MONITORING REPORT FORM (CDM-MR) *
Version 01 - in effect as of: 28/09/2010

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* as contained within the document entitled "Guidelines for completing the monitoring report form (CDM-MR)" (EB 54 meeting report, annex 34).

MONITORING REPORT
Version 0, 23/02/2012

DURBAN LANDFILL GAS TO ELECTRICITY PROJECT – MARIANNHILL AND LA MERCY LANDFILLS
Reference Number 0545
1st Monitoring Period (15/12/2006 - 01/11/2007)

SECTION A. General description of the project activity

A.1. Brief description of the project activity: >>

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 tonnes 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 tonnes of waste in total.

Both sites incorporate typical landfill gas collection and treatment infrastructure including extraction wells, pipework, engines for generation of electricity, flares 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.

The project was registered on December 15th 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 first Monitoring Period (15/12/2006 - 01/11/2007) is 24,129 tCO_2e.

A.2. Project Participants

The Project Participants as indicated by the project information on the UNFCCC website are:

- **Republic of South Africa:** Durban Solid Waste (DSW) as project developer and operator; eThekwini municipality as project sponsor;
- International Bank for Reconstruction and Development as the Trustee of the Prototype Carbon Fund (PCF);
- **Netherlands:** Netherlands' Ministry of Infrastructure and the Environment (IenM); Electrabel S.A.; Netherlands' Ministry of Economic Affairs, Agriculture and Innovation (EL&I);
- **Canada:** Government of Canada – Ministry of Foreign Affairs & International Trade;
- **Finland:** Government of Finland - Ministry of Foreign Affairs of Finland; Fortum Corporation
- **Japan**: Chubu Electric Power Co., Inc; The Chugoku Electric Power Co., Inc.; Kyushu Electric Power Co., Inc.; Mitsubishi Corporation; MIT Carbon Fund Co., Ltd.; 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**: Government 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;
- **Sweden**: Government of Sweden - Swedish Energy Agency;
- **Germany**: RWE Power AG;
- **France**: GDF SUEZ.

A.3. Location of the project activity:

The project is located within the KwaZulu Natal region of South Africa. The La Mercy site is situated 35 km north of Durban, away from residential areas. 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

The La Mercy site is located at latitude: -29.621944, Longitude: 31.134167

A.4. Technical description of the project

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 and La Mercy landfill sites. DSW functions as the technical advisor and operator of the project.

Specifically, the following technology has been installed:

- *Extraction wells*: Over time some 51 gas wells (33 on Mariannhill and 18 on La Mercy) 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 engines or the flare units. 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 units:* A landfill gas flare with minimum capacity of 1,000Nm^3/hr has been installed at each site.
- *Landfill gas generators*: A single 1MW unit has been installed at Mariannhill, which can be turned down to as low as 50% capacity (Jenbacher type 320 engine). At La Mercy, a single 0.5MW unit has been installed (Jenbacher 312 engine); and
- *Switch gears, transformers and cabling:* have been installed as needed for interconnection with the eThekwini Electricity grid.

The systems are also equipped with condensate knockout pots in order to keep pipework clear of liquids which form due to changes in temperature. All engines and flaring equipment are housed in purpose built compounds to ensure no unauthorised access and maintain high standards of health and safety. Engines are installed within acoustic housings 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, both sites are 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 flares and engines.

A.5. Title, reference and version of the baseline and monitoring methodology applied to the project activity:

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"

A.6. Registration date of the project activity:

15/12/2006

A.7. Crediting period of the project activity and related information (start date and choice of crediting period):

Start date on 15/12/2006 with 7-year crediting period, twice renewable to a total of 21 years.

A.8. Name of responsible person(s)/entity(ies):

This first Monitoring Report has been prepared by:

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SECTION B. Implementation of the project activity

B.1. Implementation status of the project activity

Status of Implementation

At both sites, 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 systems began at each site on 1st February 2006. The gas combustion equipment was commissioned in November 2006 and the first monitoring period commenced on December 15th 2006.

The project implemented a new landfill gas management system at the La Mercy site and a substantial upgrade of a previously existing, small collection system at Mariannhill which comprised six gas collection wells installed as a pilot activity (and now therefore considered as baseline wells for the CDM project activity).

The gas utilisation system at Mariannhill 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.

Three phases of the site have been landfilled:

- Phase 1(restored) which contains baseline wells 1 to 6 and CDM well No. 1;
- Phase 2 (partially capped) which contains CDM wells 2 to 11 and 9 side risers; and
- Phase 3, the active landfill area.

DSW have decided to fill Phase 3 in two halves, to allow temporary restoration and early gas extraction from the first half, whilst the second half is being filled.

The gas management system comprises:

- six baseline wells 1 to 6 in the older, fully restored first phase of the landfill;
- a single new CDM well No. 1 in the first phase;
- six CDM wells No. 2 to 7 in the partially completed second phase of the landfill;
- four CDM wells No. 8 to 11 in the temporarily capped second phase of the landfill;
- nine CDM gas riser pipes around the temporarily capped second phase of the landfill;
- a header main from the gas extraction compound which divides into;
- a main to wells No. 2 to 7; and
- a second main which connects to:
    - baseline wells 1 to 6;
    - gas well No. 1;
    - gas wells No. 8 to 11; and
    - nine gas riser pipes.

The pipe from baseline wells 1-6 has an isolating valve and flow meter. The quality of gas and flow rate is monitored at the isolating valve to allow calculation of the cumulative methane combusted from the baseline wells. This proportion of the gas is deducted from the total figures when calculating emissions reductions.

All of the wells, except 8 to 11, are of the Hofstetter through flow design. Wells 8 to 11 are of the take off flow design, each with a well head and connector pipe contained within a well chamber.

The extraction compound contains:

- a 1000m³/hr Organics extraction blower and flare (with a 5:1 turndown ratio);

- a 1MW Jenbacher engine (with a 50% turndown capability); and
- a control building and office.

There is a Supervisory Control & Data Acquisition (SCADA) system to automatically record the operation of the plant and the emission reductions (ERs). The gas management system is automated and can be remotely accessed.

La Mercy Landfill is now closed and has been restored. The site has been capped, restored (with addition of surface water runoff controls) and hydroseeded. Vegetation is generally well established and limits surface water ingress into the waste.

18 gas extraction wells have been constructed through the Berea Red Sand capping material. CDM wells No. 1 to 6 are constructed in the older southern area of the site, and CDM wells No. 7 to 14 are constructed in the more recently filled northern area. A further four CDM wells, No. 15 to 18 have subsequently been constructed in the northern area to try to increase the gas yield.

The pipework comprises a header main along the eastern boundary with 7 spur mains, each connected to between 1 and 3 wells. All wells are Hofstetter through flow design and there are no isolating valves on the spur mains.

The gas management compound contains:

- a 1,000m³/hr Organics extraction blower and flare (with a 5:1 turndown ratio);
- a 500kW Jenbacher engine (with a 50% turndown capability); and
- a control building and office.

As with Mariannhill, there is a SCADA system which automatically monitors and controls the extraction and utilisation equipment.

Operation of the Activity

Events or situations that occurred during the monitoring period

Mariannhill

Operational difficulties were experienced with the landfill gas engine throughout the monitoring period, as explained below:

- Tripping due to the network voltage rising above the limit of 440V. This is understood to be a result of the local network voltage, and GE Jenbacher (GEJ) recommended that the cos phi factor be changed to 0.98 to control the voltage within limit. GEJ's local representatives carried this out, and this problem has not occurred since;
- Initially, extensive engine/generator trips were experienced due to the selected vector group of the transformer causing the protection systems to be activated by remote network faults. In conjunction with eThekwini Electricity, it was determined that the installation of Neutral Earthing Resistors (NER's) would be required to solve the problem. Since these were installed, no further problems with remote network faults have been experienced; and
- The only other noteworthy operational problem with the engine has been related to alarm 1105 (speed of mixture temperature change maximum), resulting in frequent shut-downs over the last few months. GEJ has stated that this is most likely caused by backfiring. Site tests carried out by Organics, based on controlling the gas delivery conditions to the engine, confirmed that this fault is not a gas delivery related issue (fuel quality, flow and pressure). A borescope examination of the cylinders was carried out under the auspices of GEJ's local representatives (Agaricus Trading) on 30th October 2007, and it appears that flaky deposits have formed within the cylinders and on the spark plugs. This information will be sent to GEJ for review and recommendations will

subsequently be provided. It is possible that some sort of silica filtering system will be required for the fuel gas delivery to the engine.

Numerous other short term shutdowns have been recorded throughout the monitoring period, largely as a result of either power outages or 'load shedding' by the operator of the electrical grid system. During such events, no emission reductions are claimed as the data capture systems cannot operate.

All individual events that differ from normal practice are recorded by the monitoring contractor within the monthly SCADA workbooks.

La Mercy

At the La Mercy site, problems arose very early on in the project in terms of the ability to extract gas from the site. The engine unit was unable to operate effectively and even achieving sustained operation of the flare proved to be problematic.

An investigation was carried out by SLR Consulting in 2007, which confirmed that the site suffers from high levels of leachate as well as the presence of significant quantities of fine Red Berea Sand, leading to the blockage of gas extraction wells and thus preventing the engine and flare from operating effectively.

To efficiently operate the engine, a typical gas flow of 300Nm^3/h would be needed; to operate at half load (250kW) the Jenbacher 500kW engine requires approximately 190Nm^3/hr at 50% methane, but insufficient gas was extracted to allow the engine to operate continuously following commissioning. Initial commissioning was probably assisted by the reservoir of gas within the site which had not previously been drawn down. Extracted landfill gas is therefore now flared. Due to this situation the engine at La Mercy only ran during December 2006 and March 2007, therefore all other months will have no CER claim from electricity production.

The flaring system has an installed capacity of 1,000Nm^3/h with a turn down ratio of 5:1, resulting in a minimum required flow rate of 200Nm^3/h.

B.2. Revision of the monitoring plan

A Request for Revision of the Monitoring Plan was submitted to the UNFCCC on July 1st 2011, in order to bring the details of the Monitoring Plan into alignment with operational practice on site, while ensuring the level of accuracy and completeness in the monitoring and verification process is not reduced as a result of the revision. The request was approved by the Meth Panel on its 53rd meeting, and by the CDM EB on its 65th meeting on 25/11/2011, with corrections.

However this submission was made long after the first monitored period was completed, hence out of the scope of this monitored period, but in fact some of the changes were made in order to attend the comments of the CDM EB regarding the accepted request for deviation for the first monitored period submitted in 2007 as described in section B.3 below.

B.3. Request for deviation applied to this monitoring period

A first Request for Deviation from the registered PDD was made in March 2007[1], which got the approval on July 2007 from the CDM EB on two observed deviations from the registered document, namely:

[1] This request was submitted by the first verifying DOE: JCI. For complete details please refer to the website at http://cdm.unfccc.int/Projects/deviations/96737

- Use of an alternative method to calculate of the amount of landfill gas collected from project wells at the Mariannhill site due to the absence of a flow meter specifically recording flow from such wells; and
- Consideration of the electricity used by the project equipment at both sites, which is supplied by the grid, in evaluating net electricity exports

B.4. Notification or request of approval of changes

A Notification of Changes to the PDD was submitted to the UNFCCC on July 1st 2011 to address the decommissioning of the La Mercy site which took place in June 2009. This hence falls out of the scope of this first monitoring period.

SECTION C. Description of the monitoring system

The monitoring system for each site is based on the requirements specified by methodology AM0010, and recommendations from the CDM EB. 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.

The instruments which are employed in the monitoring of each site are presented in the following tables.

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	Due date
	Fixed Instrumentation used to measure Parameters											
1	Temperature Transmitter	WIKA	TR200	46002570	0 to 100 °C	0.7% of full scale	gas temperature	N	n/a			replace as req.
2	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.
3	Pressure Transmitter	GE Sensing - Druck	PTX 7900-3399	2345399	0 to 250mb	+/- 0.25% full scale	Delivery Pressure	N	n/a			replace as req.
5	Pressure Gauge	Dresser Ashcroft	N5500	n/a	-250 to 0 mbar	1.6% of full scale	Suction Pressure	N	n/a			replace as req.
6	Pressure Gauge	Dresser Ashcroft	N5500	n/a	0 to 250mb	1.6% of full scale	Delivery Pressure	N	n/a			replace as req.
7	Thermal Mass Flow Meter	Kurz Instruments	Series 454FT	FD20272A	0-18000SFPM	+/- 0.75% of Rate	Flare Flow	Y	annual[1]	11/10/2006		see footnote 1
8	Thermal Mass Flow Meter	Kurz Instruments	Series 454FT	FD20273A	0-18000SFPM	+/- 0.75% of Rate	Engine Flow	Y	annual[1]	11/10/2006		see footnote 1
9	Thermal Mass Flow Meter	Kurz Instruments	Series 454FT	FD20271A	0-18000SFPM	+/- 0.75% of Rate	Baseline Flow	Y	annual[1]	11/10/2006		see footnote 1
10	Stationary Gas Monitor - Methane	Madur	MaMoS-200 NDIR CH4	6051064	0 to 100%	+/- 2% of reading	CH4	Y	annual	29/05/2006		28/05/2007
11	Stationary Gas Monitor - CO2	Madur	MaMoS-200 NDIR CO2	6041058	0 to 50%	+/- 3% of reading	CO2	N	annual	15/05/2006		14/05/2007
12	Oxygen Analyzer	City Technology	T70X	12150830048	0 to 25%	+/- 0.5%	O2	N	n/a			replace as req.
13	Atmospheric Pressure Sensor	GE Sensing - Druck	PTX1400		800 to 1200mb	0.15%	Atmospheric Pressure	N	n/a			replace as req.
14	3 Phase 3 Wire Meter	Landis + Gyr	7013591M	62439251	0 to 5A	0.10%	11000V Meter Export check	Y	10 yrs[3]			
15	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
16	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											
17	Hand Held Gas Analyzer	Geotechnical Instruments	GA2000	GA08915	0 to 60% CH4	3% CH4.CO2 and 1% O2	CH4. CO2. O2		annual[4]	17/10/2006	10/07/2007	09/07/2008

[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 II 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 unit is calibrated by the manufacturer on an annual basis and is also checked at least monthly by the monitoring contractor against certified calibration gas.

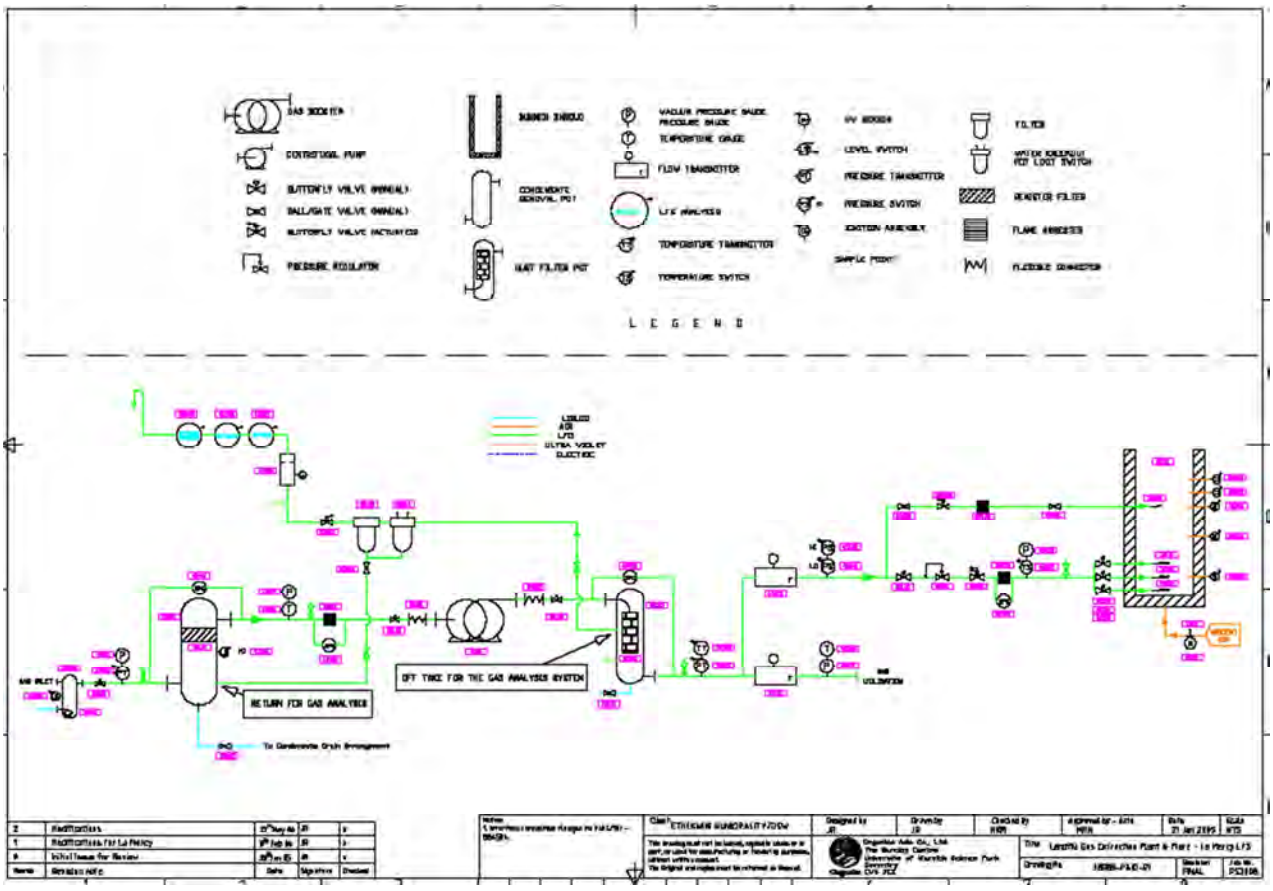
INSTRUMENTATION LIST: LA MERCY

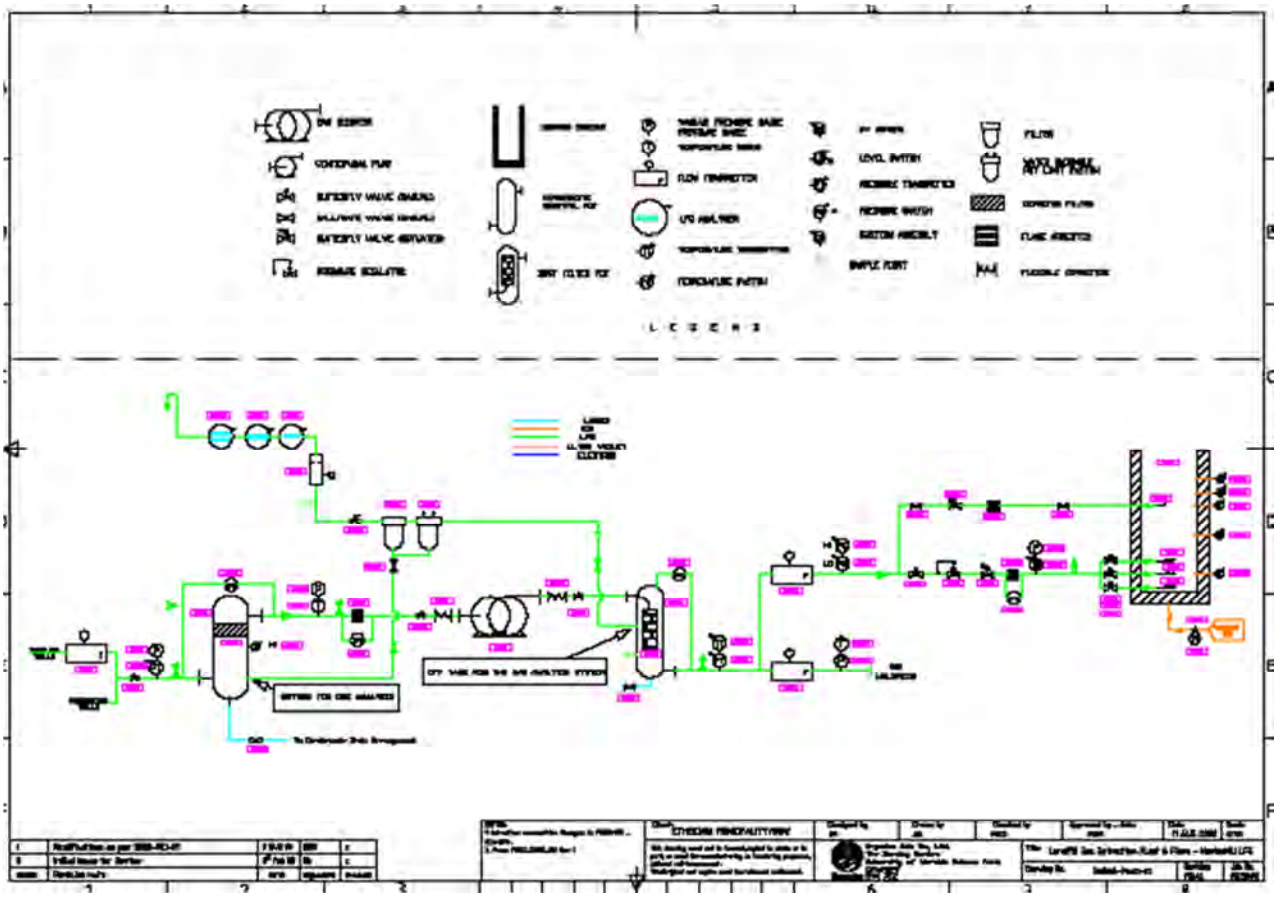
	Instrument Name/Description	Manufacturer/Supplier	Model	Type / SN	Range	Accuracy	Used to measure:	Used in Calculation?	Calibration requirement	Factory Calibrated	Factory Calibrated	Due date
	Fixed Instrumentation used to measure Parameters											
1	Temperature Transmitter	WIKA	TR200	46002570	0 to 100 °C	0.7% of full scale	Flare Temperature x2	N	n/a			n/a
2	Pressure Gauge	Dresser Ashcroft	N5500	n/a	-25 to +50 °C	1.6% of full scale	Suction Pressure	N	n/a			n/a
3	Pressure Gauge	Dresser Ashcroft	N5500	n/a	-25 to +50 °C	1.6% of full scale	Delivery Pressure	N	n/a			n/a
4	Thermal Mass Flow Meter	Kurz Instruments	Series 454FT	FD13164A	0-18000SFPM	+/- 0.75% of Rate	Flare Flow	Y	annual	18/05/2006		17/05/2007
5	Thermal Mass Flow Meter	Kurz Instruments	Series 454FT	FD13165A	0-18000SFPM	+/- 0.75% of Rate	Engine Flow	Y	annual	18/05/2006		17/05/2007
6	Stationary Gas Monitor - Methane*	Edinburgh Instruments	Gascard II	25747	0 to 100%	2%	CH4	Y	annual	17/09/2007		16/09/2008
7	Stationary Gas Monitor - CO2*	Edinburgh Instruments	Gascard II	25695	0 to 100%	2%	CO2	N	annual	02/10/2007		01/10/2008
8	Stationary Gas Monitor - Methane*	Madur	MaMoS-200 NDIR CH4	6041062	0 to 100%	+/- 2% of reading	CH4	Y	annual	15/05/2006		14/05/2007
9	Stationary Gas Monitor - CO2*	Madur	MaMoS-200 NDIR CO2	6031030	0 to 50%	+/- 3% of reading	CO2	N	annual	04/04/2006		03/04/2007
10	Oxygen Analyzer	City Technology	T70X	11077314117	0 to 25%	+/- 0.5%	O2	N	n/a			n/a
11	Atmospheric Pressure Sensor	GE Sensing	PTX1400	n/a	800 to 1200mb	0.15%	Atmospheric Pressure	N	n/a			n/a
12	3 Phase 3 Wire Meter	Landis + Gyr	7005405M	63705634	0 to 5A	0.10%	11000V Meter Export check	Y	10 yrs			n/a
13	3 Phase 4 Wire Meter	Landis + Gyr	Dialog	86342183	0 to 5A	0.10%	11000V Meter Export kW	Y	10 yrs	22/03/2006		21/03/2016
14	3 Phase 4 Wire Meter	Landis + Gyr	Dialog	85066159	0 to 120A	0.10%	400V Meter Import kW	Y	10 yrs	26/08/2005		25/08/2015
	Hand Held Instrumentation											
15	Hand Held Gas Analyzer	Geotechnical Instruments	GA2000	GA08915	0 to 40 °C	3% CH4,CO2 and 1% O2	CH4, CO2, O2		annual	17/10/2006	10/07/2007	09/07/2008

* During the 1st Verification period, the CH4 & CO2 stationary gas monitors at La Mercy started working intermittently, until failing completely. Unfortunately no replacement agreement could be reached with the supplier - Madur, to the extent that a new supplier - Edinburgh Instruments - was sourced and the La Mercy gas monitors replaced during the 1st verification period (17/10/2007).

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.

Both sites were equipped with Supervisory Control and Data Acquisition (SCADA) systems to capture all relevant performance data and maintain a database from which monthly summary reports can be easily extracted. The systems operate continuously and record data points at 15 minute intervals. Process and Instrumentation Diagrams for each site are presented 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 ERs calculation. 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 a month's data. 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'* which is presented in Annex 1 to this report.

On a monthly basis the data are downloaded from each of the computerised SCADA systems. The download, in the form of a CD or memory stick, is reviewed by the CDM Manager and kept in the CDM Project Manager's office as a 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"* which is presented in full as Annex 2.

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 and Flare Maintenance – Agaricus Trading
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.

SECTION D. Data and parameters

D.1. Data and parameters determined at registration and not monitored during the monitoring period, including default values and factors

Data / Parameter:	Methane Density
Data unit:	t CH_4/m^3CH_4
Description:	Density of methane at standard temperature and pressure (0 degrees Celsius and 1,013 bar)
Source of data used:	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 pounds 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) :	0.0007143
Indicate what the data are used for (Baseline/ Project/ Leakage emission	Conversion of volume of gas collected to mass

calculations)	
Additional comment:	n/a

Data / Parameter:	GWP_{CH4}
Data unit:	tonnes CO_2e / tonnes CH_4
Description:	Global Warming Potential value for methane
Source of data used:	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) :	21
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Conversion of emission reductions to carbon dioxide equivalent
Additional comment:	n/a

Data / Parameter:	Calorific Value of Methane
Data unit:	GJ/Nm^3
Description:	Energy content of the methane combusted
Source of data used:	PDD
Value(s) :	0.037
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Conversion of volume of gas collected to mass
Additional comment:	n/a

D.2. Data and parameters monitored

Data / Parameter:	Eskom Grid Emission Factor ($EI_{grid,y}$)
Data unit:	tCO_2/kWh
Description:	Emission factor of the South African grid system
Measured /Calculated /Default:	Default value published annually by Eskom
Source of data:	Published Eskom Annual reports, available on their website www.eskom.co.za
Value(s) of monitored parameter:	0.000958 from December 2006 – October 2007[2]
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Emission reductions from displacement of power generated by the South African grid system (please refer to section E below)
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	n/a
Measuring/ Reading/ Recording frequency:	Data are updated prior to submission to the DOE to ensure that the most appropriate factor is applied for each time period.
Calculation method (if applicable):	n/a
QA/QC procedures applied:	n/a

[2] Eskom 2007 Annual Report, page 189; Calculated using data from 01/04/2006 to 31/03/ 2007; found online at http://financialresults.co.za/2007/eskomar2007_fin/downloads/eskom_ar2007.pdf

Data / Parameter:	Regulatory requirements relating to landfill gas projects
Data unit:	n/a
Description:	Applicable laws and regulation concerning the capture and combustion of landfill gas
Measured /Calculated /Default:	Measured
Source of data:	eThekwini Municipality legal advisors for the CDM project
Value(s) of monitored parameter:	No specific requirements have been put in place during the monitoring period
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emissions assessment
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	n/a
Measuring/ Reading/ Recording frequency:	Annual check for updates
Calculation method (if applicable):	n/a
QA/QC procedures applied:	n/a

Data / Parameter:	$MV_{baseline,y}$
Data unit:	m^3
Description:	Gas collected from baseline wells (Mariannhill only)
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
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Emission reduction calculations (please refer to section E below)
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Serial Number: Kurz Instruments FD20271A Accuracy: +/-0.75% Calibration frequency: recommended annual re-certification and/or in-situ calibration Date of first calibration (factory, before installed): 11/10/2006 Date of last calibration with a reported error: 13/05/2011 Maximum error reported: 4.46% Validity of Calibration Certificate: From 11/10/2006 to 10/10/2007 *The mass flow meter installed for the baseline wells with serial number (S/N) FD20271A, had been previously calibrated by its factory (before being installed) on 11/10/2006. The equipment provider confirmed that the suggested calibration period was on a 12 month basis, even though re-test at this frequency is not mandatory. The equipment had therefore a valid calibration up to 10/10/2007. Due to delayed calibration the meter continued to be operated until 28/02/2009, when the flow meter was subject to an electrical storm which caused an instrument failure. The non-conformity was picked up on 02/03/2009, and the instrument was re-calibrated on*

	22/06/2009 and then replaced. *Therefore, between 11/10/2007 and the end of this monitored period 01/11/2007 due to unclear guidance from the technology provider there was no calibration. It only happened later on 22/06/2009 when the equipment was confirmed to be calibrated according to the manufacturer's specifications, but the calibration certificate does not indicate the % error for the calibrated equipment.* *To account for this lack of information, the most conservative approach was applied by using the guidance from the CDM EB from Annex 60EB52 – "Guidelines for Assessing Compliance with Calibration Frequency Requirement", and treating this period (October 2007) as a period of missed calibration up to the next calibration undertaken on 13/05/2010, where a maximum error of 4.46% was identified for the baseline flow meter. The data collected by this equipment during this monitored period has been adjusted by the maximum value of the uncertainty of the instruments, ultimately reducing the amount of Emission Reductions claimed. This is explained in more detail in Section E.4.*
Measuring/ Reading/ Recording frequency:	Continuous
Calculation method (if applicable):	n/a
QA/QC procedures applied:	Meters subject to maintenance and in-situ calibration. Data will be kept electronically for the duration of the crediting period.

Data / Parameter:	$MV_{project,y}$
Data unit:	m^3
Description:	Gas collected from project wells
Measured /Calculated /Default:	Measured (La Mercy) and calculated (Mariannhill)
Source of data:	Flow meters installed on site (2 at La Mercy, 3 at Mariannhill)
Value(s) of monitored parameter:	Variable throughout the monitoring period – recorded in SCADA sheets provided
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Emission reduction calculations (please refer to section E below)
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	At La Mercy 1. Serial Number: Kurz Instruments FD13164A (flare flow) Accuracy: +/-0.75% of rate Calibration frequency: recommended annual re-certification and/or in-situ calibration Date of last calibration: 18/05/2006 Maximum error applied: -2.92% Validity of Calibration Certificate: from 18/05/2006 to 17/05/2007 2. Serial Number: Kurz Instruments FD13165A (engine flow) Accuracy: +/-0.75% of rate Calibration frequency: recommended annual re-certification and/or in-situ calibration Date of last calibration: 18/05/2006 Maximum error applied: -1.31% Validity of Calibration Certificate: from 18/05/2006 to 17/05/2007

	The mass flow meters installed at La Mercy (S/N) FD13164A and FD13165A, had been previously calibrated by its factory before being installed on 18/05/2006. The equipment provider confirmed that the suggested calibration period was on a 12 month basis, even though re-test at this frequency is not mandatory. The equipment had therefore a valid calibration up to 17/05/2007. *Due to misinformation from the supplier there was no subsequent calibration of the equipment at the site, as the equipment did not show any malfunction or issue during this period. Given that the site was decommissioned there was no possibility of conducting a delayed calibration. Hence to account for this, in the most conservative way possible the guidance from the CDM EB from Annex 60EB52 – "Guidelines for Assessing Compliance with Calibration Frequency Requirement", was applied, under the assumption that the monitoring equipment was performing exactly the same as the equipment installed at the Mariannhill site; this assumption is based on the fact that these pieces of equipment were bought at the same time from the same supplier, have been run by the same PE, and have therefore had the same maintenance procedures.* *Applying the values from the subsequent calibration at the Mariannhill site (13/05/2010), we have that a maximum error of 1.31% was applied to the engine flow meter, and a maximum error of 2.92% was applied for the flare flow meter. The data collected by these two pieces of equipment during this monitored period (May – October 2007 inclusive) has been reduced by the maximum value of the uncertainty of the instruments (-1.31%, and -2.92% respectively), ultimately reducing the amount of Emission Reductions claimed. This is explained in more detail in Section E.4.* At Mariannhill 1. Serial Number: Kurz Instruments FD20272A (flare flow) Accuracy: +/-0.75% of rate Calibration frequency: recommended annual re-certification and/or in-situ calibration Date of last calibration: 11/10/2006 Date of last calibration with a reported error: 13/05/2011 Maximum error reported: 2.92% Validity of Calibration Certificate: from 11/10/2006 to 10/10/2007 2. Serial Number: Kurz Instruments FD20273A (engine flow) Accuracy: +/-0.75% of rate Calibration frequency: recommended annual re-certification and/or in-situ calibration Date of last calibration: 11/10/2006 Date of last calibration with a reported error: 13/05/2011 Maximum error reported: 1.31% Validity of Calibration Certificate: 11/10/2006 to 11/10/2007 3. Serial Number: Kurz Instruments FD20271A (baseline flow) Accuracy: +/-0.75% of rate Calibration frequency: recommended annual re-certification and/or in-situ calibration Date of first calibration (factory, before installed): 11/10/2006 Date of last calibration with a reported error: 13/05/2011 Maximum error reported: 4.46%

	Validity of Calibration Certificate: From 11/10/2006 to 10/10/2007 (for further details see parameter $MV_{baseline,y}$ above) *The mass flow meters installed at Mariannhill (S/N) FD20272A and FD20273A, had been previously calibrated by its factory before being installed on 11/10/2006. The equipment provider confirmed that the suggested calibration period was on a 12 month basis, even though re-test at this frequency is not mandatory. The equipment had therefore a valid calibration up to 10/10/2007.* *To account for this, the most conservative approach was applied to the missed calibration (October 2007) using the guidance from the CDM EB from Annex 60EB52 – "Guidelines for Assessing Compliance with Calibration Frequency Requirement", and treating this as a period of missed calibration. The data collected by these three pieces of equipment during this monitored period (October 2007) has been reduced by the maximum value of the uncertainty of the instrument (-2.92%, -1.3%1 and 4.46% respectively), ultimately reducing the amount of Emission Reductions claimed. This is explained in more detail in Section E.4.*
Measuring/ Reading/ Recording frequency:	Continuous
Calculation method (if applicable):	For Mariannhill, 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 applied:	Meters subject to maintenance and in-situ calibration. Data will be kept electronically for the duration of the crediting period.

Data / Parameter:	Methane Content
Data 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
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Emission reduction calculations (please refer to section E below)
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Stationary Gas Monitor At La Mercy 1. Used by the project activity: From 15/05/2006 to 17/09/2007 Model: Madur, MaMoS-200 NDIR CH_4 Serial Number: 06051062 Accuracy: +/- 2% of range Calibration frequency: annual Date of last calibration: 15/05/2006 Validity of Calibration Certificate: from 15/05/2006 to 14/05/2007 2. Used by the project activity: From 17/10/2007 to 01/11/2007 Serial Number: Edinburgh Instruments Gascard II 25747 Accuracy: +/- 2% of range Calibration frequency: calibration check at least annually Date of last calibration: 17/09/2007

	Validity of Calibration Certificate: from 17/09/2007 to 16/09/2008 *Due to the change in equipment there has been a missed calibration (5 months) between the end of the calibration certificate of the Madur gas monitor on 14/05/2007, and the start of the replacement Edinburgh equipment in 17/09/2007. To account for this the most conservative approach was applied, using the guidance from the CDM EB from Annex 60EB52 – "Guidelines for Assessing Compliance with Calibration Frequency Requirement", and treating this as a period of missed calibration. The data collected by the stationary gas monitor during this period (15/05/2007 – 16/09/2007) has been reduced by the maximum value of the uncertainty of the instrument (2.0%), ultimately reducing the amount of Emission Reductions claimed. This is explained in more detail in Section E.4.* At Mariannhill 1. Model: Madur, MaMoS-200 NDIR CH_4 Serial Number: 06051064 Accuracy: +/- 2% of range Calibration frequency: annual Date of last calibration: 29/05/2006 Validity of Calibration Certificates: from 29/05/2006 to 28/05/2007 Handheld Instrument (GA2000) 1. Serial Number: GA08915 Accuracy: +/-3% of methane content Calibration frequency: annual Date of calibrations: 17/10/2006 and 10/07/2007 Validity of Calibration Certificate: valid throughout the current monitored period *During this period, the Madur gas analyser was continuously used, with crosschecks from the GA2000 gas analyser. The handheld GA2000 gas analyser is 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 adjust the stationary analysers on site to maintain levels of accuracy.* *Since the main piece of reporting equipment is the Madur gas analyzer, and given that this piece of equipment was not calibrated for the period from 29/05/2007 to 01/11/2007 the most conservative approach was applied by treating this as a period of missed calibration (May 2007 – October 2007) using the guidance from the CDM EB from Annex 60EB52 – "Guidelines for Assessing Compliance with Calibration Frequency Requirement. The data collected by the Madur monitor during this period (May 2007 – October 2007) has been reduced by the maximum value of the uncertainty of the instrument (2.0%), ultimately reducing the amount of Emission Reductions claimed. This is explained in more detail in Section E.4.*
Measuring/ Reading/ Recording frequency:	Continuous and periodic. Periodic checks of the methane content from baseline wells are carried out at Mariannhill for crosschecking purposes.

Calculation method (if applicable):	n/a
QA/QC procedures applied:	Meters subject to maintenance and calibration. Data will be kept electronically for the duration of the crediting period.

Data / Parameter:	Volume of Landfill Gas Consumed in Engines
Data unit:	m^3
Description:	Amount of collected landfill gas combusted by engines
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
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Emission reduction calculations (please refer to section E below)
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	At La Mercy 1. Serial Number: Kurz Instruments FD13165A (engine flow) Accuracy: +/-0.75% of rate Calibration frequency: recommended annual re-certification and/or in-situ calibration Date of last calibration: 18/05/2006 Maximum error applied: -1.31% Validity of Calibration Certificate: 18/05/2006 to 17/05/2007 At Mariannhill 1. Serial Number: Kurz Instruments FD20273A (engine flow) Accuracy: +/-0.75% of rate Calibration frequency: recommended annual re-certification and/or in-situ calibration Date of last calibration: 11/10/2006 Date of last calibration with a reported error: 13/05/2011 Maximum error applied: -1.31% Validity of Calibration Certificate: 11/10/2006 to 10/10/2007 *As previously mentioned for parameter* $MV_{project,y,}$ *the mass flow meters installed at both sites (S/N) FD13165A and FD20273A, had been previously factory calibrated on 18/05/2006 and 11/10/2006 before being installed. The equipment provider confirmed that the suggested calibration period was on a 12 month basis, even though re-test at this frequency is not mandatory. The equipment had therefore a valid calibration up to 17/05/2007 (La Mercy) and 10/10/2007 (Mariannhill) respectively.* *To account for the missed calibration up to the end of this monitored period, the most conservative approach was applied using the guidance from the CDM EB from Annex 60EB52 – "Guidelines for Assessing Compliance with Calibration Frequency Requirement", and treating this as a period of missed calibration.* *The data collected by these two pieces of equipment during this period (May to October 2007 for La Mercy and October 2007 for Mariannhill,) has been reduced by the maximum value of the uncertainty of the instruments reported by the delayed calibration (-*

	1.31%), ultimately reducing the amount of Emission Reductions claimed. This is explained in more detail in Section E.4.
Measuring/ Reading/ Recording frequency:	Continuous
Calculation method (if applicable):	n/a
QA/QC procedures applied:	Meters subject to maintenance and in-situ calibration. Data will be kept electronically for the duration of the crediting period.

Data / Parameter:	Volume of Landfill Gas Consumed in Flares
Data unit:	m^3
Description:	Amount of collected landfill gas combusted by flares
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
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Emission reduction calculations (please refer to section E below)
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	At La Mercy 1. Serial Number: Kurz Instruments FD13164A (flare flow) Accuracy: +/-0.75% of rate Calibration frequency: recommended annual re-certification and/or in-situ calibration Date of last calibration: 18/05/2006 Maximum error applied: 2.92% Validity of Calibration Certificate: 18/05/2006 to 17/05/2007 At Mariannhill 1. Serial Number: Kurz Instruments FD20272A (flare flow) Accuracy: +/-0.75% of rate Calibration frequency: recommended annual re-certification and/or in-situ calibration Date of last calibration: 11/10/2006 Date of last calibration with a reported error: 13/05/2011 Maximum error reported: 2.92% Validity of Calibration Certificate: 11/10/2006 to 10/10/2007 *As previously mentioned for parameter* $MV_{project,y,}$ *the mass flow meters installed at both sites (S/N) FD13164A and FD20272A, had been previously calibrated by its factory before being installed on 18/05/2006 and 11/10/2006 respectively. The equipment provider confirmed that the suggested calibration period was on a 12 month basis, even though re-test at this frequency is not mandatory. The equipment had therefore a valid calibration up to 17/05/2007 and 10/10/2007.* *To account for this, the most conservative approach was applied using the guidance from the CDM EB from Annex 60EB52 – "Guidelines for Assessing Compliance with Calibration Frequency Requirement", and treating the remaining of the period as a period of missed calibration. The data collected by these two pieces of equipment during this monitored period (May to October 2007 for La Mercy and October 2007 for Mariannhill,) has been reduced by*

	the maximum value of the uncertainty of the instruments (-2.92%), ultimately reducing the amount of Emission Reductions claimed. This is explained in more detail in Section E.4.
Measuring/ Reading/ Recording frequency:	Continuous
Calculation method (if applicable):	n/a
QA/QC procedures applied:	Meters subject to maintenance and in-situ calibration. Data will be kept electronically for the duration of the crediting period.

Data / Parameter:	Electricity sold to the Grid (ES_y)
Data 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
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and Project emission calculations
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	At La Mercy 1. Serial Number: 86342183 (Export) Accuracy: 0.10% Calibration frequency: 10 yrs Date of last calibration: 2006 Validity of Calibration Certificate: valid throughout the current monitored period, up to 2016 2. Serial Number: 63705634 (Export backup meter) Accuracy: 0.10% Calibration frequency: 10 yrs Date of last calibration: 2006 Validity of Calibration Certificate: no certification available (see below) 3. Serial Number: 85066159 (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 At Mariannhill 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: 62439251 (Export backup meter - analogue) Accuracy: 0.10% Calibration frequency: 10 yrs Date of last calibration: 2006

	Validity of Calibration Certificate: no certification available (see below) 3. 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 Note: Backup export meters were not used during the monitoring period.
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 applied:	Meters subject to maintenance and performance monitoring by eThekwini Electricity. Data will be kept electronically for the duration of the crediting period.

Data / Parameter:	EG_y
Data unit:	kWh
Description:	Electricity produced by combustion of landfill gas
Measured /Calculated /Default:	Calculated
Source of data:	Electricity meters installed on site
Value(s) of monitored parameter:	Variable throughout the monitoring period – recorded in Summary CER calculation sheets provided
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Emission reduction crosscheck calculations (please refer to section E below)
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	At La Mercy 1. Serial Number: 86342183 (Export) Accuracy: 0.10% Calibration frequency: 10 yrs Date of last calibration: 2006 Validity of Calibration Certificate: valid throughout the current monitored period, up to 2016 2. Serial Number: 63705634 (Export backup meter - analogue) Accuracy: 0.10% Calibration frequency: 10 yrs Date of last calibration: 2006 Validity of Calibration Certificate: no certification available (see below) At Mariannhill 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: 62439251 (Export backup meter) Accuracy: 0.10% Calibration frequency: 10 yrs Date of last calibration: 2006

	Validity of Calibration Certificate: no certification available (see below) Note: Backup export meters were not used during the monitoring period.
Measuring/ Reading/ Recording frequency:	Recorded periodically for verification audit purposes
Calculation method (if applicable):	Value is calculated by adding 1.5% to the amount of electricity exported to account for transformer losses.
QA/QC procedures applied:	Meters subject to maintenance and performance monitoring by eThekwini Electricity. Data will be kept electronically for the duration of the crediting period.

Data / Parameter:	Combustion Efficiency
Data unit:	%
Description:	Combustion efficiency of gas engines and flares
Measured /Calculated /Default:	Default values are used in the calculation of emission reductions. The combustion efficiency of engines is not actually used in the calculation of emission reductions, but is referenced in AM0010. Annual measurements of combustion efficiency are carried out as a quality assurance measure.
Source of data:	n/a for engines manufacturer statement for flares
Value(s) of monitored parameter:	100% for engines 97% for flares
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Emission reduction crosscheck calculations (please refer to section E below)
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Field tests of combustion efficiency are carried out as a quality assurance measure.
Measuring/ Reading/ Recording frequency:	Annual
Calculation method (if applicable):	n/a
QA/QC procedures applied:	Data will be kept electronically for the duration of the crediting period.

Data / Parameter:	LFG Temperature and Pressure
Data unit:	ºC and Pa
Description:	Temperature and pressure of landfill gas
Measured /Calculated /Default:	The temperature and pressure are measured by thermal mass flow meters which automatically provide the normalised flow of the gas.
Source of data:	Thermal mass flow meters
Value(s) of monitored parameter:	n/a
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Emission reduction calculations (please refer to section E below)
Monitoring equipment (type, accuracy class, serial number, calibration	At La Mercy 1. Serial Number: Kurz Instruments FD13164A (flare flow) Accuracy: +/-0.75% of rate

frequency, date of last calibration, validity)	Calibration frequency: recommended annual re-certification and/or in-situ calibration Date of last calibration: 18/05/2006 Validity of Calibration Certificate: 18/05/2006 to 17/05/2007 2. Serial Number: Kurz Instruments FD13165A (engine flow) Accuracy: +/-0.75% of rate Calibration frequency: recommended annual re-certification and/or in-situ calibration Date of last calibration: 18/05/2006 Validity of Calibration Certificate: 18/05/2006 to 17/05/2007 At Mariannhill 1. Serial Number: Kurz Instruments FD20272A (flare flow) Accuracy: +/-0.75% of rate Calibration frequency: recommended annual re-certification and/or in-situ calibration Date of last calibration: 11/10/2006 Validity of Calibration Certificate: 11/10/2006 to 10/10/2007 2. Serial Number: Kurz Instruments FD20273A (engine flow) Accuracy: +/-0.75% of rate Calibration frequency: recommended annual re-certification and/or in-situ calibration Date of last calibration: 11/10/2006 Validity of Calibration Certificate: 11/10/2006 to 10/10/2007 3. Serial Number: Kurz Instruments FD20271A (baseline flow) Accuracy: +/-0.75% of rate Calibration frequency: recommended annual re-certification and/or in-situ calibration Date of first calibration: 11/10/2006 Date of last calibration: 22/06/2009 Validity of Calibration Certificate: from 11/10/2006 to 10/10/2007 (for further details see parameter $MV_{baseline,y}$ above)
Measuring/ Reading/ Recording frequency:	Continuous
Calculation method (if applicable):	n/a
QA/QC procedures applied:	Meters subject to maintenance and in-situ calibration. Data will be kept electronically for the duration of the crediting period.

Data / Parameter:	Flare Working Hours
Data unit:	-
Description:	Periods discounted, during which the temperature of the flare is below 500 ºC[3]
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
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Emission reduction calculations (please refer to section E below)
Monitoring equipment (type, accuracy class, serial	Thermocouples that monitor flare temperature, and SCADA system.

[3] As per the revised version of the PDD, approved by the CDM EB on its 65th Meeting.

number, calibration frequency, date of last calibration, validity)	
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 applied:	Meters subject to maintenance and calibration. Data will be kept electronically for the duration of the crediting period.

Data / Parameter:	Flare Temperature
Data 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
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Emission reduction calculations in the QA Method (please refer to section E below)
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	At La Mercy 1. Serial Number: WIKA TR200 46002570 Accuracy: 0.7% of full scale At Mariannhill 1. Serial Number: WIKA TR200 46002570 Accuracy: 0.7% of full scale *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 the first replacements at Mariannhill took place on 16/04/08, being out of this monitored period.* *Replacements were not required at La Mercy due to the infrequent operation of the gas combustion plant.*
Measuring/ Reading/ Recording frequency:	Continuous
Calculation method (if applicable):	Na
QA/QC procedures applied:	Thermocouples are subject to regular checks to ensure that they are operating as required, or replaced if a failure is noted. Emission reductions calculations are manually adjusted during periods of thermocouple malfunction in accordance with the QA Manual of the monitoring contractor.

Data / Parameter:	Heat Rate (HR_y)
Data 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
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Emission reduction calculations (please refer to section E below)
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Electricity export meter and engine 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 applied:	Parameter is also measured annually by field testing as a QA check to ensure that the values used in the emission reduction calculations are conservative. Data will be kept electronically for the duration of the crediting period.

SECTION E. Emission reductions calculation

E.1. Baseline emissions calculation

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."

Under this definition, for the La Mercy site, there no baseline emissions as, in the absence of the project activity, no gas would have been captured, destroyed and combusted.

At Mariannhill, baseline emissions ($MV_{baseline,y}$) 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 Annex 3.

E.2. Project emissions calculation

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 two sites. 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 Annex 3.

E.3. Leakage calculation

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. Emission reductions calculation / table

As per 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 tonnes of CO_2 equivalents (tCO_2e). $MD_{project,y}$ and $MD_{baseline,y}$ are measured in tonnes 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 tonnes 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.

The project operator determines the applicable annual grid carbon emission factor based on the Eskom Annual Reports and multiplies this by the metered electricity delivered to the grid.

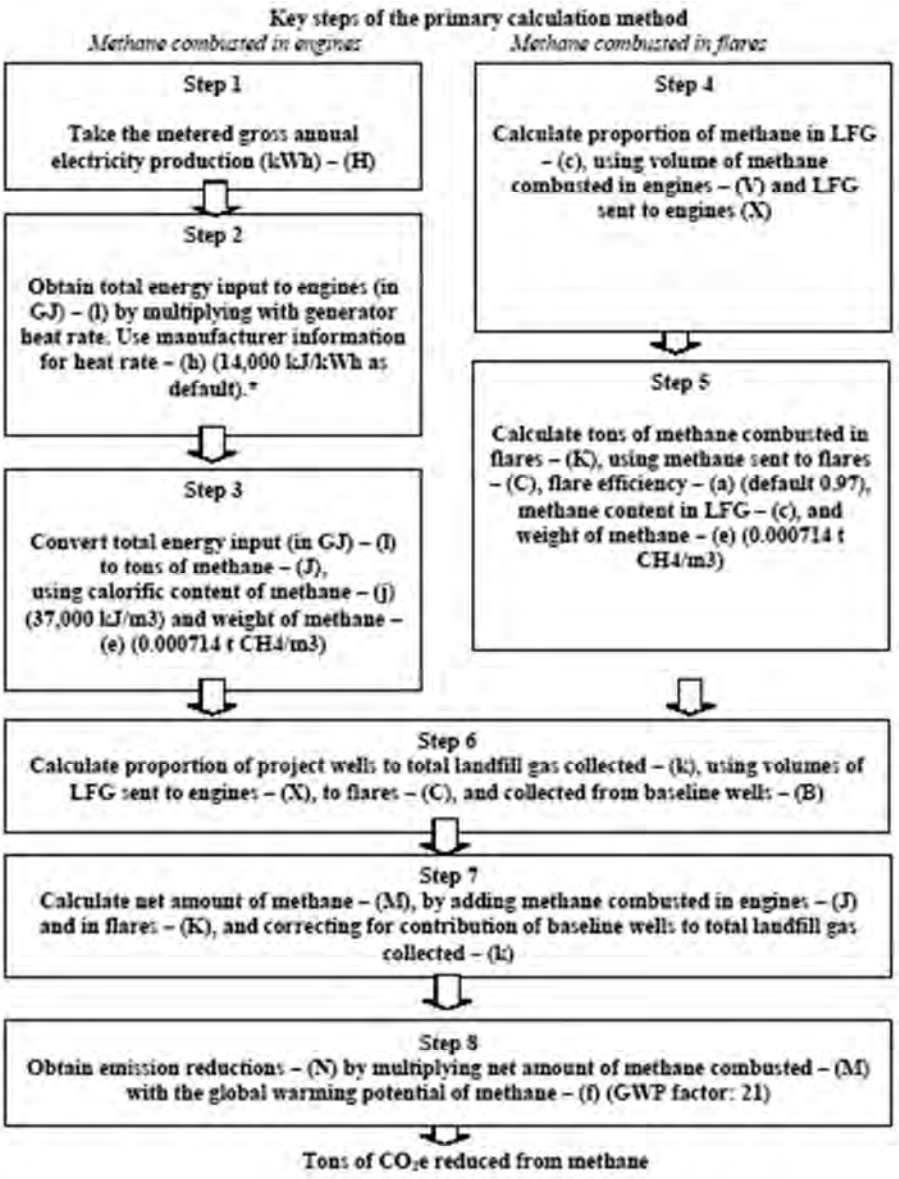
Using the formulae prescribed by AM0010, the total emission reductions have been calculated for each site. The data required to complete the calculations are collected by either the Primary Method (PM) or the Quality Assurance Method (QA). The PM is based on downstream metering wherever possible, i.e. 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.

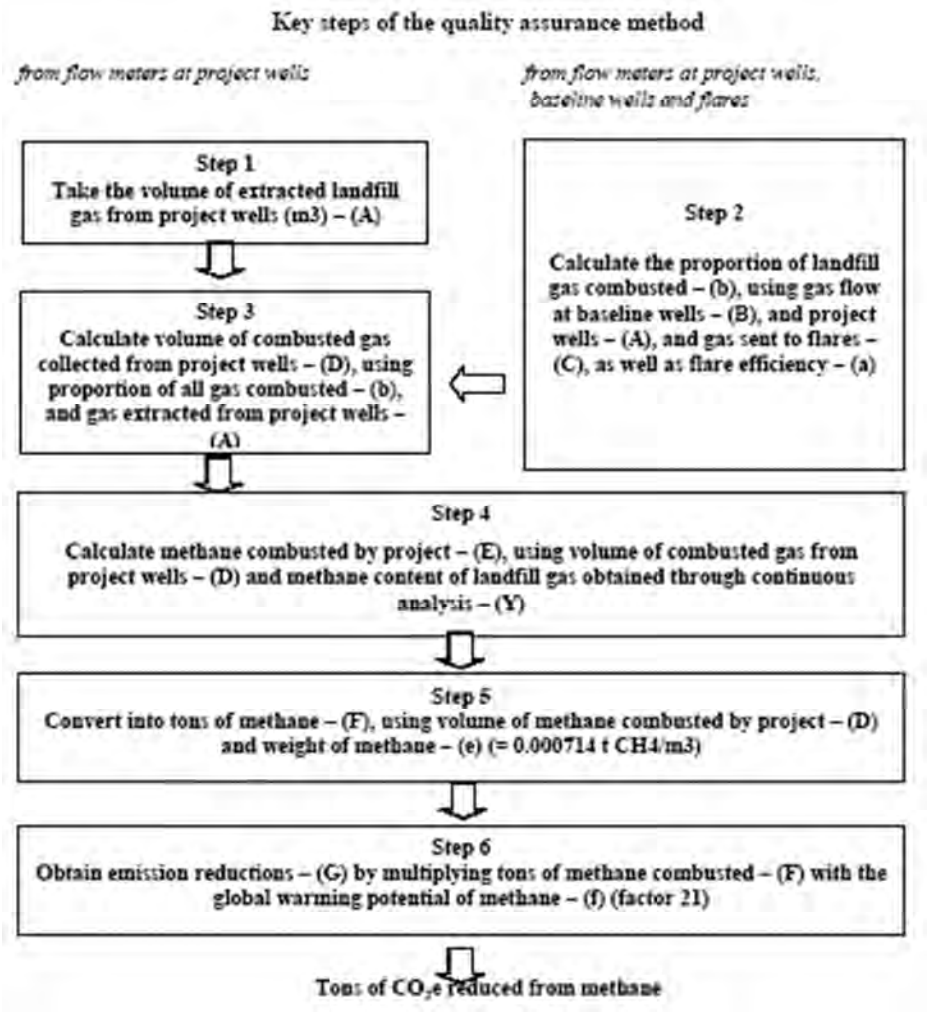
The PM uses the monthly aggregates of the following four metered variables: Gross electricity production (kWh), volume of LFG sent to engines, volume of landfill gas flared, and volume of LFG extracted from baseline wells (all in m^3). The method first calculates the quantity of methane combusted in engines using engine kWh output and technical parameters (Steps 1 – 3 in Figure 2). Step 4 calculates the methane content in LFG using the quantity of LFG sent to engines, which is then used in Step 5 to derive methane combusted in flares from LFG quantity sent to flares. Step 6 calculates the proportion of LFG collected from project wells using the above information about LFG sent to engines and flares as well as LFG collected from baseline wells. This proportion is used in Step 7 to calculate the net amount of methane combusted by the project activity and for which credits can be claimed. Step 8 concludes the calculation by multiplying with the global warming potential of methane.

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 m^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 calculation methods is presented in graphical format below.





A summary of the ERs calculated by the SCADA system for the period of 15/12/2006 to 01/11/2007 for Mariannhill and La Mercy respectively is presented in the tables below. A more detailed summary of the data is provided in spreadsheet format in Annex 3. The full SCADA data files have been made available to the Verifier.

Mariannhill CERs

Month	Primary Method (PM)	QA Method (QA)	Power supplied	With power supply	Selected method	Applied Data
Dec-06	795	744	8	Applicable	PM	795
Jan-07	1584	1,550	345	Applicable	PM	1584
Feb-07	1416	1,394	295	Applicable	PM	1416
Mar-07	1,641	1,650	353	Applicable	PM	1,641
Apr-07	1,752	1,724	402	Applicable	PM	1,752
May-07	1,726	1,594	442	Applicable	PM	1,726
Jun-07	1,558	1,453	456	Applicable	PM	1,558
Jul-07	1,507	1,377	342	Applicable	PM	1,507
Aug-07	1,647	1,524	464	Applicable	PM	1,647
Sep-07	1,496	1,221	445	Applicable	PM	1,496
Oct-07	1,525	1,206	334	Applicable	PM	1,525
Total	16,647	15,437	**3,886**			**16,647**
Total CERs Calculated				**20,533**		

La Mercy CERs

Month	Primary Method (PM)	QA Method (QA)	Power Supplied	With power supply	Selected method	Applied Data
Dec-06	416	342	1	NA	PM	416
Jan-07	0	446	-9	NA	QA	446
Feb-07	0	1	-4	NA	QA	1
Mar-07	494	564	41	NA	PM	494
Apr-07	0	251	-7	NA	QA	251
May-07	0	168	-9	NA	QA	168
Jun-07	0	458	-11	NA	QA	458
Jul-07	0	367	-18	NA	QA	367
Aug-07	0	390	-13	NA	QA	390
Sep-07	0	311	-11	NA	QA	311
Oct-07	0	345	-11	NA	QA	345
Total	910	3,649	**-51**			**3,647**
Total CERs Calculated				**3,596**		

Note: Where figures are derived for both the primary method and QA method, the primary method is preferred.

As is described in Section D.2, due to unclear recommendations on the calibration frequencies from the technology provider for the key instruments involved in the calculation of emission reductions, as identified in the Instrument List, the most conservative approach was applied following the guidance from the CDM EB from Annex 60EB52 – "Guidelines for Assessing Compliance with Calibration Frequency Requirement", and treating this as a periods of missed calibration, using the results of the maximum error between the delayed calibration for the equipment installed at the Mariannhill site, and the maximum error of the equipment. The data collected during the periods during which key instruments were out of calibration have been reduced by the maximum value of the uncertainty of the instruments, ultimately reducing the amount of Emission Reductions claimed. This is conservative because:

- the instruments were all in calibration for at least part of the respective months and the monitoring data recorded do not indicate any adverse performance other than that which has already been discounted from the calculations;
- the potential inaccuracy of each instrument could equally be underestimating emission reductions, although overestimation has been assumed throughout; and
- it is unlikely that recorded readings will in reality reflect the maximum level of potential inaccuracy throughout the period.

The key instruments used in the calculations are the thermal mass flow meters (with maximum errors of 1.31% (engine flow), 2.92% (flare flow), and 4.46% (baseline flow) inaccuracy), and the stationary methane monitors (maximum error of 2.0% inaccuracy).

The SCADA data have been adjusted by these maximum potential errors for the following periods:

Mariannhill

- Methane content reduced by 2% for the months of May to October 2007 inclusive; and
- Engine and flare flow rates reduced and baseline flow increased by the respective maximum inaccuracies stated above for the month of October 2007.

La Mercy

- Methane content reduced by 2% for the months of May to October 2007 inclusive; and
- Engine and flare flow rates reduced by the respective maximum inaccuracies stated above for the months of May to October 2007 inclusive.

It is therefore considered that reducing the emission reductions claim as described above is a conservative approach in line with the EB guidance for periods of missed calibration[4], which results in the following claimed emissions reductions:

- Mariannhill – 20,533 tCO_2e;
- La Mercy – 3,596 tCO_2e; and therefore
- **Total – 24,129 tCO_2e.**

[4] EB 52 Report, Annex 60: Guidelines for Assessing Compliance with the Calibration Frequency Requirements, Version 01, February 12th 2010.

E.5. Comparison of actual emission reductions with estimates in the CDM-PDD

The following table shows a comparison of actual values of the emission reductions achieved during the monitoring period with the estimations in the registered CDM-PDD.

Item	Values applied in ex-ante calculation of the registered CDM-PDD	Actual values reached during the monitoring period
Emission reductions (tCO_2e)	59,122 tCO_2e *	24,129 tCO_2e

*The PDD value been calculated by prorating the PDD yearly values by the number of days to match this monitored period (15/12/2006 to 01/11/2007).

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

The actual emission reductions achieved during the monitoring period were significantly lower than predicted in the registered PDD.

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History of the document

Version	Date	Nature of revision
01	EB 54, Annex 34 28 May 2010	Initial adoption.
Decision Class: Regulatory **Document Type**: Guideline, Form **Business Function**: Issuance		