



VOLUNTARY CARBON STANDARD

Project Description Template

19 November 2007

**HENRICO COUNTY LANDFILL GAS COMBUSTION PROJECT
NOVEMBER 19, 2009**

Table of contents

1.0	Description of Project	1
1.1	Project Title	1
1.2	Type / Category of the Project.....	1
1.3	Estimated Amount of Emission Reductions Over the Crediting Period Including Project Size ..	1
1.4	A Brief Description of the Project.....	1
1.5	Project Location.....	2
1.6	Duration of the Project Activity / Crediting Period.....	3
1.7	Conditions Prior to Project Implementation	3
1.8	Description of How the Project Will Achieve Emission Reductions	4
1.9	Project Technologies, Products, Services and the Expected Level of Activity	4
1.10	Compliance with Relevant Local Laws and Regulations Related to the Project.....	4
1.11	Identification of Risks	5
1.12	Demonstration to confirm that the project was not implemented to create GHG emissions primarily for the purpose of its subsequent removal or destruction	5
1.13	Demonstration that the Project has not Created Another Form of Environmental Credit.....	5
1.14	Project Proponents Roles and Responsibilities.....	5
1.15	Any Information relevant for the Eligibility of the Project	6
1.16	List of Commercially Sensitive Information (If Applicable)	6
2.0	VCS Methodology	6
2.1	Title and Reference of The VCS Methodology	6
2.2	Justification of the choice of methodology.....	6
2.3	Identifying GHG Sources, Sinks and Reservoirs.....	6
2.4	Description of How the Baseline Scenario is Identified.....	7
2.5	Project Additionality.....	8
2.5.1	Step 1: Identification of alternative scenarios	9
2.5.2	Step 2: Barrier Analysis.....	9
2.5.3	Step 3: investment Analysis	11
2.5.4	Selection of Baseline Scenario	12
2.5.5	Step 4: Common Practice Analysis	13
3.0	Monitoring	14
3.1	Title and Reference of the VCS Methodology	14
3.2	Monitoring, Including Estimation, Modelling, Measurement or Calculation Approaches	14
3.3	Data and Parameters Monitored	16
3.3.1	Monitored Parameters	16
3.3.2	Parameters not Monitored	20
3.3.3	Differences in Parameters.....	24
3.4	Description of the Monitoring Plan	25
4.0	GHG Emission Reductions	25
4.1	Explanation of Methodological Choice	25
4.2	Quantifying GHG Emissions and / or Removals for the Baseline Scenario	25
4.3	Quantifying GHG Emissions and / or Removals for the Project	29
4.4	Quantifying GHG Emission Reductions and Removal Enhancements for the GHG Project.....	31
5.0	Environmental Impact.....	31

6.0	Stakeholder Comments	31
7.0	Schedule	31
8.0	Ownership	31
8.1	Proof of Title	31
8.2	Projects that reduce GHG emissions from activities that participate in an emissions trading program (if applicable)	31

1.0 DESCRIPTION OF PROJECT

1.1 PROJECT TITLE

Henrico County Landfill Gas Combustion Project (the “Project”)

1.2 TYPE / CATEGORY OF THE PROJECT

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

1.3 ESTIMATED AMOUNT OF EMISSION REDUCTIONS OVER THE CREDITING PERIOD INCLUDING PROJECT SIZE

Emission reductions from the Springfield Road Landfill (the “Landfill”) are calculated following the CDM’s ‘Approved consolidated baseline methodology ACM0001’.

Emission reductions for 2009 through 2015 are estimated based on the quantity of waste disposed at the Landfill. A methane composition of 45% is applied, consistent with the gas quality observed from 2002 through July 2009. It is assumed that the coverage of the collection system is 80% up to the end of 2009 and 90% following the planned wellfield expansion from 2010 onwards. These percent coverage values were determined based on the estimated percent coverage of the system over the surface area of the Landfill, based on feedback from the Landfill Operator.

A default flare efficiency of 50% is applied from the monitoring period start date through to the end of 2010 and an efficiency of 98% is applied from 2011 onwards. This scenario assumes that methane composition will be monitored continuously from 2011 onwards.

Emissions are discounted by the incremental quantity of methane that would have been captured by the pre-existing landfill gas system and flared and the estimated project emissions from flaring, electricity and fuel consumption.

Table 1 shows the estimated emission reductions from the Project over the Project’s ten year crediting period.

Table 1: Emission Reductions from 2009 to 2018

Year	Emission Reductions (tonnes CO ₂ E)
2009	26,167
2010	31,548
2011	71,448
2012	73,813
2013	74,996
2014	68,373
2015	62,224
2016	56,626
2017	51,501
2018	46,692

1.4 A BRIEF DESCRIPTION OF THE PROJECT

A pre-project landfill gas collection and destruction system was voluntarily installed in the East Fill area of the Landfill in 2001 with the installation of 14 wells. Based on anecdotal evidence, gas was first flared in March 2002. However, sufficient evidence of the start date could not be provided and the project start date

was selected as the expansion of the collection system in 2005. This results in a conservative estimate of the emission reductions from the project activity, because the original amount of gas combusted by the pre-project system is netted out of the total emission reductions claimed.

The Landfill consists of three smaller sanitary landfills; the East Fill, the West Fill and the Expansion. The Project consists of two stages, both implemented at the Springfield Road Landfill. Stage one (1) of the Project is owned and operated by Henrico County (“Henrico”). Stage two (2) of the Project is owned and operated by Ingenco Distributed Energy (“Ingenco”).

The Project consists of two stages. Stage one (1) of the Project is the expansion of the pre-existing wellfield and installation of a larger capacity flare. During this stage, the captured landfill gas is flared, thereby converting methane to biogenic CO₂. As part of this project phase, in December 2004, Henrico decommissioned the pre-existing flare and in June 2005 a larger flare station was installed. The flare was installed on June 3rd, 2005. An additional 87 wells were also installed in all three of the landfills at this time. The wellfield was further expanded in 2006 with the addition of five new wells in the Expansion (Phases 2 and 3).

Stage two (2) of the Project involves the implementation of a beneficial use project. The captured biogas will be transported to a power generating facility located on-site, and used for electricity generation. As part of this phase, a 4 MW power generating facility is currently being constructed by Ingenco. It is anticipated that this stage of the Project will be operational in 2010, and gas collected from the Landfill will be destructed by Ingenco for electricity generation. It is also anticipated that the wellfield will be further expanded in late 2009 or early 2010.

Additional permits were not required by the VADEQ to construct or operate the Project in 2005. Rather, the Project was exempt from permitting requirements in Section 9 VAC 5-80-1100 through 1320 of Virginia’s Regulations for the Control and Abatement of Air pollution, given the level of uncontrolled emissions from the installation of the new flare and the size of the flare. The following permits relate to the construction and operation of the Landfill¹:

- Virginia Stationary Source Operating Permit: PRO-51286
- VADEQ Solid Waste Permit No. 545 – *This permit was amended in July 2006 for a number of activities including the expansion of the gas collection system at this time.*

The installation of the original landfill gas system by Henrico was completely voluntary. The expansion of the landfill gas collection and destruction system in 2005 was also voluntary. The objective of this expansion was to be proactive and ensure that the Landfill was not off-gassing and causing odor complaints. The system was not installed in response to odor complaints or gas migration issues and no formal complaints were received. Rather, this was a proactive step taken by Henrico to be a good neighbor.

Henrico is required to submit NMOC emission calculations every five years to ensure the landfill is not required to install a landfill gas capture system. Based on the most recent calculations, the Landfill is not expected to exceed the 50 Mg per year NMOC threshold over the duration of the crediting period. The Landfill’s NMOC emissions will be reassessed annually to ensure that the Landfill is not required to install a collection system and emission reductions remain surplus to regulatory requirements.

1.5 PROJECT LOCATION

¹ Note that this does not include permits required for the construction and operation of the landfill gas to energy part of this project as this phase has not yet been completed.

The Landfill is a municipal solid waste landfill located on a 192 acres site in Henrico County, Virginia. It is located immediately northeast of Nuckols Road and north of Interstate 295.

The address of the facility is:

10600 Fords Country Lane
Glen Allen, Henrico County, VA

The latitude and longitude of the Landfill are as follows:

- Latitude: 37°40'45"
- Longitude: 77°33'58"

The Landfill opened in 1966 and it is assumed that the Landfill will receive waste until late 2012 or early 2013. The Landfill has a design capacity of 2.901 million megagrams.

The Landfill covers an area of 103 acres and is subdivided into six cells (three areas). These include the East Fill, the West Fill and the Expansion, consisting of Phases 1 through 4. The East Fill area was closed in 1994 and covers approximately 36 acres. The West Fill area was closed prior to 1983 and covers approximately 23 acres. Phase 1 of the Expansion Area covers 12 acres and was closed in 1994. Phase 2 is 14 acres and was constructed in 1994, Phase 3 covers 10 acres and was constructed in 1998, and Phase 4 is 8 acres and was constructed in 2007. Phases 2, 3 and 4 are still active.

1.6 DURATION OF THE PROJECT ACTIVITY / CREDITING PERIOD

In June 2005, Henrico decided to invest significant capital to expand the landfill gas collection system. At this time the landfill gas capture system in the East Fill area was expanded and a collection system was installed in the remainder of the Landfill. The existing flare was decommissioned and two-3,014 scfm blowers and a new candlestick flare were also installed at this time. It is anticipated that the landfill gas capture system will be further expanded in late 2009 or early 2010. Gas will also be used to generate electricity starting in 2010.

As discussed in Section 1.3 the VCS project crediting period will depend on whether the landfill is subject to NSPS requirements. If the project is not required to install a landfill gas capture system the anticipated crediting period will be from **January 1, 2009 to December 31, 2018**.

The crediting period will be reassessed on an annual basis to ensure the Project does not exceed the NSPS threshold for NMOC emissions and is not required to collect and destruct landfill gas.

1.7 CONDITIONS PRIOR TO PROJECT IMPLEMENTATION

Prior to project implementation (2002 through 2004), landfill gas generated from the Western Fill and Expansion areas of the Landfill was passively vented to atmosphere. In 2001, an active gas collection system was installed in the East Fill area of the Landfill. At this time 14, 30-inch diameter gas wells, header and lateral lines and a vacuum blower and LFG Specialties utility flare with a maximum capacity of 793 scfm were installed. Gas was first flared in March 2002. In December 2004 the flare was decommissioned and no gas was collected from the Landfill from December 2004 through June 2005.

This system was installed by Griffin Dewatering with the objective of relieving methane gas that was detected in subsurface methane gas detection wells located on the eastern perimeter of the Landfill. While the DEQ required Henrico to control the subsurface migration of gas detected, the installation of an active gas collection system was voluntarily implemented by Henrico. Alternatively, passive gas venting could have been employed.

Total gas collection from the pre-existing system from 2002 through 2004 averaged approximately 88 scfm with a methane content of approximately 46.8%, as evidenced from historical records. In the absence of the Project, the most likely baseline scenario would have been the continued operation of the pre-existing landfill gas capture system.

Installation of the pre-project LFG management system did not require DEQ approval.

1.8 DESCRIPTION OF HOW THE PROJECT WILL ACHIEVE EMISSION REDUCTIONS AND / OR REMOVAL ENHANCEMENTS

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

Under Stage two (2) of the Project, emission reductions are also achieved through the collection and utilization of methane for electricity generation. Again, any CO₂ in the landfill gas is biogenic and is not considered as a source of emissions. No credit is claimed for displacing grid-connected electricity generation.

1.9 PROJECT TECHNOLOGIES, PRODUCTS, SERVICES AND THE EXPECTED LEVEL OF ACTIVITY

Under Stage one (1) of the Project, the pre-existing landfill gas collection system was expanded and a new larger combustion device was installed. The system consists of the following infrastructure and equipment:

- Vertical wells to extract gas from the East Fill, West Fill and Phases 1 through 4 of the Landfill
- Piping to collect and transport gas to the flare
- Open LFG Specialities candlestick flare to destruct landfill gas
- Two 2,600 scfm blowers to create a pressure differential and extract landfill gas from the wells
- Monitoring equipment including flow meters, thermocouples, gas analyzer, etc.

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

- Piping and controls required to transport landfill gas to the power generating facility
- Treatment systems required to dewater, filter and compress gas for electricity generation
- Two 2 MW dual fueled compression ignition engines capable of consuming up to 1,500 scfm of landfill gas
- Distribution lines and equipment required to transport electricity to the purchaser
- Retrofitting of existing landfill gas flare with controls and valves to function with Ingenco's infrastructure
- Monitoring equipment including flow meters, gas analyzer, etc.

1.10 COMPLIANCE WITH RELEVANT LOCAL LAWS AND REGULATIONS RELATED TO THE PROJECT

Under the 1990 Clean Air Act Amendments, landfills with a permitted capacity greater than 2.5 million megagrams and annual non-methane organic compound (NMOC) emissions greater than 50 tonnes 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. The objective of these federal landfill emissions regulations is to reduce fugitive emissions of hazardous air pollutants (HAPs), volatile organic compounds (VOCs), and greenhouse gases (GHGs) from landfills.

The Landfill has a design capacity of 2.901 million megagrams and must comply with 40 CFR Part 60 Subpart WWW and have a Title V Operating Permit (PRO-51286). In accordance with 40 CFR Part

60.754, Henrico must submit NMOC emission calculations to the US Environmental Protection Agency (USEPA) every five years. According to the most recent Tier II report completed in January 2009, the Landfill's NMOC emissions per year are 30.7 Mg per year. The Landfill is not expected to exceed the 50 Mg per year threshold through 2014. In 2014, testing will be conducted to reassess the Landfill's NMOC emissions. It is not anticipated that the Landfill will exceed the limit at this time.

These reports will be reviewed to ensure the project is still 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.

Henrico was not required to expand the pre-existing landfill gas collection system or install a flare (passive, candlestick or enclosed) to comply with NSPS requirements. There are no other applicable state or local regulations requiring Henrico to collect and destruct landfill gas at the site and the project activity complies with all local laws and regulations.

1.11 IDENTIFICATION OF RISKS THAT MAY SUBSTANTIALLY AFFECT THE PROJECT'S GHG EMISSIONS REDUCTIONS OR REMOVAL ENHANCEMENTS

No risks are anticipated.

1.12 DEMONSTRATION TO CONFIRM THAT THE PROJECT WAS NOT IMPLEMENTED TO CREATE GHG EMISSIONS PRIMARILY FOR THE PURPOSE OF ITS SUBSEQUENT REMOVAL OR DESTRUCTION

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 will not create these GHG emissions.

1.13 DEMONSTRATION THAT THE PROJECT HAS NOT CREATED ANOTHER FORM OF ENVIRONMENTAL CREDIT

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

PROJECT REJECTED UNDER OTHER GHG PROGRAMS (IF APPLICABLE):

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

1.14 PROJECT PROPONENTS ROLES AND RESPONSIBILITIES, INCLUDING CONTACT INFORMATION OF THE PROJECT PROPONENT, OTHER PROJECT PARTICIPANTS

The gas collection system and flare are owned and operated by the County of Henrico. The Ingenco electricity generation facility is owned and will be operated by Ingenco Distributed Energy. Blue Source LLC ("Blue Source") has been contracted by Ingenco Distributed Energy to monetize the greenhouse gas (GHG) emission reduction credits generated by the Project.

Operating Contact: Steve Yob, Division Director – Solid Waste and Recycling
County of Henrico
Department of Public Utilities
P.O. Box 27032
Richmond, VA 23273
Phone: (804)727-8217
Email: yob@co.henrico.va.us

Proponent Contact: Annika Colson

Vice-President
Blue Source, LLC
900 Broadway, Ste 801 B
New York, NY 10003
Phone: (212) 253-5348
Fax: (212) 253-5349
Email: acolston@bluesource.com

1.15 ANY INFORMATION RELEVANT FOR THE ELIGIBILITY OF THE PROJECT AND QUANTIFICATION OF EMISSION REDUCTIONS OR REMOVAL ENHANCEMENT, INCLUDING LEGISLATIVE, TECHNICAL, ECONOMIC, SECTORAL, SOCIAL, ENVIRONMENTAL, GEOGRAPHIC, SITE-SPECIFIC AND TEMPORAL 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 the quantity of methane destroyed / combusted as a result of the Project Activity.

The quantity of landfill gas captured using the pre-existing collection system and flared by Henrico, determined by historical records, will be used to represent the quantity of methane that would have been collected and destroyed in the absence of the project (i.e. under the baseline condition).

1.16 LIST OF COMMERCIALLY SENSITIVE INFORMATION (IF APPLICABLE)

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

- Agreements between Blue Source, Henrico and Ingenco
- Economic information related to project investment

2.0 VCS METHODOLOGY

2.1 TITLE AND REFERENCE OF THE VCS METHODOLOGY APPLIED TO THE PROJECT ACTIVITY AND EXPLANATION OF METHODOLOGY CHOICES

Approved consolidated baseline methodology ACM0001 “Consolidated baseline and monitoring methodology for landfill gas project activities”, Version 10.

2.2 JUSTIFICATION OF THE CHOICE OF METHODOLOGY AND WHY IT IS APPLICABLE TO THE PROJECT

The applicability criteria for ACM0001 require that:

- The baseline scenario be defined as either the partial or total release of landfill gas; 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 and flaring of landfill gas and the baseline is defined as the partial release of landfill gas. The Project Activity corresponds to the first of the project scenarios listed above and the baseline also meets the criteria listed above.

2.3 IDENTIFYING GHG SOURCES, SINKS AND RESERVOIRS FOR THE BASELINE SCENARIO AND FOR THE PROJECT

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

Table 2: Sources and Sinks Included in the Project Boundary²

	Source	Gas	Included / Excluded	Justification	Controlled / Related / Affected
Baseline	Emissions from decomposition of waste at the landfill	CH ₄	Included	Main baseline emission source	Controlled by the Project Proponent.
		N ₂ O	Excluded	Excluded as emissions are negligible. This is conservative.	
		CO ₂	Excluded	The source was considered, but excluded as emissions are biogenic. This is conservative.	
	Emissions from electricity consumption	CH ₄	Excluded	The sources were considered, but no credits are claimed for offsetting grid-connected electricity in the baseline. As a result, this source is not included in the emission reduction calculations. This is conservative.	Related to the Project Activity.
		N ₂ O	Excluded		
		CO ₂	Excluded		
	Emissions from thermal energy generation	CH ₄	Excluded	The sources were considered, but there is no thermal energy in this project so it is excluded since credits were not claimed.	Related to the Project Activity.
		N ₂ O	Excluded		
		CO ₂	Excluded		
Project	On-site fossil fuel consumption due to the project activity other than for electricity generation	CH ₄	Excluded	Excluded for simplicity. This emission source is very small.	Controlled by the Project Proponent.
		N ₂ O	Excluded	Excluded for simplicity. This emission source is very small.	
		CO ₂	Included	May be a significant source of emissions.	
	Emissions from on-site electricity usage	CH ₄	Excluded	Excluded for simplicity. This emission source is very small.	Related to the Project Activity.
		N ₂ O	Excluded	Excluded for simplicity. This emission source is very small.	
		CO ₂	Included	May be a significant source of emissions.	

2.4 DESCRIPTION OF HOW THE BASELINE SCENARIO IS IDENTIFIED AND DESCRIPTION OF THE BASELINE SCENARIO

Step 1: Identification of alternative scenarios

The following potential baseline scenarios have been identified for the Henrico County Project:

1. The landfill operator could continue to operate the existing active landfill gas capture system in the East Fill landfill and vent the remainder of landfill gas from the West Fill and Expansion landfills to the atmosphere;
2. The landfill operator could expand the collection system and install a higher capacity destruction device. This scenario represents the project activity without carbon credits; or

² This table follows ACM0001, Version 10.

3. The landfill operator could expand the landfill gas collection system and implement a landfill gas to energy project (i.e. electricity, thermal heat or natural gas).

Note that as part of all of the above listed baseline alternatives, Henrico may have taken other actions directed at reducing odors and gas migration, as this is an ongoing management strategy at most Landfills. All scenarios also provide the same level of service; namely operation of the landfill and mitigation of odors and subsurface emissions.

The first set of alternative scenarios for the baseline, which are defined above as Scenarios (1) (2) and (3), assess whether the LFG would have been vented or captured (i.e. whether a gas collection system would have been installed) and whether a gas to energy project would have been implemented in the absence of the proposed project activity.

The Project proposes to generate electricity as Project Stage (2). For energy generation, the following set of alternative gas to energy scenarios could then be considered:

- P1. Existing and/or new grid connected power plants
- P2. Existing or construction of a new on-site or off-site fossil fuel 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 a new on-site or off-site renewable based captive power plant
- P6. Power generation from landfill gas undertaken without generating carbon credits under VCS project activity (equivalent to baseline alternative 3)

All of the above listed baseline alternatives are in compliance with federal, state and local regulatory requirements, ordinances and permitting requirements.

(P2), (P3), (P4) and (P5) can be eliminated without further in-depth discussion in the barriers section as they are not feasible energy generating alternatives in the baseline scenario. The fundamental reasoning behind this is that the landfill would not be capable of building a power plant which is either fossil-fuel based, or renewable based, captive power, or cogeneration power, either on-site or off-site as it would require considerable specialist knowledge that is unfamiliar to Henrico landfill operators. All of these options fall outside of the scope of expertise for the landfill management. The skillset required to plan or execute the development of a power plant on-site or off-site is not recognized within Henrico landfill personnel. The landfill managements' primary objective is waste management and their expertise solely encompass landfill operations. Therefore they would not be capable of successfully building, operating or managing a power plant at, or near, the landfill site.

Step 2: Identification of baseline energy source

According to the CDM tool, step two of the procedure for selection of the most plausible baseline scenario requires the identification of the fuel for the baseline energy source. This step is not required, as no credits will be claimed for the generation of electricity, heat or natural gas to offset a baseline energy source.

Steps 3 and 4

These steps are addressed in Section 2.5.4 below.

2.5 PROJECT ADDITIONALITY

Following ACM0001, to define the baseline and assess additionality, the “Combined tool to identify the baseline scenario and demonstrate additionality”: Version 02.2 is used as described below:

2.5.1 STEP 1: IDENTIFICATION OF ALTERNATIVE SCENARIOS

Step 1a: Define alternatives scenarios to the VCS project activity

Step 1b: Consistency with mandatory laws and regulations

The first step of this analysis is to identify all potential alternative scenarios to the Project and determine their consistency with applicable laws and regulations. This step of the baseline and additionality analysis are discussed above in Section 2.4. As discussed, all baseline scenarios are in compliance with applicable legislation and regulations (including the Project).

2.5.2 STEP 2: BARRIER ANALYSIS

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

The next step in determining the baseline scenario is a barrier analysis to assess which baseline scenarios would be prevented as a result of these 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.

Evaluation of Baseline Alternatives 1, 2 and 3

Baseline Alternative (3); this alternative is also referred in step 1 as power alternative (P6). These alternatives are equivalent, therefore, from this point forward, (P6) will be known as Baseline Alternative (3) to avoid confusion. Baseline Alternative (3) involves the installation of an active landfill gas system and energy project, to supply electricity to the grid. Baseline Alternative (3) was not a viable alternative at the time of project implementation in 2005 and was subject to institutional and infrastructure barriers to implementation. These barriers did not prevent the implementation of Scenario (1) or Scenario (2).

Institutional / Infrastructure Barriers

There are a number of additional institutional / infrastructure barriers to implementation associated with scenario Baseline Alternative (3), which are significant in comparison to a landfill gas collection and flaring project.

The principal project risk categories identified by the US EPA for landfill gas to energy projects include; obtaining contracts, securing project revenues and landfill gas availability³. In terms of landfill gas availability, potential gas recovery is typically modelled based on the system collection efficiency and an estimate of the potential landfill gas yield. The volume of landfill gas recovered can be measured, however the rate of landfill gas 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, landfill gas collection system efficiency may vary from 50% to greater than 90%, thereby resulting in a wide spectrum of landfill gas recovery rates. Due to the combination of unknown and changing variables, estimates of landfill gas collection system efficiency are subject to a significant level of uncertainty.

³ US EPA.(1996, September). Landfill Gas Energy Project Development Handbook. Landfill Gas Methane Outreach Program (LMOP).

⁴ US EPA.(1996, September). Landfill Gas Energy Project Development Handbook. Landfill Gas Methane Outreach Program (LMOP).

Further, potential landfill gas yield is projected based on a first order decay model and using a combination of default values and site specific data. Modeling 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 IPCC⁵. Further, this modeling is 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. Again, due to the combination of unknown and changing variables, estimates of landfill gas recovery are subject to a significant level of uncertainty.

Due to the uncertainty in determining the quantity and methane composition of landfill gas that would be collected from a landfill cell with a newly installed collection system, the capital costs associated with constructing a landfill gas to energy project could not be justified by Henrico in the near future or without further investigation. Rather, development of a landfill gas collection and combustion project was a necessary prerequisite to determine the expected quantity and composition of gas recovered and to help assess and improve the feasibility of any future energy project.

In support of this decision and as discussed, the US EPA has identified landfill gas availability as a key risk factor to investment and project development and lists modeling of gas production over time as an option for risk mitigation⁶. In the case of the Landfill this approach was required to mitigate the risks associated with the development of the LFGTE project.

As evidenced by the necessity for a staged project development approach, now that the quantity and quality of gas from the Landfill has been characterized over the past four year of system operation, the Industrial Power Generating Company LLC (Ingenco) is currently constructing a LFGTE project at the Landfill.

There are a number of additional barriers to implementation associated with constructing a LFGTE project, which are significant in comparison to a landfill gas flare project. These include 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, and the legal stipulations associated with already existing contracts between Henrico and a LFGTE company. According to the US EPA, for LFGTE projects the estimated time required for permitting alone is six to 18 months (or longer)⁷. Negotiation of a landfill gas sales agreement would also be required, which require additional time, followed by system construction.

In comparison, the landfill gas combustion project only required Henrico to select a project developer to design and construct the system and obtain necessary permits for the flare, as described in Section 1.4. This process took approximately six to eight months. Construction was then completed in approximately five months.

As discussed, this Scenario would have required Henrico to expend significant time and effort without having a sense of the quality and composition of gas that would be collected from the system and used to generate electricity. Time and human resources would have been required to obtain necessary financing, select a contractor, design and construct the project, secure construction contracts and obtain the necessary

⁵ 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>

⁶ ibid

⁷ US EPA.(1996, September). Landfill Gas Energy Project Development Handbook. Landfill Gas Methane Outreach Program (LMOP).

permits for construction and operation of the system⁸. Given the uncertainty associated with the quantity and composition of gas recovered, the the length of time required to develop a project and the other risks and requirements associated with this scenario, baseline alternative three (3) was not a viable option at the time of project implementation.

As evidenced by the course of action selected by Henrico, investment in a LFGTE project was not feasible at the time of project implementation. Rather, demonstrating the volume of gas from the implementation of an active capture system and flare was required to justify the development of the energy project.

Ingenco is investing in a LFGTE project with the expectation that with the shared revenue from VER's, the project will generate a positive return. However, the capital costs associated with constructing a landfill gas to energy project could not be justified by Henrico and / or Ingenco in the short term without further investigation. Development of a landfill gas collection and combustion project was a necessary prerequisite to determine the expected quantity and quality of gas recovered, and to help assess and improve the feasibility of a future LFGTE project. In addition, without the potential revenue from both emissions reductions and the sale of energy, Ingenco and Henrico asserted that project economics would be marginal and project risks would be too high to warrant investment.

The implementation of a landfill gas to energy facility would provide revenues due to energy savings from the displacement of electricity, thermal energy or natural gas. However, there is typically a multi-year lag between the implementation of a landfill gas combustion project to the implementation of a landfill gas to energy project. This is due to the time involved in assessing landfill gas availability, obtaining contracts, securing project revenues and constructing the project⁹. This multi-year time lag demonstrates that energy revenues were not part of an investment repayment strategy for Henrico. Rather, the least cost option for Henrico was to continue using the pre-existing passive system and implement alternative odor mitigation techniques, since flaring landfill gas does not enhance the operation of the landfill and adds significant investment and operating costs.

Evaluation of Potential Energy Generation Alternatives (P1) and (P6)

The potential energy generation alternative (P6) (equivalent to Baseline Alternative (3)) has been eliminated in the arguments above. The remaining alternative is P1 (Existing and/or new grid connected power plants).

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

The potential energy generation alternatives which include the building of an on-site or off-site power plant (P2 thru P5) have been excluded in Step 1 of this assessment.

As a result of the barriers discussed above, Baseline Alternative (3) (energy generation (P6)) was not a viable option at the time of project implementation. Barriers did not prevent the implementation of Alternatives (1) or (2).

This analysis concludes that (P1) remains the only viable option as a baseline alternative for power generation.

2.5.3 STEP 3: INVESTMENT ANALYSIS

⁸ US EPA.(1996, September). Landfill Gas Energy Project Development Handbook. Landfill Gas Methane Outreach Program (LMOP).

⁹ US EPA.(1996, September). Landfill Gas Energy Project Development Handbook. Landfill Gas Methane Outreach Program (LMOP).

In this step, the alternative scenarios not prevented by the barriers identified in step two are assessed via an investment analysis to determine which is the most economically or financially attractive. Following the CDM tool, since there are only two alternatives remaining after Step 2, neither scenario generates any revenue other than from the sale of carbon credits, and the remaining alternative that is not the Project Activity does not incur any incremental costs, a simple costs analysis is applied.

Baseline Alternative (1)

There were no laws or regulations requiring the expansion of the gas collection system at the Landfill. Rather, as evidence by the Landfill Gas System Master Plan, the system was installed voluntarily and proactively by Henrico with the goal of taking advantage of beneficial use opportunities. One beneficial use opportunity will be obtaining VERs. If the project system had not been installed, alternative measures could have been taken to address odors and / or surface emissions and provide the same level of service. Henrico could also have chosen not to take further action to prevent odor complaints.

This alternative represents the least cost option for providing the same underlying product and service, namely the operation of the landfill and potentially the control of odors or surface emissions.

Note that while in the absence of the project, actions may have been taken by Henrico to reduce the potential for odors and subsurface gas migration, odor and gas migration management is an on-going management activity at the Landfill. Further, Henrico was not required to take action, therefore it is also possible that no management activities to reduce odors and gas migration may have been taken. As a result, no incremental costs between the project and baseline are attributed to these activities.

Baseline Alternative (2)

Investments required for the expansion of the landfill gas collection system and installation of a larger blower and flare station include the following: new extraction wells, piping, valves, and a new blower/flare station. The cost of this system was \$1,077,980. Detailed costing information is confidential and will be provided to the validator upon request.

2.5.4 SELECTION OF BASELINE SCENARIO

Baseline Alternative (1)

As indicated by the above investment analysis, Scenario (1) represents the least cost option available to Henrico. When compared to the active capture and flaring of landfill gas, this scenario provides the same level of service, but avoids the following capital costs: purchase and installation of an expanded capture system, piping, blowers and a larger flare (to accommodate the increased flow of gas). It also avoids the continuing operating expenses of personnel, electricity and fossil fuel consumption related to the Project.

This scenario is in compliance with applicable laws and regulations, is not subject to any barriers to implementation and represents the least cost option available to Henrico. It is therefore identified as the most likely baseline alternative.

Baseline Alternative (2)

Scenario (2), which is the proposed project activity without carbon credits, is eliminated because it provides the same level of service as Scenario (1), but with dramatically higher investment (and operating) costs. The project was initiated with the specific goal of controlling potential gas migration / odor issues and to take advantage of beneficial use opportunities, such as generating (and marketing) greenhouse gas emission reduction credits. If the Project was not registered as a VCS project, there would be no revenues. Without this revenue, the Project would not be able to recover any of the investment costs and would not have been developed.

This scenario is not an economically attractive course of action required additional investments without generating any additional income for the project proponent.

Baseline Alternative (3)

Prohibitive barriers prevent Scenario(3) from being a viable baseline option. Scenario (3) is currently in the construction stage, but is eliminated given that landfill gas availability was not well characterized at the time of project implementation. In addition to the exclusivity of the contract between Henrico and Ingenco, the alternative LFGTE options would require substantial efforts in securing capital costs, length of time required to design and implement a project and the other risks and requirements associated with implementing a landfill gas to energy project prior to characterizing its quantity and quality.

Potential Power Alternatives (P1) and (P6)

As indicated by the above barriers analysis, Scenario (P1) represents the only feasible alternative for energy generation in the absence of the Project. Power Alternative (P6) is equivalent to Baseline Argument three (3), which is eliminated above due to prohibitive barriers.

2.5.5 STEP 4: COMMON PRACTICE ANALYSIS

Step 4a: Analyze other activities similar to the proposed project activity

Step 4b: Discuss any similar operations that are occurring

As described, baseline alternative (1) represents the most feasible baseline alternative. This alternative does not represent the proposed Project Activity undertaken without being registered as a VCS project. Further, registration of the Project as a VCS activity will alleviate the barriers preventing the Project from occurring. A common practice analysis must next be conducted as the final step to determining if the Project is additional.

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

Common practice was assessed based on an evaluation of landfill practices in the United States. This is consistent with the geographical requirements of the CDM Methodological Tool, which requires that activities undertaken in a “relevant geographical area” (i.e. ten facilities with similar outputs or services as the Project Activity) be compared.

The source data for this analysis was a US EPA database of approximately 2,400 landfills in the United States. The analysis found that 63% of landfills are not subject to federal regulations requiring the collection and destruction of landfill gas. It also found that of the landfills not subject to federal regulations, only 22.3% have implemented landfill gas capture and destruction projects¹⁰. Projects vary from landfill gas capture and flaring, landfill gas to electricity or thermal energy projects, and the upgrading of landfill gas to natural gas for pipeline distribution.

According to the US EPA, there are many barriers to the implementation of landfill gas to energy projects in the United States, which include a lack of information and a perception of high risk, high costs and low

¹⁰ California Climate Action Registry. (2008, Nov). Landfill Project Reporting Protocol Collecting and Destroying Methane from Landfill: Version 2.0.

rate of return associated with these projects, permitting and regulatory difficulties, and poor market conditions¹¹. As a result the Landfill Methane Outreach Program (LMOP) was developed to create alliances among states, communities and industry as a means to reduce barriers and encourage the development of cost effective landfill gas to energy projects. Given the barriers associated with landfill gas to energy projects, it is likely that landfill gas flaring projects face similar barriers, however the same funding outreach programs are not available for these projects. This is an essential distinction between landfill gas capture and flaring vs. landfill gas to energy projects.

Further, only 14.2% of landfills not subject to federal regulations have implemented projects where landfill gas is flared only¹². This analysis demonstrates that the Project Activity represents a best practice and has not been subject to widespread adoption. Note that the database used for this analysis does not consider state or local regulations, ordinances or permitting requirements.

To assess the market penetration of voluntary landfill gas collection and control projects at unregulated landfills, the California Climate Action Registry's analysis assumed that all non-federally regulated landfills with flares were "required by state and local regulations, ordinances or permitting requirements to have the flares installed"¹³. This assumption was based on the fact that there is no incentive for a landfill to install a flare if it is not required by law.

From this analysis it is concluded that while similar projects have been implemented across the United States, there are essential distinctions between the majority of these projects and the proposed Project Activity. The most compelling distinction remains to be that less than one sixth of non-federally regulated landfills have installed landfill gas capture and flaring projects. Of these landfills, it is a reasonable assumption that the majority were required to implement landfill gas capture and destruction projects to meet local or state requirements.

This is a reasonable assumption due to the lack of an economic incentive associated with the implementation of landfill gas collection and flaring projects. These projects are generally implemented to meet federal, local or state requirements to reduce methane emissions, odors or surface migration of emissions from the landfill. Henrico was not required to implement the Project Activity as a result of local or state regulations, ordinances or permitting requirements, which is an essential distinction between the proposed Project Activity and other similar activities in the region. Based on this assessment and demonstration of additionality, the project is additional.

3.0 MONITORING

3.1 TITLE AND REFERENCE OF THE VCS METHODOLOGY (WHICH INCLUDES MONITORING REQUIREMENTS) APPLIED TO THE PROJECT ACTIVITY AND EXPLANATION OF METHODOLOGY CHOICES

Approved consolidated baseline methodology ACM0001: "Consolidated baseline and monitoring methodology for landfill gas project activities": Version 10

3.2 MONITORING, INCLUDING ESTIMATION, MODELLING, MEASUREMENT OR CALCULATION APPROACHES

¹¹ US EPA. (1996). Renewable Energy Annual. Energy Information Administration: Department of Energy. Washington, DC.

¹² California Climate Action Registry. (2008, Nov). Landfill Project Reporting Protocol Collecting and Destroying Methane from Landfill: Version 2.0.

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

Baseline emissions are monitored using a Rosemount Orifice Plate Model 1495C continuous gas flow meter (with a Rosemount 3095 Multi-Variable Pressure Transmitter) that measures flow on a wet basis and normalizes flow to standard temperature and pressure conditions. Standard conditions are defined as 70 degrees F and 1atm. Landfill gas flow is metered continuously at the blower / flare station, with readings being taken two times per second. Flow data is plotted on strip chart recorders located at the blower / flare station. Daily and monthly flows are determined and entered into spreadsheets by the Landfill Operator.

Two LFG Industries Type k thermocouples are also used to ensure the flare and pilot flame are burning. The strip charts also plot flare temperature to show whether or not the flare was burning. Henrico has verified that when the station is running (i.e. showing a landfill gas flow rate), the flare is also burning. This was done by going through each chart recorder.

Gas composition (CH_4 , CO_2 , O_2 and balance gases) is measured on a wet basis at the blower inlet using a portable gas analyzer. From 2005 to present measurements have been taken at least monthly. On a go-forward basis it is anticipated that gas composition will be measured at least weekly and potentially using a continuous gas analyzer.

The flowmeter was factory calibrated in 2005 prior to installation. The flowmeter was also calibrated in January 2009. On a go forward basis, the flowmeter will be calibrated annually. The gas analyzer will be calibrated prior to each use and sent to the manufacturer for calibration on a semi-annual basis.

The quantity of landfill gas collected from the pre-existing landfill gas to energy system is determined based on historical records of the flow and methane concentration of gas from 2002 through 2004. The flow of gas from the pre-existing system was measured continuously using a Fluid Components International ST98 thermal mass flowmeter and recorded on a strip chart located at the blower / flare station. This flowmeter was factory calibrated. This data is was aggregated on a daily and monthly basis and entered into spreadsheets by the Landfill Operator. Flow readings were corrected to standard conditions of 70 degrees F and 1atm.

The quantity of methane generated in the baseline condition is determined based on the quantity of waste received at the Landfill. Methane emissions are modelled based on default values from the US EPA's LandGEM model.

Project Emissions

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

Flaring Emissions

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 landfill gas and the volumetric fraction of methane in the landfill gas being flared). The composition and flow rate of landfill gas 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 temperatures are recorded on the strip charts located at the blower / flare station. Henrico has reviewed the strip charts to ensure that emission reductions are only claimed for period when

the flare was operating (i.e. to show that when the station was running and recording flow the flare was also burning).

Electricity and Fossil Fuel Combustion Emissions

Project emissions related to electricity consumption are estimated based on the quantity of electricity consumed to operate the Project, according to supplier invoices. The only fossil fuel usage related to the landfill gas collection system and flare is propane used to light the flare pilot.

The County's Public Works Department oversee monitoring activities. In particular, County Landfill Personnel are responsible for changing out the strip chart recorder and gas flow / data quality monitoring. A third party contractor takes gas composition readings. Since December 2007, following each monitoring event data is uploaded directly from the GEM 500 or GEM 2000 to a secure on-line database called Datafields, that is managed and operated by Landtec. Data is also copied and sent to the County for their records.

Flow and flare temperature data is initially recorded using a Yokogawa uR1000 Strip Chart Recorder located at the blower / flare station. Readings are recorded every 90 seconds. Each strip chart lasts approximately one month and County staff changes them as needed.

Each day's flow and hours of operation are then calculated from the strip charts and entered in excel files and saved on the County's computer system. Computer files are backed up nightly and records are kept at the County's Public Works Department Offices. The County then submits data to Blue Source for integration into emission reductions calculations.

Note that all relevant documents and records have been retained since 2002 and 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 3.3 below. It will be the responsibility of Henrico County staff to measure all variables and retain records for verification.

3.3 DATA AND PARAMETERS MONITORED / SELECTING RELEVANT GHG SOURCES, SINKS AND RESERVOIRS FOR MONITORING OR ESTIMATING GHG EMISSIONS AND REMOVALS

3.3.1 MONITORED PARAMETERS

Data / Parameter:	LFG _{total,y}
Data unit:	m ³
Description:	Total amount of landfill gas flared and used to generate electricity at standard temperature and pressure conditions (i.e. 70 degrees F and 1 atm).
Source of data:	Calculated
Measurement procedures (if any):	
Monitoring Frequency	
QA/QC procedures:	
Any comment:	This parameter represents the total amount of landfill gas flared and used to generate electricity and is calculated as the sum of LFG _{flare,y} and LFG _{electricity,y} .

Data / Parameter:	LFG _{flare,y}
Data unit:	m ³
Description:	Total amount of landfill gas captured / total amount of landfill gas flared at standard temperature and pressure conditions (i.e. 70 degrees F and 1 atm).

Source of data:	Measured
Measurement procedures (if any):	Rosemount Orifice Plate Model 1495C flowmeter with a Rosemount 3095 Multi-Variable Pressure Transmitter
Monitoring Frequency	Continuous: Readings from the open flare are taken and totaled two times per second.
QA/QC procedures:	The thermal mass flow meter was factory calibrated in 2005 prior to installation. The flowmeter was calibrated again by the Landfill Operator in January 2009. Rosemount does not have a recommended time interval. However, going forward this flow meter will be calibrated on an annual basis.
Any comment:	Currently, the total quantity of gas collected and the quantity of gas flared at the Landfill are the same at this time as there is no other consumptive gas usage. As such, the quantity of gas flared represents the entire quantity of landfill gas collected. Following the implementation of the gas to energy project, these parameters will not be equivalent and the quantity of gas flared and the quantity used to generate electricity will need to be separately metered. Flow is measured on a wet basis and the flow meter is located at the blower / flare station. In particular, it is located after the condensate knockout pot and after the blowers.

Data / Parameter:	$LFG_{electricity,y}$
Data unit:	m^3
Description:	Total amount of landfill gas used to generate electricity at standard temperature and pressure conditions (i.e. 70 degrees F and 1 atm).
Source of data:	Measured
Measurement procedures (if any):	Flowmeter
Monitoring Frequency	Continuous
QA/QC procedures:	The flowmeter will be calibrated as required on an annual basis or as required by the manufacturer.
Any comment:	The electricity generation facility is not yet commissioned, therefore this parameter is not required at this time.

Data / Parameter:	$FV_{RG,h}$
Data unit:	m^3/h
Description:	Volumetric flow rate of the residual gas in wet basis at normal conditions in the hour h
Source of data:	Measured
Measurement procedures (if any):	Measured using a flowmeter. Note that the same flow meters are / will be used to monitor this parameter as for $LFG_{flare,y}$ and $LFG_{electricity,y}$.
Monitoring Frequency	Continuous.
QA/QC procedures:	As above.
Any comment:	As above.

Data / Parameter:	$PE_{flare,y}$
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".
Measurement procedures (if any):	Calculated
Monitoring Frequency	Annual

QA/QC procedures:	
Any comment:	For this project flare efficiency is not monitored and a default value is used.

Data / Parameter:	w_{CH_4}
Data unit:	$m^3 CH_4 / m^3 LFG$
Description:	Methane fraction in the landfill gas
Source of data:	Landtec GEM 500 and / or GEM 2000 portable gas analyzer
Measurement procedures (if any):	Measured
Monitoring Frequency	Monthly
QA/QC procedures:	The GEM analyzer is calibrated prior to each use. Calibration includes zero checks and a value check test by comparison with a standard certified gas. As recommended by the manufacturer, the analyzer is also sent for factory calibration every six months. Prior to 2009, calibration prior to use of the analyzer was conducted but results were not recorded. From 2009 onwards, records will be retained.
Any comment:	Gas composition is measured on a wet basis at the blower inlet. Flow is measured at the blower outlet / flare inlet. There is no vapor phase dehydration system between the blower inlet and the flare inlet. The gas is not dried out and water vapor is not removed between these two points. As a result, both the flow readings at the flare inlet and the analyzer readings at the blower inlet are recorded on a wet basis. In the case of missing methane composition readings, for quarters during which composition measurements are not available, no emission reduction credits will be claimed. On a go forward basis a sample port will also be installed at the blower outlet / flare inlet. Beginning in 2010 it is anticipated that gas composition will be measured at least weekly and potentially continuously using a continuous gas analyzer.

Data / Parameter:	fv_i
Data unit:	-
Description:	Volumetric fraction of component i in the residual gas where $i = CH_4, CO_2, O_2$, trace gases
Source of data:	Measured
Measurement procedures (if any):	As above for w_{CH_4} .
Monitoring Frequency	As above for w_{CH_4} .
QA/QC procedures:	As above for w_{CH_4} .
Any comment:	As above for w_{CH_4} .

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".
Measurement procedures (if any):	Calculated
Monitoring Frequency	Annual
QA/QC procedures:	
Any comment:	For this project electricity is sourced from the regional grid, and Scenario A applies.

Data / Parameter:	MD _{PR,y}
Data unit:	tonnes CH ₄
Description:	Amount of methane generated during year y of the project activity
Source of data:	Calculated
Measurement procedures (if any):	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
Monitoring Frequency	
QA/QC procedures:	
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
Measurement procedures (if any):	Measured by the project proponent
Monitoring Frequency	Continuous with monthly and annual aggregation of data
QA/QC procedures:	
Any comment:	Quantity of waste disposed determined based on facility records. The County maintains scale records. Every month a summary report is prepared and maintained in the Public Utilities Office.

Data / Parameter:	Other flare operation parameters
Data unit:	-
Description:	This should include the data to monitor whether the flare operates within the range of operating conditions according to the manufacturer's specifications.
Source of data:	Measured
Measurement procedures (if any):	For the open flare system, thermocouples located at the pilot and at the flare are used detect the presence of a flame. The flare also has provisions for auto-shutdown if the flare flame fails. If a flame out occurs, the UV sensor will immediately detect this and the pilot system will turn on to attempt to relight the flare. Further, if for any reason the UV sensor fails to function, it is backed up by the temperature controller and the flare will shut down when the temperature drops to 400°F. After a preset delay time of 10 minutes, the system will try to restart. If not successful after three tries, the system will stop trying to start automatically. If the flare system shuts down, the flare's control system will automatically shut down the blowers and flare. During a shutdown, the automatic shutoff valve closes and the blowers turnoff. As a result, no gas is discharged and no flow is recorded. If a thermocouple burns out, it will read an improperly low temperature causing the automatic control system to shut the station down.
Monitoring Frequency	Continuous.
QA/QC procedures:	Thermocouples were last checked on May 20, 2008 by LFG Specialties.
	Over the years, there has not been a routine periodic check of the

	thermocouple other than monthly noting recorded temperatures on the chart recorder paper and noting the temperature reading from the thermocouple during monthly site visits for monitoring and whether or not the reading is within an expected range based on experience. However on a go forward basis, the thermocouples will be checked annually, concurrent with calibration of the flowmeter.
Any comment:	

Data / Parameter:	Operation of the energy plant
Data unit:	hrs
Description:	Operation of the energy plant
Source of data:	Measured
Measurement procedures (if any):	TBD
Monitoring Frequency	Annual
QA/QC procedures:	
Any comment:	The procedures used to measure this parameter have not yet been determined, as the energy plant is not yet operational.

Data / Parameter:	EC _{Grid,y}
Data unit:	MWh
Description:	Quantity of electricity consumed by the project electricity consumption source j in year y
Source of data:	Calculated as per the “Tool to determine baseline, project and / or leakage emissions from electricity consumption”.
Measurement procedures (if any):	Based on supplier invoices.
Monitoring Frequency	Annual
QA/QC procedures:	
Any comment:	

Data / Parameter:	PE _{Propane,y}
Data unit:	tonnes CO _{2E}
Description:	Annual project emissions from propane combustion to light the flare
Source of data:	Calculated as per the “Tool to determine project or leakage CO ₂ emissions from fossil fuel combustion”.
Measurement procedures (if any):	Calculated
Monitoring Frequency	Annual
QA/QC procedures:	
Any comment:	

Data / Parameter:	FC _{Propane,y}
Data unit:	gallons / year
Description:	Quantity of propane combusted as flare pilot fuel during the year y
Source of data:	Measured
Measurement procedures (if any):	Based on an supplier invoices
Monitoring Frequency	Annual
QA/QC procedures:	
Any comment:	

3.3.2 PARAMETERS NOT MONITORED

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 project activity.																									
Source of data:	Henrico historical data. Flow was metered continuously using a Fluid Components International ST98 Thermal Gas Flow Meter and corrected to standard temperature and pressure conditions of 70 degrees F and 1 atm. Composition was measured using a Landtec Gem 500 gas analyzer.																									
Value of data applied:	378.8																									
Measurement procedures (if any):	Prior to project implementation, landfill gas captured by the pre-existing system was flared. Since emission reductions are claimed for flaring landfill gas, the incremental quantity of landfill gas that would have gone to the flare in the baseline must be accounted for. This gas would not have been vented in the baseline condition and a baseline deduction is required. Henrico metered the flow and composition of gas flared from 2002 through 2004, prior to the project activity and the baseline quantity of landfill gas flared is presented below. <table><tr><th>Year</th><th>Flow (scfm)</th><th>Flow (scf/yr)</th><th>% CH₄</th><th>tCH₄</th></tr><tr><td>2002</td><td>66.7</td><td>15,066,025</td><td>42.97</td><td>289.2</td></tr><tr><td>2003</td><td>103.7</td><td>27,148,729</td><td>49.83</td><td>521.2</td></tr><tr><td>2004</td><td>79.1</td><td>17,720,374</td><td>42.63</td><td>340.2</td></tr><tr><td>Mean</td><td>83.2</td><td>19,729,485</td><td>45.14</td><td>378.8</td></tr></table>	Year	Flow (scfm)	Flow (scf/yr)	% CH ₄	tCH ₄	2002	66.7	15,066,025	42.97	289.2	2003	103.7	27,148,729	49.83	521.2	2004	79.1	17,720,374	42.63	340.2	Mean	83.2	19,729,485	45.14	378.8
Year	Flow (scfm)	Flow (scf/yr)	% CH ₄	tCH ₄																						
2002	66.7	15,066,025	42.97	289.2																						
2003	103.7	27,148,729	49.83	521.2																						
2004	79.1	17,720,374	42.63	340.2																						
Mean	83.2	19,729,485	45.14	378.8																						
QA/QC procedures:																										
Any comment:																										

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 of data applied:	50 (if composition is metered periodically) 98 (if composition is metered continuously)
Any comment:	According to ACM0001, in cases where less than continuous composition measurements are used, the default flare efficiency from the CDM flaring tool must be applied. In the future, methane composition may be metered continuously. In this case, a more accurate flare efficiency for the open flare will be used 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.

Data / Parameter:	Regulatory requirements relating to landfill gas
Data unit:	--

Description:	Regulatory requirements relating to landfill gas
Source of data:	Publicly available information of the host country's regulatory requirements relating to landfill gas.
Value of data applied:	
Any comment:	The information though recorded annually, is used for changes to $MD_{BL,y}$ at renewal of the credit period. Relevant regulations for LFG project activities shall be updated at renewal of each credit period. Changes to regulations should be converted to the amount of methane that would have been destroyed/combusted during the year in the absence of the project activity ($MD_{BL,y}$). Project participants should explain how regulations are translated into that amount of gas.

Data / Parameter:	GWP_{CH_4}
Data unit:	tonnes CO_2e/tCH_4
Description:	Global warming potential of CH_4
Source of data:	IPCC
Value of data applied:	21 for the first commitment period. Shall be updated according to any future COP/MOP decisions.
Any comment:	

Data / Parameter:	D_{CH_4}
Data unit:	tonnes CH_4/m^3CH_4
Description:	Methane Density
Source of data:	
Value of data applied:	Project and pre-project (70 degrees F and 1 atm): 0.000669 ¹⁴
Any comment:	

Data / Parameter:	F
Data unit:	-
Description:	Fraction of methane in the SWDS gas (volume fraction)
Source of data:	Site-specific data
Value of data applied:	0.45
Any comment:	This factor is a more accurate representation of the composition of gas historically collected from the Landfill and is based on facility records.

Data / Parameter:	Lo
Data unit:	m^3/Mg
Description:	Potential methane generation capacity
Source of data:	US EPA LandGEM Model
Value of data applied:	100
Any comment:	The LandGEM model has default values for Inventory Conventional and CAA Conventional values. To be conservative the Inventory Conventional value is applied.

Data / Parameter:	k
Data unit:	-
Description:	Decay rate
Source of data:	US EPA LandGEM model default parameter
Value of data applied:	0.04
Any comment:	The LandGEM model has a decay rate for Inventory Conventional and CAA Conventional values. To be conservative the Inventory Conventional

¹⁴ http://cdm.unfccc.int/methodologies/inputsconsmeth/MGM_methane.pdf

	value is applied.
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Data / Parameter:	NCV
Data unit:	MMBtu / gallon
Description:	Energy content of propane
Source of data:	U.S. EPA Guidelines The value of 3.824 MMBtu per barrel was obtained from US EPA and was converted to units of MMBtu per gallon by dividing the factor by the a conversion factor of 42 gallons per barrel.
Value of data applied:	0.091048
Any comment:	Values will be reviewed annual 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 The value of 17.20 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 a factor of 1,102 to convert from kilograms to tons.
Value of data applied:	0.063067 tonnes CO ₂ / MMBtu
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.

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. Emission factor sourced from the US EPA’s Emissions & Generation Resource Integrated Database (eGrid) 2007, Version 1.1: Year 2005 Summary Tables. Emission factor for SRVC.
Value of data applied:	0.515
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:	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

	2007: Chapter 2 Energy Consumption by Sector.
Value of data applied:	9
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.

3.3.3 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 thermal energy, some of the parameters related to project and baseline emissions from heat generation would not be required.

In particular, for reasons of applicability to the Henrico County Landfill Gas Combustion Project, certain parameters included in the methodology and tools have not been included in this methodology, and 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
EL _{LFG} CEF _{elec,y} NCV _{fuel,BL} ε _{gen,BL}	Not applicable since the scope of the project activity does not include emission reductions associated with electricity generation off-site.
LFG _{thermal,y} ET _{LFG} EF _{fuel,BL} NCV _{fuel,BL} ε _{boiler/airheater} Operation of the boiler/air heater / heat generating equipment	Not applicable since the project activity does not generate thermal energy.
LFG _{PL,y}	Not applicable since the project activity does not send landfill gas to pipeline for distribution.
T P	Temperature and pressure data are not required as landfill gas flow meters correct automatically to standard temperature and pressure.
w _{c,i,y} ρ _{i,y}	Not required since fossil fuel combustion emissions are calculated using 'Option B' of the CDM "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion".
BE _{CH4,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}	Not applicable as these parameters are used to calculate the

MV_n $t_{O_2,h}$ $Fv_{CH_4,FG,h}$ $MM_{CH_4}, MM_{CO}, MM_{CO_2},$ $MM_{O_2}, MM_{H_2}, MM_{N_2}$ AM_c, AM_h, AM_o, AM_n NA_{ij} P_n R_u T_n K	methane combustion efficiency of the flare if it is continuously monitored, which is not the case for this project.
$PP_{CP,j}$ and $PP_{CP,l}$ $EF_{grid,CM,y}$ $FC_{n,i,t}$ $EG_{n,t}$ $HG_{n,t}$ $n_{boiler,y}$ $NCV_{i,t}$ $EF_{CO_2,i,t}$	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.

Additional or Altered Parameters

The only parameters added or altered from the CDM methodology are related to the methodology used to estimate methane emissions from solid waste disposal. 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 ($W_{j,x}$) 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.

3.4 DESCRIPTION OF THE MONITORING PLAN

The monitoring plan is described in Sections 3.2 and 3.3 of this document.

4.0 GHG EMISSION REDUCTIONS

4.1 EXPLANATION OF METHODOLOGICAL CHOICE

The methodology selected is ACM0001 as explained in Section 2.2 of this document.

4.2 QUANTIFYING GHG EMISSIONS AND / OR REMOVALS FOR THE BASELINE SCENARIO

The following equation is used to determine baseline emissions:

$$BE_y = (MD_{project,y} - MD_{BL,y}) * GWP_{CH_4} + EL_{LFG,y} * CEF_{elec,BL,y} + ET_{LFG,y} * CEF_{ther,BL,y} \quad (1)$$

Where:

BE_y = Baseline emission in year y (tCO₂e)

$MD_{project, y}$	= The amount of methane that would have been destroyed/combusted during the year, in tonnes of methane (tCH ₄) in project scenario
$MD_{BL, y}$	= 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, in tonnes of methane (tCH ₄)
GWP_{CH_4}	= Global Warming Potential value for methane for the first commitment period is 21 tCO ₂ e / tCH ₄
$EL_{LFG, y}$	= Net quantity of electricity produced using LFG, which in the absence of the project activity would have been produced by power plants connected to the grid or by an on-site /off-site fossil fuel based captive power generation, during year y, in megawatt hours (MWh)
$CEF_{elec, BL, y}$	= CO ₂ emissions intensity of the baseline source of electricity displaced, in tCO ₂ e/MWh. This is estimated as per equation (9) below
$ET_{LFG, y}$	= The quantity of thermal energy produced utilizing the landfill gas, which in the absence of the project activity would have been produced from onsite/offsite fossil fuel fired boiler, during the year y in TJ
$CEF_{ther, BL, y}$	= CO ₂ emissions intensity of the fuel used by boiler to generate thermal energy which is displaced by LFG based thermal energy generation, in tCO ₂ e/TJ.

No emission reductions are claimed for grid-connected electricity generation that is offset by electricity produced from landfill gas destructed at the Ingenco facility, as these environmental attributes are not owned by Henrico. Further no thermal energy is produced using the landfill gas therefore equation (1) is reduced to:

$$BE_y = (MD_{project, y} - MD_{BL, y}) * GWP_{CH_4} \quad (1)$$

According to ACM0001 in the case where the $MD_{BL, y}$ is given/defined in the regulation and/or contract as a quantity that quantity will be used. In situations where in the baseline LFG captured and destroyed, for reasons other than regulation and/or contract, historic data on actual amount captured shall be used as $MD_{BL, y}$. Otherwise, ACM0001 states that historic data on the actual amount of methane captured should be used.

As such, historic data will be used to quantify $MD_{BL, y}$, as outlined in Section 3.3. As a result equations (2) through (7) are not applicable to the project and they are omitted.

Ex Ante Estimate of Emission Reductions

Following ACM0001 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 landfill gas curves in the United States. Equation (13) of ACM0001 is therefore not required.

Instead, 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:

$$MD_{project, y} = f(W, F, k, Lo)$$

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 (tCO ₂ e)
F	= Fraction of methane in the landfill gas (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 (m ³ /Mg)

Calculation of Methane Destroyed by the Project Activity

The methane destroyed by the project activity ($MD_{project,y}$) is then calculated based on monitoring the quantity of methane actually flared, used to generate electricity, thermal energy or natural gas and the total quantity of methane captured for entry into equation (1) as follows:

$$MD_{project,y} = MD_{flared,y} + MD_{electricity,y} + MD_{thermal,y} + MD_{PL,y} \quad (8)$$

Where:

$MD_{flared,y}$	= Quantity of methane destroyed by flaring (tCH ₄)
$MD_{electricity,y}$	= Quantity of methane destroyed by generation of electricity (tCH ₄)
$MD_{thermal,y}$	= Quantity of methane destroyed for the generation of thermal energy (tCH ₄)
$MD_{PL,y}$	= Quantity of methane sent to the pipeline for feeding to the natural gas distribution network (tCH ₄)

No thermal energy or natural gas for pipeline distribution is produced by the project therefore equation (8) is reduced to:

$$MD_{project,y} = MD_{flared,y} + MD_{electricity,y} \quad (9)$$

Calculation of the quantity of methane destroyed by flaring ($MD_{flared,y}$) for entry into equation (8) is outlined below:

$$MD_{flared,y} = (LFG_{flare,y} * w_{CH_4,y} * D_{CH_4}) - (PE_{flare,y} / GWP_{CH_4}) \quad (9)$$

Where:

$LFG_{flare,y}$	= Quantity of landfill gas fed to the flare(s) during the year measured in cubic meters (m ³)
$w_{CH_4,y}$	= Average methane fraction of the landfill gas as measured during the year and expressed as a fraction (in m ³ CH ₄ / m ³ LFG)
D_{CH_4}	= Methane density expressed in tonnes of methane per cubic meter of methane (tCH ₄ / m ³ CH ₄)
$PE_{flare,y}$	= Project emissions from flaring of the residual gas stream in year y (tCO ₂ e) determined following the procedure described in the “Tool to determine project emissions from flaring gases containing Methane”, for which the involved equations are listed below.

Following implementation of the LFGTE component of the Project calculation of the quantity of methane destroyed by electricity generation ($MD_{electricity,y}$) for entry into equation (8) is outlined below:

$$MD_{electricity,y} = (LFG_{electricity,y} * w_{CH_4,y} * D_{CH_4}) \quad (10)$$

Where:

$LFG_{electricity,y}$	= Quantity of landfill gas destroyed by the generation of electricity during the year measured in cubic meters (m ³)
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$w_{CH_4,y}$ = Average methane fraction of the landfill gas as measured during the year and expressed as a fraction (in $m^3 CH_4 / m^3 LFG$)

D_{CH_4} = Methane density expressed in tonnes of methane per cubic meter of methane ($tCH_4 / m^3 CH_4$)

Equations (11) and (12) are not applicable to the project and they are omitted.

Project Emissions from Flaring

The project emissions from flaring ($PE_{flare,y}$) for input into equation (9) are then 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.

In the future, if methane composition is metered on a continuous basis, a flare efficiency of 98% will be applied. 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 landfill gas must have a composition of at least 30 to maintain a stable flame and a 98% destruction efficiency. The flow range must be between 135 scfm and 1350 scfm.

To ensure the flare is operated within these limits, the average monthly methane content and the average monthly flow of landfill gas to the flare will be monitored to ensure they are within the design limits. This will ensure that the flare is operated according to the specifications required to ensure a destruction efficiency of 98%.

Landfill Gas Composition

The CDM tool requires that the volumetric fraction of each component in the landfill gas ($fv_{i,h}$) be measured continuously, however ACM0001 allows the project developer to use quarterly measurements to determine the fraction of methane in the landfill gas.

Measurements of landfill gas composition at the blower inlet are conducted monthly at a minimum. Given that methane composition measurements are not taken continuously, the lower bound of the 95% confidence interval of the annual average is used to estimate baseline methane emissions to ensure conservativeness. Further, if no measurements are conducted in any given quarter, no credits will be claimed for the quarter for which data is missing. On a go forward basis, it is anticipated that methane composition will be measured continuously.

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

$$TM_{RG} = FV_{RG} * fv_{CH_4,RG} * \rho_{CH_4,n} \text{ (13 flaring tool)}$$

Where:

TM_{RG} = Mass flow rate of methane in the residual gas

FV_{RG} = Volumetric flow rate of the residual gas in wet basis at normal conditions

$f_{V_{CH_4, RG}}$ = Volumetric fraction of methane in the residual gas on wet basis (NB: this corresponds to $f_{V_{i, RG, h}}$ where i refers to methane).
 $\rho_{CH_4, n}$ = Density of methane at normal conditions

Emissions are then calculated as follows:

$$PE_{flare, y} = \sum_{h=1}^{8760} TM_{RG} * (1 - \eta_{flare}) * GWP_{CH_4} / 1000 \text{ (15 flaring tool)}$$

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

4.3 QUANTIFYING GHG EMISSIONS AND / OR REMOVALS FOR THE PROJECT

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

$$PE_y = PE_{Grid, y} + PE_{FC, Propane, y} \text{ (16)}$$

Where:

$PE_{EC, y}$ = Emissions from consumption of electricity in the project case. The project emissions from electricity consumption ($PE_{EC, y}$) will be calculated following the latest version of “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”.
 $PE_{FC, Propane, y}$ = Emissions from consumption of heat in the project case. The project emissions from fossil fuel combustion ($PE_{FC, j, y}$) will be calculated following the latest version of “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion”.

The project emissions from electricity consumption ($PE_{EC, y}$) for input into equation (16) are calculated following the methodology outlined in the the CDM Annex 7 “Tool to calculate baseline, project or leakage emissions from electricity consumption” Version, 01.

During Phase one (1) of the Project, electricity is consumed to operate the blowers used to transport gas to the flare. Each blower is equipped with a 40 hp motor. Electricity will also be used under Phase two (2) of the Project to transport gas to the Ingenco facility and further process gas.

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 for 2005 was 0.515 tonnes CO₂ per MWh. The emission factor for electricity generation ($EF_{EL,j,y}$) is therefore assigned this value.

Emissions are then calculated as follows:

$$PE_{Grid,y} = \sum_j EC_{PJ,Grid,y} * FE_{EL,Grid,y} * (1 + TDL_{Grid,y}) \text{ (1 electricity tool)}$$

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

Equations (2) and (3) of the electricity tool are omitted as calculation of the baseline and leakage electricity consumption are not required by ACM0001.

Equations (4), (5), (6), (7) and (8) of the CDM tool are omitted as these are not relevant to the project.

Pilot fuel used in the flares represents the sole fossil fuel emission from the project activity. The project emissions from fuel consumption ($PE_{FC,j,y}$) for input into equation (16) are calculated following the methodology outlined in the the CDM Annex 19 “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion” Version 01 using Option B as follows:

$$PE_{FC,j,y} = \sum_i FC_{Propane,y} * COEF_{Propane,y} \text{ (1 fuel tool)}$$

Where:

$PE_{FC,Propane,y}$ = are the CO₂ emissions from propane combustion during the year y (tCO₂/yr)
 $FC_{Propane,y}$ = quantity of propane used in the flare as pilot fuel during the year y (gallons/yr)
 $COEF_{Propane,y}$ = CO₂ emission coefficient of propane in the year y (tCO₂/gallon)

Note that 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, U.S. EPA factors are used instead¹⁵. It is possible to use the IPCC factors for Liquefied Petroleum Gas, a mixture of Propane and Butane, but the EPA factor used is higher and therefore more conservative.

The CO₂ emission coefficient $COEF_{i,y}$ is then calculated based on the net calorific value and CO₂ emission factor of the fuel type i (Option B), as follows:

¹⁵ U.S. EPA, Inventory of Greenhouse Gas Emissions and Sinks: 1990 – 2005 (2007), Annex 2.1, Table A-40

$$\text{COEF}_{\text{Propane},y} = \text{NCV}_{\text{Propane},y} * \text{EF}_{\text{CO}_2,\text{Propane},y} \text{ (4 fuel tool)}$$

Where:

$\text{COEF}_{\text{Propane},y}$ = the CO₂ emission coefficient of propane used (tCO₂/gallon);

$\text{NCV}_{\text{Propane},y}$ = the weighted average net calorific value of propane (MMBtu/gallon)

$\text{EF}_{\text{CO}_2,\text{Propane},y}$ = the weighted average CO₂ emission factor of propane (tCO₂/MMBtu)

4.4 QUANTIFYING GHG EMISSION REDUCTIONS AND REMOVAL ENHANCEMENTS FOR THE GHG PROJECT

Emission reductions are calculated as the difference between the baseline methane emission rate and project emissions from electricity and fuel consumption at the site. A summary of the emission reductions from the Project is not available at this time and will be provided during project verification.

5.0 ENVIRONMENTAL IMPACT

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

6.0 STAKEHOLDER COMMENTS

N/A

7.0 SCHEDULE

The chronological sequence of events for implementation of the pre-existing system and anticipated dates for the construction and operation of the project activity are provided below.

Date	Activity
2001 / 2002	Fourteen wells and a flare were installed in the East Fill Landfill.
Dec 2004	Flare was decommissioned.
2005	An additional 87 wells were installed in all three landfills and a larger flare station was installed.
June 3 rd , 2005	The new flare was installed. Project start date.
2006	Five new wells were installed.
January 2009	Monitoring period and crediting period start date
Nov 2009 and annually	Validation / Annual verification.
Late 2009 / Early 2010	Anticipated date of expansion of landfill gas capture system.
2010	Anticipated date of commissioning of landfill gas to energy project.
Late 2012 / Early 2013	Anticipated dated of landfill closure.
December 2018	Renewal of project crediting period.

8.0 OWNERSHIP

8.1 PROOF OF TITLE

Documents showing proof of title and ownership of the emission reductions to be generated by the project activity are available for the validator.

8.2 PROJECTS THAT REDUCE GHG EMISSIONS FROM ACTIVITIES THAT PARTICIPATE IN AN EMISSIONS TRADING PROGRAM (IF APPLICABLE)

N/A