PROJECT DESIGN DOCUMENT FORM
FOR CDM PROJECT ACTIVITIES (F-CDM-PDD)
Version 04.1

PROJECT DESIGN DOCUMENT (PDD)

Title of the project activity	Rio Grande landfill gas project
Version number of the PDD	Version 4.1[1]
Completion date of the PDD	19/06/2013
Project participant(s)	Rio Grande Ambiental S.A. Solvi Participações S.A.
Host Party(ies)	Brazil
Sectoral scope and selected methodology(ies)	CDM Sectoral Scope 13 – Waste handling and disposal. ACM0001 – Flaring or use of landfill gas (Version 13.0.0)
Estimated amount of annual average GHG emission reductions	11,436 tCO_2e

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[1] The only differences between this revised version of the PDD and its previous version (PDD version 4.0) are the following:

- Section B.2 includes additional explanations and details on how the proposed CDM project activity meets specific applicability condition for ACM0001 (version 13) regarding non-promotion by the proposed CDM project activity (under the project scenario) of any negative change (reduction) in the quantity of organic fraction of municipal solid waste (MSW) that would eventually be recycled in the absence of the project activity (under the baseline scenario) in area of influence of the landfill where the project activity is to be implemented.
- Section F includes updated information about authorization and approval status for the project activity by the Designated National Authority (DNA) of host and only Party for the project activity. Reference to the Letter of Approval (LoA) issued for the project activity by the DNA of Brazil was added. In addition, clarification about the validity of such earlier issued LoA is also added by taking into account that the issued LoA includes a disclaimer in its text highlighting that it is valid only for the previous version of the PDD (version 4.0 from 28/11/2012).

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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The “Rio Grande landfill gas project” encompasses the construction and operation of a completely new active (forced) landfill gas (LFG) collection and destruction system at the Rio Grande landfill, which is an existing landfill, located in the city of Rio Grande in the State of Rio Grande do Sul (Southern Region of Brazil).

The project will encompass collection of LFG using vertical LFG collecting wells and/or horizontal LFG collection trenches, which will be interconnected through a LFG pipeline network (made of High Density Polyethylene (HDPE) pipes, manifolds and connecting parts). Through the LFG pipeline network, all collected LFG will be directed to a LFG destruction facility where all collected LFG will be combusted in enclosed high temperature flare(s) [2].

The Rio Grande landfill started its Municipal Solid Waste (MSW) disposal operations in November 2009. The project activity which encompass collection and destruction of LFG generated from the decomposition of MSW disposed in this landfill, is expected to be implemented around July 2013[3]

After the successful implementation of the project activity and its operation during a certain period as a LFG collection and destruction initiative (period sufficient enough to confirm the quantity and quality of collected LFG[4]), the project design may be changed from a LFG collection and destruction project-based initiative to a full LFG collection and destruction/utilization project. Under such eventually modified project design configuration, LFG may be utilized as fuel for electricity generation in a new electricity generation facility to be eventually built by the project participant as part of the project activity[5]. If the

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[2] The number of high temperature flares and other specification details of the project activity will only be defined as a result of the project's complete dimensioning and engineering phase. This phase is expected to start right after the registration of the “Rio Grande landfill gas project” as a CDM project activity by UNFCCC.

[3] The project activity is expected to start its operations at least six months after the expected registration of the “Rio Grande landfill gas project” as a CDM project activity by UNFCCC.

[4] The period which is sufficient enough to confirm the quantity and quality of collected LFG stream is not expected to be shorter than at least one year.

[5] ACM0001 (version 13.0.0) establishes that “*(...) If during the project activity the project participant wishes to change the use of the captured LFG, for instance from flaring to energy generation, then the latest version of the Procedures for notifying and requesting approval of changes from the project activity as described in the registered Project Design Document must be applied*”. So far, there is no permanent decision taken for implementing any LFG utilization solution as part of the project activity. Any decision involving utilization of LFG as fuel for electricity generation will depend inter alia on confirmation of the quantitative and qualitative specifications of LFG to be collected as part of the operation of the project activity after its implementation (e.g: most of the manufacturers of engine-generator sets fuelled by LFG specify requirements in terms of the quality of LFG: incl. inter alia minimum CH_4 content, maximum amount of furanes and siloxanes and other components in LFG, etc). The Rio Grande landfill started receiving MSW in November 2009. Although, it is planned that the Rio Grande landfill will incorporate best practice solutions in terms of design and operation of landfills, the current lack of experience about the operation of this landfill strongly increases all uncertainties related to the quality and quantity of LFG to be generated and collected as part of the project activity.
If implemented, the electricity generation system may also include a LFG pre-treatment system (in order to dry and clean LFG if it be found as required based on evaluations of LFG to be performed in the future). The eventually modified project design will be addressed after the CDM registration of the Rio Grande landfill gas project by applying the applicable CDM procedures for addressing permanent post-registration changes to the project design of a registered CDM project activity.

project design is later confirmed to be modified, the project's enclosed high temperature flare(s) may be used for the combustion of LFG under temporarily circumstances where utilization of collected LFG for electricity generation is not possible (e.g. maintenance and repair events in related equipment, non-availability of transmission lines, etc).

The Rio Grande landfill is currently licensed for a total MSW disposal area of about 79,091 m^2 (7.91 ha). About 180 t of MSW are daily disposed at the Rio Grande landfill, which serves as a disposition site for MSW generated in the city of Rio Grande, and eventually other nearby cities in the future. The As per currently available MSW disposal forecasts from Rio Grande Ambiental S.A. for this landfill, the expected technical operational lifetime for the Rio Grande landfill is about 25 years (when considering an initial MSW disposal rate of 180 t per day and a forecasted annual growth in the MSW disposal rate of about 2%)[6].

Equipment to be installed under the proposed project activity includes a complete LFG collection network (comprising vertical LFG collection wells and eventually horizontal LFG collection trenches), a LFG destruction station by flaring (comprising enclosed high temperature flare(s) and all required monitoring and control systems).

The scenario existing prior to the implementation of the project activity represents the current situation for LFG management in the Rio Grande landfill and also several other existent landfills or landfills under construction in Brazil (with exception of the ones with active LFG collection and destruction/utilization systems under operation and registered as CDM project activities): LFG (with high content of methane) being freely emitted into the atmosphere without any treatment, collection, combustion or control (baseline scenario). Thus, the baseline scenario is the same as the scenario prior to the implementation of the project activity.

While methane is a powerful greenhouse gas (GHG), the baseline situation encompassing fugitive emissions of LFG into the atmosphere (in a quantity to be equal to the amount of LFG actually collected by the project activity[7]) contributes to global warming. Furthermore, free and uncontrolled emissions of methane through the landfill surface also create potential risks of fire, explosion as well as bad odors.

The collection and destruction of LFG through an active (forced) LFG collection and flaring system greatly reduces such risks and also contribute to reduce GHG emissions. It is estimated that the project activity will promote average annual emissions reductions of about 11,436 tCO_2e per year over the selected 7-year renewable crediting period.

Besides climate change mitigation, the project activity is also expected to promote important local environmental benefits. LFG contains trace amounts of volatile organic compounds, which are local air pollutants. Capturing of LFG using an active (forced) collection system and its controlled combustion (by flaring) greatly reduces such emissions, thereby contributing towards sustainable development.

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[6] As typical in other landfills in Brazil, apart of the forecasted annual growth of 2% in the MSW disposal rate, the MSW disposal rate at the Rio Grande landfill can eventually be additionally changed after the starting of operations of the landfill. Changes in MSW disposal rate depends on local public waste management policies (definition of MSW disposal sites by municipalities located in regions nearby the landfill). The 180 t of MSW per day rate (with 2% annual increment) reflects current projections of Rio Grande Ambiental S.A.

[7] While the LFG collection efficiency of the project is expected to be lower than 100%, fugitive emissions of LFG into the atmosphere are obviously also expected to occur in the project scenario (but in a reduced magnitude). As per ACM0001 (version 13.0.0), emission reductions are determined by assuming as baseline emissions the quantity of LFG actually collected and destroyed (by combustion) by the project activity minus the share of collected LFG which is assumed as destroyed by the conventional passive LFG venting/combustion drains in the absence of the project (baseline scenario).

Furthermore, the implementation and operation of the project activity will also provide strong reduction of LFG odors at the landfill and nearby regions.

As a summary, the project provides the following additional important local environmental and social benefits, thus contributing towards sustainable development in Brazil:

- Reduction in emissions of other air pollutants such as hydrogen sulphide (that is present in trace quantities in LFG).
- Reduction of risk of occurrence of fire and/or explosions at the landfill due to improved LFG management.
- Reduction of odors at the landfill and nearby regions.
- Local job opportunities

Besides, the project activity will be able to be used as a technological demonstration initiative in terms of appropriate and environment-friendlier management of LFG as part of operation of a landfill. It is the intention of the project participant to eventually establish cooperation agreements with local NGOs, academia and community in order to demonstrate and promote this type of projects in other landfills in Brazil.

It is important to note that all initiatives encompassing LFG collection and destruction which are currently implemented (or under implementation) in the host country Brazil are project-based initiatives registered or under registration under the CDM. As one of the positive outcomes of the CDM in Brazil, significant local development in terms of technology and competence in the area of LFG collection and destruction/utilization has been transferred to the country during the latest years. While in a typical LFG collection and destruction/utilization project most of equipment are still being imported, more and more related equipment are being manufactured in Brazil: high temperature enclosed flares; HDPE pipes and manifolds; valves; flow meters; sensors, electronics, etc. Moreover, more and more local competence in LFG management is available: growing number of Brazilian experts and professionals with knowledge in design and operation of LFG collection and destruction initiatives. The role CDM has played in related technology transfer to Brazil is instrumental.

A.2. Location of project activity

A.2.1. Host Party(ies)

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Brazil

A.2.2. Region/State/Province etc.

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State of Rio Grande do Sul

A.2.3. City/Town/Community etc.

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Rio Grande

A.2.4. Physical/Geographical location

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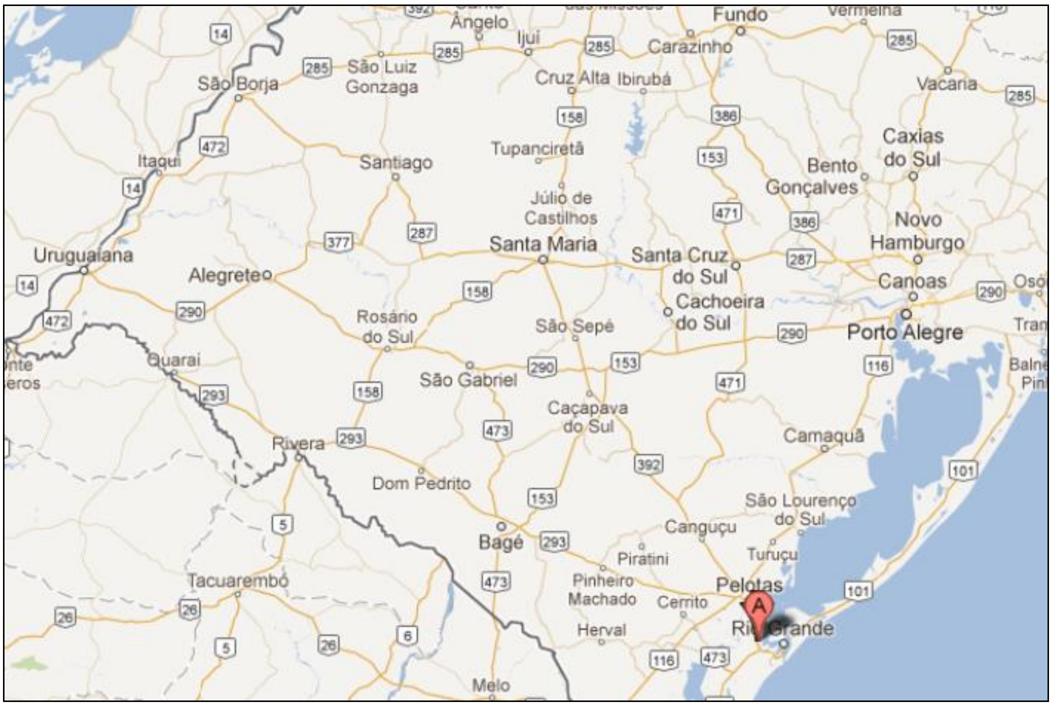
The project activity will be implemented in the Rio Grande landfill, which is located at the following address:

BR 392, km 32
Vila da Quinta
Rio Grande - RS

Project's location in Brazil



Project’s location in Rio Grande do Sul State

Project’s location in the municipality of Rio Grande

The project geographical coordinates are as follows:

Longitude:	-52.2911111 W (52º 17' 28" W)
Latitude:	-32.0288888 S (31º 01' 44" S)

A.3. Technologies and/or measures

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The “Rio Grande landfill gas project” represents a project activity being proposed under CDM’s Sectoral Scope 13 – Waste handling and disposal.

The scenario in the absence of the project at the Rio Grande landfill (baseline scenario) represents the current existing scenario at the landfill: the non-existence of appropriate equipment, procedure and practice which would allow LFG collection and its destruction by combustion at the landfill site. In the absence of the project, existing LFG venting/combustion drains would continue to be implemented only to allow passive venting of LFG (without combustion) in order to avoid significant LFG gas accumulation inside the landfill (thus reducing risks of fire and explosions) and also address odor. Use of passive conventional LFG venting/combustion drains (with no continuous combustion of LFG) is the current practice in most of the landfills in Brazil (landfills without active (forced) LFG collection and destruction systems)[8].

The main GHG emissions source in the baseline is methane, and these emissions will be mitigated by the project activity.

Along the 7-year renewable crediting period, it is assumed that in the baseline scenario (absence of the proposed project activity), the landfill site would continue to have no proper equipment, procedure, and practice for promoting effective LFG collection and destruction. Currently, there is no legal regional or national requirement in Brazil which would oblige LFG to be effectively collected and destroyed in landfills in Brazil. Currently there are no legal municipal, state or national requirements in Rio Grande, Rio Grande do Sul State and Brazil respectively that establish any management of LFG in new or existing landfills or waste dumpsites. Whenever new related legal requirement is implemented, the baseline scenario may be re-evaluated as required by applicable CDM rules upon at the time of confirmation of the practical impact of a new related legal requirement.

The baseline scenario is thus the continuation of current practice (no effective LFG collection and destruction at the Rio Grande landfill, with only a very small fraction of generated LFG being combusted in existing conventional and passive LFG venting/combustion drains (and additional new LFG venting/combustion drains that would otherwise occur as part of the expected expansion of the landfill). The baseline scenario is thus identical to the scenario existing prior to the implementation of the project activity.

The current and forecasted design and management of the Rio Grande landfill will not change as a result of the implementation of the project activity. No practice to increase methane generation has been occurring prior to the implementation of the project activity and will occur after its implementation. Any change in management or operation of the Rio Grande landfill after the implementation of the project

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[8] In all landfills in Brazil where active (forced) LFG collection and destruction /utilization solutions are existent, such initiatives are implemented as project activities registered (or under registration) as CDM project activities. In May 2012, there were 27 registered LFG collection and destruction/utilization project activities in Brazil (+ 10 under validation status). Source: UNEP/RisØ. In landfills without active (forced) LFG collection and destruction/utilization, the common practice is the use of passive (conventional) LFG flares and/or conventional LFG venting/combustion drains for safety reasons or eventually to address odor concerns (combustion of a share of LFG). The use of passive (conventional) LFG flares or conventional LFG venting/combustion drains depends on aspects such as design of the landfill, design and dimensions of the MSW disposal cells, pressure of LFG, overall management of the landfill, climate conditions (e.g winds, rain pattern, etc).

activity will be reported and will be justified by referring to applicable technical or regulatory specifications.

The project activity encompasses the implementation of an advanced active forced LFG collection and flaring system. Equipment to be installed as part of the project activity includes:

- Construction of new vertical LFG collecting wells and/or new horizontal LFG collecting trenches[9].
- LFG collection pipeline network, with HDPE pipes;
- High temperature enclosed flare(s)[10];
- Monitoring and control systems to measure the flow and composition of collected LFG and eventually equipment to measure the composition of exhaust gas of the flare(s) in terms of residual oxygen and methane. The monitoring equipments will be located along the pipeline that directs collected LFG to the project's enclosed high temperature flare(s).

The operation of the project activity will consist on collecting LFG in a forced manner (with the use of blower(s)) and direct collected LFG to combustion (in high temperature flare(s)). Such measures will enable methane contained in the LFG to be destroyed through combustion, thus promoting GHG emission reductions through abatement of methane.

The project system is expected to be equipped with all needed monitoring system which are required to measure all associated monitoring parameters (LFG mass flow, methane concentration in collected LFG, LFG pressure, LFG temperature, etc.) in order to meet not only the requirements of the baseline and monitoring methodology ACM0001 (version 13.0.0) and applicable methodological tools (this CDM baseline and monitoring methodology refers to), but also for meeting applicable safety and operational requirements.

The adopted LFG collection and destruction technological concept is environmentally safe and sound. While most of operation and monitoring equipment to be installed as part of the implementation of the project may be imported material, some relevant local content in terms of equipment are expected to be installed. Significant expertise and competence in LFG management & design and operation of LFG collection and destruction system are currently available in Brazil.

The expected operational lifetime for the LFG flaring system is at least 25 years. No technology substitution is expected to occur during the 7-year renewable crediting period if adequate maintenance

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[9] The initial number of vertical LFG collecting wells and/or horizontal LFG collection trenches will be only defined during the complete project engineering and/or start of construction of the project. New vertical LFG well can be built via perforation of the well + implementation with well head (with appropriate connection, valve and control) or via conversion of existing passive (conventional) LFG venting/combustion drains (and additional units that would otherwise be implemented in the absence of the project) into appropriate LFG collecting wells. As typical in LFG collection and destruction/utilization projects, the number of wells and/or trenches may increase along the project operational life time. It is also expected that as part of the normal operation of the landfill and also as part of the normal operation of the project activity, some of the LFG extracting wells will be often temporarily disconnected from the project's LFG collection pipeline in order to facilitate activities of MSW disposal and compacting (allowing transit of machinery (wheel loaders and excavators) and trucks) as part of the normal operations of the Rio Grande landfill. Furthermore, as also typical in LFG collection and destruction/utilization projects, it is also expected that some of the LFG extracting wells will be often temporarily disconnected from the LFG collection pipeline in order to allow repair and maintenance related services in the project's LFG pipeline and LFG wells network (welding services, repositioning of the LFG pipeline, maintenance in the head of the LFG wells, etc).

[10] The number of flares and their specifications (in terms of design and LFG combustion capacities) will only be defined as part of the complete project engineering and/or start of construction of the project which will only occur after successful registration of the Rio Grande landfill gas project as a CDM project activity by the UNFCCC's CDM Executive Board.

service is executed and if project’s equipment operates in accordance with recommendations and technical requirements as established by the equipment manufacturers.

A.4. Parties and project participants

Party involved (host) indicates a host Party	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Brazil (host)	Rio Grande Ambiental S.A. Solvi Participações S.A.	No

A.5. Public funding of project activity

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The implementation and operation of the project activity do not involve any public funding from Parties included in Annex 1.

SECTION B. Application of selected approved baseline and monitoring methodology

B.1. Reference of methodology

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The following CDM baseline and monitoring methodology is applied:

- Consolidated baseline and monitoring CDM methodology ACM0001 - “Flaring or use of Landfill Gas” (version 13.0.0) (http://cdm.unfccc.int/methodologies/DB/EYUD9R1ZAUZ2XNZXD3HQH18OK3VWIV);

The following methodological tools are also applied:

- Combined tool to identify the baseline scenario and demonstrate additionality (version 04.0.0, EB 66) (http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-02-v4.0.0.pdf);

- Emissions from solid waste disposal sites (version 06.0.1, EB66) (http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-04-v6.0.1.pdf);

- Tool to calculate baseline, project and/or leakage emissions from electricity consumption (version 1, EB39) (http://cdm.unfccc.int/Reference/tools/ls/meth_tool05_v01.pdf);

- Tool to determine project emissions from flaring gases containing methane (version 1, EB 28) (http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-06-v1.pdf);

- Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 02.0.0, EB 61) (http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-08-v2.0.0.pdf);

- Tool to calculate the emission factor for an electricity system (version 02.2.1, EB 63) (http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v2.2.1.pdf);

B.2. Applicability of methodology

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The following tables justify and demonstrate how the applicability conditions for the Consolidated baseline and monitoring CDM methodology ACM0001 - “Flaring or use of Landfill Gas” (version 13.0.0) and applied methodological tools are met.

Applicability condition of ACM0001 (version 13.0.0)	Justification
“This methodology is applicable to project activities which: (a) *Install a new LFG capture system in a new or existing SWDS; or* (b) *Make an investment into an existing LFG capture system to increase the recovery rate or change the use of the captured LFG, provided that:* (i) *The captured LFG was vented or flared and not used prior to the implementation of the project activity; and* (ii) *In the case of an existing active LFG capture system for which the amount of LFG can not 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.* (c) *Flare the LFG and/or use the captured LFG in any (combination) of the following ways:* (i) *Generating electricity;* (ii) *Generating heat in a boiler, air heater or kiln (brick firing only) or glass melting furnace; and/or* (iii) *Supplying the LFG to consumers through a natural gas distribution network.* (d) *Do not reduce the amount of organic waste that would be recycled in the absence of the project activity.”*	The project activity encompasses the installation of a new active (forced) LFG collection and destruction system in a new landfill that will displace the currently existing passive (conventional) LFG venting/combustion drains (and the expansion of this conventional system that would otherwise occur). The project thus complies with option (*b*-*i*)[11]. No active (forced) LFG capture and flaring system would be installed in the absence of the project. In the absence of the project, the existing conventional passive LFG venting/combustion drains would keep operating (and this system would expand (additional passive LFG venting/combustion drains would be implemented) within the forecasted expansion of the landfill area). All LFG collected by the project activity will be combusted in enclosed high temperature flare(s). No utilization of LFG is currently expected to occur. Thus, condition (c) is met (flare). As a result of the implementation of the project, it is not expected to occur (under the project scenario) any quantitative, qualitative, procedural or regulatory change in

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[11] As per ACM0001 (version 13.0.0) SWDS is an abbreviation for Solid Waste Disposal Site. In the context of the project activity, the landfill site is the SWDS.

Applicability condition of ACM0001 (version 13.0.0)	Justification
	terms of MSW management activities and policies valid for the Rio Grande landfill or applicable in any other potential waste treatment or disposal facility under the area of influence of this landfill (that would be promoted or triggered by the project activity) in comparison with what would occur in the absence of the project activity (baseline scenario). It is crucial to note that, mainly by taking into consideration the nature of the project activity and aspects related to recycling of organic fraction of MSW in the region of landfill and in the rest of Brazil, the implementation and operation of the project activity per se are not expected to promote any quantitative change in waste disposal activities to be undertaken at the Rio Grande landfill. Furthermore, no quantitative or qualitative changes in terms of waste management practices are expected to occur in any other existent or potential waste disposal or waste treatment facility (located or to be located in the region of the project site) as a direct outcome or consequence of the implementation of the project activity. Thus, the mere implementation of the project and its continuous operation are not expected to promote or trigger any reduction (or prevention) of the amount of organic type of MSW that would eventually be recycled or utilized in the region (e.g. prevention of implementation or reduction of activity in a waste composting facility that would promote utilization/recycling of waste in the region for example). As demonstrated in its construction and design documentation, the Rio Grande landfill per se is not expected to include any activity or initiative promoting recycling or utilization of organic fraction of waste to be disposed (such as

Applicability condition of ACM0001 (version 13.0.0)	Justification
	implementation of any waste sorting or waste composting facility). The design and operation of the Rio Grande landfill was planned in accordance with the commercial agreements that the project participant Rio Grande Ambiental S.A. currently holds and is expected to hold in the position of operator and owner of the Rio Grande landfill and regional waste management company (service provider) providing MSW disposal services for the city of Rio Grande (and eventually other nearby cities in the future). Furthermore, it is also crucial to take into account that currently there is not even any existent or planned large scale MSW sorting, recycling or utilization facility for organic fraction of MSW (e.g. a waste composting plant) located in the region of influence of the Rio Grande landfill. As a matter of fact, recycling and utilization of organic fraction of MSW is not a common practice in the whole country of Brazil. In this sense, the implementation and operation of the project activity thus do not represent any perverse incentive or driver for the promotion of any quantitative or qualitative reduction or prevention of recycling related activities or initiatives for any type of organic fraction of waste or residue that would occur in the absence of the project activity[12]. The

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[12] As per the Brazilian Federal Law 12.305/10, recycling is defined as a process of transformation of waste material and residues through promotion of changes in their physical, chemical or biological properties in order to allow and promote use of such materials as raw material or even as new products. Although recycling is being regarded in the national sector directives for waste management as a priority goal, solid waste recycling initiatives in Brazil are still being quite limited (especially in the case of organic fraction of MSW). As outlined in the publication "*Panorama dos Resíduos Sólidos no Brasil – 2012*" (tittle translated into English language as
"*Outlook of Solid Waste Sector in Brazil – year 2012"* and available online at:
http://www.abrelpe.org.br/Panorama/panorama2012.pdf), solid waste recycling initiatives in Brazil have encompassed mainly the following by-products/waste types with higher economic value: aluminum (mainly beverage aluminum cans), pre-separated/sorted clean (not contaminated) paper, pre-separated/sorted (not contaminated) plastic material (mainly PET beverage bottles) and glass material.

The “*Panorama dos Resíduos Sólidos no Brasil*” is a publication annually published by the *Associação Brasileira de Empresas de Limpeza Pública e Resíduos Especiais – ABRELPE* (translated into English language as “*Brazilian Association for Municipal Solid Waste and Special Waste*”) and represents one of the most credible annual outlook and statistics source for the solid waste management in Brazil. The most recent Greenhouse Gases Emissions National Inventory (published by the Brazilian Ministry of Technology and Science in 2010 and available online at: http://www.mct.gov.br/upd_blob/0213/213909.pdf) also confirms that non-conventional MSW treatment alternatives (such as composting of organic fraction of MSW and waste incineration) are not meaningful practices in Brazil (including the region where the project activity is to be implemented).

In year 2012 the Brazilian Ministry of City Infrastructure (through its National Secretary of Sanitation) has published the year 2010 edition of a very comprehensive and detailed sectoral analysis/diagnostic about the whole MSW sector in Brazil: the publication “*Diagnóstico do Manejo de Resíduos Sólidos Urbanos – 2010*” (tittle translated into English language as “*Diagnostics of Urban Solid Waste Management - 2010*” and available online at: http://www.snis.gov.br/PaginaCarrega.php?EWRErterterTERTer=93). Like the Report “*Panorama dos Resíduos Sólidos no Brasil – 2012*”, this Government official publication also includes relevant and detailed statistics for MSW management for the main municipalities, States and regions in Brazil.

Available statistics includes prevailing practices in terms of waste management practices (collection, disposal and re-use/recycle).

In the particular case of the region under potential influence of the Rio Grande landfill (city of Rio Grande and surrounding cities), all solid waste materials (organic or inert) to be eventually/potentially recycled are previously sorted (prior to be mixed with other types of MSW to be disposed in any landfill or dumpsite in the region). In the particular case of recycling of organic fraction of waste material to be disposed in landfills or dump sites, the current status quo is also expected to be the prevailing situation valid in the future: paper waste streams (mixed with other MSW types), food residues, textile, wood waste etc. when ready to be disposed in landfills/dump sites or already disposed in a particular landfill or dump site) are not even regarded as recyclable material (and thus not even accounted in the available statistics for recyclable material). Under the category “organic MSW fraction” only clean (not contaminated) and previously sorted pulp/paper/cardboard waste materials has been considered as recyclable material (as per both available statistics and available recycling practices). Besides some particular inert waste materials with commercial value (e.g. aluminum, clean plastic material and glass), no other waste materials have been collected in order to be recycled in the region where the project activity is implemented or transported to be recycled in other region. This has also been the common recycling scenario in other regions of Brazil. Thus, in the particular case of the Rio Grande landfill, both under the baseline and project scenarios (with or without the implementation of the project activity), no organic fraction of waste stream that would be ready to be directed to this landfill is expected to be collected and directed to any type of recycling facility (e.g. composting facility) after or prior its disposal in the landfill site. In fact, as established by related construction and design documents for the Rio Grande landfill and also established in the Environmental Impact Assessment (EIA) earlier developed for this landfill site, no waste pickers or waste sorting teams are expected to operate in the landfill area. No composting plant for organic waste (or any other type of alternative management for MSW organic content) is currently expected to be implemented in the area either. That confirms that no sorting and collection of recyclable organic material from MSW already disposed in the landfill are expected to occur regardless of the implementation of the project activity (under both baseline and project scenarios). Thus, recycling or alternative use from organic fraction of waste already disposed in the landfill are not expected to occur either regardless of the implementation of the project activity.

Based on information and data included in the “*Diagnóstico do Manejo de Resíduos Sólidos Urbanos – 2010*”; information and data available in the “*Panorama dos Resíduos Sólidos no Brasil – 2012*” and also based on common practice for waste collection, disposal e recycling in the region of the project activity and other regions in Brazil, and the local situation at the region of the project site, the following assertions are valid for the potential of recycling of organic fraction of MSW in the region of influence of the Rio Grande landfill:

- The current MSW management practice in Brazil (and its trend for the future) represents disposal of collected MSW in landfills and open dump sites. This practice currently represents almost all of MSW management for all stream of MSW which is actually collected (in mass basis); with very reduced share of collected MSW in Brazil being treated under non-conventional methods such as waste incineration (0.03%) and composting (0.11%) (in mass basis) as per data of year 2010 (data organized and published in year 2012).
- It is important to note that in all regions in Brazil with existing MSW disposal activities using landfilling techniques (in landfill or dump sites) significant quality improvements in MSW disposal services are still required for the cases where waste is disposed in dump sites and not well designed/managed landfills (e.g. construction of better designed landfills and use of appropriated technics for waste compacting and covering, etc.) In this sense, the Rio Grande landfill represents a very well designed and managed landfill. The main barrier for improving MSW management in Brazil is still being lack of capital and investment capacity from municipalities to face high associated costs for implementing environmentally friendly MSW management operations. Under the region of influence of the Rio Grande landfill, all organic fraction of

waste material which is collected as MSW and is to be directed to landfills (100%) has been historically disposed by applying landfilling and uncontrolled "waste dump" techniques.

- In all geographical regions in Brazil, relative low share of previously sorted pulp/paper/cardboard (clean and not contaminated) waste materials have been used as recycling material in the region. Materials under such conditions are termed in the available statistics as "dry recyclable material" and are not mixed with MSW stream to be sent to landfills or dump sites. It is important to note that the initiatives and businesses involving recycling of previously sorted dry pulp/paper/cardboard materials (clean and not contaminated materials) have their particular dynamics and characteristics and with not so detailed statistics in some cases. However, under no circumstance such activities are to be affected or even influenced by change, improvements or aspects related to MSW disposal activities employing good landfilling technics (for example: in most of the well managed landfills in Brazil, the landfill area is located in a closed area without waste pickers collecting waste from the landfill as a way or living). By taking into consideration the dynamics of initiatives promoting recycling of paper material, it is correct to assume that, differently than for MSW disposal activities; policies, planning and practices related to MSW collection and sorting could indeed under a certain limit play a role such initiatives.
- By merely promoting efficient collection and destruction of LFG in a landfill (where LFG is generated due to anaerobic degradation of organic fraction of MSW which is to be disposed in the landfill under the framework of contracts for MSW disposal signed with municipalities in the region), the implementation of the project activity clearly does not represent any driver or incentive to promote any change in the MSW management situation in the region where it is to be implemented (including waste recycling practices or initiatives for organic content of MSW to be disposed in landfills or dump sites).

By taking into account (i) the institutional and regulatory framework for the public service of MSW management; (ii) the dynamics of MSW sector in the region where the project activity is to be implemented and in Brazil, and (iii) magnitude of average costs for existing MSW management options (which could be regarded as alternatives to disposal of MSW in landfills (e.g. employment of MSW composting techniques)), the available related statistics, the following aspects are to be noted:

- it is clear that actions related to promotion or even disincentive of recycling of organic fraction of MSW are not waste policy aspects that would be under any influence or willingness of the project participant Rio Grande Ambiental S.A. (owner and operator of the Rio Grande landfill). Aspects and actions related to promotion of any increase or even reduction of recycling of organic fraction of waste (and/or recycling of any other type of waste material) in the region where the project activity is to be implemented, are to be seen as dependent on public service policies (including policies, laws, regulations and programmes) to be set by competent governmental authorities (under a regional and national level) and by practitioners of recycling. In Brazil, the administrations of municipalities are responsible for addressing all MSW management services. This is the case also in the region of the project site. Waste collection and disposal services are normally performed by the municipality or are performed by private companies hired and paid by one or more municipalities (under contractual commercial agreements for provision of public service on behalf of such municipality(ies)) for the provision of MSW collection and MSW disposal services by following directives and requirements established in such contracts. In this context, both under the baseline and project scenarios (with or without the implementation of the project activity), Rio Grande Ambiental S.A. is not in a position to plan the implementation of any initiative promoting recycling or use of organic waste (e.g. waste composting plant) at the Rio Grande landfill or at other location in the region.
- The implementation of the project-based initiative promoting collection of LFG and its destruction in high temperature flares in the Rio Grande landfill *per se* would not trigger any change in the regional policies and practices for MSW management in the region or outside its region of influence either. As further discussed in Section B.6.1, so far, there is still no legal restriction neither requirement for LFG gas collection and its destruction using high temperature enclosed flares in Brazil. Moreover, there is still no legal restriction neither requirement for passive venting of LFG or its combustion in conventional LFG destruction systems either. Actually, there is no applicable regulation that deals with LFG management in Brazil. Thus, the implementation of more appropriate and environmentally safe management of LFG at the Rio Grande landfill as part of the project Rio Grande landfill thus displacing or preventing such waste stream from being treated under an existent or potential (hypothetical) MSW recycling/utilization facilities (e.g. a hypothetical waste composting plant) instead.

In summary, by taking into consideration the nature of project activity and all aspects and information above-presented, the project activity does not pose any risk or potential to promote any relative decrease of the amount of organic fraction of MSW that would be otherwise recycled or utilized or prevention of any mean of waste recycling or utilization.

Applicability condition of ACM0001 (version 13.0.0)	Justification
	same is also applicable for recycling of inert waste material. Furthermore, regardless of the non-existence of any MSW recycling or utilization facility that could eventually somehow compete with the Rio Grande landfill for organic fraction of MSW waste, aspects and actions related to promotion of recycling or utilization of organic fraction of waste are to be seen as dependent on public service policies (including policies, laws, regulations and programmes) and defined/triggered by competent governmental authorities (under a regional and national level) and eventually implemented/operated by practitioners of waste recycling. In Brazil, the administrations of municipalities are the entities responsible for addressing all MSW management services. Waste management companies such as Rio Grande Ambiental S.A. normally acts as mere service providers, providing MSW collection and/or MSW disposal services as per directives and contractual requirements set by the municipalities from where MSW are managed. In this sense, as a MSW management company implementing a LFG collection and destruction system in the landfill it operates, Rio Grande Ambiental S.A. is not under position to trigger any promotion of reduction or prevention of organic waste recycling in the region. Finally, the implementation of the project activity does not represent any incentive or driver for the municipality, any other public entity or any other relevant recycling practitioner (if existent) to promote any change in the policy and practice of recycling of inert or organic waste in the region or even outside the region of influence of the Rio Grande landfill. As outlined in Section B.6.1, so far, there is still no

Applicability condition of ACM0001 (version 13.0.0)	Justification
	legal restriction or requirement for LFG gas collection and its destruction or utilization using high temperature enclosed flares or any other device/equipment in Brazil. Moreover, there is still no legal restriction neither requirement for passive venting of LFG or its combustion in conventional LFG destruction systems either (where venting/combustion of LFG in conventional drains is identified as the baseline scenario for the project activity). Actually, there is no applicable regulation that deals with LFG management in Brazil at all. Thus, the implementation of more appropriate and environmentally safe management of LFG at the Rio Grande landfill as an outcome of the project activity does not represent any driver or incentive to dispose incremental amount of MSW in the Rio Grande landfill (when compared to the situation in the absence of the project). In this sense, under no circumstance the project activity would not *per se* potentially promote any displacement of volumes of organic waste stream from eventual treatments/utilization in an existent or hypothetical MSW recycling/utilization facilities (e.g. a MSW composting plant for example) (which in the particular region is not even existent) to be disposed at the Rio Grande landfill because of the implementation and continuous operation of the project activity. Therefore condition (d) is also satisfied.
"*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) Release of LFG from the SWDS; and* *(b) In the case that the LFG is used in the project activity for generating electricity and/or generating heat in a*	As further demonstrated in Section B.4, the most plausible baseline scenario is the uncontrolled release of the LFG from the SWDS into the atmosphere (with a very small share of generated LFG being combusted in the existing passive

Applicability condition of ACM0001 (version 13.0.0)	Justification
boiler, air heater, glass melting furnace or kiln; *(i) For electricity generation: that electricity would be generated in the grid or in captive fossil fuel fired power plants; and/or* (ii) *For heat generation: that heat would be generated using fossil fuels in equipment located within the project boundary.*”	(conventional) LFG venting/combustion drains (and new additions of passive LFG venting/combustion drains that would otherwise occur)). Condition (a) is thus met. Condition (b) is not applicable as no utilization of LFG is expected to occur as per the currently considered project design.
“This methodology is not applicable: *(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;* *(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.”*	Neither (a) and (b) occur, therefore ACM0001 (version 13.0.0) is applicable to the project activity. No other baseline and monitoring methodology is considered. Moreover, no fossil fuel displacement in kilns or glass melting furnace is claimed. Moreover, after the implementation of the project activity, the landfill operator will continue waste disposal activities at the landfill as per its normal operation conditions (without changes in order to increase methane generation compared to the situation prior to the implementation of the project activity).
“*The applicability conditions included in the tools referred to above also apply.*”	Demonstration of how applicability conditions for the applicable methodological tools which ACM0001 (version 13.0.0) refers to (and which are applied by the project activity) is demonstrated in the tables below.

Regarding the applicable conditions for the “Tool to determine project emissions from flaring gases containing methane” (version 1):

Applicability condition of “Tool to determine project emissions from flaring gases containing methane”	Justification

Applicability condition of “Tool to determine project emissions from flaring gases containing methane”	Justification
“ This tool is applicable under the following conditions: • *The residual gas stream to be flared contains no other combustible gases than methane, carbon monoxide and hydrogen;* • *The residual gas stream to be flared shall be obtained from decomposition of organic material (through landfills, bio-digesters or anaerobic lagoons, among others) or from gases vented in coal mines (coal mine methane and coal bed methane).”*	LFG to be combusted by the project’s flare(s) is generated from the anaerobic decomposition of organic waste material in a landfill. LFG is the only gas to be combusted in the flare. No other gas stream, excepting air, is added in the residual gas stream. LFG is mainly composed by methane (CH_4) and carbon dioxide (CO_2). Trace elements of Volatile Organic Compounds could be found in LFG. This fulfils the applicability criteria defined in the methodological tool. Related monitoring requirements will be followed. The applicability conditions of the methodological tool are thus met.

Regarding the applicable conditions for the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” (version 1):

Applicability condition of “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”	Justification
”This tool provides procedures to estimate the baseline, project and/or leakage emissions associated with the consumption of electricity. *(...)* *The tool is only applicable if one out of the following three scenarios applies to the sources of electricity consumption:* *Scenario A: Electricity consumption from the grid. The electricity is purchased from the grid only. Either no captive power plant is installed at the site of electricity consumption or, if any on-site captive power plant exits, it is not operating or it can physically not provide electricity to the source of electricity consumption.* *Scenario B: Electricity consumption from (an) off-grid fossil fuel fired captive power plant(s). One or more fossil fuel fired captive power plants are installed at the site of the electricity consumption source and supply the source with electricity. The captive power plant(s) is/are not connected to the electricity grid.* *Scenario C: Electricity consumption from the grid and (a) fossil fuel fired captive power plant(s). One or more fossil*	As established by ACM0001 (version 13.0.0), consumption of grid electricity by the project activity is to be accounted as project emissions. The project activity will have its electricity demand met by imports of grid electricity only. No other source of electricity is currently expected to be used to meet the project's electricity demand. Scenario A of the tool is thus applicable. Related monitoring requirements will be followed. The applicable conditions of the tool are thus met.

Applicability condition of “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”	Justification
fuel fired captive power plants operate at the site of the electricity consumption source. The captive power plant(s) can provide electricity to the electricity consumption source. The captive power plant(s) is/are also connected to the electricity grid.”	

Regarding the applicable conditions for the “Emissions from solid waste disposal sites” (version 06.0.1):

Applicability condition of “Emissions from solid waste disposal sites” (version 06.0.1)	Justification
“This tool provides stepwise approach to calculate baseline emissions of methane from solid waste disposed or prevented from disposal at a SWDS. Application A is adopted. As per the tool: if “(...) the CDM project activity mitigates methane emissions from a specific existing SWDS.”, application A should be used”	The project mitigates methane emissions from a landfill. As established by ACM0001 (version 13.0.0), this methodological tool is applied for the determination of ex-ante estimation of emission reductions to be achieved by the project activity. The applicability of the methodological tool is thus met.

Regarding the applicable conditions for the “Combined tool to identify the baseline scenario and demonstrate additionality” (version 04.0.0):

Applicability condition of “Combined tool to identify the baseline scenario and demonstrate additionality” (version 04.0.0)	Justification
“*This tool is only applicable to methodologies for which the potential alternative scenarios to the proposed project activity available to project participants cannot be implemented in parallel to the proposed project activity”* *(...)* *For example, in the following situations a methodology could refer to this tool:* - *For an energy efficiency CDM project where the identified potential alternative scenarios are: (a) retrofit of an existing equipment, or (b) replacement of the existing equipment by new equipment, or (c) the continued use of the existing equipment without any retrofits;* - *For a CDM project activity related to the destruction of a greenhouse gas in one site where the identified potential alternative scenarios are: (a) installation of a thermal destruction unit, or (b) installation of a catalytic destruction system, or (c) no abatement of the greenhouse gas.*	As established by ACM0001 (version 13.0.0), this tool is applied as per the methodology for the identification of the baseline scenario and to demonstration of the additionality of the proposed CDM project activity. The project activity encompasses the destruction of a greenhouse gas in one site where one of the identified potential alternative scenarios is no abatement of the greenhouse gas. The applicability condition of the methodological tool is thus met.

Applicability condition of “Combined tool to identify the baseline scenario and demonstrate additionality” (version 04.0.0)	Justification
In these cases, the project proponents could not implement the three alternatives in parallel but they could only implement one of them. *However, the tool is, for example, not applicable in the following situation: the CDM project activity is the installation of a Greenfield facility that provides a product to a market (i.e. electricity, cement, etc.) where the output could be provided by other existing facilities or new facilities that could be implemented in parallel with the CDM project activity.”*	

Regarding the applicable conditions for the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (version 02.0.0):

Applicability condition of “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (version 02.0.0)	Justification
“*This tool is used to determine the mass flow of greenhouse gas i (CO_2, CH_4, N_2O, SF_6 or a PFC) in the time interval t.”* *This tool provides procedures to determine $F_{i,t}$ (kg/h). The mass flow of a greenhouse gas (CO_2, CH_4, N_2O, SF_6 or a PFC) in the gaseous stream in time interval t. based on measurements of:* *(a) the total volume flow or mass flow of the gas stream,* *(b) the volumetric fraction of the gas in the gas stream and* *(c) the gas composition and water content.* *Typical applications of this tool are methodologies where the flow and composition of residual or flared gases or exhaust gases are measured for the determination of baseline or project emissions, which is the case of the present project activity”*	As established by ACM0001 (version 13.0.0), applicable guidance of this methodological tool is applied for the determination of the amount of methane abated by the project activity. As established by ACM0001 (version 13.0.0), it is required the determination of the mass flow of CH_4 to be sent to the flare(s) within every minute frequency. The applicability condition of the methodological tool is thus met.

Regarding the applicable conditions for the “Tool to calculate the emission factor for an electricity system” (version 02.2.1, EB 63)

Applicability condition of “Tool to calculate the emission factor for an electricity system” (version 02.2.1)	Justification
“This methodological tool determines the CO_2 emission factor for the displacement of electricity generated by power plants in an electricity system, by calculating the .combined margin emission factor (CM) of the electricity system.” *(...)* *“this tool is also referred to in the “Tool to calculate project emissions from electricity consumption” for the purpose of calculating project and leakage emissions in case where a project activity consumes electricity from the grid or results in*	Project emissions due to the consumption of grid electricity by the project activity are determined by applying applicable guidance of Tool to calculate project emissions from electricity consumption” (which refers to the methodological tool). The applicability conditions of the methodological tool are thus met.

Applicability condition of "Tool to calculate the emission factor for an electricity system" (version 02.2.1)	Justification
increase of consumption of electricity from the grid outside the project boundary."	

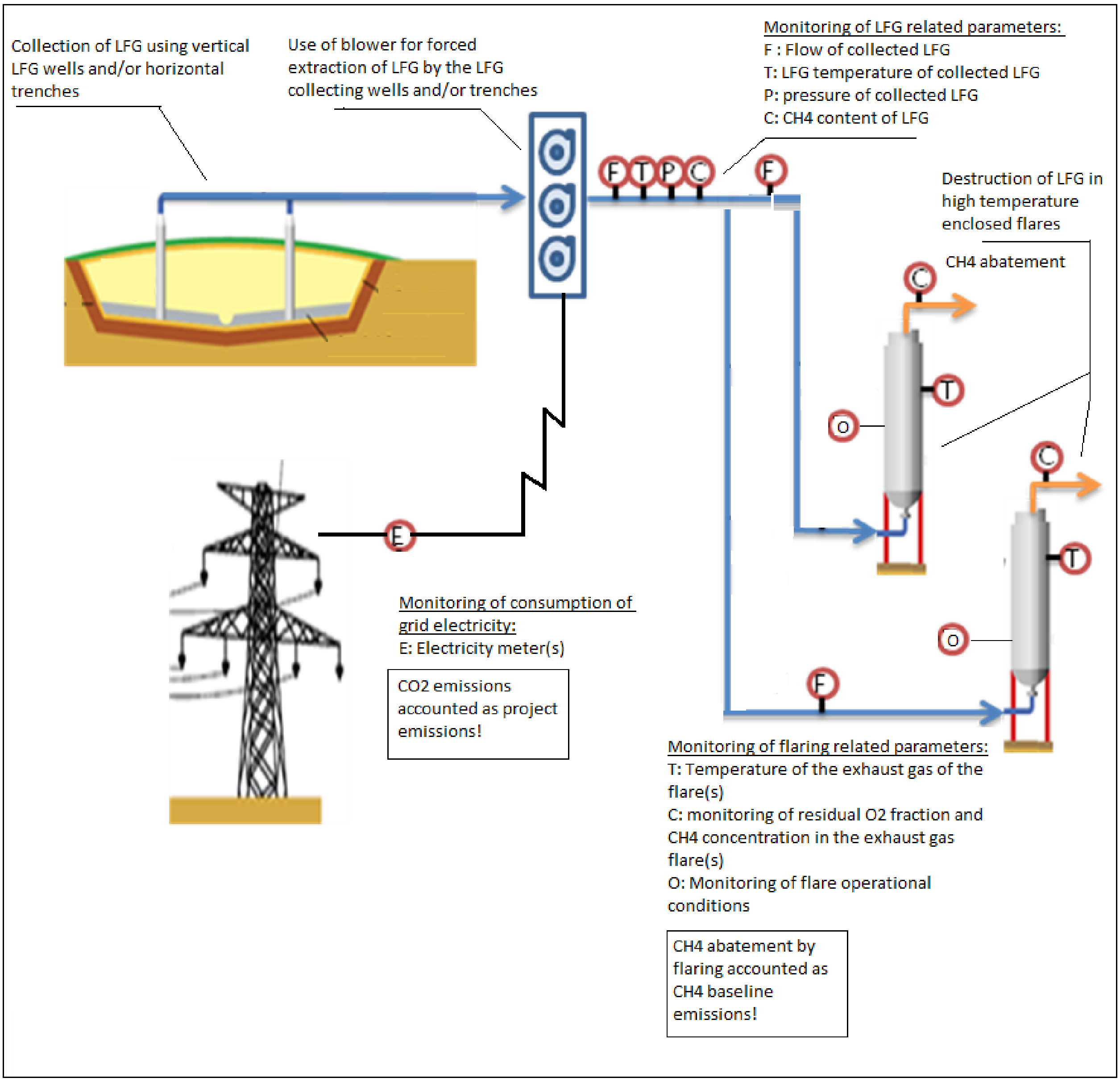
B.3. Project boundary

The project boundary of the project activity includes the site where the LFG is captured and destroyed by combustion in enclosed high temperature flare(s). The system boundary is defined as the electricity grid that supplies the electricity to be consumed by the project activity (National Electricity Grid of Brazil).

The table below provides a summary of greenhouse gases and sources included in and excluded from the project boundary:

Source		GHGs	Included?	Justification/Explanation
Baseline scenario	Emissions from decomposition of waste at the SWDS site.	CO_2	No	CO_2 emissions from decomposition of organic waste are not accounted since the CO_2 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 very small when compared to CH_4 emissions from SWDS (in tCO_2e). This is conservative.
Project scenario	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. It is important to note that residual CH_4 emission due to the combustion of LFG in enclosed flares are considered in the context of the determination of baseline emissions.
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.

The schematic flow diagram below summarizes the project boundary and delineates the project activity (equipment, parameters to be monitored, and GHG included in the project boundary).



Schematic flow diagram: delineation of the project boundary for the project activity

B.4. Establishment and description of baseline scenario

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On the next steps, it is identified the baseline scenario for the project activity. As required by ACM0001 (version 13.0.0) the stepwise approach of the “Combined tool to identify the baseline scenario and demonstrate additionality” (version 04.0.0), is applied.

Step 0: Demonstration whether the proposed project activity is the *First-of-its-kind*

This optional step is not applied.

Step 1: Identification of alternative scenarios

Step 1a: Define alternatives to the proposed CDM project activity

In this step, by following applicable guidance of ACM0001 (version 13.0.0), the following baseline alternatives for the destruction of LFG are taken into consideration:

LFG1: The project activity (i.e. capture of landfill gas and its flaring and/or its use) is undertaken as an initiative without registration as a CDM project activity. This is a technically plausible alternative scenario. However, this alternative does not promote any revenue and it requires significant initial investment capital expenditures + associated operation and maintenance costs.

LFG2: Atmospheric release of the landfill gas or partial capture of landfill gas and destruction to comply with regulations or contractual requirements, or to address safety and odors concerns. This scenario corresponds to the business-as-usual condition (with no investment being performed).

LFG3: LFG is partially not generated because part of the organic fraction of the solid waste is recycled and not disposed in the SWDS;

LFG4: LFG is partially not generated because part of the organic fraction of the solid waste is treated aerobically and not disposed in the SWDS;

LFG5: LFG is partially not generated because part of the organic fraction of the solid waste is incinerated and not disposed in the SWDS.

The current project activity is developed at a landfill site whose purpose is the final disposition of MSW by applying waste landfilling practices and techniques. Regardless of the registration of the project under the CDM, no recycling of the organic fraction of MSW, no aerobic treatment of MSW, neither incineration of MSW are expected to occur. Thus, scenarios LFG3, LFG4 and LFG5 are directly excluded in this initial step of the establishment of the baseline scenario. In fact, recycling of organic matter, aerobic treatment and incineration are not common practice in the host country Brazil and in the rest of the Latin America[13].

While the currently considered design for the project activity does not encompass any utilization of LFG[14], no alternative scenario for power generation or heat generation from LFG are identified. As the project activity does not encompass use of LFG displacing use of natural gas, no alternative scenarios for this utilization are identified either. This is in accordance with ACM0001 (version 13.0.0).

Outcome of Step 1a: The alternatives to be taken into consideration in the context of establishment of the baseline scenario after “step 1a” are only LFG1 and LFG2.

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

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[13] In fact all generated Municipal Solid Waste in Brazil is currently managed through deposition on dump sites or landfills (either controlled or uncontrolled). This is outlined in Figure 4.1.3.1 on page 46 of the publication “Panorama dos Resíduos Sólidos no Brasi - l2010. Available online: http://www.abrelpe.org.br/Panorama/panorama2010.pdf

[14] As further explained in Section A.1, after the successful implementation of the project activity and its operation during a certain period as a LFG collection and destruction initiative (sufficient period to confirm the quantity and quality of collected LFG), the project design may be changed from a LFG collection and destruction project-based initiative to a full LFG collection and destruction/utilization project. Under such eventually modified project design configuration, LFG will be utilized as fuel for electricity generation in a new electricity generation facility to be eventually built by the project participant as part of the project activity. If such permanent change in the project design occurs in the future, it will be addressed after the CDM registration of the project by applying the applicable CDM procedures for addressing permanent changes to the project design of a registered project activity.

So far, there is still no legal restriction neither requirement for LFG gas collection and its destruction by usage of high temperature enclosed flares or opened flares in Brazil. Moreover, there is still no legal restriction neither requirement for passive venting of LFG or its combustion in conventional LFG destruction systems. Actually, there is no applicable regulation that deals with LFG management in Brazil.

Therefore both alternative LFG1 and alternative LFG2 are thus in complete compliance with applicable mandatory laws and regulations. In summary there are no legal requirements or restrictions involving management of LFG in new or existing landfills in Brazil[15]. Therefore, it is demonstrated that LFG destruction or utilization is not mandatory in Brazil.

Outcome of Sub-step 1b: The alternatives to be taken into consideration in the context of establishment of the baseline scenario after “step 1b” remains being only LFG1 and LFG2.

The establishment of the baseline scenario by applying the “Combined tool to identify the baseline scenario and demonstrate additionality” (version 04.0.0) is completed in section B.5. As further demonstrated in section B.5, as an outcome of the stepwise procedure for establishment of the baseline scenario, the baseline scenario for the project is identified as follows:

- LFG2 - Atmospheric release of the LFG or partial capture of LFG and destruction to comply with regulations or contractual requirements, or to address safety and odors concerns.

Procedure for estimating the end of the remaining lifetime of existing equipment

As per ACM0001 (version 13.0.0), this procedure is only applicable if LFG has been utilized in existing equipment that was in operation prior to the implementation of the project activity. The project activity, of which the baseline scenario is identified as the atmospheric release of the LFG (without use of any equipment) will be implemented in an existing landfill where no type of LFG utilization equipment is currently in place or would be in place in the absence of the project. Moreover, all equipment to be used for collecting and destroying LFG under the project scenario (including the enclosed flare(s)) will represent acquisition of new equipment by the project participant (no use of used equipment and/or no equipment being transferred from another site will occur). Therefore, this procedure is not applied. This is in accordance with ACM0001 (version 13.0.0).

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[15] Currently, Brazil has a valid national waste management policy directive termed “*Política Nacional de Resíduos Sólidos*” (National Policy for Solid Waste). This directive was instituted as a Federal Law by the Presidential Law No. 12.305 (published on 02/08/2010). The directive is applicable, according to §1 of its Article 1, to companies or individuals, from public or private domain, responsible for solid waste generation and solid waste management. The law, which was result of years of dialogues and discussions between public and private stakeholders, establishes legal grounds for solid waste management in Brazil, including final destination, i.e. landfills. By establishing general directives for management of solid waste management in the country, the law aims to be a legal framework for promoting overall improvement of the historically poor and deficient waste management practices in Brazil. The “*Política Nacional de Resíduos Sólidos*” is however organized in a very generic way and it does not refer to LFG management in existent or new landfills or dump sites. Thus, the policy does not include any requirement or even recommendations for LFG flaring nor other types of LFG destruction or utilization technologies. The “*Política Nacional de Resíduos Sólidos*” is available online (in Brazilian Portuguese language): http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/lei/l12305.htm

Prior consideration of CDM

As clearly defined in the CDM Project Standard, if the start date of the project activity is not prior to the date of publication of the PDD for the global stakeholder consultation, evidence of the prior consideration of the CDM (in accordance with applicable provisions related to the demonstration of prior consideration of the CDM in the Project standard) is not required. Although the start of the project activity is forecasted to occur only after its successful registration as a CDM project activity, the project participant has anyway informed UNFCCC and the DNA of Brazil about the intention to seek CDM status for a new project activity on 11/05/2012[16].

A timeline summarizing the chronology of relevant events that demonstrates prior CDM consideration for the project is presented under Section B.5.

B.5. Demonstration of additionality

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On the next steps, it is demonstrated the additionality of the project by adopting Steps 2, 3 and 4 of the "Combined tool to identify the baseline scenario and demonstrate additionality" (version 04.0.0). The application of the methodological tools is initiated in Section B.4. This section also complements the establishment of the baseline scenario for the project, which is described in Section B.4. [17]

STEP 2: Barrier analysis

Step 2a: Identify barriers that would prevent the implementation of alternative scenarios

In Brazil there is no LFG collection and destruction initiatives applying active (forced) collection systems and using high temperature enclosed flares implemented or under implementation apart of the project-based initiatives which are registered as CDM project activities or are under validation stage. In the view of the project participant, significant local competence in terms of technology for LFG collection and destruction in enclosed high temperature flares (as well as its utilization for electricity generation) has been developed within the latest years. This is clearly a positive externality of the CDM in Brazil and in other countries in Latin America. Moreover, suppliers of related LFG collection and destruction equipment are currently also established in Brazil. Therefore, in the view of the project participant, currently there are no technical, logistic or competence barriers for the implementation of LFG collection and destruction initiatives in landfills in Brazil.

It is also relevant to note that Rio Grande Ambiental S.A. is a regional waste management company which is now part of Solvi Group. Solvi Group one of the leading groups in the field of waste management, water supply and waste water treatment in Brazil (and more recently in the fields of power generation and energy efficiency measures). Solvi Participações S.A. (as other Solvi Group company) is also a project participant for the project activity. As a positive externality of the CDM, Solvi Group has developed expertise and experience in the area of LFG collection and destruction utilization within the

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[16] Documented evidences of prior CDM consideration information sent to both UNFCCC and DNA of Brazil will be made available to the DOE in charge of the CDM validation assessment.

[17] Section B.4 and section B.5 below are complementary. Thus, the application of the steps of the "Combined tool to identify the baseline scenario and demonstrate additionality" as undertaken in Section B.4 are also applicable in the context of the demonstration of additionality. On the other hand, steps of this methodological tool as undertaken in Section B.5 are also applicable in the context of the determination of baseline scenario.

latest years[18]. Therefore, in the particular case of the project participants, currently there are no technical, logistic or competence barriers for the implementation of a LFG collection and destruction initiative in the Rio Grande landfill.

Outcome of Step 2a: No barriers are identified for the alternatives of the implementation of the project activity (baseline alternatives LFG1) in the context of the assessment and demonstration of additionality for the project activity.

As the alternative LFG2 represents the continuation of current practice (with no investment or action being performed by the project participants), no barriers are identified also for the alternative LFG2 in the context of the establishment of the baseline scenario.

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

In the context of the assessment and demonstration of additionality, the implementation of the proposed project activity without CDM (alternative LFG1) is assumed as not prevented by the barriers.

In the context of the continuation of the establishment of the baseline scenario (continuation of Section B.4), the business-as-usual scenario (alternative LFG2) is also assumed as not prevented by any barrier.

Outcome of Step 2b: No barriers were identified in “Step 2a”. Alternatives LFG1 and LFG2 remain after this step, and since the project activity is not the first-of-its-kind, step 3, investment analysis, is applied.

Step 3: Investment analysis

In the context of the assessment and demonstration of project additionality and identification of the baseline scenario, the financial attractiveness of the remaining alternatives after Step 2 (alternatives LFG1 and LFG2) are compared by conducting an investment analysis. As established in the “Combined tool to identify the baseline scenario and demonstrate additionality”, it is required that the analysis includes alternative scenarios where the project participants do not undertake an investment, operational costs or revenues (S2 or S3).

For the present analysis the equivalence between the remaining alternative scenarios as defined in the “Combined tool to identify the baseline scenario and demonstrate additionality” and the scenarios defined in ACM0001 (version 13.0.0) are presented in the table below:

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[18] Through its subsidiary companies Bahia Tratamento e Transferência de Resíduos S.A. (BATTRE) and Essencis Soluções Ambientais S.A., Solvi Group has implemented and operated the following LFG collection and destruction CDM project activities in Brazil:
- Salvador da Bahia Landfill Gas Management Project (UNFCCC No. 0052). (registered as CDM project on 15/08/2005. http://cdm.unfccc.int/Projects/DB/DNV-CUK1117823353.4/view
- Caieiras landfill gas emission reduction (UNFCCC No. 0171) (registered as CDM project on 09/03/2006 http://cdm.unfccc.int/Projects/DB/DNV-CUK1134509951.62/view

Equivalence between the remaining alternative scenarios as defined in the "Combined tool to identify the baseline scenario and demonstrate additionality" and the scenarios defined in ACM0001 (version 13.0.0) in the context of the demonstration of additionality for the project activity				
Alternative scenarios as per the "Combined tool to identify the baseline scenario and demonstrate additionality"		Applicable equivalent alternative baseline scenario as per the ACM0001 (for remaining alternatives after step 2)		Equivalence demonstrated?
S1	*"The proposed project activity undertaken without being registered as a CDM project activity"*	LFG1	"*The project activity implemented without being registered as a CDM project activity (i.e. capture and flaring or use of LFG)"*	Yes
S2	"*No investment is undertaken by the project participants but third party(ies) undertake(s) investments or actions which provide the same output to users of the project activity.*"	Not applicable	Not applicable	Not applicable
S3	"*Where applicable, the continuation of the current situation, not requiring any investment or expenses to maintain the current situation such as (...) the continued venting of methane from a landfill*"	LFG2	"*Atmospheric release of the LFG or partial capture of LFG and destruction to comply with regulations or contractual requirements, or to address safety and odors concerns*"	Yes
S4	*"Continuation of the current situation, requiring an investment or expenses to maintain the current situation"*	Not applicable	Not applicable	Not applicable
S5	*"Other plausible and credible alternative scenarios to the project activity scenario, including the common practices in the relevant sector, which deliver the same output."*	Not applicable	Not applicable	Not applicable
S6	*"Where applicable, the proposed project activity undertaken without being registered as a CDM project activity to be implemented at a later point in time (e.g. due to existing regulations, end of-life of existing equipment, financing aspects)."*	Not applicable	Not applicable	Not applicable

As one of the two alternative scenarios remaining after Step 2 corresponds to the situation equivalent to S3, the Net Present Value (NPV) is chosen as the financial indicator for the analysis of the alternative scenario LFG2. This is in accordance with the “Combined tool to identify the baseline scenario and demonstrate additionality”. For alternative baseline scenarios LFG1 (equivalent to S1), the proposed project activity being undertaken without being registered as CDM project is analyzed below, also choosing the NPV as financial indicator.

Alternative scenario S1/LFG1

In this scenario, there are start-up investment capital expenditures as well as regular operation & maintenance costs that are associated with implementation and operation of the LFG capture and destruction system (by flaring) respectively. For this alternative, despite of the involved costs, there are no associated revenues generated (apart of potential CDM revenues upon registration of the project as a CDM project activity). Therefore, the NPV of the scenario S1/LFG1 is always negative regardless of the values for investment capital expenditures and regular operation & maintenance costs. By considering the estimated total start-up investment and the average operational & maintenance costs [19] for the project activity, the calculated NPV (by applying the simple cost analysis method and selected discount rate of 11.75%[20]) under these assumptions is -BRL 4,044,816.

Required investments include construction of the gas collecting network: acquisition of blowers, flares, etc. As a conservative approach, it is assumed that monitoring of all related LFG parameters (including monitoring of residual CH_4 and O_2 in the exhaust gas of the flare(s)) would not be required under LFG1 alternative (as it is a CDM methodological requirement which would not be considered in the absence of the implementation of the project as a CDM project activity). Only monitoring instruments and equipment required for safety and operational reasons are considered. Thus, all start-up investment expenditures and related operational and maintenance costs for monitoring equipment which are required uniquely if the project is registered as a CDM project activity (to meet applicable CDM monitoring requirements) are excluded. This is conservative.

S3/LFG2

As per the application of the investment analysis as per the “Combined tool to identify the baseline scenario and demonstrate additionality” the NPV for the scenario S3/LFG2 is directly defined as 0 (null)[21].

Based on this analysis, the alternative scenarios (ranked by decreasing NPV result order) are presented as follows:

Alternative scenarios by decreasing NPV order	NPV
S3/LFG2	0
S1 LFG1	- BRL 4,044,816

The NPV values for the two remaining alternatives (as presented above) confirm that the most economically attractive scenario (which is regarded as the baseline scenario) is alternative S3 (“the

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[19] Details provided in Financial Analysis Spreadsheet.

[20] The selected discount rate of 11.75% is the default value for Brazil as established by the “Guidelines on the assessment of investment analysis” (EB 62 Annex 5). This value is applicable for the Host country Brazil and Group 1.

[21] As per the “Combined tool to identify the baseline scenario and demonstrate additionality” for the alternative scenario LFG2 (which corresponds to the situation described under S3 and that does not require any investment or expenses), a value of zero is assumed to the NPV financial indicator.

continuation of the current situation, not requiring any investment or expenses to maintain the current situation”). As previously demonstrated, S3 is equivalent to LFG2 (“Atmospheric release of the LFG or partial capture of LFG and destruction to comply with regulations or contractual requirements, or to address safety and odors concerns”).

As a result of the application of stepwise approach of the “Combined tool to identify the baseline scenario and demonstrate additionality”, it is also demonstrated that baseline scenario is not the alternative S1 / LFG1 (project activity being undertaken without being registered as a CDM project).

Outcome of step 3:
The baseline scenario is the most attractive scenario: alternatives S3/LFG2.

Thus alternative S1/LFG1 (project activity being undertaken without being registered as a CDM project) does not represent the baseline scenario. Furthermore, the implementation of the project without the CDM revenues is demonstrated to be not economically attractive.

Non-application of sensitivity analysis:
The performance of a sensitivity analysis is not required in the context of the investment analysis due to the following aspects:

- The calculated NPV value for alternative S1/LFG1 (implementation of the project activity without consideration of CDM revenues) will always be negative regardless of any critical variation in the input parameters and assumptions used in its calculation (as there are no associated revenues for this alternative). Any variation in the values and assumptions for related investments and costs would maintain the calculated NPV value negative.

- The calculated NPV value for alternative S3/LFG2 (atmospheric release of the LFG or partial capture of LFG and destruction to comply with regulations or contractual requirements, or to address safety and odors concerns) is demonstrated to be zero (null). As there are no associated investments, costs and revenues for this alternative, there are no technical and economic parameters of which variations could be performed in the context of a sensitivity analysis.

Step 4. Common practice analysis

This step aims to complement the previous steps with an analysis of the extent to which the proposed project type (e.g. technology or practice) has already diffused in the relevant sector and applicable geographical area. This test is a credibility check for the demonstration of project’s additionality and it thus complements the investment analysis (Step 3).

The proposed CDM project activity comprises methane destruction. Methane destruction is listed in the applicable definitions section of the “Combined tool to identify the baseline scenario and demonstrate additionality” of which a common practice analysis is required. Therefore, Step 4a is undertaken in order to comply with the requirement of the methodological tool.

Step 4a. The proposed CDM project activity(s) applies measure(s) that are listed in the definitions section above

The second “Brazilian Greenhouse Gases Emissions Inventory Report” (published in July/2010)[22] clearly states that from the period from year 1990 to 2002 the total amount of recovered methane in Brazilian landfills were considered as zero. Furthermore, from 2003 onwards, all LFG destruction/utilization considered in such inventory represented project-based initiatives being implemented as CDM project activities.

The publication Second Brazilian Greenhouse Gases Emissions Inventory Report[23] states “*(...) all of Brazilian landfills with collection and destruction system (active system) are implemented projects under the CDM*”.

Thus, in Brazil, there are no activities similar to the proposed project activity under operation or implementation without consideration of CDM benefits. All initiatives encompassing LFG collection and destruction are implemented (or are being implemented) as project-based initiatives under the CDM. Due to that, $N_{all} = 0$.

Sub-step 4a(1): This sub-step is not applicable since, as previously demonstrated, $N_{all} = 0$. Moreover, as the project activity encompasses collection and destruction of LFG (without any commercial or energetic utilization of LFG), the determination of the output range of the design output or capacity of the proposed project activity (as required by applicable guidance of the “Combined tool to identify the baseline scenario and demonstrate additionality”) is not plausible/applicable.

Sub-step 4a(2): This sub-step is not applicable either since, as previously demonstrated, $N_{all} = 0$. Moreover, as the project activity encompasses collection and destruction of LFG (without any commercial or energetic utilization of LFG), the determination of the number of similar plants that deliver the same output or capacity within the applicable output range (as required by applicable guidance of the “Combined tool to identify the baseline scenario and demonstrate additionality”) is not plausible/applicable either.

It is crucial to note that all other comparable initiatives in Brazil (collection and destruction of LFG using active (forced) systems and high temperature enclosed flares) are currently registered as CDM project activities or are under CDM validation stage. This is clearly outlined in the Second Brazilian Greenhouse Gases Emissions Inventory Report.

Sub-step 4a(3): By taking into account the outcome of application of sub-steps 4a(1) and 4a(2), sub-step 4a(3) is regarded as not applicable either.

Sub-step 4a(4): While the value for N_{all} is determined as zero and no value for N_{diff} is determined as a result of the application of the sub-steps above, the value for Factor F (calculated as "$F = 1 - N_{diff} / N_{all}$") is thus directly assumed as not determinable (1 minus an undeterminable ratio).

By taking into account the non-determined value for factor F, the following conditions of the methodological tool for having the proposed project activity being regarded as common practice within a sector in the applicable geographical area are therefore not simultaneously met:

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[22] Source: Ministry of Science and Technology. The second Brazilian Greenhouse Gases Emissions Inventory Report. Page 62. Available online: http://www.mct.gov.br/upd_blob/0213/213909.pdf

[23] Document available online: http://www.mct.gov.br/upd_blob/0213/213909.pdf, accessed on 10/11/2011.

- Factor F greater than 0.2
- N_{all}-N_{diff} greater than 3.0

As per the "Combined tool to identify the baseline scenario and demonstrate additionality", both conditions should be simultaneously fulfilled in order to have the proposed project activity being regarded as common practice within the sector in the applicable geographical area. While no value for Factor F is determinable the proposed project activity is not regarded as common practice.

Outcome of step 4: The outcome of application of "step 4" is the confirmation that the proposed project activity is not regarded as common practice.

Conclusion: As a result of the application of "step 1" to "step 4", it is confirmed that the project activity is regarded as additional in accordance with the applicable criteria of applied baseline methodology and methodological tools as well as per applicable provisions for demonstration of additionality in the CDM Project Standard.

Prior consideration of CDM

As clearly defined in the CDM Project Standard, if the start date of the project activity is not prior to the date of publication of the PDD for the global stakeholder consultation, evidence of the prior consideration of the CDM (in accordance with applicable provisions related to the demonstration of prior consideration of the CDM in the Project standard) is not required. Although the start of the project activity is forecasted to occur only after its successful registration as a CDM project activity, the project participant has anyway informed UNFCCC and the DNA of Brazil about the intention to seek CDM status for a new project activity on 11/05/2012[24].

The timeline below also summarizes the chronology of relevant events that demonstrates prior CDM consideration for the project.

Chronology of events:

Date	Event
Jan. 2012 – Mar. 2012	Internal capital budget study/evaluation for the project implementation was performed by the project participant.
11/05/2012	Decision to apply for CDM registration for LFG project evidenced by the letter informing the UNFCCC secretariat and the DNA of Brazil of the intention to seek CDM status.
01/03/2013	Expected starting date of the project activity (as per the definition of the "CDM Glossary of Terms").
01/07/2013	Date the project activity is expected to start its operations.

B.6. Emission reductions

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[24] Documented evidences of prior CDM consideration information sent to both UNFCCC and DNA of Brazil will be made available to the DOE in charge of the CDM validation assessment.

B.6.1. Explanation of methodological choices

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<u>Determination of emission reductions:</u>

As established by ACM0001 (version 13.0.0) and applicable tools, yearly emission reductions (ER_y) to be achieved by the project activity are determined (in tCO_2e) as follows:

$$ER_y = BE_y - PE_y \tag{0}$$

Where:

BE_y = Baseline emissions in year *y* (in tCO_2e/yr)

PE_y = Project emissions in year *y* (in tCO_2/yr)

<u>Determination of baseline emissions:</u>

As per ACM0001 (version 13.0.0), baseline emissions (BE_y) are determined according to equation 1 and comprise the following sources:

(A) Methane emissions from anaerobic waste decomposition in the considered solid waste disposal site - SWDS (Rio Grande landfill) in the absence of the project activity;

(B) Electricity generation using existing fossil fuel energy sources connected to the National Electricity Grid of Brazil and new additions of power generation sources in the absence of the project activity;

(C) Heat generation using fossil fuels in the absence of the project activity; and

(D) Natural gas used from the natural gas network in the absence of the project activity.

These sources are reflected in the equation below:

$$\mathrm{BE_y = BE_{CH4,y} + BE_{EC,y} + BE_{HG,y} + BE_{NG,y}} \tag{1}$$

Where:

$BE_{CH4,y}$	Baseline emissions of methane from the SWDS in year *y* (in tCO_2e/yr)
$BE_{EC,y}$	Baseline emissions associated with electricity generation in year *y* (in tCO_2/yr)
$BE_{HG,y}$	Baseline emissions associated with heat generation in year *y* (in tCO_2/yr)
$BE_{NG,y}$	Baseline emissions associated with natural gas use in year *y* (in tCO_2/yr)

In the particular case of the project activity, as no utilization of collected LFG is currently expected to occur, $BE_{EC,y}$, $BE_{HG,y}$ and $BE_{NG,y}$ are thus not applicable in the context of the determination of baseline emissions. Due to that, the project's total baseline emissions (BE_y) are thus equal to baseline emissions of methane from the SWDS in year *y* ($BE_{CH4,y}$):

$$\mathrm{BE_y = BE_{CH4,y}} \tag{2}$$

ACM0001 (version 13.0.0) also includes a stepwise approach to calculate baseline emissions. This approach (which includes four main steps: Step (A), Step (B), Step (C) and Step (D)) is applied as follows:

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

As established by ACM0001 (version 13.0.0), baseline emissions of methane from the anaerobic MSW decomposition at the Rio Grande landfill ($BE_{CH4,y}$) are determined (in tCO_2e) as a function of the amount of methane that is actually captured and combusted under the project scenario and by also taking in account the amount of methane that would eventually be captured and destroyed in the landfill in the absence of the project activity (baseline scenario) due to regulatory or contractual requirements. In addition, the effect of methane oxidation in the top layer of the landfill (that is assumed as existing under the baseline scenario but not in the project scenario)[25] is also taken into account for the determination of $BE_{CH4,y}$.

$$BE_{CH4,y} = (1 - OX_{top\_layer}) * (F_{CH4,PJ,y} - F_{CH4,BL,y}) * GWP_{CH4} \quad \textbf{(3)}$$

Where:

OX_{top_layer}	Fraction of methane in the LFG that would be oxidized in the top layer of the SWDS in the baseline scenario (dimensionless)
$F_{CH4,PJ,y}$	Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (in tCH_4)
$F_{CH4,BL,y}$	Amount of methane in the LFG that would be flared in the baseline (absence of project activity) in year *y* (in tCH_4)
GWP_{CH4}	Global Warming Potential of CH_4 (in tCO_2e/tCH_4)

Step A.1: Ex-post determination of $F_{CH4,PJ,y}$

As per ACM0001 (version 13.0.0), during the crediting period, the amount of methane in the LFG which is destroyed or utilized by the project activity ($F_{CH4,PJ,y}$) is to be determined (in tCH_4) as follows:

$$F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y} + F_{CH4,HG,y} + F_{CH4,NG,y} \quad \textbf{(4)}$$

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[25] As established by ACM0001 (version 13.0.0), the default value for the ex-ante determined parameter $OX_{top\text{-}layer}$ is regarded the fraction of the methane that would oxidize in the top layer of the SWDS in the absence of the project activity. Also as per ACM0001 (version 13.0.0), it is assumed that under the project activity, this effect is reduced since part of generated LFG is captured and does not pass through the top layer of the SWDS where it would be oxidized.

Where:

$F_{CH4,flared,y}$	Amount of methane in the LFG which is destroyed by flaring in year *y* (in tCH_4).
$F_{CH4,EL,y}$	Amount of methane in the LFG which is used for electricity generation in year *y* (in tCH_4)
$F_{CH4,HG,y}$	Amount of methane in the LFG which is used for heat generation in year *y* (in tCH_4).
$F_{CH4,NG,y}$	Amount of methane in the LFG which is sent to the natural gas distribution network in year *y* (in tCH_4).

In the particular case of the project activity, as collected LFG is currently not expected to be used as gaseous fuel for electricity generation, generation of heat in a boiler or even expected to be supplied to consumers through a natural gas distribution network; $F_{CH4,EL,y}$, $F_{CH4,HG,y}$ and $F_{CH4,NG,y}$ are thus not applicable in the context of the determination of baseline emissions (and thus assume null values). Due to that, the amount of methane in the LFG which is destroyed or utilized by the project activity ($F_{CH4,PJ,y}$) is thus equal to the amount of methane in the LFG which is destroyed by flaring in year *y* ($F_{CH4,flared,y}$):

$$F_{CH4,PJ,y} = F_{CH4,flared,\ y} \tag{4.1}$$

Where:

$F_{CH4,flared,y}$	Amount of methane in the LFG which is destroyed by flaring in year *y* (in tCH_4). $F_{CH4,flared,y}$ is determined by following applicable guidance of the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”. The following requirements apply:

- The gaseous stream the tool shall be applied to is the LFG delivery pipeline to flaring and to each item of electricity generation equipment *j*;
- CH_4 is the greenhouse gas for which the mass flow is determined;
- The flow of the gaseous stream is to be measured on continuous basis;
- The simplification offered for calculating the molecular mass of the gaseous stream is valid (equations 3 or 17 in the tool); and
- The mass flow should be calculated on a an hourly basis for each hour *h* in year *y*;
- The mass flow calculated for hour *h* is 0 if the equipment is not working in hour *h*

Determination of the amount of methane destroyed by flaring ($F_{CH4,flared,y}$)

The amount of methane in the LFG which is destroyed by flaring in year *y* ($F_{CH4,flared,y}$) is determined (in tCH_4/yr) as the difference between the amount of methane supplied to the flare(s) and any methane emissions from the flare(s), as follows:

$$F_{CH4,flared,\,y} = F_{CH4,sent\_flare\,,y} - \frac{PE_{flare,\,y}}{GWP_{CH4}} \qquad \textbf{(5)}$$

Where:

GWP_{CH4}	Global warming potential of CH_4 (tCO_2e/tCH_4)
$F_{CH4,sent\_flare,y}$	Amount of methane in the LFG which is sent to the flare(s) in year *y* (in tCH_4/yr) $F_{CH4,sent\_flare,y}$ is directly determined by applying the applicable options of the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”. Option 2: *Simplified calculation without measurement of the moisture content*, and option + option A, C or D (one of the options depending on project conditions and equipment to be installed) will be applied for determining to $F_{CH4,sent\_flare,y}$. The stepwise application of option 2 + option A, C or D of the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” for the determination of $F_{CH4,sent\_flare,y}$ is outlined below.
$PE_{flare,y}$	Project emissions from flaring of the residual gas stream in year *y* (in tCO_2e/yr). $PE_{flare,y}$ shall be determined using the methodological tool “Tool to determine project emissions from flaring gases containing methane”. 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 stepwise application of applicable guidance of the “Tool to determine project emissions from flaring gases containing methane” for the determination of $PE_{flare,y}$ is outlined below.

$F_{CH4,sent\_flare,y}$ and $PE_{flare,y}$ are determined as explained below:

Determination of the amount of methane in the LFG which is sent to the flare(s) ($F_{CH4,sent\_flare,y}$)

Applicable guidance of the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” will be applied to determine $F_{CH4,sent\_flare,y}$ by following “*Option 2: Simplified calculation without measurement of the moisture content*” and one of the options *A*, *C* or *D* (depending on project conditions and specifications of equipment to be installed) as follows:

> *Option 2: Simplified calculation without measurement of the moisture content:*
>
> This option of the methodological tool provides a simple and conservative approach to consider absolute humidity by assuming the gaseous stream is dry or saturated depending on which is the conservative situation. If it is conservative to assume that the gaseous stream is dry, then mH_2O,t,db is assumed to equal 0. If it is conservative to assume that the gaseous stream is saturated, then mH_2O,t,db is assumed to equal the saturation absolute humidity (mH2O,t,db,sat) and calculated using equation bellow.

$$m_{H_2O,t,db,SAT} = \frac{\mathrm{p}_{\mathrm{H2O,t,Sat}} * \mathrm{MM}_{\mathrm{H2O}}}{(\mathrm{P}_{\mathrm{t}} - \mathrm{p}_{\mathrm{H2O,t,Sat}}) * \mathrm{MM}_{\mathrm{t,db}}} \tag{6}$$

Where:

$m_{H2O,t,db,sat}$	Saturation absolute humidity in time interval *t* on a dry basis (in kg H_2O/kg dry gas)
$p_{H20,t,sat}$	Saturation pressure of H_2O at temperature Tt in time interval t (in Pa)
T_t	Temperature of the gaseous stream in time interval *t* (in K)
P_t	Absolute pressure of the gaseous stream in time interval *t* (in Pa)
MM_{H2O}	Molecular mass of H_2O (in kg H_2O/kmol H_2O)
$MM_{t,db}$	Molecular mass of the gaseous stream in a time interval *t* on a dry basis (in kg dry gas/kmol dry gas). $MM_{t,db}$ is estimated using the following equation:

$$\mathrm{MM}_{\mathrm{t,db}} = \sum_{\mathrm{i}} (\nu_{\mathrm{i,t,db}} * \mathrm{MM}_{\mathrm{k}}) \tag{7}$$

Where:

$MM_{t,db}$	Molecular mass of the gaseous stream in time interval *t* on a dry basis (in 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 (in m³ gas k/m³ dry gas)
MM_k	Molecular mass of gas *k* (in 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). See available simplification below

The determination of the molecular mass of the gaseous stream ($MM_{t,db}$) requires measuring the volumetric fraction of all gases (*k*) in the gaseous stream. As a simplification, the volumetric fraction of only gas methane (CH_4) (that is the only greenhouse gas which is considered in the emission reduction calculation) will be monitored. The difference to 100% is considered as pure nitrogen.

Depending on the project conditions and equipment one of the following measurement options will be chosen and the following formulas applied:

Measurement options

Option	Flow of gaseous stream	Volumetric fraction

A	Volume flow dry basis	dry or wet basis[26]
C	Volume flow wet basis	wet basis
D	Mass flow dry basis	dry or wet basis

Option A:

Flow measurement on a dry basis is not doable for a wet gaseous stream. Therefore, it is necessary to demonstrate that the gaseous stream is dry to use this option. There are two ways to do this:

- Measure the moisture content of the gaseous stream ($C_{H2O,t,db,n}$) and demonstrate that this is less or equal to 0.05 kg H_2O/m^3 dry gas; or

- Demonstrate that the temperature of the gaseous stream (Tt) is less than 60ºC (333.15 K) at the flow measurement point.

If it cannot be demonstrated that the gaseous stream (LFG) is dry, then the flow measurement should be assumed to be on a wet basis and the corresponding option from the table above should be applied instead.

The mass flow of greenhouse gas methane (F_{CH4},t) in the considered gaseous stream (LFG) in time interval *t* (in kg gas/h) is determined as follows:

$$F_{CH4,t} = V_{t,db} * v_{CH4,t,db} * \rho_{CH4,t} \qquad \textbf{(8)}$$

with

$$\rho_{CH4,t} = \frac{P_t * MM_{CH4}}{R_u * T_t} \qquad \textbf{(9)}$$

Where:

$V_{t,db}$, n	Volumetric flow of the considered gaseous stream (LFG) in time interval *t* on a dry basis at normal conditions (in m³ dry gas/h)
$v_{CH4,t,db}$	Volumetric fraction of greenhouse gas methane in the considered gaseous stream (LFG) in time interval *t* on a dry basis (in m³ gas *i*/m³ dry gas)
$\rho_{CH4,t}$	Density of methane (in kg gas *i*/m³ gas *i*)
P_t	Absolute pressure of the considered gaseous stream (LFG) in time interval *t* (in Pa)
MM_{CH4}	Molecular mass of greenhouse gas methane (in kg/kmol)

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[26] Flow measurement on a dry basis is not feasible at reasonable costs for a wet gaseous stream, so there will be no difference in the readings for volumetric fraction in wet basis analysers and dry basis analysers and both types can be used indistinctly for calculation Options A and D.

R_u	Universal ideal gases constant (in Pa.m^3/kmol.K)
T_t	Temperature of the considered gaseous stream (LFG) in time interval *t* (in K)

Option C:

The mass flow of greenhouse gas methane ($F_{CH4,t}$) in the considered gaseous stream (LFG) in time interval *t* is determined (in kg/h) as follows:

$$F_{CH4,t} = V_{t,wb,n} * v_{CH4,t,wb} * \rho_{CH4,n} \quad \textbf{(10)}$$

with

$$\rho_{CH4,n} = \frac{P_n * MM_{CH4}}{R_u * T_n} \quad \textbf{(11)}$$

Where:

$V_{t,wb,n}$	Volumetric flow of the considered gaseous stream (LFG) in time interval *t* on a wet basis at normal conditions (in m³ wet gas/h)
$v_{CH4,t,wb}$	Volumetric fraction of greenhouse gas *i* in the gaseous stream in time interval *t* on a wet basis (in m³ gas *i*/m³ wet gas)
$\rho_{CH4,n}$	Density of methane at normal conditions (in kg CH_4/m³ wet CH_4)
P_n	Absolute pressure at normal conditions (in Pa)
T_n	Temperature at normal conditions (in K)
MM_{CH4}	Molecular mass of methane (in kg/kmol)
R_u	Universal ideal gases constant (in Pa.m^3/kmol.K)

The following equation should be used to convert the volumetric flow of the considered gaseous stream (LFG) from actual conditions to normal conditions of temperature and pressure:

$$V_{t,wb,n} = V_{t,wb} * (T_n/T_t) * (P_t/P_n) \quad \textbf{(12)}$$

Where:

$V_{t,wb,n}$	Volumetric flow of the considered gaseous stream (LFG) in a time interval *t* on a wet basis at normal conditions (in m^3 wet LFG/h)
$V_{t,wb}$	Volumetric flow of the considered gaseous stream (LFG) in time interval *t* on a wet basis (in m³ wet gas/h)

P_t	Pressure of the considered gaseous stream (LFG) in time interval *t* (in Pa)
T_t	Temperature of the considered gaseous stream (LFG) in time interval *t* (in K)
P_n	Absolute pressure at normal conditions (in Pa)
T_n	Temperature at normal conditions (in K)

Option D:

By taking into account that flow measurement on a dry basis is not doable for a wet gaseous stream, it is necessary to demonstrate that the considered gaseous stream (LFG) is dry to use this option. There are two ways to do such confirmation:

- Measure the moisture content of the considered gaseous stream ($C_{H2O,t,db,n}$) and demonstrate that this is less or equal to 0.05 kg H_2O/m^3 dry gas; or
- Demonstrate that the temperature of the considered gaseous stream (Tt) is less than 60ºC (333.15 K) at the flow measurement point.

If it cannot be demonstrated that the gaseous stream is dry, then the flow measurement should be assumed to be on a wet basis and the corresponding option from the above table should be applied instead.

The mass flow of methane ($F_{CH4,t}$) is determined using applicable equations as presented in options A and C. The volumetric flow of the considered gaseous stream (LFG) in time interval *t* on a dry basis ($V_{t,db}$) is determined by converting the mass flow of the considered gaseous stream (LFG) to a volumetric flow as follows:

$$V_{t,db} = M_{t,db} / \rho_{t,db} \qquad \textbf{(13)}$$

Where:

$V_{t,db}$	Volumetric flow of the considered gaseous stream (LFG) in time interval *t* on a dry basis (in m^3 dry gas/h)
$M_{t,db}$	Mass flow of the considered gaseous stream (LFG) in time interval *t* on a dry basis (in kg/h)
$\rho_{t,db}$	Density of the considered gaseous stream (LFG) in time interval *t* on a dry basis (in kg dry gas/m^3 dry gas)

The density of the considered gaseous stream ($\rho_{t,db}$) should be determined as follows:

$$\rho_{t,db} = \frac{P_t * MM_{t,db}}{R_u * T_t} \qquad \textbf{(14)}$$

Where:

$\rho_{t,db}$	Density of the gaseous stream in a time interval *t* on a dry basis (in kg dry gas/m^3 dry gas)
$MM_{t,db}$	Molecular mass of the gaseous stream in a time interval *t* on a dry basis (in kg dry gas/kmol dry gas)
P_t	Pressure of the gaseous stream in time interval *t* (in Pa)
T_t	Temperature of the gaseous stream in time interval *t* (in K)

The molecular mass of the considered gaseous stream ($MM_{t,db}$) is estimated by applying equation (7). The option selected will be one of the options A, C or D as stated, however the selected option will depend on the environmental conditions (atmospheric and climatic conditions, humidity of the site etc.) and the choice of equipment (mass flow meter, gas dryer, etc.). Therefore, this option can be changed in a future stage, and will be address ex-post.

Determination of project emissions from flaring of the residual gas stream in year y ($PE_{flare,y}$)

Application of the "Tool to determine project emissions from flaring gases containing methane" for the determination of $PE_{flare,y}$

$PE_{flare,y}$ is calculated by following the stepwise approach of the "Tool to determine project emissions from flaring gases containing methane". This methodological tool allows two approaches (options) to determine the flare efficiency of enclosed flares. As per the tool:

> *"For enclosed flares, either of the following two options can be used to determine the flare efficiency:*
>
> *(a) To use a 90% default value. Continuous monitoring of compliance with manufacturer's specification of flare (temperature, flow rate of residual gas at the inlet of the flare) must be performed. If in a specific hour any of the parameters are out of the limit of manufacturer's specifications, a 50% default value for the flare efficiency should be used for the calculations for this specific hour.*
>
> *(b) Continuous monitoring of the methane destruction efficiency of the flare (flare efficiency).*
>
> *In both cases, if there is no record of the temperature of the exhaust gas of the flare or if the recorded temperature is less than 500 °C for any particular hour, it shall be assumed that during that hour the flare efficiency is zero."*
>
> As also required by the "Tool to determine project emissions from flaring gases containing methane", for the consideration of default value for the methane destruction efficiency, the manufacturer's specifications for the operation of the flare as well as required data and procedures to monitor these specifications are also to be monitored.

$PE_{flare,y}$ is determined by considering the available and applicable 7 steps of the methodological tool as follows:

Step 1: Determination of the mass flow rate of the residual gas that is flared ($FM_{RG,h}$)

As established by the methodological tool, under Step 1 it is calculated the residual gas mass flow rate in each hour h ($FV_{RG,h}$), based on the volumetric flow rate and the density of the residual gas as follows. The density of the residual gas is determined based on the volumetric fraction of all components in the gas.

$$FM_{RG,h} = \rho_{RG,n,h} * FV_{RG,h} \qquad \textbf{(T.1)}^{27}$$

Where:

$FV_{RG,h}$	Volumetric flow rate of the residual gas in dry basis at normal conditions in hour *h* (in m^3/h)
$\rho_{RG,n,h}$	Density of the residual gas at normal conditions in hour *h* (in kg/m^3). $\rho_{RG,n,h}$ is determined as follows:

$$\rho_{RG,n,h} = \frac{P_n}{\frac{R_u}{MM_{RG,h}} * T_n} \qquad \textbf{(T.2)}$$

Where:

$\rho_{RG,n,h}$	Density of the residual gas at normal conditions in hour *h* (in kg/m^3)
P_n	Atmospheric pressure at normal conditions (101,325 Pa)
R_u	Universal ideal gas constant (8.314 $Pa.m^3/kmol.K$)
$MM_{RG,h}$	Molecular mass of the residual gas in hour *h* (kg/kmol). $MM_{RG,h}$ is determined as follows:

$$MM_{RG,h} = \sum_i \left(fv_{i,h} * MM_i \right) \qquad \textbf{(T.3)}$$

Where:

$fv_{i,h}$	Volumetric fraction of component *i* in the residual gas in the hour *h*
MM_i	Molecular mass of residual gas component *i* (kg/kmol)
i	The components CH_4, CO, CO_2, O_2, H_2, N_2

The methodological tool states that "*As a simplified approach, project participants may only measure the volumetric fraction of methane and consider the difference to 100% as being nitrogen (N_2).*" While the methodological tool is applicable to a wide variety of residual gases to be flared, LFG is a gas generated as

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[27] All equations which refer to numbers from the Tool, are prefixed with the letter "T" to distinguish them from equations from the methodology.

result of anaerobic decomposition where hydrogen (H_2) and carbon monoxide (CO) are not produced. Thus, these two gases can be eliminated from the calculations, without any assumptions. The simplification proposed in the methodological tool involves considering only CO_2 and O_2 as N_2. Although this leads to minor errors, this simplified approach greatly simplifies related measurements without significantly affecting the estimate of flare efficiency. By considering such simplification, Eq. (T.3) becomes:

$$MM_{RG,h} = \sum_i \left(fv_{i,h} * MM_i \right) \tag{T.3a}$$

Where:

$fv_{i,h}$	Volumetric fraction of component *i* in the residual gas in the hour *h*
MM_i	Molecular mass of residual gas component *i* (kg/kmol)
i	The components CH_4, N_2. (where only CH_4 is measured and N_2 is determined as the balance)

Elemental hydrogen is a part of methane and therefore the hydrogen content of the residual gas affects its stoichiometry

Step 2: Determination of the mass fraction of carbon, hydrogen, oxygen and nitrogen in the residual gas ($fm_{i,h}$).

As established by the methodological tool, the mass fractions of carbon, hydrogen, oxygen and nitrogen in the residual gas ($fm_{i,h}$) is calculated by considering the the volumetric fraction of each component *i* in the residual gas as follows:

$$fm_{j,h} = \frac{\sum_i fv_{i,h} * AM_j * NA_{j,i}}{MM_{RG,h}}$$

(T.4)

Where:

$fm_{i,h}$	Mass fraction of element *j* in the residual gas in hour *h*
$fv_{i,h}$	Volumetric fraction of component *i* in the residual gas in the hour *h*
AM_j	Atomic mass of element *j* (in kg/kmol)
$NA_{j,i}$	Number of atoms of element *j* in component *i*
$MM_{RG,h}$	Molecular mass of the residual gas in hour *h* (in kg/kmol)

j	The elements carbon, hydrogen, oxygen and nitrogen. As per the applied simplified approach involving measurement of methane and assuming the balance to be nitrogen, it is implied that there is no elemental oxygen in the gas, and that all the carbon is in the form of methane. Thus, only hydrogen is also in methane, but this does not involve any simplification, since there is no H_2 in the other components that might be present in landfill gas: CO_2 and O_2.
i	The components CH_4 and N_2. As per the applied simplified approach, the concentrations of other gases are not determined.

Step 3: Determination of the volumetric flow rate of the exhaust gas on a dry basis ($TV_{n,FG,h}$)

As established by the methodological tool, while methane combustion efficiency in the enclosed high temperature flare(s) is to be continuously measured, this step is applicable as follows: It is determined the average volumetric flow rate of the exhaust gas in each hour *h* (in dry basis) based on a stoichiometric calculation of the combustion process. Such calculation depends on the chemical composition of the residual gas, the amount of air supplied to combust the gas stream as well as the composition of the exhaust gas (after combustion) as follows:

$$TV_{n,FG,h} = V_{n,FG,h} * FM_{RG,h}$$

(T.5)

Where:

$TV_{n,FG,h}$	Volumetric flow rate of the exhaust gas in dry basis at normal conditions in hour *h* (in m^3/h)
$FM_{RG,h}$	Mass flow rate of the residual gas in hour *h* (in kg residual gas/h)
$V_{n,FG,h}$	Volume of the exhaust gas of the flare in dry basis at normal conditions per kg of residual gas in hour *h* (in m^3/kg residual gas). $V_{n,FG,h}$ is determined as follows:

$$V_{n,FG,h} = V_{n,CO_2,h} + V_{n,O_2,h} + V_{n,N_2,h}$$

(T.6)

Where:

$V_{n,CO2,h}$ Quantity of CO_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h* (in m^3/kg residual gas). $V_{n,CO2,h}$ is determined as follows:

$$V_{n,CO_2,h} = \frac{fm_{C,h}}{AM_C} * MV_n$$

(T.9)

Where:

$fm_{C,h,}$ Mass fraction of carbon in the residual gas in the hour *h*

AM_C	Atomic mass of carbon (in kg/kmol)
MV_n	Volume of one mole of any ideal gas at normal temperature and pressure (22.4 m^3/kmol)

$V_{n,N2,h}$ Quantity of N_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h* (in m^3/kg residual gas). $V_{n,N2,h}$ is determined as follows:

$$V_{n,N_2,h} = MV_n * \left\{ \frac{fm_{N,h}}{200AM_N} + \left(\frac{1-MF_{O_2}}{MF_{O_2}} \right) * \left[F_h + n_{O_2,h} \right] \right\}$$

(T.8)

Where:

$fm_{N,h}$	Mass fraction of nitrogen in the residual gas in the hour *h*
AM_N	Atomic mass of nitrogen (in kg/kmol)
MF_{O2}	O_2 volumetric fraction of air (0.21)
F_h	Stoichiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in hour *h (in* kmol/kg residual gas). F_h is determined as follows:

$$F_h = \frac{fm_{C,h}}{AM_C} + \frac{fm_{H,h}}{4AM_H} - \frac{fm_{O,h}}{2AM_O}$$

(T.11)

Where:

$fm_{H,h}$	Mass fraction of hydrogen in the residual gas in hour *h*
$fm_{O,h}$	Mass fraction of oxygen in the residual gas in hour *h*
AM_H	Atomic mass of hydrogen (in kg/kmol)
AM_O	Atomic mass of oxygen (in kg/kmol)

$fm_{C,h}$, AM_C are defined as presented above and below.

$n_{O2,h}$ Quantity of moles O_2 in the exhaust gas of the flare per kg residual gas flared in hour *h* (in kmol/kg residual gas)

$V_{n,O2,h}$ Quantity of O_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h* (in m^3/kg residual gas). $V_{n,O2,h}$ is determined as follows:

$$V_{n,O_2,h} = n_{O_2,h} * MV_n$$

(T.7)

Where:

MV_n Volume of one mole of any ideal gas at normal temperature and pressure (22.4 m^3/kmol)

$n_{O2,h}$ Quantity of moles O_2 in the exhaust gas of the flare per kg residual gas flared in hour *h* (in kmol/kg residual gas). $n_{O2,h}$ is determined as follows:

$$n_{O_2,h} = \frac{t_{O_2,h}}{\left(1-\left(t_{O_2,h}/MF_{O_2}\right)\right)} * \left[\frac{fm_{C,h}}{AM_C} + \frac{fm_{N,h}}{200AM_N} + \left(\frac{1-MF_{O_2}}{MF_{O_2}}\right) * F_h\right]$$

(T.10)

Where:

$t_{O2,h}$ Volumetric fraction of O_2 in the exhaust gas in hour *h*

MF_{O2}, $fm_{C,h}$, $fm_{N,h}$, AM_C, AM_N *and* F_h are defined as presented above and below.

Step 4: Determination of methane mass flow rate in the exhaust gas of the flare(s) on a dry basis ($TM_{FG,h}$)

As established by the methodological tool, the mass flow of methane in the exhaust gas of the flare(s) ($TM_{FG,h}$) is determined (in kg/h) based on the volumetric flow of the exhaust gas of the flare(s) and the measured concentration of methane in the exhaust gas of the flare(s), as follows:"

$$TM_{FG,h} = \frac{TV_{n,FG,h} * fv_{CH_4,FG,h}}{1{,}000{,}000}$$

(T.12)

Where:

$TV_{n,FG,h}$ Volumetric flow rate of the exhaust gas in dry basis at normal conditions in hour *h(*in m^3/h exhaust gas)

$fv_{CH4,FG,h}$	Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in hour *h (in* mg/m^3)

Step 5: Determination of methane mass flow rate in the residual gas on a dry basis

As established by the methodological tool, the flow rate of methane in the gas flowing into the flare (LFG) is the product of the volumetric flow rate of collected LFG which is sent to the flare(s) ($FV_{RG,h}$), the volumetric fraction of methane in collected LFG ($fv_{CH4,RG,h}$) and the density of methane ($\rho_{CH4,n,h}$) in the same reference conditions (normal conditions and dry or wet basis). This is outlined in the formulae below:

The methodological tool also establishes that it is necessary to refer both measurements (flow rate of the LFG gas sent to the flare(s) and volumetric fraction of methane in LFG) to the same reference condition that may be dry or wet basis.

$$TM_{RG,h} = FV_{RG,h} * fv_{CH_4,RG,h} * \rho_{CH_4,n}$$

(T.13)

Where:

$TM_{RG,h}$	Mass flow rate of methane in the residual gas in the hour *h* (in kg/h)
$FV_{RG,h}$	Volumetric flow rate of the residual gas in dry basis at normal conditions in hour *h* (in m^3/h)
$fv_{CH4,RG,h}$	Volumetric fraction of methane in the residual gas on dry basis in hour *h* (NB: this corresponds to $fv_{i,RG,h}$ where *i* refers to methane).
$\rho_{CH_4,n}$	Density of methane at normal conditions (0.7168 kg/m^3)

Step 6: Determination of the hourly flare efficiency

The methodological tool establishes that the determination of the hourly flare efficiency depends on aspects such as the operation of flare (e.g. temperature), the type of flare used (open or enclosed) and, in case of enclosed flares, the approach selected by project participants to determine the flare efficiency (default value or continuous monitoring). For the project activity both approaches are considered to be adopted along the crediting period, where continuous monitoring is the preferable approach. The approach involving utilization of default values will be adopted in case required equipment for applying continuous monitoring option and/or related measurement records are not available.

In case and use of continuous monitoring approach, the flare efficiency in the hour h ($\eta_{flare,h}$) is:

- 0% if the temperature of the exhaust gas of the flare (T_{flare}) is below 500 °C during more than 20 minutes during the hour h.
- Determined as follows in cases where the temperature of the exhaust gas of the flare (T_{flare}) is above 500 °C for more than 40 minutes during the hour h:”

$$\eta_{flare,h} = 1 - \frac{TM_{FG,h}}{TM_{RG,h}} \qquad \textbf{(T.14)}$$

Where:

$TM_{FG,h}$	Methane mass flow rate in exhaust gas averaged in hour *h* (in kg/h)
$TM_{RG,h}$	Mass flow rate of methane in the residual gas in the hour *h* (in kg/h)

In case monitoring records for continuous measurement of the flare efficiency are not available due, for example to maintenance or failure in related equipment, the following method involving the use of default values will be used:

- 0% if the temperature in the exhaust gas of the flare (T_{flare}) is below 500 °C for more than 20 minutes during the hour *h*.
- 50%, if the temperature in the exhaust gas of the flare (T_{flare}) is above 500 °C for more than 40 minutes during the hour *h*, but the manufacturer's specifications on proper operation of the flare are not met at any point in time during the hour *h*.
- 90%, if the temperature in the exhaust gas of the flare (T_{flare}) is above 500 °C for more than 40 minutes during the hour *h* and the manufacturer's specifications on proper operation of the flare are met continuously during the hour *h*.

Step 7: Calculation of annual project emissions from flaring ($PE_{flare\ y}$)

The methodological tool establishes that project emissions from flaring are calculated (in tCO_2e) as the sum of emissions from each hour *h*, based on the methane flow rate in the residual gas ($TM_{RG,h}$) and the flare efficiency during each hour h ($\eta_{flare,h}$), as follows:

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} * \left(1 - \eta_{flare,h}\right) * \frac{GWP_{CH_4}}{1000}$$

(T.15)

Where:

$TM_{RG,\ h}$	Mass flow rate of methane in the residual gas in the hour *h* (in kg/h)
$\eta_{flare,\ h}$	Flare efficiency in hour *h*
GWP_{CH4}	Global Warming Potential of methane (in tCO_2e/tCH_4)

The following fixed constants will be considered for related calculations of $PE_{flare\ y}$ presented in Steps above:

Parameter	SI Unit	Description	Value
MM_{CH4}	kg/kmol	Molecular mass of methane	16.04
MM_{CO}	kg/kmol	Molecular mass of carbon monoxide	28.01
MM_{CO2}	kg/kmol	Molecular mass of carbon dioxide	44.01
MM_{O2}	kg/kmol	Molecular mass of oxygen	32.00
MM_{H2}	kg/kmol	Molecular mass of hydrogen	2.02

Parameter	SI Unit	Description	Value
MM_{N2}	kg/kmol	Molecular mass of nitrogen	28.02
AM_c	kg/kmol (g/mol)	Atomic mass of carbon	12.00
AM_h	kg/kmol (g/mol)	Atomic mass of hydrogen	1.01
AM_o	kg/kmol (g/mol)	Atomic mass of oxygen	16.00
AM_n	kg/kmol (g/mol)	Atomic mass of nitrogen	14.01
Pn	Pa	Atmospheric pressure at normal conditions	101,325
R_u	$Pa.m^3/kmol.K$	Universal ideal gas constant	8,314.472
T_n	K	Temperature at normal conditions	273.15
GWP_{CH4}	tCO_2/tCH_4	Global warming potential of methane	21
$D_{CH4,n,h}$	t/m^3	Density of methane gas at normal conditions	0.0007168
$NA_{i,j}$	Dimensionless	Number of atoms of element *j* in component *i*, depending on molecular structure	-

Step A.1.1: Ex ante estimation of $F_{CH4,PJ,y}$

An ex-ante estimate of $F_{CH4,PJ,y}$ is required to estimate baseline emission of methane in the considered SWDS (Rio Grande landfill) in order to estimate the annual emission reductions for the proposed project activity. While the determined ex-ante estimations of emission reduction are presented in Section B.6.3, the determination of ex-ante estimations of $F_{CH4,PJ,y}$ (in tCO_2e) is performed as follows:

$$F_{CH4,PJ,y} = \eta_{PJ} * BE_{CH4,SWDS,y} / GWP_{CH4} \qquad \textbf{(15)}$$

Where:

η_{PJ}	Efficiency of the LFG capture system that will be installed in the project activity
GWP_{CH4}	Global warming potential of CH_4 (in tCO_2e/tCH_4)
$BE_{CH4,SWDS,y}$	Amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* (in tCO_2e). $BE_{CH4,SWDS,y}$ is determined by applying applicable guidance of the methodological tool "Emissions from solid waste disposal sites" (version 06.0.1) by *inter alia* considering the following:

- f_y in the methodological tool is assigned a value of 0 because the amount of LFG that would have been captured and destroyed is already accounted
- In the methodological tool, *x* begins with the year that MSW started to be disposed in the Rio Grande landfill; and
- Sampling to determine the fractions of different waste types is not necessary as waste composition can be obtained from previous studies and no MSW disposal is prevented as a result of the operation of the project.

By following applicable guidance of the methodological tool $BE_{CH4,SWDS,y}$ is determined as follows:

$$\mathrm{BE}_{\mathrm{CH4,SWDS,y}} = \varphi_y * \left(1\text{-}\mathrm{f}_{\mathrm{y}}\right) * \mathrm{GWP}_{\mathrm{CH4}} * \left(1 - OX\right). * \frac{16}{12} * F * DOC_{f,y} * MCF_y * \sum_{x=1}^{y} \sum_{j} W_{j,x} * DOC_j * e^{-k_j.(y-x)} * \left(1 - e^{-k_j}\right)$$

(TW.1[28])

Where:

x	Years in the time period in which waste is disposed at the landfill, extending from the first year in the time period (x = 1) to year y (x = y)
y	Year of the crediting period for which methane emissions are calculated (y is a consecutive period of 12 months)
$\mathrm{DOC}_{\mathrm{f,y}}$	Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring in the SWDS for year y (weight fraction) (as per option A of the methodological tool "Emissions from solid waste disposal sites", $DOC_{f,y} = DOC_{f,default}$)
$\mathrm{W}_{\mathrm{j,x}}$	Amount of solid waste type j disposed or prevented from disposal in the SWDS in the year x (t). For every year x, it is assumed for $\mathrm{W}_{\mathrm{j,x}} = 0$.
φ_{y}	Model correction factor to account for model uncertainties
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 year y
$\mathrm{GWP}_{\mathrm{CH4}}$	Global Warming Potential of methane
OX	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
F	Fraction of methane in the SWDS gas (volume fraction)
$\mathrm{MCF}_{\mathrm{y}}$	Methane correction factor for year y (as per option A of the methodological tool "Emissions from solid waste disposal sites", $MCF_y = MCF_{default}$)
$\mathrm{DOC}_{\mathrm{j}}$	Fraction of degradable organic carbon in the waste type j (weight fraction)
k_{j}	Decay rate for the waste type j (1 / yr)
j	Type of residual waste or types of waste in the MSW

The value and source of information for each of the variables above are given in section B.6.2. The Project Participants wish to emphasize that the characteristics of the waste used as inputs for this ex-ante estimation are the ones recommended by IPCC, therefore no sampling of waste is necessary. Also, the

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[28] Equation numbers from the "Emissions from solid waste disposal sites" are prefixed with the letter "TW" to distinguish them from equations from the methodology.

project activity does not prevent waste from being deposited at the landfill. The result of the ex-ante estimations of $BE_{CH4,SWDS,y}$ is presented in Section B.6.3.

Step A.2: Determination of $F_{CH4,BL,y}$

As required by ACM0001 (version 13.0.0), this step provides a stepwise procedure for the determination of the amount of methane that would have been captured and destroyed in the baseline scenario (absence of the project) due to regulatory or contractual requirements, or to address safety and odors concerns (collectively referred to as *requirement* under this step). The four cases summarized in the table below are distinguished in ACM0001 (version 13.0.0). As also required by ACM0001 (version 13.0.0), the appropriate case is identified and justified below.

Cases for determining methane captured and destroyed in the baseline as per ACM0001 (version 13.0.0)

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

Requirement to destroy methane:

Non-existence of regional or national regulatory or contractual requirements related to LFG management in the region of the project site and in Brazil: There is no legal obligation to capture and destroy the LFG at the Rio Grande landfill.

Existence of non-regulatory requirements to destroy methane due to odor concerns: In the case of the project activity, it is assumed that a requirement to destroy methane exists due to following:

- Although there is no regional or national legal requirement in Brazil establishing LFG to be collected and destroyed in landfills, in the particular case of the Rio Grande landfill, as per the project design and operational licensing requirements, a non-defined share of LFG is to be destroyed by combustion in existing LFG venting/combustion drains in order to address odors concerns. While as per the methodological approach of ACM0001 (version 13.0.0) for determination of $F_{CH4,BL,y}$ any destruction of LFG to address safety and/or odor concerns are to be regarded as an existing requirement to destroy methane, it is thus assumed that, in the particular case of the Rio Grande landfill, there is a requirement to destroy methane.

By taking this assumption into account, thus, Case 1 and Case 3 are not applicable for the determination of $F_{CH4,BL,y}$ in the case of the Rio Grande landfill gas project.

Existence of LFG capture and destruction system at the Rio Grande landfill:

A very small fraction of methane generated in the Rio Grande landfill has been destroyed through combustion by the existing conventional LFG venting/combustion drains. Under the baseline scenario (absence of the project), such destruction of very small share of generated methane would continue to occur through the existing LFG venting/combustion drains (and through additional LFG venting/combustion drains that would otherwise been implemented as part of the forecasted expansion of the area of the landfill). In order to address the existing requirement of destroying methane in order to address odor concerns, the existing LFG venting/combustion drains would be maintained and expended (addition of new LFG venting/combustion drains).

By taking into account the definitions of "LFG capture system" and "existing LFG capture system" as per ACM0001 (version 13.0.0)[29], it is thus assumed that there is an existing LFG capture system at the Rio Grande landfill. While combustion of LFG in passive (conventional) flares represents destruction of methane, it is thus assumed that there is an existing LFG capture and destruction system at the Rio Grande landfill. Therefore, Case 2 is not applicable either and the applicable case for the project activity is Case 4 (Requirement to destroy methane = Yes + Existing LFG capture and destruction system = Yes)

Currently there is a LFG capture and destruction system available in the Rio Grande landfill. As per the design of the landfill, a set of LFG venting/combustion drains are available in the site and LFG is combusted as a priority. When the LFG venting/combustion drains are not lid, LFG is freely emitted into the atmosphere through the drains. In practical terms, a very small amount of LFG is actually combusted in these existent LFG venting/combustion drains due to the following reasons:

- The design of the existent venting/combustion drains is somehow rudimentary and it does not allow continuous combustion of LFG as such drains are not conceived for continuous combustion of LFG. Due to aspects and conditions such as the diameter of the LFG venting drains, pressure of LFG in the drains, influence of wind and other climate aspects (e.g. rain), as well as the typical operational conditions at the Rio Grande landfill (no working staff has ever been required to attempt to continuously combust LFG in the venting/combustion drains and/or monitor conditions of the LFG venting/combustion drains (e.g. regular checking whether the drains are alight), LFG has not been continuously combusted in the LFG venting/combustion drains. Thus, in the absence of the proposed CDM project activity, no continuous combustion of LFG through the existent drains (and additional drains that would be otherwise installed) would occur as there is no legal requirement to destroy methane in the Rio Grande landfill and the operators of the landfill does not have any incentive to convert the existing LFG venting/combustion drains into a more appropriate LFG flaring system. Non-continuous combustion of LFG through conventional LFG venting/combustion drains has been the practice not only in this landfill, but also in several others landfills and dump sites in Brazil and other countries in Latin America where no legal requirements for destruction of LFG exists. In most of the cases, where combustion of LFG to address odors requirements is not an issue, LFG is actually directly vented through the drains (without any LFG being combusted).

In the absence of the project activity (baseline scenario), converting in existent LFG venting/combustion drains into appropriate LFG flaring system, would require investment, operational costs and extra work from the landfill operational team.

Application of methodological guidance valid for Case 4:

Under Case 4, the following is applicable as per ACM0001 (version 13.0.0):

"$F_{CH4,BL,y}$ *shall be determined based on information in contract of regulation requirements and data related to the existing LFG capture system, as follows:*

$$F_{CH4,BL,y} = max\{F_{CH4,BL,R,y}; F_{CH4,BL,sys,y}\} \qquad \textbf{(15)}$$

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[29] As per ACM0001 (version 13.0,0), "LFG capture system" is defined as follows: "*A system to capture LFG. The system may be passive, active or a combination of both active and passive components. Passive systems capture LFG by means of natural pressure, concentration, and density gradients. Active systems use mechanical equipment to capture LFG by providing pressure gradients. Captured LFG can be vented, flared or used*".
As per ACM0001 (version 13.0,0), "existing LFG capture system" is defined as follows: "*An existing active LFG capture system is a system that has been in operation in the last calendar year prior to the start of the operation of the project activity.*"

Where:

$F_{CH4,BL,R,y}$	*Amount of methane in the LFG which is flared in the baseline due to a requirement in year y (in* tCH_4/yr*)*
$F_{CH4,BL.sys,y}$	*Amount of methane in the LFG that would be flared in the baseline in year y for the case of an existing LFG capture system (in* tCH_4/yr*)*

$F_{CH4,BL,R,y}$ *and* $F_{CH4,BL.sys,y}$ *shall be determined according to the respective procedures for Case 2 and Case 3 (...)*".

By applying the applicable guidance of Case 2 in the particular context of the Rio Grande landfill gas project, while the existing requirement (for addressing odor concerns) does not specify the amount or percentage of LFG that should be destroyed but requires the installation of a system to capture and flare the LFG, then a typical destruction rate of 20% is assumed[30].

Thus,

$$F_{CH4,BL,R,y} = 0.2 * F_{CH4,PJ,capt,y} \quad \textbf{(16)}$$

Where

$F_{CH4,PJ,capt,y}$	Amount of methane in the LFG which is captured in the project activity in year *y* (in tCH_4/yr). As the project design only encompasses LFG collection and flaring (no utilization of collected LFG as fuel for electricity or heat generation and no utilization of LFG by consumers through natural gas distribution network), $F_{CH4,PJ,capt,y}$ is equal to the amount of methane supplied to the flare(s) ($F_{CH4,sent\_flare,y}$).

By applying the applicable guidance of Case 3 in the particular context of the Rio Grande landfill gas project, while there is no monitored or historic data on the amount of methane that was captured in the year prior to the implementation of the project situation then:

$$F_{CH4,BL.sys,y} = 0.2 * F_{CH4,PJ.,y} \quad \textbf{(17)}$$

While in the case of the Rio Grande landfill gas project, $F_{CH4,PJ.,y} = F_{CH4,flared.,y,}$ the following is this applicable:

$$F_{CH4,BL.sys,y} = 0.2 * F_{CH4,flared,y}$$

Although the value of $F_{CH4,flared,y}$ along the 7-year renewable crediting period is expected to be always lower than the value of $F_{CH4,sent\_flare,y}$ $F_{CH4,BL,y}$ is determined as follows:

$F_{CH4,BL,y} = 0.2 * F_{CH4,sent\_flare,y}$ [31]

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[30] As per ACM0001 (version 13.0.0): "*This default value of 20% is based on assuming a situation in which: the efficiency of the LFG capture system in the project is 50%; the efficiency of the LFG capture system in the baseline is 20%; and, the amount captured in the baseline is flared using an open flare with a destruction efficiency of 50% (consistent with the default value provided in the .Tool to determine project emissions from flaring gases containing methane).*"

[31] It is important to note that, differently than values for $F_{CH4,flared,y,}$ values for $F_{CH4,sent\_flare,y}$ are not determined as a function of the determined efficiency of the flare (which can zero in case of not appropriate monitoring or operation conditions of the flare). Thus, as a conservative approach, $F_{CH4,BL,y} = 0.2 * F_{CH4,sent\_flare,y}$.

Monitoring of the management of the Rio Grande landfill:

The design and operational conditions of the Rio Grande landfill will be annually monitored on the basis of different sources, including *inter alia*:

- Original design of the landfill;
- Technical specifications for the management of the Rio Grande landfill;
- Applicable local or national regulations

Original design of the Rio Grande landfill should be confirmed not to be modified in order to ensure that no practice to increase methane generation have been occurring prior or after the implementation of the project activity. Any change in the management of the landfill after the implementation of the project activity should be justified by referring to technical or regulatory specifications.
Such monitoring procedure will be used for the determination of baseline emissions and/or confirmation of the project's implementation as described in the registered PDD (in terms of conditions of the landfill from which LFG is combusted).

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

As the project design currently does not encompass utilization of collected LFG for electricity generation, baseline emissions associated with electricity generation in year *y* ($BE_{EC,y}$) are not considered. Thus, this step is not applicable.

Step C: Baseline emissions associated with heat generation ($BE_{HG,y}$)

As the project design does not encompass utilization of collected LFG for heat generation, baseline emissions associated associated with heat generation in year *y* ($BE_{HG,y}$) are not considered. Thus, this step is not applicable.

Step D: Baseline emissions associated with natural gas use ($BE_{NG,y}$)

As the project design does not encompass utilization of collected LFG displacing the use of natural gas or injection of collected LFG into a natural gas distribution network, baseline emissions associated with natural gas use in year *y* ($BE_{NG,y}$) are not considered. Thus, this step is not applicable.

Determination of project emissions (PE_y):

As established by ACM0001 (version 13.0.0), project emissions in year *y* (PE_y) are calculated (in tCO_2/yr) as follows:

$$PE_y = PE_{EC,y} + PE_{FC,y} \tag{17}$$

Where:

$PE_{EC,y}$	Project emissions due to the consumption of electricity by the project activity in year *y* (in tCO_2/yr)
$PE_{FC,y}$	Project emissions due to the consumption of fossil fuels by the project activity (for purpose other than electricity generation) in year *y* (in tCO_2/yr)

Details about the determination of $PE_{EC,y}$ and $PE_{FC,y}$ are presented below:

Project emissions due to the consumption of electricity by the project activity ($PE_{EC,y}$)

As established by ACM0001 (version 13.0.0), project emissions due to the consumption of electricity by the project activity *($PE_{EC,y}$)* are calculated by following the applicable guidance of the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” with the following observations:

Project emissions from electricity consumption in year *y* ($PE_{EC,y}$) is calculated (in tCO_2/yr) as follows:

$$PE_{EC,y} = \sum_j EC_{PJ\ j,y} * EF_{EL,j,y} * (1 + TDL_{j,y}) \qquad \textbf{(18)}$$

Where:

$EC_{PJ,j,y}$	Quantity of electricity consumed by the project electricity consumption (from source *j*) in year *y* (in MWh). As under the baseline scenario (absence of the project activity) no LFG would be collected and destroyed ($F_{CH4,BL,y}$= 0), the amount of electricity consumed in the baseline scenario is thus null. Thus, no deduction in the total electricity consumption by the project ($EC_{PJ,j,y}$) should be performed in order to determine the net quantity of electricity consumption by the project activity (i.e. the increase due to the project activity).
$EF_{EL,j,,y}$	Emission factor for electricity generation for source *j* in year *y* (in tCO_2/MWh).
$TDL_{j},_{y}$	Average technical transmission and distribution losses for providing electricity to source *j* in year *y*.
j	Sources of electricity consumption in the project Electricity sources *j* in the methodological tool corresponds to the sources of electricity consumed due to the project activity. All electricity demand of the project activity is expected to be met by imports of grid electricity. The use of captive off-grid electricity generator fuelled by diesel is not expected to occur. Thus, $EC_{PJ,j,y} = EC_{PJ,grid,y}$; $EF_{EL,j,,y} = EF_{EL,grid,,y}$ and $TDL_{j},_{y} = TDL_{grid\ ,y}$.

Equation (18) is thus re-organized as follows:

$$PE_{EC,y} = EC_{PJ\,grid,y} * EF_{EL,grid,y} * \left(1 + TDL_{grid,y}\right) \tag{18.1}$$

Where:

$EC_{PJ,grid,y}$	Quantity of grid electricity consumed by the project activity in year *y* (in MWh).
$TDL_{grid,y}$	Average technical transmission and distribution losses in the National Grid of Brazil in year *y*.
$EF_{EL,grid,y}$	Emission factor for grid electricity generation in year *y* (in tCO_2/MWh). The project activity will consume electricity sourced by the National Electricity Grid of Brazil. This grid is locally denominated *Sistema Interconectado Nacional (SIN)* (Brazilian Interconnected System). The DNA of Brazil has published the delineation of SIN grid to be adopted for the purposes of CDM projects. As per Resolution Nº8 of the DNA of Brazil, the connected electricity system to be considered in this project activity is considered as a single system consisted by the sub-markets of SIN as the definition of the electric system of the project. As established by the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption", $EF_{EL,grid,y}$ will be calculated ex-post as the Combined margin CO_2 emission factor ($EF_{grid,CM,y}$) for the SIN grid by following the applicable guidance of the latest version of the "Tool to calculate the emission factor for an electricity system". The following equations are applicable for the determination of $EF_{grid,CM,y}$:

$$EF_{grid,CM,y} = w_{OM} * EF_{grid,OM,y} + w_{BM} * EF_{grid,BM,y} \tag{19}$$

Where:

$EF_{grid,OM,y}$	Operating margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EF_{grid,BM,y}$	Build margin CO_2 emission factor in year *y* (tCO_2/MWh)
w_{OM}	Weighting of operating margin emissions factor (%)
w_{BM}	Weighting of build margin emissions factor (%)

The weighting factors for build and operating margin were selected according to guidance provided in the "Tool to calculate the emission factor for an electricity system". $EF_{grid,OM,y}$ will be calculated by applying calculation guidance of the methodological tool applicable for *dispatch data analysis OM*. Under this calculation method, data for the year in which the project activity consumes grid electricity is considered for determining emission factor annually during monitoring. As per this method $EF_{grid,OM,y}$ is determined based on the grid power units that are actually dispatched at the margin during each hour *h*. $EF_{grid,OM,y}$ is calculated (in tCO_2/MWh) as the dispatch data analysis operating margin CO_2 emission factor in year *y* ($EF_{grid,OM\text{-}DD,y}$).

For the first crediting period, the build margin CO_2 emission factor will be updated annually, ex-post, including those units built up to the year of registration of the project activity or, if information up to the year of registration is not yet available, including those units built up to the latest year for which information is available.

Annual official values for $EF_{grid,OM,}$ and $EF_{grid,BM,y}$ are regularly calculated and published by the DNA of Brazil (Brazilian Inter-ministerial Commission for Global Climate Change). As per information made publicly available by the DNA of Brazil, such official values for $EF_{grid,OM,}$ and $EF_{grid,BM,y}$ are calculated in full accordance with the most recent version of the "Tool to calculate the emission factor for an electricity system".

Project emissions due to the consumption of fossil fuels by the project activity (for purpose other than electricity generation)($PE_{FC,y}$)

Since the project activity is not expected to consume any fossil fuel (for purpose other than electricity generation) either, project emissions due to the consumption of fossil fuel by the project activity are not considered. Thus, $PE_{FC,y} = 0$.

Determination of leakage emissions:

No leakage emissions are expected to occur. Moreover, no leakage effects are accounted for under ACM0001 (version 13.0.0).

B.6.2. Data and parameters fixed ex ante

Data / Parameter	OX_{top_layer}
Unit	Dimensionless
Description	Fraction of methane that would be oxidized in the top layer of the SWDS in the baseline
Source of data	Consistent with how oxidation is accounted for in the methodological tool "Emissions from solid waste disposal sites" (version 06.0.1)
Value(s) applied	0.1
Choice of data or Measurement methods and procedures	Default value as per ACM0001"Flaring or use of landfill gas", Version 13.0.0
Purpose of data	Determination of baseline emissions
Additional comment	Data is used for the determination of baseline emissions.

Data / Parameter	GWP_{CH4}
Unit	tCO2e/tCH4
Description	Global Warming Potential (GWP) of methane
Source of data	IPCC's Second Assessment Report (SAR), 1995
Value(s) applied	21
Choice of data or Measurement methods and procedures	-
Purpose of data	Determination of baseline emissions
Additional comment	The applied value shall be updated according to any future COP/MOP decisions and/or decision by the CDM-EB.

Data / Parameter	R_u
Unit	$Pa.m^3/kmol.K$
Description	Universal ideal gases constant
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream (Version 02.0.0)
Value(s) applied	8.314
Choice of data or Measurement methods and procedures	-
Purpose of data	Determination of baseline emissions
Additional comment	-

Data / Parameter	MM_i
Unit	kg/kmol
Description	Molecular mass of greenhouse gas *i*
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream (Version 02.0.0)
Value(s) applied	

Compound (*i*)	Structure	Molecular mass (kg / kmol)
Carbon dioxide	CO_2	44.01
Methane	CH_4	16.04

Choice of data or Measurement methods and procedures	-
Purpose of data	Data is used for the determination of baseline emissions (calculation of project emissions of from flaring ($PE_{flare\ y}$) when the continuous monitoring flare efficiency determination approach is selected).
Additional comment	-

Data / Parameter	MM_k
Unit	kg/kmol
Description	Molecular mass of gas *k*
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 02.0.0)
Value(s) applied	For gases *k* that are greenhouse gases, the values below are applied for MMi. <table><tr><th>Compound</th><th>Structure</th><th>Molecular mass (kg / kmol)</th></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></table>
Choice of data or Measurement methods and procedures	-
Purpose of data	Determination of baseline emissions
Additional comment	-
Data / Parameter	MM_{H2O}
Unit	kg/kmol
Description	Molecular mass of water
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream (Version 02.0.0)
Value(s) applied	18.0152 kg/kmol
Choice of data or Measurement methods and procedures	-
Purpose of data	Determination of baseline emissions
Additional comment	-

Data / Parameter	P_n
Unit	Pa
Description	Total pressure at normal conditions
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream (Version 02.0.0)
Value(s) applied	101,325 Pa
Choice of data **or** **Measurement methods and procedures**	-
Purpose of data	Determination of baseline emissions
Additional comment	-

Data / Parameter	T_n
Unit	K
Description	Temperature at normal conditions
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream (Version 02.0.0)
Value(s) applied	273.15
Choice of data **or** **Measurement methods and procedures**	-
Purpose of data	Determination of baseline emissions
Additional comment	-

Data / Parameter	η_{PJ}
Unit	-
Description	Efficiency of the LFG capture system that will be installed in the project activity
Source of data	Estimated by project participants.
Value(s) applied	0.75
Choice of data or Measurement methods and procedures	Value obtained from the mentioned literature[32], based on the forecasted physical characteristics of the site and on the planned general design LFG collection network.
Purpose of data	Determination of baseline emissions
Additional comment	Selected value can also be represented as percentage, since 0.75 = 75%

Data / Parameter	$TDL_{grid,y}$
Unit	-
Description	Transmission and distribution losses for electricity generation in the National Electricity Grid of Brazil.
Source of data	Applicable default as per the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”
Value(s) applied	20%
Choice of data or Measurement methods and procedures	-
Purpose of data	Data is used for the determination of project emissions due to the consumption of grid electricity by the project activity.
Additional comment	-

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[32] The findings of the study “*Magalhães, G.HC.; Alves, J.W.S.; Santo Filho. F.; Kelson, M. Reducing the uncertainty of methane recovered (R) in greenhouse gas inventories from waste sector and of adjustment factor (AF) in landfill gas projects under the Clean Development Mechanism”* justify the selected value for ex-ante determined parameter η_{PJ}. This technical paper, which was issued on 27/05/2010 is webhosted at the website of CETESB (the environmental authority for São Paulo State in Brazil):
http://www.cetesb.sp.gov.br/userfiles/file/mudancasclimaticas/biogas/file/docs/artigos_dissertacoes/magalhaes_alves_santofilho_costa_kelson.pdf

Data / Parameter	w_{BM}
Unit	-
Description	Weighting of build margin emissions factor
Source of data	Applicable default value as per the “Tool to calculate the emission factor for an electricity system” (Version 02.2.1)
Value(s) applied	0.5 (50%) for the first crediting period
Choice of data **or** **Measurement methods and procedures**	The applicable value as per the “Tool to calculate the emission factor for an electricity system” (Version 02.2.1) is selected.
Purpose of data	Data is used for the determination of project emissions due to the consumption of grid electricity by the project activity.
Additional comment	-

Data / Parameter	w_{OM}
Unit	-
Description	Weighting of operating margin emissions factor
Source of data	Applicable default value as per the “Tool to calculate the emission factor for an electricity system” (Version 02.2.1)
Value(s) applied	0.5 (50%) for the first crediting period
Choice of data **or** **Measurement methods and procedures**	The applicable value as per the “Tool to calculate the emission factor for an electricity system” (Version 02.2.1) is selected.
Purpose of data	Data is used for the determination of project emissions due to the consumption of grid electricity by the project activity.
Additional comment	-

Data / Parameter	φ_y
Unit	-
Description	Model correction factor to account for model uncertainties
Source of data	Applicable default value as per the methodological tool “Emissions from solid waste disposal sites” (version 06.0.1)
Value(s) applied	0.75
Choice of data **or** **Measurement methods and procedures**	Determined based on default value of table 3 of the referred methodological tool as per Option 1, Application A when determining the model correction factor.
Purpose of data	Data is used for the ex-ante estimation of the amount of methane in the LFG which is destroyed or utilized by the project activity ($F_{CH4,PJ,y}$)
Additional comment	

Data / Parameter	***OX***
Unit	-
Description	Oxidation factor (reflecting the amount of methane from the considered SWDS that is oxidized in the soil (or other material covering the waste))
Source of data	Applicable default value as per the methodological tool “Emissions from solid waste disposal sites” (version 06.0.1)
Value(s) applied	0.1
Choice of data **or** **Measurement methods and procedures**	-
Purpose of data	Data is used for the ex-ante estimation of the amount of methane in the LFG which is destroyed or utilized by the project activity ($F_{CH4,PJ,y}$)
Additional comment	

Data / Parameter	***F***
Unit	-
Description	Fraction of methane in the SWDS gas (volume fraction of methane in the collected LFG)
Source of data	Applicable default value as per the methodological tool “Emissions from solid waste disposal sites” (version 06.0.1)
Value(s) applied	0.5
Choice of data **or** **Measurement methods and procedures**	This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, under anaerobic conditions in the considered SWDS. A default value of 0.5 is recommended by IPCC.
Purpose of data	Data is used for the ex-ante estimation of the amount of methane in the LFG which is destroyed or utilized by the project activity ($F_{CH4,PJ,y}$)
Additional comment	-

Data / Parameter	***DOC$_{f,default}$***
Unit	-
Description	Fraction of degradable organic carbon (DOC) in MSW that decomposes in the considered SWDS.
Source of data	Applicable default value as per the methodological tool “Emissions from solid waste disposal sites” (version 06.0.1), which refers to applicable value as per IPCC 2006 Guidelines for National Greenhouse Gas Inventories.
Value(s) applied	0.5
Choice of data **or** **Measurement methods and procedures**	This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, in the SWDS. The default value was applied as per Application A of the tool: “*The CDM project activity mitigates methane emissions from a specific existing SWDS”.*
Purpose of data	Data is used for the ex-ante estimation of the amount of methane in the LFG which is destroyed or utilized by the project activity ($F_{CH4,PJ,y}$)
Additional comment	Application A is the case of the current project activity.

Data / Parameter	***MCF$_{default}$***
Unit	-
Description	Methane correction factor
Source of data	Value is sourced by the methodological tool “Emissions from solid waste disposal sites”, that refers to IPCC 2006 Guidelines for National Greenhouse Gas Inventories.
Value(s) applied	1.0
Choice of data **or** **Measurement methods and procedures**	Value is selected as per Application A of the methodological tool, under the following conditions: “*1.0: for anaerobic managed solid waste disposal sites. These must have controlled placement of waste (i.e., waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) and will include at least one of the following: (i) cover material; (ii) mechanical compacting; or (iii) leveling of the waste;”* The operations of the Rio Grande landfill will encompass utilization of appropriate covering material and mechanical compacting as part of the MSW disposal activities.
Purpose of data	Data is used for the ex-ante estimation of the amount of methane in the LFG which is destroyed or utilized by the project activity ($F_{CH4,PJ,y}$)
Additional comment	-

Data / Parameter	***DOCj***
Unit	-
Description	Fraction of degradable organic carbon (by weight) in the waste type *j*
Source of data	Values are selected as per applicable guidance of the methodological tool "Emissions from solid waste disposal sites" (version 06.0.1), that refers to IPCC 2006 Guidelines for National Greenhouse Gas Inventories, (adapted from Volume 5, Tables 2.4 and 2.5).
Value(s) applied	See table below
Choice of data or Measurement methods and procedures	The selected values are based on wet waste basis (moisture concentrations in the waste streams as waste is delivered to the SWDS). The IPCC 2006 Guidelines also specify DOC values on a dry waste basis, which refers to the moisture concentrations after complete removal of all moisture from the waste. However, this is not believed practical for this situation.
Purpose of data	Data is used for the ex-ante estimation of the amount of methane in the LFG which is destroyed or utilized by the project activity ($F_{CH4,PJ,y}$)
Additional comment	-

Waste type *j*	**DOCj (% wet waste)**
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
Unit	-
Description	Decay rate for the waste type *j*
Source of data	Values are selected as per applicable guidance of the methodological tool "Emissions from solid waste disposal sites" (version 06.0.1), that refers to IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3). Source of data of Mean Annual Temperature (MAT) and Mean Annual Precipitation (MAP): Tempo Agora (http://www.tempoagora.com.br)
Value(s) applied	see table below
Choice of data or Measurement methods and procedures	Parameters are selected in accordance to the climate zone of the project site: Mean Annual Temperature (MAT) = 18 ^{o}C - Boreal and Temperate climate Mean Annual Precipitation (MAP) = 1200 mm – Wet climate. Aridity index (MAP/PET) = 5 – (MAP/PET>1)
Purpose of data	Data is used for the ex-ante estimation of the amount of methane in the LFG which is destroyed or utilized by the project activity ($F_{CH4,PJ,y}$)
Additional comment	-

Degradation speed	***Waste Type***	k_j
Slowly degrading	Wood, wood products	0.03
	Pulp, paper and cardboard (other than sludge)	0.06
	Textiles	0.06
Moderately Degrading	other (non-food) organic putrescible Garden, yard and park waste	0.01
Rapidly degrading	Food, food waste, sewage sludge, beverages and tobacco	0.185

Data / Parameter	**W_j**
Unit	-
Description	Weight fraction of the waste type j
Source of data	Values are selected as per applicable guidance of IPCC 2006 Guidelines for National Greenhouse Gas, Volume 5, Chapter 2, tables 2.3-2.5, MSW composition regional default values for South-America.
Value(s) applied	see table below
Choice of data or Measurement methods and procedures	-
Purpose of data	Data is used for the ex-ante estimation of the amount of methane in the LFG which is destroyed or utilized by the project activity ($F_{CH4,PJ,y}$)
Additional comment	While MSW disposal activities have not yet started at the Rio Grande landfill, no data regarding waste composition of disposed MSW is thus available for this landfill.

Waste type *j*	**W_j (% wet waste)**
Wood and wood products	4.7
Pulp, paper and cardboard (other than sludge)	17.1
Food, food waste, beverages and tobacco (other than sludge)	44.9
Textiles	2.6
Garden, yard and park waste	0.0
Glass, plastic, metal, other inert waste	30.7

B.6.3. Ex ante calculation of emission reductions

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Ex-ante estimation of emission reductions (ER_y) is determined in (tCO_2e) as the difference between the ex-ante estimation of baseline emissions (BE_y) and ex-ante estimations of project emissions (PE_y) as follows:

Ex-ante estimation of baseline emissions (BE_y):

By following applicable guidance of ACM0001 (version 13.0.0) and methodological tool “Emissions from solid waste disposal sites” (version 06.0.1), ex-ante estimations of baseline emissions (BE_y) are determined (in tCO_2e) as follows:

$$BE_y = BE_{CH4,y}$$

Where:

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

Where:

OX_{top_layer}	Fraction of methane in the LFG that would be oxidized in the top layer of the SWDS in the baseline scenario. The value is ex-ante selected as 0.1.
$F_{CH4,BL,y}$	Amount of methane in the LFG that would be flared in the baseline (absence of project activity) in year *y*. The value is ex-ante selected as 0 tCH_4.
GWP_{CH4}	Global Warming Potential of CH_4 . The value is ex-ante selected as $21tCO_2e/tCH_4$.
$F_{CH4,PJ,y}$	Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (in tCH_4). $F_{CH4,PJ,y}$ is estimated as follows:

$$F_{CH4,PJ,y} = \eta_{PJ} * BE_{CH4,SWDS,y}/GWP_{CH4}$$

Where:

η_{PJ}	Efficiency of the LFG capture system that will be installed in the project activity. η_{PJ} is ex-ante selected as 75%.
GWP_{CH4}	Global warming potential of CH_4. GWP_{CH4} is ex-ante selected as 21 tCO_2e/tCH_4.
$BE_{CH4,SWDS,y}$	Amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* (in tCO_2e). $BE_{CH4,SWDS,y}$ is determined by applying applicable guidance of the methodological tool “Emissions from solid waste disposal sites” (version 06.0.1) by *inter alia* considering the following:

- f_y in the methodological tool is assigned a value of 0 because the amount of LFG that would have been captured and destroyed is already accounted.
- In the methodological tool, *x* begins with the year that MSW started to be disposed in the Rio Grande landfill.
- Sampling to determine the fractions of different waste types is not necessary as waste composition can be obtained from previous studies and no MSW disposal is prevented as a result of the operation of the project.

By following applicable guidance of the methodological tool $BE_{CH4,SWDS,y}$ is determined as follows:

$$\mathrm{BE}_{\mathrm{CH4,SWDS,y}} = \varphi_y * \left(1\text{-}\mathrm{f}_{\mathrm{y}}\right) * \mathrm{GWP}_{\mathrm{CH4}} * \left(1 - OX\right) . * \frac{16}{12} * F * DOC_{f,y} * MCF_y * \sum_{x=1}^{y} \sum_{j} W_{j,x} * DOC_j * e^{-k_j .(y-x)} * \left(1 - e^{-k_j}\right)$$

(TW.1)

Where:

x	Years in the time period in which waste is disposed at the landfill, extending from the first year in the time period ($x = 1$) to year y ($x = y$)
y	Year of the crediting period for which methane emissions are calculated (y is a consecutive period of 12 months)
$DOC_{f,default}$	Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring in the SWDS for year y (weight fraction) (default value)
$W_{j,x}$	Amount of solid waste type j disposed or prevented from disposal in the SWDS in the year x (t). For every year x, it is assumed for $W_{j,x} = 0$.
φ_y	Model correction factor to account for model uncertainties
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 year y
GWP_{CH4}	Global Warming Potential of methane
OX	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
F	Fraction of methane in the SWDS gas (volume fraction)
$MCF_{default}$	Methane correction factor for year y (default value)
DOC_j	Fraction of degradable organic carbon in the waste type j (weight fraction)
k_j	Decay rate for the waste type j (1 / yr)
j	Type of residual waste or types of waste in the MSW

By considering the ex-ante selected values for the parameters above-presented as described in Section B.6.2, the ex-ante estimation of the baseline emissions is as follows[33]:

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[33] All related calculations in the context of the ex-ante estimations of emissions reductions are presented in a spreadsheet enclosed to this PDD.

BE_y	Estimation of $BE_{CH4,SWDS,y}$ (tCO_2e)	Estimation of $F_{CH4,PJ,y}$ (tCH_4)	Estimation of $F_{CH4,BL,y}$ (tCH_4)	Estimation of baseline emissions (tCO_2e)
Year	$BE_{CH4,SWDS,y} = \varphi (1-f) * GWP_{CH4} * (1-OX) * 16/12 * F * DOC_f * MCF * \Sigma\Sigma w_{i,x} * DOC_i * e^{-kj(y-x)} * (1-e^{-kj})$	$F_{CH4,PJ,y} = n_{PJ} * BE_{CH4,SWDS,y} / GWP_{CH4}$	$F_{CH4,BL,y} = 0.2 * F_{CH4,PJ,y}$	$BE_y = (1-OX_{top\_layer})(F_{CH4,PJ,y} - F_{CH4,BL,y}) * GWP_{CH4}$
2013	13,458	240	48	3,634
2014	16,052	573	115	8,668
2015	18,417	658	132	9,945
2016	20,590	735	147	11,118
2017	22,601	807	161	12,205
2018	24,477	874	175	13,218
2019	26,240	937	187	14,170
2020	27,908	498	100	7,535
Total	**169,743**	**5,324**	**1,065**	**80,493**

Note: Annually estimated values for $BE_{CH4,SWDS,y}$ for year 2013 and 2020 are for these years as a whole (365 days). All other values applicable for years 2013 and 2020 are valid for the periods from 01/07/2013 to 31/12/2013 and from 01/01/2020 to 30/06/2020 respectively.

Ex-ante estimations of project emissions (PE_y):

As established by ACM0001 (version 13.0.0), project emissions in year *y* (PE_y) are calculated (in tCO_2/yr) as follows:

$$PE_y = PE_{EC,y} + PE_{FC,y} \qquad \textbf{(18)}$$

Where:

$PE_{EC,y}$	Project emissions due to the consumption of electricity by the project activity in year *y* (in tCO_2/yr)
$PE_{FC,y}$	Project emissions due to the consumption of fossil fuels by the project activity (for purpose other than electricity generation) in year *y* (in tCO_2/yr)

Details about the determination of $PE_{EC,y}$ and $PE_{FC,y}$ are presented below:

Project emissions due to the consumption of electricity by the project activity ($PE_{EC,y}$)

As established by ACM0001 (version 13.0.0), project emissions due to the consumption of electricity by the project activity *($PE_{EC,y}$)* are calculated by following the applicable guidance of the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” with the following observations:

Project emissions from electricity consumption in year *y* ($PE_{EC,y}$) are calculated (in tCO_2/yr) as follows:

$$PE_{EC,y} = \sum_{j} EC_{PJ\,grid,y} * EF_{EL,grid,y} * (1 + TDL_{grid,y}) \tag{19}$$

Where:

$EC_{PJ,grid,y}$	Quantity of grid electricity consumed by the project activity in year *y* (in MWh).
$TDL_{grid,y}$	Average technical transmission and distribution losses in the National Grid of Brazil in year *y*.
$EF_{EL,grid,y}$	Emission factor for grid electricity generation in year *y* (in tCO_2/MWh). The project activity will consume electricity sourced by the National Electricity Grid of Brazil. This grid is locally denominated *Sistema Interconectado Nacional (SIN)* (Brazilian Interconnected System). The DNA of Brazil has published the delineation of SIN grid to be adopted for the purposes of CDM projects. As per Resolution Nº8 of the DNA of Brazil, the connected electricity system to be considered in this project activity is considered as a single system consisted by the sub-markets of SIN as the definition of the electric system of the project.

As established by the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”, $EF_{EL,grid,y}$ will be calculated ex-post as the Combined margin CO_2 emission factor ($EF_{grid,CM,y}$) for the SIN grid by following the applicable guidance of the latest version of the “Tool to calculate the emission factor for an electricity system”. The following equations are applicable for the determination of $EF_{grid,CM,y}$:

$$EF_{grid,CM,y} = w_{OM} * EF_{grid,OM,y} + w_{BM} * EF_{grid,BM,y} \tag{20}$$

Where:

$EF_{grid,OM,y}$	Operating margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EF_{grid,BM,y}$	Build margin CO_2 emission factor in year *y* (tCO_2/MWh)
w_{OM}	Weighting of operating margin emissions factor (%)
w_{BM}	Weighting of build margin emissions factor (%)

Annual official values for $EF_{grid,OM,}$ and $EF_{grid,BM,y}$ are regularly calculated and published by the DNA of Brazil (Brazilian Inter-ministerial Commission for Global Climate Change). As per information made publicly available by the DNA of Brazil, such official values for $EF_{grid,OM,}$ and $EF_{grid,BM,y}$ are calculated in full accordance with the most recent version of the “Tool to calculate the emission factor for an electricity system”.

It is assumed in the context of the ex-ante estimation:

- The values for w_{OM}, w_{BM} and $TDL_{grid,y}$ as ex-ante selected and indicated in Section B.6.2;
- $EC_{PJ,grid,y}$ as being 263 MWh per year along the whole 7-year renewable crediting period;
- $EF_{grid,OM,y}$ as being 0.2920 tCO_2/MWh along the whole 7-year renewable crediting period. This is the official value for year 2011 as published by the DNA of Brazil.

- $EF_{grid,BM,y}$ as being 0.1056 tCO_2/MWh along the whole 7-year renewable crediting period. This is the official value for year 2011 as published by the DNA of Brazil.

Thus, the Combined margin CO_2 emission factor ($EF_{grid,CM,y}$) is determined as follows:

$EF_{grid,CM} = w_{OM} * EF_{grid,OM,y} + w_{BM} * EF_{grid,BM,y} = 0.5 * 0.2920 + 0.5 * 0.1056 = 0.1988\ tCO_2/MWh$

The ex-ante estimation of the project emissions is as follows:

PE_y	Grid electricity consumed by the project activity (MWh)	Project emissions due to electricity consumption (tCO_2e)
Year	$EC_{PJ, grid,y}$	$PE_{EC,y} = EC_{PJ, grid,y} * EF_{EL, grid} * (1+TDL_{grid,y})$
2013	131	31
2014	263	63
2015	263	63
2016	263	63
2017	263	63
2018	263	63
2019	263	63
2020	131	31
Total	**1,840**	**439**

Note: Values for years 2013 and 2020 are applicable for the periods from 01/07/2013 to 31/12/2013 and from 01/01/2020 to 30/06/2020 respectively.

Therefore the ex-ante estimation of the emission reductions is:

ER_y	Emission reductions (tCO_2e)
Year	$ER_y = BE_y - PE_y$
2013	3,602
2014	8,605
2015	9,882
2016	11,056
2017	12,142
2018	13,155
2019	14,107
2020	7,504
Total	**80,054**

Note: Values for years 2013 and 2020 are applicable for the periods from 01/07/2013 to 31/12/2013 and from 01/01/2020 to 30/06/2020 respectively.

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 ($t\ CO_2e$)
2013	3,634	31	0	3,602
2014	8,668	63	0	8,605
2015	9,945	63	0	9,882
2016	11,118	63	0	11,056
2017	12,205	63	0	12,142
2018	13,218	63	0	13,155
2019	14,170	63	0	14,107
2020	7,535	31	0	7,504
Total	**80,493**	**439**	0	**80,054**
Total number of crediting years	7			
Annual average over the crediting period	**11,499**	**63**	**0**	**11,436**

Note: Values for years 2013 and 2020 are applicable for the periods from 01/07/2013 to 31/12/2013 and from 01/01/2020 to 30/06/2020 respectively.

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data / Parameter	***Management of SWDS***
Unit	-
Description	Management of the SWDS Rio Grande landfill
Source of data	The design and operational conditions of the Rio Grande landfill will be annually monitored on the basis of different sources, including *inter alia*: • Original design of the landfill; • Technical specifications for the management of the Rio Grande landfill; • Applicable local or national regulations
Value(s) applied	Not applicable.
Measurement methods and procedures	Original design of the Rio Grande landfill should be confirmed not to be modified in order to ensure that no practice to increase methane generation have been occurring prior or after the implementation of the project activity. Any change in the management of the landfill after the implementation of the project activity should be justified by referring to technical or regulatory specifications.
Monitoring frequency	Annually.
QA/QC procedures	Not applicable.
Purpose of data	Monitoring data will be used for the determination of baseline emissions and/or confirmation of the project’s implementation as described in the registered PDD (in terms of conditions of the landfill from which LFG is combusted).
Additional comment	-

Data / Parameter	$V_{t,wb}$
Unit	m³/h
Description	Volumetric flow of LFG stream in time interval *t* on a wet basis
Source of data	Measured as part of the operation of the project activity by applying appropriate LFG flow meter(s). One individual LFG flow meter will be used for each available high temperature enclosed flare.
Value(s) applied	No estimated value is required for the determination of ex-ante estimation of emission reduction. Baseline emissions are ex-ante estimated by estimating the amount of methane in the LFG which is flared and/or used in the project activity in year *y* ($F_{CH4,PJ,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that will be installed in the project activity (η_{PJ}) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* ($BE_{CH4,SWDS,y}$) by using applicable guidance of the methodological tool “Emissions from solid waste disposal sites” (version 06.0.1) and considering aspects/characteristics of the Rio Grande landfill.
Measurement methods and procedures	Volumetric flow measurement of collected LFG should always refer to the actual LFG absolute pressure and LFG temperature. Calculated based on the wet basis LFG flow measurement and also by considering water concentration.
Monitoring frequency	Continuous measurements will be recorded and reported with an every-minute frequency.
QA/QC procedures	Periodic calibration events for the LFG flow meter(s) will be performed by using a reference primary device provided by a third party independent accredited calibration laboratory. Calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer’s recommendations. Instrument will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice.
Purpose of data	Monitoring data will be used for the determination of baseline emissions.
Additional comment	This parameter will be monitored only in case option C is applied for the determination of $F_{CH4,flared,y.}$ As required by ACM0001 (version 13.0.0), the gaseous stream the tool shall be applied to is flow the LFG delivery pipeline to each flare.

Data / Parameter	$V_{t,db}$
Unit	m³/h
Description	Volumetric flow of LFG stream in time interval *t* on a dry basis
Source of data	Measured as part of the operation of the project activity by applying appropriate LFG flow meter(s). One individual LFG flow meter will be used for each available high temperature enclosed flare.
Value(s) applied	No estimated value is required for the determination of ex-ante estimation of emission reduction. Baseline emissions are ex-ante estimated by estimating the amount of methane in the LFG which is flared and/or used in the project activity in year *y* ($F_{CH4,PJ,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that will be installed in the project activity (η_{PJ}) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* ($BE_{CH4,SWDS,y}$) by using applicable guidance of the methodological tool "Emissions from solid waste disposal sites" (version 06.0.1) and considering aspects/characteristics of the Rio Grande landfill.
Measurement methods and procedures	Volumetric flow measurement of collected LFG should always refer to the actual LFG absolute pressure and LFG temperature. Calculated based on the dry basis LFG flow measurement. Use of measuring instrument/equipment with recordable electronic signal (analogical or digital) is required.
Monitoring frequency	Continuous measurements will be recorded and reported with an every-minute frequency.
QA/QC procedures	Periodic calibration events for the LFG flow meter(s) will be performed by using a reference primary device provided by a third party independent accredited calibration laboratory. Calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer's recommendations. Instrument will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice.
Purpose of data	Monitoring data will be used for the determination of baseline emissions.

Additional comment	This parameter will be monitored only in case option A is applied for the determination of $F_{CH4,flared,y.}$ As required by ACM0001 (version 13.0.0), the gaseous stream the tool shall be applied to is flow the LFG delivery pipeline to each flare.

Data / Parameter	$v_{CH4,t,db}$
Unit	m^3CH_4/m^3LFG
Description	Volumetric fraction of CH_4 in the collected LFG in time interval *t* on a dry basis
Source of data	Measured as part of the operation of the project activity by applying appropriate continuous CH_4 content gas analyzer.
Value(s) applied	No estimated value is required for the determination of ex-ante estimation of emission reduction. Baseline emissions are ex-ante estimated by estimating the amount of methane in the LFG which is flared and/or used in the project activity in year *y* ($F_{CH4,PJ,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that will be installed in the project activity (η_{PJ}) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* ($BE_{CH4,SWDS,y}$) by using applicable guidance of the methodological tool “Emissions from solid waste disposal sites” (version 06.0.1) and considering aspects/characteristics of the Rio Grande landfill.
Measurement methods and procedures	Continuous gas analyzer operating in dry-basis. Volumetric flow measurement should always refer to the actual pressure and temperature.
Monitoring frequency	Continuous measurements will be recorded and reported with an every-minute frequency.
QA/QC procedures	Periodic calibration events in the continuous CH_4 content gas analyzer will be performed by utilization of calibration span gas with certified CH_4 content (for span checking/adjustment). Utilization of an inert calibration gas (e.g. N_2) will also occur (for span checking/adjustment). All calibration gases must have a certificate provided by the gas supplier and must be under their validity period. Periodic calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer’s recommendations. Instrument will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice.
Purpose of data	Monitoring data will be used for the determination of baseline emissions.
Additional comment	This parameter will be monitored only in case option A or D is applied for the determination of $F_{CH4,flared,y.}$

Data / Parameter	$v_{CH4,t,wb}$
Unit	m^3CH_4/m^3LFG
Description	Volumetric fraction of CH_4 in the collected LFG in time interval *t* on a wet basis
Source of data	Measured as part of the operation of the project activity by applying appropriate continuous CH_4 content gas analyzer.
Value(s) applied	No estimated value is required for the determination of ex-ante estimation of emission reduction. Baseline emissions are ex-ante estimated by estimating the amount of methane in the LFG which is flared and/or used in the project activity in year *y* ($F_{CH4,PJ,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that will be installed in the project activity (η_{PJ}) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* ($BE_{CH4,SWDS,y}$) by using applicable guidance of the methodological tool "Emissions from solid waste disposal sites" (version 06.0.1) and considering aspects/characteristics of the Rio Grande landfill.
Measurement methods and procedures	Continuous gas analyzer operating in wet-basis. Volumetric flow measurement should always refer to the actual pressure and temperature. Water plus water concentration measurement or continuous in-situ analyzers. Use of measuring instrument/equipment with recordable electronic signal (analogical or digital) is required.
Monitoring frequency	Continuous measurements will be recorded and reported with an every-minute frequency.
QA/QC procedures	Periodic calibration events in the continuous CH_4 content gas analyzer will be performed by utilization of calibration span gas with certified CH_4 content (for span checking/adjustment). Utilization of an inert calibration gas (e.g. N_2) will also occur (for span checking/adjustment). All calibration gases must have a certificate provided by the gas supplier and must be under their validity period. Periodic calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer's recommendations. Instrument will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice.
Purpose of data	Monitoring data will be used for the determination of baseline emissions.
Additional comment	This parameter will be monitored only in case option C is applied for the determination of $F_{CH4,flared,y.}$ This parameter may be monitored in case option A or D is applied for the determination of $F_{CH4,flared,y.}$

Data / Parameter	$M_{t,db}$
Unit	kg/h
Description	Mass flow of the LFG stream in time interval *t* on dry basis
Source of data	Measured as part of the operation of the project activity by applying appropriate LFG flow meter(s). One individual LFG flow meter will be used for each available high temperature enclosed flare.
Value(s) applied	No estimated value is required for the determination of ex-ante estimation of emission reduction. Baseline emissions are ex-ante estimated by estimating the amount of methane in the LFG which is flared and/or used in the project activity in year *y* ($F_{CH4,PJ,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that will be installed in the project activity (η_{PJ}) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* ($BE_{CH4,SWDS,y}$) by using applicable guidance of the methodological tool “Emissions from solid waste disposal sites” (version 06.0.1) and considering aspects/characteristics of the Rio Grande landfill.
Measurement methods and procedures	Continuous gas analyzer operating in dry-basis. 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 measurements will be recorded and reported with an every-minute frequency.
QA/QC procedures	Periodic calibration events for the LFG flow meter(s) will be performed by using a reference primary device provided by a third party independent accredited calibration laboratory. Calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer’s recommendations. Instrument will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice.
Purpose of data	Monitoring data will be used for the determination of baseline emissions.
Additional comment	This parameter will be monitored only in case option D is applied for the determination of $F_{CH4,flared,y.}$ As required by ACM0001 (version 13.0.0), the gaseous stream the tool shall be applied to is flow the LFG delivery pipeline to each flare.

Data / Parameter	T_t
Unit	^oC or K
Description	Temperature of the LFG stream in time interval *t*
Source of data	Measured as part of the operation of the project activity by applying appropriate LFG temperature sensor.
Value(s) applied	No estimated value is required for the determination of ex-ante estimation of emission reduction. Baseline emissions are ex-ante estimated by estimating the amount of methane in the LFG which is flared and/or used in the project activity in year *y* ($F_{CH4,PJ,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that will be installed in the project activity (η_{PJ}) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* ($BE_{CH4,SWDS,y}$) by using applicable guidance of the methodological tool “Emissions from solid waste disposal sites” (version 06.0.1) and considering aspects/characteristics of the Rio Grande landfill.
Measurement methods and procedures	Measured to determine the density of methane ρ_{CH4}. No separate monitoring of LFG temperature is necessary when using LFG flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters (by considering standard temperature and pressure (STP) conditions). Instruments with recordable electronic signal (analogical or digital) are required
Monitoring frequency	Continuous measurements will be recorded and reported with an every-minute frequency.
QA/QC procedures	Periodic calibration events will be performed in the LFG temperature sensor by a third party independent accredited calibration laboratory in a frequency as per instrument specifications and/or instrument manufacturer’s recommendations. Instrument will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice. Spare instrument(s) may be kept.
Purpose of data	Monitoring data will be used for the determination of baseline emissions.
Additional comment	In case of measurements for the applicable LFG flow parameter are automatically converted and recorded in normalized cubic meters (by considering standard temperature and pressure (STP) conditions), monitoring of this parameter may not be required (except if the applicability condition related to the gaseous stream flow temperature being below 60ºC is adopted. Under this circumstance, this parameter shall be monitored continuously to assure the applicability condition is indeed met).

Data / Parameter	P_t
Unit	Pa or mbar
Description	Pressure of the LFG stream in time interval *t*
Source of data	Measured as part of the operation of the project activity by applying appropriate LFG pressure sensor.
Value(s) applied	No estimated value is required for the determination of ex-ante estimation of emission reduction. Baseline emissions are ex-ante estimated by estimating the amount of methane in the LFG which is flared and/or used in the project activity in year *y* ($F_{CH4,PJ,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that will be installed in the project activity (η_{PJ}) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* ($BE_{CH4,SWDS,y}$) by using applicable guidance of the methodological tool “Emissions from solid waste disposal sites” (version 06.0.1) and considering aspects/characteristics of the Rio Grande landfill.
Measurement methods and procedures	Measured to determine the density of methane ρ_{CH4}. No separate monitoring of LFG pressure is necessary when using LFG flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters (by considering standard temperature and pressure (STP) conditions). Instruments with recordable electronic signal (analogical or digital) are required
Monitoring frequency	Continuous measurements will be recorded and reported with an every-minute frequency.
QA/QC procedures	Periodic calibration events will be performed in the LFG pressure sensor by a third party independent accredited calibration laboratory in a frequency as per instrument specifications and/or instrument manufacturer’s recommendations. Instrument will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice. Spare instrument(s) may be kept.
Purpose of data	Monitoring data will be used for the determination of baseline emissions.
Additional comment	In case of measurements for the applicable LFG flow parameter are automatically converted and recorded in normalized cubic meters (by considering standard temperature and pressure (STP) conditions), monitoring of this parameter may not be required (except if the applicability condition related to the gaseous stream flow temperature being below 60ºC is adopted. Under this circumstance, this parameter shall be monitored continuously to assure the applicability condition is indeed met).

Data / Parameter	$p_{H20,t,Sat}$
Unit	Pa or mbar
Description	Saturation pressure of H_2O at temperature T_t in time interval *t*
Source of data	Data as per the literature "*Fundamentals of Classical Thermodynamics*"; Authors: Gordon J. Van Wylen, Richard E. Sonntag and Borgnakke; 4º Edition 1994. Published by John Wiley & Sons, Inc.
Value(s) applied	No estimated value is required for the determination of ex-ante estimation of emission reduction. Baseline emissions are ex-ante estimated by estimating the amount of methane in the LFG which is flared and/or used in the project activity in year *y* ($F_{CH4,PJ,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that will be installed in the project activity (η_{PJ}) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* ($BE_{CH4,SWDS,y}$) by using applicable guidance of the methodological tool "Emissions from solid waste disposal sites" (version 06.0.1) and considering aspects/characteristics of the Rio Grande landfill.
Measurement methods and procedures	This parameter is solely a function of the LFG stream temperature T_t and can be found at above-referenced literature for a total pressure equal to 101,325 Pa.
Monitoring frequency	-
QA/QC procedures	-
Purpose of data	Monitoring data will be used for the determination of baseline emissions.
Additional comment	-

Data / Parameter	$EC_{PJ,grid,y}$
Unit	MWh
Description	Quantity of grid electricity consumed by the project activity during the year *y*
Source of data	Measured as part of the operation of the project activity by applying appropriate electricity meter(s). The value considered in the context of the ex-ante estimation of emission reductions was selected based on estimations of the project participant.
Value(s) applied	1,402 (per year)
Measurement methods and procedures	Measurement records will be cross-checked against available electricity consumption receipts/invoices issued by the local electricity distribution company.
Monitoring frequency	Continuous measurements will be aggregated manually or automatically. Accumulated measurement records will be reported at with a at least every-month frequency.
QA/QC procedures	Periodic calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer's recommendations. Instrument will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice.
Purpose of data	Monitoring data will be used for the determination of project emissions.
Additional comment	

Data / Parameter	***$EF_{grid,OM,y}$ = $EF_{grid,OM-DD,y}$***
Unit	tCO_2/MWh
Description	Operation margin CO_2 emission factor in year *y* = Dispatch data analysis operating margin CO_2 emission factor in year *y*.
Source of data	Data will be determined as per applicable guidance for dispatch data analysis operating margin CO_2 emission factor of the “Tool to calculate the emission factor for an electricity system”. The selected value considered in the context of the ex-ante estimation of emission reductions is the value calculated by the DNA of Brazil and valid for year 2011.
Value(s) applied	0.2920
Measurement methods and procedures	Data will be determined as per applicable guidance for dispatch data analysis operating margin CO_2 emission factor of the “Tool to calculate the emission factor for an electricity system”.
Monitoring frequency	Data will be determined as per applicable guidance for dispatch data analysis operating margin CO_2 emission factor of the “Tool to calculate the emission factor for an electricity system”.
QA/QC procedures	-
Purpose of data	Monitoring data will be used for the determination of project emissions.
Additional comment	

Data / Parameter	***$EF_{grid,BM,y}$***
Unit	tCO_2/MWh
Description	Build margin CO_2 emission factor in year *y*
Source of data	Data will be determined as per applicable guidance of the “Tool to calculate the emission factor for an electricity system”. The selected value considered in the context of the ex-ante estimation of emission reductions is the value calculated by the DNA of Brazil and valid for year 2011.
Value(s) applied	0.1056
Measurement methods and procedures	Data will be determined as per applicable guidance of the “Tool to calculate the emission factor for an electricity system”.
Monitoring frequency	Data will be determined as per applicable guidance of the “Tool to calculate the emission factor for an electricity system”.
QA/QC procedures	-
Purpose of data	Monitoring data will be used for the determination of project emissions.
Additional comment	

Data / Parameter	**T_{flare}**
Unit	ºC
Description	Temperature in the exhaust gas of the flare(s)
Source of data	Measured as part of the operation of the project activity by applying appropriate thermocouple(s). One individual thermocouple will be used for each available high temperature enclosed flare.
Value(s) applied	No estimated value is required for the determination of ex-ante estimation of emission reduction. Baseline emissions are ex-ante estimated by estimating the amount of methane in the LFG which is flared and/or used in the project activity in year *y* ($F_{CH4,PJ,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that will be installed in the project activity (η_{PJ}) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* ($BE_{CH4,SWDS,y}$) by using applicable guidance of the methodological tool “Emissions from solid waste disposal sites” (version 06.0.1) and considering aspects/characteristics of the Rio Grande landfill.
Measurement methods and procedures	Continuous measurements of the temperature of the exhaust gas of the flare by a thermocouple. Instruments with recordable electronic signal (analogical or digital) are required.
Monitoring frequency	Continuous measurements will be recorded and reported with an every-minute frequency.
QA/QC procedures	Periodic calibration events will be performed in the thermocouple(s) by a third party independent accredited calibration laboratory in a frequency as per instrument specifications and/or instrument manufacturer’s recommendations. Instrument(s) will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice. Spare instrument(s) may be kept.
Purpose of data	Monitoring data will be used for the determination of baseline emissions.
Additional comment	An excessively high temperature of the exhaust gas of the enclosed flare may be an indication that the flare is not being adequately operated or that its capacity is not adequate to the actual flow of LFG sent to the flare for combustion.

Data / Parameter	***Other flare operation parameters***
Unit	-
Description	Other flare operation parameters
Source of data	Operation of the enclosed high temperature flare(s) in accordance with requirements and recommendations as specified by the flare’s manufacturer should be monitored. Related monitoring shall include all data and parameters that are required to monitor whether the flare operates within the range of operating conditions according to the manufacturer specifications.
Value(s) applied	-
Measurement methods and procedures	-
Monitoring frequency	Applicable monitoring data will be recorded with an every-minute frequency.
QA/QC procedures	-
Purpose of data	Monitoring data will be used for the determination of baseline emissions.
Additional comment	-

Data / Parameter	***$FV_{RG,h}$***
Unit	m^3/h
Description	Volumetric flow rate of collected LFG which is sent to the flare(s) in dry basis at normal conditions in the hour *h*.
Source of data	Measured as part of the operation of the project activity by applying appropriate LFG flow meter(s). One individual LFG flow meter will be used for each available high temperature enclosed flare.
Value(s) applied	No estimated value is required for the determination of ex-ante estimation of emission reduction. Baseline emissions are ex-ante estimated by estimating the amount of methane in the LFG which is flared and/or used in the project activity in year *y* ($F_{CH4,PJ,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that will be installed in the project activity (η_{PJ}) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* ($BE_{CH4,SWDS,y}$) by using applicable guidance of the methodological tool “Emissions from solid waste disposal sites” (version 06.0.1) and considering aspects/characteristics of the Rio Grande landfill.
Measurement methods and procedures	Instruments with recordable electronic signal (analogical or digital) are required.
Monitoring frequency	Continuous measurements will be recorded and reported with an every-minute frequency.
QA/QC procedures	Periodic calibration events for the LFG flow meter(s) will be performed by using a reference primary device provided by a third party independent accredited calibration laboratory. Calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer’s recommendations. Instrument will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice.
Purpose of data	Monitoring data will be used for the determination of baseline emissions.

Additional comment	This parameter will be monitored only in case the calculation parameter hourly flare efficiency ($\eta_{flare,\ h}$) is determined by adopting the continuous monitoring approach as established by the “Tool to determine project emissions from flaring gases containing methane” Both approaches for determining $\eta_{flare,h}$ are considered to be adopted along the crediting period, where continuous monitoring is the preferable approach. The approach involving utilization of default values will be adopted in case required equipment for applying continuous monitoring option and/or related measurement records are not available. The same basis (dry or wet) is considered for related measurements when the residual gas temperature exceeds 60ºC.

Data / Parameter	$fv_{CH4,h}$
Unit	-
Description	Volumetric fraction of methane in of collected LFG which is sent to the flare(s) in the hour *h*.
Source of data	Measured as part of the operation of the project activity by applying appropriate continuous CH_4 content gas analyzer.
Value(s) applied	No estimated value is required for the determination of ex-ante estimation of emission reduction. Baseline emissions are ex-ante estimated by estimating the amount of methane in the LFG which is flared and/or used in the project activity in year *y* ($F_{CH4,PJ,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that will be installed in the project activity (η_{PJ}) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* ($BE_{CH4,SWDS,y}$) by using applicable guidance of the methodological tool "Emissions from solid waste disposal sites" (version 06.0.1) and considering aspects/characteristics of the Rio Grande landfill.
Measurement methods and procedures	As a simplified approach in the context of the determination the calculation parameter hourly flare efficiency as per the continuous monitoring approach as established by the "Tool to determine project emissions from flaring gases containing methane", only methane content of the residual gas will be measured and the remaining part will be considered as N_2. Methane concentration will be measured continuously using a continuous gas analyser. Instruments/equipment with recordable electronic signal (analogical or digital) are required.
Monitoring frequency	Continuous measurements will be recorded and reported with an every-minute frequency.
QA/QC procedures	Periodic calibration events in the continuous CH_4 content gas analyzer will be performed by utilization of calibration span gas with certified CH_4 content (for span checking/adjustment). Utilization of an inert calibration gas (e.g. N_2) will also occur (for span checking/adjustment). All calibration gases must have a certificate provided by the gas supplier and must be under their validity period. Periodic calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer's recommendations. Instrument will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice.
Purpose of data	Monitoring data will be used for the determination of baseline emissions.

Additional comment	This parameter will be monitored only in case the calculation parameter hourly flare efficiency ($\eta_{flare,\ h}$) is determined by adopting the continuous monitoring approach as established by the “Tool to determine project emissions from flaring gases containing methane” Both approaches for determining $\eta_{flare,h}$ are considered to be adopted along the crediting period, where continuous monitoring is the preferable approach. The approach involving utilization of default values will be adopted in case required equipment for applying continuous monitoring option and/or related measurement records are not available. The same basis (dry or wet) is considered for related measurements when the residual gas temperature exceeds 60ºC.

Data / Parameter	$t_{O2,h}$
Unit	-
Description	Volumetric fraction of O_2 in the exhaust gas of the flare(s) in the hour *h*.
Source of data	Measured as part of the operation of the project activity by applying appropriate residual CH_4/O_2 content gas analyzer(s). One individual residual CH_4/O_2 content gas analyzer will be used for each available high temperature enclosed flare.
Value(s) applied	No estimated value is required for the determination of ex-ante estimation of emission reduction. Baseline emissions are ex-ante estimated by estimating the amount of methane in the LFG which is flared and/or used in the project activity in year *y* ($F_{CH4,PJ,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that will be installed in the project activity (η_{PJ}) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* ($BE_{CH4,SWDS,y}$) by using applicable guidance of the methodological tool “Emissions from solid waste disposal sites” (version 06.0.1) and considering aspects/characteristics of the Rio Grande landfill.
Measurement methods and procedures	Extractive sampling residual CH_4/O_2 content gas analyzer with water and particulates removal devices or in situ analysers for wet basis determination. The point of measurement (sampling point) will be in the upper section of each available high temperature enclosed flare. Sampling will be conducted with appropriate sampling probes adequate to high temperatures level (e.g. inconel probes). Instruments/equipment with recordable electronic signal (analogical or digital) are required.
Monitoring frequency	Measurements will be recorded and reported with an every-minute frequency.
QA/QC procedures	Periodic calibration events in the residual CH_4 /O_2 content gas analyzer(s) will be performed by utilization of calibration span gas with certified CH_4 content (for span checking/adjustment). Utilization of an inert calibration gas (e.g. N_2) will also occur (for span checking/adjustment). All calibration gases must have a certificate provided by the gas supplier and must be under their validity period. Periodic calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer’s recommendations. Instrument will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice.
Purpose of data	Monitoring data will be used for the determination of baseline emissions.

Additional comment	This parameter will be monitored only in case the calculation parameter hourly flare efficiency ($\eta_{flare,\ h}$) is determined by adopting the continuous monitoring approach as established by the "Tool to determine project emissions from flaring gases containing methane" Both approaches for determining $\eta_{flare,h}$ are considered to be adopted along the crediting period, where continuous monitoring is the preferable approach. The approach involving utilization of default values will be adopted in case required equipment for applying continuous monitoring option and/or related measurement records are not available. The same basis (dry or wet) is considered for related measurements when the residual gas temperature exceeds 60ºC.

Data / Parameter	$fv_{CH4,FG,h}$
Unit	mg/m^3
Description	Concentration of methane in the exhaust gas of the flare(s) at normal conditions in the hour *h*
Source of data	Measured as part of the operation of the project activity by applying appropriate residual CH_4/O_2 content gas analyzer(s). One individual residual CH_4/O_2 content gas analyzer will be used for each available high temperature enclosed flare.
Value(s) applied	No estimated value is required for the determination of ex-ante estimation of emission reduction. Baseline emissions are ex-ante estimated by estimating the amount of methane in the LFG which is flared and/or used in the project activity in year *y* ($F_{CH4,PJ,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that will be installed in the project activity (η_{PJ}) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* ($BE_{CH4,SWDS,y}$) by using applicable guidance of the methodological tool “Emissions from solid waste disposal sites” (version 06.0.1) and considering aspects/characteristics of the Rio Grande landfill.
Measurement methods and procedures	Extractive sampling residual CH_4/O_2 content gas analyzer with water and particulates removal devices or in situ analysers for wet basis determination. The point of measurement (sampling point) will be in the upper section of each available high temperature enclosed flare. Sampling will be conducted with appropriate sampling probes adequate to high temperatures level (e.g. inconel probes). An excessively high temperature at the sampling point may be an indication that the enclosed flare is not being adequately operated or that its capacity is not adequate to the actual flow. Measurement instruments may read ppmv or % values. To convert from ppmv to mg/m^3 simply multiply by 0.716. 1% equals 10,000 ppmv. Instruments/equipment with recordable electronic signal (analogical or digital) are required.
Monitoring frequency	Continuous measurements will be recorded and reported with an every-minute frequency.

QA/QC procedures	Periodic calibration events in the residual CH_4 /O_2 content gas analyzer(s) will be performed by utilization of calibration span gas with certified CH_4 content (for span checking/adjustment). Utilization of an inert calibration gas (e.g. N_2) will also occur (for span checking/adjustment). All calibration gases must have a certificate provided by the gas supplier and must be under their validity period. Periodic calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer's recommendations. Instrument will be subject to a regular maintenance and testing regime in accordance to appropriate national / international standards/requirements and/or best practice.
Purpose of data	Monitoring data will be used for the determination of baseline emissions.
Additional comment	This parameter will be monitored only in case the calculation parameter hourly flare efficiency ($\eta_{flare,\ h}$) is determined by adopting the continuous monitoring approach as established by the "Tool to determine project emissions from flaring gases containing methane" Both approaches for determining $\eta_{flare,h}$ are considered to be adopted along the crediting period, where continuous monitoring is the preferable approach. The approach involving utilization of default values will be adopted in case required equipment for applying continuous monitoring option and/or related measurement records are not available. The same basis (dry or wet) is considered for related measurements when the residual gas temperature exceeds 60ºC.

B.7.2. Sampling plan

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Not applicable.

B.7.3. Other elements of monitoring plan

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General monitoring:

The following instruments/equipment will be used to measure the required monitoring data:

Instrument	Data monitored	
Appropriate volumetric or mass flow meter	$V_{t,wb}$ or $V_{t,db}$ or $M_{t,d}$ and $FV_{RG,h}$	Volumetric flow of LFG stream in time interval *t* on a wet basis Volumetric flow of LFG stream in time interval *t* on a dry basis Mass flow of the LFG stream in time interval *t* on dry basis Volumetric flow rate of collected LFG which is sent to the flare(s) in dry basis at normal conditions in the hour *h*. (only in case the calculation parameter hourly flare efficiency ($\eta_{flare,\ h}$) is determined by adopting the continuous monitoring approach as established by the “Tool to determine project emissions from flaring gases containing methane”)
LFG Pressure sensor	P_t	Pressure of the LFG stream in time interval *t*
LFG Temperature sensor	T_t	Temperature of the LFG stream in time interval *t*
Continuous CH_4 content gas analyser	$v_{CH4,t,db}$ or $v_{CH4,t,wb}$ and $fv_{CH4,h}$	Volumetric fraction of CH_4 in the collected LFG in time interval *t* on a dry basis Volumetric fraction of CH_4 in the collected LFG in time interval *t* on a wet basis Volumetric fraction of methane in of collected LFG which is sent to the flare(s) in the hour *h*. (only in case the calculation parameter hourly flare efficiency ($\eta_{flare,\ h}$) is determined by adopting the continuous monitoring approach as established by the “Tool to determine project emissions from flaring gases containing methane”)
Residual CH_4 /O_2 content gas analyzer(s)	$fv_{CH4,FG,h}$ and	Concentration of methane in the exhaust gas of the flare(s) at normal conditions in the hour *h*

	$t_{O2,h}$	Volumetric fraction of O_2 in the exhaust has of the flare(s) in the hour *h*.
	(both parameters will be monitored only in case the calculation parameter hourly flare efficiency ($\eta_{flare,\ h}$) is determined by adopting the continuous monitoring approach as established by the "Tool to determine project emissions from flaring gases containing methane")	
Electricity meter(s)	$EC_{PJ,grid,y}$	Quantity of grid electricity consumed by the project activity during the year *y*
Thermocouple(s)	T_{flare}	Temperature in the exhaust gas of the flare(s)
-	***Other flare operating parameters***	Data and parameters that are eventually required to monitor whether the flare operates within the range of operating conditions according to the manufacturer specifications.

All continuously measured LFG related parameters (flow of the LFG stream, fraction of CH_4 in the collected LFG, pressure of the LFG stream, temperature of the LFG stream) as well as measurements related to the exhaust gas of the flare(s) (temperature in the exhaust gas of the flare(s), concentration of methane in the exhaust gas of the flare(s), volumetric fraction of O_2 in the exhaust has of the flare(s), and eventually other parameters related to flate operational conditions) will all be recorded electronically via an appropriate data logger / data acquisition system (to be located within the site boundary) which will have the capability to record all data in a safe manner (thus ensuring the required data reliability and validity). Data recording and reporting frequency for these parameter will be every 1-minute.

Records of grid electricity consumed by the project activity aggregated manually or automatically (depending on the specifications of electricity meter(s)). Accumulated measurement records will be reported at with an at least every-month frequency.

By the use of appropriate software application, recorded monitoring data will be regularly retrieved, aggregated and reported in order to be considered in the context of calculations of emission reduction achieved by the project activity.

Monitoring records available in the data logger / data acquisition system will be regularly retrieved remotely by modem or directly on site. If automatic data logging by the logger / data acquisition system fails, measurement data will be recorded manually (whenever it is possible). If data is not properly recorded or can not be retrieved, no emissions reductions will be claimed for the period encompassing such data failure.

All monitoring data will also be recorded in a central data base.

Data records will be summarized into emission reduction calculations prior to each periodic CDM verification. All data recorded by the data logger / data acquisition system will be made available to the Designated Operational Entities (DOEs) responsible for each periodic verification. This will ensure that data integrity and reliability for related monitoring data.

Access to monitoring data will be restricted and controlled. All monitoring records will be kept archived until at least two years after the end of the crediting period or at least two years after the last issuance of CER's for the project activity, whichever occurs later.

It will be the responsibility of the monitoring team manager to ensure that all monitoring data is properly measured and recorded.

Technical specifications for monitoring instruments/equipment (e.g. manufacturer, model, serial numbers, accuracy, etc.) will be known only at the time of project's implementation.

Maintenance and calibration for monitoring instruments/equipment and project's equipment/components in general:

Maintenance service and routines will includes all preventive and corrective actions necessary for ensuring good functioning of all project related equipment, such as:

- Visual control of the equipment state and real-time check of displayed parameters,
- Cleaning up the equipment and the sensors,
- Lubrication and greasing,
- Replacement or overhauling of defective parts (including regular welding service in the HDPE pipelines and manifolds).

Calibration events in monitoring instruments/equipment will be periodically and appropriately performed as per applicable frequency, procedures and methods established or recommended by instrument/ equipment manufacturer, national/international standards and/or best practice, as available.

General malfunction of equipment: if monitoring instruments/equipment or project's equipment/components in general fail, applicable repair or replacement actions will be carried out. Spare units for some of the monitoring instruments/equipment will eventually be kept on site.

Project's operational and management structure:

An appropriate project's operational and management structure will be defined and implemented as part of the implementation of the project.

The project's operational and management structure will rely on staff with responsibilities clearly defined. All collaborators and employees involved with operation of project and/or monitoring will be trained internally and/or externally. Training may inter alia include:

a) General competence development about LFG generation and collection
b) Review of equipment operational principles and captors
c) Maintenance and calibration requirements for project's related equipment
d) Procedures for monitoring data gathering and handling
e) Emergency and safety procedures

The monitoring plan will be implemented by reflecting the best monitoring practice for LFG collection and destruction projects.

SECTION C. Duration and crediting period

C.1. Duration of project activity

C.1.1. Start date of project activity

>>

Project starting date: 01/03/2013 (estimated).

The project participant is decided to only take any real action to implement the project (initial engineering and construction work and/or selection and ordering of project related equipment, etc.) only after the obtaining a positive validation opinion about the registration of the project as a CDM project activity and/or submission of the related project registration request to the CDM Executive Board (CDM-EB) by the DOE in charge of the CDM validation assessment.

As per the current forecast, the project starting date is thus forecasted to occur in 01/03/2013. The assumed project starting date corresponds to the foreseen date when initial engineering and construction related work starts or date when ordering (acquisition) of project related main equipment occurs.

C.1.2. Expected operational lifetime of project activity

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25 years.

C.2. Crediting period of project activity

C.2.1. Type of crediting period

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First crediting period (renewable).

C.2.2. Start date of crediting period

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The crediting period will start on 01/07/2013. This date is defined as the 6 months after the estimated project starting date (as outlined in Section C.1.1)

C.2.3. Length of crediting period

7 years and 0 months.

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

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In accordance with applicable Brazilian environmental regulations, it is the responsibility of the environmental agency of the State (province) to approve the overall environmental aspects for initiatives in landfills in the context of applicable environmental licensing procedure for such initiatives. The environmental authority in Rio Grande do Sul State is the *Fundação Estadual de Proteção Ambiental Henrique Luiz Roessler* (FEPAM/RS) (*State Environmental Protection Foundation Henrique Luiz Roessler*).

In Brazil, in the particular case of environmental licensing for construction and operation of landfills, normally, the implementation of an initiative promoting forced extraction of LFG and its combustion in high temperature enclosed flares (using active LFG collection and destruction systems) do not require any dedicated or separated additional environmental licensing procedure (including development and approval of an Environmental Impact Assessment (EIA))[34].

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[34] This is in accordance with the licensing procedure currently adopted by environmental authorities from most of the Brazilian States. São Paulo State has been however an exception to this rule. In this State, the local environmental

The Rio Grande landfill has a valid operation license issued by FEPAM/RS. The operation license clearly refers to LFG management as part of the operation of the landfill. Thus, no additional licensing effort is required for the implementation of the proposed CDM project activity encompassing LFG collection and destruction. The operation license is registered under number 3402/2011 within FEPAM/RS[35].

In summary, the expected environmental aspects of the project are positive (with minor negative environmental impacts) and they can be summarized as follows:

- The project will have a positive influence on the local environment by promoting the destruction of gases like H_2S and derivatives of methane, mercaptenes and other chemical compounds that result in bad odors and sanitary risks in the neighboring populations: such as diseases and asthma due to the air pollution.

- Efficient collection and destruction of LFG will reduce risks of explosion in the landfill site. Indeed, in the presence of a specific proportion of oxygen, the methane contained in the landfill gas can become explosive. Due to that, the project activity will be operated with continuous monitoring and control of the oxygen content of collected LFG which is sent to the flare(s), thus continuously controlling the risk of explosions.

- The operation of enclosed high temperature flares can generate noise and vibration in case of operational problems. As part of the operation of the project activity, it will be ensured that the installed flare(s) always operate in accordance with the operational requirements and conditions as established by the equipment manufacturer. That will minimize the occurrence of noise and vibration that could negatively affect working staff of the landfill and people living in the surrounding areas.

D.2. Environmental impact assessment

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As mentioned in Section D.1, the development of an Environment Impact Assessment (EIA) is not required for the project activity. An EIA has been developed for the construction and operation of the Rio Grande landfill.

SECTION E. Local stakeholder consultation

E.1. Solicitation of comments from local stakeholders

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The Designated National Authority (DNA) of Brazil has established specific procedures and requirements for project developers to invite local stakeholders of projects proposed under the CDM for making comments about aspects of the projects (including contribution of the project towards sustainable development). Meeting these requirements is a pre-requisite for the issuance of the Letter of Approval (LoA) for the project activity by the DNA of Brazil.

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authority (named CETESB) has set specific additional requirements for licensing such LFG collection and destruction/utilization initiatives in some specific cases. In some cases, high temperature enclosed flares or engine-generator sets (using LFG as fuel for electricity generation) have been regarded as stationary emission sources for local criteria pollutants (SO_x, NO_x, CO, etc) and related monitoring of emissions has been a requirement set by CETESB.

[35] The environmental permit (operation license) 3402/2011 is available online: http://www.fepam.rs.gov.br/licenciamento/area3/detalheDocproc.asp?area=3&buscar=2&tipoBusca=documento&processo=34022011&codigo=120

As per Resolutions No. 1, 4 and 7 of the DNA of Brazil, project participant/project developer shall submit written communications (letters) to selected stakeholders at least 15 days prior to the start of the CDM validation assessment of a project activity being proposed under the CDM. Submitted letters should refer to the proposed project (including name and type of the activity project); refer to a web-link where the PDD for the project is made available (in a version translated into Brazilian Portuguese language) and description of how the proposed project activity contributes towards sustainable development in the host country Brazil, by referring to the document named "*Anexo III*".

As per current rules of the DNA of Brazil, the contribution of a CDM project activity being proposed in Brazil towards sustainable development shall be described by the project participants in a separated document commonly named "*Anexo III*" (Annex III). This document shall emphasize contribution of the proposed CDM project activity within 5 main aspects:

- Local environmental sustainability
- Development in local laboring conditions and net generation of employment opportunities
- Income distribution
- Technological development
- Regional integration and articulation with other sectors / actors

Furthermore, the communication shall invite the receivers for providing comments about the proposed project.

The initial version of the PDD and the "*Anexo III*" document for the Rio Grande landfill gas project are made available online at:
http://www.vega.com.br/CreditoCarbonoProjetos.asp

The following letters were sent also on 06/06/2012 to the following stakeholders involved and affected by the project activity:

1. Interministerial Commission for the Global Climate Change (DNA of Brazil)

2. *Fundação Estadual de Proteção Ambiental Henrique Luiz Roessler* (FEPAM/RS) (*State Environmental Protection Foundation Henrique Luiz Roessler*) (environmental authority in Rio Grande do Sul State).

3. Brazilian Forum of NGO´s

4. Brazilian Forum of Climate Change

5. Federal Public Attorney Office

6. Public Attorney Office for Rio Grande do Sul State

7. City Hall of Rio Grande

8. City Council (local legislative chamber) of Rio Grande

E.2. Summary of comments received

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Regarding comments received as response to the letters sent to local stakeholders inviting for comments, on 28/11/2012 (more than 4 months after the submission of the letters), there were no comments received.

Regarding relevant comments and question received during the public audiences for the implementation and operation of the Rio Grande landfill, no comments were received regarding the implementation of a potential LFG collection and destruction initiative in the landfill as a CDM project activity.

E.3. Report on consideration of comments received

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No comments were received as response to the letters sent to local stakeholders inviting for comments.

No comments were received during the occurred public audience for the implementation and operation of the Rio Grande landfill regarding the implementation of a potential LFG collection and destruction initiative in the landfill as a CDM project activity.

SECTION F. Approval and authorization

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A Letter of Approval (LoA) was issued by the Designated National Authority of Brazil (which is the host and only identified Party for the project activity). No annex I party was yet selected. The LoA was issued on 20/12/2012[36].

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[36] The issued LoA includes the following disclaimers:

- *"The Project Activity "Rio Grande landfill gas project" as defined by the Project Design Document, dated of November 28th , 2012 and identified as version 4, validated by the Designated Operational Entity Germanischer Lloyd Certification GmbH (GLC), by means of the Validation Report dated of December 9th , 2012 and identified as Revision 4, will assist the Federative Republic of Brazil in achieving sustainable development.*"
- *"I henceforth declare that the Executive Secretary of the Brazilian DNA is authorized to submit to the executive board of the CDM a request for review of the "Project", in case the Project Design Document and Validation Report submitted to the Executive Board of the CDM do not correspond to the documents identified in paragraph 1-(iii) above."*

On 19/06/2013, Rio Grande Ambiental S.A. has however received a communication from the DNA of Brazil complementing the earlier issued and received LoA and that this LoA is also valid for both a revised version of the PDD and a revised version of the Validation Report (yet to be issued by the DOE Germanischer Lloyd Certification GmbH (GLC)) in order to address request for review in project documentation previously raised by the CDM Executive Board.

Appendix 1: Contact information of project participants

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Appendix 2: Affirmation regarding public funding

Not applicable. The implementation and operation of the project do not involve any kind of public funding from Parties included in Annex I.

Appendix 3: Applicability of selected methodology

All information about the applicability of selected methodology is presented in Section B.2.

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

All information about the ex-ante calculation of emission reductions are presented in Section B.6.3.

Appendix 5: Further background information on monitoring plan

All information about the design and operation of the monitoring plan are presented in Section B.7.1.

Appendix 6: Summary of post registration changes

This section is intentionally left blank.

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History of the document

Version	Date	Nature of revision
04.1	11 April 2012	Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b.
04.0	EB 66 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	EB 25, Annex 15 26 July 2006	
02	EB 14, Annex 06b 14 June 2004	
01	EB 05, Paragraph 12 03 August 2002	Initial adoption.

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