Monitoring report form (Version 03.2)

Monitoring report

Title of the project activity	Durban Landfill-Gas-to-Electricity Project – Mariannhill and La Mercy Landfills
Reference number of the project activity	0545
Version number of the monitoring report	1
Completion date of the monitoring report	13/02/2014
Registration date of the project activity	15/12/2006
Monitoring period number and duration of this monitoring period	Fifth Monitoring Report 01/10/2012 – 14/12/2013
Project participant(s)	**South Africa:** Durban Solid Waste (DSW); eThekwini municipality; **Netherlands:** Netherlands' Ministry of Infrastructure and the Environment (IenM); Electrabel S.A.; Netherlands' Ministry of Economic Affairs, Agriculture and Innovation (EL&I); **Finland:** Government of Finland - Ministry of Foreign Affairs of Finland; Fortum Corporation; **Germany**: RWE Power AG; **Japan**: Chubu Electric Power Co., Inc; The Chugoku Electric Power Co., Inc.; Kyushu Electric Power Co., Inc.; Mitsubishi Corporation; Tohoku Electric Power Co., Inc.; The Tokyo Electric Power Co., Inc.; Shikoku Electric Power Co., Inc.; Japan International Cooperation Agency (JICA); Mitsui & Co. Ltd.; **Norway**: Govt. of Norway, Ministry of Foreign Affairs; Norsk Hydro ASA; Statoil ASA; **United Kingdom of Great Britain and Northern Ireland:** Deutsche Bank AG; BP Alternative Energy International Ltd; **France**: GDF SUEZ. **Sweden**: Government of Sweden - Swedish Energy Agency; **Bilateral and Multilateral Funds:** Prototype Carbon Fund (PCF) – Managing Company: International Bank for Reconstruction and Development (IBRD) as Trustee of the Prototype Carbon Fund (PCF)
Host Party(ies)	South Africa
Sectoral scope(s) and applied methodology(ies)	Sectoral Scopes 01 (Energy Industries – renewable/non-renewable sources) and 13 (Waste Handling and Disposal) AM0010: "Landfill gas capture and electricity generation projects where landfill gas capture is not mandated by law" Version 01.
Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD	53,759 tCO_2e

Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period	33,851 tCO_2e
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved during the period up to 31 December 2012 (if applicable)	6,858 tCO_2e
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved during the period from 1 January 2013 onwards (if applicable).	26,993 tCO_2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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The Durban Landfill-Gas-to-Electricity Project is designed to provide active landfill gas extraction and treatment by combustion in engines to produce electricity for supply to the South African grid system, or alternatively by flaring. Capture and combustion of the landfill gas converts methane to carbon dioxide. Methane is a powerful greenhouse gas, some 21 times more damaging than carbon dioxide and therefore its capture and combustion reduces the release of greenhouse gases to atmosphere which would otherwise occur in the absence of the project.

The project is part of a 3-site program implemented by eThekwini Municipality. The third site is Bisasar Road, which has been registered as an entirely separate CDM project and is therefore not discussed within this report.

Mariannhill Landfill site is an active landfill, located in the western area of Durban, which is scheduled to remain operational until 2024. It extends over 49 hectares and receives up to 700 tons of waste per day. The site was officially designated a Nature Conservancy site in late 2002, the only landfill in South Africa granted such a status.

La Mercy Landfill site is an old, closed landfill located 35km to the north of Durban and remote from residential areas. The site received approximately 1 million tons of waste in total. The La Mercy site was decommissioned in June 2009 and is no longer contributing to the emission reductions of the project. Therefore this Monitoring Report only considers operations and emission reductions at the Mariannhill Landfill site.

The site incorporates typical landfill gas collection and treatment infrastructure including extraction wells, pipework, an engine for generation of electricity, a flare for combustion of surplus landfill gas and a range of monitoring equipment to record the necessary data. At Mariannhill, the gas extraction system will be progressively expanded as the site continues to receive waste and new landfill cells are developed.

Construction of the landfill gas management system began on 01/02/2006. The gas combustion equipment was commissioned in November 2006 and the first monitoring period commenced on 15/12/2006.

The project was registered on 15/12/2006. The initial crediting period is 7 years, which is twice renewable for a total operating period of 21 years.

The total emission reductions achieved during the fifth Monitoring Period (01/10/2012 to 14/12/2013) is **33,851** tCO_2e.

A.2. Location of project activity

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The project is located within the KwaZulu Natal region of South Africa. The Mariannhill landfill site is located in the western area of the Durban unicity, around 20 km to the west of Durban in the Metro area, formerly called the Inner West City Council (IWCC).

Durban is geographically located in the southeast region of South Africa on the Indian Ocean coast.

The Mariannhill site is located at Latitude: -29.846389, Longitude: 30.837778

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)
South Africa (host)	Durban Solid Waste (DSW)-eThekwini Municipality	No
Netherlands	Netherlands' Ministry of Infrastructure and the Environment (IenM); Electrabel S.A.; Netherlands' Ministry of Economic Affairs, Agriculture and Innovation (EL&I)	Yes
Finland	Government of Finland - Ministry of Foreign Affairs of Finland; Fortum Corporation	Yes
Germany	RWE Power AG	No
Japan	Chubu Electric Power Co. Inc; The Chugoku Electric Power Co. Inc; Kyushu Electric Power Co. Inc.; Mitsubishi Corporation; Tohoku Electric Power Co. Inc.; The Tokyo Electric Power Co. Inc.; Shikoku Electric Power Co. Inc; Japan International Cooperation Agency (JICA); Mitsui & Co. Ltd.	No
Norway	Government of Norway – Ministry of Foreign Affairs; Norsk Hydro ASA; Statoil ASA	Yes
United Kingdom of Great Britain and Northern Ireland	Deutsche Bank AG; BP Alternative Energy International Ltd	No
France	GDF SUEZ	No
Sweden	Government of Sweden - Swedish Energy Agency	Yes
Bilateral and Multilateral Funds	Prototype Carbon Fund (PCF) – Managing Company: International Bank for Reconstruction and Development (IBRD) as Trustee of the Prototype Carbon Fund (PCF)	Yes

A.4. Reference of applied methodology

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The project was registered under approved baseline methodology AM0010: "Landfill gas capture and electricity generation projects where landfill gas capture is not mandated by law" Version 01.

The methodology does not refer to any tools or other methodologies.

A.5. Crediting period of project activity

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The first crediting period of the project activity, to which this monitored period applies, commenced on 15/12/2006 and runs for 7 years until 14/12/2013.

SECTION B. Implementation of project activity

B.1. Description of implemented registered project activity

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Durban Solid Waste (DSW) is the municipal agency responsible for management and operation of multiple landfills in the Durban metropolitan area. Under the project, DSW has commissioned the installation of landfill gas extraction wells, flare units and landfill gas generators for the Mariannhill landfill site. DSW functions as the technical advisor and operator of the project.

Specifically, the following technology has been installed:

- Extraction wells: Over time some 33 gas wells will be constructed during phased restoration of the site to extract the landfill gas as it is produced.
- Gas collection pipework: Pipes collect and transport the gas from the wells to the extraction plant from where the gas is used for electricity generation, with any surplus gas being flared.
- Gas extraction plant (blower): A centrifugal blower is required to extract landfill gas from the wells and supply this to either the generation engine or the flare unit. The blower creates lower pressure inside the wells than in the landfill, thereby sucking the gas from the landfill into the wells and from there to the extraction plant.
- Flare unit: A landfill gas flare with maximum capacity of 1,000Nm^3/hr has been installed at the site.
- Landfill gas generator: A single 1MW unit has been installed at Mariannhill, which can be turned down to as low as 50% capacity (Jenbacher type 320 engine); and
- Switch gears, transformers and cabling: have been installed as needed for interconnection with the eThekwini Electricity grid.

The system is also equipped with condensate knockout pots in order to keep pipework clear of liquids which form due to changes in temperature. All engine and flaring equipment is housed in a purpose built compound to ensure no unauthorised access and maintain high standards of health and safety. The engine is installed within acoustic housing to minimise noise nuisance. All equipment is manufactured to established European standards and instrument maintenance and calibration procedures are implemented in accordance with the recommendations of the respective manufacturer.

Switch gear, transformers and cabling have been supplied to provide interconnection to the electricity grid system. In addition, the site is equipped with the necessary monitoring and data capture instrumentation to ensure that the requirements of the PDD are addressed.

A regular program of operation and maintenance of gas extraction and combustion equipment has been implemented, based on suppliers' recommendations. Specialist contractors are employed to carry out environmental monitoring, in addition to maintenance and servicing of the landfill gas flare and engine.

Status of Implementation

The project has involved the installation of a network of gas collection wells and pipework to which suction pressure is applied in order to draw landfill gas from the waste to undergo controlled combustion in order to generate electricity.

Construction of the landfill gas management system began on 01/02/2006. The gas combustion equipment was commissioned in November 2006 and the first monitoring period commenced on 15/12/2006.

The project implemented a substantial upgrade of a previously existing, small collection system at Mariannhill which comprised six gas collection wells installed as a pilot activity.

The gas utilisation system at Mariannhill currently comprises a single 1MW Jenbacher 320 engine and flare. The network of gas collection wells has been expanded on a phased basis as the site continues to develop, as summarised in the following table.

During this monitoring period four new horizontal wells - HW10, HW11, HW12 and HW13 were added.

MARIANNHILL LANDFILL : GAS WELLS AS AT 14 DECEMBER 2013

Base line wells - Cell 1	Vertical wells installed under Contract WS 5607 (1No. in Cell 1; 6No. In Cell 3)	Gas Riser Pipe (GRP) wells connected under Contract WS 5607 (Cell 4)	Vertical wells installed by Envitech (Cell 4)	Horizontal wells & riser connections installed under Contract WS 5920 and O&M contract (Cell 4 & 5) Installed after 2009 and before 1 October 2012					Horizontal wells & riser connections installed between 2-10-2012 and 14-12-2013 (Monitoring Period 5)				
				Header Station No.	Valve No. in Header Station	Well No.	Level	Approx. Length	Header Station No.	Valve No. in Header Station	Well No.	Level	Approx. Length
BASELINE GW 1	GW 1	GRP 1	GW 8	HS 1	V8	HW 6	LC	130	HS 1	V15	HW 10	LC	140
BASELINE GW 2	GW 2	GRP 2	GW 9	HS 1	V9	HW 4	LB	120	HSC 3	V1	HW 11	LD	120
BASELINE GW 3	GW 3	GRP 3	GW 10	HS 1	V10	HW 1	LA	140	HSC 3	V2	HW 12	LD	120
BASELINE GW 4	GW 4	GRP 4	GW 11	HS 1	V16	HW 7	LC	102	HSC 3	V3	HW 13	LD	120
BASELINE GW 5	GW 5	GRP 5		HS 1	V17	RISERS	(LB)	varies					
BASELINE GW 6	GW 6	GRP 6		HS 1	V18	HW 2	LA	150					
	GW 7	GRP 7		HS 1	V19	HW 3	LA	145					
		GRP 8		HS 1	V20	HW 5	LB	125					
		GRP 9		HS 1	V16	HW 7	LC	130					
				~~HSC 3~~	~~V2~~	~~HW 8~~	~~LC~~	~~140~~					
				~~HSC 3~~	~~V3~~	~~HW 9~~	~~LC~~	~~140~~					

NOTE: HW 8 & HW 9 were damaged and abandoned.

HW 12 & HW 13 have been linked into the piping previously serving HW 8 & HW 9

NOTE:

- *Well lengths range between 70m and 140m;*
- *There is a vertical separation of 3.5m and 5m between the layers of horizontal wells LA, LB and LC. Horizontal wells are installed as landfilling takes place and waste thickness increases;*
- *LA denotes layer A, the deepest layer of wells with layer B (LB) some 3.5m to 5m above this and layer C (LC) another 3.5m to 5 m above layer B;*
- *The risers are perforated pipes installed with the cell lines and bedded in the leachate drainage layer on the slopes only. The risers therefore extract gas from the base of the landfill;*
- *Horizontal gas wells re-numbered since March 2011.*
- *Wells installed during this monitored period have been installed in cell 5*

The volume of gas from the baseline wells (GW1 – GW6) has been decreasing with time until it was negligible and below the accurate measurement range of the flow meter used. In addition, from March 2012 well heads and seals were failing due to settlement and allowing oxygen ingress. Trials elsewhere with re-constructing the seals did not produce any significant improvement in gas production or quality. No more gas could be extracted from the baseline wells, therefore it was monitored to the point that no gas could be extracted from them, this being November 2012.

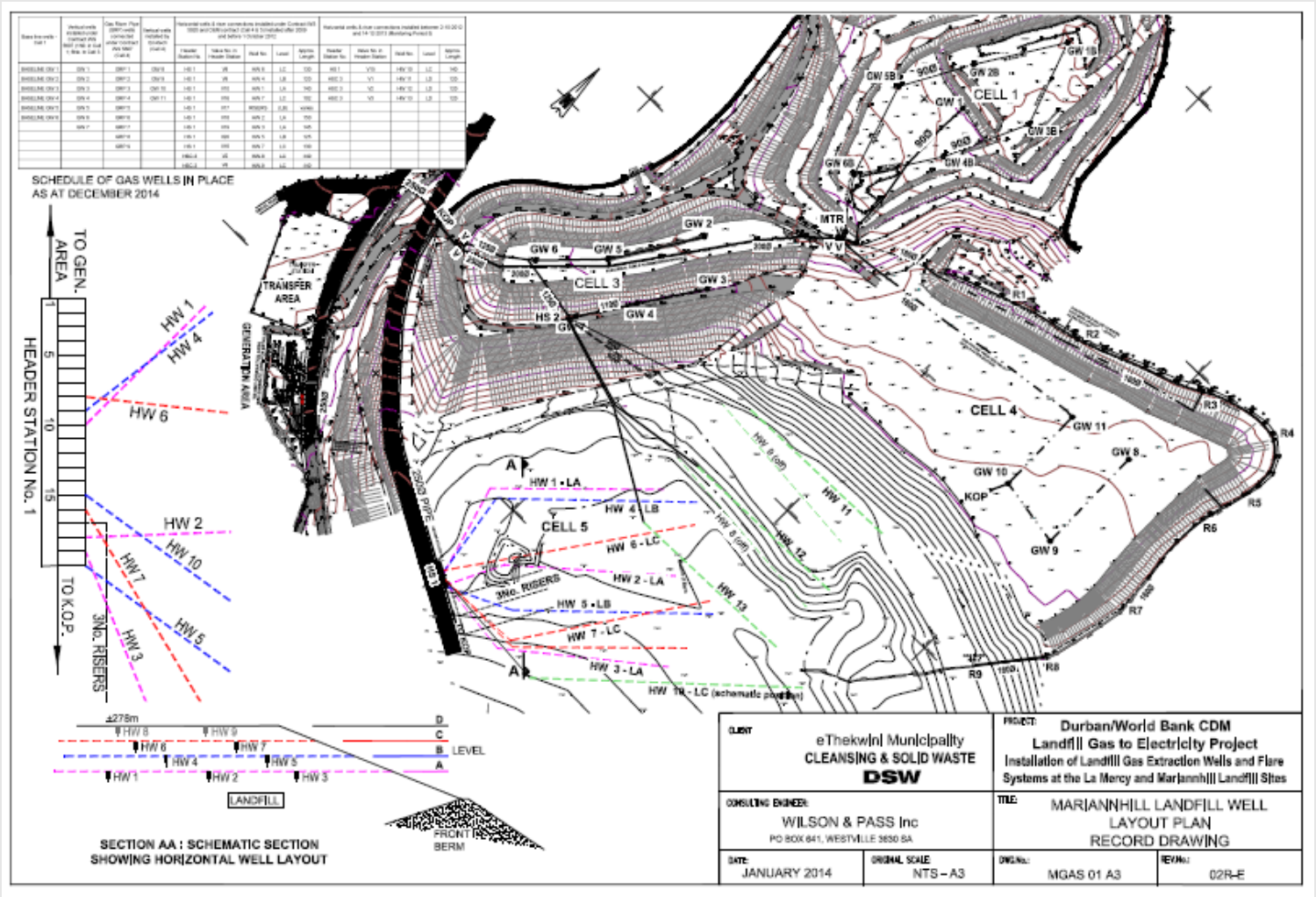
Further wells will be added at Mariannhill when new areas of landfilling are completed.

Operation of the Activity

No major operational difficulties were experienced during the monitoring period. Minor issues were experienced related to gas extraction as a result of wells not performing or being damaged on site during landfilling operations, power failures and low gas flows / temperature at the flare.

Intermittent problems were also experienced with the stationary methane analysers during the monitoring period, requiring repair and replacement. During such periods, methane concentrations are also recorded using fully calibrated hand held analysers in accordance with site management procedures.

These events were recorded in the monthly SCADA workbooks.


SCHEDULE OF GAS WELLS IN PLACE
AS AT DECEMBER 2014
TO GEN. AREA
HEADER STATION No. 1
TO K.O.P.
3No. RISERS
HW 1
HW 4
HW 6
HW 2
HW 10
HW 7
HW 5
HW 3
TRANSFER AREA
GENERATION AREA
CELL 1
CELL 2
CELL 3
CELL 4
CELL 5
GW 1
GW 2
GW 3
GW 4
GW 5
GW 6
GW 7
GW 8
GW 9
GW 10
GW 11
GW 1B
GW 2B
GW 3B
GW 4B
GW 5B
GW 6B
MTR
KOP
HS 2
HW 1 - LA
HW 4 - LB
HW 6 - LC
HW 2 - LA
HW 5 - LB
HW 7 - LC
HW 3 - LA
HW 11
HW 12
HW 13
HW 8 (off)
HW 8 (off)
3No. RISERS
LANDFILL
FRONT BERM
LEVEL
±278m
SECTION AA : SCHEMATIC SECTION
SHOWING HORIZONTAL WELL LAYOUT
CLIENT
eThekwini Municipality
CLEANSING & SOLID WASTE
DSW
PROJECT:
Durban/World Bank CDM
Landfill Gas to Electricity Project
Installation of Landfill Gas Extraction Wells and Flare Systems at the La Mercy and Marianhill Landfill Sites
CONSULTING ENGINEER:
WILSON & PASS Inc
PO BOX 841, WESTVILLE 3630 SA
TITLE:
MARIANNHILL LANDFILL WELL LAYOUT PLAN
RECORD DRAWING
DATE:
JANUARY 2014
ORIGINAL SCALE:
NTS – A3
DWG No.:
MGAS 01 A3
REV No.:
02R-E

B.2. Post registration changes

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

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There is no request for deviation for this fifth monitoring period.

B.2.2. Corrections

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Not applicable to this fifth monitoring period.

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

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Not applicable to this fifth monitoring period.

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

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Not applicable to this fifth monitoring period.

B.2.5. Changes to start date of crediting period

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N/A

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

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N/A

SECTION C. Description of monitoring system

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The monitoring system is based on the requirements specified by methodology AM0010. Gas flow rates are recorded, along with methane content and electricity generation as the principal parameters which are used in the calculation of emission reductions.

It should be noted that the Mariannhill site includes six pre-existing gas collection wells which are considered to be baseline wells for the purposes of the calculation of emission reductions. Additional flow meters are provided as necessary in order to discount the gas collected from baseline wells.

Data collection and storing procedures

The site is equipped with a Supervisory Control and Data Acquisition (SCADA) system to capture all relevant performance data and maintain a database from which monthly summary reports can be easily extracted. The system operates continuously and records data points at 15 minute intervals. A Process and Instrumentation Diagram for the site is provided below.

The SCADA facility provides the primary electronic record of the plant performance. The computerised system allows for automated recording and reporting of the data and calculation of ERs. Access to the SCADA facility is restricted to authorised users and is password protected.

Raw data from the monitoring instrumentation are automatically logged at 15 minute intervals and stored on the computer system hard drive. The data are stored in CSV format with a file containing data for each month. On a monthly basis the data are exported from the CSV files to an Excel electronic workbook. The workbook includes capacity for the operator to record any occurrences which are relevant to the calculation of emission reductions and how such occurrences have been addressed. The calculation of emission reductions is checked by use of a bespoke manual *'Methodology for the Calculation of CERs for the Durban/World Bank CDM Landfill Gas to Electricity Project'*.

On a monthly basis the electronic data from the Data Acquisition (DA) facility, including the monthly calculated ERs, are downloaded to a portable memory device (memory stick and/or an external hard drive) and transferred to the CDM Contractor's (Envitech Solutions) file server where it is archived under the Project. The CDM Contractor's file server is backed up to an external hard drive on a weekly basis. The monthly calculated ERs are then forwarded electronically to the CDM Project Manager for review and kept in the CDM Project Manager's office as an additional backup copy.

Quality Assurance

The project is operated in accordance with a bespoke manual *"Quality Assurance for the Operation of the Gas Extraction and Electricity Generation Systems"*.

This document describes in detail the arrangements and procedures which are followed concerning project personnel, equipment and data management.

Responsibilities

The organisational structure, along with detailed roles and responsibilities for the project are described within the CDM Management Manual for the project. The key participants are:

CDM Project Manager – Durban Solid Waste (DSW)
CDM Manager – Jon Pass (Wilson & Pass Engineers)
CDM Contractor - Monitoring – Envitech Solutions
CDM Contractor - Engine Maintenance – Peters Plant Services
CDM Contractor – Flare Maintenance – Envitech Solutions / Organics
Quality Assurance – SLR Consulting Limited

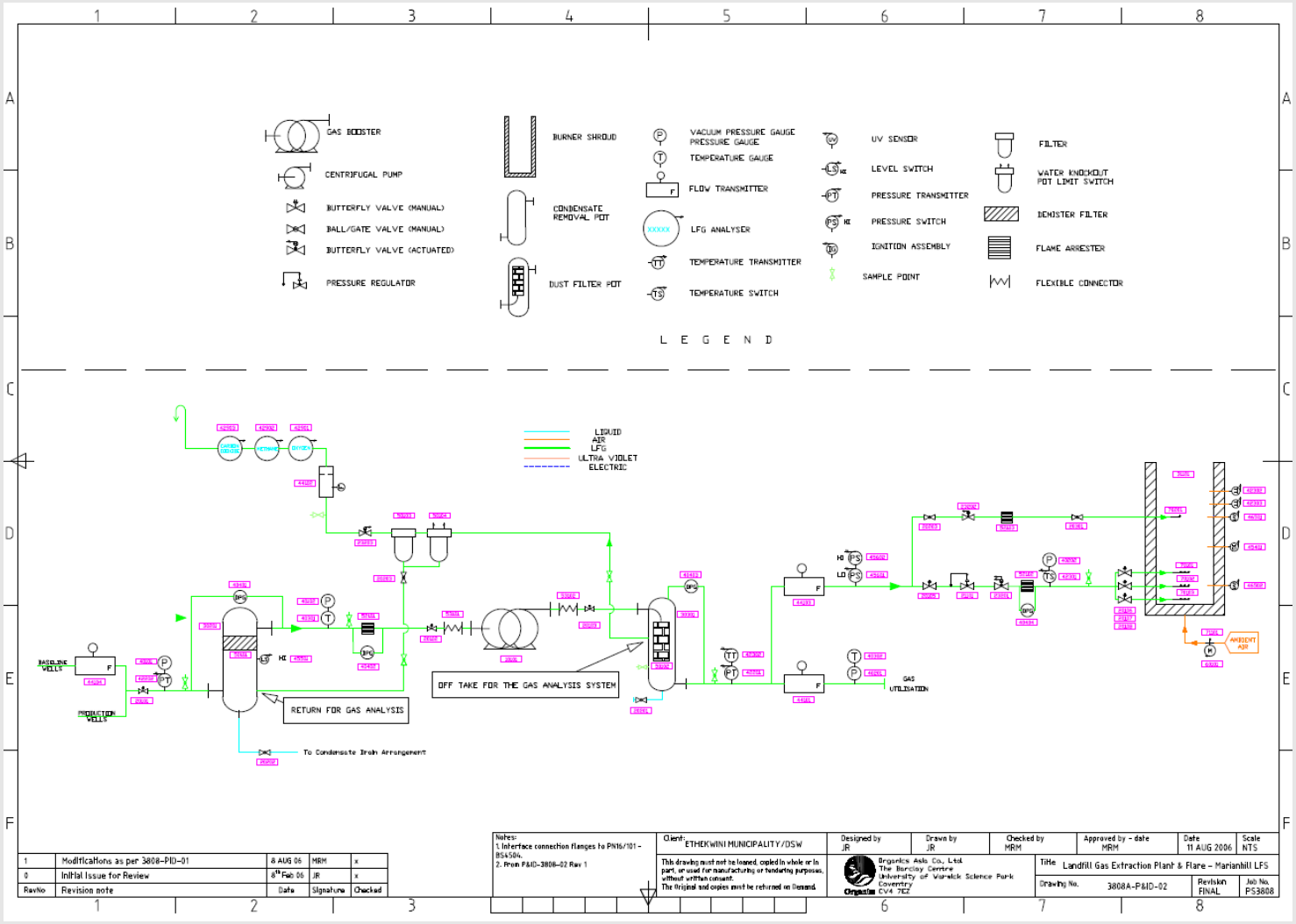
Staff Training

All required training was carried out prior to the implementation of the project, with new staff members being trained internally and externally as they have been appointed during the monitoring period. Subjects covered by the staff training have included:

- Reporting structures and lines of communication;
- Monitoring and balancing of the gas fields;
- Calibration of monitoring equipment;
- Data recording and analysis; and
- Impact of monitoring on the CDM activity.

Only authorized personnel that have received adequate training in the required fields are permitted to operate or perform any maintenance work on any of the equipment related to the project.

All monitoring data are to be retained for the duration of the crediting period and for at least two years thereafter.


GAS BOOSTER
CENTRIFUGAL PUMP
BUTTERFLY VALVE (MANUAL)
BALL/GATE VALVE (MANUAL)
BUTTERFLY VALVE (ACTUATED)
PRESSURE REGULATOR
BURNER SHROUD
CONDENSATE REMOVAL POT
DUST FILTER POT
VACUUM PRESSURE GAUGE
PRESSURE GAUGE
TEMPERATURE GAUGE
FLOW TRANSMITTER
LFG ANALYSER
TEMPERATURE TRANSMITTER
TEMPERATURE SWITCH
UV SENSOR
LEVEL SWITCH
PRESSURE TRANSMITTER
PRESSURE SWITCH
IGNITION ASSEMBLY
SAMPLE POINT
FILTER
WATER KNOCKOUT POT LIMIT SWITCH
DEMISTER FILTER
FLAME ARRESTER
FLEXIBLE CONNECTOR
L E G E N D
LIQUID
AIR
LFG
ULTRA VIOLET
ELECTRIC
RETURN FOR GAS ANALYSIS
OFF TAKE FOR THE GAS ANALYSIS SYSTEM
To Condensate Drain Arrangement
GAS UTILISATION
AMBIENT AIR
1 Modifications as per 3808-PID-01 8 AUG 06 MRM x
0 Initial Issue for Review 8th Feb 06 JR x
Rev No Revision note Date Signature Checked
Notes:
1. Interface connection flanges to PN16/101 - BS4504.
2. From P&ID-3808-02 Rev 1
Client: ETHEKWINI MUNICIPALITY/DSW
This drawing must not be loaned, copied in whole or in part, or used for manufacturing or tendering purposes, without written consent. The original and copies must be returned on Demand.
Designed by JR
Drawn by JR
Checked by MRM
Approved by - date MRM
Date 11 AUG 2006
Scale NTS
Organics Asia Co., Ltd
The Barclay Centre
University of Warwick Science Park
Coventry
CV4 7EZ
Title Landfill Gas Extraction Plant & Flare - Marianhill LFS
Drawing No. 3808A-P&ID-02
Revision FINAL
Job No. PS3808

INSTRUMENTATION LIST: MARIANNHILL

Instrument Name/Description	Manufacturer/Supplier	Model	Type / SN	Range	Accuracy	Used to measure:	Used in Calculation?	Calibration requirement	Factory Calibrated	Factory/Field Calibrated	Factory/Field Calibrated	Factory/Field Calibrated	Factory/Field Calibrated	Factory/Field Calibrated	Factory/Field Calibrated	Due date
Fixed Instrumentation used to measure Parameters																
Temperature Transmitter	WIKA	TR200	46002570	0 to 100 °C	0.75% of full scale	gas temperature	N	n/a								replace as req.
Pressure Transmitter	GE Sensing - Druck	PTX 510-1176	2343640	-250 to 0 mbar	+/- 0.15% full scale	Suction pressure	N	n/a								replace as req.
Pressure Transmitter	GE Sensing - Druck	PTX 7900-3399	2345399	0 to 250mb	+/- 0.25% full scale	Delivery Pressure	N	n/a								replace as req.
Pressure Gauge	Dresser Ashcroft	N5500	n/a	-250 to 0 mbar	1.6% of full scale	Suction Pressure	N	n/a								replace as req.
Pressure Gauge	Dresser Ashcroft	N5500	n/a	0 to 250mb	1.6% of full scale	Delivery Pressure	N	n/a								replace as req.
Thermal Mass Flow Meter	Kurz Instruments	Series 454FT	FD20272A	0-18000SFPM	+/- 2% of Rate	Flare Flow	Y	annual[1]	10/11/2006		13/04/2010	21/10/2010	28/11/2011	23/11/2012		see footnote 1
Thermal Mass Flow Meter	Kurz Instruments	Series 454FT	FD20273A	0-18000SFPM	+/- 2% of Rate	Engine Flow	Y	annual[1]	10/11/2006		13/04/2010	21/10/2010	28/11/2011	03/12/2012		see footnote 1
Thermal Mass Flow Meter	Kurz Instruments	Series 454FT	FD20271A	0-18000SFPM	+/- 2% of Rate	Baseline Flow	Y	annual[1]	10/11/2006	22/06/2009	22/04/2010	21/10/2010	28/11/2011	23/11/2012		see footnote 1
Stationary Gas Monitor - Methane	Edinburgh Instruments	Gascard NG	2309	0 to 100%	+/- 2% of range	CH4	Y	annual[2]						27/02/2012	18/06/2013	See footnote 2
Stationary Gas Monitor - Methane	Edinburgh Instruments	GasCard NG	3823	0 to 100%	+/- 2% of range	CH4	Y	annual[2]							11/07/2013	See footnote 2
Stationary Gas Monitor - Methane	Edinburgh Instruments	GasCard II	25746	0 to 100%	+/- 2% of range	CH4	Y	annual[2]	17/09/2007							See footnote 2
Stationary Gas Monitor - CO2	Edinburgh Instruments	Gascard II	25696	0 to 50%	+/- 2% of range	CO2	N	annual[2]	02/10/2007						17/06/2013	See footnote 2
Stationary Gas Monitor - CO2	Edinburgh Instruments	GasCard NG	2488	0 to 50%	+/- 2% of range	CO2	N	annual[2]						12/10/2012		See footnote 2
Stationary Gas Monitor - CO2	Edinburgh Instruments	GasCard NG	4556	0 to 50%	+/- 2% of range	CO2	N	annual[2]							12/11/2013	See footnote 2
Oxygen Analyzer	City Technology	T70X	12150830048	0 to 25%	+/- 0.5%	O2	N	n/a								replace as req.
Atmospheric Pressure Sensor	GE Sensing - Druck	PTX1400		800 to 1200mb	0.15%	Atmospheric Pressure	N	n/a								replace as req.
3 Phase 4 Wire Meter	Landis + Gyr	Dialog	86342181	0 to 5A	0.10%	11000V Meter Export kW	Y	10 yrs[3]	22/03/2006							2016
3 Phase 4 Wire Meter	Landis + Gyr	Dialog	85066208	0 to 120A	0.10%	400V Meter Import kW	Y	10 yrs[3]	26/08/2005							2015
Hand Held Instrumentation																
Hand Held Gas Analyzer	Geotechnical Instruments	GA2000	GA08915	0 to 60% CH4	3% CH4,CO2 and 1% O2	CH4, CO2, O2		annual[4]	10/07/2007	28/07/2008	04/06/2009	25/06/2010	23/08/2011	13/10/2012		
Hand Held Gas Analyzer	Geotechnical Instruments	Biogas 5000	G500625	0 to 60% CH4	3% CH4,CO2 and 1% O2	CH4, CO2, O2		annual[4]							30/08/2013	
Check Meter	Biogas		BM10509		3% CH4	CH4		annual					09/06/2011	04/07/2012	08/07/2013	

[1] Since April 2010, the Kurz flow meters are checked on at least an annual basis by a specialist contractor, in accordance with the recommendations of the manufacturer

[2] The Gascard analysers are regularly checked by the monitoring contractor using fully calibrated instruments and certified calibration gas in accordance with the recommendations of the manufacturer.

[3] The performance of the electricity meters is monitored by the eThekwini Electricity company who are responsible for management of the local grid supply network.

[4] The GA2000 and Biogas 5000 units are calibrated by the manufacturer on an annual basis and is also checked at least monthly by the monitoring contractor against certified calibration gas.

SECTION D. Data and parameters

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

Data / Parameter:	**Methane Density**
Unit:	tCH_4/m^3CH_4
Description:	Density of methane at standard temperature and pressure (0 degrees Celsius and 1,013 bar)
Source of data:	Mark's Standard Handbook for Mechanical Engineers Ninth Edition McGraw-Hill Book Company Page 4-30, Table 4.1.7 The density of methane is given in the table as; 0.0416 pound per cubic foot at 68 degrees F and 14.70 pounds per square inch. To convert that to kilograms per cubic meter at 1.013 bar and 0 degrees Centigrade: 293 degrees Kelvin/273 degrees Kelvin = 1.0732 which is the weight addition ratio at a constant volume, therefore 0.0416 x 1.0732 = 0.0446 pounds per cubic foot. 1 cubic meter = 35.31 cubic feet, therefore 0.446 x 35.31 = 1.5748 pounds per cubic meter / 2.2046 pounds per kilogram = 0.7143 kilograms per cubic meter.
Value(s) applied):	0.0007143
Purpose of data:	Emissions reduction calculation (please refer to Section E)
Additional comment:	n/a

Data / Parameter:	**GWP_{CH4}**
Unit:	tons CO_2e / tons CH_4
Description:	Global Warming Potential value for methane
Source of data:	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied):	21 up to December 2012 and 25 from then onwards
Purpose of data:	Emission reduction calculation (please refer to Section E)
Additional comment:	n/a

Data / Parameter:	**Calorific Value of Methane**
Unit:	GJ/Nm^3
Description:	Energy content of the methane combusted
Source of data:	PDD
Value(s) applied):	0.037
Purpose of data:	Emission reduction calculation (please refer to Section E)
Additional comment:	n/a

Data / Parameter:	Flare Efficiency
Unit:	%
Description:	Combustion efficiency of the flare
Source of data:	Default value as per registered PDD
Value(s) applied):	0.97
Purpose of data:	Emission reduction calculation (please refer to Section E)
Additional comment:	As per methodology AM0010, registered PDD and as confirmed by the Meth Panel, this is a default value. Request for clarification AM_CLA_0100, found online at: http://cdm.unfccc.int/methodologies/PAmethodologies/clarifications/42698

D.2. Data and parameters monitored

Data / Parameter:	Eskom Grid Emission Factor ($EI_{grid,y}$)
Unit:	tCO_2/kWh
Description:	Emission factor of the South Africa grid system
Measured/ Calculated / Default:	Default value
Source of data:	Published standardised baseline value
Value(s) of monitored parameter:	0.0009488 Source: Standardized baseline: Grid emission factor for the Southern African power pool. Version 01.0.
Monitoring equipment:	n/a
Measuring/ Reading/ Recording frequency:	Data are updated prior to submission to the DOE to ensure that the most appropriate current factor is applied.
Calculation method (if applicable):	n/a
QA/QC procedures:	n/a
Purpose of data:	Emission reduction calculation (please refer to Section E)
Additional comment:	n/a

Data / Parameter:	Regulatory requirements relating to landfill gas projects
Unit:	n/a
Description:	Applicable laws and regulations concerning the capture and combustion of landfill gas
Measured/ Calculated / Default:	Measured
Source of data:	eThekwini Municipality legal advisors to the CDM projects
Value(s) of monitored parameter:	No specific requirements have been put in place during the monitoring period

Monitoring equipment:	n/a
Measuring/ Reading/ Recording frequency:	Annual check for updates
Calculation method (if applicable):	n/a
QA/QC procedures:	n/a
Purpose of data:	-
Additional comment:	n/a

Data / Parameter:	**$MV_{baseline,y}$**
Unit:	m^3
Description:	Gas collected from baseline wells
Measured/ Calculated / Default:	Measured
Source of data:	Flow meter installed on site
Value(s) of monitored parameter:	Variable throughout the monitoring period – recorded in SCADA sheets provided
Monitoring equipment:	Serial Number: Kurz Instruments FD20271A Accuracy: +/- 2.00% Calibration frequency: recommended annual re-certification and/or in-situ calibration Date of last calibration: 28/11/2011 and 23/11/2012. Validity of Calibration certificates for this monitored period: 28/11/2011 to 27/11/2012 23/11/2012 to 22/11/2013 The volume of gas from the baseline wells had been decreasing with time until it was negligible and below the accurate measurement range of the flow meter used. In addition, from March 2012 well heads and seals were failing due to settlement and allowing oxygen ingress. Trials elsewhere with re-constructing the seals did not produce any significant improvement in gas production or quality. No more gas could be extracted from the baseline wells, therefore it was monitored to the point that no gas could be extracted from them, this being November 2012.
Measuring/ Reading/ Recording frequency:	Continuous
Calculation method (if applicable):	n/a

QA/QC procedures:	Meters subject to maintenance and in-situ calibration. Data will be kept electronically for the duration of the crediting period. Calibration of the flow meters was conducted by SGS, which is an accredited company. Accredited certificates have been made available to the DOE.
Purpose of data:	Calculation of baseline emissions
Additional comment:	n/a

Data / Parameter:	**$MV_{project,y}$**
Unit:	m^3
Description:	Gas collected from project wells
Measured/ Calculated / Default:	Calculated
Source of data:	3 flow meters installed
Value(s) of monitored parameter:	Variable throughout the monitoring period – recorded in SCADA sheets provided
Monitoring equipment:	1. Serial Number: Kurz Instruments FD20272A (flare flow) Accuracy: +/-2.00% of rate Calibration frequency: recommended annual re-certification and/or in-situ calibration Date of last calibration: 28/11/2011, 23/11/2012 and 30/10/2013 Validity of Calibration Certificate for this monitored period: 28/11/2011to 27/11/2012 23/11/2012 to 22/11/2013 30/10/2013 to 29/10/2014 2. Serial Number: Kurz Instruments FD20273A (engine flow) Accuracy: +/-2.00% of rate Calibration frequency: recommended annual re-certification and/or in-situ calibration Date of last calibration: 28/11/2011, 03/12/2012 and 30/10/2013 Validity of Calibration Certificate for this monitored period: 28/11/2011to 27/11/2012 03/12/2012 to 02/12/2013 30/10/2013 to 29/10/2014 3. Serial Number: Kurz Instruments FD20271A (baseline flow) Accuracy: +/-2.00% of rate Calibration frequency: recommended annual re-certification and/or in-situ calibration Date of last calibration: 28/11/2011, 23/11/2012 and 30/10/2013 Validity of Calibration Certificate for this monitored period: 28/11/2011to 27/11/2012 23/11/2012 to 22/11/2013 30/10/2013 to 29/10/2014 There was a period of 'missed calibration' of the engine flow meter between 28/11/2012 and 03/12/2012.

	To account for this, the most conservative approach was applied to the missed calibration using the guidance from the CDM EB – "Clean Development Mechanism Validation and Verification Standard" version 05.0, and treating this as a period of missed calibration. The data collected by this piece of equipment during this monitored period (November and December 2012) have been adjusted by the maximum value of the uncertainty of the instrument (2.0%), ultimately reducing the amount of Emission Reductions claimed.
Measuring/ Reading/ Recording frequency:	Continuous
Calculation method (if applicable):	The volume of gas collected from baseline wells (recorded by flow meter) is subtracted from the total gas extracted (recorded by engine and flare flow meters) to derive the volume collected from project wells.
QA/QC procedures:	Meters subject to maintenance and in-situ calibration. Data will be kept electronically for the duration of the crediting period. Calibration of the flow meters was conducted by SGS, which is an accredited company. Accredited certificates have been made available to the DOE.
Purpose of data:	Emission reduction calculation (please refer to Section E)
Additional comment:	n/a

Data / Parameter:	**Methane Content**
Unit:	%
Description:	Amount of the landfill gas collected which is methane
Measured/ Calculated / Default:	Measured and calculated
Source of data:	Gas monitors installed on site
Value(s) of monitored parameter:	Variable throughout the monitoring period – recorded in SCADA sheets provided
Monitoring equipment:	Model: Edinburgh Instruments, Gascard NG Serial Number: 2309 Accuracy: +/- 2% of range Model: Edinburgh Instruments, Gascard II Serial Number: 25746 Accuracy: +/- 2% of range Model: Edinburgh Instruments, Gascard NG Serial Number: 3823 Accuracy: +/- 2% of range Calibration frequency: calibration check at least annually Date of last calibration during this monitoring period: see below Validity of Calibration Certificate: valid throughout the current monitored period

In accordance with the recommendations of the manufacturer, the stationary analysers are checked on at least an annual basis using certified calibration gas or a handheld GA2000 gas analyser which is itself fully calibrated (see below).

Within the monitored period, calibrations of the stationary Gascard gas analyser using certified calibration gas took place on 22/11/2012, 13/03/2013, 25/06/2013 and 05/11/2013. Calibration is carried out each time the GDU is serviced. Additional calibrations were carried out by the manufacturer in conjunction with instrument repairs on 18/06/2013, 11/07/2013 and 22/08/2013.

The handheld GA2000 gas analyser is serviced and calibrated annually by the manufacturer and also checked and adjusted periodically by the monitoring contractor using certified calibration gas. The GA2000 is used in the event of failure of the stationary analysers and is also used to check and calibrate the stationary Gascard gas analysers on site to maintain levels of accuracy.

Whilst the GA2000 instrument is being serviced and calibrated, a handheld calibrated 'BioGas Check' gas analyzer (serial number BM10509) is used to cross check the stationary analysers against the certified calibration gas.

Handheld Instrument (GA2000)
Serial Number: GA08915
Accuracy: +/-3% of methane content
Calibration frequency: annual
Date of last calibration: 13/10/2012
Validity of Calibration Certificates: 13/10/2012 – 12/10/2013

From October 1st 2013, the GA2000 (GA08915) analyser was replaced by a Biogas 5000 analyser (an upgraded model released by the manufacturer Geotechnical Instruments).

Handheld Instrument (Biogas 5000)
Serial Number: G500625
Accuracy: +/-3% of methane content
Calibration frequency: annual
Date of last calibration: 30/08/2013
Validity of Calibration Certificates: 30/08/2013 – 29/08/2014

Due to issues with battery life, the Biogas 5000 analyser has been returned to the manufacturer and in the interim period since 06/12/2013 a temporary backup GA2000 analyser has been used.

Handheld Instrument (GA2000)
Serial Number: GA07414
Accuracy: +/-3% of methane content
Calibration frequency: annual
Date of last calibration: 19/04/2013
Validity of Calibration Certificates: 19/04/2013 – 18/04/2014

Handheld Instrument (Biogas Check Meter)
Serial Number: BM10509
Accuracy: +/-3% of methane content

	Calibration frequency: annual Date of last calibration: 04/07/2012 and 08/07/2013 Validity of Calibration Certificate: 04/07/2012 – 03/07/2013; 08/07/2013 – 07/07/2014
Measuring/ Reading/ Recording frequency:	Continuous and periodic. Periodic checks of the methane content from baseline wells are carried out at Mariannhill for cross checking purposes.
Calculation method (if applicable):	n/a
QA/QC procedures:	Meters subject to maintenance and calibration. Data will be kept electronically for the duration of the crediting period. Calibration of the biogas check meter and the GA2000 meter was conducted by Geotechnical instruments Ltd., which is accredited in accordance with the International Standard ISO/IEC 17025:2005. Accreditation certificates have been made available to the DOE.
Purpose of data:	Emission reduction calculation (please refer to Section E)
Additional comment:	n/a

Data / Parameter:	**Electricity sold to the grid (ES_y)**
Unit:	kWh
Description:	The net amount of electricity which is produced by the project for export to the grid, considering electricity usage on site
Measured/ Calculated / Default:	Measured and calculated
Source of data:	Electricity meters installed on site
Value(s) of monitored parameter:	Variable throughout the monitoring period – recorded in SCADA sheets provided
Monitoring equipment:	1. Serial Number: 86342181 (Export) Accuracy: 0.10% Calibration frequency: 10 years Date of last calibration: 2006 Validity of Calibration Certificate: valid throughout the current monitored period, up to 2016 2. Serial Number: 85066208 (Import) Accuracy: 0.10% Calibration frequency: 10 years Date of last calibration: 2005 Validity of Calibration Certificate: valid throughout the current monitored period, up to 2015
Measuring/ Reading/ Recording frequency:	Continuous

Calculation method (if applicable):	Total amount of electricity imported (measured) is subtracted from the total amount of electricity exported (measured) to derive the net electricity produced by the project.
QA/QC procedures:	Meters subject to maintenance and performance monitoring by eThekwini Electricity. Data will be kept electronically for the duration of the crediting period.
Purpose of data:	Emission reduction calculation (please refer to Section E)
Additional comment:	n/a

Data / Parameter:	**EG_y**
Unit:	kWh
Description:	Electricity produced by combustion of landfill gas
Measured/ Calculated / Default:	Measured
Source of data:	Electricity meters installed on site
Value(s) of monitored parameter:	Variable throughout the monitoring period – recorded in SCADA sheets provided
Monitoring equipment:	1. Serial Number: 86342181 (Export) Accuracy: 0.10% Calibration frequency: 10 years Date of last calibration: 2006 Validity of Calibration Certificate: valid throughout the current monitored period, up to 2016
Measuring/ Reading/ Recording frequency:	Recorded periodically for verification audit purposes
Calculation method (if applicable):	n/a
QA/QC procedures:	Meters subject to maintenance and performance monitoring by eThekwini Electricity. Data will be kept electronically for the duration of the crediting period.
Purpose of data:	Emission reduction calculation (please refer to Section E)
Additional comment:	n/a

Data / Parameter:	**Combustion Efficiency**
Unit:	%
Description:	Combustion efficiency of gas engines
Measured/ Calculated / Default:	Default values are used. The combustion efficiency of engines is not actually used in the calculation of emission reductions, but is referenced in AM0010. Annual measurements of engine combustion efficiency are therefore carried out as a quality assurance measure only.
Source of data:	n/a

Value(s) of monitored parameter:	100%
Monitoring equipment:	Field test of combustion efficiency are carried out as a quality assurance measure (see below)
Measuring/ Reading/ Recording frequency:	Annual
Calculation method (if applicable):	n/a
QA/QC procedures:	During the 5th verification period, checks have been carried out in February 2013 (SGS report). These data have been made available to the verifier and will be kept electronically for the duration of the crediting period.
Purpose of data:	Emission reduction calculation (please refer to Section E)
Additional comment:	n/a

Data / Parameter:	**LFG Temperature and Pressure**
Unit:	ºC and Pa
Description:	Temperature and pressure of landfill gas
Measured/ Calculated / Default:	The temperature and pressure are measured by temperature and pressure sensors incorporated into the flow meter units and are therefore calibrated at the same time as the flow meters.
Source of data:	Thermal mass flow meters
Value(s) of monitored parameter:	n/a
Monitoring equipment:	Since the sensors are within the flow meters, these have been calibrated at the same time as the actual flow meters mentioned previously. Hence: 1. Serial Number: Kurz Instruments FD20272A (flare flow) Accuracy: +/-2.00% of rate Calibration frequency: recommended annual re-certification and/or in-situ calibration Date of last calibration: 28/11/2011, 23/11/2012 and 30/10/2013 Validity of Calibration Certificate: 28/11/2011to 27/11/2012 23/11/2012 to 22/11/2013 30/10/2013 to 29/10/2014 2. Serial Number: Kurz Instruments FD20273A (engine flow) Accuracy: +/-2.00% of rate Calibration frequency: recommended annual re-certification and/or in-situ calibration Date of last calibration: 28/11/2011, 03/12/2012 and 30/10/2013 Validity of Calibration Certificate: 28/11/2011to 27/11/2012 03/12/2012 to 02/12/2013 30/10/2013 to 29/10/2014

	3. Serial Number: Kurz Instruments FD20271A (baseline flow) Accuracy: +/-2.00% of rate Calibration frequency: recommended annual re-certification and/or in-situ calibration Date of last calibration: 28/11/2011 and 23/11/2012 Validity of Calibration Certificate: 28/11/2011to 27/11/2012 23/11/2012 to 22/11/2013 (for further details see parameter $MV_{project,y}$ above)
Measuring/ Reading/ Recording frequency:	Continuous
Calculation method (if applicable):	n/a
QA/QC procedures:	Meters subject to maintenance and in-situ calibration. Data will be kept electronically for the duration of the crediting period. Calibration of the flow meters was conducted by SGS, which is an accredited company. Accredited certificates have been made available to the DOE.
Purpose of data:	Emission reduction calculation (please refer to Section E)
Additional comment:	n/a

Data / Parameter:	**Flare working hours**
Unit:	-
Description:	Periods discounted, during which the temperature of the flare is below 500 ºC (as per the revised version of the PDD, dated 01/04/2011, and approved by the CDM EB on its 65th Meeting)
Measured/ Calculated / Default:	Measured
Source of data:	SCADA system
Value(s) of monitored parameter:	Variable throughout the monitoring period, as evidenced by flare temperature recorded in SCADA sheets provided
Monitoring equipment:	Thermocouples that monitor flare temperature, and SCADA system
Measuring/ Reading/ Recording frequency:	Temperature data, as shown on the parameter below, is continuously monitored and recorded by the SCADA system; this is then checked monthly when finalising the emission reductions calculations for the preceding month.
Calculation method (if applicable):	Working hours are deemed to be those during which the flare temperature is greater than 500ºC. Periods during which the temperature is below this level are discounted from the emission reduction calculation.
QA/QC procedures:	Meters subject to maintenance and calibration. Data will be kept electronically for the duration of the crediting period.
Purpose of data:	Emission reduction calculation (please refer to Section E)
Additional comment:	n/a

Data / Parameter:	Flare Temperature
Unit:	ºC
Description:	Gas combustion temperature within the flare
Measured/ Calculated / Default:	Measured
Source of data:	Thermocouples; used to confirm that the flare is operating at sufficient temperature to ensure methane combustion. Periods during which the temperature is below 500ºC are discounted from the emission reduction calculation
Value(s) of monitored parameter:	Variable throughout the monitoring period – recorded in SCADA sheets provided
Monitoring equipment:	1. Serial Number: WIKA TR200 46002570 Accuracy: +/- 0.75% of reading *Initial calibrations of the thermocouples are performed in the manufacturer's factory before being installed at the project site. Function is routinely checked by the monitoring contractor and items are replaced when malfunctions are noted, usually every few months, and should be replaced at least annually. The site record sheets show that replacements took place on 20/10/2012, 26/11/2012 and 04/12/2013.*
Measuring/ Reading/ Recording frequency:	Continuous
Calculation method (if applicable):	n/a
QA/QC procedures:	Thermocouples are subject to regular checks to ensure that they are operating as required or replaced if a failure is noted. Thermocouple failure results in a full shutdown of the gas extraction system and therefore no emission reductions are claimed at these times. The monitoring contractor (Envitech) receives an automated SMS to advise of thermocouple failure, and a replacement is installed as soon as is practicable (generally the same or next working day).
Purpose of data:	Emission reduction calculation (please refer to Section E)
Additional comment:	n/a

Data / Parameter:	Heat Rate (HR_y)
Unit:	kJ/kWh
Description:	Heat rate of the engine
Measured/ Calculated / Default:	Calculated every 15 minutes, aggregated to daily average and measured annually for QA purposes
Source of data:	SCADA system and manufacturer data
Value(s) of monitored parameter:	Variable throughout the period – recorded in SCADA sheets provided

Monitoring equipment:	Electricity export meter and engines manufacturer heat rate values for new engines
Measuring/ Reading/ Recording frequency:	Every 15 minutes
Calculation method (if applicable):	Calculated from electricity export meter data and engine manufacturer heat rate values for new engines. The electricity output recorded is applied to an equation drawn from the engine manufacturer heat rate data for a new engine to derive a heat rate specific to the output level recorded. 15-minute values are averaged on a daily basis for use in the calculation of emission reductions.
QA/QC procedures:	Parameter is also measured at least annually by field testing as a QA check to ensure that the values used in the emission reduction calculations are conservative. During the 5th verification period, checks have been carried out in February 2013 (SGS report). These data have been made available to the verifier and will be kept electronically for the duration of the crediting period.
Purpose of data:	Emission reduction calculation (please refer to Section E)
Additional comment:	Heat rate testing reports conducted by SGS provide two different values, depending if the data is recorded from the plant instrumentation or from manual instruments. The heat rate value relevant for the CDM project is the one calculated as a check using data recorded from plant instrumentation, which is 3.31% higher than that established by the manufacturer. This value is conservative from the CDM point of view, because the higher the heat rate, the higher the electricity consumption, and thus the lower the amount of ERs claimed from electricity generation (however it should be noted that this has not impacted on the amount of ERs claimed for this monitored period, as the Quality Assurance Method of methodology AM0010 is applied, and thus heat rate values are only used for quality assurance purposes). A value of 3.31% is also considered a reasonable value, as the engine efficiency would deteriorate with time (i.e. the higher the heat rate, the less efficient the engine is).

Data / Parameter:	**Wx**
Unit:	Tons
Description:	Amount of waste deposited
Measured/ Calculated / Default:	Measured by weighbridge when waste comes in and recorded electronically
Source of data:	Landfill site records
Value(s) of monitored parameter:	Please see FOD model spreadsheet for further details

Monitoring equipment:	Weighbridge: Masskot 4321M, consisting of two Bridges Accuracy: +/-20kg Calibration frequency: required to be every 24 months as per Trade Metrology Act Bridge 1 Cell SN: 925374 replaced by 925400 Date of calibrations during the monitored period: 23/03/2013 Validity of Calibration Certificates: 22/03/2015 Bridge 2 Cell SN: 925250 Date of calibrations during the monitored period: 13/04/2013 Validity of Calibration Certificates: 12/04/2015
Measuring/ Reading/ Recording frequency:	As waste comes in. All waste entering the site is weighed at the weighbridge and recorded daily. Daily values are aggregated monthly and yearly, and recorded on the electronic log (see excel sheet 'MH Waste 2002-2013.xls').
Calculation method (if applicable):	n/a
QA/QC procedures:	Weighbridges are calibrated as per South African Trade Metrology Act, 1973. All data will be kept electronically during the crediting period and for two years after the end of the crediting period. Calibration of the weighbridges was conducted by Mass Measuring Systems (PTY) Ltd. (trading as Masscal), which is accredited by the South African National Accreditation System (SANAS). Accreditation certificates have been made available to the DOE.
Purpose of data:	Quality assurance of baseline emissions
Additional comment:	

Data / Parameter:	**Wj,x**
Unit:	Tons
Description:	Types of waste deposited
Measured/ Calculated / Default:	Measured by weighbridge when waste comes in and recorded electronically
Source of data:	Landfill site records
Value(s) of monitored parameter:	Please FOD model spreadsheet for further details
Monitoring equipment:	Weighbridge: Masskot 4321M, consisting of two Bridges Accuracy: +/-20kg Calibration frequency: required to be every 24 months as per Trade Metrology Act Bridge 1 Cell SN: 925374 replaced by 925400 Date of calibrations during the monitored period: 23/03/2013 Validity of Calibration Certificates: 22/03/2015 Bridge 2

	Cell SN: 925250 Date of calibrations during the monitored period: 13/04/2013 Validity of Calibration Certificates: 12/04/2015
Measuring/ Reading/ Recording frequency:	As waste comes in. All types of waste entering the site are weighed at the weighbridge and recorded daily. Daily values are aggregated monthly and yearly, and recorded on the electronic log (see excel sheet 'MH Waste 2002-2013.xls').
Calculation method (if applicable):	n/a
QA/QC procedures:	Weighbridges are calibrated as per South African Trade Metrology Act, 1973. All data will be kept electronically during the crediting period and for two years after the end of the crediting period. Calibration of the weighbridges was conducted by Mass Measuring Systems (PTY) Ltd. (trading as Masscal), which is accredited by the South African National Accreditation System (SANAS). Accreditation certificates have been made available to the DOE.
Purpose of data:	Quality assurance of baseline emissions
Additional comment:	n/a

Data / Parameter:	**Pj,x**
Unit:	%
Description:	Waste composition in the year
Measured/ Calculated / Default:	Calculated based on parameters Wx and Wj,x and used as input data to the FOD spreadsheet model
Source of data:	Landfill site records
Value(s) of monitored parameter:	Based on the monitored data for 2002 – 2013. **Waste Composition (%)** / **Average** Pulp, paper, Cardboard (other than Sludge) 0.00% Textiles 0.00% Food and Food Waste, beverages and tobacco (other than sludge) 56.12% Garden, Yard and Park Waste 5.52% Wood & Wood Products 0.00% Other Inert Waste 38.36% Please see FOD model for further details
Monitoring equipment:	n/a
Measuring/ Reading/ Recording frequency:	As waste comes in
Calculation method (if applicable):	n/a
QA/QC procedures:	
Purpose of data:	Quality assurance of baseline emissions

Additional comment:	n/a

D.3. Implementation of sampling plan

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Not applicable – sampling approach is not applied.

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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As per methodology AM0010 and registered PDD, the baseline scenario in this case is defined as "the actions that need to be implemented to meet the regulation governing the allowed methane concentration, as well as good management practice to address safety and odour concerns."

At Mariannhill, baseline emissions ($MV_{baseline,v}$) are those attributable to the six pre-existing gas extraction wells. Flow meters are used to identify the contribution of these baseline wells to the overall volume of gas collected, to ensure that such contributions are deducted from the emission reductions claim. These values are presented in the summary data included as file reference 'ER Summary - 5th MR'.

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

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Project emissions comprise the consumption of electricity which powers the gas extraction and treatment infrastructure.

To ensure that this is accounted for within the calculation of emission reductions, separate meters are installed to record the amount of electricity imported and exported from the site. The difference between the amount imported and the amount exported (ES_y) is used in the calculation of emission reductions from displaced grid electricity. These values are presented in the summary data included as file reference 'ER Summary - 5th MR'.

E.3. Calculation of leakage

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As stated in the PDD, as there will be no increase in emissions outside of the project boundary, leakage is considered to be zero.

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

As per the methodology AM0010 and the PDD, the greenhouse gas emission reductions achieved by the project activity during a given year (ER_y) is the difference between the amount of methane actually destroyed/combusted during the year ($MD_{project,y}$) and the amount of methane that would have been destroyed/combusted during the year in the absence of the project activity ($MD_{baseline,y}$), times the approved Global Warming Potential value for methane (GWP_CH_4) plus the quantity of electricity sold to the grid during the year (ES_y) multiplied by the CO_2 emissions intensity of the electricity displaced ($EI_{grid,y}$).

$$ER_y = (MD_{project,y} - MD_{baseline,y}) \times GWP\_CH_4 + ES_y \times EI_{grid,y}$$

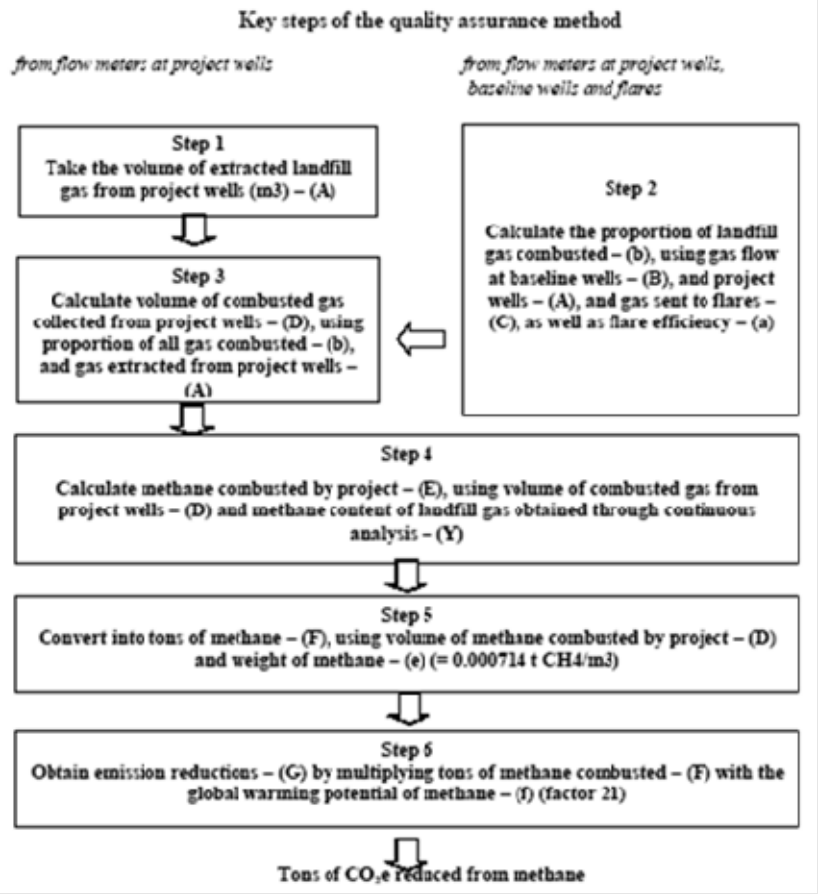
ER_y is measured in tons of CO_2 equivalents (tCO_2e). $MD_{project,y}$ and $MD_{baseline,y}$ are measured in tons of methane (tCH_4). The approved Global Warming Potential value for methane (GWP_CH_4) for the first commitment period is $21tCO_2e/tCH_4$. ES_y is measured in megawatt hours (MWh). The CO_2 emissions intensity, $EI_{grid,y}$, is measured in tons of CO_2 equivalents per megawatt hour (tCO_2e/MWh).

The Monitoring Plan provides for the calculation of emission reductions from avoided methane emissions and from displaced grid electricity. To calculate these emission reductions, the grid emission factor (from the standardized baseline tool) is multiplied by the metered electricity delivered to the grid.

Using the formulae prescribed by AM0010, the total emission reductions have been calculated. The data required to complete the calculations are collected as described in the PDD by either the Primary Method (PM) or the Quality Assurance Method (QA). The PM is based on downstream metering wherever possible, i.e. meters are placed as closely as possible to the location of combustion of methane gas or measure minor

quantities thus avoiding sources of error. The QA method relies on up-stream metering and continuous analysis of the methane content in landfill gas. This method is used as a backup and for quality control purposes, in the event that engines are not operating. However after careful prior review of the methodology, given that the quality assurance method is based on the continuous monitoring of the gas and its methane content, and methodology AM0010 does not provide formulae for calculating methane destroyed based on electricity generated, in order to be fully compliant with the methodology, the QA Method has been consistently applied in the calculation for emission reductions by the project activity.

The QA method uses the monthly aggregates of the following three metered variables: Volume of landfill gas flared, volume of gas extracted from baseline wells, and volume of gas sent to the engines (all in Nm^3). The method also uses continuous analysis of the methane content in landfill gas. The method first calculates the proportion of LFG combusted using the above gas flow information together with the flare efficiency (Step 2). In Step 3, this proportion is used to derive the volume of combusted gas that is collected from project wells. Step 4 calculates the volume of methane combusted from the volume of combusted gas using continuous measurement of the methane content in LFG. Step 5 and 6 complete the calculation of emission reductions (CO_2equiv) by converting methane volume into tons of methane and multiplication with the global warming potential. Each of the steps is presented in graphical format below.



Item	Baseline emissions or baseline net GHG removals by sinks (t CO_2e)	Project emissions or actual net GHG removals by sinks (t CO_2e)	Leakage (t CO_2e)	Emission reductions or net anthropogenic GHG removals by sinks (t CO_2e)
Total	-	-	-	33,851

** It should be noted that methodology AM0010 does not allow for separate calculation of baseline emissions, project emissions and leakage.*

In addition, in line with paragraph 35 (a) of the EB65 Meeting Report, the calculation of theoretical methane emissions using the first order decay model has been conducted to confirm the proposed approach for the parameter $MV_{project,y}$ "amount of landfill gas collected from the project wells". The results are the following:

- Theoretical CH_4 generated as per FOD model: 5,926 tCH_4*
- Theoretical CH_4 collected as per FOD model: 2,963 tCH_4*
- Monitored CH_4 from calculated $MV_{project,y}$ parameter, based on monitored data: 1,143 tCH_4

**The values have been calculated by prorating the FOD model yearly values by the number of days to match this monitored period (01/10/2012 to 14/12/2013).*

Hence parameter $MV_{project,y}$ is deemed a conservative value as compared to the theoretical methane generation and collection estimate from the FOD model.

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

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_2e)	53,760 t CO_2e	33,851 t CO_2e

**The PDD value been calculated by prorating the PDD yearly values by the number of days to match this monitored period (01/10/2012 to 14/12/2013).*

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

The actual emission reductions achieved during the monitoring period were lower than predicted in the registered PDD. This is mainly due to the conservative adjustments made to the ER calculations in order to account for inconsistencies in the accuracy values.

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
Emission reductions or GHG removals by sinks (t CO_2e)	6,858	26,993

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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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