



## Monitoring report form (Version 03.2)

### Monitoring report

<b>Title of the project activity</b>	Aurá Landfill Gas Project
<b>Reference number of the project activity</b>	0888
<b>Version number of the monitoring report</b>	1
<b>Completion date of the monitoring report</b>	10/01/2014
<b>Registration date of the project activity</b>	30/04/2007
<b>Monitoring period number and duration of this monitoring period</b>	Monitoring Period Number 8 01/01/2013 – 31/12/2013
<b>Project participant(s)</b>	Brazil: Prefeitura Municipal de Belém, City of Belém, State of Pará Brazil: Conestoga-Rovers & Associados Engenharia S/A United Kingdom of Great Britain and Northern Ireland: Thunder Road Environmental Limited
<b>Host Party(ies)</b>	Brazil
<b>Sectoral scope(s) and applied methodology(ies)</b>	Scope 13: Waste handling and disposal ACM0001 ver 4
<b>Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD</b>	294,990 tCO <sub>2</sub>
<b>Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period</b>	417,098 tCO <sub>2</sub>
<b>Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved during the period up to 31 December 2012(if applicable)</b>	
<b>Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved during the period from 1 January 2013 onwards (if applicable).</b>	417,098 tCO <sub>2</sub>

**SECTION A. Description of project activity****A.1. Purpose and general description of project activity**

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The Aurá Landfill Gas Project has been developed at the Aurá Landfill (Site), originally called the Aterro Sanitário do Aurá. The Site has received non-hazardous solid municipal, industrial, commercial, institutional, and some agricultural wastes for approximately 16 years. Carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) are generated by the anaerobic decomposition of the above-noted wastes placed at the Site. These compounds are then passively emitted to the atmosphere.

**Purpose of the Project Activity**

The purpose of the project activity is to collect landfill gas (LFG) at the Aurá Landfill and combust the extracted LFG over a ten year-period, utilizing a high efficiency enclosed flare, thereby reducing greenhouse gas emissions (GHG) and generating Certified Emission Reductions (CERs).

**Installed Technology and Equipment**

The project involved the construction of a LFG collection system consisting of horizontal trenches and vertical LFG extraction wells, centrifugal blower(s), and all other supporting mechanical and electrical subsystems and appurtenances necessary to collect the LFG.

The LFG collected from the Site is combusted in an enclosed LFG flare with full process controls and instrumentation installed and operating. The state-of-the-art flare is capable of providing sufficient temperature and retention time of the extracted LFG for complete destruction of hydrocarbons.

**Relevant dates for the project activity**

Conestoga-Rovers & Associates (CRA) started design activities in late 2005 and construction a year later in 2006. Constructed by February 2007 and ready for commissioning, the first monitoring period was from April 30, 2007 to September 30, 2008.

**Total GHG emission reductions achieved in this monitoring report**

The Certified Emission Reductions (CERs) volume claimed for the monitoring period extending from January 01, 2013 to December 31, 2013 is 417,098 tCO<sub>2</sub>e.

**A.2. Location of project activity**

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The project activity is located at:

Host country: Brazil

State: Pará

Municipality: Belém

Physical location:

The Aurá Landfill is located 19 kilometers (km) from the centre of the City of Belém, State of Pará, Brazil, and is 8 km from the centre of the City of Ananindeua. The entire Site covers an area of 120 hectares (ha) and the waste fill area of the Site is approximately 30 ha in size. The Site is located west of Curuperé Creek and east of the Parque Ambiental de Belém.

UTM Coordinates: 22 M 790853 mE and 9843207 mS.

**A.3. Parties and project participant(s)**

Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
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Brazil (host)	Prefeitura Municipal de Belém, City of Belém, State of Pará (Public entity)  Conestoga-Rovers & Associados Engenharia S/A (Private entity)	No
United Kingdom of Great Britain and Northern Ireland	Thunder Road Environmental Limited (Private entity)	No

#### A.4. Reference of applied methodology

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The approved baseline methodology applied to this project is the approved ACM0001– Consolidated Baseline Methodology for Landfill Gas Project Activities- Version 4.0.

#### A.5. Crediting period of project activity

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The crediting period for this project is from April 30, 2007 to April 29, 2017 (fixed). This is the 8<sup>th</sup> monitoring period corresponding from January 01, 2013 to December 31, 2013

### SECTION B. Implementation of project activity

#### B.1. Description of implemented registered project activity

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The technology used to gather the LFG is a grid of horizontal gas extraction wells within the landfill, connected to a centralized blower system used to induce vacuum. Upon collection of the LFG, the methane component of the LFG is combusted in a state-of-the-art high-efficiency enclosed flare. The Global Warming Potential (GWP) of the LFG is reduced by the destruction of the methane portion of the LFG.

The LFG management system is comprised of the following three major components:

1. LFG management facility - houses mechanical and electrical components required for the extraction and delivery of LFG for disposal by flaring
2. LFG collection field - removes LFG from the wastes within the limit of waste and includes trenches and collection piping to convey LFG from the field to the LFG management facility
3. Condensate management system - removes liquid condensate from the LFG collection system and directs the condensate to the leachate collection system

The design for the overall landfill gas (LFG) management system for the Site was completed by Conestoga-Rovers & Associates (CRA) from late 2005 to mid 2006. Construction of the LFG management system commenced in early 2006, and the facility was commissioned in the spring of 2007. The start date of the project activity is September 1, 2007.

To date there have been six issuances of CERs, as follows:

Verification N	Monitoring Period	CERs	Date of Issuance
First	Apr 30, 2007 to Sep 30, 2008	32,265 tCO <sub>2</sub> e	Aug 12, 2009
Second	Oct 1, 2008 to Jan 31, 2009	51,524 tCO <sub>2</sub> e	Aug 13, 2009
Third	Feb 1, 2009 to Aug 31, 2009	83,077 tCO <sub>2</sub> e	Mar 4, 2010
Fourth	Sep 1, 2009 to Feb 28, 2010	87,595 tCO <sub>2</sub> e	Oct 27, 2010
Fifth	Mar 1, 2010 to Dec 31, 2010	234,835 tCO <sub>2</sub> e	Nov 16, 2011

Sixth	Jan 1, 2011 to Oct 31, 2011	286,399 tCO <sub>2</sub> e	January 14, 2013
Seventh	Nov 1, 2011 to Dec 31, 2012	482,110 t CO <sub>2</sub>	May 17, 2013
<b>TOTAL CERs ISSUED TO DATE</b>		<b>1,257,805 tCO<sub>2</sub>e</b>	

During the current monitoring period January 01, 2013 to December 31, 2013, there have been the following major maintenance activities:

<b>Description</b>	<b>Date of maintenance activity</b>
Flare Damper was changed	May 31, 2013
Cleaning Flame arrester	August 09, 2013
Replacing the solenoid valve (SV5) and verification throughout the Landtec the panel.	November 01, 2013

There is no major deviation of project monitoring activities from applied methodology and all monitoring activities are being done in accordance with the said methodology as well as with the approved monitoring plan.

## **B.2. Post registration changes**

### **B.2.1. Temporary deviations from registered monitoring plan or applied methodology**

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There are no temporary deviations from the registered monitoring plan or the applied methodology.

### **B.2.2. Corrections**

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There are no corrections to project information or parameters fixed at validation that have been approved during this monitoring period or submitted with this monitoring report.

### **B.2.3. Permanent changes from registered monitoring plan or applied methodology**

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The monitoring plan was revised and approved before the period of this monitoring report on October 4, 2009.

### **B.2.4. Changes to project design of registered project activity**

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There are no changes to the project design of the project activity that have been approved during this monitoring period or submitted with this monitoring report.

### **B.2.5. Changes to start date of crediting period**

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There are no changes to the start date of the crediting period that have been approved during this period or submitted with this monitoring report.

### **B.2.6. Types of changes specific to afforestation or reforestation project activity**

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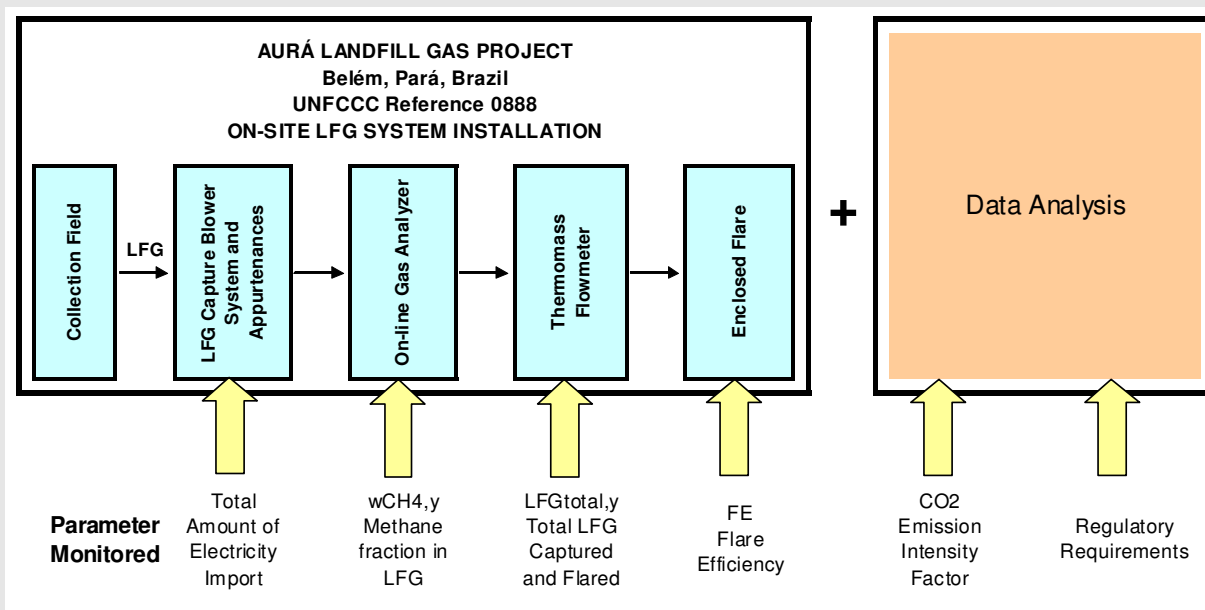
Not applicable.

**SECTION C. Description of monitoring system**

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The LFG monitoring program is designed to collect system operating data required to safely and effectively operate the system as required for the verification of CERs. This data is collected in real time, and provides a continuous record that is easy to monitor, review, and verify.

The monitoring methodology is based on the direct measurement of the quantity of LFG captured and destroyed by the LFG management system. The actual tonnage of methane emissions reduced by the project is calculated based on the flow rate of the LFG, methane concentration, and destruction/conversion efficiency of the combustion equipment. The monitoring plan provides for the continuous measurement of both LFG quantity and quality using a continuous flow meter and online LFG analyzer. The methane emissions reduced by the flare are determined on the flow, methane content, flare temperature and time.

**Monitoring Points****Flow measurement**

LFG collected by the System and subsequently flared is measured via a flow measuring device suitable for measuring the velocity and volumetric flow of a gas. The flow measurements are taken within the piping itself, and the flow sensors are connected to a transmitter that is capable of collecting and sending continuous data to the Landtec recording system. The equipment selected allows for measurement of flow parameters, normalized to a standard temperature, pressure, and gas composition.

The thermal mass flow meter must be calibrated every 18 months as per manufacturer specifications. Equipment calibration procedures are specified by the equipment manufacturer, and calibration of the sensors is required on this schedule to ensure the quality and validity of the data. The accuracy of a flow meter is dependent on the design of the equipment, and the specific type of sensor used. The equipment selected provides a minimum accuracy of +/- 1 percent by volume. The measured flow is aggregated approximately once per two minutes.

All data that is collected is recorded for the permanent record. Both electronic and hard copies of the data are maintained for auditing purposes and for use in the calculation of CERs.

### Gas quality

The two parameters that are most pertinent to the verification of CERs, as well as the safe and efficient operation of the system, are the concentrations of methane and oxygen in the gas stream. These two parameters are measured via a common sample line that is run to the main collection system piping, and measured in real time by two separate sensors, one each for methane and oxygen.

Compensation for temperature and pressure is not required for the methane and oxygen sensors and the sensors are designed to operate within specified temperature and pressure conditions. Equipment calibration is automatic as specified by the equipment manufacturer. Calibration of the sensors is conducted on a regular basis to ensure the quality and validity of the data. Regular calibration of the equipment is especially important, as the accuracy of the methane and oxygen sensors is greatest within the expected calibration range of the gas stream to be measured. The equipment selected provides an accuracy of at least +/- 1 percent by volume. Gas compositions are aggregated approximately once per two minutes.

### Emission reduction calculations

Guidelines and directives in order to standardize the data acquisition and handling processes are in place for calculating the generation of Certified Emission Reductions (CERs) for the project. The Site uses a Landtec™ data acquisition device [Field Analytical Unit – (FAU)], which measures parameters such as methane (CH<sub>4</sub>) concentration, flare temperature, and landfill gas flow on a continuous-basis. The data is collected and stored on-site using a Field Server Unit (FSU), which also sends the data to a Landtec server in California (USA) for off-site storage and back-up. Through the EnviroComp Report Service (ECRS), the data is viewed and downloaded to a spreadsheet file for further analysis.

A series of procedures are in place to retrieve and store the data, and set up tables and reports for the verification events. Based on operational data and the applicable monitoring methodology, the emission reductions are calculated on a monthly basis and compiled in a monitoring report during a verification exercise.

### Data collection and record keeping

The monitoring methodology requires the continuous measurement of the quantity and quality of the LFG being flared. A summary of all data collection and reporting requirements, as listed in the UNFCCC ACM0001 (version 4) monitoring methodology, and a summary of on-site monitoring responsibilities and frequencies are provided below.

## SUMMARY OF SITE MONITORING RESPONSIBILITIES

### Landfill Gas Development Project

#### Aurá Landfill

#### Belém, Pará, Brazil

<i><b>Project Activity</b></i>	<i><b>Equipment</b></i>	<i><b>Personnel</b></i>	<i><b>Responsibilities</b></i>	<i><b>Frequency</b></i>
Quantity of LFG Captured	Flow Meter	Site Operator	* Verify the flow meter and FSU are operating correctly and collecting gas flow rate data continuously	Daily
Methane Fraction in LFG	Gas Analyzer	Site Operator	* Verify the FAU and FSU are operating correctly and collecting gas composition data continuously	Daily
Flare Efficiency	Flare Stack	Site Operator	* Arrange for qualified technician to perform stack testing	Annually

Flare Operation Time	Flare Stack	Site Operator	* Verify the FSU is recording the flare temperature on a continual basis * Follow operation and maintenance requirements as outlined in the Operation and Maintenance Report	Daily
Amount of Electricity Used	n/a	Site Operator	* Collect all Electricity bills and file on-Site and to office.	Monthly

In addition to the previous monitoring practices, the Project Participant keeps records of sustainable development parameters to monitor benefits the project activity is having in the area. Amongst these monitored parameters are:

- record keeping of job creation: includes number of employees hired and definition of responsibilities of employees working at the LFG collection system plant;
- tracking of odour complaints (dealt with by landfill operator): for this monitoring period there were no odour complaints during March 2013, April 2013, June 2013, August 2013 and November 2013. For the rest of the period, the complaints were addressed by the City of Belém by taking the appropriate action;
- subsurface migration of LFG is monitored on a monthly basis through monitoring rounds of the applied vacuum on the collection field. Negative pressure readings indicate the gas is being collected by the combustion system avoiding LFG migrating to the surroundings;
- technology transfer and communication of results have been presented in papers submitted to conferences held in North America;
- training records of personnel: meetings are performed on site for training and communication purposes, attendees include field, administrative and technical personnel from CRA.

## SECTION D. Data and parameters

### D.1. Data and parameters fixed ex ante or at renewal of crediting period

<b>Data / Parameter:</b>	$GWP_{CH_4}$
Unit:	tCO <sub>2</sub> e/tCH <sub>4</sub>
Description:	Global warming Potential (GWP) value for methane
Source of data:	Decisions under UNFCCC and the Kyoto Protocol As described in the CDM standard "Application of the global warming potentials to clean development mechanism project activities and programme of activities for the second commitment period of the Kyoto Protocol", emission reductions of CDM projects occurring from 1 January 2013 onwards shall be determined using the GWP adopted at the CMP in Durban (IPCC Table 2.14 Errata, i.e. 25 for methane, 298 for N <sub>2</sub> O, 14 800 for HFC 23 and 22 800 for SF <sub>6</sub> ).
Value(s) applied:	25
Purpose of data:	Baseline emission calculations
Additional comment:	-

<b>Data / Parameter:</b>	$D_{CH_4}$
Unit:	tCH <sub>4</sub> /m <sup>3</sup> CH <sub>4</sub>
Description:	Methane density

Source of data:	ACM0001- Consolidated Baseline Methodology for Landfill Gas Project Activities - version 04
Value(s) applied:	0.0007168
Purpose of data:	Baseline emission calculations
Additional comment:	-

## D.2. Data and parameters monitored

<b>Data / Parameter:</b>	LFG <sub>total,y</sub>
Unit:	Nm <sup>3</sup>
Description:	Total amount of landfill gas captured and flared
Measured/ Calculated / Default:	Measured
Source of data:	On-Line LFG flow meter (thermo mass)
Value(s) of monitored parameter:	Multiple, continuously measured. Values submitted in excel tables with this report.
Monitoring equipment:	<p>Type: Thermal Instrument Co Model 62-9/9500 thermal flowmeter Serial # 2012001 Flowrate Readout Accuracy: <math>\pm 1</math> % Full Scale Calibration frequency: 18 months Date of last calibration: January 11, 2012 Validity: July 11, 2013</p> <p>Type: Thermal Instrument Co Model 62-9/9500 thermal flowmeter Serial # 2012383 Flowrate Readout Accuracy: <math>\pm 1</math> % Full Scale Calibration frequency: 18 months Date of last calibration: September 3, 2012 Validity: March 3, 2014</p>
Measuring/ Reading/ Recording frequency:	Continuously every two minutes
Calculation method (if applicable):	Not applicable
QA/QC procedures:	The flowmeter is recalibrated as per manufacturer's recommendation.
Purpose of data:	Baseline emission calculations
Additional comment:	-

<b>Data / Parameter:</b>	FE
Unit:	%

Description:	Flare/combustion efficiency determined by the operation hours (1) and the methane content in the exhaust gas (2)	
Measured/ Calculated / Default:	Measured/calculated	
Source of data:	(1) The temperature of the flare is continuously recorded within the Field Service Unit (FSU)  (2) Flare stack samplings by certified laboratories: EcoSampling Ambiental flare sampled on January 4, 2012 EcoSampling Ambiental flare sampled on February 07, 2013	
Value(s) of monitored parameter:	(1) Multiple, continuously measured  (2) From January 4, 2012 to January 02, 2013: FE= 99,9954% From February 07, 2013 to December 31, 2013: FE= 99,9973%	

Monitoring equipment:	<p>(1) Temperature from thermocouples Field Service Unit (FSU) Type K. calibrated by PAKARI</p> <p>Identification Number: 1976/2012 Accuracy: +/- 2.2°C Date of last calibration: August 23,2012 Validity: Not applicable</p> <p>Identification Number: 1977/2012 Accuracy: +/- 2.2°C Date of last calibration: August 23,2012 Validity: Not applicable</p> <p>Identification Number: 1978/2012 Accuracy: +/- 2.2°C Date of last calibration: August 23,2012 Validity: Not applicable</p> <p>Identification Number: 1979/2012 Accuracy: +/- 2.2°C Date of last calibration: August 23,2012 Validity: Not applicable</p> <p>Type K. calibrated by PAKARI</p> <p>Identification Number: 4199/2013 Accuracy: +/- 2.2°C Date of last calibration: August 16, 2013 Validity: Not applicable</p> <p>Identification Number: 4200/2013 Accuracy: +/- 2.2°C Date of last calibration: August 16, 2013 Validity: Not applicable</p> <p>Identification Number: 4201/2013 Accuracy: +/- 2.2°C Date of last calibration: August 16, 2013 Validity: Not applicable</p> <p>Identification Number: 4203/2013 Accuracy: +/- 2.2°C Date of last calibration: August 16, 2013 Validity: Not applicable</p> <p>(2) EcoSampling Flare sampled on January 4, 2012: FID chromatograph equipment CAI - California Analytical Instruments Model 600 HFID EcoSampling Flare sampled on February 7, 2013: FID chromatograph equipment CAI - California Analytical Instruments Model 600 HFID</p>
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Measuring/ Reading/ Recording frequency:	Measuring frequency: (1) continuously every two minutes and (2) monitored annually
Calculation method (if applicable):	(1) Operation hours according to temperature of the flare (2) EcoSampling tests already include the calculation on FE = (1 - (mass flow out of flare/mass flow into flare))*100
QA/QC procedures:	Regular maintenance to ensure optimal operation of controlled combustion environment.
Purpose of data:	Baseline emissions calculations
Additional comment:	Determined by (1) measurement of operation time of flare (with temperature); (2) measurement of methane content in the exhaust gas.

<b>Data / Parameter:</b>	wCH <sub>4,y</sub>
Unit:	m <sup>3</sup> CH <sub>4</sub> /m <sup>3</sup> LFG
Description:	Methane fraction in the landfill gas
Measured/ Calculated / Default:	Measured
Source of data:	Measured by continuous gas quality analyzer
Value(s) of monitored parameter:	Multiple, continuously measured. Values submitted in excel tables with this report.

Monitoring equipment:	<p>Landtec Field Analytical Unit (FAU), calibration automatically checked approximately once every three hours and re-calibrated as necessary. Auto-calibration system maintains a minimum +/- 1.0% accuracy with analysis.</p> <p>Type: Gas Cylinder Serial Number BA9177 Composition: CH<sub>4</sub> 50%; CO<sub>2</sub> 35% Date of last calibration: March 25, 2010 Validity: 36 months</p> <p>Type: Gas Cylinder Serial Number 161954 Composition: CH<sub>4</sub> 50%; CO<sub>2</sub> 35% Date of last calibration: March 30, 2012 Validity: 36 months</p> <p>Type: Gas Cylinder Serial Number D893376 Composition: O<sub>2</sub> -4% Date of last calibration: March 26, 2010 Validity: 36 months</p> <p>Type: Gas Cylinder Serial Number EFH5153 Composition: O<sub>2</sub> -4% Date of last calibration: March 26, 2012 Validity: 36 months</p>
Measuring/ Reading/ Recording frequency:	Continuously every two minutes
Calculation method (if applicable):	Not applicable
QA/QC procedures:	Calibration of equipment as per manufacturer specifications to ensure validity of data measured
Purpose of data:	Baseline emission calculations
Additional comment:	-
<b>Data / Parameter:</b>	EL <sub>IMP</sub>
Unit:	MWh
Description:	Total amount of electricity import to meet project requirements
Measured/ Calculated / Default:	Measured
Source of data:	Electric meter – Centrais Elétricas do Pará- CELPA

Value(s) of monitored parameter:	<table><tr><td>February 2013</td><td>13.198 MWh</td></tr><tr><td>March 2013</td><td>13.172 MWh</td></tr><tr><td>April 2013</td><td>13.849 MWh</td></tr><tr><td>May 2013</td><td>14.506 MWh</td></tr><tr><td>June 2013</td><td>13.388 MWh</td></tr><tr><td>July 2013</td><td>12.898 MWh</td></tr><tr><td>August 2013</td><td>12.892 MWh</td></tr><tr><td>September 2013</td><td>12.727 MWh</td></tr><tr><td>October 2013</td><td>13.758 MWh</td></tr><tr><td>November 2013</td><td>12.436 MWh</td></tr><tr><td>December 2013</td><td>12.755 MWh</td></tr><tr><td>February 01, 2013 to December 31, 2013</td><td>145.579 MWh</td></tr></table>	February 2013	13.198 MWh	March 2013	13.172 MWh	April 2013	13.849 MWh	May 2013	14.506 MWh	June 2013	13.388 MWh	July 2013	12.898 MWh	August 2013	12.892 MWh	September 2013	12.727 MWh	October 2013	13.758 MWh	November 2013	12.436 MWh	December 2013	12.755 MWh	February 01, 2013 to December 31, 2013	145.579 MWh
February 2013	13.198 MWh																								
March 2013	13.172 MWh																								
April 2013	13.849 MWh																								
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December 2013	12.755 MWh																								
February 01, 2013 to December 31, 2013	145.579 MWh																								
Monitoring equipment:	<p>Energy measurement meters. These meters are installed by the local electric provider Centrais Elétricas do Pará S.A. (CELPA), are sealed and tamper proof</p> <p>LANDIS+GYR Model: SAGA 1000-1681-B Accuracy: 0.5% Serial number: 362496 Last Calibration: December 14, 2011</p> <p>LANDIS+GYR Model: SAGA 1000-1681-B Accuracy: 0.5% Serial number: 362496 Last Calibration: February 25, 2013</p>																								
Measuring/ Reading/ Recording frequency:	Measuring frequency: monthly meter reading by the electricity distribution company (CELPA) representative and billing to the company																								
Calculation method (if applicable):	Not Applicable																								
QA/QC procedures:	Calibration of equipment as per manufactures specifications to ensure validity of data measured																								
Purpose of data:	Project emission calculations																								
Additional comment:	-																								

<b>Data / Parameter:</b>	EF <sub>grid</sub>	
Unit:	tCO <sub>2</sub> e/MWh	
Description:	CO <sub>2</sub> emission intensity of electricity used in the project activity	
Measured/ Calculated / Default:	Calculated	
Source of data:	<p>Most recent data for the build margin and operating margin (2012) found on the Brazilian Governments Ministry of Science and Technology website:</p> <p>(<a href="http://www.mct.gov.br/index.php/content/view/338049.html#ancora">http://www.mct.gov.br/index.php/content/view/338049.html#ancora</a>)</p>	

Value(s) of monitored parameter:	For 2012 ( <a href="http://www.mct.gov.br/index.php/content/view/338049.html#ancora">http://www.mct.gov.br/index.php/content/view/338049.html#ancora</a> )  0.359 tCO <sub>2</sub> e/MWh <table><tr><td>Average Operating Margin</td><td>0.5176</td><td>tCO<sub>2</sub>e/MWh</td></tr><tr><td>Build Margin*</td><td>0.2010</td><td>tCO<sub>2</sub>e/MWh</td></tr><tr><td colspan="2">Calculation of Grid Emission Factor</td><td></td></tr><tr><td colspan="3">Emission Factor = (OM*0.5) + (BM*0.5) = (0.5176*0,5) + (0.2010*0,5) = 0.359 tCO<sub>2</sub>e/MWh</td></tr></table>	Average Operating Margin	0.5176	tCO <sub>2</sub> e/MWh	Build Margin*	0.2010	tCO <sub>2</sub> e/MWh	Calculation of Grid Emission Factor			Emission Factor = (OM*0.5) + (BM*0.5) = (0.5176*0,5) + (0.2010*0,5) = 0.359 tCO <sub>2</sub> e/MWh				
Average Operating Margin	0.5176	tCO <sub>2</sub> e/MWh													
Build Margin*	0.2010	tCO <sub>2</sub> e/MWh													
Calculation of Grid Emission Factor															
Emission Factor = (OM*0.5) + (BM*0.5) = (0.5176*0,5) + (0.2010*0,5) = 0.359 tCO <sub>2</sub> e/MWh															
Monitoring equipment:	Not applicable														
Measuring/ Reading/ Recording frequency:	Annually ex-post														
Calculation method (if applicable):	The build margin and operation margin are weighted as 50 percent and 50 percent respectively, in accordance with “Tool to Calculate the Emission Factor for an Electricity System “– version 3.0.0 (EB 70 Annex 22)														
QA/QC procedures:	Not applicable														
Purpose of data:	Project emissions calculations														
Additional comment:	-														
<b>Data / Parameter:</b>	AF														
Unit:	None														
Description:	Regulatory requirements relating to landfill gas projects														
Measured/ Calculated / Default:	Test														
Source of data:	The information though recorded annually, is used for changes to the adjustment factor (AF) or directly MDreg.y at renewal of the credit period														
Value(s) of monitored parameter:	Zero														
Monitoring equipment:	Not applicable														
Measuring/ Reading/ Recording frequency:	Annually														
Calculation method (if applicable):	Not applicable														
QA/QC procedures:	Not applicable														
Purpose of data:	Baseline emission calculations														

Additional comment:	-
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**D.3. Implementation of sampling plan**

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Not applicable.

**SECTION E. Calculation of emission reductions or GHG removals by sinks****E.1. Calculation of baseline emissions or baseline net GHG removals by sinks**

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The approved baseline methodology applied to this project is the approved ACM0001 ver. 4 (dated 28 July 2006) – Consolidated Baseline Methodology for Landfill Gas Project Activities.

All greenhouse gas (GHG) emission reductions generated by the implementation of the project activity are considered fully additional based on the lack of previous LFG management activities and the current environmental regulations in Brazil.

There are no existing or pending regulatory requirements requiring the Site to implement any form of LFG emission reductions program. There was no LFG recovery and combustion system in place at the Site prior to the project implementation. Therefore, the project baseline is the uncontrolled release of LFG to the atmosphere.

**E.2. Calculation of project emissions or actual net GHG removals by sinks**

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Methodology ACM0001 ver. 4 clearly states that the CO<sub>2</sub> emission intensity of the electricity consumed by the project activity must be taken into account. In the project activity, electrical consumption is associated with the blower system used to draw landfill gas to the enclosed drum flare.

An estimate of the grid emission factor for Brazil is calculated as 199 kilograms CO<sub>2</sub>/MWh based on the calculation for the combined margin emission factor for the Brazilian interconnected grid, weighting the build margin and operating margin 50 percent and 50 percent respectively in accordance with the Tool to Calculate the Emission Factor for an Electricity System-Version 3.0.0 (EB 70 Annex 22). The most recent data for the build margin and operating margin is for 2012 and is found on the Brazilian Governments Ministry of Science and Technology website (<http://www.mct.gov.br/index.php/content/view/338049.html#ancora>).

**TOTAL EMISSIONS RESULTING FROM ELECTRICAL CONSUMPTION**  
**AURÁ LANDFILL GAS PROJECT**  
**AURÁ LANDFILL**  
**BELÉM, PARÁ, BRAZIL**

<i>Period</i>	<i>Quantity of Electricity Imported (MWh)</i> <i>EC</i>	<i>CO<sub>2</sub> Emission Intensity (tCO<sub>2</sub>e/MWh)</i> <i>EFgrid, CM</i>	<i>CO<sub>2</sub> Emissions Produced (tCO<sub>2</sub>e)</i> <i>PEEC</i>
<i>February 2013</i>	13.198	0.359	4.7
<i>March 2013</i>	13.172	0.359	4.7
<i>April 2013</i>	13.849	0.359	5.0
<i>May 2013</i>	14.506	0.359	5.2
<i>June 2013</i>	13.388	0.359	4.8
<i>July 2013</i>	12.898	0.359	4.6
<i>August 2013</i>	12.892	0.359	4.6
<i>September 2013</i>	12.727	0.359	4.6
<i>October 2013</i>	13.758	0.359	4.9
<i>November 2013</i>	12.436	0.359	4.5
<i>December 2013</i>	12.755	0.359	4.6
<b>Total</b>	<b>145.579</b>	<b>0.359</b>	<b>52.3</b>

### E.3. Calculation of leakage

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No leakage effects need to be accounted under methodology ACM0001 ver. 4 (E.2=0).

### E.4. Summary of calculation of emission reductions or net anthropogenic GHG removals by sinks

The following formulae were used to estimate emission reductions for the project activity:

$$ER_v = (MD_{\text{project},v} - MD_{\text{req},v}) * GWP_{CH_4} + EL_v * CEF_{\text{electricity},v} + ET * CEF_{\text{thermal},v}$$

Where:

- $ER_v$  are the emission reductions, measured in tCO<sub>2</sub>e
- $MD_{\text{project},v}$  is the amount of methane actually destroyed/combusted during the time period t, measured

in tCH<sub>4</sub>

- MD<sub>req,y</sub> is the amount of methane that would have been destroyed/combusted during the time period t in the absence of the project activity, measured in tCH<sub>4</sub>
- GWP<sub>CH4</sub> is the approved Global Warming Potential value for methane, 21 tCO<sub>2</sub>e/tCH<sub>4</sub>
- EL<sub>y</sub> is net quantity of electricity displaced during a given period t, measured in MWh
- CEF<sub>electricity,y</sub> is the CO<sub>2</sub> emissions intensity of the electricity displaced, measured in tCO<sub>2</sub>e/MWh
- ET is the quantity of thermal energy displaced, measured in TeraJoules (TJ)
- CEF<sub>thermal,y</sub> is the CO<sub>2</sub> emissions intensity of the thermal energy displaced, measured in tCO<sub>2</sub>e/TJ

It is noted that while the terms for electricity and thermal energy have been included to be consistent with the overall formulation stated in ACM0001 ver.4, energy displacement is not a component of the proposed project activity. As a result, the above equation reduces to the following form for the project activity:

$$ER_y = (MD_{project,y} - MD_{req,y}) * GWP_{CH4}$$

Considering that there is no regulatory or contractual requirement determining MD<sub>reg</sub>, an adjustment factor (AF) is used:

$$MD_{req} = MD_{project} * AF$$

Based on the project context, an "Adjustment Factor" of 0 percent is used for the project.

$$MD_{req,y} = MD_{project,y} * AF$$

$$MD_{req,y} = MD_{project,y} * 0$$

$$\text{And } ER_y = MD_{project,y} * GWP_{CH4}$$

The methane destroyed by the project activity during a given time period t can be determined by the following: monitoring the quantity of methane actually flared and LFG used to generate electricity and to produce thermal energy, and is given by:

$$MD_{project} = MD_{flared} + MD_{electricity} + MD_{thermal}$$

For the proposed project activity, MD<sub>electricity</sub> = MD<sub>thermal</sub> = 0, as there is no energy displacement component of the project. As a result, the total actual quantity of methane captured and destroyed will be metered ex post once the project activity is operational, and:

$$MD_{project} = MD_{flared}$$

and,

$$MD_{flared,y} = LFG_{flare,y} * w_{CH_4,y} * DCH_4 * FE$$

Where:

- $MD_{\text{flared},y}$  is the quantity of methane destroyed by flaring in a given time period  $t$ , measured in  $tCH_4$
- $LFG_{\text{flare}}$  is the quantity of landfill gas flared during the time period  $t$ , measured in cubic meters ( $m^3$ )
- $wCH_4$  is the average methane fraction of the landfill gas as measured during the given time period  $t$  and expressed as a fraction of  $CH_4$  volume per LFG volume ( $m^3 CH_4/m^3$  of LFG)
- FE is the flare efficiency (the fraction of the methane destroyed, in percent)
- $DCH_4$  is the methane density, expressed in tonnes of methane per cubic meter of methane ( $tCH_4/m^3CH_4$ ), and measured at STP (0 degree Celsius and 1.013 bar), which is  $0.0007168 tCH_4/m^3CH_4$  (as per consolidated methodology ACM0001 Ver. 4)

As a result, the formula to estimate emission reductions for the project activity is the following:

$$ER_y = (LFG_{\text{flare},y} * wCH_{4,y} * DCH_4 * FE) * GWP_{CH_4}$$

The following table summarizes the baseline emissions of the project activity. Electronic spread sheets are attached to present full calculations of the monitoring report.

#### CERTIFIED EMISSION REDUCTIONS SUMMARY

<b>Monitoring Period</b>	<b>CO<sub>2</sub> Equivalent Reduced (tCO<sub>2</sub>e)</b>	<b>CO<sub>2</sub> Emissions Produced (tCO<sub>2</sub>e)</b>	<b>Emissions reductions (tCO<sub>2</sub>e/month) E<sub>Ry</sub></b>
January/2013	0	0	0
February/2013	31,865	4.7	31,860
March/2013	43,726	4.7	43,721
April/2013	42,986	5.0	42,981
May/2013	45,424	5.2	45,419
June/2013	40,603	4.8	40,598
July/2013	39,306	4.6	39,301
August/2013	38,285	4.6	38,280

September/2013	34,131	4.6	34,127
October/2013	34,153	4.9	34,148
November/ 2013	32,578	4.5	32,573
December/ 2013	34,094	4.6	34,090
Total	417,151	52,3	417,098

Item	Baseline emissions or baseline net GHG removals by sinks (t CO <sub>2</sub> e)	Project emissions or actual net GHG removals by sinks (t CO <sub>2</sub> e)	Leakage (t CO <sub>2</sub> e)	Emission reductions or net anthropogenic GHG removals by sinks (t CO <sub>2</sub> e)
Total	417,151	52,3	-	417,098

#### E.5. Comparison of actual emission reductions or net anthropogenic GHG removals by sinks with estimates in registered PDD

As recorded in the PDD, it was estimated that for Aurá Landfill Project 328,266 tCO<sub>2</sub>e would be claimed throughout the full 2013 reporting year. As this monitoring period covers 10 months and 22 days, the amount of estimated emission reductions for the monitoring period from January 1, 2013 to December 31, 2013 is approximately 294,990 tCO<sub>2</sub>e.

Item	Values estimated in ex-ante calculation of registered PDD	Actual values achieved during this monitoring period
Emission reductions or GHG removals by sinks (t CO <sub>2</sub> e)	294,990	417,098

#### E.6. Remarks on difference from estimated value in registered PDD

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The actual quantity of CERs achieved in this Project is higher (approximately 40%) than the quantity of CERs estimated in the PDD.

Conditions for project development have been generally maintained as steady expansion of the LFG collection field to improve the performance of the LFG recovery project at the Aura landfill. Included in this development was the increased total length of trenches, improving the LFG collection efficiency, which resulted in an increased CERs generation for this monitoring period.

Additional to this, there are external factors outside of the Project Participant's control that have resulted in higher total of CERs claimed during the current monitoring period in relation to what was estimated in the registered PDD. These factors are: (1) the registered PDD included estimation of CERs based on Site assumptions as per the Site Owner observations. One of these assumptions was the Site receiving waste up to 2010 inclusive. However, the Site owner received waste on 2011, 2012 and 2013 and continues to do so. Furthermore, the Site owner has increased the amount of waste received overtime; and (2) there have been some improvements resulting from Belem's municipality decision to privatize the landfill operations. These Site improvements include the optimization of waste disposal (more localized), better drainage systems, daily cover implementation (including covering all areas of previous disposal), availability of equipment and labour, and better housekeeping of the Site.

**E.7. Actual emission reductions or net anthropogenic GHG removals by sinks during the first commitment period and the period from 1 January 2013 onwards**

Item	Actual values achieved up to 31 December 2012	Actual values achieved from 1 January 2013 onwards
<b>Emission reductions or GHG removals by sinks (t CO<sub>2</sub>e)</b>	-	417,098

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**Document information**

Version	Date	Description
03.2	5 November 2013	Editorial revision to correct table in page 1.
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net anthropogenic GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01	28 May 2010	EB 54, Annex 34. Initial adoption.

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