Onyx Landfill Gas Recovery project

Trémembé - Brazil

CLEAN DEVELOPMENT MECHANISM

UPDATE OF THE PDD SUBMITTED FOR THE PROJECT WHICH WAS INCLUDED IN THE NM0021: CERUPT LANDFILL GAS RECOVERY METHODOLOGY

OCTOBER 2004

CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 02 - in effect as of: 1 July 2004)

CONTENTS

ANNEXES

SECTION A. General description of project activity

A. 1. Title of the project activity:

Onyx gas recovery project – SASA, Brazil

A. 2. Description of the project activity:

Onyx is proposing a Clean Development Mechanism project activity at its SASA landfill facility located in the City of Tremembé – Sao Paulo – Brazil. This landfill is operated by the Brazilian subsidiary SASA. The landfill is divided in two disposal areas. The existing area (Aterro 1) had a capacity of 850,000 m^3 and is no longer used for waste disposal. A new area (Aterro 3) will have a total capacity of 1,700,000 m^3 and will receive approximately 180,000 tonnes/yr of municipal and commercial waste. The new area will be filled in 4 phases until 2012.

The latest European waste management standards are applied to the SASA landfill site. Among others is the installation of landfill gas (LFG) recovery equipment that is not common in Brazil and according to the local regulator not practised at any other landfill site in the state of Sao Paulo. The landfill gas recovery equipment will have a total capacity of 2400 m^3/h, which will be in excess of the projected volume of landfill gas. Onyx will use proven technology, including a piping and well network, blowers and flaring systems. The recovered landfill gas will mainly be used onsite for evaporation of wastewater from the landfill (leachate). At a later stage, some electricity may be generated with the LFG, although the generated electricity will be used only for onsite usage. This has **not** been taken into account for the proposed CDM project activity.

Greenhouse gas emission reductions will result from the combustion of the recovered methane contained in the landfill gas. It is estimated that this project will generate 700,625 CER's within a 10-year period (2003-2012).

There are several contributions to sustainable development.

Environmental benefits:
The local environment benefits from the highest European waste management standards that are applied to this site including:

- Fully lined disposal areas for leachate containment
- Onsite laboratory for waste analysis and environmental monitoring
- Final cover system including revegetation and reforestation as each disposal area is completed
- In addition, as part of the landfill development plans approximately 150,000 trees will be planted in "green buffer" area around the site.

The project will contribute to the continued environmental improvements by providing the infrastructure to reduce greenhouse gas emissions.

Technology transfer:
The project will support efforts aimed at facilitating the dissemination of design and operational experience gained at SASA landfill for possible use throughout the country. The following activities will be funded by the project and implemented by SASA:
1. Development of information tools (brochures describing the CDM project);

2. Organisation of open house for operators or local authorities interested in LFG management and other potentially interested parties;

View of project Participants:
ONYX:

This project represents for Onyx, the first CDM project developed to reduce Greenhouse gas emissions in line with the goal of Kyoto Protocol and the Marrakech accord. It was launched early as we believed in the importance of contributing Greenhouse gas emission reductions. This commitment expressed in our environmental reports since 2000 (Vivendi 2000 Environmental Report and Onyx 2002 Environmental Report, refer to Annexe 7). This project was the first of its kind in Brazil. As a result of this project new, “clean” technologies are now present in Brazil and local staff are trained to their operation and maintenance. Not only are the environmental benefits significant compared to the common practice in Brazil, but this project also has a direct impact on health and quality of life of site neighbours.

ONYX SASA LANDFILL SITE:
Breno Palma, General Director Onyx Brazil, declares : “Our project will have an important contribution to sustainable development. We are recovering the landfill gas to treat the landfill leachate. In Brazil most of the Municipal and Solid Waste (MSW) landfills are “uncontrolled dumps" with no leachate collection and treatment and many of them have soil and groundwater contamination problems (also health concerns for their neighbours). By recovering the landfill gas by an active system, we are not only avoiding bad odours around SASA's facility and avoiding risks of fire and explosion but also we are helping against it. If, in the future, we decide landfill recovery to produce electricity, it will be an extra contribution for the environment due to the green energy we may produce.”

SENTERNOVEM, acting on behalf of the Netherlands government:
SenterNovem is the agency of the dutch Ministry of Economic Affairs, and acts as representative of the Ministry of Environmental Affairs (VROM) for the C-Erupt programme. The C-Erupt programme aims to purchase emission reductions under the Clean Development Mechanism of the Kyoto Protocol.

A. 3. Project participants:

Project participants are described below. For full contact details, please, refer to Annexe 1 of this document.

ONYX
169 avenue Georges Clémenceau
92735 NANTERRE -
FRANCE

SASA (landfill operator, subsidiary of Onyx)
Est. Municipal, 2200 – Mato Dentro
12120-000 – Tremembé - SP
BRASIL

SenterNovem Den Haag, acting on behalf of the Government of Netherlands
P.O Box 93144
2509 AC The Hague
The NETHERLANDS

A. 4. Technical description of the project activity:

A. 4. 1. Location of the project activity:

A. 4. 1. 1. Host Party(ies):

Brazil

A. 4. 1. 2. Region./State/Province etc.:

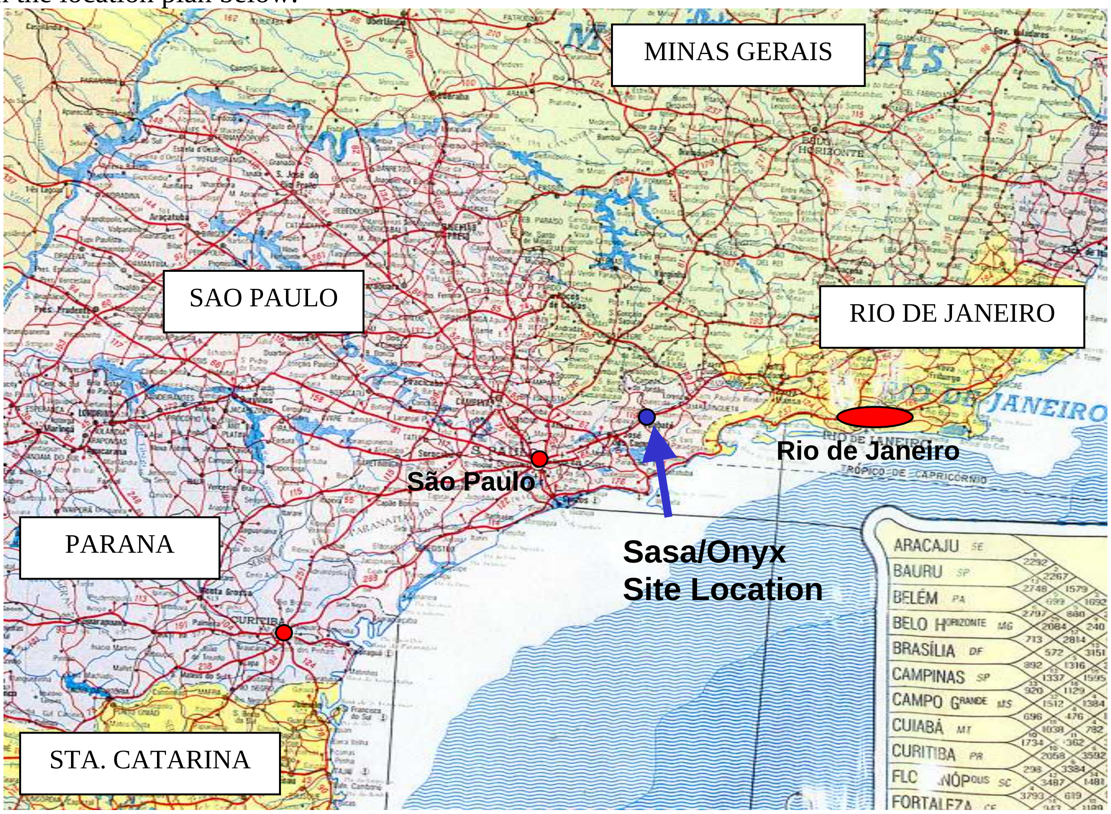
Sao Paolo

A. 4. 1. 3. City/Town/Community etc:

Tremembé

A. 4. 1. 4. Detail on physical location, including information allowing the unique identification of this project activity (maximum one page)

The investment is to be made in the city of Tremembé in the state of Sao Paulo, Brazil as shown on the location plan below.



A. 4. 2. Category(ies) of project activity

Landfill gas recovery with electricity generation and no capture or destruction of methane in the baseline scenario, as defined in the approved methodology AM0011.

A. 4. 3. Technology to be employed by the project activity:

Construction of the project started in December 2000 and included the installation of a piping network to connect the existing vents at Aterro 1. The construction was finished in March 2001 with the commissioning of the evaporator and flare in March 2001, since the gas is used to Evaporate leachate.

The project will involve proven technology and hardware for the extraction and treatment of landfill gas.

Below is a brief summary of the equipment and technology proposed for this project:

The landfill gas collection system consists of the following components:

- Progressive vertical wells

In order to allow for the possibility to collect landfill gas prior to the completion of a disposal area progressive vertical wells (perforated concrete pipes) are installed. A high density perforated pipe is installed within the centre of the well which is backfilled with gravel.

- Vertical wells

Landfill gas extraction wells will also be drilled into the landfill once areas reach their final elevation and final cover has been applied. The vertical wells consist of a pipe perforated in its lower part, placed in a drilled borehole in the waste, backfilled with gravel and sealed at the surface. Both well types will be equipped with wellheads that enable monitoring of gas flow and quality. Also valves are provided to allow adjustment of the available vacuum at each well.

- Horizontal Drains

In order to maximise the extraction capacity horizontal drains will also be installed in the waste mass. Preliminarily, it is envisioned to install a series of horizontal drains with a horizontal separation distance of 60 meters installed every 5 meters in waste lift height. The horizontal drains will consist of perforated pipes surrounded gravel or equivalent drainage material. The drains will be interconnected to the vertical well system.

- Collection Piping

A high density polyethylene collection piping system will be installed to convey the landfill gas from the well network to the blower/flare/evaporator station.

Leachate evaporator –("EVAP")
The EVAP technology uses landfill gas as a fuel/ heat source to evaporate leachate collected from the lined disposal areas. The evaporator is designed to treat up to 19 m^3 of leachate per day. To treat this maximum amount of leachate approximately 440 m^3/hr of landfill gas (at 50% methane by volume) would be required.
The landfill gas is combusted in a specially designed emerged burner. The hot combustion gas is sparged through the leachate which creates water vapour and strips the volatile organics.

Enclosed Flare
The exhaust gas from the EVAP in passed through an enclosed flare that serves as an after burner to assure the thermal destruction of VOC’s and to control odours. The flare operates at 700°C. The flare also treats the excess landfill gas not used in the evaporator.

Controls
The evaporator and flare are equipped with automatic safety and monitoring controls (operator interface, air-fuel ratio, leachate level, chamber temperature, UV scanner, emergency shut down, etc.)

Blower
A centrifugal blower is used to create the required vacuum in the collection network to extract the landfill gas.

Generator

A diesel generator for the production of power in case of disrupt of power from the grid is installed. This generator may be displaced with a landfill gas fuelled generator at a later stage if sufficient quantity of landfill gas is extracted from the site.

Possible, in the future, gensets for the production of electricity will be installed which will be interconnected to the local electricity power system. However, in the proposed CDM project activity, emission reductions from feeding electricity to the grid have not been taken into account.

Technology transfer:
By implementing these technology approaches at the SASA Landfill Site, Onyx has brought its technological know-how to local team who install and operate the system. Numerous training programs have been provided to our local staff to transmit this know-how. Technical support is always available to help resolve any difficulties.

Being unique in Brazil, the project attracts many visits by the local agency and other stakeholders who are enthusiastic by the progress made compared to the standards in other landfill sites.

A. 4. 4. Brief explanation of how the anthropogenic emissions of anthropogenic greenhouse gas (GHGs) by sources are to be reduced by the proposed CDM project activity, including why the emission reductions would not occur in the absence of the proposed project activity, taking into account national and/or sectoral policies and circumstances:

In Brazil, most of domestic waste goes either to illegal dumps or landfills with minimal environmental controls. The quality of the waste is not properly monitored and poisonous leachate is leaking into the ground water. Inevitably, the natural process of anaerobic degradation of waste will occur releasing directly to atmosphere a gas containing an average of 50% methane. Very few installations have developed gas extraction networks, few sites have proper gas wells, and the flaring of landfill gas is rare.

The Brazilian legislation does not require landfill operators to flare landfill gas. The only requirement is to vent the landfill gas in order to avoid the risk of explosion (see Annexe 5: Letter from the state environmental regulator CETESB). The flaring of landfill gas, active extraction and generation of electricity are nor compulsory nor common practise in Brazil.

The focus of the national and regional regulatory bodies is tackling the problem of illegal dumping and capturing of leachate. Capturing and flaring of LFG is not a local problem and therefore not a priority. It is unlikely that legislation can be expected in the coming decade (see Annexe 6) enforcing flaring.

A. 4. 4. 1. Estimated amount of emission reductions over the chosen crediting period:

The envisioned project activity will result in the yearly capturing and combustion of 50% to 80% of the landfill gas (specific amount dependent on the phasing of the project and landfill site filling with waste). The estimate of total emission reductions to be realized are 700,625 tCO_{2eq} over the crediting period starting the 1st January 2003 ending the 31st December 2012 included **.**

A. 4. 5. Public funding of the project activity:

In this project no public funding is involved.

SECTION B. Application of baseline methodology

B. 1. Title and reference of the approved baseline methodology applied to the project activity:

Approved baseline methodology AM0011 “landfill gas recovery with electricity generation and no capture or destruction of methane in the baseline scenario”, referring the case NM0021: “CERUPT Methodology for landfill gas recovery”, submitted by Onyx for this particular project.

B. 1. 1. Justification of the choice of the methodology and why it is applicable to the project activity

The chosen methodology is designed specifically for landfill gas recovery projects.
In this project the baseline is atmospheric release of the landfill gas;
There are no regulations governing flaring or/and combustion of landfill gas;
The captured gas is used to evaporate leachate or is flared.

The methodology prescribes to develop several alternatives for the particular landfill site in order to determine what would have the most logical course of action to determine the additionality.

B. 2. Description of how the methodology is applied in the context of the project activity:

Baseline
The core business of ONYX at the SASA landfill site is environmentally sound disposal and management of municipal and industrial waste. ONYX is applying the latest European standards at their site in Brazil and these standards exceed the current legislation in Brazil. The SASA landfill uses impermeable layers to prevent wastewater (leachate) penetrating in the ground water.

Prior to the installation of a leachate evaporator in 2001, the leachate generated at the SASA landfill was transported via tanker trucks to a local wastewater treatment plant for disposal.

In 2000, SASA began analysing possible onsite treatment methods. A number of onsite treatment technologies were considered. Although not the least expensive treatment option, SASA selected a leachate evaporation process. This technology has a number of environmental benefits such as:

- A portion of the LFG is used as a fuel and is therefore collected and combusted in the evaporator
- No discharge to surface water is required
- The process has guaranteed emission performance

As previously described, the proposed CDM project consists of:

- Installation of a landfill gas recovery network over the future disposal areas of the site
- Optimisation of the landfill gas extraction system
- Drilling of additional extraction wells, interconnection of horizontal drains
- Increase in flaring capacity

- Increase leachate evaporation process capacity
- Feasibility study to evaluate the possible extension to export electricity to the electrical grid.

If this voluntary investment was not done the atmospheric release of landfill gas could not be avoided. Consequently, **the baseline is the atmospheric release of landfill gas, captured gas is used to evaporate leachate or/and is flared.** There is no landfill gas fuel electricity generation on site yet and **Emission reductions associated with generation of the displaced electricity will not generate credits.**

Step 1: Assessment of legal requirements

The Brazilian legislation does not require landfill operators to flare landfill gas. The only requirement is to vent the landfill gas in order to avoid the risk of explosion (see Annexe 5: Letter from the state environmental regulator CETESB). The flaring of landfill gas, active extraction and generation of electricity are neither compulsory nor common practise in Brazil. The local environmental regulator CETESB confirms this in two letters presented in Annexe 5.

Current priorities with the authorities are to prevent illegal dumping and improving the conditions at ‘controlled’ sites, which apply lower standards. It is therefore highly unlikely that the Brazilian or a regional authority would require any flaring as LFG emission do not pose a threat to the local environment. The Brazilian Association of Residue Treatment Facilities (ABERTE) states in Annexe 6 that it is unlikely there will be any obligation to flare LFG within the coming 10 years.

Consequently, **there are no regulations governing flaring and/or combustion of landfill gas and no regulation is expected over the next decade.**

Step 2: Assessment of economic attractive courses of action

The following two alternatives could be identified:

1. Reference scenario LFG is vented to reduce the risk of explosions. The LFG is emitted into the atmosphere.
2. Extract and use the LFG as a fuel for a separate leachate evaporation installation and flare excess LFG

Alternative 1

As required by law, LFG is vented to the atmosphere to prevent the risk of explosion. The investment required for this alternative is minor and includes the cost for the vents. This is estimated to be approximately EUR 85,000 over the remaining life of the site. In this case, leachate is not treated on site.

Alternative 2

Under this alternative ONYX will invest in an LFG extraction system (piping and well network), leachate evaporation system and flare and possibly in a LFG engine for onsite electricity needs. Avoiding the use of another fossil fuel, LFG is used to heating the leachate. This avoided additional emissions, which would have occurred by using a fossil fuel, have **not** been taken into account in the calculation. The total investment for this infrastructure is estimated to be EUR 2,300,000. The economic lifespan of the equipment is set for 10 years. The investment will not generate any revenue and for the purpose of proving the additionality the potential CER revenues are left out of this calculation.

The cost saving associated with the avoided cost of transporting leachate to a nearby wastewater treatment plant is marginal. Consequently this solution is clearly not an attractive economically solution

Consequently, we can show that this alternative has a negative Internal Rate of Return.

Alternative 3
It is generally admitted that burning gas via gas engine to produce electricity can be in some cases an attractive scenario to recover biogas. This third alternative consisting in installing landfill gas engines to generate and export electricity onto the national grid was considered at the time of project decision. However because the electricity market is not consolidated yet for small and alternative sources, the barriers and risk are too high to develop such expensive system: impossibility to get grid connection or get a long term view on electricity sale. However, it is envisaged to study the opportunity of developing such system when the quantity of gas will be sufficient and if the economical context is more stable. Consequently, this scenario is not, at the moment, economically attractive due to the uncertainty and inability to secure long term sale of electricity.

Clearly Alternative 1 is the least cost option for the SASA landfill site and is chosen as the baseline scenario. Under alternative 1 LFG is emitted to the atmosphere and under the proposed project activity over 80% of the LFG will be captured and flared.

Step 3: Assessment of barriers and common practice

As under step 2 the most likely course of action is no LFG capturing and flaring, this step is not applicable.

Step 4 : Extra check on credibility of the baseline

This step will be assessed, as recommended in AM 0011 by the Designated Operational Entity.

It can be concluded that the project is additional and the baseline scenario is not to capture nor flare the LFG.

B. 3. Description of how the anthropogenic emissions of GhG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity:

A CDM project activity is additional if anthropogenic emissions of greenhouse gases by sources are reduced below those that would occur in the absence of the registered CDM project activity, i.e. in the baseline scenario.

In the above section B.2 ‘Description of how the methodology is applied in the context of the project activity:’, it was argued that the baseline scenario for this particular landfill site is to vent the LFG. In the proposed CDM project activity the LFG is captured, flared and the methane is converted into CO_2. Any captured LFG would otherwise be emitted to the atmosphere. Clearly the emissions are reduced below those that would have occurred in the absence of the registered CDM project activity.

As CO_2 emissions from the flaring of methane result from biomass and can therefore be set zero.

ONYX has developed an advanced first order decay model, as described in the document reference: NM0021 Cerupt Methodology for landfill gas recovery. Given the project characteristics, the amount of landfill gas that can be recovered is estimated. The recovered LFG will either be combusted in the evaporator, combusted in the generator (if and when installed) or/and simply flared.

The final amount of emission reductions is based on the amount of landfill gas combusted. In absence of the project the amount captured would otherwise have been emitted to the air.

B. 4. **Description of how the definition of the project boundary related to the baseline methodology is applied to the project activity*:***

The project boundary is defined by the emissions targeted or directly affected by the project activities, construction and operation. Project boundaries are set in a way that they comprise all relevant emissions sources that, can either be controlled or influenced by the project participants and that are reasonably attributable to project activities.

All relevant emissions of the baseline situation and the project situation were identified and shown on the below flowchart (figure 1: emission flowchart).

The following emissions were not taken into account:
Emissions from the transport of waste to the site are excluded from the project boundaries, as they are not affected by the implementation of the proposed CDM activity.

The reduction of leachate *transportation to outside wastewater treatment plant* have not been taken into account *in the baseline scenario. This assumption has been made* for simplicity and conservativeness purpose.

A schematic overview of the project boundaries of this project is summarized on the next page.
As can be seen in the scheme, the LFG will go either to the evaporator or to the flare depending on the demand of the evaporator.

This conservative approach shows that the project will lead to even further emission reduction outside of the project boundary, which are not accounting for as part of this methodology.

B. 5. Details of baseline information, including the date of completion of the baseline study and the name of person(s)/entity(ies) determining the baseline:

Date of completion: 15/07/2003

The entity defining the baseline is the project Participant described in the Annexe 1: ONYX.

The baseline scenario is defined in the Annexe 3 ‘Baseline information’.

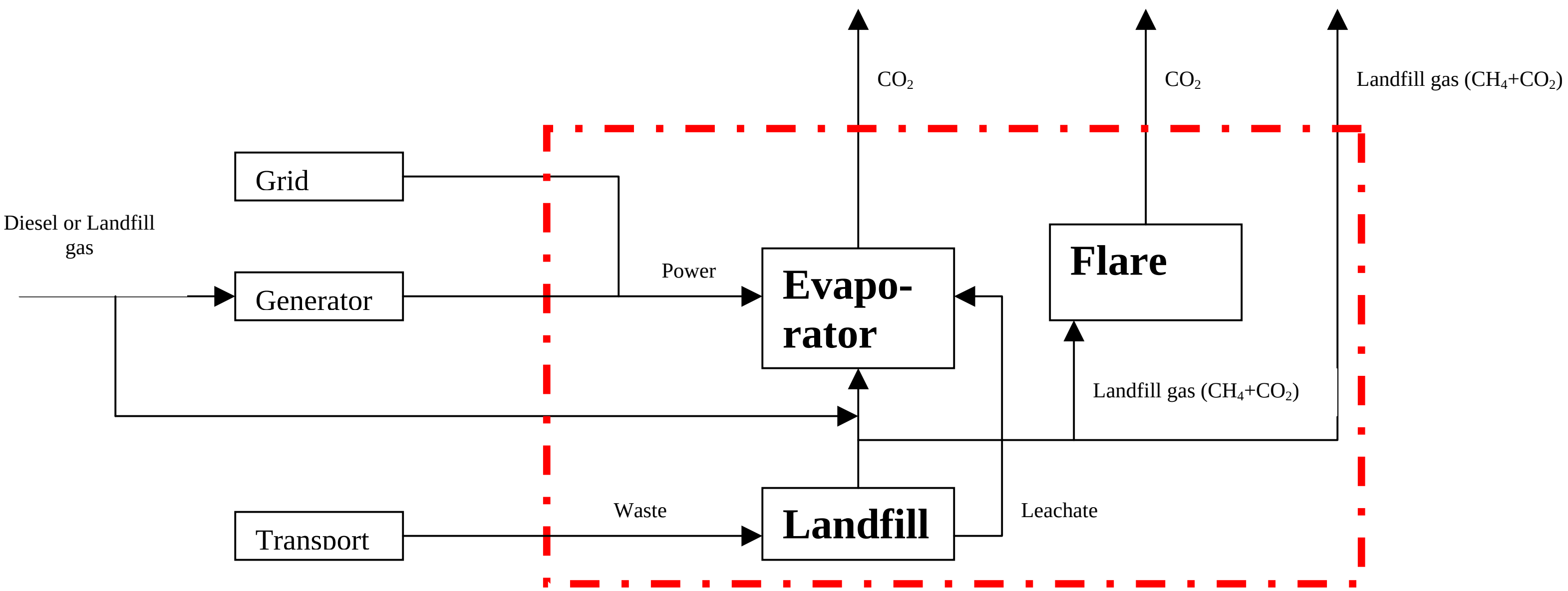


Figure 1 : Project flowchart

SECTION C. Duration of the project activity /crediting period

C. 1. Duration of the project activity:

C. 1. 1. Starting date of the project activity:

The initial installation of the project infrastructure has started in March 2001 (commissioning date) as referenced in the licence to operate the facility from the CETESB, Annexe 8.

C. 1. 2. Expected operational lifetime of the project activity:

10 years (landfill gas will be produced at the site for over 20 years, the extraction system and LFG combustion will remain in use until no longer required)

C. 2. Choice of the crediting period and related information:

The project activity will use a fixed crediting period as described below in section C.2.2 Fixed crediting Period:

C. 2. 1. Renewable crediting period

C. 2. 1. 1. Starting date of the first crediting period:

C. 2. 1. 2. Length of the first crediting period

C. 2. 2. Fixed crediting period:

C. 2. 2. 1. Starting date:

The starting date is the 1st January 2003.

The starting date for this project is prior to the registration date. Onyx along with Veolia Environment, its parents company, recognises the importance of greenhouse gas emission reductions. Amongst the group's sustainable development commitments is the reductions of greenhouse gas emissions from its activities. This has been communicated in its environment / sustainable development reports since 2000, referenced in Annexe 7. Aligned with this commitment, Onyx has developed at the SASA landfill a show case site and is without precedence in Brazil. "Onyx has been a pioneer" in greenhouse gas emission reduction and has believed in CDM project development at a very early stage.
The SASA Landfill gas recover project was selected by the Dutch Government in the CERUPT 2001 Tender process and was submitted as a reference project with the CERUPT methodology NMOO21. A contract was signed with SENTER on the 12th November 2003.

C. 2. 2. 2. Length:

10 years (equivalent to 120 months).

SECTION D. Application of a monitoring methodology and plan

D. 1. Name and reference of approved methodology applied to the project activity:

Approved monitoring methodology - AM0011: "Landfill gas recovery with electricity generation and no capture or destruction of methane in the baseline scenario", referring the case NM0021: "CERUPT Methodology for landfill gas recovery", submitted by Onyx for this particular project.

D. 2. Justification of the choice of the methodology and why it is applicable to the project activity:

The chosen methodology is designed specifically for landfill gas recovery projects. It has been approved based on the first version of this PDD, submitted and approved under the reference NM0021: Cerupt Methodology for landfill gas recovery for the Onyx Landfill Gas Recovery project at the SASA landfill.
According to the methodology, the basis for the monitoring of the emission reduction is the measurement of landfill gas amount and composition recovered for combustion. The chosen methodology is applicable for the destruction of the methane via a leachate evaporator and/or flare system. In the current project generation of electricity is foreseen in the future, but has not been included in this project activity.

This Monitoring methodology is used in conjunction with the baseline methodology AM0011 as recommended.

D. 2. 1. Option 1: Monitoring of the emissions in the project scenario and the baseline scenario.

D. 2. 1. 1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

D. 2. 1. 2. Description of formulae used to estimate baseline emission (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

D. 2. 1. 3. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GH G within the project boundary and identification if and how such data will be collected and archived:

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)

D. 2. 1. 4. Description of formulae used to estimate baseline emission (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

D. 2. 2. Option 2: Direct monitoring of emission reduction from the project activity (value should be consistent with those in section E).

D. 2. 2. 1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

ID number *(Please use numbers to ease cross-referencing to table D.6)*	Data type	Data variable	Data unit	Will data be collected on this item? (If no, explain).	How is data archived? (electronic/paper)	For how long is data archived to be kept?	Comment
1	Numbers	Well pressure	Pa	Yes	Electronic	2 years following the end of the crediting period	Daily monitoring
2	Numbers	LFG Concentration CH_4, CO_2 and O_2	m^3/hr	Yes	Electronic	2 years following the end of the crediting period	Daily monitoring. In order to increase the accuracy a continuous monitoring system will be installed shortly.
EVAP (Leachate Evaporator)							
4	Numbers	Steam temperature	°F	Yes	Electronic	2 years following the end of the crediting period	Daily monitoring
5	Numbers	Leachate volume	m^3/hr	Yes	Electronic	2 years following the end of the	Daily monitoring

						crediting period	
Flare							
7	Numbers	Combustion temperature	°F	Yes	Electronic	2 years following the end of the crediting period	Daily monitoring
EVAP + Flare (= Gas collected from project wells)							
8	Numbers	Gas flow	m^3/hr	Yes	Electronic	2 years following the end of the crediting period	Continuous monitoring
9	Numbers	Gas Pressure	Pa	Yes	Electronic	2 years following the end of the crediting period	Daily monitoring,
10	Numbers	Temperature	°F	Yes	Electronic	2 years following the end of the crediting period	Daily monitoring
Inspect collection system							
10	Comments			Yes		2 years following the end of the crediting period	Daily visual inspection

Table 1: Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

The Amount of landfill gas collected from the project wells is identical to sum of the amount combusted via the Evaporator, the flare and the Generator (when installed) as the system is closed and pipework maintained under negative pressure to avoid any leakage.

The continuous flowmeter is installed after the blower unit prior to the evaporator and flare units. The measured flow will determine the total volume of combusted landfill gas. This volume will be equal to the volume of gas collected from the project wells which are connected via a piping network under a common vacuum. Therefore only one flowmeter at this location will be adequate for monitoring the emission reductions.

The environmental benefits of the flare and of the Evaporator being the same (because the displaced electricity has not being considered for the evaporator) their gas flow has not been distinguished.

All data will be aggregated monthly and yearly.

D. 2. 2. 2. Description of formulae used to estimate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2.

As CO_2 emissions from the flaring / combustion of methane result from biomass and can therefore be set zero.

D. 2. 3. Treatment of leakage in the monitoring plan

D. 2. 3. 1. If applicable, please describe the data and information that will be collected in order to monitor leakage, effects of the project activity.

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

As shown in the baseline study, the occurrence of leakage is not likely. Data on this will therefore not be collected.

D. 2. 3. 2. Description of formulae used to estimate leakage (for each gas, source, formulae/ algorithm, emissions units of CO_2 equ.)

Not applicable

D. 2. 4. Description of formulae used to estimate emission reductions for the project activity (for each gas, source, formulae/algorithm, emission units of CO_2 equ.)

The emission reductions are defined as the difference of emissions in the baseline situation and in the project situation. For this project, this means that all landfill gas emissions that are recovered and combusted in the flare and evaporator lead to emission reductions.

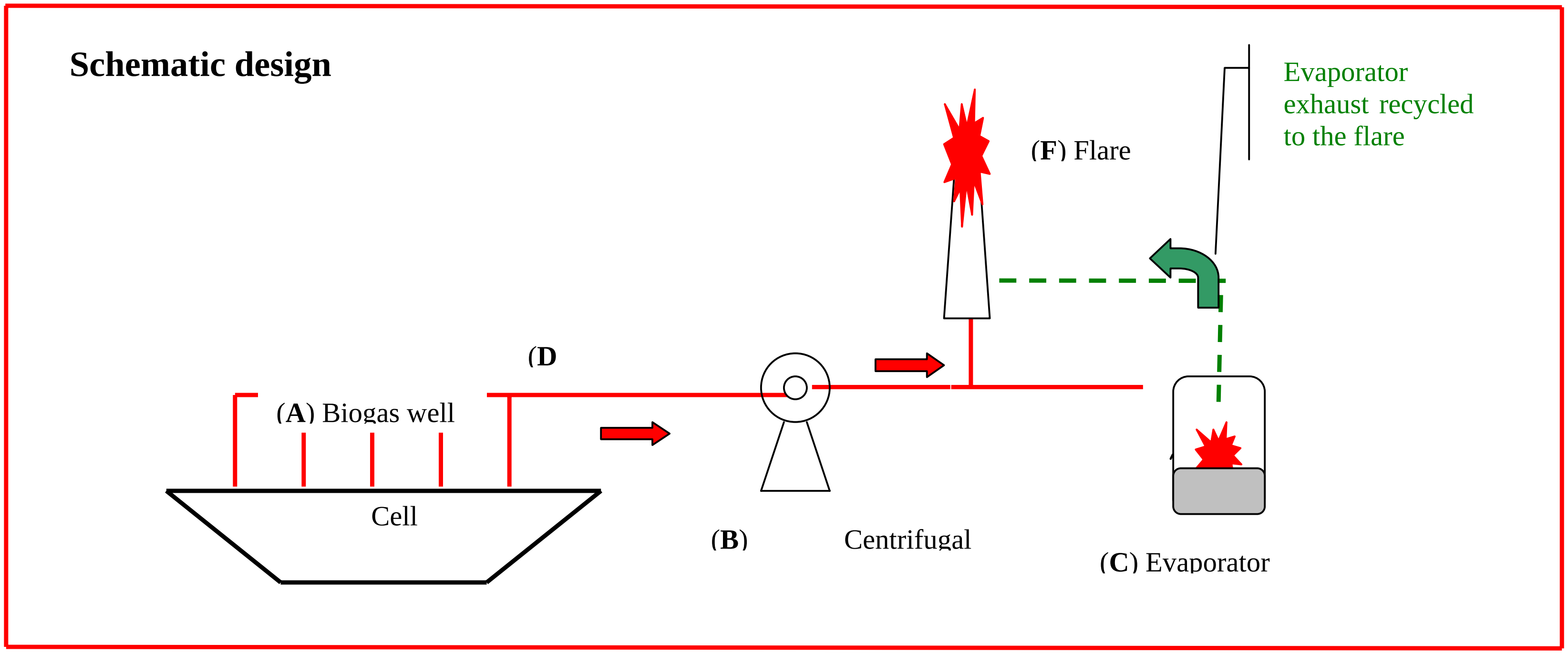
$$Q_c = \sum_{t}^{P} (Q_f + Q_e)$$

Q_c = total landfill gas recovered in year x (m^3/yr)
Q_f = total landfill gas to flare (m^3/hr) (measured)
Q_e = total landfill gas to evaporator (m^3/yr) (measured)

Furthermore, the formulae A4.2 and A4.3 (Annexe 4) will be applied to calculate the emission reduction.

SASA conducts routine monitoring of the active LFG extraction system and associated equipment. This monitoring is done to ensure optimal performance of the system.

Below is a schematic representation of the primary components of the routine monitoring activities performed by SASA's technicians.



- **In refuse Biogas wells (A)** – The gas extraction wells are monitored daily in order to check the concentration of the landfill gas (CH_4, CO_2, O_2). The optimum operational parameter being a minimum of 45% methane and a maximum of 3% oxygen).

The measurements are made with a portable gas meter. Adjustments to the individual well vacuums are made based on this monitoring.

- **Evaporator (C) and flare** - A totalising meter installed prior to the evaporator flow provides the actual gas consumption.

In addition the landfill gas concentration is also measured prior to the evaporator /flare unit. To measure the performance of the unit there is a steam temperature control device with a maximum set point of 200° F and a device to control the maximum and minimum leachate level.

There is an in -line temperature gauge to measure the combustion temperature of the flare. (The minimum operating valve is 1300 ° F; the set point of 1650° F being considered optimal).

- **Well and pipe integrity (D) -** A visual inspection is conducted of above ground piping and wells heads to ensure its integrity.

This operational data will serve as the basis for verification of emission reductions. All data collected is kept on-site in the monitoring database.

The total flow measurements taken before the flare and evaporator allow for accurate calculation of actual emission reductions.

In addition to the gas monitoring described above, the following items will also be monitored as part of the operation procedures:

- Landfill volume consumed :

Annual topographic surveys are conducted to determine the consumed and remaining landfill volume. This data will be compared with the landfill phasing assumptions used in the LFG production model.

- Waste input :

All waste entering the site is weighed on calibrated scales. The annual waste input will be compared with the assumed input used in the model.

- Waste composition

Waste accepted at the SASA landfill must be classified according to its composition. This will enable review of the model assumptions. This information is maintained onsite. This will enable review of the model assumptions concerning waste types and associated carbon content.

D. 3. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored.

Monitoring procedures have been formalised as part of documentation for planned ISO 14001 certification.

Data (Indicate table and ID number e-g 3.-1;3.2.)	Uncertainty level of data (High/Medium/Low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
In-refuse wells		
1 Well pressure	Low	Monitoring data used immediately by technician to adjust well vacuum
2 Well flow	Low	Monitoring data used immediately by technician to adjust well vacuum
3 Concentration	Low	Monitoring data used immediately by technician to adjust well vacuum
EVAP		
4 Gas Flow	Low	*Data reviewed as part of daily monitoring*
5 Steam Temperature	Low	*Data reviewed as part of daily monitoring*

6 Leachate Volume	Low	*Data reviewed as part of daily monitoring*
Flare		
7 Gas Flow	Low	*Data reviewed as part of daily monitoring*
8 Concentration	Low	*Data reviewed as part of daily monitoring*
9 Comb. Temperature	Low	*Data reviewed as part of daily monitoring*
Inspect collection system		
10 Well and pipe	Medium	*Ensure integrity of collection system*

D. 4. Please describe the operational and management structure that the project operator will implement in order to monitor emission reductions and any leakage effects, generated by the project activity.

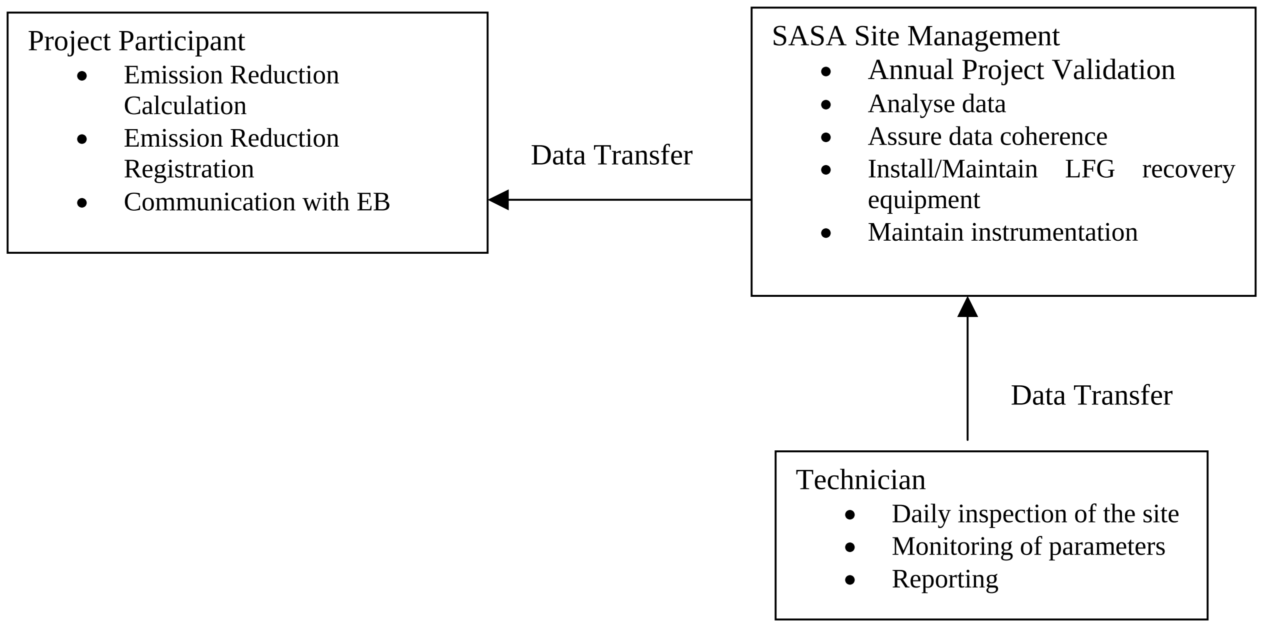


Figure 2: Operational Organisation of the project activity

D. 5. Name of person/entity determining the monitoring methodology:

The entity responsible of determining methodology is the project participant described in the Annexe 1: Onyx, represented by G. Crawford.

Company name:	ONYX
Address :	169 avenue Georges Clémenceau
Zip code + city address :	92735 NANTERRE -
Country :	FRANCE
Contact person:	Mr Gary CRAWFORD
Job title :	Vice President Environment / Quality
Telephone number :	+33 1 46 69 36 16
Fax number :	+33 1 46 69 34 67
E-mail :	gcrawford@cgea.fr
Date of registration :	23/12/1997

SECTION E. Estimation of GHG emissions by sources

E. 1. Estimate of GHG by sources:

The potential landfill gas production has been estimated in order to quantify possible gas volumes that may be generated by the SASA landfill site.

Geolia, Onyx‘s in-house landfill technical division, has developed a model to calculate landfill gas production entitled “Biogeolia”. This model estimates the evolution of landfill gas production using a *first-order degradation model* (kinetic model) with multiple waste types inputs. This model describes both the growth and descending phases.

The following assumptions have been used in the SASA landfill model run.

- *Waste volume*

The modelling for the existing filled areas is based on the actual in-place waste volumes and past waste inputs.

The recently approved extension (Aterro 3) will extend the site life to 2012. This extension is divided into four phases and the production of each phase is detailed in the calculation.
The model considers only permitted areas and does not consider the potential expansions that may extend the site life beyond 2012.

- *Annual tonnage*

The municipal and commercial waste input assumed is 180,000 tons per year. This was based on the actual waste being received in 2000 (see table 3)

- *Extraction efficiency*

The recoverable landfill gas depends on the effectiveness of the extraction system. The rate of landfill gas recoverable generally ranges between 50 and 90% of the total production.

It was considered for this calculation that the extraction efficiency is 0 % during the filling period and 80 % one year after the area is covered and equipped with an extraction system.

For the existing site "Aterro 1" the actual extraction efficiency is evaluated to be 70 %, and will increase to 80 % following the cover placement and extraction equipment installation.

For "Aterro 3 - phase 3", the extraction efficiency is evaluated to 50 % for the last part of the filling period and will increase to 80 % one year after the closure of this area.

- *Waste Composition*

The waste composition for the year 2000, as shown on table, was used as the expected waste type breakdown for the remaining site life.

The total quantity of waste material deposited at the SASA landfill from 1996 to 2000 is as follows:

Waste quantities codisposal (tons)	1996	1997	1998	1999	2000
Municipal Solid Waste	1 387	9 523	18 845	22 287	39 381
Industrial and Commercial Waste	0	11 198	27 331	62 592	110 099
Biological Sludge	518	3 569	5 395	3 695	2 143
Foundry Sand	38 405	13 030	16 268	14 468	27 136
Inert Waste	1 547	2 319	22 847	6 411	0
Total	**41 856**	**39 639**	**90 686**	**109 453**	**178 759**

Table 2: "Waste inputs in SASA landfill site"

The composition of waste used for calculations is as follows:

Waste quantities codisposal (tons)	1996	1997	1998	1999	2000
Municipal Solid Waste	3,3%	24,0%	20,8%	20,4%	22,0%
Industrial and Commercial Waste	0,0%	28,3%	30,1%	57,2%	61,6%
Biological Sludge	1,2%	9,0%	5,9%	3,4%	1,2%
Foundry Sand	91,8%	32,9%	17,9%	13,2%	15,2%
Inert Waste	3,7%	5,9%	25,2%	5,9%	0,0%
Total	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**

Table 3: Waste composition at SASA landfill site

Results

The results in the following table show the emissions by the project activity within the project boundary.

Project emissions	Landfill gas production (m^3/hr)	Landfill gas recovered (m^3/hr)	Landfill gas emitted to air m^3/hr	Landfill gas emitted to air m^3/yr	Methane gas emitted to air m^3/yr	CO_2e/yr (Ton CO_2e/yr)
2003	869	558	311	2.724.360	1.362.180	20.433
2004	1.086	689	397	3.477.720	1.738.860	26.083
2005	1.296	727	569	4.984.440	2.492.220	37.383
2006	1492	889	603	5.282.280	2.641.140	36.617
2007	1670	1.083	587	5.142.120	2.571.060	38.566
2008	1832	1.072	760	6.657.600	3.328.800	49.932
2009	1977	1.375	602	5.273.520	2.636.760	39.551
2010	2104	1.371	733	6.421.080	3.210.540	48.158
2011	2213	1.331	882	7.726.320	3.863.160	57.947
2012	2279	1.569	710	6.219.600	3.109.800	46.647
Total				**53.909.040**	**26.954.520**	**404.318**

Table 4: CO_2e emission of the project activity

E. 2. Estimated leakage:

Eventual leakages come from the use of energy (electricity from the grid or diesel engine), however as described in the Approved Methodology AM0011 these emissions are not significant:

In the first years of operation a *diesel generator* will be used for the power supply in case delivery from the grid is interrupted. Emissions from the diesel generator nor from the production of electricity from the grid are not taken into account, as the emissions are non-significant compared to the baseline emissions.

The yearly power demand of the Evaporator is 200 MWh. Assuming an efficiency of 30% of the diesel generator and an emission factor of 0.0741 CO2/TJ one can calculate the annual emissions of the diesel generator: 200MWh/30% = 666,67 MWh. 666.67 MWh * 3.6 GJ/MWh=2400 GJ = 2.4 TJ. 2.4 TJ * 0.0741 ktonne CO2/TJ= 0.18 tonne CO_2.
The diesel generator is only working when grid supply is interrupted, which is in the worst case would be 2 months[1]. The actual emissions are therefore 2/12* 0.18 tonne = 0.03 tonne CO_2. The electricity supplied from the grid has even lower emissions due to the high share of hydro power in Brazil.

Consequently, no significant leakage is expected as a result of the project activity.

[1] Based on Onyx experience

E. 3. The sum of E.1 and E.2 representing the project activity emissions:

See table 3 in E.1

E. 4. Estimated anthropogenic emissions by sources of greenhouse gases of the baseline:

In the baseline situation, all the landfill gas is emitted to the air.

To calculate the greenhouse gas emissions formulae A3.2 and A3.3 (Annexe 3) are used.

Applying these formulae leads to the following baseline emissions:

Baseline emissions	Landfill gas Produced (m^3/hr)	Landfill gas recovered (m^3/hr)	Landfill gas emitted to air m^3/hr	Landfill gas emitted to air m^3/yr	Methane gas emitted to air (m^3/yr)	CO_2e/yr (Ton CO_2e/yr)
2003	869	-	869	7.612.440	3.806.220	57.093
2004	1.086	-	1.086	9.513.360	4.756.680	71.350
2005	1.296	-	1.296	11.352.960	5.676.480	85.147
2006	1.492	-	1.492	13.069.920	6.534.960	98.024
2007	1.670	-	1.670	14.629.200	7.314.600	109.719
2008	1.832	-	1.832	16.048.320	8.024.160	120.362
2009	1.977	-	1.977	17.318.520	8.659.260	129.889
2010	2.104	-	2.104	18.431.040	9.215.520	138.233
2011	2.213	-	2.213	19.385.880	9.692.940	145.394
2012	2.279	-	2.279	19.964.040	9.982.020	149.730
Total				**147.325.680**	**73.662.840**	**1.104.943**

Table 5: CO_2e emissions of the baseline scenario

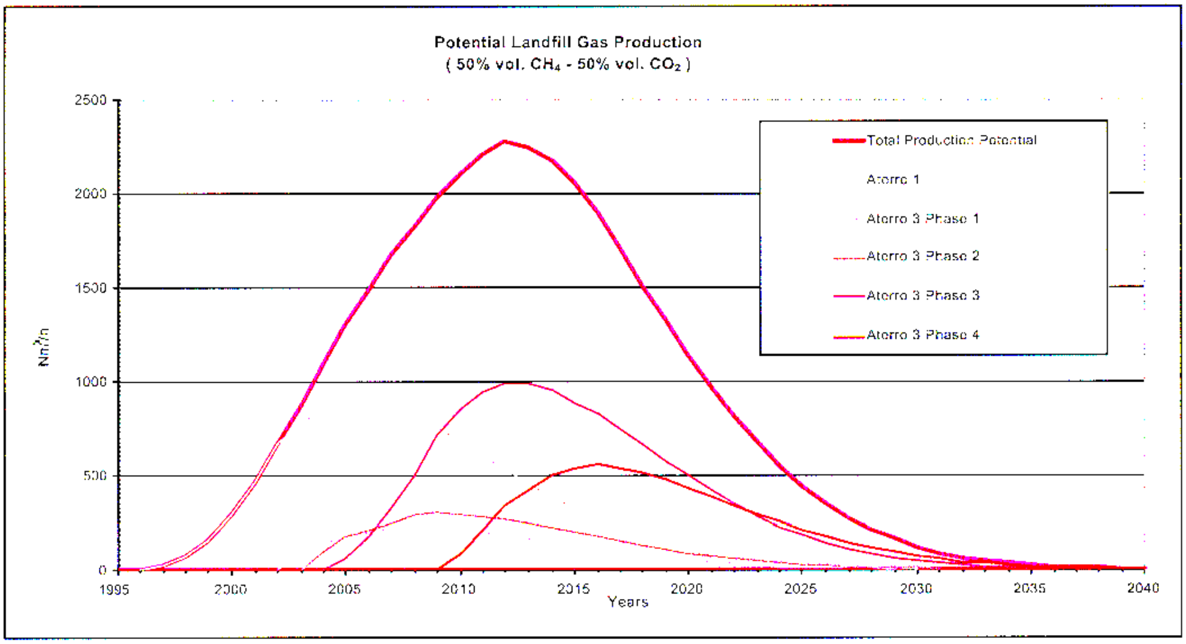


Figure 3: Potential LFG production in the baseline scenario

E. 5. Difference between E.4 and E.3 representing the emission reductions of the project activity:

See. E.6. The emission reductions are equal to the amount recovered and combusted.

E. 6. Table providing values obtained when applying formulae above:

The following table represents the avoided (reduced) emissions of GHG by the CDM project activity resulting from the recovery and combustion of landfill gas. It should however be noted that the amount of CER will be determined by monitoring the amount of captured LFG and its methane content.

Emission reductions	Landfill gas Produced (m^3/hr)	Difference in landfill gas emitted to air m^3/hr	Difference in landfill gas emitted to air m^3/yr	Difference methane gas emitted to air m^3/yr	CO_2e/yr (Ton CO_2e/yr)
2003	869	558	4.888.080	2.444.040	36.661
2004	1.086	689	6.035.640	3.017.820	45.267
2005	1.296	727	6.368.520	3.184.260	47.764
2006	1.492	889	7.787.640	3.893.820	58.407
2007	1.670	1.083	9.487.080	4.743.540	71.153
2008	1.832	1.072	9.390.720	4.695.360	70.430
2009	1.977	1.375	12.045.000	6.022.500	90.338
2010	2.104	1.371	12.009.960	6.004.980	90.075
2011	2.213	1.331	11.659.560	5.829.780	87.447
2012	2.279	1.569	13.744.440	6.872.220	103.083

Total	**93.416.640**	**46.708.320**	**700.625**

Table 6: Avoided (reduced) emissions as a result of the CDM project activity.

SECTION F. Environmental impacts

F. 1. Documentation on the analysis of the environmental impacts, including trans-boundary impacts

The project does not require an Environmental Impact Assessment as the project will be within the permit of the approved landfilling activities. SASA submitted an EIA as part of the permitting process. This EIA was reviewed and the permit for the landfill has been issued by CETESB, the local environmental agency.

This project will have no detrimental effects on the environment. In fact the project is planned in order to enhance the environmental performance of this landfill. The project will allow for optimum landfill gas extraction. This project will prevent the following risks associated with landfill gas at uncontrolled landfills:

- Risk of explosion
- Risk of fire
- Unpleasant odours nuisances
- GHG emissions effects
- Potential atmospheric pollution
- Damage to vegetation by asphyxia

The impacts are and will continue to be mitigated by the installations proposed in this project.

Final cover is placed on the landfill as areas reach their final elevation. The final cover includes a semi-impermeable clay layer overlain by topsoil. The surface is re-vegetated as part of the reforestation plan.

F. 2. If Environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the Host Party:

The environmental aspects of the project are only positive.

SECTION G. Stakeholders comments

G. 1. Brief description how comments by local stakeholders have been invited and compiled:

SASA invited the most important local stakeholders for a meeting that was held on 17th of August 2002 in Continental Inn Hotel in Taubaté, state of Sao Paulo. Kyoto Protocol Concepts and SASA's Landfill Gas Recovery Project were discussed. No comments were received.

An "Open House" program has been implemented by SASA for several years. It consists of a 2 hour site tour, to show the facility and explain all the activities developed by SASA. Most of the stakeholders invited for the 17th August have meeting, have participated in SASA's "Open House" program.

G. 2. Summary of the comments received:

There were no comments received.

G. 3. Report on how due account was taken of any comments received

No action was taken, as there were no comments received.

Annexe 1: Contact information on participants in the project activity

Organization:	ONYX
Street/P.O.Box:	169 avenue Georges Clémenceau
Building:	
City:	NANTERRE
State/Region:	
Postfix/ZIP:	92735
Country:	FRANCE
Telephone:	+33 1 46 69 36 16
FAX:	+33 1 46 69 34 67
E-Mail:	gcrawford@cgea.fr
URL:	www.onyx-environnement.com
Represented by:	Gary CRAWFORD
Title:	Vice President Environment / Quality
Salutation:	Mr
Last Name:	CRAWFORD
Middle Name:	
First Name:	Gary
Department:	Environment and Quality
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	gcrawford@cgea.fr

Organization:	SASA (landfill operator, subsidiary of Onyx)
Street/P.O.Box:	Est. Municipal,2200 – Mato Dentro
Building:	
City:	Tremembé
State/Region:	Sao Paulo
Postfix/ZIP:	12120-000
Country:	BRASIL
Telephone:	55-12-3607-2102
FAX:	
E-Mail:	bpalma@vivendi-onyx.com.br
URL:	
Represented by:	Breno Caleiro Palma
Title:	Managing Director
Salutation:	Mr
Last Name:	Palma
Middle Name:	Caleiro
First Name:	Breno
Department:	
Mobile:	
Direct FAX:	55-12 3607-2104
Direct tel:	55-12-3607-2103
Personal E-Mail:	bpalma@vivendi-onyx.com.br

Organization:	SenterNovem den Haag
Street/P.O.Box:	P.O Box 93144
Building:	
City:	AC The Hague
State/Region:	
Postfix/ZIP:	2509
Country:	The NETHERLANDS
Telephone:	+31 70 373 50 00
FAX:	+31 70 373 51 00
E-Mail:	g.j.mulder@senter.nl
URL:	www.senternovem.nl
Represented by:	Gerhard Mulder
Title:	Project Officer
Salutation:	Mr
Last Name:	Mulder
Middle Name:	
First Name:	Gerhard
Department:	
Mobile:	
Direct FAX:	+31 (0) 70 37 51 00
Direct tel:	+31 (70) 37 35 240
Personal E-Mail:	g.j.mulder@senter.nl

Annexe 2: Information regarding public funding

No public funding is involved.

Annexe 3: Baseline information

Baseline Methodology:

Approved monitoring methodology - AM0011: "Landfill gas recovery with electricity generation and no capture or destruction of methane in the baseline scenario". The whole document can be downloaded from the UNFCCC website:
http://cdm.unfccc.int/methodologies/approved.html.

Estimating baseline emissions

In LFG projects baseline emissions are determined ex post by monitoring the amount of LFG extracted. As such the estimation of baseline emissions ex ante as part of the PDD is not so relevant.
However, in order to facilitate forward sale of CER's from these projects, this methodology gives some guidance for estimating emission reductions. The user of this methodology however should feel free to use other estimation methods.

A simple first model decay model[2] can be used for the estimation of methane to be emitted through time.

$$Q_x = L_0 R\left(e^{-kc} - e^{-kt}\right) \quad \textbf{(A3.1)}$$

In which
Q_x = total methane released in year x (m^3/yr)
L_0 = theoretic potential amount of methane generated (m^3/ton). This amount is dependent on the composition of the waste and may vary from less than 100 to over 200 m^3/ton.
R = waste disposal rate (ton/yr)
t= time since landfill opened (yrs)
c= time since landfill closed (yrs)
k = rate of landfill gas generation (yr^{-1}). Values may range from less than 0.005 to 0.4 per year. Higher k values are associated with greater moisture content. In case of an existing landfill, the current amount of methane emitted from the landfill can be estimated by measuring the methane flow on several locations and extrapolating these data to the total landfill. Using these data, a more accurate estimate of k can be made.

To calculate the methane emissions expressed in tonnes per yr the following formula is used.

[2] Revised 1996 IPCC Guidelines for National Greenhouse Gas inventories: Reference Manual, Chapter 6, Waste

$$M = \frac{0.016 * Q_x}{22.4} \qquad \textbf{(A3.2))}$$

In which
M = methane emissions (ton/yr)
0.016 = molecular weight methane (ton/kmol)
22.4 = molecular volume at 0 °C(m^3/kmol) (to be adapted for different temperatures)
Q_x = total methane generated in year x (m^3/yr)

The greenhouse gas emissions are calculated as follows:

$$\mathbf{GHG_b = 21 * M_b} \qquad \textbf{(A3.3)}$$

In which
GHG_b = Baseline GHG emissions (ton CO_2e/yr)
21= GWP of methane (ton CO_2e/ton methane)[3]
M= methane emissions in baseline situation (ton/yr)

Estimating Project Emissions
To determine the project emissions, first it is estimated how much of the emitted methane will be recovered. The rate of landfill gas recovery generally ranges between 50 and 90 percent of the total emission. A description is given on how this rate is determined, as it is strongly dependent on the technologies used and the way the landfill will be filled. The following formulae are used to estimate the greenhouse gas emission in the project situation:

$$\mathbf{Q_c = E * Q_x} \qquad \textbf{(A3.4)}$$

In which
Q_c = total methane recovered in year x (m^3/yr)
Q_x = total methane released in year x (m^3/yr)
E = extraction efficiency (%)

$$\mathbf{Q_p = Q_x - Q_c} \qquad \textbf{(A3.5)}$$

Q_p = total methane emitted in project situation in year x (m^3/yr)
Q_x = total methane released in year x (m^3/yr)
Q_c = total methane recovered in year x (m^3/yr)

To calculate the methane emissions expressed in ton per yr the following formula is used.

$$\mathbf{M_p = \frac{0.016 * Q_p}{22.4}} \qquad \textbf{(A3.6)}$$

[3] Revised 1996 IPCC Guidelines for National Greenhouse Gas inventories.

In which
M_p = methane emissions in project situation(ton/yr)
0.016 = molecular weight methane (ton/kmol)
22.4 = molecular volume at 0 °C(m^3/kmol) (to be adapted for different temperatures)
Q_p = total methane emitted in project situation in year x (m^3/yr)

The greenhouse gas emissions are calculated as follows:

$$GHG_p = 21 * M_p \tag{A3.7}$$

In which
GHG_p = project GHG emissions (ton CO_2e/yr)
21= GWP of methane (ton CO_2e/ton methane)[4]
M_b= methane emissions in project situation (ton/yr)

The methane is combusted (e.g. flared or combusted via the evaporator); the methane is reacting to form CO2. However, methane originates from the organic material that can be classified as biomass. The CO2 emissions resulting from the flaring and/or combustion of this methane therefore do not have to be accounted for.

In case other significant greenhouse gas emissions arise within the selected project boundary, e.g. from the use of fuel for the ignition of a flare, these have to be calculated as well.

If the methane is used for the production of electricity, additional emission reductions will be the result, mostly off-site. It is possible that the project will displace the power from other existing power plants, or that the project will make an investment in a new power plant unnecessary. Dependent on the situation, an accepted baseline methodology for electricity projects should be chosen to determine the additional emission reductions by the production of electricity using methane.

Estimate Emission Reductions

The estimated emission reductions are calculated. Yearly emission reductions are estimated by distracting the project emissions with the baseline emissions. It is acceptable to assume that the volume of methane actually recovered is an indication of the volume of methane that would have been emitted without the project. This volume will be monitored.

In order to carry out the estimation of landfill gas production, the following figures have been used:

[4] Revised 1996 IPCC Guidelines for National Greenhouse Gas inventories.

Waste Type	Average Organic Carbon Contents (kg/ton)
Municipal Solid Waste	240
Industrial and Commercial Waste	120
Biological Sludge	400
Foundry Sand	0
Inert Waste	0

Table 7 : Contents of Organic Carbon per type of waste

Annexe 4: Monitoring plan

Applied methodology

AM0011 Approved Monitoring Methodology “Landfill Gas recovery with electricity generation and no capture or destruction of methane in the baseline scenario”, based on this case described in NM0021: CERUPT methodology for landfill gas recovery

1. Brief description of the methodology

The monitoring methodology for landfill gas recovery is designed primarily to be used in relation with the CERUPT methodology for landfill gas recovery. As part of the Approved monitoring methodology, it is acceptable to assume that the volume of LFG actually recovered is an indication of the volume of gas that would have been emitted without the project. This will be monitored.

2. Data to be collected or used in order to monitor emissions from the project activity and how this data will be archived

The emission reductions are defined as the difference of emissions in the baseline situation and in the project situation. This means that all landfill gas emissions that are recovered and combusted lead to emission reductions.

$$Q_x = \text{concentration} * Q_c \qquad \text{(A4.1)}$$

Q_c = total landfill gas recovered in year x (m^3/yr)
Concentration = % of methane in landfill gas (measured
Q_x = total methane recovered in year x (m^3/yr)
To calculate the methane emissions expressed in ton per yr the following formula is used.

$$M = \frac{0.016 * Q_x}{22.4} \qquad \text{(A4.2)}$$

In which
M = methane recovered (ton/yr)
0.016 = molecular weight methane (ton/kmol)
22.4 = molecular volume at 0 °C and 1000 hPa (m^3/kmol)
Q_x = total methane recovered in year x (m^3/yr)

The greenhouse gas emission reductions are calculated as follows:

GHG = 21* M **(A4.3)**

In which
GHG = GHG emission reductions (ton CO_2e/yr)
21= GWP of methane (ton CO_2e/ton methane)[4]
M= methane recovered (ton/yr)

Instrumentation
Instrumentation will be calibrated as recommended by manufacturers.
Data will be monitored and archived as described in the AM0011 monitoring methodology.
As recommended data will be kept for two years after the end of the crediting period of the last issuance of CER's for this project activity whatever occurs the latest.

Data collection:

Some data are collected automatically through a data logger such as information on Flare, Evaporator, gas flow...

In case of a default an alarm is automatically raised. In addition a daily visual inspection is carried out by an operator. During this visit the operator check the instrumentation and monitoring data such as gas quality.

During this daily visit the operator analyses the data and balance the landfill to the adequate suction of the landfill to maintain a steady gas quality. Gas quality and suction level are checked at each individual gas well on a daily basis. This monitoring plan allows maximising gas collection and maintaining the facility.

Data Analysis:

The data are analysed on a daily basis by the operator. In case of a drift of one parameter the operator can react quickly and fix any potential problems.

All data required for the emission reduction calculations will be kept in the onsite-monitoring database. This information will be reported to Onyx.

On a regular basis, all monitoring information are transferred to Onyx headquarter to analyse the Emission Reduction following the formulae provided within the approved methodology AM0011.

Annexe 5: Letters from the environmental regulator CETESB

Annexe 6: Letter from the association of residue treatment facilities

Annexe 7: Extract of “2000 Vivendi Environmental report” and “2001 Onyx Environmental Report”

Annexe 8: Permit to operate issued by CETESB