

BLUE SOURCE SPARTANBURG COUNTY LANDFILL GAS COMBUSTION PROJECT



Document Prepared By: Blue Source LLC.

Contact Information:

Kevin Townsend

Blue Source LLC

ktownsend@bluesource.com

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Prepared By	Blue Source, LLC
Contact	3165 East Millrock Drive, Suite 340 Holladay, UT 84121 801-322-4750 info@bluesource.com www.bluesource.com

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PROJECT DETAILS

1.1 Summary Description of the Project

The Wellford Landfill (the “Landfill”) consists of six phases designated as Phases I through VI. Phases I through IV include approximately 65 acres of unlined cells and Phase V includes an approximately 35 acre Subtitle D lined landfill. The Landfill is currently operating in Phase V1, Cell 1; a 16 acre lined Subtitle D landfill.

The Project consists of three stages, all implemented at the Wellford Landfill. Stage one (1) of the Project involves the installation of an active gas collection system consisting of 60 wells and associated piping in Phases I through V (with planned future expansion into Phase VI) of the Landfill. During this stage, the gas captured from this system is flared, thereby converting methane to biogenic CO₂. As evidenced by the meeting minutes from SCS Engineers from April 29, 2010, the project start date is April 29, 2010 when these wells were connected and began extracting and combusting landfill gas (LFG). The system will continue to be expanded throughout the duration of the crediting period. Note that the piping systems and headers for the project LFG collection and control system (LFGCCS) were constructed separately from the pre-project system and the LFG collected from the pre-project and project LFGCCS does not meet until a point just before the existing blower/flare station.

Stage two (2) of the Project involves the implementation of a beneficial use project, whereby captured biogas will be transported by pipeline approximately 6.5 miles to the Milliken Dewey Chemical Plant (the “Milliken Facility”) for use in its natural gas equipment (i.e. two steam boilers and one hot oil boiler). As part of this stage, gas will be compressed, treated and transported to the Milliken Facility for direct use. The date of commissioning of this phase was June 23, 2011.

Stage three (3) of the Project involves the implementation of a LFG to electricity project, whereby LFG will be sold to Lockhart Power (“Lockhart”) for use in electricity generation. Lockhart will use the captured biogas to generate up to 1.6 MW of electricity using a Caterpillar 3520 engine-generator unit. The unit first ran offline (burning LFG but not generating electricity) on May 3rd 2011. May 12th is when the meter first turned, but the unit didn’t run consistently and stable until June 1, 2011. Note that no emission reductions are claimed for offsetting grid connected electricity generation.

Stage one (1) of the Project is owned and operated by Spartanburg County (the “County”). Stage two (2) of the Project is owned and operated by both the County and Milliken Company (“Milliken”). In particular, the County owns the first and second stage LFG treatment system, the pipeline used to transport gas to the Milliken Facility and associated metering equipment. Lockhart has a contract with the County to maintain and operate control of the gas through to the plant, this includes flow meter equipment and the single gas analyser, control of pipeline activities. Milliken owns and operates the boilers and all equipment used to produce energy at the Milliken Facility for the facility’s use. Stage three (3) of the Project is owned and operated by Lockhart Power. Lockhart owns and operates the energy facility and all equipment used to generate electricity at the site and will operate the first and second stage LFG treatment systems. The County owns and operates the pipeline used to transport gas to Lockhart.

The installation of an active LFG collection system in 2010 was completely voluntary. The objective of this expansion was to increase gas flow and demonstrate the feasibility of developing a future beneficial use project with Milliken. The system was not installed in response to odor complaints or gas migration issues.

No permits were required for the LFG collection system expansion. A South Carolina Department of Health and Environmental Control (DHEC) Construction Permit (Permit No. 2060-0489-CA) was obtained for the installation of a generator at the Lockhart facility. A permit will also be required to operate the engine and must be requested within 12 months of initial startup. The application was submitted on January 31st, 2012.

A permit is not required to use LFG at the Milliken Facility. Instead a letter was submitted to the DHEC in February 2011 requesting permission to use LFG in the boilers and oil heater at the facility. This change will be incorporated into the facility's Title V permit at the next reissuance or revision. The existing version (Permit No. TV-2060-0300), was issued on October 5, 2009 with an effective date of January 1, 2010.

1.2 Sectoral Scope and Project Type

- Project Type: Waste Handling and Disposal, Sectoral Scope 13
- Individual Project

1.3 Project Proponent

The Landfill is owned and operated by Spartanburg County. The gas collection system, gas treatment system and flare are also owned by the County.

Lockhart has contracted with the County to maintain operational control of the gas through to the plant, including meters and analyzers, control of pipeline activities as well as the flow meter. As outlined in Section H of the sales agreement between Lockhart Power and Spartanburg County, dated Dec 29, 2009, Lockhart is entitled to develop the VERs associated with offsetting fossil fuel based energy generation at the Milliken facility. Revenues are then shared with the County.

Milliken receives gas transported by the pipeline. Milliken owns and operates the boilers and all equipment used to produce energy at the Milliken Facility for the facility's use.

Project Proponent(s):

Bryan Stone, P.E.	Cassidy Carlile	Travis Brown
Chief Operating Officer	Director of Corporate Environmental	Wellford Landfill
Lockhart Power	Milliken & Company	Spartanburg County DPW
P.O Box 10	P.O. Box 1926	P.O. Box 5666
420 River Street		
Lockhart, SC 29364	Spartanburg, SC 29304	Spartanburg, SC 29304
Phone: (864) 545-2575	Phone: 864.503.1569	Phone: 864-949-1658
Email bstone@lockhartpower.com	Email: Cassidy.Carlile@milliken.com	twbrown@spartanburgcounty.org

1.4 Other Entities Involved in the Project

Blue Source LLC ("Blue Source") has been contracted by Lockhart Power to create and monetize the greenhouse gas (GHG) emission reduction credits generated by the Project.

Project Developer: Kevin Townsend
Chief Commercial Officer
Blue Source, LLC

1.5 Project Start Date

The project start date is April 29, 2010 when the County began collecting and destructing LFG from the project collection system.

1.6 Project Crediting Period

The crediting period start date is defined as June 15, 2010. This corresponds with the installation of metering equipment for the project system and does not correspond with the project start date. The crediting period will extend from June 15, 2010 to June 14, 2020, assuming the Landfill is not required to install a LFG capture system during this time.

The crediting period will be reassessed on an annual basis to ensure that the Project does not exceed the NSPS threshold for NMOC emissions and is not required to collect and destruct LFG. If the landfill does become subject to regulations which would require it to collect and destroy landfill gas in the future, no credits will continue to be claimed, from either methane destruction or fossil fuel displacement.

1.7 Project Scale and Estimated GHG Emission Reductions or Removals

Project	X
Mega-project	

Years	Estimated GHG emission reductions or removals (tCO ₂ e)
2010	34,744
2011	68,768
2012	72,786
2013	74,373
2014	75,810
2015	77,109
2016	78,285
2017	79,349
2018	80,312
2019	81,183
2020	37,055
Total estimated ERs	759,775
Total number of crediting years	10
Average annual ERs	75,977

1.8 Description of the Project Activity

Under Stage one (1) of the Project, the collection system is designed to collect from new wells throughout Phases I through V of the Landfill and is routed on a separate collection system. This allows the gas collected in the new system to not mix with the LFG from the old wells until being measured for flow rate and methane concentration. The system will also be expanded into Phase VI in the future. The system consists of the following infrastructure and equipment:

- Vertical wells to extract gas from the Landfill;
- Header and lateral piping to collect gas and tie the project system into the existing collection system piping for transportation to the flare;
- Pre-existing blower / flare station; and
- Monitoring equipment including flow meters, gas analyzer, data acquisition unit, etc. to monitor the quantity and composition of LFG collected from the project collection system prior to comingling with the pre-project gas stream and at the flare inlet.

Additional infrastructure required for Stages two (2) and three (3) of the Project includes:

- Piping and controls required to transport LFG from the gas collection system to the gas treatment system;
- First stage gas compression and treatment system to compress, cleanup and dehydrate the gas to medium MMBTU gas (MMG) for transportation to the Milliken and Lockhart Facilities. This system will include an inlet moisture separator, two multistage centrifugal blowers, a gas/air aftercooler, a discharge moisture separator, a recirculation valve and associated piping, fittings, valves and other instrumentation;
- Second stage gas compression and treatment system to further treat LFG to the specifications required for use at the Milliken Plant. This system will include two capacity sliding vane compressors, a gas/air aftercooler, a gas/gas economizer, a gas/water heat exchanger, a coalescing filter, a recirculation valve and piping, a glycol/water chiller package and associated piping, fittings, valves and other instrumentation;
- Interconnecting piping, valves and fittings between the first and second stage treatment systems and between the second stage treatment system and the chiller system;
- Oil/water separator;
- SCADA equipment to record the quality and quantity of LFG collected from the project system on a (time period) basis Daily aggregation of data was conducted before SCADA was implemented. SCADA became operational on June 2, 2011 which records data every second; and
- Other miscellaneous ancillary equipment.

Stage two (2) of the Project will consist of the following additional components:

- Piping and controls required to transport LFG approximately 6.5 miles to the Milliken Facility;
- Modification of Milliken's two boilers (one Cleaver-Brooks 600 HP fire-tube boiler and one Cleaver-Brooks 250 HP fire-tube boiler) and one oil heater (one Carotek 400 HP hot oil heater) for the use of LFG; and
- Three fans to operate the boilers; and
- Metering station including a methane gas analyzer, gas dew point measurement, local control panel, cellular modem for communication with the SCADA system and a flowmeter to monitor LFG flow to the Milliken Facility.

Stage three (3) of the Project consists of the following additional components:

- Piping and controls required to transport LFG to the Lockhart Facility;
- Caterpillar Model No. G3520C Engine Generator Unit with rated capacity of 1.6 MW;
- A radiator to provide cooling for the engine;
- A silencer on the engine exhaust;
- Associated electrical equipment including switchgear, motor control center, transformers and a main breaker; and

- Flowmeter to monitor LFG flow to the Lockhart Facility and associated energy generation from LFG at the Facility.

The Project achieves emission reductions through the collection and flaring of LFG, thereby converting methane into CO₂ and reducing the quantity of methane released to the atmosphere from the Landfill. Note that any CO₂ in the LFG is biogenic and is therefore not considered as a source of emissions. In the absence of the project, the methane captured from the expanded LFG system would have been vented to the atmosphere (as per pre-existing operating conditions).

Emission reductions are also achieved in Stage two (2) of the Project through the collection and utilization of methane for thermal energy generation. These emission reductions are claimed for the displacement of fossil fuel based thermal energy generation. VER's are not claimed for the displacement of fossil fuel based electricity generation in Stage three (3). Again, CO₂ in the LFG is biogenic and is not considered as a source of emissions.

1.9 Project Location

The Landfill is a municipal solid waste landfill located on 390 acres in Spartanburg County, South Carolina. It is bordered by Little Mountain Road, Montgomery Road and the North Tyger River. The address of the facility is:

595 Little Mountain Road
Wellford, South Carolina

The latitude and longitude of the Landfill are as follows:

- Latitude: 35.001193
- Longitude: -82.13042

The Landfill opened in 1977 and had an estimated 2.26 million Megagrams of waste in place as of January 2009. The design capacity is 3.44 million Megagrams.

The site includes two closed and unlined MSW landfill cells, an active and lined MSW area, a closed construction and demolition (C&D) waste cell and an active C&D waste cell. The two closed MSW areas are referred to as Phases I through IV. The active MSW areas are referred to as Phase V and VI.

Phases I through IV were operational from 1977 through 1992, Phase V accepted waste from 1992 through 2009 and Phase VI opened in 2009 and is expected to operate until 2022. Additional permitting may be obtained to extend the life of the Landfill past 2022.

1.10 Conditions Prior to Project Initiation

In September 1998 the County voluntarily installed an active perimeter gas collection system consisting of 24 extraction wells in Phases I through IV of the Landfill and a 1,000 cfm flare to destruct the gas. This system was installed to mitigate gas migration. From 2002 to 2004 four additional wells were installed. This was prior to the County's 2010 installation, collection and destruction of LFG from the Project collection system.

Fifteen passive vents were also installed in Phase V of the Landfill to relieve pressure within the Landfill. Gas routed through these vents was allowed to vent to the atmosphere, it was never destructed. A summary of the number and location of pre-existing wells is provided below.

Table 2 Pre-Project Well Locations

Phase	Number of
-------	-----------

	Pre Project Wells
I	10
II	3
III	13
IV	0
V	15

The pre-project gas collection and destruction system consists of the following:

- Vertical extraction wells to extract gas from the Landfill;
- LFG header piping to collect gas for transportation to the flare;
- Header valves for LFG flow control;
- A 25 Hp Hoffman Series 383 (Model #38303B) centrifugal blower to create a pressure differential and extract LFG from the wells; and
- A 1,000 CFM capacity LFG Specialties Model PCF82418 open flare (Serial No. 1529) with an eight inch tip to destruct LFG.

Installation of the pre-project LFG management system required an air quality permit (Permit No. 2060-0300) for operation of the flare. No other water quality or explosive gas permits were required.

The pre-project collection system installed in Phases I through IV of the Landfill is not within the scope of the Project. LFG will continue to be collected from this pre-project system; however project system gas flow will be metered independently of the pre-project system to ensure that no credit is claimed for LFG collected from the pre-project system. SCS Engineers specifically designed the project system to ensure that the radius of influence of the project and pre-project wells do not overlap. Further, the pre-project system is installed in an old area of the Landfill where gas quality and quantity is low. As such, gas flow from this area is already low and will continue to decline over the duration of the crediting period.

Odors and Gas Migration

In the late 1990's the County had gas migration issues, and a pre-project LFG management system was installed to address these issues. In March 1998, the County was required to submit a plan to mitigate gas migration, and chose to enhance an existing passive system consisting of 28 vent wells, into an active collection system. Subsequently, the pre-existing passive wells were tied into a central header and a blower/flare system was installed to destruct the gas.

The County was not required to install an active collection system, and could have instead addressed the issue through passive venting, trenching, etc. There have been no issues with gas migration or odors since the pre-project system was installed.

As discussed, the pre-project system is not included within the scope of the Project.

The pre-project activity consists of the disposal and anaerobic decomposition of waste at the landfill. This activity results in the generation and release of methane emissions to the atmosphere. The project activity of capturing and destructing methane results in the reduction of these GHG emissions. The project activity does not result in the creation of GHG emissions for the purpose of their subsequent destruction.

1.11 Compliance with Laws, Statutes and Other Regulatory Frameworks

Under the 1990 Clean Air Act Amendments, landfills with a permitted capacity of greater than 2.5 million megagrams and 2.5 million cubic meters are subject to the New Source Performance Standards (NSPS), as specified in 40 CFR Part 60 Subpart WWW – Standards of Performance for Municipal Solid Waste Landfills, and are required to install and operate a gas collection and control system if annual non-methane organic compound (NMOC) emissions exceed 50 Megagrams. The objective of these federal

landfill emissions regulations is to reduce fugitive emissions of (NMOC) and hazardous air pollutants (HAPs) from landfills.

The Landfill has a design capacity of 3.44 million Megagrams and must comply with 40 CFR Part 60 Subpart WWW and have a Title V Operating Permit. Correspondingly, the County applied for a Title V Operating Permit in July 2008. The permit (Permit No. TV-2060-0300) was issued by the SCDHEC on October 5, 2009, effective January 1, 2010.

In accordance with 40 CFR Part 60.754, the County must submit NMOC emission calculations to the US Environmental Protection Agency (USEPA) every five years. According to the most recent NMOC Emission Rate Report completed in January 2009, based on actual Landfill filling rates, the Landfill's NMOC emissions in 2009 were 35.02 Mg per year. Therefore, the County is not subject to the collection and control standards of the NSPS and was not required to expand the pre-existing LFG collection system to comply with NSPS requirements. The Landfill is not expected to exceed the 50 Mg per year threshold through 2017.

To ensure regulatory surplus, subsequent Tier II reports will be reassessed to ensure that the Landfill is not required to install a collection system and emission reductions remain surplus to regulatory requirements. If at any time during the Project's crediting period, the Landfill exceeds the NMOC threshold and is required to install a collection system, emission reduction credits will only be claimed until the date when the system is required to be operational.

There are no other applicable state or local regulations requiring the County to collect and destruct LFG at the site and the project activity complies with all local laws and regulations.

1.12 Ownership and Other Programs

1.12.1 Proof of Title / Right of Use

The gas collection system, gas treatment system, flare and pipeline to Milliken are owned by Spartanburg County. The equipment used to burn LFG at Milliken's plant is owned by Milliken. Lockhart Power owns and operates all of its electricity generation equipment. Together, these entities maintain overall control over the project and the emission reductions generated. Per VCS, right of use may be demonstrated by an enforceable and irrevocable agreement with the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions and/or removals which vests the right of use in the project proponent (Option 5). Copies of the agreements between Spartanburg County and Lockhart Power and between Spartanburg County and Milliken have been provided to the Validator as evidence of the right of use of each Project Proponent.

Lockhart power has ownership over all VCU's generated by the project.

1.12.2 Emissions Trading Programs and Other Binding Limits

Not applicable as the project is not subject to any binding emission trading program.

1.12.3 Participation under Other GHG Programs

The Project has not created emission reductions credits in any other GHG program apart from the VCS. Periodic attestation will be supplied to the verifier as needed.

1.12.4 Other Forms of Environmental Credit

The Project has not created emission reductions credits in any other GHG program apart from the VCS.

1.12.5 Projects Rejected by Other GHG Programs

The Project has not been rejected under any other GHG program.

1.13 Additional Information Relevant to the Project

Eligibility Criteria

Section not applicable since the project activity is not a Grouped Project.

Leakage Management

The project activity does not anticipate any leakage emissions.

Commercially Sensitive Information

The following commercially sensitive information is not included in this PDD but will be provided to the verifier, as required:

- Agreement between Blue Source and Lockhart Power;
- Agreement between Spartanburg County and Lockhart Power;
- Agreement between Spartanburg County and Milliken;
- LandGem model using proprietary K and L₀ values developed by SCS Engineers used in the estimation of ex-ante emission reductions;
- Proprietary K and L₀ values developed by SCS Engineers used in the estimation of ex-ante emission reductions; and
- Discussion of contract structures between Spartanburg County, Lockhart and Milliken as they pertain to the Barriers Analysis in Section 2.5.1.

Further Information

In the calculation of baseline emissions, ACM0001 requires that the amount of methane that would have been destroyed / combusted in the absence of the Project be subtracted from the quantity of methane destroyed / combusted as a result of the Project Activity.

Metering of the quantity and composition of LFG collected from the project system prior to comingling with the pre-project gas flow will be conducted, to ensure that credits are only claimed for the incremental quantity of methane captured from the project collection system. As such, no baseline deduction is required.

2 APPLICATION OF METHODOLOGY

2.1 Title and Reference of Methodology

Approved consolidated baseline methodology ACM0001, Version 11.

2.2 Applicability of Methodology

The applicability criteria for ACM0001 require that:

- The baseline scenario be defined as either the partial or total release of LFG; and
- The project scenario include one of the following;
 - Flaring of captured gas;

- Use of captured gas to produce energy; and / or
- Use of captured gas to supply consumers through the natural gas distribution network.

The proposed Project Activity includes the capture of LFG and the destruction of gas by either flaring or use to generate thermal energy and/or electricity. The baseline is defined as the partial release of LFG. The Project Activity corresponds to the first two project scenarios listed above and the baseline also meets the criteria listed above.

2.3 Project Boundary

The project boundary is the site of the project activity where the gas is captured and destroyed/used.

Consistent with ACM0001, since the electricity for the project activity is sourced from grid, the power generation sources connected to the grid to which the project activity is connected are also included in the project boundary.

Although there is electricity generated by the LFG in Phase 3 of the project, which would have been generated by power generation sources connected to the grid, emission reductions from this portion of the project are not claimed. Therefore, the project boundary does not include these grid-connected power generation sources. This exclusion is conservative as it reduces baseline emissions.

A listing of the emission sources and sinks considered in the baseline and project conditions is provided below:

Table 3: Sources and Sinks Included in the Project Boundary¹

	Source	Gas	Included?	Justification / Explanation
Baseline	Emissions from decomposition of waste at the landfill site	CH ₄	Yes	The major source of emissions in the baseline
		N ₂ O	No	N ₂ O emissions are small compared to CH ₄ emissions from SWDS. Exclusion of this gas is conservative
		CO ₂	No	CO ₂ emissions from decomposition of organic waste are not accounted
	Emissions from electricity consumption	CO ₂	No	Electricity may be consumed from the grid or generated onsite/offsite. Although electricity is being generated at the Lockhart facility, emission reductions from this portion of the project are excluded. Such exclusion is conservative as it reduces baseline emissions.
		CH ₄	No	Excluded for simplification. This is conservative
		N ₂ O	No	Excluded for simplification. This is conservative
	Emissions from thermal energy generation	CO ₂	Yes	Major emission source if heat generation is included in the project activity
		CH ₄	No	Excluded for simplification. This is conservative
		N ₂ O	No	Excluded for simplification. This is conservative
Project Activity	On-site fossil fuel consumption due to the project activity other than for electricity generation	CO ₂	Yes	May be an important emission source
		CH ₄	No	Excluded for simplification. This emission source is assumed to be very small.
		N ₂ O	No	Excluded for simplification. This emission source is assumed to be very small
	Emissions from	CO ₂	Yes	May be an important emission source

¹ This table follows ACM0001, Version 11.

	Source	Gas	Included?	Justification / Explanation
	on-site electricity use	CH ₄	No	Excluded for simplification. This emission source is assumed to be very small.
		N ₂ O	No	Excluded for simplification. This emission source is assumed to be very small.

2.4 Baseline Scenario

Baseline and Additionality (Sections 2.4 and 2.5) are completed using guidance from ACM0001 and the CDM “Combined tool to identify the baseline scenario and demonstrate additionality”, Version 03.0.1 (the “CDM Tool”). The steps outlined in the CDM Tool are also addressed in Section 2.5.

2.4.1 Step 1: Identification of alternative scenarios

Sub-Step 1a: Define alternative scenarios to the VCS project activity

In this part of the step all realistic and credible alternative scenarios for the project are identified. The following potential baseline scenarios are:

Alternatives for the Disposal/Treatment of Waste

Following ACM0001, the first set of alternative scenarios for the baseline, which are defined below as Scenarios LFG1 and LFG2 assess whether LFG would have been vented or captured (i.e. whether a gas collection system would have been installed). The following potential baseline scenarios have been identified for the treatment of waste in the Project:

LFG1: The project activity (i.e. capture of landfill gas from Phases I through VI of the landfill and its flaring and/or its use) undertaken without being registered as a VCS project activity;

LFG2: Atmospheric release of the landfill gas or partial capture of landfill gas and destruction to comply with regulations or contractual requirements, or to address safety and odor concerns.

All scenarios provide the same level of service; namely the operation of the Landfill.

Energy Generation Baseline Alternatives

As outlined in ACM0001 and the CDM Tool, since the project activity includes several different facilities, technologies, outputs or services, and proposes to generate thermal energy and electricity as project stages two (2) and three (3), respectively, alternative scenarios for power and heat generation are considered below.

For power generation, the following LFG to energy scenarios are considered:

P1. Electricity generation from LFG undertaken without generating carbon credits under VCS project activity.

P2. Existing or construction of new on-site or off-site fossil fuel fired cogeneration plant;

P3. Existing or construction of a new on-site or off-site renewable based cogeneration plant;

P4. Existing or construction of a new on-site or off-site fossil fuel fired captive power plant;

P5. Existing or construction of new on-site or off-site renewable based captive power plant;

P6. Existing and/or new grid-connected power plant.

For thermal energy generation, the following LFG to energy scenarios are considered:

- H1. Heat generation from LFG undertaken without being registered as a VCS project activity;
- H2. Heat generation in existing or a new on-site or off-site fossil fuel fired cogeneration plant(s);
- H3. Heat generation in existing or new on-site or off-site renewable based cogeneration plant(s);
- H4. Heat generation in existing or new on-site or off-site fossil fuel based boiler(s), air heater(s) or other heat generating equipment;
- H5. Heat generation in existing or new on-site or off-site renewable based boiler(s), air heater(s) or other heat generating equipment
- H6. Any other source of heat such as district heating; and
- H7. Other heat generation technologies (i.e. heat pumps or solar energy).

Sub-Step 1b: Consistency with mandatory applicable laws and regulations

All of the above listed baseline alternatives are in compliance with federal, state and local regulatory requirements, ordinances and permitting requirements. Specifically, scenario LFG2, the release of LFG from Phases I through VI of the landfill, is compliant with regulations; however, this will be reassessed on an annual basis to ensure that the project does not exceed the NSPS threshold for NMOC emissions and is not required to collect and destruct LFG during the crediting period. If the landfill does become subject to regulations which would require it to collect and destroy landfill gas in the future, no credits will continue to be claimed, from either methane destruction or fossil fuel displacement.

2.4.2 Identification of baseline energy source

According to ACM0001, step two of the selection of the most plausible baseline scenario requires the identification of the fuel for the baseline energy source. As a conservative approach, ACM0001 indicates that the lowest carbon intensive fuel such as natural gas may be used.

As evidenced by a three year natural gas use summary for Milliken, the Milliken Facility currently combusts natural gas to fuel their two steam boilers and #6 fuel oil for their hot oil boiler. The boilers also burn some industrial by-products and all have No. 6 fuel oil for a back-up. The Project is not expected to displace the by-products and Milliken will continue to burn their industrial by-products at the same rate. Natural gas will be used as a start-up fuel and as needed for backup and the boilers will also retain the ability to use No. 6 fuel oil as a second backup foil. The lowest carbon intensive fuel used by the boiler is natural gas. As such, for the heat generation baseline alternatives natural gas is assumed to be the most likely baseline energy source.

For the power generation alternatives, according to the US EPA's eGrid resource mix summary table², electricity in the SRVC region where the project is located is generated predominantly by coal (51%), followed by nuclear (38%) and gas (7%). The most likely baseline scenario is therefore electricity generation with an emission intensity of 1,118.41 pounds of CO₂E per MWh. VERs are not claimed for the displacement of fossil fuel based electricity generation by Lockhart.

2.4.3 Selection of Baseline Scenario

As determined in Section 2.5 below, Scenarios LFG2, P6 and H4 are selected as the baseline activities.

² http://www.epa.gov/cleanenergy/documents/egridzips/eGRID2010V1_1_year07_SummaryTables.pdf

These scenarios are in compliance with applicable laws and regulations, are not subject to any barriers to implementation for the County. This combination is therefore identified as the most likely baseline alternative.

2.5 Additionality

2.5.1 Step 2: Barrier Analysis

Sub-Step 2a: Identify barriers that would prevent the implementation of the proposed project activity / alternatives

Since Spartanburg County owns and operates the landfill and is responsible for the treatment and disposal of waste, the decision as to whether or not to install a collection system resides squarely with this entity. Therefore, additionality is assessed from the perspective of Spartanburg County. As further described below, neither Milliken's nor Lockhart's energy projects are viable without a collection system expansion, and given the fact that Milliken has a long history of combusting natural gas and other fuels in its boilers and Lockhart is selling power into the grid that would simply be replaced by grid-sourced electricity in the absence of the utilization of landfill gas, both energy projects are a by-product of Spartanburg County's decision to proceed with the project activity.

The next step in determining the baseline scenario is a barriers analysis to assess which baseline scenarios may be prevented by barriers. This step requires the project developer to demonstrate that there are realistic and credible barriers that would prevent the implementation of the proposed project if it is not registered as a VCS project and / or other alternative scenarios.

Technical / Operational Barriers

According to a LFG Utilization Feasibility Study completed by Joyce Engineering in 2007, a minimum gas flow rate of 1,000 scfm is required by Milliken for use in its boilers. This study concluded that the implementation of a beneficial use project at Milliken would be feasible if a comprehensive collection system was installed throughout the landfill and if modeled gas flows were representative of actual gas flows.

Since at least 2005, the County had been exploring the potential development of a LFGTE project with Milliken. However due to insufficient gas flows generated by the pre-existing perimeter system, at approximately 130 scfm, in the absence of the wellfield expansion project gas flows would not have been sufficient to warrant the development of a beneficial use project by Milliken.

Similarly, according to the agreement between Lockhart and the County, a minimum of 333 scfm is required to even make operation of the Lockhart project economical, let alone to warrant investment. As such, the LFG flow rate from the pre-project system would not have been sufficient to justify the development or operation of the Lockhart component of the project.

Spartanburg County would not pursue heat and electricity generation activities on its own, primarily because it has no use for the thermal and/or electricity supply that is produced from such projects. Both captive power plants and cogeneration facilities, regardless of renewable or fossil fuel inputs, typically produce energy far in excess of the landfill's demand. Furthermore, the County does not have internal expertise or capital available to deploy to such projects.

Infrastructure Barriers

Due to the uncertainty in determining the quantity and methane composition of LFG that would be collected from landfill cells with a newly installed collection system (and an expanded system in older landfill cells), the capital costs associated with constructing a LFG to energy project prior to confirming gas flows could not be justified by the County, Lockhart or Milliken at the time of project implementation. While the County was exploring the potential implementation of these beneficial use projects prior to

expanding the collection system, there may not have been enough LFG to operate them and confirmation of gas flows was required prior to investment in project phases (2) and (3).

In support of this approach, the LFG Utilization Feasibility Study completed by Joyce Engineering in March 2007, to assess the feasibility of using LFG in Milliken's boilers and to determine the quantity and composition of LFG available, concluded that a beneficial end use project was not feasible if the collection system was not expanded. It also concluded that a beneficial end use project would only be feasible if the collection system was expanded and actual and modeled gas flows were comparable, but indicated that there are risks and limitations associated with modeling LFG flows based on a desktop analysis, flow from the pre-project perimeter collection system and pump test results. This risk could not be justified until LFG availability was confirmed through the expansion and operation of the LFG collection system for several months.

Modeling potential LFG yield is dependent on a number of assumptions, including the selection of a value for the degradable organic carbon content of the waste stream (dependant on waste composition) and the decay constant (dependant on waste composition and climate). The factors selected may or may not accurately represent any given project site. For example, the uncertainty range associated with the decay constant is -40 to +300% according to IPCC³. Modeling is also dependent on a variety of operational characteristics including whether the wells are fully functioning or become watered in, waste composition, the quality of waste disposal data, the rate of waste disposal, the date of site closure, etc.

Due to the combination of unknown and changing variables, estimates of LFG recovery are subject to a significant level of uncertainty. The volume of LFG recovered can be measured; however the rate of LFG generation cannot be directly measured, resulting in a high level of uncertainty associated with estimates of actual system collection efficiency⁴. According to the US EPA, due to the combination of unknown and changing variables, LFG collection system efficiency may vary from 60% to greater than 90%, thereby resulting in a wide spectrum of LFG recovery rates. Due to this uncertainty, development of a LFG collection and combustion project was a necessary prerequisite to quantify recoverable gas flows and help assess and improve the feasibility of a future beneficial use project.

In addition to the potential discrepancy between modeled and actual gas flows, according to the US EPA there are a number of additional barriers to implementation associated with constructing a LFG beneficial use project⁵. Project implementation is time intensive and project developers must account for the time required to obtain necessary financing, select a contractor, design and construct the project, secure construction contracts, and obtain the necessary permits for construction and operation. According to the US EPA, the estimated time required for permitting LFGTE projects can range from six to 18 months (or longer)⁶. Negotiation of a LFG sales agreement would also be required, which requires additional time, followed by system construction.

In terms of construction, the development of the Milliken and Lockhart LFGTE projects required the installation of additional gas treatment equipment to process the gas prior to delivery, the installation of a LFG generator and associated equipment at the Lockhart Facility, the modification of the boilers/heater at the Milliken Facility for the use of LFG, and the construction of a pipeline to transport gas to each facility. Construction required significant time and effort by the County and its consultants. Permits to construct and operate the Lockhart facility were also required.

Institutional / Investment Barriers

³ IPCC. (2000). Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories: Chapter 5 Waste. Retrieved from <http://www.ipcc-nggip.iges.or.jp/public/gp/english/index.html>

⁴ US EPA.(2010, September). Landfill Gas Energy Project Development Handbook. Landfill Gas Methane Outreach Program (LMOP).

⁵ US EPA.(2010, September). Landfill Gas Energy Project Development Handbook. Landfill Gas Methane Outreach Program (LMOP).

⁶US EPA.(2010, September). Landfill Gas Energy Project Development Handbook. Landfill Gas Methane Outreach Program (LMOP).

For this project a phased development approach was applied to mitigate the risks associated with the investment required to develop a LFGTE project. Now that the quantity and quality of gas from the Landfill have been characterized, the County, Milliken and Lockhart have invested in, and have constructed LFGTE projects to use the gas collected from the Landfill.

Landfill gas (LFG) projects are commonly developed using this phased approach, whereby Phase one (1) includes the voluntary development of a LFG collection and destruction system and is used to assess the quality and composition of LFG recovered from a given landfill. If LFG flow rates are sufficient and energy market conditions warrant further investment then development of the LFG to energy project is pursued as Phase two (2).

However, LFG flaring projects do not generate any revenue for the project developer and investment in Phase one (1) projects is only made possible only with the revenue generated from the issuance and sale of VERs. As indicated above, given that LFG modeling is subject to a high level of uncertainty and there is no guarantee that modeled flows will be consistent with actual gas flows, there is no assurance that a phase two (2) beneficial use project will even be possible. Since the development of a phase two (2) project is not assured prior to confirming gas flows and is also highly dependent on fluctuating energy prices, in the absence of carbon credit revenues, a return on investment for phase one (1) of the project could not be guaranteed.

Even in cases where a phase two (2) beneficial use project is feasible, LFG to energy projects produce modest returns compared to other investments; in most states energy prices are low and it is the additional revenue from the environmental benefits (both Renewable Energy Credits and VERs) that make these projects feasible. Given the requirement for a phased development approach, revenue from energy-derived sources (RECs and Green Pricing Programs) do not help overcome phase 1 investment. Registration as a VCS project alleviates the barriers that prevent the proposed project activity from occurring by introducing an additional revenue stream to drive phase one (1) investment.

LFG to energy projects are subject to an enhanced degree of project-specific risk related to confirming gas flows, and the return on risk necessary to justify the substantial investment in a LFG beneficial use project presents a substantial burden to these projects, especially without the revenues from REC and VER sales. According to the US EPA, there are many barriers to the implementation of LFG to energy projects in the United States, which include a lack of information and a perception of high risk, high costs and low rate of return associated with these projects, permitting and regulatory difficulties, and poor market conditions⁷. In this case, the Landfill is also owned by a government body, and government owned organizations tend to be risk-averse and non-speculative. As such, registration as a VCS project was required to achieve a guaranteed return on investment for the LFG collection system and was a necessary pre-requisite to the development of this system.

The project was initiated to take advantage of beneficial use opportunities, such as generating and marketing greenhouse gas emission reduction credits. While the potential for other revenue streams existed, these revenues were too risky on their own to warrant investment in the project. When making investment decisions, it is just as important to account for revenue risks as it is to account for revenue potential. [COMMERCIAL SENSITIVE INFORMATION REMOVED]

In acknowledgment of these risks, revenue from carbon credits was extremely important to the County, and without it, the County would have waited to expand the collection system until required to do so by regulations. Therefore, if the Project was not registered as a VCS project, there would be no revenue. Without this revenue, the Project would not be able to recover investment costs and would not have been developed.

Step 2b: Eliminate scenarios which are prevented by the identified barriers

⁷ US EPA. (1996). Renewable Energy Annual. Energy Information Administration: Department of Energy. Washington, DC.

Due to the risks associated with modelling gas flows and the numerous barriers to implementation associated with constructing a LFG beneficial use project at the Milliken and Lockhart facilities (described above in Infrastructure Barriers), Scenario LFG1 is not a viable option since there is absolutely no incentive to expend capital on a project that provides the same level of service as continuing to allow the LFG from Phases I through VI to be vented. This leaves LFG2 as the only viable alternative for the treatment of waste.

Considering the lack of energy demand at the County, coupled with the additional level of effort and capital investments that would have been required to build a new heat generation facility or an alternative electricity generation facility (Technical / Operational Barriers), and given that the County was already in discussions with Milliken and Lockhart at the time of project implementation, alternative energy generation alternatives (P2) through (P5) and (H2) through (H6) are eliminated without further consideration.

Based on the magnitude of pre-project gas flows (described above in Technical/Operational Barriers), the development of beneficial use projects by Lockhart and Milliken would not have been feasible in the absence of a LFG collection system expansion. Since LFG2 has been deemed to be the baseline scenario for the treatment of waste, Scenarios P1 and H1 could not have been completed in the absence of the project activity and are therefore eliminated. If the collection system had not been expanded, Milliken would have continued using fossil fuels to power its boilers and electricity would have been generated by a new or existing grid-connected power plant. As such, energy-related baseline alternatives P6 and H4 are the only remaining alternatives.

2.5.2 Does the VCS Alleviate the Barriers?

If following the Barriers Analysis only one alternative remains, the CDM Tool requires that registration as the VCS project alleviate the prohibitive barriers.

Registration as a VCS project eliminates the barriers to develop the project because it provides an incentive for Spartanburg County to install the Phase 1 collection system despite the risks that an energy project might never have happened. The revenue from the VER credit stream de-risks the project sufficiently such that the phased development approach can proceed. As a result of the VCS, not only is methane prevented from entering the atmosphere, but additional fossil fuels from energy generation are able to be displaced.

2.5.3 Selection of Remaining Alternatives

As assessed in this section (and consistent with Section 2.4.3), Scenarios LFG2, P6 and H4 are the only remaining alternatives.

These scenarios are in compliance with applicable laws and regulations, are not subject to any barriers to implementation for the County. As previously noted, scenario LFG2 will be evaluated in each monitoring period to ensure it is not required by regulations. If the landfill does become subject to regulations which would require it to collect and destroy landfill gas in the future, no credits will continue to be claimed, from either methane destruction or fossil fuel displacement.

2.5.4 Step 4: Common Practice Analysis

Following the CDM tool, a common practice analysis is conducted as the final step to determining if the Project is additional. The common practice analysis is used as a final quality check to assess the level to which similar activities to the Project have been adopted within the applicable sector and geographical area. Where similar activities are identified, CDM requires that they be assessed to identify essential distinctions between the Project and other similar activities as a means to demonstrate that the existence of these activities does not contradict the claim that the proposed Project is financially / economically unattractive or subject to barriers unless it is registered as a VCS project.

As CDM's Combined Tool v.3.0.1 suggests, the relevant geographical area should be in principle the host country (United States of America) of the proposed project activity; however, a region within the country could be the relevant geographical area if the framework conditions vary significantly within the country. The relevant geographical area should include preferably ten facilities (or projects) that provide outputs or services with comparable quality, properties and application areas as the proposed CDM project activity. According to the EPA's LMOP database⁸, South Carolina has 51 MSW landfills, of which only 11 sites have implemented LFG to energy projects, allowing the state of South Carolina to be considered the relevant geographical area.

There is currently limited development of LFG capture and destruction projects in the United States at non-regulated landfills. Large landfills where these projects tend to be more economical are typically regulated and are therefore required to install a LFG collection system to control NMOC emission rates. Of those with an energy component, four are direct use boiler projects (<8%), eight are electricity generation projects (<15%) and only one landfill has both a direct use and electricity generation component. A listing of these projects is provided below. Information regarding the status of gas collection at the remaining 40 landfills in South Carolina is not readily available but it is reasonable to assume that these landfills do not have operational LFG to energy projects.

Landfill Name	Location	LFGTE Project Type	Electricity Capacity (MW)	Waste in Place (tons)	Registered as a VCS/CAR Project (Yes/No)
Anderson Regional Landfill	Belton	Electricity	3.2	1,497,000	No
Enoree Landfill	Greer	Electricity	3.2	2,573,786	Yes (CAR) ⁹
Georgetown County Landfill	Georgetown	Electricity	1.2	1,179,565	No
Greenwood Landfill	Greenwood	Direct	NA	1,904,959	Yes (CAR)
Horry County Landfill	Conway	Electricity	3.0	4,681,748	No
Langley Landfill	Langley	Direct	NA	1,273,000	No
Lee County Landfill	Bishopville	Electricity	10.9	3,674,775	No
Palmetto Landfill	Wellford	Direct and Electricity	11.0	19,537,406	No
Richland County Landfill	Elgin	Electricity	5.5	15,250,000	No
Three Rivers Regional MSWLF	Jackson	Direct	NA	2,890,700	Yes
Berkeley County LF	Moncks Corner	Electricity	1.5	2,715,200	Yes (CAR)

According to the CDM Tool, other projects registered with a VER program should not be included in the common practice analysis, therefore the Greenwood, Enoree, Three Rivers and Berkeley County projects are not considered further. Furthermore, projects required by law to collect and destroy LFG are involuntary by nature and are not comparable. Anderson Regional, Lee County, Palmetto, and Richland County are eliminated since they are required to collect and destroy landfill gas due to NSPS requirements. Langley is also eliminated because it was required to install its gas collection system to mitigate off-site migration issues. As a result of mandatory requirements excluding these landfills, only 2 landfills remain for comparison, Georgetown County and Horry County.

Upon examination of the Georgetown project, Santee Cooper (a state-owned utility in South Carolina) was interested in a project at this site as part of its push for several LFGTE projects in SC, and it paid for the collection system and energy component. The County did not pay for the collection system, which was specifically installed for the energy project. Santee Cooper was investing in these projects from a somewhat different lens in that it was not entirely driven by economics. State-owned utilities have a

⁸ <http://www.epa.gov/lmop/projects-candidates/operational.html>

⁹ Project is registered as the 'Greenville County Landfill Gas Utilization Project'.

different business model entirely. The case where the utility pays for all infrastructure is certainly not typical of other LFG/LFGTE projects in SC and represents for Georgetown the elimination of a major barrier which Spartanburg County faced (raising its own funds to complete construction of the collection system). Spartanburg had to issue bonds to pay for its wellfield expansion, an essential distinction and a significant barrier which Georgetown did not face and to which the proposed project activity is subject.

The Horry County project is substantially larger than the Spartanburg County landfill, with 4.25 million Megagrams of waste in place as opposed to Spartanburg's 2.26 million Megagrams. Since total waste in place is a major driver of total gas generation, it is probable that the Horry County landfill produces significantly more gas, thus improving its energy-based economics.¹⁰ As further evidence of this, the Horry County project is producing 3.3 MW of electricity.¹¹ Spartanburg County would only be able to produce roughly 2 to 2.4 MW if all gas was directed toward electricity production (based on an average of 400 cfm required per MW of generation¹²). This represents a benefit to Horry County that Spartanburg cannot realize and which made that project more financially attractive.

The discrepancy between the number of active LFG to energy projects and the number of potential project sites also suggests that installing LFG to energy projects is not common practice, and that barriers exist to developing these projects in South Carolina.

Based on this analysis LFG to energy projects are not common practice in South Carolina and there are no other landfills in the state that meaningfully resemble the Spartanburg project which are not already pursuing carbon revenue. Lastly, there are no other comparable landfills in the state with both a direct use and electricity component.

Based on this assessment and demonstration of additionality, the Project is additional.

2.6 Methodology Deviations

2.6.1 MD_{BL}

MD_{BL}, the baseline discount which calculates the amount of methane destroyed historically for the previous year before the start of the project, is measured differently in this project. The basis for this deviation is because of how the new collection system was designed and constructed. The project proponents understand that the Landfill had several existing LFG extraction wells that were installed in the late 1990's and early 2000's. Given the start-up date of those extraction wells, any LFG recovered from them is not eligible for GHG reduction credits. When SCS Engineers designed the recent expansion to the wellfield at the Landfill, the new LFG extraction wells were routed to a separate collection system, and the LFG collected from these new wells does not mix with LFG from the old wells until a point just before the LFG is flared. The LFG recovered from the new wells is measured for flow rate and methane concentration before it is mixed with LFG collected from the old wells.

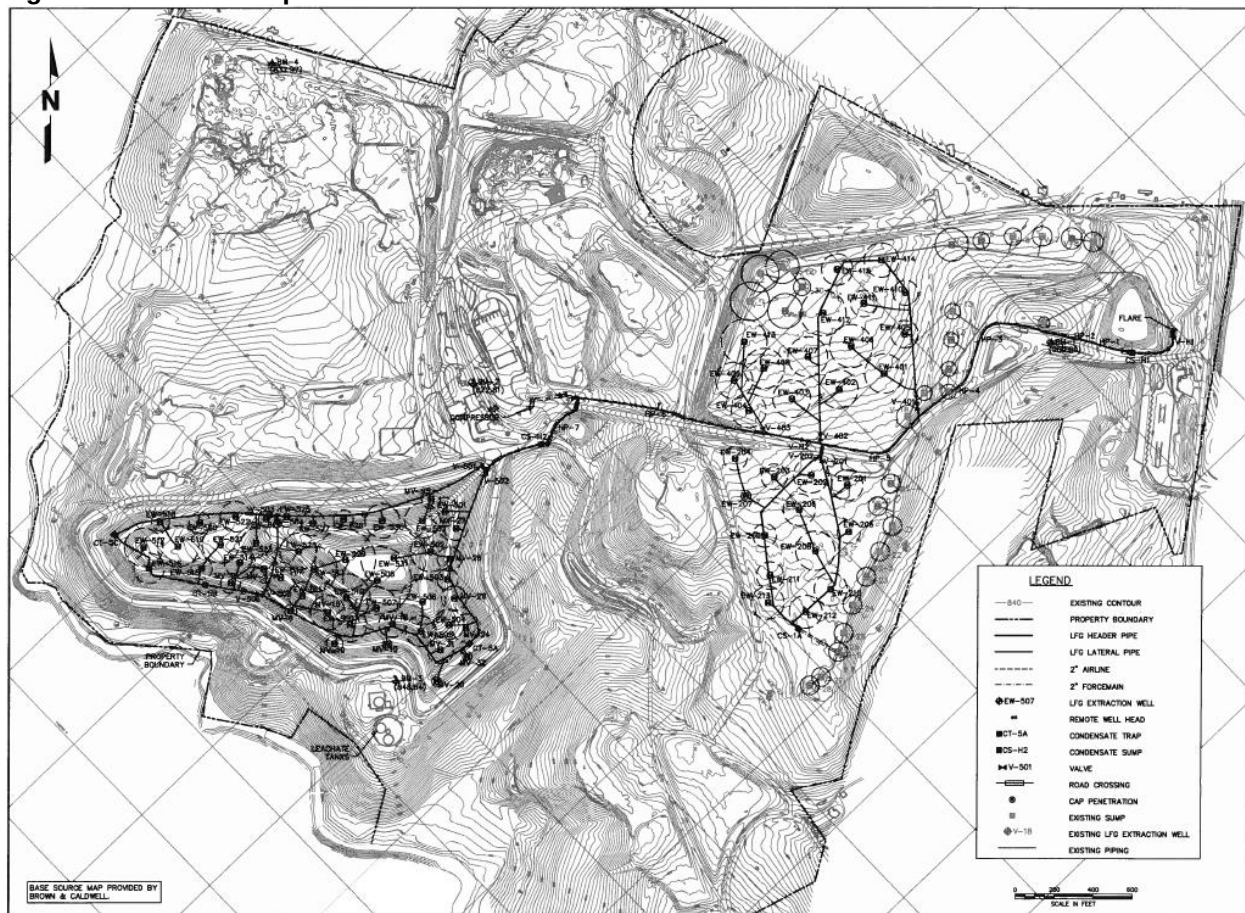
Upon inspection of the Wellford wellfield map showing radii of influence (Figure 2), it appears that three project wells' radii of influence may overlap with those of three pre-project perimeter wells.

¹⁰ Waste in place is the best available public data for comparisons related to the quantity of methane produced from landfills. The CAR landfill gas protocol uses waste in place to include or exclude LFGTE projects from its performance standard.

¹¹ "Green Power Markets," Renewable Energy Certificates, Santee Cooper, U.S. Department of Energy, Energy Efficiency and Renewable Energy, July 2005, <http://apps3.eere.energy.gov/greenpower/markets/certificates.shtml?page=2&companyid=224>.

¹² "LFG Energy Project Development Handbook," Chapter 3. Project Technology Options, Table 3-3. Internal Combustion Engine Sizes, U.S. EPA, LMOP, http://www.epa.gov/lmop/documents/pdfs/pdh_chapter3.pdf.

Figure 2. Wellfield Map of Wellford Landfill



The project wells in question are EW-210, EW-412 and EW-413, with concerns of overlap with perimeter wells V-24, V-29 and V-01, respectively. After calculating the amount of overlap for each of these scenarios based on each well's radius of influence and distance from one another, the overall impact of the overlap is calculated assuming an equal distribution of flow across each of the 41 wells in the perimeter system. The perimeter system as a whole is anticipated to produce 160.3 scfm, or 3.91 scfm per well. The following results are determined:

- EW-210 does not overlap with V-24.
- EW-412 potentially overlaps V-29 by up to 13 ft. The impacted area on V-29's 24,328 ft² area of influence is 625 ft², or 2.57% of its total area of influence. This could result in an error of 0.100 scfm, or 0.014%.
- EW-413 potentially overlaps V-01 by up to 5 ft. The impacted area on V-01's 30,171 ft² area of influence is 149 ft², or 0.49% of its total area of influence. This could result in an error of 0.019 scfm, or 0.003%.

Although potential maximum errors are shown above, in all likelihood the radii of influence is very unlikely to overlap. This is due to a number of factors, including the fact that perimeter wells must be operated at a lower vacuum to reduce the risk of air intrusion into the landfill, which in turn reduces their radius of influence. Furthermore, even in the case that equal vacuum were to be applied to perimeter and project wells, the perimeter well is always in closer proximity to the area of overlap than the project well due to its shallower depth and reduced radius of influence. Therefore, gas flow would tend to flow toward the perimeter well.

The maximum potential error is immaterial (less than 0.02% in aggregate), far less than errors due to instrumentation accuracy ranges or rounding to significant digits. More importantly, true overlap is not likely to occur at all, but in the event that it does, gas is likely to be directed to the pre-project wells, causing no error at all. As such, the deviation is acceptable since it does not negatively affect the conservativeness of the calculations.

2.6.2 Flare Efficiency

Following the options outlined in the CDM “Tool to determine project emissions from flaring gases containing methane,” a default flare efficiency is used. The CDM tool specifies a default flare efficiency of 50% for open flares; however, a flare efficiency of 98% is applied instead. This represents the flare efficiencies typically achieved in the United States for flares designed in accordance with 40 CFR 60.18. This standard specifies requirements for flare operating variables (i.e. Btu content, exit velocity) that must be met in order to achieve 98% or higher flare destruction efficiencies, and are applicable if the flare is operated in accordance with design limits. The flare’s design limits specify that the flare is designed in accordance with 40 CFR 60.18. The flare will achieve 98% destruction efficiency if operated within design limits of 100 scfm to 1,000 scfm and a gas methane content of at least 20%. This flare efficiency is widely accepted in the United States since 40 CFR 60.18 has caused flare manufacturers to develop flares specifically designed to meet this criteria. As such, the proposed deviation, which impacts the measurement and monitoring of flare efficiency, is accurate and does not negatively affect the conservativeness of the calculations.

2.6.3 Grid-Connected Electricity Emission Factor

For determination of the emission factor for grid connected electricity generation ($EF_{EL,j,y}$), ACM0001 indicates that the ‘Tool to calculate the emission factor for an electricity system’ should be used. Under Option A2 a conservative default value may be used instead. Following ACM0001 only project emissions from electricity consumption are calculated, therefore a default value of 1.3 tonnes CO₂ per MWh would be applied. However given the generation mix and emission intensity of electricity generation from the applicable regional grid, this value is not representative of the emissions associated with electricity generation for the Landfill. A deviation from the methodology is proposed and the emission factor for electricity generation ($EF_{EL,j,y}$) is determined as outlined below:

The grid average emission intensity of electricity generation in the region was examined to define a value to the CO₂ emissions intensity of the project source of grid-connected electricity. The electricity grid from which the Landfill draws electricity is part of the SRVC region. The emission rate of electricity generation from this grid in 2007 was 0.507 tonnes CO₂ per MWh. The emission factor for electricity generation ($EF_{EL,j,y}$) is assigned this value. Since this deviation reflects an accurate measurement of the emission factor, conservativeness of the calculations is not negatively impacted.

2.6.4 Quantity of Thermal Energy Produced Utilizing LFG

The quantity of thermal energy produced utilizing LFG which in the absence of the project activity would have been produced from onsite/offsite fossil fuel fired boiler, $ET_{LFG,y}$, is required to be monitored continuously according to ACM0001. Such continuous monitoring is not appropriate for the project activity since Milliken utilizes LFG in three separate boilers, all of which also burn natural gas, sometimes concurrently. It is therefore not possible to accurately monitor the thermal energy produced using the enthalpy approach in conjunction with a steam meter.

To account for this, a deviation to ACM0001 is proposed whereby $ET_{LFG,y}$ will be determined by multiplying the amount of methane utilized in Milliken’s boilers by the NCV of methane and by the efficiency of the boilers. Net Caloric Value (NCV), also known as Low Heating Value (LHV), is a conservative way to measure energy content of natural gas displaced by LFG because NCV accounts for energy losses due to moisture contained in the fuel. Since two stages of gas treatment are undertaken to dry the gas prior to combustion in Milliken’s boilers, the actual energy content achieved in combustion is

most likely much closer to the High Heating Value (HHV), also known as the Gross Caloric Value (GCV), of methane. NCV in this application represents a low value of energy content compared to what is likely actually being achieved.

It is noted that when calculating emission reductions, it is conservative to use a high boiler efficiency (ϵ_{boiler}) in Equation 12, whereas it is conservative to use a lower boiler efficiency ($\epsilon_{\text{boiler,BL}}$) in Equation 11. In recognition of this, $\epsilon_{\text{boiler,BL}}$ is calculated in accordance with the CDM “Tool to determine the baseline efficiency of thermal or electric energy generation systems,” Version 01. This Tool permits the use of a conservative default value for various types of heat generating equipment. The lowest relevant value “Old natural gas fired boiler (w/o condenser)” has been used for $\epsilon_{\text{boiler,BL}}$, a value of 87%.

This deviation which addresses the measurement of thermal energy is a conservative approach to determining the baseline emissions due to generation of thermal energy using fossil fuels at Milliken’s facility.

2.6.5 Operation of the Boiler/Air Heater/Heat Generating Equipment

Rather than measuring operation of the boiler/air heater/heat generating equipment in terms of hours of operation (which would not be accurate given Milliken’s concurrent use of natural gas in its boilers), to ensure that all LFG sent to the Milliken boilers is burned and not vented to the atmosphere, Milliken has fail-safes built into the control system on each boiler gas train that include two automatic valves that shut anytime the landfill gas line is switched off or the boiler goes down. This stops the flow of gas to the boiler. This deviation pertains to measurement of an operational parameter and does not negatively impact conservativeness in any way.

2.6.6 Measurement of Methane Content and Flow to the Milliken Facility

It should be noted that LFG flow to the Milliken facility is measured on a dry basis, while the applicable methane content is measured on a wet basis. Measuring methane content (along with temperature and pressure) on a wet basis and flow rate on a dry basis results in a conservative calculation of the fraction of methane in the landfill gas. This is because after the gas is de-watered, the methane fraction will be larger, while the overall volume of gas will be smaller. If methane fraction is measured on a wet basis and flow is measured on a dry basis, the resulting figures for methane volume will always be lower than if both measurements were taken on the same basis (both wet or both dry).¹³

2.6.7 Use of LandGEM Model in Ex-Ante Calculations

Instead of estimating ex-ante baseline methane emissions using the CDM “Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site”, the US EPA LandGEM Landfill Gas Emissions model is used. This is the accepted standard for developing LFG curves in the United States. The LandGEM model requires the user to input variables to determine the emissions associated with disposal of waste at the solid waste disposal site. For this project, proprietary K and L_0 values developed by SCS Engineers and inputted into the LandGEM model. The use of the LandGEM model is generally accepted as the most accurate way to model landfill gas emissions in the United States and only impacts the estimation of ex-ante emission reductions. It does not impact the conservativeness of emission reduction quantification in any way.

¹³ http://www.climateactionreserve.org/wp-content/uploads/2011/10/Errata_and_Clarifications_LFPP_V3.0_102611.pdf

3 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

3.1 Baseline Emissions

The following equation is used to determine baseline emissions:

$$BE_y = (MD_{\text{project}, y} - MD_{\text{BL}, y}) * GWP_{\text{CH}_4} + ET_{\text{LFG}, y} * CEF_{\text{ther}, \text{BL}, y} \quad (1)$$

Where:

- BE_y = Baseline emissions in year y (tCO₂e)
- $MD_{\text{project}, y}$ = The amount of methane that would have been destroyed/combusted during the year, in project scenario (tCH₄)
- $MD_{\text{BL}, y}$ = The amount of methane that would have been destroyed/combusted during the year in the absence of the project due to regulatory and/or contractual requirements (tCH₄)
- GWP_{CH_4} = Global Warming Potential value for methane (tCO₂e / tCH₄)
- $CEF_{\text{ther}, \text{BL}, y}$ = CO₂ emissions intensity of the fuel used by boiler to generate thermal energy which is displaced by LFG based thermal energy generation (tCO₂e/GJ).
- $ET_{\text{LFG}, y}$ = The quantity of thermal energy produced utilizing LFG, which in the absence of the project activity would have been produced from onsite/offsite fossil fuel fired boiler, during the year y (GJ)

For this project, the flow of methane from the project system is metered prior to comingling with the pre-project collection system and the baseline deduction ($MD_{\text{BL}, y}$) is equal to zero.

Calculation of Quantity of Methane Destroyed

The methane destroyed by the Project ($MD_{\text{project}, y}$) is then calculated based on the quantity of methane flared, used to generate electricity or used to generate thermal energy as follows:

$$MD_{\text{project}, y} = MD_{\text{flared}, y} + MD_{\text{electricity}, y} + MD_{\text{thermal}, y} \quad (2)$$

Where:

- $MD_{\text{flared}, y}$ = Quantity of methane destroyed by flaring (tCH₄)
- $MD_{\text{electricity}, y}$ = Quantity of methane destroyed by generation of electricity (tCH₄)
- $MD_{\text{thermal}, y}$ = Quantity of methane destroyed for the generation of thermal energy (tCH₄)

The proportion of methane collected by the project system and flared, combusted at the Lockart Facility and Combusted at the Milliken facility will be calculated as follows:

$$\text{Proportion}_{\text{Flared}, y} = (LFG_{\text{flare}, y} * w_{\text{CH}_4 \text{ flare}, y}) / ((LFG_{\text{flare}, y} * w_{\text{CH}_4 \text{ flare}, y}) + (LFG_{\text{thermal}, y} * w_{\text{CH}_4 \text{ thermal}, y}) + (LFG_{\text{electricity}, y} * w_{\text{CH}_4 \text{ electricity}, y})) \quad (3)$$

$$\text{Proportion}_{\text{Electricity}, y} = (LFG_{\text{electricity}, y} * w_{\text{CH}_4 \text{ electricity}, y}) / ((LFG_{\text{flare}, y} * w_{\text{CH}_4 \text{ flare}, y}) + (LFG_{\text{thermal}, y} * w_{\text{CH}_4 \text{ thermal}, y}) + (LFG_{\text{electricity}, y} * w_{\text{CH}_4 \text{ electricity}, y})) \quad (4)$$

$$\text{Proportion}_{\text{Thermal}, y} = (LFG_{\text{thermal}, y} * w_{\text{CH}_4 \text{ thermal}, y}) / ((LFG_{\text{flare}, y} * w_{\text{CH}_4 \text{ flare}, y}) + (LFG_{\text{thermal}, y} * w_{\text{CH}_4 \text{ thermal}, y}) + (LFG_{\text{electricity}, y} * w_{\text{CH}_4 \text{ electricity}, y})) \quad (5)$$

Where:

- $LFG_{\text{flare}, y}$ = Quantity of LFG fed to the flare(s) during the year (ft³)
- $w_{\text{CH}_4 \text{ flare}, y}$ = Average methane fraction of LFG delivered to the flare during the year (ft³ CH₄/ ft³ LFG)
- $LFG_{\text{electricity}, y}$ = Quantity of LFG fed into Lockhart's generator during the year (ft³)
- $w_{\text{CH}_4 \text{ electricity}, y}$ = Average methane fraction of LFG fed into Lockhart's generator during the year (ft³ CH₄/ ft³ LFG)
- $LFG_{\text{thermal}, y}$ = Quantity of LFG fed into Milliken's boilers during the year (ft³)
- $w_{\text{CH}_4 \text{ thermal}, y}$ = Average methane fraction of LFG fed into Milliken's boilers during the year (ft³ CH₄/ ft³ LFG)

The quantity of methane captured by the project system and destroyed by flaring ($MD_{\text{flared},y}$) is calculated as:

$$MD_{\text{flared},y} = LFG_{\text{Project total},y} * W_{\text{CH}_4,y} * D_{\text{CH}_4} * \text{Proportion}_{\text{Flared},y} - PE_{\text{flare},y} / GWP_{\text{CH}_4} \quad (6)$$

Where:

$LFG_{\text{Project total},y}$ = Quantity of LFG collected from the project system during the year (ft^3)
 $W_{\text{CH}_4,y}$ = Average methane fraction of the LFG as measured during the year ($\text{in ft}^3 \text{CH}_4 / \text{ft}^3 \text{LFG}$)
 D_{CH_4} = Methane density expressed in tonnes of methane ($\text{tCH}_4 / \text{ft}^3 \text{CH}_4$)
 $PE_{\text{flare},y}$ = Project emissions from flaring of the residual gas stream in year y (tCO_2e) determined following the procedure described in the “Tool to determine project emissions from flaring gases containing Methane”

Following commissioning of the Lockhart Project the quantity of methane destroyed for electricity generation ($MD_{\text{electricity},y}$) that consists of project gas will be calculated as:

$$MD_{\text{electricity},y} = LFG_{\text{Project total},y} * W_{\text{CH}_4,y} * D_{\text{CH}_4} * \text{Proportion}_{\text{Electricity},y} \quad (7)$$

Following commissioning of the Milliken Project the quantity of methane destroyed for thermal energy generation ($MD_{\text{thermal},y}$) that consists of project gas will be calculated as:

$$MD_{\text{thermal},y} = LFG_{\text{Project total},y} * W_{\text{CH}_4,y} * D_{\text{CH}_4} * \text{Proportion}_{\text{Thermal},y} \quad (8)$$

Project Emissions from Flaring

The project emissions from flaring ($PE_{\text{flare},y}$) are calculated following the methodology outlined in the CDM Annex 13 “Tool to determine project emissions from flaring gases containing methane”.

Flare Efficiency

Following the options outlined in the CDM tool, a default flare efficiency is used. The CDM “Tool to determine project emissions from flaring gases containing methane” specifies a default flare efficiency of 50% for open flares.

However, a flare efficiency of 98% is applied instead. This represents the flare efficiencies typically achieved in the United States for flares designed in accordance with 40 CFR 60.18. This standard specifies requirements for flare operating variables (i.e. Btu content, exit velocity) that must be met in order to achieve 98% or higher flare destruction efficiencies, and are applicable if the flare is operated in accordance with design limits.

The flare’s design limits specify that the flare is designed in accordance with 40 CFR 60.18. The flare will achieve 98% destruction efficiency if operated within design limits of 100 scfm to 1,000 scfm and a gas methane content of at least 20%. To ensure the flare is operated within these limits, the flow rate of gas to the flare and methane content of the LFG will be monitored to ensure that they are within design limits. The flare will shut-off if the thermocouple indicates a temperature of less than 300F, but this value may be adjusted according to changing conditions. There is also a UV scanner (flame detection system) and thermocouple to make sure the flare stays lit, and to shut it down when it is not. For visual emissions, Lockhart has historically made visual observations of any visible emissions and recorded any instances of such. Effective March 1, 2012, a checklist requiring the on-site operator to visually check stack emissions each day that the operator is on site and report any unusual visual emissions for follow-up maintenance will be instituted. Currently the operator is on site 4 days per week. This will ensure that the flare is operated according to the specifications required to ensure a destruction efficiency of 98%.

To calculate project emissions from flaring, the mass flow rate in the residual gas on a wet basis is calculated as follows:

$$TM_{\text{RG}} = LFG_{\text{Project total},y} * W_{\text{CH}_4,y} * D_{\text{CH}_4} * \text{Proportion}_{\text{Flared},y} \quad (9)$$

Where:

TM_{RG} = Mass of methane in the residual gas (tCH_4)
 $LFG_{Project\ total,y}$ = Quantity of LFG collected from the project system during the year (ft^3)
 $w_{CH_4,y}$ = Average methane fraction of the LFG as measured during the year ($ft^3 CH_4 / ft^3 LFG$)
 D_{CH_4} = Methane density ($tCH_4 / ft^3 CH_4$)

Emissions are then calculated as follows:

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG} * (1 - \eta_{flare}) * GWP_{CH_4} \quad (10)$$

Where:

$PE_{flare,y}$ = Project emissions from flaring of the residual gas stream in year y
 TM_{RG} = Mass flow rate of methane in the residual gas
 η_{flare} = Flare efficiency
 GWP_{CH_4} = Global Warming Potential of methane valid for the commitment period

Baseline Emissions from Thermal Energy Generation

The baseline emissions from thermal energy produced by Milliken's boilers/heater from project gas is calculated as follows:

$$ET_{LFG,y} = LFG_{Project\ total,y} * Proportion_{Thermal,y} * w_{CH_4,y} * \epsilon_{boiler,BL} * NCV_{methane} \quad (11)$$

Where:

$w_{CH_4,y}$ = Average methane fraction of the LFG as measured during the year and expressed as a fraction ($m^3 CH_4 / m^3 LFG$)
 $\epsilon_{boiler,BL}$ = The energy efficiency of the boilers used in the project activity to generate thermal energy
 $NCV_{methane}$ = Net calorific value of LFG used in the boilers to generate thermal energy (GJ per scfm)

The emission intensity of baseline thermal energy generation is then calculated as follows:

$$CEF_{ther,BL,y} = EF_{natural\ gas,BL} / (NCV_{natural\ gas,BL} * \epsilon_{boiler}) \quad (12)$$

Where:

$NCV_{natural\ gas,BL}$ = Net calorific value of fuel used in the boilers to generate the thermal energy in the absence of the project activity (GJ per unit of volume or mass)
 $EF_{natural\ gas,BL}$ = Emission factor of the fuel used in the boilers to generate the thermal energy in the absence of the project activity ($tCO_2 / unit\ of\ volume\ or\ mass\ of\ the\ fuel$)

To estimate boiler efficiency, project participants may choose between two options: Option A involves using the highest of the following three values as a conservative approach; the measured efficiency prior to project implementation, the measured efficiency during monitoring or manufacturer's information on the boiler efficiency. Alternatively, Option B includes assuming a boiler efficiency of 100% as a conservative approach.

For this project, Option B will be applied to be conservative.

To ensure that all LFG sent to the Milliken boilers is burned and not vented to the atmosphere, Milliken has fail-safes built into the control system on each boiler gas train that include two automatic valves that shut anytime the landfill gas line is switched off or the boiler goes down. This stops the flow of gas to the boiler.

3.2 Project Emissions

According to ACM0001 project emissions are defined by the following equation:

$$PE_y = PE_{EC,y} + PE_{FC,j,y} \quad (13)$$

Where:

$PE_{EC,y}$ = Emissions from consumption of electricity in the project case.

$PE_{FC,j,y}$ = Emissions from consumption of fossil fuels in the project case.

Electricity Emissions

The project emissions from electricity consumption ($PE_{EC,y}$) are calculated following the methodology outlined in the CDM Annex 7 "Tool to calculate baseline, project or leakage emissions from electricity consumption" Version, 01 as follows:

$$PE_{EC,y} = \sum_j EC_{PJ,Grid,y} * EF_{EL,Grid,y} * (1 + TDL_{Grid,y}) \quad (14)$$

Where:

$PE_{EC,y}$ = Project emissions from electricity consumption in year y (tCO₂/yr)

$EC_{PJ,Grid,y}$ = Quantity of electricity consumed by the project from the regional grid in year y (MWh/yr)

$EF_{EL,Grid,y}$ = Emission factor for electricity generation from the regional grid in year y (tCO₂/MWh)

$TDL_{Grid,y}$ = Average technical transmission and distribution losses for the regional grid in year y

During Phase one (1) of the Project, electricity is consumed to operate the blower used to transport gas to the flare and an automatic valve that prevents passive flow of LFG to the flare following system shut down. The blower is equipped with a 25 hp motor.

Electricity will also be used in Phase two (2) and three (3) of the Project, to further process and compress gas for transportation to the Lockhart and Milliken facilities and to operate auxiliary equipment required to operate the boilers at the Milliken facility.

Electricity consumption from these sources is calculated as follows:

$$EC_{PJ,Grid,y} = EC_{flare\ and\ transport,y} + EC_{Milliken,y} \quad (15)$$

Where:

$EC_{flare\ and\ transport,y}$ = Sum of the quantity of electricity consumed by the blowers used to transport gas to the flare and the quantity of electricity consumed to treat and compress gas for transportation to the Milliken and Lockhart facilities in year y (MWh/yr)

$EC_{Milliken,y}$ = Quantity of electricity consumed to operate auxiliary equipment required to operate the boilers and destruct LFG in year y (MWh/yr)

Calculation of Electricity Usage

A dedicated meter is used to monitor electricity usage at the flare and treatment skids ($EC_{flare\ and\ transport,y}$). Electricity usage at the Milliken facility ($EC_{Milliken,y}$) is not metered independently and will be calculated based on the rated capacity of the equipment used as follows:

$$EC_{Milliken,y} = L_{Milliken} \times t_{Milliken,m} \quad (16)$$

Where:

$L_{Milliken}$ = Load ratings of the equipment used to operate the boilers/heater at the Milliken facility (MW);

$t_{\text{Milliken},m}$ = Hours of operation of the equipment used to equipment used to operate the boilers/heater at the Milliken facility in month m

Load ratings are calculated based on the nameplate horsepower for each piece of equipment. Electricity consumption is calculated based on full load (minus any outages) for conservativeness as follows:

$$L_{\text{equipment},j} = \text{Rating (hp)} \times 0.746 \times 0.001 \quad (17)$$

Where:

0.746 = kW/hp

0.001 = kW/MW

Determination of $EF_{EL,j,y}$

For determination of the emission factor for grid connected electricity generation ($EF_{EL,j,y}$), ACM0001 indicates that the 'Tool to calculate the emission factor for an electricity system', Version 01.1 should be used. For determination of the emission factor for electricity generation ($EF_{EL,j,y}$) the methodology presents a number of options. In this case the electricity consumed is purchased from the regional grid and the applicable options are Option A1 and Option A2.

Option A1 is the calculation of a grid emission intensity factor following the methodology outlined in the CDM Annex 12 "Tool to calculate the emission factor for an electricity system" Version 01.1 (Option A1). However, calculation of an emission factor is data intensive and not administratively simple. Given that the project does not consume or generate a significant quantity of electricity and electricity consumption does not represent a large emission source for the project, this approach is not reasonable.

Under Option A2 a conservative default value may be used instead. Following ACM001 only project emissions from electricity consumption are calculated, therefore a default value of 1.3 tonnes CO₂ per MWh would be applied. However given the generation mix and emission intensity of electricity generation from the applicable regional grid, this value is not representative of the emissions associated with electricity generation for the Landfill. A deviation from the methodology is proposed and the emission factor for electricity generation ($EF_{EL,j,y}$) is determined as outlined below:

The grid average emission intensity of electricity generation in the region was examined to define a value to the CO₂ emissions intensity of the project source of grid-connected electricity. The electricity grid from which the Landfill draws electricity is part of the SRVC region. The emission rate of electricity generation from this grid in 2007 was 0.507 tonnes CO₂ per MWh. The emission factor for electricity generation ($EF_{EL,j,y}$) is assigned this value.

Fossil Fuel Emissions

For project Phases one (1), two (2) and three (3) flare pilot fuel represents the sole fossil fuel emission.

The project emissions from fuel consumption ($PE_{FC,j,y}$) are calculated following the methodology outlined in the CDM Annex 19 "Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion" Version 01, using Option B as follows:

$$PE_{FC,j,y} = PE_{\text{Propane},y} = FC_{\text{flare,propane},y} * COEF_{\text{Propane},y} \quad (18)$$

Where:

$PE_{\text{Propane},y}$ = are the CO₂ emissions from propane combustion during the year y (tCO₂/yr)

$FC_{\text{flare,propane},y}$ = quantity of propane used during the year y (gallons/yr)

$COEF_{\text{Propane},y}$ = CO₂ emission coefficient of propane in the year y (tCO₂/gallon)

The CDM "Tool to Calculate Project or Leakage CO₂ Emissions from Fossil Fuel Combustion" recommends calculating emission coefficients based on IPCC factors; however, no such IPCC factors

exist for propane. As such, USEPA factors are used instead¹⁴. It is possible to use the IPCC factors for Liquefied Petroleum Gas, a mixture of Propane and Butane, but the EPA factor is higher and therefore more conservative.

The CO₂ emission coefficient is calculated based on the net calorific value and CO₂ emission factor of propane (Option B), as follows:

$$\text{COEF}_{\text{Propane},y} = \text{NCV}_{\text{Propane},y} * \text{EF}_{\text{CO}_2,\text{Propane},y} \quad (19)$$

Where:

COEF_{Propane,y} = the CO₂ emission coefficient of propane used (tCO₂/gallon);
 NCV_{Propane,y} = the weighted average net calorific value of propane (MMBtu/gallon)
 EF_{CO₂,Propane,y} = the weighted average CO₂ emission factor of propane (tCO₂/MMBtu)

Before the Milliken project started accepting landfill gas, the three boilers were started by a natural gas pilot light. The boilers are still started with a natural gas pilot light, thus not using any additional natural gas because of the landfill gas. Milliken does not have a dedicated landfill gas boiler as the company desired to maintain flexibility to use the methane in any of the three boilers. Thus the boilers used to produce steam or hot oil is not considered a source of project emissions.

3.3 Leakage

The project activity does not anticipate any leakage emissions.

3.4 Summary of GHG Emission Reductions and Removals

Ex Ante Estimate of Emission Reductions

Following ACM0001, for comparison with the calculation of GHG emissions destroyed by the Project, Project Proponents must provide an ex ante estimate of emission reductions by projecting the future GHG emissions of the Landfill.

Instead of estimating baseline methane emissions using the CDM “Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site”, the US EPA LandGEM Landfill Gas Emissions model is used. This is the accepted standard for developing LFG curves in the United States. The LandGEM model requires the user to input the following variables to determine the emissions associated with disposal of waste at the solid waste disposal site:

$$\text{MD}_{\text{project},y} = f(W_x, F, k, Lo) \quad (20)$$

Where:

MD_{project,y} = Methane emissions generated during the year y from waste disposal at the solid waste disposal site (SWDS) during the period from the start of the project activity to the end of the year y (tCO₂e)
 F = Fraction of methane in the LFG (volume fraction) (0.5)
 W_x = Amount of waste disposed in the landfill in each year x from the year the landfill / landfill cell began accepting waste to present (tons)
 k = Decay constant (1/yr)
 Lo = Methane potential generation capacity (ft³/Mg)

Following ACM0001 the sum of the quantities fed to the flare, Milliken and Lockhart facilities will be compared annually with the total quantity of methane generated. The lowest value of the two will be adopted as MD_{project,y}.

¹⁴ U.S. EPA, Inventory of Greenhouse Gas Emissions and Sinks: 1990 – 2005 (2007), Annex 2.1, Table A-40

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y \quad (21)$$

Where:

ER_y = Emission reductions in year y (tCO₂e)
 PE_y = Project emissions in year y (tCO₂e)
 BE_y = Baseline emissions in year y (tCO₂e)

Years	Estimated baseline emissions or removals (tCO ₂ e)	Estimated project emissions or removals (tCO ₂ e)	Estimated leakage emissions (tCO ₂ e)	Estimated net GHG emission reductions or removals (tCO ₂ e)
2010	37,538	2,795	0	34,744
2011	74,032	5,264	0	68,768
2012	78,182	5,396	0	72,786
2013	79,889	5,515	0	74,373
2014	81,433	5,623	0	75,810
2015	82,830	5,721	0	77,109
2016	84,095	5,810	0	78,285
2017	85,239	5,890	0	79,349
2018	86,274	5,962	0	80,312
2019	87,211	6,028	0	81,183
2020	39,807	2,752	0	37,055
Total	816,530	56,755	0	759,775

4 MONITORING

4.1 Data and Parameters Available at Validation

A listing of the variables that are estimated or quantified using emission factors or default values is provided below.

Data / Parameter:	MD _{BL,y}
Data unit:	tonnes CH ₄
Description:	Amount of methane destroyed historically for the previous year before the start of the Project.
Source of data:	N/A
Value applied:	0

Purpose of the data:	This is used for baseline emissions
Any comment:	Prior to project implementation, some LFG was captured and flared. However, gas flow / composition from the project system is metered prior to comingling with the pre-project system. A baseline deduction is not required.

Data / Parameter:	η_{flare}
Data unit:	%
Description:	Default Flare Efficiency
Source of data:	CDM Methodological "Tool to determine project emissions from flaring gases containing methane)
Value applied:	98
Purpose of the data:	This is used for project emissions.
Any comment:	A more accurate flare efficiency for the open flare is applied based on guidance from the US EPA and the Climate Action Reserve (CAR). This approach is justified on the basis that it is more <u>accurate</u> for equipment and conditions in the United States (versus ACM0001). Further, the flare is designed and operated in accordance with 40 CFR 60.18. This standard specifies requirements for flare operating variables (i.e. Btu content, exit velocity) that must be met in order to achieve a 98% or higher flare destruction efficiency. These include max/min exit velocity, max/min BTU content, max/min flare temperature and confirmation that there are no visual emissions. The design maximum capacity of the flare is 1000 scfm. The flow meter data can be compared to the design capacity to ensure that max exit velocity is being met. The current temperature shutdown is 300F, but this value may be adjusted according to changing conditions. There is also a UV scanner (flame detection system) and thermocouple to make sure the flare stays lit, and to shut it down when it doesn't. Additionally, minimum fuel Btu content can be demonstrated through continuous methane monitoring system. Since this flare is non-assisted, it is required to have a minimum fuel content of 200 Btu/scf. This would translate into a minimum methane content of approximately 20%. Continuously monitored methane content can be reviewed to demonstrate minimum Btu Content. For visual emissions, Lockhart has the standard operating procedure for their operator to look at stack emissions when he is on site and when the flare is operating, and record any unusual visual emissions for follow-up maintenance. Beginning on March 1, 2012, a formal checklist requiring that this be done on a daily basis for each day that the operator is on site will be implemented. Currently the operator is on site 4 days per week.

Data / Parameter:	ϵ_{boiler}
Data unit:	%
Description:	Energy efficiency of the boilers used to generate thermal energy in the absence of the Project
Source of data:	Guidance from ACM0001
Value applied:	100%
Purpose of the Data:	This is used for baseline emissions.

Any comment:	To be conservative, Option B from the methodology is applied
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Data / Parameter:	$\epsilon_{\text{boiler, BL}}$
Data unit:	%
Description:	Energy efficiency of the boilers used to generate thermal energy in the absence of the Project
Source of data:	CDM "Tool to determine the baseline efficiency of thermal or electric energy generation systems," Version 01
Value applied:	87%
Purpose of the Data:	This is used for baseline emissions.
Any comment:	Selected the value for "Old natural gas fired boiler" since it is the most conservative relevant equipment type.

Data / Parameter:	GWP_{CH_4}
Data unit:	tonnes $\text{CO}_2\text{e/tCH}_4$
Description:	Global warming potential of CH_4
Source of data:	IPCC
Value applied:	21
Purpose of the Data:	This is used for baseline and project emissions
Any comment:	

Data / Parameter:	$\rho_{\text{CH}_4, n} / \text{DCH}_4$
Data unit:	tonnes $\text{CH}_4/\text{ft}^3 \text{CH}_4$
Description:	Density of Methane at normal conditions
Source of data:	http://cdm.unfccc.int/methodologies/inputsconsmeth/MGM_methane.pdf for 60 degrees F, and calculated for 75 degrees F (see comments)
Value applied:	60 degrees F and 1 atm: 1.915×10^{-5} tonnes $\text{CH}_4/\text{ft}^3 \text{CH}_4$ 75 degrees F and 1 atm: 1.867×10^{-5} tonnes $\text{CH}_4/\text{ft}^3 \text{CH}_4$
Purpose of the Data:	This is used for project emissions
Any comment:	Density at 75 degrees F and 1 atm is calculated using the ideal gas law, $P \cdot V = n \cdot R \cdot T = (m/M) \cdot R \cdot T$, where: $\rho_{\text{CH}_4} = m/V$ M = Molar mass of methane (16.04 g/mol) M = Mass of methane (g) P = Pressure, 1 atm = 101.325 kPa = 14.7 psia T = Temperature, 75 F = 23.89 C = 297.15 K R = Ideal Gas Constant = 8.314 J/(mol K)

Data / Parameter:	F
Data unit:	-
Description:	Fraction of methane in the LFG (volume fraction)
Source of data:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories and LandGEM default value.
Value applied:	0.5
Purpose of the Data:	This is used for baseline and project emissions
Any comment:	This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, under anaerobic conditions in the SWDS. A default value of 0.5 is recommended by IPCC.

Data / Parameter:	L_0
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Data unit:	m ³ /Mg
Description:	Potential methane generation capacity
Source of data:	Site-specific value developed by SCS Engineers applied to the LandGem model
Value applied:	[COMMERCIALY SENSITIVE INFORMATION REMOVED]
Purpose of the Data:	This is used for baseline and project emissions
Any comment:	

Data / Parameter:	K
Data unit:	-
Description:	Decay rate
Source of data:	Site-specific value developed by SCS Engineers applied to the LandGem model
Value applied:	[COMMERCIALY SENSITIVE INFORMATION REMOVED]
Purpose of the Data:	This is used for baseline and project emissions
Any comment:	

Data / Parameter:	TDL _{Grid,y}
Data unit:	-
Description:	Average technical transmission and distribution losses for grid in year y
Source of data:	Recent, accurate and reliable data from the United States is used to quantify the average line losses. This value is obtained from the Energy Information Administration (EIA) Department of Energy (DOE) Annual Energy Review 2009: Section 8: Electricity 264 ¹⁵
Value applied:	7%
Purpose of the Data:	This is used for baseline and project emissions
Any comment:	This value should be updated annually. In the absence of data from the relevant year, most recent figures should be used, but not older than 5 years.

Parameter	L _{Milliken}
Data Unit	MW
Description	Electricity consumption ratings of the blower fans used to operate Milliken's boilers. Fans are rated at 20 hp (for the 600 hp boiler), 7.5 hp (for the 250 hp boiler) and 15 hp (for the 400 hp boiler).
Source of Data	Manufacturer specifications
Value Applied	0.01492 MW for 20 hp fan 0.005595 MW for 7.5 hp fan 0.01119 MW for 15 hp fan Total is 0.03171 MW for all three fans
Purpose of the Data:	This is used for project emissions
Any Comment	Full load will be used in calculations for conservativeness. Relevant equipment and applicable load ratings may change and will be verified during each monitoring period.

Data / Parameter:	NCV _{methane}
Data unit:	GJ / scf
Description:	Energy content of methane

¹⁵ U.S EIA Annual Energy Review 2009 <http://ftp.eia.doe.gov/multifuel/038409.pdf> page 264

Source of data:	U.S. EPA Landfill Methane Outreach Program Interactive Conversion Tool (http://www.epa.gov/lmop/projects-candidates/interactive.html)
	The value of 1,012 Btu per scf was obtained from US EPA and was converted to units of GJ per scf by dividing the factor by a conversion factor of 947,817 Btu per GJ.
Value applied:	0.0010677
Purpose of the Data:	This is used for baseline and project emissions
Any comment:	Values will be reviewed annually to ensure they are appropriate or following any future revision of US EPA guidelines, as applicable.

Data / Parameter:	NCV _{natural gas, BL}
Data unit:	GJ / scf
Description:	Energy content of natural gas
Source of data:	U.S. EPA Inventory of GHG Emissions and Sinks
	The value of 1,029 Btu per scf was obtained from US EPA and was converted to units of GJ per scf by dividing the factor by a conversion factor of 947,817 Btu per GJ.
Value applied:	0.0010857
Purpose of the Data:	This is used for baseline emissions
Any comment:	Values will be reviewed annually to ensure they are appropriate or following any future revision of US EPA guidelines, as applicable.

Data / Parameter:	EF _{natural gas, BL}
Data unit:	tCO ₂ / scf
Description:	CO ₂ emission factor of the fossil fuel type used in the boiler (natural gas) for heat generation in the absence of the project activity
Source of data:	U.S. EPA Inventory of GHG Emissions and Sinks
Value applied:	0.0000546
Purpose of the Data:	This is used for baseline emissions
Any comment:	Values will be reviewed annually to ensure they are appropriate or following any future revision of US EPA guidelines, as applicable.

Data / Parameter:	NCV _{propane}
Data unit:	MMBtu / gallon
Description:	Energy content of propane
Source of data:	U.S. EPA Guidelines, Inventory of US Greenhouse Gas Emissions and Sinks, April 2011, Annex 2, Table A-46
	The value of 3.836 MMBtu per barrel was obtained from US EPA and was converted to units of MMBtu per gallon by dividing the factor by a conversion factor of 42 gallons per barrel.
Value applied:	0.09133
Purpose of the Data:	This is used for baseline emissions
Any comment:	Values will be reviewed annually to ensure they are appropriate or following any future revision of US EPA guidelines, as applicable. Note that IPCC values are not available for propane.

Data / Parameter:	EF _{CO₂, Propane, y}
Data unit:	t CO ₂ / MMBtu
Description:	CO ₂ emission factor for propane
Source of data:	U.S. EPA Guidelines, Inventory of US Greenhouse Gas Emissions

	and Sinks, April 2011, Annex 2, Table A-46
	The value of 16.76 kg C per MMBtu was obtained from the US EPA, and was multiplied by a factor of 44/12 to convert carbon to carbon dioxide and divided by 1000 to convert from kilograms to tons.
Value applied:	0.061453 tonnes CO ₂ / MMBtu
Purpose of the Data	This is used for baseline emissions
Any comment:	Value will be reviewed annually to ensure it is appropriate or following any future revision of the US EPA emission factors, as applicable. Note that IPCC values are not available for propane.

4.2 Data and Parameters Monitored

Data / Parameter:	Regulatory requirements relating to LFG
Data unit:	-
Description:	Regulatory requirements relating to LFG
Source of data:	Publicly available information of the host country's regulatory requirements relating to LFG.
Description of measurement methods and procedures to be applied:	N/A
Frequency of monitoring/recording:	Annual
Value Monitored	N/A
Monitoring equipment	N/A
QA/QC procedures:	N/A
Calculation Method:	N/A
Any comment:	Annual review of the Landfill's NSPS status and any other applicable regulations, followed by a review of the Project's crediting period, to ensure the Project is still surplus to regulatory requirements.

Data / Parameter:	LFG Project total,y
Data unit:	ft ³
Description:	Total amount of LFG collected from the project system at normal temperature and pressure conditions (likely to 60 degrees F and 1 atm).
Source of data:	Measured
Description of measurement methods and procedures to be applied:	FCI Thermal Mass Flowmeter (Serial No. 324341)
Frequency of Monitoring/Recording	Continuous Monitoring; Recording every 15 minutes
Value Monitored	812 to 944 scfm used in ex-ante projections
Monitoring Equipment	FCI Thermal Mass Flowmeter (Serial No. 324341)
QA/QC procedures:	The flowmeter was calibrated by the manufacturer prior to installation.

	Consistent with manufacturer recommendations, the flowmeter will be calibrated starting at a 12 month interval. If no calibration correction is required for the first two calibrations (i.e. for two years), the calibration interval will be extended to 24 months. Calibration will consist of a "Delta R" check to validate the electronics and resistance values of the sensor element. If test results are within the manufacturer recommended tolerance, calibration is complete. If test results are not within recommended tolerance, in-field recalibration will be conducted.
Calculation Method:	N/A
Any comment:	This parameter is measured on a wet basis prior to comingling with the pre-project gas stream. If the flow meter is found to be correcting to a temperature and pressure other than 60 degrees F and 1 atm, $\rho_{CH_4,n}$ will be updated accordingly for relevant data.

Data / Parameter:	$w_{CH_4} / f_{v_{CH_4,RG}}$
Data unit:	$ft^3 CH_4 / ft^3 LFG$
Description:	Methane fraction in the LFG
Source of data:	Siemens Ultramat 23 Continuous Gas Analyzer
Description of measurement methods and procedures to be applied:	Measured
Frequency of Monitoring/Recording	Continuous Monitoring; Recorded every 15 minutes
Value Monitored	50% used in ex-ante projections
Monitoring Equipment	Siemens Ultramat 23 Continuous Gas Analyzer
QA/QC procedures:	The unit is currently calibrated once a month, although the OEM recommendation is only once every 6-12 months, and the interval between calibrations may be extended to align with this recommendation. If the unit malfunctions, Lockhart will attempt to repair it on site, calling out an OEM representative if necessary. If a malfunction occurs, the unit will indicate "malfunction" on the screen, and it will be the responsibility of Lockhart personnel to review the malfunction code and correct if applicable. If the unit cannot be repaired on site, Lockhart would either send it to the OEM to repair off-site or order a replacement unit, depending on the cost of repairs versus replacement.
Calculation Method	N/A
Any comment:	Gas composition is measured on a wet basis prior to comingling with the pre-project gas stream. Flow is measured on a wet basis at the same location.

Data / Parameter:	$LFG_{flare,y}$
Data unit:	ft^3
Description:	Total amount of LFG flared at standard temperature and pressure conditions. Flow will be corrected via post-processing, likely to 60 degrees F and 1 atm from the project start date through February 7, 2011. From February 7, 2011 onwards no correction will be required.
Source of data:	Measured

Description of measurement methods and procedures to be applied:	Thermal Instruments TI 62/9 thermal mass flowmeter (Serial No. 98181)
Frequency of Monitoring/Recording	Monitoring continuous, Recorded every 15 minutes
Value Monitored	N/A
Monitoring Equipment	Thermal Instruments TI 62/9 thermal mass flowmeter (Serial No. 98181)
QA/QC procedures:	The flowmeter was calibrated by the manufacturer prior to installation in September 2009. The flowmeter will be calibrated every 12 to 18 months following manufacturer recommendations.
Calculation Method	N/A
Any comment:	Flow is measured on a wet basis and the flow meter is located at the flare inlet, after the blowers. There is no liquid or condensate removal between the blower inlet and flare inlet. The flowmeter was calibrated at 75 degrees F and 1 atm in the fall of 2009. It was recalibrated to 60 degrees F on February 7, 2011. Data is corrected for temperature and pre-calibrated for pressure. According to Thermal Instruments, no pressure adjustment is needed given the expected operating pressures of this application, because significant changes in thermal convection do not occur unless pressure changes by 150 psi or more. If the flow meter is found to be correcting to a temperature and pressure other than 60 degrees F and 1 atm, $p_{CH_4,n}$ will be updated accordingly for relevant data.

Data / Parameter:	$W_{CH_4 \text{ flare},y} / W_{CH_4 \text{ electricity},y}$
Data unit:	$ft^3 \text{ CH}_4 / ft^3 \text{ LFG}$
Description:	Methane fraction in the LFG flared and Methane fraction in the LFG delivered to the Lockhart facility
Source of data:	Siemens Ultramat 23 Continuous Gas Analyzer
Description of measurement methods and procedures to be applied:	Measured
Frequency of Monitoring/Recording	Continuous Monitored; Recorded every 15 minutes
Value Monitored	50% used in ex-ante projections
Monitoring Equipment	Siemens Ultramat 23 Continuous Gas Analyzer
QA/QC procedures:	The unit is currently calibrated once a month, although the OEM recommendation is only once every 6-12 months, and the interval between calibrations may be extended to align with this recommendation. If the unit malfunctions, Lockhart will attempt to repair it on site, calling out an OEM representative if necessary. If a malfunction occurs, the unit will indicate "malfunction" on the screen, and it will be the responsibility of Lockhart personnel to review the malfunction code and correct if applicable. If the unit cannot be

	repaired on site, Lockhart would either send it to the OEM to repair off-site or order a replacement unit, depending on the cost of repairs versus replacement.
Calculation Method:	N/A
Any comment:	The analyzer is located at the billing gate between Lockhart and the County. Composition is measured on a wet basis.

Data / Parameter:	LFG _{electricity,y}
Data unit:	ft ³
Description:	Total amount of LFG combusted by Lockhart for electricity generation at standard temperature and pressure conditions (i.e. 60 degrees F and 1 atm).
Source of data:	Measured and/or based on supplier invoices
Description of measurement methods and procedures to be applied:	Gas flow and composition to the Lockhart facility is metered for invoicing purposes. Rosemount 3051 SFC compact conditioning orifice plate mass flowmeter with integrated pressure and temperature integration.
Frequency of Monitoring/Recording	Continuous Monitoring; Recorded once every 15 minutes
Value Monitored	N/A
Monitoring Equipment	Rosemount 3051 SFC
QA/QC procedures:	The official Emerson manufacturer recommended maintenance practices are that Rosemount orifice plate technologies should be inspected once every 3 years. Emerson also recommends that calibration occur once every 3 years. The sensors do not have separate model numbers from the 3051. Since it is an orifice-based flow meter, calibration is addressed by checking the pressure sensor. The pressure sensor is currently calibrated on an approximately annual basis, but this may be extended to the 3 year interval in accordance with the manufacturer's recommendations. The flow meter was configured by a Rosemount technician. If an alternate flowmeter is purchased it will be calibrated following manufacturer recommendations.
Calculation Method:	N/A
Any comment:	Flow will be measured on a wet basis at the delivery point between the Landfill and the Lockhart facility. The flowmeter will automatically correct flow for temperature and pressure. There will be a gas treatment and compression process prior to this meter. If the flow meter is found to be correcting to a temperature and pressure other than 60 degrees F and 1 atm, $\rho_{CH_4,n}$ will be updated accordingly for relevant data.

Data / Parameter:	LFG _{thermal,y}
Data unit:	ft ³
Description:	Total amount of LFG combusted in Milliken's boilers at standard temperature and pressure conditions (i.e. 60 degrees F and 1 atm).
Source of data:	Measured and/or based on supplier invoices

Description of measurement methods and procedures to be applied:	Gas flow and composition to the Milliken facility is metered for invoicing purposes. Rosemount 3051 SFC compact conditioning orifice plate mass flowmeter with integrated pressure and temperature integration.
Frequency of Monitoring/Recording:	Continuous monitoring; Recorded once every 15 minutes
Value Monitored	353 scfm used in ex-ante projections
Monitoring Equipment:	Rosemount 3051 SFC
QA/QC procedures:	The official Emerson manufacturer recommended maintenance practices are that Rosemount orifice plate technologies should be inspected once every 3 years. Emerson also recommends that calibration occur once every 3 years. The sensors do not have separate model numbers from the 3051. Since it is an orifice mass flow meter, calibration is addressed by checking the pressure sensor. The pressure sensor is currently calibrated on an approximately annual basis, but this may be extended to the 3 year interval in accordance with the manufacturer's recommendations. If an alternate flowmeter is purchased it will be calibrated following manufacturer recommendations.
Calculation Method:	N/A
Any comment:	Flow will be metered on a dry basis at the delivery point between the Landfill and the Milliken Facility. The flowmeter will automatically correct flow for temperature and pressure. If process changes materially alter measurement accuracy, calculations will be updated accordingly. To ensure that all LFG sent to the Milliken boilers is burned and not vented to the atmosphere, Milliken has fail-safes built into the control system on each boiler gas train that include two automatic valves that shut anytime the landfill gas line is switched off or the boiler goes down. This stops the flow of gas to the boiler.

Data / Parameter:	$W_{CH_4, thermal,y}$
Data unit:	ft ³ CH ₄ / ft ³ LFG
Description:	Methane fraction in the LFG delivered to the Milliken facility
Source of data:	Siemens Ultramat 23 Continuous Gas Analyzer
Description of measurement methods and procedures to be applied:	Measured
Frequency of Monitoring/Recording:	Continuous monitoring; Recorded every 15 minutes
Value Monitored	50% used in ex-ante projections
Monitoring equipment	Siemens Ultramat 23 Continuous Gas Analyzer
QA/QC procedures:	The unit is currently calibrated once a month, although the OEM recommendation is only once every 6-12 months, and the interval between calibrations may be extended to align with this recommendation. If the unit malfunctions, Lockhart will attempt to repair it on site, calling out an OEM representative if necessary. If a malfunction occurs, the unit will indicate "malfunction" on the screen,

	and it will be the responsibility of Lockhart personnel to review the malfunction code and correct if applicable. If the unit cannot be repaired on site, Lockhart would either send it to the OEM to repair off-site or order a replacement unit, depending on the cost of repairs versus replacement.
Calculation Method:	N/A
Any comment:	Composition will be measured on a wet basis.

Data / Parameter:	ET _{LFG,y}
Data unit:	GJ
Description:	Quantity of thermal energy produced utilizing LFG
Source of data:	Calculated
Description of measurement methods and procedures to be applied:	The flow rate of LFG will be monitored at locations '1' and '4' to determine the relative quantity of gas that is collected from the Project system and delivered to the Milliken Facility. The flow rate and composition of LFG at location '1' will then be multiplied by the relative quantity of gas delivered to the Milliken Facility. Flow will then be converted to units of GJ and multiplied by the thermal efficiency of the boilers to determine the quantity of thermal energy produced.
Frequency of monitoring/recording:	Continuous monitoring;
Value Monitored	100,764 used in ex-ante projections
Monitoring Equipment:	See applicable flow parameters
QA/QC procedures:	See applicable flow parameters
Calculation Method:	See Equation 11
Any comment:	The County will likely bill Milliken based on monthly total delivery of LFG. This monthly energy flow will be totalized on an annual basis. Note that the flow of LFG to the Milliken facility is directly proportional to utilization of the LFG at the facility as the process control systems only allow for compression and distribution of LFG when utilized by the boilers.

.	PE _{flare,y}
Data unit:	tonnes CO _{2E}
Description:	Project emissions from flaring of the residual gas stream in year y
Source of data:	Calculated as per the "Tool to determine project emissions from flaring gases containing Methane".
Description of measurement methods and procedures to be applied:	Calculated
Frequency of monitoring/recording	Annual
Value Monitored	5,126 to 6,087 used in ex-ante projections
Monitoring Equipment	N/A
QA/QC procedures:	N/A
Calculation Method	See Equation 10
Any comment:	For this project flare efficiency is not monitored and a default value is used.

Data / Parameter:	MG _{PR,y}
Data unit:	tonnes CH ₄
Description:	Amount of methane generated during year y of the project activity
Source of data:	Calculated
Description of measurement methods and procedures to be applied:	Estimated based on the quantity of waste disposed in the Landfill and using the US EPA's LandGEM Landfill Gas Emissions Model, Version 3.02
Frequency of monitoring/recording	Annually
Value Monitored	1,054 to 1,226 scfm used in ex-ante projections
Monitoring Equipment	N/A
QA/QC procedures:	N/A
Calculation Method	Calculated using the US EPA LandGEM model
Any comment:	ACM001 requires that this parameter be estimated using the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site. However, the US EPA LandGEM model is the accepted standard for estimating landfill methane emissions in the United States and is used instead.

Data / Parameter:	W _x
Data unit:	tons
Description:	Total amount of waste disposed in year x
Source of data:	Measured
Description of measurement methods and procedures to be applied:	Measured by the Project Proponent
Frequency of monitoring/recording	Annual
Value Monitored	116,000 tpy used in ex-ante projections
Monitoring Equipment	Continuous with monthly and annual aggregation of data
QA/QC procedures:	N/A
Calculation method:	N/A
Any comment:	Quantity of waste disposed determined based on facility records.

Data / Parameter:	Other flare operation parameters
Data unit:	-
Description:	This should include data to monitor whether the flare operates within the range of operating conditions specified by the manufacturer.
Source of data:	Measured
Description of measurement methods and procedures to be applied:	A Pyromation thermocouple and ultraviolet flame detector are used to monitor flame temperature and ensure proper operation of the flare. The flare also has provisions for auto-shutdown if the flare flame fails. The flare is equipped with an automatic shutoff valve that shuts immediately upon loss of combustion at the flare, power failure or other alarm conditions. As a result, when the flare is not operational no gas is discharged and no flow is recorded.

	The flare is currently programmed to shut down at 300 degrees F but this value may be adjusted according to changing conditions. During a shutdown, the automatic shutoff valve closes and the blowers turnoff. If a thermocouple burns out, it will read an improperly low or high temperature, causing the automatic control system to shut the station down. Landfill gas flow data to the flare will be excluded from emission reduction calculations if temperature measurements are below the temperature cut-off setpoint (currently 300 F, but may be adjusted as long as flare operation in accordance with 40 CFR 60.18 continues).
Frequency of Monitoring/recording:	Continuous monitoring; Recorded every 15 minutes
Value monitored	N/A
Monitoring equipment:	Pyromation thermocouple and ultraviolet flame
QA/QC procedures:	Thermocouples are replaced as required and are not calibrated.
Calculation method:	N/A
Any comment:	A stack test cannot be performed for the flare; however, the flare manufacturer has guaranteed a destruction efficiency of 98 percent for this flare model.

Data / Parameter:	Operation of the Lockhart energy plant
Data unit:	Hours
Description:	Operation of the energy plant
Source of data:	Measured
Description of measurement methods and procedures to be applied:	Wattmeter or similar
Frequency of monitoring/recording	Continuous with readings taken every 15 minutes.
Value monitored	N/A
Monitoring equipment	Wattmeter or similar
QA/QC procedures:	Maintenance will be performed according to instrument manufacturer's recommendations, if any.
Calculation method:	N/A
Any comment:	Note that the quantity of electricity produced will also be metered and this information may be used to demonstrate operation of the generators at the Lockhart facility.

Data / Parameter:	CEF _{ther,BL,y}
Data unit:	tCO ₂ /GJ
Description:	CO ₂ emission intensity of the fuel used by the boiler(s) to generate thermal energy that is displaced by LFG based thermal energy generation
Source of data:	Calculated
Description of measurement	N/A

methods and procedures to be applied:	
Frequency of monitoring/recording	N/A
Value monitored:	0.5029
Monitoring equipment:	N/A
QA/QC procedures:	N/A
Calculation method:	See Equation 12
Any comment:	

Data / Parameter:	$PE_{EC,y}$
Data unit:	tonnes CO ₂
Description:	Project emissions from electricity consumption by the project activity during the year y
Source of data:	Calculated as per the "Tool to determine project, baseline, and / or leakage emissions from electricity consumption".
Description of measurement methods and procedures to be applied:	Calculated
Frequency of monitoring/recording	Annual
Value monitored	N/A
Monitoring equipment	N/A
QA/QC procedures:	N/A
Calculation method:	See Equation 14
Any comment:	For this project electricity is sourced from the regional grid, and Scenario A applies.

Data / Parameter:	$EC_{PJ, Grid,y}$
Data unit:	MWh
Description:	Quantity of electricity consumed by the project in year y
Source of data:	Calculated as per the "Tool to determine baseline, project and / or leakage emissions from electricity consumption".
Description of measurement methods and procedures to be applied:	Direct metering and/or calculation based on equipment load ratings.
Frequency of monitoring/recording	Annual
Value monitored	N/A
Monitoring Equipment	N/A
QA/QC procedures:	N/A
Calculation method:	N/A
Any comment:	This parameter is calculated as the sum of $EC_{flare \text{ and transport}}$, and $EC_{Milliken}$

Data / Parameter:	$EC_{flare \text{ and transport},y}$
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Data unit:	MWh
Description:	Sum of quantity of electricity consumed to transport gas to the flare and quantity of electricity consumed to treat and compress gas for transportation to the Milliken and Lockhart facilities
Source of data:	Measured
Description of measurement methods and procedures to be applied:	Dedicated electricity meter. Electricity supplier invoices will be the source of this data.
Frequency of monitoring/recording	Monthly
Value monitored	N/A
Monitoring equipment	Dedicated electricity meter
QA/QC procedures:	3 rd party statements/invoices are used to ensure accuracy of data.
Calculation method	N/A
Any comment:	Note that compression/treatment skids will be installed to transport LFG to the two beneficial use facilities. This system will also be used to provide vacuum to the well-field and transport any excess LFG to the flare. Following the energy project coming online, the existing blower is only be operated when the compression/treatment skid is down. The flare and the two blower skids have a dedicated electricity meter that is used to quantify energy use.

Data / Parameter:	EC _{Milliken,y}
Data unit:	MWh
Description:	Quantity of electricity consumed to operate the boiler fans used by Milliken's boilers
Source of data:	Calculated
Description of measurement methods and procedures to be applied:	Direct metering and/or calculation based on equipment load ratings
Frequency of monitoring/recording	Monthly
Value monitored	N/A
Monitoring equipment	N/A
QA/QC procedures:	In the case of direct metering, 3 rd party statements/invoices are used to ensure accuracy of data. In the case of equipment load ratings, such load ratings are to be verified by the verification body during each verification.
Calculation method:	See Comments below
Any comment:	Electricity usage will be calculated by multiplying the manufacturer specified load ratings of the blower motor by the operating hours of the blower on a monthly basis. Relevant equipment and applicable load ratings may change and will be verified during each monitoring period.

Data / Parameter:	t _{Milliken,m}
Data unit:	hours

Description:	Hours of operation of the boiler fans used to operate the boilers at the Milliken facility in month, m.
Source of data:	Measured
Description of measurement methods and procedures to be applied:	Hour meter or assumed to be operational 24 hours a day and 365 days per year to be conservative.
Frequency of monitoring/recording:	Continuous
Value monitored:	N/A
Monitoring equipment:	Hour Meter (if applicable)
QA/QC procedures:	N/A
Calculation method:	Totalized hourly readings or assumption of 24 hour / 365 day operation
Any comment:	If hourly operational data is not available, it will be assumed that the equipment is operational 24 hours a day and 365 days per year. This is conservative.

Data / Parameter:	FE _{EL,Grid,y}
Data unit:	tonnes CO ₂ /MWh
Description:	Emission factor for electricity generation in year y
Source of data:	Following the CDM Annex 7 "Tool to calculate baseline, project and / or leakage emissions from electricity consumption" Option A2, regional values are used as the default value provided by the tool was not representative of the emission intensity of grid-connected electricity generation in the United States. The emission factor is sourced from the US EPA's Emissions & Generation Resource Integrated Database (eGrid) 2010, Version 1.1: Year 2007 Summary Tables. Emission factor for SRVC.
Description of measurement methods and procedures to be applied:	N/A
Frequency of monitoring/recording	Annual check for most recent value
Value monitored	0.507
Monitoring equipment	N/A
QA/QC procedures to be applied	N/A
Calculation method:	N/A
Any comment:	Value will be reviewed annually upon release of the US EPA eGrid Summary Tables to ensure they are appropriate. The "Tool to calculate the emission factor for an electricity system" Version 01.1 was not used as calculation of an emission factor is fairly extensive given that the project does not consume or generate a significant quantity of electricity and electricity consumption does not represent a large emission source for the project.

Data / Parameter:	PE _{Propane,y}
Data unit:	tonnes CO _{2E}
Description:	Annual project emissions from fossil fuel combustion
Source of data:	Calculated as per the "Tool to determine project or leakage CO ₂ emissions from fossil fuel combustion".
Description of measurement methods and procedures to be applied:	Calculated
Frequency of monitoring/recording:	Annual
Value monitored:	N/A
Monitoring equipment:	N/A
QA/QC procedures:	N/A
Calculation method:	See Equation 18
Any comment:	

Data / Parameter:	FC _{flare,propane,y}
Data unit:	gallons / year
Description:	Quantity of propane combusted as flare pilot fuel during the year y
Source of data:	Measured
Description of measurement methods and procedures to be applied:	Based on an supplier invoices
Frequency of monitoring/recording:	Annual
Value monitored:	N/A
Monitoring equipment:	N/A
QA/QC procedures:	3 rd party statements/invoices are used to ensure accuracy of data.
Calculation method:	N/A
Any comment:	

4.3 Differences in Parameters

Depending on how CDM ACM0001 and the required CDM tools are applied, not all parameters listed in the methodology / tools are required. For example, if the Project does not generate electricity, some of the parameters related to project and baseline emissions from heat generation would not be required. Likewise, new parameters have been added when necessary.

A discussion of all such differences is included below.

Omitted Parameters

The following parameters were omitted, as they are not relevant to the project.

Parameter	Justification
LFG _{PL,y}	Not applicable since the project activity does not send LFG to pipeline for distribution.
EL _{LFG,y} CEF elec,BL,y	Not applicable since no emission reductions are claimed for displacing fossil fuel based electricity generation.

T P	Temperature and pressure data are not required as LFG flow meters correct automatically to standard temperature and pressure.
$W_{c,i,y}$ $\rho_{i,y}$	Not required since fossil fuel combustion emissions are calculated using 'Option B' of the CDM "Tool to calculate project or leakage CO ₂ emissions from fossil fuel combustion".
$BE_{CH_4,SWDS,y}$ $W_{j,x}$ f DOC _i $p_{n,j,x}$ z Φ OX DOC _f MCF	Not applicable since the ex ante estimate of methane emissions is not based on the CDM "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site".
MF _{O₂} MV _n t _{O₂,h} Fv _{CH₄,FG,h} MM _{CH₄} , MM _{CO₂} , MM _{CO₂} , MM _{O₂} , MM _{H₂} , MM _{N₂} AM _c , AM _h , AM _o , AM _n NA _{i,j} P _n R _u T _n K	Not applicable as these parameters are used to calculate the methane combustion efficiency of the flare if it is continuously monitored, which is not the case for this project.
PP _{CP,j} and PP _{CP,l} EF _{grid,CM,y} FC _{n,i,t} EG _{n,t} HG _{n,t} $\epsilon_{gen,BL}$ n _{boiler,y} NCV _{i,t} EF _{CO₂,i,t}	Not applicable as these parameters are only required if electricity is sourced from an off-grid fossil fuel fired captive power plant and / or in cases where a non default emission factor is calculated.
Operation of the boiler/air heater/heat generating equipment	To ensure that all LFG sent to the Milliken boilers is burned and not vented to the atmosphere, Milliken has fail-safes built into the control system on each boiler gas train that include two automatic valves that shut anytime the landfill gas line is switched off or the boiler goes down. This stops the flow of gas to the boiler.

Additional or Altered Parameters

Parameters added or altered from the CDM methodology are related to the methodology used to estimate methane emissions from solid waste disposal and the calculation of electricity usage. Parameters altered or added to the methodology include the following:

Parameter	Justification
k_i , W_x	These parameters are altered to be applicable for the LandGEM model instead of the CDM tool to calculate an ex ante estimate of methane emissions. The decay

	constant (k) is based instead on LandGEM default values. Instead of the quantity of each type of organic waste disposed ($W_{i,x}$) the total quantity of waste disposed is input into the LandGEM model (defined as W).
Lo	This parameter is required to calculate an ex ante estimate of methane emissions using the LandGEM model instead of the CDM tool.
$t_{\text{Milliken},m}$, L_{Milliken}	Electricity usage at the Milliken facility will not be directly measured. These parameters were added for that electricity usage may be calculated.
NCV _{methane}	This parameter is required to calculate the quantity of energy produced from LFG destructed in Milliken's boilers.
$W_{\text{CH}_4 \text{ flare},y}$ $W_{\text{CH}_4 \text{ electricity},y}$ $W_{\text{CH}_4 \text{ thermal},y}$	These parameters are used to calculate the relative quantity of project gas that is destructed by each destruction device. To ensure an accurate comparison the total quantity of methane delivered to each destruction device is used.

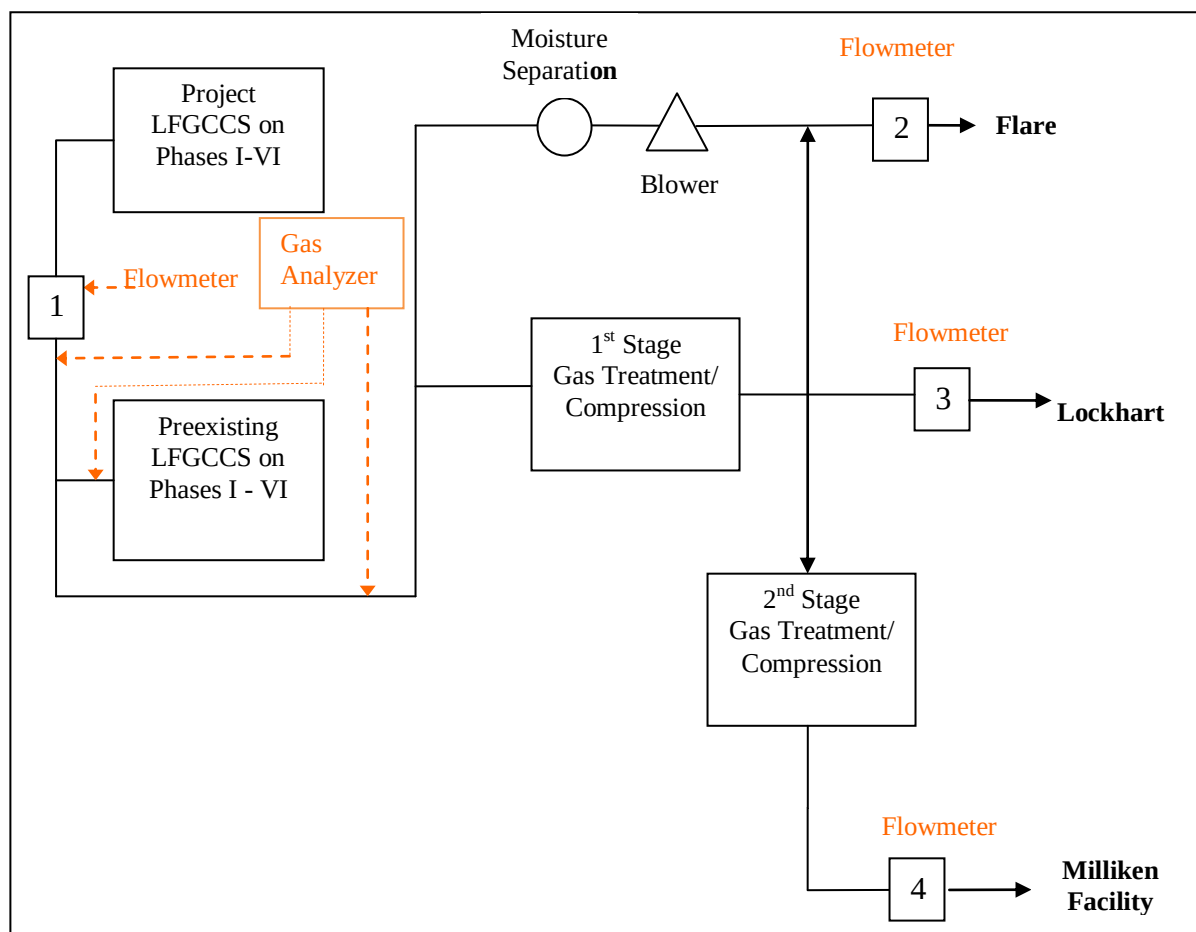
4.4 Description of the Monitoring Plan

The purpose of monitoring is to measure the quantity of methane captured by the Project Activity that would have been released to the atmosphere in the baseline condition.

Baseline Emissions

Monitoring Equipment

The flow rate of LFG will be metered at four locations; in the field prior to comingling with the pre-project gas stream, at the flare inlet, prior to delivery to the Milliken Facility and prior to delivery to Lockhart. A schematic diagram showing each metering location is provided below:



Gas flow and composition of the project gas stream are measured continuously on a wet basis prior to comingling with the pre-project gas stream (location '1'). Composition is again measured after comingling. LFG flow from the project system is monitored using an FCI Thermal Mass flowmeter that measures flow on a wet basis and normalizes flow to standard temperature and pressure conditions. Composition is metered using a Siemens Ultramat 23 continuous gas analyzer. Gas flow and composition data are recorded at least once every fifteen minutes.

Landfill gas flow is measured continuously at the blower / flare station (location '2') using a TI 62/9 thermal mass flowmeter. A Pyromation thermocouple is used to ensure the flare is burning. Flow and temperature data from the flare is recorded at least once every fifteen minutes. Additionally, an ultraviolet flame detector is in place to monitor the presence of a flame and activate the safety interlock system.

For the LFG to electricity phase of the Project, the gas flow to Lockhart (location '3') is metered continuously using a Rosemount 3051 SFC compact conditioning orifice plate mass flowmeter with integrated pressure and temperature integration. Flow data from location '3' is recorded at least once every fifteen minutes.

For the LFG to heat phase of the Project, the gas flow to the Milliken Facility (location '4') is metered continuously using a Rosemount 3051 SFC compact conditioning orifice plate mass flowmeter with integrated pressure and temperature integration. Flow data from location '4' is recorded at least once every fifteen minutes. There is also a methane analyzer at location 4. It is not anticipated that data from this analyzer will be used in the calculation of emission reductions; however, in the event back-up data is needed during an outage of the main analyzer, data from this secondary analyzer could be used to demonstrate methane concentration. Back-up data from this unit may be used provided that during any

such periods, methane concentration is monitored continuously and recorded at least every 15 minutes and manufacturer's recommendations for calibration frequency have been followed during the relevant time period.

It should be noted that LFG flow to the Milliken facility is measured on a dry basis, while the applicable methane content is measured on a wet basis. Measuring methane content (along with temperature and pressure) on a wet basis and flow rate on a dry basis results in a conservative calculation of the fraction of methane in the landfill gas. This is because after the gas is de-watered, the methane fraction will be larger, while the overall volume of gas will be smaller. If methane fraction is measured on a wet basis and flow is measured on a dry basis, the resulting figures for methane volume will always be lower than if both measurements were taken on the same basis (both wet or both dry).¹⁶

The flowmeter used to record gas flow at location '1' will be calibrated every 12 to 24 months following manufacturer recommendations. The flowmeter used to record gas flow at location '2' will be calibrated every 12 to 18 months following manufacturer recommendations. The flowmeters used to record gas at locations '3' and '4' will be calibrated following manufacturer recommendations.

The gas analyzer is currently calibrated once a month, although the OEM recommendation is every 6-12 months, and the interval between calibrations may be extended to align with this recommendation. If the unit malfunctions, Lockhart will attempt to repair it on site, calling out an OEM representative if necessary. If a malfunction occurs, the unit will indicate "malfunction" on the screen, and it will be the responsibility of Lockhart personnel to review the malfunction code and correct if applicable. If the unit cannot be repaired on site, Lockhart would either send it to the OEM to repair off-site or order a replacement unit, depending on the cost of repairs versus replacement.

Record Keeping

The flow rate and methane concentration of project LFG, the flow rate of LFG delivered to the flare, flare temperature, the flow rate of LFG delivered to the Lockhart Power facility, Lockhart Power facility electricity generation, and the flow rate of LFG to the Milliken Facility are documented in the SCADA system. Before the SCADA system data from the flow meters, methane meters, and thermocouples was recorded using an Automation Direct DL-250 process logic controller (PLC).

When the Lockhart Facility came online, a supervisory control and data acquisition system (SCADA) system began to be used to record data. The SCADA operates Wonderware, Historian In-Touch, Active Factory, and Microsoft Terminal Server 2003 software on a Dell Power Edge server located at the Lockhart facility.

A solenoid switch has been installed to transfer between methane sampling locations and readings are taken at least once every 15 minutes from each location. The switch is currently setup to take readings from locations (1) and (2). In the raw data, there is a column that indicates which location readings are being taken from. For example, '1' means that the system is monitoring project gas and '0' means that the system is monitoring the quantity of gas being flared. This will change when the energy projects come online. Upon completion of the energy project, the SCADA will be programmed to control the solenoids which transfer methane sampling locations and will tag each data point with the appropriate sample source (e.g., project gas, comingled gas to flare, comingled gas to energy projects).

The data collected by the PLC and SCADA system is saved to an off-site server and Lockhart Power and the County have developed specific folders on off-site computer servers to store the data. At least once per week, data from the PLC is uploaded to the server. The SCADA system uploads data to the server on a monthly basis and data will also be aggregated on a monthly and yearly basis.

¹⁶ http://www.climateactionreserve.org/wp-content/uploads/2011/10/Errata_and_Clarifications_LFPP_V3.0_102611.pdf

Lockhart and the County will conduct a detailed data review to identify any data gaps or data sets that are outside expected operating ranges at least once per week. Suspect data will be flagged and causes for suspect data will be investigated to correct any future data issues.

Project Emissions

Project emissions associated with flaring LFG, electricity consumption and fuel usage are estimated using both measured and default values.

Flaring Emissions

The emissions associated with methane destruction by flaring are determined based on the flare's destruction efficiency and the mass flow rate of methane in the gas stream (determined from the volumetric flow rate of LFG and the volumetric fraction of methane in the LFG being flared). The composition and flow rate of LFG gas that is flared are determined as outlined above.

Following ACM0001, the flare's operating parameters are to be continuously monitored to ensure compliance with manufacturer specifications. Accordingly, the temperature of the flare is monitored using a thermocouple and ultraviolet flame detector. However, only the temperature measured by the thermocouple is recorded.

Electricity and Fossil Fuel Combustion Emissions

Project emissions related to electricity consumption and fossil fuel usage are estimated based on the quantity of electricity and fossil fuels consumed to operate the Project, according to direct metering or supplier invoices.

Monitoring Roles and Responsibilities

County and Lockhart staff will oversee monitoring activities at monitoring locations '1', '2', '3' and '4'. Initially, electronic data was recorded by the PLC and records were maintained on the County and Lockhart's off-site servers. When the Lockhart facility came online, Lockhart began to manage the monitoring system / data, and the SCADA system for its engines began collecting all of the project data beginning on June 2, 2011. Records will be maintained on the County and Lockhart's off-site servers.

The County, Lockhart and / or SCS will submit data to Blue Source for integration into emission reductions calculations or Blue Source will download this data from the server.

Note that all relevant documents and records will be retained for a period of at least two years following the end of the Project's crediting period. All records will be available for review by a verification body.

A listing of the variables that will be monitored, including the source of data and a description of measurement methods and QA/QC calibration procedures are provided in Section 4.2 above.. It will be the responsibility of County and Lockhart staff to measure all variables and retain records for verification.

5 ENVIRONMENTAL IMPACT

An Environmental Impact Assessment (EIA) was not required by the federal or state authority prior to the implementation of the Project.

6 STAKEHOLDER COMMENTS

Stakeholder consultations were not required by any regulatory agency prior to project implementation.