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ENVIRONMENTAL

Environmental Impact Assessment for the De Groote Boom Project

Soils, Land Capability, and Land Use

Project Number:

UAR2967

Prepared for:

De Groote Boom (Pty) Ltd

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EXECUTIVE SUMMARY

Introduction

The conservation of South Africa's limited soil resources is essential for human survival. In the past, misuse of land due to not classifying the soils and their capability/potential correctly has led to loss of these resources through erosion and destabilisation of the natural systems. In order to identify soils accurately, it is necessary to undertake a soil survey, in accordance with standard procedures. The aim of the soil assessment is to provide an accurate record of the soil resources of an area. Land capability and land potential is then determined from these results. The objective of determining the land capability/potential is to identify the most sustainable use of the soil resource without degrading the system.

Digby Wells Environmental was requested by De Groote Boom (Pty) Ltd to compile and submit an Environmental Management Plan, pursuant to an application for a mining permit, in terms of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) to the Limpopo Department of Mineral Resources. This Soil Assessment forms part of the report and application.

Study Area

The study area is in the Limpopo province, located near the town of Steelpoort. The desktop research, undertaken prior to the field survey showed the area to have steep mountainous areas, with slopes greater than 5%, which were expected to have shallow soils and rock. The soils on the foot slopes were expected to be deeper.

Methodology

Soils were investigated using a bucket type auger to a maximum depth of 1200 mm or to the depth of refusal. At each observation point the South African Taxonomic Soil Classification System was used to describe and classify the soil.

Land capability was 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.

Findings

Five land use classifications were identified using aerial imagery and then ground-truthed during the site visit. These include: Cultivated, Natural, Wetlands, Urban and Mining.

The project area is dominated by shallow rocky soils (Mispah/Glenrosa) on upper slopes. The flatter slopes show greater accumulation of soil. The dominant soil in the downslope region is Hutton soil form. The lower slopes are currently used for subsistence grazing. There is evidence of overgrazing and large areas of erosion. This is due to the combination of high runoff velocity from the steep slopes and reduced ground cover (overgrazing).

The dominant land capability for the area is the Class VI (Moderate Grazing) and Class VIII (Wilderness). These capability classifications are due to the steep slopes. The footslopes where the slopes are less than 5% the shallower soils (Mispah/Glenrosa) have a Class IV (Low Cultivation/Intensive Grazing) land capability. The deeper Hutton soils have Class III (Moderate Cultivation) land capability.

The land use dominating the project area is natural veld which has been used in some parts for subsistence grazing by the community. There are portions downslope that show signs of erosion.

Impacts

The construction phase of the project will comprise of the construction of the mine and supporting infrastructure. This will entail the clearing of areas and the disturbance of the topsoil through excavations as well as the construction of a soil stockpile. The topography and natural drainage lines will be disturbed. The impact with regards to soil will be the loss of topsoil as a result of erosion, if mismanaged. Additionally possible contamination of the soil by fuel, and oils may occur due to the excavation activities. Soil compaction caused by heavy vehicles and machinery surrounding the pit area could also be a problem.

Soil stripping, prior to development, will require the removal of all soil materials to a depth of at least 0.3 m in order to conserve the valuable topsoil. This activity will provide needed soil cover material for rehabilitation purposes. Construction activities will change the land use from arable farming to mining.

Soil erosion through wind and storm water run-off, and soil pollution by means of hydrocarbon contamination may occur during the operational phase. Water runoff from roads must be controlled and managed by use of proper storm water management facilities. Diesel and oil spills are common at mine sites, however be localised and remediate using commercially available hydrocarbon emergency clean-up kits.

During the decommissioning phase all infrastructure will be demolished and removed, which will entail vehicle movement in the infrastructure area. The potential impacts associated with these activities will include the risk of hydrocarbon spills, and compaction.

The rehabilitation of the mining area and infrastructure area should have a positive impact if done correctly.

Recommendations

In light of the study findings, the following recommendations for the stripping and stockpiling of soils are suggested;

- Soil stockpiles must not exceed a height of 4-5 m (practical tipping height for dump trucks) to prevent compaction;
- Stockpiles should be re-vegetated as quickly as possible to reduce or prevent erosion;

- Stockpiles should be demarcated and logged, as to make sure the right stockpiles (soil types) are used when rehabilitating; and
- Limit the slopes on the stockpiles to 1:3 to reduce erosion losses, or place a smaller berm around the edge of each stockpile to contain any erosion;

The major concern for this area is the potential for erosion due to the steep slopes. Stockpiles and reshaped land must be re-vegetated as quickly as possible to reduce the erosion hazards.

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The conservation of South Africa's limited soil resources is essential for human survival. In the past, misuse of land due to not classifying the soils and their capability/potential correctly has led to loss of these resources through erosion and destabilisation of the natural systems.

In order to identify soils accurately, it is necessary to undertake a soil survey, in accordance with standard procedures. The aim is to provide an accurate record of the soil resources of an area. Land capability and land potential is then determined from these results. The objective of determining the land capability/potential is to find identify the most sustainable use of the soil resource without degrading the system.

Furthermore soil mapping is essential to determine the types of soils present, their depths, their land capability, and their stripping ratios. These results will then be used to give practical recommendations on preserving and managing the stripping and stockpiling of the soil resource.

2 Terms of Reference

Digby Wells Environmental (hereafter Digby Wells) was commissioned by De Groote Boom (Pty) Ltd (hereafter De Groote Boom) to conduct a survey of the project area.

The soil assessment included following activities:

- Field survey. The soils occupying the area were surveyed during field visits. The project site was traversed by vehicle and on foot. A hand soil auger was used to survey the soil types present as well as to obtain soils samples;
- Land Capability. Survey positions were recorded as waypoints using a handheld GPS; and
- The findings of the study are to be included in the Environmental Management Plan Report, and provide a baseline analysis of existing soil conditions.

3 Project Description

The De Groote Boom Project is situated on the Remaining Extent of the farm De Grooteboom 373 KT, near the town of Steelpoort situated in the Limpopo Province (Plan 1).

Digby Wells Environmental (hereafter Digby Wells) has been requested by De Groote Boom, to compile and submit an Environmental Management Plan (EMP), pursuant to an application for a mining permit, in terms of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA) to the Limpopo Department of Mineral Resources (DMR).

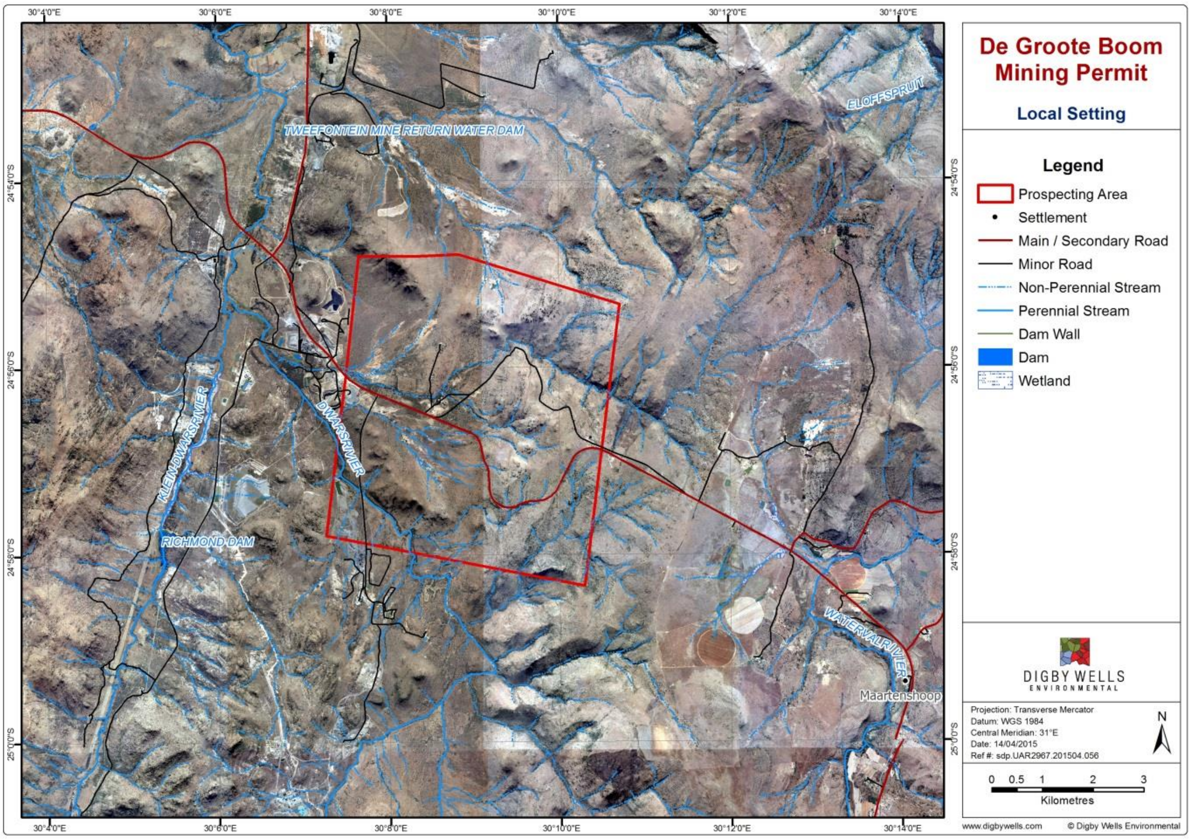
The Mining Permit Application has been accepted by the Regional Manager, Limpopo Region, of the DMR under Reference LP 10656 MR and De Groote Boom has been instructed to prepare an EMP, which will include various specialist investigations, including a soil, land capability and land use assessment.

3.1 Project Background and Description

De Groote Boom currently holds an approved Prospecting Right valid for three years (with the right to Mine) and it now proposes to mine primarily chromite (chrome ore, platinum group metals, gold ore and all associated minerals) and also associated Platinum Group Metals (PGMs) covering an extent of not more than 5 ha on the Remaining Extent of the farm De Grooteboom 373 KT (refer to Plan 1). It is possible that after completing work under the mining permit, De Groote Boom will commence with full scale mining of Chromite and PGMs in terms of a mining right that would be applied for at that stage. Mining will be undertaken by open cut methods and the ore will be transported to a portable plant for crushing and screening. The ore will be stockpiled until transported off site by truck. The mining permit area is adjacent to the Mining area and the operational and related infrastructure areas are depicted on the infrastructure plan.

3.2 Description of Study Area

The study area, as shown in Plan 1 is in the Limpopo province, near the Steelpoort town. The area has steep mountainous areas and as a result the soils that are expected in the areas with slopes greater than 5% will be shallow and rock. The soils on the foot slopes are expected to be deeper.



Plan 1: The local setting for the De Groote Boom Project

4 Methodology

4.1 Soil classification

The soils were investigated by making observations with the use of a bucket type auger to a maximum depth of 1200 mm or to the depth of refusal. At each observation point the South African Taxonomic Soil Classification System (Soil Classification Working Group, 2nd edition 1991) was used to describe and classify the soil. The classification system categorises soil types in an upper soil form level.

4.2 Pre-Mining land capability

Land capability 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 (Schoeman, et al., 2000) (Smith, 2006).

Land capability is divided into eight classes and these may be divided into three capability groups.

Table 4-1 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 4-1: 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

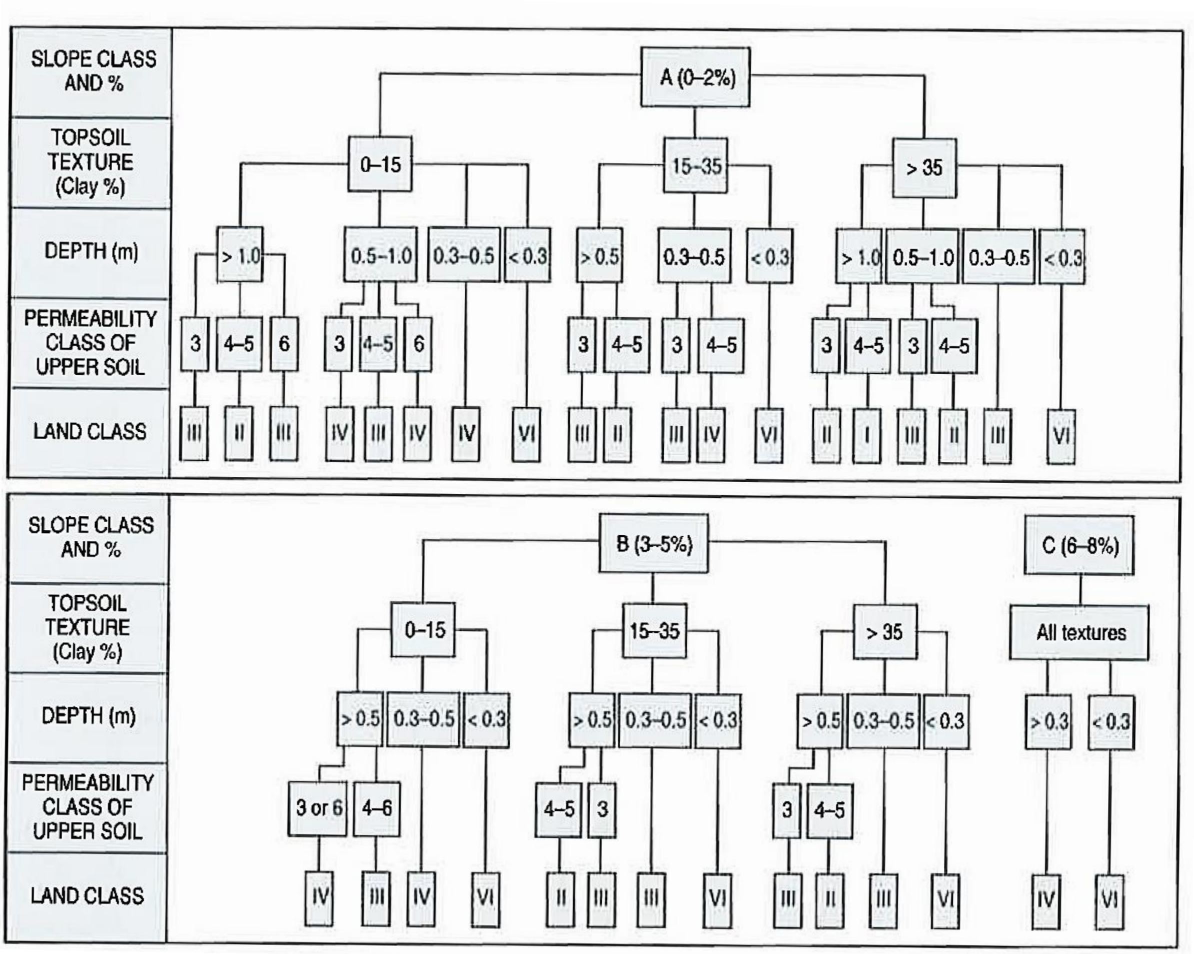
4.2.1 Land capability flow chart

The land capability flow chart shown in Table 4-2 was chosen as the rainfall in the area is less than 750mm is used to classify the land capability based on the following criteria;

- Slope (%);
- Topsoil Texture (clay %);
- Effective rooting depth; and
- Permeability class topsoil.

Once a land capability is derived from this the capability class is adjusted using the soil characteristics discussed in the sections to follow.

Table 4-2: Land capability flow chart for areas with rainfall of below 750mm and soils are eutrophic (high base status) (Smith, 2006)



4.2.2 Soil characteristics to determine and adjust land capability

The tables below are to be used to adjust the land capability that was derived from the flow chart (Table 4-2) above.

4.2.2.1 Soil permeability

Soil permeability is calculated using an infield test technique, by applying a couple of drops of water to the soil surface and recording the amount of seconds it takes to be absorbed into the soil. Table 4-3 shows the classification system. The permeability class is then used to adjust the value from Table 4-4.

Table 4-3: The soil permeability classes (Smith, 2006).

Class	Rate (seconds)	Description	Texture
7	<1	Extremely Rapid	Gravel and coarse sand, 0 to 10% clay
6	1 to 3	Rapid	5 to 10% clay
5	4 to 8	Good	> 10% clay
4	9 to 20	Slightly restricted	
3	21 to 40	Restricted	Strong structure, grey colour, mottled, >35% clay
2	41 to 60	Severely restricted	Strong structure, weathered rock, >35% clay
1	>60	Impermeable	Rock and very strong structure, >35% clay

Table 4-4: The soil permeability adjustment factors (Smith, 2006).

Permeability Class	Adjustment to be made
1 to 2	If in subsoil, rooting is likely to be limited. Use the permeability of topsoil in the flow chart. If this is the permeability of the topsoil, then the topsoil is probably dark structured clay, in which case a permeability class 3 can be used in the flow chart.
3 to 5	Classify as indicated in the flow chart
6	Topsoil should have < 15% clay - use the flow chart
7	Downgrade land classes I -III to land class IV

4.2.2.2 Soil wetness factors

Soil wetness is divided into the five categories shown in Table 4-5, these describe varying degrees of wetness at various depths. Wetness affects plant production when the roots are wet for extended periods of time near the surface, and as a result this will downgrade a soils land capability based on the below definitions.

Table 4-5: The soil wetness adjustment factors (Smith, 2006)

Class	Definition	Land Class
W0	Well drained - no grey colour with mottling within 1,5m of the surface. Grey colour without mottling is acceptable.	No Change
W1	There is no evidence of wetness within the top 0,5m. Occasionally wet - grey colours and mottling begin between 0,5m and 1,5m from the surface	Downgrade Class I to Class II, otherwise no change
W2	Temporarily wet during the wet season. No mottling in the top 0,2m but grey colours and mottling occur between 0,2m and 0,5m from surface. Included are: soils with G horizons (highly gleyed and often clayey) at depths of more than 0,5m; soils with E horizon over G horizon where the depth to the G horizon is more than 0,5m.	Downgrade to Class IV
W3	Periodically wet. Mottling occurs in top 0,2m, and includes soils with a heavily gleyed or G horizon at a depth of less than 0,5m. Found in bottomlands.	Downgrade to Class V (a)
W4	Semi-permanently/permanently wet at or above soil surface throughout the wet season. Usually an organic topsoil or an undrained vlei. Found in bottomlands.	Downgrade to Class V (b)

4.2.2.3 Soil rockiness factors

Soil rockiness affects the management of a soil in a negative way. And the soils land capability will be reduced as described in Table 4-6 accordingly.

Table 4-6 : The soil rockiness adjustment factors (Smith, 2006).

Class	Definition	Land Class
R 0	No rockiness	No change
R 1	2 to 10% rockiness	Downgrade class I to class II, otherwise no change
R 2	10 to 20% rockiness	Downgrade class II to class III, otherwise no change
R 3	20 to 30% rockiness	Downgrade class I - III to class IV
R 4	>30% rockiness	Downgrade classes I, II, III, and IV to class VI

4.2.2.4 Surface crusting

Surface crusting has an effect on initial infiltration and could cause erosion to some degree. Table 4-7 shows how to adjust the flow chart results for land capability accordingly.

Table 4-7: The soil crusting adjustment factors (Smith, 2006).

Class	Definition	Land Class
t0	No surface crusting when dry	No Change
t1	Slight surface crusting when dry	Downgrade class I to II, no Change
t2	Unfavourable surface crusting when dry	Downgrade class I to II, no Change

4.3 Current Land use

Land use was identified using aerial imagery and then ground-truthed while out in the field. The land use is classified as:

- Cultivated;
- Natural;
- Wetlands;
- Urban; or
- Mining.

4.4 Impact Rating Methodology

The methodology utilised to assess the significance of potential environmental impacts is discussed in detail below. The significance rating formula is as follows:

Significance = Consequence x Probability

Where

Consequence = Type of Impact x (Intensity + Spatial Scale + Duration)

And

Probability = Likelihood of an Impact Occurring

In addition, the formula for calculating consequence:

Type of Impact *=* ***+1*** *(Positive Impact) or* ***-1*** *(Negative Impact)*

The weight assigned to the various parameters for positive and negative environmental impacts is provided for in the formula and is presented in Table 4-8. The probability consequence matrix for social and heritage impacts is displayed in Table 4-9, with the impact significance rating described in Table 4-10.

Table 4-8: Social and Heritage Impact Assessment Parameter Ratings

Rating	Intensity		Spatial scale	Duration	Probability
	Negative Impacts (Type of Impact = -1)	***Positive Impacts (Type of Impact = +1)***			
7	Very significant impact on the environment. Irreparable damage to highly valued species, habitat or ecosystem. Persistent severe damage. Irreparable damage to highly valued items of great cultural significance or complete breakdown of social order.	Noticeable, on-going social and environmental benefits which have improved the livelihoods and living standards of the local community in general and the environmental features.	International The effect will occur across international borders.	Permanent: No Mitigation The impact will remain long after the life of the Project.	Certain/ Definite. There are sound scientific reasons to expect that the impact will definitely occur.
6	Significant impact on highly valued species, habitat or ecosystem. Irreparable damage to highly valued items of cultural significance or breakdown of social order.	Great improvement to livelihoods and living standards of a large percentage of population, as well as significant increase in the quality of the receiving environment.	National Will affect the entire country.	Beyond Project Life The impact will remain for some time after the life of a Project.	Almost certain/Highly probable It is most likely that the impact will occur.

Rating	**Intensity**		**Spatial scale**	**Duration**	**Probability**
	Negative Impacts (Type of Impact = -1)	***Positive Impacts (Type of Impact = +1)***			
5	Very serious, long-term environmental impairment of ecosystem function that may take several years to rehabilitate. Very serious widespread social impacts. Irreparable damage to highly valued items.	On-going and widespread positive benefits to local communities which improves livelihoods, as well as a positive improvement to the receiving environment.	Province/ Region Will affect the entire province or region.	Project Life The impact will cease after the operational life span of the Project.	Likely The impact may occur.
4	Serious medium term environmental effects. Environmental damage can be reversed in less than a year. On-going serious social issues. Significant damage to structures / items of cultural significance.	Average to intense social benefits to some people. Average to intense environmental enhancements.	Municipal Area Will affect the whole municipal area.	Long term 6-15 years.	Probable Has occurred here or elsewhere and could therefore occur.

Rating	Intensity		Spatial scale	Duration	Probability
	Negative Impacts ***(Type of Impact = -1)***	***Positive Impacts*** ***(Type of Impact = +1)***			
3	Moderate, short-term effects but not affecting ecosystem function. Rehabilitation requires intervention of external specialists and can be done in less than a month. On-going social issues. Damage to items of cultural significance.	Average, on-going positive benefits, not widespread but felt by some.	Local Extending across the site and to nearby settlements.	Medium term 1-5 years.	Unlikely Has not happened yet but could happen once in the lifetime of the Project, therefore there is a possibility that the impact will occur.
2	Minor effects on biological or physical environment. Environmental damage can be rehabilitated internally with/ without help of external consultants. Minor medium-term social impacts on local population. Mostly repairable. Cultural functions and processes not affected.	Low positive impacts experience by very few of population.	Limited Limited to the site and its immediate surroundings.	Short term Less than 1 year.	Rare/ improbable Conceivable, but only in extreme circumstances and/ or has not happened during lifetime of the Project but has happened elsewhere. The possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures.

Rating	Intensity		Spatial scale	Duration	Probability
	Negative Impacts ***(Type of Impact = -1)***	***Positive Impacts*** ***(Type of Impact = +1)***			
1	Limited damage to minimal area of low significance that will have no impact on the environment. Minimal social impacts, low-level repairable damage to commonplace structures.	Some low-level social and environmental benefits felt by very few of the population.	Very limited Limited to specific isolated parts of the site.	Immediate Less than 1 month.	Highly unlikely/None Expected never to happen.

Table 4-9: Probability Consequence Matrix for Social and Heritage Impacts

Probability	Significance																																					
7	-147	-140	-133	-126	-119	-112	-105	-98	-91	-84	-77	-70	-63	-56	-49	-42	-35	-28	-21	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140	147
6	-126	-120	-114	-108	-102	-96	-90	-84	-78	-72	-66	-60	-54	-48	-42	-36	-30	-24	-18	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120	126
5	-105	-100	-95	-90	-85	-80	-75	-70	-65	-60	-55	-50	-45	-40	-35	-30	-25	-20	-15	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105
4	-84	-80	-76	-72	-68	-64	-60	-56	-52	-48	-44	-40	-36	-32	-28	-24	-20	-16	-12	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84
3	-63	-60	-57	-54	-51	-48	-45	-42	-39	-36	-33	-30	-27	-24	-21	-18	-15	-12	-9	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63
2	-42	-40	-38	-36	-34	-32	-30	-28	-26	-24	-22	-20	-18	-16	-14	-12	-10	-8	-6	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42
1	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	-21	**-20**	**-19**	**-18**	**-17**	**-16**	**-15**	**-14**	**-13**	**-12**	**-11**	**-10**	**-9**	**-8**	**-7**	**-6**	**-5**	**-4**	**-3**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
	Consequence																																					

Table 4-10: Significance Threshold Limits

Score	Description	Rating
109 to 147	A very beneficial impact which may be sufficient by itself to justify implementation of the Project. The impact may result in permanent positive change.	**Major (positive)**
73 to 108	A beneficial impact which may help to justify the implementation of the Project. These impacts would be considered by society as constituting a major and usually a long-term positive change to the (natural and/or social) environment.	Moderate (positive)
36 to 72	An important positive impact. The impact is insufficient by itself to justify the implementation of the Project. These impacts will usually result in positive medium to long-term effect on the social and/or natural environment.	Minor (positive)
3 to 35	A small positive impact. The impact will result in medium to short term effects on the social and/or natural environment.	Negligible (positive)
-3 to -35	An acceptable negative impact for which mitigation is desirable but not essential. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in negative medium to short term effects on the social and/or natural environment.	Negligible (negative)

Score	Description	Rating
-36 to -72	An important negative impact which requires mitigation. The impact is insufficient by itself to prevent the implementation of the Project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in negative medium to long-term effect on the social and/or natural environment.	Minor (negative)
-73 to -108	A serious negative impact which may prevent the implementation of the Project. These impacts would be considered by society as constituting a major and usually a long-term change to the (natural and/or social) environment and result in severe effects.	Moderate (negative)
-109 to -147	A very serious negative impact which may be sufficient by itself to prevent implementation of the Project. The impact may result in permanent change. Very often these impacts are immitigable and usually result in very severe effects.	Major (negative)

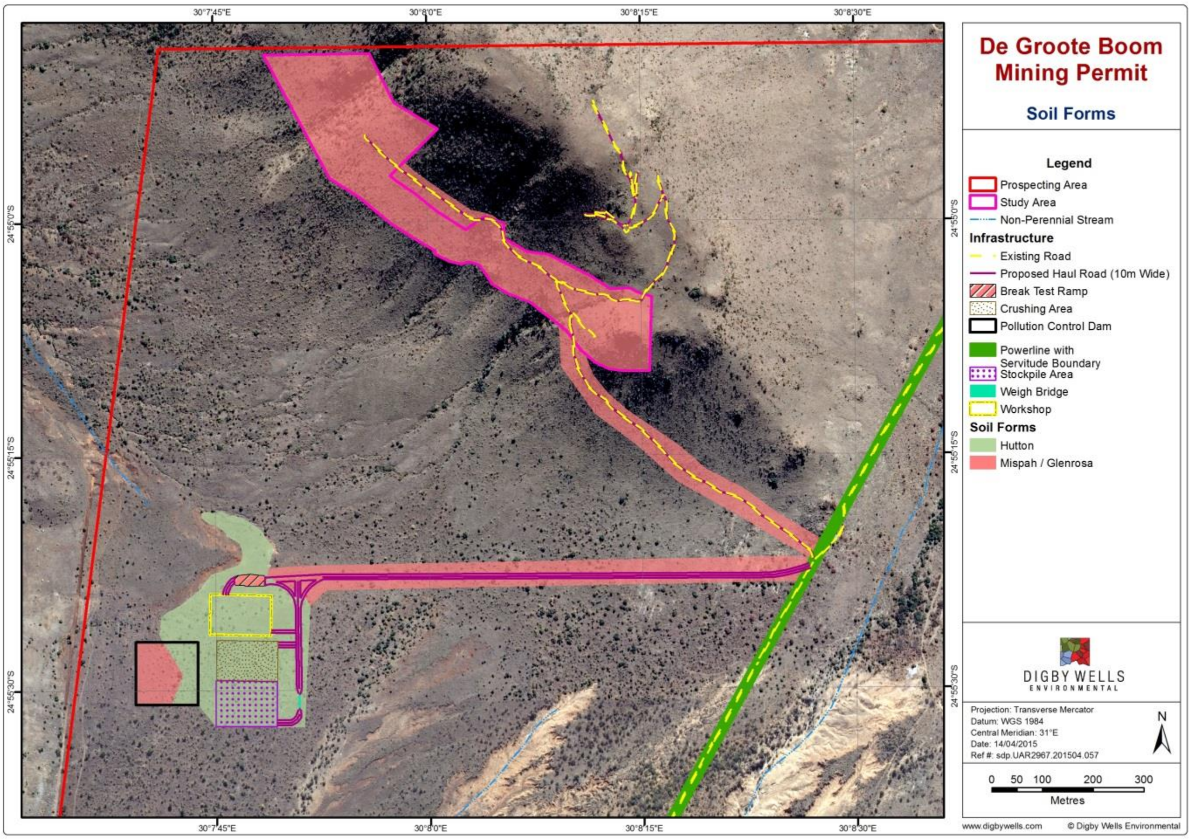
5 Results and Discussion

The project area was dominated by shallow rocky soils (Mispah/Glenrosa) on the upper slopes. The flatter slopes shows accumulation of soil and the dominant soil in the downslope region is the deep well drained Hutton soil as shown in Plan 2.

The lower slopes are used for subsistence grazing and as a result there is evidence of overgrazing. Large areas have been eroded. The combination of high runoff velocity from the steep slopes and the reduced ground cover (overgrazing) in the lower slopes has contributed significantly to the erosion of the soils in the lower landscape positions. Table 5-1 below summarises the soil, slope, land capability and land potential within the project area.

Table 5-1: Summary of soil forms, slopes, land capability, and land potential.

Soil form	Slope (%)	Final Land Capability Class
Hutton (Hu)	4	III
Glenrosa (Gs)	<5	IV
Glenrosa (Gs)	>5	VI
Mispah (Ms)	<5	VI
Mispah (Ms)	>5	VIII



Plan 2: Soil forms for the De Groote Boom project area

5.1 Dominant soils found

Details of the three dominant soils (Mispah, Glenrosa and Hutton) found within the study area are provided in the following sections.

5.1.1 Mispah

The Mispah soil form is an Orthic topsoil on hard rock. These soils are shallow as shown in Figure 5-1. These soils have a limited rooting depth.

Figure 5-1: Mispah soil at the De Groote Boom project site

5.1.2 Glenrosa (Gs)

The Glenrosa soil form is an Orthic topsoil on a weather rock material. These soils are generally shallow as shown in Figure 5-2. These soils have a limited rooting depth.

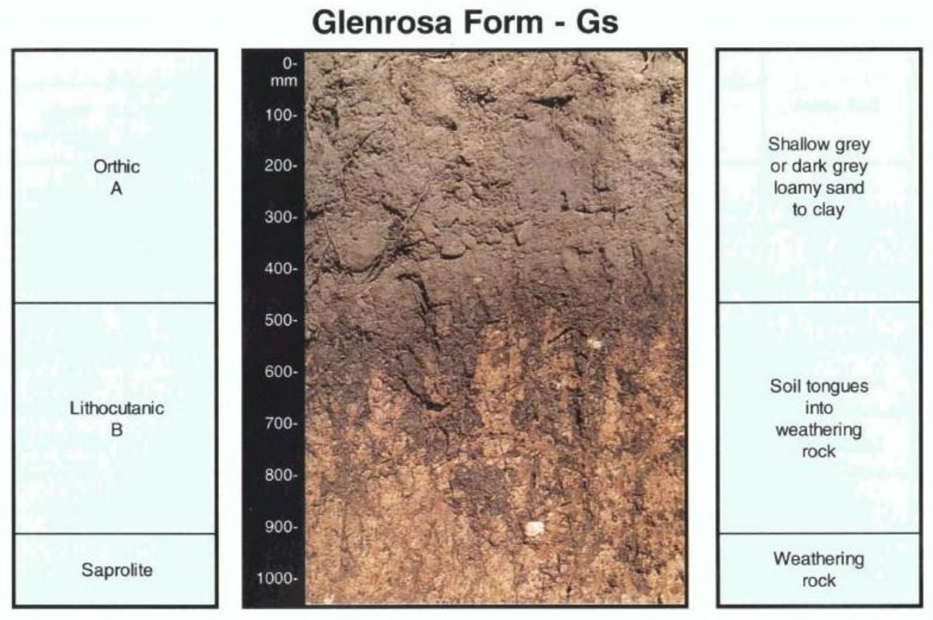


Figure 5-2: The Glenrosa soil form (SASA, 1999)

5.1.3 Hutton (Hu)

The Hutton soil form as shown in Figure 5-3 consists of an Orthic A, Red apedal B, and an unspecified C horizon which could be hard rock, saprolite, or unknown as no limiting layer was identified. These soils are freely drained and as a result, can be slightly acidic due to the low cation exchange capacity (CEC) and thus the low base status. These soils are prime soils for irrigated crop production, however they are marginal to good in dry land conditions.

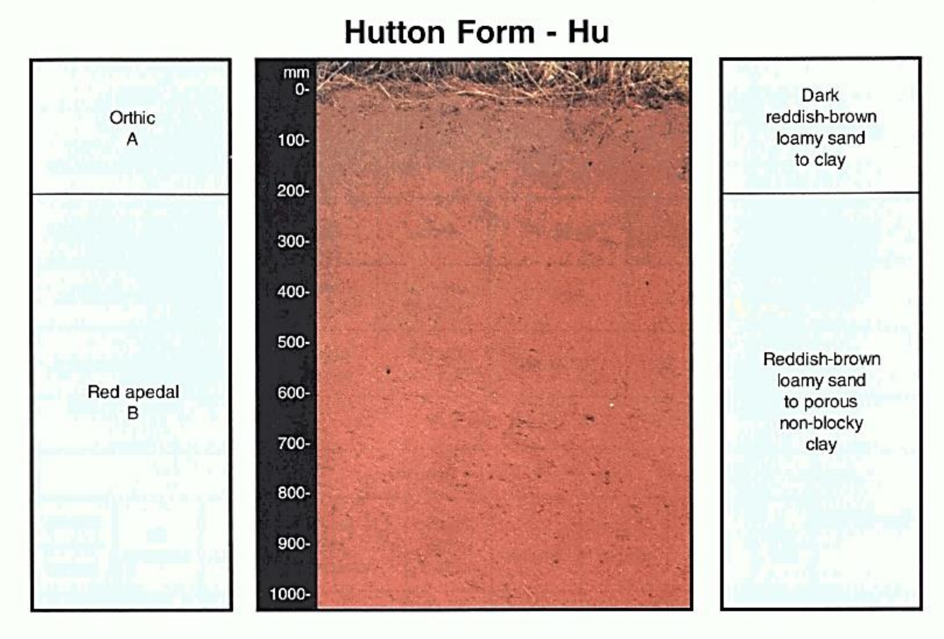


Figure 5-3: The Hutton soil form (SASA, 1999)

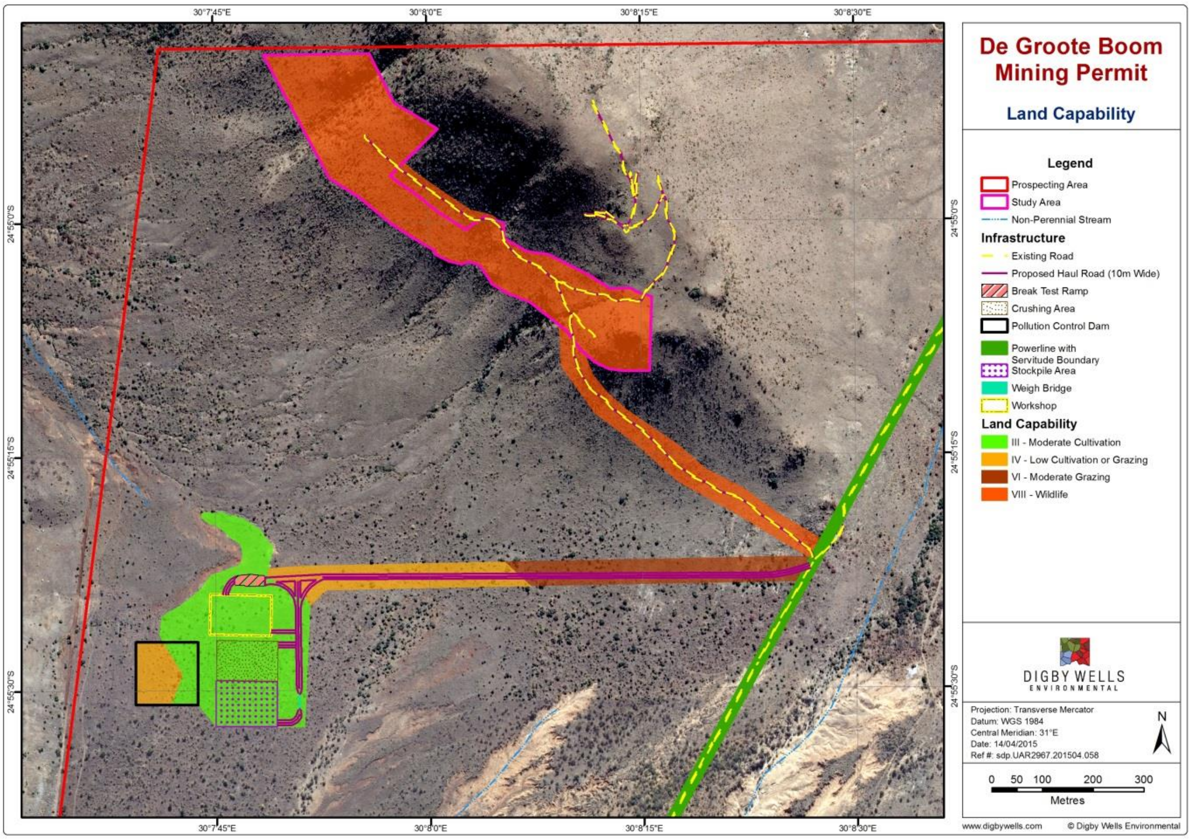
5.2 Land Capability

Land capability is determined by a combination of soil, and terrain features. An indication is given about the permanent limitations associated with the different land use classes based on the soil physical properties as well as the slope of an area.

The dominant land capability for the area is the Class VI (Moderate Grazing) and Class VIII (Wilderness). These are mainly due to the steep slopes. On the footslopes where the slopes are less than 5 % the shallower soils (Mispah/Glenrosa) have a Class IV (Low Cultivation/ Intensive Grazing) land capability. The deeper Hutton soils have Class III (Moderate Cultivation) land capability as shown in Plan 3. The calculations are shown in the summary Table 5-2.

Table 5-2: The land capability assessment results

Soil form	Depth (m)	Clay (%)	Slope (%)	Permeability Class	Land Capability	Permeability Adjustment	Wetness Adjustment	Rockiness Adjustment	Surface crusting Adjustment	Final Land Capability Class
Hutton (Hu)	>0.6	6	4	3	III (Moderate cultivation)	No Change	W0	R0	t0	III (Moderate cultivation)
Glenrosa (Gs)	0.3	6	<5	3	IV (Low cultivation/ Intensive Grazing)	No Change	W0	R 4	t0	IV (Low cultivation/ Intensive Grazing)
Glenrosa (Gs)	0.3	6	>5	3	VI (Moderate Grazing)	No Change	W0	R 4	t0	VI (Moderate Grazing)
Mispah (Ms)	0.3	6	<5	3	VI (Moderate Grazing)	No Change	W0	R 4	t0	VI (Moderate Grazing)
Mispah (Ms)	0.3	6	>5	3	VIII (Wilderness)	No Change	W0	R 4	t0	VIII (Wilderness)

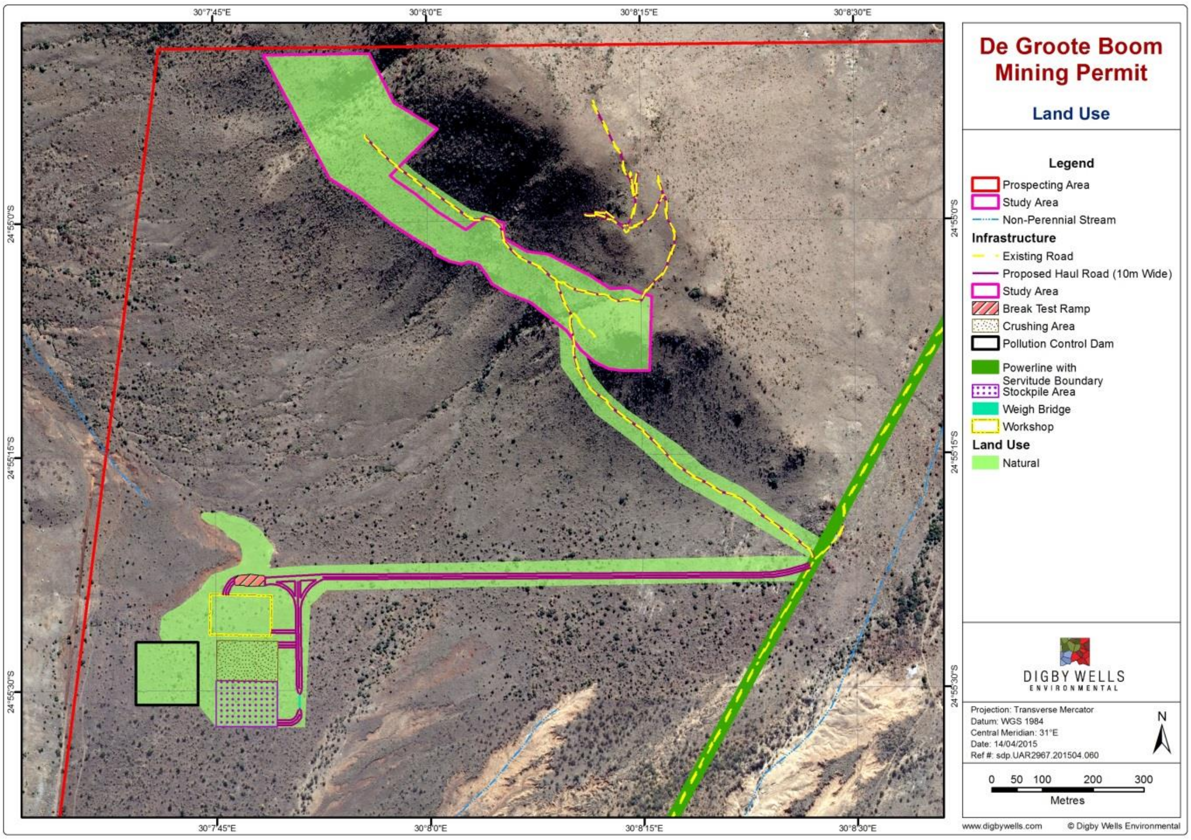


Plan 3: Land capability map for the De Groote Boom project site

5.3 Current Land Use

The land use dominating the project area is natural veld as shown in Plan 4. It has, however been used in some parts for subsistence grazing by the surrounding community. There are portions downslope that show signs of erosion as shown in Figure 5-4.

Figure 5-4: Downslope area, within the De Groote Boom project area which has been affected by erosion (area indicated by white arrow)



Plan 4: Land use map for the De Groote Boom project site

6 Potential Environmental Impacts

6.1 Construction Phase

During the construction phase the work carried out will include the construction of the mine and supporting infrastructure. This will entail the clearing of areas and the disturbance of the topsoil through excavations as well as the construction of a soil stockpile. The topography and natural drainage lines will be disturbed. The overall impact will be loss of topsoil as a result of erosion and possible contamination of the soil by fuel, and oils due to the excavation activities. Soil compaction caused by heavy vehicles and machinery surrounding the pit areas could also be a problem.

Soil stripping will require the removal of all soil materials to a depth of at least 0.3 m. This activity will provide needed soil cover material for rehabilitation purposes. Construction activities will change the land use from natural/subsistence grazing to mining causing unsuitable conditions for any further commercial farming.

6.2 Operation Phase

Soil erosion through wind and storm water run-off, and soil pollution by means of hydrocarbon contamination and, may be encountered during the operational phase. Water runoff from roads must be controlled and managed by means of proper storm water management facilities in order to prevent soil erosion. Diesel and oil spills are common at mine sites due to the large volumes of diesel and oil consumed by mining vehicles, also vehicles must be maintained to reduce the chances of any leaks occurring. Pollution may however be localised. Small pockets of localised pollution may be cleared up easily using commercially available hydrocarbon emergency clean-up kits.

6.3 Decommissioning Phase

During the decommissioning phase all infrastructure will be demolished and removed, which will entail vehicle movement in the infrastructure area. The potential impacts associated with these activities will include the risk of hydrocarbon spills, and compaction.

The rehabilitation of the mining area and infrastructure area should have a positive impact if done correctly.

7 Impact Assessment

The environmental impact assessment is designed to identify impacts related to various mining activities as provided in Table 7-1. However with the correct mitigation measures being put in place these impacts can be reduced. The activities impacting on soil as the receiving environment are shaded (**Brown**) and discussed within the related impact discussions.

Table 7-1: Proposed project activities

Activity	Description
	Construction phase
1	**Augmenting existing roads**
2	**Construction of pollution control dam (PCD)**
3	**Transport of construction material, mobile plant and equipment to the site; and movement of haul trucks and excavator on haul roads**
4	**Storage of material / diesel at site in temporary facilities**
5	**Site clearing and topsoil removal for bulk sample area; and construction of bulk sample cut**
6	**Preparing an area of approximately 2-3 ha for portable plant and infrastructure (crushing, screening, workshops, ablution and offices etc.) and stock piling**
7	**Use of existing drilled / new boreholes**
	Sampling phase
8	**Storage of fuel and lubricants in temporary facilities**

Activity	Description
9	Topsoil removal and stockpiling; and extraction and transportation of bulk sample;
10	Vehicular activity on haul roads; and operation of mining equipment
11	Crushing and screening of ore in mobile plant
12	Stockpiling material
13	Water management
14	Waste generation and disposal (including sewage)
Decommissioning phase	
15	Demolition / removal of portable and related infrastructure (if applicable)
16	Vehicular activity: removal of mobile plant / equipment and vehicles
17	Rehabilitation of site (As per surface use agreement roads, buildings etc. need not be rehabilitated)
It should be noted: There may be no decommissioning phase as the mining area will remain for subsequent mining should the project be viable.	

7.1 Construction Phase

When topsoil is removed from a soil profile, the profile loses effective rooting depth, water holding capacity and fertility. The largest volumes of topsoil will be removed in preparation for the site infrastructure and the mining area. The remove soil will be stockpiled and can be lost if not managed correctly.

7.1.1 Impact: loss of topsoil as a resource

Criteria	Details / Discussion
Description of impact	Impact on soil through removal and stockpiling of soil, as well as the loss of soil through erosion.
Mitigation required	▪ The topsoil should be stripped by means of an excavator bucket, and loaded onto dump trucks; ▪ Stockpiles are to be kept to a maximum height of 4-5m (the practical tipping height of dump trucks); ▪ Topsoil is to be stripped when the soil is dry, as to reduce compaction; ▪ The topsoil 0.3 m of the soil profile should be stripped first and stockpiled separately from the sub soil; ▪ The subsoil approximately 0.7 – 0.9 m thick (on the Hutton soils) will then be stripped and stockpiled separately; ▪ The Mispah and Glenrosa soil forms will only need to be stripped to 0.3m; ▪ Soils to be stripped according to the rehabilitation management plan and stockpiled accordingly; ▪ Foundation excavated soil should also be stockpiled;

Criteria	Details / Discussion				
	▪ Stockpiles are to be maintained in a fertile and erosion free state by sampling and analysing annually for macro nutrients and pH; ▪ The handling of the stripped topsoil will be minimized to ensure the soil's structure does not deteriorate; ▪ Compaction of the removed topsoil should be avoided by prohibiting traffic on stockpiles; ▪ Prevent unauthorised borrowing of stockpiled soil; ▪ 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; ▪ Storm water management systems need to be put in place to reduce minimise the erosion hazards; ▪ Stockpiled soils must be re-vegetated as soon as possible to reduce the risk of erosion; ▪ Erosion berms are to be put in place where there is a high risk of erosion; ▪ Soils will be stripped using the delineated soil types as guide. Yellow and red soils may be stripped together. Wetland soils (if allowed) should be stripped and stockpiled separately but also in the order topsoil (0.3 m) then subsoil separately; and ▪ Access should be limited to prevent any unnecessary compaction from occurring.				
Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	3 (Local)	5 (Project Life)	5 (Very Serious)	7 (Certain)	-91
Post-Mitigation	2 (Limited)	5 (Project Life)	3 (Moderate)	3 (Unlikely)	-30

7.1.2 Impact: Hydrocarbon Pollution

Criteria	Details / Discussion
Description of impact	Impact on soil quality while hydrocarbon spills can occur when heavy mining machinery is used because big machines contain large volumes of oils and diesel. There is a chance of the machines breaking down and/or leaking during mining and removal of topsoil.
Mitigation required	▪ Prevent any spills from occurring; ▪ If a spill occurs it is to be cleaned up immediately and reported to the appropriate authorities; ▪ All vehicles are to be serviced in a correctly bunded area or at an off-site location; and ▪ Leaking vehicles will have drip trays place under them where the leak is occurring.

Criteria	**Details / Discussion**				
Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	1 (Very Limited)	7 (Permanent)	7 (Very Serious)	6 (very Likely)	-90
Post-Mitigation	1 (Very Limited)	1 (Immediate)	7 (Very Serious)	5 (Likely)	-45

7.1.3 Impact: Loss of land capability

Criteria	**Details / Discussion**				
Description of impact	Removal of soil layers will impact on the land capability because vegetation can no longer be supported.				
Mitigation required	▪ No land capability mitigation is possible during the construction and operational phases because the land use is changed from natural/subsistence grazing to mining; and ▪ Mitigation of land capability post mining is required through legislation through land rehabilitation.				
Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	1 (Very Limited)	5 (project life)	6 (Significant)	7 (definite)	-84
Post-Mitigation	1 (Very Limited)	5 (project life)	5 (Very Serious)	6 (almost certain)	-66

7.2 Operational Phase

7.2.1 Impact: loss of stockpiled topsoil as a resource

Criteria	**Details / Discussion**				
Description of impact	Topsoil losses can occur during the operational phases as a result of rain water runoff and wind erosion, especially from roads and soil stockpiles where steep slopes are present.				
Mitigation required	▪ Stockpiles are to be maintained in a fertile, vegetated, and erosion free state; ▪ Stockpiles are to be clearly demarcated; ▪ Ensure proper storm water management designs are in place; ▪ Access routes are to be kept to a minimum as to reduce any unnecessary compaction from occurring; ▪ If erosion occurs, corrective actions must be taken to minimize any further erosion from taking place; and ▪ Unauthorised borrowing of stockpiled soil materials should be prevented.				
Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	3 (Local)	5 (Project Life)	5 (Very	7 (Certain)	-91

Criteria	Details / Discussion				
			Serious)		
Post-Mitigation	2 (Limited)	5 (Project Life)	3 (Moderate)	3 (Unlikely)	-30

7.2.2 Impact: Hydrocarbon Pollution

Criteria	Details / Discussion				
Description of impact	Hydrocarbon spills can occur where heavy machinery are parked such as the hard park area because they contain large volumes of lubricating oils, hydraulic oils, and diesel to run. There is always a chance of these breaking down and/or leaking.				
Mitigation required	▪ Prevent any spills from occurring; ▪ If a spill occurs it is to be cleaned up immediately and reported to the appropriate authorities; ▪ All vehicles are to be serviced in a correctly bunded areas or at an off-site location; and ▪ Leaking vehicles will have drip trays place under them where the leak is occurring.				
Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	1 (Very Limited)	7 (Permanent)	7 (Very Serious)	6 (very Likely)	-90
Post-Mitigation	1 (Very Limited)	1 (Immediate)	7 (Very Serious)	5 (Likely)	-45

7.2.3 Impact: Loss of Land Use and Land Capability

Criteria	Details / Discussion
Description of impact	Impact on the rehabilitation of soil, soil quality and land capability. Backfilling of soil layers will impact on the land capability by restoring the land capability to some extent because vegetation will be supported and therefore returned to the planned post mining land capability such as arable and or grazing.
Mitigation required	Mitigation is possible because the land use is changed from mining back to natural/grazing as follows: ▪ The rock spoil should be shaped taking the pre-mining landscape into consideration; ▪ The designed post mining landforms should be modelled to establish the post mining landscape stability by using a combination of GIS and erosion modelling techniques by a suitably qualified expert using site specific soil quality data; ▪ The soil layers should be put back in the reverse order of stripping namely subsoil first then topsoil; ▪ The yellow and red soils should be replaced in upland landscape positions;

Criteria	**Details / Discussion**				
	▪ The soil quality should be investigated prior to establishing vegetation on the rehabilitated soil through representative sampling and laboratory analysis; ▪ The analytical data should be evaluated by a suitably qualified expert and vegetation fertility and or soil acidity problems should be corrected prior to vegetation establishment; ▪ Clear targets incorporating medium to long term post mining land capability influencing land use, should be part of a potentially successful closure plan; and ▪ From a national food security viewpoint, ways need to be found of rendering land rehabilitated to arable standards suitable for the economic production of cash crops.				
Parameters	Spatial	*Duration*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	1 (Very Limited)	5 (project life)	6 (Significant)	7 (definite)	-84
Post-Mitigation	1 (Very Limited)	5 (project life)	4 (Serious medium term)	6 (almost certain)	-60

7.3 Decommissioning Phase

During the decommissioning phase the sites will be rehabilitated. These impacts are described below along with their mitigation measures.

7.3.1 Impact: loss of topsoil as a resource

Criteria	**Details / Discussion**
Description of impact	When topsoil is replaced on the surface for rehabilitation purposes it is vital to try minimise the impacts on the topsoil by following the mitigation measures.
Mitigation required	▪ The slopes are to be kept as shallow as possible to reduce runoff and erosion; ▪ a bowl scraper is to be avoided as this piece of machinery compacts soil; ▪ soil replacement should be in accordance with pre-mining land capability requirements; ▪ placed soils are to be maintained in a fertile and erosion free state by sampling them annually for macro nutrients and pH; ▪ The handling of the topsoil will be minimize to ensure the soil's structure does not deteriorate; ▪ Compaction of the topsoil will be avoided; ▪ The replaced soils will be vegetated in order to reduce the risk of erosion, prevent weed growth and to reinstitute the ecological processes within the soil; ▪ Soils will be replaced according to the soil types.

Criteria	**Details / Discussion**				
Parameters	*Spatial*	*Duration*	*Severity*	*Probability*	*Significant rating*
Pre-Mitigation	3 (Local)	5 (Project Life)	5 (Very Serious)	7 (Certain)	-91
Post-Mitigation	2 (Limited)	5 (Project Life)	3 (Moderate)	3 (Unlikely)	-30

7.3.2 Impact: Compaction & Erosion

Criteria	**Details / Discussion**				
Description of impact	Compaction occurs when heavy machinery drives over soils and compresses them. Erosion is grouped with compaction as compacted areas increase the erosion hazards that are present by reducing vegetation cover and increasing runoff potential.				
Mitigation required	▪ Limit access to one route; ▪ Deep rip compacted areas to allow for natural vegetation regrowth; ▪ Ensure proper storm water management designs are in place; ▪ If erosion occurs, corrective actions must be taken to minimize any further erosion from taking place; and ▪ Replaced soils to be re-vegetated and designed according to Chamber of Mines Rehabilitation Guidelines.				
Parameters	*Spatial*	*Duration*	*Severity*	*Probability*	*Significant rating*
Pre-Mitigation	1 (Very Limited)	7 (Permanent)	7 (Very Serious)	6 (very Likely)	-90
Post-Mitigation	1 (Very Limited)	3 (Medium Term)	3 (Moderate)	4 (Probable)	-28

7.3.3 Impact: Hydrocarbon/Slurry Pollution

Criteria	**Details / Discussion**
Description of impact	Hydrocarbon spills occur when using heavy machinery, as they all use oils and diesel to run. There is a chance of these breaking down and/or leaking. Hydrocarbons have a devastating effect on the soil quality.
Mitigation required	▪ Prevent any spills from occurring; ▪ Educate labour force on procedures for emergency spill clean ups;

Criteria	Details / Discussion				
	▪ If a spill occurs it is to be cleaned up immediately and reported to the appropriate authorities; ▪ All vehicles are to be serviced in a correctly bunded area; and ▪ Leaking vehicles will have drip trays place under them where the leak is occurring				
Parameters	*Spatial*	*Duration*	*Severity*	*Probability*	*Significant rating*
Pre-Mitigation	1 (Very Limited)	7 (Permanent)	7 (Very Serious)	6 (very Likely)	-90
Post-Mitigation	1 (Very Limited)	1 (Immediate)	7 (Very Serious)	5 (Likely)	-45

8 Recommendation

Some recommendations which have been prescribed in light of the study findings for the stripping and stockpiling of soils, include;

- Stockpiles must not exceed a maximum height of 4-5 m (practical tipping height for dump trucks) in order to prevent compaction;
- Stockpiles should be re-vegetated as quickly as possible to reduce or prevent erosion;
- Stockpiles should be demarcated and logged, as to make sure the right stockpiles (soil types) are used when rehabilitating; and
- If possible try limit the slopes on the stockpiles to 1:3 to reduce erosion losses, or place a smaller berm around the edge of each stockpile to contain any erosion which will limit soil losses and increase chances of re-vegetation.

The general surface rehabilitation will ensure the following:

- Surface topography that emulates the surrounding areas and aligned to the general landscape character;
- Landscaping that would facilitate surface runoff and result in free draining areas. If possible drainage lines should be reinstated;
- An area without unnecessary remnants of structures and surface infrastructure to give the rehabilitated area a neat appearance. Special attention must be given to shape and/or removal of heaps of excess material; and the area should suitable for vegetation.
- The PCD close to the plant will be removed at closure. The plastic lining must be removed and can be recycled. The earth walls will be flattened and the area profiled. The pipes associated with the dam must be removed and if possible sold.

Once the final land-form has been created, soil replacement can begin. The Hutton soil is to be replaced into the original locations of this soil.

Compaction limits the effectiveness of replaced soils. The equipment used during the replacement of the soils has a major impact on the compaction levels. Ideally heavy machinery should not be used to spread and level soils during replacement. The truck and shovel method should be used since it causes less compaction than, for example, a bowl scraper.

When using trucks to deposit soils, the full thickness of the soil required can be placed in one lift. This does, however, require careful management to ensure that the correct volumes of soil are replaced. The soil piles deposited by the trucks will have to be smoothed before re-vegetating the area.

The soil that is deposited with trucks need to be smoothed before re-vegetation can take place. A dozer (rather than a grader) should preferably be used to smooth the soil since it exerts a lower bearing pressure and thus compacts less than wheeled systems.

Replaced soils require both physical and chemical amelioration as the actions of soil removal, stockpiling and replacement result in high levels of soil compaction and a dilution of the fertility of the soil originally present and concentrated in the surface layers. The actions that should be taken during the amelioration of soils are as follows:

- The deposited soils must be ripped to ensure reduced compaction;
- An acceptable seed bed should be produced by surface tillage;
- Restore soil fertility;
- Incorporate the immobile fertilisers in to the plant rooting zone before ripping; and
- Apply maintenance dressing of fertilisers on an annual basis until the soil fertility cycle has been restored.

9 Conclusion

Three dominant soil forms were found in the project area, all found in typical positions within the landscape. The dominant soils associated with steep slopes were shallow and rocky (Mispah/Glenrosa). The dominant soils associated with footslopes are deeper (Hutton) as the soil forming process is an accumulation of soil from upper slopes.

The dominant land capability for the project area is the Class VI (Moderate Grazing) and Class VIII (Wilderness). The footslopes, where the slope is less than 5 % with the shallow soils (Mispah/Glenrosa) have a Class IV (Low Cultivation/ Intensive Grazing) land capability. The deeper Hutton soils have Class III (Moderate Cultivation) land capability. The major concern for this area is the potential for erosion due to the steep slopes.

The impacts expected to occur during the construction, operational and decommissioning phase have been described. The pre-mitigation scores for these impacts are regarded to be extremely high and therefore very serious. Recommendations have been made regarding the mitigation of these impacts which would decrease these scores substantially. Post mitigation scores of these impacts are regarded to be moderate to low. It is therefore essential that the recommendations regarding management of these impacts are implemented.

The primary impact of concern is the loss of topsoil. This loss is expected to be caused by erosion and pollution. Both of these causes can be controlled through effective management. It is strongly suggested that the recommendations regarding the management of the soil on site are implemented in order to limit the expected negative impacts associated with the project.

The rehabilitation of the impacted areas should follow the rehabilitation plan.

10 References

SASA, S. A. (1999). *Identification & management of the SOILS of the South African sugar industry.* Mount Edgecombe: South African Sugar Association Experiment Station.

Schoeman, J. L., Van der Walt, M., Monnik, K. A., Thackrah, A., Malherbe, J., & Le Roux, R. E. (2000). *The Development and Application of a Land Capability Classification System for South Africa.* ARC-Institute for Soil, Climate and Water. Pretoria: ARC-ISCW report no GW/A/2000/57.

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.