eMadlangeni Waste Landfill Site

Engineering Needs Assessment and Preliminary Closure Design Report

22 December 2017

Project Name:	***Closure of eMadlangeni Waste Landfill Site***
Report Title:	***Engineering Needs Assessment and Preliminary Closure Design Report***
Author(s):	***Reon A Pienaar***
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Prepared by:

RA Pienaar PrEng
RAPienaar Consulting (Pty) Ltd

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1 Introduction

1.1 Project Background

As a result of numerous complaints about the state of poorly operated municipal landfills and the associated impacts on the biophysical and social environment, the Department of Environmental Affairs (DEA) has embarked on an initiative to assist various Municipalities in South Africa with the licensing of the existing illegal waste disposal sites. The existing eMadlangeni landfill has been identified as one of the sites that will require a Waste Management Licence for decommissioning.

The eMadlangeni landfill occupies an area of about 6Ha (300m x 200m) and is located on Erf 10000 and Erf 1006 eMadlangeni within the eMadlangeni Local Municipality which falls within the Amajuba District Municipality. The site is within the boundaries of the Utrecht Balele Community Game Park and on the western foothills of the Balele Mountains. The landfill is approximately 4km north of the R34 which provides the main access into the Utrecht CBD. Direct access to the site can be gained from the surfaced President Street leading to Paulpietersburg. The Dorpspruit lies about 1.5km North West of the site. The locality map of the site is shown as **Figure 1**.

Figure 1: Location of eMadlangeni Landfill

1.2 Scope of Work

GA Environment (Pty) Ltd were appointed by the DEA to undertake the environmental authorisation process for a closure license at the eMadlangeni landfill and RAPienaar Consulting (Pty) Ltd was in turn appointed by GA Environment (Pty) Ltd to undertake Engineering investigations at the site to assist with the license application.

The scope of work for this report is to:

- To assess the existing site against standard legislative requirements for landfill design and operations, and develop a suit of conceptual engineering recommendations, which must be considered as license conditions to ensure that the landfill site is designed and operated within legal compliance;
- Assess and evaluate the requirements for the landfill containment barrier system (geomembrane lining) in accordance with the current legal framework and make key recommendations in relation to the above site investigations;
- Provide preliminary engineering design for capping of facilities that will be licensed for closure;
- Develop a suit of site-specific recommendations for consideration during the detail engineering design of the proposed landfill site and associated infrastructure;
- Landfill Engineering Cost Estimate;
- Provide recommendations to incorporate into the Closure/End Use Plan;

It is anticipated that should the Licence be granted, the Municipality will be able to source funding for the compilation of detailed engineering designs for the landfill and to allow for all activities related to the decommissioning of the landfill in line with NEM: WA, 2008, requirements. This report will thus aim to provide preliminary designs to aid the licensing process and a detailed engineering design would be required and approved prior to construction.

1.3 Details and CV of Author

This report was compiled by Mr Reon Pienaar (PrEng) who is the owner and director of RAPienaar Consulting (Pty) Ltd. Mr Pienaar holds a University degree in Civil Engineering, a BEng Honours degree and an MEng (Masters) degree in Environmental Engineering (specializing in Waste Management) from the University of Pretoria in South Africa. He has more than 12 years' experience in solid waste management, environmental management and dam engineering. The majority of his experience was spent in charge of projects and project teams.

He is registered as a Professional Engineer with the Engineering Council of South Africa (ECSA Reg. Nr. 20100281), he is a full member of the South African Institute of Civil Engineers (SAICE), a member of the Geosynthetic Interest Group (GIGSA), a member of the International Solid Waste

Association, a member of MENSA and sits on the Central Branch Committee of the Institute of Waste Management of South Africa (IWMSA) as vice chairman.

1.4 Methodology

The methodology followed to compile this report was for the Engineer to study all available background information on the site in order to familiarize himself with the history and requirements of the facility. In order to gain a full perspective of the requirements for closure, the Engineer then undertook a site visit in the presence of the Geotechnical expert to assess the actual site conditions, and evaluate a concept of the ultimate preliminary design.

The site visit was undertaken on 31 October 2017. The Engineer was also present during the excavation of the test pits used for geotechnical evaluation, in order to familiarize himself with the available materials and actual site conditions.

After visually assessing the site the Engineer then used all available information obtained, and applied his mind in order to best compile engineering recommendations for closure of the site in accordance with the technical, legal and legislative requirements for landfill closures in South Africa.

Non-technical base data used for report compilation was solely based on the site visit, discussions with municipal officials and the project EAP.

2 Site Assessment

2.1 Site Description

The landfill site is transected by numerous drainage lines which have formed dongas that are notable in the north western section of the site and in the areas immediately outside the landfill boundaries. The drainage lines feed into the Dorpspruit which is located approximately 1.5km North-West of the site. Discussions on site with the driver of the municipal waste disposal vehicle, as well as the operator of the TLB, indicated that waste disposal had been taking place at the site since the 1970's. It is assumed that the natural erosion dongas forming from the Balele mountains South-East to the Dorpspruit in the North-West created an area that was deemed fit for use as a waste disposal site when the site originated.

The eMadlangeni landfill receives general waste from areas located within the eMadlangeni Local Municipality. **Figure 2** shows a general layout of the site. Waste disposal took place to the extent that the area in the top of the image is filled with waste and is slowly encroaching on the bottom area (towards the Dorpspruit) by means of end tipping and pushing the waste downhill. About half of the 6Ha fenced area is covered with waste. The site entrance shown to the top right of the image and the site is fenced along the shape of the shown polygon in the image.

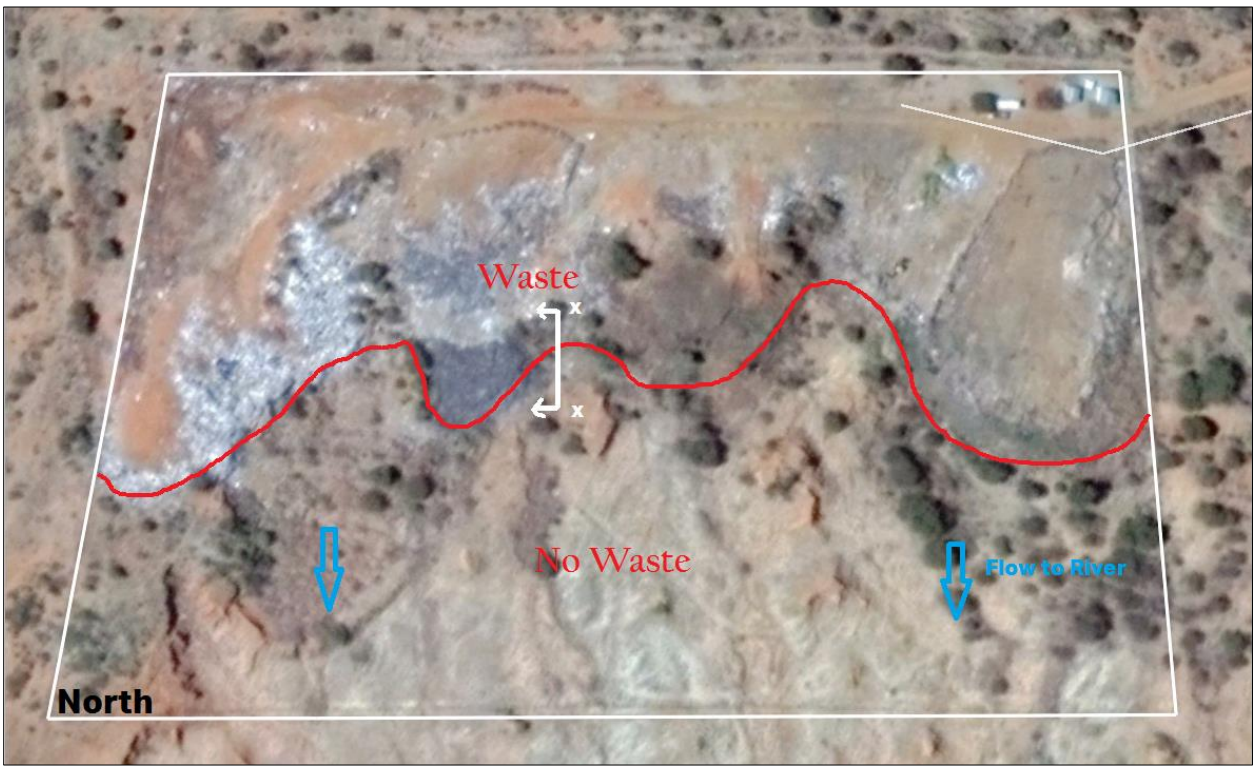


Figure 2: Waste Site Layout

Figure 3 shows the rough cross section X-X indicated in the image above. Waste is typically end pushed from point B to point A and left to stand at the natrual angle of repose which is in the order of 45^{o} or 1V:1H. The elevation between point A and B ranges from 2m to about 10m in places.

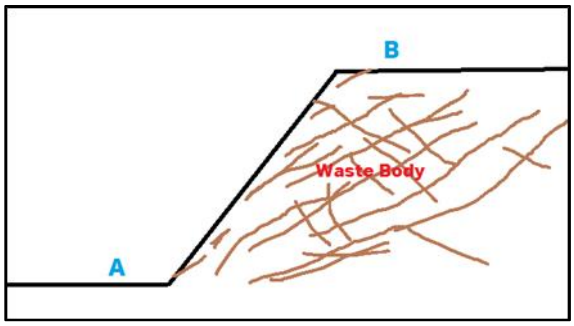


Figure 3: General Cross Section through Waste Body

The site receives general municipal waste from the surrounding areas and the municipal officials on site indicated that the municipal waste truck dumps a load at the landfill about 2 to 3 times per day. The rest of the waste is brought in by private individuals and small contractors etc.

Figure 4: Waste Disposal Vehicle

The municipal vehicle used to dump waste at the site is picture in **Figure 4** and typically holds a load of about 12m^3 of waste. If indications of up to four loads a day are accurate then the site receives in the order of 40m^3 of waste per day including waste disposed of by the public. Using a conservative loose waste density of 0.2t/m^3 this equates to about 8 tons waste per day.

A landfill receiving 8 tons of waste per day would have been classified as a Communal (C) site when using the Minimum Requirements classification system. With the observed site dimensions and waste profile it is estimated that the site currently holds in the order of 120,000m^3 of waste. It is thus possible that the facility is in the order of 30 to 40 years old. The site slopes naturally at about 4.5% from the mountain to the river.

It is assumed that the site has no base liner and that disposed had been placed in non-uniform layers over time with no direct purposeful compaction. By virtue of the topography the north eastern (upper) portion of the site has some form of stormwater diversion but it does not appear to be purposeful and thus does not provide good stormwater diversion.

2.1.1 Climate

According to www.saexplorer.co.za the area receives in the order of 615mm of rain per year, ranging from an average low of 3mm in July to an average high of 114mm in January. This is slightly more than the national average of about 450mm. The average midday temperatures for Utrecht range from 18.7°C in June to 26.1°C in January.

The site visit was undertaken for one day at the end of October 2017 which is in the summer season when temperatures and rainfall numbers are historically higher. It was a sunny and dry day on the day of the site visit with very little visual signs of leachate. With no leachate collection or detection system installed, it can be expected that leachate from rainwater falling on site will gradually make its way to the groundwater and/or the surface water bodies downstream. In winter it would be expected that the waste body would dry out slightly with higher risks of fires. The capping design measures proposed will be applicable for all seasons of the year since it works as a composite system.

2.2 Geotechnical Information

The 2017 Geotechnical Assessment by North Arrow Holdings contained the following information on the Geotechnical conditions at the site.

2.2.1 Site Geology

The eMadlangeni Landfill is underlain by sedimentary sandstone, shale (of the Ecca Group) which in turn are overlain by post Karoo dolerite (of the Drakensburg Group). The site is located inside a valley covered on the northwest and southeast sides by resistive dolerite plateaus which form the topography of the area escarpment consisting of hills and cliffs. Where dolerite has weathered it tends to form deep red residual soils. The runoff from the landfill site washes the sediments into a stream and a dam located approximately 1.5km downhill. There are no major geological lineaments visible from the geological map. No groundwater or perched leachate tables were encountered within the test pits.

The laboratory sieving results indicate that in general the soils tested comprise of silty (15%) clayey (21%) sand (64%). In terms of the Unified Soil Classification system the soil classifies mainly as a “SC” soil type, these clayey sand and poorly graded sand-clay mixtures. The Grading Modulus of 0.72 seems to reflects its fairly fine nature as corroborated with the sieving analysis results. Based on the indicator tests, the sand is considered to be of fair workability as a cover material, semi pervious. The plasticity indices (a measure of the plasticity of the clay) recorded show low values (< 12) which are indicative of fairly low activity (low expansiveness) for the soils. These should therefore not constitute any serious problems under conditions of moisture migration.

Permeability (hydraulic conductivity) tests conducted in the laboratory using the flexible wall constant head permeability test, on disturbed samples, indicate a permeability coefficient of $1.3x10^{-9}$ m/s ($1.3x10^{-7}$cm/s) for the soil tested.

2.2.2 Groundwater

The Aquifer Classification Map of South Africa classifies the aquifer as a minor aquifer. The explanatory notes for the Aquifer Classification Map (Parsons and Conrad, 1998) describe a minor aquifer as a moderately yielding aquifer system of variable water quality. The Hydrogeological Map of Vryheid (2730) classifies the aquifer type as Intergranular and Fractured with the lithology of predominantly arenaceous rocks such as sandstone and conglomerate with typical borehole yield ranging from 0.5 to 2 L/s. The lithology of the site is confirmed by the national groundwater archive database were three boreholes recorded show shale and sandstone as rock type found and the borehole yields range from 0.47 to 2.29 L/s. The water strikes are expected on the contact between the shale and sandstone and possibly on the dolerite intrusion contacts. eMandlangeni landfill site is expected to have recharge values of between 37 and 50 mm/annum. The mean groundwater level depth range between 11 to 15m below ground level.

2.2.3 Geotechnical Conclusions

Permeability (hydraulic conductivity) tests conducted in the laboratory on disturbed samples indicate values of $1.3x10^{-7}$ cm/s. The residual deep red soil is suitable to use as capping material subject to further consolidation at optimum density and moisture content.

There is potentially enough cover material judging by the depth of soil erosion down to some 3-4m depth. A borrow pit to extract some 40,000m^3 of soil to use as capping material needs to be identified in the vicinity.

The close proximity of the landfill to the river and dam 1.5km down slope presents a leachate pollution risk to surface water and possibly ground water.

The site does not reflect any risk for the formation of sinkholes or subsidence caused by the presence of water-soluble rocks (dolomite or limestone) and no evidence of mining activity beneath the site.

3 Legislative Review

3.1 Minimum Requirements

The 1998 Department of Water Affairs and Forestry (now Department of Water and Sanitation) document called "*Minimum Requirements for Waste Disposal by Landfill*" (referred to as Minimum Requirements from her on) is still very widely used today to provide guidelines for waste management in South Africa. Most of it has been replaced by the regulations of the 2008 Waste Act (more about that in the following section) but in terms of landfill capping and closure, the Minimum Requirements is still used extensively. The minimum requirements document promotes environmental protection and provides guidelines for waste management best practice. In terms of capping requirements it is most important to note section 8.4.7 which inter alia provides the following information on capping.

1. The main purpose of the capping layer is to separate the waste body from the atmospheric environment. It is intended for protection and isolation of the waste from the long term effects of wind and water erosion, burrowing animals etc.
2. It limits and controls the amounts of precipitation that enters the waste and should also allow water to leave the landfill by evapo-transpiration and vent landfill gas in a responsible manner.
3. The cap is intended to work in conjunction with the base liner by limiting the long term generation of leachate.

3.2 Waste Act

The National Environmental Management: Waste Act (Act 59 of 2008) and the subsequent National Environmental Management: Waste Amendment Act (Act 26 of 2014) then built on the principles described in the Minimum Requirements to provide sustainable regulation of waste management practices in South Africa. Through regulations 634, 635 and 636 the waste act further provided information on the classification, management, assessment of waste for disposal to landfill and although these regulations do not cover the capping of waste facilities, there are still principles of design, monitoring etc. that holds true for both lining and capping of landfills.

3.3 Capping Notes

Due to fact that the regulations in the waste act focussed more on waste disposal and lining, the guidelines for capping is still primarily derived from the 1998 minimum requirements document. For this reason the South African Institute of Waste Management (IWMSA) as recently as 2015 approached the Department of Water and Sanitation (DWS) to provide updated guidelines on the capping of landfills. This has been workshopped at more than one occasion and a DWS Technical Advisory Practice Note on capping and closure of waste management facilities and pollution point sources is being prepared.

The DWS practice note had not yet been officially released upon compilation of this report but the principles discussed are that of groundwater and environmental protection when capping landfills by assessing each facility on its own merits.

4 Specifications for Closure Design

4.1 Required Closure Principle

When assessing the eMadlangeni landfill for closure and capping design, the information on site specific conditions and legislative requirements discussed in the preceding chapters were taken into full consideration. Since the facility has no basal liner, the minimum requirements capping design for Small (S) landfills cannot be used.

For the capping design of this landfill it is proposed to use a restricted moisture cap (also called dry cap) in order to minimize the ingress of rain water and isolate the waste body form the atmospheric environment. The materials used in the design shall aim to reduce the percolation through the cap to less than 15 litres per hectare per day. Furthermore in order to address stability between layer works and assist runoff the maximum slopes for capping design will be limited to 1:4 (one vertical and 4 horizontal).

4.2 Site Geometrics

The final elevations of the capped landfill are shown on **Drawing EMA – 001** in **Annexure A**. They were designed to best align with the natural topography of the site. Although a topographical survey was not done, the Geotechnical expert took GPS coordinates and elevations at key points on site as shown in **Figure 5**. These data points were used in the design of the final capping layout and elevations.

The site slopes naturally from south-east to north-west and the final elevations at the fence line to the south-east of the site should tie in with the natural ground level in that area. The capped waste body should then slope gradually towards the top of the slope at a 5% gradient to facilitate run off and prevent ponding of rain water etc.

The rehabilitated landfill slope should not exceed gradient of 1V:4H and this design was done to allow for run off from the slope whilst maximizing slope stability. The slope shall not exceed a vertical height of 12m with a drainage bench being placed at a maximum height of 6m. The drainage bench will thus probably not be required for the full slope of the capped landfill and this would have to be confirmed during detail design of the facility with a full topographical survey. The drainage bench should be at least 800mm wide and sloped at 2% to allow for run off. A cut to fill operation and landscaping would have to be done in order to obtain the final landform.

Figure 5: GPS Data Points taken during site visit

4.3 Capping Design

The design of the capping layers was done to maximize run off and minimize ingress of water into the waste body. Opportunity for water ingress on the top of the capped landfill is higher due to the flatter slopes. Long term ingress of water into the 1V:4H side slopes are less possible, but runoff needs to be encouraged, and thus capping designs for the top of the landfill and the side slopes differ slightly. The side slopes capping was designed without the HDPE Geomembrane contained in the top capping, but including a Geosynthetic Composite drainage layer as shown on Drawing EMA-002 in **Annexure A**. this was done to facilitate run-off of possible ingress on the slopes and limit ingress of water on the plateau.

4.3.1 Capping Layers Works

The description of the proposed design layers for the capping of the landfill plateau and side slopes is described here beginning from the waste body and ending at the final (top) layer. **Figure 6** shows the proposed capping layers on the plateau and side slopes of the landfill and results in a maximum layer works thickness of about 1,500mm depending on the final geosynthetic options chosen. Full descriptions are given for the layer works on the landfill top and also hold true for side slope layer works where applicable.

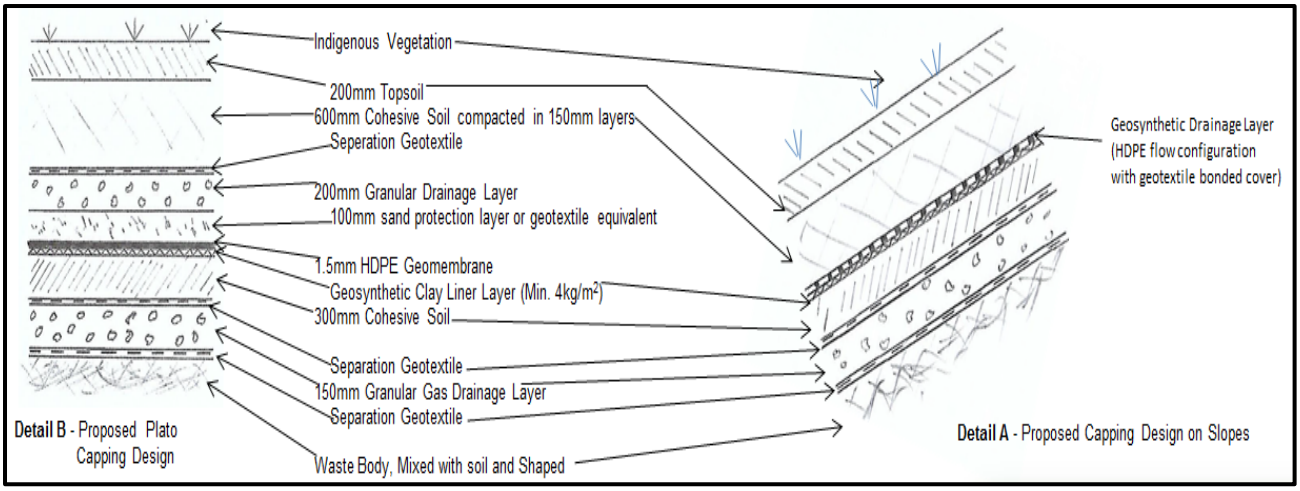


Figure 6: Proposed capping design

The various levels of the capping are described as follows:

- **Waste Body:** The final waste body is to be shaped as per the design drawings and compacted as well as possible with the equipment used during construction. It should be mixed with soil material where possible and shaped to a final profile that is as smooth as practically possible.

- **Separation Geotextile:** The separation geotextile separates the waste body from the capping layers and should be a non-woven geotextile with a typical thickness of about 2.5mm and unit weight of at least 1.5kg/m^2. This layer assists in preventing fine particles from the layer works entering the waste body.

- **150mm Granular Gas Drainage Layer:** This is a landfill gas venting layer having a minimum thickness of 150mm and consisting of single sized stone or gravel of between 25mm and 50mm in size. This layer needs to be connected to a gas management system with gas vents being installed in key areas.

- **Separation Geotextile:** The separation geotextile separates the drainage layer from the capping layers and should be a non-woven geotextile with a typical thickness of about 2.5mm and unit weight of at least 1.5kg/m^2. This layer assists in preventing fine particles from the layer works entering the drainage layer.

- **Cohesive Soil Layer:** This is a support layer to the below drainage system and should be 300mm thick consisting of in situ material compacted to a minimum density of 95% Standard Proctor maximum dry density at a water content of Proctor optimum to optimum +2%.

- **Geosynthetic Clay Liner (GCL):** A GCL is two geotextile layers with a layer of bentonite in the middle that acts as a containment barrier. The GCL should have minimum mass per unit

area of 4kg/m2 and the permeability of the GCL must be such that an outflow rate of $1x10^{-6}$ cm/s will not be exceeded. These parameters are to be tested for the chosen material as per the construction Quality Assurance and Quality Control (QA/QC plan) that needs to form part of the detail design report before construction. The GCL and HDPE composite layer is considered to be the primary barrier layer.

- **HDPE Geomembrane Layer (Plateau only):** The High Density Polyethylene (HDPE) Geomembrane (GM) sheet needs to be in direct contact with the GCL and needs to be manufactured by a reputable company and installed according to the Engineer's specifications contained in the construction QA/QC plan. The thickness specified shall be minimum thickness, as measured with the SABS Specification 1526 test method. This layer is only considered for eh top of the landfill cover and not the side slopes.

- **Sand Protection Layer (Plateau only):** The protection layer is placed directly above the GM to protect it from mechanical damage and can be in the form of a 100mm layer of fine to medium silty sand or a geotextile equivalent able to provide similar protection to the GM. If the geotextile options is chosen during detail design the total ballast layer above the GCL/GM composite should be carefully designed to still ensure full and proper contact between the GCL and GM. This layer is not required for the side slopes.

- **Granular Drainage Layer (Plateau only):** This system is provided to detect and remove any water leakage that has penetrated the layers above it. The granular drainage layer should consist of a 200mm thick layer of granular material (crushed stone) having a size of between 38mm and 50mm with perforated HDPE pipes installed at 20m intervals on the plateau of the landfill to direct leakage to the leachate collection system and sump.

- **Separation Geotextile (Plateau only):** The separation geotextile separates the drainage layer from the capping layers and should be a non-woven geotextile with a typical thickness of about 2.5mm and unit weight of at least 1.5kg/m^2. This layer assists in preventing fine particles from the layer works entering the drainage layer.

- **Geocomposite Drainage Layer (Slopes only):** There are a number of products on the market that could potentially be used here. The final design should replicate the specifications of a geocomposite drainage system similar to the ABG Pozidrain® product which consists of a high strength flexible polyethylene cuspated drainage core (at least 4mm thick) with a non-woven geotextile filter fabric bonded onto one or either side. The geotextile filters a wide range of materials and is bonded to the core to ensure that it does not deform into the drainage channels under the load of the backfill material. The drainage composite allows fluids and gases to percolate into the core whilst supporting the backfill material. The

collected fluids are then transported along the core to the leachate collection system at the landfill toe.

- **Cohesive Soil Layer:** This is a support layer to the below drainage system and should be 600mm thick consisting of in situ material compacted to a minimum density of 95% Standard Proctor maximum dry density at a water content of Proctor optimum to optimum +2%. The layers are to be placed and compacted in 150mm layers and also assist in providing the required pressure for the GCL/HDPE composite to function optimally. As indicated in the Geotechnical report the soils on site are predominantly weathered shales with a clay content and fairly low permeability. This soil will work well in conjunction with the other layers of the capping system.

- **Topsoil Layer:** This needs to be a minimum of 200mm topsoil layer to assist in the establishment of vegetative cover as soon as possible. The layer needs to be optimally compacted to assist plant growth and can contain a mixture of hydro seeding if required.

- **Indigenous Vegetation:** The vegetation layer assists with stability and run off and needs to be established as soon after construction as possible. The vegetation needs to be indigenous to the area in order to ensure optimal sustainability of the capping system.

4.3.2 Properties of Capping Materials

The long term performance of the capping system will depend on the quality of the design and construction process. This preliminary design needs to be confirmed through a detail design process after award of the waste licenses and the detail design report should contain a full QA/QC plan to be followed during the construction process. Certain key material properties for the proposed capping layers are described here, to be confirmed during detail design.

<u>In situ soil</u>

The in situ-soil tested as part of the Geotechnical assessment is a clayey soil with very low permeability according to the results from the laboratory. This material, if well compacted, would be suited for use as capping for the facility. Due to the volume of material available however, legislative requirements and the nature of the site conditions, it is not recommended that this soil be used as a barrier layer for water ingress without combining it with geosynthetic layers as per the design.

<u>GCL/GM</u>

The stability of barriers composed of geomembranes and/or geosynthetic clay liners (GCLs) depends on the interface and/or internal shear resistances of the materials involved in the design materials. The internal resistance of stitch-bonded and needle-punched GCLs depends on the

resistance of the core material (bentonite) and on the technique used to attach each geotextile layer of the GCL. When using a GCL in a slope, the evaluation of its internal shear strength is of fundamental importance for stability analysis, and for this reason it is recommended that a fully needlepunched GCL with nonwoven cover and either woven or nonwoven carrier geotextile be used on the slopes of the capping. The bentonite in the GCL should contain at least 75% Montmorillonite.

Although the stability of the rehabilitated waste body and specifically the slopes rely on many factors, the most important is proper moisture control and drainage. Capping failures tend to occur under saturated conditions and layer works thus need to be quality controlled and tested to ensure design parameters of drainage and permeability are adhered to.

4.4 Stormwater Management

Stormwater management is a critical component of sustainable capping and closure designs of landfills. The stormwater management infrastructure was designed to ensure clean and dirty water separation, to facilitate non critical flow and to prevent ponding. The main objectives of the proposed stormwater design are:

- Protection of the downstream water resources described in Chapter 1 by separating, collecting and discharging all stormwater runoff from the eMadlangeni landfill site before contamination;
- Ensuring that stormwater management infrastructure is designed to handle a storm event equal to the 1:50 year storm event;
- Preventing of standing water on site that could penetrate the capping layers and waste body creating leachate and possible failures of the capping layer works.

The final shaping and capping of the landfill as described, is aimed at preventing stormwater from coming into contact with the waste and any contamination. Any stormwater on the rehabilitated site could thus be considered clean and runoff from the rehabilitated site will be discharged into the existing natural watercourse.

The proposed eMadlangeni stormwater management system shall at least include:

- Catchwater banks at least 500mm high constructed of compacted in situ material at the top edge of the landfill to prevent erosion and control the runoff down the side slopes (See Section A – A on Drawing 002 in **Annexure A**);
- Downchutes to direct the runoff down the side slopes in a controlled manner. The downchutes are to be constructed of flexible material that would allow for moderate plant growth and possible future landfill deformation. The downchutes can be lined by GCL/GM to ensure permeability protection in the event of large deformations;

- A drainage bench to be constructed midway down the side slope, as per the drawings, to reduce the flow velocity and also assist in the prevention of erosion.

4.5 Gas Management

Waste materials contained in a closed landfill degrade at various rates and stages, producing a range of gases. Municipal waste found on the eMadlangeni landfill is commonly known to produce methane and carbon dioxide gases which are considered dangerous greenhouse gases that need to be controlled. These gases could potentially result in gas bubbles beneath the capping layer if not fully captured by the gas drainage layer, and then cause uplift of the capping layers. It is thus recommended to install gas vents, connected to the gas drainage layer, at key areas to release these gases. Gas monitoring probes could also be installed for use during post closure monitoring to trace gas releases. If the probes are considered too expensive or deemed a target for theft, the monitoring team could use hand held gas monitoring devices during post closure gas monitoring.

5 Engineering Cost Estimate

5.1 Introduction

Capping designs that adhere to the legislative framework can be considered expensive and even with the best efforts of the design engineer and construction contractor, this could result in high budget allocations required from small municipalities. There are sources of funding that the municipality can use, other than its own funds and these have been widely used with great success. The reality is that most small municipal landfill sites have no base liner which is mostly due to the age of the facility (liners became a requirement from 1998) and /or the budgets of the municipality at the time. As described earlier in this report, the requirements of capping designs for landfills with no base liner is more strict than for facilities with operational base lining systems.

The costs given in this chapter is an estimate of construction costs for the establishment of the landfill cap and is not be considered a final value since it needs to be confirmed during the detail design stage prior to development of tender documentation for municipal procurement of construction contractors.

5.2 Engineering Estimate

The below table shows a summary of the construction estimate at the preliminary design stage, this would need to be confirmed during detail design. A full breakdown of the below amounts is given in **Annexure B**.

Table 1: Preliminary Engineering Construction Cost Estimate

SUMMARY OF BILL OF QUANTITIES		
PART	**DESCRIPTION**	**AMOUNT**
		R-c
PART 1	PRELIMINARY AND GENERAL	3 060 000.00
PART 2	EARTHWORKS: EMADLANGENI LANDFILL	17 139 255.00
SUB-TOTAL A		**20 199 255.00**
PART 3	DAYWORKS	345 000.00
SUB-TOTAL B		**20 544 255.00**
CONTINGENCIES Add 10 % for Sub-total B (Provisional sum)		**2 054 425.50**
SUB-TOTAL C		**22 598 680.50**
VALUE ADDED TAX Add 14 % for Sub-total C (Provisional sum based on current rate of VAT)		3 163 815.27
ESTIMATE TOTAL AMOUNT (INCL VAT)		**25 762 495.77**

6 Closure and End Use Planning

6.1 Introduction

An integral part of the successful rehabilitation and closure of a landfill site is the closure and end use plan. Once capping and rehabilitation has been constructed, monitoring and maintenance of the site will be required to ensure that it remains effective. Rehabilitation cannot be regarded as completed until the vegetation has been suitably established across the site. Several years of management and maintenance may well be required,

Once the eMadlangeni landfill has been formally closed, additional monitoring activities will be necessary to assess water quality around the landfill, monitor the landfill gas collection system and inspect the landfill for signs of disrepair. The Closure and End Use Plan Report is a separate document to be developed by the Environmental Assessment Practitioner, and is intended to serve a guide for the formal closure and end use planning for the future closure of the eMadlangeni landfill site.

This section of the Preliminary Design Report will provide some key recommendations for future inclusion into closure and end use plan.

6.2 Recommendations for inclusion in Closure and End Use Plan

6.2.1 General

The following provides some general rehabilitation measures that may be implemented on the site.

- The site is cleaned up and all the residual waste, that cannot be compacted and included in the waste body that will be capped must be removed and stored in skips for final disposal at a licensed landfill site;
- The waste and cover material that has been placed on the site should be used to rehabilitate some of the areas, which have been damaged by soil erosion and loss of ground cover;
- A vegetative layer of approximately 200mm should be laid down in these scarred areas on the site and spread and lightly compacted;

- The site should then be grassed with the same type of indigenous grass mixtures as per specifications for the Utrecht area;
- The closure design needs to be prepared and supervised by a professional engineer working with an environmental scientist, and needs to be designed such that the site does not sharply contrast against the local geomorphology and background. The site shall have a slight cross-fall allowing easy drainage off the site away from any potential risk areas;
- The capping layer works provided in the engineering design should be conservatively constructed according to the specifications of the design and approved by the relevant authority to ensure compliance with the applicable legislation;

6.2.2 Cover Material

As reported in the engineering design of this report, the permeability of the in situ soil is in the order of $1.3x10^{-7}$cm/s which is a comparatively low permeability when compared to the minimum requirements for permeability of liner clay material of 1×10^{-6}cm/s. Thus, this material, even if used in a mixture of commercial material is well suited for cover material and the only additional material required over the capping would be a 200mm topsoil layer for facilitation of plant growth etc.

6.2.3 Erosion Control

Erosion is one of the major sources of damage to both natural and man-made slopes. Erosion gulleys are already visible on site so indications are that the natural soils are prone to erosion. Erosion on slopes can be caused by detachment and movement of soil particles due to raindrop impact and surface runoff. Some recommendations for protection of the site from erosion may include but not limited to the following:

- Cover the sloped edge of the waste body and the top of the waste body with the capping layers as per the engineering design;
- Cover the capping layer with the topsoil and compact;
- Seed all surfaces and banks with indigenous grass to allow vegetation growth and further protection and natural look;

Once the vegetation has established itself on the site possibilities of erosion are limited. Any signs of erosion should be reported and corrected immediately as part of the closure plan of the site.

6.2.4 Water Quality Monitoring

A Water Quality Monitoring Program should form part of the Closure Plan of the eMadlangeni landfill site. The water quality monitoring program is expected to continue for at least 10 years following closure due to the importance of water quality for the residents of the area. The program should involve quarterly monitoring of surface water, groundwater and leachate at and surrounding the landfill. The water quality results will be compared to the accepted local and national standards and should be reviewed and reported yearly. The report will provide information on the effectiveness of the landfill cap and surface water drainage system, and address any identified water quality issues.

After ten years, it is anticipated that the water quality at the landfill should stabilize and the water quality monitoring frequency will be reduced to semi-annually. After 25 years, the results should again be reviewed and if there is sufficient evidence that shows that the landfill has not had significant impact on the surrounding environment, the water quality monitoring program can be concluded.

6.2.5 Gas Management

It is proposed in the preliminary engineering design that a landfill gas management system will be constructed prior to closure. The details of required operation, maintenance and monitoring of this system is to be include in the detail design phase and carried through tot eh closure plan. After closure, a remote monitoring system could be utilized and maintenance staff will be contacted for emergencies. A quarterly inspection and monitoring program will likely have to be established to evaluate landfill gas generation for a minimum of 25 years.

6.2.6 Inspections and Maintenance

After closure, a regular inspection and maintenance program must be initiated to maintain the integrity of the landfill. Allow for a maintenance period of one year following practical completion, (unless otherwise specified) and implement the following.

- Maintain the integrity of the fence around the site to ensure limited to no access for any pedestrians and livestock. The landfill is located within a game park and thus extra precautions need to be taken to keep wild animals out of the rehabilitated site as far as possible;
- Re-vegetation must match the vegetation type indigenous to the Utrecht area
- A minimum grass cover of 80% is required, and individual plants must be strong and healthy growers at the end of the Maintenance Period;

- In the case of sodding, acceptable cover entails that 100% cover is attained by the specified vegetation;
- Bare areas that show no specified vegetation growth after three months of the Rehabilitation Work are to be spread with additional topsoil, ripped to a depth of 100mm and re-planted, re-sodded, re-hand sown or re-hydro seeded.

Regular inspections are to be undertaken at the landfill and must include evaluation of the:

- landfill cap by noting any significant erosion, cracking, settlement or seepage;
- fence for structural integrity and performance;
- landfill cap for evidence of wildlife or rodent impacts; and,
- leachate collection system components for containment.

The inspection reports should identify if maintenance activities are required. Inspections are anticipated to be monthly for the first year and quarterly for the years following.

6.2.7 Stormwater and Leachate Management

Stormwater management shall be by means of proper landscaping, allowing the surface run off to flow naturally away off the site in accordance with the design measures proposed. Once the site is properly vegetated the management of stormwater becomes less problematic. The site does not generate any significant amount of leachate at this stage but the proposed leachate management system of collection, trenching and storage should be monitored regularly and the leachate sump cleaned out at regular intervals.

6.2.8 Post Closure Monitoring

A post closure monitoring plan shall be developed to ensure that certain critical aspects are monitored continuously even after closure as may be required by the waste license for the site. These aspects may include but are not limited to the matters described above. Following each site inspection, a brief internal site audit report must be prepared with mitigation or recommended actions for mitigating any observed negative impacts on the site. Such measures may include but not be limited to the following:

- Any eroded material on site will have to be excavated;
- The eroded area must be filled with excavated material and compacted;

- Cover with capping impermeable material, compacted and top soiled as per specification;
- Vegetation of landfill with indigenous grass and vegetation;
- Cover with netting and protect until vegetation has been re-established

Generally the mitigation measures will depend on the nature, extent and significance of the impacts observed during the site audits.

7 Conclusion

As a result of numerous complaints about the state of poorly operated municipal landfills and the associated impacts on the biophysical and social environment, the Department of Environmental Affairs (DEA) has embarked on an initiative to assist various Municipalities in South Africa with the licensing of the existing illegal waste disposal sites. The existing eMadlangeni landfill has been identified as one of the sites that will require a Waste Management License for Decommissioning.

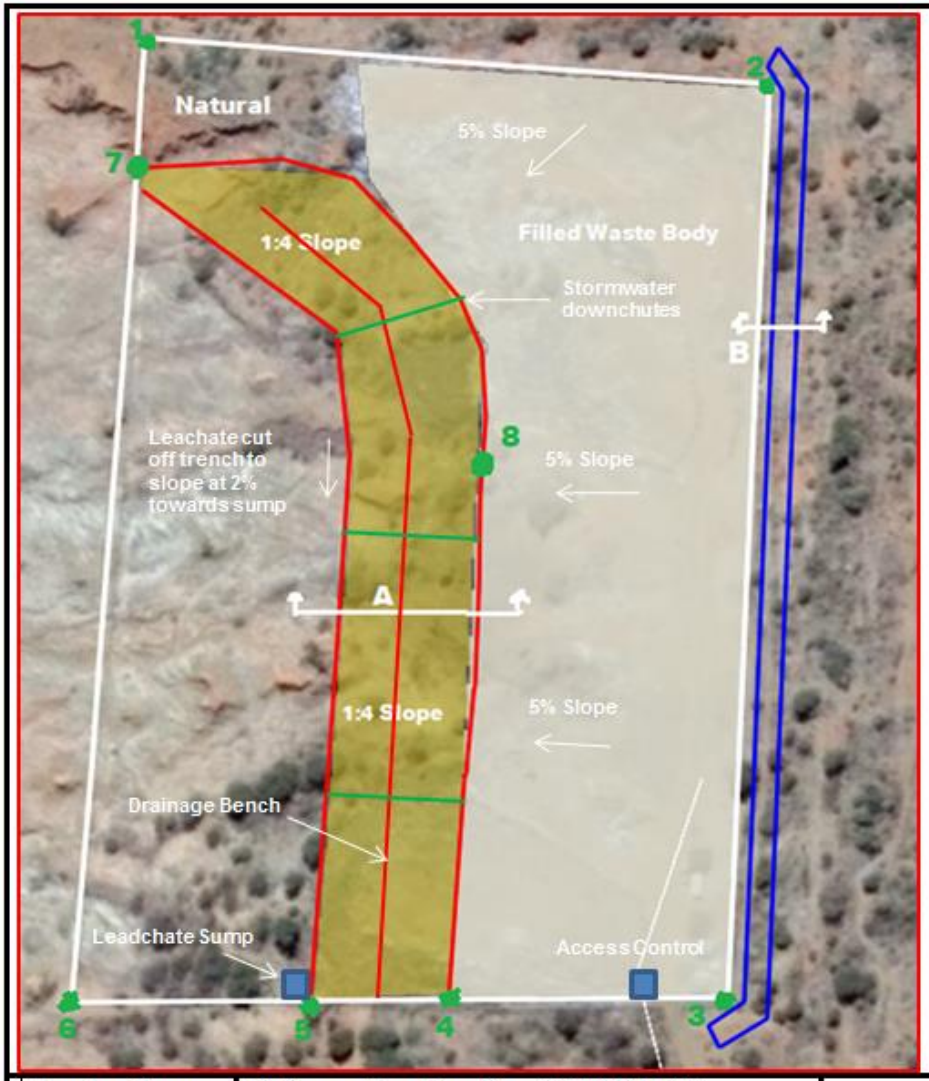
The closure of the eMadlangeni Landfill site is subject to the requirements described in this report and the Closure and End Use Plan. The final shaping and capping of the landfill should be carried out as per the capping design and on-going monitoring of the groundwater and landfill gas should continue according to the requirements given. The site should be fenced off to prevent unauthorized access and any dumping.

For the capping design of this landfill it is proposed to use a restricted moisture cap (also called dry cap) in order to minimize the ingress of rain water and isolate the waste body form the atmospheric environment. The materials used in the design aimed to reduce the percolation through the cap to less than 15 litres per hectare per day. Furthermore in order to address stability between layer works and assist runoff the maximum slopes for capping design will be limited to 1:4 (one vertical and 4 horizontal).

It is recommended that this report be used as basis for the detail design phase of the landfill capping process once a waste license is issued for closure of the landfill.

ANNEXURE A :

Preliminary Engineering Design Drawings



North

Point	Elevation (m)	Description
1	1,252	Fence, North Corner
2	1,263	Fence, North East Corner
3	1,261	Fence, South Corner
4	1,258	Top of Consolidated Waste, South
5	1,247	Bottom of rehabilitated slope
6	1,247	Fence, West Corner
7	1,254	Top of Slope, North
8	1,259	Top of Consolidated Waste Central

Section A - A : Section through rehabilitated landfill (**See Drawing 002**)

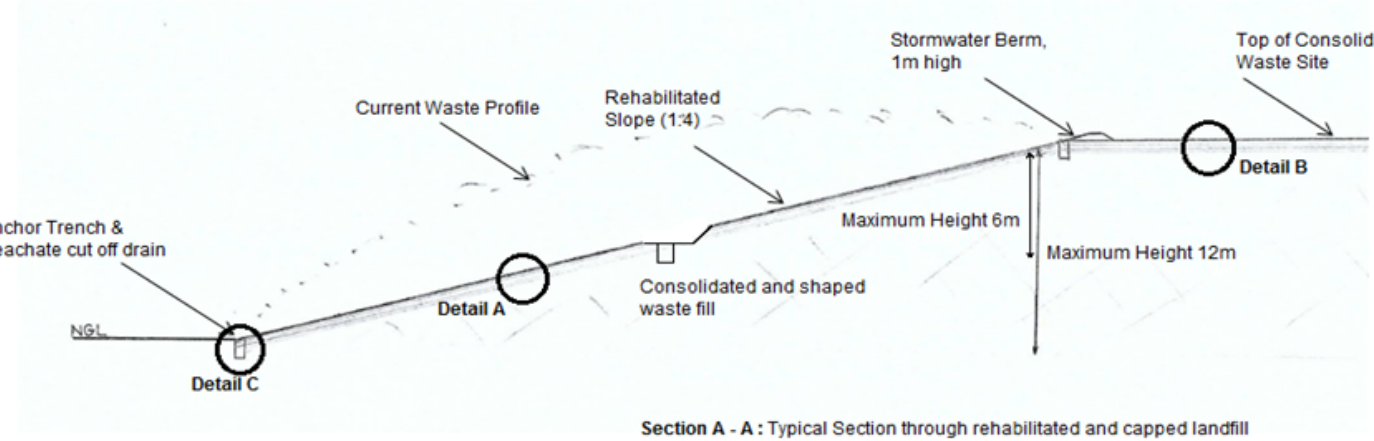
Section B - B : Section through stormwater berm (**See Drawing 003**)

Notes:

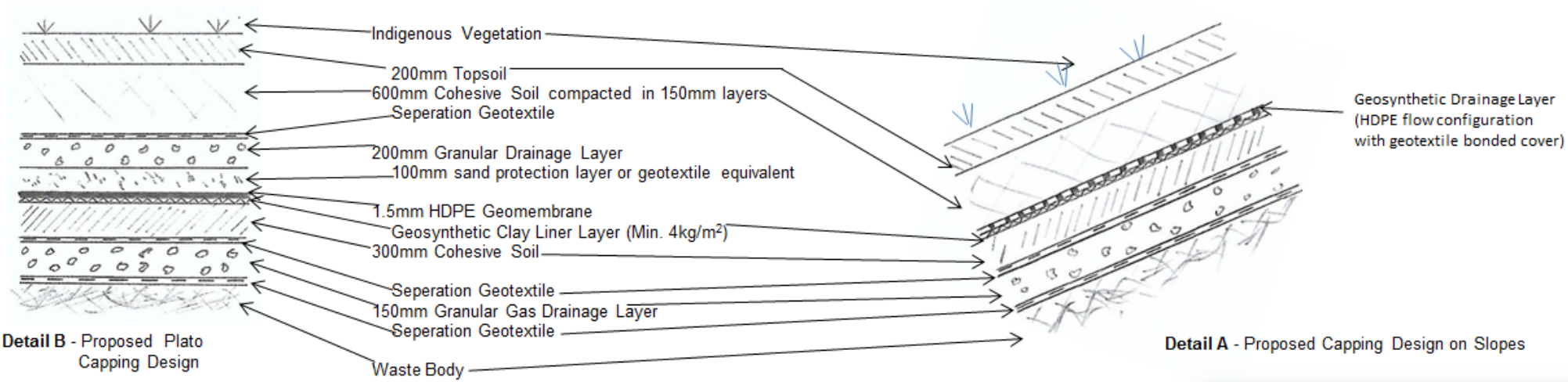
- Toe Drain 7 Leachate Collection Trench to be installed from point 7 to point 5
- Elevations in table are post rehabilitation levels
- Drainage bench on slopes at max 6m, 800mm wide sloped at 2%
- Points 4,5 and 7 to tie in with natural ground levels

Drawing Owner:	RAPienaar Consulting Reg: 2017/174192/07		
Project Name:	Kwazulu Natal Landfill Licenses	**Drawing Number:**	EMA - 001
Drawing Title:	eMadlangeni Rehabilitated Landfill Layout	**Revision:**	1
Date:	30 November 2017	**Client:**	GA Environment
Drawing By:	Reon Pienaar (PrEng Nr. 20100281)	**Approved By:**	Reon Pienaar (PrEng Nr. 20100281)

R.A.PIENAAR CONSULTING (PTY) LTD
Tel: 0721235517, Monumentpark, Pretoria



Section A - A : Typical Section through rehabilitated and capped landfill

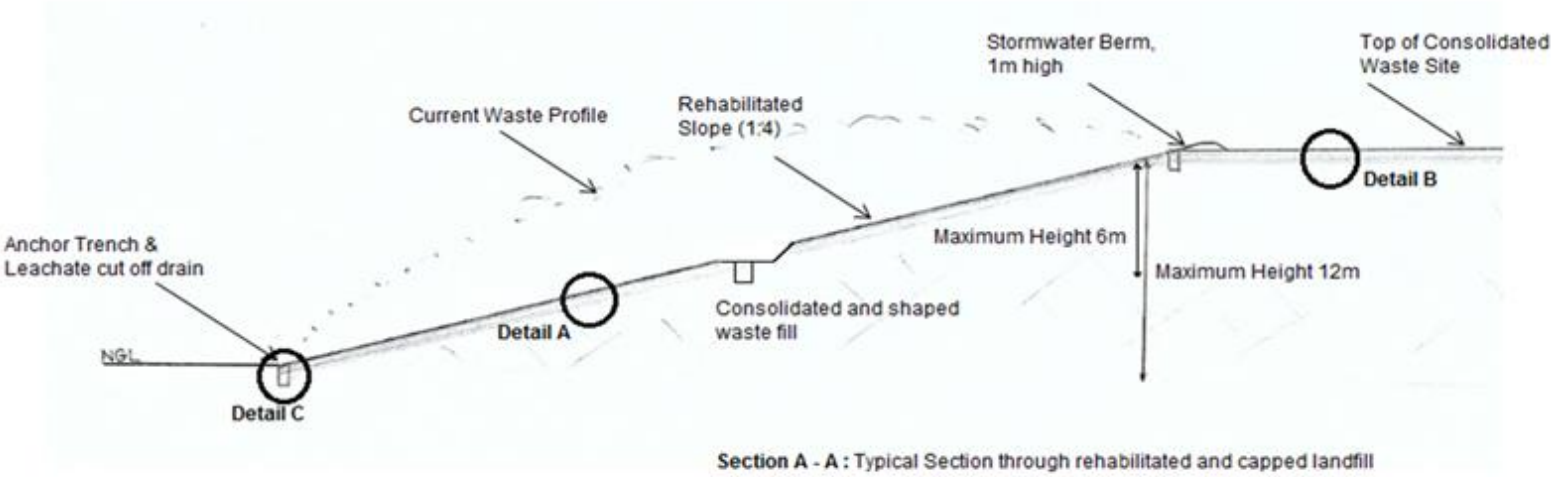


Detail B - Proposed Plato Capping Design

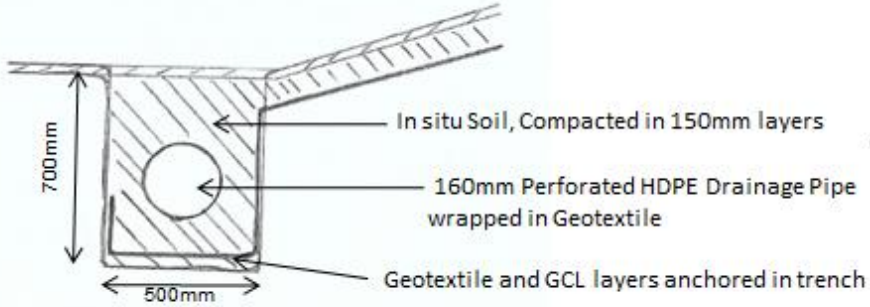
Detail A - Proposed Capping Design on Slopes

Drawing Owner:	RAPienaar Consulting Reg: 2017/174192/07		
Project Name:	Kwazulu Natal Landfill Licenses	**Drawing Number:**	EMA - 002
Drawing Title:	eMadlangeni Landfill Sections and Details	**Revision:**	1
Date:	30 November 2017	**Client:**	GA Environment
Drawing By:	Reon Pienaar (PrEng Nr. 20100281)	**Approved By:**	Reon Pienaar (PrEng Nr. 20100281)

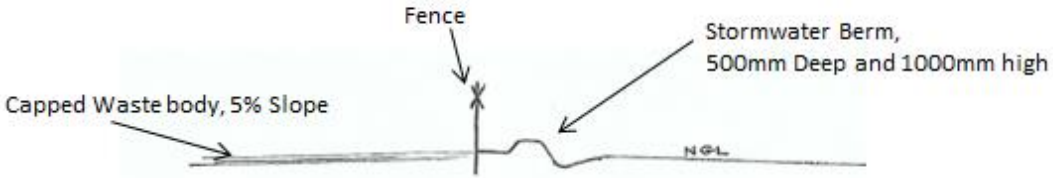
R.A.PIENAAR
CONSULTING (PTY) LTD
Tel: 0721235517, Monumentpark, Pretoria



Section A - A : Typical Section through rehabilitated and capped landfill



Detail 3: Anchor Trench and Leachate cut off drain



Section B - B: Sectional view through upstream stormwater berm

Drawing Owner:	RAPienaar Consulting Reg: 2017/174192/07		
Project Name:	Kwazulu Natal Landfill Licenses	**Drawing Number:**	EMA - 003
Drawing Title:	eMadlangeni Landfill Sections and Details	**Revision:**	1
Date:	30 November 2017	**Client:**	GA Environment
Drawing By:	Reon Pienaar (PrEng Nr. 20100281)	**Approved By:**	Reon Pienaar (PrEng Nr. 20100281)

R.A. PIENAAR CONSULTING (PTY) LTD
Tel: 0721235517, Monumentpark, Pretoria

ANNEXURE B :

Preliminary Engineering Design Cost Estimate

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
1.0		**PART 1: PRELIMINARY AND GENERAL**				
1.1	**SANS 1200A**	**GENERAL**				
	8.3	**Scheduled Fix-charge and Value-related Items**				
1.1.1	8.3.1	Contractual Requirements	Sum			2 000 000.00
	8.3.2	Establishment of Facilities on the Site				
1.1.2	PSA- 8.3.2.2	Facilities for Contractor	Sum			
1.1.3	8.3.3	Other Fixed-charge Obligations	Sum			
1.1.4	8.3.4	Removal of Site Establishment	Sum			
	8.4	**Scheduled Time-related Items**				
1.1.5	8.4.1	Contractual Requirements	Sum			1 000 000.00
	8.4.2	Operation and Maintenance of Facilities on Site, for Duration of Contruction, except where otherwise stated				
1.1.6	PSA- 8.4.2.2	Facilities for the Contractor	Sum			
1.1.7	8.4.3	Supervision for Duration of Construction	Sum			
1.1.8	8.4.4	Company and Head Office Overhead Costs for the Duration of the Contract	Sum			
1.1.9	8.4.5	Other Time-related Obligations	Sum			
	8.5	**Sums Stated Provisionally by Engineer**				
	(PSA)	(c) Additional Tests				
1.1.10		1) Additional tests ordered by the Engineer	Prov Sum	1		20 000.00
1.1.11		2) Handling cost and charges on (c)(1)	%	20 000		
		(d) Survey in terms of Land Survey Act				
1.1.12		1) Provisonal allowance for survey	Prov Sum	1		40 000.00
1.1.13		2) Handling cost and charges on (d)(1)	%	40 000		
TOTAL CARRIED FORWARD TO SUMMARY						**3 060 000.00**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
2.0		**PART 2: EARTHWORKS: EMADLANGENI**				
2.1	**SANS 1200D**	**SECTION: EARTHWORKS**				
	8.3.1	Site Preparation				
2.1.1	8.3.1.1	Clear and Strip Site	m^2	54 000	7	378 000.00
	8.3.2	Bulk Excavation				
2.1.3	PSD 8.3.2	a) Excavate in all materials and use for embankment or backfill or dispose, as ordered	m^3	18 000	40	720 000.00
		b) Extra over for				
2.1.4		1) Intermediate Excavation	m^3	80	100	8 000.00
	PSD 8.3.4	Importing of Materials				
2.1.5		a) Extra over for importing materials from commercial sources or from Borrow pits for use in capping	m^3	40 000	80	3 200 000.00
2.1.6		b) Opening up and closing down designated borrow pits	Sum	1	50000	50 000.00
	8.3.6	Overhaul				
2.1.7		a) Limited Overhaul	m^3	200	100	20 000.00
21.8	PSD 8.3.14	Stormwater chutes as shown on drawings	m	200	1500	300 000.00
2.2	**SANS 1200 DE**	**PART 2: SECTION : SMALL EARTH DAMS**				
	PSDE-8.3.5	Forming embankment				
		(i) Cut from excavation and/or stockpile				
2.2.1		(1) Suitable as fill material for stormwater berm	m^3	1 200	120.00	144 000.00
	PSDE- 8.3.11	Forming Site Capping				
2.2.2		(a) Shape and Compact In situ Waste Material	m^3	135 000	10.0	1 350 000.00
2.2.3		(b) Cut to fill from commercial sources a Drainage layer comprising of single sized crushed stone or gravel having a size of between 38 mm and 50 mm as shown on drawings	m^3	8 738	250.00	2 184 375.00

2.2.4		(c)	Cut to fill from commercial sources silty sand material for use in protection layer as shown on drawings	m^3	2 400	300.00	720 000.00
2.2.5		(d)	Cut to fill from commercial sources Topsoil layer as shown on drawings	m^3	7 800	120.00	936 000.00
2.2.6	PSDE- 8.3.12	160 mm dia perforated HDPE pipes placed inside gravel drainage layer on plato as shown on drawings including all bends, tees, corrections etc.		m	320	250.00	80 000.00
2.3	**PART SPEC PCI**	**PARTICULAR SPECIFICATION PCI: GEOTEXTILES**					
	PCI-5.1	Supply and install geotextile					
2.3.1		(a)	Seperation Geotextiles in capping works as shown on drawings, 2.5mm thick, minimum 1.5kg/m^2	m^2	117 000	12.00	1 404 000.00
2.3.2		(b)	Around drainage pipes	m^2	1 240	12.00	14 880.00
2.4	**PART SPEC PDI**	**PARTICULAR SPECIFICATION PDI : GEOSYNTHETIC MEMBRANES**					
	PDI-15.1	Supply and Installation of geosynthetic membranes					
2.4.1		(a)	1.5mm HDPE geomembrane for use in plato capping	m^2	24 000	55.00	1 320 000.00
2.4.2		(b)	Geosynthetic Clay Liner (GCL) as per drawings	m^2	39 000	60.00	2 340 000.00
2.4.3		(c)	Geocomposite Drainage Layer (ABG Pozidrain® or similar)	m^2	15 000	65.00	975 000.00
2.4.3	PDI-15.2	Geomembrane Guarantee		Sum	1	20 000.00	20 000.00
2.5	**PART SPEC PNE**	**SECTION: ESTABLISHMENT OF VEGETATION ON LANDFILL**					
2.5.1	PNE-7.1	The preparation, application and maintenance of vegetation		m^2	39 000	25	975 000.00
TOTAL CARRIED FORWARD TO SUMMARY							**17 139 255.00**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
3.0		**PART 3: DAYWORKS**				
3.1	DW-1	Labour				
3.1.1		(a) Net cost of labour	Prov Sum	1		100 000
3.1.2		(b) Contractor's charges and profit associated with administration of the above item 3.1.1	%	100 000	15	15 000
3.2	DW-2	Plant				
3.2.1		(a) Net cost of plant (including operator, assistance, fuel, oil, maintenance, etc)	Prov Sum	1		100 000
3.2.2		(b) Contractor's charges and profit associated with administration of the above item 3.2.1	%	100 000	15	15 000
3.3	DW-3	Material				
3.3.1		(a) Net cost of material	Prov Sum	1		100 000
3.2.2		(b) Contractor's charges and profit associated with administration of the above item 3.3.1	%	100 000	15	15 000
TOTAL CARRIED FORWARD TO SUMMARY						**345 000.00**

SUMMARY OF BILL OF QUANTITIES

PART	DESCRIPTION	AMOUNT R-c
PART 1	PRELIMINARY AND GENERAL	3 060 000.00
PART 2	EARTHWORKS: EMADLANGENI LANDFILL	17 139 255.00
SUB-TOTAL A		**20 199 255.00**
PART 3	DAYWORKS	345 000.00
SUB-TOTAL B		**20 544 255.00**
CONTINGENCIES Add 10 % for Sub-total B (Provisional sum)		**2 054 425.50**
SUB-TOTAL C		**22 598 680.50**
VALUE ADDED TAX Add 14 % for Sub-total C (Provisional sum based on current rate of VAT)		3 163 815.27
ESTIMATE TOTAL AMOUNT (INCL VAT)		**25 762 495.77**

Professional Civil Engineer **Curriculum Vitae**

Reon Pienaar, PrEng

Education

- MEng (Environmental Engineering), University of Pretoria, 2015
- BEng Hons (Environmental Engineering), University of Pretoria, 2007
- BEng Civil, University of Pretoria, 2004
- Lichtenburg High School, 1999
- Mafikeng Primary School, 1994

Professional Registration

Professional Engineer with ECSA, Reg Nr. 20100281

Experience

With BKS / AECOM: 12 Years

With Other Firms: 5 months

Professional Memberships

- Registered as Member of SAICE, Nr 205479
- Vice Chair of Institute of Waste Management of South Africa (IWMSA) Central Branch, Member Nr 10114089
- Member of International Solid Waste Association (ISWA), Nr 14-1081
- Member of the Geosynthetics Interest Group of South Africa (GIGSA), Nr 9738

Date of Birth

10 March 1981 ID: 8103105137081

Nationality & HDI Status

South African

White male, no disabilities

Key Technical Qualifications

Reon Pienaar holds a University degree in Civil Engineering, a BEng Honours degree and an MEng (Masters) degree in Environmental Engineering (specializing in Waste Management) from the University of Pretoria in South Africa. He has more than 12 years' experience in solid waste management, environmental management and dam engineering. The majority of his experience was spent in charge of projects and project teams.

He has experience in project management, planning, design and procurement as well as construction supervision of projects related to all types of waste management as well as dams. He has experience with the feasibility and viability of alternative waste treatment technologies and has presented papers on the topic at waste management conferences. He has experience in working with the Public Finance Management Act and Treasury Regulations and has spent a great deal of his recent time on PPP projects. His work within the South African Institute of Waste Management as vice chair of the Central Branch committee, has also given him experience in the intricacies of the circular economy as well as waste minimization and beneficiation and ultimate resource efficiency.

Reon worked for AECOM SA until May 2017 on various projects in South Africa; and has experience working in Lesotho. He has travelled on business to the United Kingdom, Turkey, Canada, Austria, Hungary and the Czech Republic. He started his own company, RAPienaar Consulting (Pty) Ltd, in May 2017 focussing on waste management and environmental engineering consulting. He has a very good understanding of the work and policies of the South African Government through his liaison with government clients and projects over the years.

He is registered as a Professional Engineer with the Engineering Council of South Africa (ECSA Reg. Nr. 20100281), he is a full member of the South African Institute of Civil Engineers (SAICE), a member of the Geosynthetic Interest Group (GIGSA), a member of the International Solid Waste Association, a member of MENSA and sits on the Central Branch Committee of the Institute of Waste Management of South Africa (IWMSA) as vice chairman.

Key Non-Technical Qualifications

Reon is a person that gets along very well with his peers. He likes to have fun and work hard. In his role at AECOM he was responsible for managing staff and finances on a range of large projects. He is very well spoken and communicates well with his staff, peers and managers. He is very skilled in technical report writing and always looks for creative ways to solve problems. He is a team player who demonstrates an adaptability and willingness to seek and implement new solutions wherever possible. He is an emotionally intelligent person who cares for others and is aware of his own shortcomings and willing to work on them. He enjoys a challenge and is not afraid to work hard.

General

He is a very good home cook, a music lover and an average but passionate golf player. He also enjoys other outdoor activities and sports like cricket, rugby, camping, hiking etc. He lives in Monumentpark, Pretoria, with his family. He has been married to Su-Marie (Primary School Maths Teacher) since 8 December 2007 and they have three daughters. Karla (6), Jani (4) and Nina (2). He has a code B South African Driver's License and is willing to travel.

Work Experience

Employer	Post Held	From	To	Reason for Leaving
RAPienaar Consulting (Pty) Ltd	Director and Owner	May 2017	Present	N/A
AECOM SA (Pty) Ltd	Associate	Sep 2013	May 2017	Restructuring
AECOM SA (Pty) Ltd	Senior Manager/Engineer	Sep 2009	Sep 2013	Promotion
BKS (Pty) Ltd (later AECOM)	Engineer	March 2005	Sep 2009	Promotion
Jenkins & Potter Consulting (in the UK)	Engineer	Nov 2004	March 2005	Contract Ended

Professional Project Related Experience

RAPienaar Consulting (Pty) Ltd
May 2017 to Present

- **Project:** Engineering Investigation and Reporting for Sappi Enstra H:H Landfill in Springs
  Client: Sappi Enstra
  Approx. Project Value: R26,000
  Date: June 2017
  Position: Engineer responsible for site investigation and reporting on facility audit for Sappi Enstra Landfill in Springs.

- **Project:** Waste Company and Facility Audits on behalf of Betha Waste
  Client: Betha Waste
  Approx. Project Value: R25,000
  Date: July 2017
  Position: Engineer responsible for Audits on Betha Waste company and sub contract on behalf of Prominent Paints (PPG Group)

AECOM (Pty) Ltd (formerly BKS (Pty) Ltd)
October 2009 – May 2017

- **Project:** Feasibility Study on Development of Alternative Waste Treatment Technologies for the Ekurhuleni Metropolitan Municipality
  Client: Gauteng Infrastructure Financing Agency
  Approx. Project Value: ± R 5 Million
  Date: 2015 - present
  Position: Project Manager and Waste Engineer for lead transaction advisor team comprising technical, financial and legal specialists. Working with Treasury and PFMA.
- **Project:** Tshwane Regional Landfill Facility
  Client: Interwaste (Pty) Ltd
  Approx. Project Value: ± R 2.5 Million
  Date: 2014 - 2017
  Position: Project Manager and Lead Engineer. Responsible for client liaison and project management as well as designs required to obtain a waste license from authorities.
- **Project:** Landfill Master Planning
  Client: Ekurhuleni Metropolitan Municipality
  Approx. Project Value: ± R 2.5 Million
  Date: 2014 - 2016
  Position: Engineer and Project Manager responsible for updating the City's Landfill Master Planning and development of materials recovery facility master
  planning.

- **Project:** Franschhoek Waste Drop Off
  Client: Stellenbosch Municipality
  Approx. project value: ± R 2 Million
  DATE: 2015 - 2017

POSITION: Project Manager and Engineer responsible for site selection, design and construction monitoring of a major waste drop off facility in the Franschhoek area.

- **Project:** Stilfontein and Orkney Landfill Closures
  Client: City of Matlosana
  Approx. Project Value: ± R 3 Million
  Date: 2010 - 2014
  Position: Engineer responsible for Design, Tender Documentation and Construction Monitoring for the closure and rehabilitation of the Old Orkney and Stilfontein Landfill sites.

- **Project:** GIBELA Train Manufacturing Facility
  Client: GIBELA
  Approx. Project Value: ± R 100 Million
  Date: 2014 - 2017
  Position: Engineer responsible for planning and design of waste management requirements of the GIBELA train manufacturing facility in Gauteng, South Africa.

- **Project:** Mkuze Regional Landfill
  Client: Jozini Local Municipality
  Approx. Project Value: ± R 4 Million
  Date: 2013 - 2016
  Position: Engineer responsible for Design, Tender Documentation and Construction Monitoring for the upgrading of the Mkuze landfill site (project cancelled prior to construction).

- **Project**: Arnot Ash Water Return Dam
  Client: ESKOM
  Approx. Project Value: ± R 25 Million
  Date: 2013 - Present
  Position: Engineer responsible for Tender Documentation, Project Management and Construction Supervision of HDPE lined ash water return dam.

- **Project:** Municipal Landfill Audits
  Client: Masilonyana / Maquassi Hills Local Municipality
  Approx. Project Value: ± R 100 000
  Date: 2012 - 2014
  Position: Project Manager and engineer responsible for auditing and reporting on condition of landfill facilities in the Municipality.

- **Project:** De Beers (Mothusi) Dam Safety Inspections
  Client: Letseng Diamond Mine in Lesotho
  Approx. Project Value: ± R 500 000
  Date: 2011 - 2014
  Position: Responsible for the safety inspections at the De Beers (Mothusi) Dam at the Letseng Diamond Mine in Lesotho. Reon assisted Mr Danie Badenhorst (APP) with the initial inspection after which he was responsible to compile the report and undertake further inspections.

- **Project:** Western Cape Waste Licenses

  Client: Department of Environmental Affairs

  Approx. Project Value: ± R 10 Million

  Date: 2013 - 2015

  Position: Engineer responsible for Preliminary Design inputs into the closure or operations license applications for 50 waste disposal facilities in the Western Cape Province.

- **Project:** Construction Monitoring - North and South Dams
  Client: NCP Chlorchem
  Approx. Project Value: ± R 500 000
  Date: 2010 - present

Position: Engineer responsible to assist the APP with the Safety Inspection. Reon was then responsible for compilation of report and subsequently responsible or design and tender process to implement the recommended rehabilitation work. He was then also responsible for construction monitoring and project management at the Dams.

- **Project:** Rustenburg Waste Disposal Strategy and Transfer Stations
  Client: Rustenburg Local Municipality
  Approx. Project Value: ± R 40 million
  Date: 2010 – present
  Position: Responsible for planning and design of Solid Waste Transfer Stations as part of the municipality's plan to expand the waste services in the Rustenburg area.

- **Project:** Msukaligwa & Albert Luthuli Regional Landfill
  Client: Gert Sibande District Municipality
  Approx. Project Value: ± R 15 million
  Date: 2009 - 2010
  Position: Project Manager for the Feasibility Study and Waste License Application for a regional landfill site near Ermelo in Mpumalanga. Waste license was successfully obtained. Study included Site Selection and conceptual design. Reon was also responsible for the detail design of the facility as well as the compilation of the Tender Document and the management of the tender process.
- **Project:** Govan Mbeki Regional Landfill
  Client: Mpumalanga Department of Environment, Economic Development and Toursim
  Approx. Project Value: ± R 15 million
  Date: 2009 - 2014
  Position: Project Manager for the Feasibility Study and Waste License Application for a regional landfill site near Secunda in Mpumalanga (project stopped before completion).
- **Project:** Klinkerstene Regional Landfill
  Client: Interwaste (Pty) Ltd
  Approx. Project Value: ± R 5 million
  Date: 2009 - 2014
  Position: Project Manager for the Feasibility Study and Waste License Application for a regional landfill site near Delmas in Mpumalanga. Responsible for client liaison and project management as well as designs required to obtain a waste license from authorities.
- **Project:** Polihali Gauging Weir
  Client: Lesotho Highlands Development Authority
  Approx. Project Value: ± R 20 million
  Date: 2011 - 2014
  Position: Engineer responsible for the design, tender and construction monitoring of a gauging weir in the Senqu River in Lesotho as part of the second phase of the Lesotho Highlands Water Project to provide Water to South Africa.
- **Project:** Acid Mine Drainage (Witwatersrand)
  Client: TCTA (DWAF)
  Approx. Project Value: ± R 200 million
  Date: 2011 - 2013
  Position: Responsible for Waste Classification, wayleave Liaison and land acquisition in order to implement the Acid Mine Drainage project in the Witwatersrand area of Gauteng.
- **Project:** Exxaro Pollution Control Dams
  Client: EXXARO
  Approx. Project Value: ± R 70 000
  Date: 2012
  Position: Engineer responsible for Conceptual Design Report for the development of two pollution control dams at the Mooifontein Colliery.

BKS (Pty) Ltd
March 2005 – October 2009 (Candidate Engineer)

- **Project:** Rietfontein Weir

Client: Department of Water Affairs
Approx. Project Value: ± R 10 Million
Date: 2007 - 2008
Position: Engineer responsible for the preliminary design, final design, tender documentation and construction monitoring of the raising of the Rietfontein Weir near Kriel in Mpumalanga. Reon was also responsible for the design and tender process of a hazardous waste lagoon near the Rietfontein Weir that was never built due to budget constraints.

- **Project:** Orkney Solid Waste Transfer Station
  Client: Southern District Municipality
  Approx. Project Value: ± R 10 million
  Date: 2007
  Position: Design Engineer for the development of the Orkney Solid Waste Transfer Station.
- **Project:** Felophepha Waste Disposal Site
  Client: Potchefstroom Local Municipality
  Approx. Project Value: ± R 800 000
  Date: 2009
  Position: Engineer responsible for design, tender and (part time) construction monitoring of the second cell at the Felophepha landfill site near Potchefstroom.
- **Project:** Gert Sibande Integrated Waste Management Plan
  Client: Gert Sibande District Municipality
  Approx. Project Value: ± R 1 Million
  Date: 2004 - 2006
  Position: Engineer responsible for technical inputs and report writing to develop an integrated waste management plan for the Gert Sibande District Municipality.

Signed: ……. Date:12 September 2017

e-mail : reon@rapienaar.co.za

Cell: **072 123 5517**

edtea

Department :
Economic Development, Tourism and Environmental Affairs

PROVINCE OF KWAZULU-NATAL

Details of specialist and declaration of interest

in terms of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008), and the Environmental Impact Assessment Regulations, 2014

Reference number:	DC25/WML/0005/2017
Project title:	*Basic Assessment for the proposed Decommissioning (Closure) of the eMadlangeni Landfill, eMadlangeni Local Municipality, KwaZulu Natal Province*

Specialist:	Civil Engineer		
Name of company:	RAPieneer Consulting (Pty) Ltd		
Postal address:	635 Bosspruer Str, Monumentpark, Pretoria		
Postal code:	0181	Cell:	0721235517
Telephone:	0721235517	Fax:	-
E-mail:	reon@rapieneer.co.za		
Qualifications:	BEng ; BEng(Hons); MEng		
Professional affiliations:	SAICE, IWMSA, ECSA (PrEng 20100281)		
Expertise:	13 years, Waste Management		

EAP:	Nyaladzi Nleya		
Name of company:	GA Environment (Pty) Ltd		
Postal address:	P.O Box 6723, Halfway House		
Postal code:	1685	Cell:	0761479451
Telephone:	011 312 2537	Fax:	27 11 805 1950
E-mail:	environment@gaenvironment.com /nyaladzin@gaenvironment.com		

Declaration by the specialist

I, REGN PIENAAR , declare that --

- I act as the independent specialist in this application;
- I do not have and will not have any vested interest (either business, financial, personal or other) in the undertaking of the proposed activity, other than remuneration for work performed in terms of the EIA Regulations, 2014;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Waste Act and NEMA, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Waste Act and NEMA, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I am aware that a person is guilty of an offence in terms of Regulation 48 (1) of the EIA Regulations, 2014, if that person provides incorrect or misleading information. A person who is convicted of an offence in terms of subregulation 48(1) (a)-(e) is liable to the penalties as contemplated in section 49B(1) of the National Environmental Management Act, 1998 (Act 107 of 1998).

Signature of the specialist

RAPIENAAR Consulting (Pty) Ltd

Name of company

11/12/17

Date