Soils and Land Capability Scoping Assessment for the Ash Disposal Facility at Arnot Power Station

Mpumalanga, South Africa

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Report Name	**Soils and Land Capability Scoping Assessment for the Ash Disposal Facility at Arnot Power Station**	
Report	**Wayne Jackson**	
Report Review	**Andrew Husted**	

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Declaration

I, Wayne Jackson declare that:

- I act as the independent specialist in this application;
- 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;
- I declare that 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 Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, 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 realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of Section 24F of the Act.

Wayne Jackson

Soil Specialist

The Biodiversity Company

5 May 2018

1 Introduction

The Biodiversity Company was commissioned to conduct a comprehensive soil scoping, baseline and impact assessment for Eskom's Arnot Power Station Ash Disposal Facility.

Two site alternatives, and adjoining buffer areas have been assessed for the scoping phase of the project. The baseline study and impact assessment will then only be completed for the selected site.

The conservation of South Africa's limited soil resources is essential. In the past misuse and poor management of the soil resource has led to the loss of these resources through erosion and destabilisation of the natural systems. In addition, loss of high potential agricultural land due to land use changes is a big concern presently in South Africa.

Soils can be seen as the foundation for ecological function as shown in Figure 1. Without a healthy soil system for microbes to thrive in, both flora and fauna would be negatively impacted, which in turn feeds the natural soil system with organics and nutrients.

To identify soils accurately, it is necessary to undertake a soil survey. The aim is to provide an accurate record of the soil resources of the proposed project area. The objective of determining the land capability is to find and identify the most sustainable use of the soil resource without degrading the system.

Figure 1: The relationship between soil and above-ground ecological succession

1.1 Study Area

The project area is approximately 19km north of Hendrina in the Mpumalanga province, South Africa, (Figure 2). The project area is characterised by croplands.

Figure 2: Map showing the project area

2 Scope of Work

Two site alternatives, and adjoining buffer areas will be assessed for the scoping phase of the project. The baseline study and impact assessment will then only be completed for the selected site.

3 Limitations

This scoping level assessment was conducted as a desktop study exercise only, no site inspections have been completed. The scoping study has therefore assumed that all information provided for the study is correct.

4 Methodology

The agricultural assessment was conducted using the Provincial and National Departments of Agriculture recommendations. The assessment was divided into two phases. Phase 1 is a desktop assessment to determine the following:

- Historic climatic conditions;
- The terrain features using 5m contours;
- The base soils information from the land type database (Land Type Survey Staff, 1972 - 2006); and
- The geology for the proposed development site.

4.1 Impact Assessment Methodology

The impact assessment methodology was provided by EIMS and is guided by the requirements of the NEMA EIA Regulations (2010). The broad approach to the significance rating methodology is to determine the environmental risk (ER) by considering the consequence (C) of each impact (comprising Nature, Extent, Duration, Magnitude, and Reversibility) and relate this to the probability/likelihood (P) of the impact occurring. This determines the environmental risk. In addition, other factors, including cumulative impacts, public concern, and potential for irreplaceable loss of resources, are used to determine a prioritisation factor (PF) which is applied to the ER to determine the overall significance (S).

5 Legislative & Policy Framework

Currently, various pieces of legislation and related policies exist that guide and direct the land user in terms of land use planning both on a national and provincial level. This legislation includes, but is not limited to:

- The Constitution of the Republic of South Africa (Act 108 of 1996);
- Sub-division of Agricultural Land Act (Act 70 of 1970);

- Municipal Structures Act (Act 117 of 1998);
- Municipal Systems Act (Act 32 of 2000); and
- Spatial Planning and Land Use Management Act, 16 of 2013 (not yet implemented).

The above mentioned are supported by additional legislation that aims to manage the impact of development on the environment and the natural resource base of the country. Related legislation to this effect includes:

- Conservation of Agricultural Resources Act (Act 43 of 1983);
- Environment Conservation Act (Act 73 of 1989);
- National Environmental Management Act (Act 107 of 1998); and
- National Water Act (Act 36 of 1998).

6 Results

6.1 Climate

The project area falls within the Eastern Highveld Grassland region (Gm12) (Mucina & Rutherford, 2006). Strongly seasonal summer rainfall, with very dry winters. MAP 650-900 mm (overall average: 726 mm), MAP relatively uniform across most of this unit, but increases significantly in the extreme southeast. The coefficient of variation in MAP is 25% across most of the unit, but drops to 21% in the east and southeast. Incidence of frost from 13-42 days, but higher at higher elevations.

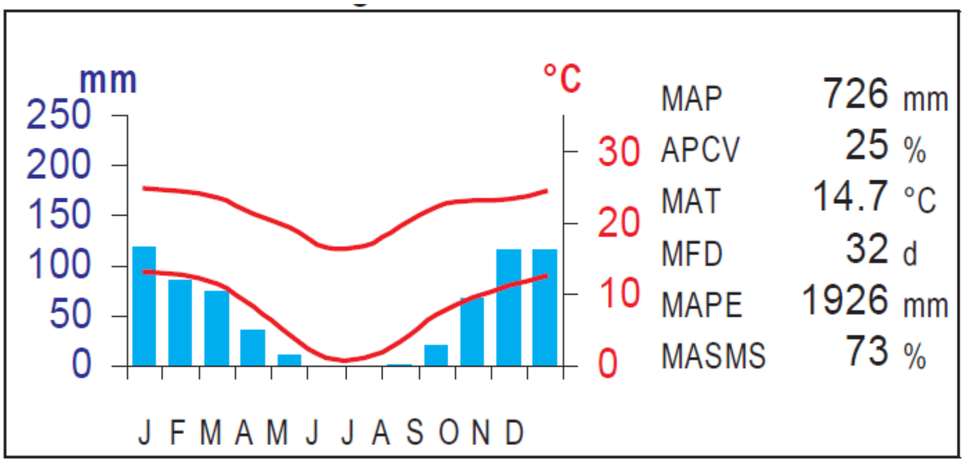

Figure 3: The climate summary for the Eastern Highveld Grassland (Gm 12) region (Mucina & Rutherford, 2006)

6.2 Terrain

A National Aeronautics and Space Administration (NASA) Shuttle Radar Topography Mission (SRTM) (V3.0, 1 arcsec resolution) Digital Elevation Model (DEM) was obtained from the United States Geological Survey (USGS) Earth Explorer website. Basic terrain analysis was performed on this DEM using the SAGA GIS software that encompassed a slope and channel network analyses in order to detect catchment areas and potential drainage lines respectively. The following processes have been considered for the desktop assessment:

- The relief map (Figure 4): The project area is flat throughout with an elevation range from approximately 1640 meter above sea level (masl) to 1680 masl.
- The slope map (Figure 5): The project area is dominated by flat slopes between 0% and 8% without any major height changes within the project boundaries.

- The aspect map (Figure 6): The map shows that the southern portions of both alternatives are south facing, with the remainder either being flat or slightly north facing.

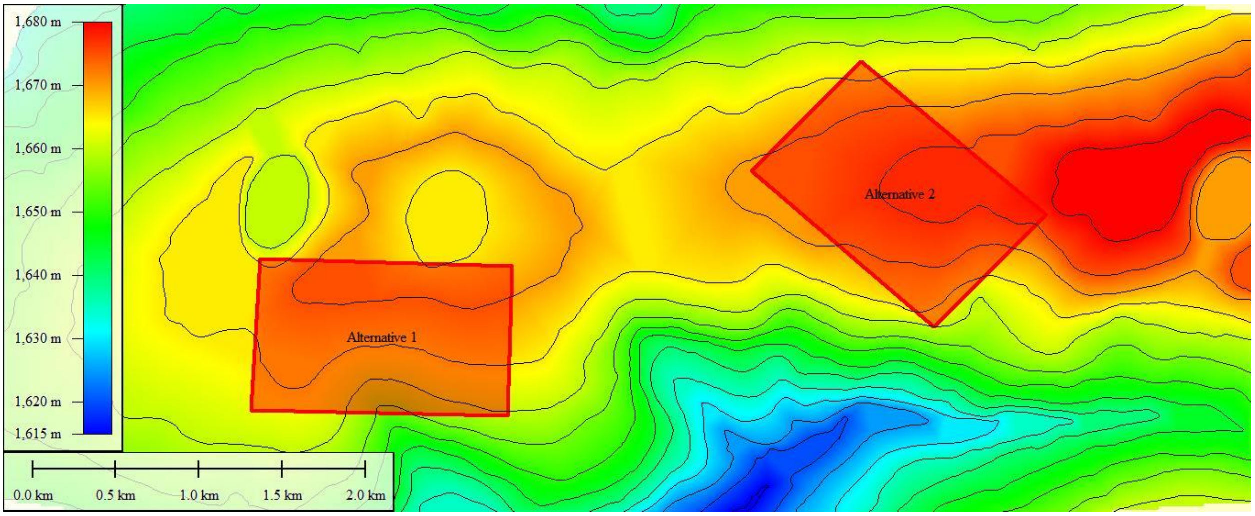

Figure 4: The relief map for the project area

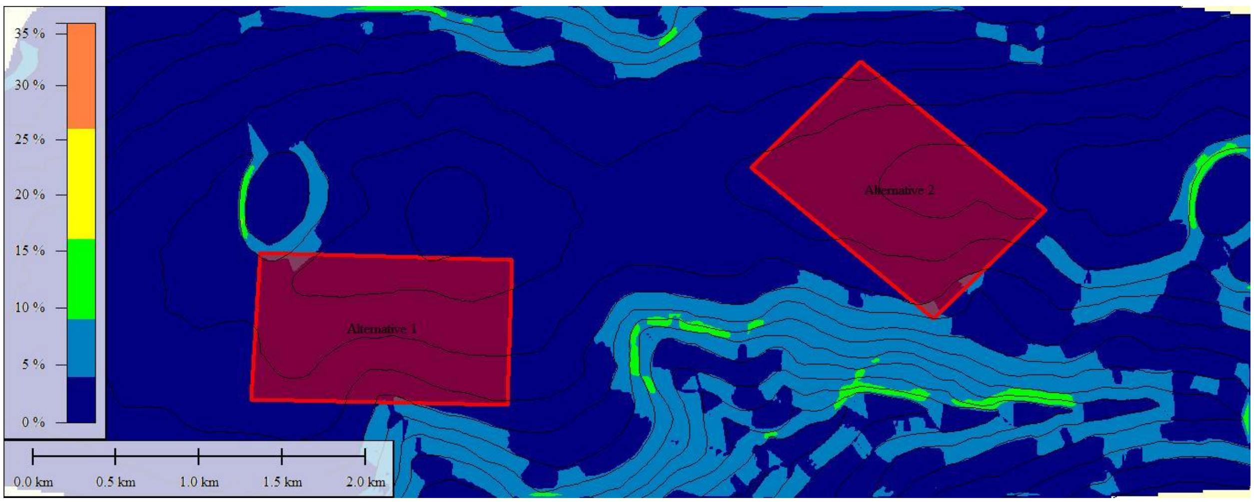

Figure 5: The Slope Percentage map for project area

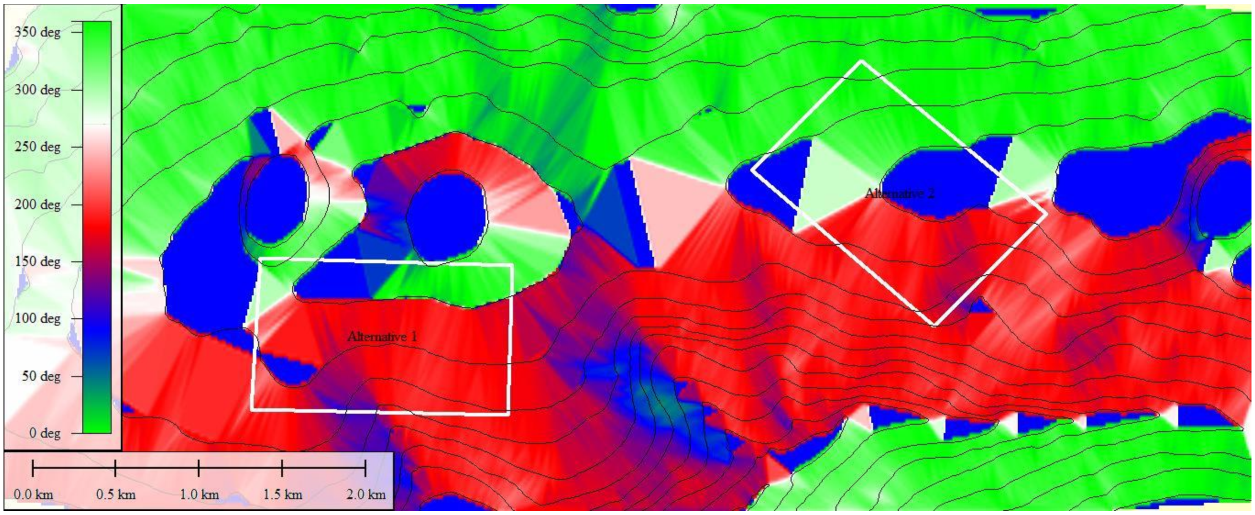

Figure 6: The Slope Aspect map for project area

6.3 Soils & Geology

According to the land type database (Land Type Survey Staff, 1972 - 2006) the project falls within the Ba22 land type. This land type is described in Table 1.

The geology of dominated by shale, shaly sandstone, grit, sandstone and conglomerate of the Ecca Group, Karoo Sequence; dolerite.

Table 1: The expected soil features for the Land types present

Land Type	Expected Soil Features
Ba22	Plinthic catena: upland duplex and margalitic soils rare; Dystrophic and/or mesotrophic; red soils widespread

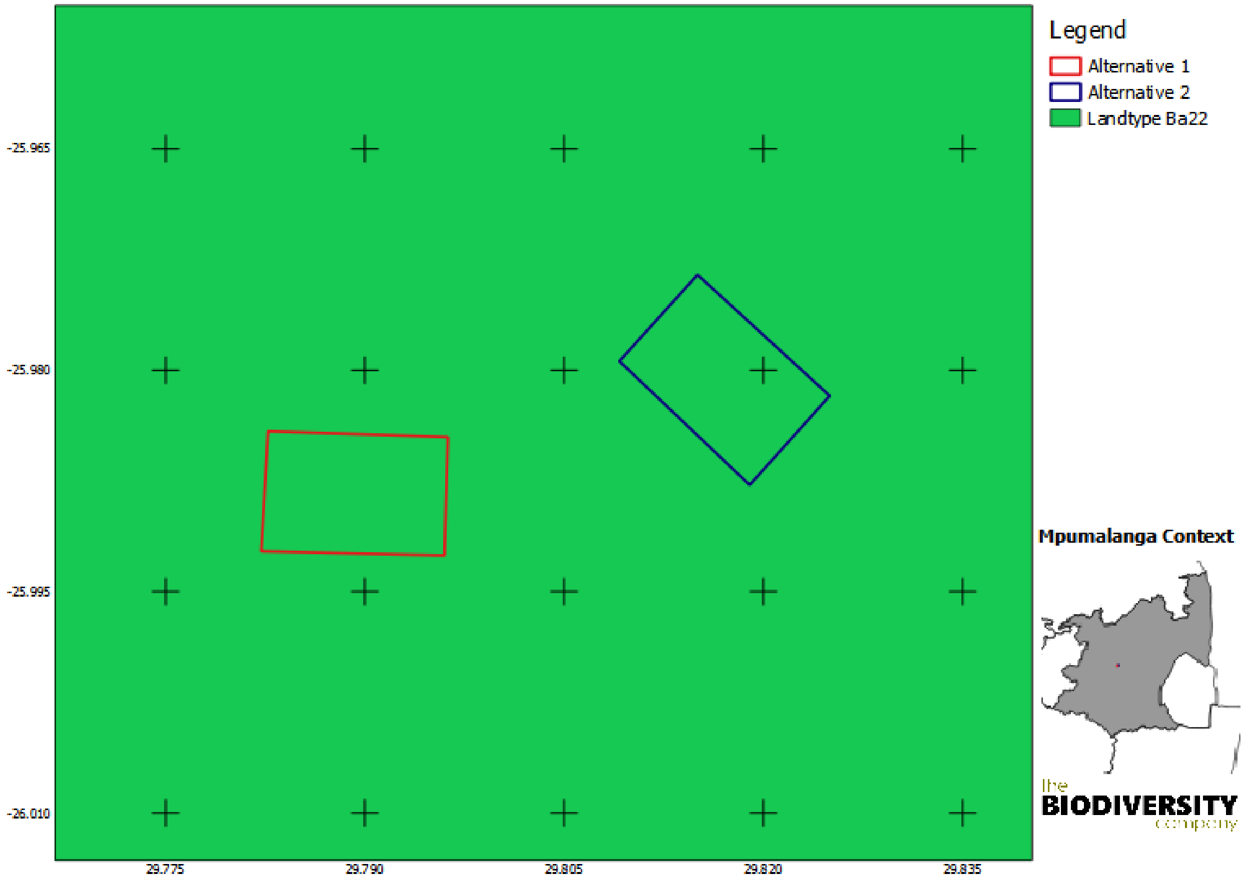

Figure 7: Land type map for the project area

7 Discussion

The project area is flat in relief with slopes of less than 4%. The land type data suggest that soils of the Hutton, Glencoe, and Wasbank forms are present in the crest to midslope positions, with Longlands, Rensburg, and Katspruit soil forms in the valley bottoms. The average land capability based on the land type data is that of a class III (moderate cultivation). Class III land would pose moderate limitations to agriculture with some erosion hazard and would require special conservation practice and tillage methods. The farming method for this capability would require the rotation of crops and ley (50%).

The current land use seems to be croplands with some depressions in the areas. Alternative one shows lower agricultural potential from the areal imagery and therefor from an agricultural perspective Alternative 1 is the selected site.

7.1 Impact Assessment

From an agricultural perspective, the loss of high value farm land and / or food security production, as a result of the proposed activities, is the primary concern of this assessment. In South Africa there is a scarcity of high potential agricultural land, with less than 14% of the total area being suitable for dry land crop production (Smith, 2006).

It must be noted that no detailed project activity list has been provided and the following is to assess the potential impacts that could occur.

Planning Phase (Table 2): a detailed Project Program, Soil Stripping Guideline and Rehabilitation Plan must be completed before commencement. Poor planning of soil stripping stockpiling and rehabilitation will result in losses of land capability and soil as a valuable and irreplaceable resource.

Proper planning prior to construction would reduce the level of impacts from a Medium to a Low impact.

Table 2: Loss of land capability assessed for the proposed project during the planning phase

Loss of Land Capability					
Impact Name	**Loss of Land Capability**				
Alternative	**Ash Dump**				
Phase	**Planning**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	5	3
Extent of Impact	1	1	Reversibility of Impact	3	2
Duration of Impact	5	2	Probability	5	2
Environmental Risk (Pre-mitigation)					-17,50
Mitigation Measures					
• Proper planning of project sequences; • stripping and stockpiling guidelines; and • rehabilitation and monitoring plans.					
Environmental Risk (Post-mitigation)					-4,00
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					2
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					3
The impact may result in the irreplaceable loss of resources of high value (services and/or functions).					
Prioritisation Factor					1,50
Final Significance					-6,00

Construction phase (Table 3): The impacts to consider are those relating to the disturbance of the natural soil state. When soil is stripped the physical properties are changed and this impacts on the soils health. When the soil is stockpiled, the soils chemical properties will deteriorate unless properly managed. These all lead to the loss of the topsoil layer as a natural resource. Soil is considered a slowly regenerating resource due to the fact that it takes hundreds of years for a soil profile to gain 10cm of additional soil through natural processes. During a single rainfall event on unprotected bare soil, erosion could remove that same amount of soil if not more.

Whilst the construction takes place vehicles will drive on the soil surface compacting it. This reduces infiltration rates as well as the ability for plant roots to penetrate the compacted soil. This then reduces vegetative cover and increases runoff potential. The increased runoff potential then leads to increased erosion hazards.

If the topsoil and subsoil are stripped and stockpiled as one unit, the topsoil's seed bank and natural fertility balance is diluted. This will affect the regrowth of vegetation on the stockpiles as well as the regrowth when they have been replaced during the rehabilitation process, therefor soils should be handled with care from the construction phase through to the decommissioning phase.

Operational phase (Table 3): During the operational phase, similar scores are expected regarding the extent of the impacts than those scored for the construction phase. It is of vital importance that the correct procedures be adhered to during this activity and that the different soil horizons be kept separate. During this phase, erosion is a major concern for these stockpiles, especially in cases where proper vegetation has not been established. Erosion within these sections will cause extensive sediment transport and ultimately pollution and degradation of healthy water courses and soil resources nearby.

These designated stockpiles often compact the soil underneath them due to their extremely high masses. Compaction of natural soil resources for extended time periods can cause irreversible degradation. Stockpiles themselves aren't the only aspect contributing to compaction. During the operational phase, a large degree of vehicle activity takes place to ensure that extracted minerals as well as additional waste material is transported to its designated storage areas. These heavy machinery vehicles compact the soil between the project site and the mentioned storage areas severely. Additionally, such stockpiles tend to entail very fine sediment that is prone to be carried away by gusts of wind and ultimately contributes to dust pollution.

Table 3: Loss of land capability assessed for the proposed project during the construction and operational phase

Loss of Land Capability					
Impact Name	**Loss of Land Capability**				
Alternative	**Ash Dump**				
Phase	**Construction and operational phase**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	4	5
Extent of Impact	2	2	Reversibility of Impact	5	4
Duration of Impact	5	4	Probability	5	4
Environmental Risk (Pre-mitigation)					-20,00
Mitigation Measures					
• Bush clearing of all bushes and trees taller than one meter; Ensure proper storm water management designs are in place; • If any erosion occurs, corrective actions (erosion berms) must be taken to minimize any further erosion from taking place; • If erosion has occurred, topsoil should be sourced and replaced and shaped to reduce the recurrence of erosion; • Only the designated access routes are to be used to reduce any unnecessary compaction; • Compacted areas are to be ripped to loosen the soil structure; • The topsoil should be stripped by means of an excavator bucket, and loaded onto dump trucks; • Topsoil stockpiles are to be kept to a maximum height of 4m; • Topsoil is to be stripped when the soil is dry, as to reduce compaction; • Bush clearing contractors will only clear bushes and trees larger than 1m the remaining vegetation will be stripped with the top 0.3 m of topsoil to conserve as much of the nutrient cycle, organic matter and seed bank as possible; • The subsoil approximately 0.3 to the designated thickness in the stripping guidelines, will then be stripped and stockpiled separately; • The handling of the stripped topsoil will be minimized to ensure the soil's structure does not deteriorate significantly; • Compaction of the removed topsoil must be avoided by prohibiting traffic on stockpiles; • Stockpiles should only be used for their designated final purposes; • The stockpiles will be vegetated (details contained in rehabilitation plan) in order to reduce the risk of erosion, prevent weed growth and to reinstitute the ecological processes within the soil. • Place the above cleared vegetation were the topsoil stockpiles are to be placed; and • Strip the topsoil and the remaining vegetation as per the rehabilitation guideline and place in the allocated locations for the various soil types, on top of the previously cleared bushes and trees.					
Environmental Risk (Post-mitigation)					-15,00
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					2
Low: Issue not raised in public responses					
Cumulative Impacts					3
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					3
The impact may result in the irreplaceable loss of resources of high value (services and/or functions).					
Prioritisation Factor					1,83
Final Significance					-27.5

Decommissioning phase (Table 4): During this phase, vehicle activity is likely to compact soils even further due to the necessary material. The infrastructure established during the construction phase is subsequently destroyed to ensure as little as possible is left after the relevant operations.

Table 4: Loss of land capability assessed for the proposed project during the decommissioning phase

Loss of Land Capability					
Impact Name	**Loss of Land Capability**				
Alternative	**Ash Dump**				
Phase	**Decommissioning**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	4	3
Extent of Impact	2	2	Reversibility of Impact	5	3
Duration of Impact	5	3	Probability	5	3
Environmental Risk (Pre-mitigation)					-20,00
Mitigation Measures					
• Ensure proper storm water management designs are in place; • Ensure that proper phyto-stabilization takes place on top of the relevant stockpiles; • Only the designated access routes are to be used to reduce any unnecessary compaction; • If erosion occurs, corrective actions (erosion berms) must be taken to minimize any further erosion from taking place; • Only the designated access routes are to be used to reduce any unnecessary compaction; • Implement land rehabilitation measures as defined in rehabilitation report. • Follow rehabilitation guidelines; • The topsoil should be moved by means of an excavator bucket, and loaded onto dump trucks; • Topsoil is to be moved when the soil is dry, as to reduce compaction; • After the completion of the project the area is to be cleared of all infrastructure; • The foundations to be removed; • Topsoil to be replaced for rehabilitation purposes; • The handling of the stripped topsoil will be minimized to ensure the soil's structure does not deteriorate; • Stockpiles should only be used for their designated final purposes; • Compacted areas are to be ripped to loosen the soil structure and vegetation cover re-instated; and					
Environmental Risk (Post-mitigation)					-8.25
Degree of confidence in impact prediction:					Medium
Impact Prioritisation					
Public Response					2
Issue has received a meaningful and justifiable public response					
Cumulative Impacts					3
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					3
The impact may result in the irreplaceable loss of resources of high value (services and/or functions).					
Prioritisation Factor					1,83
Final Significance					-15,13

7.2 Field Verification Methodology

A soil auger will be used to determine the soil form/family and depth. The soil will be hand augured to the first restricting layer or 1.5 m. Soil survey positions will be recorded as waypoints using a handheld GPS. Soils will be identified to the soil family level as per the "Soil Classification: A Taxonomic System for South Africa" (Soil Classification Working Group, 1991). Landscape features such as existing open trenches will also be helpful in determining soil types and depth.

Agricultural Potential Assessment

Land capability and agricultural potential is determined by a combination of soil, terrain and climate features. Land capability is defined by the most intensive long term sustainable use of land under rain-fed conditions. At the same time an indication is given about the permanent limitations associated with the different land use classes (Smith, 2006)

Land capability is divided into eight classes and these may be divided into three capability groups. Table 5 shows how the land classes and groups are arranged in order of decreasing capability and ranges of use. The risk of use increases from class I to class VIII (Smith, 2006).

Table 5: Land capability class and intensity of use (Smith, 2006).

Land Capability Class	**Increased Intensity of Use**									**Land Capability Groups**
I	W	F	LG	MG	IG	LC	MC	IC	VIC	**Arable Land**
II	W	F	LG	MG	IG	LC	MC	IC		
III	W	F	LG	MG	IG	LC	MC			
IV	W	F	LG	MG	IG	LC				
V	W		LG	MG						**Grazing Land**
VI	W	F	LG	MG						
VII	W	F	LG							
VIII	W									**Wildlife**
W - Wildlife		**MG - Moderate Grazing**			**MC - Moderate Cultivation**					
F- Forestry		**IG - Intensive Grazing**			**IC - Intensive Cultivation**					
LG - Light Grazing		**LC - Light Cultivation**			**VIC - Very Intensive Cultivation**					

The land potential classes are determined by combining the land capability results and the climate capability of a region as shown in Table 6. The final land potential results are then described in Table 7.

Table 6: The combination table for land potential classification.

Land capability class	Climate capability class							
	C1	C2	C3	C4	C5	C6	C7	C8
I	L1	L1	L2	L2	L3	L3	L4	L4
II	L1	L2	L2	L3	L3	L4	L4	L5
III	L2	L2	L3	L3	L4	L4	L5	L6
IV	L2	L3	L3	L4	L4	L5	L5	L6
V	Vlei	Vlei	Vlei	Vlei	Vlei	Vlei	Vlei	Vlei
VI	L4	L4	L5	L5	L5	L6	L6	L7
VII	L5	L5	L6	L6	L7	L7	L7	L8
VIII	L6	L6	L7	L7	L8	L8	L8	L8

Table 7: The Land Potential Classes.

Land potential	Description of land potential class
L1	Very high potential: No limitations. Appropriate contour protection must be implemented and inspected.
L2	High potential: Very infrequent and/or minor limitations due to soil, slope, temperatures or rainfall. Appropriate contour protection must be implemented and inspected.
L3	Good potential: Infrequent and/or moderate limitations due to soil, slope, temperatures or rainfall. Appropriate contour protection must be implemented and inspected.
L4	Moderate potential: Moderately regular and/or severe to moderate limitations due to soil, slope, temperatures or rainfall. Appropriate permission is required before ploughing virgin land.
L5	Restricted potential: Regular and/or severe to moderate limitations due to soil, slope, temperatures or rainfall.
L6	Very restricted potential: Regular and/or severe limitations due to soil, slope, temperatures or rainfall. Non-arable
L7	Low potential: Severe limitations due to soil, slope, temperatures or rainfall. Non-arable
L8	Very low potential: Very severe limitations due to soil, slope, temperatures or rainfall. Non-arable

8 References

Land Type Survey Staff. (1972 - 2006). *Land Types of South Africa: Digital Map (1:250 000 Scale) and Soil Inventory Databases.* Pretoria: ARC-Institute for Soil, Climate, and Water.

Smith, B. (2006). *The Farming Handbook.* Netherlands & Southafrica: University of KwaZulu-Natal Press & CTA.

Soil Classification Working Group. (1991). *Soil Classification A Taxonomicsystem for South Africa.* Pretoria: The Department of Agriculturel Development.