subtitle D of the Resource Conservation and Control Act (RCRA Subtitle D) to promulgate rules for landfills. It is also possible that some landfills that exceed applicable emission thresholds will require site-specific permits requiring controls under the New Source Review (NSR) or Prevention of Significant Deterioration (PSD) permitting program authorized by the CAA and implemented by states. These state-level rules generally follow federal guidelines, however, the state rules can be more stringent or require the installation of a gas collection and combustion system, or the destruction of volatile organic compounds (VOC), NMOC, or CH_4 earlier, or at smaller facilities, than the federal regulations would require.

This protocol may be revised as future federal, state or regional regulations are adopted in an effort to better control landfill gas emissions, including specific GHG programs as applicable.

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For example, on June 21, 2007, the California Air Resources Board (ARB) approved a Landfill Methane Capture Strategy as a discrete early action measure. Accordingly, ARB staff, in collaboration with California Integrated Waste Management Board (CIWMB) staff are currently developing a control measure to provide enhanced control of methane emissions from landfills. The control measure will reduce methane emissions from landfills by requiring gas collection

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and control systems where these systems are not currently required, and will establish statewide performance standards to maximize methane capture efficiencies"

In recent years, the inclusion of air quality, water quality and even GHG emissions control measures in permitting requirements (e.g., CEQA, NEPA, etc.) is becoming more prevalent. State and local governments may also regulate MSW landfills by putting in place nuisance laws or requiring solid waste facilities smaller than the facilities regulated by the CAA or RCRA Subtitle D to control landfill gas. Other regulations or ordinances may require minimal gas collection to prevent lateral migration of the landfill gas to neighboring properties. Collection and destruction activities at landfills regulated under NSPS, EG, NESHAP, CAA, and other state and local regulations, ordinances or permitting requirements are not eligible as GHG reduction projects.[11]For non-CAA programs, the regulatory or permit requirement must explicitly require the collection and destruction of landfill gas.

The California Registry acknowledges that RCRA Subtitle D and water quality regulations do not typically dictate the installation of a landfill gas collection system as the only compliance mechanism to manage subsurface methane migration or VOC water contamination. The installation of a landfill gas collection system is commonly the most expensive and effective and demanding compliance mechanism available. Therefore, the installation of a landfill gas collection and combustion system to comply with water quality regulations may qualify as a GHG reduction project under this protocol. These projects must also meet the eligibility requirements discussed below.

Some water quality, explosive gas mitigation and local nuisance regulations and ordinances allow for passive landfill gas control systems which collect and vent landfill gas to the atmosphere, but are not required to treat or combust the vented gasses. Project activities that add a combustion device to a landfill that is only required to implement a passive landfill gas control system pass the Regulatory Test.

Some water quality, explosive gas mitigation and local nuisance regulations and ordinances call for the installation of landfill gas collection systems. Once the landfill gas is collected and vented, the landfill then can become subject to air quality regulations requiring the landfill to control NMOC emissions. The air quality regulations may allow for flexibility to treat the landfill gas for NMOCs using combustion devices or carbon adsorption (for the latter the methane would be vented to atmosphere). Even in the regulatory situation where carbon adsorption is a compliance option, sometimes the installation of a landfill gas combustion device will clearly be the most preferred compliance mechanism. In the situation where flexibility is allowed for regulatory compliance to control NMOCs and the most cost effective compliance mechanism is the installation of a combustion device, the landfill gas control system in question does not pass the Regulatory Test.

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[11] The Registry acknowledges that the third party verifier will need to exercise some discretion when reviewing permits that require the installation of a landfill gas control system or any portion thereof. Permits tend to include strong language, such as "must" or "shall" install a landfill gas control system, even in the case that a landfill chooses to voluntarily install a landfill gas control system but is required to obtain a permit to do so.

For the case in which a landfill is required to treat landfill gas for NMOCs in order to comply with a regulation, ordinance or permitting condition, but combustion of the landfill gas is not the only compliance mechanism available to the landfill operator, the California Registry has developed an NMOC emissions threshold whereby the eligibility of a project can be determined. If the total mass flow of NMOC for the landfill gas control system is less than 3000 pounds NMOC per month, then the landfill gas control system is eligible as a GHG reduction project under this protocol. If

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[8] California Air Resources Board, Landfill Methane Control Measure web page http://IMVN.arb.ca. gov/cc/ccea/land!; lis/land!; lis. hlm

[9] The California Registry acknowledges that the third party verifier will need to exercise some discretion vvhen reviewing permits that require the installation of a landfill gas control system or any portion there of. Permits tend to include strong language, such as "must" or "shall" install a landfill gas control system, even in the case that a landfill chooses to voluntarily install a landfill gas control system but is required to obtain a permit to do so.

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the total mass flow of NMOC for the landfill gas control system is greater than 3000 pounds NMOC per month, then the landfill gas control system is *not* eligible as a GHG reduction project under this protocol. A summary of the development of the NMOC emissions threshold is provided in Appendix B.

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Additionally, for project developers to pass the Regulatory Test they must demonstrate that the project meets Federal, State and local air and water quality regulations. In some cases the installation of landfill gas destruction devices may cause co-pollutant emissions such as NOx and Carbon Monoxide. Therefore, while controlling GHG emissions, an offset project has the potential to degrade local air quality.

In the rare case where the project developer can demonstrate that a GHG emission reduction project should be considered eligible even though the total mass flow of NMOC is greater than 3000 pounds NMOC per month, the project developer can submit a written request for variance to the Registry, including sufficient documentation to substantiate the case. In such cases the Registry would consult with interested stakeholders in the decision process. A variance would be appropriate in cases where the developer can show that a carbon unit or similar non-destruction device is the most cost effective option in the developer's situation despite exceeding 3000 pounds per month.

In the case that a landfill gas collection project triggers the need for criteria pollutant offsets, the project operator must demonstrate that appropriate emissions offsetting measures have been followed.

Projects that are in non-compliance with air or water quality regulations are not eligible to register GHG reductions with the California Registry. If a project verifier finds that a GHG reduction project is in a state of recurrent non-compliance or non-compliance that is the result of negligence or intent, then GHG reduction credits from the period of non-compliance will be deemed void. Non-compliance solely due to administrative and reporting issues or "acts of god" will not affect GHG reduction registration and crediting. Once the project developer verifies regulatory compliance, GHG reductions associated with the portion of the crediting period for which the project developer was in compliance will be considered valid.

Project developers pass the Regulatory Test by demonstrating:

- there are no federal, state or regional regulations or permitting requirements (as well as local agency ordinances/rulings) requiring the landfill to control NMOC emissions or requiring the installation of a landfill gas collection and destruction system at the project location, and
- if adding a combustion device to a passive landfill gas control system - the regulation, ordinance or permitting condition that requires the landfill gas control system does not require any treatment of the vented landfill gas, or
- a landfill gas control system is installed to treat landfill gas for NMOCs in order to comply with a regulation, ordinance or permitting condition, but combustion of the landfill gas is not the only compliance mechanism available to the landfill operator and the total mass flow of NMOC for the landfill gas control system is less than 3000 pounds NMOC per month or a variance has been received to exceed the 3000 pound threshold.

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In the event that a landfill hosting a gas collection and destruction project becomes subject to a regulation, ordinance or permission condition that would call for the installation of a landfill gas control system, emission reductions can be reported to the California Registry up until the date that the landfill gas control system and destruction is required to be operational.

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Additionally, project developers pass the Registry's Regulatory Test by demonstrating that the project meets Federal, State and local air regulations. In some cases the installation of landfill gas combustion devices may cause co-pollutant emissions such as NOx and Carbon Monoxide. In the case that a landfill gas collection project triggers the need for criteria pollutant offsets, the project operator needs to demonstrate that appropriate emissions offsetting measures have been followed. Projects that are in a state of non-compliance with air regulations, related to landfill gas, are not eligible to register GHG reductions with the Registry.[12]

4 The GHG Assessment Boundary

The project boundary delineates the GHG sources and gasses assessed by project developers to determine the net change in emissions associated with installing a landfill gas collection and destruction system.

Physical Boundary. The physical boundary for the project includes sources from the operation of the landfill gas collection system to the destruction or conversion of the methane in the landfill gas.

For a new GHG reduction project at a landfill that is currently collecting and combusting landfill gas (e.g., to address lateral migration of landfill gases), the components of the physical boundary must be considered separately from any existing equipment used for collection and destruction.

Carbon dioxide emissions associated with the generation and combustion of landfill gas are considered biogenic emissions[13] (as opposed to anthropogenic) and will not be included in the GHG reduction calculation. This is consistent with the Intergovernmental Panel on Climate Change's (IPCC) guidelines for captured landfill gas.[14]

This protocol accounts for carbon dioxide reductions associated with displacing grid-delivered electricity or natural gas. Displacing grid delivered electricity or utility-provided natural gas constitutes a better than business-as-usual practice. This is classified as an indirect emissions reduction activity because the change in GHGs occur from sources owned and controlled by the power or gas producer, even though the project developer produces the renewable electricity or gas that displaces the fossil-based electricity or gas. Capturing and using methane to produce electricity for the grid or utility-provided natural gas is considered a complimentary and a better than business–as-usual GHG reduction project. The Registry understands the importance of developing renewable energy and impeding such efforts would result in a negative impact on the environment.

Figure 1 provides a general illustration of the project boundary; it encompasses the full landfill gas collection and combustion system. Table 1 (on page 11) identifies the main GHG sources associated with the source categories and specifies the gasses included in the calculation procedure.

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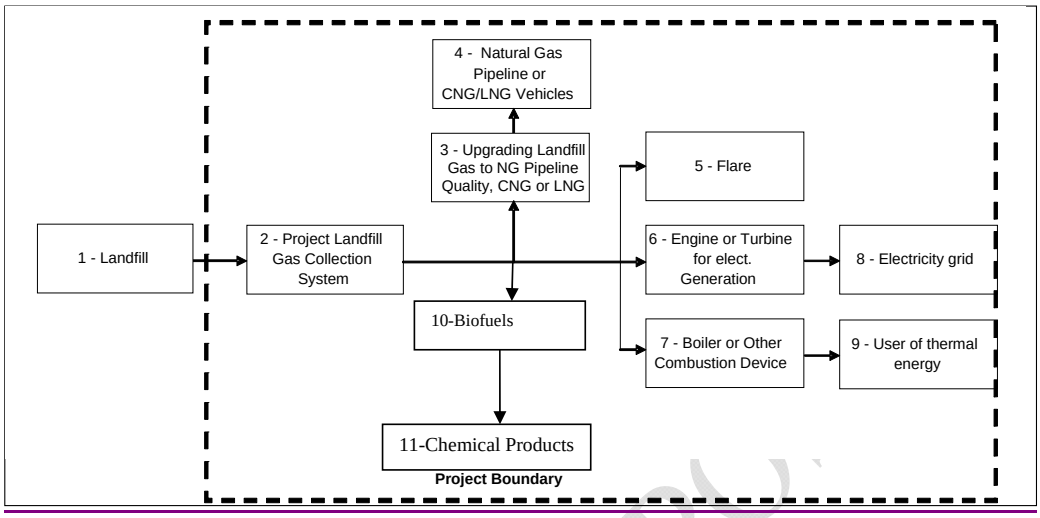
[12] If a project verifier finds that a GHG reduction project is in a state of recurrent non-compliance or non-compliance that is the result of negligence or intent, then GHG reduction credits from the period of non-compliance will be deemed void. Non-compliance solely due to administrative and reporting issues or "acts of nature" (also referred to as "acts of God") will not effect GHG reduction crediting. Once the project developer verifies regulatory compliance, GHG reductions associated with the proportion of the crediting period for which the project developer was in compliance will be considered valid.

[13] The rationale is that carbon dioxide emitted during combustion represents the carbon dioxide that would have been emitted during natural decomposition of the solid waste. Emissions from the landfill gas control system do not yield a net increase in atmospheric carbon dioxide because they are theoretically equivalent to the carbon dioxide absorbed during plant growth.

[14] *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*; p.5.10, ftnt

Figure 4-1: Landfill GHG source categories and the project boundary



Landfill gas projects using this protocol will report emissions reductions to the California Registry based on an annual accounting cycle (calendar year). The regulatory additionality test should be applied to the landfill gas project at the beginning of each annual accounting cycle.

4.2 Leakage

Leakage is an increase in GHG emissions or decrease in sequestration caused by the project but not accounted for within the project boundary. The underlying concept is that a particular project can produce effects outside of the physical boundary that fully or partially negate the benefits of the project. Although there are other forms of leakage, for this performance standard, leakage is limited to activity shifting – the displacement of activities and their associated GHG emissions outside of the project boundary.

Landfill methane collection and destruction projects are not expected to result in leakage of GHG outside the project boundary.

Table 1 relates GHG source categories to sources and gasses, and indicates inclusion in the calculation methodology.

Table 4-1: Landfill source categories, GHG sources, associated gases, and coverage in the landfill project boundary

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[10] The rationale is that carbon dioxide emitted during combustion represents the carbon dioxide that would have been emitted during natural decomposition of the solid waste. Emissions from the landfill gas control system do not yield a net increase in atmospheric carbon dioxide because they are theoretically equivalent to the carbon dioxide absorbed during plant growth.

[11] *IPeG Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories;* p.5.1 0, ftnt

GHG Source Category	GHG Source	Gas	Included in Project Boundary	Comment
1. Landfill	• Fugitive emissions from landfill surface	CO_2	No	*Biogenic emissions are excluded.**
		CH_4	No	*Emissions would have occurred absent the project. *****
2. Landfill Gas Collection System	• Well heads and collection headers	CH_4	No	*Emissions would have occurred absent the project.***
	• Emissions resulting from fossil fuel derived energy used by compressors, blowers, and/or gathering system	CO_2	Yes	*All CO_2 emissions (direct and indirect) due to fossil fuel combustion are included.*
		CH_4	No	*Excluded, as this emission source is assumed to be very small.*
		N_2O	No	*Excluded, as this emission source is assumed to be very small.****
	• Fugitive emissions from conduit to combustion device	CH_4	No	*Emissions would have occurred absent the project.***
3. Upgrading Landfill Gas to NG Pipeline Quality	• Emissions resulting from fossil fuel derived energy used to upgrade the quality of and transport the gas to the NG pipeline	CO_2	Yes	*All CO_2 emissions (direct and indirect) due to fossil fuel combustion are included.*
		CH_4	No	*Excluded, as this emission source is assumed to be very small.*
	•	N_2O	No	*Excluded, as this emission source is assumed to be very small.****
4. Natural Gas Pipeline or CNG/LNG	• Emissions from compressors and other equipment associated with transporting the natural gas through the pipeline.	CO_2	No	*Excluded, as this emission source is assumed to be very small.*
		CH_4	Yes	*Based on efficiency of end-user combustion, as well as processing, transmissions, and distribution losses. ******
	•	N_2O	No	*Excluded, as this emission source is assumed to be very small.****
5. Flare	• Emissions resulting from the combustion of landfill gas in flare.	CO_2	No	*Biogenic emissions are excluded.**
		CH_4	Yes	*Based on combustion efficiency of flare.*
	•	N_2O	No	*Excluded, as this emission source is assumed to be very small.****
	• Emissions resulting from the combustion of fossil fuel in flare.	CO_2	Yes	*All CO_2 emissions due to fossil fuel combustion are included.*
		CH_4	Yes	*Un-combusted CH_4 is based on destruction efficiency of flare.*
	•	N_2O	No	*Excluded, as this emission source is assumed to be very small.****
6. Engine or Turbine for Electricity	• Emissions resulting from the combustion of landfill gas in engine or turbine.	CO_2	No	*Biogenic emissions are excluded.**
		CH_4	Yes	*Based on combustion efficiency of engine or turbine*

GHG Source Category	GHG Source	Gas	Included in Project Boundary	Comment
Generation	•	N_2O	No	*Excluded, as this emission source is assumed to be very small.****
	• Emissions resulting from the combustion of fossil fuel in engine or turbine	CO_2	Yes	*All CO_2 emissions due to fossil fuel combustion are included.*
		CH_4	Yes	*Un-combusted CH_4 is based on destruction efficiency of engine or turbine.*
	•	N_2O	No	*Excluded, as this emission source is assumed to be very small.****
7. Boiler or Other Combustion Device	• Emissions resulting from the combustion of landfill gas in boiler or other combustion device.	CO_2	No	*Biogenic emissions are excluded.**
		CH_4	Yes	*Based on combustion efficiency of boiler or other combustion device.*
	•	N_2O	No	*Excluded, as this emission source is assumed to be very small.****
	• Emissions resulting from the combustion of fossil fuel in boiler or other combustion device.	CO_2	Yes	*All CO_2 emissions due to fossil fuel combustion are included.*
		CH_4	Yes	*Un-combusted CH_4 is based on destruction efficiency of boiler.*
		N_2O	No	*Excluded, as this emission source is assumed to be very small.****
8. Electricity Grid	• Displacement of GHG emissions from fossil fuel combustion from electricity generated using landfill gas.	CO_2	Yes	*Offset emissions for grid power and natural gas based on the Registry's General Reporting Protocol.*****
		CH_4	Yes	
		N_2O	Yes	
9. User of Thermal Energy	• Displacement of GHG emissions from fossil fuel combustion from thermal energy generated using landfill gas.	CO_2	Yes	*Offset emissions for grid power and natural gas based on the Registry's General Reporting Protocol.*****
		CH_4	Yes	
		N_2O	Yes	

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2.1 Carbon dioxide emissions from the combustion of landfill gas are considered biogenic emissions (as opposed to anthropogenic) and will not be included in the GHG reduction calculation.** Methane emissions that escape from the cap, or from leaking valves or seals do not need to be included within the project boundary because these methane emissions would have occurred absent the project.

*** Nitrous Oxide emissions are excluded from this protocol as they are considered to be very small. Also, the level of uncertainty associated with the nitrous oxide emission factors that are currently available is substantial.

**** The Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories gives a standard value for the fraction of carbon oxidized for gas combustion 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 118,000kgCH4/PJ on the basis of gas consumption, which is 0.6%. Leakage in the residential and commercial sectors is stated to be 0 to 87,000kgCH4/PJ, which equates to 0.4%, and in industrial plants and power station the losses are 0 to 175,000kg/CH4/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.[15]

GE AES Greenhouse Gas Services Landfill Gas Methodology V.1, and the RGGI Model Rule (January 5, 2007). Total14

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

5 GHG Reductions Calculation Methods 13

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Project GHG reductions are registered on an annual basis, thus projects will have yearly project (actual) emissions reductions.

To support project developers and facilitate consistent and complete emissions reporting, the Registry's on-line reporting tool (CARROT) will incorporate the equations in this protocol.[16] Until the landfill offset project component of CARROT becomes operational the Registry will provide spreadsheet-based calculation tools.

Models that estimate biological and physical processes, such as the biological decomposition of solid waste in landfills and the migration of the landfill gas to the atmosphere are still becoming increasingly available. Process models typically rely on a series of input data that research has shown to be important drivers of the biological and geochemical process. In terms of GHG emissions models, process models identify the mathematical relationships between inputs, basic conditions, and GHG emissions. The procedure for modeling landfills can be quite complex and subject to many different interpretations of how to address site-specific landfill gas generation factors and how to apply models effectively to landfills. At this time, no widely accepted method exists for determining the total amount of uncontrolled landfill gas emissions to the atmosphere from landfills. As new technologies and/or widely accepted modeling methods become available for the estimation of fugitive methane emissions from landfills, the California Registry will consider updating the protocol to incorporate these new approaches into the methane emissions reduction quantification methodologies.

5.1 Baseline emissions

Traditional baseline emission calculations are not required for this protocol for the quantification of methane reductions. In the baseline scenario, all uncontrolled methane emissions are considered to be released to the atmosphere except for the portion of methane which would be oxidized by bacteria in the soil of uncovered landfills, absent the project.[17] However, the cover oxidation only affects uncollected landfill gas; therefore, the oxidized methane has no bearing on the reductions that occur from the landfill gas collection and destruction system.

For landfills where the current collection and combustion system is only installed at a portion of the landfill in order to comply with local regulations, ordinances or permitting requirements, the assumption is also made that any methane beyond that currently being collected would be emitted to the atmosphere. Only the landfill gas destroyed beyond that resulting from the existing collection and combustion system is considered additional (i.e., those reductions resulting from the implementation of the GHG reduction project). The GHG project must either

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[16] For more information on CARROT, see the Registry's website, www.climateregistry.org

[17] Landfill cover systems incorporating synthetic liners as part of the final cover systems should use a default methane oxidation rate of zero. A 10% methane oxidation factor shall be used for all other landfills. A small portion of the methane generated in landfills (around 10%) is naturally oxidized to carbon dioxide by methanotrophic bacteria in the cover soils of well managed landfills. The 10% factor is based on Intergovernmental Panel on Climate Change (IPCC) guidelines (2006).

be designed to be entirely separate from the existing collection system or it may be integrated as a continuous extension of the existing collection system. In the case of where the GHG project is integrated into the existing collection system, separate system piping and independent flow control monitor must be installed at the control device..[18] These conditions will ensure that the reductions resulting from the GHG project can be accounted for separately from current collection and combustion.

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In the above mentioned situation where[13] **The California Registry's GHG reduction calculation method is derived from the Kyoto Protocol's Clean** Development Mechanism (ACM0001 V.6 and AM0053 V.1), the EPA's Climate Leaders Program (Draft Landfill Offset Protocol, October 2006), the GE AES Greenhouse Gas Services Landfill Gas Methodology V.1, and the RGGI Model Rule (January 5, 2007).

[14] **Landfill cover systems incorporating synthetic liners as part of the final cover systems should use a default methane oxidation rate of zero. A 10% methane oxidation factor shall be used for all other landfills. A small portion of the methane generated in landfills (around 10%) is naturally oxidized to carbon dioxide by methanotrophic bacteria in the cover soils of well managed landfills. The 10% factor is based on Intergovernmental Panel on Climate Change** (IPCG) guidelines (2006).

[15] **The new landfill gas collection system can use the existing combustion device, as long as the project landfill gas is metered separately and the total quantity of landfill gas sent to the combustion device is within the acceptable limits of the manufacture specifications.**

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[18] The new landfill gas collection system can use the existing combustion device, as long as the project landfill gas is metered separately and the new quantity of landfill gas sent to the combustion device is within the acceptable limits of the manufacture specifications.

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When a new GHG reduction project is sited at a landfill where an existing landfill gas collection and combustion system is in operation, it is important that the new landfill gas collection system is designed to minimize the overlap of the effective radius of influence of the original and the newly installed landfill gas collection wells. In order to account for any potential overlap of the two systems, specific pre-project installation and post-project installation monitoring of the landfill gas flow rate and methane concentration for the original landfill gas collection system is required. If a post-project installation decrease in landfill gas flow rate and methane concentration is noted for the original landfill gas collection system, an adjustment may be applied annually to the GHG emission reductions that are calculated for the duration of the GHG reduction project.

As stated above, landfill operations that utilize bioreactor technologies are eligible to use this protocol. Although landfills which utilize bioreactor technologies have higher landfill gas generation in the early years of the landfill's life; their net emissions, over the life span of the landfill, are comparable to that of a traditional landfill. Only bioreactor landfills which contain moisture content less than 40 percent (by weight) and satisfy the other eligibility rules are eligible to register GHG reductions using this protocol.

This protocol also accounts for the difference in electricity consumption between the baseline scenario and the project.

GHG emissions from grid electricity and utility natural gas to baseline in quantities equal to power produced and BTUs from landfill gas to energy projects.

5.2 Project emissions reductions

Project emissions reductions are actual GHG emissions reductions that occur within the project boundary after the installation of the landfill gas control system. Project emissions reductions are calculated on an annual, *ex-post* basis.

As shown in Equation 1, project GHG emissions reductions equal:

the total amount of uncontrolled methane collected from the landfill and destroyed by the project landfill gas control system, minus

- carbon dioxide emissions from fossil fuel consumption, minus
- methane emissions from incomplete combustion of natural gas if applicable, minus
- indirect carbon dioxide emissions from the

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use of electricity from the grid, if applicable, plus,

- the indirect emissions resulting from the displacement of fossil fuels (from LFG to energy or LFG to chemical products), minus
- the effective radius of influence adjustment, if applicable, minus,

the discount factor to account for uncertainties associated with the project monitoring equipment, if applicable. Oxidation of methane by soil bacteria is only applied to methane which is not collected. Fugitive emissions are not calculated or considered by the protocol; therefore the amount of methane is not relevant to this protocol. *Landfill Project Reporting Protocol*

ER_y = $[(CH_4Dest_{PR}) * 21 * (1-0X) *(1-DF)]-FFC0_2 - ELC0_2 - EROld;"o"",$

Where,

ER_y $CH_4$0est_{PR} =

21 =

OX

EROldiscounl =

OF

=

=

Where, $FFC0_2$

FF_{pR} =

EF_{FF}

total annual project GHG emissions reductions ($tC0_2elyr$)
total annual methane emissions destroyed by the project landfill

Eauation 5-1. Proiect GHG Emissions reductions
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gas collection and destruction system (tCH_4/yr) - see Equation 5-2

Global Warming Potential factor of methane to carbon dioxide equivalent [16]

factor for the oxidation of methane by soil bacteria. Equal to 0.10 for all landfills except those that are covered with a synthetic liner as part of the final cover systems where OX = 0.

adjustment to account for overlap of LFG collection well effective radius of influence (tCH_4/yr) (see Equation 5-3). Equal to zero if no pre-existing LFG collection system is in place prior to project implementation.

discount factor to account for uncertainties associated with the project monitoring equipment Either 0,0.05,0.10,0.15,0.20, 0.25 (see section VI Project Monitoring). Equal to zero if using continuous methane monitor with no missing data and all calibration tests are within a 5% margin of error.

$$FFC0_2 = 2:FF_{PR} * \mathbf{EF}_{FF}$$

total annual carbon dioxide emissions from the destruction of fossil fuel ($tC0_2$/yr)

total annual fossil fuel consumed by the project landfill gas collection and destruction system, by fuel type (volume fossil fuel/yr)

fuel specific emission factor (kg CO_2/volume fossil fuel) California Registry General Reporting Protocol Appendix C3 and C5[17]

$$ELC0_2 = EL_{pR} * EF_{EL}$$

Where,

$ELC0_2$

EL_{pR}

EF_{EL}

total annual indirect carbon dioxide emissions from the consumption of electricity from the grid (tCOhr)

total annual electricity consumed by the project landfill gas collection and destruction system(MWh)

carbon emission factor for electricity used (kg CO_2/MWh) [18]

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[16] IPCC Second Assessment Report: Climate Change 1996

[17] California Climate Action Registry. General Reporting Protocol V. 2.2, Appendix C, tables C.3 and C.5

[18] **Utility specific emission factors for California Registry member utilities are available in the Public Reports section of** the CARROT database (see Reference Documents section of the Public Report for a link to the PUP reporting form) **-http://V'vVVW.c1imateregistry.org/CARROT/public/reports.aspx. If a utility specific emission factor is not available, use** the EPA eGRID subregion emission factor available in the California Registry's General Reporting Protocol (GRP) V. 2.2, Appendix C, tables C.1 (also see GRP Figure 111.6.1)

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Equation 5-2. Total annual methane emissions destroyed

$$CH_4\ Dest_{PR} = CH_4\ Dest_{flare} + CH_4\ Dest_{electricity} + CH_4\ Dest_{thermal} + CH_4\ Dest_{upgrade}$$

Where,

CH, Dest'''' **CH_4 Destelectricily**	=	the net quantity of methane destroyed by flaring (tCH,/yr)
	=	the net quantity of methane destroyed by generation of electricity (tCH,/yr)
CH_4 Desttherm al	=	the net quantity of methane destroyed for the generation of thermal energy (tCH,/yr)
CH_4 Destupgrade	=	the net quantity of methane destroyed by upgrading landfill gas to natural gas pipeline quality and injecting it into the pipeline for destruction by end users (tCH,/yr)

$$CH_4\ Dest'''e = (LFG'''e * PR_{cH4} * 0.0423 * 0.000454 * DE) - FFCH_4$$

Where, **LFG_{flare}**

	=	total annual quantity of landfill gas fed to the flare(s) (ft'/yr) - see Equation 5-4 for additional guidance on adjusting the LFG flow for temperature and pressure
PR_{cH},	=	the average methane fraction of the landfill gas as measured (ft' CH, / ft' LFG)
0.0423	=	density of methane (lbCH, / ft' CH,)
0.000454	=	tCH, / lbCH,
DE	=	default methane destruction efficiency for closed flare 19.20 = 0.995, for open flare = 0.960
$FFCH_4$	=	emissions from incomplete destruction of supplemental natural gas (refer to Equation 5-2a)

$$CH_4\ Deste1e,'rlo;,y = (LFGe1e''rlo;ly * PR_{cH4} * 0.0423 * 0.000454 * DE) - FFCH_4$$

Where, **LFGelectricity**

	=	total annual quantity of landfill gas fed to the electricity generator(s) (ft'/yr) - see Equation 5-4 for additional guidance on adjusting the LFG flow for temperature and pressure
DE	=	default methane destruction efficiency for electricity generation''·24 using Lean Burn IC engines = 0.936, Rich Burn IC Engines = 0.995, Large Gas turbine = 0.995, Microturbine = 0.995

$$CH_4\ Dest'herm,' = (LFG'herm,' * PR_{cH4} * 0.0423 * 0.000454 * DE) - FFCH_4$$

Where, **LFGthermal**

	=	total annual quantity of landfill qas fed to the boiler(s) (ft'/yr) -

[19] **If available, the official source tested methane destruction efficiency shall be used in Equation 5-2 n place of the default methane destruction efficiency. Otherwise, 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 case.** [20] **The default destruction efficiencies for this source 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 California Registry.**

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see Equation 5-4 for additional guidance on adjusting the LFG flow for temperature and pressure

DE = default methane destruction efficiency for boiler" = 0.98

Eauation 5-2 continued

$$CH_4\ Dest,pg,ade = LFG,pg,ade * PR_{cH4\ upgrade} * 0.0423 * 0.000454 * DE$$

Where, **LFGupgrade** = total annual quantity of upgraded landfill gas injected into the natural gas transmission and distribution system or converted to CNG or LNG for use in vehicles (fl'/yr) - see Equation 5-4 for additional guidance on adjusting the LFG flow for temperature and pressure

PR_{CH4} upgrade = the average methane fraction of the upgraded landfill gas as measured (fl' CH_4lft' LFG)

DE = Methane destruction efficiency for upgraded landfill gas injected into the natural gas transmission and distribution system = 0.98 (see footnote to Table 4-1 for description). Destruction efficiency for use in CNG and LNG vehicles = 0.95

Equation 5-2a: Methane emissions from incomplete destruction of natural qas

$$FFCH_4 = FF_x * FFG_{CH4} * 0.0423 * 0.000454 *(1-DE_x)$$

Where,

$FFCH_4$ emissions from incomplete destruction of supplemental natural gas (tCH_4/yr). To be quantified for each destruction device. total

FF_x annual quantity of natural gas destroyed by destruction device (fl' /yr)

FFG_{CH4} the average methane fraction of the natural gas as provided for by fuel vendor (fl' CH_4/ fl' FFG)

0.0423 density of methane ($lbCH_4$ / fl' CH_4)

0.000454 tCH_4 / $lbCH_4$

DE_x methane destruction efficiency (use destruction efficiency provided in Equation 5-2)

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Equation 5-3. Adjustment for overlap of LFG collection well effective radius of influence

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$$EROI_{discount} = (LFG_{OR1} * OR1_{CH4} *0.0423*0.000454) - (LFG_{OR2} * OR2_{CH4} * D_{CH4})*21$$

Where,

$EROI_{discount}$ = Adjustment to account for overlap of LFG collection well Effective Radius Of Influence (tCH_4/yr). Equal to zero if no pre-existing LFG collection system is in place prior to project implementation.

$OR2_{CH4}$ = post-project installation methane fraction in the landfill gas of the original collection system (ft^3 CH_4 / ft^3 LFG)

LFG_{OR1} = pre-project installation extrapolated annual amount of landfill gas collected by the original collection system (

$OR1_{CH4}$	=	Pre-project installation methane fraction in the landfill gas collection system (ft^3 CH$_4$/ft^3 of the original collection system (ft^3/yr)	

0.0423	=	LFG) the original collections system (ft’CH4/ft’LFG) guidance on adjusting the LFG flow for temperature and pressu

LFG_{OR2} = reduction post-project installation extrapolated annual amount of landfill gas collected by the original collection system

m (ft^3/yr) = Global Warming Potential factor of methane to carbon dioxide equivalent

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Equation 5-4. Adjusting **the landfill** qas **flow for temperature and pressure**

If the landfill gas flow metering equipment does not internally correct for the temperature and pressure of the landfill gas, separate pressure and temperature measurements must be used to correct the flow measurement. The temperature and pressure of the landfill gas must be measured continuously or on a weekly basis at a minimum

Important - Apply the following equation only if the landfill gas flow metering equipment does not internally correct for temperature and pressure.

LFG = LFG"adj,,'ed ***(520fT)* * (Pf1)**

Where, LFG = adjusted volume of Landfill Gas collected (ftA3) for the given time period

LF $_{GunadjUsted}$ = unadjusted volume of landfill gas collected (ft^A3) for the given time period

T = measured temperature of the landfill gas in oR (OR = of + 459.67) for the given time period

P = measured pressure of the landfill gas in atm for the given time period

6 Project Monitoring

The California Registry requires a monitoring plan to be established all monitoring and reporting activities associated with the project. The monitoring plan will serve as the basis for verifiers to confirm that the stipulations of Sections VI and VII have been and will continue to be met, and that consistent, rigorous monitoring and record-keeping occurs. The monitoring plan does not require ISO or any other certification, but must cover all aspects of monitoring and reporting contained in this protocol. Further, the monitoring plan must provide a mechanism by which to annually evaluate and attest to the status of the regulatory test. At a minimum the monitoring plan must include a written account of the frequency of data acquisition, the record keeping plan (see section VIL2 for minimum record keeping requirements), the frequency of instrument calibration activities and the role of the individual performing each specific monitoring activity. The monitoring plan shall also include QA/QC provisions to ensure that data acquisition and meter calibration are carried out consistently and with precision.

Project developers are responsible for monitoring the performance of the project and operating the landfill gas collection and destruction system in a manner consistent with the manufacturer's recommendations for each component of the system. According to this protocol, methane emissions from landfill gas capture and control systems are monitored with measurement equipment that directly meter

- the continuous rate of landfill gas flow and weekly measurements of temperature and pressure using a calibrated portable analyzer prior to delivery to the combustion device, and
- the fraction of methane in the landfill gas measured with a continuous analyzer or, alternatively, with weekly measurements using a calibrated potable gas analyzer, and
- the continuous flow of landfill gas to each destruction device, and
- the continuous rate of landfill gas flow and weekly measurements of temperature and pressure and methane concentration using a calibrated portable analyzer prior to injection into the natural gas transmission and distribution system or distributed as CNG or LNG for use in vehicles, and
- the amount of methane diverted from landfill gas and converted into chemical products.

According to this protocol, avoided emissions resulting from the displacement of fossil fuels through landfill gas capture and energy recovery systems are monitored with measurement equipment that directly meter

- the continuous rate of landfill gas flow, temperature and pressure prior to delivery to the combustion device, and
- the fraction of methane in the landfill gas measured with an analyzer, and
- the continuous flow of landfill gas to each destruction device, and
- the continuous rate of supplemental natural gas flow prior to delivery to the combustion device (if applicable).

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Often the direct measurement instrument also uses a data recorder to store and document the landfill gas flow and methane concentration data and can be tailored to provide the amount of methane (ft^3) collected from the landfill on a periodic basis as specified by the operator. The continuous methane analyzer should be the preferred option for monitoring methane concentrations, as on the rare occurrence that the methane content of landfill gas captured varies by more than 20% ,for more than 10% of the days per year, due to gas capture network conditions (dilution with air at wellheads, leakage on pipes, etc). [25,26] However, weakly testing is sufficient if the 20% variability does not occur.

When using the alternative approach of weekly methane concentration measurement using a calibrated portable gas analyzer, project developers must document the time period which a 20% variance of methane content occurred. The dates of the variance in methane content must be documented where the project developers can account for the uncertainty associated with these measurements by applying a 20% discount factor to the total quantity of methane collected and combusted during the time of the variance.

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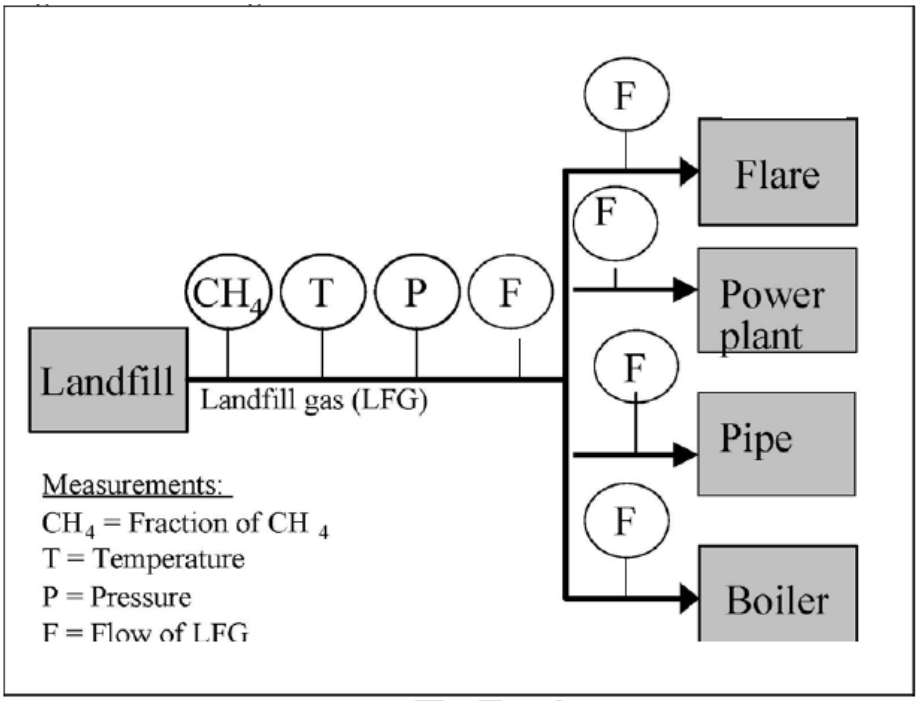
Figure 6-1 represents the suggested arrangement of the landfill gas flow meters and methane concentration metering equipment.

Figure 2. Monitoring Plan

[25] Methane fraction of the landfill gas to be measured on a wet bases. No separate monitoring of temperature and pressure is necessary when using flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters.

[26] Consolidated baseline methodology for landfill gas project activities, Clean Development Mechanism, Version 07, Sectoral Scope 13 (2007).



[21] **Methane fraction of the landfill gas to be measured on a wet basis. No separate monitoring of temperature and pressure is necessary when using flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters.**

[22] **Consolidated baseline methodology for landfill gas project activit**

ies, Clean Development Mechanism, Version 07, Sectoral Scope 13 (2007).

Source: Consolidated baseline methodology for landfill gas project activities, Clean Development Mechanism, Version 07, Sectoral Scope 13 (2007).

For Qualifying projects that became operational between January 1, 1990 and January 1, 2001, the use of monthly, bimonthly and weekly methane concentration measurements using a calibrated portable gas analyzer is acceptable under this protocol. In order to account for the uncertainty associated with the measurements due to incomplete record keeping, a sliding discount factor scale must be applied. In the case where monthly methane concentration measurements are used, project developers must apply a 75% discount factor to the years prior to 2001. In the case where bimonthly methane concentration measurements are used, project developers must apply an 80% discount factor to the years prior to 2001. In the case where weekly methane concentration measurements are used, project developers must apply a 85% discount factor to the years prior to 2001.

For qualifying projects that became operational between January 1, 1990 and January 1, 2008, the use of monthly methane concentration measurements using a calibrated portable gas analyzer is acceptable under this protocol up until January 1, 2008 after which a continuous methane analyzer or weekly measurement using a calibrated portable gas analyzer is required. In the case where monthly methane concentration measurements are used, project developers must document the time period which a 20% variance of methane content occurred. In order to account for the uncertainty associated with the measurements, during the period of methane variance, the project developer must apply a 20% discount factor to the total quantity of methane collected and combusted during that time period.

The hourly operational activity of the landfill gas collection system and the destruction devices shall be monitored and documented to ensure actual landfill gas destruction. GHG reductions will not be accounted for during periods which the destruction device was not operational. The measurement equipment is sensitive for gas quality (humidity, particulate, etc.), so a strong *QAJQC* procedure for the calibration of this equipment should be built into the monitoring plan. At a minimum, monitoring instruments shall be inspected, cleaned and calibrated quarterly.

In situations where the flow rate or methane concentration monitoring equipment has failed a calibration test (tested to be outside of allowable 5% margin of error), or is missing data, the project developer should apply the data substitution methods provided for under the EPA Acid Rain Program in 40 CFR Part 75 Subpart D 75.33.23.[27] In the case where monitoring

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23 Available at the Electronic Code of Federal Regulations website: http://ecfr.gpoaccess.gov/cgiltltextltextidx?c-ecfr&tpl-%2Findex.tpl

[27] Available at the Electronic Code of Federal Regulations website: http://www.ecfr.gpoaccess.gov/cgi/test/text-idx?c=ecfr&tpl=%2Findex.tpl

equipment has failed a calibration test, or is missing 5% or more data, project developers must account for the uncertainty associated with the data substitution methods by applying a 5% discount factor to the total quantity of methane collected and combusted during the period effected by the faulty calibration or missing data. If for any reason the combustion device monitoring equipment (for example, the thermal coupler on the flare) is inoperable, then no emission reduction credits can be registered for the period of inoperability.

GHG reductions will not be accounted for during periods which the combustion device was not operational. so a strong QA/QC procedure for the calibration of this equipment is required. Monitoring instruments shall be inspected, cleaned and calibrated in accordance local state and federal regulations and manufacturer's specifications.

In the case where a new GHG reduction project is sited at a landfill where an existing landfill gas collection and combustion system is in operation, project developers are required to monitor pre-project installation and port-project installation landfill gas flow and methane concentration for the original landfill gas collection system as required to calculate the effective radius of influence adjustment factor in equation 3. Either of the above mentioned methane concentration measurement methodologies can be used for this monitoring activity.

If available, the official source tested methane destruction efficiency shall be used in Equations 2 and 2a in place of the default methane destruction efficiency. Otherwise, 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 case.

Provisions for monitoring variables to calculate baseline and project emissions are provided in the table below (adapted from ACM0001, V.6). Project developers are required to retain all documentation of project activity data for a minimum of five years post project verification.

Table 6-1. Data to be collected and used to monitor emissions from the project activity

ID number	Data variable	Data unit	calculated (c) measured (m) estimated (e)	Recording frequency	Comment
1. $LFG_{PR\ total}$	Total amount of Project landfill gas captured	ft^3	m	Continuously or alternative	Measured y by a flow meter and recorded. Data to be aggregated monthly and yearly.
1. LFG_{OR1}	Pre-project installation amount of landfill gas collected by the original collection system	ft^3	m	Continuously or alternative	Measured by a flow meter and recorded Data to be aggregated for the month proceeding the date that the project became operational and extrapolated to a yearly amount of LFG. Measured for calculation of discount factor in Equation 3.
1. LFG_{OR2}	Post-project installation amount of landfill gas collected by the original collection system	ft^3	m	Continuously or alternative	Measured by a flow meter and recorded. Data to be aggregated for the month proceeding the date that the project became operational and extrapolated to a yearly amount of LFG. Measured for calculation of discount factor in Equation 3.

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ID number	Data variable	Data unit	calculated (c) measured (m) estimated (e)	Recording frequency	Comment
2. LFG_{flare}	Amount of landfill gas flared	ft^3	m	Continuously or alternative	Measured by a flow meter and recorded Data to be aggregated monthly and yearly for each flare.
3. $LFG_{electricity}$	Amount of landfill gas combusted in power plant	ft^3	m	Continuously or alternative	Measured by a flow meter and recorded. Data to be aggregated monthly and yearly for each power plant.
4. $LFG_{thermal}$	Amount of landfill gas combusted in boiler	ft^3	m	Continuously or alternative	Measured by a flow meter and recorded. Data to be aggregated monthly and yearly for each boiler.
5. $LFG_{upgrade}$	Amount of upgraded landfill gas delivered to NG Transmission and Distribution System of CNG/LNG vehicles	ft^3	m	Continuously or alternative	Measured by a flow meter and recorded Data to be aggregated monthly and yearly for each system.
6. PR_{CH4}	Methane fraction in the landfill gas	ft^3 CH4 / ft^3 LFG	m	Continuously or weekly or monthly	Measured by gas analyzer or a calibrated portable gas analyzer. Data to be averaged monthly and annually for the reporting cycle. Methane fraction of the landfill gas to be measured on wet basis. Measured to determine the density of methane D_{CH4}.
6. $OR1_{CH4}$	Pre-project installation methane fraction in the landfill gas of the original collection system	ft^3 CH4 / ft^3 LFG	m	Continuously or weekly or monthly	Measured by gas analyzer or a calibrated portable gas analyzer. Data to be averaged for the month proceeding the date that the project became operational. Methane fraction of the landfill gas to be measured on wet basis. Measured for calculation of discount factor in Equation 3.
6. $OR2_{CH4}$	Post-project installation methane fraction in the landfill gas of the original collection system	ft^3 CH4 / ft^3 LFG	m	Continuously or weekly or monthly	Measured by gas analyzer or a state approved sampling device. Data to be averaged for the first month after the date that the project became operational. Methane fraction of the landfill gas to be measured on wet basis. Measured for calculation of discount factor in Equation 3.
7. T	Temperature of the landfill gas	°C	m	Continuously or weekly	Measured to determine the density of methane D_{CH4}. No separate monitoring of temperature is necessary when using flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic feet.
8. P	Pressure of the	atm	m	Continuously	Measured to determine the density of

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ID number	Data variable	Data unit	calculated (c) measured (m) estimated (e)	Recording frequency	Comment
	landfill gas			or weekly	methane D_{CH4}. No separate monitoring of pressure is necessary when using flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters.
9. EL_{PR}	Total amount of electricity required to meet project requirement	MWh	m	Monthly	Obtained from either onsite metering of utility purchase records. Required to determine CO2 emissions from use of electricity to operate the project activity.
10. EF_{EL}	Carbon emission factor of electricity	Kg CO2/MWh	c	Annually	Utility specific emission factors for Registry member utilities are available in the Public Reports section of the CARROT database. Utility specific not available use the EPA eGRID subregion emission factor from the California Climate Action Registry's General Reporting Protocol (GRP) V. 2.2, Appendix C, tables C.1 (also see GRP Figure III.6.1).
11. FF_{PR}	Total amount of fossil fuel required to meet project requirement	scf or Gallons	c	Monthly	Calculated from monthly record of fossil fuel purchased and consumed. Required to determine CO2 emissions from use of fossil fuels to operate the project activity.
12. Regulations	Project developer attestation to compliance with regulatory requirements relating to landfill gas projects	n/a	n/a	At the renewal of each crediting period.	The information is used for the application of the regulatory additionality test. The project developer shall document all Federal, State and local regulations, ordinances and permit requirements (and compliance status for each) that apply to the GHG reduction project. The project developer shall provide a signed attestation to their compliance status for the above mentioned Federal, State and local regulations, ordinances and permit requirements.
13.	Operation of the landfill gas collection system	Hours	m	Monthly	This is monitored to ensure methane destruction is claimed only for methane used in the combustion devices.
14.	Operation of the energy plant	Hours	m	Monthly	This is monitored to ensure methane destruction is claimed for methane used in electricity plant only when it is operational.
15.	Operation of the boiler	Hours	m	Monthly	This is monitored to ensure methane destruction is claimed for methane used in boiler only when it is operational.
16.	Operation of the	Hours	m	Monthly	This is monitored to ensure methane

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ID number	Data variable	Data unit	calculated (c) measured (m) estimated (e)	Recording frequency	Comment
	flare				destruction is claimed for methane used in flare only when it is operational.
17. DE	Optional: Source test data for combustion device methane destruction efficiency	% destruction efficiency	m	Annually	Project developers have the option to use a State or local agency accredited source test service provider to test the actual methane destruction efficiency of each of the combustion devices used in the project case. If using source test data for destruction efficiencies in Equation 2, all source test documentation shall be provided to the verifier.
18. $DISCO_2$	Total electricity produced	tCO_2	c	Annually	Calculated from monthly record of electricity produced and sold to the grid and consumed. Electricity (kWh) is converted into CO_2 equivalents.
19.$CH_4Dest_{chemical}$	Total methane destroyed by converting to chemical products	Tons CH_4	c	Annually	Calculated from monthly record of methane captured from landfill gas and converted into chemical products.
20. $MWh_{produced}$	Electricity Usage = $MWh_{produced}$	kWh	c	Monthly	Calculated from monthly record of electricity sold to the grid.
21.EF_{EL}	Emission factor for electricity used	kg CO_2/MWh	n/a	n/a	Mathematical constant
22.EF_{Btu}	Emission factor for electricity used	kg CO_2/MMBtu	n/a	n/a	Mathematical constant
23.HR	Engine/turbine heat rate	MMBtu/MWh	c		
24.$MMbtu_{upgrade}$	Quantity of fuel used to upgrade quality of gas	MMBtu	c	Monthly	Measured by a flow meter and recorded. Data to be aggregated monthly and yearly for each system.
25.EU_{Btu}	Fossil fuel directly displaced	MMBtu	c	Monthly	Measured by a flow meter and recorded. Data to be aggregated monthly and yearly for each system.
26.EF_{Btu}	Emission factor for displaced fossil fuel	kg CO_2/MMBtu	n/a	n/a	Mathematical constant
27.$NG_{displace}$	Amount of natural gas displaced by direct use of LFG	MMBtu	m	Monthly	Measured by a flow meter and recorded. Data to be aggregated monthly and yearly for each system.
28.$Propane_{displace}$	Amount of propane displaced by direct use of LFG	MMBtu	m	Monthly	Measured by a flow meter and recorded. Data to be aggregated monthly and yearly for each system.

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Parameter	Description	Data Unit	calculated (c) measured (m) estl mated (e)	Measurement frequency	Comment
	gas destroyed in boiler				and recorded at least once every 15 minutes. Data to be aggregated monthly and yearly for each boiler.
LFGupgrade	Amount of upgraded landfill gas delivered to NG Transmission and Distribution System or CNG/LNG vehicles	fe	m	Continuously	Measured continuously by a flow meter and recorded at least once every 15 minutes. Data to be aggregated monthly and yearly for each system.
PR_{CH4}	Methane fraction in the landfill gas	ft3 *CH41* ft3 LFG	m	Continuously or weekly	Measured by continuous gas analyzer or a calibrated portable gas analyzer. Data to be averaged monthly and annually for the reporting cycle. Methane fraction of the landfill gas to be measured on wet basis. Measured to determine the density of methane D_{CH4}.
$OR1_{cH4}$	Pre-project installation methane fraction in the landfill gas of the original collection system	ft3 *CH41* ft3 LFG	m	Continuously, weekly, or monthly	Measured by continuous gas analyzer or a calibrated portable gas analyzer. Data to be averaged for one year preceding the date that the project became operational. Methane fraction of the landfill gas to be measured on wet basis. Measured for calculation of discount factor in Equation 5-3.
$OR2_{cH4}$	Post-project installation methane fraction in the landfill gas of the original collection system	ft3 *CH41* ft3 LFG	m	Continuously or weekly	Measured by continuous gas analyzer or a calibrated portable gas analyzer. Data to be averaged for one year after the date that the project became operational. Methane fraction of the landfill gas to be measured on wet basis. Measured for calculation of discount factor in Equation 5-3.
T	Temperature of the landfill gas	°C	m	Continuously or weekly	Measured to adjust the flow of LFG. No separate monitoring of temperature is necessary when using flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic feet.
P	Pressure of the landfill gas	atm	m	Continuously or weekly	Measured to adjust the flow of LFG. No separate monitoring of pressure is necessary when using flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic feet.
Elpp	Total amount of electricity required to meet project	MWh	m	Monthly	Obtained from either onsite metering or utility purchase records. Required to determine C02 emissions from use of

	requirement				electricity to operate the project activity.
EF_{EL}	Carbon emission factor of electricity	Kg C02/MWh	c	Annually	Utility specific emission factors for California Registry member utilities are available in the Public Reports section of the CARROT database. Utility specific not available use the EPA eGRID subregion emission factor from the California Registry's General

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Parameter	Description	Data Unit	calculated (c) measured (m) estl mated (e)	Measurement frequency	Comment
					Reporting Protocol (GRP), Appendix C, tables C.1 (also see GRP Figure 111.6.1)
FF_{pp}	Total amount of fossil fuel required to meet project requirement	scf or Gallons	c	Monthly	Calculated from monthly record of fossil fuel purchased and consumed Required to determine C02 emissions from use of fossil fuels to operate the project activity.
Regulations	Project developer attestation to compliance with regulatory requirements relating to landfill gas project	*nla*	*nla*	At the begining of each reporting cycle.	The information is used for the application of the regulatory additionality test The project developer shall document all Federal, State and local regulations, ordinances and permit requirements (and compliance status for each) that apply to the GHG reduction project. The project developer shall provide a signed attestation to their compliance status for the above mentioned Federal, State and local regulations, ordinances and oermit reauirements.
Operation of the landfill gas collection svstern	Operation of the landfill gas collection system	Hours	m	Hourly	This is monitored to ensure methane destruction is claimed only for methane used in the destruction devices
Operation of the energy plant	Operation of the energy plant	Hours	m	Hourly	This is monitored to ensure methane destruction is claimed for methane used in electricity plant only when it is operational.
Operation of the boiler	Operation of the boiler	Hours	m	Hourly	This is monitored to ensure methane destruction is claimed for methane used in boiler only vvhen it is operational.
Operation of the flare	Operation of the flare	Hours	m	Hourly	This is monitored to ensure methane destruction is claimed for methane used in flare only when it is operational.
DE	Optional: Source test data for destruction device methane destruction efficiency	% destruction efficiency	*elm*	Annually	Project developers have the option to use a State or local agency accredited source test service provider to test the actual methane destruction efficiency of each of the destruction devices used in the project case. If using source test data for destruction efficiencies in Equation 5-2, all source test documentation shall be provided to the verifier.

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7 Reporting Parameters

This section provides guidance on reporting rules and procedures. A priority of the California Registry is to facilitate consistent and transparent information disclosure among project developers. All direct methane and carbon dioxide should be reported within the project boundary. Project developers submit annual project reports through the Registry's on-line reporting tool – CARROT.[28]

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7.1 Project Submittal Documentation

Project developers provide the following information to the California Registry before registering reductions associated with installing a landfill gas collection and combustion system.

Form 1: General Landfill Information

[28] Until the Registry's CARROT tool is updated to accept GHG reductions data submitted according to this protocol, spreadsheet-based tools will be provided to project developers.

1. Date of data collection:
2. Form completed by (name):
3. Name of Landfill:
4. Address (including county) :
5. Owner of Landfill and owner contact information:
6. Type of landfill (sanitary, controlled, or open dump):
7. Landfill size – designed area for waste placement (acre or hectare):
8. Year landfill opened:
9. Year landfill closed or estimated date of closure:
10. Average annual quantity of waste accepted at landfill (cubic meters or tons):
11. Description of any regulatory framework for landfill methane capture and control (include an estimate of the date which the landfill will meet or exceed the 50 megagrams per year threshold of calculated NMOC emissions per NSPS/EG regulations and the type of testing that justifies the estimate (i.e. Tier 1 or Tier 2 NMOC emission rate estimates)):
12. Description of local and state air and water quality, explosive gas, or other regulations pertinent to the project:

Form 2: Pre-existing landfill gas control system information

1. Type of existing landfill gas collection and control system in place, if any (e.g., flare, energy recovery etc.):
    i. If Landfill gas collection system is in place, is the system actively collecting or passively venting gas?
    ii. If flare or energy project is in place, what is the landfill gas flow rate (in scfm) and methane content?
2. When was the system installed and operational?

Form 3: Landfill gas utilization information

1. Landfill gas utilization (*e.g.*, flared, generation of electricity, use on-site as a boiler or furnace fuel, or sale to a third party)
2. When was the system installed and operational?
3. If designed to generate electricity,
    a. Type of engine-generator set (*e.g.*, internal combustion engine, micro turbine or fuel cell with the name of the manufacturer, model, power output rating (kW or MJ) for biogas, and nominal voltage
    b. If interconnected with an electric utility
        - Name of the utility
        - Type of utility contract (e.g., sell all/buy all, surplus sale, or net metering)
    c. If engine-generator set waste heat utilization
        - Heat source (e.g., cooling system or exhaust gas or both) and heat recovery capacity (Btu or kJ/hr)
        - Waste heat utilization (*e.g.*, water heating, space heating, *etc.*)
4. If designed to use on-site as a boiler or furnace fuel, a description of the boiler or furnace including manufacturer, model, and rated capacity (Btu or kJ/hr)
   If designed for landfill gas sale to a third party, a description of the methods of processing, transport, and end use
5. If designed to convert to chemical products,
    a. Name of the chemical produced
    b. Name of primary and secondary chemicals converted

- Completed project submittal form (see appendix C)
- Signed attestation of title document
- Complete project verification report
- Positive verification opinion document

At a minimum, the above project documentation will be available to the public via the California Registry's online reporting tool - The Climate Action Reserve (Reserve). Further disclosure and other documentation may be made available on a voluntary basis through the Reserve.

Project developers shall submit annual project reports through the Reserve. Project Submittal forms and project registration information can be found at:
www.c1imateregistry.org/offsets/project-registration.html

7.2 Record Keeping

For the purposes of independent verification and historical documentation, project developers shall be required to keep all information outlined in this protocol for a minimum of 5 years post project verification.

System Information:

- Relevant sections of the landfill operating permits (solid waste, air, and water)
- Project developer attestation to compliance with regulatory requirements relating to landfill gas project
- Collection and control device information (installation dates, equipment list, etc)
- LFG flow meter information (model number, serial number, manufacturer's calibration procedures
- Methane monitor information (model number, serial number, calibration procedures)
- Combustion device monitor information (model number, serial number, calibration
- procedures)
- LFG flow data (for each flow meter)
- LFG flow meter calibration data (for each flow meter)
- Methane monitoring data
- Methane monitor calibration data
- Combustion device monitoring information (for each combustion device)Combustion*2.1* device monitor calibration data (for each combustion device)
- CO2e monthly, and annual tonnage calculations
- Copies of the results of the NSPS/EG Tier 1 and/or Tier 2 NMOC emission rate estimates and the projected date when system start-up will be required by NSPS
- Initial and annual verification records and results

Calibrated portable gas analyzer information:

- Date, time, and location of methane measurement
- Methane content of LFG (% by volume) for each measurement
- Methane measurement instrument type and serial number
- Date, time and results of instrument calibration
- Corrective measures taken if instrument does not meet performance specifications

7.3 Reporting cycle

For the purposes of this protocol, project developers report GHG reductions associated with installing a landfill gas collection and combustion system that occurred the preceding year. In keeping with the reporting rules of the Registry's General Reporting Protocol, the reporting deadline for project developers is August 31 the year following the reduction year, and the certification deadline is December 31.[30]

7.4 Project crediting period

Project developers are eligible to register GHG reductions with the California Registry according to this protocol for a period of ten years or until regulatory compliance is required due to failure of the regulatory additionality test. In the event that a landfill hosting

[30] General Reporting Protocol, IV.14.7. http://www.climateregistry.org/PROTOCOLS/GRCP/

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a gas collection and combustion project becomes subject to a regulation, ordinance or permitting condition that would call for the installation of a landfill gas control system, emission reductions can be reported to the California Registry up until the date that the landfill gas control system is required to be operational. The first reduction year commences after the landfill gas collection and combustion system becomes operational. A system is operating if it is capturing and destroying/converting methane gas from the landfill.

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The first reduction year commences after the landfill gas collection and destruction system becomes operational. A system is operating if it is capturing and destroying methane gas from the landfill.

7.5 Non-California Climate Action Registry reporting

The California Registry requests that project developers only register reductions from GHG reduction projects with one registry. However, under a voluntary system, enforcement authority is limited. Therefore, if a project developer participates in this program it is their responsibility to transparently disclose the registration of all emissions reductions associated with the project activity that occur outside of the California Registry. Upon submittal of a verified GHG reductions to the California Registry, project developers are required to provide a signed attestation to the California Registry stating that the GHG reductions being registered are not being registered elsewhere. If the California Registry determines that duplicative emissions reductions registration has occurred, all duplicate reductions reported with the California Registry will be made void.

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In the event that GHG reductions from the project were previously registered with or claimed by another registry or program, or sold to a third party prior to submitting the project to the California Registry, a Project Transfer Form must be completed and submitted to the California Registry along with other project listing documentation.

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Glossary of Terms

Accredited verifier	A verification firm approved by the California Registry to provide verification services for project developers
Additionality	Landfill Management practices that are above and beyond business as usual operation, exceed the baseline characterization, and are not mandated by regulation
Anaerobic	Pertaining to or caused by the absence of oxygen
Anthropogenic Emissions	GHG emissions resultant from human activity that are considered to be an unnatural component of the Carbon Cycle (i.e. fossil fuel destruction, de-forestation etc.)
Biogenic C02 Emissions	C02 emissions resulting from the destruction and/or aerobic decomposition of organic matter. Biogenic emissions are considered to be a natural part of the Carbon Cycle, as opposed to anthropogenic emissions
Bioreactor	A MSW landfill or portion of a MSW landfill with a minimum average moisture content of at least 40 percent by weight that is recirculating lechate or, an MSW landfill or portion of a MSW landfill that is adding any liquid other than leachate (leachate includes landfill gas condensate) in a controlled fashion to accelerate or enhance the anaerobic biodegradation of the waste
Carbon dioxide (C02)	The most common of the six primary greenhouse gases, consisting of a single carbon atom and two oxygen atoms
C02 Equivalent (C02e)	The quantity of a given GHG multiplied by its total global warming potential. This is the standard unit for comparing the degree of warming which can be caused by different GHGs
Direct Emissions	Greenhouse gas emissions from sources that are owned or controlled by the reporting entity
Emission factor (EF)	A unique value for determining an amount of a greenhouse gas emitted for a given quantity of activity data (e.q., metric tonnes of carbon dioxide emitted per barrel of fossil fuel burned)
Emission Guidelines (EG)	Guidelines for State regulatory plans that have been developed by the U.S. EPA For landfills, emission guidelines are codified in 40 CFR 60 Subpart Cc. Federal Plan for EG is included under 40 CFR G2 Subpart GGG
Flare	A destruction device that uses an open flame to burn combustible gases with combustion air provided by uncontrolled ambient air around the flame
Fossil fuel	A fuel, such as coal, oil, and natural gas, produced by the decomposition of ancient (fossilized) plants and animals
Greenhouse gas (GHG)	Carbon dioxide (C02), methane (CH4), nitrous oxide (N20), sulfur hexafluoride (SF6), hydrofluorocarbons (HFCs), or perfluorocarbons (PFCs)
Global Warming Potential (GWP)	The ratio of radiative forcing (degree of warming to the atmosphere) that would result from the emission of one unit of a given GHG compared to one unit of C02
Indirect Emissions	Emissions that are a consequence of the actions of a reporting entity, but are produced by sources owned or controlled by another entity

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Landfill	A defined area of land or excavation that receives or has previously received waste that may include household waste, commercial solid waste, non hazardous sludge and industrial solid waste
Landfill Gas	Gas resulting from the decomposition of wastes placed in a landfill. Typically, landfill gas contains methane, carbon dioxide and other trace organic inert gases
Landfill Gas Project	Installation of infrastructure that in operating causes a decrease in GHG emissions through destruction of the methane component of landfill gas
Metric tonne (MT) or "tonne"	A common international measurement for the quantity of GHG emissions, equivalent to about 2204.6 pounds or 1.1 short tons
Methane (CH4)	A potent GHG with a GWP of 21, consisting of a single carbon atom and four hydrogen atoms
MMBtu	One million British thermal units
Mobile combustion	Emissions from the transportation of materials, products, waste, and employees resulting from the combustion of fuels in company owned or controlled mobile combustion sources (e.g., cars, trucks, tractors, dozers, etc.)
National Emission Standards for Hazardous Air Pollutants (NESHAP)	Federal emission control standards codified in 40 CFR 63. Subpart AAAA of Part 63 prescribes emission limitations for MSW landfills.
New Source Performance Standards (NSPS)	Federal emission control standards codified in 40 CFR 60. Subpart WWW of Part 60 prescribes emission limitations for MSW landfills.
Non-Methane Organic Compounds (NMOC)	Non-methane organic compounds as measured according to the provisions of 40 CFR 60.754
Nitrous oxide (N20)	A GHG consisting of two nitrogen atoms and a single oxygen atom
Project Baseline	A business-as-usual GHG emission assessment against which GHG emission reductions from a specific GHG reduction activity are measured
Project Developer	An entity that undertakes a project activity, as identified in the Landfill Project Protocol. A project developer may be an independent third party or the Landfill operating entity
Resource Conservation and Recovery Act (RCRA)	Federal legislation under which solid and hazardous waste disposal facilities are regulated.
Stationary combustion source	A stationary source of emissions from the production of electricity, heat, or steam, resulting from combustion of fuels in boilers, furnaces, turbines, kilns, and other facility equipment

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Verification

The process used to ensure that a given participant's greenhouse gas emissions or emissions reductions have met the minimum quality standard and complied with the California Registry's procedures and protocols for calculating and reporting GHG emissions and emission reductions

Verification body

A California Registry and state of California accredited firm that is able to render a verification opinion and provide verification services for operators subject to reporting under this protocol.

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Assembly Bill 32, Chapter 488, Pg 89

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Appendix A

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Development of the Performance Standard Threshold

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Development of the Performance Standard Threshold

The primary data source for the performance standard threshold is the database of nearly 2,400 landfills in the United States developed and maintained by the EPA's Landfill Methane Outreach Program (LMOP)[31]. As landfill gas collection and combustion projects at regulated landfills do not pass the California Registry's Regulatory Test, they are not eligible as greenhouse gas offset projects. Therefore, detailed data on these landfills need not be included in this analysis.

Landfill summary information is provided in Tables 1 and 2 with a focus on those landfills not currently subject to the New Source Performance Standards and Emission Guidelines for existing sources (NSPS/EG) promulgated in March 1996.

The results of this analysis reveal that of the 1866 landfills in the U.S., an estimated 697 are subject to NSPS/EG, and 1169 are not subject to NSPS/EG (not required to combust landfill gas under federal regulations). Of the non-NSPS/EG landfills, 261 (22.33%) currently have gas collection and combustion projects, of which 166 (14.20%) are flare only, 67 (5.73%) are electricity projects, and 28 (2.40%) are gas projects.

Focusing on the non-NSPS/EG landfill operations, the California Registry has developed an estimated

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[31] LMOP is a voluntary partnership program that was created to reduce methane emissions from landfills by encouraging the use of landfill gas for energy. LMOP tracks whether or not specific landfills are required to reduce landfill gas emissions under the New Source Performance Standards and Emission Guidelines for Municipal Solid Waste Landfills (NSPS/EG). Because LMOP is not a regulatory program, it cannot make an official EPA designation regarding any landfill's NSPS/EG status. Information relating to NSPS/EG was obtained by voluntary submittal and is subject to change over time. Therefore, LMOP can not guarantee the validity of this information.

range for market penetration of voluntary landfill gas collection and control projects at non-regulated landfills. As the LMOP database does not contain information on state and local regulations, ordinances or permitting requirements that may affect landfill operations, it is necessary to make assumptions regarding additional regulatory influence on landfill operations. To estimate an upper bound for market penetration, it is assumed that all 261 non-NSPS/EG landfills with gas collection and control (see Table 2) are *not* required to collect and control gas. Under this assumption 261 out of 1169 landfills have implemented voluntary landfill gas projects, equating to a market penetration of 22.3%. To construct a lower bound, it is assumed that all 166 non-NSPS/EG landfills with flares (see Table 2) are required by state and local regulations, ordinances or permitting requirements to have the flare(s) installed. This assumption is based on the observation that there is generally no incentive for a landfill to install a flare absent requirements imposed by regulations, ordinances or permitting requirements. This is likely conservative since many landfills have conducted voluntary projects for energy recovery. Therefore it is likely that many non-NSPS/EG landfills with flares are required by state or local regulations, ordinances or permitting requirements to combust landfill gas. By assuming all 166 non-NSPS/EG landfills with flares are required to combust landfill gas, a lower bound for market penetration can be estimated. Under this assumption, 95 out of 1003 non- regulated landfills have implemented voluntary landfill gas projects, a market penetration of 9.4%.

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Table 1 Summary of Information on US Landfills (NSPS/EG and Non-NSPS/EG)

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Table A-1. Summary of Informat

Landfills in Analysis	
NSPS/EG	
Non-NSPS/EG	
Subtotal	
Landfills Excluded from Analysis	
Total US Landfills	

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Table A-2.
Summary of

Non-NSPS/EG Landfills

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Non-NSPS/EG Landfills	Number of Landfills	Percent of Unregulated Landfills - Flares Included	Percent of Unregulated Landfills - Flares Excluded
Flares Only	166	14.2%	Excluded
Electricity	67	5.73%	6.7%
Gas Projects	28	2.40%	2.8%
Subtotal	261	22.33%	9.5%
No Gas Collection and Control	908	77.67%	90.5%
Total	1169	100.0%	100.0%
Estimated Market Penetration of Gas Collection and Control Projects into non-regulated landfills		22.3%	9.5%

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Appendix B

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Development of the NMOC Emissions Threshold

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Development of the NMOC Emissions Threshold

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[NOTE: The California Registry has been reviewing the following analysis and is in the process of finalizing some of our findings. We are concerned that the numbers derived for calculating the carbon amounts are based on too small a data set. We are still actively pursuing more data from carbon vendors and landfills using carbon adsorption systems. The specific data needed is the NMOC emissions rate (lbs/month) and the amount of carbon used per month for the system. Pending the outcome of this data acquisition exercise and consideration of other variables the NMOC threshold may be adjusted.]

Purpose:
For the specific case in which a landfill gas control system is required to treat landfill gas for NMOCs in order to comply with a regulation, ordinance, or permitting condition, but combustion of the landfill gas is not the only compliance mechanism available to the landfill operator, the California Registry has developed an NMOC emissions threshold whereby the eligibility of a project can be determined. If the total mass flow of NMOC for the landfill gas control system is less than or equal to the threshold (measured in pounds NMOC per month), then the landfill gas control system is eligible as a GHG reduction project under this protocol. If the total mass flow of NMOC for the landfill gas control system is greater than the threshold, then the landfill gas control system is *not* eligible as a GHG reduction project under this protocol.[32]

Data:
The primary data source for the threshold analysis is a series of capital cost and monthly operating cost estimates supplied to the California Registry by the solid waste industry workgroup for actual operating landfill gas project with carbon units. Flare installation cost information was gathered from various workgroup members (Table 1).

Summary:
The analysis below reveals an estimated NMOC mass flow threshold of **3000 lbs NMOC/month**. This analysis was performed assuming an average flare system cost[35] of $350,000 and a carbon adsorption system operational period of 5 years. Both carbon adsorption systems and flare systems have an operational life in excess of 10 years. The upfront costs for a flare system are relatively high (approximately $350,000), but once a flare is installed and operational the annual maintenance costs are relatively low. In contrast the installation costs for a carbon adsorption system are relatively low ($5,000 to $25,000), but the system maintenance cost is relatively high. The analysis shows that the installation of a flare system for NMOC control is more cost effective than carbon adsorption if the measured landfill gas flow rate (CFM) and NMOC concentration (ppmV) result in a total mass flow of 3000lbs of NMOC/month

25 In the rare case where the project developer can demonstrate that a project should be considered eligible even though the total mass flow of NMOC is greater than the threshold, the project developer can submit a written request for variance to the Registry, including sufficient documentation to substantiate the case. In such cases the Registry would consult with interested stakeholders in the decision process.
26 Due to proprietary confidentiality, the service provider will remain anonymous. 27 NMOC concentration (ppmV) normalized to hexane.

38 or greater. Above this level, costs of carbon adsorption systems, particularly the monthly carbon replacement costs, become cost prohibitive relative to flare systems.

[32] In the rare case where the project developer can demonstrate that a project should be considered eligible even though the total mass flow of NMOC is greater than the threshold, the project developer can submit a written request for variance to the Registry, including sufficient documentation to substantiate the case. In such cases the Registry would consult with interested stakeholders in the decision process.
[35] Inclusive of all necessary components needed for a fully permitted and operational flare system.

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Deleted: (over $350,000), the costs for installing a carbon adsorption system are significantly lower ($106,000 - $165,000). Both systems require comparable operation
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Deleted: is therefore highly dependent on the flow of NMOC, as the carbon must be replaced once saturated. Thus, determining the NMOC threshold is a matter of identifying the NMOC level that requires carbon costs equal to or greater than the additional cost of the flare.
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Methodology:
In order to carry out this analysis, the California Registry required reliable information for the capital, installation, operation and maintenance costs of both carbon adsorption and enclosed flare systems. These data were obtained by soliciting quotes from the technical sales departments of well known carbon and flare vendors who supplied accurate cost estimates. Multiple quotes were obtained for each system type to accurately reflect the costs of systems scaled to varying landfill gas capacities. These quotes allowed us to calculate an amortized monthly capital and installation cost as well as monthly operation, maintenance and regulatory costs. A summary of these costs is provided in Table 1.

As noted previously, carbon adsorption systems also require periodic replacement of the activated carbon in volumes dependent on the flow of NMOC. To obtain a relationship between the NMOC mass flow at a landfill and the monthly carbon required in the control system, the California Registry obtained both carbon and NMOC data for several landfills currently utilizing carbon adsorption technology. As indicated in Figure 1, a regression of these data points provides the following relationship between NMOC mass flow and carbon usage:

Lower Bounds, based on four field data points (Figure **B-1):**

Carbon/month = 23.8 + 3.19 x NMOC/month

or

NMOC/month = (Carbon/month- 23.8) 3.19

Upper Bounds, based on seven carbon vendor quotes (Figure **B-2):**

Carbon/month = 582.8 + 0.156 x NMOC/month

or

NMOC/month = (Carbon

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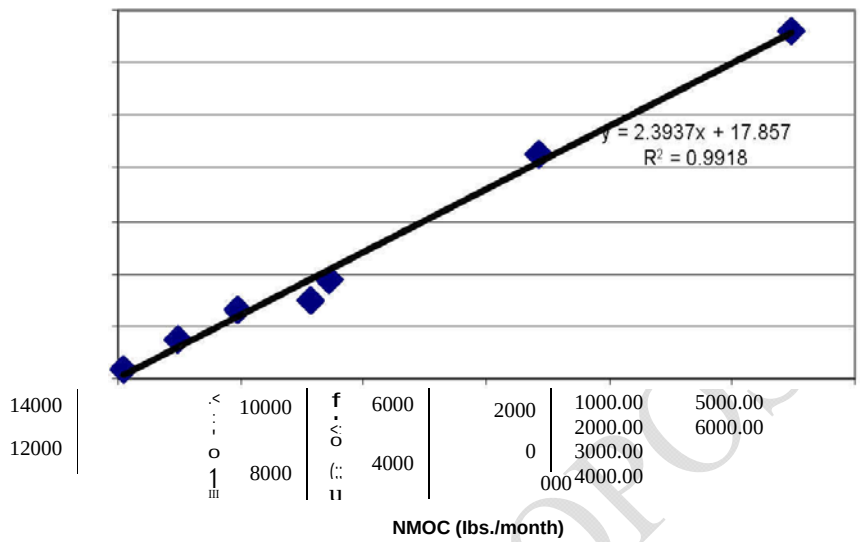
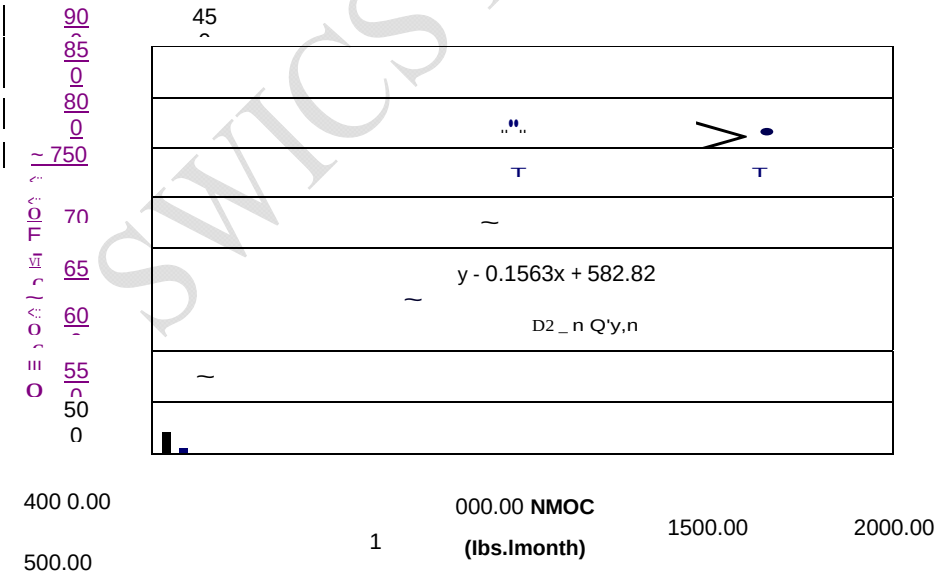


• Collected Data -Regression of Carbon lbs. to NMOC lbs.

Figure B-1. Carbon required for variouis NMOC mass flows in carbon adsorption system (Lower Bound data collected)



• Collected Data --Regression of Carbon lbs. to NMOC lbs per month

Figure B-2. Carbon required for various NMOC mass flows in carbon adsorption system (Upper bound data collected)

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These data and relationships allowed us to calculate the NMOC mass flow at which an enclosed landfill flare becomes more cost effective than a carbon adsorption system at a range of landfill gas control system capacities. Both control systems have standard monthly costs, and in all scenarios the flare costs exceeded the carbon system costs. This excess amortized monthly cost of the flare represents the amount of money a landfill operator could invest in carbon each month and remain more cost effective than the correspondingly scaled flare system.

Additional Monthly = Total Monthly - Total Monthly
Cost of Flare Cost of Flare Cost of Carbon

In order to determine how many pounds of carbon this additional cost would purchase, the Climate Registry reviewed the cost of carbon purchase, transportation, and disposal from various sources throughout the country and established a conservative net cost of $3 per pound of activated carbon. Using this price, we were then able to calculate the pounds of carbon a landfill control system could use and remain cost effective compared to the flare.

Pounds of Carbon = Additional Monthly Cost of Flare $3 per pound

Finally, because we previously established the relationship between NMOC mass flow and the amount of carbon required to manage that flow, we were able to determine the NMOC mass flow for which all carbon purchased with the additional cost associated with the flare would be saturated. This figure represents the "break-even" cost of the two technologies.

NMOC/month = !carbon/month- 582.8) 0.156
or
NMOC/month = !Carbon/month- 23.8) 3.19

The results of this analysis are presented in Table 1, and reveal a range of NMOC values from 2,081 to 3,159 pounds NMOC per month, and an average of 2,713 pounds NMOC per month. There appears to be no consistent relationship between the control system capacity and the NMOC threshold. Therefore based on this analysis, the California Registry has chosen a static Performance Threshold of 2,700 pounds NMOC per month for all landfill gas control system capacities.

Table B-3. Analysis of NMOC threshold

Landfill Gas Control System Capacity (SCFMi	Cost Categories[28]	Total Monthly Costs of Flare System ($/monthl	Total Monthly Costs of Carbon System ($/monthl	Additional Cost of Flare System ($/monthl	Estimated Cost of Carbon ($/poundl	Carbon That Could Be Purchased with Additional Flare Cost (pounds carbonl	NMOC Required to saturate Carbon (pounds/monthl
	Amortized Capital	$2,929	$881				
40	Monthly O&M	$6,885	$6,208				
	Sum	$9,814	$7,090	$2,724	$3	908	277.07-2081.33
	Amortized Capital	$2,929	$907				
200	Monthly O&M	$7,810	$6,671				
	Sum	$10,739	$7,578	$3,161	$3	1,054	322.71 - 3013.52
	Amortized Capital	$2,929	$1,138				
300	Monthly O&M	$8,310	$7,133				
	Sum	$11,239	$8,271	$2,967	$3	989	302.46 - 2599.86
	Amortized Capital	$2,929	$1,348				
500	Monthly O&M	$8,782	$7,133				
	Sum	$11,711	$8,481	$3,230	$3	1,077	329.83 - 3158.91
						AVERAGE	308.02 - 2713.40

[28] The total cost over a 10 year operating period does not consider the time value of money or inflation.

Appendix C

Project Submittal Form

Version 2.1 DRAFT

2.

climate action reserve

Landfill Project Subm ittal Forms

Instructions:
This form must be submitted to the Reserve and to the verifier in the first year of reporting prior to verification. In some cases, it may be necessary to update parts of the Project Submittal Form in subsequent years. **All information in this form will be made publicly available.**

These forms are to be used for reporting general Landfill Project information to the California Climate Action Registry in order to initiate the project listing process. All fields must be completed as thoroughly as is possible. If the project in question is still in the planning/development phase, all fields must be completed using best available data and estimations based on the proposed system design. Upon receipt of completed submittal forms, Registry staff will perform a general eligibility screen (in accordance with the most current version of the Califomia Climate Action Registry Landfill Project Reporting Protocol) based on the information provided. Project Developers can expect an Invoice for the $500 project listing fee within 15 days of receipt of the completed forms, and a letter regarding the status of project within 15 days of the receipt of the project listing fee. If a project passes the eligibility screen, it will be officially "listed" with the Climate Action Reserve

This is an interactive PDF form that can be filled out and saved as a PDF. All fields must be completed, if a field is not applicable insert N/A in the space provided. The completed form must be saved and uploaded to your Climate Action Reserve account. Submit all questions regarding the project submittal process to: reserve@climateregistry.org.

Version 2.2
July 2008

4
4

California Climate Action Registry, 523 *West* S" *Street, Suite* 428, *Los Angeles,* CA *90014*

Landfill Project Registration

Section 1: General *Landfill Information*

1. Date of form completion:

2. Form completed by (name):

3. Project Name:

4. Name of Landfill:

5. Approximate Latitude/Longitude of Landfill Project (degrees/minutes/seconds):

6. Address (including county):

Owner of Landfill and owner contact information:

Type of landfill (sanitary, controlled, or open dump): _____ _

7. Landfill size - designed area for waste placement (acre or hectare):

8. Total waste in place (cubic meters ortons): _____ _

9. Designed landfill capacity (cubic meters ortonnes): _____ _

10. Year landfill opened: _____ _

11. Year landfill closed or estimated date of c1osure: _____

12. Average annual quantity of waste accepted at landfill (cubic meters or tonnes):

13. Waste Characteristics Table

Waste Types	Estimated Percent of Waste Stream
Paper and Paperboard	
Glass	
Metals	
Plastics	
Rubber and Leather	
Textiles	
Wood	
Food Scraps	
Yard Trimmings	
Misc. Inorganic wastes	
Other	

Explain basis of estimates (i.e, site specific Information, regional or national studies, EPA, etc.).

Section 2: Project Eligibility and Monitoring

14. Initial verification period: _____ _

15. When did the project first commence operation, or when is the project expected to commence operation?

16. Have any vintage reduction tonnes from the project ever been registered with or claimed by another registry or program, or sold to another third party prior to registering with the Reserve?

If the answer is yes, you must complete and return a *"Project Transfer'* form.

17. Description of any regulatory framework for landfill methane capture and control (include an estimate of the date which the landfill will meet or exceed the 50 megagrams per year threshold of calculated NMOC emissions per NSPS/EG regulations and the type of testing that justifies the estimate (i.e. Tier 1 or Tier 2 NMOC emission rate estimates)):

18. Description of local and state air and water quality, explosive gas, or other regulations pertinent to the landfill or project:

19. Is this project required by any local, state, or federal regulation? Yes No
Comments (if any):

20. Has a detailed monitoring plan been developed for this project? If not, what date will a monitoring plan be in place?

Section 3: Pre-existing landfill gas control system information (fill out only if there was a landfill gas collection and control system in place that is separate from the Project system)

1. Type of pre-existing landfill gas collection and control system in place, if any (e.g., flare, energy recovery etc.):

i. If Landfill gas collection system is in place, is the system actively collecting or passively venting gas?

ii. If flare or energy project is in place, what is the landfill gas flow rate (in scfm) and methane content?

iii. Supply a copy of the as built drawings for the pre-existing system. Be sure to include in the diagram the location of all pre-existing wells and/or other collection equipment and the location of all project-related wells and/or other collection equipment. (Attach as a separate PDF file titled: Existing LFG System Diagram)

iv. Name of system designer, address and other contact information.

2. When was this pre-existing control system installed and operational?

3. Provide a summary of the permits obtained to build and operate this Landfill Gas Control System).

Section 4: Landfill gas utilization information for project activity

1. Landfill gas utilization (e.g., flared, generation of electricity, use on-site as a boiler or furnace fuel, or sale to a third party):

2. When was this combustion/LFG utilization system installed and operational, or when is it expected to be installed and operational?

3. If designed to generate electricity:

   a. Type of engine-generator set (e.g., internal combustion engine, micro turbine or fuel cell with the name of the manufacturer, model, power output rating (kWor MJ) for biogas, and nominal voltage:

   b. Pretreatment of landfill gas (e.g., none, condensate trap, dryer, hydrogen sulfide removal, etc. with the names of manufacturers, models, etc.):

   c. Exhaust gas emission control (e.g., none, catalytic converter, etc.):

   d. If interconnected with an electric utility:
      Name 01 the utility: _____ _
      Type 01 utility contract (e.g., sell alilbuy all, surplus sale, or net metering):

e. If engine-generator set waste heat utilization:

Heat source (e.g., cooling system or exhaust gas or both) and heat recovery capacity (Btu or kJlhr):

Waste heat utilization (e.g., water heating, space heating, etc.):

f. If designed to use on-site as a boiler or furnace fuel, a description of the boiler or furnace including manufacturer, model, and rated capacity (Btu or kJ/hr):

g. If designed for biogas sale to a third party, a description of the methods of processing, transport, and end use:

Pretreatment of Biogas (e.g., none, condensate trap, dryer, hydrogen sulfide removal, etc.) include names of manufacturer, model etc.:

Exhaust gas emission controls from gas processing step:

4. Provide a summary of the permits obtained to build and operate this Landfill Gas Utilization System).

Page 58: [1] Deleted **3210cbd** **10/13/2008 2:41:00 PM**

after the information is generated or 7 years after the last

Page 58: [2] Deleted **3210cbd** **10/13/2008 2:41:00 PM**

All data inputs for the calculation

Page 58: [3] Deleted **3210cbd** **10/13/2008 2:41:00 PM**

project emission reductions

Copies of all

Page 58: [4] Deleted **3210cbd** **10/13/2008 2:41:00 PM**

land use permits, NOVs, and any administrative or legal consent orders dating back at least 3 years prior to the project start date, and for each subsequent year of project operation.

Page 58: [5] Deleted **3210cbd** **10/13/2008 2:41:00 PM**

26

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Page 58: [6] Deleted 3210cbd
10/13/2008 2:41:00 PM

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Destruction

Page 58: [7] Deleted **3210cbd** **10/13/2008 2:41:00 PM**

All maintenance records relevant to the LFG control system, monitoring equipment, and destruction devices.

Page 58: [8] Deleted **3210cbd** **10/13/2008 2:41:00 PM**

Although projects must be verified annually at a minimum,

Page 58: [9] Deleted **3210cbd** **10/13/2008 2:41:00 PM**

California Registry will accept verified emission reduction reports on a sub-annual basis, should

Page 58: [10] Deleted **3210cbd** **10/13/2008 2:41:00 PM**

choose to have a sub-annual verification schedule (i.e. monthly, quarterly, etc.).

Page 58: [11] Deleted **3210cbd** **10/13/2008 2:41:00 PM**

If an eligible project has begun operation at