



**CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006**

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**SECTION A. General description of project activity****A.1 Title of the project activity:**

Alto-Tietê landfill gas capture project

Version 06. PDD completed on 13/12/2007.

A.2. Description of the project activity:

The Project activity aims to extract the landfill gas (LFG) produced at the *Itaquaquecetuba* landfill by means of using a gas collection and gas flaring system. In contrast to the project activity, the baseline scenario shows a landfill operating only with a passive ventilation system.

The implementation of the project activity foresees the interconnection of the current and future vertical drains ended up by a gas pumping equipment through aerial horizontal tubing. At this point two torches will be installed in order to burn the extracted gases. Through this process, the oxidation of the methane generates H₂O and CO₂ gases that will be monitored, measured and controlled directly on site. Finally, the income generated from the CER sales will make possible to eliminate the barriers preventing the implementation of this project.

The landfill is currently operated by the *Empreiteira Pajoan Ltd*, (hereafter referred to as *Pajoan Ltd*) a private landfill operator company. The landfill was the second private site licensed in the State of *Sao Paulo*, attending around 1,670,000 inhabitants and providing high quality waste management services. Moreover, the proposed project activity is conducted by *Alto Tietê Biogás Redução de Emissões e Geração de Energia LTDA*. (listed as Project Participant), which is a private company created exclusively to manage and assess the CDM project activity.

The *Alto-Tietê* landfill was opened on March 2000 and was designed to manage waste type class 2, 3 (non-hazardous waste). The waste disposition area is of 500,000 m² from a total surface of 884,000 m², being 2,319 m² of constructed areas, were now is central office and the area for equipments storage. Currently, the landfill receives around 600,000 tones of waste per year (1,500 tonnes/day) from the metropolitan area of *São Paulo*. The release of landfill gas at the baseline scenario brings negative impacts to the quality of the environment and to the health of the local inhabitants, also increasing risks of explosions. Furthermore the *Alto-Tietê* project can be seen in association with a large program of rationalization and management of urban waste collection, initiated by the *Itaquaquecetuba* municipality and its influence area, to manage the growing development of the local economy. The project activity will improve the waste handling and waste management of many small municipalities, industries and commercial establishments within the *São Paulo* State.

In addition to its efforts in reducing the levels of GHG emissions, the project activity promotes local sustainable development as it foresees the creation of jobs in different fields associated with the project activity operation (i.e., garbage selection, flare operations and waste management) and the further possibility of energy generation from a renewable source.

Moreover, the project activity will strength the already in place social responsibility programs, such as environmental education, construction of sport facilities, afforestation activities (tropical forest conservation) and reforestation with native species. The already ongoing reforestation plan covers an area of 55,400 m² and makes use of native species coming from a sampling nursery built at the landfill premises. The native species produced are also distributed for use at local schools and green public areas.

**A.3. Project participants:**

Name of the Party involved	Private and/or public entity (ies) project participants	Kindly indicate if the Party involved wishes to be considered as project participant
UK	<i>Carbon Capital Markets Ltd.</i>	No
Brazil (Host Country)	<i>Alto Tietê Biogás, Redução de Emissões e Geração de Energia Ltda.</i>	No

A.4. Technical description of the project activity:**A.4.1. Location of the project activity:**

The landfill is located at the Municipality of *Itaquaquecetuba*, northeast of *Sao Paulo* State, in the *Alto Tietê* Region.

A.4.1.1. Host Party(ies):

Brazil.

A.4.1.2. Region/State/Province etc.:

Sao Paulo State. Southeast Brazil.

A.4.1.3. City/Town/Community etc:

Itaquaquecetuba.

A.4.1.4. Detail of physical location, including information allowing the unique identification of this project activity (maximum one page):

Nossa Senhora das Graças Avenue, 599, *Jardim Pinheirinho*, *Itaquaquecetuba/SP*, Brazil, ZIP: 08589-140. The geographical coordinates are Latitude South: 23°26'00'' and 23°26'20'', Longitude West: 46°17'30'' and 46°17'45''.

A.4.2. Category(ies) of project activity:

The sectoral scope for the project activity is waste handling and disposal (Sectoral number 13).

A.4.3. Technology to be employed by the project activity:

The LFG is composed primarily of carbon dioxide and methane and, in minor degree of additional trace constituents such as hydrogen sulphide, mercaptans, vinyl chloride, and numerous other non methanogenic volatile organic compounds (NVOCs). The production of LFG is a consequence of a methanogenesis reaction influenced by the composition and moisture of the waste present at the landfill, the absence of oxygen and toxics, a relatively neutral waste moisture pH, 6.7 - 7.2, and an appropriate internal temperature.

At the first phase, the project activity begins with the installation of a gas collection and flaring system (enclosed flares) through a network of pipes connected to the wellheads at the already ongoing cells. The second phase foresees the infrastructure of the gas extraction and flaring system at the new cells in parallel to the waste disposal.

The gas collection system will mainly be composed by the following elements:



- Vertical progressive drains to extract gas made on PVC perforated material. The drains are equipped with gas sensors (sampling points) to monitor the LFG flux and quality in order to analyse the trace gases.
- Horizontal drains (HDPE type) are installed each 4 meters high to maximize the extraction efficiency; the project activity forecasts an intensive use of these horizontal wells on the shallow areas to increase gas yields and to reduce the number of wells required for proper gas pumping.

The pipes used for the gas network system (HDPE) are placed down on slope downwards to the water-collection points. By doing so, the condensate can be drained away by gravity. Attached to the vertical progressive drain, a sampling point will regulate and monitor the LFG passing through.

The LFG must be condensed and stored on the lowest collecting points for further decantation and pumping. At the flare point, the combustion temperature is controlled to achieve a value range from 700 °C to 1,000 °C during 0.3 seconds of retention time for 50% methane content on the landfill gas. Eventually the enclosed flare must allow a homogeneous temperature distribution across the combustion chamber at the flare.

The monitoring and control equipment will optimize the LFG pressure, volume and temperature at the flare inlet for the best burning efficiency. According to the Brazilian environmental regulations on flaring gas emissions, the flare operation must ensure that emissions on carbon monoxide (CO), oxides of nitrogen (NO_x) and unburned hydrocarbons are kept under standard values.

Since the landfill gas extraction and management is not compulsory in Brazil, many landfill components are not present at the Brazilian market, such as control and monitoring equipment, LFG treatment and high efficient flare. However, local technology for the project activity will be used, where possible. The latter applies for the components used on the vertical/horizontal drains, gas network and pumps which are made in Brazil.

A.4.4 Estimated amount of emission reductions over the chosen crediting period:

Year	Annual estimation of emission reductions in tonnes of CO ₂ equ
2008	354,776
2009	396,399
2010	438,048
2011	479,900
2012	522,128
2013	564,779
2014	608,138
Total estimated reductions (tCO₂ equ.)	3,364,168
Total number of crediting years	7



Annual average over the crediting period of estimated reductions (tonnes of CO ₂ equ.)	480,595
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Table 1: Estimated emission reductions during the crediting period.

A.4.5. Public funding of the project activity:

No public financing for the project activity.

**SECTION B. Application of a baseline and monitoring methodology****B.1. Title and reference of the approved baseline and monitoring methodology applied to the project activity:**

The approved baseline methodology ACM0001 Version 05: “Consolidated baseline methodology for landfill gas project activities”. The project activity relates to the sectoral scope “Waste handling and disposal”.

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

This methodology is applicable to landfill gas capture project activities, where the baseline scenario is the partial or total atmospheric release of the gas. The proposed project activity does not consider the energy (electricity and/or thermal) generation, therefore no emission reductions are claimed from this source. The only source claimed in this project will be the flaring of the capture gas from the landfill.

B.3. Description of the sources and gases included in the project boundary

For the *Alto-Tietê* landfill there is only one primary source of CO₂ emissions within the boundary of the project activity. The emissions are due to the use of electricity in extracting and pumping the landfill gas.

In the baseline ex-ante emissions calculations, 30% is considered as LFG not captured and 2% not flared by the technology (efficiency 98%). This emissions sum 3,364,168 tCO₂equ for the period of March 2008-February 2015. The emissions of CO₂ in the flaring equipment of extracting and pumping of the landfill gas, is based on an electricity based pump system with 30kW resulting a total of 27.40 tCO₂e/year.

	Gas	Source	Included ?	Justification
Baseline	CO ₂	Waste	No	Emissions from biomass that can be defined as zero
	CH ₄	Waste	Yes	Anaerobic decay of the biomass
	N ₂ O	Waste	No	Emissions from biomass that can be defined as zero
Project Activity	CO ₂	Flaring equipment	Yes	Emissions from the use of electricity in extracting and pumping the landfill gas
	CH ₄	Flaring equipment	Yes	Methane capture and flaring with efficiency of 98%
	N ₂ O	Flaring equipment	No	Emissions from biomass combustion that can be defined as zero

**B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:**

According to the National Inventory of Greenhouse Effect Gas Emission conducted by CETESB¹ in 1994, Brazil has more than 6,000 garbage dumping sites that receive more than 60,000 tons of garbage per day.

Related to the same study, the 76% of the total waste amount produced currently in Brazil is disposed in unmanaged "dumping sites", 12% on basic landfills, 10% on controlled landfills (sanitary landfills) and 2% on other disposal ways (see table 2). Moreover, the ABETRE (Brazilian Association for Waste Treatment) estimates nearly 3 millions tonnes of industrial waste are disposed on uncontrolled dump sites and only the 20% are disposed under some technical regulations. Overall figures show that 84% of methane emissions in Brazil are from unmanaged waste dumpsites.

Final waste destination	Percentage	Source
Open Dump	76 %	CETESB ²
Controlled landfill	12 %	CETESB
Sanitary landfill	10 %	CETESB

Table 2: Final waste deposition in Brazil.

The current Brazilian legislation does not require an efficient treatment of the LFG generated besides gas venting (passive ventilation). In spite of the guidelines provided by the Brazilian Association of Technical Norms (ABNT), there are no binding regulations for the technical conditions of LFG recovery systems in Brazil.

The baseline scenario shows the atmospheric release of the LFG gas with no regulations and/or contractual requirements governing the landfill gas emissions. For the *Alto-Tietê* landfill, the baseline scenario represents a basic LFG ventilation system currently ongoing under no basic flaring at the wellhead. In opposite, the project activity foresees, as defined on section B.6.4, a total GHGs (green house gases) emissions reduction of 3,364,168 tonnes of CO₂equ.

The baseline scenario relates to the waste management activities currently ongoing on the *Alto-Tietê* landfill. The sanitary landfill currently serves a total population of 1,500,000 inhabitants, gathering the cities of *Arujá*, *Carapicuíba*, *Ferraz de Vasconcelos*, *Itaquaquecetuba*, *Mairiporã*, *Mogi das Cruzes*, *Poá*, *Suzano* and *São Paulo* (only commercial waste).

The core business of *Pajoan* is the control and management of the waste disposition of municipal and commercial waste in an environmental sustainable way. No hazardous waste material is on place, in compliance with the Brazilian technical standard 10-0004 for such landfill type.

Under this scenario the company operates a landfill based on a simple landfill gas venting system that releases the LFG generated as a consequence of the anaerobic decomposition of the waste. The *Alto-Tietê* landfill covers an approximate surface of 500,000 m² and sanitary cells of 5 meters depth with a bottom covered by a PVC coating to avoid leachate leakage into the freatic layers.

The leachate is being treated by a sanitary service provider, *SABESP*³. Furthermore, a processing plant (aerobic lagoon) was implemented with the following characteristics:

¹ CETESB (Environmental and Sanitation Company of the São Paulo State)

² Methane emissions from waste treatment and waste disposal in Brazil, MCT.

³ São Paulo state sanitation company www.sabesp.com.br

1. Sludge sedimentation and blending.
2. Physic-Chemical treatment stage.
3. Biological (bacterial) treatment stage, aerobic treatment (lagoon).
4. Water free sludge decantation.
5. Decanted water goes to treatment plant for recycling.
6. Recycled water is returned to the natural watercourse (local stream course, *Taboãozinho*).

Moreover, a waste recycling facility was build, the equipments covers about 10% of the daily waste in (1,500 tonnes/day).

In opposition to the business as usual scenario (BAU), the project activity will capture and flare the landfill gas through forced gas exhaustion. The proposed project activity is covered and defined under the applicability of the ACM0001 methodology.

On Table 3, project data relating to the baseline scenario.

Variable	Units	Definition	Value	Data Source
k	(1/yr)	Methane generation rate	0.09	<i>Pajoan Ltd (see Annex 3)</i>
L ₀	m ³ / Mg	Methane generation potential	132.5	<i>Pajoan Ltd (see Annex 3)</i>
MCF		Methane correction factor	1	IPCC Guidelines, 1996
R _{x,y}	Mg	Daily waste in at the landfill	1,500	<i>Pajoan Ltd</i>
Od	Year	Opening date of the landfill	2000	<i>Pajoan Ltd</i>
Cd	Year	Closing date of the landfill	2020	<i>Pajoan Ltd</i>
FE	%	Flaring efficiency	98	<i>Pajoan Ltd</i>
EE	%	Extraction efficiency	70	<i>Pajoan Ltd</i>
W _{CH₄,y}	m ³ CH ₄ / m ³ LFG	Average methane fraction of the landfill gas	0.5	IPCC Guidelines, 1996

Table 3. Key project variables and data used to determine the baseline scenario.

B.5. 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 (assessment and demonstration of additionality):

This chapter is constructed based on the document: “Tool for the demonstration and assessment of additionality” version 03, as defined from the 29th Meeting of the Executive Board.

Step 1. Identification of alternatives to the project activity consistent with current laws and regulations

The Brazilian Association for Waste treatment, Recycling and Management (*ABETRE*) states that no legislation will/may be prescribed in the future obliging LFG flaring within the next 10 years in Brazil⁴. Therefore there are no current specific regulations governing LFG flaring and it is not expected to have any regulation within the near future.

“Sub-step 1a. Define alternatives to the project activity”.

Definition of possible/potential alternatives to the project activity:

⁴ The letter was sent by ARBETRE to ONYX relating the CDM project “Projeto Onyx de Recuperação de Gás de Aterro” approved the 9th September of 2005 by the Brazilian DNA. (<http://www.mct.gov.br/clima/cigmc/projaprov.htm>)

**ALTERNATIVE 1****Continuation of the current situation
Business as usual in Brazil**

This scenario defines the business as usual in Brazil. The current regulations oblige passive venting in order to avoid potential risk of explosion. Under this scenario, the project developer would continue to use a venting system for safety reasons as conformed by the regulations.

ALTERNATIVE 2**The proposed project activity not undertaken as a CDM project activity
Landfill gas is extracted and flared, with no use or energy generation.**

Under this alternative, the project proponent will invest on the implementation of a gas collection, flaring and monitoring system. The technology to be employed presents the following characteristics:

- Use of a collection piping system, installed to convey the landfill gas from the well network to the blower/flare/evaporator station.
- Use of a leachate evaporator (EVAP), which uses landfill gas as a fuel/heat source to evaporate leachate collected from the lined disposal areas.
- Use of an enclosed flare that serves as an after burner to assure the thermal destruction of NVOC's (Non volatile organic compounds) and to control odours.
- Use of a control system to outfit flare and evaporator with an automatic safety and monitoring controls of the waste disposal and of the GHGs, such as CO₂, CH₄, N₂O, NO_x and CO gases.

The total investment for the project activity is estimated on USD 2,311,983. The investment would not have any financial return. Under the current Brazilian legislation for landfill gas management this scenario has no advantages for the landfill operator and is not economically feasible.

ALTERNATIVE 3**Credible alternatives to the project activity that deliver outputs and on services
LFG commercial use off-site**

Upgrading the landfill from the current scenario (passive venting) into a natural gas producer scenario will face high investment cost for the gas capture and treatment phase. Therefore, the project is economically and technically not interesting for the project developer.

ALTERNATIVE 4**Credible alternatives to the project activity that deliver outputs and on services
Landfill gas is extracted for energy generation**

The landfill gas will be captured and flared for commercial purposes (energy generation). This option foresees the installation of an electric generation system based on LFG. Moreover an electrical transformer of 12.5kVA will be necessary to step up the energy generated for the local transmission lines, specially built for the project.

However the high investment cost surrounding the landfill gas treatment stage (gas quantity and quality) brings the generation cost into uncompetitive market prices. Moreover, the fact that the energy generation is not on the core business of the landfill operator and the uncertainty to secure a fare selling price for the energy results on a high risk and unprofitable activity. It would represent a non attractive option for the landfill operator.

***Sub-step 1b. Consistency of applicable laws and regulations:***

There is no landfill gas extraction and/or flaring system on site, only a passive ventilation system attending all applicable legal requirements and therefore all its necessary licenses in date. Potential alterations in the possible future of the baseline will be followed by the monitoring plan elaborated for the project.

There are no specific laws governing LFG mitigation in Brazil. Nevertheless local environmental agencies at state level are acting towards closing rubbish dumps and forcing municipalities and industries to give proper destination to the waste generated through concessions to private entities. In all cases, however, active collection and flaring of the landfill gas has never been enforced by law. In addition, all of the identified scenarios are in consistency with the applicable laws and regulations.

Step 2. Investment analysis.

This step is to determine whether the proposed project activity is economically or financially less attractive than at least one other alternative, identified in step 1, without the revenue from the sale of certified emission reductions (CERs). To conduct the investment analysis, the following sub-steps is applied:

Sub-step 2a. Determine appropriate analysis method

The proposed project activity does not generates financial or economic benefits other than CDM related income, therefore the Option I – Simple cost analysis shall be applied.

Sub-step 2b – Option I. Apply simple cost analysis.

The *Alto-Tietê* landfill has currently no LFG flaring system installed. The installation of a LFG capture and flaring system, even an undeveloped one, would require costs for the landfill operator with no sort of financial compensation. On table 4 below, the costs associated with the CDM project activity are specified.

The investment costs for the LFG collection system are proportional to the landfill surface, cell dimensions, waste volume and the landfill topography.

BIOGAS CAPTURE AND FLARING IMPLEMENTATION COST						
Item #		Description		Amount	Unit	Total (US\$)
1	Invoice for projects and environmental license					
	1.1	Civil works and Environmental license		1.00	--	103,841.73
	Sub-total					103,841.73
2	Gas drain and gas capture					
	2.1	Auxiliary vertical drains		2,000.00	Meters	186,915.11
	2.2	Primary network		3,000.00	Meters	349,039.04
	2.3	Secondary network		8,000.00	Meters	690,339.81
	Sub-total					1,226,293.97
3	Gas management					
	3.1	Gas collection point		1.00	Unit	186,981.56



	3.2	Gas filter	3.00	Unit	462,388.109
	3.3	Civil works	1.00	--	80,921.78
	Sub-total				730,291.45
4	Gas flaring				
	4.1	Decantation network	500.00	Meters	50,659.19
	4.2	Burners	1.00	Un	200,896.98
	Sub-total				251,556
Total (US\$): 2,311,983					

Table 4. Cost related to the CDM project activity.

Under this scenario (investment with no financial returns) the project activity produces no economic benefits and therefore is not financially attractive without the CDM revenue stream (as defined on *Sub-step 2b*).

Step 4. Common practice analysis

Sub-step 4a. Analyze other activities similar to the proposed project activity.

There is not a similar project activity implemented previously or currently underway (other than CDM project activities) in Brazil.

Sub-step 4b. Discuss any similar options that are occurring.

No similar activities as the project activity are carried out in Brazil out of the CDM.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

The greenhouse gas emission reductions achieved by the project activity during a given year “y” (ER_y) are estimated as follows (Equation 1):

$$ER_y = (MD_{project,y} - MD_{reg,y}) * GWP_{CH_4} + EL_y * CEF_{electricity,y} - ET_y * CEF_{thermal,y}$$

Where:

ER_y	Is emissions reduction, in tonnes of CO ₂ equivalents (tCO ₂ e).
$MD_{project,y}$	Amount of methane that would have been destroyed/combusted during the year, in, tonnes of methane (tCH ₄)
$MD_{reg,y}^3$	Amount of methane that would have been destroyed/combusted during the year in the absence of the project, in, tonnes of methane (tCH ₄)
GWP_{CH_4}	Global Warming Potential value for methane for the first commitment period is 21 tCO ₂ e/tCH ₄



EL_y	Net quantity of electricity exported during year y, in megawatt hours (MWh).
$CEF_{electricity}$	CO ₂ emissions intensity of the electricity displaced, in tCO ₂ e/MWh ⁵ . This can be estimated using either ACM0002 or AMSI.D, if the capacity is within the small scale threshold values, when grid electricity is used or displaced, or AMS-I.A if captive electricity is used or displaced.
ET_y	Incremental quantity of fossil fuel, defined as difference of fossil fuel used in the baseline and fossil use during project, for energy requirement on site under project activity during the year y, in TJ.
$CEF_{thermal,y}$	CO ₂ emissions intensity of the fuel used to generate thermal/mechanical energy, in tCO ₂ e/TJ

1. Baseline emissions.

The baseline is the atmospheric release of the gas and the baseline methodology considers that some of the methane generated by the landfill may be captured and destroyed to comply with regulations or contractual requirements, or to address safety and odour concerns.

Estimating baseline emissions from the *Alto-Tietê* landfill requires a kinetic approach⁶. The IPCC advises a first order decay model to determine the rate of CH₄ generation over time. Further derivation of the mathematical model allows also waste variances in annual acceptance rates.

$$Q_{T,x} = k R_x L_o e^{-k(T-x)}$$

Equation 2

Where:

$Q_{T,x}$ = the amount of methane generated in the current year (T) by the waste R_x

x = the year of waste input.

R_x = the amount of waste disposed in year x (Mg).

T = current year.

k = methane generation rate

L_o = methane generation potential

The yearly waste input (R_x) at the landfill is as follows:

⁵ An ex-post calculation for the national grid electricity emissions factors are available at: <http://www.mct.gov.br/index.php/content/view/50862.html>

⁶ Chapter 5, IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, May 2000: <http://www.ipcc-nggip.iges.or.jp/public/gp/english/> in chapter 5, named as WASTE. or directly on http://www.ipcc-nggip.iges.or.jp/public/gp/english/5_Waste.pdf



Year	Waste input (Tonnes) ⁷	Waste on place (Tonnes)	Data Source
2000	200,000	200,000	<i>Pajoan Ltd</i>
2001	350,000	550,000	<i>Pajoan Ltd</i>
2002	480,000	1,030,000	<i>Pajoan Ltd</i>
2003	540,000	1,570,000	<i>Pajoan Ltd</i>
2004	573,937	2,143,937	<i>Pajoan Ltd</i>
2005	602,633	2,746,570	<i>Pajoan Ltd</i>
2006	632,764	3,379,334	<i>Pajoan Ltd</i>
2007	664,402	4,043,736	<i>Pajoan Ltd</i>
2008	697,622	4,741,358	<i>Pajoan Ltd</i>
2009	732,503	5,473,861	<i>Pajoan Ltd</i>
2010	769,128	6,242,989	<i>Pajoan Ltd</i>
2011	807,584	7,050,573	<i>Pajoan Ltd</i>
2012	847,963	7,898,536	<i>Pajoan Ltd</i>
2013	889,150	8,787,686	<i>Pajoan Ltd</i>
2014	933,610	9,721,296	<i>Pajoan Ltd</i>

Table 5: Waste input and on place disposal

In order to estimate the current emissions from waste placed in all years, Equation 2 can be solved for all values of R_x and the results summed.

Values for the Equation 2 above are sourced from the table 6 and 7.

Variable	Units	Definition	Value	Data Source
k	(L/yr)	Methane generation rate	0.09	Pajoan Ltd
Lo	m ³ / Mg	Methane generation potential	132.5	Pajoan Ltd

Table 6: Values of k and Lo for equation 2.

2. Methane destroyed/flared at the project activity ($MD_{project,y}$)

The methane destroyed by the project activity ($MD_{project,y}$) during a year is determined by monitoring the quantity of methane actually flared and gas used to generate electricity and/or produce thermal energy, if applicable, and the total quantity of methane captured. The *Alto-Tietê*

landfill project do not consider any electricity and/or thermal generation, thus the quantity of methane for these applications is assumed to be zero. The $MD_{flared,y}$ (quantity of methane destroyed by flaring) is calculated as follows (Equation 3):

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

(Equation 3)

Where $LFG_{flare,y}$ is the quantity of landfill gas fed to the flare during the year measured in cubic meters (m^3), $w_{CH_4,y}$ is the average methane fraction of the landfill gas as measured during the year and expressed as a fraction (in $m^3 CH_4 / m^3 LFG$), D_{CH_4} is the methane density expressed in tonnes of methane per cubic meter of methane ($tCH_4 / m^3 CH_4$) and the $PE_{flare,y}$ are the project emissions from flaring of the residual gas stream in year y (tCO_2e) determined following the procedure described in the “Tool to determine project emissions from flaring gases containing Methane”. The tool offers two options for enclosed flares. Option 2 will be used: continuous monitoring of the methane destruction efficiency of the flare as per the tool methodology.

This tool involves the following seven steps:

STEP 1: Determination of the mass flow rate of the residual gas that is flared

STEP 2: Determination of the mass fraction of carbon, hydrogen, oxygen and nitrogen in the residual gas

STEP 3: Determination of the volumetric flow rate of the exhaust gas on a dry basis

STEP 4: Determination of methane mass flow rate of the exhaust gas on a dry basis

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

STEP 6: Determination of the hourly flare efficiency

STEP 7: Calculation of annual project emissions from flaring based on measured hourly values.

These steps will be applied to calculate project emissions from flaring ($PE_{flare,y}$) based on the measured hourly flare efficiency ($PE_{flare,h}$). Steps 3 and 4 will be applied only in case of enclosed flares and continuous monitoring of the flare efficiency.

The calculation procedure in this tool determines the flow rate of methane before and after the destruction in the flare, taking into account the amount of air supplied to the combustion reaction and the exhaust gas composition (oxygen and methane). The flare efficiency is calculated for each hour of a year based either on measurements plus operational parameters. Project emissions are determined by multiplying the methane flow rate in the residual gas with the flare efficiency for each hour of the year.

According to ACM0001 methodology, the increase in emissions outside the project boundary (leakage) does not need to be accounted.

According to ACM0001 methodology, the emissions resulting from the use of electricity in extracting and pumping the LFG should be accounted as project emissions. The considered pump has a nominal potency of 30kW and is supplied by the local grid electricity (Southeast Electrical

Subsystem).

The ex-post electricity emission factor ($CEF_{\text{electricity, y}}$) is 0.10425 tonnes of CO₂e per MWh which has been calculated (averaged) based on the 2006 monthly emission factors provided by the Brazilian Designated National Authority⁸, therefore the total emissions related to the extraction and pumping system is 27.40 tCO₂e/year. The ($CEF_{\text{electricity, y}}$) will be calculated on an annual basis, on an ex-post vintage, and specifically as data becomes available (if data is not made available on an annual basis). The table 8 below summarizes the presented data.

Extraction and Pumping System			
Nominal Potency	Operational time	Southeast Emission Factor	Resulting Emissions
30 kW	8,760 hours/year	0.10425 tCO ₂ /MWh	27.40 tCO ₂ e/year

Table 8. Extraction and pumping related emissions.

B.6.2. Data and parameters that are available at validation:

Data / Parameter:	Adjustment Factor
Data unit:	Percent
Description:	In cases where regulatory or contractual requirements do not specify MD _{reg,y} an adjustment factor shall be used and justified taking into account the project context.
Source of data used:	Brazilian DNA letter (Number MDL 0152/2006/CIMGC) dated 22 Sept 2006.
Value applied:	20%
Justification of the choice of data or description of measurement methods and procedures actually applied :	Suggested by the Brazilian DNA
Any comment:	

Data / Parameter:	Extraction efficiency
Data unit:	%
Description:	Rate of efficiency in the extraction of methane from the LFG
Source of data used:	Based on the project's landfill designers and contractors
Value applied:	70%
Justification of the	Based on the project's landfill designers and contractors
Any comment:	

⁸ National grid electricity emissions factors are available at:

<http://www.mct.gov.br/index.php/content/view/50862.html>

**B.6.3 Ex-ante calculation of emission reductions:**

The ex-ante calculation for Equation 1 was carried out accordingly:

In cases where regulatory or contractual requirements do not specify $MD_{reg,y}$ an “Adjustment Factor” (AF), suggested by Brazilian DNA⁹, shall be used and justified, taking into account the project context. For the *Alto Tietê* project the adjustment factor has been estimated to be 20% of the gas captured by the passive venting system, it represents the amount of LFG flared that would have been destroyed/combusted in the absence of the proposed project. Thus, the first half of the equation could be simplified to:

$$MD_{project,y} - [(MD_{project,y}) * 0.20]; \text{ (Equation 4a)}$$

and, further simplified to:

$$MD_{project,y} (0.8) \text{ (Equation 4b)}$$

As for the second half of the equation, the proposed project activity do not foresees electricity generation to be exported to the grid or for captive utilization nor will there be generation of thermal/mechanical energy, thus the “ EL_y ” and “ ET_y ” are assumed to be zero.

However, as an electrical pump will be used to operate the flare, additional parameters “ $CE_{elec,y}$ ” (in tCO₂e/MwH) and EL_{IMP} (in MwH) has been included in the equation which considers project emissions from electricity also be expressed in. These emissions will be deducted from the equation.

In summary, the equation used, which was derived from ACM0001 is the following:

$$ER_y = MD_{project,y} (0.8) * GWP_{CH_4} - EL_{IMP} * CE_{elec,y} \text{ (Equation 4c)}$$

For the Project Design Document (PDD), *ex ante* emission reductions estimative are made by projecting the future greenhouse gas emissions of the landfill using a first order kinetic model. These estimates are for reference purposes only, since emission reductions will be determined (*ex post*) by metering of the quantity of captured and flared methane once the project activity is operational.

For the ex-ante calculation, $MD_{flared,y}$ was calculated based on Equation 3 and simplified accordingly:

$$MD_{flared}$$

$MD_{flared} = CH_{4\text{extracted},y} - PE_{flared,y}$ (Equation 5)			
Variable	Description	Unit of Measurement	Data Source
$MD_{flared} =$	CH ₄ destroyed in project	tCH ₄	calculation
$CH_{4\text{extracted},y} =$	CH ₄ fed to flaring in project	tCH ₄	Calculation
$PE_{flared,y} =$	emissions in project from flaring	tCH ₄	calculation

⁹ Source: Brazilian DNA letter (Number MDL 0152/2006/CIMGC) dated 22 Sept 2006.

For the ex-ante calculation of $PE_{flare,y}$ the following equation was used, consistent with Equation 3 and Equation 5:

$PE_{flare,y} = CH4_{extracted,y} * (1-EFF_{flare})$ (Equation 6)			
Variable	Description	Unit of Measurement	Data Source
$PE_{flare,y} =$	emissions in project from flaring	tCH ₄	calculation
$CH4_{extracted,y} =$	CH ₄ fed to flaring in project	tCH ₄	Calculation
$Eff_{flare} =$	Efficiency of CH ₄ destruction by flaring	%	According to manufacturer (98%)

Variable	Units	Definition	Value	Data Source
$W_{CH4,y}$	m ³ CH ₄ / m ³ LFG	Average methane fraction of the landfill gas	0.5	IPCC Guidelines, 1996
D_{CH4}	tCH ₄ /m ³ CH ₄	Density of methane	0.0007168 ¹⁰	IPCC Guidelines, 1996

Table 7: Values for the variables of equation 3.

For ex ante calculation, the $LFG_{flare,y}$ is calculated as result of the methane generated when extracted, treated and finally available at the flaring point . The quantity of $CH4_{extracted,y}$ is a result of the following equation:

$CH4_{extracted,y} = EE * Q_{T,x} * D_{CH4}$	Equation 7
--	-------------------

Where the value $Q_{T,x}$ represents the amount of methane generated in the current year (T) and EE is the extraction efficiency of LFG at the landfill for the project activity.

The ex post emission reduction calculation is described in detail in Annex 4.

Landfill designers and landfill operators consulted by *Ecologica Assessoria* recommends a conservative approach for the flaring efficiency of 98% and a 70% on the extraction efficiency of the LFG for ex-ante calculations.

¹⁰ At standard temperature and pressure (0 degree Celsius and 1,013 bar) the density of methane is 0.0007168 tCH₄/m³CH₄.



The estimated emission reductions for each gas, source and formulae/algorithm due to the Project activity are presented at the table 9¹¹.

Variable	CH4 Baseline (m ³ /year)	CH4 extracted (tonnes/yr)	Project's Emissions (electricity) (tCO ₂ e/year)	PE _{flared,y} (tCH ₄ /yr)	MD _{flared} (tCH ₄ /yr)	Project emissions reduction ¹¹ (tCO ₂ e/yr)
Notes	Based on the FOD model (Equation 2)	Equation 7	Based on Table 8	Equation 6	Equation 5	Equation 4c
March 2008-Feb 2009	42,949,372	21,550	27.40	431	21,119	354,776
March 2009-Feb 2010	47,987,869	24,078	27.40	482	23,597	396,399
March 2010-Feb 2011	53,029,461	26,608	27.40	532	26,076	438,048
March 2011-Feb 2012	58,095,718	29,150	27.40	583	28,567	479,900
March 2012-Feb 2013	63,207,447	31,715	27.40	634	31,081	522,128
March 2013-Feb 2014	68,370,371	34,306	27.40	686	33,619	564,779
March 2014-Feb 2015	73,619,113	36,939	27.40	739	36,200	608,138
TOTAL	407,259,351	204,346	191.8	4,087	200,260	3,364,168

Table 9: Estimated emissions reductions for the gases due to the Project activity.

¹¹ The emission reduction calculation reflects 7 years; that is from 1 March 2008 until 28 February 2015.

**B.6.4 Summary of the ex-ante estimation of emission reductions:**

Year	Estimation of project activity emissions (tonnes of CO ₂ e)	Estimation of baseline emissions (tonnes of CO ₂ e)	Estimation of leakage (tonnes of CO ₂ e)	Estimation of overall emission reductions (tonnes of CO ₂ e)
March 2008-Feb 2009	27.40	646,508	0	354,776
March 2009-Feb 2010	27.40	722,352	0	396,399
March 2010-Feb 2011	27.40	798,242	0	438,048
March 2011-Feb 2012	27.40	874,503	0	479,900
March 2012-Feb 2013	27.40	951,449	0	522,128
March 2013-Feb 2014	27.40	1,029,166	0	564,779
March 2014-Feb 2015	27.40	1,108,174	0	608,138
Total (tonnes of CO ₂ e)	191.80	6,130,394	0	3,364,168

Table 10. Values obtained when applying formulae above.

B.7 Application of the monitoring methodology and description of the monitoring plan:**B.7.1 Data and parameters monitored:**

Data / Parameter:	LFG_{total,y}
Data unit:	m ³
Description:	Total amount of landfill gas captured from project wells
Source of data to be used:	Measured
Value of data applied for the purpose of calculating expected emission reductions in section B.5	N/a
Description of measurement methods and procedures to be applied:	Measured continuously by a flow meter. Data to be aggregated monthly and yearly. Data will be archived in electronic format during the crediting period and two years after.
QA/QC procedures to be applied:	Flow meters should be subject to a regular maintenance and testing regime to ensure accuracy
Any comment:	-

Data / Parameter:	LFG_{flared,y}
Data unit:	m ³



Description:	Total amount of landfill gas flared
Source of data to be used:	Measured by PLC-Electronic device.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	CH ₄ extracted,y in Table 9.
Description of measurement methods and procedures to be applied:	Measured continuously by a flow meter. Data to be aggregated monthly and yearly. Data will be archived in electronic format during the crediting period and two years after.
QA/QC procedures to be applied:	Flow meters should be subject to a regular maintenance and testing regime to ensure accuracy
Any comment:	-

Data / Parameter:	PE_{flare,y}
Data unit:	tCO _{2e}
Description:	Project emissions from flaring of the residual gas stream in year y, determined according to Annex 13 “Tool to determine project emissions from flaring gases containing methane”
Source of data to be used:	Calculated
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Please observe table 9.
Description of measurement methods and procedures to be applied:	Determined according to Annex 13 “Tool to determine project emissions from flaring gases containing methane” Continuous monitoring of the methane destruction efficiency of the flare measured hourly. Data will be archived in electronic format during the crediting period and two years after.
QA/QC procedures to be applied:	Calibration of equipment as per manufacturer’s specifications to ensure validity of data measured.
Any comment:	If the temperature of the exhaust gas of the flare (T_{flare}) is below 500°C during the hour h, the flare efficiency value will be $\eta_{flare,h} = 0\%$.

Data / Parameter:	WCH_{4,y}
Data unit:	m ³ CH ₄ / m ³ LFG
Description:	Methane fraction in the landfill gas
Source of data to be used:	Measured by analyzer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.5
Description of measurement methods and procedures to be applied:	Measured by continuous gas quality analyzer. Data will be archived in electronic format during the crediting period and two years after.
QA/QC procedures to	The gas analyser should be subject to a regular maintenance and testing regime



be applied:	to ensure accuracy.
Any comment:	Methane fraction of the landfill gas should be measured on wet basis.

Data / Parameter:	T
Data unit:	°C
Description:	Temperature of the landfill gas
Source of data to be used:	Measured by a temperature sensor
Value of data applied for the purpose of calculating expected emission reductions in section B.5	60°C
Description of measurement methods and procedures to be applied:	Temperature will be continuously measured and data will be kept in electronic format. Data will be archived in electronic format during the crediting period and two years after.
QA/QC procedures to be applied:	The temperature sensor will be checked and tested to ensure accuracy.
Any comment:	This measurement is used to determine the density of methane.

Data / Parameter:	P
Data unit:	Mbar
Description:	Pressure of the landfill gas
Source of data to be used:	Measured by pressure sensor
Value of data applied for the purpose of calculating expected emission reductions in section B.5	200
Description of measurement methods and procedures to be applied:	Pressure will be continuously measured and data will be kept in electronic format. Data will be archived in electronic format during the crediting period and two years after.
QA/QC procedures to be applied:	The gas sensor will be checked and tested to ensure accuracy.
Any comment:	This measurement is made to determine the density of methane.

Data / Parameter:	EL_{IMP}
Data unit:	MWh/year
Description:	Total amount of electricity imported to meet project requirement
Source of data to be used:	Measured
Value of data applied for the purpose of calculating expected emission reductions in section B.5	262.8 MWh/year
Description of measurement methods and procedures to be applied:	Measured continuously by an energy meter. Data to be aggregated monthly and yearly. Data will be archived in electronic format during the crediting period and two years after.



QA/QC procedures to be applied:	Energy meters should be subject to a regular maintenance and testing regime to ensure accuracy.
Any comment:	Required to determine CO ₂ emissions from use of electricity or other energy carriers to operate the project activity. The records of any electricity imported in the baseline too should be recorded at the start of project.

Data / Parameter:	CEF _{elec, BL,y(GRID)}
Data unit:	Tonnes of CO ₂ e/MWh
Description:	CO ₂ e emissions conversion factor for electricity
Source of data used:	Brazilian DNA
Value applied:	0.10425 tCO ₂ /MWh
Justification of the choice of data or description of measurement methods and procedures actually applied :	The emission factor was developed based on official emission and generation data of the Southeast region, the region where the project is located, in 2006. An Excel spreadsheet has been provided to the DOE separately detailing the calculation that has derived the value.
Any comment:	This value will be reviewed annually on an ex-post vintage basis (and specifically, when data becomes available)

Data / Parameter:	Landfill Waste
Data unit:	Metric tonnes
Description:	Waste disposal during a year in <i>Alto-Tietê</i> Landfill
Source of data used:	Data will be measured
Value applied:	Variable. Values available at table 5.
Justification of the	Waste will be measured at weight bridge at landfill entrance. Data will be archived daily in paper and monthly in electronic format.
Any comment:	

Data / Parameter:	Regulatory requirements relating to landfill gas projects
Data unit:	Test
Description:	Regulatory requirements relating to landfill gas projects
Source of data to be used:	
Value of data applied for the purpose of calculating expected emission reductions in section B.5	N/a
Description of measurement methods and procedures to be applied:	The information though recorded annually, is used for changes to the adjustment factor suggested by the DNA (AF) or directly MD _{reg,y} at renewal of the credit period. Data to be aggregated yearly and archived in electronic format during the crediting period and two years after.
QA/QC procedures to be applied:	All documentation will be available for revision for a verifier.
Any comment:	-



Data / Parameter:	FE
Data unit:	%
Description:	Combustion efficiency
Source of data to be used:	Measured and calculated
Value of data applied for the purpose of calculating expected emission reductions in section B.5	98% as per advise from manufacturer
Description of measurement methods and procedures to be applied:	It will be performed by (1) Continuous measurement of methane content of flare exhaust gas. (2) Continuous measurement of operation time of flare (e.g. with temperature), as flare is considered an enclosed flare. Data will be measured weekly or monthly, if unstable. Data will be archived in electronic format during the crediting period and two years after.
QA/QC procedures to be applied:	The flare is monthly checked and the flare efficiency is measured continuously to ensure optimal operation.
Any comment:	-

Data / Parameter:	T_{Flaring}
Data unit:	°C
Description:	Flaring temperature/ temperature used for flaring
Source of data to be used:	Measured by temperature sensor
Value of data applied for the purpose of calculating expected emission reductions in section B.5	N/a
Description of measurement methods and procedures to be applied:	Temperature will be metered continuously and data will be kept in electronic format. Data will be archived in electronic format during the crediting period and two years after.
QA/QC procedures to be applied:	The flaring temperature sensor will be checked to ensure a proper activity, as suggested in the manufacturer's specification guidance.
Any comment:	-

Data / Parameter:	Flare_h
Data unit:	Hours
Description:	Flare working hours
Source of data to be used:	Measured
Value of data applied for the purpose of calculating expected emission reductions in section B.5	8760
Description of	The period will be metered continuously and data will be recorded in electronic



measurement methods and procedures to be applied:	format during the crediting period and two years after.
QA/QC procedures to be applied:	Regular maintenance will ensure optimal operation of flares. Flare activity will be checked continuously, with daily checks if the efficiency shows significant deviations from previous values.
Any comment:	-

Data / Parameter:	fvch_{4,h}
Data unit:	-
Description:	Volumetric fraction of component i in the residual gas in the hour h where i = CH ₄ , CO, CO ₂ , O ₂ , H ₂ , N ₂
Source of data to be used:	Measurements by project participants using a continuous gas analyzer.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	n/a
Description of measurement methods and procedures to be applied:	For fvCH _{4,h} ensure that the same basis (dry or wet) is considered for this measurement and the measurement of the volumetric flow rate of the residual gas (FVRG,h) when the residual gas temperature exceeds 60 °C. It must be measured continuously. Values to be averaged hourly or at a shorter time interval. Thus, only methane content of the residual gas will be measured. As for the remaining parts (where i = CO, CO ₂ , O ₂ , H ₂ , N ₂), it will be considered as N ₂ .
QA/QC procedures to be applied:	Analyzers must be periodically calibrated according to the manufacturer's recommendation. A zero check and a typical value check should be performed by comparison with a standard certified gas.
Any comment:	

Data / Parameter:	Fv_{RG,h}
Data unit:	m ³ /h
Description:	Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour h.
Source of data to be used:	Measurements by project participants using a flow meter.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	n/a
Description of measurement methods and procedures to be applied:	Ensure that the same basis (dry or wet) is considered for this measurement and the measurement of volumetric fraction of all components in the residual gas (fvi,h) when the residual gas temperature exceeds 60 °C. It must be measured continuously. Values to be averaged hourly or at a shorter time interval
QA/QC procedures to be applied:	Flow meters are to be periodically calibrated according to the manufacturer's recommendation.
Any comment:	



Data / Parameter:	t_{o2,h}
Data unit:	-
Description:	Volumetric fraction of O ₂ in the exhaust gas of the flare in the hour h
Source of data to be used:	Measurements by project participants using a continuous gas analyser
Value of data applied for the purpose of calculating expected emission reductions in section B.5	n/a
Description of measurement methods and procedures to be applied:	Extractive sampling analysers with water and particulates removal devices or in situ analysers for wet basis determination. The point of measurement (sampling point) shall be in the upper section of the flare (80% of total flare height). Sampling shall be conducted with appropriate sampling probes adequate to high temperatures level (e.g. inconel probes). An excessively high temperature at the sampling point (above 700 °C) may be an indication that the flare is not being adequately operated or that its capacity is not adequate to the actual flow. Values to be averaged hourly or at a shorter time interval. Data will be archived in electronic format.
QA/QC procedures to be applied:	Analysers must be properly calibrated according to the manufacturer's recommendation. A zero check and a typical value check should be performed by comparison with a standard gas.
Any comment:	Monitoring of this parameter is only applicable in case of enclosed flares and continuous monitoring of the flare efficiency.

Data / Parameter:	f_{vCH₄,FG,h}
Data unit:	mg/m ³
Description:	Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour h
Source of data to be used:	Measurements by project participants using a continuous gas analyzer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	n/a
Description of measurement methods and procedures to be applied:	Extractive sampling analysers with water and particulates removal devices or in situ analyser for wet basis determination. The point of measurement (sampling point) shall be in the upper section of the flare (80% of total flare height). Sampling shall be conducted with appropriate sampling probes adequate to high temperatures level (e.g. inconel probes). An excessively high temperature at the sampling point (above 700 °C) may be an indication that the flare is not being adequately operated or that its capacity is not adequate to the actual flow. It must be measured continuously. Values to be averaged hourly or at a shorter time interval
QA/QC procedures to be applied:	Analysers must be periodically calibrated according to manufacturer's recommendation. A zero check and a typical value check should be performed by comparison with a standard gas.
Any comment:	Monitoring of this parameter is only applicable in case of enclosed flares and continuous monitoring of the flare efficiency. 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.
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Data / Parameter:	T_{flare}
Data unit:	°C
Description:	Temperature in the exhaust gas of the flare (not the temperature used to flare)
Source of data to be used:	Measurements by project participants.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	n/a
Description of measurement methods and procedures to be applied:	Measure the temperature of the exhaust gas stream in the flare by a Type N thermocouple. A temperature above 500 °C indicates that a significant amount of gases are still being burnt and that the flare is operating. It must be measured continuously.
QA/QC procedures to be applied:	Thermocouples should be replaced or calibrated every year.
Any comment:	An excessively high temperature at the sampling point (above 700 °C) may be an indication that the flare is not being adequately operated or that its capacity is not adequate to the actual flow.

B.7.2 Description of the monitoring plan:

The monitoring plan at the *Alto-Tietê* landfill, based on the approved monitoring methodology ACM0001 -“Consolidated baseline methodology for landfill gas project activities”, foresees the direct measurement of the amount of landfill gas captured ($MD_{project,y}$) and destroyed (flared). The monitoring plan provides for continuous measurement of the quantity and quality of LFG flared. The main variables to account are the quantity of methane actually captured ($MD_{project,y}$), quantity of methane flared ($MD_{flared,y}$), and the quantity of methane generated ($MD_{total,y}$). Where the landfill gas flows through the gas network up to the flaring point where the monitoring equipment is placed, composed of several sensors placed on-line to the gas pipeline to measure continually the gas flow, which will be calibrated by an officially accredited entity.

The party responsible for implementing the monitoring plan shall be the project activity proponent (*Alto Tietê Biogás – ATB*). The *ATB* through the technical team, will be also responsible for the day-to-day operation of the landfill gas monitoring, flaring and the party responsible for developing the data and registration forms for further classification. And also an automatic system controlling flare adjustments, blowers speed and alarm system in failure case is under the proponent responsibility.

1. Operational structure.

It will be based on daily monitoring of the LFG flow from the gas extraction stage to the landfill gas flaring. Continuous measurers of gas flow and flared gas meter will be installed along the landfill gas



extraction network. The main purpose is the direct monitoring of any fugitive emissions and the empirical calculation of the landfill gas generated.

2. Monitoring follow-up process.

All data collected following the B.7.1 will be registered and transferred to electronic spreadsheets and/or other suitable electronic files.

The calibration certificates should be stored as paper copies and calibration data would be subject to quality control procedures as described in each description of data to be monitored (Quality control and Quality assurance) The management structure will also ensure that the monitoring equipment is perfectly equilibrated based on the INMETRO standards (Brazilian institute for metrology and calibration).

Following an internal audit of the collected data carried out by the Project developer, the electronic data would be verified by an independent Designated Operational Entity (DOE), on an annual basis. The DOE would issue a verification report based on the data sheets to calculate emissions reductions.

3. The management structure.

The landfill operator will be responsible for training of the monitoring and operation staff with the help of the equipment manufactures. Then, the technical team will manage the monitoring, quality control and the quality assessment procedures carried out at the landfill premises. Further detailed procedures for monitoring shall be developed during the final design of the facilities.

B.8 Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies)

The baseline study for the project activity and monitoring methodology were completed on 12/12/2007 by *Ecologica Assessoria*, which is not a project participant. Below, the name of person and entity determining the baseline:

Name of person/Organization	Project Participant
Paulo Zanardi Ecologica Assessoria Ltda. São Paulo, Brazil. Tel: +55 11 5083 3252 Fax: +55 11 5083 8442 e-mail: zanardi@ecologica.ws WWW: www.ecologica.ws	NO

**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:**

01/03/2008

C.1.2. Expected operational lifetime of the project activity:

21 years – 0m.

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

The CDM project activity will use a renewable crediting period.

C.2.1. Renewable crediting period**C.2.1.1. Starting date of the first crediting period:**

01/03/2008

C.2.1.2. Length of the first crediting period:

7 years – 0 m.

C.2.2. Fixed crediting period:**C.2.2.1. Starting date:**

Not applicable.

C.2.2.2. Length:

Not applicable.

SECTION D. Environmental impacts

**D.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:**

The project will extract and flare landfill gas, therefore improving the landfill management by reducing adverse global and local environmental effects of uncontrolled releases of landfill gas. The project activity shall start operation with all operation and the environmental licenses in compliance with local and national regulations.

Baseline scenario: LFG contains over 150 trace components that may cause: odour nuisances, stratospheric ozone layer depletion and in concentrated amounts leads to asphyxia and/or toxic effects in humans.

Project activity: The installation of a set of wells designated for gas collection and further flaring will lead into a daily monitoring (as stated at the monitoring plan) and proper landfill operation. The operation will remove safety risks from the surrounding communities by reducing the risks of toxic effects on the local community, freatic layers, watercourse pollution and odour nuisances. The combustion of the LFG at the flare point will lead on the release of organic compounds and trace amounts of toxic materials, including mercury and dioxins.

Operation mitigation measures: A set of mitigation measures are defined during the operation of the project activity, i.e. concerning the noise of the flare and the mitigation of the NVOCs compounds present at the flare point, the project operator will follow local and national regulations and technical specifications defined by the ABNT (Brazilian technical standard association) for the project activity. The mitigation measures will be defined at the operation plan implemented by the project operator. Once the project activity is implemented, further studies and mitigation measures may be undertaken.

D.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:

No significant negative impacts applicable.

**SECTION E. Stakeholders' comments****E.1. Brief description how comments by local stakeholders have been invited and compiled:**

According to the Resolution number 1 of the Brazilian Inter-Ministerial commission on Climate Change¹², invitations for comments by local stakeholders are required by the Brazilian Designated National Authority (DNA) as part of the procedures for analyzing CDM projects and issuing letters of approval.

The DNA required project participants to communicate with the public through letters, to be sent inviting for comments to:

- The Brazilian national NGO's forum.
- The local attorneys' and prosecutors' agency.
- The municipality's chamber (mayor and assembly men).
- State's and municipal's environmental authorities.
- Local communities' associations.

As defined by the Designated National Authority (DNA), the project developer sent information letters to the key institutions, describing the major aspects of the implementation and operation of the proposed project. The project participant should leave 30 days opened for comments. The letters were distributed by the project proponent via mail to the key institutions (see table 11, below).

¹² Issued on December 2nd of the 2003, decree from July 7th 1999.



Name of the Institution	Type of Entity	Address	Phone / Fax	Contact Point	E-mail
Brazilian Forum of NGOs	Association of NGOs	SCLN 210 Block C Room 102 CEP 70856-530 Brasília DF	(61) 3340-0741	--	forumbr@tba.com.br
Public Ministry of the State of São Paulo	Ministry	115 Riachuelo Street, Center São Paulo	(11) 3119-9015	--	web-master@mp.sp.gov.br
Itaquaquecetuba City Hall	City Hall	283, Ver. João Fernandes da Silva Avenue	(11) 4640-1000	Armando Tavares	--
CETESB	Environmental Agency	345, Prof. Frederico Hermann Jr Avenue, Alto de Pinheiros, São Paulo, ZIP Code: 05459-900	(11) 3030-6000	--	--
Foundation for the Conservation and Forestry Production of São Paulo	Governmental Organization	931, Horto Street, São Paulo, ZIP Code: 02377-000	(11) 6997-5000		fflorestal@fflorestal.sp.gov.br
Botany Institute	Governmental Organization	3687, Miguel Estéfano Avenue, Água Funda, São Paulo, ZIP Code: 04301-902	(11) 5073-6300	--	--
Geological Institute	Governmental Organization	3900, Miguel Estéfano Avenue, Água Funda, São Paulo, ZIP Code: 04301-903	(11) 5077-1155	--	igeologico@igeologico.sp.gov.br
State Secretariat of Health	Public Secretariat	188, Dr Enéas de Carvalho Aguiar Avenue, ZIP Code: 05403-000, São Paulo, SP	(11) 3066-8000	Danilo Vicente	--
Environment Secretariat of the State of São Paulo	Public Secretariat	345, Prof Frederico Hermann Jr Avenue, ZIP Code: 05489-900	(11) 3030-6477	José Goldemberg	ouvidoria@ambiente.sp.gov.br
Environmental Policing Command	Governmental Organization	345, Prof Frederico Hermann Jr Avenue, ZIP Code: 05489-900, 4th floor, Alto de Pinheiros	(11) 3030-6625	Deputy Marcelo Robis	cpambp5@polmil.sp.gov.br
Name of the Institution	Type of Entity	Address	Phone / Fax	Contact Point	E-mail
Waters and Electric Energy Department	Public Department	170, Boa Vista Street, 8th floor, Block 5 ZIP Code: 01014-000, São Paulo	(11) 3293-8571	Ubirajara Félix	ufelix@sp.gov.br
Ferraz de Vasconcellos City Hall	City Hall	1841, Brasil Avenue, Center, ZIP Code: 08529-310	(11) 4674-1000	Jorge Abissamra	ferrazadm@superig.com.br



Mogi das Cruzes City Hall	City Hall	277, Vereador Narciso Yague Guimaraes Avenue, ZIP Code: 08780-000	(11) 4798-5000	Jungi Abe	gabinete@pmmc.com.br
Health Secretariat of Mogi das Cruzes	Public Secretariat	277, Vereador Narciso Yague Guimaraes Avenue, ZIP Code: 08780-000	(11) 4795-4500	Cláudio Miyake	saude@pmmc.com.br
Poá City Hall	City Hall	198, Brasil Avenue, Center, ZIP Code: 08550-000	(11) 4634-8800	Carlos Roberto da Silva	--
Suzano City Hall	City Hall	501, Baruel Street, Center, ZIP Code: 08675-000	--	Marcelo Souza Candido	suzano.gabinete@uol.com.br
Health Secretariat of Suzano	Public Secretariat	179, Baruel Street, Vila Costa, ZIP Code: 08675-902	--	Célia Bortoletto	saude@suzano.sp.gov.br
Arujá City Hall	City Hall	90, José Basilio Alvarenga Street, Vila Flora Regina	(11) 4652-7600	Genésio da Silva	--
Carapicuíba City Hall	City Hall	205, Joaquim das Neves Street, Center, ZIP Code: 06310-030	(11) 6886-5200	--	carapic@pmcarapicuiiba.com.br
Health Secretariat of Arujá	Public Secretariat	231, Pedro Severino Martins Street	(11) 4655-2871	Messias Covre	--
Health Secretariat of Carapicuíba	Public Secretariat	1304, President Tancredo Neves Street	(11) 4167-9116	--	--

Table 11. Participant entities.



E.2. Summary of the comments received:

No comments have been received.

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

Not applicable, as no comments were received.

Annex 1**CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY.**

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E-Mail:	---
URL:	---
Title:	Director
Salutation:	Mr.
Last Name:	Pais de Arruda
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

There are no public financing for the project.

Annex 3

BASELINE INFORMATION

The fraction of the organic compounds presented in the waste for the project activity is defined as 64.4 %. Based on the Brazilian study about methane emissions from waste treatment and waste disposal, the estimative is that for the mayor part of the waste disposal, the 80% comes from domestical waste where almost 60% is composed of organic waste.

Landfill	Location	% Total of commercial and waste Disposal	% Organic Waste
Bandeirantes	São Paulo	75	55
Biguaçu	Florianópolis	95	60
Caximba	Curitiba	80	65
Goiânia	Goiânia	90	High
Joinville	Joinville	70	50 - 60
Lara	Mauá	72	65
Zona Norte	Porto Alegre	66	60

Table 12: Percentage of organic waste presented at the waste. Data Source: USAID, 1997.

Below, the parameters and data sources used to determine the baseline for the project activity. The key elements such as variables and parameters are provided below. The tables 13 and 14 show the values for the parameters used for the LFG emissions estimation.

PROJECT ACTIVITY MAIN INFORMATION	
Alto-Tietê landfill project specifications	
Year when operations started	2000
Year when flaring starts	2008
R=daily average deposition (t/day)	1,500
Lo (m ³ / Mg)	132.5
k (1/year)	0.09
Methane Global Warming Potential	21
% of Methane in landfill gas	50 %

Table 13: Alto-Tietê landfill project specifications

Fraction of Degradable Organic Carbon (DOC)		
Waste type	Value	Data Source
Paper & Cardboard	14.40 %	<i>Pajoan Ltd</i>
Plastics	12 %	<i>Pajoan Ltd</i>
Aluminum, other metallic compounds	3.2 %	<i>Pajoan Ltd</i>
Organic waste	64.4 %	<i>Pajoan Ltd</i>
Glass	1.1 %	<i>Pajoan Ltd</i>
Others	4.9 %	<i>Pajoan Ltd</i>

Table 14: Fraction of degradable organic carbon

For the *Alto-Tietê* landfill to gas project the type of weather is humid and the waste decomposition occurs under rapid degradation conditions. However, for the LFG estimation purposes the k value was defined, conservatively speaking, as of 0.09 (L/year), which is 87.5% less than the default value of 0.4 for tropical, moist and wet climate with rapidly degrading waste¹³. In selecting the k value, the premises below were adopted¹⁴:

¹³ Source: See Table 3.3, Chapter 3 of the IPCC Guidelines, 2006.

¹⁴ Information/data source: *Itaquaquecetuba* City Hall – Environment Secretary Office. Available at: http://www.itaquaquecetuba.sp.gov.br/v1/a_cidade/a_cidade_dados_gerais.asp?Codigo=13)

- Mean Annual Temperature: 22° C (maximum: 35 °C and minimum: 9 °C)
- Climate Zone: Tropical
- Mean Annual Precipitation: 1200 mm/year

Apart from the value obtained from the IPCC (0.4), the Project Developer adopted a more conservative value (0.09) due to the fact that precipitation and temperature conditions could suffer a lot of variations during the crediting period. The value of 0.09 is widely applied by several CDM projects in Brazil and it is in accordance with the CETESB¹⁵ (Environmental and Sanitation Company of the São Paulo State) recommendations.

Moreover, the waste composition (See Table 14) was considered to determine the total disposed residues as “rapidly degrading waste”. Almost 80% of the total waste is composed from organic waste (64.40% of food waste and 14.40% of paper).

The Lo factor depends directly to the waste composition (see Table 14) as well as the site physical conditions. The values here adopted for Lo are defined as 132.5 m³/Mg of waste for the year 2006. The old landfill site close to the new one is not considered in the project activity. It was estimated using the national and sectoral average. According to the IPCC Guidelines, 1996, Lo values can range from less than 100 to 200 m³/Mg. For this project, 80% is the estimated organic waste content, which would be expected to be in the range of 200 m³/Mg. Thus, the 132.5 Lo value is quite conservative for its 80% organic waste content.



Photo 1: Alto-Tietê landfill entrance.

¹⁵ Source: National Inventory of Greenhouse Effect Gas Emission – CETESB, 2004.



Photo 2: Alto-Tietê landfill top view.

Annex 4

MONITORING INFORMATION

The Monitoring plan is based on the approved monitoring methodology ACM-0001, “Consolidated baseline methodology for landfill gas project activities”. The monitoring methodology is based on direct measurement of the amount of landfill gas captured and destroyed at the flare platform to determine the quantities as shown in Figure 2.

The monitoring plan provides for continuous measurement of the quantity and quality of LFG flared. The main variables that need to be determined are the quantity of methane actually captured ($MD_{project,y}$, which represents the amount of methane that *would* have been destroyed/combusted during the year), quantity of methane flared ($MD_{flared,y}$, which represents the real quantity of methane destroyed by the flaring system), which are the same in the project activity and the quantity of methane generated ($MD_{total,y}$).

The monitoring plan for the project activity and the Quality control (QC) and quality assurance (QA) procedures are based on the ACM-0001. The monitoring plan provides for continuous measurement of the quantity and quality of LFG flared and the quality control and quality assurance procedures are needed to ensure consistency on monitoring equipment and the data collected.

1. Monitoring Process

Below, the monitoring plan defines a set of parameters in order to calculate the main project activity variables.

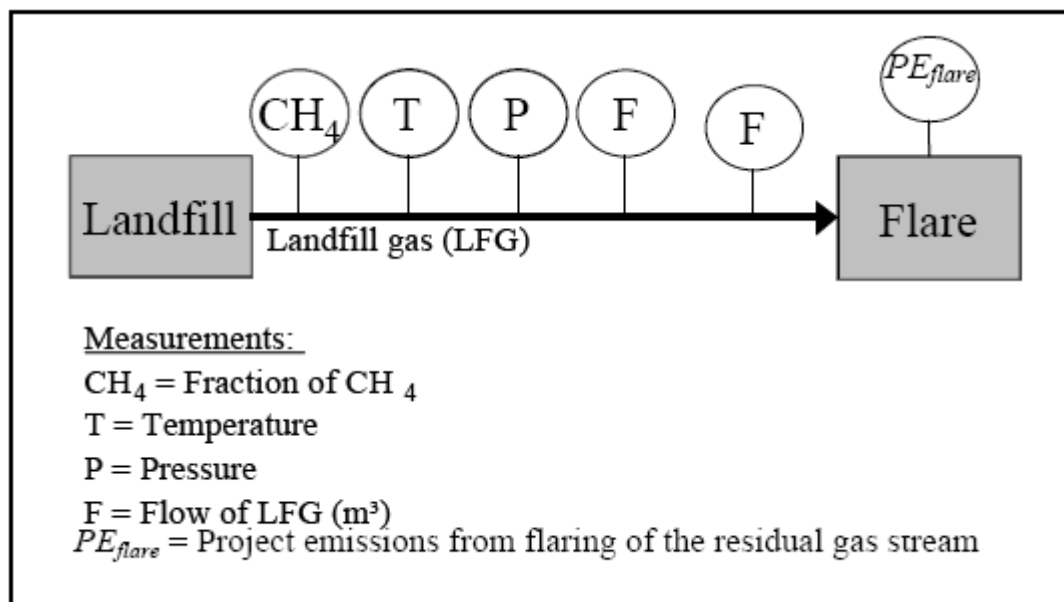


Figure 2. Monitoring plan scheme for the Alto-Tietê landfill to gas project.

At the figure 2, the landfill gas flows through the gas network up to the flaring point where the monitoring equipment is placed. Several sensors are placed on-line to the gas pipeline in order to measure continuous gas flows and this gas flow meter must be calibrated by an officially accredited entity.

The party responsible for implementing the monitoring plan shall be the project proponent (*Alto Tietê Biogás – ATB*), which will also be responsible for developing the forms and registration formats for data collection and further classification.

2. Emissions reduction calculation process

The monitoring process will establish the effective emissions reduction occurred at the landfill. The LFG generated at the cells will flow through the gas network to the gas treatment system under pressure conditions. The monitoring operation will result on tCO₂equ. as the LFG is being flared.

For this purpose, the quantity LFG (m³) and the methane content (%) of the LFG is monitored. The equation below outputs the amount of CO₂e (in tonnes):

$$ER_y = (MD_{project,y} - MD_{reg,y}) * GWP_{CH_4} + EL_y * CEF_{electricity,y} - ET_y * CEF_{thermal,y}$$

Parameter	Definition	Unit
ER_y	Emissions reduction.	tCO ₂ e
$MD_{project,y}$	Amount of methane that would have been destroyed/combusted during the year y.	tCH ₄
$MD_{reg,y}^3$	Amount of methane that would have been destroyed/combusted during the year in the absence of the project.	tCH ₄
GWP_{CH_4}	Global Warming Potential value for methane for the first commitment period.	tCO ₂ e/tCH ₄
EL_y	Net quantity of electricity exported during year y.	MWh
$CEF_{electricity}$	CO ₂ emissions intensity of the electricity displaced. This can be estimated using either ACM0002 or AMSI.D, if the capacity is within the small scale threshold values, when grid electricity is used or displaced, or AMS-I.A if captive electricity is used or displaced. For this project, the value used for CEF _{electricity} was calculated (ex-post) by the Brazilian DNA.	tCO ₂ e/MWh
ET_y	Incremental quantity of fossil fuel, defined as difference of fossil fuel used in the baseline and fossil use during project, for energy requirement on site under project activity during the year y.	TJ
$CEF_{thermal,y}$	CO ₂ emissions intensity of the fuel used to generate thermal/mechanical energy.	tCO ₂ e/TJ

Table 15. Parameter used at the equation cited above..

Parameter	Definition	Unit
$Q_{T,x}$	Amount of methane generated in the current year by the waste R_x	tonnes
x	year of waste input	-
R_x	Amount of waste disposed in year x	Mg
T	Current year	-
k	Methane generation rate	(L/yr)
Lo	Methane generation potential	m ³ / Mg

Table 16. Parameter used at the equation cited above.

The tables 15 and 16 show the parameters used at the equations above. The parameter $CEF_{\text{electricity}}$ is an ex-post calculated value¹⁶ related to the region where the project activity is inserted. The amount of waste displaced on site is defined by the technical equipment.

The monitoring methodology schedules a continuous screening of the defined values and the further storage on a data-logger (set on place). Finally the data will be daily download and archived on electronic format. Please refer to the B.7.1 for more information.

3. QA/QC procedures (Data consistency)

The planning procedures are set to ensure consistency on the monitoring equipment and sensors (Quality control) and the data collected (Quality assurance). In cases of failure of measurement, failure will be reported to equipment supplier and repairs carried out. If repair is not possible, equipment will be replaced by equivalent item within one month. Failure events will be recorded in the site events log book. In addition, an alarm system in failure case will be adopted

The procedures are defined and based throughout the following points: process scheduling, operation and maintenance plan, data collecting and data registration, equipment calibration, quality auditing and quality prevention plan. The procedures also include measures to resolve non-conformities due to the implementation, operation and maintenance of the project activity.

The data to be included within the QA/QC procedures corresponds to B.7.1 on this PDD. The uncertainty level for the data was set in low. In order to ensure the reliability of the sensors, the following operation steps will be undertaken:

1. On-field sensors.

- LFG flow meter

The meter will provide two values, the daily amount of LFG (m³) stored by the data-logger and the total value to date passed through that will be shown at the flow meter. The validator will check both for consistency.

- Sampling points.

The sensors will be placed at the gas network directly connected to the data logger that will register the pressure of the flowing gas. The meter will be checked by the technical team for consistency.

¹⁶ National grid electricity emissions factors are available at: <http://www.mct.gov.br/index.php/content/view/50862.html>



- Methane analyzer.

The most important parameter at the gas analyzer is the normal deviation from the marginal error presented at the electronic device. In order to ensure consistency, the project developer will follow the operation guidelines set up by the fabricant and technical standards provide by the Brazilian technical standard association (ABNT) for the sensor operation.

- Temperature and pressure sensor.

The temperature and pressure will also suffer time to time deviation outside boundaries of the normal deviation set up by the fabricant. In order to ensure consistency, the project developer will follow recommendations on the operation guidelines defined either by the fabricant and the Brazilian technical standard association (ABNT) for the sensor operation.

2. Data logger

Several models for data logger are available at the market. The data logger will be connected directly to the electronic devices (PLC, flow meter, analyzer, temperature sensor). The performance of the data logger will allow hourly registration of the B.7.1 data being daily checked for consistency.

3. Energy meter

The electrical power consumption is measured by means of a kWh-meter.

4. Operation and validation

Nowadays, the project owner develops its own operation and environmental monitoring at the landfill and landfill premises. The current operation plan monitors the flux of the percolated liquid from landfill to the final treatment, the water quality at the freatic layers, cleaning and pest control activities and finally the administration of the existing re-forestation activities. The operation routine scheduled for the project activity will be added to the existing operation plan.

Moreover, the project developer will prepare an operation handbook for the monitoring plan. The manual will define the necessary technical and safety procedures for normal operation and the emergency measures for the project operation.

The project developer is the only responsible for the operation of the guidelines described at the handbook. Also the project developer will ensure enough human and material resources for the accomplishment of the activities within the monitoring plan.

5. Regulatory requirements governing landfills in Brazil.

The project developer will be responsible for the analysis and direct monitoring on the governmental rules regarding the landfill gas capture and destruction.

6. Corrective, Preventive and Improvement actions.

Actions and procedures are here defined for treating and correcting non-conformities, deviations from the Monitoring Plan and Operational Manual, observed by the landfill operator or during the periodic monitoring. In case of non-conformities regarding the maintenance and operation, further actions are implemented:

1. Problem analysis: Definition of the origin, causes and further actions to be undertaken.
2. Corrective actions: Administration staff will implement and reported to the technical staff the necessary measures.

