# Table of Contents

1.0 **INTRODUCTION** ........................................................................................................................................................ 1  

1.1 Background ............................................................................................................................................................................. 1  

1.2 Objectives ................................................................................................................................................................................ 1  

1.3 Scope ...................................................................................................................................................................................... 2  

2.0 **SITE DESCRIPTION** ...................................................................................................................................................... 2  

2.1 Location, size and land-use ..................................................................................................................................................... 2  

2.1.1 Candidate Site 1 .............................................................................................................................................................. 2  

2.1.2 Candidate Site 2 .............................................................................................................................................................. 2  

2.1.3 Candidate Site 3 .............................................................................................................................................................. 3  

2.2 Climate .................................................................................................................................................................................. 3  

2.2.1 Precipitation and evaporation .......................................................................................................................................... 3  

2.2.2 Temperature ..................................................................................................................................................................... 3  

2.2.3 Wind .................................................................................................................................................................................. 3  

2.3 Geology .................................................................................................................................................................................. 5  

2.4 Fauna and Flora ................................................................................................................................................................. 5  

2.5 Hydrology ............................................................................................................................................................................. 6  

3.0 **SITE CLASSIFICATION AND WASTE DISPOSAL NEED** .......................................................................................... 9  

3.1 Current volumes ................................................................................................................................................................. 9  

3.2 Landfill Classification ............................................................................................................................................................ 9  

3.2.1 Waste type ...................................................................................................................................................................... 9  

3.2.2 Size of the landfill ........................................................................................................................................................... 10  

3.2.3 Climatic Water Balance .................................................................................................................................................. 10  

3.2.4 Classification ................................................................................................................................................................. 10  

4.0 **CONCEPTUAL DESIGN OF LANDFILL FACILITY** ................................................................................................. 11  

4.1 Disposal need/Airspace required ........................................................................................................................................ 11  

4.2 Available airspace ............................................................................................................................................................... 12  

4.3 Cover material ..................................................................................................................................................................... 12  

4.4 Site life .................................................................................................................................................................................. 13  

4.5 Basal Liners ....................................................................................................................................................................... 13  

4.6 Site layout elements ............................................................................................................................................................ 14  

4.7 Drainage .............................................................................................................................................................................. 15
4.7.1 Upslope run-off ............................................................................................................................................... 15
4.7.2 Contaminated run-off ..................................................................................................................................... 15
4.7.3 Highly contaminated leachate .................................................................................................................. 15
4.8 Impacts identified by the investigations ........................................................................................................ 16
4.9 Development plan .......................................................................................................................................... 16
4.10 Closure/rehabilitation plan .......................................................................................................................... 17
4.11 End-use plan .................................................................................................................................................. 17
4.12 Operating Plan ............................................................................................................................................... 17

5.0 REFERENCES .................................................................................................................................................. 17

TABLES
Table 1: Waste collection volumes and estimated disposal volumes at the Devon Landfill ....................................................... 9
Table 2: Landfill size classes ........................................................................................................................................ 10
Table 3: Waste Generation Volumes and Airspace Required .............................................................................................. 11
Table 4: Available airspace ........................................................................................................................................ 12
Table 5: Cover volume analysis .................................................................................................................................. 13
Table 6: Site life ...................................................................................................................................................... 13

FIGURES
Figure 1: Wind speed and direction at the Springs meteorological station ................................................................. 3
Figure 2: Locality map of the three candidate landfill sites .......................................................................................... 4
Figure 3: Geology of the area ....................................................................................................................................... 7
Figure 4: Surface water bodies in the area .................................................................................................................. 8
Figure 5: Class B containment barrier design ........................................................................................................... 14
Figure 6: Cover/ capping design for G:L:B’ Landfills (Minimum Requirements, 1998) ...................................................... 17

APPENDICES
APPENDIX A
Document Limitations

APPENDIX B
Drawings

APPENDIX C
Operating Plan
1.0 INTRODUCTION

1.1 Background

The Lesedi Local Municipality (LLM) forms part of the Sedibeng District Municipality and is situated on the south eastern border of Gauteng.

The LLM provides a number of waste services to residents and commercial enterprises within the municipality. A weekly domestic collection service is provided in each of the four main areas within the municipality whereas a bulk container service is available on request in the Heidelberg and Ratanda area.

The four main service areas within LLM incorporate:

- Waste collected in the Heidelberg/Ratanda area that is disposed of at a transfer station from where it is transported to the Platkop landfill (situated within the Ekurhuleni Metropolitan Municipality) for final disposal;
- The town of Devon which has its own municipal landfill which is open to the public;
- Waste from Impumelelo which is being disposed of at the Devon landfill site (the landfill at Impumelelo was closed some time ago due to its close proximity to housing); and.
- Waste from Vischkui is collected by the Waste Group, a private contractor, and disposed of at the Rooikraal landfill.

The Devon landfill is therefore the only remaining operating landfill within the municipality.

Lesedi Local Municipality (LLM) appointed SCIP Engineering Group (SCIP) to act as project managers and to appoint a consultant to license the existing landfill at Devon with a view to closure and to identify and license a new landfill for the Devon area. SCIP appointed Golder Associates Africa (Pty) Ltd (Golder) to undertake a licence application for the closure of the existing site and to identify and conduct the licensing process for a new landfill site.

Golder identified three candidate sites in the vicinity of Devon and Impumelelo as potentially new landfills for replacing the Devon landfill. These sites were investigated and ranked based upon environmental, economic and public acceptance criteria in the Site Selection Process Report (Golder 2012). The investigation concluded that Site 3, which is located about 3.7 km North West of Devon at the existing sewage works, was the most favourable.

This report presents a conceptual design and concomitant assessment for a new waste disposal facility at the favoured site. From this design and assessment, the site may be further analysed with regards to confirming its suitability for the new landfill site. The conceptual designs will also provide further insight into the expected life of the landfill as well as the design parameters and requirements.

1.2 Objectives

The overall objective of this project is to provide a suitable landfill to accommodate the General waste disposal needs of Devon and surrounding areas in the Lesedi Local Municipality over the next 30 years.

More specifically, the objectives of this conceptual design phase are as follows:

- To confirm the suitability of the preferred sites and provide further comparison in terms of engineering design and expected life;
- To develop a preliminary operating plan which can be applied to either of the landfill sites and ultimately adapted to specifically apply to the chosen site;
- To design a waste disposal facility which will cater for the waste disposal needs of Devon and surrounding areas in the Lesedi Local Municipality, will not impact unfavourably on the environment and that will be legally compliant;
To design the landfill in accordance with the Minimum Requirements for Waste Disposal by Landfill (MRs), second edition of 1998, published by the Department of Water Affairs and Forestry; and

To obtain authorisation so that the detailed design, tender process and construction of the facility can proceed.

1.3 Scope

The scope of this Conceptual Design Report is to document the design criteria, assumptions and preliminary details of the proposed waste disposal facility, for the purpose of incorporation into the Waste Management Licence Application and EIA reports to be submitted to the regulatory authorities.

The conceptual design is based on the Minimum Requirements for Waste Disposal by Landfill (MRs), second edition of 1998, published by the Department of Water Affairs and Forestry. The MRs address site selection, investigation, design, operation and monitoring of landfill sites, with particular attention being paid to the design section.

The scope of this report therefore includes the following:

- Determination of the waste disposal needs, including types and quantities of waste to be disposed of at the site, and thus the airspace and leachate management requirements;
- A description of the various sites and their surroundings based on site visits and previous studies; and
- A conceptual design of a waste disposal facility for each site, including the various aspects outlined in the MRs.

2.0 SITE DESCRIPTION

Three candidate sites were analysed in the Site Selection Process Report (Golder, 2012). As previously mentioned, Site 3 was found to be the most favourable site, scoring significantly better than the other two sites. Site 1 obtained the second highest score, with Site 2 being the least favourable based on the criteria used.

2.1 Location, size and land-use

2.1.1 Candidate Site 1

Candidate Site 1 borders the north eastern portion of the existing Devon landfill (refer to Figure 2). This site was chosen since it is located directly adjacent to the existing site making further development of the existing site possible. It also ensures that landfill activities do not “sterilize” a new greenfields site area.

The site is approximately 18 ha and the surrounding land use of the area is residential to the South and North West with agricultural or farming areas to the North and North East. The area south west from the site can also be categorized as residential. Various informal and formal residential properties as well as businesses are within 1 000 m of this site.

2.1.2 Candidate Site 2

Candidate Site 2 encompasses the old sewage works to the North of Impumelelo (refer to Figure 2). The surrounding land use of this area is residential to the South and agricultural or farming areas to the North, West and East. The area available for landfill development is approximately 19 ha.

This site is unfortunately very close to Impulelelo to the South and this will not provide the required buffer zone of 400 m around the Landfill site. Should the landfill site area be reduced to 5 - 7 ha, the required buffer zone of 400 m can be achieved.

The Lesedi Local Municipality has indicated that planning is in place to extend the nearby residential area towards the site in the south. As a result hereof Candidate Site 2 will not be feasible for development.
2.1.3 Candidate Site 3

Candidate Site 3 is situated within the boundaries of the existing sewage works about 3.7 km from Devon to the South-east and 2.5 km from Impumelelo to the East (refer to Figure 2). The surrounding land use of the area is agricultural/farming areas with the sewage works to the East of the site.

The area available for landfill development is approximately 4 ha and is situated immediately adjacent the existing sewage works and evaporation dams.

2.2 Climate

2.2.1 Precipitation and evaporation

The study area falls within the Highveld macro climatic region. The rainfall is from October to March and almost exclusively due to showers and thunder storms. Average annual rainfall is approximately 700 mm, while the average annual evaporation is approximately 1 500 mm. The climatic water balance, as carried out in the Site Selection Process Report (Golder, 2012) and summarised in Section 3.2.3, indicates that the area has a negative water balance based on data (1966 to 2008) from Deneyesville meteorological station (approximately 90 km South West of Devon, the nearest station with sufficient reliable data). The landfill should therefore not generate significant amounts of leachate on account of rainfall.

2.2.2 Temperature

Average daily maximum temperatures range from 27°C in January to 17°C in July, and daily minima range from 13°C in January to 0°C in July. Frost can be expected in the months from May to September (Schulze, B.R., 1986). Sunshine duration in the summer months is approximately 60% of the possible maximum, and during winter months approximately 80%.

2.2.3 Wind

Figure 1 shows the wind roses for the various seasons as recorded by the Springs meteorological station (approximately 40 km north west of Devon). Wind roses comprise 16 spokes, which represent the directions from which winds blew during the period. The colours reflected the different categories of wind speeds, the blue area, for example, representing winds of 1.5 m/s to 3.3 m/s. The dotted circles provide information regarding the frequency of occurrence of wind speed and direction categories. For this wind rose, each dotted circle represents a 5% frequency of occurrence. The number given in the centre of the circle gives the frequency with which calms occurred, i.e. periods during which the wind speed was below 1 m/s. It may be observed that the predominant wind direction is one from a northerly direction which is present throughout the year.

![Wind Speed and Direction](image)

*Figure 1: Wind speed and direction at the Springs meteorological station*
Figure 2: Locality map of the three candidate landfill sites
2.3 Geology

Based on maps indicating the regional geology, all three candidate landfill sites are situated in the network of dolerite sills, sheets and dykes, mainly intrusive into the Karoo Supergroup (Figure 3). Neither of these sites is situated in unstable areas such as dolomites and fault zones. A high-level geotechnical investigation has been commissioned to give further information for the final report.

Further geological information was obtained from the draft *Environmental Management Programme report, Zitholele 2011,* for the existing Devon landfill site (adjacent to Site 1). It was assumed that this information may be the same or similar for the other proposed sites. The following observations were made:

- The dark grey to black, very stiff, silty clay that blankets the area surrounding the waste site is potentially “medium” to “high” in the degree of expansiveness;
- No problems should be experienced in excavating any of the transported and residual dolerite soils down to an average depth of 1.5 m below natural ground level in order to construct the proposed waste cells. Very hard excavation using more powerful machines and possibly the use of jackhammers will be required to remove the soft rock dolerite bedrock from depths below 1.5 m. The sidewalls of excavations should be stable during the dry season. Slightly unstable sidewall conditions can be expected in the weathered dolerite;
- The site soils are expected to be potentially mildly chemically aggressive with regards to underground ferrous metal pipes (pH values ranging from 6.9 to 7.7 and electrical conductivity values ranging from 3.23 to 13.16 mS/m). The use of non-ferrous metal pipes or plastic pipes is recommended for wet services. The foundation soils should be treated with an environmentally friendly insecticide to combat termites;
- The transported and residual soils were tested to determine their compaction characteristics. It was evident that the colluvial clay that blankets the undisturbed portion of the site has a high plasticity and low compacted strength whereas the residual granular material (sugary dolerite) has a higher compacted strength and should be suitable for use as cover material during the closure of the General Waste Disposal Site. The clayey colluvial material should be suitable for use as the final “impermeable” capping;
- Permeability tests carried out on undisturbed soil samples indicate that the colluvial clay has a relative permeability of “impervious” whereas the remoulded residual dolerite is considered to be “semi-pervious” to “impervious” in its compacted state i.e. when used as cover material for the waste material; and
- Foundations for proposed rigid commercial structures on the site may be founded onto conventional spread or strip footings, bearing onto the dense, residual dolerite or onto the dolerite bedrock. Foundations may be placed at depths ranging from 0.3 m to about 1 m below the natural ground surface and adopting a safe allowable bearing pressure of 200 kPa to 600 kPa. Nominal reinforced strip footings are envisaged where the foundations straddle material with different engineering qualities.

2.4 Fauna and Flora

This area falls under the Highveld biome (Rutherford, M.C. and Westfall, R.H., 1994). The vegetation on the site is a mix of veld grasses and shrubs, together with alien shrubs and weeds. The latter are typical in areas where builder’s soil and rubble have been dumped or where the natural vegetation has been disturbed by earthmoving and quarrying. Khakibos (*Tagetes minuta*), Castor-oil Bush (*Ricinus communis*) and Cosmos (*Cosmos bipinnatus*) are most prevalent.

The sites are situated in disturbed areas where farming activities and/or residences have impacted on the natural fauna. Mammal species diversity was very low at the sites, with the only species recorded being domestic species. This is evident of the highly disturbed nature of the sites. In addition no red data species are known to occur in this area.
There are 19 Red Data faunal species that may occur on the site, and in this case, all of the species are birds. Birdlife is typical of the Highveld biome, however, the habitat suitability on waste sites for Red Data species is low.

2.5 Hydrology

Figure 4 indicates the water bodies surrounding the study area. The Water Management Areas maps published by the then Department of Water Affairs and Forestry (now Department of Water Affairs) were checked to determine the water catchment areas. Furthermore, the Internal Strategic Perspectives (DWAF, 2004) on the water management areas were also consulted.

Candidate site 2 and 3 occur within the catchment area of C21A (the Upper Vaal Water Management Area), the most upper portion of this catchment area. Candidate Landfill Site 1 is situated within catchment B2OE (Olifants Water Management Area), the most southern portion of the Olifants Water Management Area.

A brief overview from the Internal Strategic Perspective (DWAF, 2004) for the two abovementioned Water Management Areas (WMA) is given below.

An overview of the Upper Vaal Water Management Area

Candidate Sites 2 and 3 fall within this catchment area. Due to the extensive development in the Vaal River System and in the Upper Vaal and Crocodile (West) WMA, which are supplied from the Upper Vaal WMA, the local surface water resources in all three the Vaal WMAs have been fully exploited, more than three decades ago. There are extensive coal and gold mining activities located in the Upper Vaal water management area. These are having significant impacts on the water quality in the main stem of the Vaal River, throughout all three of the Vaal water management areas. The water quality varies from poor in the highly developed areas to good in the less developed areas. The Vaal Water Management area presents a stressed water basin however it is not believed that the proposed candidate sites will have any negative water quality impacts on this system.

An overview of the Olifants Water Management Area

The WMA has been divided into 4 sub-areas (Upper Olifants, Middle Olifants, Steelpoort and Lower Olifants Sub-areas) of which Candidate Site 1 falls within the Upper Olifants sub-area. The Olifants River originates in the Highveld of Mpumalanga. The river initially flows northwards before curving in an easterly direction through the Kruger National Park and into Mozambique. The rainfall is strongly seasonal occurring mainly in summer. The potential evaporation is well in excess of the rainfall.

The Upper Olifants Sub-area is the most urbanised of the four sub-areas with the majority of the urban population located in Witbank and Middelburg where the presence of coal also led to the establishment of the steel manufacturing industries. Site 1 is relatively far from these centres.

Groundwater plays an important role in supplying the rural areas with water for domestic and stock watering use in the Upper Olifants Sub-area. It is believed that candidate site number 1 will have no detrimental effect on the water quality of the Olifants Water Management Area.
Figure 3: Geology of the area
Figure 4: Surface water bodies in the area
3.0 SITE CLASSIFICATION AND WASTE DISPOSAL NEED

3.1 Current volumes

Current disposal Information at the existing Devon Landfill Site, as received from the LLM, was summarised and reworked in Table 1 below.

Table 1: Waste collection volumes and estimated disposal volumes at the Devon Landfill

<table>
<thead>
<tr>
<th>Days</th>
<th>Volume disposed (m³) by LLM</th>
<th>Estimated density (kg/m³)</th>
<th>Estimated tons/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>24</td>
<td>350</td>
<td>8.40</td>
</tr>
<tr>
<td>Tuesday</td>
<td>16</td>
<td>350</td>
<td>5.6</td>
</tr>
<tr>
<td>Wednesday</td>
<td>36</td>
<td>300</td>
<td>10.8</td>
</tr>
<tr>
<td>Thursday</td>
<td>8</td>
<td>350</td>
<td>2.8</td>
</tr>
<tr>
<td>Friday</td>
<td>8</td>
<td>350</td>
<td>2.8</td>
</tr>
<tr>
<td>Saturday</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Sunday</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Sub-total/week</td>
<td>92</td>
<td>330</td>
<td>30.4</td>
</tr>
<tr>
<td>Estimated private disposal (10% of week “sub-total”)</td>
<td>9.2</td>
<td></td>
<td>3.0</td>
</tr>
<tr>
<td>Total/week</td>
<td>101.2</td>
<td></td>
<td>33.4</td>
</tr>
<tr>
<td>Total/annum</td>
<td>5262.4</td>
<td></td>
<td>1738.88</td>
</tr>
<tr>
<td>Average per day</td>
<td>20.2</td>
<td>330</td>
<td>6.7</td>
</tr>
</tbody>
</table>

Using the above data, it was calculated that 1 740 tons of waste per year is currently being disposed of at the existing landfill (based on a 260 day year), at a rate of 6.7 tons per day.

3.2 Landfill Classification

The site classification for the new landfill site was conducted in accordance with the Minimum Requirements for Waste Disposal by Landfill (Second Edition, 1998 by the Department of Water Affairs and Forestry) (MRs). This involves the type of waste to be disposed, the volume of waste to be disposed and the potential for significant leachate generation (Climatic Water Balance). The MRs prescribes a classification system where the following aspects have to be addressed:

- The waste type can be General or Hazardous (“G” or “H”);
- The size of the landfill be Communal, Small, Medium and Large (“C”, “S”, “M” and “L” respectively); and
- The Site Water Balance (the possibility to generate significant leachate) is determined by calculating the Climatic Water Balance difference between Rainfall and Evaporation and in addition here to taking into account the moisture content of the type of waste to be disposed of at the site.

The landfill classification was done as part of the feasibility study by Golder in 2009 and is reflected below.

3.2.1 Waste type

The landfill will receive only general waste and the class should thus be General (“G”).
3.2.2 Size of the landfill

The estimated size of the general waste stream is based on the current volumes collected by the LLM as well as approximately 6.7 tons of waste per day of which 6.1 tons/day is disposed by the municipality and 0.6 tons/day by the public.

The average density of the waste is taken for mainly informal areas at an estimated 330 kg/m³ to calculate the tonnages. The reason is that the majority of the waste coming from Impumelelo has high ash content.

The landfill size classification as per the 1998 edition of the *Minimum Requirements for Waste Disposal by Landfill* is indicated in the Table 2 below.

<table>
<thead>
<tr>
<th>Landfill Size Class</th>
<th>Maximum Rate of Deposition (MRD) (Tonnes per day) 1998</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communal</td>
<td>&lt;25</td>
</tr>
<tr>
<td>Small</td>
<td>&gt;25 &lt;150</td>
</tr>
<tr>
<td>Medium</td>
<td>&gt;150 &lt;500</td>
</tr>
<tr>
<td>Large</td>
<td>&gt;500</td>
</tr>
</tbody>
</table>

The size of the landfill is calculated as follows:

- \[ \text{MRD} = (\text{IRD})(1+d)^t \]
- \[ \text{IRD} - (\text{Initial rate of deposition on site in T/day}) = 6.7 \text{ tons} \]
- \[ d - (\text{Expected annual development rate, based on population growth})^1 = 3.0\% \]
- \[ t - (\text{years since deposition started at IRD}) = 50 \]
- \[ \text{MRD} - (\text{Maximum rate of deposition after t years}) = 29.4 \text{ tons} \]

The maximum rate of deposition for the site is calculated as follows:

- \[ 6.7 \text{ tons} \times (1 + 0.03)^{50} = 29.4 \text{ tons}. \]

Based on the calculation the site will be classified as an “S” or Small site according to the MRs.

3.2.3 Climatic Water Balance

The full climatic water balance calculation was carried out in the *Site Selection Process Report* (Golder, 2012). The calculation used data from the Denysville meteorological station at the Vaal Dam, which was the closest station with sufficient data over a prolonged period of time. Based on the calculations, all the years from 1966 to 2008 have an annual water deficit; the site therefore has a negative water balance i.e. “B”.

3.2.4 Classification

Based on the above the landfill classification is “G:S:B“.

The National Norms and Standards for Disposal of Waste to Landfill, GN R.636 promulgated on 23 August 2013, supersedes the disposal site classification system as outlined above prior to advent of GN R.636. The liner design for the envisaged new General Waste Disposal Site will therefore be for a Class B which is

---

1 The IDP shows an increase in population by 2.19%. A conservative growth rate of 3% was used.
comparable to a Class G:L:B+ design as per previous Minimum Requirements. This design criterion was accepted by the Department of Water Affairs as it is in accordance with these new regulations.

4.0 CONCEPTUAL DESIGN OF LANDFILL FACILITY

All three candidate sites have been considered for a high level conceptual design but the preferred site, as per the Site Selection Process Report (Golder, 2012), is Site 3. Site 3 design has been developed in more detail.

4.1 Disposal need/Airspace required

The airspace utilisation calculations are based on the volumes of waste disposed at the existing Devon Landfill. The total estimated volume of 5 262 m³ per annum was used starting from the year 2009. This value is based on estimated disposal information presented in both the Devon Landfill Feasibility Report (Golder, 2009) as well as the Site Selection Process Report (Golder, 2012). An annual growth in volumes of 3% per annum was also used to predict future disposal quantities. It was also assumed that disposal at the new landfill would begin in January 2014. In addition to the waste, the volume of cover at a ratio of 1:5 was factored in.

Table 3: Waste Generation Volumes and Airspace Required

<table>
<thead>
<tr>
<th>Year No.</th>
<th>Year</th>
<th>Waste volume generated in the year (m³)</th>
<th>Total waste volume (m³)</th>
<th>Total Airspace used (waste and cover)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2009</td>
<td>5262.4</td>
<td>5262.4</td>
<td>7320.7</td>
</tr>
<tr>
<td>2</td>
<td>2010</td>
<td>5420.3</td>
<td>5420.3</td>
<td>7556.6</td>
</tr>
<tr>
<td>3</td>
<td>2011</td>
<td>5582.9</td>
<td>5582.9</td>
<td>7795.3</td>
</tr>
<tr>
<td>4</td>
<td>2012</td>
<td>5750.4</td>
<td>5750.4</td>
<td>7880.2</td>
</tr>
<tr>
<td>5</td>
<td>2013</td>
<td>5922.9</td>
<td>5922.9</td>
<td>7997.8</td>
</tr>
<tr>
<td>6</td>
<td>2014</td>
<td>6100.6</td>
<td>6100.6</td>
<td>8107.2</td>
</tr>
<tr>
<td>7</td>
<td>2015</td>
<td>6283.6</td>
<td>6283.6</td>
<td>8218.0</td>
</tr>
<tr>
<td>8</td>
<td>2016</td>
<td>6472.1</td>
<td>6472.1</td>
<td>8328.8</td>
</tr>
<tr>
<td>9</td>
<td>2017</td>
<td>6666.3</td>
<td>6666.3</td>
<td>8439.5</td>
</tr>
<tr>
<td>10</td>
<td>2018</td>
<td>6866.2</td>
<td>6866.2</td>
<td>8550.2</td>
</tr>
<tr>
<td>11</td>
<td>2019</td>
<td>7072.2</td>
<td>7072.2</td>
<td>8661.0</td>
</tr>
<tr>
<td>12</td>
<td>2020</td>
<td>7284.4</td>
<td>7284.4</td>
<td>8771.7</td>
</tr>
<tr>
<td>13</td>
<td>2021</td>
<td>7502.9</td>
<td>7502.9</td>
<td>8882.3</td>
</tr>
<tr>
<td>14</td>
<td>2022</td>
<td>7728.0</td>
<td>7728.0</td>
<td>8992.9</td>
</tr>
<tr>
<td>15</td>
<td>2023</td>
<td>7959.9</td>
<td>7959.9</td>
<td>9103.6</td>
</tr>
<tr>
<td>16</td>
<td>2024</td>
<td>8198.6</td>
<td>8198.6</td>
<td>9214.3</td>
</tr>
<tr>
<td>17</td>
<td>2025</td>
<td>8444.6</td>
<td>8444.6</td>
<td>9325.0</td>
</tr>
<tr>
<td>18</td>
<td>2026</td>
<td>8697.9</td>
<td>8697.9</td>
<td>9435.7</td>
</tr>
<tr>
<td>19</td>
<td>2027</td>
<td>8958.9</td>
<td>8958.9</td>
<td>9546.3</td>
</tr>
<tr>
<td>20</td>
<td>2028</td>
<td>9227.7</td>
<td>9227.7</td>
<td>9657.0</td>
</tr>
<tr>
<td>21</td>
<td>2029</td>
<td>9504.5</td>
<td>9504.5</td>
<td>9767.7</td>
</tr>
<tr>
<td>22</td>
<td>2030</td>
<td>9789.6</td>
<td>9789.6</td>
<td>9878.4</td>
</tr>
<tr>
<td>23</td>
<td>2031</td>
<td>10083.3</td>
<td>10083.3</td>
<td>10000.0</td>
</tr>
<tr>
<td>24</td>
<td>2032</td>
<td>10385.8</td>
<td>10385.8</td>
<td>10121.5</td>
</tr>
</tbody>
</table>

Assuming Landfill will become operational in January 2014.
From the table above it can be deduced that for a site life of 20 years, an airspace of 196,709 m³ is required. For a site life of 30 years, an airspace of 348,284 m³ is required. These figures are approximate and depend on many variables. The type of plant used in the operation can have a significant effect on compaction and hence, density. The assumed density of waste in the landfill is 350 kg/m³. By using a landfill compactor \textit{in-situ} densities of 700 to 1,000 kg/m³ can be achieved, which would increase the life of the site by many years.

### 4.2 Available airspace

After developing a conceptual site layout for each site, a footprint for the disposal area was established and measured. From this footprint an airspace calculation was carried out, yielding the following results:

**Table 4: Available airspace**

<table>
<thead>
<tr>
<th>Site</th>
<th>Cell footprint dimensions</th>
<th>Cell footprint area</th>
<th>Available airspace</th>
<th>Cover volume</th>
<th>Remaining airspace</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site 3</td>
<td>240 m x 93 m</td>
<td>22,320 m²</td>
<td>172,332 m³</td>
<td>34,466 m³</td>
<td>137,866 m³</td>
</tr>
</tbody>
</table>

Some of the parameters used in calculating the airspace were as follows:

- Side slopes of 1:3;
- The final height approximately 10 m above ground level;
- Sufficient room should be available on the top level (platform for truck turning radius);
- The cell extends approximately 2 m below ground level; and
- A cover ratio of 1:5 was used.

### 4.3 Cover material

The volume of cover required was calculated using a ratio of 1:5 (cover: waste). The cover volumes required and available (pending investigations regarding the suitability and excavatability of the \textit{in situ} soil) are shown in Table 5 below. The cover volume available was calculated using the amount of soil excavated over the footprint area to a depth of 2 m below the ground level.
### Table 5: Cover volume analysis

<table>
<thead>
<tr>
<th>Site</th>
<th>Cover volume available</th>
<th>Cover volume required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site 3</td>
<td>36 972 m³</td>
<td>34 466 m³</td>
</tr>
</tbody>
</table>

### 4.4 Site life

Based on calculations from the available airspace, with the site operational from January 2014 and an annual volume increase of 3%, with a cover ratio of 1:5 the following was calculated:

#### Table 6: Site life

<table>
<thead>
<tr>
<th>Site</th>
<th>Life</th>
<th>Capacity reached</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site 3</td>
<td>17.5 years</td>
<td>June 2031</td>
</tr>
</tbody>
</table>

It should be noted that site life may be increased through the implementation of recycling initiatives in the area or at the landfill facility. It is also influenced by the *in-situ* density which is in turn affected by the compaction method and settlement of the waste body as decomposition takes place. Typically smaller landfill sites receive more ash and less putrescible waste than similar volumes from a city, and settlement is therefore less.

The preferred site, Site 3, shows 17.5 years of site life. The estimation parameters used have been conservative and unless generation rates increase significantly, it is almost certain that a site life of 20 years is practically possible.

### 4.5 Basal Liners

The analysis of liner requirements at the conceptual design stage is not required by the Minimum Requirements, however, for the purpose of this report a brief analysis has been carried out. According to the recently promulgated *Standards for Disposal of Waste to Landfill (GN R.636 of 23 August 2013)*, published by the DEA, the type of waste and not the landfill classification decides the containment barrier design (as opposed to the case in the Minimum Requirements specifications). The waste is classified as a Type 2 waste and thus requires a Class B containment barrier (liner). The standard Class B liner design can be seen in Figure 5, however, it is proposed that the clay layer be replaced with a geosynthetic clay liner (GCL).

The reasons for this modification are that a GCL is quicker and easier to install on site than natural clay layers, which are notoriously difficult to compact while achieving the required moisture content. Even more significant than the practicality during construction is the homogenous nature of a GCL compared to a natural clay. The GCL is produced in factories where the bentonite specification can be strictly controlled. Provided the GCL provides the same or less permeability than the natural clays specified, it is suitable for use in a domestic waste General (or Class B) landfill basal liner.
The contaminated water pond liner would be similar to that of the landfill, except that the leachate drainage layer would not be required. The liner layers on the base of the pond would therefore comprise of the following components, working from the top downwards:

- Sand cushion/ballast layer 100 mm thick;
- 1.5 mm HDPE liner;
- GCL liner;
- Geotextile separation layer; and
- Finger drains in a 150 mm base preparation layer.

### 4.6 Site layout elements

The site layout is to comprise of the following components, the layout of which will be arranged to suit the site shape and topography:

- A fence enclosing the site;
- A firebreak at least 5 m wide along the inner side of the fence;
- An upslope berm along the relevant boundaries;
- Entrance and access roads (7.5 m wide) around the disposal area with adequate turning radii (20 m);
- A leachate pond downslope of the disposal area;
- A “wet cell” near to the site entrance, to accommodate waste during periods when the site is inaccessible due to heavy rains, for later removal to the landfill;
- Toe drains surrounding the footprint (approximately 1.5 m wide);
- A cover stockpile area;
- Office, guard house and toilet facilities near to the site entrance;
A suitably sized, lined landfill with a minimum fall to the base of 2%;
- A leachate drain from the landfill to the leachate pond; and
- Sub-soil finger drains connected to a manhole- lump before discharge, to enable monitoring for contamination (liner leakage).

Based on these elements, conceptual designs have been developed and drawings are attached to this report in Appendix B.

### 4.7 Drainage

The drainage systems normally associated with a landfill site address three systems:
- Uncontaminated upslope run-off;
- Contaminated run-off from the landfill slopes and ring roads; 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.

#### 4.7.1 Upslope run-off

Uncontaminated upslope stormwater run-off is to be diverted from the landfill site by means of a diversion berm. This berm will be present on the upslope boundaries of the site, thereby preventing uncontaminated water from entering the site. The berm would be constructed from in-situ soils compacted in a mound at least 500 mm high. On steep slopes and for high volume flows a grader-cut drain and erosion protection measures must be considered.

#### 4.7.2 Contaminated run-off

Potentially contaminated run-off from the surface of the waste body and site roads should be impounded on the site in a lined facility and tested before being discharged to the environment in a controlled way. Preferably this water should be managed on site by means of lined drains, collection in a lined pond, evaporation and re-use for dust suppression on the landfill and landfill roads.

#### 4.7.3 Highly contaminated leachate

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.

On a small domestic waste, General landfill a sophisticated water treatment plant is generally unnecessary. In a water-deficit climate such as this, a treatment facility is definitely not required. The leachate pond should be designed to accommodate at least a 1:50 year, 24 hour duration storm with a 0.5 m freeboard.

Leakage from the landfill and pond should be minimal, but must be monitored. At least one downslope borehole should be installed if there is no existing borehole. Downslope monitoring points for surface water should be confirmed in the Operating Plan. Further, the sub-soil drain discharge point/manhole should be monitored regularly, for both volumes and water quality.
4.8 Impacts identified by the investigations

Site 1
- The site falls in an “important area” as per Gauteng Department of Agriculture and Rural Development (GDARD) policies*;
- The site is nearby to a residential settlement (0.3 km from Devon);
- Lies within a drainage area or 5 km of a water source;
- The buffer zone is less than 400 m**; and
- The site is located upwind of a residential area in the prevailing wind direction.

Site 2
- The site falls in an “important area” according to GDARD policies*;
- Nearby to a residential settlement (adjacent to Impumelelo);
- Lies within a drainage area or 5 km of a water source;
- The buffer zone is less than 400 m**; and
- The site is located upwind of a residential area in the prevailing wind direction.

Site 3
- A small portion of the site falls in an “irreplaceable area” according to GDARD policies*. The rest of the site falls into an “important area”; and
- Lies within a drainage area or 5 km of a water source.

*The Proposed Tshwane Open Space Framework, Volume 3, Implementation Strategies (November 2005) define an irreplaceable area/site as: “A site designated as essential in meeting targets set for the conservation of biodiversity in Gauteng. Options for achieving these targets will be reduced should the site not be protected”. An important area/site on the other hand, is designated as important for the conservation of biodiversity in Gauteng, the significance of which is subject to ground truthing. The site is important to protect in some way, but not essential and can be replaced by a similar site, but a trade-off in the efficiency of the conservation plan may be the result.

**The buffer zone limitation could potentially be overcome by doing an air dispersion model to prove to the Regulator that the air quality impact on neighbouring communities could be acceptable (especially being downwind).

4.9 Development plan

The aim of the Development Plan is to develop the landfill from its initial constructed state, to its proposed final landform. The development plans should be developed in the detail design phase and included in the Operating Plan. At this stage, for the purpose of airspace and site life calculations, a basic landform and final shape of the landfill have been established and the practicality of the shape considered in terms of accessibility, operating platform dimensions, side slopes and geotechnical stability.
4.10 Closure/rehabilitation plan

As the various sections of the landfill reach their final height, they are to be appropriately shaped, graded and capped in accordance with the MRs and the approved Development Plan. The new Standards require a final capping design in accordance with the G:L:B+ design of the Minimum Requirements, depicted in Figure 6.

G:M:B+, G:L:B+ and Hazardous Landfills

Figure 6. Cover/capping design for G:L:B+ Landfills (Minimum Requirements, 1998)

Completed areas should be vegetated as soon as possible after capping. The “rising green wall” effect should be implemented by means of progressively grading and vegetating the side berms and then working behind them. Planting indigenous shrubs and grass around the site will also support this initiative. Through the on-going implementation of this vegetation strategy, there will be no or limited need for later rehabilitation. Maintenance, however, will need to be continued after closure. The prevention of water ingress is of paramount importance and thus the integrity of the capping as well.

4.11 End-use plan

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. The buffer zone could be considered for recreational purposes. Trees and shrubs should not be grown on the landfill itself, nor should any use be considered, such as playing fields, that would require extra watering of the grass.

4.12 Operating Plan

Together with the design, the design engineer draws up an Operating Plan, to ensure that the design intent is understood and carried through to the Operating phase. From this a more detailed operating manual may be drawn up, if necessitated by the particular conditions. The Operating Plan or manual also serves the purpose of providing a consistent background document for site managers, auditors and for training of the operations personnel.

The Operating Plan for the Devon site is attached in Appendix C and will appropriately be expanded once a final site has been chosen.

5.0 REFERENCES


4) Department of Water Affairs and Forestry (March, 2004) Internal Strategic Perspective Upper Vaal Management Area.

5) Department of Water Affairs and Forestry (February, 2004) Internal Strategic Perspective Olifants River Management Area.

GOLDER ASSOCIATES AFRICA (PTY) LTD.

Gregory Dode  
Jnr Waste Engineer  

Leon Bredenhann  
Principal and Strategic Advisor  

GD/LB/js

Reg. No. 2002/007104/07  
Directors: SAP Brown, L Greyling, RGM Heath

Golder, Golder Associates and the GA globe design are trademarks of Golder Associates Corporation.

gd/project/12452 - scip engineering permitting for closure of existing landfill/reports/concept design/10612452-12628-7_rep_conceptual_design_final_14feb14.docx
APPENDIX A
Document Limitations
APPENDIX B
Drawings
APPENDIX C
Operating Plan
February 2014

SCIP ENGINEERING GROUP

New Devon Landfill Preliminary Operating Plan

Submitted to:
SCIP Engineering for
Lesedi Local Municipality
PO Box 201
Heidelberg
1438

REPORT

Report Number. 10612452-12641-8
Distribution:
1 x copy Lesedi Local Municipality
1 x copy SCIP Engineering Group
1 x unbounded copy Project File
1 x copy GAA Library
Table of Contents

1.0 INTRODUCTION ........................................................................................................................................................ 1
2.0 RESPONSIBLE PERSON .................................................................................................................................................. 1
3.0 STAFF COMPLEMENT .................................................................................................................................................... 1
4.0 ACCESS ........................................................................................................................................................................ 2
    4.1 Access control ............................................................................................................................................................ 2
    4.2 Security ..................................................................................................................................................................... 3
    4.3 Fencing ....................................................................................................................................................................... 3
5.0 CONTROL AND MONITORING ...................................................................................................................................... 3
    5.1 Waste acceptance ........................................................................................................................................................ 3
    5.2 Medical waste ........................................................................................................................................................... 3
    5.3 Records ..................................................................................................................................................................... 3
    5.4 Auditing ...................................................................................................................................................................... 4
    5.5 Volume surveys ......................................................................................................................................................... 4
    5.6 Landfill gas monitoring ............................................................................................................................................ 4
    5.7 Water quality monitoring ........................................................................................................................................ 4
        5.7.1 Background analyses ............................................................................................................................................ 4
        5.7.2 Surface water ...................................................................................................................................................... 4
        5.7.3 Ground water .................................................................................................................................................... 5
        5.7.4 Leachate and contaminated water .................................................................................................................. 5
        5.7.5 Reporting .......................................................................................................................................................... 5
    5.8 Landfill monitoring committee .................................................................................................................................. 5
    5.9 Recycling .................................................................................................................................................................. 5
6.0 LANDFILL OPERATION .................................................................................................................................................. 5
    6.1 Drainage ...................................................................................................................................................................... 5
    6.2 Landfilling of waste at the working faces .................................................................................................................. 6
        6.2.1 Cell operation ..................................................................................................................................................... 6
        6.2.2 Daily cover ......................................................................................................................................................... 7
        6.2.3 Wet weather cell .................................................................................................................................................. 7
        6.2.4 Manoeuvring space .......................................................................................................................................... 7
    6.3 Screening by means of the “Rising Green Wall Approach” ...................................................................................... 7
6.4 Composting of garden waste ........................................................................................................................ 7
6.5 Waste reclamation ........................................................................................................................................ 7
6.6 Plant and requirements ............................................................................................................................... 8

7.0 CONTROL OF NUISANCES ......................................................................................................................... 8
7.1 Fires............................................................................................................................................................... 8
7.2 Litter ........................................................................................................................................................... 8
7.3 Odours .......................................................................................................................................................... 9
7.4 Flies .............................................................................................................................................................. 9
7.5 Dust and emissions ...................................................................................................................................... 9
7.6 Vegetation .................................................................................................................................................... 9

8.0 DEVELOPMENT PLAN ................................................................................................................................ 9

9.0 REHABILITATION ........................................................................................................................................ 10

10.0 CLOSURE PLAN ..................................................................................................................................... 10

11.0 CONCLUSION ............................................................................................................................................ 10

12.0 REFERENCES ............................................................................................................................................. 11

APPENDICES

APPENDIX A
Document Limitations
1.0 INTRODUCTION

The objective of the Operating Plan is to ensure that all waste is disposed, reclaimed and landfilled in a manner that is environmentally acceptable, safe and according to sanitary landfill practice. The operation must conform to the Minimum Requirements associated with the site classification. In this case, although the site may be classified as a G:S:B* facility, the design has been carried out in accordance with the new National Norms and Standards for Disposal of Waste to Landfill, GN R. 636, promulgated on 23 August 2013. This classifies the design as a Class B, which is comparable to a Class G:L:B+ design as per the previous Minimum Requirements. For this reason, the operating requirements will be in line with those of a G:L:B+ facility.

The Operational Plan describes the way in which the waste disposal facility should be operated, addressing aspects such as access, controls, drainage, etc. The detailed implementation and application of the Operational Plan will be achieved by means of regular monitoring and auditing.

In order to ensure environmentally acceptable waste disposal, resources such as funds, suitable facilities, equipment and trained staff, including a Responsible Person, are required.

It is noted that this is a preliminary Operating Plan and that it is to be superseded by a comprehensive Operating Manual which will be prepared as part of the detailed engineering phase.

2.0 RESPONSIBLE PERSON

The Responsible Person for the Devon Landfill is a suitably qualified representative at the Lesedi Local Municipality. If operated by an outside Contractor, a Responsible Person will be nominated from that company as well, although ultimate authority lies with the Municipality.

3.0 STAFF COMPLEMENT

The Specialist Operator must appoint sufficient people to operate the site to the required standards, including health and safety aspects. The following staff compliment is suggested:

- **Site Supervisor:** This person is responsible for the day-to-day management of the disposal facility. The site Supervisor must ensure that all the applicable permit conditions, applicable Minimum Requirements and other legislative requirements are complied with. He must also ensure that the final landform and remediation design are implemented. He will also be responsible for submitting a monthly progress report and contractor’s invoice to the Municipality’s Responsible Person;

- **Plant Operators:** The plant operators are responsible for operating the required landfill equipment. This could include a landfill compactor, bulldozer, water cart, tipper truck and front-end-loader. Operators will also be required to operate the tyre cutter and composting equipment. The plant operators are required to operate their equipment in a safe, competent and predictable manner. They must also ensure that their equipment is well maintained and that any defects are reported to the Site Supervisor;

- **Spotters:** The spotters will be responsible for, inter alia:
  - Directing waste transport vehicles to the correct disposal areas, for example to the correct working face;
  - Identifying hazardous and health care waste loads that have been disposed of, and identifying and reporting vehicles disposing of these and other unacceptable waste types at the site;
  - Identifying and reporting speeding vehicles and people behaving irresponsibly towards the Site Supervisor; and
  - Managing the waste reclaimers, i.e., ensuring that the reclaimers are not exposed to unsafe situations, that children and animals are removed from the site, that fires are only made in dedicated areas, and that the storage area for the reclaimed material is kept clean and tidy.
Litter Pickers and General Workers: These people will be responsible for:
- Picking up windblown litter and isolating and removing health care and other hazardous waste from the working faces for safe storage, treatment and disposal elsewhere;
- Removing alien vegetation;
- Cleaning and maintaining drainage systems and erosion gullies, etc.;
- Cleaning the toilets and other facilities;
- Other work required to maintain a high standard of housekeeping; and
- Inspecting fences and fixing these where holes and other damages are observed.

Administrative People: Sufficient people must be appointed to ensure that the required records are kept;

Guards: The guards will be responsible for safe guarding the contractor’s yard and landfill equipment. They must also ensure that waste reclaimers do not hitch rides on vehicles or intimidate any person or persons disposing of waste at the facility. Guards will be required during working hours and after hours; and

Others: Other people will be required part-time to ensure that the site is operated to a high standard and that safe environmental conditions are maintained. This would include a surveyor to survey the airspace usage every three months and auditors for conducting air quality monitoring and other monitoring that may be specified in the Landfill Licence. Subcontractors for specialist work, such as capping and repairing the liners may have to be appointed from time to time.

4.0 ACCESS
4.1 Access control

Vehicle access must always be limited to a single site entrance, to facilitate control. During hours of operation, this entrance must be manned. It must be locked when the facility is not in operation, to prevent unauthorised entry. A notice board, in accordance with the Minimum Requirements, must be erected at the entrance, stating the name, address, and telephone number of the Licence Holder and Site Supervisor, the hours of operation and an emergency telephone number in at least three official languages. Suitable signs must also be erected on site, to direct waste transport vehicles to the correct working areas and to control speed.

Access control is to be of a high standard to prevent unacceptable waste types from entering the site. In addition, records are to be kept of all loads for control and planning purposes. Waste loads are to be checked for hazardous waste (unidentified industrial wastes, chemicals and chemical containers, sludges, and so forth), which must be directed to a hazardous waste disposal facility, and the details of the load and vehicle recorded. Loads are also to be verified for problematic waste types, such as expired food, dead animals, odorous wastes and so forth, which must be disposed of and covered immediately to minimise negative impacts. It is suggested that the disposers of such waste loads be identified and that these disposers contact the Site Supervisor well in advance before problematic wastes are transported to the site.

Road access to the 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 surfaced and maintained in such a manner so as to ensure that waste can reach the working face with the minimum of inconvenience in all weather conditions. Roads must also be regularly graded and wetted to control dust, when necessary. Two-way traffic must be possible on the approach road to all on-site facilities in all weather conditions.
4.2 Security
Suitable security must also be provided at the site to protect facilities, plant and personnel on site. To this effect, security may assist with access control measures at the site.

4.3 Fencing
Gates and fences shall be inspected on a daily basis to verify that they have not been vandalised. Broken fences and gates shall be repaired as soon as the damage is reported to the License Holder.

The cost of repairing the damaged fences and gates will be to the account of the License Holder, but the Operator must arrange the repairs. In cases where the Operator has caused the damage, the cost of repairing the damage will be to the account of the Operator.

5.0 CONTROL AND MONITORING
5.1 Waste acceptance
One of the purposes of the Site Classification System is to ensure that G sites receive only general waste. Prior to waste being accepted at the entrance, it must be verified as general waste by visual inspection by the gatekeeper and confirmed with the transporter.

The plant operators and spotters at the working face must also ensure that no hazardous waste (e.g. hazardous liquids, sludges, solids, medical waste or even drums containing hazardous waste) is disposed of. In the event that hazardous waste is intercepted or detected, the Site Supervisor must be informed. Hazardous wastes must be directed to suitable facilities for disposal elsewhere.

5.2 Medical waste
Medical waste presents a problem on landfills. Problems include the exposure of workers and reclaimers to infected material and human tissue, the danger of injury and infection from sharps, etc.

It is thus essential that medical waste be treated as hazardous waste from the moment that it is generated until its disposal. It is important to note that medical waste may not be disposed of at a General waste site and should be incinerated/treated elsewhere. If medical waste is noted at the working face, the Site Supervisor must be informed, the landfill operation stopped, the medical waste isolated and removed from the waste body, safely stored and then taken to a registered incinerator or other approved treatment facility. The removed medical waste should be stored in the correct waste containers and should be stored in a lockable facility prior to removal from the site. Spotters and general workers handling the medical waste must wear the correct Personnel Protective Equipment (PPE).

5.3 Records
Records must be kept of all waste entering and leaving the site as well as deposition rates. Waste must be categorised by the number of loads, defined by mass and type. Records must be kept on both a daily and a cumulative basis. The following types of waste must be recorded, namely:

- Household waste;
- Commercial and industrial waste;
- Clean garden waste;
- Building rubble and spoil; and
- Problematic and hazardous waste types, including those turned away, such as sludges, condemned foods, carcasses, health care waste, etc.; and
- Meteorological records should also be kept, including rainfall, evaporation, wind, etc.
5.4 Auditing
Regular auditing of the site should be carried out to ensure that the final landform and remediation plans are implemented, that the landfill is operated and maintained at a high standard and that the licence conditions and applicable Minimum Requirements are complied with.

It is therefore required that the Operator conducts four internal audits per annum. The Operator must ensure that internal audit reports are compiled and that these are submitted to the Responsible Person. The internal audit must contain a programme (target dates) for rectifying audit findings. The internal audit must cover the licence conditions, applicable Minimum Requirements or regulations, site-specific requirements of the contract, final landform and remediation design, and health and safety issues, i.e., aspects applicable to the landfill and covered under the Occupational Health and Safety Act.

The Responsible Person will appoint an external auditor. The Site Supervisor will also make all internal audit reports available to the external auditor for his perusal. External audits are to be carried out twice per annum.

5.5 Volume surveys
In order to track the remaining airspace at the landfill on a continual basis, annual surveys must be performed with the appropriate instruments and accuracy. The entire site should also be surveyed prior to the facility becoming operational.

5.6 Landfill gas monitoring
Landfill gas monitoring systems should be installed and monitored during the routine audits, or at three month intervals. Monitoring may continue after the closure of the site until the Department is satisfied that landfill gas no longer presents a risk.

5.7 Water quality monitoring
A long term water quality monitoring programme is required to ensure adequate environmental protection. Surface water, ground water and leachate all need to be monitored. The programme would include a background analysis, conducted prior to the waste facility becoming operational, as well as detection and investigative monitoring when operational. Post closure monitoring would also be a requirement.

The objectives of the water quality monitoring programme are:

- To indicate any escape of leachate into the environment and to quantify its effect; and
- To serve as an early warning system so that pollution problems that arise can be timeously identified and rectified.

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

5.7.1 Background analyses
Groundwater samples should be taken from all the monitoring wells installed over the life of the landfill. These should include upstream and downstream boreholes. These samples must be analysed to obtain background water quality data before the construction of the new extended landfill. A complete background analysis of the groundwater should be taken before the construction of the landfill.

5.7.2 Surface water
Surface water bodies in the vicinity of the site should be monitored, both upstream and downstream of the landfill site. Samples should be taken and analysed four times per year to identify any deterioration in water quality that may be associated with the landfill operation.
5.7.3 Ground water
Ground water monitoring points have to be identified and monitored around the landfill site. Boreholes will be drilled as part of the construction phase to be used for this purpose. Ground water is to be sampled and analysed at three monthly intervals.

5.7.4 Leachate and contaminated water
Leachate in the leachate tank 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 at three monthly intervals together with the surface and ground water monitoring.

5.7.5 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. These results and associated reports should be kept on site as well as submitted to the relevant regulatory authorities.

5.8 Landfill monitoring committee
A Landfill Monitoring Committee is required for G:L:B\(^*\) landfills in the Minimum Requirements and may also be specified in the License Conditions. It is important that a formal Landfill Monitoring Committee is established, which can be used as a forum to resolve disputes and complaints. Representatives of the following organisations should form part of the Committee:

- The licence holder, namely the Lesedi Local Municipality;
- The Specialist Contractor;
- The waste reclaimers;
- The general public, especially those living nearby;
- The Department of Water Affairs (DWA); and
- The provincial Department of Agriculture, Conservation and Environment.

The Landfill Monitoring Committee should develop a constitution, which should be acceptable to all representatives (MR, 1998). Meetings should be held once every three months following the generation of the external audit report. Formal minutes must be kept and circulated. The minutes must be made available to the external auditor.

5.9 Recycling
If deemed feasible, controlled salvaging may be implemented at the landfill working face, provided that it is carried out in a safe and hygienic manner, and provided that it does not create a litter problem.

6.0 LANDFILL OPERATION

6.1 Drainage
Once constructed, the drainage systems must be managed and maintained. Drainage at the working face must continually be adapted and developed as the landfill develops. On-site drainage must also be managed as follows:

- All clean, uncontaminated water must be allowed to drain off the site under controlled conditions and within the structures constructed for this purpose;
- The working faces must be so graded that water drains away from the deposited waste;
Polluted run-off from the stockpile area for reclaimed material (if any) must drain towards the polluted water dam;

Under wet weather conditions, all storm water contaminated by contact with waste must be directed into the contaminated water pond. This water may be used for dust suppression on areas that drains to the contaminated water system. The contaminated water pond must be kept as empty as possible under dry weather conditions;

All temporarily and finally covered areas must be graded and maintained to promote run-off and eliminate ponding or standing water;

Drainage systems, including silt traps, must be inspected and cleaned on a daily basis, and all drains must be cleaned of wind-blown litter, debris, silt and vegetation to ensure effective drainage of surface water. Collected windblown litter and other debris must be removed to the working face and not burned; and

Erosion gullies that develop on the waste body must be filled in and erosion damaged drains rehabilitated.

6.2 Landfilling of waste at the working faces

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.

6.2.1 Cell operation

The method most commonly proposed for the disposal of domestic waste, and required in terms of the Minimum Requirements, is the cell method, which is based on the construction of a series of cells, which are prepared to receive the waste. The cell method is to be used to operate the Devon landfill site at all times.

At the Devon landfill site a two-cell method, i.e., two active working faces, is to be deployed. The reason for this is that while waste is off-loaded at the one working face, compaction and spreading will be allowed at the other. In the cell where off-loading is occurring, the waste reclaimers may collect recyclable material. Recovery of recyclable material is to be carried out under the supervision of the spotters. Every so-often the operation has to be swapped around.

The waste is to be deposited at the base of the cell, and needs to be spread towards the back of the cell at a slope of 1 in 3. "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. The waste is compacted in the cell by several passes of the landfill compactor, up and down the slope. 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. The top of the cell should be covered during the course of the day once the appropriate level is reached, and the cell slope must be covered at the end of each day's operation. Cover material should be placed at the top of the cell and not at the bottom of the working face. Waste transport vehicles with suitable material for daily cover should be directed to the top of the cell so that it can be disposed in the correct position.

The basic landfill unit is thus a cell of compacted solid waste, which at the end of each working day, is entirely contained by cover material.

Problematic waste types, such as expired food, dead animals, odorous wastes and so forth, must be disposed of in trenches and covered immediately to minimise negative impacts. It is suggested that the disposers of such waste loads be identified and that they contact the Site Supervisor well in advance so that a trench can be prepared timeously.
There must always be sufficient cell capacity on site to accommodate at least a week’s waste.

6.2.2 Daily cover
The DWA’s Minimum Requirements specifies daily or more frequent cover of the compacted waste body, with cover of approximately 150 mm. A sanitary landfill operation generally uses a cover to waste ratio of 1:5. The cover must be sufficient that windblown litter does not result. For daily cover, material such as building rubble and spoil may be used.

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 to fully cover the waste at the end of each working day.

Stockpiles of topsoil, capping material and excavated soil should be piled separately and maintained. The Operator is to protect the stockpiled topsoil by preventing compaction (vehicle movement), contamination and mixing with any other material. Soil to be used for final capping of the waste would be a more clayey material. Excavated soils are to be used for daily cover when other material such as rubble is not available.

6.2.3 Wet weather cell
A wet weather cell should be located near the entrance of the site for use under abnormally wet weather conditions. This cell should be large enough to contain at least one week’s waste and should be cleared of waste immediately after roads become trafficable again. 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.

6.2.4 Manoeuvring space
Space must be made available by the Operator at the working face to enable vehicles to manoeuvre and reverse without causing excessive congestion and safety risks. A minimum face width must be maintained to enable two vehicles to work alongside each other. The width should be regularly evaluated to ensure that congestion of vehicles does not occur. Incoming vehicles depositing in the cells should reverse into the cell under the direction of the spotter.

6.3 Screening by means of the “Rising Green Wall Approach”
The “rising green wall” approach is one which is intended to screen the waste disposal operation once ground level has been reached. It typically entails constructing a 2 m high berm, with 1:3 slopes and a 1 m wide crest. Waste is then deposited behind the berm until the berm height is reached, where after the next berm is constructed. On each occasion that the berm is raised, the outer slope is covered with fine soils and vegetated.

6.4 Composting of garden waste
The landfill site may receive a significant amount of garden waste, which consumes airspace, and requires spreading, compaction and cover. It is therefore suggested that clean garden waste be composted in a dedicated area. The composted material could be used as a soil amelioration product in the topsoil layer when the site is capped during closure.

In order to enhance composting, the plant material needs to be chipped, placed in windrows and then regularly turned. Only clean garden waste is to be used for composting.

6.5 Waste reclamation
Waste reclamation and sanitary landfilling are not compatible activities, as reclaimers require access to the waste, while sanitary landfilling aims at confining it. Also, having reclaimers working in the vicinity of heavy machinery is a significant safety risk.

The reclaimed material presents a fire hazard and fire extinguishers should be kept at the site offices. Cooking fires and day shelters should be developed in a separate area, which must be well away from the...
storage area. Babies and small children will not be allowed on the site and, hence, also not the storage area for reclaimed material and the day-shelter area.

The contractor may not interfere with the buying and selling activities of the waste reclaimers.

In order to ensure effective communication, regular meetings between site management and representatives of the reclaimers must be held. The reclaimers should appoint their own representatives. Minutes must be kept of meetings and these must be made available to the external auditor.

6.6 Plant and requirements

The waste and cover should be spread and compacted by means of a landfill compactor. A front-end–loader (FEL) and tipper truck would also be required to load and cart cover material to the working face. A bulldozer can also be used for placing cover over the compacted waste.

A water cart is required for dust control measures. The contractor may use a tyre cutter in order to manage the large number of tyres. The FEL may also service the composting plant.

Further to this, with regards to plant on site, the Operator is responsible for the following:

- Cleaning vehicles three (3) times per week with a pressure cleaner at the end of the working day;
- Cleaning the radiators of plastic, paper and any other material on a daily basis;
- Inspecting equipment daily for any obvious oil or other leaks;
- Greasing the equipment and checking of all fluid levels;
- Reporting any performance problems and/or breakdowns immediately;
- Drip trays are to be placed underneath vehicles when parked on site; and
- Back-up vehicles shall be made available within 24-hours by the Operator’s Area Manager as and when required.

7.0 CONTROL OF NUISANCES

Nuisances resulting from the waste disposal facility and operations should be controlled as follows:

7.1 Fires

Burning of waste is prohibited in all areas of the waste disposal facility, except in the area allocated for cooking fires, which must be far removed from the waste body. In the case of accidental fires at the working face, these must be extinguished immediately by means of smothering with cover material as opposed to applying water. Reclaimers are not allowed to set fire to any waste or reclaimed material.

Cooking fires will only be allowed in a special assigned place well away from the waste disposal, materials storage and the composting areas and any other infrastructure. Stockpiled tyres awaiting disposal may not be set alight.

Fire extinguishers must be available on the landfill compactor (one), other landfill equipment, such as the FEL (one), and the offices (two). Additional extinguishers must be placed as and when required, such as at fuel tanks if a bowser are not used. All fire extinguishers must be inspected and maintained on a regular basis in accordance with the required SANS standard.

7.2 Litter

Litter must be contained within the site by means of waste compaction and cover. Windblown litter must be picked up on a daily basis and taken to the working faces for disposal. Collected windblown litter may not be burned. All other areas of the disposal facility must be kept clean of litter, especially the reclaimed material storage area.
7.3 Odours
Odours must be combatted by good cover application and maintenance. Furthermore, the prompt covering of putrescible waste, such as abattoir waste, will reduce odour problems.

7.4 Flies
Should flies create a nuisance, these must be combated by placing fly-traps at strategic places at and around the waste disposal and the waste reclamation areas.

7.5 Dust and emissions
The following procedures should be followed to minimise any potential dust and emission pollution from the landfill site:

- All site roads, especially the access road, as well as other bare areas and stockpiled soil should be regularly wetted in order to prevent significant dust generation. Water used for this purpose must be used in quantities that must not result in the generation of run-off;
- Vehicles to be properly maintained to avoid unnecessary emissions;
- Ambient PM10 concentrations and dust fallout measurements should be undertaken in the vicinity of the proposed Devon waste disposal site prior to and during operations in order to establish background ambient air quality;
- Vehicles must be regularly serviced to ensure that no smoke is generated; and
- Construction vehicles must travel at low speeds to reduce the effect of dust.

7.6 Vegetation
The following procedures regarding vegetation on site should be adhered to:

- On-site vegetation, which has been planted, must be well watered and maintained until established to ensure effectively screening where required;
- No vegetation must be unnecessarily removed;
- A firebreak is to be maintained around any such vegetation to prevent it from being damaged by fires;
- Declared invasive and alien vegetation must be removed from the site on a regular basis;
- Workers and machinery are to remain inside the site footprint, so as not to damage surrounding vegetation; and
- All labourers are to be informed of disciplinary actions for the willful damage to plants.

8.0 DEVELOPMENT PLAN
The aim of the Development Plan is to develop the site from its current state to the intended final landform (see Drawing No. 10612452-14). The intention is that controlled development should take place, and that all the operating principles in the preceding sections should be implemented and controlled through site audits.

Before any work is carried out at the constructed facility, the co-operation of the waste reclaimers must be obtained. Once this has been achieved, access and gate control must be implemented. Cover material should also be identified and stockpiled prior to commencing with waste deposition. In the landfill, a pioneering layer of waste at least 600 mm thick is to be placed over the constructed liner before any landfilling is to proceed. This is to be carried out by end-tipping and spreading the waste ahead of the equipment, so as to create a bed of waste on which to operate, and so protect the installed liner systems.
The detailed development of the landfill should follow the development plan, and adapted if necessary based on site specific circumstances as they arise.

The final capping layer will be applied at the end of the site life, i.e., in the last year of the operation. Completed areas will require on-going maintenance, including the repair of cracks and erosion gullies. The appointed contractor must appoint the necessary sub-contractors to conduct specialist work, such as applying the final capping layer.

9.0 REHABILITATION

All final levels and slopes must be in conformance with the landfill design and the end-use plan, with slopes not steeper than 1:3. Once the final level is achieved, the area must be capped/covered with the final cover in accordance with the plan. Rehabilitation is to commence as soon as practically possible after the final level has been reached in order to rehabilitate on an ongoing basis and to prevent wind exposure of waste.

10.0 CLOSURE PLAN

The landfill should be surveyed with increased regularity and accuracy at it approaches its final levels. This will ensure that the final gradient and drainage are correct and in accordance with the end-use design, and limit any re-shaping at closure.

Immediately on completion of an area, final cover must be applied. Completed areas also require ongoing maintenance, including the repair of cracks and areas exposed by wind, and the filling of any settlement depressions. The rehabilitated areas should be controlled by ongoing monitoring after site closure, which should be complemented by water pollution monitoring.

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

- To create an aesthetically acceptable landform with gentle slopes that blend in with the surrounding terrain;
- To ensure that the site is shaped in a manner that will suit the final end use; and
- To ensure and environmentally compliant site.

The proposed end-use of the site is restricted open space, but this has not been finalised. A recreational area such a picnic area and bird sanctuary could be considered.

11.0 CONCLUSION

The preliminary Operating Plan outlined above should, if properly implemented, prevent the possible negative impacts normally associated with waste disposal from becoming a nuisance or an environmental threat. It must be stressed, however, that to ensure environmentally acceptable waste disposal, the resources outlined in this plan, such as funds, suitable facilities, equipment and staff, must be made available.
12.0 REFERENCES


GOLDER ASSOCIATES AFRICA (PTY) LTD.

Greg Dode
Jnr Waste Engineer

Leon Bredenhann
Principal and Strategic Advisor

Reg. No. 2002/007104/07
Directors: SAP Brown, L Greyling, RGM Heath

Golder, Golder Associates and the GA globe design are trademarks of Golder Associates Corporation.
APPENDIX A
Document Limitations
DOCUMENT LIMITATIONS

This Document has been provided by Golder Associates Africa Pty Ltd (“Golder”) subject to the following limitations:

i) This Document has been prepared for the particular purpose outlined in Golder’s proposal and no responsibility is accepted for the use of this Document, in whole or in part, in other contexts or for any other purpose.

ii) The scope and the period of Golder’s Services are as described in Golder’s proposal, and are subject to restrictions and limitations. Golder did not perform a complete assessment of all possible conditions or circumstances that may exist at the site referenced in the Document. If a service is not expressly indicated, do not assume it has been provided. If a matter is not addressed, do not assume that any determination has been made by Golder in regards to it.

iii) Conditions may exist which were undetectable given the limited nature of the enquiry Golder was retained to undertake with respect to the site. Variations in conditions may occur between investigatory locations, and there may be special conditions pertaining to the site which have not been revealed by the investigation and which have not therefore been taken into account in the Document. Accordingly, additional studies and actions may be required.

iv) In addition, it is recognised that the passage of time affects the information and assessment provided in this Document. Golder’s opinions are based upon information that existed at the time of the production of the Document. It is understood that the Services provided allowed Golder to form no more than an opinion of the actual conditions of the site at the time the site was visited and cannot be used to assess the effect of any subsequent changes in the quality of the site, or its surroundings, or any laws or regulations.

v) Any assessments made in this Document are based on the conditions indicated from published sources and the investigation described. No warranty is included, either express or implied, that the actual conditions will conform exactly to the assessments contained in this Document.

vi) Where data supplied by the client or other external sources, including previous site investigation data, have been used, it has been assumed that the information is correct unless otherwise stated. No responsibility is accepted by Golder for incomplete or inaccurate data supplied by others.

vii) The Client acknowledges that Golder may have retained sub-consultants affiliated with Golder to provide Services for the benefit of Golder. Golder will be fully responsible to the Client for the Services and work done by all of its sub-consultants and subcontractors. The Client agrees that it will only assert claims against and seek to recover losses, damages or other liabilities from Golder and not Golder’s affiliated companies. To the maximum extent allowed by law, the Client acknowledges and agrees it will not have any legal recourse, and waives any expense, loss, claim, demand, or cause of action, against Golder’s affiliated companies, and their employees, officers and directors.

viii) This Document is provided for sole use by the Client and is confidential to it and its professional advisers. No responsibility whatsoever for the contents of this Document will be accepted to any person other than the Client. Any use which a third party makes of this Document, or any reliance on or decisions to be made based on it, is the responsibility of such third parties. Golder accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this Document.
At Golder Associates we strive to be the most respected global company providing consulting, design, and construction services in earth, environment, and related areas of energy. Employee owned since our formation in 1960, our focus, unique culture and operating environment offer opportunities and the freedom to excel, which attracts the leading specialists in our fields. 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 who operate from offices located throughout Africa, Asia, Australasia, Europe, North America, and South America.