February 2010

ESKOM TUTUKA WASTE DISPOSAL SITE

Permit Amendment Licence Application Report for Tutuka Waste Disposal Site

Submitted to:
Zitholele Consulting (Pty) Ltd
PO Box 6001
Halfway House
1685

Report Number: 12330-9629-2

Distribution:

1 x Zitholele Consulting (Pty) Ltd
1 x Project File
1 x Library

REPORT

A world of capabilities delivered locally

Golder Associates

Table of Contents

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

1.1 Objective

This Report with its appendices represents an application for an authorization (permit amendment) in respect of the National Environmental Management: Waste Act, 2008 (Act 59 of 2008) (NEMWA). In this context this Report contains information in terms of the relevant legislation and guidelines required with regard to the application for proposed Eskom Tutuka Power Station general waste disposal site extension.

The overall objective of the new Tutuka General Disposal Site (hereinafter referred to as the "Site") project is to provide sustainable waste management solutions to Tutuka Power station for the general waste disposal over the operational life of the Power Station and base here on to acquire the required authorisation (permit amendment) for the Site and to apply for the closure of the current Site within the requirements of its S.20 Environment Conservation Act, 1989 (Act 73 of 1989) permit.

1.2 Background

1.2.1 Tutuka Power Station

Eskom Holdings (Ltd) is the South African utility that generates, transmits and distributes electricity. Eskom supplies ~95% of the country's electricity, and ~60% of the total electricity consumed on the African continent. Eskom plays a major role in accelerating growth in the South African economy by providing a high-quality supply of electricity.

Eskom is currently operating Tutuka Power Station, a coal fired power station in Mpumalanga, as part of its electricity generation fleet.

The waste of relevance to this application that is being generated throughout the operational life of the station encompasses general waste, inclusive of garden waste and building rubble.

1.2.2 The Site

Tutuka power station's waste disposal site provides waste disposal services to New Denmark Colliery, Thuthukani Township, Tutuka Power Station, selected contractors and some neighbouring farmers. Until October 2008 (at which time the site has been approaching its authorised carrying capacity in terms of height) these wastes were disposed of in the authorised general waste Site within the Tutuka Power Station premises.

At the time when Tutuka disposal site reached its capacity in terms of the height restriction as of the end of October 2008, the additional waste generated has been transported to a waste disposal site at Kriel town, which is approximately 200 km away from the Tutuka power station. The associated transportation costs are high and therefore a more sustainable alternative means of waste disposal needed to be established.

The existing Site was permitted by the previous Department of Water Affairs and Forestry (DWAF) on 18 January 1991. This authorisation was a Class II permit, issued in terms of Section 20(1) of the Environment Conservation Act, 1989 (Act 73 of 1989) using the old classification system of Class I to Class III. This classification has been superseded by the First Edition of the Minimum Requirements for Waste Disposal by Landfill by the Department of Water Affairs and Forestry, which was implemented in September 1994.

Since the Site has been running out of airspace and the alternative means of disposal was excessively high, the Site needed to be extended or otherwise altogether replaced with a new site to provide for a further 40 years of airspace.

Therefore at least two options are available to Tutuka Power Station in respect of providing for the necessary landfill airspace in a sustainable manner. As alluded to the above, the first would be to extend the current waste disposal site and to apply for a permit amendment. The second alternative is to establish a new waste disposal site, based on a new license application, within close proximity to the power station property and the current site and apply for closure of the current site. These two options have been considered in a Report on the "Future of the existing Tutuka Site".

After consideration of the two options it was concluded that an extension to the existing site will provide an optimum solution in respect of sustainable waste disposal airspace as considered against technical and legal requirements.

From an engineering and site operation point of view, this extension could be achieved with or without closing the existing site.

From a legal point of view, however, it must be borne in mind that the existing site was established before the advent of the Minimum Requirements and therefore has not been designed and constructed in accordance with the standards of these Requirements.

Therefore, if the Site extension takes place without closing the current site (which presents a less costly option), it first needs to be demonstrated that the current site will meet the objectives of Minimum Requirements for Waste disposal by Landfill of the Department of Water Affairs and Forestry (Second Edition 1998) (MRs). Failing this, the site first needs to be closed in accordance the MRs before it could be extended vertically and laterally and based on the standard of the MRs.

This application therefore is for the amendment of the current ECA Permit Nr B33/2/310/45-P129 dated 11 July 1994 in terms of the NEMWA (and with reference to the transitional arrangement in Section 81 of NEMWA) in order to, within the current legal framework, resolve the current issue of a lack of a disposal facility and hence to provide a sustainable waste management solution for general waste generated by the power station and surrounding areas.

1.2.3 Proposed waste disposal site extension

The purpose of the development of a Tutuka general waste disposal site extension is to provide landfill airspace at the Tutuka Power Station, for a further 40 years with associated infrastructure.

1.3 Legal requirements

Since commencement of this project for the authorisation of the extension of the Tutuka general waste disposal facility, the Environment Conservation Act, 1989 (Act 73 of 1989) has been repealed by the National Environmental Management: Waste Act, 2008 (Act 59 of 2008) (NEMWA). The NEMWA became enforceable on 1 July 2009. Therefore an application to amend the existing Class II permit or to extend the current site will now be performed in terms of the NEMWA as supported by the latest published edition of Minimum Requirements, 1998 (Second Edition).

With the recent proclamation of the NEMWA, all waste related activities previously listed under the National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA) EIA regulations have been repealed and are now listed in the ambit of the NEMWA. The Minister of Water and Environmental Affairs promulgated Regulation 718 in terms of Section 19 (1) of the NEMWA. These regulations stipulate the waste management activities that require environmental licensing. The regulations comprise two Categories, namely Category A, which identifies activities that require a Basic Assessment process and Category B, which identifies activities that require a full scoping and EIA process to be followed. In terms of these regulations the following activities require authorisation:

- Regulation 718 - Category B:
  - Activity 10: The disposal of general waste to land covering an area in excess of 200 m^2; and
  - Activity 11: The construction of facilities for activities listed in Category B of this Schedule.

The two activities listed above both fall into Category B of Section 19 of the regulations, and therefore this development requires a full scoping and EIA process to be undertaken under the NEMWA in order to obtain authorisation.

1.4 Purpose of the Waste Licence Application Report

The objective of this report is as a motivational document in support of obtaining a licence from the Department of Environmental Affairs (DEA) in terms of NEMWA, to establish a new site for disposal of

general waste arising from the operation of the Tutuka power station, New Denmark Colliery and Thutukani Township. The licence application is underpinned by this report and associated supporting documentation.

This report is to provide the Authorities with information necessary to make a decision on whether a licence can be issued.

The report is based on the requirements and procedures set out in NEMWA and DWAF's "Minimum Requirements for Waste Disposal by Landfill" (1998).

The necessary information includes detail on:

- Waste classification;
- Site description;
- Environmental impact assessment;
- Geohydrological investigation;
- Public participation;
- Design;
- Operating plan;
- Monitoring plan; and
- Closure, rehabilitation and end-use.

2.0 DISPOSAL NEED AND WASTE CLASSIFICATION

Tutuka power station generates a number of waste streams requiring disposal. These include general waste such as domestic, paper, scrap metals, steel, ash, garden refuse, builder's rubble as well as hazardous waste. Hazardous waste is disposed at the Holfontein hazardous waste site. There is a need for a nearby facility for disposal of general waste as the nearest permitted site is the site at Kriel, about 200 km away.

2.1 The Integrated Waste Management Hierarchy

When considering the licensing of a waste management activity, NEMWA section 48 (a) states that a number of matters must be taken into account including "*the need for, and desirability of, the waste management activity and alternatives considered, including similar waste management activities, if any, that have already been licensed*."

The first option to consider would be whether there is a more environmentally acceptable option to waste management than landfill disposal. Tutuka Power Station is currently practising recycling and therefore any waste disposed of by means of landfilling is waste that is not practically or economically feasible to recycle. The volumes of waste received and recycled are indicated in Table 1.

General waste that cannot be recycled is currently disposed at Kriel (General) landfill site. For sustainable logistical reasons a closer landfill site is required.

Table 1: Waste volumes

YEAR 2009

SUBSTANCES	***JULY***	***A***	***B***	***MEASUREMENT***
DOMESTIC WASTE	387	7801	134931	*CUBIC METERS*
GARDEN WASTE	72	4309	11915	*CUBIC METERS*
BUILDING WASTE	34	1390	54410	*CUBIC METERS*
WORKSHOP STEEL	0	0	2477	*KILOGRAMS*
ASH FROM STATION	0	0	15731	*CUBIC METERS*
COAL FROM STATION	0	0	12162	*CUBIC METERS*
RECLAIM AT DUMPING SITE	***JULY***	***A***	***B***	***MEASUREMENT***
STEEL	0	0	11123	*TONS*
DOMESTIC RUBBLE	0	0	9801.5	*KILOGRAMS*
RECYCLING AT STATION	***JULY***	***A***	***B***	***MEASUREMENT***
STEEL	0	0	60658.64	*TONS*
OIL	0	0	240711.42	*LITERS*
PAPER	0	0	49854.15	*KILOGRAMS*
KITCHEN FOOD	0	0	17652	*KILOGRAMS*
OTHERS (BUILDING & GARDEN)	289	5853	10318	*CUBIC METERS*
SHEETS RECEIVED	22	366	4438	*EACH*
SHEETS SPOILED	0	4	127	*EACH*
WATER METER READING	0	0	255.61	*KILO LITERS*
OPERATING COST	29981.5	479281.82	2357222.82	*RAND*

NOTE 1:
A = TOTAL RECEIVED, YEAR TO DATE
B = TOTAL RECEIVED UP TO DATE AS FROM MAY 1993

2.2 Disposal need and waste streams generated

The waste that requires disposal on the disposal site originates from four main sources:

- Tutuka Power Station domestic and garden waste;
- Tutuka Power Station contractor domestic and building rubble waste;
- Thuthukani township domestic waste; and
- New Denmark Colliery domestic and garden waste.

Waste volumes vary from month-to-month; however a detailed register of all the waste entering the site is kept at the station. Statistics are available for the total volumes of all wastes received by the waste disposal site to date. The average is between 484 and 754 m^3 per month. It is anticipated that the new site will have to take the same types and quantities of waste for the estimated life of the Tutuka Power Station, which is estimated at another 40 years.

2.3 Classification of waste streams

In terms of the Minimum Requirements, the Tutuka Site Classification (for both the current site as well as the proposed extension) (see Appendix A), was done as a first step in the authorisation process in order to determine the requirements in respect of further investigations and specialist studies pertaining to the license authorisation process.

The purpose of site classification is:

- To assess each waste disposal scenario in respect of waste class, waste stream size and potential for significant leachate generation; and
- To use the landfill class to select the prescribed set of Minimum Requirements for the cost- effective investigation, design, operation and closure of a specific class of landfills.

Site classification system is done by determining:

- The class of waste disposed of;
- The size of the waste stream; and
- The potential for significant leachate generation.

2.3.1 Site classification in respect of waste class

In order to determine the class of site (Hazardous or General) the type of waste to be accepted at the site must be established. General (G) waste includes domestic, commercial and inert waste and poses an insignificant threat to the environment if correctly managed. Hazardous (H) waste is material that can, even in low concentrations, have an unacceptable adverse effect on public health and/or the environment and if not managed properly cause mortality.

Since the waste that has been disposed of on the existing Tutuka Site since May 1993 originates from offices and hostels, it was assumed that no dedicated hazardous waste streams, for example oils from workshops or chemicals reagents from laboratories, were allowed onto the Tutuka Site. This assumption was also based on the data in the permit application forms that was submitted by SRK in 1991, which did not make any mention of hazardous waste received at the site.

The Tutuka site was classified as a Class II disposal site at the time of permitting by the then Department of Water Affairs and Forestry in terms of Section 20(1) Environment Conservation Act, 1989 (Act 73 of 1989). Class II is based on the fact that the site receives general waste only.

Based on the above and existing information, the current Tutuka site as well as the proposed extension will classify as General.

2.3.2 Site classification in terms of size

The ultimate physical size of a site is a function of the amount of waste it receives over a lifetime. The size classification focuses on the size of the waste stream and as a result hereof the size of the operation.

The classification is determined from the following formula:

$MRD = (IRD)(1 + d)^t$

Where:

MRD = “Maximum Rate of Deposition” (MRD) in tonnes per day, during the expected life of the site;

IRD = in initial rate of deposition of refuse on site in T/day;

d = expected development rate, based on expected population growth rate in the area served by the landfill; and

t = years since the deposition started at IRD.

The application forms submitted by SRK in 1991 recorded the Initial Rate of Deposition (IRD) as 13 000 m^3 per annum of which 5 500 m^3 is of domestic origin. This was converted to18 t/d by the previous DWAF.

Three sets of data were available for the classification of the site; however it was decided to use the third Tutuka set, using values from January 2004 to December 2008. This gives a growth rate of 3.7%.

It is Golder's view that the 3,7% growth rate should be used to calculate site class in respect of its size. The reasons for using this growth rate were as follows:

- It was based on the most complete set of data (Jan 2004 until December 2008);
- This set of data did not portray figures that provide reason not to accept its correctness; and
- It was based on an IRD of 18 t/d which is on record with the Regulator and at the same time provides growth rates that appear the most reasonable.

A life of 40 years was selected which resulted in the site being classified as Small.

After consideration of various waste stream growth rates during the life of the existing landfill site, it was decided to use a growth rate of 3.7% per annum, for determining the maximum rate of deposition (MRD) at the end of the site life, and for calculating the landfill airspace required for 40 years of waste disposal.

Since the MRD is between 25 T/d and 150 T/d, the site would classify as a Small (S) landfill site.

2.3.3 Site classification in respect of water balance

General waste landfills are classified in terms of their potential to generate leachate. This depends on the water balance associated with the site. Climate is the most common cause of leachate generation. The Climatic Water Balance is used as the first step in determining the potential for significant leachate generation.

Other factors that could affect the water balance of a waste site include the moisture content of the incoming waste, and the ingress of groundwater and/or surface water into the waste body due to poor siting, design and maintenance of the site.

No high moisture content wastes are expected to be received at the site. Provided that upslope surface water drainage systems are installed to prevent the ingress of stormwater runoff onto the waste body, the site water balance should not be affected and significant leachate generation should not be expected.

Based on the water balance calculations performed from data of the 10 wettest years for the site and S-pan evaporation data, it is indicated that the waste disposal site will be classified as B^- that is that the site is in a water deficit area and is therefore not expected to generate significant leachate.

In terms of the Minimum Requirements, it should not be necessary to install a leachate management system.

2.3.4 Landfill airspace requirements

For the 40 year life of the site, the total mass of general waste to be disposed of would be approximately 845 000 tonnes, assuming no reduction due to composting or recycling. With an assumed *insitu* landfill density of 1 000 kg/m^3 and a cover to waste ration of 1:5, the total landfill airspace required is 1 014 000 m^3. This would require approximately 167 000 m^3 of cover material for a proper sanitary landfill operation.

2.3.5 Conclusion on site classification

The new site will be:

- General in terms of the waste it receives;
- Small in respect of the size of the waste stream if the operation life of the site was reduced to 39,9 years from now (using the lowest calculated growth rate i.e. 3,7%); and
- B^- in terms of the Site water balance.

The existing site as well as the proposed extension therefore classified as a G:S: B^- (for Site life of 39.9 i.e. 40 years) based on the Second Edition of the DWAF Minimum Requirements and the various assumptions as discussed in this report.

It is highly unlikely that the size classification of the extension to the site will change should more accurate waste generation data become available.

3.0 CONSIDERATION OF ALTERNATIVES

3.1 Project alternatives

Eskom Tutuka Power Station proposes to extend the current permitted landfill by extending the waste body vertically and laterally adjacent to the current landfill on land that belongs to Eskom as an alternative means of disposing waste that cannot be recycled.

The following project alternatives were assessed during the planning phase due to the cost, accessibility, time and safety implications:

- Alternative sites available to dispose the waste; and
- Permanent road transportation to Kriel.

These project alternatives were considered and the following was concluded:

- There are no other waste disposal sites available in close proximity;
- Transporting the waste to the disposal site at Kriel is not sustainable or cost effective; and
- The only feasible option is to either extend the existing site or to establish a new site in close proximity to the existing facility within the power station land.

It was therefore decided that the required disposal space should be identified in the immediate vicinity of the power station.

A site selection exercise was undertaken in line with the requirements of the Minimum Requirements (draft 3rd edition, 2005).

The requirements that had to be met by the site were:

- It must be located on Eskom Property;
- It cannot interfere with the existing operations at the Tutuka Power Station or the New Denmark Colliery;
- It must be within a 2 km radius of the existing site to minimise travelling distance of the waste i.e. lower transport costs; and
- It had to have a minimum size of 12 ha to accommodate the calculated waste volume.

Twelve site alternatives were identified as part of the scoping of the project, all within the power station property. The twelve sites were selected following a conceptual design of the space required for the 40 year life of the waste disposal site. It was calculated that using the “worst case” growth rate in waste volumes the site would be approximately 12 ha in size (footprint) and 10 – 15 m in height. The available space within the power station properties was analysed using the above dimensions that the 12 alternatives resulted. The initial site selection aimed to avoid any water features and existing infrastructures from the power station.

These twelve sites were then subjected to a more detailed site selection exercise according to the Minimum Requirements, where the sites have to be ranked according to selection criteria. The selected site was the one that ranked highest in terms of suitability based on fatal flaws, economic, environmental and public criteria.

4.0 SITE DESCRIPTION

4.1 Regional description

The site is situated on the Highveld plateau, which characteristically comprises a dissected plain formed by ancient plantation. Erosion of this plain has resulted in a gently undulating landscape in which rock outcrops are most characteristically found in the lower slope positions where the mantle of pre-weathered material has been stripped by erosion. The most common topographical form found on site is gentle side slopes extending from hillcrests down to streams and occasionally gullies.

According to the South African National Biodiversity Institute (SANBI), the site is situated in an area that falls within the Grassland Biome, where most of the country's maize production occurs. The area is vegetated by typical Highveld Grassland. Natural vegetation has re-established itself; even in the older borrow pits.

4.2 Site description

The current landfill site is located approximately 2 km to the west of Tutuka Power Station on the farm Pretorius Vley 374 IS, on property that is owned by Eskom. This entire property has been zoned for industrial use. The permitted landfill site covers an area of 3.224 ha, although the landfill itself has a footprint area of 2.543 ha. It is approximately 250 m long by 100 m wide, and is 7 m above natural ground level at its northern end. It is situated on a slight slope with the southern end having the surface at ground level. The area available for the new landfill is in excess of 50 ha, which is far greater than required.

The current site is located within a highly disturbed area as a result of extensive gravel excavation operations for the power station site. It was sited within a borrow pit previously utilised for the mining of dolerite. There is a small area of undisturbed land approximately 100 m wide immediately to the west of the landfill. To the west of this undisturbed area, and to the east of the landfill, there is evidence of gravel excavations, resulting in a highly uneven ground surface and ponded water.

A stormwater diversion trench was constructed on the upstream side to divert stormwater around the site and into an adjacent rehabilitated gravel pit. This pit is self draining by means of the stormwater trench situated at the lowest point. There is an upslope stormwater diversion drain along the southern side of the landfill that drains in a westerly direction to the borrow pit on the west side.

Access to the landfill site is by means of a gravel road from the south side, which then runs along the western toe of the landfill. Cover material for the landfilling operations is obtained from a dolerite borrow pit approximately 400 m to the south west of the landfill.

Figure 1 indicates the site locality.

4.3 Land use

The land use in the region is industrial and agricultural and dominated by maize, grazed fields, coal mines and power stations. The proposed alternatives are located in areas of cultivation/unimproved grassland and some water bodies. Water bodies are the only land use regarded as sensitive. The proposed site is located in an area of unimproved grassland that has been used for cultivation in the past. It is covered by grassland with scattered aliens.

4.4 Climate

The site falls within the summer rainfall region of the Highveld. The climate of the area is typical of the Highveld region of Mpumalanga, with warm, wet summers and cold, dry winters with frost in places.

Air temperatures show significant daily and seasonal variations, with mean temperatures at their maximum in December and January, and minimum in June and July. Temperatures range from below zero during winter to above 30°C during summer, with mean daily temperatures of 12 to 25°C in summer and 0 to 20°C in winter.

Figure 1: Site locality plan

Thunderstorms occur frequently during summer, between October and March, and are usually accompanied by lightning, heavy rain, strong winds and occasionally hail. Snow falls are recorded most winters in the high-lying areas of the study area's south-eastern portion. Average annual rainfall for the area is about 680 with annual evaporation about 1 780 mm. The site therefore has a negative climatic water balance and is not expected to generate significant leachate.

Winds in the study area blow predominantly from the north, west and north-west, and may reach speeds of up to 60 km/h in summer. Regular dust storms can also be expected during periods of prolonged dry weather.

4.5 Geology and soils

The dominant geology in the area in the vicinity of the site is that of sedimentary rocks of the Ecca Group of the Karoo Supergroup (intercalated shales, mudrocks and sandstones with coal measures). The Power Station itself is situated directly over Karoo shales, whilst at the landfill site the Karoo shales are overlain by large dolerite sill of significant thickness under which unweathered dolerite is found.

The site falls within the Carboniferous to early Jurassic aged Karoo Basin, a geological feature that covers much of South Africa. Late Triassic to Middle Jurassic aged Dolerite dykes and sills are common in the Karoo Basin, and occur throughout the power station area. Previous as well as the current investigations identified the presence of a near surface, slightly weathered to fresh dolerite sill beneath the domestic waste site.

Dolerite dykes were observed on, and adjacent to the site, and were typically found to have a north-south or east-west trend, consistent with the orientation of major streams in the area. It thus seems reasonable to assume that stream orientation and dyke occurrence has been in part controlled by the occurrence pre-existing fractures such as joints.

Available data suggests that the thick deep fresh dolerite sill is relatively impermeable at the site. Thus, excavations associated with waste disposal activities could extend to the soil/weathered rock interface, equating to the depth of excavation refusal for normal plant associated with waste disposal in rural areas.

Surface drains could also be constructed to this depth to intercept any water perched on the fresh dolerite sill, as was done during the construction of the current waste site.

Soil cover surrounding the site appears relatively thin, particularly in the vicinity of the domestic waste site where soil has been removed for rehabilitation purposes. The type and distribution of site soils appears to be, in part, controlled by parent rock material. Soils overlying doleritic material are typically highly plastic and dark brown to black in colour, while those on Karoo sediments are typically lighter in colour and moderate to highly reactive in character. Shrinkage cracks can, however; be expected to develop in site soils irrespective of parent material during periods of prolonged dry weather.

While laboratory testing suggests that site soils are unsuited for use as liner material, they can be used as a waste cover. For rehabilitation purposes, however, the final cover layer should predominantly comprise of topsoil.

4.6 Surface water

Tutuka Power Station is located on a topographical high. The facility occurs within drainage region C11K and can be sub-divided into secondary drainage regions comprised of smaller streams and creeks. The waste site is situated in sub-catchment C11K-B and has been developed upon gradual slopes and a semi-developed drainage system.

The main drainage feature of the area is the Leeu Spruit which drains northwards. Surface water is confined to ephemeral runoff via a tributary of the Leeu Spruit. This tributary has its' origin some 1 km to the west of the site. Several dams are also being found in the region. A small earthen farm dam 100 m north of the site is used as a surface water monitoring point. The streams and their associated dams support a number of faunal and floral species uniquely adapted to these aquatic ecosystems, and therefore all surface water bodies are earmarked as sensitive.

The design and final site layout will avoid all water bodies and streams and will take them into consideration as part of the planning. Detailed studies undertaken in the EIA phase will determine the buffer zones required around these sites.

A covered filter trench was installed to intercept any possible near surface seepage. Pollution of surface water has been mitigated against by the construction of a stormwater diversion trench upstream of the site.

4.7 Stormwater management and leachate

A leachate collection system and sump was installed at the outset of the existing site, on the downstream boundary. No leachate has been generated by the existing site.

4.8 Groundwater

At Tutuka the water table is generally a reflection of surface topography in the area. This has also been influenced to some extent by the coal mining activities in the area.

GHT Consulting Scientists recently carried out a geohydrological investigation of the Tutuka landfill and its surrounds that included the following:

- Geological mapping;
- Geophysical investigations;
- Installation of three more monitoring boreholes;
- A hydocensus;
- Sampling and analysis of surface water and groundwater; and
- A geohydrological assessment.

The results of this investigation are contained in GHT Report No RVN574.1/1025 "Proposed Extension Domestic Waste Site, Tutuka Power Station", April 2010(6) (Appendix C). The key findings of the investigation are discussed below.

There are perched and regional aquifer systems associated with the Karoo sediments at the site. The upper aquifer appears to be perched on an impermeable dolerite sill and has a relatively localized occurrence depending on the thickness of the weathered dolerite zone, while the deeper aquifer is restricted to minor fractures, cracks and joints interfaces within the fresh dolerites. No significant aquifer is present in the vicinity of the site. Groundwater flow in the perched aquifer takes place in a northerly direction towards a tributary of the Leeu Spruit.

These aquifers can be recharged directly from rainfall or from surface water bodies, with the rate of recharge influenced by site hydraulic conductivity. Laboratory testing indicates that the in-situ soils are more permeable than the underlying dolerites by at least an order of magnitude. Water will therefore preferentially flow through the soil profile of weathered fractured dolerite. Further, once a moisture front reaches the weathered/fresh dolerite interface, lateral as opposed to vertical flow will predominate.

The three new borehole water levels were measured eight days after drilling and again on 14 April 2010 a month after drilling. The water levels in these newly drilled boreholes has risen since measuring the first time (DMB87 0.38 m– 0, DMB88 – 2.22 m, DMB89 – 0.05 m). This is a clear indication of the low permeabilities of the aquifers in the area.

Borelogs indicate that only very small amounts of groundwater were encountered in the three new bores during drilling. All the water strikes were encountered on the contact between weathered dolerite and fresh hard dolerite. All the groundwater occurs within the first 5 m therefore associated with a shallow perched aquifer. The rest of the formations, below 5 m yielded no water. All boreholes were found to contain water about 1 week after drilling, however, which suggests that seepage inflow from fractures of low permeability occurred in the period between borehole construction and initial bore sampling. Slug tests performed at monitoring bore sites on the 25th March 2010 also suggest that site aquifers have low permeability.

From the geohydrological investigation it was estimated that contaminants from the landfill would take at least 200 years to reach the ephemeral stream north of the site through the dolerite aquifer. However, the rate of groundwater movement through perched aquifers in the weathered fractured zone is significantly higher than through deeper aquifers and thus it would take at least 37 years for contaminants to reach the same ephemeral stream.

Monitoring has indicated fluctuations in the groundwater and piezometric levels in the boreholes near the domestic waste site since 1995. Relatively stable trends in the water table depths with some seasonal fluctuations in the groundwater levels of all the existing boreholes have been observed.

The sudden change in the orientation of the water table adjacent to the non-perennial stream, which act as a groundwater divide east and north of the site and the relatively high hydraulic gradient within aquifers adjacent to the divide suggests that the risk of aquifer pollution on adjoining properties due to solid waste disposal is remote. Further, increases in surface elevation along the ridge south of the site suggest that there will be no impacts on groundwater quality in areas to the south and west of the domestic waste site either.

The following conclusions and recommendations were made from the geohydrological investigation:

- While groundwater is used for stock and domestic purposes in the area surrounding the domestic waste site, the number of people dependent on the resource is limited to residents on adjoining farms. This appears unlikely to change in the near future due to the proximity of large, reliable surface water bodies to nearby communities of Thuthukani, Standerton, and Sakhile as well as large industries such as Tutuka Power Station and New Denmark Collieries. New Denmark Colliery currently supplies a lot of farmers with potable drinking water. The extraction of groundwater for stock use in the area can be expected to continue, however;

- Using the values for potential sustained yields suggested by the Department of Water Affairs and Forestry (1994), available data suggests that aquifers in the area surrounding the landfill site have a low to moderate yield (<1 to 5L/s), and thus have limited development potential. Further, since groundwater

in the area is not currently exploited by major users or nearby communities, and alternative water supplies are readily available for future use, aquifers here can be classified as being of “low” to “no significance”;

- There is a significant risk of perched aquifer contamination and a slight risk of pollution to migrate to the adjacent surface water body during waste disposal operations, if site drainage is not considered during the design stage. There is evidence to suggest that past waste disposal activities have already degraded site water quality to the north of the current domestic waste site, thus design of the new site will take this into account; and
- Geohydrological assessment of the site suggests the site should be classified “marginal” to “suitable” for solid waste disposal, as aquifer pollution on adjoining properties is unlikely.

The position of the existing monitoring points is indicated in the following Figure 2.

5.0 LANDFILL CONCEPTUAL DESIGN

The objective of landfill design is to provide a cost-effective and environmentally acceptable waste disposal facility based on the outcome of the site investigation and EIA and which is in compliance with the requirements of the Minimum Requirements documents.

Design is specifically to fulfil the following objectives:

- Mitigate potential adverse impacts identified in the site investigation and EIA;
- Prevent pollution of adjacent ground and surface water; and
- Provide sufficient cover material to ensure an environmentally and aesthetically acceptable operation.

The design of the site will take into account any shortcomings in the site selected and compensate for these shortcomings. If any environmental risks are identified in the EIA process, design must take this into account by upgrading the design to compensate for this.

The conceptual design, discussed later in this in this section, will address the principles of the intended design but not the detailed specifications and takes the following into account:

- Site classification in terms of type and size of waste stream;
- Site water balance;
- Cover, airspace and site life;
- Site layout; and
- Preliminary closure plan.

5.1 Mitigation measures and risk assessment

Risk assessment assesses the consequences of escape of contaminants from the landfill. Mitigation measures will be both proactive and reactive systems. Should the impact assessment indicate potential environmental impacts, measures will be implemented to mitigate these impacts.

Proactive systems will be implemented by means of engineering design. Reactive systems consist of monitoring and early warning systems that have already been established for the existing landfill site. These monitoring results will be used to understand the potential risks and thus ensure that the design of the new site minimises these risks.

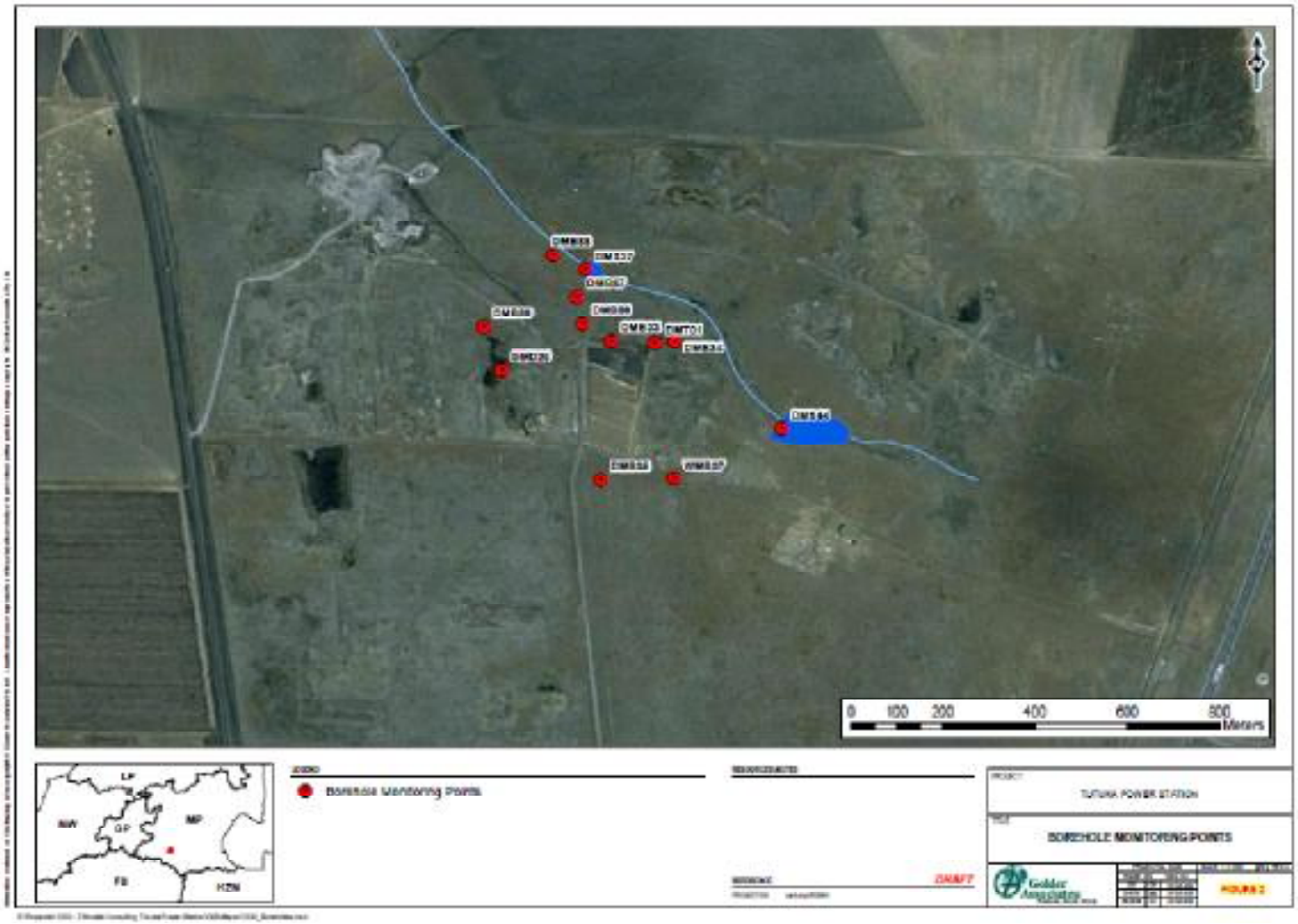

Figure 2: Boreholes currently monitored

The following conclusions and recommendations have been made on the basis of field investigations and laboratory test results for the existing site:

- As available evidence suggests that groundwater quality in the to the north of the proposed facility has already been degraded by past waste disposal activities, measures will be put in place to ensure that this does not occur with the new facility;
- The control of surface run-off and sub-surface seepage with a view to preventing the pollution of adjacent surface water bodies is of major importance at the site. As a minimum requirement, ponding within these drains and any associated dams constructed within in situ soils should be prevented as testing undertaken to date suggests that site soils are not suited for use as a liner material. Bare site soils are also at risk of erosion, particularly if flow velocities within channels constructed in the profiles are excessive. The construction of interception drains to the soil/weathered rock interface around the perimeter of the site to prevent and control the rapid migration of pollutants through perched aquifers towards the non-perennial spruit is recommended; and
- Site soils are unsuited for use as a liner material to prevent the migration of contaminants, but can be used as a waste cover. The final covering layer should predominantly comprise topsoil, however, to aid with site rehabilitation.

Detection monitoring will be performed as per the frequency and parameter list as determined by the previous investigation done by GHT Consulting. It is recommended that groundwater is monitored at the seven borehole sites and three surface water sites. The leachate detection sump will also be included in the monitoring program.

Additional sampling will also be required in those areas where surface water impoundments are constructed as part of any waste disposal operations. Should detection monitoring indicate that water quality is degrading over time, an increase in the sampling frequency and the number of parameters to be determined during laboratory testing will be implemented. Specialist geohydrological advice would also be sought if required.

5.2 Preliminary design of the landfill facility

The design presented in this section is a preliminary technical design of the proposed new Tutuka landfill site. It is presented with a view to providing the general layout and content of what is envisaged at this stage, rather than providing a detailed technical design and construction specification. The design is based on the Minimum Requirements for the class of landfill under consideration, although in certain instances, the design has been changed from the Minimum Requirements due to site specific conditions. Included in this preliminary design is the following:

- Proposed layout;
- Liner details;
- Drainage features;
- Infrastructure; and
- Development of the site.

A full design specification, including construction drawings and schedules of quantities, will be drawn up once the preliminary design is approved.

The general objective of landfill design is to provide a cost-effective, yet environmentally safe and socially acceptable waste disposal facility. More specifically, the design presented is aimed at minimising the potential for pollution of the environment, particularly the ground water and surface water bodies, as well as the surrounding air. Due attention is therefore given to the site specific aspects identified during on-site investigations.

The design makes provision for the phased development of the site, as determined by the waste disposal need. The intention is to monitor the operation of the facility closely for the first few years and on the basis of this the design may then be modified and further refined for the subsequent phases of the development.

The layout and details of the design proposed for the Tutuka Landfill site are shown on Drawing No's 12333/01 to 12333/07 included in Appendix E of this report.

5.2.1 Constraints and factors affecting the design

Taking into consideration the waste disposal need, the physical conditions of the site, and discussions with various the relevant parties, there are several factors that affect the design philosophy adopted. These are as follows:

- The design needs to comply with the Minimum Requirements for a G:S:B- landfill;
- The design needs to cater for a total waste stream of 845 000 tonnes over the 40 year site life. With a 20% allowance for soil cover material, a total landfill airspace of 1 014 000 m^3 is required;
- The domestic or municipal solid waste will not be co-disposed with hazardous waste but will be landfilled separately, with separate leachate management systems. Any hazardous waste received will be removed to hazardous facility;
- The northern boundary of the site is defined by the ephemeral stream, whilst the western boundary is defined by the borrow pit with ponded water. The existing landfill defines the eastern boundary of the new landfill. Although the site fence and stormwater drain define the southern boundary of the site, it is possible to move this boundary southwards to achieve the required airspace;
- The soils on the site are not suitable for use in the landfill liner construction. The liner design is therefore based on a geocomposite landfill liner;
- The existing landfill has impacted negatively on the groundwater environment and must therefore be closed and capped as soon as possible;
- The design of the new landfill should be integrated with the closure and capping of the existing landfill in terms of liner and drainage; and
- The design must make provision for the sequential phased development of the landfill, such that leachate flows from the lowest point of the landfill cell can discharge into the leachate pond under gravity.

5.2.2 General site layout

Based on these constraints and factors, the overall layout of the initial phase of the Tutuka landfill facility has been developed as shown on the drawings in Appendix E. The arrangement of the various facilities and the sequence of development have been determined according to topography, drainage requirements, geology and distribution of soils over the site, access to the various portions of the site, and the possible impacts on surrounding land users.

Initially a strip of land adjacent to the western toe of the existing landfill is to be developed together with the shaping and capping of the existing landfill as indicated on Drawing No 12333/05. This area (0.68 ha) is still within the originally permitted footprint of the landfill site and can proceed under the existing landfill permit. Thereafter the remainder of the area (1.77 ha) on the west of the existing landfill is to be developed up to the borrow pit as indicated on Drawing No 12333/03. Once this landfill footprint (including the existing landfill) has filled with waste up to its maximum design height, the area to the south of the site would be developed as shown on Drawing No 12333/07 to give the 1 million m^3 of total landfill airspace required for the 40 years of site life. The total final footprint area would be approximately 8.54 ha.

The entrance to the site would remain in its current position at the south western corner of the existing landfill for the Phase 1 landfill operation. The existing gravel access road off the Tutuka Power Station road would continue to be used for waste deliveries to the site. The existing gate house at the entrance would also

continue to be used for Phase 1 operations. Once the Phase 2 area is developed on the south side of the existing landfill, the southern fence, site entrance and gate house would have to be relocated further south on the access road.

The Phase 1 landfill cells are to be developed adjacent to the western side of the existing landfill with the contaminated water and leachate ponds located downslope to the north of the landfill to facilitate gravity drainage of contaminated run-off and leachate.

The landfill cells are to be developed generally according to the footprint shapes shown on the drawings. The initial development of the strip alongside the western toe of the existing landfill and the shaping of the surface of the existing landfill up to its maximum permitted height of 5 m above natural ground level would give approximately 4 years of operational life.

Once the new landfill site licence is obtained, the remainder of Phase 1 would be developed and landfilling would take place up to a height of 30 m above natural ground level. Development sequence would be from south to north, starting at the higher elevation to enable gravity drainage of leachate and contaminated water away from the waste body. A starter berm is to be constructed around the perimeter of the landfill by means of a cut-to-fill operation.

At the lower end of the site on the northern side, the contaminated water and leachate ponds would be constructed and lined to the Minimum Requirements standards. Provision is to be made at the ponds to extract excess leachate and water either for disposal at the nearby sewage works or for spraying over the landfill for dust control. This would facilitate reduction of the contaminated water and leachate through evaporation of the water component whilst retaining the contaminants within the lined landfill.

A ring road would be constructed around the perimeter of the site, as well as storm water drains to divert clean up-slope run-off away from the facility.

5.2.3 Services and infrastructure

5.2.3.1 Access and roads

Access to the site is directly from the existing Tutuka Power Station eastern access road. The road to the landfill site from this road is a gravel road which will have to be maintained regularly according to weather and traffic conditions. A gravel ring road is to be constructed around the facility to allow for maintenance and monitoring, as well as to form a firebreak.

Incoming vehicles would be checked at the gatehouse for the type of waste being delivered. From there, the vehicles would be directed to active tipping area on the landfill.

5.2.3.2 Weighbridge

Due to the small quantities of waste expected, it does not justify the installation of a weighbridge. In exceptional circumstances where vehicle weighing is necessary, this can be arranged at the Power Station.

5.2.3.3 Laboratory

For a small general waste landfill, a laboratory is not required on site. Water quality analyses are to be conducted at commercial laboratories or at the Power Station laboratory.

5.2.3.4 Fencing

The entire perimeter of the site is to be fenced with a 1.8 m high razor mesh security fence to prevent unauthorised access. Lockable vehicle access gates are to be provided at the entrance to the site, which should also be manned 24 hours per day by a security guard.

5.2.3.5 Water

For the small size of operation and small number of site personnel, there is no need to pipe potable water to the site. Potable water can be brought to the site in containers for drinking purposes.

For dust control purposes on the landfill, water from the contaminated water pond is to be used however, if this is insufficient, additional water from the nearby gravel borrow pits will have to be used.

5.2.3.6 Electricity

There is no need for electrical power at the site. Lighting is not required as the site is only operated during daylight hours.

5.2.3.7 Staff facilities

The only building required on the site for the size of the current operation is the existing gatehouse, which has a toilet for the use of the few site staff. When the site entrance is moved to accommodate the southern extension of the landfill, the new gate house should be larger to include a mess room for the site staff.

5.2.3.8 Plant maintenance facilities

Due to the landfill site's close proximity to the Tutuka Power Station, there is no need to establish a plant and equipment maintenance facility on the site, as the plant and equipment would be sent to the Station workshops for maintenance.

5.2.4 Landfill design

5.2.4.1 Design approach

The Tutuka landfill site has been classified as a G:S:B- and the Minimum Requirements for this class of landfill only requires a recompacted base preparation layer beneath the landfill rather than a proper liner, and no leachate management system. However, based on the fact that the existing landfill has already impacted on the groundwater environment and that the fractured/weathered dolerite is highly permeable, it is believed that an engineered landfill liner is required at the site.

Although the climatic water balance suggests that there should not be generation of significant leachate, a leachate detection and collection system, as well as a small leachate sump pond is to be constructed.

The existing landfill needs to be capped as soon as possible. It is proposed that this cap would double as a bottom liner for extending the landfill on top of the existing landfill. This "piggy-back" liner would tie in to the new landfill liner and leachate collection system.

5.2.4.2 Existing landfill capping and initial landfill development

In order to address the short-term disposal needs, the remaining permitted landfill footprint is to be developed for waste disposal. This development is to be done in conjunction with the construction of a landfill capping/"piggy-back" liner over the existing landfill. In addition, a leachate sump is to be installed as part of this development. The extent and details of this development are shown on Drawing Nos 12333/05 and 1233/06.

The surface of the existing landfill is to be raised and shaped to create a cross-fall in a north-westerly direction using deposited waste, to the levels indicated on Drawing No 12333/05. The "piggy-back" liner is to be constructed on this shaped surface as described in section 4.7. Perforated HDPE leachate collector pipes are to be installed on the "piggy-back" liner as detailed, to connect into the main leachate drain running along the western toe of the existing landfill. The outer slopes of the landfill are to be cleared of vegetation, trimmed and the outer capping constructed as detailed.

Along the western side of the existing landfill, a strip approximately 30 m wide is to be developed for waste disposal as shown on Drawing No 12333/05. The area is to be stripped of black clay, and a 1 m high perimeter berm constructed to clearly demarcate the extent of the landfill footprint. The landfill liner is to be constructed as shown on Drawing No 12333/06. A 315 mm diameter HDPE leachate main drain is to be installed along the toe of the existing landfill, to drain into an HDPE leachate sump installed to the north of the site. Perforated leachate collector pipes are to be installed "herring-bone" fashion on top of the landfill liner to drain into the leachate main drain.

By landfilling the area with waste up to the raised levels of the existing landfill, it will give an airspace of approximately 40 500 m^3, which would give an operational site life of about 4 years.

5.2.4.3 Phase 1 landfill development

Once the landfill site licence has been issued, the remainder of Phase 1 can be developed. The layout and details of this development are shown on Drawing Nos 12333/03 and 12333/04.

The area is to be stripped of black clay and a 1.5 m high starter berm is to be constructed around the perimeter of the new landfill. The landfill liner is to be constructed as detailed and a “herring-bone” system of perforated HDPE leachate collector pipes, installed diagonally down the slope to connect into the leachate pipes beneath the initial development area. A lined contaminated water drain is to be constructed along the outside of the landfill toe, to drain into the contaminated water pond to the north of the site.

The existing upslope stormwater cut-off drain is to be extended in a westerly direction to drain into the western borrow pit water body.

By landfilling this entire Phase 1 area with waste up to the raised levels of the existing landfill, it will give an airspace of approximately 86 500 m^3, which would give an operational site life of about 7 years. If the landfill is then taken up to its maximum practicable height of approximately 30 m above natural ground level, it will give an airspace of approximately 454 000 m^3, which would give an operational site life of about 25 years.

5.2.4.4 Development plan

The aim of the Development Plan is to develop the landfill from its initial constructed state to its proposed final landform.

Landfilling is to commence on the existing landfill to achieve the required cross falls for drainage in the initial development area at the higher end of the cell, and is to proceed downslope in a northerly direction. Initially, a pioneering layer of waste at least 600 mm thick is to be placed over the liner by means of end tipping and spreading to protect the installed liner.

The working surface of the landfill is to be sloped towards the leachate collector drains at the lower end of the cell. Landfilling is to be taken up to maximum practicable height (approximately 5 m above natural ground level) before moving downslope to the next deposition area. The outer slopes of the landfill are to be taken up at a slope of 1V:3H.

Once the Phase 1 area has been developed, landfilling can be taken up to the final height of approximately 30 m above natural ground level. Once this area has been landfilled with waste, the operation would move into the southern extension area.

As each section of the landfill cell is completed to final height, the outer slopes of the landfill are to be graded and final cover applied on an ongoing basis. This will help to minimise leachate generation and will also make the landfill more aesthetically pleasing.

Drawing No 12333/07 shows the sequential development plan for the various stages of development from the initial development through to the final landform after 40 years.

5.2.5 Leachate and drainage management

The drainage systems normally associated with a landfill site address three components:

- Uncontaminated upslope run-off;
- Contaminated run-off from the landfill itself; and
- Highly contaminated leachate generated within the landfill.

All upslope run-off water must be diverted away from the waste to prevent water contamination and minimise leachate generation. Surface run-off from uncovered waste on the landfill and waste handling areas is considered to be potentially contaminated, and should not enter natural drainage courses without prior treatment or sufficient dilution. Highly contaminated leachate should similarly not enter the natural water regime without prior treatment or purification.

The different drainage streams are discussed separately below.

5.2.5.1 Upslope storm water drainage

Uncontaminated upslope run-off is to be prevented from entering the landfill facility area by means of a diversion drain along the higher southern side of the landfill. The existing drain will have to be extended in a westerly direction past the Phase 1 landfill area. When the landfill development moves into the southern extension area, a new upslope drain will have to be constructed.

In addition, due to the presence of the perched aquifer within the fractured/weather dolerite, a “fin drain” is to be constructed upslope of the landfill site to intercept and divert groundwater seepage away from the waste body. This “fin drain” would comprise of a perforated HDPE pipe with a geonet vertical fin, all wrapped in a geotextile, set in a trench through the fractured/weathered dolerite, and backfilled with granular soil (dolerite gravel). The “fin-drain” would daylight on either side of the landfill. In addition, the perimeter road around the landfill will also act as a drainage diversion berm. At the side of the landfill, the upslope cut-off drains would discharge into the open fields or into the adjacent water bodies. The drains are to be sized to handle peak flows from the 1 in 50 year recurrence interval design storm.

The layout and details of the storm water drainage system are shown in Appendix C.

5.2.5.2 Contaminated surface run-off

Potentially contaminated run-off from the outer surfaces of the waste body and site roads is to be directed towards an open V-drain along the outer toe of the starter berm. This contaminated water drain would discharge into the contaminated water pond located next to the north of the site. The working surface of the landfill is to slope towards the outer berms so that water drains away from the working face towards the toe drains. As portions of the landfill reach final height and final cover has been applied, run-off from these areas would be considered as uncontaminated, and the toe drain would then be directed to link up with the clean storm water system.

The contaminated water pond has been sized to contain the runoff from half of the exposed waste body for the 1 in 50 year recurrence interval 24 hour duration storm. The run-off pond has been sized at 1 880 m^3, plus a 500 mm freeboard. The contaminated water pond is to be 50 m x 25 m x 3 m deep, with a geocell lined spillway to discharge overflow water during extreme rainfall events.

5.2.5.3 Leachate management

The three main components of a leachate management system include the following:

- The liner beneath the landfill to prevent infiltration into the ground water;
- The collection system to transfer leachate to the treatment system; and
- The leachate treatment system to prevent surface water pollution by leachate.

Any leachate emanating from the waste in the landfill would appear in the 150 mm thick granular soil layer overlying the composite liner and would flow downslope beneath the landfill towards the leachate collector drains. These drains would consist of 110 mm diameter perforated HDPE pipes placed within a zone of 38 mm aggregate approximately 1 m wide.

These primary leachate collectors would discharge into a 315 mm diameter. The main leachate gravity drain running along the centre of the landfill discharges into the leachate sump located to the north of the facility. Manholes are to be provided at the top and bottom of this leachate main drain for inspection and maintenance purposes. Manholes on all leachate drains are to have vented manhole covers to prevent the build up of landfill gas in these manholes.

Leachate emanating from the landfill is to be contained in an HDPE sump, located to the north of the landfill. Leachate from the leachate sump is to be removed by tanker and taken to the nearest sewage treatment works for treatment. The leachate sump will have a manhole to facilitate leachate removal and an overflow into the contaminated water pond.

Since the landfill is located within a water deficit area with a negative climatic water balance, significant leachate generation is not expected. However, during the early stages of waste deposition over the exposed

liner, there would be significant run-off that will enter the leachate system. This run-off would tend to be a very weak contaminated water rather than actual leachate, so there should be no problem allowing it to overflow from the leachate sump into the contaminated water pond. The leachate sump is to consist of a "Weholite" HDPE pipe 1.8 m diameter by 6 m long laid horizontally and with blank flanges welded to both ends. The leachate inlet and outlet pipes will be welded through the end flanges, and a vertical manhole is to be welded into the top of the sump. The effective volume of the leachate sump would be approximately 12 m^3.

5.2.6 Liner designs

The liner designs for the landfill and the contaminated water pond have been developed in accordance with the Minimum Requirements, although various modifications and improvements have been made to address site specific conditions. The various liner designs are shown on Drawing Nos 12333/04, 12333/06 and 12333/08.

5.2.6.1 Landfill liner (G:S:B-)

In terms of the Minimum Requirements, a G:S:B- landfill liner would normally comprise of only a recompacted base preparation layer of in-situ soil. However, in view of the fact that the in-situ dolerite soils and fractured dolerite are highly permeable, and because the existing landfill, that does not have a bottom liner has contaminated the groundwater, an upgrade liner is proposed for the landfill extension. As there is no suitable clay in the area for the construction of a compacted clay liner, a geosynthetic clay liner (GCL) is proposed. The liner proposed for the landfill extension would therefore comprise of the following components, working from the top downwards:

- Leachate detection and collection drains at 25 m centres, comprising of 110 mm diameter perforated HDPE pipes, set in 1 m wide strips of 38 mm aggregate 300 mm deep;
- 150 mm layer of granular soil (blocky, "sugar" dolerite);
- 150 mm layer of fine soil;
- Geosynthetic clay liner (GCL) (3 600 kg/m^2); and
- 150 mm base preparation layer (recompaction of in-situ sandy soil).

5.2.6.2 Existing landfill "Piggy-back" liner

As stated earlier, the top of the existing landfill is to be brought up to the required levels to achieve gravity drainage in a north westerly direction by means of landfilling further waste on top. Thereafter, the surface is to be compacted and shaped to receive the "Piggy-back" liner system over the existing landfill surface, comprising of the following components, working from the top downwards:

- Leachate detection and collection drains at 25 m centres, comprising of 110 mm dia perforated HDPE pipes, set in 1 m wide strips of 38 mm aggregate 300 mm deep;
- 150 mm layer of granular soil (blocky, "sugar" dolerite);
- 150 mm layer of fine soil;
- Geosynthetic clay liner (GCL) (3 600 kg/m^2);
- 150 mm layer of fine soil;
- Geogrid (RockGrid PC50/50 or equivalent) to address localised differential settlement of the waste; and
- 150 mm base levelling layer of dolerite soil on compacted waste.

5.2.6.3 Contaminated water pond liner (G:S:B-)

The liner design for the contaminated water pond would be similar to the landfill liner, except that the leachate drainage layer would not be required. The liner layers on the base and walls of the pond would therefore comprise of the following components, working from the top downwards:

- 500 mm soil protection and confining layer;
- Geosynthetic clay liner (GCL) (3 600 kg/m^2); and
- 150 mm base preparation layer (recompaction of in-situ silty soil).

5.2.6.4 Existing landfill final cover

The outer slopes of the existing landfill will have to be capped and rehabilitated. As these slopes are steeper than 1:3 (V:H), it will be necessary to retain the soil on the slopes. The final cover for the eastern and northern slopes of the existing landfill include the following components, working from the top downwards is as follows:

- 200 mm topsoil with indigenous grass;
- 150 mm deep geocells filled with dolerite soil;
- Geosynthetic clay liner (GCL) (3 600 kg/m^2); and
- 150 mm base preparation and levelling layer of soil.

5.2.6.5 Construction quality assurance

The main risk to the performance of a geosynthetic liner system is mechanical/physical damage, during and after installation. For this reason, it is imperative that the liner is supplied and installed by a competent and reputable contractor, and in accordance with a strict quality assurance programme. In particular, extreme care must be taken when placing the cover soil over the installed GCL so as not to damage the liner. Strict supervision is required.

5.2.7 Landfill gas management

On account of the organic content of the general waste it is highly likely that the landfill will produce landfill gas. Since the site is to be operated according to sanitary landfilling principles with daily covering of waste, proper ventilation must be provided. This is necessary to prevent the lateral migration of gas and uncontrolled venting from the site, causing odour problems and explosion hazards in confined structures such as manholes, etc. To achieve this, rock filled gabion chimneys are to be constructed within the waste body, extending upwards as the landfill rises. Each chimney is to be wrapped in geotextile filter fabric and a small mound of soil is to be placed around it to prevent ingress of surface run-off, and to stabilise the chimney. These gas chimneys are to be spaced at approximately 1 per 0,1 hectare.

When the final capping is applied to the landfill at various stages of completion, appropriate capping structures would be constructed over the gas chimneys to enable passive venting to continue. Although active gas extraction and flaring of landfill gas would be preferable to passive venting, it is not considered to be appropriate or cost effective for such a small landfill located in a remote area.

Notwithstanding the above, the gas management system at the site must incorporate a gas monitoring system, including the following:

- Monitoring of landfill gas concentrations on a regular basis on the landfill during operation and after closure; and
- Regular monitoring of safe practices to avoid hazardous concentrations of gases at temporary or permanent working areas of the site.

6.0 ENVIRONMENTAL IMPACT ASSESSMENT

6.1 Approach to EIA

The EIA process has followed the GNR 385 procedure and as a result has addressed the following elements. Of more importance that for this EIA mitigatory measures have been identified which are summarised as follows:

- An EIA is being undertaken to ensure that all environmental, social and cultural impacts are identified and to ensure that stakeholders have the opportunity to raise issues and concerns. This is necessary to obtain Environmental Authorisation from the competent authority in this case the Department of Environmental Affairs (DEA); and
- All stakeholders and property owners will be engaged in the EIA.

The Impact Assessment will highlight and describe the impact to the environment following the above mentioned methodology and will assess the following components:

- Air;
- Aquatic ecology;
- Avi-fauna;
- Geology;
- Groundwater;
- Heritage;
- Noise;
- Risk;
- Social;
- Soils and agricultural potential;
- Terrestrial ecology;
- Topography;
- Traffic;
- Visual; and
- Wetlands and surface water.

7.0 PUBLIC PARTICIPATION

The principles of the old EIA regulations and Minimum Requirements have both been upheld during the public participation process.

Issues and concerns have also been documented during the EIA process.

Public involvement in the process of developing a landfill begins once other waste management options have been addressed and the need for waste disposal has been established. The process is designed to lead to a joint effort by stakeholders. Stakeholders should represent all relevant interests and sectors of society, technical specialists and the relevant organs of state who work together to produce better decisions that if they had acted independently.

The public participation process is designed to provide sufficient and accessible information to Interested and Affected Parties (I&AP's) in an objective manner to assist them to:

- Raise issues of concern and offer suggestions for alternatives and enhanced benefits;
- Contribute local knowledge;
- Verify that their issues have been captured;
- Verify that their issues have been considered by the technical investigations; and
- Comment on the findings of the impact assessment.

Public criteria identified were possible displacement of local residents, visibility of the site, sensitivity of the access road and distance to the nearest residential area. These factors were taken into account when selecting the site.

7.1 Stakeholders

In the case of the Tutuka site the need for closure of the existing site and establishment of a new site in the same vicinity for general waste has been established.

IAP's have been contacted and registered in accordance with the EIA Regulations and have been informed of the process being undertaken with regard to the landfill site.

The public criteria that were considered during the site selection was the possible displacements of local habitants, the visibility of the site, the sensitivity of the access road and the distance to the nearest residential area. According to the evaluation of the public criteria, the most suitable sites were those that will present the least visibility of the disposal facility from the main roads and settlements in the area. This was taken into account during the site selection process and therefore. A decision on site selection was made by combining sensitivities.

8.0 OPERATING PLAN

The objective of the operating plan is to ensure that all waste arriving at the facility is managed in an environmentally acceptable manner. The negative impacts, normally associated with waste management operations, should be minimised or avoided.

A detailed Operating Plan in terms of which the proposed facility will be operated will be compiled once the final details of the engineering phase of the project have been completed.

The operation must therefore conform to the South African "Minimum Requirements for Waste Disposal by Landfill" (DWAF, Second Edition 1998) and the Minimum Requirements for Monitoring at Waste Management Facilities (DWAF, Second Edition 1998).

The Operating Plan is site specific and describes the manner in which the facility must be operated, addressing aspects such as access, controls, record keeping, storage, treatment, drainage, landfilling, monitoring, etc.

In order to ensure that the operation complies with the aforementioned requirements, resources such as funds, suitable facilities, equipment and staff will be made available.

8.1 Preliminary Operating Plan

This section provides a preliminary Operating Plan for the operation of the landfill facility.

8.1.1 Access

Vehicle access must always be limited to a single entrance, to facilitate control. During hours of operation, this entrance must be manned and it must be locked when the facility is not in operation, to prevent unauthorised entry. A notice board must be erected at the entrance, stating the name, address, and

telephone number of the operator, the hours of operation and an emergency telephone number. Suitable signs must also be erected on-site, to direct drivers and to control speed.

Road access to the landfill working face must be maintained at all times in a manner suitable to accommodate vehicles normally expected to utilise the facility. All on-site roads must be so surfaced and maintained as to ensure that waste can reach the working face with minimum inconvenience in all weather. Roads must also be regularly graded and wetted to control dust, when necessary.

8.1.2 Control

8.1.2.1 Waste acceptance

Prior to waste being accepted at the gate, it must be verified as general waste by visual inspection by the gatekeeper and confirmed with the transporter. Industrial wastes, liquids, sludges, and drummed wastes should be regarded as potentially hazardous. In the event of such wastes being intercepted, the site operator should be informed and hazardous waste must not be accepted at the landfill site. It must be directed back to the generator for subsequent disposal at a permitted hazardous waste facility, as appropriate. The operator at the landfill working face must also ensure that no hazardous wastes are disposed of in this area.

At all times the precautionary principle should apply, i.e. any consignment of waste suspected of being hazardous, must be considered hazardous unless proven otherwise by means of laboratory testing.

No hazardous or health care risk waste may be accepted at the landfill site.

8.1.2.2 Records

Accurate and comprehensive records must be kept of all waste entering the site. Records must be kept on both a daily and a cumulative basis of the number of loads, waste type and origin. One or a combination of the following systems could be used for record keeping:

- An electronic, totally computerised, mass measuring device providing detailed records of daily, weekly and monthly transactions. This system would require the installation of a weighbridge or similar mass measuring device;
- A simple record system where entries are made by hand onto pre-prepared forms in such a way that it can be collated manually or introduced into a computer. Office personal computers inclusive of appropriate software should be provided; and/or
- A mass measuring unit with hand capturing of data for manual or computerised collation.

In addition, meteorological records should be kept, including rainfall, evaporation, wind, etc.

8.1.2.3 Auditing

Regular auditing of the site should be carried out to ensure that the site design and the development plans are implemented, and that an acceptable standard of operation is adhered to. The audit team should typically consist of the site operator, representatives from Tutuka Power Station and the appropriate environmental authorities. It may also be appropriate to include representatives of the interested and affected public on the audit team. The frequency of the audits must be agreed to by all the parties concerned, but intervals should not exceed 12 months.

8.1.2.4 Landfill gas monitoring

During routine audits, detection for landfill gas at the landfill should be carried out to determine the need for gas management.

8.1.2.5 Landfilling operation

Incoming waste can be discharged directly into the working cell of the landfill. The landfill must, as far as possible, be operated in accordance with the following sanitary landfill operating principles:

- Waste must be spread and compacted in cells; and

- Covered at the end of each day's operation.

8.1.2.6 Cell operation

The landfill operation is based on the construction of a series of cells, which are prepared to receive the waste. The basic landfill unit is thus a cell of compacted solid waste which, when completed at the end of each day, is entirely contained by cover material. The sides may be formed by 1 m high soil or rubble berms, or sloped waste covered by daily cover. The width of the cell is determined by the working face, which is determined by the manoeuvring needs of the vehicles depositing waste. This must be sufficiently wide to avoid traffic congestion, but not so wide that waste is unnecessarily left exposed. There must always be sufficient cell capacity on site to accommodate at least one week's waste.

"End tipping", where waste is pushed over the edge of an advancing face, is not permitted. Waste must be deposited at the bottom of the working face, spread, and worked up a 1 in 3 slope up the working face within the cell. Compaction is best achieved if the waste is spread in layers not exceeding 500 mm thick (uncompacted) and passed over a minimum of five times by the landfill compactor or loader.

8.1.2.7 Cover

The sanitary landfill definition specifies daily or more frequent cover. The material to be used for cover will be excavated and loaded up from the nearby dolerite borrow pit, but may also be imported soil, builders' rubble, or other approved covering. In all cases, a strategic stockpile of cover, enough for at least three days, should be maintained close to the working face for use in emergencies. Suitable equipment and resources must also be available to ensure that there is sufficient cover material, so that no area is left uncovered at the end of the day's operation. In order to facilitate this, incoming cover should be deposited along the top of the cell, either on the completed portion of the current cell, or on the adjacent cell.

Putrescible waste, such as food waste or dead animals, should be deposited and covered immediately with soil. Alternatively, such waste can be deposited at the base of the working face and covered immediately with other waste.

Daily or periodic cover must be sufficient to isolate the waste from the environment. A minimum thickness of 100 mm of compacted soil or other appropriate inert material is usually required. If there is a problem with odours from the landfill, the thickness of the cover might have to be increased. Final cover must be as thick as possible, using construction rubble and gravel.

8.1.2.8 Wet weather cell

An easily accessible wet weather cell must be constructed close to the haul road, for use under abnormally wet weather conditions. The wet weather cell must have sufficient capacity to accommodate two weeks' waste. The wet weather cell should be constructed in the same manner as the standard cell, except that it should have a well-drained base using construction rubble or similar material to ensure vehicle access in wet weather. As far as possible, the wet weather cell should be operated in the same manner as the standard cell.

8.1.2.9 Landfill drainage

The underlying principles of landfill site drainage are as follows:

- All run-off water must be diverted away from the waste, to prevent water contamination and minimise leachate generation;
- Where contaminated water or leachate does arise on site, it must be managed and kept out of the environment; and
- Clean, uncontaminated run-off water must not be permitted to mix with and increase the volumes of contaminated water.

A drainage system which achieves the above is presented in the design section of this report. Once constructed, this system must be maintained. As part of the leachate management procedure, the quality of

both leachate and contaminated water should be monitored on a regular basis to determine the suitability for discharge to the sewage treatment plant or other disposal methods.

Detailed on-site drainage at the working faces must continuously be adapted and developed as the landfill develops. Detailed on-site drainage must also be properly managed as follows:

- All clean, uncontaminated water must be allowed to flow off the site into the natural drainage system, under controlled conditions;
- The base of the site at the working face must be so graded that water drains away from the deposited waste;
- All water contaminated by contact with waste must be contained and discharged into the run-off water pond;
- All leachate collected must be discharged into the leachate sump; and
- All temporarily and finally covered areas must be graded and maintained to promote run-off and eliminate ponding or standing water.

8.1.3 Resources

Suitable equipment and resources must be made available to ensure that the waste is properly spread, compacted and covered at the end of each day's operation. The equipment must therefore have the versatility to execute several functions, including grading and shaping, as well as mixing and blending of wastes. Backup plant must also be available in case of breakdowns.

8.1.3.1 Plant

Normally, a purpose built landfill compactor would be recommended as the main item of plant, together with other items of plant. However, in this case a small tracked loader or TLB with solid tyres would be recommended as the main item of plant, as it is considered to provide more flexibility for cover operations. In addition, there should be access to a second TLB as backup.

Other items of plant would include a small water tanker or trailer for dust control, and a tipper truck for handling cover material.

8.1.3.2 Staffing

For the operation of the facility, the following staff compliment is recommended to ensure that the site is operated to a high standard:

- A Site Supervisor to take responsibility for the proper operation of the entire facility. The site supervisor must ensure that all the facility requirements are fully complied with;
- A Plant Operator to take responsibility for operating the waste disposal area and hence the TLB. They will also be responsible for operating the tractor-trailer, tractor-water cart and other landfill equipment;
- A Gate Controller to control access and record waste loads during operating hours. They can also act as the spotter to direct vehicles to the correct tipping area;
- A Litter Picker and General Worker; and
- A Security Guard for general site security.

8.1.4 Control of nuisances

In order to control nuisances, sanitary landfilling principles must be used. This is a method of disposing of waste on land without causing nuisances or hazards to public health or safety, by utilising the principles of engineering to compact the waste and to cover it with a layer of soil at the conclusion of each day's operation, or at more frequent intervals as may be necessary.

To ensure that the waste management facility is operated to these standards, environmental management and control of the operations are essential. Some of the common short-term problems associated with landfill operations and their possible solutions, are listed below:

- Dust: On-site roads should be wetted in hot dry weather to reduce dust from traffic, if necessary;
- Odours: Odours are generated as a result of biological degradation of waste. Daily covering of the waste and the maintenance of this cover should ensure that odours from both "fresh" and decomposed waste do not become a problem. Putrescible waste should be covered immediately;
- Fires: Burning of waste is prohibited. Compaction and covering of waste minimises the fire risk by minimising oxygen and exposure. Where fires do occur, the burning waste should be exposed, spread, and smothered with cover material. On no account is water to be added;
- Flies and Rodents: Immediate compaction and daily covering of waste reduces the likelihood of this becoming a nuisance. Nevertheless, flies are commonly associated with landfill sites and fly traps should be used to control this problem;
- Litter: Compaction and covering of the waste reduces the risk of windblown litter. Litter screens can also be used to control litter. All windblown litter should be collected from around the site on a regular basis;
- Aesthetics: The rehabilitation of completed areas would improve the general appearance of the site;
- Health: Health Care Risk Waste cannot be accepted and should be handled with the appropriate care if identified. It should be stored and incinerated at a licensed facility. Other putrescible waste should be covered immediately; and
- Drainage: Waste deposition should be such that it ensures that water runs away from the waste body, and does not form ponds on top of the waste, from where it might infiltrate.

9.0 MONITORING PLAN

The objective of the site monitoring plan is to verify that all aspects of the disposal site, including any leachate management and treatment systems, conform to the required standards and the site permit conditions.

More specific objectives are:

- To ensure that the accepted site design is properly implemented;
- To function as a control measure to ensure that the operation conforms to the required standards;
- To quantify any effect that the operation has on the environment and, in particular, any effect on the water regime; and
- To serve as an early warning system, so that any problems that arise can be timeously identified and rectified.

Monitoring at the existing site is done in accordance with existing permit conditions. This requires monitoring of boreholes, surface water, leachate and background monitoring.

9.1 Water quality monitoring

To ensure adequate environmental protection, a long term water quality monitoring programme for the site is required. This would involve background analyses, routine detection monitoring, investigative monitoring and post closure monitoring.

The water quality monitoring system therefore includes the monitoring of surface water bodies, groundwater, leachate and contaminated water in the pond. Water and leachate samples are to be collected and analysed

for the water quality parameters as required in the "Minimum Requirements for Monitoring at Waste Management Facilities". Eskom has appointed specialist groundwater consultants GHT Consulting Scientists for all the water quality monitoring on and around the Tutuka Power Station complex. Monitoring at Tutuka Power Station takes place at a number of areas in addition to the landfill site. These monitoring sites have been classified according to their location relative to the infrastructure and natural streams in the environment. Five different monitoring areas have been identified at the power station, namely:

- The Ashing Area, including the Wolwe Spruit;
- The Power Station Area including the Pretorius Spruit;
- The Domestic Waste Site Area;
- The Coal Stockyard Area including the Uitkyk Spruit and the Racesbult Spruit; and
- The Leeu Spruit.

The following actions are included as part of the quarterly auditing and routine monitoring of the Waste Site:

- The collection of water samples for chemical analysis of the surface and groundwater sites;
- The collation of monthly records outlining the type and quantity of waste deposited;
- Auditing of site conditions and operation;
- Auditing and evaluation of weekly and monthly reports, including monthly surface water monitoring by the Environmental Department of Tutuka Power Station;
- The submission of summary report with conclusions and recommendations to the Management of Tutuka Power Station; and
- Quarterly meeting with the management and interested and affected parties to discuss the conclusions and recommendations of the audit reports. The discussions during this meeting, the way forward and feedback on the previous reports are included in quarterly reports.

The details of the water quality monitoring system for the landfill would include the following:

9.1.1 Background analyses

Groundwater samples should be taken from all the monitoring wells installed over the life of the landfill. These include one upstream borehole (DMB35) and 6 downstream boreholes (DMB33, DMB34, DMB86, DMB87, DMB88, DMB89). These samples must be analysed to obtain background water quality data. A complete background analysis of the groundwater should be taken before the construction of the landfill extension.

9.1.2 Surface water

There are three surface water bodies in the vicinity of the site. The monitoring points are in the two dams on the ephemeral stream both upstream and downstream of the landfill site, and the ponded water in the borrow pit to the west of the site. Samples should be taken and analysed quarterly.

9.1.3 Ground water

The monitoring wells installed as part of the plant monitoring programme are to be used for ground water monitoring. Ground water is to be sampled and analysed quarterly.

9.1.4 Leachate and contaminated water

Leachate in the leachate sump and the existing leachate detection well, as well as water in the contaminated water pond, is to be sampled and analysed for control purposes. Samples are to be taken and analysed quarterly together with the surface and ground water monitoring.

9.1.5 Reporting

The analyses of all samples should be interpreted to identify any trends or deterioration of water quality that could result from the operations of the waste management facility. The water quality monitoring report should be submitted to Tutuka Power Station environmental management and the relevant regulatory authorities.

Any major anomalies are noted and recommendations are made to improve the situation with regard to environmental contamination. New boreholes have been installed to improve the monitoring network around the site. The total monitoring system at the domestic waste site consist of 7 monitoring boreholes, 2 surface water stream sites, 1 leachate detection site and one borrow pit filled with water. Detailed descriptions of the sites as well as locations are listed in the following tables (Table 2 and Table 3).

A detailed monitoring plan will be drawn up and aligned with the specific requirements of the licence, once issued.

9.2 Current monitoring system – Existing domestic waste site

- During the construction of the existing domestic waste site only two monitoring sites were installed. A borehole DMB86 to a depth of approximately 9 m to monitor any seepage that may occur on top of the dolerite sill as well as DMT01, a seepage collection sump and inspection manhole at the end of a subsurface seepage interception trench down gradient to the north of the domestic waste site;

- In July 1994 three additional monitoring boreholes were drilled for monitoring purposes, (DMB33; DMB34 and DMB35). Two boreholes were drilled down-gradient from the domestic waste site outside the northern fence, while one was drilled up-gradient outside the southern fence. These boreholes were sited geophysically by means of a detailed magnetic survey. From this it was concluded that fresh, solid dolerite forms the largest part of the underlying formations;

- No water was found in Borehole DMB33 and drilling was stopped at a depth of 18 m. The seepage water in the formations is considered to be sufficient for monitoring purposes. Boreholes DMB34 is 24 m deep and a small volume of water was found at depths of 4 and 21 m. Borehole DMB35 yielded very little water in the dolerite at 12 m and 18 m. In this borehole, which was drilled down to a depth of 36 m, the water was found in cracks and joints in the dolerite; and

- Two surface water sites were also added to the monitoring system in July 1994. These are two sample points in the non-perennial stream that originates east of the domestic waste site and flows in a north-western direction where it joins the Racesbuit Spruit north of the domestic waste site. DMS44 is the upstream sample point and DMS37 the downstream sample point.

- A borehole was drilled during October 2005 to provide the security guard at the domestic waste site with sanitary facilities. This includes drinking water as well as a flush toilet. This borehole was eventually destroyed by the construction of borrow pits for dolerite gravel.

Table 2: Location and description of monitoring points

Sites	Date Site Visit	Site Description	Objective	Farm Name	Farmer Owner
DMB33	24/03/2010 07:29	BH 50m downstream & north of existing DWS	Seepage from waste site	PRETORIUS VLEY 374/7	Eskom Holding LTD
DMB34	24/03/2010 07:50	BH 90m downstream & northeast of existing DWS	Seepage from waste site	PRETORIUS VLEY 374/7	Eskom Holding LTD
DMB35	24/03/2010 08:48	BH 30m upstream and south of existing and proposes DWS and next to the entrance.	Background water quality	PRETORIUS VLEY 374/7	Eskom Holding LTD
DMB86	23/03/2010 16:00	BH 5m downstream & north of existing DWS. Shallow borehole with pizometer.	Seepage from waste site	PRETORIUS VLEY 374/7	Eskom Holding LTD
DMB87	24/03/2010 07:08	BH 50m downstream & north of proposed extension of DWS	Seepage from waste site	PRETORIUS VLEY 374/7	Eskom Holding LTD
DMB88	24/03/2010 07:11	BH 130m downstream & north of proposed extension of DWS	Seepage from waste site	PRETORIUS VLEY 374/7	Eskom Holding LTD
DMB89	24/03/2010 07:19	BH 70m downstream & west of proposed extension of DWS & north of the borrow pit	Seepage from waste site	PRETORIUS VLEY 374/7	Eskom Holding LTD
WMB37	Historical Records	BH 150m upstream & east of existing DWS - Destroyed	Drill for water supply	PRETORIUS VLEY 374/7	Eskom Holding LTD
DMT01	23/03/2010 16:20	leachate detection sump downstream at north-eastern corner of DWS	Seepage from waste site	PRETORIUS VLEY 374/7	Eskom Holding LTD
DMD25	24/03/2010 07:08	Borrow pit 370m downstream & west of DWS	Run-off and seepage from site	PRETORIUS VLEY 374/7	Eskom Holding LTD
DMS37	24/03/2010 14:40	Non-perennial Spruit 130m downstream & north of DWS	Run-off from site	PRETORIUS VLEY 374/7	Eskom Holding LTD
DMS44	24/03/2010 14:30	Non-perennial spruit 280m upstream & east of DWS	Background water quality	PRETORIUS VLEY 374/7	Eskom Holding LTD

Table 3: Location and description of monitoring points

Sites	Longitude °E	Latitude °S	Elevation mamsl	Casing Diameter mm	Coller Hight mm	Sample Depth	BH Depth m	Water Level (m below CH) / Level & Flow	Equipment	Use	Sampled	Photo nr.	Current State
DMB33	29.3249	-26.7711	1602	165	0.4	14	18	1.45	None	Monitoring	Y	7	Satisfactory
DMB34	29.3261	-26.7711	1601	165	0.4	22	24	1.11	None	Monitoring	Y	8	Satisfactory
DMB35	29.3247	-26.7738	1612	165	0.5	16	36	4.39	None	Monitoring	Y	9	Satisfactory
DMB86	29.32434	-26.77076	1602	165	0.5	6	8.5	1.28	None	Monitoring	Y	10, 11	Satisfactory
DMB87	29.32423	-26.77023	1600.5	165	0.72	3	21	1.96	None	Monitoring	Y	12	Satisfactory
DMB88	29.32376	-26.76941	1597	165	0.66	3	20	3.9	None	Monitoring	Y	13	Satisfactory
DMB89	29.32241	-26.77081	1603	165	0.44	4	20	1.59	None	Monitoring	Y	14	Satisfactory
WMB37	29.326097	-26.773779	1612.9	165	~	~	120	~	None	Monitoring	N	~	Destroyed
DMT01	29.32574	-26.77114	1604	1200	0	Surface	2.5	1 .4	Manhole	Monitoring	Y	15	Seepage visible below sump
DMD25	29.322769	-26.771659	1604		~	Surface	~	Full	None	Monitoring & Stock	Y	16	Satisfactory
DMS37	29.3244	-26.7697	1598	0	~	Surface	~	Dry	None	Monitoring & Stock	N	17	Satisfactory
DMS44	29.3282	-26.7728	1607	0	~	Surface	~	Low	None	Monitoring & Stock	Y	18	Satisfactory condition.

9.3 Upgrading of monitoring system – proposed extension of domestic waste site

A total of three monitoring boreholes (DMB87 DMB88 and DMB89) were installed in the period between the 16th and 17th of March 2010 with a view to intercepting leachate generated from any future waste operations. They were installed down gradient within the dolerite sill identified during geophysical investigations.

9.4 Auditing

Audits conducted have investigated the current state of the monitoring system and various monitoring sites as well as the observed water level trends. These methods include:

- A description of the current state of the water monitoring system and infrastructure at Tutuka Power Station to identify any problems that may require attention; and
- A description of the actions taken in response to problems identified during the previous monitoring phase.

10.0 CLOSURE, REHABILITATION AND END-USE

Closure of the landfill will involve the application of final cover, top soiling, vegetating and drainage maintenance. This will be done to conform to the South African "Minimum Requirements for Waste Disposal by Landfill" (DWAF, Second Edition 1998). After closure the landfill will be utilised for the designed end-use as specified on the closure plan.

The closure of the extended landfill will only be considered towards the end of the life of the site and assumed to become a license condition of the amended permit.

Closure will be preceded by Closure Design and the implementation of all the recommendations contained in the Closure Report. Once implementation has been completed, this will be assessed at a final site inspection attended by all relevant stakeholders including the relevant government departments.

The End-Use Plan and how to maintain the landfill in an environmentally acceptable condition will be completed before closure and will include determination of the final use (if required) of the buffer zone.

The long term environmental impacts, public health, safety and nuisance problems associated with a landfill may persist long after the site has been closed. Ongoing inspections and maintenance are therefore required after site closure to ensure that such problems do not continue unidentified and unabated, and that the End-use Design is properly implemented.

The following aspects will be addressed as part of the control of the potential long term environmental impacts, public health, safety and nuisance problems:

- Integrity of cover;
- Ongoing monitoring and public participation;
- Security;
- Drainage systems; and
- Potential subsidence.

10.1 Closure and end-use

The objectives of the end-use design of the landfill are as follows:

- To create an aesthetically acceptable landform with gentle slopes (not exceeding 1:3) that, as far as possible, blends in with the surrounding terrain; and
- To maximise the landfill airspace available for waste disposal and hence the site life.

10.2 Final landform and end-use

The proposed final shape of the landfills would be determined according to the surrounding terrain as well as to maximise the airspace from the available footprint. It would also be designed to meet drainage and end-use requirements. It is recommended that the end-use of the landfill be considered as restricted open space, on account of the waste disposed on it. Other forms of development could also be considered. The end-use of the site should, however, be discussed with all stakeholders to ensure that the rehabilitated site is acceptable to them.

Based on the surrounding topography and land use, the maximum height of the landfills would be about 30 m above the original natural ground level. The upper surfaces of the landfill must have general slopes of at least 1:50 to promote rapid drainage of the landfill surface.

10.3 Closure and rehabilitation

As the different sections of the landfill are completed to final height, they are to be appropriately shaped, graded and capped in accordance with the Minimum Requirements. As the new landfill would have a bottom liner, the final capping for a G:S:B- landfill would only need to include a 200 mm layer of topsoil, appropriately grassed.

Vegetation of completed areas is to commence as soon as possible after capping. Indigenous shrubs are to be planted around the site for screening purposes, as well as in any areas where the substrate will support tree growth. Over the rest of the site, grass is to be established using indigenous grass types. The intention is to implement what is known as "the rising green wall effect" by progressively grading and vegetating the side berms and then working behind them.

Provided the vegetation is always maintained during operation, there should be no need for later rehabilitation. After closure, ongoing maintenance of the landfill capping and vegetation will be required.

11.0 CONCLUSIONS

The existing landfill site was established prior to the advent of the Minimum Requirements and thus does not conform to Minimum Requirements principles. The extended Site will be designed and operated according to Minimum Requirements principles and thus the risk of environmental pollution is reduced to within acceptable limits.

The content of the licence application report demonstrates that based on current information the establishment and operation of the facilities will improve potential impacts from the current site and will advance key concepts of the Integrated Waste Management Hierarchy and NEMWA/NEMA environmental principles and practices in respect of waste management.

The current permit amendment application process and the ongoing EIA processes also have the objective to ensure that the site will be constructed, operated, monitored and eventually closed within acceptable standards.

Based on the results of the site investigations undertaken and the content of this report, the following conclusions are drawn regarding the proposed Tutuka landfill facility:

- There is a requirement for a small sized general waste landfill, classified as G:S:B$^-$, with an airspace of approximately 1 014 000 m^3 for the 40 year design life;

- From a consideration of various alternative candidate landfill sites, as well as the ability of the current Site to conform to the objectives of the Minimum Requirements, it was determined that integrating the new waste disposal facility with the closure and rehabilitation of the existing landfill represents the best environmental alternative;
- As the existing landfill has already impacted on the environment (including the groundwater), it would be preferable to address the current environmental impacts of the existing landfill, and extend the landfill, rather than create a new potential environmental impact by developing a new landfill site elsewhere. Capping the existing waste body will limit further groundwater pollution from taking place. Should unacceptable levels of downstream groundwater quality impacts still occur, intervention will follow based as per agreement with the Regulator;
- The proximity of the existing landfill site to the Tutuka Power Station, Thutukani Township and New Denmark Colliery, and its relatively easy access from the main road supports the development of an adjacent facility as a long-term waste disposal facility;
- The existing site has infrastructure such as a gate house, monitoring boreholes, drains and fencing that could be used for the new landfill site;
- There is sufficient land available for the proposed extension of the landfill and the natural topography of the area favours the development of a landfill. Due to the dolerite gravel excavation activities on and around the site, it is not pristine and the development of the landfill extension should not impact significantly on flora and fauna;
- The shallow excavatable soils on the site mean that soil for waste covering operations will have to be imported from nearby borrow pits. The black clayey colluvial soils are unsuitable for use in the landfill liner construction, and will have to be removed. The residual dolerite soils are gravelly and sandy and therefore also not suitable for use in the liner construction;
- From a groundwater perspective, the site has a perched aquifer within the fractured/weathered dolerite, and a deeper aquifer beneath the dolerite sill. The aquifer is classified as “low/no significance”, and the geohydrological assessment rates the site as “marginal” to “suitable” for the development of a waste disposal facility.
- The site design is based on developing the following main areas of operation, namely:
  - Extension of the existing landfill to use the full permitted (Permit Nr B33/2/310/45-P129 dated 11 July 1994) footprint;
  - Raising, shaping and capping the existing landfill with a GCL based “piggy-back” liner;
  - Development of a GCL lined extension of the landfill to the west of the existing landfill, followed by a further extension to the south to achieve the required site life; and
  - Construction of a leachate sump and contaminated water pond.
- The landfill is based on sanitary landfilling of general waste in a lined landfill cell;
- In formulating the preliminary design for the Tutuka landfill site, every effort has been made to meet the objectives of landfill design, i.e. to provide a cost effective, environmentally and socially acceptable facility. In addition, the requirements of the Minimum Requirements have been followed and the “Precautionary Principle” has been implemented throughout; and
- Whilst the design meets the waste disposal needs of the current users of the Tutuka landfill site, it also addresses all the site specific factors and constraints identified during the site investigation.

12.0 REFERENCES

1. Tutuka Power Station Routine Monitoring Report Phase 30; December 2008; Final Report; GHT Consulting Scientists.
2. Permit Application Motivation Report for Tutuka Power Station Class II Solid Waste Site, Stefan, Robertson and Kirsten, November 1990.
3. Proposed Extension Domestic Waste Site, Tutuka Power Station, GHT Consulting Scientists, RVN574.1/1025.
4. Minimum Requirements for Waste Disposal by Landfill; Department of Water Affairs and Forestry; Second Edition, 1998.
5. Minimum Requirements for Water Monitoring at Waste Management Facilities; Department of Water Affairs and Forestry; Second Edition; 1998.
6. Design and Operating Plan Report for the Extension of the Tutuka Power Station Landfill Site; Report No P029-02; April 2010.

GOLDER ASSOCIATES AFRICA (PTY) LTD

Michele Muller
Waste Consultant

Leon Bredenhann
Divisional Leader

MM/LB/js

Reg. No. 2002/007104/07

Directors: FR Sutherland, AM van Niekerk, SAP Brown, L Greyling, SM Manyaka

g:\projects\12330 - zitholele consulting tutuka power station\reports\licence application\12330-9629-2_rep_licence application.docx

At Golder Associates we strive to be the most respected global group of companies specialising in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organisational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

Africa	+ 27 11 254 4800
Asia	+ 852 2562 3658
Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

solutions@golder.com
www.golder.com

Golder Associates Africa (Pty) Ltd
PO Box 13776, Hatfield, 0028
Ditsela Place
1204 Park Street
Hatfield, Pretoria
Gauteng
South Africa
T: [+27] (12) 366 0100

Golder Associates