Project design document form
(Version 11.0)

Complete this form in accordance with the instructions attached at the end of this form.

BASIC INFORMATION	
Title of the project activity	EnviroServ Chloorkop Landfill Gas Recovery Project
Scale of the project activity	☒ Large-scale ☐ Small-scale
Version number of the PDD	65789
Completion date of the PDD	13/04/201528120651/0321/2020
Project participants	EnviroServ Waste Management (Pty)Ltd
Host Party	South Africa
Applied methodologies and standardized baselines	ACM0001: Large-scale Consolidated Methodology: Flaring or use of landfill gas, Version 15.0. ASB0001: Standardized baseline: Grid emission factor for the Southern African Power Pool (Version 01.0)
Sectoral scopes	Sectoral scope(s):13 Conditional sectoral scope(s): 1
Estimated amount of annual average GHG emission reductions	75,-00312173 041 tCO_2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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The EnviroServ Chloorkop Landfill Gas Recovery Project was registered on 27 April 2007. The project was implemented, and credits have been issued during the first crediting period from 19 January 2009 to 18 January 2015. The PDD has been updated in order to facilitate the renewal of the second crediting period: 19 January 2015 - 18 January 2022.

The objective of the project is to extract landfill gas (LFG) at the site and combust the LFG by flaring. In addition, the project includes the staggered implementation of project components that entail the productive use of the gas. These components include electricity generation, for sale to third parties upon the finalisation of purchase agreements.

The EnviroServ Chloorkop Landfill Site has been used for the disposal of municipal solid waste since 1997. The landfill site is located in the eastern parts of Gauteng Province in South Africa and receives approximately 400,~~ ~~000 tons annually. Waste accepted includes general (or domestic) waste, garden waste, soil and builder's rubble.

~~The objective of the project is to extract landfill gas at the Site and combust the landfill gas (LFG) by flaring or productive use for electricity generation of heat sales.~~ Landfill gas consists of approximately 50% methane, which has a global warming potential 21[1] times greater than CO_2. Through the destruction of methane, the emissions of greenhouse gases are reduced. In addition, the use of the landfill gas for electricity generation will further reduce greenhouse gas emissions due to the displacement of electricity from the national grid, which is predominantly fossil fuel based.

The project boundary includes the landfill site itself, alongside the installed landfill gas flare compound, as well as the planned LFG-use component of the project which includes an offsite electricity generation facility.

The emissions reductions due to the project activity during its second crediting period have been calculated ex ante: an estimated annual average CO_2e-reduction of 75,~~ 121~~003 ~~73 041~~ tonnes, with a total emissions reduction of 525,~~-~~021 ~~525 850511 289~~ tCO_2e for the chosen crediting period (19/01/2015 – 18/01/2022). As the annual average CO_2e reductions is exceeding the limit for small-scale projects (i.e. 15,~~-~~000 tCO_2e annual emissions reductions for type III project activities) therefore the project activity qualifies as a large-scale project activity.

The project activity involves the installation of a new LFG capture and uses systems in an existing solid waste disposal site (SWDS). The scenario existing prior to the implementation of the project activity includes a SWDS where no LFG capture system was installed, ~~and~~ where LFG was vented into the atmosphere and where no use of the LFG existed.

Therefore, the baseline scenario for the destruction of LFG through flaring is the same as the scenario existing prior to the implementation of the project activity: the atmospheric release of LFG. The baseline scenario for the electricity generation component is the use of grid-electricity in South Africa, which is largely coal-based.
~~The project was registered on 27/04/2007 with the first crediting period being 19/01/2008 – 18/01/2015. After successful verification of the monitored emission reductions in the first crediting period, the project~~

[1] As per IPCC: 21 for the first commitment period and in accordance with the latest COP/MOP decision. The latest COP/MOP decision (Decision 24/CP.19, paragraph 2) stipulates that "from 2015 until a further decision is adopted by the Conference of the Parties, the global warming potential values used by Parties included in Annex I to the Convention (Annex I Parties) ... shall be those listed in the column entitled "Global warming potential for given time horizon" in table 2.14 of the errata to the contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, based on the effects of greenhouse gases over a 100- year time horizon, as contained in annex III"; This means that from 2015 the value 25 shall be used for the GWP of methane.

participant is applying for an extension of the crediting period through a request for renewal of the crediting period.

The technologies/measures implemented by the project activity The installed technology consists of wells in the landfill, a gas collection system connecting the wells and a two flare installations connected to the gas collection system. . Each The flare installation consists of a blower that draws the gas from the wells and the gas collection system, and the flare itself.

The additional project technologies that entail the use of the captured LFG includes a pipeline to an electricity generation facility and an associated waste-heat recovery facility. The methodology used for this project (ACM0001, Version 15.0) does not account for any waste heat recovery system, thus this project will make use of electricity generated emission reduction calculations only. The electricity generation component of the project will be implemented if and once it is deemed to be financially viable (i.e. implementation will be staggered).

Project Participants' view on how the CDM project activity contributes to sustainable development

The project continues to contribute to sustainable development in multiple ways, including:

1. The project results in foreign direct investment through the purchase of certified emission
2.
3.

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4. 1As per IPCC: 21 for the first commitment period and in accordance with the latest COP/MOP decision. The latest COP/MOP decision (Decision 24/CP.19, paragraph 2) stipulates that "from 2015 until a further decision is adopted by the Conference of the Parties, the global warming potential values used by Parties included in Annex I to the Convention (Annex I Parties) ... shall be those listed in the column entitled "Global warming potential for given time horizon" in table 2.14 of the errata to the contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, based on the effects of greenhouse gases over a 100- year time horizon, as contained in annex III"; This means that from 2015 the value 25 shall be used for the GWP of methane.

1. The project results in foreign direct investment through the purchase of certified emission rreductions by one or more overseas buyers. In addition, the project continues to contribute to economic development by creating new markets and/or strengthening existing markets within the country for goods and services required by the project.

1.2. The project will generate jobs, which would not otherwise exist and build capacity, which would not otherwise occur. Landfill personnel are receiving training related to the gas recovery operation, which they would not have received otherwise. The project intends to utilise the gas provided that a feasible and viable utilisation project can be developed. Such utilisation will provide additional contribution to sustainable development in the country.

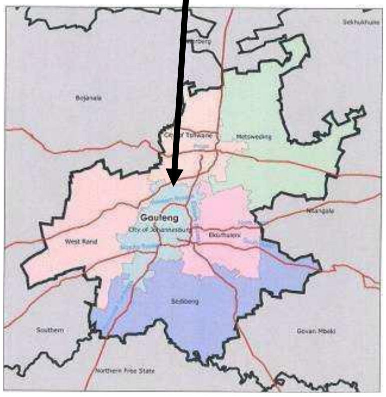
2.3. The project reduces pollution. The collection and destruction of methane gas reduces greenhouse gas emissions and reduces the impact of the landfill operation on air quality. In addition, labour conditions and safety on the Site have been improved due to the reduction in the risk of fire and explosion at the landfill. The capture and destruction of landfill gas trace components contributes to an improvement of local air-quality.

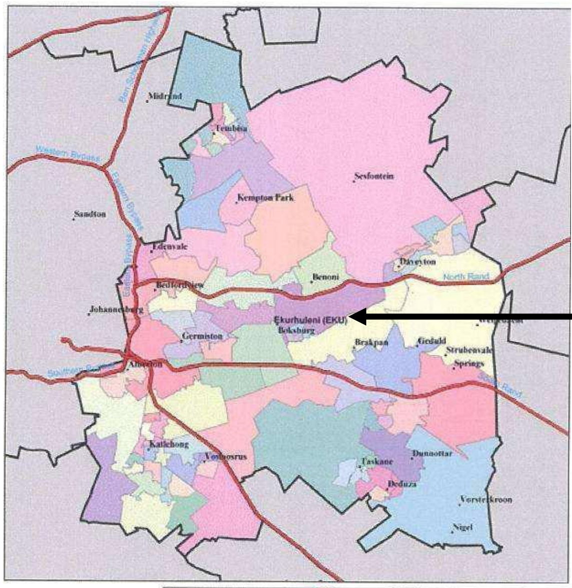
3.4. On the 26th November 2013, the project received host country approval from the South African DNA. The letter of approval confirms that the project supports sustainable development in the country.

A.2. Location of project activity

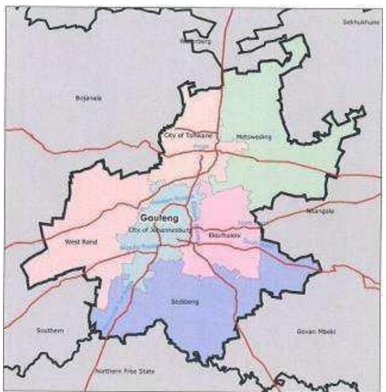
The EnviroServ Chloorkop Landfill Site is situated in the Northern Service Delivery Area of the Ekurhuleni Metropolitan Municipality. This is located in the eastern part of the Gauteng Province. It is approximately 13km from the Johannesburg International Airport, 7 km from the Buccleuch Interchange and 7 km from the Allandale off-ramp from the N1. The closest residential area is Phomolong to the east and Klipfontein View to the west (approximately 0.5 km). The Site is surrounded by industrial areas to the north, south and east. GPS coordinates: 26° 02’ 30.35” S, 28° 10’ 04.58” E. In decimal: Latitude (-26.0417) Longitude (28.1679).

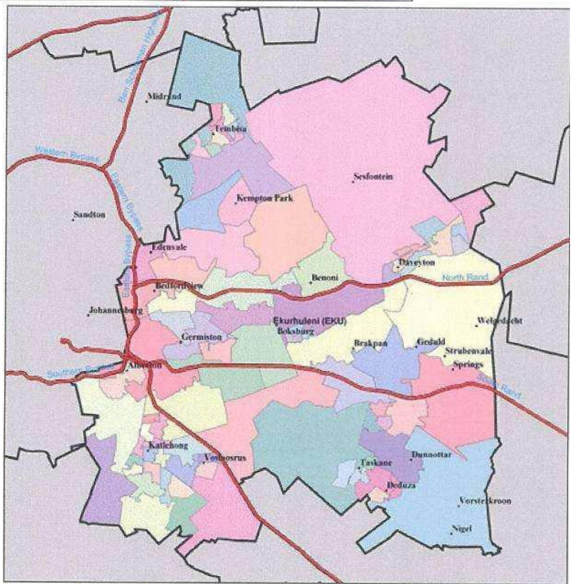
Gauteng Province:





Ekurhuleni Metropolitan Municipality, within the province of Gauteng





The flare compound was originally located on the north-eastern corner of the Chloorkop facility. The flare compound was subsequently moved to the south-western corner of the facility and was recommissioned on 09/12/2019. The new location of the flare is illustrated in the diagram above. The flare compound was moved due to the approval for the expansion of the landfill site towards the location where the flare was previously situated.

The electricity generation engine will be situated at an offsite location which will receive landfill gas via a pipeline to the nearby site (approximately 1.4km away).

A.3. Technologies/measures

The EnviroServ Chloorkop Landfill Site has been used for the disposal of municipal solid waste since 1997, receiving 396,000 to 448,000 tons of waste per annum. The waste accepted includes general (or domestic) waste, garden waste, soil and builder's rubble. To date, 5 cells have been constructed and are now full. Cell 6 started receiving waste in May 2010 and is still in operation. EnviroServ was granted approval by the authorities to develop cell 7 of the landfill on 30 September 2019 (which required the moving of the flaring compound to a different location on the landfill site).

Vertical wells were installed in cells 1 to 3 by auguring into the existing waste body once the cell reached final grade. Horizontal collectors were installed in cells 4, 5 and 6 and involved the excavation of trenches into the waste at intermediate intervals before a cell reached final grade. The vertical wells and the horizontal collectors were connected to a number of headers leading to the flare installations.

There ~~are~~ were ~~previously~~ two high temperature enclosed flares installed initially ~~operation~~. However, since 8 June 2018, Flare 2 on the site was shut down and only one flare has remained operational to date due to low gas volumes ~~installations~~. ~~The flares used are is a high temperature enclosed flares. The two flare installations are situated alongside each other.~~

~~All~~ The LFG that was previously sent to Flare 2 has been redirected to Flare 1. The design capacity of the flare is 2000 Nm^3/h.

The commercial utilisation of the captured gas is being investigated after better definition of gas quantity and quality, as well as after consultation with prospective gas users/customers. Some possible uses of the gas which are fully investigated include generation of electricity for onsite use, and/ -or -use and sale to a nearby industry~~,~~ and/ or to export electricity onto the national grid~~,~~; ~~and/ or direct off-site use of the gas as a replacement for other fossil fuels~~.

Offsite electricity generation with an associated waste heat recovery system (not included in the project boundary as this is not provided for in the methodology ACM0001) is to be included in this project boundary. This methodology does not account for waste heat recovery, and thus, electricity generation is the only considered addition to this project's activities. Landfill gas will be piped to a single, offsite gas engine wherein the combustion of the landfill gas will be used to produce electricity. At full load, the engine to be used can produce around 1136 kW of power. When adjusted according to the location of the engine (an altitude deration factor of 83% at 1750m above sea level is applied), the approximate capacity of the engine is estimated to be just under 950kW.

Metering equipment will monitor all components of the project activities, as and when they are commissioned. As a minimum, the following meters will be used to monitor the destruction of the LFG by flaring:

- Gas analyser measuring gas composition;
- Flow meter measuring gas flow to the flare;
- Thermocouple measuring temperature;
- Flame detector to monitor whether the flare is on or off; and
- Electricity meter to monitor the consumption of electricity.

In addition to flaring, the following meters will be used in the electricity generation component of the project, once this component is implemented:

- Electricity meter measuring electricity generation;
- Flow meter measuring gas flow to the engine.

A.4. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
South Africa (host party)	Private entity - EnviroServ Waste Management (Pty) Ltd	No
~~*Party B*~~	~~*Private entity B*~~ ~~*Public entity B*~~ ~~*…*~~	

A.5. Public funding of project activity

There is no public funding of the project activity.

A.6. History of project activity

The proposed Chloorkop LFG project activity is neither registered as another CDM project activity nor included as a component project activity in a registered CDM programme of activities. Additionally, the proposed CDM project activity is not a project activity that has been deregistered.

The EnviroServ Chloorkop Landfill Site consists of seven waste disposal cells. Construction of the wellfield was done in a phased manner and initiated in 2005. Commissioning of the initial flaring phase took place in late 2007 with the first gas flared on 19/01/2008 (the start date of the project activity).

The second project crediting period was renewed and is valid for the period 19/01/2015 – 18/01/2022. Initially two high temperature enclosed flares were installed. However, since 8 June 2018, only one flare has remained operational due to low gas volumes.

As of 2019, electricity generation is being considered to utilise the gas.

A.7. Debundling

Not Applicable.

SECTION B. Application of methodologies and standardized baselines

B.1. References to methodologies and standardized baselines

ACM0001
Large-scale Consolidated Methodology: Flaring or use of landfill gas Version 15.0
Sectoral scope(s): 13

Hereinafter referred to as "the applied methodology".

The other methodological tools referred to in the applied methodology and used are:

- Emissions from solid waste disposal sites (Tool 04Version 06.0.1)
- Project emissions from flaring (Version 02.0.0)
- Tool to determine the mass flow of a greenhouse gas in a gaseous stream (Version 02.0.0)
- Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period (Version 03.0.1)
- Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion (Version 02.0)
- Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation (Version 03.0)
- ASB0001: Standardized baseline: Grid emission factor for the Southern African Power Pool (Version 01.0)

~~"Tool to determine project emissions from flaring gases containing methane", Version 01, adopted at EB 28.~~

~~"Tool to calculate baseline, project and/or leakage emissions from electricity consumption", Version 01, adopted at EB 39.~~
~~"Tool to calculate project or leakage CO2 emissions from fossil fuel combustion", Version 02, adopted at EB 41~~
~~"Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site", Version 05.1.0, adopted at EB 61.~~
~~"Tool to calculate the emission factor for an electricity system", Version 02.2.0, adopted at EB 61.~~

As per paragraph 48 of the CDM modalities and procedures, when choosing a baseline methodology, the approach "Existing actual or historical emissions, as applicable" has been selected as deemed being the most appropriate for the project activity.

B.2. Applicability of methodologies and standardized baselines

Applicability Conditions	***Justification***
The methodology is applicable under the following conditions:	
(a) Install a new LFG capture system in a new or existing SWDS where no LFG capture system was installed prior to the implementation of the project activity; or	The project activity is the installation of a new landfill gas capture system at an existing SWDS where no LFG capture system was installed prior to the implementation of the project activity.
Make an investment into an existing LFG capture system to increase the recovery rate or change the use of the captured LFG, provided that: *The captured LFG was vented or flared and not used prior to the implementation of the project activity; and* *In the case of an existing active LFG capture system for which the amount of LFG cannot be collected separately from the project system after the implementation of the project activity and its efficiency is not impacted on by the project system: historical data on the amount of LFG capture and flared is available;*	The project activity is the installation of a new LFG capture system in an existing SWDS where no LFG capture system was installed prior to the implementation of the project activity. Therefore condition (b) is not relevant.
Flare the LFG and/or use the captured LFG in any (combination) of the following ways: *Generating electricity;* *Generating heat in a boiler, air heater or kiln (brick firing only) or glass melting furnace,*[2] *and/or* *Supplying the LFG to consumers through a natural gas distribution network;*	The LFG is captured in the project activity and then flared. Electricity generation will also be included once determined to be economically viable and/or a suitable off-taker is appointed.

[2] For claiming emission reductions for other heat generation equipment (including other products in kilns), project participants may submit a revision to this methodology.

Supplying compressed/liquefied LFG to consumers using trucks;[3]	
(d) Do not reduce the amount of organic waste that would be recycled in the absence of the project activity.	The project does not imply any change in the waste received at the landfill and has not reduced the amount of organic waste that would have been recycled in the absence of the project activity. This was confirmed through the following additional sources: An official letter from the division/company responsible for collecting and depositing of waste at Chloorkop Landfill was obtained, confirming that the implementation of the “EnviroServ Chloorkop Landfill Gas Recovery Project” did not and will also continue to not reduce the amount of organic waste that would have been recycled in the absence of the project activity. A review of the South African Waste Information Centre (SAWIC) confirmed that recycling of organic waste is not a common/widely used practice in South Africa and in the region of the project.
The methodology is only applicable if the application of the procedure to identify the baseline scenario confirms that the most plausible baseline scenario is:	
(a) Atmospheric release of the LFG or capture of LFG and destruction through flaring to comply with regulations or contractual requirements, to address safety and odour concerns, or for other reasons; and	The baseline scenario is the atmospheric release of the LFG. Moreover, no regulations or contractual requirements, prescribing capturing of LFG and/or flaring thereof, exist currently[4].
In the case that the LFG is used in the project activity for generating electricity and/or generating heat in a boiler, air heater, glass melting furnace or kiln; *For electricity generation: that electricity would be generated in the grid or in captive fossil fuel fired power plants; and/or* *For heat generation: that heat would be generated using fossil fuels in equipment located within the project boundary.*	In the project activity, the LFG is captured and flared and may potentially be ~~not used for other purposes~~used for grid-tied electricity generation, once the second phase of the project commences.
This methodology is not applicable:	

[3] In case other means of transportation are used a revision to this methodology may be requested.

(a) In combination with other approved methodologies. For instance, ACM0001 cannot be used to claim emission reductions for the displacement of fossil fuels in a kiln or glass melting furnace, where the purpose of the CDM project activity is to implement energy efficiency measures at a kiln or glass melting furnace;	The project activity does not apply any methodologies in addition to ACM0001 (Version 15.0).
(b) If the management of the SWDS in the project activity is deliberately changed during the crediting in order to increase methane generation compared to the situation prior to the implementation of the project activity.	The management of the SWDS has not~~,~~ and will not be deliberately changed in order to increase methane generation.
The applicability conditions included in the tools referred to below also apply.	The applicability conditions in the tools referred to ~~below~~ have been met.

B.3. Project boundary, sources and greenhouse gases (GHGs)

The project boundary of the project activity includes the site where the LFG is captured and:

(a) Sites where the LFG is flared or used (e.g. flare, power plant, boiler, air heater, glass melting furnace, kiln, natural gas distribution network or biogas processing facility)

Summary of greenhouse gases and sources included in and excluded from the project boundary:

Source		GHG	Included?	Justification/Explanation
Baseline	Emissions from decomposition of waste at the SWDS site	CO_2	No	CO2 emissions from decomposition of organic waste are not accounted for since the CO2 is also released under the project activity
		CH_4	Yes	The major source of emissions in the baseline
		N_2O	No	N_2O emissions are small compared to CH_4 emissions from SWDS. This is conservative
	Emissions from electricity generation	CO_2	Yes~~No~~	Major emission source if power generation is included in the project activity ~~Power generation is not included in the project activity~~
		CH_4	No	Excluded for simplification. This is conservative ~~Power generation is not included in the project activity~~
		N_2O	No	Excluded for simplification. This is conservative ~~Power generation is not included in the project activity~~
	Emissions from heat generation	CO_2	No	Heat generation is not included in the project activity
		CH_4	No	Heat generation is not included in the project activity
		N_2O	No	Heat generation is not included in the project activity
	Emissions from the use of natural gas	CO_2	No	The supply of LFG through a natural gas distribution network or using trucks is not included in the project activity
		CH_4	No	The supply of LFG through a natural gas distribution network or using trucks is not included in the project activity
		N_2O	No	The supply of LFG through a natural gas distribution network or using trucks is not included in the project activity
Project activity	Emissions from fossil fuel consumption for purposes other than electricity generation or transportation due to the project activity	CO_2	No	Fossil fuel consumption for purposes other than electricity generation or transportation due to the project activity is not applicable.
		CH_4	No	Fossil fuel consumption for purposes other than electricity generation or transportation due to the project activity is not applicable.
		N_2O	No	Fossil fuel consumption for purposes other than electricity generation or transportation due to the project activity is not applicable.
	Emissions from electricity consumption due to the project activity	CO_2	Yes	May be an important emission source
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.
		CO_2	No	Emissions are considered negligible.

Source		GHG	Included?	Justification/Explanation
	Emissions from flaring	CH_4	Yes	May be an important emission source.
		N_2O	No	Emissions are considered negligible.
	Emissions from distribution of LFG using trucks	CO_2	No	The supply of LFG through a natural gas distribution network or using trucks is not included in the project activity
		CH_4	No	The supply of LFG through a natural gas distribution network or using trucks is not included in the project activity
		N_2O	No	The supply of LFG through a natural gas distribution network or using trucks is not included in the project activity

The applied methodology, paragraph 16, 17 and 18, prescribes that the procedure for estimating the end of the remaining lifetime of existing equipment must be followed in case the LFG is used in equipment that was in operation prior to the implementation of the project activity. As LFG is not being captured and/or used in the baseline, this procedure is not applicable.

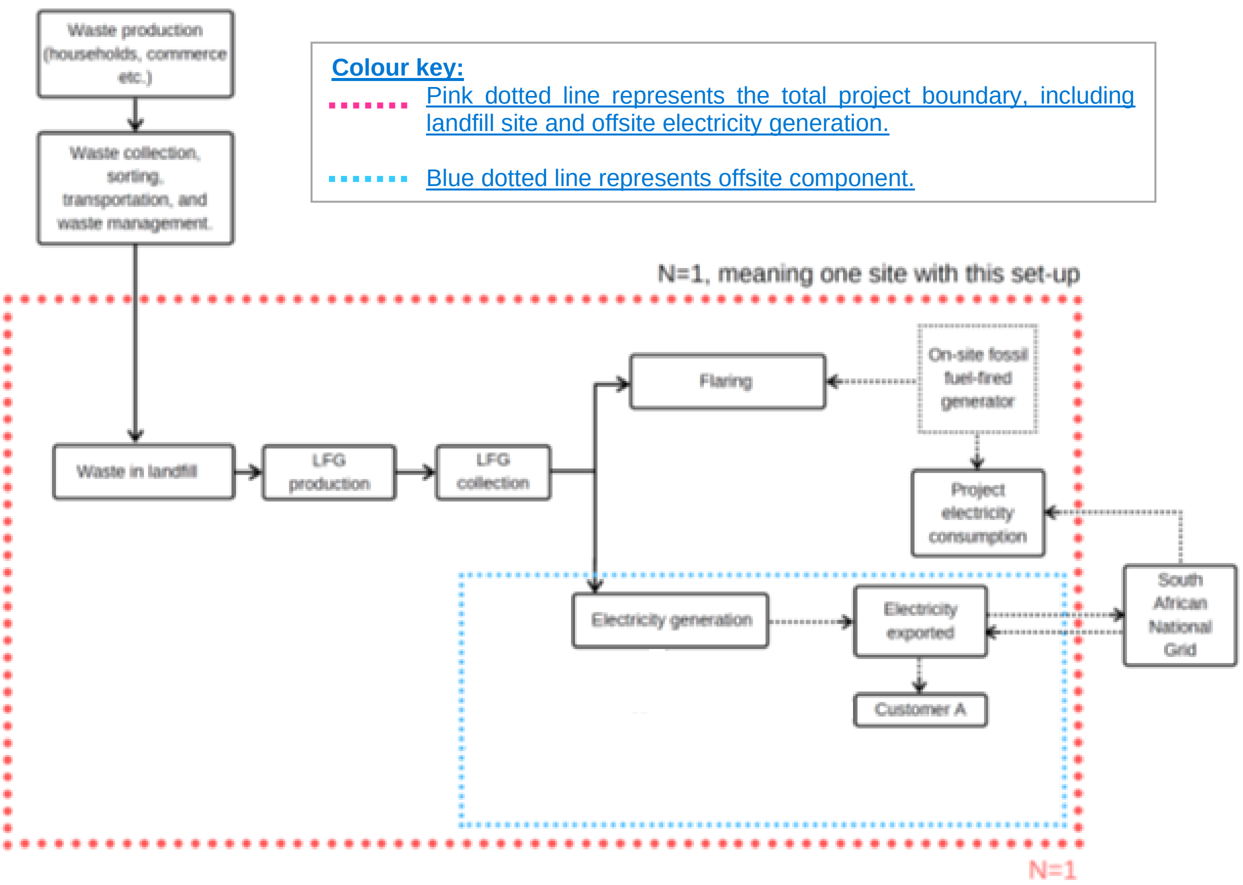


Figure: Illustration of the project boundaries for EnviroServ's Chloorkop Site

The Figure above indicates a flow diagram of the LFG flaring operations project boundary for the EnviroServ Chloorkop project.

B.4. Establishment and description of baseline scenario

In accordance with the applied methodology, paragraph 19, the simplified procedures to identify the baseline scenario and demonstrate additionality are valid and applicable.

(i) Accordingly, as per, paragraph 22 of the applied methodology, the baseline scenario for LFG is assumed to be the atmospheric release of the LFG or capture of LFG and destruction through flaring to comply with regulations or contractual requirements, to address safety and odour concerns, or for other reasons.

~~(i)~~ If all or part of the electricity generated by the project activity is exported to the grid, the baseline scenario for all or the part of the electricity exported to the grid is assumed to be electricity generation in existing and/or new grid-connected power plants. If all or part of the electricity is supplied to off-grid application, the baseline electricity generation equipment is assumed to correspond to the default emission factor from the "ASB0001: Standardized baseline: Grid emissions factor for Southern African Power Pool".

~~(ii)~~

~~Prior to the implementation of the project activity, the LFG at the EnviroServ Chloorkop Landfill was released into the atmosphere.~~

~~The EnviroServ Chloorkop Landfill Gas Project, i.e. the project activity, captures LFG and flares it accordinglywith the potential to erelated waste recovery.~~

~~Therefore, the baseline scenario for the project activity is the atmospheric release of LFG.~~

~~(iii)~~(ii)

B.5. Demonstration of additionality

In accordance with the applied methodology, paragraph 21: "The following types of project activities are deemed automatically additional, if prior to the implementation of the project activity the LFG was only vented and/or flared but not utilized for energy generation:

(a) The LFG is used to generate electricity in one or several power plants with a total nameplate capacity that equals or is below 10 MW;
(b) The LFG is used to generate heat for internal or external consumption;
(c) The LFG is flared.

Prior to the implementation of the project activity, the LFG was only vented. In the project scenario, the LFG is flared, and potentially used to generate electricity (below 10 MW), therefore the project activity is deemed automatically additional.

B.6. Estimation of emission reductions

B.6.1. Explanation of methodological choices

The baseline emissions are determined according to equation (1) of the applied methodology:

$$BE_y = BE_{CH_4,} + BE_{EC,} + BE_{HG,y} + BE_{NG,y}$$ ACM0001 Equation (1)

Where:

BE_y	Baseline emissions in year *y* (tCO_2e/y)
$BE_{CH_4,y}$	Baseline emissions of methane from the SWDS in year *y* (tCO_2e/y)
$BE_{EC,y}$	Baseline emissions associated with electricity generation in year *y* (tCO_2/y)
$BE_{HG,y}$	Baseline emissions associated with heat generation in year *y* (tCO_2/y)
$BE_{NG,y}$	Baseline emissions associated with natural gas use in year *y* (tCO_2/y)

In the baseline, no ~~electricity or~~ heat is generated~~,~~ and natural gas use is not applicable, therefore:

~~BEEC,y =~~ $BE_{HG,y} = BE_{NG,y} = 0$

Baseline emissions of methane from the SWDS ($BE_{CH4,y}$)

Baseline emissions of methane from the SWDS are determined according to equation (2) of the applied methodology:

$$BE_{CH4} = ((1 - OX_{top\ \mathrm{layer}}) \times F_{CH4,PJ,y} - F_{CH,BL,y}) \times GWP_{CH4} \qquad \text{ACM0001 Equation (2)}$$

Where:

$BE_{CH_4,y}$	Baseline emissions of methane from the SWDS in year *y* (tCO_2e/y)
$OX_{top\ layer}$	Fraction of methane in the LFG that would be oxidized in the top layer of the SWDS in the baseline (dimensionless)
$F_{CH4,PJ,y}$	Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (tCH_4/y)
$F_{CH4,BL,y}$	Amount of methane in the LFG that would be flared in the baseline in year *y* (tCH_4/y)
GWP_{CH4}	Global warming potential of CH_4 ($tCO_2e/t\ CH_4$)

For the purposes of these calculations, and in accordance with the applied methodology, the following values are applied:

- OX_{top_layer} = 0.1 (default value as per applied methodology);
- $F_{CH4,BL,y}$ = 0, since in the baseline no requirements to destroy methane were existing and neither was the LFG captured and destroyed prior to implementation of the project activity, as per the applied methodology, paragraph 39 and 40; and
- GWP_{CH4} = 25 (as per Decision 24/CP.19, paragraph 2).

$F_{CH4,PJ,y}$ is determined ex ante according to equation (5) of the applied methodology:

$$F_{CH4,PJ,y} = \eta_{PJ} \times \frac{BE_{CH4,SWDS,y}}{GWP_{CH4}} \qquad \text{ACM0001 Equation (5)}$$

Where:

GWP_{CH4}	Global Warming Potential of CH_4 (tCO_2e/tCH_4)
η_{PJ}	Efficiency of the LFG capture system that will be installed in the project activity

$BE_{CH4,SWDS,y}$	Amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* (tCO_2e/y)

η is stipulated based on the efficiency of the LFG capture system of the project activity. In accordance with the ACM0001 (Version 15.0) in Table 6 of paragraph 79, the default value of 0.5 is used in this baseline calculation.

$BE_{CH4,SWDS,y}$ is determined using the methodological tool "Emissions from solid waste disposal sites".

~~**Determination of $F_{CH4,BL,y}$**~~

To determine $F_{CH4,BL,y}$ or ~~This section provides a procedure to determine~~ the amount of methane that would have been captured and destroyed in the baseline due to regulatory or contractual requirements, to address safety and odour concerns, or for other reasons (collectively referred to as requirement in the table below), distinguishes four cases as presented in the table below. The appropriate case should be identified and determination of $F_{CH4,BL,y}$ can be calculated following the corresponding guidance in the applied methodology.

Situation at the start of the project activity	Requirement to destroy methane	Existing LFG capture and destruction system
Case 1	No	No
Case 2	Yes	No
Case 3	No	Yes
Case 4	Yes	Yes

Case 1 is applicable to the project activity: no requirement to destroy methane exists at the start of the project activity and no LFG system exists at the start of the project activity.

Hence, in accordance with the applied methodology:

$F_{CH4,BL,y} = 0$

Baseline emissions associated with electricity generation ($BE_{EC,y}$)

Baseline emissions associated with electricity generation from LFG combustion will be calculated using the values for the CO_2 emission factors for the interconnected electricity systems of the Southern African Power Pool (SAPP). This stipulated within the Standardized Baseline ASB0001: Grid emission factor for Southern African Power Pool (Version01.0)

Thus, for all project activities except wind and solar power generation is stipulated as 0.9488 tCO_2/MWh for the second and third crediting periods.

The capacity of the generator is assumed to be 950 kW and will run for an average of 7210 hours per annum, thus the assumed baseline electricity generated is approximated as 6849.5 MWh per annum.

$$BE_{EC,y} = \sum_k EC_{BL,k,y} \times EF_{EF,k,y} \times \left(1 + TDL_{k,y}\right)$$ Electricity consumption tool Eq.(2)

Where:

$BE_{EC,y}$	Baseline emissions from electricity consumption in year y (tCO_2 / yr)
$EC_{BL,k,y}$	Quantity of electricity that would be consumed by the baseline electricity consumer k in year y (MWh/yr)
$EF_{EF,k,y}$	Emission factor for electricity generation for source k in year y (tCO_2 / yr)
$TDL_{k,y}$	Average technical transmission and distribution losses for providing electricity to source k in year y

Ex post determination of $F_{CH4,PJ,y}$

In accordance with the applied methodology, during the crediting period, $F_{CH4,PJ,y}$ is determined as the sum of the quantities of methane flared and used in power plant(s), boiler(s), air heater(s), glass melting furnace(s), kiln(s) and/or a natural gas distribution network, as follows:

$$F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y} + F_{CH4,HG,y} + F_{CH4,NG,y}$$ ACM0001 Equation (3)

Where:

$F_{CH4,PJ,y}$	Amount of methane in the LFG which is flared and/or used in the project activity in year y (tCH_4/yr)
$F_{CH4,flared,y}$	Amount of methane in the LFG which is destroyed by flaring in year y (tCH_4/yr)
$F_{CH4,EL,y}$	Amount of methane in the LFG which is used for electricity generation in year y (tCH_4/yr)
$F_{CH4,HG,y}$	Amount of methane in the LFG which is used for heat generation in year y (tCH_4/yr)
$F_{CH4,NG,y}$	Amount of methane in the LFG which is sent to the natural gas distribution network and/or to the trucks in year y (tCH_4/yr)

In the project activity, electricity generation will also be implemented. ~~no electricity or heat is generated, and natural gas use is not applicable therefore,~~ $F_{CH4,flared,y}$ and $F_{CH4,EL,y}$ are thus used and are determined using the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0) and monitoring the working hours of the electricity generators such that no emission reduction are claimed for methane destruction during non-working hours. In addition, heat generation and natural gas use are not~~:~~ used, thus:

$$\sout{F_{CH4,EL,y} =} F_{CH4,HG,y} = F_{CH4,NG,y} = 0$$

~~Therefore the requirement as per paragraph 33(a) of the applied methodology ACM0001, Version that "the gaseous stream the tool shall be applied to the LFG delivery pipeline to each item of electricity generation or heat generation equipment j, or the natural gas distribution system, or the trucks" is not applicable.~~

~~Requirements (33(b), (c), (d) and (e) however are applicable when determining $F_{CH4, flared,y}$, using the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0) as described below.~~

$F_{CH4,flared,y}$ is determined as the difference between the amount of methane supplied to the flare(s) and any methane emissions from the flare(s), as follows:

$$F_{CH4,flared,y} = F_{CH4,sent\_flare,y} - \frac{PE_{flare,y}}{GWP_{CH4}}$$ ACM0001 Eequation (4)

Where:

$F_{CH4,flared,y}$	Amount of methane in the LFG which is destroyed by flaring in year y (tCH_4/yr)
$F_{CH4,sent\_flare,y}$	Amount of methane in the LFG which is sent to the flare in year y (tCH_4/yr)
$PE_{flare,y}$	Project emissions from flaring of the residual gas stream in year y (tCO_2e/yr)
GWP_{CH4}	Global Warming Potential of CH_4 (tCO_2e/tCH_4)

~~$F_{CH4,sent\_flare,y}$ is determined~~ $F_{CH4,sent\_flare,y}$ and $F_{CH4,EL,y}$ are determined ~~directly~~ using the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0), applying the requirements described in paragraph 33 (a), (b), (c), (d) and (e) and where the gaseous stream the tool shall be applied to is the LFG delivery pipeline to the flares. As per paragraph 33 of the underlying methodology (ACM0001, Version 15.0), the following requirements apply:

a) The gaseous stream the tool shall be applied to the LFG delivery pipeline to each item of electricity generation or heat generation equipment j, or the natural gas distribution system-, or the trucks. This will apply to the LFG delivery pipelines to both the flare ($F_{CH4,sent\_flare,y}$) and the electricity generation equipment for this project ($F_{CH4,EL,y}$). ~~The gaseous stream the tool shall be applied to is the LFG delivery pipeline to the flares.~~
b) CH_4 is the greenhouse gas for which the mass flow should be determined.
c) The simplification offered for calculating the molecular mass of the gaseous stream is valid (equations (3) or (17) in the tool).
d) The mass flow should be calculated on an hourly basis for each hour *h* in year *y.*
e) The mass flow calculated for hour *h* is 0 if the equipment is not working in hour h ($Op_{j,h}$ = not working), the hourly values are then summed to a yearly unit basis.

As per the applied "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0), the mass flow of CH_4 in a gaseous stream (for both $F_{CH4,sent\_flare,y}$ and $F_{CH4,EL,y}$) is determined through measurement of the flow and volumetric fraction of the gaseous stream.

Measurements will be made for each flare and instruments are located as following:

- Flowmeters are fitted to the gas inlet and the main burner gas train and measure the flow rate of the gas.
- The gas data analyser is connected to the outlet of the extraction fan and measures the methane concentration.
- Flowmeters are fitted to the gas inlet of the electricity generator to measure the flow rate of the gas.

Since the gas analyser ~~(GIR 5000)~~ measures the gas per volume, 0-100% ~~and being almost dry~~ and the flow meter measures the gas volume per hour (Nm^3/hour) as being wet, Option F~~B~~ from Table 1 in the applied tool was selected: to measure the volume flow of the gaseous stream on a wet basis and to measure the volumetric fraction of CH_4 on a ~~dry~~ wet basis.

The absolute humidity is a parameter required for Option B. Option 2 was selected to determine the absolute humidity by assuming the gaseous stream is dry or saturated in a simplified conservative approach.

Option 2: Simplified calculation without measurement of the moisture content

This option provides a simple and conservative approach to determine the absolute humidity by assuming the gaseous stream is saturated[4]. Accordingly, the saturation absolute humidity ($m_{H2O,t,db,sat}$) is calculated using equation (4) of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0):

$$m_{H2O,sat} = \frac{\rho_{H2O,t} \times MM_{H2O}}{(P_t - \rho_{H2O,t}) \times MM_{t,db}}$$

Where:

$m_{H2O,t,db,sat}$ = Saturation absolute humidity in time interval *t* on a dry basis (kg H_2O/kg dry gas)
$p_{H2O,t,Sat}$ = Saturation pressure of H_2O at temperature T_t in time interval *t* (Pa)
T_t = Temperature of the gaseous stream in time interval *t* (K) (to be monitored) P_t = Absolute pressure of the gaseous stream in time interval *t* (Pa)
MM_{H2O} = Molecular mass of H_2O (kg H_2O/kmol H_2O) = 18.0152 kg/kmol
$MM_{t,db}$ = Molecular mass of the gaseous stream in a time interval *t* on a dry basis (kg dry gas/kmol dry gas) (to be monitored)

The molecular mass of the gaseous stream in a time interval t on a dry basis is estimated using equation (3) of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0):

$$MM_{t,db} = \sum_k (v_{k,t,db} \times MM_k)$$

Where:

$MM_{t,db}$ = Molecular mass of the gaseous stream in time interval t on a dry basis (kg dry gas/kmol dry gas) $v_{k,t,db}$ = Volumetric fraction of gas *k* in the gaseous stream in time interval *t* on a dry basis (m^3 gas k/m^3 dry gas)
MM_k = Molecular mass of gas *k* (kg/kmol)
k = All gases, except H_2O, contained in the gaseous stream (e.g. N_2, CO_2, O_2, CO, H_2, CH_4, N_2O, NO, NO_2, SO_2, SF_6 and PFCs)

Equation (3) of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0), requires measuring the volumetric fraction of all gases (k) in the gaseous stream. However as a simplification, the volumetric fraction of only CH_4 must be monitored and the

[4] An assumption that the gaseous stream is saturated is conservative for the situation that the mass flow of greenhouse gas *i* is underestimated (applicable for calculating baseline emissions).

difference to 100% may be considered as pure nitrogen. The underlying methodology does not specify that such simplification is not acceptable.

Option FB of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0)

The mass flow of CH_4, greenhouse gas *i* ($F_{CH4,sent\_flare,y i,t}$) is determined using the equations (5) and (6) below as stipulated in of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0):

$$F_{i,t} = V_{t,wb,n} \times v_{i,t,wb} \times \rho_{i,n}$$ Mass Flow Tool Equation (9)

$$\rho_{i,n} = \frac{P_n * MM_i}{R_u * T_n}$$ Mass Flow Tool Equation (10)

$$F_t = V_{t,db} \times v_{i,t,db} \times \rho_{i,t}$$

$$V_{t,wb,n} = M_{t,wb} / \rho_{t,wb,n}$$ Mass Flow Tool Equation (155)

With

$$\rho_{t,wb,n} = \frac{P_n \times MM_{t,wb}}{R_u \times T_n} \quad \rho_{t,wb,n} = \frac{P_n \times MM_{t,wb}}{R_u \times T_u} \quad \rho_{i,t} = \frac{P_t \times MM_i}{R_u \times T_t}$$ Mass Flow Tool Equation (16)

Where:

$F_{i,t}$ Mass flow of greenhouse gas i in the gaseous stream in time interval t (kg gas/h) Fi,t = Mass flow of greenhouse gas i in the gaseous stream in time interval t (kg gas/h)

$V_{t,wdb,n}$ = Volumetric flow of the gaseous stream in the time interval t on a dry wet basis (m³ dry wet gas/h)
$v_{i,t,wdb}$ = Volumetric fraction of greenhouse gas *i* in the gaseous stream in a time interval *t* on a dry wet basis (m³ gas *i*/m³ dry wet gas)
$\rho_{i,n}$ Density of greenhouse gas *i* in the gaseous stream normal conditions (kg gas/m³ wet gas i)
P_n Absolute pressure of the gaseous stream in time interval *t* at normal conditions (Pa)
MM_i Molecular mass of greenhouse gas *i* (kg/kmol)
R_u = Universal ideal gases constant (Pa.m³/kmol.K)
T_{tn} = Temperature of the gaseous stream at normal conditions in time interval *t* (K)
$M_{t,wb}$ Mass flow of the gaseous stream in time interval *t* on wet basis (kg/h)
$\rho_{t,wb,n}$ Density of greenhouse gas *i* in the gaseous stream in interval *t* on a wet basis at normal conditions (kg wet gas/m³ wet gas)
$MM_{t,wb}$ Molecular mass of greenhouse gas *i* in time in time interval *t* on a wet basis (kg/kmol wet)

The volumetric flow of the gaseous stream in time interval t on a dry basis ($V_{t,db}$) is determined by converting the measured volumetric flow from wet to dry basisThe molecular mass of the gaseous stream ($MM_{t,wb}$) is determined –according to equation (17) belowof, as stipulated in the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0):

$$MM_{t,wb} = \sum_k (V_{k,t,wb} \times MM_k)$$ Mass Flow Tool Equation (17)

~~$V_{t,} = V_{t,b} / (1 + v_{H2O,t,db})$ (7)~~

Where:

$MM_{t,wb}$	Molecular mass of gaseous stream in time interval *t* on a wet basis (kg wet gas/kmol wet gas)
$V_{~~t~~k,t,wb,~~db~~}$	~~=~~ Volumetric ~~flow~~ fraction of ~~the~~ gas~~eous~~ *k* in the gaseous stream in time interval *t* on a ~~dry~~ wet basis (m³ ~~dry~~ gas *k*/ m³ wet gas~~h~~)
$MM~~V_{t,}~~_{k~~wb~~}$	~~= Volumetric flow of the gaseous stream in time interval *t* on a wet basis (m³ wet gas/h)~~ Molecular mass of gas *k* (kg/kmol)
k	All gases contained in the gaseous stream (e.g. N_2, CO_2, O_2, CO, H_2, CH_4, N_2O, NO, NO_2, SO_2, SF_6 and PFCs and H_2O in vapor phase).

The determination of the molecular mass of the gaseous stream ($MM_{t,wb}$) requires measuring the volumetric fraction of all gases (k) in the gaseous stream. However, as a simplification, the volumetric fraction of only the gases k that are greenhouse gases and are considered in the emission reduction calculation in the underlying methodology must be monitored and the difference to 100% may be considered as pure nitrogen.

$PE_{flare,y}$ ~~shall be~~is determined using the methodological tool "Project emissions from flaring". If LFG is flared through more than one flare, then $PE_{flare,y}$ is the sum of the emissions for each flare determined separately.

The project activity involves the installation of ~~two~~ one enclosed flare~~s~~. The calculation procedure in the applied tool "Project emissions from flaring" (Version 02.0.0) determines the project emissions from flaring the residual gas ($PE_{flare,y}$) based on the flare efficiency ($\eta_{flare,m}$) and the mass flow of methane to the flare ($F_{CH4,RG,m}$).

Step 1: Determination of the methane mass flow in the residual gas

The mass flow of methane in the residual gaseous stream in the minute *m* has been determined in accordance with the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0) as described above.

Step 2: Determination of flare efficiency

The flare efficiency depends on the efficiency of combustion in the flare and the time that the flare is operating. For determining the efficiency of combustion of enclosed flares there is the option to apply a default value or determine the efficiency based on monitored data.

Option A~~B~~ to ~~measure~~ make use of the default flare efficiency has been selected for ~~determining~~ the flare efficiency for minute *m* ($\eta_{flare,m}$).

The flame enclosure has a height of 4.1 times the diameter of the enclosure and is therefore classified to be a low height flare.

For enclosed flares that are defined as low height flares, the flare efficiency in the minute *m* ($\eta_{flare,m}$) shall be adjusted, as a conservative approach, by subtracting 0.1 from the efficiency as determined in Options A or B.

Option A: Default value

The flare efficiency for the minute m ($\eta_{flare,m}$) is 90% when the following two conditions are met to demonstrate that the flare is operating:

1. The temperature of the flare ($T_{EG,m}$) and the flow rate of the residual gas to the flare ($F_{RG,m}$) is within the manufacturer's specification for the flare ($SPEC_{flare}$) in minute m; and
2. The flame is detected in minute m ($Flame_m$).

Otherwise $\eta_{flare,m}$ is 0%.

~~**Option B: Measured flare efficiency**~~

~~The flare efficiency in the minute *m* is a measured value ($\eta_{flare,m} = \eta_{flare,calc,m}$) when the following three conditions are met to demonstrate that the flare is operating:~~

~~The temperature of the flare ($T_{EG,m}$) and the flow rate of the residual gas to the flare ($F_{RG,m}$) is within manufacturer's specification for the flare ($SPEC_{flare}$) in minute *m*;~~

~~The flame is detected in minute *m* ($Flame_m$); and Otherwise $\eta_{flare,m}$ is 0%.~~

~~In applying Option B, the project participants may choose to determine $\eta_{flare,calc,m}$ using either Option B.1 or Option B.2. Under Option B.1 the measurement is conducted by an accredited entity on a biannual basis and under option B.2 the flare efficiency is measured each minute. Option B.1 has been selected.~~

~~**Option B.1: Biannual measurement of the flare efficiency**~~

~~The calculated flare efficiency $\eta_{flare,calc,m}$ is determined as the average of two measurements of the flare efficiency made in year y ($\eta_{flare,calc,y}$), as follows:~~

$$\eta_{flare,calc,y} = 1 - \frac{1}{2}\sum_{t=1}^{2}\frac{F_{CH4,EG,t}}{F_{CH4,RG,t}} \quad (14)$$

~~Where:~~

~~$\eta_{flare,calc,y}$~~	~~= Flare efficiency in the year y~~
~~$F_{CH4,EG,t}$~~	~~= Mass flow of methane in the exhaust gas of the flare on a dry basis at reference conditions in the time period *t* (kg)~~
~~$F_{CH4,RG,t}$~~	~~= Mass flow of methane in the residual gas on a dry basis at reference conditions in the time period *t* (kg)~~
~~t~~	~~= The two time periods in year *y* during which the flare efficiency is measured, each a minimum of one hour and separated by at least six months~~

~~$F_{CH4,EG,t}$ is measured according to an appropriate national or international standard. $F_{CH4,RG,t}$ is calculated according to Step 1, and consists of the sum of methane flow in the minutes *m* that make up the time period *t*.~~

Step 3: Calculation of project emissions from flaring

Project emissions from flaring are calculated as the sum of emissions for each minute *m* in year *y*, based on the methane mass flow in the residual gas ($F_{CH4,RG,m}$) and the flare efficiency ($\eta_{flare,m}$), as follows:

$$PE_{flare,y} = GWP_{CH4} \times \sum_{m=1}^{525600} F_{CH4,m} \times (1 - \eta_{flare,m}) \times 10^{-3} \qquad \text{Flaring Tool Eq. (15)}$$

Where:

$PE_{flare,y}$	Project emissions from flaring of the residual gas in year *y* (tCO_2e)
GWP_{CH4}	Global warming potential of methane valid for the commitment period (tCO_2e/tCH_4)
$F_{CH4,RG,m}$	Mass flow of methane in the residual gas in the minute *m* (kg)
$\eta_{flare,m}$	Flare efficiency in minute *m*

Flare Specifications

In accordance with the applied methodological tool "Project emissions from flaring", the flare specifications set by the manufacturer for the correct operation of the flare are documented in the CDM-PDD for the following parameters:

a) The minimum and maximum inlet flow rate is ~~50~~ 400 – 2000 Nm^3/h
b) The minimum and maximum operating temperature is 3~~10~~5~~0~~0 - 1150°C
a) The maximum duration between maintenance events is provided by the manufacturer by means of an overview of maintenance tasks and frequency and is provided in the technical manual to the installed flares. Different tasks have different maintenance frequencies. Some maintenance tasks have to be performed daily (maximum duration in days between maintenance events is 1), e.g. condensate drain valves; whereas only every six months (maximum duration in days between maintenance events is 182) e.g. the condition of all cables and connectors needs to be checked and replaced in case of any defective items. ~~The enclosed flares will require a complete overhaul after prolonged operations, and it isrecommended that this should be carried out at least at once every three years~~ The technical manual to the installed flares is available upon request.

Estimation of $BE_{CH4,SWDS,y}$

$BE_{CH4,SWDS,y}$is determined using the methodological tool "Emissions from solid waste disposal sites" (Version 06.0.1). In accordance with the applied methodology, paragraph 38, the following guidance has been taken into account when applying the tool:

- f_y in the tool has been assigned a value of 0 because the amount of LFG that would have been captured and destroyed is already accounted for in equation (2) of the applied methodology;
- In the tool, x begins with the year that the SWDS started receiving wastes (e.g. the first year of SWDS operation, i.e. 1997); and
- Sampling to determine the fractions of different waste types is not necessary because the waste composition has been obtained from previous studies.

<u>Procedure to determine methane emissions from the SWDS:</u>

The amount of methane generated from disposal of waste at the Solid Waste Disposal Site (SWDS) is calculated based on a first order decay (FOD) model.

The amount of methane generated from disposal of waste at the SWDS is calculated for the year *y* ($BE_{CH_4,\mathrm{SWDS},y}$) using equation (1) from the applied methodological tool "Emissions from solid waste disposal sites":

$$\left.\begin{array}{l} BE_{CH4,SWDS,y} \\ PE_{CH4,SWDS,y} \\ LE_{CH4,SWDS,y} \end{array}\right\} = \varphi_y \cdot (1 - f_y) \cdot GWP_{CH4} \cdot (1 - OX) \cdot \frac{16}{12} \cdot F \cdot DOC_{f,y} \cdot MCF_y \cdot \sum_{x=1}^{y} \sum_{j} W_{j,x} \cdot DOC_j \cdot e^{-k_j \cdot (y-x)} \cdot (1 - e^{-k_j})$$

SWDS Tool Equation (1)

Where:

φ_y	Model correction factor to account for model uncertainties for year *y*
f_y	Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in the year *y*
GWP_{CH_4}	Global Warming Potential of CH_4 (tCO_2e/tCH_4)
OX	Oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering the waste)
F	Fraction of methane in the SWDS gas (volume fraction)
$DOC_{f,}$	Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring at the SWDS for year *y* (weight fraction)
MCF_y	Methane correction factor for the year *y*
$W_{j,}$	Amount of solid waste type *j* disposed or prevented from disposal in the SWDS in the year *x* (tons)
DOC_j	Fraction of degradable organic carbon in the waste type *j* (weight fraction)
k_j	Decay rate for the waste type *j* (l/yr)
j	Type of residual waste or types of waste in the MSW
x	Years in the time period in which waste is disposed at the SWDS, extending from the first year in the time period (*x* = 1) to year *y* (*x* = *y*) (*x* = 1) to the year *y* for which avoided emissions are calculated (*x* = *y*)
y	Year of the crediting period for which methane emissions are calculated (*y* is a consecutive period of 12 months)

<u>Determining the parameters required to apply the FOD model:</u>

The table below summarises the parameters used in this calculation.

Parameter	Application A	Value Applied	Units	Explanation
φ_y	Default value	0.75	-	Ekurhuleni's mean annual precipitation is less than its annual potential evapotranspiration rate [5]. Therefore, MAP/PET <1. Therefore, the site is dry. Application A is also selected as the CDM project activity mitigates methane emissions from a specific existing SWDS.
OX	Default value	0.1	-	In accordance with the applied tool.
F	Default value	0.5	-	In accordance with the applied tool.
$DOC_{f,y}$	Default value	0.5	-	In accordance with the applied tool.
MCF_y	Default value	1.0	-	The landfill is an anaerobic managed solid waste disposal site. This is because there is a controlled placement of waste at the landfill (waste is specifically deposited in designated cells, and mining waste is deposited in a separate cell) and cover material and compacting equipment is used.
kj	Default values	See table under "explanation"	l/yr	Landfill is: Boreal and temperate (MAT <20°C)[6] Dry (MAP/PET <1)[7]
Wj,x	Estimated once		tonnes	Based on information from the SWDS owner
DOC_j	Default value	See table under "explanation"	-	Wood & Wood Products: 43 Pulp, Paper & Cardboard: 40 Food & Food Waste: 15 Textiles: 24 Garden, Yard & Park Waste: 20 Glass, Plastic, Metal, Inerts: 0
f_y	Estimated once	0	-	No methane is captured and flared in the baseline.

Project Emissions

The project emissions are calculated in accordance with equation (22) of the applied methodology:

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[5] Adelana, S. (2010). Groundwater Resource Evaluation and Protection in the Cape Flats, South Africa (University of the Western Cape).

[6] ClimaTemps.com, 2017, *Cape Town Climate & Temperature*, [Online] Available at: http://www.cape-town.climatemps.com/ [Accessed on 22/10/2019].

[7] Adelana, S. (2010). Groundwater Resource Evaluation and Protection in the Cape Flats, South Africa (University of the Western Cape).

$$PE_y = PE_{EC,y} + PE_{FC,y} + PE_{DT,y}$$ ACM0001 equation (22)

Where:

PE_y	Project emissions in year y (tCO_2/y)
$PE_{EC,y}$	Emissions from consumption of electricity due to the project activity in year *y* (tCO_2/y)
$PE_{FC,y}$	Emissions from consumption of fossil fuels due to the project activity, for purpose other than electricity generation, in year y (tCO_2/y)
$PE_{DT,y}$	Emissions from distribution of compressed/liquefied LFG using trucks, in year y (tCO_2/y)

~~For the purposes of this type of project, there will be no consumption of fossil fuels due to the project activity, and:~~

Project emissions from distribution of compressed/ liquefied LFG using trucks is not applicable as all the LFG captured will be flared on-site.

Project emissions associated with consumption of electricity ($PE_{EC,y}$)

Project emissions from consumption of electricity due to the project activity shall be calculated in accordance with equation (1) of the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” (Version 01).

$$PE_{EC,y} = \sum_j EC_{PJ,j,y} \times EF_{EF,j,y} \times (1 + TDL_{j,y})$$ Electricity consumption tool Equation (1)

Where

$PE_{EC,}$	Project emissions from electricity consumption in year y (tCO_2 / yr)
$EC_{PJ,y}$	Quantity of electricity consumed by the project electricity consumption source j in year y (MWh/yr)
$EF_{EF,y}$	Emission factor for electricity generation for source j in year y (tCO_2/MWh)
$TDL_{j,y}$	Average technical transmission and distribution losses for providing electricity to source j in year y

$EF_{EF,j/k/l,y}$ is determined according to the Standardised Baseline Methodology (ASB0040-2018: Grid emission factor for Southern African Power Pool, Version 01.0), with the amount from electricity consumed ($EC_{PJ,j,y}$) from the grid being monitored.

Project emissions associated with fossil fuel combustion ($PE_{FC,y}$)

The use of diesel in the onsite generator contributes towards project emissions in accordance with the “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion” (Version 02).

The CO_2 emissions from fossil fuel combustion in process j are calculated based on the quantity of fuels combusted and the CO_2 emission coefficient of those fuels, as per Equation (1) of the tool, as follows:

$$PE_{FC,j,y} = \sum_i FC_{i,j,y} \times COEF_{i,y}$$

Fossil Fuel Tool Equation (1)

$PE_{FC,j,y}$	Project emissions from fossil fuel combustion in project j during year y (tCO_2/yr)
$FC_{i,j,y}$	Quantity of fuel type i combusted in process j during year y (mass or volume unit/yr)
$COEF_{i,y}$	CO_2 emission coefficient of the fuel type i in year y (tCO_2/ mass or volume unit)
i	Fuel types combusted in the project j during year y

The CO_2 coefficient will be calculated using Option B of the "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion", which makes use of the net calorific value and CO_2 emission factor of the fuel type, as follows:

$$COEF_{i,y} = NCV_{i,y} \times EF_{CO2,i,y}$$ Fossil Fuel Tool Equation (4)

Where:

$COEF_{i,y}$	CO_2 emission coefficient of the fuel type I in year y (tCO_2/ mass or volume unit)
$NCV_{i,y}$	Weighted average net calorific value of the fuel type i in year y (GJ/mass or volume unit)
$EF_{CO2,i,y}$	Weighted average CO_2 emission factor of the fuel type i in year y (tCO_2/GJ)

~~Project emissions associated with distribution of compressed/liquefied LFG using trucks (PEDT,)~~

~~No project emissions associated with the distribution of compressed/ liquified LFG using trucks has been calculated since EnviroServ does not make use of trucks.~~

Leakage

No leakage effects are accounted for under the applied methodology.

Emission Reductions

The emission reductions of the project activity are calculated using equation (25) of the applied methodology:

$$ER_y = BE_y - PE_y$$ ACM0001 Equation (25)

As per the latest approved version of the methodological tool "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period" (Version 03.0.1) the original baseline is still valid and therefore not required to be updated:

- The original baseline complies with all relevant mandatory national and/or sectoral policies which have come into effect after the submission of the project activity for validation;
- Circumstances, taking into consideration changes in market characteristics such as availability of new fuels and the impact of electricity prices or fuel prices, do not affect the continued validity of the original baseline;
- Since the methodology applied in the original PDD was withdrawn after the

registration of the project activity and replaced by a consolidated methodology, the only data used both at time of request for registration and at time of request for renewal of the crediting period is the input-data for the First Order Decay Model, as applied using the tool “Emissions from solid waste disposal sites” (Version 06.0.1); i.e. the amount of waste disposed of at the SWDS annually. Other (default) values are as per the latest methodology and applicable tools.

B.6.2. Data and parameters fixed ex ante

Data/Parameter	OX_{top_layer}
Data unit	Not applicable
Description	Fraction of methane that would be oxidized in the top layer of the SWDS in the baseline.
Source of data	ACM0001 (Version 15.0)
Value(s) applied	0.1
Choice of data or measurement methods and procedures	According to the applied methodology, this value is consistent with how oxidation is accounted for in the methodological tool ‘Emissions from Solid Waste Disposal Sites’.
Purpose of data	Baseline emissions calculations
Additional comment	Not applicable

Data/Parameter	GWP_{CH4}
Data unit	tCO_2e/tCH_4
Description	Global warming potential of CH_4
Source of data	ACM0001 (Version 15.0)
Value(s) applied	25
Choice of data or measurement methods and procedures	As per IPCC: 21 for the first commitment period and in accordance with the latest COP/MOP decision. The latest COP/MOP decision (Decision 24/CP.19, paragraph 2) stipulates that “from 2015 until a further decision is adopted by the Conference of the Parties, the global warming potential values used by Parties included in Annex I to the Convention (Annex I Parties) ... shall be those listed in the column entitled “Global warming potential for given time horizon” in table 2.14 of the errata to the contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, based on the effects of greenhouse gases over a 100-year time horizon, as contained in annex III”; This means that from 2015 the value 25 shall be used for the GWP of methane.
Purpose of data	Baseline emissions calculations
Additional comment	Not applicable

Data/Parameter	η_{PJ}
Data unit	Not applicable
Description	Efficiency of the LFG capture system that will be installed in the project activity.
Source of data	ACM0001 (Version 15.0)
Value(s) applied	0.5
Choice of data or measurement methods and procedures	Since the technical specifications are not available for the LFG capture system, a default value of 50% is applied for the purposes of ex-ante emissions estimation.
Purpose of data	Baseline emissions calculations
Additional comment	Not applicable

Data/Parameter	φ_y
Data unit	Not applicable
Description	Default value for the model correction factor to account for model uncertainties.
Source of data	Version 06.0.1 of the ‘Emissions from solid waste disposal sites’.
Value(s) applied	0.75
Choice of data or measurement methods and procedures	Application A is applied as the project activity mitigates methane emissions from a specific existing SWDS. The project site is located within dry conditions9.
Purpose of data	Baseline emissions calculations
Additional comment	Not applicable

Data/Parameter	OX
Data unit	Not applicable
Description	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste).
Source of data	Based on an extensive review of published literature on this subject, including the IPCC Guidelines for National Greenhouse Gas Inventories, as per Version 06.0.1 of the ‘Emissions from solid waste disposal sites’.
Value(s) applied	0.1
Choice of data or measurement methods and procedures	Default value
Purpose of data	Baseline emissions calculations
Additional comment	When methane passes through the top-layer, part of it is oxidised by methanotrophic bacteria to produce CO_2. The oxidation factor represents the proportion of methane that is oxidised to CO_2. This should be distinguished from the methane correction factor (MCF) which is to account for the situation that ambient air might intrude into the SWDS and prevent methane from being formed in the upper layer of SWDS.

Data/Parameter	F
Data unit	Not applicable
Description	Fraction of methane in the SWDS gas (volume fraction).
Source of data	Version 06.0.1 of the ‘Emissions from solid waste disposal sites’.
Value(s) applied	0.5
Choice of data or measurement methods and procedures	Default value
Purpose of data	Baseline emissions calculations
Additional comment	Upon biodegradation, organic material is covered to a mixture of methane and carbon dioxide.

Data/Parameter	$DOC_{f,default}$
Data unit	Weight fraction
Description	Default value for the fraction of degradable organic carbon (DOC) in MSW that decomposes in the SWDS.
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories as per Version 06.0.1 of the 'Emissions from solid waste disposal sites'.
Value(s) applied	0.5
Choice of data or measurement methods and procedures	Default value applied since the project activity mitigates methane emissions from a specific existing SWDS.
Purpose of data	Baseline emissions calculations
Additional comment	This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, in the SWDS. This default value can only be used for

Data/Parameter	$MCF_{default}$
Data unit	Not applicable
Description	Methane correction factor
Source of data	Version 06.0.1 of the 'Emissions from solid waste disposal sites'.
Value(s) applied	1.0
Choice of data or measurement methods and procedures	The project site is an anaerobic managed solid waste disposal site. This is because there is a controlled placement of waste at the landfill (waste is specifically deposited in designated cells, and mining waste is deposited in a separate cell)and cover material and compacting equipment is used.
Purpose of data	Baseline emissions calculations
Additional comment	Not applicable

Data/Parameter	$DOCj$
Data unit	Not applicable
Description	Fraction of degradable organic carbon in the waste type j.
Source of data	Version 06.0.1 of the ‘Emissions from solid waste disposal sites’.
Value(s) applied	Wood and wood products: 43 Pulp, paper and cardboard (other than sludge): 40 Food, food waste, beverages and tobacco (other than sludge): 15 Textiles: 24 Garden, yard and park waste: 20 Glass, plastic, metal, other inert waste: 0
Choice of data or measurement methods and procedures	The most appropriate fraction(s) based on the options provided on page 11 of version 06.0.1 of the ‘Emissions from solid waste disposal sites’ were selected.
Purpose of data	Baseline emissions calculations
Additional comment	Not applicable

Value(s) applied ($DOCj$):

Wood and wood products	43
Pulp, paper and cardboard (other than sludge)	40
Food, food waste, beverages and tobacco (other than sludge)	15
Textiles	24
Garden, yard and park waste	20
Glass, plastic, metal, other inert waste	0

Data/Parameter	k_j
Data unit	l/yr
Description	Decay rate for the waste type j.
Source of data	Version 06.0.1 of the ‘Emissions from solid waste disposal sites’.
Value(s) applied	Pulp, paper, cardboard (other than sludge), textiles: 0.04 Wood, wood products and straw: 0.02 Other (nonfood) organic putrescible garden and park waste: 0.05 Food, food waste, sewage sludge, beverages and tobacco: 0.06
Choice of data or measurement methods and procedures	The most appropriate decay rate(s) based on the options provided on page 12 of version 06.0.1 of the ‘Emissions from solid waste disposal sites’.
Purpose of data	Baseline emissions calculations
Additional comment	In the case of this project activity, the landfill site is boreal and temperate, and dry.

Data/Parameter	EF_{EFL}
Data unit	tCO_2/MWh
Description	Emission factor for electricity generation
Source of data	Standardized baseline: ASB0001 Grid emission factor for the Southern African Power Pool (Version 01.0).
Value(s) applied	0.9488
Choice of data or measurement methods and procedures	Combined margin CO_2 emission factor for the project electricity system applicable to all project activities other than wind and solar for the second or third crediting period.
Purpose of data	Calculations of baseline and project emissions
Additional comment	Not applicable

Data/Parameter	$\mathbf{W}_{j.x}$
Data unit	Tonnes
Description	Amount of solid waste type *j* disposed in the SWDS in year *x* – Domestic Waste
Source of data	Measured by the project participant
Value(s) applied	430,-536 tonnes annually
Choice of data or measurement methods and procedures	Data taken from historical records of landfill operation, aggregated into annual figures and provided by EnviroServ.
Purpose of data	Baseline emission calculations
Additional comment	The amount of waste in tonnes has been obtained from the project participant. However, assumptions have been applied when differentiating the waste as required for the calculations using the First Order Decay Model.

Data/Parameter	P_n
Data unit	Pa
Description	Total pressure at normal conditions
Source of data	Version 02.0.0 of the 'Tool to determine the mass flow of a greenhouse gas in a gaseous stream'.
Value(s) applied	101,325
Choice of data or measurement methods and procedures	Not applicable
Purpose of data	Calculation of baseline emissions
Additional comment	Not applicable

Data/Parameter	T_n
Data unit	K
Description	Temperature at normal conditions
Source of data	Version 02.0.0 of the ‘Tool to determine the mass flow of a greenhouse gas in a gaseous stream’.
Value(s) applied	273.15
Choice of data or measurement methods and procedures	Not applicable
Purpose of data	Calculation of baseline emissions
Additional comment	Not applicable

Data/Parameter	R_u
Data unit	Pa.m^3/kmol.K
Description	Universal ideal gases constant
Source of data	Version 02.0.0 of the ‘Tool to determine the mass flow of a greenhouse gas in a gaseous stream’.
Value(s) applied	8,314
Choice of data or measurement methods and procedures	Not applicable
Purpose of data	Calculation of baseline emissions
Additional comment	Not applicable

<table>
<tr><td>Data/Parameter</td><td>MM_i</td></tr>
<tr><td>Data unit</td><td>kg/kmol</td></tr>
<tr><td>Description</td><td>Molecular mass of greenhouse gas i</td></tr>
<tr><td>Source of data</td><td>Version 02.0.0 of the ‘Tool to determine the mass flow of a greenhouse gas in a gaseous stream’.</td></tr>
<tr><td>Values</td><td>
<table>
<tr><th>Compound</th><th>Structure</th><th>Molecular mass (kg / kmol)</th></tr>
<tr><td>Carbon dioxide</td><td>CO_2</td><td>44.01</td></tr>
<tr><td>Methane</td><td>CH_4</td><td>16.04</td></tr>
<tr><td>Nitrous oxide</td><td>N_2O</td><td>44.02</td></tr>
<tr><td>Sulfur hexafluoride</td><td>SF_6</td><td>146.06</td></tr>
<tr><td>Perfluoromethane</td><td>CF_4</td><td>88.00</td></tr>
<tr><td>Perfluoroethane</td><td>C_2F_6</td><td>138.01</td></tr>
<tr><td>Perfluoropropane</td><td>C_3F_8</td><td>188.02</td></tr>
<tr><td>Perfluorobutane</td><td>C_4F_{10}</td><td>238.03</td></tr>
<tr><td>Perfluorocyclobutane</td><td>$c\text{-}C_4F_8$</td><td>200.03</td></tr>
<tr><td>Perfluoropentane</td><td>C_5F_{12}</td><td>288.03</td></tr>
<tr><td>Perfluorohexane</td><td>C_6F_{14}</td><td>338.04</td></tr>
</table>
</td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>Not applicable</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comment</td><td>Not applicable</td></tr>
</table>

<table>
<tr><th>Data/Parameter</th><th>MM_k</th></tr>
<tr><td>Data unit</td><td>kg/kmol</td></tr>
<tr><td>Description</td><td>Molecular mass of gas k</td></tr>
<tr><td>Source of data</td><td>Version 02.0.0 of the ‘Tool to determine the mass flow of a greenhouse gas in a gaseous stream’.</td></tr>
<tr><td>Value(s) applied</td><td>For gases k that are greenhouse gases apply values for MM_i.
<table>
<tr><td>Compound</td><td>Structure</td><td>Molecular mass (kg/kmol)</td></tr>
<tr><td>Nitrogen</td><td>N_2</td><td>28.01</td></tr>
<tr><td>Oxygen</td><td>O_2</td><td>32.00</td></tr>
<tr><td>Carbon monoxide</td><td>CO</td><td>28.01</td></tr>
<tr><td>Hydrogen</td><td>H_2</td><td>2.02</td></tr>
<tr><td>Nitric oxide</td><td>NO</td><td>30.01</td></tr>
<tr><td>Nitrogen dioxide</td><td>NO_2</td><td>46.01</td></tr>
<tr><td>Sulfur dioxide</td><td>SO_2</td><td>64.06</td></tr>
</table>
</td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>Not applicable</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comment</td><td>Not applicable</td></tr>
</table>

~~**Data/Parameter**~~	~~MM_{H2O}~~
~~Data unit~~	~~kg/kmol~~
~~Description~~	~~Molecular mass of water~~
~~Source of data~~	~~Version 02.0.0 of the ‘Tool to determine the mass flow of a greenhouse gas in a gaseous stream’.~~
~~Value(s) applied~~	~~18.0152~~
~~Choice of data or measurement methods and procedures~~	~~Not applicable~~
~~Purpose of data~~	~~Calculation of baseline emissions~~
~~Additional comment~~	~~Not applicable~~

Data/Parameter	$SPEC_{flare}$
Data unit	Temperature - °C Flow rate kg/h or m^3/h Maintenance schedule – number of days
Description	Manufacturer's flare specifications for temperature, flow rate and maintenance schedule
Source of data	Flare manufacturer
Value(s) applied	Document in the CDM-PDD the flare specifications set by the manufacturer for the correct operation of the flare for the following parameters: (a) Minimum and maximum inlet flow rate, if necessary converted to flow rate at reference conditions or heat flux; (b) Minimum and maximum operating temperature; and (c) Maximum duration in days between maintenance events The flare specifications set by the manufacturer for the correct operation of the flare are the following: a) The minimum and maximum inlet flow rate is 40050 – 2000 Nm^3/h b) The minimum and maximum operating temperature is 3501000 - 1150°C The maximum duration between maintenance events is provided by the manufacturer by means of an overview of maintenance tasks and frequency and is provided in the technical manual to the installed flares. Different tasks have different maintenance frequencies. Some maintenance tasks have to be performed daily (maximum duration in days between maintenance events is 1), e.g. condensate drain valves; whereas only every six months (maximum duration in days between maintenance events is 182) e.g. the condition of all cables and connectors needs to be checked and replaced in case of any defective items. The enclosed flares will require a complete overhaul after prolonged operations, and it is recommended that this should be carried out at least at once every three years. The technical manual to the installed flares is available upon request.
Choice of data or measurement methods and procedures	Not applicable
Purpose of data	Determination of flare efficiency
Additional comment	Only applicable in case of enclosed flares. The maintenance schedule is not required if Option A is selected to determine flare efficiency of an enclosed flare.

B.6.3. Ex ante calculation of emission reductions

The baseline emissions are determined according to equation (1) of the applied methodology:

$$BE_y = BE_{CH4,} + BE_{EC,} + BE_{HG,y} + BE_{NG,y}$$ ACM0001 equation (1)

Year	BE_y	$BE_{CH4,y}$	$BE_{EC,y}$	$BE_{HG,y}$	$BE_{NG,y}$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2015	70,548	70,548	0	0	0
2016	71,883	71,883	0	0	0
2017	72,990	72,990	0	0	0
2018	73,890	73,890	0	0	0
2019	74,597	74,597	0	0	0
2020	81,998~~75 130~~	75,130~~75 130~~	6,868~~0~~	0	0
2021	82,369~~75 501~~	75,501~~75 501~~	6,868~~0~~	0	0

Baseline emissions of methane from the SWDS are determined according to equation (2) and equation (5) of the applied methodology:

$$BE_{CH4} = ((1 - OX_{top\_layer}) \times F_{CH4,PJ,y} - F_{CH4,BL,y}) \times GWP_{CH4}$$ ACM0001 equation (2)

Year	$BE_{CH4,y}$	$OX_{top\ layer}$	$F_{CH4,PJ,y}$	$F_{CH4,BL,y}$	GWP_{CH4}
	tCO_2e	-	tCH_4	tCH_4	tCO_2e/tCH_4
2015	70,548	0.1	3,135	0	25
2016	71,883	0.1	3,195	0	25
2017	72,990	0.1	3,244	0	25
2018	73,890	0.1	3,284	0	25
2019	74,597	0.1	3,315	0	25
2020	75,130	0.1	3,339	0	25
2021	75,501	0.1	3,356	0	25

$$F_{CH4} = \eta_{PI} \times \frac{BE_{CH4,S,y}}{GWP_{CH4}}$$ ACM0001 equation (5)

Year	$F_{CH4,PJ,y}$	η_{PJ}	$BE_{CH4,SWDS,y}$	GWP_{CH4}
	tCH_4/yr	-	tCO_2e/yr	tCO_2e/tCH_4
2015	3,135	0.5	156,773	25
2016	3,195	0.5	159,739	25
2017	3,244	0.5	162,201	25
2018	3,284	0.5	164,199	25
2019	3,315	0.5	165,772	25

2020	3,-339	0.5	166,-955	25
2021	3,-356	0.5	167,-780	25

$$BE_{EC,} = \sum_j EC_{\mathrm{BL,k,y}} \times EF_{\mathrm{EF,k,y}} \times (1 + TDL_{\mathrm{k},y})$$ Electrical consumption tool Eq. (2)

Year	BE_{EC}	$EC_{BL,k,y}$	$EF_{EF,k,y}$	$TDL_{k,y}$
	tCO_2	MWh	tCO_2/MWh	tCO_2
2015	0	0	0.9488	0.0568
2016	0	0	0.9488	0.0568
2017	0	0	0.9488	0.0568
2018	0	0	0.9488	0.0568
2019	0	0	0.9488	0.0568
2020	6,868	6,850	0.9488	0.0568
2021	6,868	6,850	0.9488	0.0568

Project Emissions

The project emissions are determined according to equation (22) of the applied methodology:

$$PEy = PE_{EC,} + PE_{FC,} + PE_{DT,y}$$ ACM0001 equation (22)

Year	PE_y	$PE_{EC,y}$	$PE_{FC,y}$	$PE_{DT,y}$
	tCO_2	tCO_2	tCO_2	tCO_2
2015	464	464	0	0
2016	464	464	0	0
2017	464	464	0	0
2018	464	464	0	0
2019	464464	464464	0.310	0
2020	466464	464464	1.880	0
2021	466464	464464	1.880	0

$$PE_{EC,} = \sum_j EC_{PJ,,} \times EF_{EL,j,y} \times (1 + TDL_{j,y})$$ Applied tool equation (1)

Year	PE_{EC}	EC_{PJ}	EF_{EF}	TDL
	tCO_2	MWh	$tCO_{2/MWh}$	tCO_2
2015	464	463	0.9488	0.0568
2016	464	463	0.9488	0.0568
2017	464	463	0.9488	0.0568
2018	464	463	0.9488	0.0568
2019	464	463	0.9488	0.0568
2020	464	463	0.9488	0.0568
2021	464	463	0.9488	0.0568

$$PE_{FC,j,y} = \sum_{i} FC_{i,j,y} \times COEF_{i,y}$$ Fossil Fuel Tool Equation (1)

Year	$PE_{FC,y}$	$FC_{diesel,y}$	$COEF_{diesel,y}$
-	tCO_2	l diesel	tCO_2/l diesel
2015	0.000	0	0.0028
2016	0.000	0	0.0028
2017	0.000	0	0.0028
2018	0.000	0	0.0028
2019	0.313	111	0.0028
2020	1.875	664	0.0028
2021	1.875	664	0.0028

Leakage

No leakage effects are accounted for under the applied methodology.

Emission reductions

The emission reductions are determined according to equation (25) of the applied methodology:

$$ER_y = BE_y - PE_y$$ ACM0001 equation (25)

Year	ER_y	BE_y	PE_y
	tCO_2e	tCO_2e	tCO_2e
2015	70-084	70,-548	464
2016	71 ,418	71,-883	464
2017	72,-526	72,-990	464
2018	73-,425	73,-890	464
2019	74,-133	74,-597	464
2020	81,-532 ~~74 666~~	81,-998 ~~75 130~~	466 ~~464~~
2021	81,-903 ~~75 037~~	82,-369 ~~75 501~~	466 ~~464~~
Total	525,-021 ~~**511 289**~~	528,-274 ~~**514 538**~~	3,-253 ~~**3 249**~~
Average	75,-003 ~~73 041~~	75,-468 ~~73 505~~	465 ~~464~~

B.6.4. Summary of ex ante estimates of emission reductions

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
Year 2015	70,-548	464	0	70,-084
Year 2016	71,-883	464	0	71,-418
Year 2017	72,-990	464	0	72,-526
Year 2018	73,-890	464	0	73,-425
Year 2019	74,-597	464	0	74,-133
Year 2020	81,-998 ~~75 130~~	466 ~~464~~	0	81,-532 ~~74 666~~
Year 2021	82,-369 ~~75 501~~	466 ~~464~~	0	81,-903 ~~75 037~~
Total	528,-274 ~~514 538~~	3 253 ~~3 249~~	0	525,-021 ~~511 289~~
Total number of crediting years	7			
Annual average over the crediting period	73,-468~~505~~	4654	0	75,-003~~73 041~~

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data/Parameter	*Management of SWDS*
Data unit	Not applicable
Description	Management of SWDS
Source of data	Different sources of data: • Original design of the landfill; • Technical specifications for the management of the SWDS; National regulations.
Value(s) applied	Waste management licence: number 16/2/7/A230/D17/Z1/P280.
Measurement methods and procedures	Annual
Monitoring frequency	Annual
QA/QC procedures	The waste management licence is granted by a governmental department (third party).
Purpose of data	To ensure that management of the SWDS is not changed during the crediting period in order to increase methane generation compared to the situation prior to the implementation of the project activity and to ensure that the SWDS complies with the waste management licence.
Additional comment	Not applicable

Data/Parameter	$Op_{j,h}$
Data unit	Not applicable

Description	Operation of the equipment that consumes the LFG.
Source of data	Project Participants
Value(s) applied	Not applicable
Measurement methods and procedures	For each equipment unit *j* using the LFG monitor that the plant is operating in hour *h* by the monitoring any one or more of the following three parameters: (a) Temperature. Determine the location for temperature measurements and minimum operational temperature based on manufacturer's specifications of the burning equipment. Document and justify the location and minimum threshold in the PDD; (b) Flame. Flame detection system is used to ensure that the equipment is in operation; (c) Products generated. Monitor the generation $Op_{j,h}$ = 0 when: (a) One of more temperature measurements are missing below the minimum threshold in hour h (instantaneous measurements are made at least every minute); (b) Flame is not detected continuously in hour h (instantaneous measurements are made at least every minute) Otherwise, $Op_{j,h}$ = 1
Monitoring frequency	Hourly
QA/QC procedures	Equipment shall be maintained and calibrated in accordance with manufacturer's recommendations.
Purpose of data	Calculation of baseline emissions
Additional comment	Not applicable

Data/Parameter	$EG_{PJ,y}$
Data unit	MWh
Description	Amount of electricity generated using LFG by the project activity in year y
Source of data	Electricity meter
Value(s) applied	Not applicable
Measurement methods and procedures	As per Table 13, in paragraph 80 of the applied tool, ACM0001. Monitor net electricity generation by the project activity using LFG
Monitoring frequency	Continuous
QA/QC procedures	Electricity meter will be subject to regular (in accordance with stipulation of the meter supplier or the applicable standard SANS) maintenance and testing to ensure accuracy.
Purpose of data	Calculation of project emissions

Additional comment	This parameter is required for calculating baseline emissions associated with electricity generation (*$BE_{EC,y}$*) using the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption". Parameter in accordance with the applied tool ACM0001.

Data/Parameter	*$EG_{EC,y}$*
Data unit	MWh
Description	Amount of electricity consumed by the project activity in year y.
Source of data	Electricity meter
Value(s) applied	Not applicable
Measurement methods and procedures	As per Ttable 14, in paragraph 80 of the applied tool.the applied methodology: sources of consumption shall include electricity consumed for the operation of the LFG capture system (blowers) and for the operation of the twoflare installations.
Monitoring frequency	Continuous
QA/QC procedures	Electricity meter will be subject to regular (in accordance with stipulation of the meter supplier) maintenance and testing to ensure accuracy. The readings will be double checked by the electricity distribution company.
Purpose of data	Calculation of project emissions
Additional comment	This parameter is required for calculating project emissions from electricity consumption due to an alternative waste treatment process t $PE_{EC,y}$) using the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption".

Data/Parameter	*CAPEX and OPEX*
Data unit	Currency (USD, EUR, etc.)
Description	Total investment to implement the project and total cost to operate the project.
Source of data	Engineering, procurement and construction contracts; and maintenance contracts.
Value(s) applied	Not applicable
Measurement methods and procedures	Not applicable
Monitoring frequency	At the first issuance request after each phase of the project is fully implemented.
QA/QC procedures	Audited by professional, independent financial auditors. The DOE should only verify that the data provided corresponds to the data from independent financial auditors.

Purpose of data	In order to collect the information that is required for the update of the provisions in section 5.3.1 of ACM0001 (version 15). Project activities that are registered using these simplified procedures are required to report cost and revenue information at the first issuance request after each phase of the project is fully implemented.
Additional comment	The information provided for CAPEX shall indicate the investment made: (i) in the collection and flaring system. The information supplied for OPEX shall indicate the costs for: (i) staff and maintenance involved in the operation of the collection and flaring system. The monitoring of this parameter is only required for projects applying the simplified procedures to identify the baseline scenario and demonstrate additionality.

Data/Parameter	*Tariff of electricity exported*
Data unit	Currency (USD, EUR, etc.)
Description	Tariff of electricity exported
Source of data	Power purchase agreement
Value(s) applied	-
Measurement methods and procedures	-
Monitoring frequency	At the first issuance request after each phase of the project is fully implemented
QA/QC procedures	Audited by professional, independent financial auditors. The DOE should only verify that the data provided corresponds to the data from independent financial auditors
Purpose of data	~~Calculation of baseline and project emissions-~~
Additional comment	The monitoring of this parameter is only required for projects applying the simplified procedures to identify the baseline scenario and demonstrate additionality. Parameter in accordance with the applied ACM0001.

~~**Data/Parameter**~~	~~*Revenues from the sale of heat / Savings based on the heat generated and consumed on-site*~~
~~Data unit~~	~~Currency (USD, EUR, etc.)~~
~~Description~~	~~(i) Revenues from the heat sold outside of the project boundary; or~~ ~~(ii) Savings based on the heat consumed on-site, which would have been generated outside of the project boundary~~
~~Source of data~~	~~(i) Heat supply agreement;~~ ~~(ii) Monthly average expenses of heat purchased during the previous year prior to the implementation of the project activity~~
~~Value(s) applied~~	~~-~~

~~Measurement methods and procedures~~	~~-~~
~~Monitoring frequency~~	~~At the first issuance request after each phase of the project is fully implemented~~
~~QA/QC procedures~~	~~Audited by professional, independent financial auditors. The DOE should only verify that the data provided corresponds to the data from independent financial auditors~~
~~Purpose of data~~	~~Calculation of baseline and project emissions~~
~~Additional comment~~	~~The monitoring of this parameter is only required for projects applying the simplified procedures to identify the baseline scenario and demonstrate additionality. Parameter in accordance with the applied tool ACM0001.~~

Data/Parameter	TDL_y
Data unit	Not applicable
Description	Average technical transmission and distribution losses for providing electricity.
Source of data	Data obtained from grid operator.
Value(s) applied	0.0568
Measurement methods and procedures	Use recent, accurate and reliable data available within the host country.
Monitoring frequency	Annually. In the absence of data from the relevant year, most recent figures should be used, but not older than 5 years.
QA/QC procedures	Not applicable
Purpose of data	Calculation of project emissions
Additional comment	Not applicable

Data/Parameter	$EC_{PJ,j,t}$
Data unit	MWh/yr
Description	Quantity of electricity consumed by the project electricity consumption source j in year y
Source of data	Direct measurement or calculated based on measurements from more than one electricity meters
Value(s) applied	Not Applicable
Measurement methods and procedures	Use electricity meters installed at the electricity consumption sources.
Monitoring frequency	Continuous measurement and at least monthly recordings.

QA/QC procedures	In cases where electricity meters are regulated (e.g. the electricity is supplied by the electric grid – scenario A), the electricity meter will be subject to regular maintenance and testing in accordance with the stipulation of the meter supplier and/or as per the requirements set by the grid operators or national requirements. The calibration of meters, including the frequency of calibration, should be done in accordance with national standards or requirements set by the meter supplier or requirements set by the grid operators. The accuracy class of the meters should be in accordance with the stipulation of the meter supplier and/or as per the requirements set by the grid operators or national requirements.
Purpose of data	Calculation of project emissions
Additional comment	Parameter in accordance with the "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" tool (Version 03.0, Tool 5).

Data/Parameter	$EC_{BL,k,t}$
Data unit	MWh/yr
Description	Quantity of electricity consumed by the baseline electricity consumption source j in year y
Source of data	Direct measurement or calculated based on measurements from more than one electricity meters
Value(s) applied	6,849.5
Measurement methods and procedures	Use electricity meters installed at the electricity consumption sources.
Monitoring frequency	Continuous measurement and at least monthly recordings.
QA/QC procedures	In cases where electricity meters are regulated (e.g. the electricity is supplied by the electric grid – scenario A), the electricity meter will be subject to regular maintenance and testing in accordance with the stipulation of the meter supplier and/or as per the requirements set by the grid operators or national requirements. The calibration of meters, including the frequency of calibration, should be done in accordance with national standards or requirements set by the meter supplier or requirements set by the grid operators.
Purpose of data	Calculation of project emissions
Additional comment	Parameter in accordance with the "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" tool (Version 03.0, Tool 5).

Data/Parameter	$Flame_m$
Data unit	Flame on or Flame off
Description	Flame detection of flare in the minute m
Source of data	Measurements by the project participants
Value(s) applied	n/a as only used in ex-post calculations

Measurement methods and procedures	Measured using a fixed installation optical flame detector: Ultra Violet detector or Infra Red or both.
Monitoring frequency	Once per minute. Detection of flame recorded as a minute that the flame was on, otherwise recorded as a minute that the flame was off.
QA/QC procedures	Equipment shall be maintained and calibrated in accordance with manufacturer's recommendations.
Purpose of data	Calculation of baseline emissions
Additional comment	Applicable to all flares

Data/Parameter	$V_{t,wb}$
Data unit	m^3 wet gas/h
Description	Volumetric flow of the gaseous stream in time interval *t* on a wet basis
Source of data	Measurement
Value(s) applied	Not available ex ante
Measurement methods and procedures	Volumetric flow measurement should always refer to the actual pressure and temperature. Instruments with recordable electronic signal (analogical or digital) are required.
Monitoring frequency	Continuous if not specified in the underlying methodology
QA/QC procedures	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. Calibration and frequency of calibration is according to manufacturer's specifications.
Purpose of data	Ex post determination of the amount of methane in the LFG which is flared in the project activity in the year *y*.
Additional comment	This parameter will be monitored in Option B as per the applied "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0).

Data/Parameter	$v_{i,t,wdb}$
Data unit	m^3 gas $_i$/m^3 dry wet gas
Description	Volumetric fraction of greenhouse gas $_i$ in a time interval $_t$ on a dry wet basis.
Source of data	Measurement
Value(s) applied	Not available ex ante
Measurement methods and procedures	Continuous in-situ analyzers Continuous gas analyser operating in a dry-basis. Volumetric flow measurement should always refer to the actual pressure and temperature.
Monitoring frequency	Continuous if not specified in the underlying methodology.
QA/QC procedures	Calibration should include zero verification with an inert gas (e.g. N_2) and at least one reading verification with a standard gas (single calibration gas or mixture calibration gas). All calibration gases must have a certificate provided by the manufacturer and must be under their validity period.

Purpose of data	Ex post determination of the amount of methane in the LFG which is flared in the project activity in the year *y*.
Additional comment	This parameter will be monitored in Option FB as per the applied "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0).

Data/Parameter	$M_{t,wb}$
Data unit	kg/h
Description	Mass flow of the gaseous stream in time interval t on a wet basis
Source of data	Flow meter
Value(s) applied	Not Applicable
Measurement methods and procedures	Instruments with recordable electronic signal (analogical or digital) are required.
Monitoring frequency	Continuous if not specified in the underlying methodology.
QA/QC procedures	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. Calibration and frequency of calibration is according to manufacturer's specifications.
Purpose of data	Ex post determination of the amount of methane in the LFG which used in the project activity in the year *y*.
Additional comment	This parameter will be monitored in Option F as per the applied "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0).

Data/Parameter	T_t
Data unit	K
Description	Temperature of the gaseous stream in time interval *t*.
Source of data	Measurement
Value(s) applied	Not available ex ante
Measurement methods and procedures	Instruments with recordable electronic signal (analogical or digital) are required. Examples include thermocouples, thermos resistance, etc.
Monitoring frequency	Continuous unless differently specified in the underlying methodology.
QA/QC procedures	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. Calibration and frequency of calibration is according to manufacturer's specifications.
Purpose of data	Ex post determination of the amount of methane in the LFG which is flared in the project activity in the year *y*.
Additional comment	Provided all parameters are converted to normal conditions during the monitoring process, this parameter may not be needed except for moisture content determination and therefore it should be metered only when performing such measurements (with same frequency).

Data/Parameter	P_t
Data unit	Pa

Description	Absolute pressure of the gaseous stream in time interval *t*
Source of data	Measurement
Value(s) applied	Not available ex ante
Measurement methods and procedures	Instruments with recordable electronic signal (analogical or digital) are required. Examples include pressure transducers, etc.
Monitoring frequency	Continuous unless differently specified in the underlying methodology.
QA/QC procedures	Periodic calibration against a primary device must be performed periodically and records of calibration procedures must be kept available as well as the primary device and its calibration certificate. Pressure transducers (either captive or resistive) must be calibrated monthly.
Purpose of data	Determination of absolute humidity of the gaseous stream.
Additional comment	Provided all parameters are converted to normal conditions during the monitoring process, this parameter may not be needed except for moisture content determination and therefore it should be metered only when performing such measurements (with same frequency).

Data/Parameter	$Pp_{H2O,t,sat}$
Data unit	Pa
Description	Saturation pressure of H_2O at temperature T_t in time interval *t*
Source of data	Fundamentals of Classical thermodynamics; Gordon J. Van Wylen, Richard E. Sonntag and Borgnakke; 4° Edition 1994, John Wiley & Sons, Inc.
Value(s) applied	-
Measurement methods and procedures	This parameter is solely a function of the gaseous stream temperature Tt and can be found at reference [1] (Fundamentals of Classical thermodynamics; Gordon J. Van Wylen, Richard E. Sonntag and Borgnakke; 4° Edition 1994, John Wiley & Sons, Inc.) for a total pressure equal to 101,325 Pa
Monitoring frequency	Not applicable
QA/QC procedures	Not applicable
Purpose of data	Determination of absolute humidity of the gaseous stream.
Additional comment	Fundamentals of Classical thermodynamics; Gordon J. Van Wylen, Richard E. Sonntag and Borgnakke; 4° Edition 1994, John Wiley & Sons, Inc.

Data/Parameter	$v_{k,t,wbdb}$
Data unit	m^3 gas k/m^3 dry wet gas
Description	Volumetric fraction of gas *k* in the gaseous stream in time interval *t* on a dry wet basis.
Source of data	MeasurementCalculated
Value(s) applied	Not available ex ante

Measurement methods and procedures	Continuous in-situ analyzers
Monitoring frequency	Continuous if not specified in the underlying methodology.
QA/QC procedures	Calibration should include zero verification with an inert gas (e.g. N_2) and at least one reading verification with a standard gas (single calibration gas or mixture calibration gas). All calibration gases must have a certificate provided by the manufacturer and must be under their validity period.
Purpose of data	Ex post determination of the amount of methane in the LFG which is flared in the project activity in the year *y*.
Additional comment	Not applicable

Data/Parameter	$FC_{i,j,y}$
Data unit	Mass or volume unit per year (e.g. ton/yr or m^3 /yr)
Description	Quantity of fuel type i combusted in process j during the year y
Source of data	Onsite Measurements
Value(s) applied	Not available ex ante
Measurement methods and procedures	Use either mass or volume meters. In cases where fuel is supplied from small daily tanks, rulers can be used to determine mass or volume of the fuel consumed, with the following conditions: The ruler gauge must be part of the daily tank and calibrated at least once a year and have a book of control for recording the measurements (on a daily basis or per shift).
Monitoring frequency	Continuously
QA/QC procedures	The consistency of metered fuel consumption quantities should be cross-checked by an annual energy balance that is based on purchased quantities and stock changes. Where the purchased fuel invoices can be identified specifically for the CDM project, the metered fuel consumption quantities should also be cross-checked with available purchase invoices from the financial records.
Purpose of data	Ex post determination of the amount of diesel (fuel type i) combusted in the project activity in the year *y*.
Additional comment	Not applicable

Data/Parameter	$NCV_{diesel,y}$
Data unit	GJ/ L diesel
Description	Weighted average net calorific value of diesel in year y
Source of data	IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Volume 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.
Value(s) applied	0.0381
Measurement methods and procedures	Not Applicable
Monitoring frequency	Any future revision of the IPCC Guidelines should be taken into account

QA/QC procedures	Not Applicable
Purpose of data	Project emissions determination of the amount of diesel (fuel type i) combusted in the project activity in the year *y*.
Additional comment	Applicable where Option B of the "Tool to determine project emissions from fossil fuel combustion" (Version 02.0, Tool 3).

Data/Parameter	$EF_{CO2,diesel,y}$
Data unit	tCO_2/GJ
Description	Weighted average CO_2 emission factor of diesel in year y
Source of data	IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Volume 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.
Value(s) applied	0.0741
Measurement methods and procedures	Not Applicable
Monitoring frequency	Any future revision of the IPCC Guidelines should be taken into account
QA/QC procedures	Not Applicable
Purpose of data	Project emissions determination of the amount of diesel (fuel type i) combusted in the project activity in the year y.
Additional comment	Applicable where Option B of the "Tool to determine project emissions from fossil fuel combustion" (Version 02.0, Tool 3).

Data/Parameter	$F_{CH4,EG,t}$
Data unit	kg
Description	Mass flow of methane in the exhaust gas of the flare on a dry basis at reference conditions in the time period *t*.
Source of data	Measurements undertaken by a third party accredited entity
Value(s) applied	Not available ex ante
Measurement methods and procedures	Measure the mass flow of methane in the exhaust gas according to an appropriate national or international standard e.g. UKs Technical Guidance LFTGN05. The time period t over which the mass flow is measured must be at least one hour. The average flow rate to the flare during the time period *t* must be greater than the average flow rate observed for the previous six months.
Monitoring frequency	Biannual
QA/QC procedures	According to the standard applied.
Purpose of data	Determination of flare efficiency
Additional comment	Monitoring of this parameter is required in the case of enclosed flares and if the project participants select Option B.1 to determine flare efficiency.

Data/Parameter	$T_{EG,m}$
Data unit	°C
Description	Temperature in the exhaust gas of the enclosed flare in minute *m*.
Source of data	Project Participants
Value(s) applied	Not available ex ante
Measurement methods and procedures	Measure the temperature of the exhaust gas in the flare by an appropriate temperature measurement equipment. Measurement outside the operational temperature specified by the manufacturer may indicate that the flare is not functioning correctly and may require maintenance. Flare manufacturers must provide suitable monitoring ports for the monitoring of the temperature of the flare. These would normally be expected to be in the middle third of the flare. Where more than one temperature port is fitted to the flare the flare manufacturer must provide written instructions detailing the conditions under which each location shall be used and the port most suitable for monitoring the operation of the flare according to manufacturer's specifications for temperature.
Monitoring frequency	Once per minute
QA/QC procedures	Temperature measurement equipment should be replaced or calibrated in accordance with their maintenance schedule.
Purpose of data	Determination of flare efficiency
Additional comment	Unexpected changes such as a sudden increase/drop in temperature can occur for different reasons. These events should be noted in the site records along with any corrective action that was implemented to correct the issue. Monitoring of this parameter is applicable in case of enclosed flares. Measurements are required to determine if manufacturer's flare specifications for operating temperature are met.

Data/Parameter	$Maintenance_y$
Data unit	Calendar dates
Description	Maintenance events completed in year *y*.
Source of data	Project Participants
Value(s) applied	Not available ex ante
Measurement methods and procedures	Record the date that maintenance events were completed in year *y*. Records of maintenance logs must include all aspects of the maintenance including the details of the person(s) undertaking the work, parts replaced, or needing to be replaced, source of replacement parts, serial numbers and calibration certificates.
Monitoring frequency	Annual

~~QA/QC procedures~~	~~Records must be kept in a maintenance log for two years beyond the life of the flare.~~
~~Purpose of data~~	~~Determination of flare efficiency.~~
~~Additional comment~~	~~Monitoring of this parameter is required for the case of enclosed flares and the project participant selects Option B to determine the flare efficiency.~~ ~~These dates are required so that they can be compared to the maintenance schedule to check that maintenance events were completed within the minimum time between maintenance events specified by the manufacturer ($SPEC_{flare}$).~~

B.7.2. Sampling plan

>>

None of the data and parameters monitored in section B.7.1.are to be determined by a sampling approach.

B.7.3. Other elements of monitoring plan

>>

The amount of methane will be determined by monitoring the amount of landfill gas, the temperature and pressure of the landfill gas and the percentage methane in the landfill gas.

The regulatory framework will be monitored on an annual basis. In case upcoming regulations in South Africa mandate methane capture and destruction during the crediting period, the baseline scenario and emissions shall be adapted accordingly.

Monitoring as required in terms of the EIA authorisation will also be conducted.

To assure correct monitoring, staff will receive ongoing on-the-job training, including:

- General knowledge of equipment used in the landfill and for landfill gas extraction and monitoring;
- Specialized training with reading and recording data;
- Specialized training regarding calibration of equipment;
- Environmental safety and health, including emergency situations; and
- General CDM understanding

A training-register and an operations and maintenance manual is being kept on-site. The operations and maintenance manual has been developed for the EnviroServ Chloorkop Landfill Gas Recovery Project which is inclusive of environmental safety and health.

This manual includes:

- Detailed information on operations
- As-built drawings
- Maintenance procedures
- Equipment drawings and specifications

- Methodologies for monitoring, maintenance of monitoring equipment, and equipment calibration
- Environmental safety and health guidelines and procedures.

Parameters that will be monitored and the frequency of monitoring are described in section B7.1.

SECTION C. Start date, crediting period type and duration

C.1. Start date of project activity

>>

The start date of the project activity was 01/07/2007, being the earliest date at which construction of the flare and the LFG capture system began.

C.2. Expected operational lifetime of project activity

>>

Landfill gas will be produced at the Site for more than 20 years, and the gas extraction and combustion system will remain in place until no longer required.

C.3. Crediting period of project activity

C.3.1. Type of crediting period

>>

Second renewable crediting period

C.3.2. Start date of crediting period

>>

~~The starting date of the second crediting period will depend on the timing of the approval of the updated project description. The anticipated starting date is~~ 19/01/2015.

C.3.3. Duration of crediting period

>>

7 years (up to 18~~22~~/01/2022)

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>>

There are no transboundary impacts associated with this project as the project is far from any neighbouring country.

Pollution and degradation will be avoided, and the collection and destruction of methane gas will reduce greenhouse gas emissions and reduce the impact of the landfill operation on air quality. This includes odour nuisances, local air pollution, and stratospheric ozone destruction. In addition, labour conditions and safety on the Site will be improved.

The Gauteng Department of Agriculture, Conservation and Environment (GDACE), is the relevant provincial South African authority required an Environmental Impact Assessment (EIA) for this project. As agreed with the authorities at the start of the project, a Scoping Report was prepared with a focus on air quality issues.

D.2. Environmental impact assessment

>>
Although the project is expected to have a net positive impact, the competent authority (GDACE) required that an environmental impact assessment be conducted. A detailed Scoping Report was compiled by Synergistics Environmental Services. The main findings and conclusions were as follows:

Findings:

No fatal flaws or negative impacts of high significance were identified. The scoping assessment concluded that the benefits of the project far outweigh its costs. The overall benefits of the project include:

- *Direct foreign investment in South Africa through the purchase of CERs by an overseas buyer (the JCF).*
- *The recovery and combustion of methane gas that will result in an improvement of air quality and the reduction of greenhouse gas, thus contributing to more sustainable landfill practices.*
- *There will be a reduction in the ozone depletion potential of the waste disposal facility.*
- *The destruction of the trace gases in landfill gas that will contribute to the reduction of local odour nuisances and an improvement of the air quality.*
- *The reduced ozone depletion potentials and global warming potentials will have positive transboundary impacts as these are global phenomena.*
- *Promotion of local economic development through the creation of a new market and/or strengthening the existing market in South Africa for the equipment and materials required by the project (i.e. piping and flares).*
- *Improved protection of the groundwater resource in the vicinity of the waste disposal facility since the gas extraction wells will be equipped for leachate removal.*
- *EnviroServ's site personnel will receive training related to the gas recovery operation, which they would not receive in the absence of the project.*
- *The project will be developed in accordance with the laws and regulations of*

South Africa, which would demonstrate to the overseas emissions trading market that South Africa is a prime destination for further CDM projects, thereby attracting additional and sustainable foreign investment into the country.

- *As a case study, the project may eventually lead to future reductions of greenhouse gas emissions in South Africa through the promotion of future CDM projects.*
- *EnviroServ is committed to investigate the feasibility of future downstream utilisation of the gas or the heat energy generated by the flaring process – this provides the option to create and utilise landfill gas and/or landfill gas energy, which is a renewable source of energy.*
- *EnviroServ is committed to assist with the establishment of a social benefit project.*

Conclusions

The scoping assessment concluded that the project is desirable from an environmental point of view and that it would contribute to sustainable landfill practices.

No information gaps or need for further studies have been identified and, to date, IAPs have not raised any concerns or issues regarding the project. IAPs were provided with the opportunity to review the scoping report (Version 0) for a period of 30 days. No comments were received.

SECTION E. Local stakeholder consultation

E.1. Modalities for local stakeholder consultation

>>

The stakeholder consultation prior to implementation of the project has been sufficient for initial project validation and subsequent registration and is therefore deemed to still be relevant in terms of extension of the crediting period.

Stakeholder consultation to date has included the following: <u>Pilot project (2005):</u>

Letters and the Briefing Paper describing the pilot project and inviting Interested and Affected Parties (I&APs) to become involved were faxed and e-mailed to the Chloorkop Monitoring Committee members and other I&APs on 24 March 2005. The closing date for comments was 19 May 2005.

- The Ekurhuleni Department of Environmental Health sent a letter stating that there was no objection to the project.

- No further comments were received.

The Pilot Project was discussed at the meeting of the Chloorkop Monitoring Committee held on 16 May 2005.

- No comments were raised regarding the landfill gas extraction project.

A meeting to discuss the pilot project and expected future phased of the project was held on 17 November 2005. This included a site visit to the pilot project installation.

- The only comment received was a request to share information about CDM projects for landfills owned by the Local Authority.

Full-scale project:

As part of the EIA process the following public consultation was undertaken:

- Advertising the project in a local newspaper on 2 February 2006, inviting Interested and Affected Parties to register with the public consultation office.
- A briefing document with details regarding the project was distributed to the Chloorkop Monitoring Committee during February 2006 and other registered I&APs on request.
- The draft Scoping Report was made available for a period of 30 days (7 April to 8 May 2006) for comment by stakeholders. The availability of the report was advertised in a local newspaper on 30March 2006 and written notification was sent to the members of the Chloorkop Landfill Monitoring Committee.
- A meeting was held on 18 April 2006 at which the outcome of the impact assessment was discussed. This meeting was advertised in the advertisement placed in the local newspaper on 30 March 2006 and the Monitoring Committee members and registered Interested and Affected Parties were notified by telephone or fax. Only one community member attended the meeting and her main concern was the odours arising from the landfill site and the potential impact of the project on odours.

No written comments were received from the stakeholders on the Scoping Report.

E.2. Summary of comments received

>>
Only one comment was received at the Monitoring Committee meeting held on 18 April 2006. The concern was related to odours from the landfill site

E.3. Consideration of comments received

>>
A detailed air quality assessment was done as part of the Scoping Process of the EIA. Odours are expected to improve as a result of the Chloorkop Landfill Gas Recovery project.

SECTION F. Approval and authorization

>>

The letter of approval was issued on 26/11/2013 by the Department of Energy being the Designated National Authority for the Clean Development Mechanism in South Africa, the Host Country.

Appendix 1. Contact information of project participants

Organization name	EnviroServ Waste Management (Pty) Ltd
Country	South Africa
Address	PO Box 232 Bedfordview, Gauteng Province 2008
Telephone	+27 11 456 5400
Fax	+27 11- 456 54843 9048
E-mail	nvermeulen@enviroserv.co.za
Website	http://www.enviroserv.co.za/
Contact person	Mr Nico Vermeulens Esmé Gombault Group Operations Director +27 82- 653 6903779 6276 +11 456 5400 nvermeulenesmeg@enviroserv.co.za

Appendix 2. Affirmation regarding public funding

Not applicable

Appendix 3. Applicability of methodologies and standardized baselines

Refer to Section B.2. of this PDD.

ENVIROSERV
WASTE MANAGEMENT

27 February 2015

CDM team
UNFCCC Secretariat
(Via email: cdmregistration@unfccc.int)

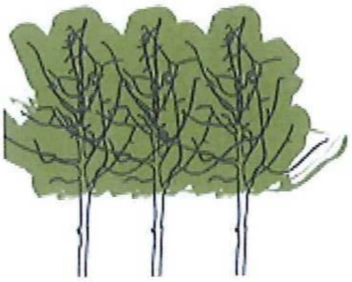
Dear Sir/Madam,

Solid Waste, a division of EnviroServ Waste Management Ltd, wishes to record that the implementation of the "EnviroServ Chloorkop Landfill Gas Recovery Project" did not and will also continue to not imply any change to the waste received at the landfill and therefore has not reduced the amount of organic waste that would have been recycled in the absence of the project activity.

I trust to have informed you sufficiently.

Yours Sincerely,

N Vermeulen
GM - TDS
nvermeulen@enviroserv.co.za



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Appendix 4. Further background information on ex ante calculation of emission reductions

The ex-ante emission reductions calculation is based on data obtained from the project participant on tonnages of waste disposed of at the Chloorkop SWDS, which in turn has been used as input- data for the First Order Model:

General (domestic) waste inputs as follows:

Year	Domestic Waste	Waste Total
1997	16412	16412
1998	137125	137125
1999	198239	198239
2000	312867	312867
2001	338733	338733
2002	327923	327923
2003	317114	317114
2004	279566	349457
2005	344429	430536
2006	344429	430536
2007	344429	430536
2008	344429	430536
2009	344429	430536
2010	344429	430536
2011	344429	430536
2012	344429	430536

Cumulative mass of waste= 4683409.41 tonnes and 4257644.92 m^3

Chloorkop domestic waste was assumed to be 70% from affluent communities and 30% from non-affluent communities. Assumed waste fraction characteristics were as follows [all mass fractions]:

- Affluent domestic waste assumed to be 0.45 putresibles [food, garden, etc.] and 0.25 paper.

  This is based on data from the Benoni area in the Gauteng Province from a study by Shamrock in 1998, which showed that the waste fraction from rich/affluent areas is 0.46 putresibles and 0.24 paper, based on data collected during a comparative study.

- Non-affluent domestic waste assumed to be 0.20 putresibles and 0.05 paper.

  This is based on data from the Wattville area from a study by Shamrock in 1998, which showed the waste fraction from poor/non-affluent residential areas is 0.18 putresibles and 0.04 paper.

{Reference: Shamrock, J.R., 1998, A Comparative Study of the Decomposition Processes and Products of Rich and Poor Refuse in South Africa, M.S. thesis, Faculty of Engineering, University of the Witwatersrand, Johannesburg}.

Appendix 5. Further background information on monitoring plan

The amount of methane will be determined by monitoring the amount of landfill gas, the temperature and pressure of the landfill gas and the percentage methane in the landfill gas.

The regulatory framework will be monitored on an annual basis. Other monitoring as required in terms of the EIA authorisation will also be conducted.

Parameters that will be monitored and the frequency of monitoring are indicated below:

Parameter	Unit	Monitoring frequency	Comment
Amount of landfill gas collected from project wells	m^3	continuous	Measured by a flow meter. Data will be aggregated monthly and yearly
Methane fraction in the landfill gas	% g/m^3	continuous	Measured by continuous gas quality analyser. The % - reading will be calculated to a g/m^3 unit by using the molecular mass of methane and relevant temperature and pressure measurements.
Amount of landfill gas flared	m^3	continuous	Measured by a flow meter. Data will be aggregated monthly and yearly
Combustion efficiency	%	annual	Methane content of flare exhaust gas: The efficiency of the enclosed flare (% of methane completely oxidized by combustion in the flare) will be determined on a yearly basis, with the first measurement to be made at the time of installation. The measured value of the efficiency of the flare shall be applicable for the period up to the next measurement. In case the yearly measurement of efficiency of the flare is not performed, the efficiency of the flare shall be a default value of 90%. If the last measured value of the efficiency of the flare is lower than 90%, then the last lower measured value shall be used.
Combustion efficiency	%	semi-annual, monthly if unstable	Methane content of boiler/engine exhaust gas. Data will be aggregated monthly and yearly
LFG temperature and pressure	°C, Pa	continuous	Thermometer and pressure meter. To monitor the efficiency of the flare. Data will be aggregated monthly and yearly Standard calculations for mass/volume of a given gas at NTP require measurement of gas temperature (in K) and pressure and calculations using standard gas law equations. These measurements and calculations will be performed
Flare working hours	h	continuous	Clock. Data will be aggregated monthly and yearly
Flare temperature	°C	continuous	Thermometer. Data will be aggregated monthly and yearly.

Appendix 6. Summary report of comments received from local stakeholders

~~Document information~~

~~Version~~	~~Date~~	~~Description~~
~~05.0~~	~~25 June 2014~~	~~Revisions to:~~ • ~~Include the Attachment: Instructions for filling out the project design document form for CDM project activities (these instructions supersede the "Guidelines for completing the project design document form" (Version 01.0));~~ • ~~Include provisions related to standardized baselines;~~ • ~~Add contact information on a responsible person(s)/ entity(ies) for the application of the methodology (ies) to the project activity in B.7.4 and Appendix 1;~~ • ~~Change the reference number from *F-CDM-PDD* to *CDM-PDD-FORM;*~~ • ~~Editorial improvement.~~
~~04.1~~	~~11 April 2012~~	~~Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b~~
~~04.0~~	~~13 March 2012~~	~~Revision required to ensure consistency with the "Guidelines for completing the project design document form for CDM project activities" (EB 66, Annex 8).~~
~~03.0~~	~~26 July 2006~~	~~EB 25, Annex 15~~
~~02.0~~	~~14 June 2004~~	~~EB 14, Annex 06b~~
~~01.0~~	~~03 August 2002~~	~~EB 05, Paragraph 12~~ ~~Initial adoption.~~

~~Decision Class: Regulatory~~
~~Document Type: Form~~
~~Business Function: Registration~~
~~Keywords: project activities, project design document~~

Not Applicable

Appendix 7. Summary of post-registration changes

The following post registration changes are applied for proceeding a request for issuance (i.e. along the prior-approval track).

Corrections	
1.	The range of operating temperatures (°C) and gas flow volumes (Nm3/h) in the fixed parameter $Spec_{flare}$ were incorrectly recorded in the registered PDD. The values have been changed accordingly and are aligned with the manufacturer's specifications.
2.	The measurement of gas mass flow and subsequent calculation of volume were incorrectly recorded as being undertaken on a dry basis. The monitored parameters have been revised to reflect gas flow monitoring on a wet basis, by a mass flow meter.
3.	The requirement to overhaul the flare every three years was incorrectly included in the registered PDD in section B.6.1. The manufacturer has confirmed that the decision to overhaul the flare is at the project participant's discretion because the general plant parts and the CDM equipment are fully operational and calibrated as required.
Changes to the project design	
4.	Decrease in capacity (type b change as per § 241 of CDM PS for Project Activities v 02.0): the project participant removed one of two the flares from the emission boundary due to low gas volumes. Flare 2 was decommissioned on 8 June 2019.
5.	Addition of new component (type c change as per § 241 of CDM PS for Project Activities v 02.0): the project participant is investigating offsite electricity generation from the landfill gas and hence this technology component has been added to the project design. The capacity of the generator is expected to be 950 kW and is expected to run for an average of 7210 hours per annum. The project boundary has therefore been expanded to reflect the offsite generation of electricity. The baseline scenario and emissions have also been revised to include electricity generation, which is expected to start in 2020. The standardized baseline for the Southern African Power Pool (ASB0001 v1) is used to calculate the baseline electricity emissions.
6.	Actual operational parameters that are within the control of the project participants, differing from the expected parameters (type h change as per § 241 of CDM PS for Project Activities v 02.0): a. The project participant has moved the flare to a different area of the landfill site to accommodate expansion of the landfill. The flare was officially commissioned in the new location on 9 December 2019. b. A back-up diesel generator has been added in the project boundary. The decision to utilise the back-up diesel generator was motivated by the current programme of electricity load shedding by Eskom, the national electricity utility, which is expected to continue for the next two years.
Permanent changes to the registered monitoring plan The changes to the project design described above will also be reflected in the monitoring plan going forward. In addition to the design changes, the following changes are applied for in terms of the registered monitoring plan:	
7.	The reference to the GIR 5000 gas analyser in section B.6.1 was removed as the gas analyser has been replaced with a Guardian NG Infrared Gas Monitor.
8.	Change the monitoring plan to use the default flare emission value as opposed to biannual sampling for flare efficiency. The use of the default value is preferred as it is considered the more efficient and cost-effective method of monitoring the flare efficiency. The change is also likely to result in fewer emission reductions (due to the

	flare being low height the default efficiency factor will be 80%, which is lower than the expected actual methane destruction efficiency of the flare of 99%, as specified by the manufacturer.
9.	The monitored parameters $M_{t,wb}$ and $v_{k,t,wb}$ were included in the monitoring plan to reflect actual gas monitoring on a wet basis by a mass flow meter.
10.	The monitored parameters $EG_{PJ,y}$, *Tariff of electricity exported*, $EC_{PJ,j,t}$ and $EC_{BL,k,t}$ were included in monitoring plan to accommodate the inclusion of electricity generation in the project design.
11.	The monitored parameters $FC_{i,j,y}$, $NCV_{diesel,y}$ and $EF_{CO2,diesel,y}$ were included in monitoring plan to accommodate the inclusion of project emissions from a back-up diesel generator in the project design.

The impacts of the post registration changes on the CDM project activity are as follows:

Impact categories[8]	**Impact on project activity**
(a) The applicability and application of the applied methodologies, the applied standardized baselines and the other applied methodological regulatory documents with which the project activity has been registered;	All the post registration changes above are within the requirements of the applied methodology, tools, standardized baseline and methodological regulatory documents with which the project activity has been registered.
(b) The compliance of the monitoring plan with the applied methodologies, the applied standardized baselines and the other applied methodological regulatory documents;	The monitoring plan has been revised to reflect post registration changes 1, 2, 4, 5, 7, 8, 9, 10 and 11. These post registration changes comply with the applied methodologies, standardized baselines and the other applied methodological regulatory documents.
(c) The level of accuracy and completeness in the monitoring of the project activity compared with the requirements contained in the registered monitoring plan;	Post registration changes 1, 2, 5, 7, 9, 10 and 11 have increased the level of accuracy and completeness in the monitoring of the project activity, compared with the requirements contained in the registered monitoring plan. Post registration changes 3 and 4 do not impact the accuracy of the monitoring plan. Post registration change 8 provides for a more conservative emission reduction calculation methodology.
(d) The additionality of the project activity;	The project additionality, prior to the post registration changes above, was based on the baseline scenario where all landfill gas was vented

[8] Source: paragraph 242 of the CDM project standard for project activities, Version 02.0.

	to the atmosphere. Hence the project activity was registered using the principle of automatic additionality (as per paragraph 21 of methodology ACM0001, version 15). None of the post registration changes above impact the baseline scenario (venting to atmosphere) and therefore the additionality of the project in this regard is not affected. Post registration change 5 entails the inclusion of an offsite electricity generation component in the project design. The expected electricity generation capacity is 950 kW, which is below 10 MW. Electricity generation below 10 MW also results in automatic additionality, as per paragraph 21 of methodology ACM0001, version 15. Therefore, the inclusion of the electricity generation component (under 10 MW) does not impact the additionality of the project.
(e) The scale of the project activity.	The project was registered as a large scale project. Therefore none of the post registration changes affect the scale of the project activity.

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Document information

Version	*Date*	*Description*
11.0	31 May 2019	Revision to: • Ensure consistency with version 02.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN); • Make editorial improvements.
10.1	28 June 2017	Revision to make editorial improvement.
10.0	7 June 2017	Revision to: • Improve consistency with the “CDM project standard for project activities” and with the PoA-DD and CPA-DD forms; • Make editorial improvement.
09.0	24 May 2017	Revision to: • Ensure consistency with the “CDM project standard for project activities” (CDM-EB93-A04-STAN) (version 01.0); • Incorporate the “Project design document form for small-scale CDM project activities” (CDM-SSC-PDD-FORM); • Make editorial improvement.

Version	*Date*	*Description*
08.0	22 July 2016	EB 90, Annex 1 Revision to include provisions related to automatically additional project activities.
07.0	15 April 2016	Revision to ensure consistency with the “Standard: Applicability of sectoral scopes” (CDM-EB88-A04-STAN) (version 01.0).
06.0	9 March 2015	Revision to: • Include provisions related to statement on erroneous inclusion of a CPA; • Include provisions related to delayed submission of a monitoring plan; • Provisions related to local stakeholder consultation; • Provisions related to the Host Party; • Make editorial improvement.
05.0	25 June 2014	Revision to: • Include the Attachment: Instructions for filling out the project design document form for CDM project activities (these instructions supersede the "Guidelines for completing the project design document form" (Version 01.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for the application of the methodology (ies) to the project activity in B.7.4 and Appendix 1; • Change the reference number from F-CDM-PDD to CDM-PDD-FORM; • Make editorial improvement.
04.1	11 April 2012	Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b.
04.0	13 March 2012	Revision required to ensure consistency with the “Guidelines for completing the project design document form for CDM project activities” (EB 66, Annex 8).
03.0	26 July 2006	EB 25, Annex 15
02.0	14 June 2004	EB 14, Annex 06b
01.0	03 August 2002	EB 05, Paragraph 12 Initial adoption.

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