



**Verified Carbon
Standard**

HENRICO COUNTY LANDFILL GAS COMBUSTION PROJECT



Document Prepared by Blue Source LLC

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1 PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

- The Project is a landfill gas (LFG) capture and combustion project located at the Springfield Road Landfill (the “Landfill”). Landfill gas is actively captured at the solid waste disposal site (SWDS) and combusted in either the on-site flare or the on-site electricity generation facility. Under this project condition, methane is converted to CO₂ through combustion which results in measurable emission reductions.
- The Landfill was opened in 1966 and received waste until 2014; it was permanently closed in 2016. The Landfill consists of three areas: The East Fill, the West Fill, and the Expansion, all of which are tied into the LFG capture system which collects and destroys methane at the facility.
- The project activity consists of two stages:

Stage 1 (2005 – 2010)

In December 2004 the small flare was decommissioned and on June 3, 2005, a larger flare was commissioned. Along with a new flare, 87 wells were installed across all three areas of the Landfill, in addition to the existing 14. The wellfield was further expanded in 2006 with the addition of five new wells in the Expansion area. This stage of the Project is owned and operated by Henrico.

Stage 2 (2010 – present)

This stage involves the installation of a 4 MW power generating facility on site that combusts the landfill gas to generate electricity using twelve recycled Detroit Diesel dual-fuel compression ignition engines. This is owned and operated by Industrial Power Generating Company LLC (“Industrial Power Generating Company”) and became operational in September 2010. In Fall 2010, an additional 18 wells were installed across the Landfill.

- The power generating facility is owned and operated by Industrial Power Generating Company LLC (“Industrial Power Generating Company”) and became operational in 2010. During this monitoring period, there were no significant shutdowns of the facility. When the facility was not receiving LFG, the gas was instead sent to the flare for combustion which was also operating under normal conditions during the monitoring period.
- A total of 41,343 t CO₂e of emission reductions were generated in the monitoring period between January 1, 2021 – December 31, 2021.

1.2 Sectoral Scope and Project Type

Project Category: Sectoral Scope 13 (Waste Handling and Disposal) and Sectoral Scope 1 (Energy)

Project Type: Individual project

1.3 Project Proponent

The gas collection system and flare are owned and operated by the County of Henrico.

Organization name	County of Henrico – Department of Public Utilities
Contact person	Jon Clary, P.E.
Title	Division Director – Solid waste and Recycling
Address	P.O. Box 27032 Richmond, VA 23273
Telephone	(804) 727-8217
Email	cla06@co.henrico.va.us

1.4 Other Entities Involved in the Project

The power generation facility is owned and operated by Industrial Power Generating Company. Industrial Power Generating Company contracted with the County of Henrico to purchase the landfill gas to use in the electricity generator.

Organization name	Industrial Power Generating Company LLC
Role in the Project	Thomas Fabrie is the contact person for Industrial Power Generating Company responsible for providing the generation/proof of destruction data, as well as documentation on the electricity generator.
Contact person	Thomas Fabrie
Title	Chief Financial Officer
Address	2250 Dabney Road Richmond, VA 23230
Telephone	(804) 521-3578
Email	thomas.fabrie@riverviewpwr.com

Organization name	Blue Source LLC
Role in the Project	Project Developer
Contact person	Tooraj Moulai

Title	Director, Engineering & Technical Services
Address	1605 – 840 7th Ave SW Calgary, AB Canada, T2P 3G2
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1.5 Project Start Date

The project start date is June 3, 2005 when the Landfill began collecting and destructing landfill gas from the project collection system in Stage 1.

1.6 Project Crediting Period

The Project's current 10-year crediting period is January 1, 2019 – December 31, 2028

The Project's first 10-year crediting period was January 1, 2009 – December 31, 2018.

1.7 Project Location

The Landfill is a municipal solid waste landfill located on a 192-acre 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, 23060

The latitude and longitude of the facility are as follows:

Latitude: 37° 40' 45"

Longitude: 77° 33' 58"

1.8 Title and Reference of Methodology

The Methodology used for the Project is ACM0001 Large-scale Consolidated Methodology: "Flaring or use of landfill gas" (version 19.0).

The tools applied by the Project are:

TOOL 11: Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period (version 3.0.1)

TOOL 5: "Baseline, project and/or leakage emission from electricity consumption and monitoring of electricity generation" (version 3.0)

TOOL 8: “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (version 3.0)

Tool 3: “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion” (version 3.0).

Tool 6: “Project emissions from flaring” (version 3.0)

1.9 Participation under other GHG Programs

The Project does not reduce GHG emissions that are included in any other emissions trading program or any other mechanism that includes GHG allowance trading. The Project is not registered under any other GHG program than the Verified Carbon Standard (VCS Standard, v4.2, 20 January 2022).

1.10 Other Forms of Credit

This Project is not included in any other emissions trading program or any other mechanism that includes GHG allowance trading.

This Project has not received any other form of GHG-related environmental credit during this monitoring period.

1.11 Sustainable Development Contributions

The Project is a landfill gas (LFG) capture and combustion project that implements the active capture of landfill gas at the solid waste disposal site (SWDS) for combustion in either the on-site flare or the on-site electricity generation facility. This results in SD contributions (SDG 13.0) as under this project condition, methane is converted to CO₂ through combustion which results in measurable greenhouse gas emission reductions.

Table 1: Sustainable Development Contributions

Row number	SDG Target	SDG Indicator	Net Impact on SDG Indicator	Current Project Contributions	Contributions Over Project Lifetime
1)	13.0	Tonnes of greenhouse gas emissions avoided or removed	Under this project condition, methane is converted to CO2 through combustion of captured landfill gas which results in measurable greenhouse gas emission reductions	By implementing the active capture of landfill gas at the solid waste disposal site (SWDS) for combustion in either the on-site flare or the on-site electricity generation facility, the Henrico County Landfill Gas Combustion Project has prevented the release of 41,343 tonnes of carbon dioxide equivalent into the atmosphere during the monitoring period	Prevented the release of 683,805 tonnes of carbon dioxide equivalent into the atmosphere

2 SAFEGUARDS

2.1 No Net Harm

There are no potential negative environmental and socio-economic impacts from this Project.

2.2 Local Stakeholder Consultation

No concerns have from local stakeholders have been brought forth during this reporting period, or since the Project's initial validation.

Any new changes to the Landfill or Project operations are shared with the public and local stakeholders can submit any input and raise concerns as they see fit. Additionally, questions or comments can be submitted directly to the Landfill Manager or Public Works Director at any time and will be addressed as needed.

2.3 AFOLU-Specific Safeguards

This Section is not applicable as this is a non-AFOLU project.

3 IMPLEMENTATION STATUS

3.1 Implementation Status of the Project Activity

The Project was fully operational during the monitoring period. There were not changes to the operations at the facility that impacted the quantification.

3.2 Deviations

3.2.1 Methodology Deviations

There are no methodology deviations applied during this monitoring period.

3.2.2 Project Description Deviations

There are a couple minor deviations to the monitoring plan that do not impact the applicability of the methodology, additionality or the appropriateness of the baseline scenario. As a result, project remains in compliance with the applied methodology. These minor deviations applied during the 2021 reporting period are:

- The primary landfill gas analyzer, previously a FAU-TDL Gas Analyzer (SN 1037), was replaced on 28/05/2020 with a Siemens Ultramat 23 Gas Analyzer (SN N1M4372).

- The primary landfill gas analyzer, a Siemens Ultramat 23 Gas Analyzer (SN N1M4372) was intended to measure landfill gas methane content during the current reporting period from 01/01/2021 to 12/31/2021. However, around July 23, 2021, the methane analyzer appeared to have failed. As a result, from July 1, 2021 to Dec 31, 2021, the backup analyzer (Landtec GEM 2000, SN GM12536) was used to measure landfill gas methane content. This change between the continuous and the back up analyzer does not impact eligibility of the project, as measurement using the backup analyzer was maintained throughout the process.
- The Rosemount Flow Meter (SN 306661) was not calibrated as per its three-year calibration schedule. The meter was calibrated two months out of schedule. This delay is not expected to have any impact on accuracy as the meter was calibrated on 12/10/2021, and the meter found to have less than 1% drift.
- The backup gas analyzer Landtec GEM 2000 (SN GM12536) was not calibrated in July 2021 as per its 6-month calibration schedule. However, this delayed meter calibration is not expected to have any impact on accuracy as the meter was calibrated on 01/20/2022 found to have less than 1% drift.
- The flow meter to the flare (SN 135079 operating at 68F and 1 atm) was replaced by a new flow meter to the flare (SN 25855 operating at 60F and 1 atm) on 07/20/2021, and was calibrated on the same day. The replacement was due to the meter's older age. Noting however, meter age did not hinder the meter performing within the required accuracy specifications.
- The project description lists the reference density of methane at a temperature of 68F and a pressure of 1 atm. The flow meter to the *Industrial Power Generating Company* facility measures flow rate at a temperature of 60F and a pressure of 1 atm, while the historic flow meters measured flow at reference conditions of 70F and 1 atm. For ease of calculation, reference densities of methane at these two temperature and pressure conditions have been included in the current quantification to calculate the mass of methane destroyed in the project for electricity generation and destroyed in the baseline by the historic LFG flare.
- Calibration reports from the electricity meters measuring generation at the Industrial Power Generating Company facility have not been routinely saved by the project. Electricity generation data is used to double check claimed destruction of LFG sent to the Industrial Power Generating Company facility. These checks consist of a simple comparison to ensure that there is no LFG destruction claimed at times when no electricity generation is reported. The project accuracy is not expected to be impacted in the absence of these records, as the meters are regularly inspected per requirements for commercial electricity metering and the values collected from these meters are not used in any calculation pertaining to emissions reductions.

3.3 Grouped Projects

This section is not applicable as this is not a grouped project.

4 DATA AND PARAMETERS

4.1 Data and Parameters Available at Validation

Data / Parameter	OX_{top_layer}
Data unit	Dimensionless
Description	Fraction of methane that would be oxidized in the top layer of the Landfill in the baseline
Source of data	Methodology
Value applied	0.1
Justification of choice of data or description of measurement methods and procedures applied	Value provided in the Methodology
Purpose of Data	Calculation of baseline emissions
Comments	

Data / Parameter	$F_{CH_4,BL,y}$
Data unit	t CH ₄
Description	Amount of methane in the LFG that would have been flared in the baseline
Source of data	Historical flare data between 2002 - 2004
Value applied	401.19 t CH ₄ /yr
Justification of choice of data or description of measurement methods and procedures applied	Three years of historical flare data between 2002-2004 is used to determine this value as per equations 13 & 14 of ACM0001.
Purpose of Data	Calculation of baseline emissions
Comments	Calculated based on parameters LFG_{BL} , $WCH_{4,BL}$, and ρ_{CH_4} .

Data / Parameter	LFG_{BL}
Data unit	m ³
Description	Historic volume of landfill gas sent to the flare in the baseline

Source of data	Historical flare data between 2002 - 2004
Value applied	1,308,860 m ³ / yr
Justification of choice of data or description of measurement methods and procedures applied	Three years of historical flare data between 2002-2004 is used to determine this value. This value was measured continuously using a Fluid Components International ST98 Thermal Gas Flow Meter and corrected to standard temperature and pressure conditions of 68 degrees F and 1 atm. Calibration was performed annually, but calibration records were not routinely kept until 2009.
Purpose of Data	Calculation of baseline emissions
Comments	

Data / Parameter	WCH ₄ ,BL
Data unit	m ³ CH ₄ / m ³ LFG
Description	Historic average methane fraction of the LFG in the baseline
Source of data	Historical flare data between 2002 - 2004
Value applied	46.02%
Justification of choice of data or description of measurement methods and procedures applied	Three years of historical flare data between 2002-2004 is used to determine this value. This value was measured by Henrico County personal approximately monthly with a Landtec Gem 500 gas analyzer. Calibration was performed before every measurement, but calibration records were not routinely kept until 2009.
Purpose of Data	Calculation of baseline emissions
Comments	

Data / Parameter	GWP _{CH₄}
Data unit	t CO ₂ e / t CH ₄
Description	Global warming potential of methane
Source of data	Reference
Value applied	28

Justification of choice of data or description of measurement methods and procedures applied	IPCC fifth assessment report
Purpose of Data	Calculation of baseline and project emissions
Comments	This value has been updated throughout the 10-year crediting renewal period to align with the latest published IPCC value

Data / Parameter	ρ_{CH_4}
Data unit	t CH ₄ / m ³ CH ₄
Description	Density of methane at three temperature/pressure combinations used as references by metering associated with the project.
Source of data	Reference
Value applied	60F, 1atm: 0.000678 68F, 1atm: 0.000667 70F, 1 atm: 0.000666
Justification of choice of data or description of measurement methods and procedures applied	Metering operated by Draper Aden and Associates was calibrated to 68F, 1atm for the first flow meter which was replaced by a second flow meter calibrated to 60F, 1 atm on July 20, 2021. Metering operated by Industrial Power Generating Company is calibrated to 60F, 1atm. Meters used from 2002-2004 to determine baseline conditions were calibrated to 70F, 1atm. Values are referenced from the UNFCCC inputs received on consolidated methodologies and Air Products and Chemicals, Inc's product data sheet for methane gas.
Purpose of Data	Calculation of baseline and project emissions
Comments	https://cdm.unfccc.int/methodologies/inputsconsmeth/MGM_methane.pdf http://www.airproducts.pt/products/Gases/gas-facts/physical-properties/~::~/link.aspx?id=7A3C61CB791F4B959798D5544A06E617&z=z

Data / Parameter	η_{flare}
Data unit	%

Description	Efficiency of the flare
Source of data	Reference
Value applied	98%
Justification of choice of data or description of measurement methods and procedures applied	Value is used based on guidance from the US EPA for flares operated within the requirements for 40 CFR 60.18.
Purpose of Data	Calculation of baseline emissions
Comments	https://www3.epa.gov/airtoxics/flare/2012flaretechreport.pdf

Data / Parameter	η_{EL}
Data unit	%
Description	Efficiency of the electricity generation engines
Source of data	Reference
Value applied	100%
Justification of choice of data or description of measurement methods and procedures applied	Engines are continuously maintained and operated under lean burn conditions, therefore can reasonably be expected to destroy 100% of LFG methane. Destruction is cross referenced against electricity generation data to ensure operation.
Purpose of Data	Calculation of baseline emissions
Comments	

Data / Parameter	EF_{EF}
Data unit	lbs CO ₂ / MWh
Description	Emission factor for the grid that supplies electricity
Source of data	Reference
Value applied	623.1
Justification of choice of data or description of	Value is obtained using the US EPA eGRID summary tables 2020 Region SRVC. This is the most accurate source of this data.

measurement methods and procedures applied	
Purpose of Data	Calculation of project emissions
Comments	This value will be updated to align with the most recent published eGRID values https://www.epa.gov/egrid/summary-data

Data / Parameter	TDL
Data unit	%
Description	Average transmission and distribution losses in the grid
Source of data	Reference
Value applied	5.30%
Justification of choice of data or description of measurement methods and procedures applied	Value is obtained using the US EPA eGRID summary tables 2020 Region SRVC. This is the most accurate source of this data.
Purpose of Data	Calculation of project emissions
Comments	This value will be updated to align with the most recent published eGRID values. https://www.epa.gov/egrid/summary-data

Data / Parameter	COEF _{propane}
Data unit	t CO ₂ e / gal
Description	CO ₂ emission coefficient for propane
Source of data	Calculated
Value applied	0.005297 t CO ₂ e/gal
Justification of choice of data or description of measurement methods and procedures applied	COEF = NCV * EF which are both reference values
Purpose of Data	Calculation of project emissions
Comments	

Data / Parameter	COEF _{diesel}
Data unit	t CO ₂ e / gal
Description	CO ₂ emission coefficient for diesel
Source of data	Calculated
Value applied	0.010210 t CO ₂ e/gal
Justification of choice of data or description of measurement methods and procedures applied	COEF = NCV * EF which are both reference values
Purpose of Data	Calculation of project emissions
Comments	

Data / Parameter	NCV _{propane}
Data unit	MMBtu / gal
Description	Energy content of propane
Source of data	Reference
Value applied	0.084250
Justification of choice of data or description of measurement methods and procedures applied	U.S. EPA Guidelines https://afdc.energy.gov/fuels/fuel_comparison_chart.pdf
Purpose of Data	Calculation of project emissions
Comments	

Data / Parameter	NCV _{diesel}
Data unit	MMBtu / gal
Description	Energy content of diesel
Source of data	Reference

Value applied	0.128488
Justification of choice of data or description of measurement methods and procedures applied	U.S. EPA Guidelines https://afdc.energy.gov/fuels/fuel_comparison_chart.pdf
Purpose of Data	Calculation of project emissions
Comments	

Data / Parameter	EF _{CO2,propane}
Data unit	t CO ₂ e / MMBtu
Description	CO ₂ emission factor for propane
Source of data	Reference
Value applied	0.06287
Justification of choice of data or description of measurement methods and procedures applied	US EPA Emission Factors for Greenhouse Gas Inventories https://www.epa.gov/sites/default/files/2021-04/documents/emission-factors_apr2021.pdf
Purpose of Data	Calculation of project emissions
Comments	

Data / Parameter	EF _{CO2,diesel}
Data unit	t CO ₂ e / MMBtu
Description	CO ₂ emission factor for diesel
Source of data	Reference
Value applied	0.07946
Justification of choice of data or description of measurement methods and procedures applied	US EPA Emission Factors for Greenhouse Gas Inventories https://www.epa.gov/sites/default/files/2021-04/documents/emission-factors_apr2021.pdf Table 2 shows 10.21 kg CO ₂ /gal.
Purpose of Data	Calculation of project emissions

Comments

4.2 Data and Parameters Monitored

Data / Parameter	$F_{CH_4,PJ,y}$
Data unit	t CH ₄ /yr
Description	Total amount of methane in the LFG collected and destroyed by the project system at standard temperature and pressure (68 F, 1 atm)
Source of data	Continuously monitored
Description of measurement methods and procedures to be applied	Flow rates of methane to the landfill gas flare and electricity generating engines are calculated based on continuous monitored. $F_{CH_4,PJ,y}$ is calculated by summing $F_{CH_4,flared,y}$ and $F_{CH_4,EL,y}$.
Frequency of monitoring/recording	Continuously monitored
Value monitored	2,098.9
Monitoring equipment	See applicable parameters
QA/QC procedures to be applied	See applicable parameters
Purpose of data	Calculation of baseline emissions
Calculation method	Methane content sent to the flare and the Industrial Power Generating Company engines is calculated each month. $F_{CH_4,flared,y}$ and $F_{CH_4,EL,y}$ are summed to calculate the total methane captured and destroyed by the system. See sample calculations in Section 5 for exact methodologies.
Comments	

Data / Parameter	$F_{CH_4,flared,y}$
Data unit	t CH ₄ /yr
Description	Amount of methane in captured LFG which is destroyed by flaring.

Source of data	The amount of methane sent to the flare is calculated based on continuous monitoring. Project emissions from the flare are calculated using continuous monitoring and a flare efficiency factor. $F_{CH_4, \text{flared}, y}$ is calculated as the difference between $F_{CH_4, \text{sent to flare}, y}$, and $PE_{\text{flare}, y}$.
Description of measurement methods and procedures to be applied	Calculated value
Frequency of monitoring/recording	Annual
Value monitored	275.39
Monitoring equipment	See applicable parameters
QA/QC procedures to be applied	See applicable parameters
Purpose of data	Calculation of baseline emissions
Calculation method	$F_{CH_4, \text{flared}, y}$ is determined as the difference between the amount of methane supplied to the flare and any methane emissions from the flare. See sample calculations in Section 5 for exact methodologies.
Comments	Flare efficiency is not monitored, and a default value is used, as per the parameter η_{flare} in section 4.1.

Data / Parameter	$F_{CH_4, \text{sent to flare}, y}$
Data unit	t CH ₄ /yr
Description	Amount of methane in the LFG which is sent to the flare in year y
Source of data	Calculated based on LFG_{flare} , w_{CH_4} and p_{CH_4} as per CDM Tool 8: Tool to determine the mass flow of a greenhouse gas in a gaseous stream.
Description of measurement methods and procedures to be applied	Calculated value
Frequency of monitoring/recording	Continuous

Value monitored	281.01
Monitoring equipment	See applicable parameters
QA/QC procedures to be applied	See applicable parameters
Purpose of data	Calculation of baseline emissions
Calculation method	Measured flowrate of landfill gas is multiplied by the measured methane percentage and methane density at standard temperature and pressure. See sample calculations in Section 5 for exact methodologies.
Comments	

Data / Parameter	$PE_{\text{flare},y}$
Data unit	t CO ₂ e /yr
Description	Project emissions from flaring of the residual gas stream in year y
Source of data	Calculated based on $F_{\text{CH}_4,\text{sent to flare}}$ and η_{flare} as per CDM Tool 6: "Project emissions from flaring".
Description of measurement methods and procedures to be applied	Calculated value
Frequency of monitoring/recording	Annual
Value monitored	140.51
Monitoring equipment	See applicable parameters
QA/QC procedures to be applied	See applicable parameters
Purpose of data	Calculation of project emissions
Calculation method	Methane sent to the flare is multiplied by the destruction efficiency of the flare and the global warming potential of methane to determine project emissions. See sample calculations in Section 5 for exact methodologies.
Comments	

Data / Parameter	LFG _{flare}
Data unit	m ³
Description	Volume of landfill gas sent to flare at normal temperature and pressure.
Source of data	The volume of landfill gas sent to the flare is calculated based on continuous monitoring and recordings.
Description of measurement methods and procedures to be applied	Volume of landfill gas to the flare is measured by an orifice plate flowmeter. Data is continuously monitored and recorded by Henrico data collection software.
Frequency of monitoring/recording	Continuous monitoring. Readings are recorded every five minutes.
Value monitored	1,075,820
Monitoring equipment	Rosemount Orifice Plate Model 1495C flowmeter with a Rosemount 3051S Multi-Variable Transmitter SN: 25855
QA/QC procedures to be applied	The calibration schedule will follow manufacturer's recommendations. Rosemount guarantees meter stability for a 10 year period. For enhanced surety, the project developer has the meter inspected and calibrated at least every 3 years. If the meter is non-functioning for any reason, Industrial Power Generating Company personal will identify this during equipment inspections and repair or replace the malfunctioning meter.
Purpose of data	Calculation of baseline emissions
Calculation method	Measured value
Comments	Data is recorded at 68F and 1atm, and from July 20, 2021 onwards, data is recorded at 60F and 1atm. 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	WCH ₄
Data unit	m ³ CH ₄ /m ³ LFG

Description	Average methane fraction of the LFG
Source of data	Continuously monitored data via the continuous gas analyzer and daily values recorded via the backup gas analyzer
Description of measurement methods and procedures to be applied	The methane fraction in the LFG is normally measured using a continuous gas analyzer. Due to inconsistent readings by the analyzer, a backup meter was used which records a daily value for methane concentration.
Frequency of monitoring/recording	Daily
Value monitored	39.8%
Monitoring equipment	Primary meter: Siemens Ultramat 23 Gas Analyzer SN: N1M4372 Backup meter: Landtec GEM 2000 SN: GM12536
QA/QC procedures to be applied	Siemens Ultramat's recommended maintenance practices are to have the meter inspected and calibrated once annually. If the meter is non-functioning for any reason, Henrico personnel will identify this during equipment inspections and repair or replace the malfunctioning meter. Landtec's recommended maintenance practices are to have the meter inspected and calibrated bi-annually. In the case that the meter is not calibrated within the recommended range, the meter will display an error message on its screen warning that the meter is out of calibration.
Purpose of data	Calculation of baseline emissions
Calculation method	Measured value
Comments	If the regular field checks of the continuous gas analyzer identify a drift greater than 5% over- or under-reporting, a conservative drift factor will be applied manually in the calculations.
Data / Parameter	$F_{CH_4,EL,y}$
Data unit	t CH ₄ /yr

Description	Amount of methane in the landfill gas which is destroyed by electricity generation.
Source of data	Calculated based on $LFG_{Electricity}$, W_{CH4} and ρ_{CH4} as per CDM Tool 8: Tool to determine the mass flow of a greenhouse gas in a gaseous stream.
Description of measurement methods and procedures to be applied	Calculated value
Frequency of monitoring/recording	Continuous
Value monitored	1,823.47
Monitoring equipment	See applicable parameters
QA/QC procedures to be applied	See applicable parameters
Purpose of data	Calculation of baseline emissions
Calculation method	Measured flowrate of landfill gas is multiplied by the measured methane percentage and methane density at standard temperature and pressure. See sample calculations in Section 5 for exact methodologies.
Comments	

Data / Parameter	$LFG_{Electricity}$
Data unit	m^3
Description	Volume of landfill gas sent to power generation unit at standard temperature and pressure.
Source of data	Volume of landfill gas sent to power generation unit is continuously measured via the flowmeter and data is recorded on data collection software
Description of measurement methods and procedures to be applied	Volume of landfill gas to the Industrial Power Generating Company power generation unit is measured by a flowmeter. Data is continuously monitored and recorded by Industrial Power Generating Company data collection software.
Frequency of monitoring/recording	Continuous monitoring. Readings are recorded every five minutes.

Value monitored	6,776,652
Monitoring equipment	Rosemount Orifice Plate, Model 1595C with Rosemount 3095 Multi-Variable Pressure Transmitter SN: 306661
QA/QC procedures to be applied	The calibration schedule will follow manufacturer's recommendations. Rosemount guarantees meter stability for a 10 year period. For enhanced surety, the project developer has the meter inspected and calibrated at least every 3 years. If the meter is non-functioning for any reason, Industrial Power Generating Company personal will identify this during equipment inspections and repair or replace the malfunctioning meter.
Purpose of data	Calculation of baseline emissions
Calculation method	Measured value
Comments	Data is recorded at 60F and 1atm.

Data / Parameter	EC _{PJ,y}
Data unit	MWh/yr
Description	Quantity of electricity consumed by the Project in year y
Source of data	Calculated using supplier invoices from the Henrico and Industrial Power Generating Company facilities as per the "Tool to determine baseline, project and / or leakage emissions from electricity consumption".
Description of measurement methods and procedures to be applied	Review of supplier invoices for electricity consumed at both the Henrico Landfill facility and the Industrial Power Generating Company power generation facility. These invoices are based off direct measurement by commercial electricity meters.
Frequency of monitoring/recording	Monthly
Value monitored	31.306
Monitoring equipment	n/a
QA/QC procedures to be applied	n/a
Purpose of data	Calculation of project emissions

Calculation method	Electricity usage by the Henrico Landfill facility and the Industrial Power Generating Company power generation facility are summed to generate this value.
Comments	

Data / Parameter	PE _{propane}
Data unit	t CO ₂ e/yr
Description	CO ₂ emissions from propane combustion in the flare in year y
Source of data	Calculated based on FC _{propane} and COEF _{propane} as per the CDM “Tool to determine project or leakage CO ₂ emissions from fossil fuel combustion”.
Description of measurement methods and procedures to be applied	Calculated value
Frequency of monitoring/recording	Annually
Value monitored	0.4
Monitoring equipment	See applicable parameters
QA/QC procedures to be applied	See applicable parameters
Purpose of data	Calculation of project emissions
Calculation method	Quantity of propane combusted is multiplied by an appropriate emission factor to determine total emissions. See sample calculations in Section 5 for exact methodologies.
Comments	

Data / Parameter	PE _{diesel}
Data unit	t CO ₂ e/yr
Description	CO ₂ emissions from diesel combustion at the Industrial Power Generating Company facility in year y

Source of data	Calculated based on FC_{diesel} and $COEF_{\text{diesel}}$ as per the CDM “Tool to determine project or leakage CO2 emissions from fossil fuel combustion”.
Description of measurement methods and procedures to be applied	Calculated value
Frequency of monitoring/recording	Monthly
Value monitored	305
Monitoring equipment	See applicable parameters
QA/QC procedures to be applied	See applicable parameters
Purpose of data	Calculation of project emissions
Calculation method	Quantity of diesel combusted is multiplied by an appropriate emission factor to determine total emissions. See sample calculations in Section 5 for exact methodologies.
Comments	

Data / Parameter	FC_{propane}
Data unit	Gallons/yr
Description	Volume of propane combusted by the flare in the project activity in year y
Source of data	Supplier invoices
Description of measurement methods and procedures to be applied	Review of supplier invoices for propane consumed at the facility. Invoices are based upon commercial fuel meters.
Frequency of monitoring/recording	Invoiced on an as-delivered basis
Value monitored	70.2
Monitoring equipment	Commercial fuel meters

QA/QC procedures to be applied	3rd party statements/invoices are used to ensure accuracy of data.
Purpose of data	Calculation of project emissions
Calculation method	Measured Value
Comments	

Data / Parameter	FC _{diesel}
Data unit	Gallons/yr
Description	Volume of diesel combusted by Industrial Power Generating Company engines in the project activity in year y
Source of data	Data is continuously monitored and recorded via flowmeter
Description of measurement methods and procedures to be applied	Volume of diesel consumed by the Industrial Power Generating Company engines is monitored by a Coriolis flowmeter. Data is continuously monitored and recorded by Industrial Power Generating Company data collection software.
Frequency of monitoring/recording	Continuous monitoring. Readings are recorded hourly.
Value monitored	29,870
Monitoring equipment	Micromotion Coriolis Flowmeter SN: 14354124
QA/QC procedures to be applied	Coriolis meter is equipped with Smart Meter Verification that continuously monitors performance indicators to ensure measurement accuracy. Industrial Power Generating Company technicians regularly cross reference diesel consumption against electricity generation data to ensure it behaves as expected.
Purpose of data	Calculation of project emissions
Calculation method	Measured Value
Comments	

Data / Parameter	T _{Flare}
Data unit	Degrees F

Description	Temperature of the landfill gas flare tip
Source of data	Data is continuously monitored via thermocouple
Description of measurement methods and procedures to be applied	Flame temperature is continuously monitored by thermocouple installed in the flare tip.
Frequency of monitoring/recording	Continuous
Value applied	208 F
Monitoring equipment	LFG Industries Type k thermocouple data logger
QA/QC procedures to be applied	The thermocouple meter will be calibrated annually to ensure proper function.
Purpose of data	Verification of landfill gas flare operation.
Calculation method	n/a
Comments	Landfill gas destruction is double checked against flare temperature to ensure that destruction is not claimed when the flare is not operational.

Data / Parameter	EGen _{Ingenco}
Data unit	MWh/yr
Description	Electricity generated by the Industrial Power Generating Company engines during the project period. This is used to ensure operation of the energy plant.
Source of data	Electricity meters
Description of measurement methods and procedures to be applied	Records from commercial electricity meters.
Frequency of monitoring/recording	Continuous
Value applied	9,034.419
Monitoring equipment	Commercial wattmeter or similar.

QA/QC procedures to be applied	n/a
Purpose of data	Verification of operation of Industrial Power Generating Company engines
Calculation method	n/a
Comments	Landfill gas destruction is double checked against generation data from the Industrial Power Generating Company engines to ensure that destruction is not claimed when engines are not operational.

Data / Parameter	Management of Henrico County Landfill
Data unit	n/a
Description	Management practices of the solid waste disposal site.
Source of data	Original landfill design documents, design documents for any changes to landfill equipment or operation, publicly available information of the host country/state's regulatory requirements relating to LFG.
Description of measurement methods and procedures to be applied	Annual review of any changes to the operation of the landfill to ensure they have not increased methane generation and still meet all requirements of the methodology. Annual review of the Landfill's NSPS status and any other applicable regulations, followed by a review of the Project's crediting period, to ensure the Project is still surplus to regulatory requirements.
Frequency of monitoring/recording	Annually
Value applied	n/a
Monitoring equipment	n/a
QA/QC procedures to be applied	n/a
Purpose of data	Ensuring the Project meets methodology requirements and is still surplus to regulatory requirements.
Calculation method	n/a
Comments	No changes to the landfill gas system design or operation were identified during the reporting period. The landfill's NSPS status has not changed and no new regulations pertaining to landfill

gas collection and destruction were identified during the reporting period.

4.3 Monitoring Plan

The purpose of monitoring is to measure the quantity of methane captured by the Project Activity that would have been released to the atmosphere in the baseline condition, as well as ensure the quality and accuracy of the data collected. While Henrico County owns and operates the landfill, they have contracted with Draper Aden Associates to monitor the data and manage necessary compliance reporting and recordkeeping requirements. On a monthly basis, Draper Aden Associates performs a QC review and, if errors are detected, a design engineer analyzes the data to determine if adjustments need to be made. Bluesource receives both the adjusted data and the raw data from Draper Aden Associates and performs their own internal calculations to determine the carbon offset credits generated during the verification period.

If Draper Aden and Associates detect errors in the data stemming from potential equipment failure, Henrico County and Industrial Power Generating Company employees will be informed to arrange for calibration, repair, or replacement of meters or infrastructure. In the interim period where equipment is out of commission, handheld meters will be used to sample values regularly to ensure continued operation.

A summary of all monitored parameters and the relevant maintenance procedures are detailed below in Table 2 and Table 3, and the configuration of applicable meters can be seen in Figure 1.

Table 2: Summary of Monitored Data

Monitored Parameter	Data Source	Monitoring Frequency	Responsible Party
Gas Flow to Flare	Rosemount 3051S multi-variable transmitter	Continuous, logged every 5 minutes	Henrico Technicians and Draper Aden Associates
CH ₄ Concentration at Flare	Siemens Ultramat 23 data logger	Continuous, logged every 5 minutes	Henrico Technicians and Draper Aden Associates
CH ₄ Concentration at Industrial Power Generating Company Facility	Landtec Gem 2000 data logger	Daily	Industrial Power Generating Company Technicians and Draper Aden Associates
Flare Temperature	LFG Industries Type k thermocouple data logger	Continuous, logged every 5 minutes	Henrico Technicians and Draper Aden Associates
Gas Flow to Engines	Rosemount 3095 multi-variable pressure transmitter	Continuous, logged every 5 minutes	Industrial Power Generating Company Technicians and Draper Aden Associates
CH ₄ Concentration at Engines	Landtec Gem 2000 data logger	Daily	Industrial Power Generating Company Technicians and Draper Aden Associates

Operation of Generation Engines	Logs of power sent to the grid for purchase	Hourly	Industrial Power Generating Company Technicians
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Table 3: Summary of Monitoring Equipment Maintenance

Equipment	Maintenance Procedure	Maintenance Frequency	Responsible Party
Rosemount Orifice Plate Model 1495C to Flare	Professional calibration at least every 3 years; Inspection should Draper Aden Associates note irregular data	Calibrated every 3 years; Data summarized and inspected monthly	Henrico Technicians and Draper Aden Associates
Rosemount Orifice Plate Model 1495C to Engines	Professional calibration at least every 3 years; Inspection should Draper Aden Associates note irregular data	Calibrated every 3 years; Data summarized and inspected monthly	Industrial Power Generating Company Technicians and Draper Aden Associates
Siemens Ultramat 23 data logger	Professional calibration at least every year; Inspection should Draper Aden Associates note irregular data	Calibrated every year; Data summarized and inspected monthly	Henrico Technicians and Draper Aden Associates
Landtec Gem 2000 Continuous Gas Analyzer	Professional calibration every 6 months;	Calibrated every 6 months; Data summarized and inspected monthly	Industrial Power Generating Company Technicians and Draper Aden Associates
LFG Industries Type K Thermocouples	Professional calibration at least every year; Inspection should Draper Aden Associates note irregular data	Calibrated every year; Data summarized and inspected monthly	Henrico Technicians and Draper Aden Associates
Generator Operating Data	Calibration per manufacturer's specifications and regulations regarding commercial electricity meters	Calibrated every 6 months;	Industrial Power Generating Company Technicians

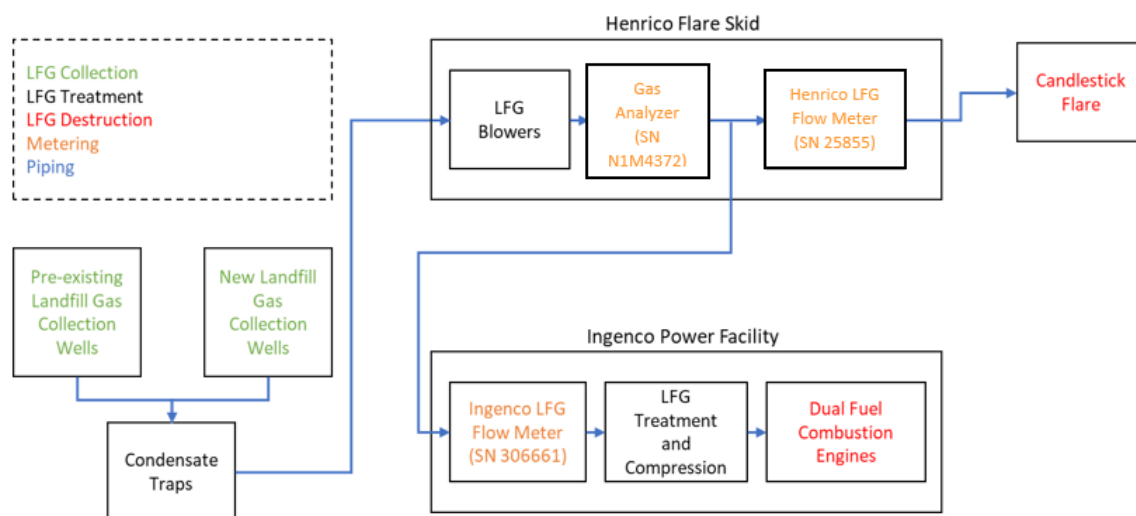


Figure 1: Configuration of the Main Landfill Gas Collection and Control Technologies

Baseline Emissions

Gas Flow

Baseline emissions are monitored using two Rosemount Orifice Plate Model 1495C continuous gas flow meters (one with a Rosemount 3095 Multi-Variable Pressure Transmitter and one with a Rosemount 3051S Multi-Variable Transmitter) that measure flow on a wet basis and normalizes flow to standard temperature and pressure conditions. Flow data to the flare is recorded at 68 F & 1 atm before July 20, 2021. July 20, 2021 onwards, flare data to the flare is recorded at 60F & 1 atm. Flow data to the Industrial Power Generating Company plant is recorded at 60 F & 1 atm. Landfill gas flow is metered continuously at the blower / flare station and at the Industrial Power Generating Company plant, with readings being taken every five minutes. A Red Lion data logger is installed to record flow, methane concentration and flare temperature continuously.

The flow meter to the flare (SN 135079) was factory calibrated 11/23/2015, 11/22/2016, 11/8/2017, 11/14/2018, 11/13/2019, and 11/04/2020 and was found to be operating as per manufacturer specifications. A new flow meter to the flare (SN 25855) was installed and calibrated on 07/20/2021 and 08/18/2021, as the previous unit was replaced due to older age. Noting, meter age did not hinder the meter performing within the required accuracy specifications. The reference temperature of differential pressure and static pressure is not relevant as it is dynamically compensated by the actual temperature, which is also part of the NIST traceable calibration. On a go forward basis, the new flow meter will continue to be calibrated by certified technicians at least every three years as per the project developer's policies.

The flow meter to the Industrial Power Generating Company plant (SN 306661) was factory calibrated on 9/1/2010 before it was installed and came online 9/8/2010. The flow meter was also calibrated 10/19/2015, 10/4/2016, 10/25/2017, 10/7/2018, and 12/10/2021 and found to be operating as per manufacturer specifications. On a go forward basis, the flow meter will continue to be calibrated by certified technicians at least every three years as per the project developer's policies.

Flare Operation

Two LFG Industries Type k thermocouples are used to ensure the flare and pilot flame are burning. The data logger records 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. In the event that gas flow is recorded to the flare at a time when a flame is not detected, or the flare temperature falls outside of manufacturer's recommended values, destruction efficiency of the flare will be treated as 0% as per CDM Tool 06 (version 3.0).

During every monthly site visit, the temperature readout from the main flame thermocouple's (upper) is recorded. During these visits, if the temperature reading were to be inconsistent with the flame condition (i.e., temp reading indicating that the flame was burning while it was not or vice versa) this would have been apparent. Both thermocouples were successfully calibrated by the manufacturer 11/23/2015, 11/22/2016, 11/8/2017, 11/14/2018, 11/13/2019, 11/04/2020, and 07/20/2021. On a go forward basis, the thermocouples will continue to be calibrated annually by certified technicians.

In our quantification, the daily flow is also being checked against the flare design capacity (flare operating temperature and flow capacity), to ensure the flow is only taken into account when the flares are operable. The final corrected value is used in the credit quantification to improve the accuracy of the data used in the calculation.

Engine Operation

Electricity generation records from the twelve dual-fuel combustion engines are collected to demonstrate methane destruction. These records are compared with monitored landfill gas flow data and, in the event that gas flow is measured to the engines during a time period when no electricity generation is recorded, the destruction efficiency of these engines will be considered 0% for that time period. All electricity generation data will be obtained from commercial electricity meters maintained by Industrial Power Generating Company.

Gas Composition

Gas composition (CH₄, CO₂, O₂ and balance gases) was measured during the reporting period by a Landtec Gem 2000 gas analyzer. The gas analyzer (SN# GM12536) is designed by Landtec to monitor the methane, carbon dioxide, and oxygen content of landfill gas. Landfill gas is sampled daily as this meter is intended for use as a backup to the continuous meter.

The Landtec Gem 2000 meter (SN# GM12536) was calibrated on 10/11/2019, 04/19/2019, 10/14/2019, 4/30/2020, 01/06/2021, and 01/20/2022. On a go forward basis, the Landtec flowmeter will continue to be calibrated on a 6 month interval by certified technicians as per manufacturer's recommendation.

Gas composition is normally monitored by the primary continuous gas monitor. During the reporting period, the Siemens Ultramat 23 gas analyzer was used, however there were issues with improper conditioning of the LFG before entering the analyzer (additional moisture) leading to decrease in accuracy for certain periods of time. Data collected using the Landtec GEM 2000 backup meter was therefore utilized for the part of the monitoring period where the Siemens Ultramat 23 gas analyzer was not in operation.

Pre-project Gas Flow

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. Data was aggregated on a daily and monthly basis and entered into spreadsheets by the Landfill Operator.

The quantity of methane generated in the baseline condition is determined based on the quantity of landfill gas combusted in the project activity.

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 the Methodology, the flare's operating parameters are to be continuously monitored to ensure compliance with the requirements of regulation 40 CFR 60.18. Accordingly, the temperature of the flare is monitored using a thermocouple and temperatures are recorded on the Red Lion data logger located at the blower / flare station.

Electricity and Fossil Fuel Combustion Emissions

Project emissions related to electricity consumption are estimated based on the quantity of electricity supplied to the facility according to supplier invoices. Emissions from propane consumptions are similarly estimated based on the quantity of propane supplied to the facility according to supplier invoices. Diesel consumption by the electricity generation engines is measured continuously using the Micromotion Coriolis Flow meter. This flow meter is equipped with Smart Meter Verification, which continuously monitors the meter for reading drift and will display an error if it is found out of calibration. Should this error occur, certified maintenance and calibration will be conducted.

Monitoring Roles and Responsibilities

The County of Henrico's Public Works Department has partnered with engineering consultant Draper Aden Associates (DAA) to oversee monitoring activities. In particular, DAA handles all the operations and management of gas collection system and has field technicians that balance the well field and downloads the data from the Red Lion data logger for off-site storage. DAA also assists the County in areas of permitting. DAA staff download the facility data from the data logger and submits data to Bluesource for integration into emission reductions calculations. Bluesource saves the raw data files and then after applying the appropriate emission reduction parameters creates the emission reduction calculator that undergoes an internal QA/QC procedure.

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 Sections 5.1 & 5.2 above. It will be the responsibility of Henrico County staff to measure all variables and retain records for verification.

5 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

5.1 Baseline Emissions

Baseline emissions are calculated with the following equations. No emission reductions are claimed for grid-connected electricity generation that is offset by electricity produced from LFG destructured at the Industrial Power Generating Company facility as these environmental attributes are not owned by Henrico. Further, no thermal energy is produced using the LFG, and the baseline scenario also does not include natural gas used from the natural gas network in the absence of the project activity. Therefore, the equation for baseline emissions is:

$$BE_y = BE_{CH_4,y}$$

Where,

BE_y = Baseline emissions in year y (t CO₂e/yr)

$BE_{CH_4,y}$ = Baseline emissions from the Landfill in year y (t CO₂e/yr)

Determination of BE_{CH_4}

Baseline emissions of methane from the Landfill are determined with the following equation, based on the amount of methane that is captured under the project activity and the amount that would have been captured and destroyed in the baseline. In addition, the effect of methane oxidation that is present in the baseline and absent in the project is considered.

$$BE_{CH_4} = \left((1 - OX_{top\ layer}) * F_{CH_4,PJ,y} - F_{CH_4,BL,y} \right) * GWP_{CH_4}$$

Where,

$BE_{CH_4,y}$ = Baseline emissions from the Landfill in year y (t CO₂e/yr)

$OX_{top\ layer}$ = Fraction of methane in the LFG that would be oxidized in the top layer of the Landfill in the baseline (dimensionless)

$F_{CH_4,PJ,y}$ = Amount of methane in the LFG which is flared and/or used to generate electricity in the project activity in year y (t CH₄/yr)

$F_{CH_4,BL,y}$ = Amount of methane in the LFG that would have been flared in the baseline year y (t CH₄/yr)

GWP_{CH_4} = Global warming potential of methane (t CO₂e / t CH₄)

Ex Post Determination of $F_{CH_4,PJ,y}$

$F_{CH_4,PJ,y}$ is the sum of quantities of methane flare and used to generate electricity during the reporting period, as follows:

$$F_{CH_4,PJ,y} = F_{CH_4,flared,y} + F_{CH_4,EL,y}$$

Where,

$F_{CH_4,PJ,y}$ = Amount of methane in the LFG which is flared and/or used to generate electricity in the project activity in year y (t CH₄/yr)

$F_{CH_4,flared,y}$ = Amount of methane in the LFG which is destroyed by flaring (t CH₄/yr)

$F_{CH_4,EL,y}$ = Amount of methane in the LFG which is destroyed by electricity generation (t CH₄/yr)

Determination of $F_{CH_4,flared,y}$

$F_{CH_4,flared,y}$ is determined as the difference between the amount of methane supplied to the flare and any methane emissions from the flare as follows:

$$F_{CH_4,flared,y} = F_{CH_4,sent\ to\ flare,y} - \frac{PE_{flare,y}}{GWP_{CH_4}}$$

Where,

$F_{CH_4,flared,y}$ = Amount of methane in the LFG which is destroyed by flaring (t CH₄/yr)

$F_{CH_4,sent\ to\ flare,y}$ = Amount of methane in the LFG which is sent to the flare in year y, (t CH₄/yr)

$PE_{flare,y}$ = Project emissions from flaring of the residual gas stream in year y (t CO₂e/yr)

GWP_{CH_4} = Global warming potential of CH₄ (t CO₂e / t CH₄)

Determination of $F_{CH_4,sent\ to\ flare,y}$

Henrico meters the volume of LFG sent to the flare and the composition of this gas on a wet basis. As such, $F_{CH_4,sent\ to\ flare,y}$ is determined using option C in the CDM Tool 8: "Tool to determine the mass flow of a greenhouse gas in a gaseous stream". Option C includes instructions for determining the volume of greenhouse gas sent to the flare under reference temperature and pressure conditions. As the Henrico meters automatically record data to 68 F and 1 atm before July 20, 2021, and then 60F and 1 atm onwards, methane density can be considered a reference value and conversion of volumetric flow rate is not necessary. Equation 9 is therefore used to calculate the quantity of methane sent to the flare, while equations 10 and 11 are not used.

$$F_{CH_4,sent\ to\ flare} = LG_{flare} * w_{CH_4} * \rho_{CH_4}$$

Where,

$F_{CH_4,sent\ to\ flare,y}$ = Amount of methane in the LFG which is sent to the flare in year y, (t CH₄/yr)

LG_{flare} = Volume of landfill gas sent to flare (m³)

w_{CH_4} = Average methane fraction of the LFG (m³ CH₄ / m³ LFG)

ρ_{CH_4} = Density of methane at 68F and 1atm before July 20, 2021, from which density of methane at 60F and 1 atm is used onwards (t CH₄ / m³ CH₄)

Determination of $PE_{flare,y}$

$PE_{flare,y}$ is determined directly by using the CDM Tool 6: “Project emissions from flaring” (version 3.0). The flare efficiency that will be applied is 98% as discussed in Section 4.1, except in cases when the flare thermocouples detect a flare temperature outside of manufacturer’s recommended settings. In these cases, a flare efficiency of 0% will be used as per section 6.2 of CDM Tool 6. The landfill gas composition is continuously measured at the facility. Therefore, equation 15 from the Tool is used:

$$PE_{flare} = \sum (F_{CH_4, sent\ to\ flare} * (1 - \eta_{flare})) * GWP_{CH_4}$$

Where,

$F_{CH_4, sent\ to\ flare}$ = Mass flow of methane in the gas sent to flare (t CH₄)

η_{flare} = Efficiency of the flare (%)

GWP_{CH_4} = Global warming potential of CH₄ (t CO_{2e} / t CH₄)

Determination of $F_{CH_4,EL,y}$

Henrico meters the volume of LFG sent to the Industrial Power Generating Company’s power generation unit and the composition of this gas on a wet basis. As such, $F_{CH_4, sent\ to\ flare,y}$ is determined using option C in the CDM Tool 8. Option C includes instructions for determining the volume of greenhouse gas sent to the flare under reference temperature and pressure conditions. As the Henrico meters automatically record data at the Industrial Power Generating Company facility to 60 F and 1 atm, methane density can be considered a reference value and conversion of volumetric flow rate is not necessary. Equation 9 is therefore used to calculate the quantity of methane sent to the flare, while equations 10 and 11 are not used.

$$F_{CH_4,EL,y} = LFG_{Electricity} * w_{CH_4} * \rho_{CH_4}$$

Where,

$F_{CH_4,EL,y}$ = Amount of methane in the LFG which is destroyed by electricity generation (t CH₄/yr)

$LFG_{Electricity}$ = Volume of landfill gas sent to power generation unit (m³)

w_{CH_4} = Average methane fraction of the LFG (m³ CH₄ / m³ LFG)

ρ_{CH_4} = Density of methane (t CH₄ / m³ CH₄)

Determination of $F_{CH_4,BL,y}$

In order to calculate the $BE_{CH_4,y}$ we must subtract the amount of methane that would have been flared in the absence of the project activity, $F_{CH_4,BL,y}$. Before the project activity, there was no requirement for the Landfill to destroy methane, and there was an existing LFG capture and

destruction system in place. This means the baseline scenario falls into “Case 3” as outlined in Table 3 of the Methodology.

The calculation of methane that would have been flared in the absence of the project activity is done by using historical values for the flared landfill gas volumes and average methane fraction on a wet basis. It follows option C in CDM Tool 8. Option C includes instructions for determining the volume of greenhouse gas sent to the flare under reference temperature and pressure conditions. As data collected by the historic Henrico meters was recorded to 70 F and 1 atm, methane density can be considered a reference value and conversion of volumetric flow rate is not necessary. Equation 9 is therefore used to calculate the quantity of methane sent to the flare, while equations 10 and 11 are not used.

$$F_{CH_4,BL,y} = LFG_{BL} * w_{CH_4,BL} * \rho_{CH_4}$$

$F_{CH_4,BL,y}$ = Amount of methane in the LFG that would have been flared in the baseline year y (t CH₄/yr)

LFG_{BL} = Historic volume of landfill gas sent to the flare in the baseline (m³)

$w_{CH_4,BL}$ = Historic average methane fraction of the LFG in the baseline (m³ CH₄ / m³ LFG)

ρ_{CH_4} = Density of methane (t CH₄ / m³ CH₄)

5.2 Project Emissions

Project emissions come from electricity and fossil fuels consumed in the project activity. These emissions are calculated as follows:

$$PE_y = PE_{EC,y} + PE_{FC,y}$$

Where,

PE_y = Project emissions in year y (t CO_{2e} / yr)

$PE_{EC,y}$ = Emissions from consumption of electricity due to the project activity in year y (t CO_{2e}/yr)

$PE_{FC,y}$ = Emissions from consumption of fossil fuels due to the project activity in year y (t CO_{2e}/yr)

Determination of PE_{EC}

Project emissions from consumption of electricity by the project activity are calculated using equation 2 (the generic approach) from CDM Tool 5: “Baseline, project and/or leakage emission from electricity consumption and monitoring of electricity generation” (version 3.0).

$$PE_{EC} = EC_{PJ,y} * EF_{EF} * (1 + TDL)$$

Where,

$EC_{PJ,y}$ = Quantity of electricity consumed by the Project (MWh/yr)

EF_{EF} = Emission factor for the grid that supplies the electricity (t CO₂e/MWh)

TDL = Average transmission and distribution losses for providing electricity to the source (%)

The parameter EF_{EF} is obtained from the US EPA's eGrid database, and will be regularly updated to reflect the most recent value published for the region.

The Methodology section 5.5(65)(b) states "If in the baseline a proportion of LFG is destroyed, then the electricity consumption in the tool should refer to the net quantity of electricity consumption (i.e. the increase due to the project activity)."

There was no historical data for electricity consumed in the baseline. Therefore, it will be assumed the net consumption is only what is consumed in the project activity. This will increase the project emissions which is a conservative approach.

Determination of PE_{FC}

Both propane and diesel are used in the project activity. Therefore, the equation for $PE_{FC,y}$ is:

$$PE_{FC,y} = PE_{propane} + PE_{diesel}$$

Project emissions from consumption of fossil fuel in the project activity are calculated using equation 1 in the CDM Tool 3: "Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion" (version 3.0). The following equations are used:

$$PE_{propane} = FC_{propane} * COEF_{propane}$$

$$PE_{diesel} = FC_{diesel} * COEF_{diesel}$$

Where,

$PE_{propane}$ = CO₂ emissions from propane combustion in the flare in year y (t CO₂e/yr)

PE_{diesel} = CO₂ emissions from diesel combustion in the power generation facility in year y (t CO₂e/yr)

$FC_{propane}$ = Volume of propane combusted in the project activity in year y (gal)

FC_{diesel} = Volume of diesel combusted in the project activity in year y (gal)

$COEF_{propane}$ = CO₂ emission coefficient for propane (t CO₂e / gal)

$COEF_{diesel}$ = CO₂ emission coefficient for diesel (t CO₂e / gal)

The CO₂ emission coefficients are calculated based on net calorific value and CO₂ emission factor of the fuel type. This is Option B in Tool 3.

$$COEF_{propane} = NCV_{propane} * EF_{CO2,propane}$$

$$COEF_{diesel} = NCV_{diesel} * EF_{CO2,diesel}$$

$COEF_{propane}$ = CO₂ emission coefficient for propane (t CO₂e / gal)

$COEF_{diesel}$ = CO₂ emission coefficient for diesel (t CO₂e / gal)

$NCV_{propane}$ = Energy content of propane (MMBtu / gal)

NCV_{diesel} = Energy content of diesel (MMBtu / gal)

$EF_{CO2,propane}$ = Emission factor for the propane used in the project activity (t CO₂e / MMBtu)

$EF_{CO2,diesel}$ = Emission factor for the diesel used in the project activity (t CO₂e / MMBtu)

The Methodology section 5.5(66)(b) states “If in the baseline a proportion of LFG is captured and flared ($F_{CH4,BL,y} > 0$), then the fossil fuels consumption used in the calculation should refer to the net of that consumed in the baseline.”

There is no historical data for fuel consumed in the baseline. Therefore, it will be assumed the net consumption is only what is consumed in the project activity. This will increase the project emissions which is a conservative approach.

5.3 Leakage

The Project is not known to create any leakage emissions.

5.4 Net GHG Emission Reductions and Removals

The emission reductions were calculated as baseline emissions minus project emissions for each month in the monitoring period. The emission reductions are specified by vintage and final values are rounded down for conservativeness.

Year	Baseline emissions or removals (tCO ₂ e)	Project emissions or removals (tCO ₂ e)	Leakage emissions (tCO ₂ e)	Net GHG emission reductions or removals (tCO ₂ e)
2021	41,658	315	0	41,343
Total	41,658	315	0	41,343

APPENDIX A: EVIDENCE OF SD CONTRIBUTIONS



Project Henrico County Landfill Gas Combustion Project
Proponent Henrico County
Crediting Period January 1, 2021 - December 31, 2021
System VCS
Protocol ACM0001: Flaring or Use of Landfill Gas (version 19.0)

EMISSIONS OFFSET SUMMARY

This sheet contains a summary of baseline and project emissions from each SS as well as a calculation of the total credits created

REPORTING PERIOD: January 1, 2021 - December 31, 2021

		TOTAL (t CO ₂ e)	Final rounding
BASELINE			
BE_CH4	Emissions from Landfill	41,658.1	
Baseline Totals		41,658.1	41,658
PROJECT			
PE_EC	Emissions from electricity consumption	9.3	
PE_FC	Emissions from fossil fuel consumption	305.3	
Project Totals		314.7	315
NET			
TOTAL OFFSETS		41,343.4	41,343