GENERAL MANAGEMENT ASSISTANCE CONTRACT (GMAC)
Contract No: 674-C-00-01-10051-00

Methane Emission Reduction Opportunities in Twelve South African Cities: Turning a Liability into a Resource

Final Report

Prepared by

Palmer Development Group

December 2004

This report was prepared under Mega-Tech, Inc.'s prime contract with USAID and addresses USAID/South Africa's Strategic Objective No. 6: Increased Access to Shelter and Environmentally Sound Municipal Services

MTI Contract No.: 0122-0603-PO-TA42

Contact Details

Mega-Tech

Please direct all queries regarding this report to:

Mega-Tech/South Africa
Bank Forum Building
Lobby 1, Second Floor
337 Veale Street
New Muckleneuk
0181 Pretoria RSA
Tel. 012 452 0060
Fax 012 452 0070
E-mail megatech@intekom.co.za

Or

Mega-Tech, Inc.
180 South Washington Street, Suite 200
Falls Church, VA 22046
Tel. (703) 534-1629
Fax (703) 534-7208
E-mail tsmith@megatechinc.com

Palmer Development Group

Contact	**Michael Goldblatt**
Postal address	Postnet Suite #259, Private Bag X30500, Houghton, 2041
Physical address	7 St Davids Place, Parktown, Johannesburg
Telephone	(011) 484 9992
Facsimile	(011) 643 1423
Cell phone	082 337 9792
E-mail	mike@pdg.co.za

Cape Town office	
Postal address	PO Box 53123, Kenilworth, 7745
Physical address	254 Main Road, Kenilworth, Cape Town
Telephone	(021) 797 3660
Facsimile	(021) 797 3671
Cell phone	083 308 5522
E-mail	mark@pdg.co.za

P·D·G
PALMER DEVELOPMENT GROUP

Executive Summary

Introduction

Certain municipal services, primarily waste-water treatment and solid waste disposal generate significant amounts of methane gas which enter the atmosphere. Methane is a local pollutant and a powerful greenhouse gas (GHG) globally and is one of the gases targeted for reduction under the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC). Methane is also a source of energy and is the main constituent of natural gas. The reduction and use of methane therefore has the dual benefits of removing a pollutant while harnessing its energy content productively.

Reductions in methane emissions are not only beneficial to the environment, they also offer municipalities the potential for new sources of revenue and investment. Under the Clean Development Mechanism (CDM) of the Kyoto Protocol methane reductions can give rise to the generation of certified emission reductions (CERs), commonly known as carbon credits. The sale of these credits, coupled with revenue from the sales of methane as an energy source, can be used to finance infrastructure improvements and potentially provide a new source of income to local authorities.

This project was aimed at evaluating the potential that methane reduction offers as a new resource for South African municipalities. The project investigated methane emission reduction and use opportunities in the nine SACN cities, as well as Richards Bay (uMhlathuze Local Municipality), Polokwane and Nelspruit (Mbombela Local Municipality). This was supported by an investigation into the financial and institutional options available to municipalities in developing methane reduction projects.

Results

The data-gathering from municipalities was generally successful but was limited by the fact that many cities do not capture data on some of the key parameters required to thoroughly analyse potential landfill gas or waste-water emissions. Despite these limitations the results of the investigation indicate that there are many possible landfill gas reduction opportunities in South African municipalities but are less promising with regards to methane reduction projects at waste-water treatment works – though some potential exists here as well.

The analysis suggests that, if used for electricity generation, the total generation potential of these landfill sites is about 104 MW. It is difficult to identify which of these projects offers the greatest potential since there are many success factors. As a simple approach to identifying priority projects those with a generation potential greater than 4 MW have been listed in the report. There are nine such projects in Johannesburg, Cape Town, eThekwini, Ekurhuleni and Buffalo City. Apart from these large projects there are likely to be 40 other viable projects scattered amongst all the cities investigated. The potential landfill gas projects range in size from 0.5 MW to >10MW projects with the bulk of projects clustered in the 1-4MW range.

Landfill gas use opportunities

The "default" option for landfill gas use is electricity generation despite the fact that it is not always the most financially attractive option. This is due to the fact that it is seen as the simplest option to implement, with well understood technologies, a limited set of stakeholders and requiring relatively easy institutional arrangements. A further merit to electricity generation is the possibility of securing power purchase agreements from the municipality itself, rather than from an external purchaser, typically Eskom. Given the national government's commitment to renewable energy the licensing of independent power producers is likely to become easier over time.

Some cities managed to identify other potential uses – typically use of the gas for direct heating in industrial boilers to displace coal or fuel oil where landfill sites were within reasonable distance of industrial zones. Despite the fact that it is typically the simplest option electricity generation may not always the best option from a financial perspective and from an energy efficiency perspective. Therefore those cities intending to utilise waste methane should undertake a proper feasibility study which explores alternative uses of the gas.

Waste-water treatment

There are fewer and smaller opportunities in the waste-water sector for a number of reasons including: limited use of anaerobic treatment and a fairly high standard of waste-water treatment management, with a large proportion of treatment works that do generate methane already using or flaring their biogas. The implication of these findings is that the there will be limited carbon finance benefits from bio-gas use projects since the baseline for the vast majority of these projects will include the combustion of the methane – thereby removing the methane reduction benefits from the carbon finance component of the project.

Institutional and financial considerations

A number of cities already have some understanding of the CDM and are investigating the potential for landfill gas reduction projects with the support of carbon finance. Despite this limited progress the city interviews suggest that given the existence of a fairly large numbers of potential projects the barriers to project development are not limitations on underlying opportunities but rather institutional and information limitations, and to a lesser extent limitations on project development finance, or at least difficulties in accessing available financial resources.

A complex set of legal, institutional and financial arrangements are required to bring methane reduction projects, financed by the sale of carbon credits, to fruition. The report outlines these requirements and shows that the broad context is currently favourable to project development – with a demonstrable demand for carbon credits, national level legal and regulatory structures in place; and national policy support for these projects. However, at the municipal level there is a less favourable institutional climate with limited awareness of the opportunities available and limited capacity to develop and implement such projects internally.

The focus on developing institutional capacity is supported by the municipal level analysis which indicate that most municipalities, if they were to engage in methane reduction projects, would prefer to establish an institutional structure to implement the project that was outside of the normal structure of the municipality. Most municipalities, however, did not have a clear sense of the appropriate structure or of the procurement procedures required to arrive at the stage of project implementation. The report suggests that there is a role to be played by the SACN, possibly in association with other agencies, to provide guidance in this area. A possible approach would combine a knowledge network with the development of more formal guidance. This guidance could include, for example, a manual that would take potential developers through the steps needed to develop such projects, highlighting key issues in their development and implementation as well as providing formats for management contracts. This could be done in association with the National Treasury PPP unit.

Significant awareness raising is also required for senior decision-makers in the cities, at both the management and Council level. These individuals need to understand the opportunities available to their cities to expedite the process of project establishment and to avoid delays and opportunity costs of not implementing projects

Institutional capacity is not the only constraint. There is also no single source of project development finance for these projects. Current project development is being financed in the main from carbon credit purchasers. There are some serious limitations to such an approach. To overcome the constraint of initial project development finance it is suggested that the SACN engages with a number of key players in the area of project finance to identify the availability of project development funds which its members could access for projects. Suggested organizations include the DBSA, the World Bank, DANIDA and AfD. The SACN could also establish a 'virtual' project preparation facility by facilitating access to available project development funds by member cities of the network.

There is currently no single institution championing the development of methane reduction projects in municipalities. The implication of the evaluation in the report is that there is value in an organisation or organisations assisting municipalities to take methane reduction projects forwards. This 'champion' could be the SACN or a broader set of institutions. The analysis suggests two main areas of support that could be provided. These being awareness raising and funding for project development and technical assistance.

Acknowledgements

Funders

We would like to ackowledge the Steering Committee of the project for their support and advice. The Steering Committee members were Nkosiphambili Ndlovu (USAID); Sithole Mbanga and Senzeni Maphalala (SACN); Fiona Bizos, Barbara DeGroot and Steve Horn (Mega-Tech Inc.).

This report was made possible through support provided under Mega-Tech, Inc.'s prime contract with USAID/South Africa's *Strategic Objective No. 6: Increased Access to Shelter and Environmentally Sound Municipal Services*. The opinions expressed herein are those of the author(s) and do not necessarily reflect the views of the U.S. Agency for International Development.

Authors

The lead author of the report was Michael Goldblatt of Palmer Development Group. He was supported by Rob Short of Sustainable Transactions and Stan Jewaskiewitz from Envitech Solutions.

Associated Reports

The following reports form part of the project output and provide additional information to that contained in the final report.

Twelve city reviews:

- Johannesburg
- eThekwini
- Cape Town
- Tshwane
- Nelson Mandela
- Ekurhuleni
- Msunduzi
- Buffalo City
- Mangaung
- uMhlathuze
- Polokwane
- Mbombela

Excel spreadsheet:

- Summary emissions analysis

Contents

Tables

Figures

1 Background

Palmer Development Group was appointed by Mega-Tech in support of a South African Cities Network (SACN) project to undertake an investigation into the possibilities for methane emission reductions at the municipal level in South Africa. The project was funded by the United States Agency for International Development (USAID).

Certain municipal services, primarily waste-water treatment and solid waste disposal generate significant amounts of methane gas which enter the atmosphere. Methane is a local pollutant and a powerful greenhouse gas (GHG) globally and is one of the gases targeted for reduction under the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC). Methane is also a source of energy and is the main constituent of natural gas. The reduction and use of methane therefore has the dual benefits of removing a pollutant while harnessing its energy content productively.

Reductions in methane emissions are not only beneficial to the environment, they also offer municipalities the potential for new sources of revenue and investment. Under the Clean Development Mechanism (CDM) of the Kyoto Protocol methane reductions can give rise to the generation of certified emission reductions (CERs), commonly known as carbon credits. The sale of these credits, coupled with revenue from the sales of methane as an energy source, can be used to finance infrastructure improvements and potentially provide a new source of income to local authorities.

This project is aimed at evaluating the potential that methane reduction offers as a new resource for South African municipalities. The project investigated methane emission reduction and use opportunities in the nine SACN cities, as well as Mhlatuze Local Municipality (Richards Bay), Polokwane and Mbombela Local Municipality (Nelspruit). This was supported by an investigation into the financial and institutional options available to municipalities in developing methane reduction projects.

1.1 Project objectives

The objectives of the project are to identify, and quantify where possible, current methane emissions from municipal facilities in the twelve selected cities. Further objectives are to identify the possibilities for emission reductions, particularly the productive use of the methane as an energy source.

The project also provides an evaluation of the role that the sale of carbon credits, under the clean development mechanism (CDM) of the Kyoto Protocol or in other forms, can play in supporting identified methane reduction projects.

Methane, historically viewed simply as a hazardous waste gas, has the potential to be a new resouce for South African municipalities. It is an important objective of the project to demonstrate the new opportunities made available to municipalities by carbon finance, and the scope that municipalities have, to simultaneously meet domestic environmental and energy targets and benefit financially under the emerging global emissions trading regime.

1.2 Approach

Research for the project was based on data collected during field visits in all the twelve cities investigated (see list of of cities in Table 1). This data was supported by the collection of published data, including Water Service Development Plans (WSDPs), Integrated Development Plans (IDPs) and published statistics on municipalities. Internal reports, such as investigations under Section 78 of the Municipal Systems Act were also made available by some municipalities as background information.

In the municipalities, officials from the solid waste, waste-water, and, in some cases, electricity departments were interviewed. Where appropriate, officials from other departments, such as environmental management or local economic development, were also consulted. In addition, some interviews were conducted with service authorities or providers that were not located at the local government level. For example, some waste-water treatment plants are managed by external service providers in which case these providers were interviewed.

Table 1. Cities included in the study

Municipality	South African Cities Network Member
Metropolitan Municipalities	
Johannesburg	Yes
eThekwini	Yes
Cape Town	Yes
Tshwane	Yes
Nelson Mandela	Yes
Ekurhuleni	Yes
Local Municipalities	
Msunduzi	Yes
Buffalo City	Yes
Mangaung	Yes
uMhlatuze Local Municipality (Richards Bay)	No
Polokwane	No
Mbombela Local Muncipality (Nelspruit)	No

2 Methane Emissions

Methane (CH_4) is the principal component of natural gas. It is also produced from a number of human sources. In these instances methane production typically arises as a result of microbial processes under anaerobic (without oxygen) conditions. In landfills methane is generated as waste decomposes within the landfill site. Waste-water treatment works often rely on the anaerobic action of bacteria to decompose the organic contents of waste-water. In the process, methane is produced as a by-product. The main sources of methane emissions at the municipal level are therefore landfill sites and waste-water treatment plants, although some smaller sources do exist, such as composting and sewerage reticulation networks.

Methane is a powerful greenhouse gas (GHG), with an impact on the global climate 21 times that of carbon dioxide (used as the standard benchmark). Methane also carries significant amounts of energy (discussed in section 3.1) . The combination of these two factors give rise to the focus on methane as a new opportunity for municipalities since there is the potential to generate environmental gains from reducing methane emissions while simultaneously gaining a new energy source from a waste product.

The South African National Greenhouse Gas Inventory (CSIR, 2001) estimated that in total South Africa released about 21 000 tonnes of methane per year to the atmosphere from waste-water treatment and about 721 000 tonnes of methane from waste disposal. In total this was equivalent to 15.6 million tonnes of carbon dioxide (CO_2). Detailed figures are presented below which show the contribution of these emissions to the SA total GHG emissions for the year.

Table 2. Waste and wastewater contribution to SA greenhouse gas emissions (1994)

Tonnes emissions per year	**CH_4**	**CO_2e**	**% of total**
Solid waste disposal on land	721,740	15,156,544	4.0%
Wastewater handling	21,327	447,872	0.1%
Total SA emissions		**379,839,527**	

CSIR, 2001: South Africa Greenhouse Gas Inventory, 1994, prepared by the CSIR for the Department of Environmental Affairs and Tourism, Pretoria.

2.1 Methane reduction and the CDM

The Clean Development Mechanism (CDM) established under the Kyoto Protocol provides an opportunity for projects in developing countries that can reduce greenhouse gas emissions to attract financing or technology investment from industrialised country companies in exchange for carbon credits, formally known as Certified Emissions Reductions (CERs). One CER is equivalent to one tonne of carbon dioxide equivalent reduced.

The CDM was established under article 12 of the Kyoto Protocol (UNFCCC, 1997). The Protocol states in article 12 (3) that:

3. Under the clean development mechanism:

(a) *Parties not included in Annex I will benefit from project activities resulting in certified emission reductions; and*

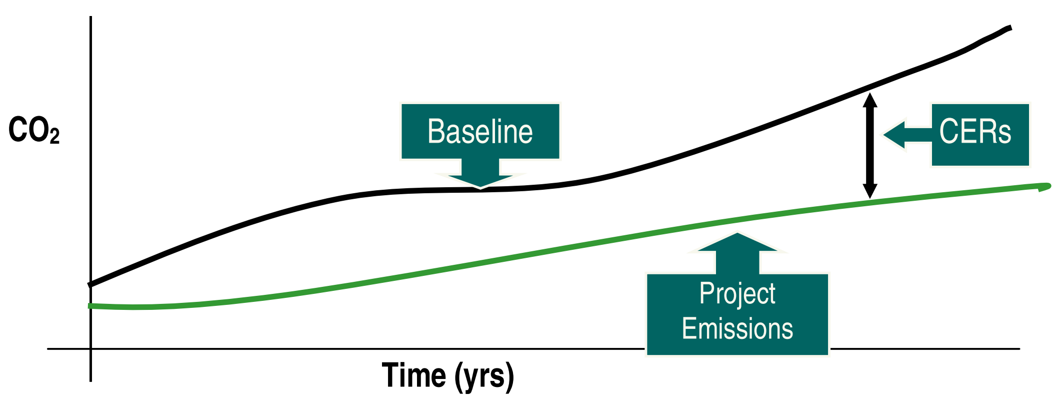
(b) *Parties included in Annex I may use the certified emission reductions accruing from such project activities to contribute to compliance with part of their quantified emission limitation and reduction commitments under Article 3, as determined by the Conference of the Parties serving as the meeting of the Parties to this Protocol.*

Methane reduction projects are particularly attractive under the CDM since methane is 21 times as powerful a greenhouse gas as carbon dioxide thereby generating 21 CERs for each tonne of methane reduced. There has been much interest recently in developing landfill gas reduction projects as CDM projects in South Africa, led by eThekwini Municipality which is developing such a project in collaboration with the World Bank's Prototype Carbon Fund.

2.1.1 How the CDM operates

The CDM is a project based mechanism. A project that can reduce greenhouse gases is identified and if that project appears to meet the CDM eligibility criteria the project is prepared as a CDM project. CDM project preparation has a number of required elements, which are discussed in some more detail below. Following registration of the project with the international Executive Board of the CDM and successful project implementation the project will begin generating certified emission reductions. The amount of certified emission reductions generated is equivalent to the difference between the business-as-usual scenario, termed the *baseline*, and the actual project emissions. The generation of CERs is shown diagrammatically below.

Figure 1. Diagram of the generation of certified emission reductions



The certified emission reductions are the commodity that is generated from the CDM component of the project. These certified emission reductions can then be sold or traded internationally to buyers who require such certificates to offset their own greenhouse gas reduction commitments. Such buyers include institutional purchasers, such as the Prototype Carbon Fund of the World Bank, brokers, utilities and firms, and some national governments, such as the Dutch and Danish Governments.

Because the CDM is still in its early stages there is not yet a highly liquid market for certified emission reductions and most sales of certified emission reductions happen on a bilateral basis under a contract between a seller, the project owner, and a buyer. In some cases these transactions are facilitated by brokers.

The price of certified emission reductions is therefore subject to negotiations between the parties to the transaction. The financial issues pertaining to CDM transactions are discussed further in section 6.2.

Requirements for participation

In order to participate in the CDM, a country must be a Party to the Kyoto Protocol. South Africa acceded to the Protocol on July 31, 2002 and hence is eligible to host CDM projects.

The Conference of the Parties to the UNFCCC also decided to facilitate a prompt start for the CDM, allowing certified emission reductions to be obtained starting with the year 2000. Despite the fact that the Kyoto Protocol has not yet come into force the UNFCCC has established the international mechanisms for the CDM, and countries and private organisations are actively participating in the mechanism globally. The Protocol will come into force when countries making up 55% of global greenhouse gas emissions ratify the Protocol. The current signatories to the Protocol do not yet reach this percentage. However, at the time of writing, the Russian Parliament was in the process of ratifying the Protocol and if this process is successfully completed the Kyoto Protocol will come into force.

In order to participate in the CDM, the country hosting CDM project activities needs to meet certain participation requirements which require the establishment in host countries of effective institutional and legal frameworks for approving such projects. Specifically the CDM rules require host countries to establish a Designated National Authority (DNA) for CDM projects.

South Africa has chosen to act in accordance with the Protocol pending its coming into force and in order to fulfil the Protocol's requirement the government of South Africa has appointed the Department of Minerals and Energy with the task of establishing and operating a Designated National Authority. This Authority is currently being established and will be operational by the end of 2004.

CDM project activities must comply with the the guidelines set out in the CDM rules and the requirements of the host country, including its sustainable development priorities. A key criterion for project eligibility under the CDM is additionality of emissions reductions. This means that the project activity must reduce greenhouse gas emissions beyond what would have happened without the project activity. The emission reductions, once verified and certified, become certified emission reduction units (CERs), which have a market value and can be used by industrialised countries to comply with their commitments under the Protocol.

The CDM project cycle

The main steps of the CDM project cycle and the role players in those steps are as follows:

- **Project identification and design**: the project owner/project developer identifies an opportunity, conducts a pre-feasibility study, and develops an official Project Design Document (PDD). This step includes:
  - **Baseline determination**: the project developer determines what the emissions would be in the absence of the project (the business as usual scenario) to enable a determination of the emission reductions from the project
- **Host country approval**: the Designated National Authority (DNA) of the host country approves the project, based on the country's evaluation criteria and assessment of the project's contribution to sustainable development.
- **Third party validation of project design and baseline**: The Project Design Document is validated by an accredited organisation that serves as an independent third party auditor.
- **Registration**: Once a project is validated and approved by the host country, and after a 30 day public comment period, it is registered by the CDM Executive Board.
- **Financing and implementation**: The project is financed and implemented like any normal investment project.
- **Monitoring**: Project performance, including baseline conditions, is measured by the project developer in the commissioning process and throughout the crediting lifetime of the project, to calculate the actual emissions reductions.

- **Verification of project performance**: An independent auditor verifies project performance against the validated design and baseline, in order to certify the credits.
- **Issuance**: Based on the successful performance of these steps, the CERs are issued by the CDM Executive Board.

2.2 Implications for Municipal Methane Capture and Use

The CDM has significant potential for municipal greenhouse gas reduction projects in general, and methane reduction projects in particular. Because of the ability to turn emission reductions into a saleable commodity the CDM has the potential to transform the environmental problem of methane emissions into the resource of certified emission reductions. Revenue generated from the sale of certified emission reductions can be used to improve infrastructure and operations at the local level.

There are two significant areas of municipal infrastructure that typically generate significant quantities of methane – anaerobic waste-water treatment and solid waste landfills. The details of these two municipal infrastructure activities are discussed further below. In brief, however, it is apparent that the types of waste-water treatment works and waste disposal sites typically found in the medium to larger municipalities combined with the typical operating parameters under which these are managed gives rise to a situation where significant methane reduction potential exists.

In addition to direct revenue from the sale of certified emission reductions, CDM projects are likely to make a number of alternative uses of methane possible that would otherwise not be financially viable. In many cases there is the potential for additional revenue streams that will accrue to the municipality from the sale of the methane or energy derived from the gas. These new revenue streasms can be used in supporting the waste management functions of the municipality or other service provision requirements.

3 Methane Reduction and Use Opportunities

Unlike most other greenhouse gases, such as carbon dioxide (CO_2), the major sources of methane emissions are under the control of municipalities. The supply side of methane reduction can therefore be evaluated by a consideration of uncontrolled methane emissions that are currently occuring from municipal facilities. The demand side relates to the potential use of the gas.

The only methane reduction oportunities of sufficient scale to warrant further investigation where found to be landfill site and waste-water treatment works. These are both discussed in some detail below. Because of the different characteristics of the gas that arises from each source – landfill gas versus biogas from digesters, the potential use options are discussed separately for each source. There is, however, a fairly standard set of generic options that can be considered for the use of methane from either source.

Methane use opportunities

The major uses of methane from landfill gas or biogas are electricity generation and industrial fuel switching. There are numerous examples of both of these uses internationally and power generation from landfill gas is now considered a standard technology. There are also more marginal applications such as the use of compressed methane for replacing diesel in vehicles; the use of methane as a chemical feedstock; and the residential use of purified landfill gas or biogas. These latter applications have been tried in a number of sites but remain limited in application due to financial or technical difficulties in making them viable.

The main determinants of viability for the possible gas use options include:

- gas yield;
- proximity of industry to the gas source;
- proximity of the electrical grid or anchor client to the gas source; and
- cost of alternative energy sources (fuel or electricity)

Viable project opportunities will depend on the combination of supply and demand factors as well as non-technical issues such as the relationship of the project to local IDP priorities, capacity to manage the project, project “bankability”, eligibility of the project as a PCF or CDM project and so forth.

Municipal methane reduction opportunities

For the purposes of this report municipal methane reduction opportunities are defined as opportunities for methane, CO_2 and other greenhouse gas reduction in facilities or activities *under the direct control or ownership of the municipality*. Methane reduction opportunities within municipal areas that are not under the direct control of municipalities, that is, for activities for which the municipality is not the service authority, are not included.

Figure 2. Definition of municipal methane reduction opportunities

3.1 Methane as an energy source

Apart from the highly unusal use of methane derived from landfill gas as a chemical feedstock, i.e. as an input into the production of industrial chemicals, the productive use of methane stems from its value as an energy source. The following equation shows the combustion reaction of methane (CH_4) which combines with oxygen (O_2) to form carbon dioxide (CO_2) and water (H_2O) releasing 891 kilajoules (kJ) of energy in the process:

$$CH_4 + 20_2 \Rightarrow CO_2 + 2H_2O + 891kJ$$

The methane combustion process is a clean process compared to other fossil fuels, such as coal or oil, which have more complicated chemical structures and hence tend to release more harmful combustion products into the atmosphere.

3.1.1 Scale of energy available

Methane from municipal sources will not replace large proportions of energy used at the municipal level but can make an important difference to the energy profile of a municipality by:

- replacing coal-derived electricity or polluting fossil fuels;
- introducing a renewable source of energy into the energy mix of the municipality;
- reducing peak demand of the municipality; and
- potentially providing a back-up source of power for key installations in the event of an electrical outage

To provide a sense of the scale of a typical municipal LFG-to-energy project a hypothetical example is shown schematically below:

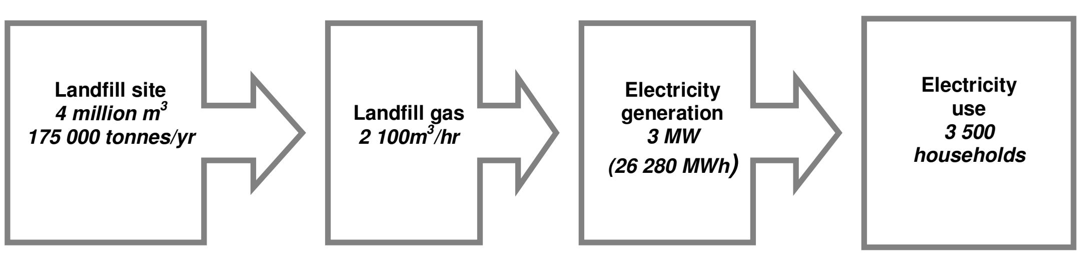


Figure 3. Schematic indication of energy supply from a LFG project

A 4 million m^3 landfill site would be a typical sized site, however both larger and smaller LFG projects would be viable. Cape Town uses approximately 10 000 GWh of electricity per year. Therefore such a project would displace about 0.25% of the city’s total electricity use. For a city the size of Msunduzi such a project would displace about 1-1.5% of the city’s electricity use.

When comparing energy content of different types of energy it is useful to note the following energy conversion factors:

$$1kWh = 3.6MJ = 3412Btu = 860kcal$$

where:

kWh = kilowatt hours

MJ = mega-joules

Btu = British thermal units

Kcal = kilo-calories;

and

$$1000MJ = 1GJ = 3600kWh$$

where:

GJ = giga-joules

Figure 4. Energy Unit Conversion Factors

3.2 Landfill Gas

Landfill gas is a complex mixture of gas produced from biological processes within landfills. Methane typically makes up about 40-50% of landfill gas.

3.2.1 Landfill gas production

Anaerobic breakdown of organic material results in the production of methane (CH_4) carbon dioxide (CO_2) and other volatile organic compounds. The resulting water saturated gas mixture is referred to as landfill gas (LFG). A typical composition for *residual* landfill gas is as follows:-

Table 3. Typical Composition of Landfill Gas

Gas	*Percentage by Volume*
CH_4	64%
CO_2	34%
Nitrogen	2%

The term *residual* when applied to landfill gas is generally understood to mean gas that is **not** being actively extracted and represents the equilibrium composition as a result of natural generation and migration.

At 25^0C landfill gas typically contains 1.8% by mass of water (H_2O) and has a density of 1.295 kg/m_3. The gas contains trace amounts of volatile fatty acids (VFA), hydrogen sulphide (H_2S), mercaptans (R-SH) and ammonia/amines ($R\text{-}NH_2$) that are responsible for the typical sour odour associated with landfill gas. The mercaptan and amine compounds have particularly strong and objectionable odours at low concentrations. Typical landfill gas from an **active extraction** scheme has a CH_4 content of 40 – 50% by volume.

Landfill sites that are anaerobic, with a depth of refuse greater than 2m and sufficiently moist will generate landfill gas after 6 – 9 months from deposition.

Landfill gas properties and hazards

Methane (CH_4) is a colourless, odourless, asphyxiant, flammable, non-toxic gas that is lighter than air. Typical landfill gas, if permitted to accumulate in low lying or enclosed or confined spaces, may produce an atmosphere that is both explosive and hazardous to life. The CO_2 and VFA components of landfill gas are highly aggressive to concrete, brick mortar and mild steel.

Landfill gas will displace oxygen from enclosed spaces making entry to them extremely hazardous. CH_4 is explosive in air between the concentrations of 5 – 15% by volume. This concentration range is referred to as the explosive range.

Landfill gas can severely damage plant growth in migration pathways due to a lack of O_2 and high temperature in the root zone. This occurs both by physical displacement and microbiological use of O_2 in the conversion of CH_4 to CO_2. All of the intermediate products are toxic and may pass to atmosphere with migrating gas if the overall reaction becomes inhibited. The generation of both CO_2 and heat in the root zone will cause severe plant stress and may prevent growth totally.

Variability of landfill gas emissions and composition

Because landfill gas is the result of biological processes operating on a material (solid waste) with variable composition there is a constant fluctuation in landfill gas production and composition and the landfill gas generation profile will be different from site to site. The following conditions will cause variation in landfill gas emission and composition:

- Changes in atmospheric pressure
- Changes in aquifer levels
- Migration through biologically or chemically active media
- Rainfall or lack of rainfall
- Changes in the composition of the underlying waste
- Alterations in operating procedures on site

Rapidly falling atmospheric pressure will result in greatly increased landfill gas emission rates with an increased CH_4 content. The more stable the pressure prior to a fall the greater the increase in gas migration. This is due to a gas build up during periods of stable pressure.

Landfill gas migrates in porous media through the processes of diffusion and advection. These two processes are driven by concentration and pressure gradients respectively. Landfill gas pressures within a landfill are typically within the range 5 – 25 mbar. Landfill gas migration typically reaches 50 – 100m from a landfill but is seldom seen more than 300m from one.

3.2.2 Landfill site classification/Minimum standards

The Minimum Requirements for Waste Disposal by Landfill (1998), as issued by the Department of Water Affairs and Forestry (DWAF), basically determine the following:

- Sets out procedures, actions and information required from a permit applicant during the landfill site permitting process,
- Provides a point of departure against which environmentally acceptable waste disposal practices can be distinguished from environmentally unacceptable waste disposal practices, and
- Provides the applicable standards or specifications that must be followed in the absence of any valid motivation to the contrary.

All landfill sites in South Africa are required to be registered and permitted in accordance with the above Minimum Requirements.

The relevant landfill site, is generally classified in terms of the waste types that are to be accepted by the site. Other factors, including site size, waste input rates, climatic conditions, leachate generation potential etc also determine the ultimate classification of the landfill site.

In terms of the Minimum Requirements, gas management systems are required if it has been determined that landfill gas migration and accumulation are found to represent a potential safety hazard or odour problem, or if an operating or closed site is situated within 250m of residential or other structures.

Although gas management systems are not obligatory, gas monitoring systems are required to monitor the potential threat of landfill gas migration. Only when such a threat has been determined, is it required to implement a gas management system.

Both active extraction and passive gas management systems are permitted. In either case the gas management system requires approval from DWAF.

3.2.3 Productive use of landfill gas

As a carrier of energy, predominantly due to the methane component, landfill gas is of interest in a range of applications. Since LFG is approximately 50% methane, it is considered a low/medium grade fuel. This resource can be harnessed in a number of applications including direct fuel use for heating, electrical generation, and commercial chemical by-products. In addition to mitigating LFG migration and odour concerns, LFG utilization can also generate revenues from the sale of LFG products that can defray the costs of landfill operation and maintenance.

Energy replacement

Landfill gas, which is actively extracted under steady state conditions, may typically contain 40 – 45% CH_4 and have a lower calorific value (LCV) of some 16 – 18 MJ/Nm^3. By comparison, the LCV of coal and fuel oils is 22 and 40 -42 MJ/kg respectively.

The conversion of thermal energy to electricity via a reciprocating spark ignition engine, which is generally the preferred option, has an efficiency off 33 – 65% depending on the degree of use of exhaust heat. Generation of 1.3 MW of electrical power requires some 750 Nm^3/hr of landfill gas at a concentration of 40 – 45% CH_4. Alternatively, in order to generate 1 MW of power, some 700 Nm^3/hr of landfill gas at a concentration of 50% CH_4, is required.

Direct thermal use of landfill gas requires 3 – 4% additional energy to compensate for the energy lost in heating the non-combustible CO_2 component. The direct use of gas in applications such as cement kilns, asphalt hot mix plants, brick kilns, glass furnaces, incinerators or steam raising plants is likely to be the most economic in the South African context strictly from an energy conversion point of view.

If however, landfill gas extraction is required for environmental control purposes (controlling gas migration and effecting greenhouse gas reduction), or the capital costs of extraction can be offset via other means, such as CDM project finance, then the generation of electricity may well become financially viable.

3.2.4 Landfill gas use and quality

LFG can be classified into three categories, based on the level of pretreatment/processing prior to utilization[1]. These are:

- **Low-grade LFG fuel**: Utilization of LFG as a low-grade fuel typically requires minimal processing, mainly involving reducing the amount of moisture in the gas stream.
- **Medium-grade fuel**: Additional gas treatment devices are used to extract more moisture as well as contaminants and finer particulate matter. This is a more complex and expensive process and typically involves compression and refrigeration of LFG and/or chemical treatments.
- **High-grade fuel**: Use of LFG as a high-grade fuel involves extensive gas pre-treatment to separate the carbon dioxide and other major constituent gases from the methane and to remove most impurities as well as gas compression to dehydrate the gas.

Low and medium-grade fuel produced from LFG has a heating value of approximately 16.8 MJ/m^3. This heat value is roughly one-half the heating value of natural gas. LFG that has been further processed and treated to produce high-grade fuel has a higher heating value (37.3 MJ/m^3) than low and medium grade fuel, and can be substituted directly for natural gas in pipeline applications (CRA, 2003).

[1] Much of the information in this section is drawn from a feasibility assessment report prepared for the Msunduzi Municipality evaluating the use of LFG from the New England Road landfill site (Knight Piesold and Palmer Development Group, 2004).

Low-grade fuel applications

Heating

LFG can be used with minimal treatment for fueling an on-site or off-site furnace, drying kiln, or boiler. Due to the relatively low heating value, such equipment must be designed to operate on the LFG fuel. The end user must have a constant and adequate demand for the fuel and be within close proximity to the site. The gas is typically transported to a neighboring facility through a dedicated pipeline. It is necessary to design the supply pipeline to avoid condensate accumulation within the pipeline resulting in possible blockage.

Raw LFG can also be used for small pilot or demonstration projects, such as heating an on-site greenhouse. Although direct use of the LFG makes intuitive sense, it is necessary for a suitable user to already exist in close proximity to the site. This means an application that has a base load user profile, which demonstrates an adequate and continuous year round fuel demand exceeding the supply available at the site. It also requires the use of equipment that combusts the fuel with suitable retention time and temperature to ensure adequate destruction efficiency of the numerous trace gas components in the LFG.

Boiler fuel

Low-grade LFG can also be used as a fuel for boilers to produce steam for heating or electricity generation. This utilization method requires minimal treatment because the potentially damaging LFG does not contact any moving parts because the gases are contained within the boiler tubes, which are more robust. The steam produced by the boiler could be used for space heating or process (CRA, 2003).

Micro-turbines

Micro-turbines for electricity production can use low grade LFG. They can provide up to 75 kW of electrical power and 85 kW of heat for combined heat and power applications. Microturbine systems contain a compressor, recuperator, combustor, turbine, and permanent magnet generator, but require a very small footprint for operation. The smaller capacity of these units makes them most suitable at older, smaller or remote sites with low LFG production rates.

Medium-grade fuel applications

Heating

Medium-grade fuel has a broader range of fuel applications than low-grade fuel because of the reduction in corrosive constituents. It may be used in industrial boilers, dryers, kilns, or gas furnaces. Costs incurred as a result of processing the gas may by offset by a reduction in operation and maintenance costs, and an increased life in the heating equipment. As with low-grade fuel, it is necessary to have a nearby market to which the heat produced can be sold.

Reciprocating gas engines

Reciprocating engines that use medium grade LFG as a fuel are readily available and may be obtained as modular units or within a complete parallel generator package. They are available in various sizes with electrical outputs ranging from less than 0.5 MW to more than 3.0 MW per unit. They have a comparatively low capital cost per kW and a higher efficiency than most gas turbines and the modular nature of reciprocating engine systems provides flexibility for incremental expansion that may be required due to the uncertain nature of future LFG production. These units can be added in smaller incremental stages than gas turbines. The disadvantages of this technology include higher maintenance costs than for gas turbines and a requirement for more skilled maintenance personnel. Exhaust gases may contain some products of incomplete combustion and there is a high lubricating-oil consumption, which includes need for provision of disposal of the waste oil (CRA, 2003).

Gas turbines

Gas turbines are available as modular and packaged systems. Gas turbines may have some application for sites with higher, more stable LFG production rates. Gas turbines are generally larger than reciprocating engines with electrical outputs ranging from 1 MW to 8 MW for each unit. Gas turbines also offer the flexibility of modular expansion to suit changes in LFG production however, the incremental stages are larger than for reciprocating engines. Gas turbines usually have a higher capital cost associated with initial set up with somewhat lower energy conversion efficiencies compared to reciprocating engines. However, they generally offer superior exhaust emission characteristics, reduced operating and maintenance costs and greater operational flexibility (in the ability to maintain reasonable efficiency despite fluctuations in LFG flow and characteristics) than reciprocating engines.

High-grade fuel applications

Pipeline quality gas

Utilization of high quality LFG to produce pipeline quality gas has been undertaken at several landfills in the United States. The methane component of refined LFG is generally used as a direct substitute for natural gas. The pipeline quality gas is delivered under pressure either to the local utility or directly to a customer(s). Therefore, the markets for this type product are nearby natural gas utilities or industrial users where a gas reticulation network already exists. There are not many sites where this has been a financially viable option, however.

Chemical products production

Methane and carbon dioxide, the principal components of LFG, may be used as feedstock for certain chemical products such as methanol, fertilizers, and fuel cells. There are proprietary processes available to produce methanol from LFG. Methanol can be used as an alternative fuel or fuel-additive for gasoline and diesel-powered engines, and as an alternative bleaching agent for the pulp and paper industry. The high capital costs, limited markets for products, and complexity of the process make this option a less favoured alternative and it does not appear to be economically viable at the present time.

Vehicle fuel

Compressed LFG produced through proprietary processes, have been used to fuel vehicles at a number of locations. These include a pilot project at the Weltevreden Landfill Site in Ekurhuleni where a locally developed membrane technology was used to purify the gas. For this application the LFG must first be treated to remove impurities and boost its fuel value before it is compressed. Advantages of this application include a reduction in fossil fuel consumption and local pollution. However, there are significant costs associated with the retrofitting of vehicles to accept this type of fuel and the cost of building fueling stations.

3.2.5 Methane Emission Modelling Approaches

A review of the available literature and site data obtained for the various landfill sites was conducted. The review of this literature, historical information and site monitoring data was used to form the basis of inputs required to complete the landfill gas generation models for the sites. Where necessary, two different models were utilised for the assessment in order to obtain the best possible estimation of the current and future gas yields from the respective sites. The Environment Agency (UK) software package called GasSim was used to carry out the landfill gas generation modelling.

The model relies on multi-phase (waste inputs per year) and a single-stage mathematical approach. The GasSim model can also be run in the US EPA LandGEM mode which is simpler than the more complex GasSim multi-phase equation. The GasSim model has been developed by the UK Environment Agency and is now the UK industry standard programme, approved by the Environment Agency and used routinely by the UK landfill industry. See www.gassim.co.uk. Although GasSim has been developed primarily as a risk assessment tool, the first module is a generation model which is applicable to predicting yields at landfill sites such.

The user inputs for the GasSim model differs from other models in that the model relies on the use of Probability Density Functions (PDFs). These PDFs are more complex and can also result in a greater margin of error if not used correctly. The model has been utilised to offer modelling over a range of scenarios to represent the uncertainly with the modelling.

Site Data and Model Inputs

With all modelling, the accuracy of the outputs will depend on the accuracy of the input site data. The following are examples of model inputs that need to be defined or supplied as site data:

- Quantities and types of wastes deposited in the landfill, on a tons per year basis
- Waste composition and moisture content of wastes
- Type, thickness and permeability of liner and cap design(s) (Clay/ BES, GCL, geomembrane, composite etc)
- Size of landfill: footprint dimensions, height and existing volumes or capacity
- Mean annual rainfall

Landfill Characteristics

All the landfill sites that were evaluated, mainly accept municipal solid wastes, which are classified as “General Waste” in terms of the Department of Water Affairs (DWAF) Minimum Requirements for Waste Disposal by Landfill (1998). The waste data are the most important inputs needed for accurate gas generation to be calculated. The wastes deposited at the site need to be categorised into different waste streams e.g. domestic, industrial and commercial. In GasSim the waste type can then be defined further to enable a waste profile for the site to be generated by estimating the percentages of biodegradable (i.e. gas generating) and non-biodegradable (i.e. non-gas generating) materials that are contained within each of the waste types.

Unfortunately, in most cases accurate site data is not available for most landfill sites. For this modelling assessment a combination of actual site data; data collected by the UK Environment Agency on waste streams; best estimate data (based on knowledge of South African waste streams); and default data have been utilised in different modelled scenarios.

3.3 Waste-water Treatment

As outlined, methane emissions are generated during the anaerobic stage of waste-water treatment via a similar biological process to that occuring under anaerobic conditions in landfill sites. There are a number of ways to reduce and/or to use these waste emissions (EPA, 2004).

Methane emissions can be virtually eliminated if waste-water and sludge are stored and treated under aerobic conditions. Options for preventing methane production during waste-water treatment and sludge disposal include aerobic primary and secondary treatment and land treatment. Alternatively, waste-water can be treated under anaerobic conditions and the generated methane can be captured and used as an energy source to heat the waste-water or sludge digestion tank. If additional methane is available, it can be used as fuel or to generate electricity. As a last resort, the gas may be flared, which converts the methane to CO_2, with a much lower global warming potential. All of these options are in use in some form or another in waste-water treatment works in South Africa.

Waste-water treatment costs are highly dependent on the technological approach employed and site-specific conditions. High-rate anaerobic processes for the treatment of liquid effluents with high organic content (such as sewage and food processing wastes) can help reduce uncontrolled methane emissions.. Both Brazil and India, for example, have developed extensive and successful infrastructure for these technologies, which have lower hydraulic retention times than aerobic processes and therefore are much smaller and cheaper to build. More importantly, unlike aerobic processes, no aeration is involved and there is less electricity consumption and hence lower operating costs than aerobic systems (IPCC, 1996).

3.3.1 Methane emissions from waste-water treatment

Anaerobic Digestion

Anaerobic digestion is a common method used for treating waste water sludges. Its attractiveness comes from it being a relatively stable process if properly controlled, with low operating costs and the production of a useful by-product, a combustible gas, which can be used as a source of energy. This gas is commonly referred to as biogas.

Anaerobic digestion is a multi-stage biological process whereby bacteria, in the absence of oxygen, decompose organic matter to carbon dioxide, methane and water.

The biogas consists of a mixture of 25 – 40% carbon dioxide (CO_2) and 60 – 75% methane (CH_4) which very often is used for digester heating or to generate power. In most cases, where the biogas is not used for digester heating, it is simply vented or flared off.

Factors Affecting Sludge Digestion

The anaerobic digestion process is controlled by a number of factors which are critical for the optimum production of biogas. These include:

- Sludge composition- nutrient levels, solids content, type of sludge, toxicity.
- Method of sludge addition
- Degree of mixing
- Temperature: heating increases the activity of the anaerobic bacteria
- pH value – normally 7.0 to 7.5
- Solids retention time
- Anaerobic conditions – no free oxygen must be present

Biogas Production Rate

Experience has shown that some 1 m^3 of biogas should be produced per kg of volatile solids destroyed over a period of some 20 days at a digestion temperature of 35^oC. It is thus possible to calculate how much biogas should be produced based on the daily feed loading to the digester.

However, in many cases insufficient information is available for the accurate determination of potential biogas production and records with respect to the measurement of biogas production are not maintained. In some cases, basic information relating to waste water flow rates, sludge type and organic content (BOD or COD) are not available.

In order to assess potential biogas production rates for the various waste-water treatment plants, a simple methodology was employed as described below.

The Intergovernmental Panel on Climate Change (IPCC) conceptual approach for estimating potential CH_4 emissions from waste-water treatment plants is simple and straightforward. The basic calculations are formulated as follows:

CH4 emissions (kg/day) = Total COD (kg/day) x Bo (kg CH_4/kg COD) x MCF

where:

COD is the Chemical Oxygen Demand of the waste water to be treated

Bo is the maximum methane producing capacity (default value: 0.25 kg CH_4/kg COD)

MCF is the methane conversion factor (for anaerobic conditions, MCF = 1)

Due to the lack of sufficient information from many of the waste-water treatment plants that were surveyed in the study, the above simplified IPCC methodology was used to determine maximum potential biogas generation. Where appropriate, allowance was made for reduced efficiency and where other treatments processes (such as aerobic processes) were also being used.

Results

Potential biogas production was determined for all the waste-water treatment plants that were identified as currently generating biogas (where measurements are taken on a regular basis) and those having the capacity to generate biogas. In many cases, the waste-water treatment plant operators had no idea what volume of biogas was being produced, although in some cases the biogas was being utilised to heat the digesters.

3.3.2 Productive use of excess methane from waste-water treatment

The options for the productive use of biogas from waste-water treatment works are similar to the uses of landfill gas. The major differences between landfill gas and waste-water treatment emissions are that typically gas from anaerobic digestion has a much higher proportion of methane than landfill gas and therefore has a much higher energy content per equivalent volume of gas. On the other hand, the overall volumes of gas from waste-water treatment works tends to be significantly smaller than that from landfill sites which also has implications for potential productive uses.

The most common productive use of methane from anaerobic digesters is for process heat for the digester itself. The anaerobic digestion process works best if the sludge is kept at a temperature of approximately 35°C. Waste methane can be drawn off and passed through a boiler to heat water which in turn is used to heat the sludge in the digesters to the optimal termperature. This is an effective and relatively simple means of using the energy contained in the waste methane. Aside from this application biogas from waste-water treatment works can be used for the same range of applications as landfill gas as long as the volumes of methane are sufficient to warrant the required capital investment.

3.4 Summary of Existing Projects and Studies

The potential for developing CDM projects in South Africa has been recognized by a number of potential buyers of emission reductions including governments, private sector organizations and brokers. This has resulted in a number of capacity building projects to assist in potential project developers in understanding the CDM, followed by more targeted project development activities.

The South African National Strategy Study on the CDM was the first to look in detail at the opportunities for CDM projects in the country. Even at that stage LFG projects were identified as having significant potential as a result of the so-called "methane kick", but also because of the fact that a number of municipalities had well run waste management programmes (specifically with regard to landfill site management) that could underpin the development of such projects.

The World Bank's identification of the potential of the Bisasar Road Landfill Site (an eThekwini Municipality project) added to the momentum in this area, as it gave a clear example of a credible buyer of emission reductions willing to get involved in such a project in South Africa. The UNDP also undertook a capacity-building initiative that specifically targeted the understanding of municipalities as to what the potential for such projects could be and what factors should be considered in their development. This programme was run with the assistance of SouthSouthNorth (SSN), an NGO operating in a number of developing countries including South Africa and Bangladesh. SSN had been active in this area through their support of Cape Town's initiative to develop a landfill gas project at its Bellville landfill site.

Since these early initiatives there have been a number of potential projects identified which are being supported in their project development phase by a range of parties. These include:

- A landfill gas feasibility study at Msunduzi Municipality's New England Road landfill site (this study is being supported by the Development Bank of Southern Africa);
- The Ekurhuleni Metro is currently investigating the potential gas yields at a number of their sites, as a prelude to a more detailed feasibility study which they have secured funding for from the DBSA; and,
- Pikitup's (Johannesburg's waste utility) investigations into a LFG CDM project, which are being supported by DANIDA.

Other types of opportunities for methane emission reductions, including waste-water treatment facilities and composting, have not received the same level of attention given to LFG projects simply because of the smaller volumes involved potentially and the greater challenges around developing such projects. However the ICLEI Cities for Climate Protection initiative (supported by USAID) and a series of municipal scoping studies looking for greenhouse gas reduction opportunities undertaken by the local office of the International Institute for Energy Conservation (IIEC) have looked and identified such opportunities. This work, amongst others, has also identified a number of other project types that could lead to greenhouse gas reductions within municipalities including:

- The installation of energy efficient street lighting;
- Installation of solar water heating in housing developments; and
- Fuel switching in public transport.

A recent significant initiative in this area has been DME's recognition that use of landfill gas to generate electricity will assist them in achieving the country's renewable energy generation target. To support this initiative the DME have commissioned, as part of the DANIDA supported Capacity Building in Energy Efficiency and Renewable Energy Programme, a study to investigate this potential in more detail.

There is also an emerging trend of city level energy audits or plans. These include those conducted by the City of Cape Town (City of Cape Town, 2003) and one recently commissioned by Ekurhuleni. The results from these other projects and studies will be used where appropriate in the identification of opportunities. This will prevent a duplication of effort and data gathering where this has occurred already and will free resources for more in depth investigations into areas currently under-investigated.

4 Relationship to city development strategies

The establishment of any new development project by municipalities needs to be done in alignment with the development strategies of the cities. The development vision of South African municipalities is contained within their Integrated Development Plans (IDPs) and these have been used as guiding documents to ascertain the alignment of methane reduction and use projects with city development strategies.

Typically both landfill gas and waste-water treatment methane reduction projects will contribute to improvements in local air quality. In particular, the controlled extraction and combustion of landfill gas offers opportunities to control and reduce odours and noxious emissions and also can reduce health and safety risks for workers on site.

The productive use of methane provides opportunities for employment creation in the management of the gas extraction, treatment and transport process and also provides opportunities for the establishment of local economic development projects that can use the energy resources.

A well designed methane reduction and use project can transform an environmental risk and liability into a new resource for a municipality. There are two components to this resource. One is the energy itself and the productive uses to which it can be put. The other component is the revenue that accrues from the methane reduction via the sale of certified emission reductions. This new revenue stream can be used to support improved service delivery in the waste management sector, such as improving operations and landfill sites, or can be used to support an associated local economic development project that is using the energy. The revenue stream can also be used as collateral for capital expenditure, such as infrastructure upgrading or can simply be returned to the municipal budget.

The individual city reports include more detailed and specific insights into the relationship between the various project options and the individual municipals IDPs.

At a broader scale than the municipal level energy from methane projects will also support the renewable energy policy of the Department of Minerals and Energy published in the form of the *White Paper On The Promotion of Renewable Energy and Clean Energy Development*. This policy specifically mentions the use of methane from landfill gas and waste-water treatment works. In the White Paper the DME (2002) has established a medium-term (10-year) target for renewable energy development which is, "an additional 10 000 GWh (0.8 Mtoe) renewable energy contribution to final energy consumption by 2012". The effective use of their methane resources by municipalities will contribute to this developmental target of government.

5 Results

A set of twelve individual city reports have been prepared which provide a city level insight into potential methane reduction opportunities and in some cases provide indications of the potential productive use of the methane resource. The main findings from the data gathering and interviews conducted in the twelve cities are summarised in this section. The twelve individual city reports are attached as Appendix A to this report.

The data-gathering from municipalities was generally successful. However, many cities do not yet capture data on some of the key parameters required to thoroughly analyse potential landfill gas or waste-water emissions. For example, many municipalities have only a limited sense of the composition of their solid waste streams. Very few municipalities have conducted full gas yield trials or have gas monitoring networks in place on their landfill sites.

In those instances where information was patchy default values have been used in the modeling exercise undertaken to evaluate the potential landfill gas and methane yields from the various facilities. The quantitative results presented in Table 6 and Table 7 should therefore be seen as indicative values that will need to be refined as municipalities enter into the project development process.

5.1 Key findings

The results of the investigation indicate that there are many possible landfill gas reduction opportunities but are less promising with regards to methane reduction projects at waste-water treatment works for a number of reasons discussed below.

For ease of presentation the potential projects are categorised according to their scale in terms of potential gas-to-electricity production (in MW). The potential landfill gas projects range in size from 0.5 MW to >10MW projects with the bulk of projects clustered in the 1-4MW range. The distribution of potential projects is shown in the graph below.

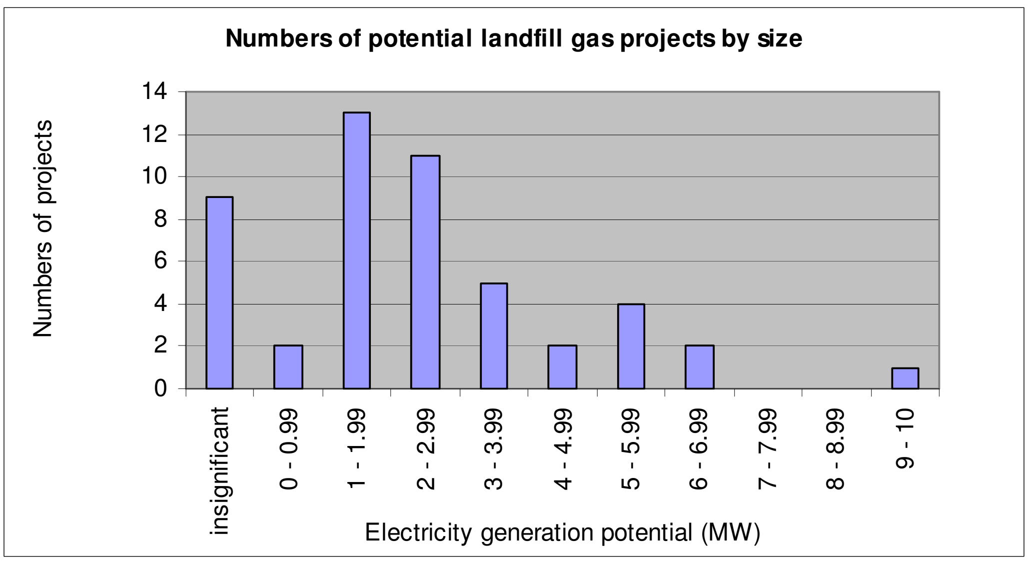


Figure 5. Number of potential landfill gas to energy projects

The total generation potential of these sites is about 104 MW. It is difficult to identify which of these projects offers the greatest potential since there are many success factors. As a simple approach to identifying some specific priority projects those with a generation potential greater than 4 MW have been listed below in Table 4. The full set of landfill sites and their methane reduction and power generation potential are shown in Table 6 below.

Table 4. Landfill sites with the greatest potential electricity generation potential

Local Authority	Landfill Site	Remaining capacity (tonnes)	Estimated Peak LFG Yield (Nm3/hr)	Estimated Methane (tons/annum)	Potential Electricity Generation (MW)
Buffalo City	Round Hill	12,640,000	3,400	10,658	4.0
Joburg Metro	Marie Louise	5,200,000	3,200	10,031	4.0
Cape Town	Vissershok	9,000,000	4,400	13,793	5.0
Cape Town	Coastal Park	6,800,000	4,400	13,793	5.0
Ekurhuleni Metro	Zesfontein (future)		> 4000	> 12500	5.0

Local Authority	Landfill Site	Remaining capacity (tonnes)	Estimated Peak LFG Yield (Nm3/hr)	Estimated Methane (tons/annum)	Potential Electricity Generation (MW)
Ekurhuleni Metro	Rooikraal	11,286,000	3,850	12,069	5.0
eThekwini	Bisasar Road		7,500	23,511	6.0
Joburg Metro	Goudkoppies	11,400,000	5,000	15,674	6.0
eThekwini	Buffelsdraai (future)		>7000	>21900	10.0

Unsurprisingly, the larger opportunities tend to exist in the larger metros as they tend to have larger solid waste disposal sites. At the same time it can be seen from Table 6 that there are project opportunities in the second tier cities, such as Polokwane, that are of reasonable sizes and worthy of further investigation.

5.1.1 Use opportunities

It was apparent that the “default” option for landfill gas use was electricity generation despite the fact that it may not always be the most financially attractive option. This is due to the fact that it is seen as the simplest option to implement, with well understood technologies, a limited set of stakeholders and requiring relatively easy institutional arrangements. A further merit to electricity generation is the possibility of securing power purchase agreements from the municipality itself, in other words the municipality will be both the generator and purchaser of electricity. This will generally be simpler than establishing a contract to supply power, be it in the form of electricity or gas, to an external entity. Some city officials suggested that there may also be a developing market in so-called ‘green energy’ which could command a price premium and act as a further support to such projects. Given the national government’s commitment to renewable energy in general the licensing of independent power producers is likley to become easier over time.

Some cities managed to identify other potential uses – typically use of the landfill gas for direct heating in industrial boilers to displace coal or fuel oil in those cases where landfill sites were within reasonable distance of industrial zones.

Despite the fact that it is typically the simplest option electricity generation may not always the best option from a financial perspective and from an energy efficiency perspective. Therefore those cities intending to utilise waste methane should undertake a proper feasibility study which explores alternative options. It is relatively easy to conduct an initial scoping of the potential for such options by a rapid scan of industrial energy use within reasonable proximity of the site and by a consideration of the other potential gas uses and their applicability in the particular city setting.

5.1.2 Waste-water treatment

There are fewer and smaller opportunities in the waste-water sector for a number of reasons. The first reason is the predominant technology used for waste-water treatment in the cities investigated. Only about 30% of the waste-water treatment facilities for which data was gathered had some anaerobic component. Only a proportion of this 30% used anaerobic digestion as a significant component of their waste-water treatment process.

Secondly, there appears to be a fairly high standard of waste-water treatment management, with a large proportion of treatment works that do generate methane either using the bio-gas to assist in the heating of the digestion process or at the minimum flaring the excess or unused methane. It appears that Polokwane are Ekurhuleni are the only cities that are currently venting bio-gas without flaring it. The implication of these findings is that the there will be limited carbon finance benefits from bio-gas use projects since the baseline for the vast majority of these projects will include the combustion of the methane – thereby removing the methane reduction benefits from the carbon finance component of the project.

Small projects may exist for the productive use of gas that is currently flared. For example in Msunduzi, the treatment works have an excess of methane that is flared. Potential opportunities exist for the use of this methane as an energy source for future small manufacturing firms in the area. There may be some merit in using carbon finance to support these types of projects, since the bio-gas may displace more carbon intensive fossil fuels, however the contribution of the CDM to these projects will be much more limited than the landfill gas projects identified.

5.2 Institutional arrangments and project design

A number of cities, see the table below, already have an understanding of the CDM and are investigating the potential for landfill gas reduction projects with the support of carbon finance.

Table 5. Cities with CDM projects under consideration

City	*CDM projects under consideration*
Johannesburg	**Yes**
eThekwini	**Yes**
Cape Town	**Yes**
Tshwane	**Yes**
Nelson Mandela	No
Ekurhuleni	**Yes**
Msunduzi	**Yes**
Buffalo City	No
Mangaung	No
uMhlatuze	No
Polokwane	No
Mbombela	No

The city interviews suggest that given the existence of a fairly large numbers of potential projects the barriers to project development are not limitations on underlying opportunities but rather institutional and information limitations. Some of the cities interviewed had no knowledge of the potential for the CDM to support methane reduction opportunities and limited understanding of the potential benefits of landfill gas use. Almost all officials expressed the view that they did not have the capacity to manage the entire CDM process internally.

A number of the officials interviewed also noted that few cities had expertise in electricity generation and that this may be a barrier to cities undertaking such projects. At the minimum there was a fairly widespread view that most cities would outsource the management and development of methane reduction projects either as concessions or management contracts. Given the current capacity limitations in most municipalities these external models seem appropriate.

In support of the focus on the institutional capacity and information barriers is the fact that there do not appear to be any major legal obstacles to methane reduction project development. Although a fair number of regulatory requirements, often including environmental impact assessments, will need to be undertaken these do not seem disproportionate to the typical regulatory hurdles faced by other municipal investments. Similarly, as discussed further below, access to capital is unlikely to be a problem.

5.3 Landfill site and treatment works summary

The tables below provides a summary of the potential project opportunities in the landfill sites and waste-water treatment works under the control of the twelve municipalities investigated.

The landfill summary table headings are explained below:

Heading	Explanation
Landfill Site	Name of site
Year Opened	Year the site started accepting waste (where known)
Landfill Classification	Classification in terms of the DWAF minimum requirements
Operator	Operator of the site – either the municipality or a private contractor
Landfill Footprint Area (Ha)	Area covered by the landfill
Landfill Height (m)	Current height of the landfill contents
Current Input (tons/year) 2004	Annual tonnages of waste deposited
Total Capacity (m^3/tonnes)	Total available capacity of the site
Current In-place volume (m^3/tonnes)	Total volume of waste deposited to the present time
Remaining capacity (m^3 / tons)	Remaining capacity (airspace) in the site
Remaining Life (years)	Years to site closure
Year to Close	Year in which the site is scheduled to close
Estimated Peak LFG Yield (Nm^3/hr)	Modeled maximum yield of landfill gas from the site in cubic meters of gas per hour
Estimated Methane (tonnes/annum)	Modeled methane emissions from the site in tones per annum
Potential Electricity Generation (MW)	Estimate of the power that could be generated from the expected volume of gas

The waste-water summary table headings are explained below:

Heading	Explanation
Local Authority/Owner	The relevant local authority or other owner of the works where appropriate
Waste Water Treatment Works	Name of the works
Average Flow (Ml/day)	Average daily waste-water flow through the works
Treatment Process	Brief explanation process of the treatment process or processes used at the works
Volume of Raw Sludge (Ml/day)	Average daily volume of raw sewerage sludge treated
Organic Carbon Content (COD in mg/l)	Average organic carbon content of the waste-water
Volume Biogas Produced (m3/day)	Modeled volume of biogas produced from anaerobic digestion processes
Biogas Use	Current use of the bio-gas produced if any
Biogas Use Options	Potential use options for the waste bio-gas

Where information is uncertain or unavailable this is indicated with a question mark (?) or with n/a for not available.

In the case of waste-water treatment works there are many works where sufficient information is not available to make an accurate estimation of bio-gas generation or where information is still outstanding from local authorities.

Table 6. Landfill Gas Analysis Summary

Landfill Site	Year Opened	Landfill Classification	Operator	Landfill Footprint Area (Ha)	Landfill Height (m)	Current Input (tons/year) 2004	Total Capacity (m^3 / tons)	Current In-place Volume (m^3 / tons)	Remaining capacity (m3 / tons)	Remaining Life (years)	Year to Close	Estimated Peak LFG Yield (Nm^3/hr)	Estimated Methane (tonnes/annum)	Potential Electricity Generation (MW)
Buffalo City														
Second Creek	1955	GLB+	Municipality	38.0	20	200,000	7,500,000	6,900,000	600,000	3	2007	2,000	6,270	2
Round Hill	2005	GLB+	Municipality	63.2	20	316,000	12,640,000	0	12,640,000	40+	2045	3,400	10,658	4 - 5
NU 2	1985	Very small site									2007	n/a		
King Williams Town	1985	Very small site									2007	n/a		
Cape Town														
Bellville South (old)	1963	GLB+	CTM	29	30	315,000	3,000,000	3,000,000	0	0	2003	900	2,821	1
Bellville South (new cells)	2003	GLB+	CTM	7	13	325,000	975,000	325,000	1,500,000	3	2006	875	2,743	1
Vissershok	1980	GLB+/H:h	CTM	210	50	320,000	16,500,000	7,500,000	9,000,000	11	2015	4,400	13,793	5 - 6
Coastal Park	1980	GLB+	CTM	62	20	377,000	10,832,000	4,032,000	6,800,000	14	2016	4,400	13,793	5 - 6
Swartklip (closed)	1980	GLB+	CTM	103	10 - 15?	253,000	3,565,000	3,565,000	0	0	2003	1,800	5,643	2
Faure	1972	GLB+	CTM	36	34	211,000	6,120,000	5,065,000	750,000	3	2007	2,300	7,210	2 - 3
Brackenfell	1995	GMB+	CTM	4.5	30	246,000	1,363,000	1,123,000	240,000	1	2005	1,100	3,448	1
Ekurhuleni Metro														
Weltevreden	1995	GLB^+	Envirofill	20	25+	254,700	12,377,400	1,680,000	10,697,400	42	2046	2,900	9,091	3 - 4
Rietfontein	1997	GLB^+	Millenium	10	50	135,000	5,758,600	805,000	4,953,600	29	2029	1,480	4,639	2
Simmer & Jack	1983	GLB^-	Kutu Waste	13	45	350,000	5,850,000	375,000	2,100,000	6	2010	2,850	8,934	3 - 4
Platkop	1993	GLB^-	Millenium	18	30	100,280	5,309,000	600,000	4,709,000	37	2041	1,460	4,577	2
Zesfontein (future)	n/a	GLB^-	n/a			n/a	n/a			future site	n/a	> 4000	> 12500	> 5
Rooikraal	1988	GLB^-	Envirofill	95	30	350,000	14,386,000	3,100,000	11,286,000	38	2042	3,850	12,069	5

Landfill Site	Year Opened	Landfill Classification	Operator	Landfill Footprint Area (Ha)	Landfill Height (m)	Current Input (tons/year) 2004	Total Capacity (m^3 / tons)	Current In-place Volume (m^3 / tons)	Remaining capacity (m3 / tons)	Remaining Life (years)	Year to Close	Estimated Peak LFG Yield (Nm^3/hr)	Estimated Methane (tonnes/annum)	Potential Electricity Generation (MW)
eThekwini Metro														
Bisasar Road	1985	GLB+	DSW	LFG / CDM Study carried out by Enviros Consulting								7,500	23,511	6
Marrianhill	1997	GLB+	DSW	LFG / CDM Study carried out by Enviros Consulting								1,750	5,486	1.5
La Mercy	?	GMB+	DSW	LFG / CDM Study carried out by Enviros Consulting								700	2,194	0.5
Buffelsdraai	2005	GLB+	DSW	700+								>7000	>21900	> 10
Johannesburg Metro														
Kya Sands (closed)		GLB$^-$	Pikitup	Information not available		n/a	?	?	0	closed	2003	>1000	>3000	1
Linbro Park	1969	GLB$^-$	Pikitup	21	30	360,000	6,300,000	5,580,000	720,000	2	2006	2,300	7,210	3
Robinson Deep	1930	GLB$^-$	Pikitup	39.25	40	270,000	15,700,000	14,300,000	1,400,000	5	2009	2,900	9,091	3 - 4
Marie Louise	1991	GLB$^-$	Pikitup	38	20	299,700	7,600,000	2,400,000	5,200,000	17	2021	3,200	10,031	4
Goudkoppies	1989	GLB$^-$	Pikitup	45.3	30	270,000	13,600,000	2,200,000	11,400,000	35	2039	5,000	15,674	6 - 7
Ennerdale	1988	GLB$^-$	Pikitup	10	10	70,500	1,000,000	239,300	760,700	10	2014	400	1,254	n/a
Mangaung Local Municipality														
Northern Landfill	1990	GMB-	MLM	24.7	15	97,760	3,704,000	1,260,000	2,444,000	25	2029	1,000	3,135	1
Southern Landfill	1990	GLB-	MLM	33.3	15	132,860	5,001,500	1,680,000	3,321,500	25	2029	1,350	4,232	1
Botshabelo	1990	GSB-	MLM	6.5	10	22,000	646,800	210,000	436,800	20	16-Jul	205	643	n/a
Mbombela Local Municipality														
Nelspruit	1987	GMB-	MLM	15	10	70,560	1,175,560	1,105,000	71,000	1	2005	675	2,116	0.5
White River	1987	n/a	MLM	5.6	10	33,360	558,440	425,000	133,440	4	2008	310	972	n/a
Msunduzi Local Municipality														
New England Road	1950+	GLB+	MMC	30	30	175,000	7,600,000	3,400,000	4,200,000	20	2024	2,500	7,837	3
Nelson Mandela Metro														
Arlington	1984	GLB- (?)	NMM	72	20	240,000	17,400,000	3,000,000	14,400,000	60	2064	1,700	5,329	2

Landfill Site	Year Opened	Landfill Classification	Operator	Landfill Footprint Area (Ha)	Landfill Height (m)	Current Input (tons/year) 2004	Total Capacity (m^3 / tons)	Current In-place Volume (m^3 / tons)	Remaining capacity (m3 / tons)	Remaining Life (years)	Year to Close	Estimated Peak LFG Yield (Nm^3/hr)	Estimated Methane (tonnes/annum)	Potential Electricity Generation (MW)
Koedoeskloof	1987	GMB- (?)	NMM	18.7	20	130,000	3,740,000	1,530,000	2,210,000	17	2021	1,300	4,075	1.5
Polokwane Local Municipality														
Weltevreden	1990	n/a	PMC	25	15	146,000	3,736,000	1,400,000	2,336,000	16	2020	1,400	4,389	1.5
Mankweng	Not sufficient information - site very small. Only 50 tons/day													
Tshwane Metro														
Hatherley	1998	GLB$^-$	Tshwane	96	10	144,000	14,400,000	840,000	13,560,000	50	2054	1,450	4,545	2
Valhalla	1975	GLB$^-$	Tshwane	11.7	15	216,000	2,340,000	2,340,000	0	0	2004	575	1,802	n/a
Kwaggasrand	1965	GLB$^-$	Tshwane	27.2	18	192,000	4,860,000	3,900,000	960,000	5	2009	1,400	4,389	2
Onderstepoort	1997	GLB$^-$	Tshwane	51.8	12	204,000	6,500,000	1,400,000	5,100,000	25	2029	2,050	6,426	2 - 3
Garstkloof	1980	GLB$^-$	Tshwane	43.6	20	264,000	7,560,000	6,240,000	1,320,000	5	2009	975	3,056	1
Temba	1995	GLB$^-$	Tshwane	3.7	20	96,000	740,000	810,000	96,000	1	2005	490	1,536	n/a
Derdepoort	1997	GLB$^-$	Tshwane	12.4	16.5	216,000	2,048,000	1,400,000	648,000	3	2007	1,260	3,950	1.5
Soshanguve	1995	GLB$^-$	Tshwane	39.1	8	132,000	3,060,000	1,080,000	1,980,000	15	2019	1,410	4,420	2
Garankuwa	1995	GLB$^-$	Tshwane	41.9	12	180,000	4,950,000	1,350,000	3,600,000	20	2024	1,550	4,859	2
uMhlathuze Local Municipality														
Alton (closed)	1981	(GLB+)	MM	+/- 15	20	65,000	2,760,275	2,760,275	0	0	2003	1,375	4,310	1.5
Empangeni (closed)	?	(GLB+)	MM	?	?	n/a	Insufficient information available.		0	0	2003	n/a		n/a
Uthungulu Regional	2003	GLB+ (?)	UDM	34	20	156,000	6,800,000	175,000	6,625,000	40	2044	1,120	3,511	1.5

Table 7. Wastewater Biogas Analysis Summary

Local Authority / Owner	Waste Water Treatment Works	Average Flow (Ml/day)	Treatment Process	Volume of Raw Sludge (Ml/day)	Organic Carbon Content (CODmg/l)	Volume Biogas Produced (m^3/day)	Current Biogas Use	Potential Biogas Use Options
Buffalo City								
Buffalo City	Berlin	<1	Bio-filters			Nil	n/a	n/a
Buffalo City	Central Treatment Works	5	PETRO			Potential 1390	n/a	Too small
Buffalo City	Dimbaza	7	Extended aeration			Nil	n/a	n/a
Buffalo City	East Bank	33	Extended aeration			Nil	n/a	n/a
Buffalo City	Gonubie	8	Extended aeration			Nil	n/a	n/a
Buffalo City	Mdantsane East	20	Bio-filters			Potential 5240	n/a	Too small
Buffalo City	Potsdam	7	Bio-filters			Nil	n/a	n/a
Buffalo City	Schornville	5	Extended aeration & Bio-filters			Nil	n/a	n/a
Buffalo City	Westbank	8	Sea Outfall			Nil	n/a	n/a
Buffalo City	Zwelitsha	8	Bio-filters			Nil	n/a	n/a
Cape Town								
Cape Town	Athlone	75	Anaerobic		916	23,996	Vented	Thermal or 1.5 MW_e
Cape Town	Bellville	51	Aerobic		1079	n/a	n/a	n/a
Cape Town	Borchards Quarry	25	Aerobic		1565	n/a	n/a	n/a
Cape Town	Cape Flats	173	Anaerobic		774	46,772	Vented	Thermal or 3 MW_e
Cape Town	Gordons Bay	2	Aerobic		611	n/a	n/a	n/a
Cape Town	Kraaifontein	6	Anaerobic		818	1,715	Vented	n/a
Cape Town	Llandudno	0.36	Anaerobic		650	82	Vented	n/a
Cape Town	Macassar	34	Aerobic		644	n/a	n/a	n/a

Local Authority / Owner	Waste Water Treatment Works	Average Flow (Ml/day)	Treatment Process	Volume of Raw Sludge (Ml/day)	Organic Carbon Content (CODmg/l)	Volume Biogas Produced (m^3/day)	Current Biogas Use	Potential Biogas Use Options
Cape Town	Melkbos	2	Aerobic		516	n/a	n/a	n/a
Cape Town	Mitchells Plain	29	Anaerobic		1144	11,588	Vented	Thermal or 0.5 MW_e
Cape Town	Parow	2	Aerobic		654	n/a	n/a	n/a
Cape Town	Potsdam	29	Aerobic		1009	n/a	n/a	n/a
Cape Town	Scottsdene	5	Aerobic		630	n/a	n/a	n/a
Cape Town	Simons Town	2	Anaerobic primary		615	429	Vented	n/a
Cape Town	Wesfleur	10	Aerobic		1115	n/a	n/a	n/a
Cape Town	Wildevoelvlei	6	Aerobic		852	n/a	n/a	n/a
Cape Town	Zandvliet	48	Aerobic		655	n/a	n/a	n/a
Ekurhuleni Metro								
Ekurhuleni Metro	Ester Park	0.31	Aerobic		450	n/a	n/a	n/a
Ekurhuleni Metro	Olifantsfontein	70	Anaerobic		759	18,570	Vented	Thermal or 1 MW_e
Ekurhuleni Metro	Hartebeesfontein	35.7	Anaerobic		845	10,530	Vented	Thermal or 0.5 MW_e
Ekurhuleni Metro	Ancor	26.5	Anaerobic		856	7,920	Vented	Thermal
Ekurhuleni Metro	Benoni	8.3	Anaerobic		646	1,875	Vented	Thermal
Ekurhuleni Metro	Daveyton	6.9	Anaerobic		925	2,230	Vented	Thermal
Ekurhuleni Metro	Carl Grundling	2.2	Aerobic		895	n/a	n/a	n/a
Ekurhuleni Metro	Herbert Bickley	13.2	50% Anaerobic		755	3,480	Vented	Thermal
Ekurhuleni Metro	Jan Smuts	6.6	Anaerobic		450	1,030	Vented	Thermal
Ekurhuleni Metro	JP Marais	13.2	Aerobic		695	n/a	n/a	n/a
Ekurhuleni Metro	Rynfield	5.8	Anaerobic		460	930	Vented	Thermal
Ekurhuleni Metro	Tsakane	14	Aerobic		387	n/a	n/a	n/a
Ekurhuleni Metro	Welgedacht	42	Aerobic		579	n/a	n/a	n/a
Ekurhuleni Metro	Rondebult	14.6	Anaerobic		1230	6,270	Vented	Thermal
Ekurhuleni Metro	Dekema	26.2	Anaerobic		822	7,530	Vented	Thermal
Ekurhuleni Metro	Vlakplaats	80.4	Anaerobic		695	19,515	Heating digesters	Thermal or 1 MW_e
Ekurhuleni Metro	Waterval	107.8	Anaerobic		1002	37,740	Heating digesters	Thermal or 2 MW_e
eThekwini								

Local Authority / Owner	Waste Water Treatment Works	Average Flow (Ml/day)	Treatment Process	Volume of Raw Sludge (Ml/day)	Organic Carbon Content (CODmg/l)	Volume Biogas Produced (m^3/day)	Current Biogas Use	Potential Biogas Use Options
eThekwini	KwaMashu	60	Anaerobic	45 t/d @ 18% solids	17484 kg/d	3000 (indicated)	Incinerator 100%	nil
eThekwini	Northern	54	Anaerobic	40 t/d @ 20% solids	30882 kg/d	4000 (indicated)	Drying plant 3000 m3/d	1000 m3/d available
eThekwini	Phoenix	15	Anaerobic	30 t/d @ 16% solids	12000 kg/d	2000 (indicated)	Heating digestors?	1200m3/d to flare
eThekwini	Verulam	6	Anaerobic	12 t/d @ 15% solids	5000 kg/d	800 (indicated)	800 m3/d to flare	800 m3/d available
eThekwini	Tongaat Central	7.7		14 t/d @ 14% solids	5800 kg/d	nil	nil	nil
eThekwini	Hammarsdale	9		30 t/d @ 14% solids	15500 kg/d	nil	nil	nil
eThekwini	Umbilo	14.3	Anaerobic	30 t/d @ 16% solids	10200 kg/d	2000 (indicated)	Heating digestors?	1000 m3/d to flare
eThekwini	Central	60		57 t/d TSS	44000 kg/d	nil	nil	nil
eThekwini	Southern	170		76 t/d TSS	195000 kg/d	nil	nil	nil
eThekwini	Amanzimtoti	24	Anaerobic	n/a	18000 kg/d	2000 (indicated)	Heating digestors?	1200 m3/d to flare
Joburg Metro								
Joburg Metro	Northern Works	323	Aerobic / limited anaerobic (assume 20%)	30529 dt/a	460	10,360	Boilers (qty unknown), excess flared	Thermal or 0.5 MW_e
Joburg Metro	Driefontein	18	Aerobic	1937 dt/a	490	nil	n/a	n/a
Joburg Metro	Goudkoppies	126	Aerobic / limited anaerobic (assume 20%)	21381 dt/a	450	3,960	Boilers (qty unknown), excess flared	Local small industries?
Joburg Metro	Bushkoppie	186	Aerobic	see comment	650	nil	n/a	n/a
Joburg Metro	Olifantsvlei	182	Aerobic / limited anaerobic (assume 20%)	36047 dt/a	400	5,085	Boilers (qty unknown), excess flared	Local small industries?
Joburg Metro	Ennerdale	4.5	Aerobic	22 dt/a	400	nil	n/a	n/a
Mangaung								
Mangaung	Bloemspruit	60	Anaerobic	500m3/d @ 6%	500	25,000	All biogas used to heat digestors.	Shortage of gas in winter.
Mbombela								
Mbombela	Kingstonvale	12	Activated sludge + Biofilters		25	nil	n/a	n/a

Local Authority / Owner	Waste Water Treatment Works	Average Flow (Ml/day)	Treatment Process	Volume of Raw Sludge (Ml/day)	Organic Carbon Content (CODmg/l)	Volume Biogas Produced (m^3/day)	Current Biogas Use	Potential Biogas Use Options
Mbombela	Matsulu	3	Activated sludge		18	nil	n/a	n/a
Mbombela	Kanyamazane	4	Oxidation ponds + Biofilters		32	nil	n/a	n/a
Msunduzi								
Msunduzi	Darvill	55	Anaerobic (2 digestors) & Aerobic	1.7 to 2.0	?	5,000	50% used to heat digestors	50% (2500 m3/d) available
Nelson Mandela								
Nelson Mandela	Fish Water Flats	100	Mainly anaerobic (Aerobic 12% max)		52000 kg/d	15,980	Boilers / Flared (75 m3/hr max)	Thermal or 0.5 MW_e
Nelson Mandela	Kelvin Jones	16.7	Activated sludge		718	nil	n/a	n/a
Nelson Mandela	Kwanobhule	6.2	Activated sludge		627	nil	n/a	n/a
Nelson Mandela	Despatch	3.9	Activated sludge		380	nil	n/a	n/a
Nelson Mandela	Cape Receife	7	Aerobic		400	nil	n/a	n/a
Nelson Mandela	Driftsands Water Reclamation	11	Aerobic		650	nil	n/a	n/a
Polokwane								
Polokwane	Polokwane	22	Activated sludge / Upflow anaerobic blanket		900	6,910	Heating digestors	Too small
Polokwane	Seshego	5 - 7	Biological filters with Anaerobic digestion		800	1,675	Vented to atmosphere	Too small
Polokwane	Thokgoaneng	0.13	Anaerobic / aerobic pond system			n/a	n/a	n/a
Polokwane	Mankweng	7(?)	Biological filters with Anaerobic digestion		700	1,710	Vented to atmosphere	Too small
Tshwane Metro								
Tshwane Metro	Babelegi	2.5	Aerobic		609	nil	n/a	n/a
Tshwane Metro	Baviaanspoort	35	Anaerobic		693	8,470	See comment	Thermal or 0.5 MW_e
Tshwane Metro	Rooiwal	120	Aerobic 50% Anaerobic 50%		586	12,280	See comment	Thermal or 0.5 MW_e
Tshwane Metro	Daspoort	55	Anaerobic		548	10,520	See comment	Thermal or 0.5

Local Authority / Owner	Waste Water Treatment Works	Average Flow (Ml/day)	Treatment Process	Volume of Raw Sludge (Ml/day)	Organic Carbon Content (CODmg/l)	Volume Biogas Produced (m^3/day)	Current Biogas Use	Potential Biogas Use Options
								MW_e
Tshwane Metro	Zeekoegat	35	Aerobic		548	nil	n/a	n/a
Tshwane Metro	Sunderland Ridge	43	Anaerobic		536	8,050	See comment	Too small
Tshwane Metro	Sandspruit	4	Aerobic		555	nil	n/a	n/a
Tshwane Metro	Rietgat	8	Aerobic		608	nil	n/a	n/a
Tshwane Metro	Klipgat	32	Anaerobic		550	6,150	See comment	Too small
Tshwane Metro	Temba	8	Anaerobic		n/a	?	See comment	Too small
uMhlathuze								
uMhlathuze	Nseleni	0.9	Aerobic			nil	n/a	n/a
uMhlathuze	Ngwelezane	2.1	Aerobic			nil	n/a	n/a
uMhlathuze	Esikhaweni	9	Aerobic			nil	n/a	n/a
uMhlathuze	Vulindlela	0.9	Aerobic			nil	n/a	n/a
uMhlathuze	Empangeni	8	Aerobic			nil	n/a	n/a

6 Institutional and Financial Options

There are a number of legal, institutional and financial considerations to be taken into account in the development of a CDM project. Many of these are similar to the standard factors that a municipality has to consider when developing any new project but some are particular to the CDM.

6.1 Institutional and Legal Context for the CDM

CDM projects are implemented in accordance with both international and domestic law. The international rules and procedures for the CDM are outlined in Decision 15/CP.7 of the UNFCCC (2001). The international CDM rules must be implemented in the context of the relevant domestic legislation controlling project development and investment. This domestic legislation includes national, provincial and municipal legislation related to environmental and planning controls, health and safety, and other applicable legislation.

Typically, a CDM project developer will have to ensure that the underlying project activity is in compliance with existing legislation and may also have to demonstrate compliance with regulations governing project initiation and implementation for the new CDM components of the project activity. For example, a LFG project is likely to have to demonstrate compliance with the relevant operating permit for the landfill site. In addition, an environmental impact assessment may be required for the new activity as well as any other legislation controlling the particular LFG end-use activities to be undertaken as part of the proposed project.

6.1.1 International CDM Regime

The CDM modalities and procedures (UNFCCC, 2001) determine the scope of the international regime applicable to CDM projects and prescribe the project cycle that must be undertaken. The modalities and procedures, referred to as the Marrakech Accords, also contain specific requirements for undertaking public participation and environmental assessment prior to project implementation.

The Marrakech Accords imposes the requirement of “additionality” on CDM projects and further require that the GHG emissions reductions potentially to be generated by the CDM project be measured against an objectively identifiable emissions “baseline”.

The provisions of the Marrakech Accords also require that certain domestic compliance is accomplished. The primary domestic requirements are obtaining approval from the designated national authorites of the countries involved in the CDM project and adherence to the national EIA regime of the Host country. These issues are both elaborated on below.

6.1.2 CDM project baselines

All CDM projects are required to use an approved baseline methodology for estimating carbon emissions reductions, or to propose a new methodology if an appropriate one is not available. A baseline methodology is a protocol for selecting the baseline scenario and calculating baseline emissions for a particular project type or within a particular sector so as to produce a baseline scenario. A baseline methodology contains formulae and algorithms for a particular project type, as well as certain parameters for calculating the baseline scenario. The methodology also explains how *additionality* will be tested for that project category.

Additionality is one the most difficult concepts in assessing and developing CDM project proposals. The CDM rules state that the CDM project activity is additional if anthropogenic emissions of greenhouse gases are below those which would have occurred in the absence of the registered CDM project activity (UNFCCC, 2001). Projects are not eligible for the CDM if they are not additional. The CDM Executive Board has provided some guidance as to how to evaluate whether a project is additional to the business-as-usual scenario or not (see UNFCCC, 2004a).

6.1.3 Baseline determination and additionality requirements

As discussed above, a key step in CDM project development is the determination of a suitable project baseline. The baseline *methodology* has to be approved by the Executive Board of the CDM prior to the project being submitted as a CDM project. If there is a pre-existing approved methodology for the project type under consideration this methodology can be used by the project developer.

Fortunately, there have been a number of landfill gas projects implemented as CDM projects internationally and baseline methodologies in this regards have been approved by the Executive Board of the CDM. In addition, the methodology panel of the Executive Board has prepared a draft consolidated methodology which incorporates the methodologies of already approved landfill gas reduction and landfill gas-to-energy projects (UNFCCC, 2004b). While this consolidated methodology is subject to amendment it provides a guide as to what will be required by a municipality to have a landfill gas project registered as a CDM project. The presence of an approved methodology for landfill gas projects removes a time-consuming step in the project cycle and paves the way for relatively rapid landfill gas project development.

There is as yet no consolidated methodology for methane reduction from waste-water treatment works. A number of waste-water treatment methane reduction projects have been developed and an approved methodology exists for some limited types of waste-water treatment projects (see UNFCCC, 2004c). The methodology is, however, only applicable to "methane recovery project activities involving organic wastewater treatment plants with the following applicability conditions:

- The existing waste water treatment system is an open lagoon system with an 'active' anaerobic condition i.e. with a high level of methane generation;
- The methodology applies to *forced* methane extraction project cases, as there is a process change from open lagoon to accelerated methane generation in a closed tank digester or similar technology. Therefore, depending only on the amount of captured methane emissions to establish baseline emissions will not be adequate as the project activity may extract more methane than would be emitted in the baseline case;
- The captured methane is used for electricity generation, which avoids emissions due to displaced electricity in a well-defined grid electricity;
- For projects with a renewable power generation capacity lower than 15 MW." (UNFCCC, 2004c).

It is unlikely that there would be major technical difficulties in developing new methodologies for other types of waste-water methane reduction projects since the various operating parameters of waste-water treatment works are well understood and because of the similarities with methane reduction from landfill sites. Nevertheless, there is the added element of developing a new baseline methodology for approval that will be required in the case of any early waste-water treatment projects pending the approval of a consolidated baseline methodology for the sector by the CDM Executive Board.

6.1.4 Current legislative baseline for landfill gas management

Under the additionality requirements of the CDM it is incumbent on the project proponent to demonstrate that the project would not have occurred in the absence of the CDM. An important issue raised by this requirement is the "legislative baseline" for project activities – by this it is meant that legislation may be in place that requires a certain activity to be undertaken and hence establishes a baseline of what should or would occur in the absence of the CDM. If an activity should be carried out to be in compliance with local legislation then it becomes difficult for a project proponent to argue that the project is additional. This is of particular importance in relation to landfill gas management where legislation does exist that in some cases is used to control landfill gas emissions.

In order to provide a standard reference for waste management activities DWAF has published a series of minimum requirements documents, including a document entitled *Minimum Requirements for Waste Disposal by Landfill* which addresses landfill classification and the siting, investigation, design operation and monitoring of landfill sites (DWAF, 1998). The enforcement of the Environmental Conservation Act (ECA) section 20(1) permitting system, which currently regulates landfill site management, is facilitated through these minimum requirements documents. Typically, certain of the minimum requirements are incorporated as conditions to ECA Section 20(1) permits. Once such incorporation has occurred the relevant sections of the minimum requirements become legally binding on the landfill operator and must be complied with[2].

In some cases landfill permits will contain requirements specific to a particular landfill site based on local site conditions. Generally, however, the following provisions of the minimum requirements document, with regard to gas monitoring and management, provide the general prescriptions for landfill site management in South Africa.

- **Gas management and gas and air quality monitoring systems**: these systems are required if, in the site investigation and the risk assessment, landfill gas migration and accumulation are found to represent a *potential safety hazard* or *odour problem* or if an operating or closed *site is situated within 250m of residential or other structures*.[3]
- **Landfill gas management**: landfill gas actively extracted from a landfill, e.g., by applying suction to a system of perforated pipes within the landfill, must, if the collected gas is not used for energy production or chemical feedstock, be flared off. In the same way gas that is passively managed, e.g., through the construction of impervious migration barriers adjacent to the landfill or passive venting from boreholes and perforated pipes within the landfill, must either be flared or passed through filters to remove odour.

The main implication from the above discussion is that the *Minimum Requirements for Disposal of Waste by Landfill* do not require that landfill gas management systems be put in place unless there is the potential for danger or nuisance to be caused by the landfill gas. Therefore, there is currently not a legislative baseline in general requiring landfill gas extraction and combustion and such projects are likely to be deemed additional by the CDM Executive Board.

The minimun requirements do require that if landfill gas is actively extracted or passively managed from a site it must be flared where it is not used for energy production or chemical feedstock or alternatively it must be treated for odour. Therefore, there would be more difficult additionality arguments for a project that was based on gas that was already being extracted but not being flared or treated since the underlying project would not be in compliance with the minimum requirements.

It should be noted that the Executive Board of the CDM recognised that the mere presence of a legal requirement does not necessarily mean that it can be complied with. The Exective Board accordingly have indicated that they will allow project proponents the space to argue that a project that leads to compliance with applicable legislation may still be additional if there is evidence of widespread non-compliance with the legislation in the relevant sector due to one barrier or the other.

The Executive Board states that a viable alternative to the project (i.e. a baseline) can be claimed on the following basis – "if an alternative does not comply with all applicable regulations and legislation, then show, based on an examination of current practice in the country or region in which the law or regulation applies, that the non-complying element of the alternative is currently widespread." (UNFCCC, 2004a).

DWAF is currently in the process of amending the minimum requirements series as they are somewhat out of date with the most recent version being published in 1998. However, it appears that the proposed amendments will only be made available for public comment in 2005. It is therefore not possible to assess the potential impact of such amendments on future legal requirements with regards to landfill gas management. Cities are advised to remain informed as to the proposed amendments to the minimum requirements series.

6.1.5 Environmental Impact Assessments

The Marrakech Accords explicitly required that an EIA needs to be undertaken on a project activity prior to it being validated as a CDM project if such an EIA is required by the procedures in the host country. The Accords note that a project cannot be validated until:

[2] Much of this section is drawn from Imbewu, 2004

[3] Emphasis added

"*Project participants have submitted to the designated operational entity documentation on the analysis of the environmental impacts of the project activity, including transboundary impacts and, if those impacts are considered significant by the project participants or the host Party, have undertaken an environmental impact assessment in accordance with procedures as required by the host Party*" (UNFCCC, 2001).

South Africa has a well-developed EIA regime which requires that a detailed EIA is carried out for certain activities that fall onto a list of so-called "listed activities", the performance of which triggers a mandatory EIA. There are a number of LFG capture and use activities which may trigger the EIA requirement.

Municipalities therefore need to check whether any activities considered as CDM projects may require EIAs. If so, such an EIA will have to be conducted prior to the validation of the CDM project. This may cause delays in the establishment of the project and needs to be borne in mind when selecting an end-use option for the methane since some end-uses may require an EIA whereas others may not.

Certain additional consents and licences will be required should the a CDM project be based on the end-uses of electricity generation or transfer of LFG off-site. The need for these consents and licences are determined *inter alia* by the provisions of the Electricity Act and Regulations and the Gas Act (Imbewu, 2004).

6.1.6 Designated National Authority for the CDM

The Republic of South Africa ratified the UNFCCC on August 29, 1997 and acceded to the Kyoto Protocol on July 31, 2002. In order to participate in the CDM the country hosting CDM project activities needs to meet certain participation requirements which require the establishment in host countries of effective institutional and legal frameworks for approving such projects. Specifically the CDM rules require host countries to:

- ratify the Kyoto Protocol; and
- establish a Designated National Authority (DNA) for CDM projects.

In order to fulfil these requirement the government of South Africa has appointed the Department of Minerals and Energy with the task of establishing and operating a Designated National Authority and mandated the establishment of a Designated National Authority Steering Committee.

The South African DNA has been established and is in a position to receive and evaluate projects. The major responsibility of the DNA in terms of the Marrakech Accords is to evaluate proposed CDM projects and decide whether such projects support sustainable development in the host country. A set of sustainable development criteria to be used in this process have been developed, as well as a procedure for the approval process.

Indications are that the process is unlikely to be onerous or lengthy and that host country approval should not be a stumbling block to project development as long as municipalities can demonstrate that the project's support the sustainable development criteria established by government.

6.2 Institutional and Financing options

The world carbon market is growing rapidly. According to a recent World Bank report (PCF, 2004) 64 million tonnes of CO_2e was traded between January and May 2004, which is nearly as much as during the whole of 2003 (78 million tonnes) which suggests a doubling of the market over a period of a year. The vast majority of these trades are from project-based transactions intended for compliance with the Kyoto Protocol.

These figures show that municipal CDM projects will be part of a rapidly expanding financial mechanism, with CERs becoming real commodities that have real value and are tradable. There are a range of financial arrangements which can assist municipalities in deriving the maximum benefit from these types of projects. There are two general financing options for methane emission reduction projects that exist for any municipality i.e. accessing internal or external resources. These options, and related institutional and financial considerations are discussed below.

6.2.1 Internal financing

In the case of internal resources any such project would preferably be mandated for financing through its inclusion in the Integrated Development Plan (IDP). The likelihood of such financing becoming available for projects such as a landfill gas project is dependant on a number of factors, such as whether there is strong political support for such a project and\or such a project can be linked to another initiative that already has support in the IDP process (for example extensions to existing waste water treatment works, or the necessity to close landfill sites that could involve landfill gas use). In all South African municipalities the developmental backlogs they are experiencing means that there is always a scarcity of capital and so such projects would tend not to be seen as priorities. However if it can be shown that methane emission reduction projects can produce positive income streams for municipalities and so support their developmental programmes in general, then there are options to “ring-fence” such projects and for the municipality to raise project finance to supplement their internal resources in order to take such initiatives forward.

The Durban landfill project is an example where the project team has shown the municipality that, over and above the environmental benefits, the project will provide a net income stream to the municipality. It is therefore willing to take on debt in order to fund the project using its own internal resources. The key issue in all these cases is that the business case for such projects has to be placed in the broader context of its fit with the development priorities of the municipality.

6.2.2 External Financing

The other option for a municipality is to mobilise external resources for the development of such projects. This could involve a project developer implementing the whole project (including providing the finance) with the municipality potentially receiving income from the project in a number of ways - either being paid a fee for the use of the resource or a royalty on electricity or gas sales. In this case the income stream that the municipality would derive from such a project would be less than an internally financed project, as there would have to be a sharing of benefits (and risks) with the developer. However the attractiveness of such an option is that it does not use internal financial resources, meaning reduced risk and also no diversion of funds away from the municipalities broader developmental programme.

There is also another benefit to an external approach. In most cases the municipal capacity to implement such projects is extremely limited not only due to the human resource constraints that exist generally within the local government sector, but also due to the fact that these types of projects (especially with regard to landfill gas use) have not been core areas of activity and so the internal capacity to implement such projects does not generally exist. Project developers interested in this type of arrangement would typically have had experience of such projects, removing the requirement for the municipality to have or to develop such capacity internally. Most municipalties in order to overcome internal capacity issues, even when funding such projects from their own resources, are likely to look favorably at contracting in expertise to run such facilities, particularly if local economic development opportunities could be developed as part of the arrangement. The use of external technical or management partners also opens up opportunities for black economic empowerment and small, medium and micro enterprise (SMME) promotion. Gas extraction and related infrastructure investments and management offer the opportunity for the entry of new firms into the energy market or for the transfer of skills from established firms to emerging entrepreneurs.

6.2.3 The role of carbon finance

Municipalities, therefore have a number of options as to how to finance the asset underlying such projects. Carbon finance is obviously the major new area of project finance that municipalities need to consider. There is a range of buyers and carbon finance options available in South Africa currently that reflects the international interest in purchasing emission reductions from the country. Buyers active in the market include the World Bank, the Danish Government overseas development assistance agency, DANIDA and a number of other developed (Annex 1) countries including Canada, Germany (through the development bank KfW) and Japan. There are also a number of brokers who are acting on behalf of Governments and\or private sector buyers.

Municipalities as potential sellers of CERs need to consider a number of factors before entering into carbon finance deals. These include:

- **Transaction Costs**: developing a carbon finance project is a very formalized and specialized process, involving a number of potential transaction costs (for example the development of baseline methodologies and the need to get projects validated). The seller should always be aware of what potential costs there are and who will incur them. In some cases potential purchasers may pay for costs during the project development phase and then recover them later during the project's implementation. There are also purchasers that will provide grants to sellers for some of the transaction costs. However in these cases sellers should check that such funds have not been diverted from other sources of overseas development assistance, as this is not permitted in terms of CDM rules. In all cases sellers should be aware of what their potential liability is for transaction costs incurred. A potential method of addressing this is to negotiate a cap on transaction costs that would be recovered from the seller. Some organizations are also offering a service where they will take a project through the carbon finance project cycle on risk, but will recover their costs in the form of a success fee as a percentage of the value of total carbon finance deal.
- **CDM Related Risks**: one of the potential risks that was until recenly faced in the market was whether the Kyoto Protocol would actually enter into force or not and the implications this would have for the contracts entered into. In some cases buyers of CERs were willing to take the risk that the Kyoto Protocol would not come into effect, Due to the fact that the Russian Government has recently agreed to sign the Kyoto Protocol the Protocol will now come into force and this broad area of risk has diminished considerably. There are possibly some remaining risks – such as the impact of Russia's entry into the Protocol on global supply of CERs, and potential sellers should seek advice on the likely evolution of the carbon market before entering into any binding commitments.
- **Purchasing period**: some buyers will only buy credits that would be eligible for credit against their obligations during the first Kyoto Protocol commitment period from 2008 – 2012, whereas others will buy emission reductions generated beyond 2012. This obviously may have a significant impact on the project's viability.
- **Price**: the issue of price is important but needs to be seen in the context of all the other risks that a seller may take in a deal including certainty of off-take, potential penalties for non-delivery of CERs and who is taking the risk with regard to the processes that exist around the CDM. The currency that the deal is denominated in should also be considered for any potential implications of foreign exchange fluctuations.

There is therefore a range of potential options that exist for municipalities for the financing of the underlying asset, as well as a range of options with regard to the selling of emission reductions. One important consideration is to ensure that both aspects are considered from the very beginning of any project and integrated with one another. This is particularly important as potential project financiers would look for a signed Emissions Reduction Purchase Agreement (ERPA), as part of their due-diligence for any such project.

6.3 The role and expectations of the financial sector

Accessing finance for CDM projects has been identified as a key barrier to their implementation in a number of developing countries. South Africa is however fortunate that it has a well-developed financial services sector, particularly with regard to the area of project finance.

In the discussions held with the financial sector it is clear that there is already a well developed awareness of the issues related to the financing of such projects and around the opportunities of accessing carbon finance to support such deals. This is illustrated by the relationships that have been built between providers of project finance and organisations that are able to assist projects in accessing carbon finance. Examples include the Development Bank of Southern Africa's (DBSA) intermediary agreement with the World Bank's Carbon Finance Unit, Standard Bank's co-operation agreement with Ecosecurities and Investec's involvement with the ICECAP fund.

In the discussions held there is a clear appetite for such projects that are seen as part of the emerging area of renewable energy financing, that has been recently stimulated by the government's commitment to a target for renewable energy generation. Whatever form the project takes it is clear that a municipality or business will be able to find a number of financial institutions interested in providing finance to the project, whether this is to finance the entire or a significant portion of the project (for example the commercial banks, the DBSA, the Central Energy Fund and the French Development Agency, AfD), or particular components of it for instance a back economic empowerment component within a concession. In the latter case the Energy through Empowerment Fund esatblished by the Shell Foundation, ABSA Bank, the IDC, RAPS Finance and Shell Southern Africa has a specifc mandate with regard to this area, but there would also be interest from the commercial banks, the Industrial Development Corporation (IDC), the DBSA and funders such as E&CO that look at smaller loan and equity deals.

In essence then it appears from interviews with financial sector stakeholders that any potential project developer, whether municipal or private, would have a range of institutions to discuss opprtuntities with - especiallly with those institutions that have a history of municipal financing like the DBSA.

The general approach to the funding of carbon finance projects would follow that of standard project financing, with institutions typically indicating that they would consider the usual set of issues in their appraisal processes. These include for example the project's financial model, credit-worthiness of the sponsor and the sponsor's commitment to the project.

Beyond the above general criteria, there are some specific issues that a financier would consider in looking at methane emission reduction projects that are specific to both the resource (methane) and to the carbon finance element. It is these areas that are less well understood by the financial sector and which would require particular attention from the side of the project proponent or municipality to ensure that the financial institutions understand the CDM project cycle and neither over-estimate nor under-estimate the risks involved.

Some of the specific methane reduction and carbon finance issues that a municipality would have to address in project preparation include the following:

- An adequate assessment of the methane gas resource;
- Secure off-take agreements for example with regard to the emission reductions and energy produced;
- Well constructed emission reduction purchase agreements that clearly outline the respective roles and responsibilities of the buyers and the sellers;
- A financial model that takes into account the peculiarities of the carbon finance market (such as price and foreign exchange movements);
- Ensuring the necessary regulatory requirements were fulfilled (specifically with regard to the EIA and landfill licensing requirements);
- Ensuring that all the CDM project cycle elements are correctly prepared and documented to enable the project to be registered and certified emission reductions to be generated;
- An institutional arragement that ensures that there is the necessary management and technical capacity to implement the project in the long-term;
- A clear indication of the ownership of the underlying asset and of the right of the project proponent, either the municipality or an external project partner, to sell the certified emission reductions accruing from the project

If the above issues are addressed there is little inherently unique in these types of projects that would mean financial institutions would treat these as particularly risky other than an appropriate appreciation of the potential technology risks of such projects. Even the technology risk will reduce as a number of these projects are implemented and there is increased awareness of what implementing such projects actually involves. On the creditworthiness side the point was made that the use of guarantees would assist municipalities in accessing finance. These are available in the market from a number of institutions inlcuding the DBSA and USAID.

6.3.1 Project development support

Another issue that was raised was the question of potential project development support from financial institutions, as a clear need was identified by municipalities for such support to move projects towards implementation. In general the commercial sector does not see this as its role, whereas institutions such as the DBSA are already providing grants to municipalities to develop projects.

There are a number of potential sources of grant suport available including the DBSA, the Special Municipal Innovation Fund, local economic development agencies, the Municipal Infrastructure Investment Unit (MIIU) and those institutions that are interested in doing a carbon finance deal with the project (for example the DANIDA programme in South Africa). Certain carbon finance brokers also offer funds to assist in some of the initial CDM related work required for projects. The extent of their support is typically reflected in the final price they are willing to pay for the emission reductions.

A possible option raised in some of the interviews is the establishment of a project development facility focusing on methane emission reduction projects. This would mean that potential project developers would be able to go to one place to access project development support. The French Development Agency, AfD, expressd their interest in investigating the development of such a facility in partnership with the SACN.

A final issue to be raised on the financing side was the potential of such projects to access grant funding for the capital development side. There has been some degree of capital support for renewable energy projects in the country, for example the Darling Wind Farm. However it is unlikely that this will occur for methane gas projects because in general, these projects are able to stand on thier own financially whereas other renewable energy technologies such as wind are not. However the DME's renewable energy programme will include, in its initial phases, the provision of capital grants to suport project development. The modalities of this support are unclear at this stage, but should be monitored by potential developers of methane emission reduction projects.

7 Strategic Considerations and Recommendations

The primary focus of this study has been on the identification of methane reduction opportunities at the municipal level in South Africa and an explanation of how municipalities can capitalise on these opportunities. The intention was not to develop a strategic approach to methane emission reductions nor the use of carbon finance by local authorities. Nevertheless, by the nature of this type of study it is inevitable that insights are gained which can provide useful guidance to local authorities in identifying and pursuing new opportunities. This final section therefore outlines some strategic recommendations for municipalities in transforming their current methane producing liabilities into assets.

Attention is first turned to some further discussion on the existing and the required institutional capacity and arrangements at the municipal level. After the discussion on institutional and capacity situation some additional strategic issues are raised. These strategic issues are followed by some indications of possible ways in which the South African Cities Network and allied institutions can assist municipalities in pursuing potential opportunties in their municipal areas.

7.1 Institutional capacity and arrangements

The issue of institutional capacity is given primacy since there do not appear to be significant legal, financial, or technical barriers to project implementation. From the municipal interviews it was apparent that the main barriers to project implementation were either lack of awareness of the technical and carbon finance opportunities in the municipality; uncertainty as to the correct mechanisms (institutional, procurement, and procedural) to take projects forward; or lack of political insight at senior official or Council levels which were delaying project development. In some cases there were also financial constraints related to the above factors where officials were aware of the CDM possibilities but had difficulty in securing internal funds to undertake the initial work required to investigate and develop projects.

A fairly subjective assessment of capacity needs particular to each municipality can be made on the basis of the interviews and on an understanding of the various municipal approaches to methane reduction projects. This assessment is shown in table 8 below. The table indicates where, in the assessment of the study authors, municipalities would benefit from general awareness raising at a senior municipal level; detailed technical support for project development; and financial support for project feasibility studies and development.

Table 8. Capacity requirements at the municipal level

City	*CDM projects under consideration*	*Do Council or Senior Management Level require awareness raising and information?*	*Does the municipality require project level support? (Technical, Legal or Institutional)*	*Does the municipality require financial support for project development?*
Johannesburg	Yes	Yes	Yes – now	No
eThekwini	Yes	No	No	No
Cape Town	Yes	Yes	Yes – now	Yes
Tshwane	Yes	Yes	Yes – now	No
Nelson Mandela	No	Yes	Yes – in future	?
Ekurhuleni	Yes	Yes	Yes – now	No
Msunduzi	Yes	Yes	Yes – now	Yes
Buffalo City	No	Yes	Yes	?
Mangaung	No	Yes	Yes – now	Yes
uMhlathuze	No	Yes	Yes – in future	Yes
Polokwane	No	Yes	Yes – in future	Yes
Mbombela	No	Yes	Yes – in future	Yes

It can be seen from the table that even those cities that currently have CDM projects under consideration do not necessarily have the internal capacity to take projects forwards to the commissioning or implementation stage. Further, even in those cities that are already considering CDM projects it seems that, except for eThekwini, there remains a lack of awareness at the senior municipal level of the opportunities available. This lack of awareness is generally unnecessarily slowing the process of project development even where there technical opportunities exist. In these cities it is important to expose senior decision-makers in the city, at both the management and Council level, to the opportunities available to expedite the process of project establishment and to avoid delays and opportunity costs of not implementing projects.

In those cities where the process is even less advanced similar awareness raising is required. This will generally need to be followed up by both technical and financial support for project development. Naturally, financial support in the form of technical assistance grants and similar arrangements, can be used to procure technical support or technical support can be provided directly.

7.1.1 Institutional options

The ability to choose the right institutional model for such projects is key to their successful implementation. A number of different institutional arrangements are already being used for the first stage of project development at the municipal level. These range from external support from NGOs (the case of Cape Town and SouthSouthNorth), to carbon purchaser driven projects (the case of eThekwini and the Prototype Carbon Fund of the World Bank and Johannesburg and the Danish Government). There are other options available. While there is not necessarily a preferred option to be recommended one principle to be borne in mind is municipal independence in the ultimate sale of carbon credits. When entering into a developer or carbon purchaser led approach municipalities should as far as possible retain the ability to secure the best carbon purchase deal available and avoid being locked into a single purchaser arrangement as this limits their ability to negotiate effectively.

Following initial project development there still remain decisions to be taken on the final implementation model to be used. From the study it appears that given the existing capacity constraints some form of external implementation model would be the most appropriate way forward for the majority of municipalities. The study suggests that the knowledge and experience to select appropriate implementation models does not currently exist including the ability to assess their relative disadvantages and advantages.

To assist municipalities in making this choice the SACN, possibly in association with other agencies, could provide guidance in this area. A possible approach would combine the objectives of a knowledge network with the development of more formal guidance. This guidance could include, for example, a manual that would take potential developers through the steps needed to develop such projects, highlighting key issues in their development and implementation as well as providing formats for management contracts. National Treasury is currently developing a toolkit to support the development of PPPs in the tourism industry and perhaps a partnership with National Treasury in this area would make sense, particularly with new regulations governing such transactions at local authority level.

In some cases a potential vehicle for project development might be the development agencies which a number of municipalities are setting up with the support of institutions such as the IDC. These structures focus on developing projects that would not normally be seen as the business of the municipality. Their focus on local economic development means that these agencies have a broad space to act and can help municipalities to consider the various merits of concessions, setting up joint venture companies and other possible institutional models for methane reduction projects. These agencies also have the ability to mobilize project development funding and the associated technical support in those cases where this is a barrier to developing such projects.

7.2 Strategic considerations

The first strategic issue identified **is the need for rapid decision making** and progress in pursuing methane reduction opportunities and their associated carbon finance. The rationale for this is two-fold. Firstly, the nature of the global carbon market is somewhat uncertain after the 2012 end of the first commitment period of the Kyoto Protocol. Therefore many purchasers of certified emission reductions are only purchasing these CERs until 2012. As it gets closer to that date there are therefore fewer years of CER sales in which to recoup project capital investment costs making project finance increasingly difficult. The second related reason is the opportunity costs that municipalities are incurring by not developing projects. Each year of delay in emission reductions means further damage to the global atmosphere and lost revenue that can never be recaptured.

Opportunity costs of delaying project implementation

A medium sized landfill site (as illustrated in Figure 3) can generate about 2 100m^3 of landfill gas per hour. On some reasonable technical assumptions the combustion of this gas could lead to the generation of about 160 000 CERs per year (that is, the equivalent of 160 000 tonnes of CO^2 reduced). In turn a municipality could derive about R4 million per annum from the sale of these CERs. By not implementing a landfill gas reduction project the municipality will be losing this revenue and will not be able to recoup this revenue later as the emissions of methane will have already occurred. There are, therefore, substantial environmental and financial opportunity costs of delaying the implementation of these projects.

Figure 6. Opportunity costs of delaying project implementation

Another issue that was strongly identified was the need for **clarity on institutional approaches** to project development and management. A major perceived obstacle to many municipalities taking these projects forwards was the lack of internal capacity. Suitable institutional arrangements would enable municipalities to rapidly take projects forwards through the use of external support and partners.

Although methane reduction projects offer significant opportunities, as with all investment projects there are risks attached to these projects. Municipalities should be aware of some of these risks to enable them **to mitigate risks where possible**. Possible areas of risks and mitigation approaches include:

- *Gas yield assessment*: an inaccurate assessment of the underlying resource (that is, the likely gas yield) will place projects in jeopardy and may lead to over or under investment. It is therefore crucial to assess the resource well and to secure the right partners or technical experts to assist in this regards. In this light it should be noted again that the modeled results presented in this report are only indicative and need to be ground-truthed on a case-by-case basis.

- *Environmental Impact Assessments:* EIAs can be problematic because of the risks of not being able to clearly differentiate the CDM project from other, more general concerns, that may exist about the landfill site. One means of addressing this issue is making clear the benefit of improved landfill site management that is likely to occur from CDM projects because of the enhanced revenue and management requirements.
- *Price uncertainties and fluctuations:* Municipalities face the risk of selling their emission reductions at too low a price or entering into contracts that expose them to future price uncertainty. Prices of certified emission reductions are becoming more and more transparent as the market matures and with some external support municipalities should be able to get a fairly sound indication of acceptable price ranges. Suitable transaction advice, on both price and contract structure, is also crucial to ensure that municipalities are not exposed to unacceptable levels of risk in these projects.

Methane reduction projects offer many **opportunities for local economic development, SMME development and black economic empowerment**. These projects will typically require capital investment and ongoing project management which opens up the space for the use of small to medium size firms and allows for creative opportunities of transferring skills through joint ventures between established firms and new entrepreneurs. Further, some of the methane use opportunities can spur local economic development projects through the supply of low cost heat or power. A large number of creative ideas have been raised for the use of waste methane, ranging from greenhouses for horticulture or food production to small-scale brick-making, wood-drying or other energy intensive activities. Municipalities should see these projects as a means to generate local economic development and to introduce new entrants into the energy market – and not only as methane reduction and revenue generating opportunities.

7.2.1 A municipal CDM project champion

There does not seem to be any obvious single ‘champion’ of methane reduction projects in municipalities. Some national departments, specifically the Department of Minerals and Energy, have a direct interest in supporting landfill gas to energy projects. However, these departments themselves have limited technical and financial resources to provide direct support to municipalities. The DME, in discussion with the National Treasury, is already pursuing mechanisms of renewable energy subsidies that could be used to support such projects but these are likely to be very limited.

The single NGO active in this arena, SouthSouthNorth, has a limited mandate and limited capacity to support municipalities on a broad scale. The lessons from their experiences with Cape Town will be of much value to other municipalities, however, they do not appear to be in a position to significantly extend their direct support to other local authorities.

The other main avenues of support are carbon credit purchasers. These include the national, multilateral and institutional purchasers already mentioned. The major limitations with these institutions are that they are self interested. The implication is that they will seek the lowest net carbon credit price and will also typically seek to support only the easiest and largest projects.

The implication of the above evaluation is that there is value in an organisation or organisations assisting municipalities to take methane reduction projects forwards. This ‘champion’ could be the SACN or a broader set of institutions. The analysis suggests two main areas of support that could be provided. These being awareness raising and funding for project development and technical assistance. These areas are discussed below.

7.3 Proposed SACN Methane Emission Reduction Support Programme

This study has made it clear that there is an opportunity to transform a resource into an asset for the twelve municipalities considered. It is likely that similar opportunities also exist in some other secondary cities and possibly even in smaller municipalities. These projects fit well with the policy imperatives of national and local government as expressed in the renewable energy policy of the DME and the Cape Town Declaration on sustainable city energy strategies.

From the results of the study it is clear that the most promising projects are those involving the use of landfill gas in terms of developmental impact. All the SACN members have the potential to develop such projects and there are clear opportunity costs in delaying project development due to the closing window for accessing carbon finance, which currently would stop at the end of 2012 (the end of the First Commitment Period under the Kyoto Protocol). This study therefore recommends that these cities move actively and rapidly towards project implementation using the steps as outlined below .

- **Resource assessment:** the first step in the development process is getting certainty around the resource; the quantity of landfill or bio-gas gas available and over what period of time it will be produced. Depending on the circumstances and the level of certainty required either a model-based assessment or a gas yield pump test may be required. Cities will require technical advice on a case-by-case basis on this issue.
- **Feasibility study:** this would involve looking at the best options in terms of gas use; financial modeling of the project; evaluation of preferred institutional arrangements for the project; identification of key risks; clarification of the associated regulatory requirements, including EIA regulations.
- **Environmental impact assessment:** an EIA would be undetaken if required. EIAs will not be needed for all project types identified.
- **Tendering for the project:** the tendering of such projects is likely to be complex and dependent on the institutitonal model selected. In the case of a concession all elements of the project would be addressed by the concessionairre. On the other hand, some cities may choose to internally manage projects and only tender out the construction of the initial infrastructure required. Key decisions here will include whether the carbon finance component is tendered separately from the physical project itself; and the tender process for the sale of CERs.
    - **Contracting:** an important component of the tender process will be the establishment of the necessary contractual arrangements with the project managers, operators or owners. There will also need to be appropriate contractual arrangements for the sale of the CERs generated. One of the key issues will be to ensure that the risk of project non-performance is clearly specified and located with the appropriate party and that they are compensated for bearing this risk.
- **Commissioning**: the final step in project establishment is the commissioning of the project. There will be ongoing management of the project as well as the annual verification and certification requirements of the CDM.

7.3.1 Role for the SACN

Although some cities are able to move through the project steps as outlined above it appears that significant barriers to project development do exist – since promising projects are not currently moving forwards even where they have been identified. It is likely that the SACN is in a position to pay a valuable role in the facilitation of methane reduction projects by overcoming a number of the barriers that exist to taking them forward. The approach proposed is the creation of a methane emission reduction support programme that will primarily assist SACN members to overcome these barriers and to develop the knowledge and skills necessary to take projects through the development phase and into implementation. Before defining the potential elements of such a programme it is therefore important to clarify exactly what these barriers are.

7.3.2 Barriers to Project Development

It is clear from the discussions held by the study team in the various cities that there is little unwillingness at the operational level to take such projects forward, as the potential benefits of such projects in terms of their fit with IDP objectives and their ability to generate additional revenues are generally understood. However, there is, in general, **a lack of awareness at the higher management and political levels** of these potential benefits, which means the opportunity for such projects is not currently being taken up. This, in our opinion, is the first barrier that any SACN support programme would have to address.

The second barrier is linked to the general **problems with human resource capacity** faced by all cities in delivering services to their constituents. Methane reduction projects are not seen as core activities and are therefore not prioritised against addressing service delivery backlogs, whatever the potential they may have for supporting the cities' developmental objectives. The existing human resources available therefore do not have the time to take such projects forward and develop the required skills and knowledge.

These projects also require **project development funds** to take them forward, which tend to be scarce internally and which are more likely to be allocated to core functions. In the study team's view there is however no lack of potential external sources of project development funds for such projects that can be accessed. However applying for these funds takes time and requires the necessary knowledge, which as indicated above, is not readily available.

In order to address these barriers any city would, in general, have to go through a two-step process to successfully develop such a project. The first involves the creation of awareness at the political and official level of the potential benefits of such projects and the processes needed to develop them. The outcome of such a step would be a willingness to take such projects forward and the identification of a champion at a senior enough level within the city's management structure willing to drive the project forward, supported by the political structures.

Once this step has occurred the problem of human resource capacity to actually manage taking the project development process comes into play. The second step therefore involves accessing capacity either within the municipality or more likely externally to take the project forward, and in addition having access to funds to implement the studies necessary to implement such projects e.g. an EIA. If used correctly, external support can also allow for the building of the necessary internal knowledge and skills within the city to ensure the project moves successfully into implementation.

The SACN support programme proposed below is intended to support this process and help remove the barriers identified.

7.3.3 SACN Support Programme - Proposed Elements

For the proposed programme to achieve its aims of assisting the development and implementation of such projects it is proposed that it has two elements that would be mutually supporting. These are:

- The development of a knowledge network; and,
- Mobilising resources for project development.

Development of a Knowledge Network

This element of the programme is specifically designed to address the barriers of lack of awareness and the need for the ongoing development of skills and knowledge through the project development and implementation process.

This would involve the programme developing a network of municipal officials and councillors that are either interested in or involved with the development of such projects. These individuals, it is assumed, would not only be interested in receiving information but also sharing their experiences in this area. The network would enable them to share information in general and specifically to ask for guidance on particular issues they may be facing,

From discussions with the SACN it seems that there is also the potential for this network to form the nucleus of a 'Sustainable Cities' network in line with the SACN's priority areas of support to their member cities.

It is suggested that the programme would have a series of dedicated web pages linked to the SACN website that would support members of the network in their activities and that there would be regular meetings of the Network to share experiences and identify areas where further support is needed.

A number of activities are also proposed to support the knowledge network's functioning i.e.

- **Development of Materials**: there are a number of studies currently being undertaken with regard to methane reducton projects. The problem is that there are no standardized approaches to, for example, feasibility studies and methane resource assessments that municipalities can draw on that also reflect the experience developed by SACN members such as eThekwini and Msunduzi. A potential product here could be the development of a project development manual that takes cities step by step through the process, including supporting documentation for the creation of PPPs in this area (similar to the current work being done by National Treasury through the development of a manual to support PPPs in the tourism sector). In the first instance, however, a useful product would be the development of guidance to support accurate and standardized approaches to the assessment of the methane resource in landfills;

- **Seminars:** the development of materials as mentioned above may involve significant timeframes, however they may be a need for more rapid interventions on particular issues e.g. the EIA requirements around landfill gas projects. A potential approach here could be for the running of focused seminars to assist in resolving any potential barriers with the SACN acting as a facilitator. These seminars would most likely identify needs for follow up interventions including discussions with stakeholders and\or material development, which the support programme could potentially take forward. Currently most landfill gas projects involve the use of existing sites and so a potentially useful seminar to support the development of such projects would be how to incorporate methane emission reduction opportunities in the development of new landfill sites; and,
- **Awareness creation** – the study has identified a lack of awareness in a number of municipalities as a barrier in terms of understanding the potential benefits in developing such projects. The programme should therefore have an outreach role in spreading awareness of such projects through presentations to officials and councillors to develop this understanding and the associated implications of taking such projects forward. These awareness creation activities should also ensure that methane emission reductions opportunities other than those associated with landfill gas are taken forward (for example with regard to wastewater treatment facilities and composting). The support programme should not focus on the landfill gas to the exclusion of these other potential opportunities.

Mobilization of Resources for Project Development

In order to address the overcome human resource constraints more direct facilitation of access to existing sources of funding for project development is needed. It is important that the SACN is able to help cities access development grants in such a way that they are not overly dependent on their internal capacity to do so. It has been demonstrated that if municipalities are reliant on internal staff to raise funds and to manage project development the process of project development is too slow due to capacity constraints. The success of the external technical assistance grant approach has been shown by the support given by the DBSA to the Msunduzi Municipality in the implementation of their landfill gas feasibility study.

There a number of existing sources of project development funds available from a range of sources (purchasers, lenders such as the DBSA, donor agencies, NGOs, and national government) for taking these types of initiatives forward. The SACN programme would assist municipalities in accessing such funds through clarifying what is available, the conditions associated with them, their relative advantages and disadvantages and the required application procedures. The programme would also look for, if necessary, additional sources of such funds for municipalities as well as facilitating the interest of other organizations in getting involved in this area.

We are therefore proposing that a centralised resource mobilisation effort is undertaken. At this stage the proposal is for a support and information based mobilisation effort rather than the creation of a dedicated project preparation facility with its own funds. The resources and infrastructure required to develop and run a formal project development facility are substantial and it is not clear that given the diversity of funding sources (and the various requirements associated with them) that a single funding facility would be simple to establish or appropriate.

The proposal is therefore based on the concept of ‘clearing house’ for project funding. This could be seen as a virtual project preparation facility drawing together various sources and types of funding. It is felt that this would also be better aligned with the SACN’s facilitation and networking role. However, the case for the possible creation of a formal project development facility should be re-assessed on a regular basis and such a facility may evolve in due course.

The resource mobilisation element of the programme would be primarily focussed on the accessing of project development resources. Typical uses of the funding would include the contracting of project managers to work with cities; the procurement of feasibility studies and so forth. It is envisaged that the resource mobilisation effort would have a capacity building element as well and would also assist cities in understanding the options for financing the implementation of such projects.

7.3.4 Programme Business Plan – Broad Elements

In taking this proposal forward it is assumed that the SACN would be accessing external sources of funding and so would have to develop a detailed business plan in the process. Broad elements of such a business plan are proposed below.

Table 9. Elements of a Proposed SACN Methane Reduction Business Plan

Action Steps	*Time-frames*	*Resource Requirements*
Development and Approval of a Detailed Business Plan (guided by a programme steering committee)	First quarter 2005	• Funding for 20 days of consulting time. • Time from SACN staff and steering committee members.
Accessing Funding and Appointment of Programme Manager	Second quarter 2005	• Time from SACN staff and steering committee members. • Need for office space and supporting infrastructure (incl. computers)
Implementation of Proposed Programme Elements i.e. • Development of a knowledge network; and, • Resource Mobilisation for Project Development	Start Third Quarter 2005 End Second Quarter 2007	• One part time programme manager (possibly supported by a technical specialist).

It is assumed that the programme would at a minimum require a professional with experience in the project development processes of such projects at local government level to manage the programme. This person could perhaps be supported by an individual with a more in depth technical understanding of this area, perhaps sourced internationally as such skills are scarce in South Africa. It is also assumed that the programme, to show its utility, should have an initial timeframe of two years with the option for a possible extension based on need. It is also proposed that the programme should also assist non-SACN members participating in order to share the benefits and learning of this initiative throughout the local government system. This could be done in collaboration with the South African Local Government Association (SALGA).

Concluding Remarks

In taking this proposed programme forward the SACN will in the team's opinion not only play an active role in taking new projects forward, but would be assisting those cities that are looking to initiate their own projects to learn from those that are further down the line as regards project development. SACN members will also be able to show in a practical manner the leadership role their cities are taking in supporting environmental concerns as part of their broader sustainable development agendas.

References

CDM Methodology Panel, 2004: *Consolidated Baseline Methodology for Landfill Gas Project Activities*, draft report, 28 May 2004.

City of Cape Town, 2003: *Cape Town Energy Strategy*, October 2003, Draft, prepared with the support of Sustainable Energy Africa, Cape Town.

CSIR, 2001: *South Africa Greenhouse Gas Inventory, 1994*, prepared by the Centre for Scientific and Industrial Research for the Department of Environmental Affairs and Tourism, Pretoria.

Department of Minerals and Energy, 2002: *The White Paper On The Promotion of Renewable Energy and Clean Energy Development*, DME, Pretoria.

Department of Water Affairs and Forestry, 1998: *Waste Management Series: Minimum Requirements for Waste Disposal by Landfill*, Second Edition, 1998.

Conestoga-Rovers & Associates; 2003: *Handbook for the Preparation of Landfill Gas-To-Energy Projects in Latin America and the Caribbean*, prepared for the World Bank, Washington.

Environmental Protection Agency, 2004: *United States EPA website*, Global Warming Home, Methane Home, http://www.epa.gov/methane/sources.html, EPA, Washington D.C.

Imbewu, 2004: *Output "A" Report for the Proposed Msunduzi Clean Development Mechanism Project to be undertaken at the New England Road Landfill Site*, by Imbewu Enviro-Legal Specialists (Pty) Ltd, April 2004.

Intergovernmental Panel on Climate Change; 1996: *Technologies, Policies and Measures for Mitigating Climate* Change, edited by Watson. R., World Bank Zinyowera, M., Zimbabwe Meteorological Services, and Moss, R., Battelle Pacific Northwest National Laboratory, Technical Paper of the Intergovernmental Panel on Climate Change.

Prototype Carbon Fund, 2004: *State and Trends of the Carbon Market*, 2004, Washington DC.

United Nations Framework Convention on Climate Change, 1997: *The Kyoto Protocol to the United Nations Framework Convention on Climate Change*, Kyoto.

United Nations Framework Convention on Climate Change, 2001: *Marrakech Accords*, Decision 15/CP.7 Annex. FCCC/CP/2001/13/Add.2, UNFCCC.

United Nations Framework Convention on Climate Change, 2004a: *Draft Consolidated Tools for Demonstration of Additionality*, Executive Board No. 15 Report, Annex 3.

United Nations Framework Convention on Climate Change, 2004b: *Consolidated Baseline Methodology for Landfill Gas Project Activities*, Draft Methodology Panel Report, AM00XX/Version 1, Sectoral Scope 13, 28 May 2004, Annex 2.

United Nations Framework Convention on Climate Change, 2004c: *Forced Methane Extraction from Organic Waste-Water Treatment Plants for Grid-Connected Electricity Supply*, Approved baseline methodology AM0013/Version 01, Sectoral Scope 13, 3 September 2004.

Finance sector interviews

Dave Allen, ICECAP

Greg Babaya, Standard Bank

Christina Golino, DBSA

Martin Krause, UNDP

Philippe Lecrinier, AFD

James Mollenze, INCA

Sibusiso Ngubane, Central Energy Fund

Pontso Ntseuoa, IDC

Chris Venter, Energy Through Empowerment Fund

Gavin Watson, E&Co

GENERAL MANAGEMENT ASSISTANCE CONTRACT (GMAC)
Contract No: 674-C-00-01-10051-00

Methane Emission Reduction Opportunities in Twelve South African Cities: Turning a Liability into a Resource

City Reports

Prepared by

Palmer Development Group

December 2004

This report was prepared under Mega-Tech, Inc.'s prime contract with USAID and addresses USAID/South Africa's Strategic Objective No. 6: Increased Access to Shelter and Environmentally Sound Municipal Services

MTI Contract No.: 0122-0603-PO-TA42

Contents

This document contains the reports on the investigations into methane reduction opportunities carried out for 12 municipalities in South Africa. This forms background documentation for the main report.

The following cities reports are included:

- Buffalo City Local Municipality
- Cape Town Metropolitan Municipality
- Ekurhuleni Metropolitan Municipality
- eThekwini Metropolitan Municipality
- Johannesburg Metropolitan Municipality
- Mangaung Local Municipality
- Mbombela Local Municipality
- Msunduzi Local Municipality
- Nelson Mandela Metropolitan Municipality
- Polokwane Local Municipality
- Tshwane Metropolitan Municipality
- uMhlathuze Local Municipality

Buffalo City Local Municipality

Prepared by Rob Short
October 2004

1 Introduction

The purpose of this report is to document the findings of the study with regard to the Buffalo City Local Municipality.

2 Methodology

The investigation involved identifying all Buffalo City's waste sites and wastewater treatment works. This was done using interviews with municipal officials and documentation provided by a number of key departments within the local municipality.

The key documents reviewed included the IDP and the IDP Review for 2004 / 2005.

3 Contextual Information

The Buffalo City LM is a part of the Amatole District Municipality in the Eastern Cape Province and includes the towns of East London, King William's Town and Bisho.

The municipal area covers approximately 2512 square kilometers. It has a total population of 701 890 (figures from the 2001 census) with 191 046 households. For lighting purposes, 63% of all households have access to electricity and 34% have access to paraffin. 71% of households have access to a weekly refuse service and in terms of sanitation arrangements 64% have flush toilets. As regards water 58% of households have access either in their dwelling or inside their yard, while 35% have access in terms of a community standpipe.

Relationship to the developmental goals of the municipality

The IDP clearly identifies environmental concerns as a key issue for the municipality to address and the municipality has used the principles of Agenda 21 to guide its development processes. Job creation is a key priority, as is the municipality looking for projects with positive cash flows to support their developmental agenda. Sustainability, in all its facets, is an issue that Buffalo City actively considers in all it does.

The 2004 \ 2005 IDP review identified the need for innovative service arrangements for the solid waste management function at the municipality. A key environmental objective is "landfills and transfer stations comply with national and local environmental legislation", with the commissioning of the regional landfill site and the development and implementation of closure plans identified as activities to support this objective. The municipality is developing an Integrated Environmental Management plan.

On the basis of the above methane emission reduction projects including landfill gas use do have the potential to support Buffalo City's developmental objectives.

Institutional Arrangements

The local municipality manages all the waste management and wastewater treatment facilities.

4 Landfill Gas

The two key sites for this study within the municipality are the existing Second Creek site and the new Roundhill site, which is in the process of being commissioned (mid 2005). There are small existing sites i.e. NU 2 and King Williams Town, which are due for closure in 2007. There are also two small sites that have already been closed (in 2000) at Ducats and Dimbaza. A small composting project was implemented as a pilot (approximately 1500m^3 per year) but did not go further, due to funding and technical capacity issues.

Table 1: Landfill Site Characteristics

Landfill Site Name	*Classification*	*Waste Composition*	*Annual Tonnages*	*5 Remaining Life*	*Closure Date*	*Site Capacity (cubic meters)*
Roundhill (near Berlin; regional waste management site)	GLB+	General non-hazardous waste (will be applying for a hazardous waste permit	Approximately 316 000 tonnes	40 years (will be commissioned in mid 2005)	2045	12640 000
Second Creek	GLB+	General non-hazardous	200 000 tonnes	3	2007	7 500 000

Gas Emissions from the Sites

No measurements of gas emissions and\or the potential for landfill gas migration are carried out by the municipality. There have also been no formal gas yield trials carried out, test wells sunk or formal gas modeling undertaken.

Potential Gas Use Options

The municipality has already been approached by a number of interested parties in terms of the landfill gas potential for Second Creek. This has the potential to support a 2MW electricity generation facility and the municipality has applied to the Special Innovation Fund for grant support to take such a project further. The municipality sees this project as a means to reduce closure costs, while also reducing the potential for health related impacts and the methane produced by the landfill catching fire.

The regional landfill site has the potential to support a 4 – 5 MW facility. The municipality is already considering the potential for using the methane that would be produced by the site.

6 Wastewater Treatment

The municipality has responsibility for ten wastewater treatment works (see table below). In terms of the information provided none have anaerobic components and therefore there are no significant methane emissions that could form the basis of emission reduction project.

Table 2: Wastewater Treatment Facility Characteristics

Name and Location of Facility	*Process Description*	*Volumes Treated per Day*	*Average COD Value*	*Methane Production at Site*
Berlin	Bio-filters	<1Ml	234	Aerobic process – no methane produced
Central Treatment Works	PETRO – Deep fermenting pit with bio-filters	5Ml	1327	Aerobic process – no methane produced
Dimbaza	Extended Aeration	7Ml	394	Aerobic process – no methane produced
East Bank	Extended Aeration	33Ml	591	Aerobic process – no methane produced
Gonubie	Extended Aeration	8Ml	395	Aerobic process – no methane produced
Mdantsane East	Bio-filters	20Ml	660	Aerobic process – no methane produced
Potsdam	Bio-filters	7Ml	635	Aerobic process – no methane produced
Schornville	Extended Aeration & Bio-filters	5Ml	625	Aerobic process – no methane produced
Westbank	Sea outfall	8Ml		Aerobic process – no methane produced
Zwelitsha	Bio-filters	8Ml	503	Aerobic process – no methane produced

.

7 Summary and Recommendations

There is a significant opportunity on the landfill gas side in terms of Second Creek and the new regional waste management facility. Buffalo City Local Municipality has already been considering these issues as a result of a number of approaches to them, and has proactively applied for funds to take forward the Second Creek project.

8 Reference List

Personal Communications

Shirley Fergus, Manager – Integrated Environment and Sustainable Development, Buffalo City Local Municipality.

Johan Koekemoer, Manager – Sewerage Services, Buffalo City Local Municipality.

Zonwabele Plata, Manager – Waste Management Services, Buffalo City Local Municipality.

Dennis Smith, General Manager – Water, Sewerage and Scientific Services.

Quentin Williams, Manager – IDP, Buffalo City Local Municipality.

Reports

Buffalo City Municipality, Integrated Development Plan, 2002.

Buffalo City Municipality, Integrated Development Plan Review 2004 \ 2005.

Cape Town Municipality

Prepared by Michael Goldblatt
6 October 2004

1 Introduction

The City of Cape Town is the third largest metropolitan area in South Africa, by population, with approximately 2.9 million inhabitants. The city has begun to consider the potential for carbon finance projects. Projects considered include methane reduction from landfill gas projects and energy efficiency of housing. The city has also prepared a sustainable energy strategy which focuses strongly on climate change mitigation as a driver for renewable energy sources.

The focus of this investigation was on the city's six major landfill sites and its six waste-water treatment plants that have an anaerobic digestion component. It appears that there is significant scope for methane emissions reduction from landfill sites within the city, although most of these have not yet been verified through on-site gas yield trials. One of the sites, Bellville South, is already the subject of a landfill gas reduction project. There are also limited options for waste-water methane reduction but these may be difficult to develop due to technical constraints.

2 Methodology

The information for the City of Cape Town was based on interviews with personnel from the municipality's water and sanitation, electricity and solid waste departments as well as information received from those departments. A number of reports pursuant to the development of an integrated waste management plan in Cape Town have been prepared which contain much of the basic information required. Other secondary sources of information were used including the municipal IDP and the Cape Town Energy Strategy.

3 Contextual information

There are approximately 800 000 households within the City of Cape Town. Of these households about 240 000 are inadequately housed. The levels of access to water, electricity and sanitation are relatively high with approximately 90% of households having access to piped water in dwelling or on-site, electricity and flush toilets (City of Cape Town, IDP Needs Analysis, 2001). See the table below for further details (Census Data).

According to the City although service levels are relatively high, the city fares less well with regard to broader poverty indicators with 26% of households earning below the Household Subsistence Level. The high levels of poverty are also reflected in poor health indicators. In 2000, there were 565 new cases of tuberculosis per 100 000 people and an infant mortality rate of 26 infant deaths per 1000 live births. Contributing to the high level of poverty is a high unemployment rate and low skill levels.

Cape Town's economy generated R89.5 billion in goods and services (Gross Geographic Product) in 2000. The city's economy is important in both a provincial and national context, contributing to 11% of the national economy and 75% of the provincial economy. The economy has been growing at an average rate of 2.6%. However, the formal economy has not been able to accommodate growth in the labour force, with the result that unemployment has increased from 10% in 1991 to 18% in 2000. A strength of the metropolitan economy is that it is well-diversified with contributions to Gross Geographic Product from a range of sectors

The City intends to maintain and expand service delivery through an internally funded capital budget of R685 million in 2004/05, increasing to R835 million in the following two financial years. Cash flow projections show that this affordability level will produce a balanced budget for the City and, with careful planning, sustainable service delivery can be maintained and improved upon, while the expansion of services keeps taking place. Through accessing further funds from sources external to the City, infrastructure development can be accelerated in order to address the backlogs experienced by the City, and, depending on the level of funding received, keep pace with the predicted economic growth rate (City of Cape Town, 2004).

Relationship to the developmental goals of the municipality

The city's natural environment and beauty is one of its greatest assets. The aesthetic beauty of the area; access to natural resources and biodiversity is fundamental to the sustainable development of the city. The environment needs to be managed and protected not only for its intrinsic worth but also as the city's primary economic asset. In this light the City identifies one of the three main threats to the natural environment posed by unsustainable urban growth (City of Cape Town, 2001) as the "increasing problem of littering and illegal dumping that can have adverse social and health effects." The impact of urban growth on the natural environment is particularly bad in poorer areas. A particular problem faced by the city is identifying and developing waste disposal sites to cope with future demand.

The establishment of projects that make productive use of waste energy such as methane and that also create carbon finance revenue that did previously not exist can assist the city in the maintenance and improvement of existing solid waste and waste-water treatment assets. The City has indicated that priority should be given to the maintenance and upgrading of existing utility services over the implementation of new services to ensure that compaction, greater equity, efficiency and financial sustainability are promoted (City of Cape Town, 2004). Because of financial constraints in the City the IDP notes that the first financial imperative is to increase City revenue. This will be achieved by "focusing on other ways of increasing revenue. This will include improved collection administration, ***external funding and leveraging Council assets***". Carbon finance projects are likely to support this strategy.

With regards to the productive use of waste methane, one of the 2020 goals of the City identified in the IDP is that the renewable energy share of the City should be equal to 10% of total energy consumed. Landfill gas to power projects can contribute to this target.

Institutional arrangements

The municipality is the water services authority (WSA) and is also the water services provider for the municipal area. The wastewater treatment works are owned and operated by the Municipality. The Municipality has a Solid Waste Management Directorate which is the service authority and provider for solid waste services.

Table 1. Access to services in the City of Cape Town (2001, Municipal Demarcation Board)

Source of energy for lighting	no.	%	Refuse	no.	%
Electricity	674,508	89%	Municipal Weekly	717,028	94%
Gas	2,067	0%	Municipal Other	8,474	1%
Paraffin	66,325	9%	Communal Dump	9,532	1%
Candles	15,786	2%	Own Dump	14,245	2%
Solar	576	0%	No Disposal	10,485	1%
Other	501	0%			
Water			**Sanitation**		
Dwelling	526,866	69%	Flush Toilet	648,412	85%
Inside Yard	114,551	15%	Flush septic tank	14,243	2%
Community Stand	51,405	7%	Chemical toilet	1,584	0%
Community stand over 200m	57,315	8%	VIP	1,968	0%
Borehole	464	0%	Pit latrine	4,441	1%
Spring	81	0%	Bucket latrine	33,946	4%
Rain Tank	283	0%	None	55,169	7%
Dam/Pool/Stagnant Water	476	0%			
River/Stream	112	0%			
Water Vendor	259	0%			
Other	7,955	1%			

4 Landfill Gas

Cape Town has six formal solid waste disposal sites owned and operated by the Municipality. There is also a privately owned site, the Vissershok Waste Management Facility, which accepts hazardous waste. The city also has a number of waste transfer and composting facilities.

One of the municipal-owned landfills, Swartklip, has ceased to accept municipal wastes, except for builder's rubble and garden refuse. It is expected that three of the remaining five municipal landfills will be closed within the next four years. Planning has commenced for the development of a regional landfill site that will provide the shortfall of airspace as the existing landfills reach their full capacity prior to their eventual final closure.

The Cape Town Solid Waste Status Quo Report (Mega-Tech Incorporated, 2004) provides detailed information on the disposal sites in the City. The relevant chapter has been included as an addendum to this report. The salient details on the waste sites are tabled below and displayed in a graph to demonstrate the changing distribution of solid waste disposal in the city.

Table 2. Historical annual tonnages of waste disposed in formal landfill sites in Cape Town (thousand tonnes/annum)

	1997/98	1998/99	1999/2000	2000/01	2001/02	2002/03
Vissershok	328	289	269	273	302	317
Coastal Park	222	235	298	338	359	377
Swartklip	185	183	221	234	241	253
Bellville	329	392	290	309	300	315
Brackenfell	79	130	203	222	234	246
Faure	166	229	212	220	201	211
Total	1,309	1,458	1,493	1,596	1,637	1,719
% Annual Increase		**11.20%**	**2.40%**	**6.90%**	**2.60%**	**5.00%**

Table 3. Projected annual tonnages of waste disposed in formal landfill sites in Cape Town (thousand tonnes/annum)

	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08
Vissershok	317	460	600	940	1,225	1,325
Coastal Park	377	395	415	430	445	455
Swartklip	253	120	30	30	30	30
Bellville	315	330	350	365	100	-
Brackenfell	246	290	275	-	-	-
Faure	211	220	230	237	250	275
Total Requirement	1,719	1,815	1,900	2,002	2,050	2,085
% Annual Increase		**5.50%**	**5%**	**4%**	**3%**	**2%**

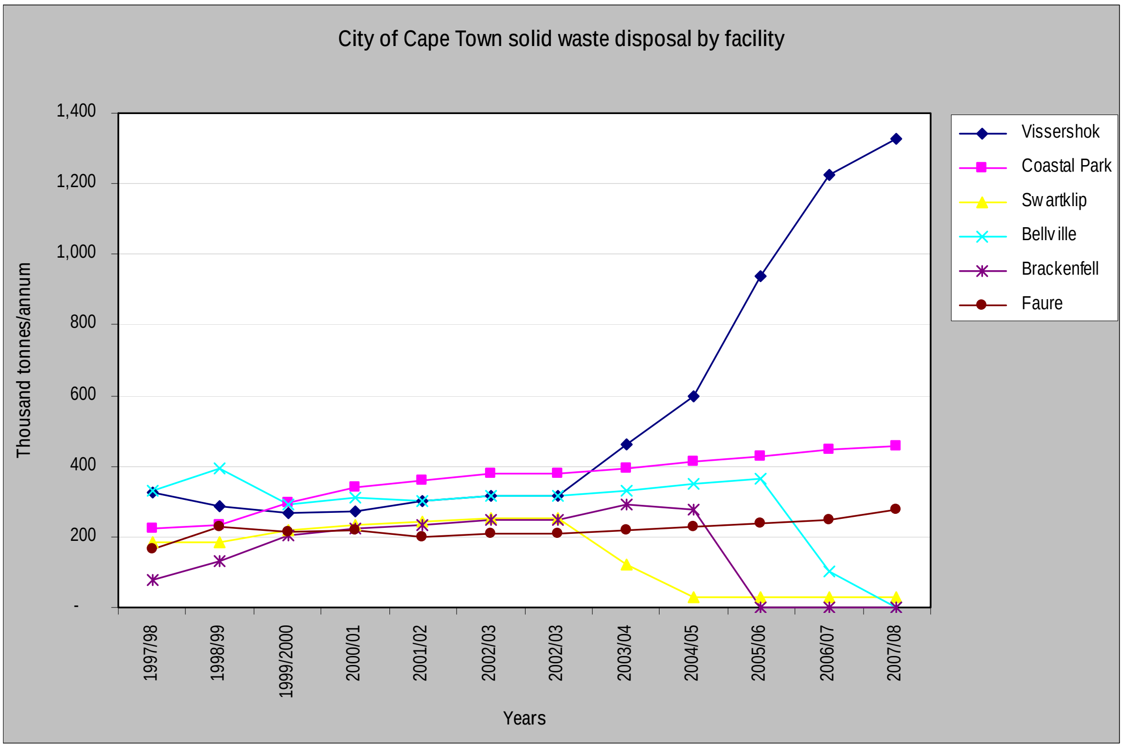


Figure 1. Historical and projected waste disposal rates by site in the City of Cape Town

Gas emissions from the sites

None of the City's existing landfills currently extracts landfill gas for beneficial utilisation. A greenhouse gas inventory for the City was prepared in 2003 that estimated that approximately 38% of the total city's greenhouse gas emissions (in tonnes CO_2 equivalents) emanate from landfill sites. A pre-feasibility study was completed by the SouthSouthNorth (SSN) Project Team in 2003 (an international project which assists in identifying, developing and transacting CDM) to determine whether the Bellville South landfill would be feasible for landfill gas exploitation. A detailed feasibility study, undertaken by the SSN Project Team, is currently in progress.

The Bellville South landfill has three gas wells (not in production) which were installed in 2002 to determine the quantities of methane gas being generated. Tests revealed that the landfill will generate approximately 16 million m^3 of landfill gas per annum over the next 15-20 years. This accords well with the modelling results presented below and provides a measure of confidence in the analysis conducted for the current study.

According to Peter Novella, former Director of waste disposal in the City of Cape Town, in the early 1990s some gas yield trials were done on the Coastal Park landfill. Aside from this there is limited understanding in the city as to the current emissions from the landfill sites under their control.

The presumed gas emissions from the formal sites are therefore based on initial modelling done as part of this project. The parameters of the various landfill sites that have informed the modeling are shown in detail in the appendix. The table below provides the core information required to assess the feasibility of landfill gas emission reductions and use in the city.

It appears from the analysis that all the city's landfill sites are worthy of further investigation as potential landfill gas projects. In particular, Vissershok and Coastal Park – partly due to their continued growth, appear to offer significant potential as future landfill gas reduction and power generation projects. These sites may offer in the region of 5-6 MW of potential power generation capacity. The other sites, apart from Bellville, range from Brackenfell, with an estimated 1MW potential, to Faure, with an estimated 2-3 MW potential. The closed Swartklip site may be able to prove about 2 MW of power if used in this manner.

Table 4. Landfill Gas Analysis for the City of Cape Town Solid Waste Disposal Sites

Location	Landfill Site	Current Input (t/yr) 2004	Total Capacity (m3 / tons)	Remaining capacity (m3 / tons)	Year to Close	Estimated Peak LFG Yield (Nm3/hr)	Estimated Methane (t/yr)	Potential Electricity Generation (MWe)
Tygerberg	Bellville South (old)	315,000	3,000,000	0	2003	900	2,821	1
Tygerberg	Bellville South (new cells)	325,000	975,000	1,500,000	2006	875	2,743	1
Blaauberg	Vissershok	320,000	16,500,000	9,000,000	2015	4,400	13,793	5 - 6
Muizenberg	Coastal Park	377,000	10,832,000	6,800,000	2016	4,400	13,793	5 - 6
False Bay	Swartklip (closed)	253,000	3,565,000	0	2003	1,800	5,643	2
Eersterivier	Faure	211,000	6,120,000	750,000	2007	2,300	7,210	2 - 3
Oostenberg	Brackenfell	246,000	1,363,000	240,000	2005	1,100	3,448	1

Potential gas use options

The default option for the use of landfill gas is typically electricity generation and the City's Electricity department indicated that they were willing to support the generation of electricity from landfill gas and the purchase of power from these sources. The total power generated would be very small in comparison with the total amount of electricity purchased by the City from Eskom and from their own sources. Nevertheless, this generation would support the Cape Town Energy Strategy (Cape Town, 2003) and is likely to be technically feasible, particularly in the larger sites.

There are other options for the use of the landfill gas. The Bellville South project is exploring the sale of the gas to industrial users within a short distance of the site. There are environmental and financial benefits to the use of the gas for industrial boilers which makes this the preferred option for the Bellville South site where there appear to be users of adequate size within a reasonable distance of the site. There may be similar industrial use opportunities at the Coastal Park site become of the proximity of the site to an industrial zone.

Other, more technically complex options, such as the use of gas as diesel replacement are likely to be more viable in a large metro like Cape Town than smaller towns due to the availability of suitable vehicle fleets for conversion but have not been explored in any depth yet in the city.

Relationship to IDP objectives and to improved service delivery

The use of landfill gas is compatible with the municipality's strategy with regards to disposal site closure and development. The extraction of gas from sites soon to be closed would help to finance those sites which no longer will have a revenue stream associated with them. This extraction would also assist in the safe management of gas from these sites. Active gas extraction at operating sites would similarly add a new revenue stream to these sites and would assist in sound site management.

The Cape Town Energy Strategy makes explicit reference to the potential for landfill gas to energy projects and there appears to be real potential for this potential to be realised.

The Solid Waste Management division has fairly advanced systems for composting of organic solid waste. At the same time only a small proportion of refuse is diverted to composting and the Status Quo report (Mega-Tech Incorporated, 2004) has identified the expansion of composting as an appropriate and affordable mechanism of reducing the amount of waste going to landfill. There is the potential that aerobic composting operations, as carried out by the City, could qualify as CDM projects and this option should be explored by the City in support of the expansion of their composting facilities.

5 Waste-water treatment

The City of Cape Town has 17 waste-water treatment works of which only six have anaerobic sludge digestion and therefore would be generating methane. Of these six, three (Simons Town, Llandudno and Kraaifontein) generate amounts of biogas that are too small to warrant further investigation as CDM projects. The other three sites are significantly larger but offer uncertain potential as CDM projects.

The Cape Flats works store all the gas produced and use it for fuel in their boilers for heating the digesters or for a thermal drying plant. Sludge pellets are dried on site. The gas saves the treatment works significant amounts of money in fuel (diesel) savings. The amount of biogas produced is estimated at about 47 000 m^3/day by the model used for this analysis, while the City estimates that about half this is produced. This may indicate that some fugitive gas emissions are occurring that could be captured and used.

Athlone Works generates fairly large quantities of biogas but most of this is drawn off and captured. The gas holder is in disrepair and the roofs of the digesters are cracked and require significant upgrades. Despite these deficiencies a large proportion of the gas is used for heating of the process within the works. There may be the potential for a CDM project designed around the upgrading of the digesters to prevent fugitive emissions. This warrants further investigation. The Mitchells Plain works has a gas holder and boiler and uses all the gas generated on-site.

Table 5. Cape Town waste-water treatment works emissions

Waste Water Treatment Works	*Treatment Capacity (Ml/day)*	*Average Flow (Ml/day)*	*Treatment Process*	*Organic Carbon Content (CODmg/l)*	*Volume Biogas Produced (m3/day)*	*Current Biogas Use*	*Potential Biogas Use Options*	*Comments*
Cape Flats	200	173	Anaerobic	774	**46,772**	Used as fuel for boilers	**Thermal or 3 MW_e**	Potential use as thermal energy / electricity generation
Athlone	80	75	Anaerobic	916	**23,996**	Some used as fuel for boilers	**Thermal or 1.5 MW_e**	Potential use as thermal energy / electricity generation
Mitchells Plain	32	29	Anaerobic	1144	**11,588**	Gas holder and boiler	**Thermal or 0.5 MW_e**	Potential use as thermal energy / electricity generation
Kraaifontein	7	6	Anaerobic	818	1,715	Vented	n/a	Too small for use consideration
Simons Town	5	2	Anaerobic primary	615	429	Vented	n/a	Too small for use consideration
Llandudno	0.5	0.36	Anaerobic	650	82	Vented	n/a	Too small for use consideration

Gas use options

As indicated, those treatment works generating biogas of any significant volume are already using the gas generated productively. There may be some scope for upgrades and the reduction of fugitive emissions which could be supported by carbon finance if the scale of the reductions was sufficiently large. Aside from this there do not appear to be other important uses of the waste biogas.

6 Summary and Recommendations

There appears to be the potential for landfill gas projects at all six of the city's landfill sites. The Bellville South landfill gas CDM project is already well advanced and there appears to be little reason for the City not to pursue projects at the other sites.

A small proportion of the City's waste-water treatment works generate significant amounts of biogas but they already uses this productively and relatively efficiently and the only possible project that is immediately apparent is the upgrade and maintenance of facilities to reduce and use fugitive emissions which may be fairly significant in some works.

Institutional context

The Municipality has some experience with CDM projects – both in the landfill gas and housing sectors. There is therefore the political readiness to engage with these projects. The landfill gas project has shown that the Metro itself lacks the capacity to take these projects forwards and the project has been driven by an outside NGO. It is therefore likely that other similar projects will require external assistance and suitable contractual arrangements that allow for additional capacity to be brought to bear on project development.

7 Reference List

Personal communications

Haider, S.: personal communication, 30 July 2004, Acting Director, Solid Waste Management, City of Cape Town.

Maxwell, A.: personal communication: 30 July 2004, Director, Waste-water management, City of Cape Town.

Munroe, G.: personal communication, 29 July 2004, Electricity Department, City of Cape Town,

Novella, P.: personal communication, 18 October 2004, former Director, Solid Waste Disposal, City of Cape Town.

Reports

City of Cape Town, 2003: *Cape Town Energy Strategy*, draft document, City of Cape Town in association with Sustainable Energy Africa and ICLEI, October 2003.

City of Cape Town and Mega-Tech Incorporated, 2004: *City of Cape Town Integrated Waste Management Plan, Draft Assessment Report* , May 2004.

City of Cape Town, 2001: *IDP Needs Analysis*, report prepared in support of the Integrated Development Plan.

City of Cape Town, 2004: *Draft Integrated Development Plan*, Cape Town.

Mega-Tech Incorporated, 2004: *City of Cape Town Integrated Waste Management Plan, Draft Assessment Report* , May 2004, prepared under Mega-Tech Inc.'s prime contract with USAID by Jeffares and Green & Ingerop Africa in support of the Integrated Waste Management Plan for the City of Cape Town.

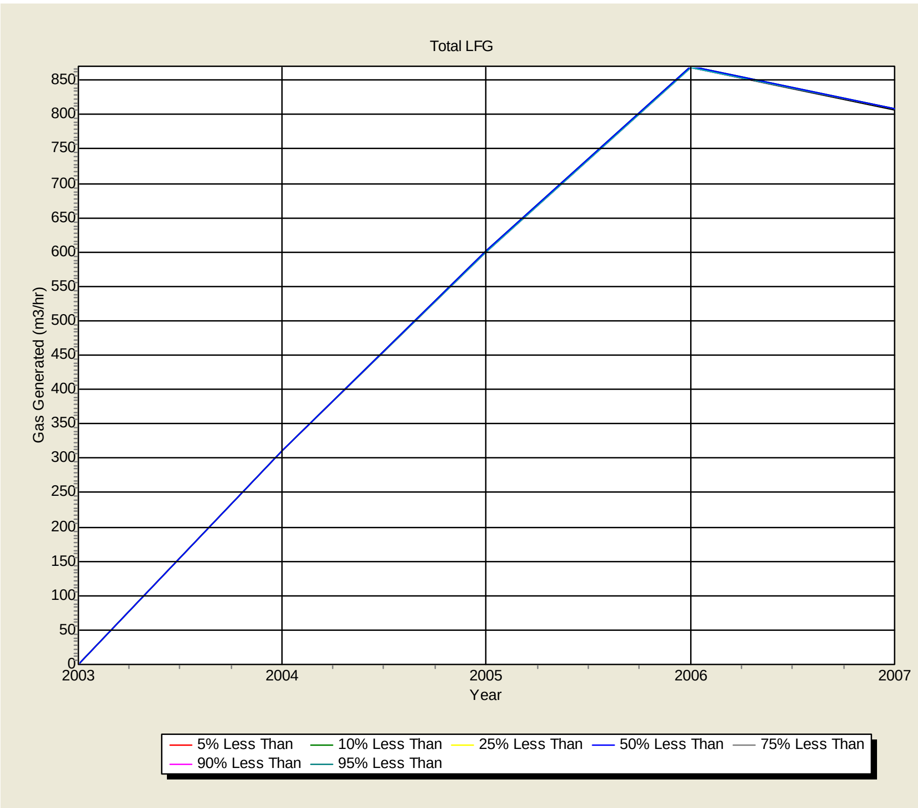
Municipal Demarcation Board, 2004: URL: http://www.demarcation.org.za/

Appendix A: Modelled Landfill Gas Curves for Cape Town

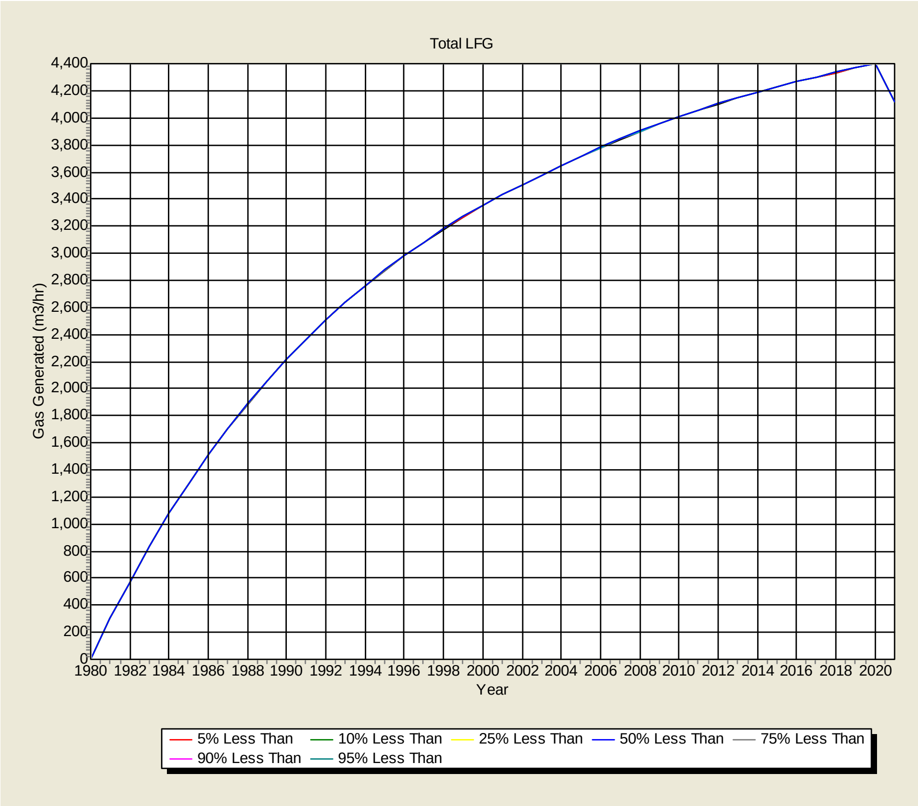
Key Landfill Data Used

Location	Tygerberg	Tygerberg	Blaauberg	Muizenberg	False Bay	Eersterivier	Oostenberg
Local Authority / Owner	Cape Town	Cape Town	Cape Town	Cape Town	Cape Town	Cape Town	Cape Town
Landfill Site	Bellville South (old)	Bellville South (new cells)	Vissershok	Coastal Park	Swartklip (closed)	Faure	Brackenfell
Year Opened	1963	2003	1980	1980	1980	1972	1995
Landfill Classification	GLB+	GLB+	GLB+/H:h	GLB+	GLB+	GLB+	GMB+
Operator	CTM	CTM	CTM	CTM	CTM	CTM	CTM
Landfill Footprint Area (Ha)	29	7	210	62	103	36	4.5
Landfill Height (m)	30	13	50	20	10 - 15?	34	30
Current Input (tons/year) 2004	315,000	325,000	320,000	377,000	253,000	211,000	246,000
Total Capacity (m^3 / tons)	3,000,000	975,000	16,500,000	10,832,000	3,565,000	6,120,000	1,363,000
Current In-place Volume (m3 / tons)	3,000,000	325,000	7,500,000	4,032,000	3,565,000	5,065,000	1,123,000
Remaining capacity (m3 / tons)	0	1,500,000	9,000,000	6,800,000	0	750,000	240,000
Remaining Life (years)	0	3	11	14	0	3	1
Year to Close	2003	2006	2015	2016	2003	2007	2005
Rainfall (mm/year)	555	555	555	555	555	555	555
Estimated Peak LFG Yield (Nm3/hr)	900	875	4,400	4,400	1,800	2,300	1,100
Estimated Methane (tons/annum)	2,821	2,743	13,793	13,793	5,643	7,210	3,448
Potential Electricity Generation (MW)	1	1	5 - 6	5 - 6	2	2 - 3	1
Comments / Contact Details	>1997: 60,000 t/a ; 1998>: 329,000 t/a ; Unlined; LFG monitoring; estimated LFG production: 16 million m3/annum (15-20yrs)	Geomembrane lined - new cells. Does not take into account further expansion potential.	1998: 328,000 t/a; co-disposal; liquids: 80,000 t/a; close 2031?	1998: 222,000 t/a	1998: 166,000 t/a ; 2003: 211,000 t/a; Closed; now to Vissershok	1998; 166,000 t/a	1998: 79,000 t/a; 2003: 246,000 t/a

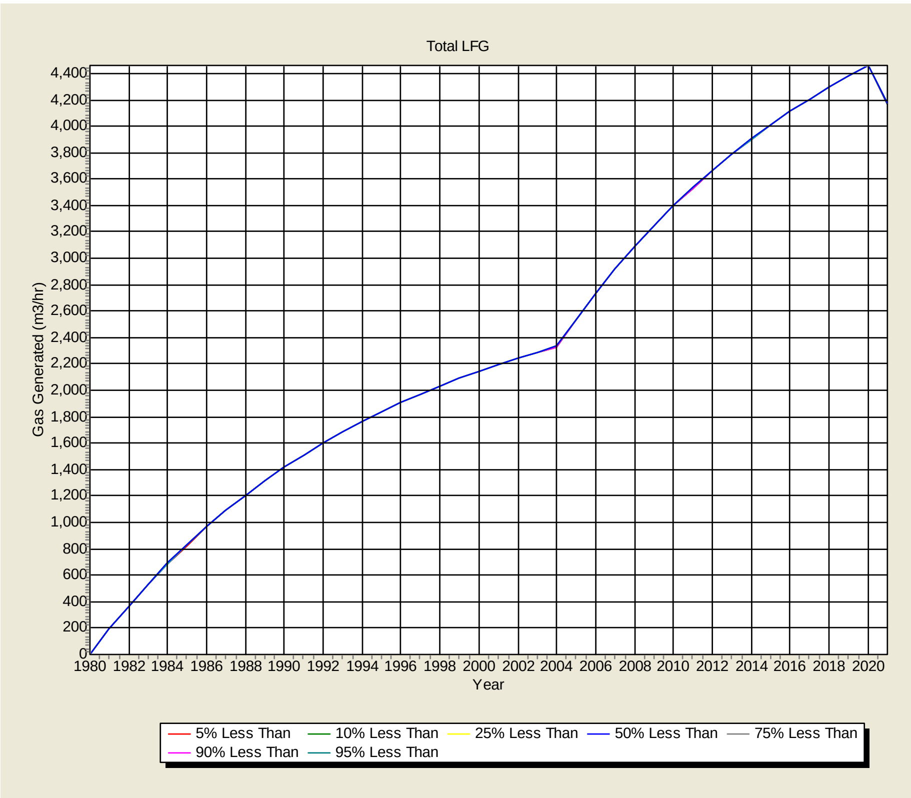
Cape Town : Bellville South Landfill (Old)



Cape Town : Bellville South Landfill (New)

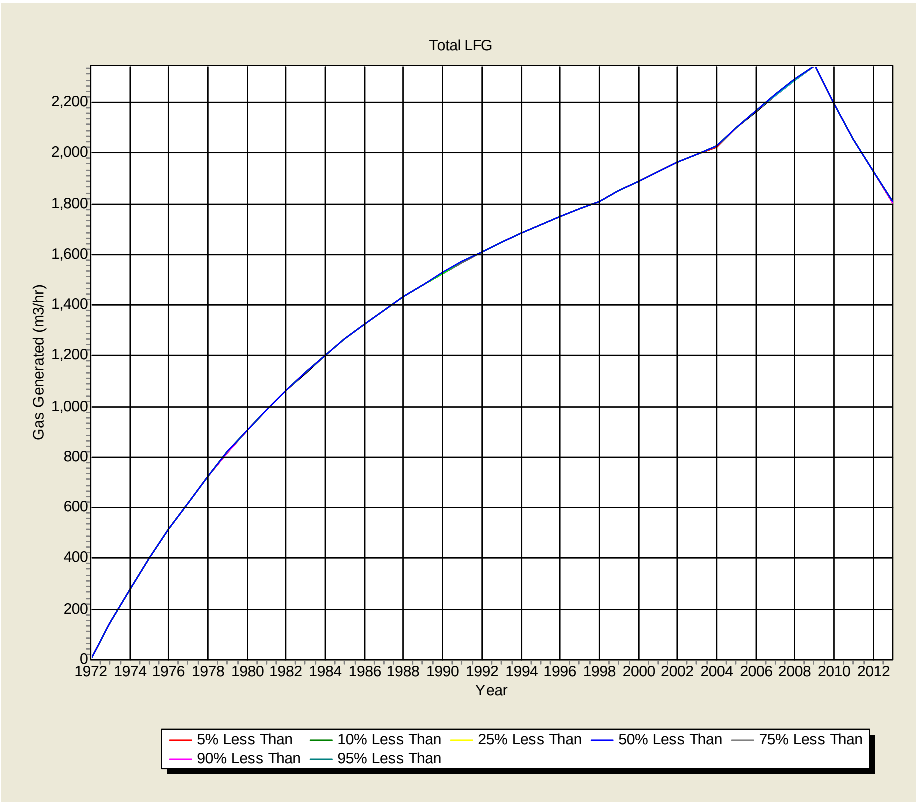


Cape Town : Vissershok Landfill

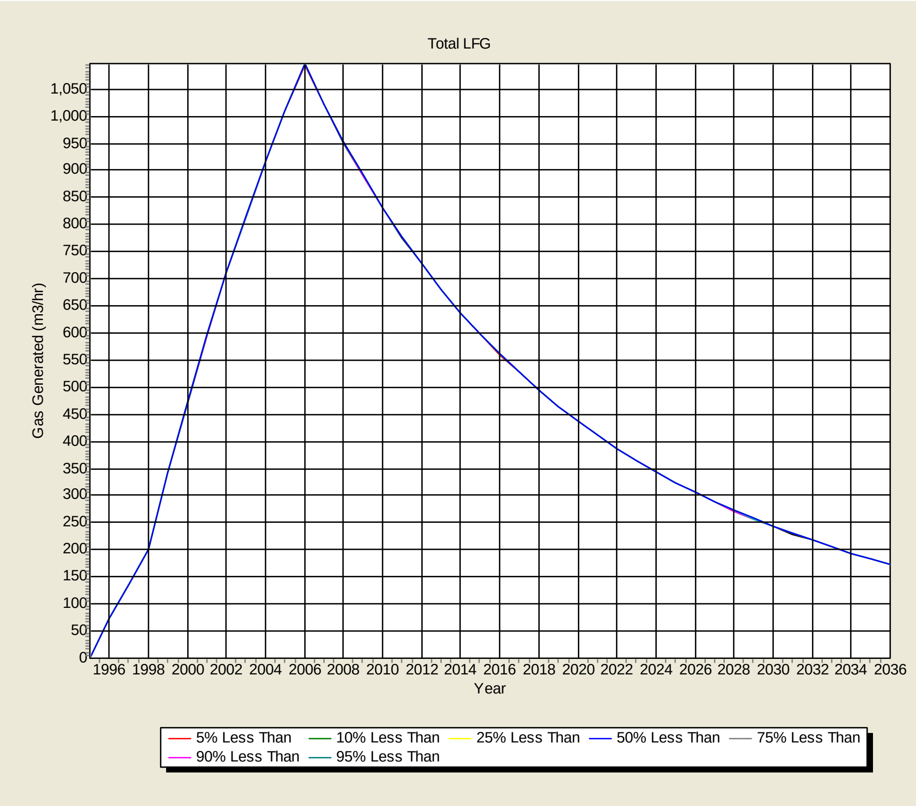


Cape Town : Coastal Park Landfill

Cape Town : Swartklip Landfill (Closed)



Cape Town : Faure Landfill



Cape Town : Brackenfell Landfill

Addendum: Extract from CT Solid Waste Status Quo report, Chapter 7 (Disposal)

Extract from: Mega-Tech Incorporated, 2004: *City of Cape Town Integrated Waste Management Plan, Draft Assessment Report* , May 2004, prepared under Mega-Tech Inc.'s prime contract with USAID by Jeffares and Green & Ingerop Africa in support of the Integrated Waste Management Plan for the City of Cape Town.

7.1.1 Bellville South (CCT) GLB+

The Bellville South waste disposal site (BSWD site), approximately 72 ha in extent, is one of the city's largest facilities receiving domestic and commercial general wastes and is strategically situated in the central metropolitan area.

The BSWD site (see Figure 7.4) is located in the industrial area of the Tygerberg Municipal Area, south of the Sacks Circle industrial area, with Belhar residential areas on the western and southern boundaries and the R300 freeway on the eastern boundary. The site was permitted in 2003 for GLB+ disposal, with closure to take place by September 2006. The BSWD site was used in the early 1930's for sewage disposal and has been in operation as a waste disposal site since the 1960's, receiving general domestic and commercial onto an unlined landfill. The close proximity to residential areas and the risk of contamination to the underlying Cape Flats aquifer were the main reasons for the decision taken to prematurely close the site.

Following reconstruction of local government in 1997, the CMC Administration took over the responsibility for operating the site from the former Bellville Municipality and extended the catchment area from which general and commercial wastes, garden refuse and builders' rubble are received.

Prior to 1997 the volume of waste received at the site was approximately 60 000 t/annum. After 1997, when the CMC Administration took over the responsibility of the site and increased the catchment area serving the site, the volume of waste received has remained fairly constant. A disposal rate of 329 000 t/annum was estimated in 1998 and 315 000 t/annum in 2002/2003 – (see Table 7.2). The annual growth rate of disposal is therefore not consistent with the City's average annual disposal growth rate of 5,5%. This can be ascribed to the upgrading of the Athlone Transfer Station (which resulted in decanting waste from the Bellville South catchment area) and the installation of a weigh-bridge at the BSWD site which has resulted in a more accurate measurement of the in-coming waste.

The footprint of the unlined landfill is approximately 29,0 ha. The landfill is approximately 30,0m above the western boundary (Belhar Road Extension), at its highest point.

Two lined cells of approximately 5,0 ha in total extent were constructed in 2003, which will provide airspace for a further two years (650 000 tonnes), i.e. until the end of 2005. The Bellville South waste disposal site has been in operation since the 1960's, where general waste was disposed of onto an unlined landfill. The close proximity to residential areas and the risk of contamination to the underlying Cape Flats aquifer were the main reasons for the decision taken to prematurely close the site.

The site facilities include a lined leachate dam, from which the leachate generated from the lined landfill is to be pumped to the adjacent Bellville wastewater treatment site for treatment. A leachate pumpstation and rising main are planned for construction in 2004. Progressive remediation of the unlined landfill has commenced, with capping of the western side and portion of the southern side completed in 2002. Extensive landfill gas testing has been undertaken to determine the quantities and characteristics of the landfill gases. Gas monitoring wells have been installed around the perimeter of the site to measure migration of landfill gas. The BSWD site facilities include a mini public drop-off station for after-hours disposal where loads of less than 1 ton are accepted free of charge. Clean builders' rubble and fill material suitable for use as daily cover material is also accepted free of charge at the site.

A future cell of approximately 2,0ha will be required to provide additional airspace for disposal of waste until closure in September 2006. The CCT has appealed against the closure date decided by DEADP in terms of their Record of Decision (June 2001), and is awaiting a response. A further requirement of the abovementioned Record of Decision is that a transfer station serving the central CTM area be operational by September 2006.

The site is externally audited three times a year for compliance with the operating permit. A Landfill Monitoring Committee meets regularly.

The BSWD site allows recycling of waste by informal salvagers managed by a private contractor. The following quantities of materials are estimated to be recycled annually at

Figure 7.6: Photograph showing an aerial view of the Coastal Park (CCT) Waste/ disposal site

Figure 7.7: Photograph showing an aerial view of the Faure (CCT) waste disposal site.

the BSWD site (Ref 7-10) – see Table 7.6. The total annual quantity of materials recycled is 542.9 t/annum (1,7%).

Table 7.6: Quantities of materials recycled at the BSWD site

Material	Plastic (Soft)	Plastic (Hard)	Paper	Cardboard	Metal	Glass
Tons/annum	129.6	32.4	309.6	23.3	37.1	10.9

7.1.2 Brackenfell (CCT) GMB+

The Brackenfell waste disposal site (BWD site), approximately 4,5 ha in extent, is located in the Oostenberg Administration area. The site is an elevated disused rock quarry located off Reservoir Road in the Bracken Nature Reserve. There is pressure to close the landfill as it is located near to a residential area and the original excavation pit will soon be filled to the original ground surface level.

The BWD site (see Figure 7.5) was permitted in 1995 for GMB+ disposal, with closure to take place by the end of 2004. The volume of waste received at the site has increased from a disposal rate of 79 000 t/annum in 1998 to an amount of 246 000 t/annum in 2002/2003 – (see Table 7.2). The site is externally audited three times a year.

7.1.3 Coastal Park (CCT) GLB+

The Coastal Park waste disposal site (CPWD site) (see Figure 7.6) is situated on Baden Powell Drive, west of Muizenberg in the South Peninsula Administration area and was permitted in July 2002 for GLB+ disposal.

The site occupies approximately 62 ha and currently receives general municipal waste, garden refuse and builders' rubble which is compacted in place. The volume of waste received at the site has increased from 222 000 T/annum in 1998 to a current disposal rate of approximately 377 000 T/annum, representing an average annual growth rate of more than 11% (the most significant growth rate of the City's landfills). The Coastal Park landfill is expected to serve a major role in the future disposal of the CCT's waste because of its strategic geographical location and relatively long lifespan. Planned expansion of the landfill will allow it to remain open until approximately 2025.

The construction of linings for a new cell (Phase 2B) commenced at Coastal Park during 2003, to be completed by June 2004. The CPWD site facilities include a mini public drop-off station for after-hours disposal.
The CPWD site allows recycling of waste by informal salvagers managed by a private contractor. The following quantities of materials are estimated to be recycled annually at the CPWD site [Ref 7-10] – see Table 7.7. The total annual quantity of materials recycled is 374.2 t/annum (1,0%). Garden waste is regularly chipped by a private contractor (Interwaste) and removed from the site.

Table 7.7: Quantities of materials recycled at the CPWD site

Material	Plastic (Soft)	Plastic (Hard)	Paper	Cardboard	Metal	Glass
Tons/annum	40.0	-	226.0	4.6	77.1	26.5

The site is externally audited three times a year for compliance with the operating permit. A Landfill Monitoring Committee meets regularly.

7.1.4 Faure (CCT) GLB+

The Faure waste disposal site (FWD site) (see Figure 7.7), situated on the Old Faure Road, Eersteriver, is in the extreme southern portion of the Oostenberg Administration area near the border of Helderberg and Blue Downs. A permit to operate the site (until closure) has been applied for.

It is envisaged that the FWD site will operate for a possible period of approximately five years. The potential threat of groundwater contamination and increased urban development in the area has led to the decision to close and rehabilitate the site in the short-term. A waste transfer station may be required once the site closes.

The site occupies approximately 36 ha and currently receives general municipal waste, garden refuse and builders' rubble which is compacted in place. The landfill is approximately 34,5m high at its highest point. The volume of waste received at the site has increased from 166 000 T/annum in 1998 to a current disposal rate of approximately 211 000 T/annum, representing an average annual growth rate of more than 5%. The FWD site receives the least waste of the City's landfills.

The FWD site has an informal mini public drop-off station for after-hours disposal. The site is externally audited three times a year.

7.1.5 Swartklip (CCT) – GLB+

The Swartklip waste disposal site (SWD site), approximately 103 ha in extent, is located approximately a kilometre from the False Bay coast in the Cape Town Administration

Figure 7.8: Photograph showing an aerial view of the Swartklip (CCT) waste disposal site

Figure 7.9: Photograph showing an aerial view of Vissershok (CCT) waste disposal site.

area, on the outskirts of Mitchell's plain. The site, serving mainly Mitchell's Plain and Khayalitsha, was closed in 2003 as a result of it's location near to a residential area and its potential for contamination of the Cape Flats aquifer, considered to be a future source of potable water.

The SWD site (see Figure 7.8) was not permitted, but prior to 2003 used for GLB+ disposal, with only selected builders' rubble currently being disposed of onto the site. The volume of waste received at the site increased from a disposal rate of 166 000 t/annum in 1998 to an amount of 211 000 t/annum in 2002/2003 – (see Figure 7.3), representing a growth rate of 6% per annum. A transfer station has been built on the site which was commissioned in 2003, with all wastes transported to the Vissershok waste disposal site, except for builders' rubble that is disposed of on the site, and garden refuse that is composted. The site is externally audited three times a year.

7.1.6 Vissershok (CCT) GLB+, Hh

The Vissershok waste disposal site, see Figure 7-9, approximately 210 ha in extent, is situated 25km north of Cape Town in the Blaauwberg Administration area, off the N7 and Frankdale roads. The site was permitted in 1998 for H:h and GLB+ disposal. The volume of waste received at the site has remained fairly constant, with 328 000 T/annum disposed of in 1998 and having a current disposal volume of approximately 317 000 T/annum. The disposal volume is, however, expected to increase significantly over the next five years as waste is received as a result of the closure of the Bellville South, Brackenfell, Swartklip and Faure landfills.

Disposal operations at the site include landfilling of containerised waste from the Athlone and Swartklip RTF's, co-disposal of liquid hazardous waste and solid waste in trenches (H:h) and landfilling of mixed domestic and industrial wastes (H:h).

The site is underlain by 0,4 to 5,0m of Cape Flats sand, overlying a 10 to 20m layer of clay, resulting in the site being located in one of the few areas within reasonably close proximity to the CTMA suitable for the disposal of hazardous wastes. The Vissershok site is made up of the following areas:

- Cell (0): Currently unused unlined landfill adjacent to Frankdale Road: Permit Status is H:h
- Cell (1): Current lined landfill receiving selected general waste.
- Cell (2): In use since January 2003.
- Cell (G): Used as a previous balefill operation, as a GLB+ facility. Currently in use for containerised and selected general waste.
- Pan Area: Existing area with discontinued H:H disposal.
- Encapsulation Area: Existing concrete encapsulation blocks, discontinued H:H disposal.

The present height of Cell (0) is approximately 50,0m. A further lined cell is planned for construction in 2004/05. A leachate treatment works was commissioned in June 2003.
The volumes of liquid wastes, sludges, fuel fired systems (FFS), foodstuff and sanitary wastes received annually at the site are shown in Table 7.8 below.

Table 7.8: Quantities of Liquid Wastes, Sludges, Contaminated Foodstuff, Sanitary and FFS Wastes

Waste	Liquid Waste	Contaminated Foodstuff and Sanitary Waste	Wastewater Sludge	FFS Waste
Tons/annum	22 200	3 300	53 000	1 380

The Vissershok site allows recycling of waste by informal salvagers managed by a private contractor. The following quantities of materials are estimated to be recycled annually at the BSWD site (Ref 7-10) – see Table 7.9. The total annual quantity of materials recycled is 652.1 t/annum (2,1%).

Table 7.9: Quantities of materials recycled at the Vissershok site

Material	Plastic	Paper	Cardboard	Metal
Tons/	59.9	277.7	60.0	154.5

The Vissershok landfill is expected to serve a major role in the future disposal of the CCT's waste because it is one of only two existing landfills that are expected to be in operation after 2007; it can accept high and low hazard wastes; it has good road and rail access; it has the infrastructure to receive and dispose of containerised waste and has a projected closure date of 2015. Furthermore, the site has potential expansion to remain open until 2031.

The site is externally audited three times a year for compliance with the operating permit. A Residents' Monitoring Committee meets regularly. The site is permitted in accordance with Permit No. 16/2/7/G203/D29/Y1/P300 dated April 1998, as amended in June 2003.

7.1.7 Vissershok Waste Management Facility(VWMF) - (Private Company) - HH

The Vissershok Waste Management Facility (VWMF) is the only privately owned and operated facility in the CTMA (owned by Enviroserve / Wasteman), and is located adjacent to the CCT waste disposal site at Vissershok. The VWMF is permitted for HH disposal and accepts, treats and disposes of low and high hazard waste and general waste. In 1997/98 the site disposed of approximately 295 000 t/annum (ref 7-1) and is estimated to currently receive in the order of 320 416 t/annum.

Co-disposal of wastewater sludge has previously taken place at the Vissershok site, but this practice has now ceased, with the sludge being disposed of onto agricultural lands at controlled and environmentally acceptable application rates (see Section 7.8).

The VWMF is expected to play a significant role in future waste management in the CTMA because it is the only site in the CTMA able to accept high hazard wastes (HH), and one of two sites in the CTMA able to accept low hazard wastes (Hh). The site is expected to remain open until 2014.

Appendix: Waste-water treatment analysis for Cape Town

Key Waste-Water Treatment Data Used

Waste Water Treatment Works	Treatment Capacity (Ml/day)	Average Flow (Ml/day)	Treatment Process	Raw Sludge %	Organic Carbon Content (CODmg/l)	Volume Biogas Produced (m3/day)	Current Biogas Use	Potential Biogas Use Options	Comments
Athlone	80	75	Anaerobic	Maximum potential methane generation based on flow rate and COD	916	23,996	Vented	Thermal or 1.5 MW_e	Potential use as thermal energy / electricity generation
Bellville	46	51	Aerobic		1079	n/a	n/a	n/a	
Borchards Quarry	30	25	Aerobic		1565	n/a	n/a	n/a	
Cape Flats	200	173	Anaerobic	Maximum potential methane generation based on flow rate and COD	774	46,772	Vented	Thermal or 3 MW_e	Potential use as thermal energy / electricity generation
Gordons Bay	4	2	Aerobic		611	n/a	n/a	n/a	
Kraaifontein	7	6	Anaerobic	Maximum potential methane generation based on flow rate and COD	818	1,715	Vented	n/a	Too small for use consideration
Llandudno	0.5	0.36	Anaerobic	Maximum potential methane generation based on flow rate and COD	650	82	Vented	n/a	Too small for use consideration
Macassar	35	34	Aerobic		644	n/a	n/a	n/a	
Melkbos	3.75	2	Aerobic		516	n/a	n/a	n/a	
Mitchells Plain	32	29	Anaerobic	Maximum potential methane generation based on flow rate and COD	1144	11,588	Vented	Thermal or 0.5 MW_e	Potential use as thermal energy / electricity generation
Parow	1.2	2	Aerobic		654	n/a	n/a	n/a	
Potsdam	32	29	Aerobic		1009	n/a	n/a	n/a	
Scottsdene	7.5	5	Aerobic		630	n/a	n/a	n/a	

Waste Water Treatment Works	Treatment Capacity (Ml/day)	Average Flow (Ml/day)	Treatment Process	Raw Sludge %	Organic Carbon Content (CODmg/l)	Volume Biogas Produced (m3/day)	Current Biogas Use	Potential Biogas Use Options	Comments
Simons Town	5	2	Anaerobic primary	Maximum potential methane generation based on flow rate and COD	615	429	Vented	n/a	Too small for use consideration
Wesfleur	14	10	Aerobic		1115	n/a	n/a	n/a	
Wildevoelvlei	14	6	Aerobic		852	n/a	n/a	n/a	
Zandvliet	48	48	Aerobic		655	n/a	n/a	n/a	

Ekurhuleni Metropolitan Municipality

Prepared by Rob Short
December 2004

1 Introduction

The purpose of this report is to document the findings of the study with regard to the Ekurhuleni Metropolitan Municipality (EMM).

2 Methodology

The investigation involved identifying all Ekurhuleni's waste sites and wastewater treatment works. This was done using interviews with municipal officials and documentation provided by a number of key departments within the local municipality.

3 Contextual Information

The EMM serves a population fast approaching three million (the 2001 census had the population at a figure of 2 480 276) in the area previously know as the East Rand in the Province of Gauteng and is the fourth largest municipality in South Africa. It is highly industrialized and produces approximately 23% of the Gross Geographic Product of the Gauteng. There are 744 935 households in the EMM and the unemployment rate is in the order of 40%.

Relationship to the developmental goals of the municipality

Ekurhuleni's vision is to build the smart, creative and developmental city. Its mission statement highlights its focus on the social, environmental and economic regeneration of the city and its communities. The EMM is also committed to the implementation of an Integrated Environmental Management Framework within the 2003 – 2007 period and ensuring that it complies with Agenda 21 principles, as well as the implementation of targets and programmes arising from the World Summit on Sustainable Development held in 2002. The anticipated positive cash flows from methane emission reduction projects would also fit into the EMM's key performance area of financial sustainability, as well as assisting it in ensuring that all services are provided in as affordable manner as possible.

Institutional Arrangements

The municipality has ownership of all the waste sites under its jurisdiction, but has outsourced their management to private companies. In terms of the wastewater treatment works these are owned and managed by ERWAT (the East Rand Water Care Company established in 1992), which the EMM has a shareholding in.

4 Landfill Gas

There are a number of existing and future landfill sites that have the potential resource to support projects. These are detailed in table one below.

Table 1: Landfill Site Characteristics

Landfill Site Name	*Classification*	*Waste Composition*	*Annual Tonnages*	*Remaining Life*	*Closure Date*	*Site Capacity (cubic meters)*
Weltevreden	GLB^+	General non-hazardous	254,700	42	2046	12,377,400
Rietfontein	GLB^+	General non-hazardous	135,000	29	2033	5,758,600
Simmer & Jack	GLB^-	General non-hazardous	350,000	6	2010	5,850,000
Platkop	GLB^-	General non-hazardous. Asbestos has been disposed there historically.	100,280	37	2041	5,309,000
Zesfontein (future)	GLB^-	General non-hazardous	n/a	future site	n/a	n/a
Rooikraal	GLB^-	General non-hazardous	350,000	38	2042	14,386,000

Gas Emissions from the Sites

A study is currently being undertaken by the municipality to investigate the landfill gas resource at Weltevreden, Rietfontein, Simmer and Jack and Rooikraal sites (through pumping trials). It is unlikely that the Platkop site would be used for such a project due to the fact that asbestos has been disposed of there. Regular monitoring of the sites is done for potential explosion risks (i.e. 4 times per year).

Potential Gas Use Options

The municipality has been considering the use of the landfill gas resource for a number of years and has applied to the DBSA (and received approval for) grant funding to assist it in developing a project. In their opinion the most likely use for the gas would be in the generation of electricity, however the Rietfontien site has the potential for industrial off take due to its proximity to an industrial area.

5 Wastewater Treatment

ERWAT has responsibility for 17 works, a significant proportion of which use anaerobic processes that are venting methane. This provides a number of opportunities for methane emission reductions projects, which could be utilized for process heating and\or electricity generation.

Table 2: Wastewater Treatment Facility Characteristics

Name and Location of Facility	*Process Description*	*Volumes Treated per Day*	*Average COD Value*	*Methane Production at Site*
Ester Park	Aerobic	0.31	450	n/a
Olifantsfontein	Anaerobic	69.95	759	18,570 m^3\day of Biogas. Currently vented.
Hartebeesfontein	Anaerobic	35.70	845	10,530 m3\day of Biogas. Currently vented.
Ancor	Anaerobic	26.49	856	7,920 m3\day of Biogas. Currently vented.
Benoni	Anaerobic	8.31	646	1,875 m3\day of Biogas. Currently vented.
Daveyton	Anaerobic	6.91	925	2,230 m3\day of Biogas. Currently vented.
Carl Grundling	Aerobic	2.22	895	n/a
Herbert Bickley	50% Anaerobic	13.21	755	3,480 m3\day of Biogas. Currently vented.
Jan Smuts	Anaerobic	6.55	450	1,030 m3\day of Biogas. Currently vented.
JP Marais	Aerobic	13.18	695	n/a
Rynfield	Anaerobic	5.81	460	930 m3\day of Biogas. Currently vented.
Tsakane	Aerobic	14.01	387	n/a
Welgedacht	Aerobic	42.02	579	n/a
Rondebult	Anaerobic	14.59	1230	6,270 m3\day of Biogas. Currently vented.
Dekema	Anaerobic	26.23	822	7,530 m3\day of Biogas. Currently vented.
Vlakplaats	Anaerobic	80.39	695	19,515 m3\day of Biogas. Currently used for heating digesters.
Waterval	Anaerobic	107.83	1002	37,740 m3\day of Biogas. Currently used for heating digesters.

6 Summary and Recommendations

There are significant opportunities on the landfill side for methane emission reduction projects, which could lead to significant electricity generation. On the wastewater treatment side it appears that ERWAT could have a number of project opportunities due to the fact that methane is vented from a number of treatment works.

7 Reference List

Personal Communications

Osman Asmal, Director – Environment, Ekurhuleni Metropolitan Municipality

Tony Pieterse, Executive Manager: Landfill Division, Municipal Infrastructure Department, Ekurhuleni Metropolitan Municipality.

Jurie Terblanche, Executive Manager – Operations, ERWAT.

Reports

Ekurhuleni Metropolitan Municipality, Integrated Development Plan 2003 – 2007, Summary Report.

Ekurhuleni Metropolitan Municipality, Solid Waste Management Annual Report 2002 \ 2003.

ERWAT, Annual Report, 2001.

eThekwini Metropolitan Municipality

Prepared by Rob Short
October 2004

1 Introduction

The purpose of this report is to document the findings of the study with regard to the eThekwini Metropolitan Municipality.

2 Methodology

The investigation involved identifying all eThekwini's waste sites and wastewater treatment works. This was done using interviews with municipal officials and documentation provided by a number of key departments within the local municipality.

3 Contextual Information

The eThekwini Metropolitan Municipality (EMM) is located in the Province of KwaZulu Natal and has a population of approximately 3 million people. It covers an area of 2 297 square kilometers and generates around 60% of its economic activity. Approximately 75% of its citizens have adequate access to services.

Relationship to the developmental goals of the municipality

The EMM is pursuing its vision of becoming a world-class city and is supportive of any innovation that supports it in this endeavor. The pursuit of sustainable development is integral to its objectives and it has used Agenda 21 principles in guiding its programmes. The city has been extremely active on the environmental front and has regular State of the Environment Reports, an environmental management system and is participating in ICLEI's Cities for Climate Protection programme, which specifically looks at identifying greenhouse gas reduction opportunities. It is recognized as a leader in the area of environmental management at the local government level.

One of the anticipated outcomes of the city's programmes is financially viable and sustainable local government. This recognizes that the city has limited resources in relation to the needs of its citizens and as a part of addressing this it is constantly looking for ways to grow its income streams.

Methane emission reduction projects therefore have the potential to support eThekwini's development programmes in a substantive manner.

Institutional Arrangements

All EMM's waste disposal sites and wastewater treatment facilities are owned and managed by the city.

4 Landfill Gas

EThekwini has been the leader in South Africa in taking forward the opportunities offered by landfill gas projects. The current flagship project involves using the Bisasar Road, Mariannhill and La Mercy sites to generate in the region of 8MWs, with the majority being generated at the Bisasar Road site. The current status of the project is that it is waiting for the results of the appeals generated by the EIA process the projects have to go through. The new site at Buffelsdraai will be developed with methane emission reduction opportunities in mind right from the start, with the installation of gas riser pipes in the drainage layer. EThekwini also feel there is an opportunity in reducing emissions by using the landfill gas from their closed sites. This however would need further investigation and resources, which the EMM does not currently have.

Table 1: Landfill Site Characteristics

Landfill Site Name	*Classification*	*Waste Composition*	*Annual Tonnages*	*Remaining Life*	*Closure Date*	*Site Capacity (cubic meters)*
Bisasar Road	GLB+	General non-hazardous		Unclear	Unclear	
Mariannhill	GLB+	General non-hazardous				
La Mercy	GMB+	General non-hazardous				
Buffelsdraai	GLB+	General non-hazardous	1000 tonnes per day increasing to 5000 tonnes per day in 2012	Commissioning in 2006	2056 is the anticipated closure date.	100 million m^3 in 2056

Gas Emissions from the Sites

There is gas monitoring happening at a number of sites. The Bisasar Road site has done monitoring studies to assess its gas resource, which combined with their flaring information has given them an excellent understanding of the potential resource available to them.

Potential Gas Use Options

The Bisasar Road, La Mercy and Mariannhill projects will be using the gas resource to generate electricity. It is assumed that this would be the preferred option at the Buffelsdraai site.

5 Wastewater Treatment

The city has 29 wastewater treatment works under its jurisdiction. Of these a number are anaerobic as detailed in the table below which offer methane emission reduction opportunities.

Table 2: Wastewater Treatment Facility Characteristics

Name and Location of Facility	*Process Description*	*Volumes Treated per Day*	*Average COD Value*	*Methane Production at Site*
KwaMashu	anaerobic	60	17484 kg/d	3000 m^3 of biogas produced per day (indicated). Used for incineration.
Northern	anaerobic	54	30882 kg/d	4000 m^3 of biogas produced per day (indicated). Used in drying plant.
Phoenix	anaerobic	15	12000 kg/d	2000 m^3 of biogas produced per day (indicated). Used for heating digestors.
Verulam	anaerobic	6	5000 kg/d	800 m^3 of biogas produced per day (indicated). Flared.
Umbilo	anaerobic	14.3	10200 kg/d	2000 m^3 of biogas produced per day (indicated). Used for heating digestors.
Amanzimtoti	anaerobic	24	18000 kg/d	2000 m^3 of biogas produced per day (indicated). Used for heating digestors.

There is therefore potential for methane emission reduction projects but on a limited scale. The most viable option would appear to be the use of methane for process heating.

6 Summary and Recommendations

eThekwini is the leader in this area and has signed the first carbon finance deal with the World Bank, which is worth approximately $15 million. The new proposed landfill site at Buffelsdraai offers another significant opportunity for a methane emission reduction project. On the wastewater side there are more limited opportunities.

7 Reference List

Personal Communications

Colin Howarth, Works Manager, Water and Sanitation Department, eThekwini Metropolitan Municipality.

Deborah Roberts, Manager: Environment, eThekwini Metropolitan Municipality.

Frank Stephens, Deputy Head: Water and Sanitation, eThekwini Metropolitan Municipality.

Lindsay Strachan, Manager; Engineering and Projects, Department of Cleansing and Solid Waste, eThekwini Metropolitan Municipality.

Reports

eThekwini Metropolitan Municipality, Review Integrated Development Plan 2003 – 2007, Review Period 2004 – 2005.

Prototype Carbon Fund (World Bank), Project Design Document for Bisasar Road, La Mercy and Mariannhill Project.

City of Johannesburg Metropolitan Municipality

Prepared by Stan Jewaskiewitz
18 October 2004

1 Introduction

The City of Johannesburg Metropolitan Municipality is located within the Province of Gauteng. The methane emissions investigation in the metropolitan area mainly focused on landfill sites used for solid waste disposal and waste water treatment plants (WWTPs). No other significant sources of methane or other single sources of greenhouse gases were found to be under the control of the metro.

2 Methodology

The investigation into the City of Johannesburg metropolitan area was facilitated by various internet searches and information provided by the utility companies: Pikitup and Johannesburg Water. Information for this study was augmented by interviews with personnel from the waste management and waste water treatment utility companies. In addition, the metro's IDP was consulted.

3 Contextual information

The City of Johannesburg Metropolitan Municipality is located in the Gauteng Province of South Africa, and comprises the Johannesburg Central, Sandton/Alexandra, Midrand, Randburg/ Roodepoort, Soweto, and Deep South regions. It is the largest urban centre within the province of Gauteng, and South Africa.

Generally, the metropolitan area consists of a predominantly urban core. This urban core is relatively well serviced and is surrounded by a periphery of peri-urban and rural areas with limited access to formal services (see Table 1 below). The methane emissions generation stems largely from those households with access to formal refuse removal and waterborne sanitation services.

Relationship to the developmental goals of the municipality

The establishment of a project utilising waste methane would fit well within the developmental priorities of the metropolitan municipality. In particular, such a project would be suitable if it simultaneously provided new employment opportunities. The project would also fit well within the expressed strategic issue of "promoting the reduction of greenhouse gases", based on the IDP.

Institutional arrangements

Johannesburg Water is the city's water and sanitation utility company. It is the water services authority (WSA) and is also the water services provider for the municipal area. The wastewater works falling under the control of the municipality are operated by Johannesburg Water who are also the wastewater treatment service provider.

With respect to waste management, the municipality utilises the services of Pikitup, the city's waste management utility company, which is the service authority and provider for solid waste services. Pikitup owns ten waste management depots, five landfill sites and one incinerator, with all the landfill sites complying with permit requirements and licensed by the Department of Water Affairs and Forestry (City of Johannesburg, 2004).

With regards to electricity, Eskom, and City Power Johannesburg, the metro's electricity utility company, are the service providers to the metro. Each supply 50% of the total number of consumers, but in terms of total units distributed, Eskom distribute approximately 40% of units sold, and City Power Johannesburg distribute approximately 60% of units sold (City Power Johannesburg, 2004).

Table 1. Access to services in Johannesburg (2001)

Source of energy for lighting	***no.***	***%***	***Refuse***	***no.***	***%***
Electricity	854,754	85%	Munic Weekly	918,792	91%
Gas	1,888	0%	Munic Other	27,051	3%
Paraffin	25,247	3%	Communal Dump	13,715	1%
Candles	122,539	12%	Own Dump	34,744	3%
Solar	1,376	0%	No Disposal	12,630	1%
Other	1,126	0%			
Water			***Sanitation***		
Dwelling	499,469	50%	Flush Toilet	827,253	82%
InsideYard	351,223	35%	Flush septic tank	26,270	3%
Community Stand	66,010	7%	Chemical toilet	18,034	2%
Community stand over 200m	60,312	6%	VIP	13,401	1%
Borehole	1,208	0%	Pit latrine	55,051	5%
Spring	264	0%	Bucket latrine	38,368	4%
RainTank	2,082	0%	None	28,553	3%
Dam/Pool/Stagnant Water	956	0%			
River/Stream	526	0%			
Water Vendor	3,977	0%			
Other	20,905	2%			

Source: Municipal Demarcation Board (Census 2001 statistics)

4 Landfill Gas

Currently, five landfill sites service the metropolitan area. These sites are listed below, in addition to the Kya Sands site which is now closed.

Table 2: Landfill Sites (2004)

Name	***Type / DWAF Classification***	***Location***
Robinson Deep	GLB-	South Section of City
Goudkoppies	GLB- (One cell GLB+)	South-West
Linbro Park	GLB-	North-East
Marie Louise	GLB-	West
Ennerdale	GLB-	Deep South
Kya Sands (closed)		North

Source: Pikitup

As part of its environmental mandate, the City of Johannesburg Metropolitan Municipality is committed to promoting sustainable landfilling practices at its various landfill sites, to ensure that its environmental obligations at the sites are fulfilled, specifically with regard to providing effective gas management.

The relevant characteristics regarding the five operational landfill sites with respect to this study are provided below.

Table 3. Landfill site characteristics

Landfill	Waste Composition				Input (tons/year)	Start Date	Closure Date	Site Capacity (m^3)
	Domestic	Garden	Construction	Other				
Robinson Deep	74%	10%	10%	6%	270,000	1930	2009	1,4 million (15,7 million)
Goudkoppies	74%	10%	10%	6%	270,000	1989	2039	11,4 million (13,6 million)
Linbro Park	73%	18%	6%	3%	360,000	1969	July 2006	710,000 (6,3 million)
Marie Louise	79%	12%	6%	3%	299,700	1991	2024	5,2 million (7,6 million)
Ennerdale	48%	26%	26%	-	70,500	1988	2014	760,707 (1,0 million)

All the above landfill sites, with the exception of Ennerdale, have the capacity to generate significant volumes of landfill gas.

The closed Kya Sands landfill was capped and rehabilitated in 2003. The closure of the site included for a “passive” landfill gas management system which consists of a series of vertical gas wells, some 14 to 18 metres deep, linked to each other with stone filled trenches acting as gas collector drains. The gas wells are, in turn, fitted with “whirly bird” ventilators which assist in dispersing the emitted landfill gas to the atmosphere.

Historically, landfill gas was extracted from the Robinson Deep landfill in the mid 1980’s and pumped to the Klipspruit Waste Water Treatment Plant, where the gas was processed and the resultant methane utilised to produce cyanide for the gold processing industry. This operation ceased to operate some years later (early 1990’s) when cyanide was more freely available on the world markets and alternative more cost effective production processes became available.

Both Robinson Deep and the closed Kya Sands landfill sites are currently being investigated by Pikitup and the Danish Government with the view to converting these sites to CDM projects in terms of landfill gas extraction and the use thereof for energy.

Gas emissions from the sites

Gas emissions from some of the sites have been subject to investigation in the past as described above. Currently, the gas generated by the various landfill sites is not being utilised, however, the metropolitan municipality does have plans for the future utilisation of landfill gas generated at the Robinson Deep and Kya Sands landfills and is under investigated as described above.

A review of the available literature and site data obtained for the various landfill sites was conducted. The review of this literature, historical information and site monitoring data was used to form the basis of inputs required to complete the landfill gas generation models for the sites. The Environment Agency (UK) software package called GasSim was used to carry out the landfill gas generation modelling.

In brief, the anticipated landfill gas yields (with a methane concentration of 50%) for the various landfills were estimated as shown below.

The estimated peak gas yields are as follows:

- Kya Sands Landfill (closed) >1000 Nm^3/hr
- Linbro Park Landfill 2300 Nm^3/hr
- Robinson Deep Landfill 2900 Nm^3/hr
- Marie Louise Landfill 3200 Nm^3/hr
- Goudkoppies Landfill 5000 Nm^3/hr
- Ennerdale Landfill 400 Nm^3/hr

As can be seen from the above gas yields, the various landfill sites, with the exception of Ennerdale, have the potential for generating significant landfill gas yields and therefore have the capacity to generate between 1 and 7 MW_e of electrical power.

Potential gas use options

The metro has already identified the Robinson Deep and Kya Sands landfill sites as potential sources of energy through landfill gas extraction and utilisation.

A range of potential gas use options are available and would require further investigation as to which would be the more appropriate for the respective landfill sites. These include:

- Electricity generation
- Industrial fuel switching (thermal energy)
- Residential use
- Diesel replacement in transport

Of these options it appears that residential fuel use and diesel replacement in transport are unlikely to be viable options. There is no existing gas reticulation infrastructure and the costs of installing this would be prohibitive. Further, the purification of landfill gas to pipeline quality standards poses large technical challenges and expenses. The difficulty of purifying the gas to acceptable levels, coupled with the management challenges of vehicle fleet conversion make it unlikely that this would be a preferred option. The remaining options appear viable to differing degrees.

There appears to be few technical barriers to on-site electricity generation and the feeding of this electricity into the local electricity grid. Based on the results of the gas modelling exercise there appears to be sufficient gas to generate between 1 and 7 MW of electricity on the relevant sites. A likely scenario would be the installation of on-site gas engines in a modular fashion – beginning with one or two 1MW units and adding another unit if gas yield proved to be stable.

In terms of industrial usage, the need to convert from coal or fuel oil to gas would need to be considered and the benefits thereof compared. The main constraints related to landfill gas supply to industrial sites are:

- The costs and complexities of off-site transport of the landfill gas;
- Whether landfill gas can compete on a price basis with coal / fuel oil / or Sasol gas;
- The costs of boiler conversions to gas;
- The ability of the landfill site to provide an assured supply of gas to the industrial sites

A further consideration would be whether industrial customers are sufficiently large enough to utilise all the landfill gas. Supplying a larger number of relatively small industrial customers (especially if they are not located near to each other) may become prohibitively expensive.

Relationship to IDP objectives

The use of landfill gas is compatible with the metro’s strategy with regards to the various landfill sites. The metro has indicated in the IDP that it is a priority to promote the reduction of greenhouse gases, through its Air Quality Management Plan. This would be compatible with a

LFG extraction project. The metro has also identified the potential to increase the sites' revenue generating potential. The gas use options are similarly compatible with the IDP's strategic areas.

The metro has also identified waste recycling and a reduction in waste generation as issues to be addressed. If these issues are addressed there may be some implications for future gas yield from the sites. This is unlikely to have any major implications for the project options identified.

5 Waste-water treatment

The City of Johannesburg Metropolitan municipal area has six operational wastewater treatment works, operated and managed by Johannesburg Water. These are the Olifantsvlei (south), Bushkoppies (south), Northern (north), Goudkoppies (south-west), Driefontein (North) and Ennerdale waste water treatment works. All the works, except for Driefontein, are owned by the City of Johannesburg.

There are no immediate plans to build new treatment works, however, a 50 Ml/day expansion to the Northern Treatment Works is in the planning stages.

None of the wastewater treatment works would appear to have any methane production potential, at this stage, due to the nature of the various treatment processes. However, it is understood that Johannesburg Water intends introducing limited anaerobic treatment processes at various treatment works in the future. At this stage, the details of such plans are unclear.

Johannesburg Water is a public utility of which the City of Johannesburg is the sole shareholder. A five year management contract was signed on 1 April 2001 between JOWAM, a consortium comprising of Ondeo Services (France), Northumbrian Water (UK) and WSSA (RSA) and Johannesburg Water. Johannesburg Water provides water and sanitation services to about 550000 domestic, commercial and industrial customers in the Greater Johannesburg metropolis from Orange farm in the south to Midrand in the north, Roodepoort in the West and Alexandra in the east.

In total, Johannesburg's operational waste water treatment works have an overall capacity to treat 900 Ml/day. An average of 800 Ml/day is treated at present. Of the seven treatment plants, the Northern Works, situated in the Diepsloot area, is the largest, treating approximately 300 Ml/day, serving the northern areas of Alexandra, Edenvale, Randburg, Sandton, and parts of Midrand and Roodepoort. The Bushkoppies Works, located at the south-east of Eldorado Park on the northern banks of the Harringtonspruit, serving the south-eastern suburbs and extreme west of Johannesburg, eastern Roodepoort and Soweto, is operating at capacity, treating over 200 Ml/day.

The technical details pertaining to the various treatment works are given in Table 4 below.

Based on the volumes currently being treated, modifying the treatment process to include anaerobic treatment would most probably result in the generation of sufficient quantities of biogas to warrant further investigation into the generation potential and possible gas uses for the various sites. However, this is unlikely due to technical constraints resulting from the current method of treating sludges.

The volatile solids concentrations in the raw sludges prior to fermentation is 85% on average.

Fermented raw sludge is used on all of the works for the generation of volatile fatty acids required for enhanced biological orthophosphate and nitrogen removal. This operation reduces the volatile solids content (which has a direct impact on the ability to generate biogas) in the sludge feed to the digesters. In all cases, biological and raw sludges are mixed before digestion. No change in this operation would be considered due to the huge cost savings achieved due to reduced chemical usage.

Biogas production

Biogas, in terms of methane, can be measured at the Olifantsvlei Works. However, no measurement facilities exist at either of the Northern or Goudkoppies Works.

Generally measurement of biogas production is not undertaken, hence information in this regard is not available. The gas production is also not considered to be constant.

Where feasible, biogas is utilised for firing boilers and the excess is flared off.

Based on the available information, the potential biogas production has been calculated using a simple methodology based on the Intergovernmental Panel on Climate Change (IPCC) conceptual approach for estimating potential methane (CH4) emissions from WWTPs.

The potential yields of methane gas were estimated as follows:

- Northern Works 10 360 m3/day
- Goudkoppies Works 3 960 m3/day
- Olifantsvlei Works 5 085 m3/day

Gas use options

As indicated, some of the biogas currently generated is being used to fire boilers, leaving a small amount for possible use in other applications.

It is possible, in the near future, that with optimisation of the treatment processes, enough gas may be generated for small industries to use near the Olifantsvlei and Goudkoppies Works.

The above gas yields are considered to be rather small for any significant application such as in the generation of electrical power.

Carbon Finance Implications

It has been established that the City of Johannesburg Metropolitan Municipality is aware of the CDM process, but has not actively investigated the potential benefits of any CDM projects any further. However, its waste management utility company, Pikitup, have commenced with such investigations in conjunction with the Danish government on certain of their landfill sites.

Since the biogas produced is currently either being used for firing boilers, or simply being flared off, it is unlikely that a project based on this gas would be able to claim any credits from methane reduction. The GHG reduction occurring from such a project would arise from the replacement of another energy source if this source was not derived from renewable energy. It is likely that a new project that used biogas instead of a fossil fuel based energy could be eligible as a CDM project if it were shown that there were barriers to the biogas use that the CDM project helped to overcome.

Table 4: City of Johannesburg – Waste Water Treatment Works : Technical Details

Waste Water Treatment Works	**Northern Works**	**Driefontein Works**	**Goudkoppies Works**	**Bushkoppie Works**	**Olifantsvlei Works**	**Ennerdale Works**
Average Flow (Ml/day)	323 (incr. @ 2.2% pa)	18 (incr. @ 3.5% pa)	126 (decr. @ 1.0% pa)	186 (incr. @ 0.7% pa)	182 (incr. @ 2.3% pa)	4.5
Volume of Raw Sludge (dry tons/annum)	30529	1937	21381	Sludge sent to Goudkoppies (raw) and Olifantsvlei (biological)	36047	22
Organic Carbon Content (average COD mg/l)	460	490	450	650	400	400
Treatment Process	Mainly aerobic, limited anaerobic	Mainly aerobic	Mainly aerobic, limited anaerobic	Mainly aerobic	Mainly aerobic, limited anaerobic	Mainly aerobic
Comment	Sludge either composted or disposed to farmland. 7903 d.t./a. composted	Sludge disposed to farmland	Sludge disposed to farmland	-	Sludge either composted or disposed to farmland. 2884 d.t./a. composted	Sludge disposed of in landfill

6 Summary and Recommendations

There appears to be significant opportunities in the extraction and utilisation of landfill gas from the various landfill sites falling within the City of Johannesburg Metropolitan Municipal area. It is recommended that feasibility studies for the viability of a gas management and utilisation scheme funded by carbon credits be commissioned and that the metro should start investigating the establishment of CDM projects related to the use of gas from the various sites. There are a number of possible options for the gas use, with power generation likely to be the simplest and more cost effective option. However, there are other uses, such as energy supply to new industrial developments, which have local economic development benefits and should therefore also be considered.

While some methane is currently being flared from the waste water treatment works, it appears that the potential uses of this gas are more limited than that from the landfill sites due to the smaller volumes. Small scale uses of the biogas, where available, should be investigated. However, it is unlikely that carbon finance will make a significant contribution to these projects.

Institutional context

The IDP demonstrates an awareness of environmental matters and a willingness to engage with them.

The metro is also aware of the advantages and potential benefits of CDM projects. At the same time, the metro would appear to have certain capacity constraints and it would appear that the preferred options for project development would be via either a public-private-partnership (PPP), where the project would be outsourced to a private contractor, or via a management contract, where the municipality would own the assets of the project but would contract the management of the project to an external contractor.

7 Reference List

Personal communications

Van Aswegen, F. : personal communication: 15 August 2004, Pikitup Johannesburg

Van Aswegen, F. : email – technical information: 25 August 2004, Pikitup Johannesburg

De Wet, J. : personal communication: 25 August 2004, Johannesburg Water

De Wet, J. : interview: 31 August 2004, Johannesburg Water

Deacon, S. : personal communication and interview: 31 August 2004, Johannesburg Water

Deacon, S. : email – technical information: 7 September 2004, Johannesburg Water

Reports

Municipal Demarcation Board, 2004: http://www.demarcation.org.za

Websites

City of Johannesburg Official Website: http://www.joburg.org.za

Johannesburg Water: http://www.johannesburgwater.co.za

City Power Johannesburg: http://www.citypower.co.za

Pikitup Johannesburg: http://www.pikitup.co.za

Mangaung Municipality

Prepared by Michael Goldblatt
26 October 2004

1 Introduction

The Mangaung Municipality is a local municipality situated within the Motheo District in the Free State. The methane emissions investigation primarily considered the three operating and permitted landfill sites in the municipality as well as the single waste-water treatment works in Mangaung which has anaerobic waste digestion. No other significant greenhouse gas reduction opportunities under the control of the municipality were found although some minor methane sources are discussed in the report. The Municipality owns a coal-fired power station, however no investigations into greenhouse gas reduction options related to this power generation facility were investigated as this was beyond the ambit of the study.

2 Methodology

The information for Mangaung was based on interviews with personnel from the municipality's water and sanitation and solid waste departments as well as information received from those departments. A recent *status quo* report on solid waste management in Mangaung provided additional information, as well as a draft solid waste management business plan. Other secondary sources of information were used including the municipal IDP. It has been acknowledged by the municipality that information, particularly with regards to waste disposal, is inadequate and they are currently preparing an integrated waste management plan which should provide further information on the status of waste disposal in the area.

3 Contextual information

Mangaung Local Municipality is located in the centre of the Free State and consists of a large rural area and three urban areas, namely the City of Bloemfontein and the two peri-urban towns of Botshabelo and Thaba 'Nchu. Bloemfontein is the economic hub of the municipality and of the province. There is not, however, a major manufacturing sector in the municipal area and most employment comes from the community, social and personal services sector (Mangaung Local Municipality, 2003). There is a high unemployment rate of 40%.

There are about 740 000 people in the municipality, of which 700 000 are in urban areas. The urban areas are relatively well serviced with regards to refuse removal and electricity with most households in these areas receiving a regular kerbside refuse removal service and having an electricity connection. There are lower levels of service with regards to water and sanitation provision. In general, service delivery is much lower outside of the urban core. Further details on access to services are provided in the table below.

The Municipality has a capital budget of R223 million and an operating budget of R1 277 billion (for the 2003/4 financial year). The Municipal finances are in a reasonably sound position, but face some important pressures arising from rising personnel costs and rising arrears. Important services are being squeezed out by these expenditure increases and any additional sources of revenue for key services will be important to maintain service levels (MLM, 2003). The Municipality has low debt levels and has the capacity to take on new loans if these are financially sustainable.

Relationship to the developmental goals of the municipality

The establishment of projects making productive use of waste methane have the potential to support the development objectives of Mangaung as expressed in the municipal IDP. As with many other municipalities an important benefit from such projects would be the potential for employment generation and local economic development opportunities. In addition, the solid waste service in particular faces capital constraints in upgrading its disposal sites and operating them in accordance with DWAF permit conditions. Any additional financial resources that enabled them to improve landfill site operations would be beneficial to the municipality and in line with the business plan for the solid waste service.

The IDP also places some stress on environmental sustainability and on cleaning the city and improving its image in this regard. An innovative greenhouse gas reduction project would fit well with this objective (MLM, 2002).

Institutional arrangements

The municipality is the water services authority (WSA) and is also the water services provider for the municipal area. The wastewater treatment works are owned and operated by the Municipality. The municipality has a waste management division which is the service authority and provider for solid waste services. Both water and waste-water and solid waste services fall under the Executive Director, Infrastructural Services.

Bloemfontein Electricity is the municipal electricity service provider. They supply electricity to Mangaung as well as to 18 other Free State towns on an agency basis. About 30 000 customers get their electricity directly from Eskom.

Table 1. Access to services in Mangaung (2001)

Source of energy for lighting	**no.**	**%**	**Refuse**	**no.**	**%**
Electricity	157,220	85%	Municipal Weekly	110,660	60%
Gas	362	0%	Municipal Other	3,822	2%
Paraffin	9,733	5%	Communal Dump	6,544	4%
Candles	17,222	9%	Own Dump	42,923	23%
Solar	221	0%	No Disposal	21,064	11%
Other	255	0%			
Water			**Sanitation**		
Dwelling	46,805	25%	Flush Toilet	87,596	47%
Inside Yard	80,535	44%	Flush septic tank	3,376	2%
Community Stand	26,542	14%	Chemical toilet	2,195	1%
Community stand over 200m	23,231	13%	VIP	23,143	13%
Borehole	390	0%	Pit latrine	20,822	11%
Spring	57	0%	Bucket latrine	30,406	16%
Rain Tank	74	0%	None	17,475	9%
Dam/Pool/Stagnant Water	84	0%			
River/Stream	40	0%			
Water Vendor	361	0%			
Other	6,893	4%			

Source: Municipal Demarcation Board (Census 2001 statistics)

4 Landfill Gas

Mangaung Local Municipality has three formal landfills servicing the area, as well as number of informal landfills. The three formal sites in use by the municipality are Northern Landfill, Southern Landfill and Botshabelo Landfill.

The Northern Landfill is classified as a GMB- site based on the daily rate of deposition of waste. The site is located about 10km north of the city centre and is near to a shopping centre but no other commercial or industrial facilities. The site is in the process of securing an operating permit and it appears that this will be issued shortly. The site is designed for general, non-hazardous waste and accepts about 237 tonnes per day. There is no gas monitoring system in place at present and there is no control of landfill gas. There are indications that some aspects of site management are inadequate and need to be improved. The site has a life expectancy of more than 25 years.

The Southern Landfill is the largest disposal facility in the municipal area and accepts about 441 tonnes per day. The site is located about 5km south of the city centre and is adjacent to the N1 highway. The site is classified as a GMB- site but is in the process of being upgraded to a GLB- site as a result of the higher waste deposition estimated – an operating permit in this regard is expected to be issued shortly. The site has a life expectancy of more than 25 years. There is a materials recovery facility (MRF) being established at the site which in the short term will remove tyres and some clean organic materials from the waste-stream entering the site. The extent of the MRF and its future impact on the composition of disposed waste is unclear at present.

Botshabelo Landfill is located 10km south of Botshabelo and is the smallest of the formal sites. The landfill would be classified as a GSB- site, however the site has no permit and has to be upgraded to achieve a permit or be closed. The site accepts general non-hazardous waste from predominantly residential and limited commercial enterprises.

Further technical detail on the sites can be found in the table in the appendix to this report.

Table 2. Key characteristics of the formal landfill sites in Mangaung

Names	Waste Composition	Annual Tonnages	Total Capacity (m3 / tons)	Lifespan (yrs)	Estimated Peak LFG Yield (Nm3/hr)	Estimated Methane (tons/annum)	Potential Electricity Generation (MW)
Northern	General non-hazardous	97 760	3,704,000	25	1,000	3,135	1
Southern	General non-hazardous	132 860	5,001,500	25	1,350	4,232	1
Botshabelo	General non-hazardous	21 840	646,800	20	205	643	n/a

The three informal sites in the area are no longer operational. The Thaba Nchu site is an informal communal site of about 0.6 hectares where general domestic waste was disposed and burnt in a controlled but informal manner. The Mangaung Landfill is a larger site which began as an informal site and grew to a site of 16 hectares. Domestic waste was similarly disposed and burnt in a semi-controlled manner. The site requires formal closure. The Bainsvlei Landfill is also a small informal communal site of about 1 hectare where waste was disposed of in a similar manner to the other two sites.

Gas emissions from the sites

No measurement of gas emissions or landfill gas migration from any of the sites is carried out by the Mangaung Local Municipality. There have also been no formal gas yield trials carried out, test wells sunk nor formal gas modelling undertaken.

Gas monitoring is currently not a permit requirement at any of the three landfill sites. It is, however, a minimum requirement for medium (M) sites that an expert opinion on gas emissions must be obtained, and based on the outcome of the opinion, a decision needs to be taken by the DWAF regarding gas and air quality monitoring (Dynacon, 2004)

Because of the nature and history of the three non-operational informal sites, including the fact that much of the refuse was burnt, there is unlikely to be much generation of landfill gas from these sites.

The presumed gas emissions from the formal sites are therefore based on initial modelling done as part of this project and indicate that the Northern and Southern sites will have a peak landfill gas yield of 1 000 and 1 350 cubic metres per hour respectively. This corresponds to 3 135 and 4 232 tonnes of methane per annum and at this yield would allow for the generation of I MW of electricity per site. The Botshabelo site is smaller with an estimated yield of only 205 cubic metres per hour which would mitigate against significant productive use of the gas.

The is further detail on the landfill gas modelling results in the Appendix: Modelled Landfill Gas Curves for Mangaung.

Potential gas use options

There are some potential uses of the landfill gas that were identified by the municipality. The potential for use of gas from the various sites is outlined below:

- **Southern Site**: there are no nearby industrial sites. The landfill is near a cemetery and there is the potential for using the gas for a crematorium. There is also an incinerator on the site for hazardous materials destruction which currently uses diesel. This could possibly be converted to use landfill gas although the intention is to move to a non-incineration technology in the future. A nearby small shopping centre could potential use energy from the site.
- **Northern Site**: the site is within a conservation area and there are limited developments nearby apart from a small shopping complex that could possibly use energy generated from the landfill gas.
- **Botshabelo**: the site is in an area zoned for industrial use but there are very few facilities nearby. There is a chicken farm within a reasonable distance from the site which could possibly use energy from landfill gas.

Electricity generation may be possible, given sufficient gas quantities. The Southern Site would be the most promising in this regards since it is the largest site and is relatively close to a sub-station (within about 3 kms) that could be used to feed power into the local grid.

Relationship to IDP objectives and to improved service delivery

The use of landfill gas is compatible with the municipality's strategy with regards to the landfill site. The municipality has indicated in the IDP that it is a priority to extend the landfill site to its maximum lifespan by proper site utilisation. This would be compatible with a LFG extraction project as such a project would tend to increase settling and conserve airspace in the site. The municipality has also identified the potential to increase the site's revenue generating potential. The gas use options are similarly compatible with the IDP's strategic areas as discussed above.

The municipality has identified waste recycling and a reduction in waste generation as issues to be addressed. If these issues are addressed there may be some implications for future gas yield from the site. This is unlikely to have major implications for the project options identified.

The solid waste *status quo* report carried out for the municipality indicates that the operations of the landfill sites could be improved. A well designed carbon finance project could assist in raising the revenue for improved site management hence solid waste service delivery.

5 Waste-water treatment

The municipal area has a number of wastewater treatment works, however only one of the facilities has an anaerobic waste treatment process. The anaerobic facility is the Bloemspruit Purification Plant.

The Bloemspruit works is therefore the only significant source of methane from wastewater treatment. The works currently generates about 1 042 m^3 per hour of methane from anaerobic digesters. All of the gas generated is currently used in heating at the works itself. According to the General Manager, Mechanical Services, responsible for the waste-water treatment works additional energy, beyond that available from the biogas, is required on site and all gas generated is used internally.

Bloemspruit Purification Plant: Technical Details

Operating Data		*Comment*
Treatment capacity	56 Ml/day	
Average flow	60 Ml/day	The plant is at full capacity (sometimes over-capacity) and the works are to be expanded soon.
Raw sludge %	500 m^3/day at 1% of total flow	
Volume of digesters	16 ML	
Volume of biogas produced	2 500 m^3/day (1 042 m^3/hr)	All of the gas is used to heat the digesters. Production fluctuates due to the variable nature of the digestion process and to changes in temperature and humidity at the site with lower generation in winter when the heating requirements are greatest. There are shortages of gas in winter.
Volume of raw sludge	500 m^3/day at 6%	
Organic carbon content of waste-water	Mean Raw COD 500 mg/l	
Treatment process	Anaerobic digestion and drying beds	

Gas use options

As indicated, the site currently uses all the biogas produced. The relevant manager at the municipality indicated that it may be possible to supply methane from the works as an energy source to some local industrial sites nearby the works if this was financially preferred or more energy efficient than current use of the gas. However, he indicated that the variability in flows from the works would mitigate against this option.

There may be options for the more efficient use of the methane in the plant itself via the use of heat exchangers as opposed to the current practice of heating the waste directly. This could possibly free up some of the biogas which could be used productively. One possible option would be to use the gas for vehicle fuelling as a municipal vehicle depot is near to the site. However, again caution was expressed about the limited volumes of gas that might sometimes be available.

Carbon Finance Implications

Since the biogas produced is currently used it is unlikely that a project based on this gas would be able to claim any credits from methane reduction. The GHG reduction occurring from any biogas project would arise from the replacement of another energy source if this source was not derived from renewable energy. It is likely that a new project that used biogas instead of a fossil fuel based energy could be eligible as a CDM project if it were shown that there were barriers to the biogas use that the CDM project helped to overcome. However the scale of any such project is likely to be very small and probably would not warrant a carbon finance investigation.

6 Minor methane reduction opportunities

There are some illegal feedlots in the municipal area that currently do not dispose of the animal waste in compliance with environmental regulations. There are also plans from the municipality to develop a pound to house stray livestock that are a problem in the area. There may be some opportunities for biogas production from manure from these facilities that could reduce the environmental impact of the feedlots and pound, reduce greenhouse gas emissions and provide a source of energy. Little technical investigation into these options has yet occurred and even if they prove to be technically and financially viable it is not likely that these projects will be large enough to warrant further carbon finance investigations.

7 Summary and Recommendations

There appears to be the potential for a landfill gas project at the three formal landfill sites in Mangaung. However, due to the climatic conditions and variable operating procedures at the sites the gas yield from the sites is uncertain and has the potential to be erratic. There are also no clear users for the landfill gas in close proximity to the site, suggesting that power generation may be the preferred option for productive use of the gas.

The waste-water treatment works does generate significant amounts of bio-gas but already uses this productively and relatively efficiently and there appears to be little merit in pursuing a carbon finance project to alter or improve this bio-gas utilisation.

Institutional context

The Municipality has, as yet, had no experience with carbon finance projects, nor has it considered any landfill gas capture and use projects. Nevertheless, the relevant municipal officials are willing to consider potential project options and are willing to engage with the new area of carbon finance.

Technical and management capacity in the solid waste services is limited and if a landfill gas project were to go ahead it is likely that external capacity would be required to implement and manage the project.

8 Reference List

Personal communications

Shakoane, T.: personal communication, 7 October 2004, Mangaung environmental management department.

Twala, G: personal communication: 26 August 2004, General Manager, Mangaung Solid Waste Management.

Wagener, P.: personal communication: 26 August 2004, General Manager, Mangaung Mechanical Services, Mangaung Waste-Water Treatment.

Reports

Arcus Gibb, 2003: *Investigation into an appropriate mechanism to provide solid waste management services*, Status quo and assessment report, Mangaung.

Dynacon Consulting Engineers, 2004: *The Development of a Business Plan to Address the Findings and Recommendations of the Investigation into Appropriate Mechanisms to Provide Solid Waste Management Services in Mangaung Local Municipality*, Draft Business Plan, Version 1.0, 3 May 2004

Mangaung Local Municipality, 2004: *Mangaung Local Municipality Integrated Development Plan 2003/4*, Mangaung.

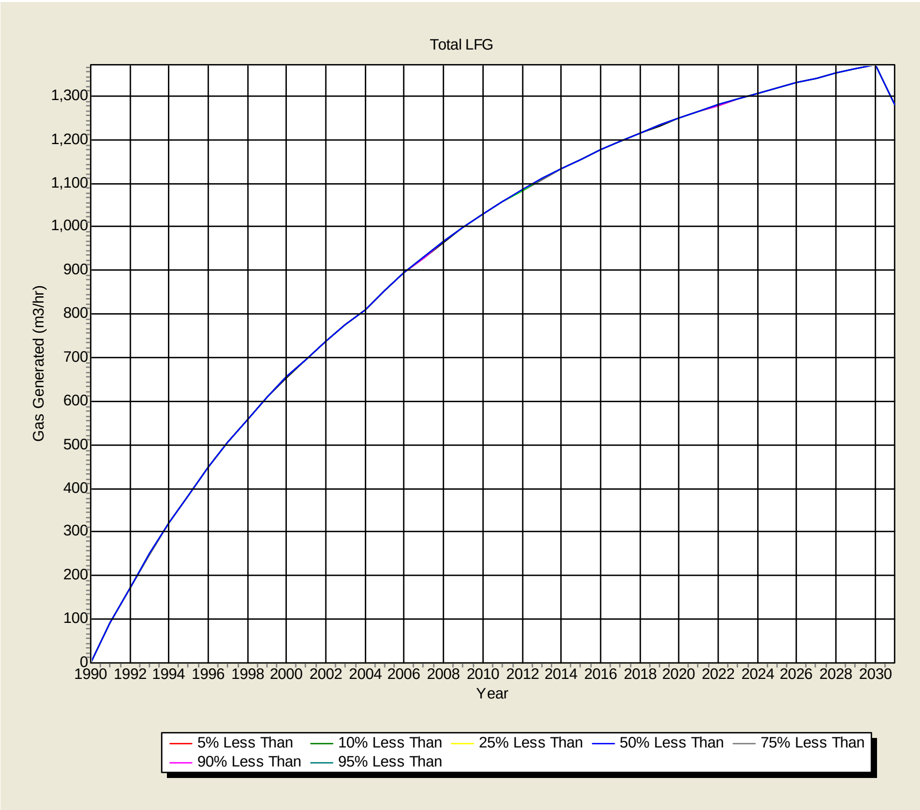
Municipal Demarcation Board, 2004: URL: http://www.demarcation.org.za/,

Appendix: Modelled Landfill Gas Curves for Mangaung

Key Landfill Data Used

Local Authority / Owner	Mangaung	Mangaung	Mangaung
Landfill Site	Northern Landfill	Southern Landfill	Botshabelo
Year Opened	1990	1990	1990
Landfill Classification	GMB-	GLB-	GSB-
Operator	MLM	MLM	MLM
Landfill Footprint Area (Ha)	24.7	33.3	6.5
Landfill Height (m)	15	15	10
Current Input (tons/year) 2004	97,760	132,860	22,000
Total Capacity (m^3 / tons)	3,704,000	5,001,500	646,800
Current In-place Volume (m3 / tons)	1,260,000	1,680,000	210,000
Remaining capacity (m3 / tons)	2,444,000	3,321,500	436,800
Remaining Life (years)	25	25	20
Year to Close	2029	2029	2024
Rainfall (mm/year)	600	600	600
Estimated Peak LFG Yield (Nm3/hr)	1,000	1,350	205
Estimated Methane (tons/annum)	3,135	4,232	643
Potential Electricity Generation (MW)	1	1	n/a
Comments / Contact Details	Assume landfill started 1990. Lack of data.	Assume landfill started 1990. Lack of data.	Site too small for utilisation.

Mangaung : Northern Landfill



Mangaung : Southern landfill

Mangaung : Botshabelo Landfill

Mbombela Local Municipality

Prepared by Rob Short
November 2004

1 Introduction

The purpose of this report is to document the findings of the study with regard to the Mbombela Local Municipality (MLM).

2 Methodology

The investigation involved identifying all MLM's waste sites and wastewater treatment works. This was done using interviews with municipal officials and documentation provided by a number of key departments within the local municipality.

The key documents reviewed included the Municipality's Integrated Development Plan (Review 2004 – Final Draft), as well as the Water Services Development Plan (June 2003). The integrated waste management plan for the municipality is still being developed (it is anticipated that this will be completed in the first quarter of 2005).

3 Contextual Information

The Mbombela Local Municipality (MLM) is located within the Ehlanzeni District Municipality in the Province of Mpumalanga.

The municipality has within its boundaries the town of Nelspruit and a large rural area. It has a population of 474 807 thousand with 121 951 households. In terms of service provision 64,89 % of the municipalities residents have water on stand, with 19,07% having water available less than 200m away and 16,04% further than 200m away.

Over 72,29% of the population have their own dump site, with only 25,79% having access to MLM removal services. Sanitation figures reflect a similar picture with 26,84% having access to waterborne sewage or French drains, and the remaining 73.16% having pit latrines and\or the bucket system. 49,52% of the population have access to electricity (please note that this information is taken from the municipality's 2004 Review of the IDP, final draft).

Relationship to the developmental goals of the municipality

Any projects that would make use of methane would support the municipality's development goals in two ways; firstly, in terms of their ability to support local economic development and secondly, the environmental objectives of the municipality. The MLM sees the incorporation of the principles of sustainable development (as expressed in Agenda 21) into the IDP as an important goal. A methane emission reduction project would have a clear fit with such objectives and it is important to note that the IDP specifically mentions the role the municipality plays with regard to emissions from fossil fuels, as linked to the municipality's electricity consumption. The municipality is already generating its own electricity with a small 2MW hydroelectric station (the management of this is outsourced) and had looked at the possible development of a new facility in early 2003 (this was shelved on the basis of financial considerations, which could potentially be revisited if carbon finance is brought into the overall financial equation).

Institutional Arrangements

Waste management is the responsibility of the MLM. The municipality is also the water services authority for the area, but has concession out these functions to a private sector company in a number of areas including Nelspruit itself. This concession includes the operation of several wastewater treatment facilities. The municipality is the license holder for electricity provision for Nelspruit, Hazyview and White River, whereas ESKOM is responsible for the farm areas.

4. Landfill Gas

There are currently three landfill sites that are managed by the MLM. These are located in Nelspruit (at the airport), White River and Hazyview on the road to the Kruger National Park. One of the key issues facing the municipality is that the Nelspruit Site has approximately 12 months of air space left and is therefore considering the creation of a new central landfill site. The White River site is currently not permitted, while the Hazyview site is subject to uncontrolled dumping and burning of refuse.

Further details on the two key landfill sites Nelspruit and Hazyview are given in the table below.

Table 1: Landfill Site Characteristics

Landfill Site Name	*Classification*	*Waste Composition*	*Annual Tonnages*	*4 Remaining Life*	*Closure Date*	*Site Capacity (cubic meters)*
Nelspruit	GMB-	General non-hazardous	70 560	1	2005	1,175,560
White River	Not permitted	General non-hazardous	33 360	4	2008	558,440

Gas Emissions from the Sites

No measurements of gas emissions and\or the potential for landfill gas migration are carried out by the municipality. There have also been no formal gas yield trials carried out, test wells sunk or formal gas modeling undertaken.

The estimated peak gas yields are:

- For Nelspruit 675 Nm3/hr
- For Hazyview 310 Nm3/hr

Of the two sites the Nelspruit site is the only one that shows a real potential for significant gas yield and has the capacity to generate around 0,5 MW of electricity.

Potential Gas Use Options

In terms of the Nelspruit site, and specifically considering its location, the only potential gas use option is electricity generation.

5 Wastewater Treatment

The municipal area has a number of wastewater treatment facilities and as indicated above some are being managed by MLM itself (Hazyview, Rockies Drift and White River), while the others are being managed in terms of the concession being operated by the Greater Nelspruit Utility Company (Kingstonvale, Matsulu and Kanyamanze).

None of the facilities are using anaerobic processes currently (the Kingstonvale anaerobic digestion plant was closed down) which means there is no possibility for implementing methane emission projects at this stage. However the White River facility will need upgrading in the near to medium term which could provide such an opportunity. In such a scenario it is likely that any methane produced would be used for process heat, rather than electricity generation.

6 Summary and Recommendations

There appears to be the potential for one methane emission reduction project within the Mbombela Local Municipality i.e. a 0,5 MW landfill gas generation project.

This project would fit in with the municipality's development objectives in terms of promoting local economic development and its environmental objectives. The municipality has indicated a willingness to take forward such project a part of its LED initiatives.

The development of a new landfill site is also a potential opportunity for the municipality in terms of methane emission reductions and the associated ability to access carbon finance.

7 Reference List

Personal Communications

Leon Hallatt, Deputy-Director: Civil Engineering, Mbombela Local Municipality.

Eugene Hlongwane, Assistant Director: Waste Management, Mbombela Local Municipality.

Roelf Kotze, Deputy Municipal Manager, Development Facilitation Unit, Mbombela Local Municipality.

Brian Sims, Greater Nelspruit Utility Company.

Reports

Mbombela Local Municipality, Integrated Development Plan. Review 2004 (Final Draft).

Mbombela Local Municipality, Water Services Development Plan (June 2003).

Msunduzi Municipality

Prepared by Michael Goldblatt
4 July 2004

1 Introduction

The Msunduzi Municipality is a local municipality, within the Umgungundlovu District in KwaZulu Natal. The methane emissions investigation in the municipality focused on the single landfill site in the municipality, the New England Road site, and the nearby Darvill waste-water treatment works. No other significant sources of methane or other single sources of greenhouse gases were found under the control of the municipality.

2 Methodology

The investigation into Msunduzi was facilitated by the existence of a parallel study considering the use of LFG from the New England Road site. Information from this study was augmented by interviews with personnel from the municipality's electricity, water and sanitation and solid waste departments, as well as the Darvill wastewater works owned by Umgeni Water. A site visit to the wastewater treatment works and the landfill site was undertaken. In addition the municipal IDP was consulted as well as reference material from Umgeni Water, and previous and current studies being undertaken on the landfill site.

3 Contextual information

Msunduzi municipality is located along the N3 highway at a junction of an industrial corridor from Durban to Pietermaritzburg and an agro-industrial corridor stretching from Pietermaritzburg to Escourt. It has the second largest urban centre within the province of KwaZulu-Natal (Municipality of Msunduzi, 2002).

The City of Pietermaritzburg and Greater Edendale make up the urban core of the municipality. This urban core is relatively well serviced and is surrounded by a periphery of peri-urban and rural areas with limited access to formal services (see table 1 below). The methane emissions generation stems largely from those households with access to formal refuse removal and waterborne sanitation services.

The ongoing increase in amounts owed to the Council is having a negative effect on the ability to fund capital from internal funds as these are required to fund the debtors

Relationship to the developmental goals of the municipality

The establishment of a project utilising waste methane would fit well within the developmental priorities of the municipality. In particular such a project would be suitable if it simultaneously provided new employment opportunities since a strategic goal of the municipality is the funding of local economic development and creating labour intensive and entrepreneurial undertakings. The project would also fit well within the expressed strategic issues of "the development of sustainable, habitable and healthy environments" and the "good management of infrastructure, facilities and services" (Msunduzi Municipality, 2002).

Institutional arrangements

The municipality is the water services authority (WSA) and is also the water services provider for most of the municipal area. The wastewater works are owned and operated by Umgeni water who are the wastewater treatment service provider under a long term contract with the municipality.

The municipality has a waste management division which is the service authority and provider for solid waste services. In addition the division manages the New England Road landfill site which serves as a district and even regional site.

With regards to electricity, Eskom are the service providers in the area known generally as Greater Edendale and Vulindlela, while Pietermaritzburg Electricity provides a service in the remainder of the Msunduzi Municipality. Distribution of electricity will be consolidated in due course into the relevant Regional Electricity Distributor (RED).

Table 1. Access to services in Msunduzi (2001)

Source of energy for lighting	***no.***	***%***	***Refuse***	***no.***	***%***
Electricity	111,655	86%	Munic Weekly	77,005	59%
Gas	343	0%	Munic Other	1,283	1%
Paraffin	730	1%	Communal Dump	1,268	1%
Candles	17,191	13%	Own Dump	46,655	36%
Solar	194	0%	No Disposal	4,175	3%
Other	273	0%			
Water			***Sanitation***		
Dwelling	48,627	37%	Flush Toilet	66,901	51%
InsideYard	42,681	33%	Flush septic tank	5,573	4%
Community Stand	13,281	10%	Chemical toilet	3,821	3%
Community stand over 200m	17,653	14%	VIP	10,427	8%
Borehole	1,226	1%	Pit latrine	39,671	30%
Spring	2,302	2%	Bucket latrine	652	1%
RainTank	370	0%	None	3,340	3%
Dam/Pool/Stagnant Water	301	0%			
River/Stream	1,194	1%			
Water Vendor	231	0%			
Other	2,521	2%			

Source: Municipal Demarcation Board (Census 2001 statistics)

4 Landfill Gas

The New England Road landfill site is the sole landfill site servicing the municipal area. The site is situated to the south east of Pietermaritzburg between the confluence of the Msunduzi River and the Blackburrow Spruit As part of its environmental mandate the Msunduzi Local Council is committed to promoting sustainable landfilling practices at its New England Road Landfill Site to ensure that its environmental obligations at the site are fulfilled, specifically with regard to providing effective gas management at the site.

There are records that suggest that the site has been used for waste disposal since as early as the 1930's. Changing trends in wastes management saw procedures improve at the site in the late 1980's and waste records have been kept since 1986. Unfortunately, no weighbridge was installed until 1995 which renders waste data prior to this date of limited use for modelling.

The old wastes that were deposited at the site prior to 2000 have been capped in a phased manner. The capping was developed to allow the phased development of a 'new' landfill site as a piggyback extension over the 'old' site. The two sites combined will be fully engineered to allow the effective control of both leachate and landfill gas. The site currently flares a small amount of gas for gas migration control purposes.

There are now an estimated 3.4 million tonnes of waste present in the 'old' landfill site. It is estimated that there is space for 4.2 million tonnes in the 'new' landfill. This gives a combined total of 7.6 million tonnes of waste deposited at the site which represents a significant source of landfill gas. Due to the anaerobic nature of the processes that produce landfill gas modern engineering of landfill sites including capping contain the gas that is generated. Effective gas management installed at the site will provide improved health benefits as well as offering the potential for generation of significant revenue.

Gas emissions from the site

Gas emissions from the site have been subject to investigation in the past. A pumping trial was conducted by Lombard and Associates in 2000. In 2003 an in-depth investigation into the potential use of landfill gas from the site was commissioned by the Municipality with financial support from the DBSA. This study is in progress but has completed formal gas yield modelling based on a number of computer simulations. The study has also considered potential uses of gas from the site.

The results that were generated by the models compared favourably with the results that were calculated from the pumping trial by Lombard and Associates. The pumping trial results indicated that there was in the region of 2400 m3/ hr to 2880 m3/ hr of landfill gas being generated by the site in 2000.

The model that best represented this range of gas flows for 2000 was Model 1 for a wet waste moisture scenario. The graph produced for this scenario would suggest that there will be between 2000 – 2500 m^3/ hr of landfill gas generated from the site from 2000 to 2024. A gas management system should extract approximately 85% of the gas that is being generated, provided the landfill is well engineered (capped). 85% of 2500 m^3/ hr is 2125 m3/ hr, which should generate 3 MW of electricity based on 700 m^3/ hr/ MW.

Potential gas use options

A range of potential gas use options have been investigated. These include:

- Electricity generation
- Industrial fuel switching
- Residential use
- Diesel replacement in transport
- New industrial development

Of these options it appears that residential fuel use and diesel replacement in transport are unlikely to be viable options. There is no existing gas reticulation infrastructure and the costs of installing this would be prohibitive. Further, the purification of landfill gas to pipeline quality standards poses large technical challenges and expenses. This latter issue is also a reason why the transport fuel option appears to be unviable. The difficulty of purifying the gas to acceptable levels, coupled with the management challenges of vehicle fleet conversion make it unlikely that this would be a preferred option for the municipality. The remaining options appear viable to differing degrees.

Initial discussions have been held with the Electricity Department of the Msunduzi Municipality about the potential for power generation from the landfill gas. They are interested in the project and would support it if technically viable and if the price of power was less than or equal to the current prices that they pay Eskom. The municipality is on the Megaflex tariff and would ideally like to reduce its peak time purchases from Eskom as much as possible.

The New England Road landfill site is located near to a municipal electricity sub-station and there appear to be few technical barriers to on-site electricity generation and the feeding of this electricity into the municipal grid. Based on the results of the gas modelling exercise there is likely to be sufficient gas to generate between 2-3 MW of electricity. A likely scenario would be the installation of on-site generation turbines in a modular fashion – beginning with one or two 1MW units and adding another unit if gas yield proved to be stable.

There appears to be limited interest from the industrial sector for the use of landfill gas from the site. A number of firms have expressed interest but have indicated that they will need final information on the price of the gas and the sustainability of the gas yield before making any commitments to convert from coal or fuel oil to gas. The main constraints related to landfill gas supply to these industrial sites are:

- The costs and complexities of off-sight transport of the landfill gas;
- Whether landfill gas can compete on a price basis with coal;
- The costs of boiler conversions to gas;
- The ability of the landfill site to provide an assured supply of gas to the industrial sites

A further issue is whether these industrial customers are sufficiently large to utilise all the landfill gas. Supplying a larger number of relatively small industrial customers (especially if they are not located near to each other) may become prohibitively expensive.

During stakeholder consultations within the New England Road landfill gas study some possible new industrial projects came to light that could utilise the landfill gas. These include a proposed wood drying facility where a local firm is interested in the use of the gas for wood-drying. This is an energy intensive process and any way in which the energy costs can be reduced makes this a more economically attractive exercise. There is also the potential for employment creation within the municipal area. The IDP indicates that the city is the epicentre of a vast timber growing operation in the surrounding Midlands area and the municipality would like to encourage associated industries.

A scan of the IDP also indicates the need for new crematoria within the municipality since there are three public cemeteries operating in the city with around one year's availability of plots between them. There is also community resistance to locating cemeteries nearby. There is therefore the possibility of using the landfill gas to establish such a facility near to the landfill site.

There is also a proposal in preparation by some private entrepreneurs in the city who are considering the creation of integrated waste recycling centre to be called the Msunduzi Waste Park. This may include WPC composite technologies, a resin-board manufacturing process and some other industries to be included in an industrial park on the fringe of the existing landfill site that will employ about 600 people. According to the park proponents there will be significant energy requirements for the Waste Park and this would be an ideal user of the landfill gas negating requirements for reticulation to existing industrial areas in the City and allowing new users to install the correct gas use equipment from start-up. The main consideration with respect to this option is the potentially long lead time that it may take to develop.

Relationship to IDP objectives

The use of landfill gas is compatible with the municipalities strategy with regards to the landfill site. The municipality has indicated in the IDP that it is a priority to extend the landfill site to its maximum lifespan by proper site utilisation. This would be compatible with a LFG extraction project as such a project would tend to increase settling and conserve airspace in the site. The municipality has also identified the potential to increase the site’s revenue generating potential. The gas use options are similarly compatible with the IDP’s strategic areas as discussed above.

The municipality has identified waste recycling and a reduction in waste generation as issues to be addressed. If these issues are addressed there may be some implications for future gas yield from the site. This is unlikely to have major implications for the project options identified.

5 Waste-water treatment

The municipal area has one wastewater treatment works, the Darvill wastewater works situated 8km from the city centre, east of Pietermaritzburg. Umgeni water purchased the works from the city in 1992 and manages the works under a 10 year renewable contract with the municipality. The plant has recently been upgraded at a cost of R36 million and the plant has adequate capacity for the foreseeable future. A levelling off (and even decline) in wastewater volumes has been experienced. Although many households in the municipality lack waterborne sanitation it is unlikely that these households will have such a system in the foreseeable future. Sanitation service improvements to these households is likely to focus on household level or small scale local solutions . Technical details of the works are shown in the table below.

The Darvill works is therefore the only significant source of methane from wastewater treatment with real potential for capture and use. The works currently generates about 200m^3 per hour of methane from anaerobic digesters. Half of this gas is used in heating at the works itself and the remainder is flared.

Darvill Wastewater Treatment Works: Technical Details

Darvill wastewater treatment works		***Comment***
Treatment capacity	60 Ml/day	
Average flow	55 Ml/day	Dry weather. No significant increase in flow is expected in the near future
Raw sludge %	30% of total organic load	
Recycle ratio (activated sludge)	0.9 to 1.2:1	
Volume of digesters	2* 4500 m^3 (9 000 m^3)	
Volume of biogas produced	5 000 m^3/day (208 m^3/hr)	Biogas production is closely monitored at source. About 50% of the gas is used to heat the digesters while the rest is flared. Production is relatively constant but is subject to the variable nature of the digestion process.
Volume of raw sludge	1.7 to 2.0 Ml/day	
Anaerobic retention time	30- 40 days	
Organic carbon content of waste-water	n/a	The average may be affected by intermittent treatment of high organic load industrial waste.
Treatment process	The works treats waste both anaerobically (in 2 large digesters) and aerobically in an activated sludge reactor. Sludge disposal to land is carried out.	

Gas use options

As indicated the site currently uses about 50% of the biogas produced. The remaining gas is therefore potentially available for productive use. The site is located within 2-3km of the New England Road landfill site and the Willowton industrial area. There is vacant land, zoned for light industrial use, between the works and the landfill site which is potentially available for new industrial users of spare energy from these sources.

Umgeni Water has investigated the possibility of sludge drying for fertiliser production. Such an operation would be energy intensive and could use waste methane. However the investigations indicate that this is unlikely to be a financially viable operation given the high capital costs required and the limited value of the type of fertiliser produced.

There do not appear to be any other existing opportunities for this volume of gas production since it is too small to be used for power generation at a reasonable scale.

Future opportunities for the gas use are likely to be tied to gas use options developed for the landfill site. The works are close enough to the landfill to relatively easily transport the gas to the landfill site’s gas collection point. The spare biogas generated from the works is equivalent to about 10% of the energy value of the landfill gas production. The addition of this gas would help to improve the viability of any gas use project implemented at the New England Road site.

Due to the proximity of available land some small scale opportunities may be sought for the use of the waste gas. These include wood drying, greenhouse establishment and similar small but energy intensive developments.

Carbon Finance Implications

Since the biogas produced is currently flared it is unlikely that a project based on this gas would be able to claim any credits from methane reduction. The GHG reduction occurring from such a project would arise from the replacement of another energy source if this source was not derived from renewable energy. It is likely that a new project that used biogas instead of a fossil fuel based energy could be eligible as a CDM project if it were shown that there were barriers to the biogas use that the CDM project helped to overcome.

6 Summary and Recommendations

There appears to be significant opportunity in the capture and use of landfill gas from the New England Road site. A feasibility study for the viability of a gas management and utilisation scheme funded by carbon credits is currently underway and the municipality should start preparing for the establishment of CDM project related to the use of gas from the site. There are a number of possible options for the gas use, with power generation likely to be the simplest option. However, there are other uses, such as energy supply to new industrial developments, which have local economic development benefits and should therefore be considered.

While some methane is currently being flared from the wastewater treatment works it appears that the potential uses of this gas are more limited than that from the landfill site due to the smaller volumes. If a landfill gas project is designed the addition of the biogas from the Darvill works to the landfill gas should be considered as a joint project. Small scale uses of the biogas should be investigated, however it is unlikely that carbon finance will make a significant contribution to these projects.

Institutional context

The IDP demonstrates an awareness of environmental matters and a willingness to engage with them. A local environmental forum exists which can also be used to consult with on new project ideas. At the same time the municipality has significant capacity constraints in the electricity and waste divisions. The general view of officials consulted was that there would not be sufficient internal human resources to establish and maintain any project developed to use the landfill or biogas. In this light the preferred options for project development would be via either a PPP, where the project would be outsourced to a private contractor, or via a management contract, where the municipality would own the assets of the project but would contract the management of the project to an external contractor.

7 Reference List

Personal communications

Nagassar, S., and Fowles, P.: personal communication: 25 June 2004, Pietermaritzburg Electricity.

Greatwood, M.: personal communication: 24 June 2004, Manager, Msunduzi Water and Sanitation Department.

McNab, N., and Graydon, P.: 25 June 2004, Umgeni Water, Darvill Wastewater Treatment Works, scientific officers.

Reports

Municipality of Msunduzi, 2002: The Msunduzi Municipality Integrated Development Plan, May 2002, Pietermaritzburg.

Municipal Demarcation Board, 2004: URL: http://www.demarcation.org.za/,

Lombard & Associates, 2000: Investigation of the Landfill Gas Generation Potential of the New England Road Landfill Site, unpublished document.

Site Visits

Darvill Wastewater Treatment Works, 25 June 2004.

Nelson Mandela Metropolitan Municipality

Prepared by Rob Short
October 2004

1 Introduction

The purpose of this report is to document the findings of the study with regard to the Nelson Mandela Metropolitan Municipality (NMMM).

2 Methodology

The investigation involved identifying all the municipality's waste sites and wastewater treatment works. This was done using interviews with municipal officials and documentation provided by a number of key departments within the local municipality.

3 Contextual Information

The NMMM has a population of approximately 1.2 million people and covers an area of around 1 950 km^2. In 2001 there were 260 798 households within its borders of which 82% have access to potable water and 89% have access to electricity. Though growing economically the unemployment rate is increasing (21.5% in 1996 to 28.2% in 2002)

Relationship to the developmental goals of the municipality

The NMMM has developed a Vision 2020, which seeks to improve the quality of life of the communities within its borders. The vision speaks of a sustainable municipality that focuses on sustainable environmental, social and economic development. The economic imperative is key, due to the need for jobs to assist in alleviating the poverty that exists in the area. "Cleansing and environment" is one of the developmental priorities of the NMMM and the municipality has identified the need to ensure sustainable waste management practices within the Metro as an objective to support this priority. In order to do this the NMMM will be developing a corporate environmental management system (as part of its integrated environmental plan) to monitor and manage the environmental impact of its activities. The NMMM has shown an interest in the renewable energy area, as illustrated by it actively considering a 13.5 MW wind energy development as part of its infrastructure programme.

This combined with the fact that the municipality is looking for ways to support its financial stability indicates that there is potentially a supportive environment for the development of methane emission reduction projects.

Institutional Arrangements

The NMMM is responsible for the ownership and management of all the landfill sites and wastewater treatment works.

4 Landfill Gas

The NMMM only has two sites in operation. There are a number of closed sites but in the opinion of the municipality there would limited, if any, methane emissions from these sites.

Table 1: Landfill Site Characteristics

Landfill Site Name	Classification	Waste Composition	Annual Tonnages	Remaining Life	Closure Date	Site Capacity (cubic meters)
Arlington	GLV-	General non-hazardous	240 000 tonnes per annum	60	2064	17,400,000
Koedoeskloof	MB- (and a h:h area where they handle oils)	General non-hazardous (but have hazardous area)	130 000 tonnes per annum	17	2021	3,740,000

Gas Emissions from the Sites

Monitoring does occur at the sites, but only involves water testing.

Potential Gas Use Options

The most probable potential use would be the generation of electricity due to site location.

5 Wastewater Treatment

The NMMM is responsible for the operation of 6 treatment works, of which only one uses an anaerobic process that leads to methane emissions. There is the possibility here for the biogas to be used for process heat, but this is a very limited reduction opportunity.

Table 2: Wastewater Treatment Facility Characteristics

Name and Location of Facility	Process Description	Volumes Treated per Day	Average COD Value	Methane Production at Site
Fish Water Flats	Mainly anaerobic (Aerobic 12% max)	100	52000 kg/d	Boilers / Flared (75 m3/hr max)
Kelvin Jones	Activated sludge	16.7	718	Not applicable
Kwanobhule	Activated sludge	6.2	627	Not applicable
Despatch	Activated sludge	3.9	380	Not applicable
Cape Receife	Aerobic	7	400	Not applicable

Name and Location of Facility	Process Description	Volumes Treated per Day	Average COD Value	Methane Production at Site
Driftsands Water Reclamation	Aerobic	11	650	Not applicable

6 Summary and Recommendations

There appears to be limited opportunities for methane emissions reduction opportunities within the Nelson Mandela Metropolitan Municipality, mostly with regard to the landfill sites.

7 Reference List

Personal Communications

George Ferreira, Business Unit Manager: Electricity, Nelson Mandela Metropolitan Municipality.

Ken Kendall, Assistant Manager: Waste Management Division, Nelson Mandela Metropolitan Municipality.

Barry Martin, Manager: Water and Sanitation, Nelson Mandela Metropolitan Municipality

Reports

Nelson Mandela Metropolitan Municipality, Annual Report, 2002\2003.

Nelson Mandela Metropolitan Municipality, Integrated Development Plan 2002 – 2006.

Polokwane Local Municipality

Prepared by Rob Short
November 2004

1 Introduction

The purpose of this report is to document the findings of the study with regard to the Polokwane Local Municipality (PLM).

2 Methodology

The investigation involved identifying all PLM's waste sites and wastewater treatment works. This was done using interviews with municipal officials and documentation provided by a number of key departments within the local municipality.

The key documents reviewed included the municipality's Integrated Development Plan, PLM's Annual Service Delivery and Budget Implementation Plan (2004\2005) and PLM's Multi-Year Budget (2004\2005). The municipality is planning to develop an Integrated Waste Management Plan in the near future.

3 Contextual Information

The PLM is a category B municipality and is located within the Capricorn District Municipality in Limpopo Province.

The municipal area covers approximately 3700 square kilometers, which is about 3% of the total area of the Province. Polokwane City is the Province's capital city and the municipality contributes about 13% of the Province's total GGP. The population is 483 000 and the unemployment rate is in the region of 39%. Access to services is a key issue in the municipality with, for example, gaps in waste management services having been specifically identified as a problem area that needs addressing.

Relationship to the developmental goals of the municipality

The key performance areas (KPAs) as identified by the municipality are:

- Meeting Basic Needs;
- Local Economic Development;
- Community participation and empowerment; and,
- Transform the municipal structure.

The development of projects that would make productive use of methane could fit into the municipality's development objectives in a number of ways; firstly in terms of supporting the right to a clean environment (within the Basic Needs KPA); secondly, in terms of the retention and attraction of investments objective (this falls within the Local Economic Development KPA); and thirdly the municipality has identified ensuring environmental sustainability as one of the cross-cutting issues that have to be considered, while designing strategies and planning projects, as an integral part of the four key performance areas,

Institutional Arrangements

The local municipality is responsible for all waste and wastewater related services

4 Landfill Gas

There are currently two landfill sites operating under the municipality's jurisdiction, Weltevreden (located 8 kms from the Polokwane in an agricultural area) and Mankweng (located 25 kms from Polokwane in a rural area). The Mankweng site is not permitted and a decision is to be taken whether it should be upgraded, closed or a transfer station built. Currently waste is burnt at the site, so there is unlikely to be any potential for methane production. Composting proposals, which have the potential to lead to reductions in methane emissions, have been put to the council and received limited budget allocations for implementation.

Table 1: Landfill Site Characteristics

Landfill Site Name	*Classification*	*Waste Composition*	*Annual Tonnages*	*5 Remaining Life*	*Closure Date*	*Site Capacity (cubic meters)*
Weltevreden	B-	General non-hazardous	146 000	16	2020	3 736 000
Mankweng	Not permitted	General non-hazardous	Estimated 50 tonnes per day	-	-	-

Gas Emissions from the Sites

No measurements of gas emissions and\or the potential for landfill gas migration are carried out by the municipality. There have also been no formal gas yield trials carried out, test wells sunk or formal gas modeling undertaken.

Potential Gas Use Options

Due to the location of the Welteverden site in an agricultural area, away from any industrial facilities, the only likely use of landfill gas would be for electricity generation.

6 Wastewater Treatment

The municipality has responsibility for four wastewater treatment works (see table below).

Table 2: Wastewater Treatment Facility Characteristics

Name and Location of Facility	*Process Description*	*Volumes Treated per Day*	*Average COD Value*	*Methane Production at Site*
Polokwane	Activated sludge, up flow anaerobic sludge blanket (USB)	22 ml\day	900 mg\l	Methane is produced from the USB and the biofilter digesters. No measurements of quantity. Currently used for incineration and heating primary digesters. Augmented with diesel
Seshego	Biological filters with anaerobic digesters	5 – 7 ml\day	800 mg\l	Methane is currently vented (no flaring). No monitoring and\or measurements of quantity.
Mankweng	Biological filters with anaerobic digestion	5 – 7 ml\day	Assumed to be in the region of 700 mg\l	Methane is currently vented (no flaring). No monitoring and\or measurements of quantity.
Thokgoaneng	Anaerobic \ aerobic pond system	130 000 l per month	Not available	Would be methane emissions. No monitoring and\or measurements of quantity.

The municipality is planning to upgrade Polokwane during the current financial year (no increase in methane production is anticipated) as a precursor to the building of a new regional facility in the medium-term (within 3 – 5 years). It is anticipated that this regional facility would have an anaerobic component.

7 Summary and Recommendations

From the data collected there appear to be a number of potential methane emission projects within the Polokwane Local Municipality. The Weltevreden landfill site has the potential to support a 1.5 MW electricity generation facility and further there are a number of opportunities on the waste water treatment side as a result of the current venting of methane (it appears here that the best use for this methane would be as process heat, but the proximity of the facilities to industrial areas does offer a potential industrial take off option).

8 Reference List

Personal Communications

Mr. L. Ledwaba, Manager – Environment and Waste, Polokwane Local Municipality.

Mr. N. Nchabaleng, Manager – IDP, Polokwane Local Municipality.

Mr. W. Olivier, Deputy Manager – Electricity, Polokwane Local Municipality.

Mr. S. Rabie, Chief Chemist, Water and Sanitation, Polokwane Local Municipality.

Mr. N. van Rensburg, Manager – Water and Sanitation, Polokwane Local Municipality.

Reports

Polokwane Local Municipality, Integrated Development Plan "Putting People First – A New Perspective", May 2003.

Polokwane Local Municipality, 2004\2005 Annual Service Delivery and Budget Implementation Plan.

Polokwane Local Municipality, Multi-Year Budget 2004/2005.

City of Tshwane Metropolitan Municipality

Prepared by Rob Short
October 2004

1 Introduction

The purpose of this report is to document the findings of the study with regard to the City of Tshwane Metropolitan Municipality (CTMM).

2 Methodology

The investigation involved identifying all City of Tshwane Metropolitan Municipality's waste sites and wastewater treatment works. This was done using interviews with municipal officials and documentation provided by a number of key departments within the local municipality.

3 Contextual Information

The CTMM population in 2001 was approximately two million and growing at an average of 1.7% per annum living in approximately 600 000 households. The unemployment rate is 31.5%, with an estimated 29.1% of the population leaving in poverty. Over 95% of households have access to piped water and 70% have access to a flush toilet. Though service delivery has improved since 1996, the backlogs are still significant and job creation is a specific focus of the municipality to alleviate poverty.

Relationship to the developmental goals of the municipality

The CTMM has a vision of being a world-class capital city and its strategic objectives include economic development and natural resource development. Environmental management issues are being taken forward through the development of an environmental policy for the city and the accompanying management system that will ensure its aims are implemented. The city has also formed a sustainable energy committee to look at ways it can improve its performance in the energy sector, as regards development impact. The city is also looking at means to develop new income sources to support its developmental agenda.

In this context it would be reasonable to assume that methane emission reduction projects would be supported.

Institutional Arrangements

The landfill sites and wastewater treatment facilities are owned and operated by the municipality.

4 Landfill Gas

The municipality has already been approached by a number of potential landfill gas project developers, as well as carbon financiers, and is seriously considering developing a project. There is potential at a number of sites and though individually they may not be large, there is the potential for a significant programme.

Table 1: Landfill Site Characteristics

Landfill Site Name	*Classification*	*Waste Composition*	*Annual Tonnages*	*Remaining Life*	*Closure Date*	*Site Capacity (cubic meters)*
Hatherley	GLB^{-}	General non-hazardous	144,000	50	2054	14,400,000
Valhalla	GLB^{-}	General non-hazardous	216,000	0	2004	2,340,000
Kwaggasrand	GLB^{-}	General non-hazardous	192,000	5	2009	4,860,000
Onderstepoort	GLB^{-}	General non-hazardous	204,000	25	2029	6,500,000
Garstkloof	GLB^{-}	General non-hazardous	264,000	5	2009	7,560,000
Temba	GLB^{-}	General non-hazardous	96,000	1	2005	740,000
Derdepoort	GLB^{-}	General non-hazardous	216,000	3	2007	2,048,000
Soshanguve	GLB^{-}	General non-hazardous	132,000	15	2019	3,060,000
Garankuwa	GLB^{-}	General non-hazardous	180,000	20	2024	4,950,000

Gas Emissions from the Sites

No monitoring currently occurs.

Potential Gas Use Options

Though the generation of electricity is the most likely option, there may be some opportunities for industrial off take.

5 Wastewater Treatment

The plants operated by the municipality are identified in the table below. There are a number of anaerobic plants but these are already utilizing the methane produced for process heating. Though there may be opportunities to improve efficiencies, and therefore methane production, it appears that this would offer very limited benefits. The municipality is also looking at the use of dried sewage sludge as a fuel.

Table 2: Wastewater Treatment Facility Characteristics

Name and Location of Facility	*Process Description*	*Volumes Treated per Day*	*Average COD Value*	*Methane Production at Site*
Babelegi	Aerobic	2.5	609	Not applicable
Baviaanspoort	Anaerobic	35	693	8,470 m^3 of biogas produced per day. Used for process heat.
Rooiwal	Aerobic 50% Anaerobic 50%	120	586	12,280 m^3 of biogas produced per day. Used for process heat.
Daspoort	Anaerobic	55	548	10,520 m^3 of biogas produced per day. Used for process heat.
Zeekoegat	Aerobic	35	548	nil
Sunderland Ridge	Anaerobic	43	536	8,050 m^3 of biogas produced per day. Used for process heat.
Sandspruit	Aerobic	4	555	nil
Rietgat	Aerobic	8	608	nil
Klipgat	Anaerobic	32	550	6,150 m^3 of biogas produced per day. Used for process heat.
Temba	Anaerobic	8	Not available	Used for process heat.

6 Summary and Recommendations

The landfill resource at a number of the sites does offer potential, but there is little or no opportunity on the wastewater treatment side. Tshwane is considering the use of sewage sludge as a fuel in for example cement kilns. This may turn out to be an innovative approach that should be considered for replication, if successful.

7 Reference List

Personal Communications

Kobie Pretorius, Manager: Waste Management, City of Tshwane.

Koot Snyman, Manager: Wastewater Treatment, City of Tshwane.

Reports

Tshwane Metropolitan Municipality, Integrated Development Plan, 2002.

Tshwane Metropolitan Municipality, Integrated Development Plan, Review - 2004.

City of uMhlathuze Municipality

Prepared by Stan Jewaskiewitz
19 October 2004

1 Introduction

The City of uMhlathuze Municipality is a local municipality, located within the Uthungulu region, on the north coast of KwaZulu-Natal. The municipal area comprises the towns of Richards Bay and Empangeni, and the supporting areas of Esikhawini, Ngwelezane, Nseleni, Felixton and Vulindlela.

The methane emissions investigation in the municipal area focused on the three landfill sites within the municipality, namely the Alton site which has been closed for approximately one year, the new Uthungulu regional site, and the adjacent old Empangeni site which is also closed, but un-rehabilitated.

The various waste water treatment plants (WWTPs) were also investigated and these include: Nseleni, Esikhawini, Ngwelezane, Vulindlela and Empangeni.

Although there are a number of heavy industries located in Richards Bay, emitting an array of gases, no other significant sources of methane or other single sources of greenhouse gases were found to be under the control of the municipality.

2 Methodology

The investigation into the uMhlathuze Municipal area, was facilitated by various internet searches and information provided by the uMhlathuze Municipality. Information from this study was augmented by meetings and interviews with personnel from the municipality's solid waste, wastewater, electrical and air pollution sections, and a site visit to the three landfill sites was undertaken. The municipality's Strategic Environmental Management Plan (EMP) was also reviewed in the context of this study.

3 Contextual information

The City of uMhlathuze is located along the N2 highway on the north coast of KwaZulu-Natal, and comprises the towns of Richards Bay and Empangeni, and its supporting areas of Esikhawini, Ngwelezane, Nseleni, Felixton and Vulindlela, and rural areas. It covers a region of approximately 800 square kilometres and provides services to a population of approximately 400 000 (uMhlatuze Municipality, 2004)

Richards Bay and Empangeni make up the urban core of the municipality, with good physical infrastructure linking the commercial hub of Empangeni to the industrial and tourism hub of Richards Bay. This urban core is relatively well serviced and is surrounded by a periphery of peri-urban and rural areas with limited access to formal services (see Table 1 below). 57% of the population reside in the urban areas of the City of uMhlatuze (City of uMhlatuze Annual Report 2003). The methane emissions generation stems largely from those households with access to formal refuse removal.

Relationship to the developmental goals of the municipality

The establishment of a project utilising waste methane would fit well within the developmental priorities of the municipality. In particular, such a project would be suitable if it simultaneously provided new employment opportunities. The project would also fit well within the expressed strategic issues of "the extension of the city's municipal open space system", "a coastal management plan", and "strategic environmental assessment" (uMhlatuze Municipality, 2004).

Institutional arrangements

The municipality is the water services authority (WSA) and is also the water services provider for most of the municipal area. The wastewater treatment works are all owned by the municipality and are managed by WSSA who are the management and operating contractors.

The role of the local uMhlatuze Water Board is still to e defined in terms of the IDP.

The municipality has a waste management division which is the service authority and provider for solid waste services, and are responsible for the Alton and old Empangeni sites. Millennium Waste Management is the contracted operator of the Uthungulu landfill site which serves as a district regional site. The Uthungulu Regional Landfill site is owned by the Uthungulu District Council.

With regards to electricity, Eskom are the main service providers. Richards Bay and Empangeni buy electricity in bulk from Eskom and then reticulate it to their customers. The industrial companies of Foskor and Mondi are also running co-generation plants, and a project is underway whereby Millennium Rainbow intends to generate electricity using natural gas supplied by Sasol.

Table 1: Access to services in uMhlatuze (2001)

Source of energy for lighting	***no.***	***%***	***Refuse***	***no.***	***%***
Electricity	57,748	86%	Municipal Weekly	28,696	43%
Gas	111	0%	Municipal Other	958	1%
Paraffin	396	1%	Communal Dump	244	0%
Candles	8,576	13%	Own Dump	34,118	51%
Solar	104	0%	No Disposal	3,110	5%
Other	192	0%			
Water			***Sanitation***		
Dwelling	21,891	33%	Flush Toilet	28,505	42%
Inside Yard	23,792	35%	Flush septic tank	1,765	3%
Community Stand	5,816	9%	Chemical toilet	5,427	8%
Community stand over 200m	7,935	12%	VIP	8,075	12%
Borehole	559	1%	Pit latrine	16,538	25%
Spring	960	1%	Bucket latrine	644	1%
Rain Tank	295	0%	None	6,174	9%
Dam/Pool/Stagnant Water	533	1%			
River/Stream	3,221	5%			
Water Vendor	150	0%			
Other	1,976	3%			

Source: Municipal Demarcation Board (Census 2001 statistics)

4 Landfill Gas

Currently, the Uthungulu regional landfill site is the sole operational landfill site servicing the municipal area. The site is situated adjacent to the old Empangeni landfill site, to the east of Empangeni, adjacent to the John Ross Highway which connects Empangeni with Richards Bay. As part of its environmental mandate, the Uthungulu District Municipality is committed to promoting sustainable landfilling practices at its landfill site to ensure that its environmental obligations at the site are fulfilled. The other sites that require consideration with respect to landfill gas generation potential are the old Empangeni site, and the Alton site, located in the Alton area of Richards Bay, both of which are closed and are not operational.

The relevant characteristics regarding the Uthungulu and Alton (closed) landfill sites with respect to this study are provided below.

Table 1: Landfill site characteristics

Landfill	Waste Composition			Input (tons/year)	Start Date	Closure Date	Site Capacity (m^3)
	Domestic	Garden	Industrial				
Uthungula Regional	30%	40%	30%	156,000	2003	2044+	175,000 (6,8 million+)
Alton (closed)	30%	40%	30%	-	c. 1980	2003	(2,76 million)

Both the above landfill sites have the capacity to generate significant volumes of landfill gas. The old Empangeni landfill was not evaluated due to the lack of available information.

The old Empangeni landfill still requires to be formally closed and rehabilitated in accordance with the DWAF Minimum Requirements (1998). The Alton landfill site which was closed in 2003 and also requires be formally capping and rehabilitating.

To date, no attempt has been made to monitor gas emissions from these landfill sites nor has the municipality entertained the idea of utilising any potential that may be generated.

Gas emissions from the landfill sites

A review of the available literature and site data obtained for the two landfill sites was conducted. The review of this literature, historical information and site monitoring data was used to form the basis of inputs required to complete the landfill gas generation models for the sites. The Environment Agency (UK) software package called GasSim was used to carry out the landfill gas generation modelling.

In brief, the anticipated landfill gas yields (with a methane concentration of 50%) for the two landfills were estimated as shown below.

The estimated peak gas yields are as follows:

- Alton Landfill (closed) 1,375 Nm^3/hr
- Uthungulu Regional Landfill 1,120 Nm^3/hr

As can be seen from the above gas yields, both landfill sites have the potential for generating significant landfill gas yields and therefore have the capacity to generate between 1 and 2 MW_e of electrical power.

The Uthungulu Regional Landfill is a relatively new site and has the potential to generate significantly more gas as the site is further developed. A more detailed analysis should be undertaken to evaluate the true potential of this site in terms of its development and hence gas generating potential.

Potential gas use options

A range of potential gas use options are available and would require further investigation as to which would be the more appropriate for the respective landfill sites. These include:

- Electricity generation
- Industrial fuel switching (thermal energy)

- Residential use
- Diesel replacement in transport

Of these options it appears that residential fuel use and diesel replacement in transport are unlikely to be viable options. There is no existing gas reticulation infrastructure and the costs of installing this would be prohibitive. Further, the purification of landfill gas to pipeline quality standards poses large technical challenges and expenses. The difficulty of purifying the gas to acceptable levels, coupled with the management challenges of vehicle fleet conversion make it unlikely that this would be a preferred option. The remaining options appear viable to differing degrees.

There appears to be few technical barriers to on-site electricity generation and the feeding of this electricity into the local electricity grid. Based on the results of the gas modelling exercise there appears to be sufficient gas to generate between 1 and 2 MW of electricity on the relevant sites. A likely scenario would be the installation of on-site gas engines in a modular fashion – beginning with one or two 1MW units and adding another unit if gas yield proved to be stable.

In terms of industrial usage, the need to convert from coal or fuel oil to gas would need to be considered and the benefits thereof compared. The main constraints related to landfill gas supply to industrial sites are:

- ♦ The costs and complexities of off-site transport of the landfill gas;
- ♦ Whether landfill gas can compete on a price basis with coal / fuel oil / or Sasol gas;
- ♦ The costs of boiler conversions to gas;
- ♦ The ability of the landfill site to provide an assured supply of gas to the industrial sites

A further consideration would be whether industrial customers are sufficiently large enough to utilise all the landfill gas. Supplying a larger number of relatively small industrial customers (especially if they are not located near to each other) may become prohibitively expensive.

There is also the possibility of Local industries such as Foskor or Mondi, who have cogeneration plants, utilising the landfill gas as part of their own energy requirements. These possibilities warrant further investigation.

Relationship to IDP objectives

The use of landfill gas is compatible with the municipality's Strategic Environmental Management Plan (EMP). The establishment of a project utilising waste methane would fit well within the developmental priorities of the municipality. In particular, such a project would be suitable if it simultaneously provided new employment opportunities. The municipality has thus far not identified the potential to increase the landfill site's revenue generating potential. The gas use options are similarly compatible with the IDP's strategic areas.

The municipality has, however, identified waste recycling and a reduction in waste generation as issues to be addressed. If these issues are addressed there may be some implications for future gas yield from the site. This is unlikely to have major implications for the project options identified.

5 Waste-water treatment

The uMhlatuze municipal area has five wastewater treatment works, namely the Nseleni, Ngwelezane, Esikhawini, Vulindlela and Empangeni wastewater treatment works. These plants would appear to have adequate capacity for the foreseeable future, although the capacity of the Esikhawini works will be investigated shortly. All of these plants are managed and operated by WSSA on behalf of the uMhlatuze Municipality.

A gradual levelling off of wastewater volumes is being experienced, with a minor increase in volume of 2% to 5% being expected in the next three years. WSSA has also confirmed that no particular industrial flow problems currently exist.

Although many households in the municipality lack waterborne sanitation it is unlikely that these households will have such a system in the foreseeable future. Sanitation service improvements to these households are likely to focus on household level or small scale local solutions.

Technical details of the works are shown in the table below.

None of the wastewater treatment works would appear to have any methane production potential, due to the aerobic nature of the treatment process.

uMhlatuze Wastewater Treatment Works: Technical Details

Nseleni wastewater treatment works		***Comment***
Treatment capacity	3 Ml/day	
Average flow	0,9 Ml/day	No significant increase in flow is expected in the near future
Treatment process	Aerobic – primary treatment	
Ngwelezane wastewater treatment works		***Comment***
Treatment capacity	5,8 Ml/day	
Average flow	2,1 Ml/day	No significant increase in flow is expected in the near future
Treatment process	Aerobic – primary treatment	
Esikhawini wastewater treatment works		***Comment***
Treatment capacity	12 Ml/day	
Average flow	9 Ml/day	No significant increase in flow is expected in the near future
Treatment process	Aerobic – primary treatment	
Vulindlela wastewater treatment works		***Comment***
Treatment capacity	2,8 Ml/day	
Average flow	0,9 Ml/day	No significant increase in flow is expected in the near future
Treatment process	Aerobic – primary treatment	
Empangeni wastewater treatment works		***Comment***
Treatment capacity	10 Ml/day	
Average flow	8 Ml/day	No significant increase in flow is expected in the near future
Treatment process	Aerobic – primary treatment	

Gas generation and gas use options

Since all the WWTPs within the municipal area are based on aerobic treatment processes, no biogas is produced and hence no methane.

Carbon Finance Implications

From the above it would appear therefore, that there are no opportunities at this stage for the implementation of CDM projects.

6 Summary and Recommendations

There appears to be an opportunity in the extraction and use of landfill gas from the Alton (closed site) and the new Uthungulu Regional Landfill sites. There are a number of possible options for the gas use, with power generation likely to be the simplest option. However, there are other uses, such as energy supply to local industry (Foskor, Mondi, etc), which will have local economic development benefits and should therefore be considered.

Institutional context

The municipality’s Strategic Environmental Management Plan (EMP) demonstrates an awareness of environmental matters and a willingness to engage with them. A local environmental forum exists which can also be used to consult with on new project ideas.

Whilst the municipality appears to have sufficient capacity to undertake a project of this nature, it would be prudent to investigate whether they would require outside assistance to establish and maintain any project developed for the use of landfill gas.

The preferred options for project development may be via either a public private partnership (PPP), where the project would be outsourced to a private contractor, or via a management contract, where the municipality would own the assets of the project but would contract the management of the project to an external contractor.

7 Reference List

Personal communications

Van Der Wateren T. : personal communication: 15 August 2004

Van Der Wateren T. : personal communication: 26 August 2004

Taylor, D. (Uthungula District Council) : 15 August 2004

Baker, D (City Electrical), Phillips, R (Community Services & Health), Ambrose, B (Waste Management, Coastal), de Jager, D (Waste Management, Inland), Fenton, V & Volschenk, P (Environmental & Health, Inland), Haripersadh, N (Air Quality), Matingwa, C (Water Quality) & van der Wateren, T (Environmental Planning): personal communication (meeting): 2 September 2004, uMhlatuze Municipality, Richards Bay.

Van Der Wateren T. : email - information: 3 September 2004

Reports

Municipal Demarcation Board, 2004: http://www.demarcation.org.za

Websites

KwaZulu-Natal Top Business Portfolio 2004: http://www.kzntopbusiness.co.za

City of uMhlatuze: http://www.richemp.org.za

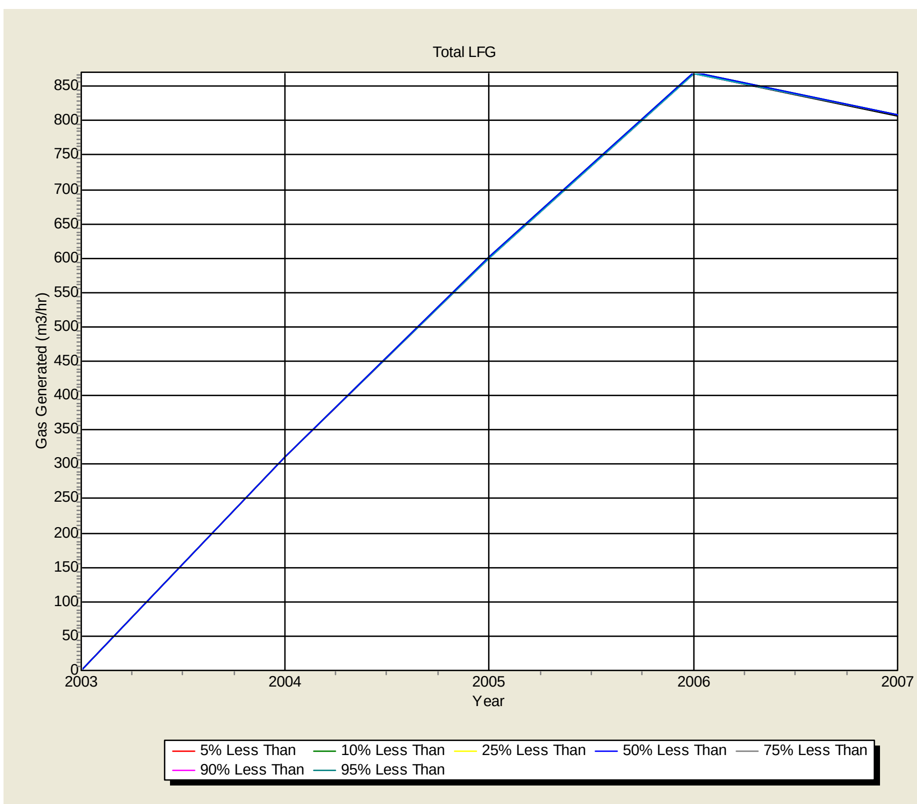
Site Visits

A site visit was carried out to all three the landfill sites on 3 September 2004 to assess the status quo and to obtain site specific information regarding the waste streams.

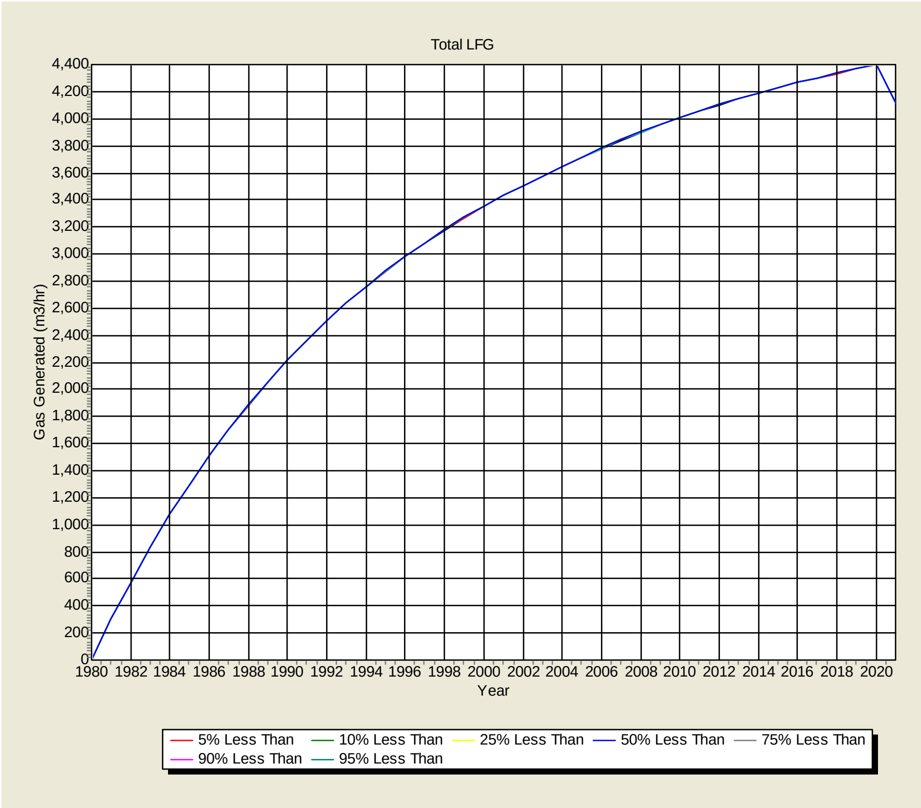
Buffalo City : Second Creek Landfill

Buffalo City : Roundhill Landfill

Cape Town : Bellville South Landfill (Old)

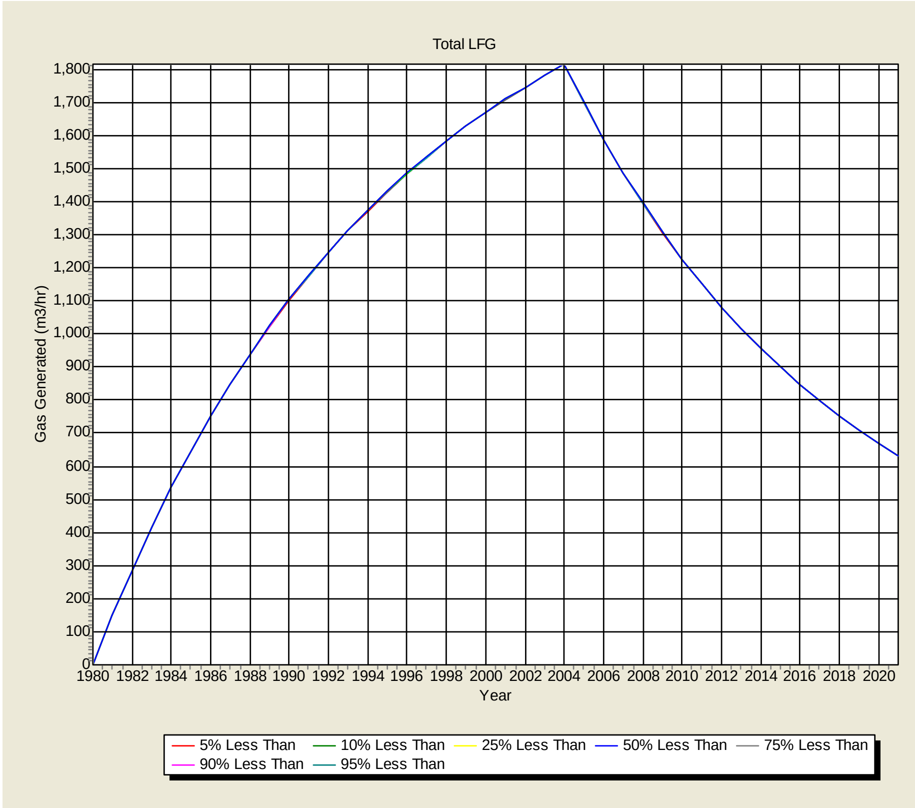


Cape Town : Bellville South Landfill (New)

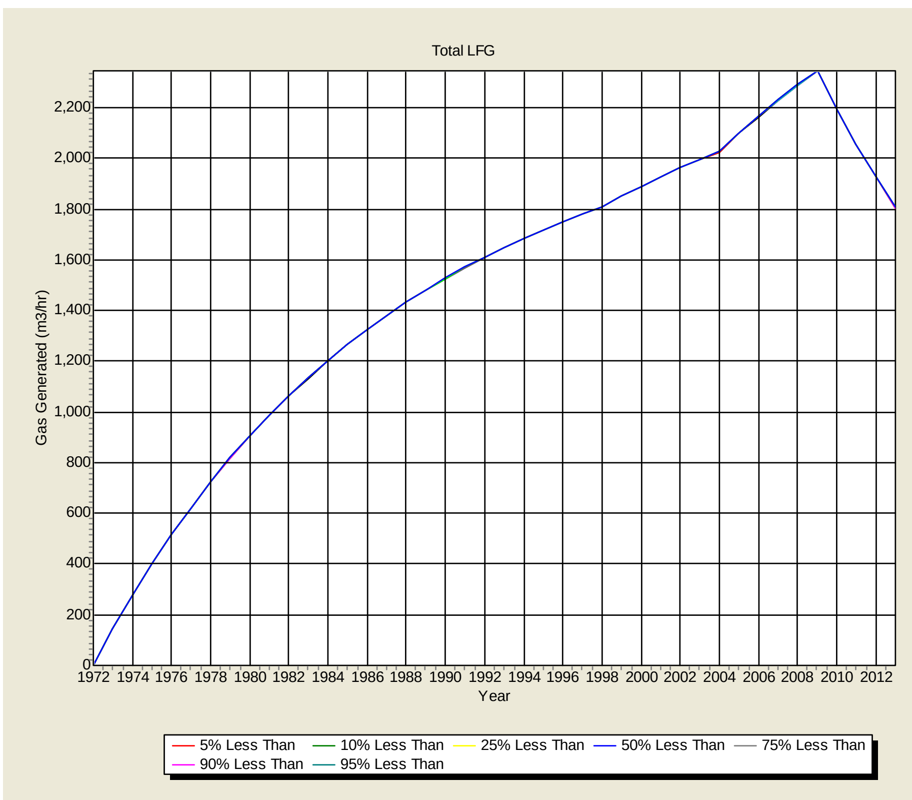


Cape Town : Vissershok Landfill

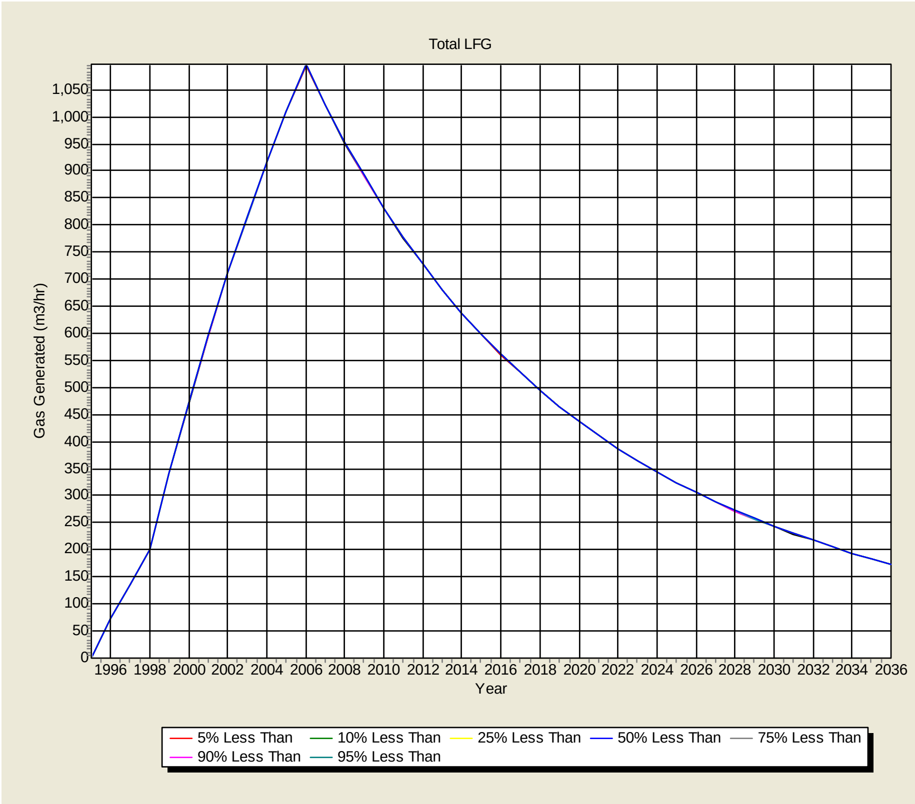
Cape Town : Coastal Park Landfill



Cape Town : Swartklip Landfill (Closed)

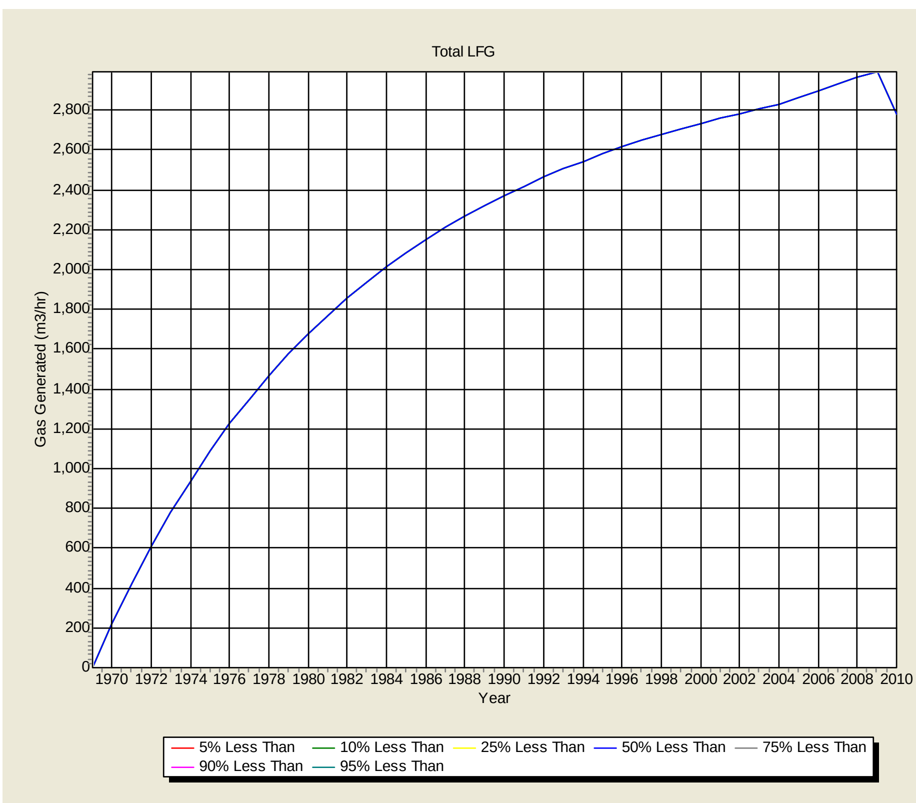


Cape Town : Faure Landfill

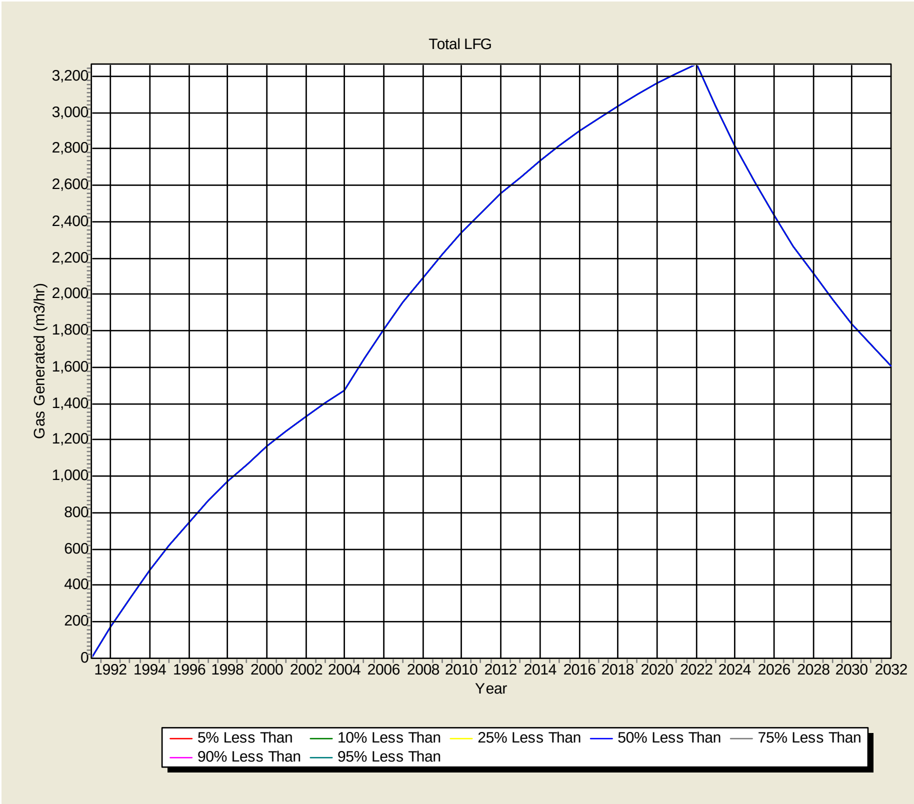


Cape Town : Brackenfell Landfill

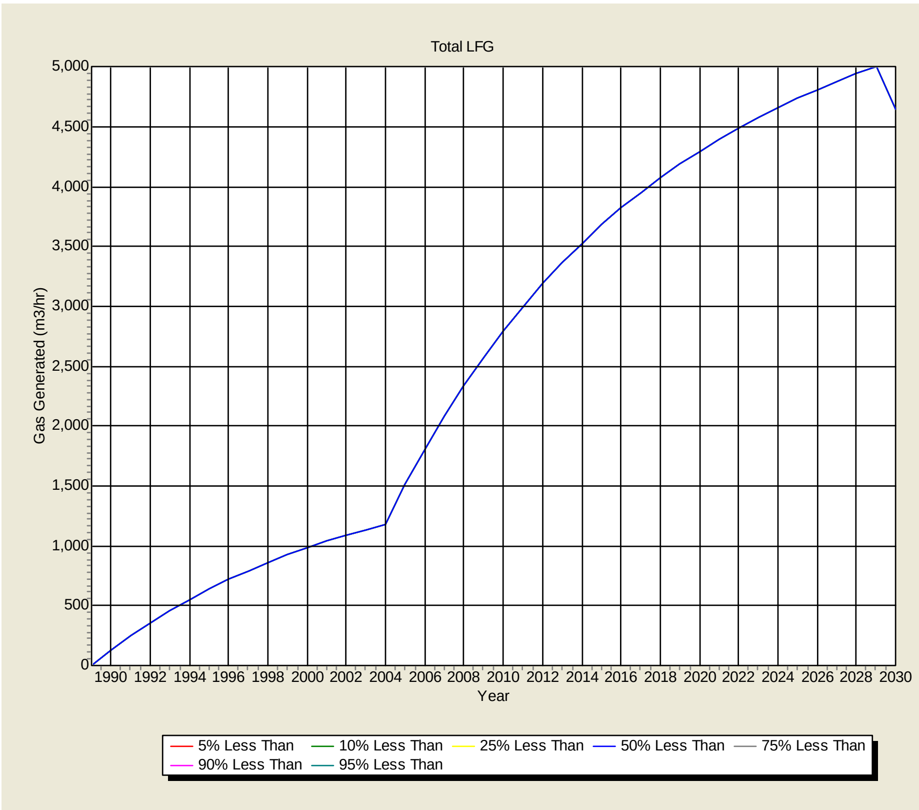
Joburg : Linbro Park Landfill



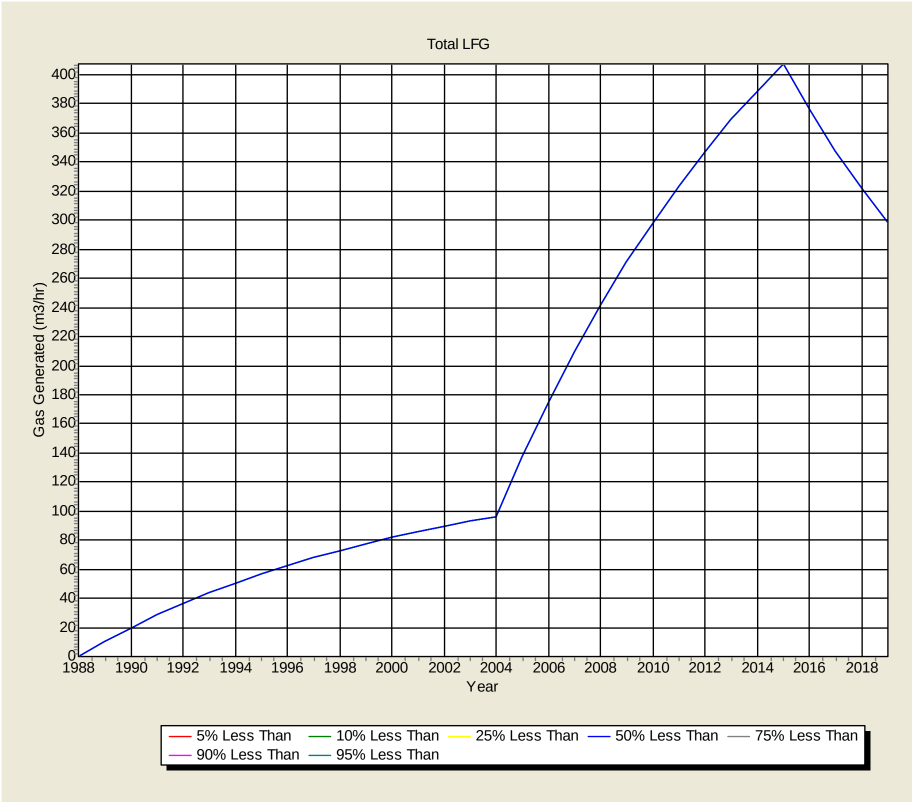
Joburg : Robinson Deep Landfill



Joburg : Marie Louise

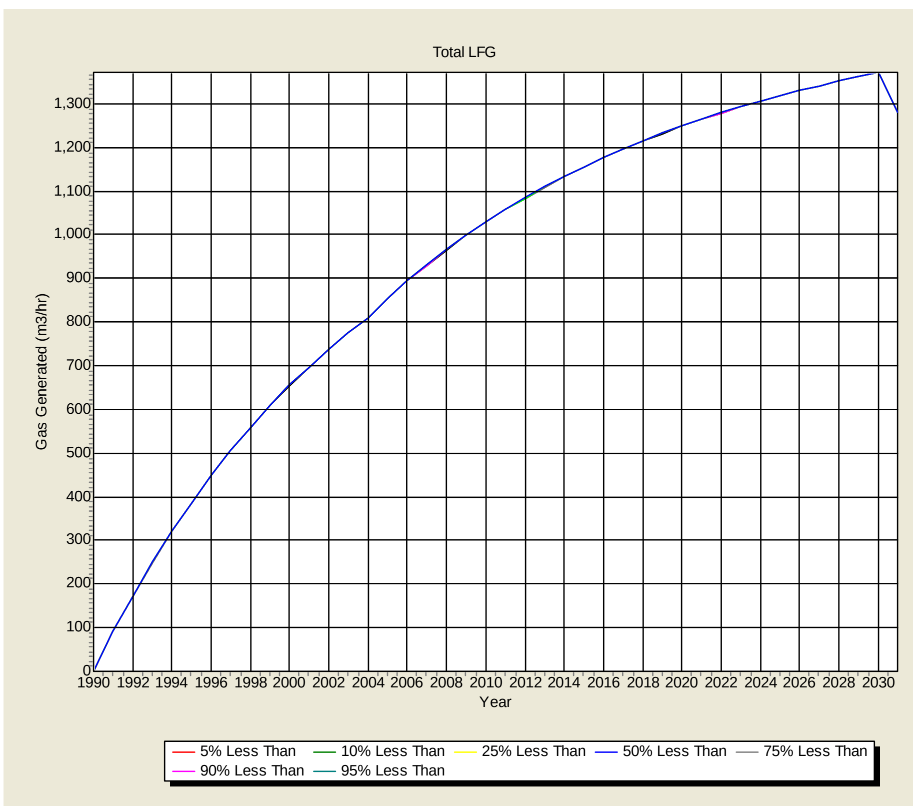


Joburg : Goudkoppies Landfill



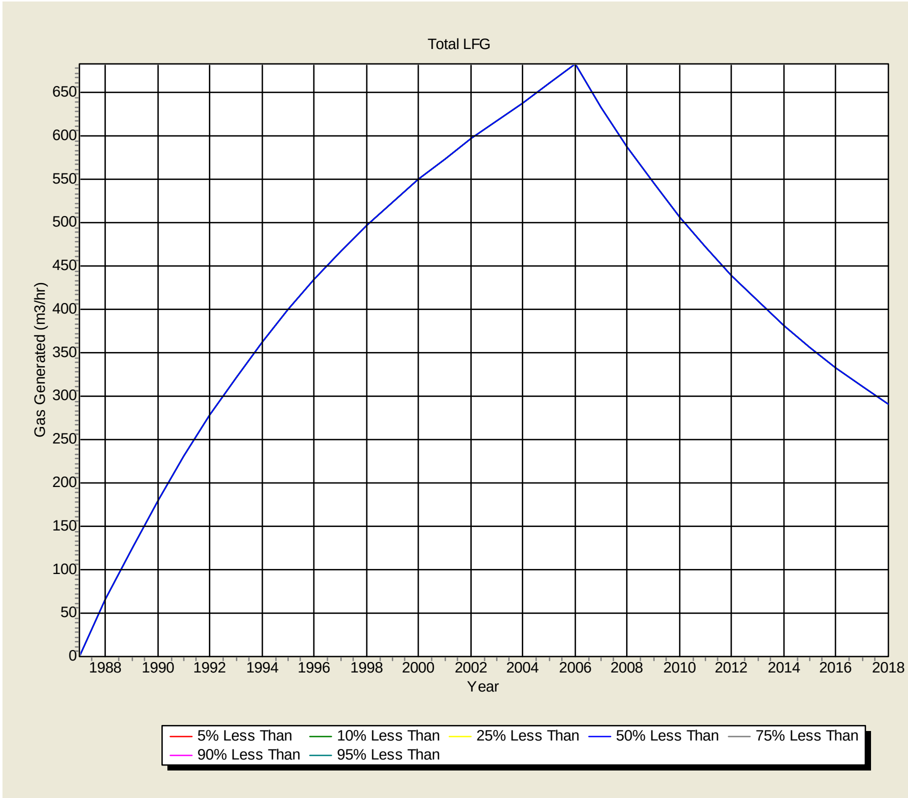
Joburg : Ennerdale Landfill

Mangaung : Northern Landfill

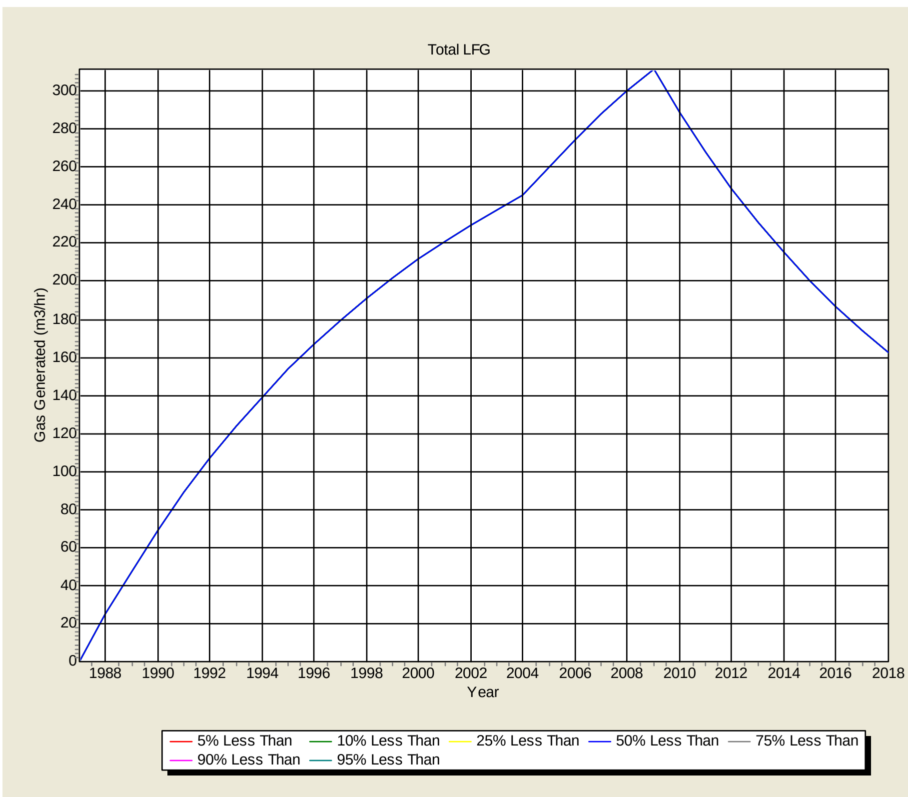


Mangaung : Southern landfill

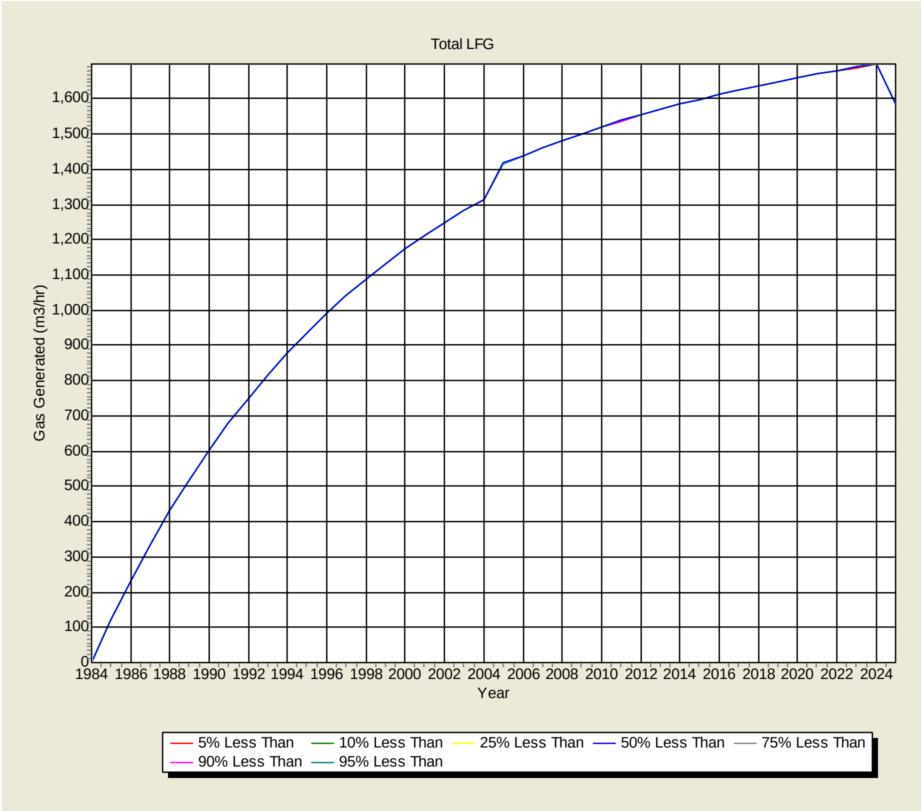
Mangaung : Botshabelo Landfill



Mbombela : Nelspruit Landfill

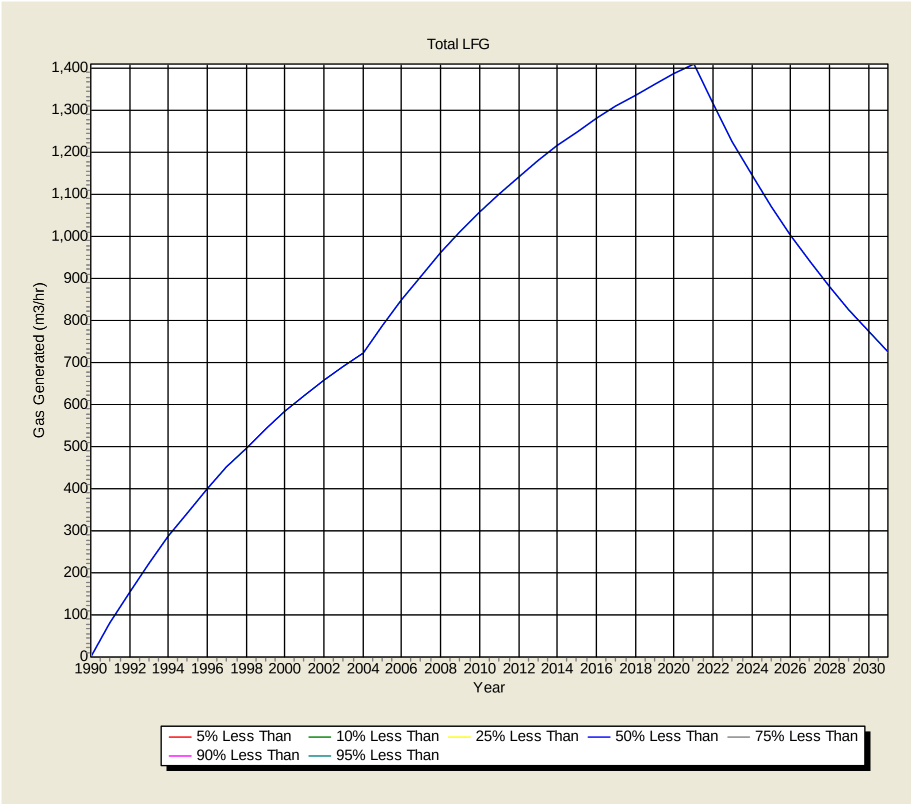


Mbombela : White River Landfill

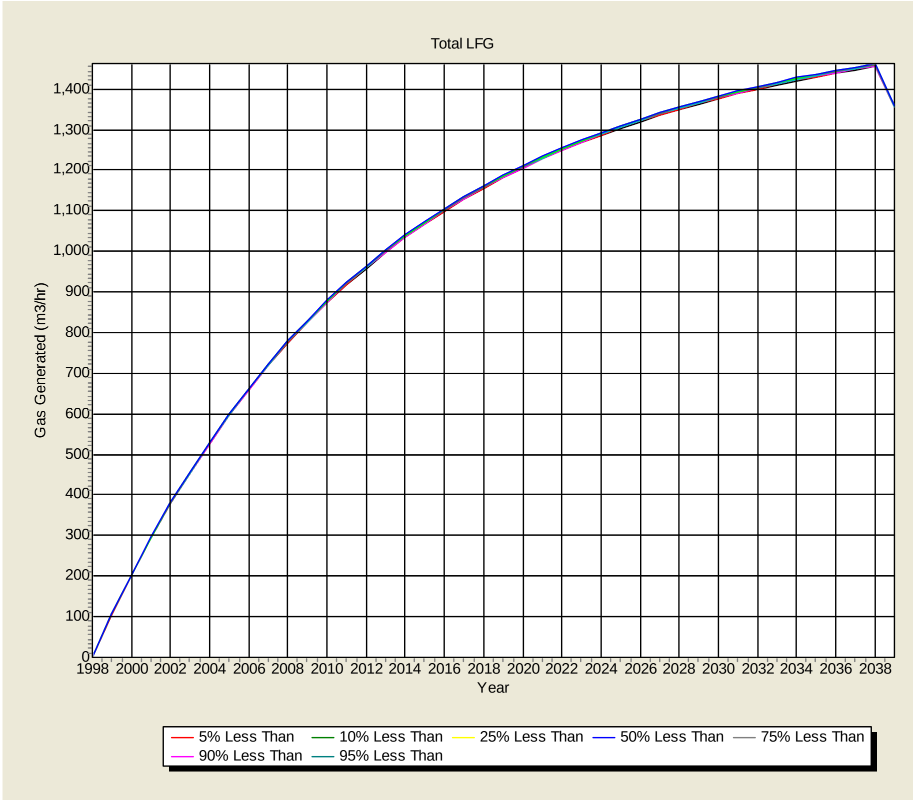


Nelson Mandela Metro : Arlington Landfill

Nelson Mandela Metro : Koedoeskloof Landfill



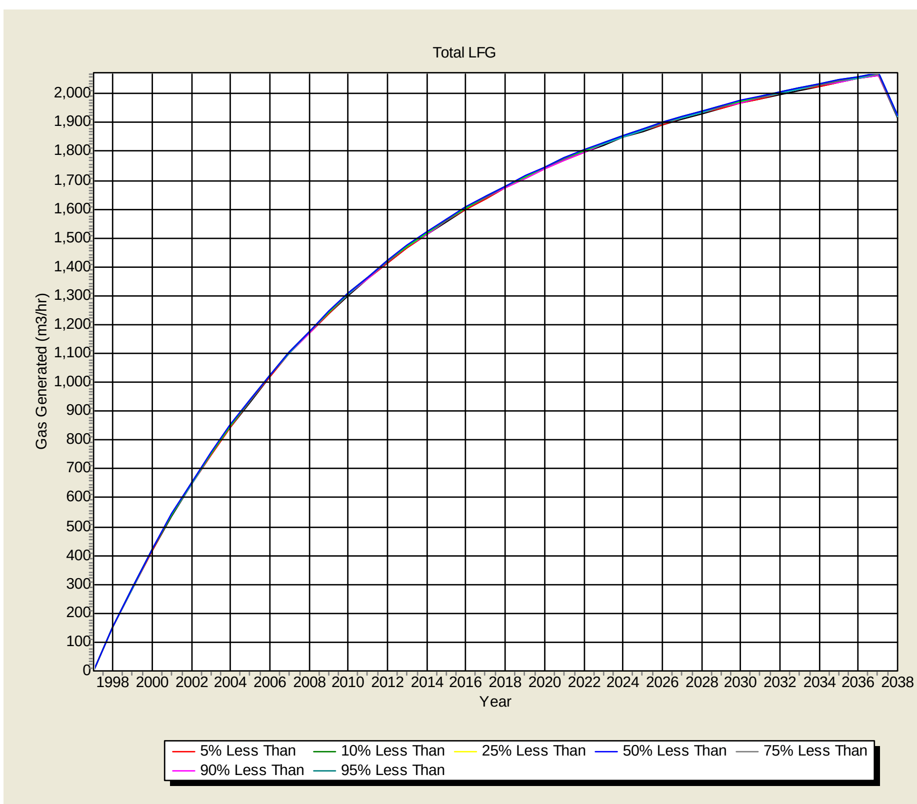
Polokwane : Weltevreden Landfill



Tshwane Metro : Hatherly Landfill

Tshwane Metro : Valhalla Landfill

Tshwane Metro : Kwaggasrand Landfill

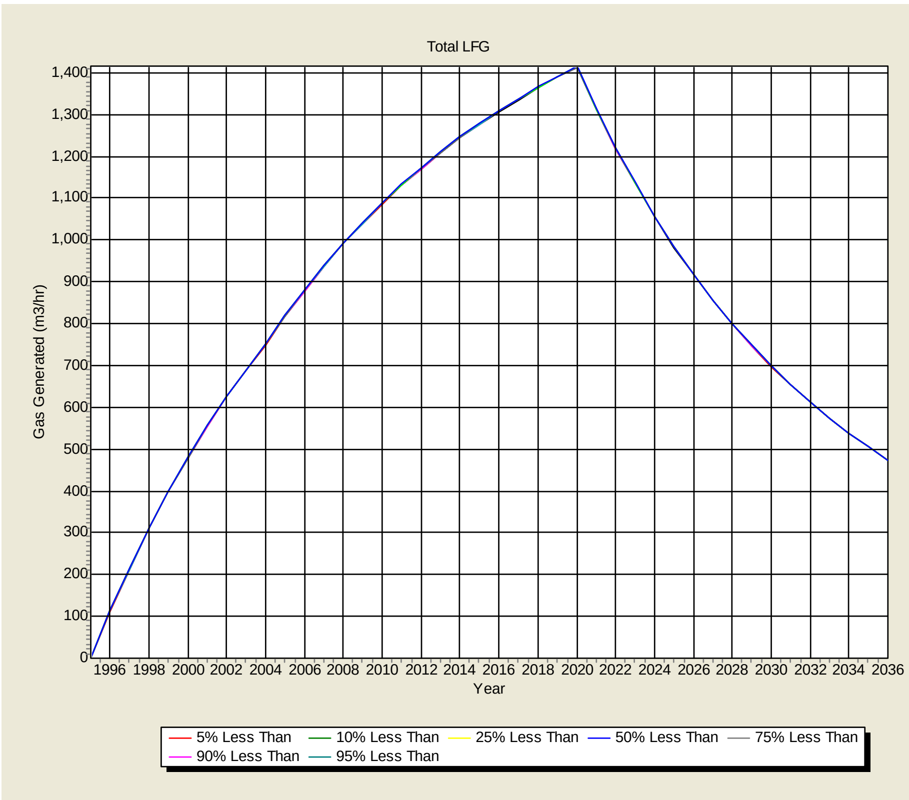


Tshwane Metro : Onderstepoort Landfill

Tshwane Metro : Garstkloof Landill

Tshwane Metro : Temba Landfill

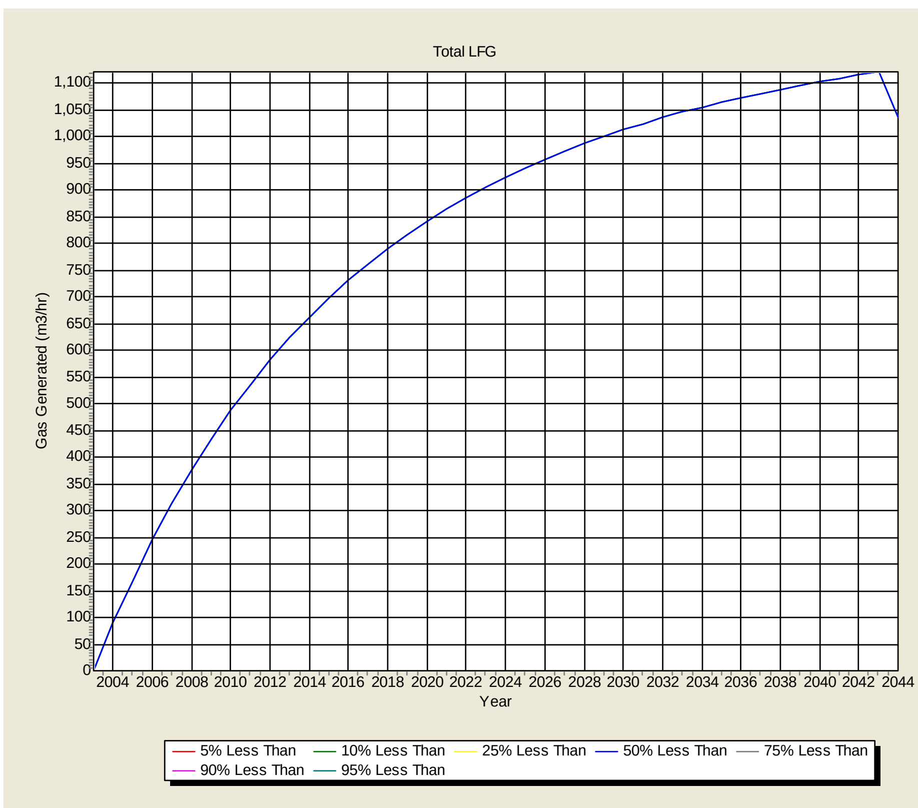
Tshwane Metro : Derdepoort Landfill



Tshwane Metro : Soshanguve Landfill

Tshwane Metro : Garankuwa Landfill

Umhlatuze : Alton Landfill



Umhlatuze : Uthungulu Regional Landfill