Landfill
Project Reporting Protocol

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Note: This document contains comments on the CCAR Landfill Project Reporting Protocol that were submitted by Cameron-Cole

Collecting and combusting methane from landfills

DRAFT

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The California Climate Action Registry

Landfill Project Reporting Protocol
Collecting and combusting methane from landfills

TABLE OF CONTENTS

I. Introduction

The California Climate Action Registry's (Registry) Landfill Greenhouse Gas Project Reporting Protocol – for collecting and combusting 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.

Established by the California Legislature in 2000 as a non-profit, public/private partnership, the Registry runs a voluntary GHG registry. 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 Registry's protocols.

Project developers that install landfill gas capture and combustion technologies use this document to register GHG reductions with the Registry. It provides eligibility rules, methods to calculate reductions, performance-monitoring instructions, and procedures for reporting project information to the Registry. Additionally, all project reports receive annual, independent verification by California Air Resources Board - and 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]

Document organization

The 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

Project developers that follow the guidance in this protocol and register GHG reductions with the Registry must comply with all local, state, and federal municipal solid waste, air and water quality regulations. (Note: this would be exceedingly difficult and costly to verify, and may not be appropriate, as determination of compliance with regulations is ultimately the responsibility of a project developer's legal counsel, or the regulatory authorities. Consultants can opine on applicability, but this is from a technical perspective, rather than a legal one. Perhaps this sentence could be re-worded to state: "…nothing in this Protocol obviates the need for project developers to comply with all local, state and federal municipal solid waste, air and water quality regulations, and any other applicable legal requirement. An official from the project development entity shall certify -- and provide proof of the fact -- that they are in compliance with all such regulations.")

To register GHG reductions with the Registry, project developers are not required to take an annual entity-level GHG inventory of their municipal solid waste operations.

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

II. 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 combusted, over time, this landfill gas is released to the atmosphere. In the United States, landfills are the largest source of anthropogenic emissions of CH_4, accounting for 25 percent of total CH_4 emissions.[2]

Project definition

For the purpose of this protocol, the GHG reduction project is the installation of a landfill gas control system for capturing and combusting methane gas that commences operation on or after January 1, 2002. Captured landfill gas could be combusted on-site, transported for off-site use (e.g., through gas distribution or transmission pipeline), or used to power vehicles. Regardless of how project developers take advantage of the captured landfill gas, the ultimate fate of the methane must be combustion.

The landfill gas collection and combustion systems typically consist of wells, pipes, blowers, caps and other technologies that enable or enhance the collection landfill gas and convey it to a combustion technology. At some landfills, a flare will be the only site where landfill gas is destroyed. 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 the main sites where landfill gas is combusted. Direct use arrangements which entail the piping of landfill gas to be combusted by an industrial end user at an off-site location are also an eligible approach to combustion of the landfill gas.[3] Most projects that produce energy or process heat also include a flare in their design to combust gas during periods when the gas utilization project is down for repair or maintenance. (Note: If the collection and combustion system only has a flare, the project developer will need to account for fugitive losses when the flare is down for repair or maintenance.)

In addition to reducing methane, the installation of a landfill gas collection and combustion system could impact anthropogenic carbon dioxide emissions (from the

consumption of electricity and fossil fuels) associated with the installation and operation of the gas collection system. The effect could either increase or decrease these GHG emissions, depending on the project's particular circumstance. These system-related effects are secondary to the primary effect of the project (reducing methane emissions). Section IV, The Project Boundary, delineates the scope of the accounting framework.

[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] For direct use agreements, between the project developer and the end user of the landfill gas (i.e. an 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. (Note: this is essential to ensure the validity of the credits. Even the perception that the same reductions can be registered more than once (and credits sold more than once) will reduce their value and negatively impact the market.)

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The project developer

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

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Additional GHG reduction activities in the solid waste sector

The 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.

However, at this time, GHG reduction activities not associated with installing a landfill gas collection and combustion system do not meet this protocol's definition of the GHG reduction project. Furthermore, producing power for the electricity grid (and thus displacing fossil-fueled power plant GHG emissions) is a complementary and separate GHG project activity to destroying methane gas from landfills, and not included within this protocol's accounting framework.

The Registry anticipates that separate project protocols may be developed in the future to facilitate reduction opportunities in the solid waste sector, including waste reduction & recycling and waste to energy.

III. Eligibility Rules

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

Eligibility Rule I: Additionality *Meet performance standard*
Exceed regulatory requirements
Eligibility Rule II: Location *U.S. landfill*
Eligibility Rule III: Project Start Date no earlier than *January 1, 2002*

Additionality

The Registry will only support 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.

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(Note: we suggest keeping the protocol language strong here, as additionality is a key issue.)

Project developers satisfy the "additionality" eligibility rule by passing two tests:

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

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." 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 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 combustion system at a landfill that is not required to do so by regulations, a project developer passes the Performance Standard Test.

The first determinant of additionality is whether there is already collection and combustion of landfill gas at the proposed project site. There are two possible scenarios under which the practice-based performance threshold is applied:

1. If the landfill is not currently collecting and combusting any landfill gas, the project is considered additional.

2. If the landfill is currently required to collect and combust landfill gas, two conditions must be met for the project to be considered additional.[4] First, only the landfill gas combusted 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). Second, the GHG project must either be designed to be entirely separate from the existing collection system or must be monitored separately from the existing system. These conditions will ensure that the reductions resulting from the GHG project can be accounted for separately from current collection and combustion.

The 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.

The Registry will periodically re-evaluate the appropriateness of the Performance Standard. All projects that pass this test are eligible to register reductions with the 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.

[4] Landfills which are currently collecting and combusting 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.

The Regulatory Test. The Registry subjects all greenhouse gas reduction projects 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 regulations.[5]

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

• New Source Performance Standards (NSPS) for Municipal Solid Waste Landfills, codified in
40 CFR 60 subpart WWW – Targets landfills that commenced construction or made modifications after May 1991.
• Emission Guidelines (EG) for Municipal Solid Waste Landfills, codified in 40 CFR 60 subpart
Cc. – Targets existing landfills that commenced construction before May 30, 1991, but accepted waste after November 8, 1987.
• The National Emission Standards for Hazardous Air Pollutants (NESHAP), codified in 40 CFR
63 subpart AAAA – Regulates new and existing 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 are subject to the NSPS, EG and the NESHAP. Landfills above the design capacity size cutoff must calculate their annual NMOC emissions using equations in the rules. If the calculated uncontrolled NMOC emissions reach 50 megagrams per year, the landfill must install a gas treatment system within 30 months of the failed emissions test.

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

State and Local Regulations, Ordinances and Permitting Requirements. All states are required by the Clean Air Act (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.

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

On June 21, 2007, the California Air Resources Board (ARB) approved a Landfill Methane Capture Strategy as an early action measure. Accordingly, ARB staff, in collaboration with California Integrated Waste Management Board (CIWMB) staff, is developing a control measure to provide enhanced control of methane emissions from municipal solid waste (MSW) landfills. The control measure will reduce methane emissions from MSW landfills by requiring gas collection and control systems on landfills where these systems are not currently required and will establish statewide performance standards to maximize methane capture efficiencies.[6]

In recent years the inclusion of air quality, water quality and even GHG emissions control measures in permitting requirements (CEQA, NEPA, etc.) is becoming more prevalent.

State and local governments may also regulate municipal solid waste 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 combustion activities at landfills regulated under NSPS, EG, NESHAP, CAA, RCRA Subtitle D and other state and local regulations, ordinances or permitting requirements are not eligible as greenhouse gas reduction projects.[7] (Note: see previous comment on verification of regulatory applicability. We suggest that an official from the project developer certifiy / attest that these regulations are not applicable, and as proof, provide a letter / written correspondence from Federal, State and Local regulators which states that these specific regulations do not apply to their project, as described. Assuming that enforcement officials at these agencies will not want to provide such strong language, modifiers could be applied to the statement and the Registry can provide guidance on whether or not this suffices. If these items were added to the pre-registration requirements for project developers, it would screen out projects that were not eligible – before verification a year later.)

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 require the installation of landfill gas control systems with the 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, oftentimes 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 clear compliance mechanism (Note: again, this is more appropriate for a regulatory agency or the project developer's legal counsel to decide what the 'clear compliance mechanism' entails, and the "certification / attestation plus proof" option would provide third-party verifiers a much higher level of certainty here.) is the installation of a combustion device, the landfill gas control system in question does not pass the Regulatory Test.[8,9]

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[6] California Air Resources Board, Landfill Methane Control Measure web page http://www.arb.ca.gov/cc/ccea/landfills/landfills.htm

[7] 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 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. (Note: see previous comments on regulatory applicability.)

[8] The Registry will provide guidance to Registry Approved third party verifiers to assist in the assessment of additionality in situations where regulations or ordinances allow for flexibility regarding compliance mechanisms. (Note: see previous comments on regulatory applicability.)

[9] The Registry is currently accepting data to assist in the development of a threshold (pounds NMOC/hr) whereby verifiers could assess the NMOC/VOC concentration and LFG flow rate that renders carbon adsorption technology less viable than the installation of a flare for regulatory compliance purposes.

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 installation of a landfill gas collection and combustion 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.
- In situations where flexibility is allowed for regulatory compliance to control NMOCs and the most practical compliance mechanism is NOT the installation of a combustion device.

(Note: see previous comments on "certification / attestation plus proof" option.)

In the event that a landfill hosting a gas collection and combustion project becomes subject to regulatory or permitting obligations requiring the installation of a landfill gas control system, emission reductions can be reported to the Registry up until the date that the landfill gas control system falls under regulatory control.

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Additionally, project developers pass the Registry's Regulatory Test by demonstrating that the project meets Federal, State and local air and water quality regulations. In some cases the installation of landfill gas combustion devices may cause co-pollutant emissions such as Nox and Carbon Monoxide. Therefore, while controlling GHG emissions, an offset project has the potential to be worsening local air quality. 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 or water quality regulations are not eligible to register GHG reductions with the Registry.[10]
The regulatory additionality test must be applied annually, at the beginning of each emissions reduction accounting cycle.

Location

All projects located at landfill operations in the U.S. are eligible to register reductions with the Registry. The scope of the analysis of landfill practices that formed the basis of the Performance Standard covered landfill operations in the U.S. Therefore, the Registry will treat GHG reductions from all U.S.-based projects that follow the guidance in this protocol equally.

The 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 Registry.

[10] If a project verifier finds that a landfill hosting a GHG reduction project is in a state of recurrent non-compliance or non-compliance that is the result of negligence or intent (Note: findings of non-compliance by a third-party verifier will be based on technical opinion, not legal review. This statement makes it appear as if third-party verifiers would be de-facto auditors for regulatory agencies.), then GHG reduction credits from the period of noncompliance will be deemed void. Once the landfill verifies regulatory compliance, GHG reductions associated with the proportion of the crediting period for which the landfill was in compliance will be considered valid.

Project start date

The Seventh Conference of the Parties (COP-7) to the United Nations Framework Convention on Climate Change was held in Marrakesh, Morocco, from October 29th to November 9th 2001. The main agenda of the Conference included finalization of detailed rules of the Clean Development Mechanism, Joint Implementation and Emission Trading under the Kyoto Protocol through which developed countries having emission limitation and reduction commitments under the Kyoto Protocol can undertake emissions reductions activities outside their own domestic environment at relatively lower costs. The Conference ended with the Marrakesh Accord that contains agreement on key elements relating to implementation of the provisions of the Kyoto Protocol. This sent a signal to GHG-emitting entities, including landfill operators, that project activities could receive recognition for their carbon value. The creation of the Marrakesh Accord to support GHG reduction activities is the basis for the project start date criterion.[11]

All GHG reduction projects that install a landfill gas collection and combustion system are eligible to register reductions with the Registry if the system started operating on or after January 1, 2002. Projects that began operating before January 1, 2002 are not eligible to register reductions according to this protocol. For the Registry's purpose, the commencement of operation means a constructed system that is capturing and combusting methane gas from the landfill operation.

IV. The Project 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 combustion system.

Physical Boundary. The physical boundary for the project includes sources from the operation of the landfill gas collection system to (in most cases) the combustion of the landfill gas. (Note: 'collection to combustion' is the case except when LFG is collected and sent off-site via a NG pipeline or combusted in vehicles off-site. In Figure 1 item 4, combustion takes place outside the physical boundary (i.e., at the end users of natural gas from a pipeline and in vehicles)).

For a 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 combustion.

Carbon dioxide emissions associated with the generation and combustion of landfill gas are considered biogenic emissions[12] (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.[13]

[11] The Voluntary Carbon Standard also uses the Marrakesh Accord as the basis for the start date criterion.
[12] 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.
[13] *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*; p.5.10,
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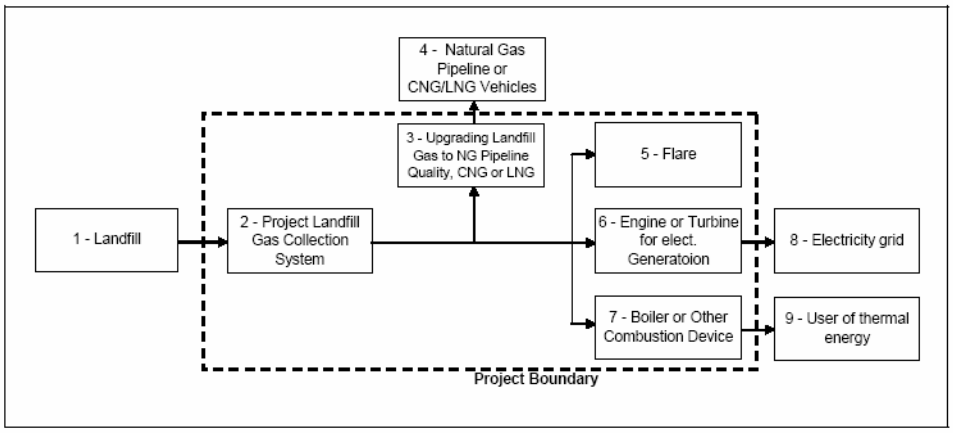
Figure 1 provides a general illustration of the project boundary; it encompasses the full landfill gas collection and combustion system. Table 1 (on page 9) identifies the main GHG sources associated with the source categories and specifies the gasses included in the calculation procedure.

Figure 1: Landfill GHG source categories and the project boundary (Note: see previous note regarding combustion for Item #4 taking place outside the physical boundary of the project.)



Temporal Boundary. Landfill gas projects using this protocol will report emissions reductions to the 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 accounting cycle.

Leakage. Leakage is an increase in greenhouse gas 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 offsetting 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 combustion projects are not expected to result in leakage of greenhouse gases outside the project boundary. (Note: what is the basis for this statement? If all of the direct and indirect emissions associated with project planning, mobilization to the site and project development were calculated, it may not be insignificant. Requiring project developers to be accountable for these emissions would help to reduce the carbon footprint of these activities and perhaps encourage local sourcing.)

This protocol does not account for carbon dioxide reductions associated with displacing griddelivered electricity. This is classified as an indirect emissions reduction activity because the change in GHGs occurs from sources owned and controlled by the power producer, even though the project developer produces the renewable electricity that displaces the fossil-based electricity. Capturing and using methane to produce electricity for the grid would be defined as a complimentary and separate GHG reduction project.

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

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

(note : no comments on Table 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
******* 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 additive. 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.14

V. GHG Reductions Calculation Methods

The 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).

Total 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.15 Until the landfill 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.

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 10% which is oxidized by bacteria in the soil.[16]

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[14] GE AES Greenhouse Gas Services, Landfill Gas Methodology, Version 1.0 (July 2007)
[15] For more information on CARROT, see the Registry's website, www.climateregistry.org
[16] 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 managed landfills.

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 (minus the 10% oxidized). Only the landfill gas combusted 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 be designed to be entirely separate from the existing collection system or must be monitored separately from the existing system. These conditions will ensure that the reductions resulting from the GHG project can be accounted for separately from current collection and combustion.

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

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 combusted by the project landfill gas control system, minus
- the portion of methane oxidized in the baseline scenario, minus
- carbon dioxide emissions from fossil fuel consumption, minus
- indirect carbon dioxide emissions from the use of electricity from the grid, if applicable.

Equation 1: Project GHG emissions reductions

(Note: no comments on Equation 1)

[17] IPCC Second Assessment Report: Climate Change 1996
[18] California Climate Action Registry. General Reporting Protocol V. 2.2, Appendix C, tables C.3 and C.5
[19] Utility specific emission factors for 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://www.climateregistry.org/CARROT/public/reports.aspx. If a utility specific emission factor is not available, use the EPA eGRID subregion emission factor available in the Registry's General Reporting Protocol (GRP) V. 2.2, Appendix C, tables C.1 (also see GRP Figure III.6.1)

(Note: there is no text in the Protocol before Equation 2. Was this intended?)

Equation 2: Total annual methane emissions destroyed

(Note: no comments on Equation 2)

[20] Density of landfill gas should be calculated based on the metered temperature and pressure of the gas.
[21] Project developers have the option to use a State or local agency accredited source test service provider to test the actual combustion efficiency of each of the combustion devices used in the project case. The official source test combustion efficiency can be used in Equation 2 in place of the default combustion efficiency.
[22] 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. These default destruction efficiencies may be updated as more source test data is made available to the Registry.

Equation 2: Continued

VI. Project Monitoring

Project developers are responsible for monitoring the performance of the project and operating the landfill gas collection and combustion 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, temperature, pressure and methane concentration[23] prior to delivery to combustion device, and
- the continuous rate of landfill gas to each combustion device, and
- the continuous rate of landfill gas flow, temperature, pressure and methane concentration prior to injection into the natural gas transmission and distribution system.

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 (m^3) collected from the landfill on a daily basis.

The measurement equipment is sensitive for gas quality (humidity, particulate, etc.), so a strong QA/QC procedure for the calibration of this equipment is required. Monitoring instruments shall be calibrated at least once per year and maintained as specified by the manufacturer. The hourly operational activity of the landfill gas collection system and the combustion devices shall be monitored and documented to ensure actual landfill gas destruction. GHG reductions will not be accounted for during periods which the combustion device was not operated.

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[23] 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.

Rather than using default destruction efficiencies, 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.

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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 for a minimum of two years post project verification.

(Note: we strongly suggest that project developers be required to create and maintain a "Landfill Project Management Plan" similar to a GHG Inventory Management Plan (IMP), as provided in guidance by U.S. EPA. This drastically reduces the amount of time and effort required of third-party verifiers, and helps the project developer strengthen their internal management systems.)

Table 2. Data to be collected and used to monitor emissions from the project activity

(Note: no comments on Table 2)

VII. Reporting Parameters

This section provides guidance on reporting rules and procedures. A priority of the 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.[24]

Pre-registration reporting forms

Project developers provide the following information to the Registry before registering reductions associated with installing a landfill gas collection and combustion system.[25]

(Note: see previous comments on adding "certification / attestation plus proof" for regulatory applicability / regulatory compliance as part of pre-registration forms.)

Form 1: General Landfill Information

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. Waste in place (cubic meters or tons):
9. Designed landfill capacity (cubic meters or tonnes):
10. Year landfill opened:
11. Year landfill closed or will close:
12. Approximation of percent municipal / industrial / inert wastes:
13. Quantity of waste generated annually (cubic meters or tonnes):
14. Quantity of waste accepted annually at landfill (cubic meters or tonnes):
15. Description of any regulatory framework for landfill methane capture and control:
16. Description of local and state air and water quality, explosive gas, or other regulations pertinent to the project:

[24] 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.
[25] The pre-registration reporting forms are sourced from the Methane to Markets Partnership Landfills Subcommittee. *2007 Methane To Markets Partnership Expo, Preliminary Assessment For Landfill Methane Partnership Opportunities*.

Form 1: Continued

(Note: we suggest that a column be added to provide that basis for the estimation of each waste stream.)

17. Waste Characteristics Table

Waste Types	**Estimated Percent of Waste Stream**
Food Waste	
Garden and park waste	
Wood	
Paper and textiles	
Plastics	
Concrete	
Metal	
Other Inert waste	

Form 2: Landfill Operations Data

1. Daily Cover? (Yes/No)
2. Landfill Site Capped? (Yes/No)
3. Landfill Lined? (Yes/No)
   - Type of liner (soil, clay, plastic)?
4. Waste Compaction? (Yes/No)
5. Average annual rainfall at the landfill (cm):
6. Average annual temperature (^{0}C):
7. Describe filling process (i.e., large area shallow lifts, small areas deeper lifts)
8. Note waste pickers or recycling activities:

Form 3: Biogas control system information

(Note: we suggest that plan view and cross-sections of the cells / areas with LFGC systems be provided.)

1. Type of 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. What is the number and average depth of vertical or horizontal wells?
   iv. Name of system designer, address, and other contact information
2. When was the system installed and operational?

Form 4: 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. Component integration (factory or owner)
    c. Origin of equipment controller (manufacturer integrated, third party off-the-shelf, or third party custom)
    d. System installer
    e. Pretreatment of landfill gas (*e.g.,* none, condensate trap, dryer, hydrogen sulfide removal, *etc.* with the names of manufacturers, models, *etc.*)
    f. Exhaust gas emission control (*e.g.,* none, catalytic converter, *etc.*)
    g. 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)
    h. 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)
5. If designed for landfill gas sale to a third party, a description of the methods of processing, transport, and end use

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.[26]

Project crediting period

Project developers are eligible to register GHG reductions with the 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. The first reduction year commences after the landfill gas collection and combustion system becomes operational. A system is operating if it is capturing and combusting methane gas from the landfill.

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

Non-California Climate Action Registry reporting

The 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 Registry. If the Registry determines that duplicative emissions reductions registration has occurred, all duplicate reductions reported with the Registry will be made void. (Note: this is another key issue. In order to ensure the veracity of the credits, there must be no perception (let alone reality) of reductions being registered more than once. There appears to be a need for a clearinghouse with a direct connection to all registries to quickly verify that registration of reductions has only occurred once. Alternatively, project developers could pay an NGO or other credible organization to show that they have only registered the reductions once.)

(Note: no comments on References or Appendix A.)

Landfill Project Verification Protocol

Note: This Document contains comments on the CCAR Landfill Project Verification Protocol that were submitted by Cameron-Cole

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Capturing and combusting methane from landfills

DRAFT

October, 2007

The California Climate Action Registry Landfill Project Verification Protocol Capturing and combusting methane from municipal solid waste landfills

TABLE OF CONTENTS

I. Introduction

The California Climate Action Registry's (Registry) Landfill Project Verification Protocol provides guidance to California Air Resources Board (CARB) and Registry-approved verifier[1] for verifying greenhouse gas (GHG) emissions reductions associated with installing a landfill gas control system, in accordance with the Registry's Landfill Project Reporting Protocol. Verification occurs on an annual basis. This verification protocol supplements the Registry's General Certification Protocol (GCP). It describes the core verification activities in the context of a Landfill operation and provides information on project monitoring parameters.

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The purpose of verification is to provide an independent review of data and information used to produce a GHG project report. It aims to ensure that a participant's reported emissions reductions are: real, permanent, surplus, and verifiable. The intended audience of the project verification protocol is approved verifier. However, Landfill emission reduction project developers will also find it useful to review this document to develop a better understanding of the verification activities associated with reporting GHG reductions to the Registry.

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Landfill sector verifier must read and be familiar with the following Registry reporting tools:

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- General Reporting Protocol,
- Landfill Project Reporting Protocol,
- General Certification Protocol,
- Landfill Project Verification Protocol,
- Climate Action Registry Reporting Online Tool (CARROT)[1].

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The Registry's general and industry-specific verification protocols are designed to be compatible with each other and are available on the Registry's website at www.climateregistry.org. Only CARB- and Registry-approved landfill sector verifier are eligible to verify landfill project reports. Approved verifier under the Registry's GCP are not automatically permitted to verify the project reports. To become an approved landfill sector verifier, a general verifier must successfully complete a landfill sector-specific application process. Information on the application process can be found at www.climateregistry.org/verifier/certifiers.

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[1] Until the landfill project component of CARROT becomes operational the Registry will provide spreadsheet-based calculation tools.

[1] Note: it would be helpful to provide the definition of a verifier here (third-party, independent, no COIs,) and that the Registry is transitioning from the term 'certifier' to 'verifier'.

II. Standard of Verification

The Registry's standard of verification for landfill GHG projects is the Landfill Project Reporting Protocol. To verify a Landfill project developer's project report, verifier apply the guidance in the GCP and this document to the standards described in the project reporting protocol. It provides eligibility rules, methods to calculate reductions, performance-monitoring instructions, and procedures for reporting project information to the Registry. The Landfill Project Reporting Protocol:

- defines the GHG reduction project,
- defines project eligibility rules,
- delineates the project boundary,
- provides GHG reductions calculation methods,
- identifies procedures for project monitoring, and
- describes project reporting parameters.

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Specifically, this verification protocol supports the verification of GHG reduction projects associated with the installation of a landfill gas control system that captures and combusts methane gas from landfill operations and that commences operation on or after January 1, 2002. The landfill gas control system destroys methane associated with the biodegradation of landfill waste that would have otherwise been emitted to the atmosphere. Captured landfill gas could be combusted on-site, or transported for off-site use (e.g., through gas distribution or transmission pipeline), or used to power vehicles. Regardless of how project developers take advantage of the captured landfill gas, the ultimate fate of the methane must be combustion.

Project verification occurs annually. GHG reductions associated with the landfill gas control system are accounted for on an ex-post basis, and project developers annually report reductions that occurred the preceding year. In keeping with the reporting rules of the General Reporting Protocol, the reporting deadline for project developers is August 31 the year following the reduction year, and the verification deadline is December 31.[2]

Table 1 in the Landfill Project Reporting Protocol delineates which emission sources should be reported within the project boundary.

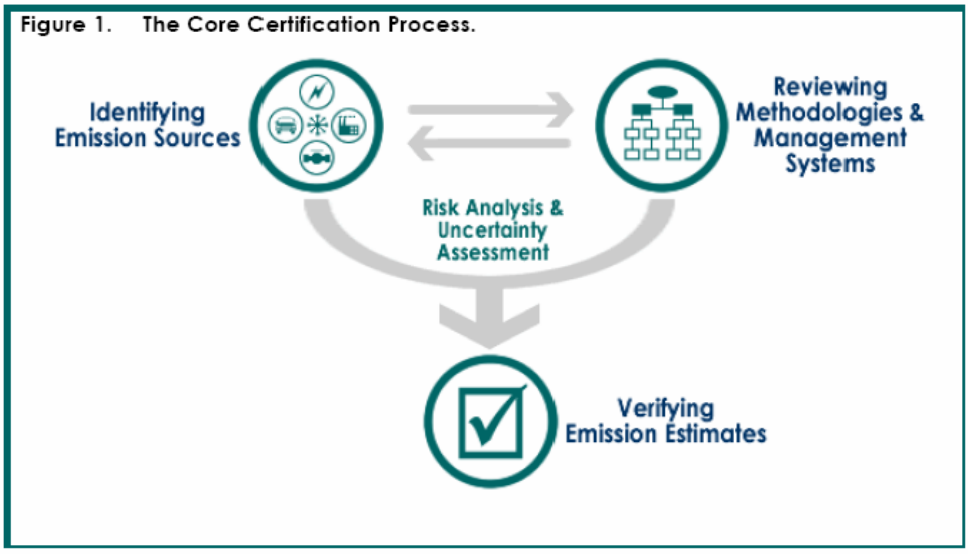
III. Core Verification Activities – Landfill Operations

Although the Registry's Landfill Project Reporting Protocol provides explicit guidance to determine the GHG impact associated with installing a landfill gas control system, the focus of this verification protocol is on the process to undertake a review and verify a Landfill project developer's GHG reduction report.

The Registry's core verification activities are a risk assessment and data sampling effort developed to ensure that the risk of a reporting error is assessed and addressed through appropriate sampling and review. An illustration of the core verification process is

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

provided in Figure 1, and a description of the three-step procedure is provided below, which is adapted from the Registry's GCP.



The GHG reduction project's impacts are determined within a project boundary. The project reporting protocol delineates the GHG sources and gasses assessed by project developers to determine the net change in emissions associated with installing a landfill gas control system and combusting collected gases. The boundary captures sources from landfill gas collection to combustion. (Note: see Cameron-Cole's comment in the LF PRP regarding the delineation of the physical boundary of the project, which does not include the combustion of gases sent off site in NG pipelines or to vehicles.)

Within the defined project boundary, project developers at landfill operations quantify the impact on methane, and carbon dioxide, by assessing project emission reductions. Therefore, a Landfill project developers project report will consist of two main parts:

1. A baseline emissions determination
2. A project emissions reduction assessment

The verification process includes the identification of emissions sources, data management systems review, and verification of emissions reduction estimates to verify the project's GHG impacts.

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Registry verifier apply verification procedures consistently for all project developers. However, based on the size and complexity of a landfill project, verification activities may vary.

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Step 1: Identifying Emission Sources

Verifier review the project developer's emissions and emissions reductions source categories (various components of the landfill gas collection and combustion system including fossil fuel consumption, indirect CO_2 emissions and methane destruction) for both the baseline scenario and after project implementation.

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Verifier then determine the GHG emissions and emissions reductions that result from the identified sources and estimate their magnitude. Finally, verifier rank, by the total annual emissions and emissions reductions, the remaining reported emissions and emissions reductions by CO_2e to assess the environmental risk associated with the emissions.

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Project verifier review the GHG emissions reduction report and document whether the report reflects the characterization and scope of the operation. The "Pre-registration forms" from Section VII in the project reporting protocol should help this assessment. Questions to answer are:

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1. Does the project meet the definition of the project as provided in the project reporting protocol?
2. Does the project satisfy the eligibility criteria?
3. Did the project developer sufficiently review and provide proof of compliance with local, state and federal air and water quality regulations?
4. Does the report correctly depict the landfill system under the baseline scenario and project case?
5. Does the project report include all necessary direct and indirect methane and carbon dioxide sources within the project boundary – for the baseline case and post project implementation?[3]

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Step 2: Reviewing GHG Management Systems and Estimation Methodologies

After confirming the scope and comprehensiveness of the project developer's emission sources, verifier review the methodologies and management systems that the landfill project developer used to calculate project emission reductions. The objective is to assess the appropriateness of the data management systems that provide emissions information to the Registry.

This is principally a risk assessment exercise, in which the verifier/certifier weighs the relative complexity of the scope of the project, the methodologies and management systems used to prepare the GHG project report, and the risk of calculation error as a result of reporting uncertainty or misstatement. A verifier's review of a project developer's GHG data collection and organization system should consider the following questions:

1. Are GHG sources within the project boundary correctly organized by source category?
2. Are the GHG sources differentiated by gas?
3. Are the landfill parameters accurate?
4. Are the waste characteristics accurate?
5. Are there federal, state or local regulations, ordinances or permitting requirements pertaining to air quality, water quality, explosive gas, or local nuisance that may affect landfill operations?

[3] Table 1 in the Landfill Project Reporting Protocol delineates which emission sources should be reported within the project boundary.

6. Does the landfill pass the regulatory additionality test? (Note: please see Cameron-Cole's comments on the regulatory test in the LF PRP.)
7. Did the project developer provide source testing data for all combustion devices, or did the developer choose the default combustion efficiencies provided in the Landfill Project Reporting Protocol?
8. Did the project developer correctly monitor, quantify and aggregate the amount of uncontrolled methane collected from the landfill and combusted by the project landfill gas control system?
9. Did the project developer correctly monitor, quantify and aggregate the amount of uncontrolled methane collected from the landfill, upgraded, and injected into a natural gas pipeline or used in CNG/LNG vehicles?
10. Did the project developer correctly monitor, quantify and aggregate direct and indirect CO_2 emissions from the project?

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11. Did the project developer correctly monitor, quantify and aggregate methane emissions reductions from the project?
12. Did the project developer correctly monitor, quantify and aggregate CO_2 emissions and methane emission reductions?
13. Did the project developer apply the correct carbon dioxide emission factors?
14. Did the project developer apply the correct methane destruction efficiencies?
15. For other calculation variables, did the project developer use correct data inputs?
16. Did the project developer correctly monitor, quantify and aggregate fossil fuel use?
17. Is the landfill gas control system operated in a manner consistent with the design specifications?
18. Is the landfill gas control system monitored in a manner consistent with the Landfill Project Reporting Protocol?
19. Are the landfill gas combustion devices operated and maintained in a manner consistent with manufacturer specifications?
20. Is an individual responsible for managing and reporting GHG emissions? Is this individual qualified to perform this function?
21. Is appropriate training provided to personnel assigned to GHG emissions reporting duties?
22. If the project developer relies on external staff to perform required activities, are the contractors qualified to undertake such work? Is there internal oversight to assure quality of the contractor's work?
23. Are appropriate documents created to support and/or substantiate activities related to GHG emissions reporting activities, and is such documentation retained appropriately? For example, is such documentation maintained through reporting plans or procedures, fuel purchase records, etc.? (Note: please see Cameron-Cole's comment on the LFPRP regarding the need for project developers to produce a "Landfill Project Management Plan" similar to an IMP for GHG inventories.)
24. For direct use agreements, between the project developer and the end user of the landfill gas (i.e. an industrial client purchasing the landfill gas from the project developer), is a legally-binding mechanism built into the agreement language to assure that the GHG offset credits will not be double counted?
25. Are the mechanisms used to measure and review the effectiveness of GHG emissions reporting programs appropriate for this purpose? For example, are policies, procedures, and practices evaluated and updated at appropriate intervals?

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Once the verifier has assessed the overall risk of misstatement associated with the GHG management systems, those risks should be assessed in conjunction with the project characterization and emissions source assessment in Step 1 (Identifying Emission Sources).

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Verifier then identify the areas with the greatest potential for material misstatements (either based on volume of emissions, lack of management systems, or both) to determine the best risk-based strategy to identify a representative sample of emissions to recalculate in Step 3 below.

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Step 3: Verifying Emission Estimates

The final step in completing the core verification activities is to verify the emission estimates. To do so, verifier re-calculate a subset of the landfill project's emission reductions from the post-project implementation and compare the sub-sample re-calculated results with the project developer's calculated results from the same sources to determine if the GHG project emissions inventory is free of material misstatements. It is possible that during the verification process differences will arise between the emissions estimated by the project developer and those estimated by the verifier. Differences of this nature may be classified as either material (significant) or immaterial (insignificant). A discrepancy is considered to be material if the overall reported emissions differ from the overall emissions estimated by the verifier by 5% or more. An overall difference is immaterial if this difference is less than 5%.

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1. Similar to Step 2, this procedure is a risk assessment exercise. The verifier weighs the relative complexity of the scope and diversity of the landfill project GHG emissions and emissions reductions, the appropriateness of the calculation methodologies, the strength of theGHG management systems, and the risk of a calculation or reporting error to determine the best risk-based strategy for selecting a representative sample to re-calculate. Verifiers must compare estimated GHG emissions in the baseline scenario and post-project implementation to those of the project developer to determine if any material misstatements exist.

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Deleted: the emissions data and re-calculations to the project developer's emissions data and calculations for the same sources, and complete the following tasks: ¶
<#>Assess the areas of greatest impact and uncertainty in the emissions profile. ¶
<#>Select a representative sample of data to recalculate and sources to visit.¶
<#>Develop and implement a strategy to recalculate the GHG emissions/emissions reductions and visit the sources in the sample. ¶
<#>Assess the project developer's data collection. ¶
Compare estimated GHG emissions in the baseline scenario and post-project implementation to those of the project developer to determine if any material misstatements exist.

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Verifiers should concentrate their activities in the areas that have the greatest impact to the net change in emissions due to installing a landfill gas control system. The verification of emissions estimates should document the answers to the following questions:

1. Have you documented your process for determining the appropriate sampling plan?
2. Have you performed data triangulations (Note: this phrase should be defined.) where reasonable?

3. Are the current year's baseline and post-project implementation reported emissions significantly different from the prior year's emission levels? If so, do you understand the reasons for the changes, and to the best of your knowledge, do they explain the differences in emissions?
4. Are any discrepancies between your emissions estimates and the project developer's material?

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Completing the Verification Process

The Registry's GCP provides general instructions for verifiers to finalize the verification process. It describes completing a Verification Report, preparing a Verification Opinion, conducting an Exit Meeting with the project developer, and notifying the Registry of the project developer's verification status. Furthermore, verifiers should refer to the GCP for information on the Verification/Certification Activities Log. Verifiers are responsible for applying the guidance in a manner that meets the goals of project verification.

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IV. Project Monitoring Parameters

To confirm that a project developer's GHG emissions have been reported accurately, verifiers should review appropriate data sources. Verifiers should validate the activity data for the calculation inputs to substantiate the baseline and post-project implementation determinations. Prior to the first meeting, verifiers should identify key documents, and project developers should provide them to the verifier in a timely manner for review. This will help to expedite the verification process.

Please reference the Landfill Project Reporting Protocol for project monitoring parameters to be reviewed by verifiers.

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