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Report No: RG/2008/05/19/1
Date: February 2009

REPORT

Soil, Land Capability and Land Use Assessment of Portions 15 and 16 of the Farm Weltevreden 381 JT for the Proposed Weltevreden Opencast Project

Requested By
Digby Wells & Associates

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1. INTRODUCTION

Rehab Green Monitoring Consultants cc was requested by Digby Wells and Associates to conduct a soil, land capability and land use assessment of the proposed opencast mine situated on portions 15 and 16 of the farm Weltevreden 381 JT in Mpumalanga province. The farm is situated approximately 10 km south of Belfast, approximately 5 km south of the N4 highway and 1.5 km west of the R33 national road.

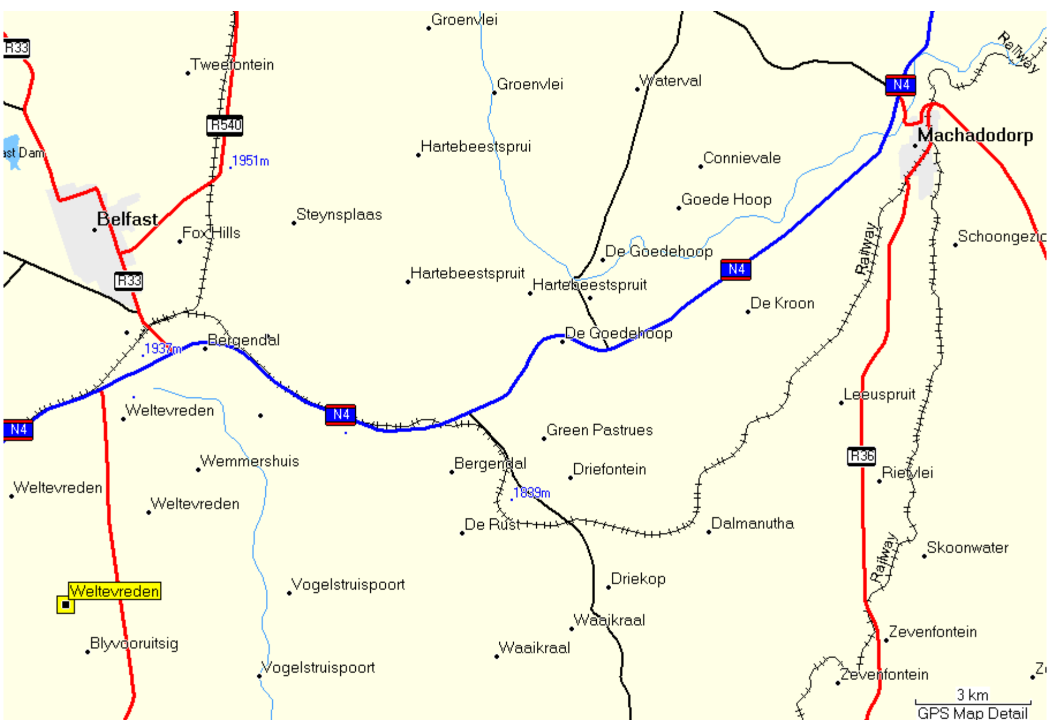
The survey was conducted during September 2008. Soils were assessed by means of hand auger observations at a predefined grid with a density of 150 x 150 meters. The total area surveyed by Rehab Green cc covers 505.72 ha which includes both portions and an 80m wide strip (towards the R33 tar road) on the southern boundary of Portion 2.

The original proposed opencast pit involves only the eastern parts of portions 15 and 16 (approximately 50% of each portion) and comprises 204.91 ha. Wetlands within the proposed opencast area and their associate 50m buffer zones comprise 16.75 ha and 17.92 ha respectively which translates to a total of 34.67 ha which was excluded from the original proposed opencast area. The remainder of the proposed opencast comprises 170.24 ha.

This report describes the baseline soil condition, the physical and chemical characteristics, land capability and current land uses as well as survey and laboratory procedures. The soils data is shown on 4 maps namely: a Soil map, a Land capability map, a Land use map and a Soil utilization guide map (Figures: 2-5 respectively).

Further soil issues related to the mining operation, mining impacts and management thereof are described in Appendix 1.

Figure 1: Weltevreden regional setting



2. METHODOLOGY

Field survey

To enable accurate surveying, a fixed point grid with a density of 150 x 150 meters was generated. The coordinates of these points were loaded onto a Global Positioning System to locate the positions of the points in the field. The soils were investigated by hand auger observations at each grid point. Additional observations were made in between grid points where necessary to accurately locate soil boundaries. The soils were classified according to the Taxonomic System for South Africa (Soil Classification, A Taxonomic System for South Africa, 1991).

A total of 231 auger observations were made at grid points and a further 40 observations were made randomly in-between grid points during the field assessment. Auger observations were made to the first restricting layer or to a maximum depth of 1500 mm. The positions of the observation points are shown on the soil maps, Figures 2a and 2b.

Soil sampling and analyses

The A and B-horizons (0-250 and 300-700mm) of the dominant soil types were sampled and analysed in the soil laboratories of the South African Institute for Soil, Climate and Water (ISCW). The laboratory methods, which are currently in use for routine analyses in South Africa, as set out in the Handbook of Standard Testing for Advisory Purposes (Soil Science Society of South Africa, 1990), were used. A total of 12 localities (23 samples) were sampled and the positions of the sampling points are shown on the soil maps Figure 2a and 2b and the coordinates are shown in Table 4.

Routine fertility analysis was done. Soil acidity (pH) was determined in a 1:2.5 water solution. Cation exchange capacity (CEC), as well as extractable cations, sodium (Na), potassium (K), calcium (Ca) and magnesium (Mg) were determined by the ammonium acetate method. The P status (phosphorus) was determined by the Bray 1 method.

Maps

Maps were compiled on aerial photo background. In order to display information more effectively the data of each map was superimposed on aerial photos in polygon and line format. The extent and distribution of units in polygon format are easy to visualize but it cover the visual aerial photo information. Line data are more difficult to visualize but retain all visual aerial photo information. The soil, land capability and land use information was thus each displayed on 2 maps (eg. Figure 2a and 2b) where Figure 2a display data in polygon format and 2b in line format.

The maps were generated in a projected coordinate system using the longitude of origin (LO) coordinate system based on the 31° East meridian, WGS 1984 spheroid and Hartebeesthoek 1994 Datum.

Soil Map

The Soil Maps (Figures 2a and 2b), consisting of soil types was compiled by classifying and manually grouping areas displaying similar soil properties. The following attributes were recorded at each observation point:

- Soil form (Soil Classification, A Taxonomic System for South Africa, 1991);

- Soil depth;
- Estimated clay content of A and B-horizon (soil texture class);
- Soil structure;
- Soil colour
- Underlying material;
- Agricultural potential;
- Derived land capability; and
- Current land use.

Land Capability

Land capability was assessed according to the definitions of the Chamber of Mines of South Africa and Coaltech Research Association (2007: Guidelines for the Rehabilitation of Mined land. Johannesburg).

Soil properties such as effective soil depth, mechanical limitation, internal drainage, soil texture, soil structure, erosion susceptibility and slope percentage were evaluated in order to classify the soil types in Figure 2a, according to the above-mentioned guidelines into four land capability classes namely arable land, grazing land, wetlands/riparian areas and wilderness land. The area and percentage comprised by each land capability class are shown on the land capability maps Figures 3a and 3b.

Wetlands

The practical field procedure for the identification and delineation of wetlands and riparian areas of the Department of Water Affair and Forestry were used as guideline to delineate wetland zones.

Terrain unit, soil form, soil wetness and vegetation indicators were used to locate the outer edge of temporary and seasonal wetland zones. The wetland zones are shown on the land capability maps Figures 3a and 3b.

Land Use

The localities and extents of land use practices were surveyed during the time of the soil assessment and shown on the land use maps, Figure 4a and 4b.

Soil Utilization Guide

The soil utilization guide map covers only the proposed opencast area and not the full extent of portions 15 and 16. The stripping depth was considered as the average depth of each soil type shown on the soil map, Figure 2a. Figure 5 shows the stripping depth per soil type, the area and available soil volume per soil type as well as the soil types that can be stockpiled together.

Evaluation of Other Derived Soil Properties

Derived soil properties of each soil type, e.g. fertility, erodibility, dry land production potential and irrigation potential are given in Table 2. Properties were evaluated in terms of three classes: high, moderate and low with classification in-between these. The classes are defined as follows:

Natural fertility

- **Low:** Essential macro elements (N, P, K, Ca, Mg, S, Na and Al) are available in concentration levels much less than the threshold extraction levels by annual crops. Fertilisation should substantially exceed annual crop extraction levels to ensure a build-up of the natural fertility.

- **Medium:** The essential elements are available in concentration levels more or less the same as the threshold extraction levels of annual crops. Fertilisation should exceed annual crop extraction levels to ensure a slow build-up of the natural soil fertility.

- **High:** The essential elements are available in concentration levels more than the threshold extraction levels by annual crops. Fertilisation should meet annual crop extraction levels to maintain the natural fertility.

Erodibility

- **Low:** Soils with stable physical and chemical properties which occur on flat to gentle slopes to ensure low erosion susceptibility in the natural state. Few erosion protection measures are necessary.

- **Medium:** Soils with low to moderately unstable physical or chemical properties or soils occurring on moderate to steep slopes. Sheet and rill erosion often occur in the natural state but may become severe when these soils are disturbed or due to any misuse such as overgrazing. Erosion protection measures are necessary.

- **High:** Soils with unstable physical and chemical properties or soils occurring on very steep slopes. Rill and donga erosion often occur in the natural state and will become severe during any disturbance or misuse. Specialised erosion protection measures are necessary.

Dry land crop production potential

- **Low:** Production is seriously limited by negative soil properties such as insufficient soil depth, very sandy textures, abrupt texture and structure transitions between horizons, very high clay textures, strong structured horizons, wet and water logged horizons, steep slopes and low fertility.

- **Medium:** Production is limited by some negative soil properties such as insufficient soil depth, very sandy textures, abrupt texture and structure transitions between horizons, very high clay texture, strong structured horizons, wet and water logged horizons, steep slopes and low fertility.

- **High:** Production is limited by very little negative soil properties such as insufficient soil depth, very sandy textures, abrupt texture and structure transitions between horizons, very high clay textures, strong structured horizons, wet and water logged horizons, steep slopes and low fertility.

Soil potential for irrigation

- **Low:** Irrigation potential is seriously limited by negative soil properties such as insufficient soil depth, very sandy textures, abrupt texture and structure transitions between horizons, very high clay textures, strong structured horizons, wet and water logged horizons, steep slopes and low fertility.

- **Medium:** Irrigation potential is limited by some negative soil properties such as insufficient soil depth, very sandy textures, very high clay textures, strong structured horizons, wet and water logged horizons, steep slopes and low fertility.

- **High:** Irrigation potential is limited by very little negative soil properties such as insufficient soil depth, very sandy textures, very high clay textures, strong structured horizons, wet and water logged horizons, steep slopes and low fertility.

SURVEY RESULTS - SOIL, LAND CAPABILITY AND LAND USE

3. SOIL

3.1 Surveyed area

The proposed opencast mine will be situated on portions 15 and 16 of the farm Weltevreden 381 JT in Mpumalanga province. The farm is situated approximately 10 km south of Belfast, approximately 5 km south of the N4 highway and 1.5 km west of the R33 national road.

The total extent of portions 15 and 16 were surveyed including an 80m wide strip (towards the R33 tar road) on the southern boundary of Portion 2 covering 505.72 ha in total. The original proposed opencast pit involves only the eastern parts of portions 15 and 16 (approximately 50% of each portion) and comprises 204.91 ha. Wetlands within the proposed opencast area and their associate 50m buffer zones comprise 16.75 ha and 17.92 ha respectively which translates to a total of 34.67 ha which was excluded from the original proposed opencast area. The remainder of the proposed opencast comprises 170.24 ha.

Two tributaries of the Klien-Komatierivier originate in the area and are dominated by leached, grey sandy soils of the Longlands type classified as seasonal wetland zones. Isolated seepage zones occur and were classified as temporary wetland zones. A pan occurs in the north east of portion 15 comprising approximately 3.6 ha and was classified as a permanent wetland zone.

The majority of the area, approximately 65%, is dominated by moderately deep, yellow brown, loamy sand soils of the Clovelly, Avalon and Glencoe types classified as arable land with moderate agricultural potential. Small patches of the Hutton soil type occurs which were classified as arable land with high agricultural potential. Isolated small dolerite outcrops occur.

The majority of the area (approximately 52%) is utilized for dry land maize production and 34% for grazing purposes.

The majority of the area consists of gently sloping crests (1-2% slopes), mild sloping midslopes (2-5% slopes) and narrow valley bottoms.

The geology is dominated by Ecca sandstone of the Vryheid formation with isolated dolerite intrusions.

3.2 Soil results

A total of 231 auger observations were made at grid points and a further 40 observations were made randomly in-between grid points during the field assessment. The positions of the observation points are shown on Figures 2a and 2b. A total of 13 soil types, based on dominant soil form and effective soil depth were identified during field observations and were named as: **Hu1**, **Hu2**, **Hu3**, **Cv1**, **Av1**, **Gc1**, **Gc2**, **Dr1**, **Lo1**, **Ka**, **Dr2**, **Ms/R**, **Hu/R**. These soil types are shown in Figures 2a and 2b.

The soil types are summarised in the soils legend (Table 1) in terms of the dominant and subdominant soil forms and families, average effective soil depth, the clay content of the A and B- or E- or G-horizon, the texture class, a broad description of the dominant soil form, the agricultural potential, the land capability and the area and percentage comprised by each soil type.

Table 1: Soil legend based on soil types and effective soil depth

SOIL LEGEND										
Soil Type Code	**Dominant Soil Form and Family**	**Subdominant Soil Form and Family**	**Effective Depth (mm)**	**Clay % A-horizon B/E/G-horizon**	**Texture Class**	**Summarized Description of Dominant Soil Form**	**Agricultural Potential**	**Land Capability**	**Area (ha)**	**Area (%)**
Hu1	Hutton 2100	Bainsvlei	1100-1500	A: 15-20 B: 15-25	Sandy loam-Sandy clay	Very deep, red, structureless, well drained, sandy loam to sandy clay loam soils.	High	Arable	24.73	4.89
Hu2	Hutton 2100	Bainsvlei	800-1200	A: 15-20 B: 15-20	Sandy loam	Moderately deep to deep, red, structureless, well drained, sandy loam soils.	High	Arable	19.34	3.83
Hu3	Hutton 2100	Bainsvlei	450-600	A: 15-20 B: 15-20	Sandy loam	Shallow to moderately deep, red, structureless, well drained, sandy loam soils.	Moderate	Arable	6.67	1.32
Cv1	Clovelly 2100	Avalon, Glencoe	600-1000	A: 11-14 B: 12-18	Loamy sand	Moderately deep to deep, yellow brown, structureless, well drained, loamy sand soils underlain by hard or weathered rock.	Moderate	Arable	218.65	43.22
Av1	Avalon 2100	Clovelly, Glencoe	700-1000	A: 10-13 B: 12-15	Loamy sand	Moderately deep to deep, yellow brown, structureless, moderately drained, loam sand soils underlain by soft plinthite.	Moderate	Arable	67.48	13.35
Gc1	Glencoe 2100	Avalon, Clovelly	500-900	A: 10-12 B: 10-14	Loamy sand	Moderately deep, yellow brown, structureless, moderately drained, sandy loam soils underlain by hard plinthite.	Moderate	Arable	25.81	5.1
Gc2	Glencoe 2100	Dresden, Avalon, Wasbank	400-600	A: 10-12 B: 10-14	Loamy sand	Shallow, yellow brown, structureless, moderately drained, sandy loam soils underlain by hard plinthite.	Low	Grazing	39.07	7.73
Dr1	Dresden 2000	Longlands, Wasbank, Cartref	100-300	A: 7-10	Sandy	Temporary seepage zone. Very shallow, greyish yellow, imperfectly drained, loamy sand soils underlain by hard plinthite.	Low	Temporary wetland	21.63	4.28
Lo1	Longlands 1000	Dresden, Wasbank, Kroonstad	400-1000	A: 5-10 E: 2-8	Sandy	Moderately deep, grey, imperfectly drained soils underlain by soft plinthite, with signs of wetness and lateral movement of water in the soil profile.	Low	Seasonal wetland	51.91	10.25
Ka	Katspruit 1000	Kroonstad, Longlands, Wasbank	200-300	A: 20-30 G: 50-60	Clay	Shallow, grey, poorly drained soils underlain by gleyed clay, with signs of long term wetness or permanent saturated conditions.	Low	Permanent wetland	1.67	0.33
Dr2	Dresden 1000	Longlands, Wasbank, Cartref	100-300	A: 7-10	Sandy	Relict seepage zone. Very shallow, greyish yellow, imperfectly drained, loamy sand soils underlain by hard plinthite.	Low	Grazing	5.97	1.18
Ms/R	Miapah 1100	Glenrosa	0-400	A: 10-15	Loamy sand	Shallow rocky areas. Shallow yellowish brown, loamy sand soils in association with exposed surface rock.	Low	Grazing	3.54	0.71
Hu/R	Hutton 2100	Mispah, Shortlands, Glenrosa	200-1000	A: 20-25 B: 20-35	Sandy clay loam	Dolerite outcrops. Shallow to deep, red, sandy clay loam soils in association with exposed surface rock.	Low	Grazing	19.25	3.81
								Total	**505.72**	**100.0**

3.3 Other derived soil properties

Derived soil properties of each soil type, e.g. fertility, erodibility, dry land production potential and irrigation potential are given in Table 2. Properties were evaluated in terms of three classes: high, moderate, and low with classification in-between these (see section 2, Methodology).

Table 2: Other Derived soil properties

Soil Type Code	Natural Fertility	Erodibility	Dry land crop production potential	Soil potential for Irrigation
Hu1	Moderate-low	Low	High	High
Hu2	Moderate-low	Low	High	High
Hu3	Moderate-low	Low	Moderate	Moderate-low
Cv1	Moderate-low	Low	Moderate	Moderate
Av1	Moderate-low	Low	Moderate	Moderate
Gc1	Moderate-low	Low	Moderate	Moderate
Gc2	Moderate-low	Low	Low	Low
Dr1	Moderate-low	Low	Low	Low
Lo1	Low	Moderate	Low	Low
Ka	Moderate-low	Low	Low	Low
Dr2	Low	Low	Low	Low
Ms/R	Low	Low	Low	Low
Hu/R	Moderate	Low	Low	Low

3.4 Soil chemical analyses

A sample of the A- and B- or E- or G-horizon of the dominant soil types were taken at 12 localities (23 samples). The localities of the sampling points are shown on the detailed soil maps (Figure 2a and 2b) and the soil chemical results are shown in Table 3. The coordinates of the sampling points are given in Table 4.

Table 3: Soil chemical analyses

Samp Point	Soil Form	Hor	Depth	K	Ca	Mg	N	T.Acid / T.Suur	Acid saturat.	Resistance	P (Bray1) mg/kg	pH (H_2O)
				mg/kg	mg/kg	mg/kg	mg/kg	cmol(+)/kg	%	ohm		
G13	Cv2100	A1	0-250	20	160	56	0.1	0.4	23.3855	3470	18.7	5.16
		B1	350-700	68	455	89	0.1	0		1630	1.3	5.6
H9	Dr2000	A1	0-250	90	382	111	1.2	0		3310	36.3	5.63
J6	Hu2100	A1	0-250	220	174	118	3.9	0.2	7.6861	2450	2.7	5.37
		B	350-700	88	57	110	3.2	0.34	19.3749	4910	1.3	5.21
J11	Cv2100	A1	0-250	127	787	66	1.7	0.24	4.7665	4500	9.1	5.29
		B1	350-700	56	167	42	2.9	0.33	19.9729	5850	2.2	5.23
J13	Hu2100	A1	0-250	39	144	52	1.5	0.73	36.9379	5210	2.9	4.84
		B	350-700	12	240	61	5.8	0.44	20.2732	5360	0.25	5.12
L9	Hu2100	A1	0-250	73	257	62	0.9	0.36		3770	4.5	5.19
		B1	350-700	33	332	70	2.4	0.49	17.4550	3700	0.1	5.06

N12	Lo/Kd1000	A1	0-250	64	54	34	9.5	0.89	55.5216	5050	0.37	4.67
		E1	350-700	82	223	190	12.6	0		3830	0.29	5.56
		B1	700-1000	58	172	142	10.4	0		4300	0.33	5.68
N15	Cv2100	A1	0-250	51	236	56	0.9	0.36	16.9095	3120	13.5	5.2
		B1	350-700	25	240	52	1	0.4	19.1431	3880	1.2	5.16
P9	Cv2100	A1	0-250	88	504	99	0.6	0		2610	2.8	5.73
		B1	350-700	23	242	67	1.5	0.1	5.2142	4320	0.41	5.46
P11	Gf2100	A1	0-250	123	574	83	0.6	0		1990	13.6	5.76
		B1	350-700	52	742	86	1.4	0		3360	5.4	5.72
4	Cv2100	A1	0-250	26	49	16	1.4	1.02	69.7343	4880	2.1	4.54
		B1	350-700	12	32	15	2.6	0.74	70.2202	8310	1.9	4.81
9	Dr2000	A1	0-250	33	111	34	4.6	0.44	32.3976	4200	2.6	5.08

Cation concentrations K (potassium), Ca (calcium) and Mg (magnesium) are moderate to low. Phosphorus concentrations are low except for sampling points G13 and H9 which is high. pH values vary from 4.54-5.76 which indicate fairly acid soil conditions.

Table 4: Coordinates of soil sampling points

Coordinates of Soil Sampling Points				
Soil sampling point	Projected Coordinate System LO 31, Wgs 1984, Hartebeesthoek 1994		Geographic Coordinate System Wgs 1994	
	Y (m)	**X (m)**	**X/Lat (dd)**	**Y/Long (dd)**
G13	-2853600.00	-97930.00	-25.786999	30.023635
H9	-2853450.00	-98530.00	-25.785605	30.017665
J6	-2853150.00	-98980.00	-25.782867	30.013201
J11	-2853150.00	-98230.00	-25.782918	30.020678
J13	-2853150.00	-97930.00	-25.782938	30.023668
L9	-2852850.00	-98530.00	-25.780190	30.017709
N12	-2852550.00	-98080.00	-25.777513	30.022217
N15	-2852550.00	-97630.00	-25.777543	30.026703
P9	-2852250.00	-98530.00	-25.774775	30.017754
P11	-2852250.00	-98230.00	-25.774795	30.020744
4	-2852748.321	-96696.268	-25.779394	30.035996
9	-2852429.699	-96311.417	-25.776544	30.039855

4. PRE-MINING LAND CAPABILITY

The soil characteristics of each soil type are described in the soils legend Table 1. The soil types are grouped into land capability classes (see section 2 Methodology) and shown on the land capability maps, Figures 3a and 3b. Table 5 shows the soil types grouped into each land capability class, a broad description of the soil group, the number of units per land capability class, and the area and percentage comprised by each land capability class.

Table 5: Areas and percentages of land capability classes

Areas and Percentages Comprised by Land Capability Classes						
Land Capability Code	**Land Capability Class**	***Soil Types**	**Broad Soil Description**	**Unit Count**	**Area (ha)**	**Area (%)**
A	**Arable**	Hu1, Hu2, Hu3, Cv1, Av1, Gc1	Moderately deep to deep red and yellow soils with moderate to high agricultural potential.	4	362.67	71.71
G	**Grazing**	Gc2, Dr2, Ms/R, Hu/R	Shallow, stony soils within soil-rock complexes with low agricultural potential.	14	67.83	13.43
W/T	**Temporary Wetland**	Dr1	Temporary seepage zones. Shallow, greyish, imperfectly drained, sandy soils underlain by hardpan ferricrete.	2	21.63	4.28
W/S	**Seasonal Wetland**	Lo1	Seepage zones and drainage lines. Grey, leached, imperfectly drained sandy soils.	8	51.91	10.26
W/P	**Permanent Wetland**	Ka	Pan. Grey, mottled soils underlain by gleyed clay showing signs of prolonged wetness.	1	1.67	0.33
W	**Wilderness**	None	-	0	0.00	0.00
			Total	**29**	**505.71**	**100.01**
*See soil map Figure 2						

5. LAND USE

5.1 Pre-mining Land Use

The extent of land use practices were surveyed during the time of the soil assessment. The current land uses are shown on the land use maps, Figure 4a and 4b. The current land use, the number of units per land use, the area and percentage comprised by each land use is shown in Table 6.

Table 6: Areas and percentages of current land uses

LEGEND – CURRENT LAND USE				
Land Use Code	**Current Land Use**	**Unit Count**	**Area (ha)**	**Area (%)**
M	Dry land maize production.	5	262.93	51.99
G	Grazing – Areas properly fenced off and permanently used for grazing purposes. Mainly commercial cattle farming.	2	171.20	33.85
DW	Dense wattle infestation – no specific land use.	1	7.94	1.57
D	Local farm dams.	4	6.32	1.24
V/G	Mainly small patches within maize fields which are wet or shallow but not fenced off and there not grazed. Probably grazed during winter together with maize rests.	16	57.32	11.34
	TOTAL	**28**	**505.71**	**100.0**

5.2 Historical agricultural production

The maize fields indicated on the Land Use maps Figure 4a and 4b had been cultivated for many years as derived from old 1:50 000 topographical maps. Crop yields vary from farm to farm and even between different fields on the same farm due to varying characteristics of soil types such as effective soil depth, soil texture, soil water holding capacity, annual precipitation and farm management and therefore crop yields are strongly correlated with soil properties. Long term average crop yields as estimated by Rehab Green cc based on soil types and associated properties noted during the field assessment and based on an average precipitation between 650 and 750 mm per annum are as follows.

Table 7: Historical agricultural production

Product	*Soil Types)	Derived soil potential	Potential Yield (tons/ha/annum)
Maize (Dry land)	Hu1, Hu2	High	4-6
	Hu3, Cv1, Av1, Gc1	Moderate	3-4
Soybeans (Dry land)	Hu1, Hu2	High	1.8-2.2
	Hu3, Cv1, Av1, Gc1	Moderate	1.5-2

5.3 Evidence of misuse

No evidence of misuse was observed.

5.4 Existing structures

Existing structures are farm fences, a power line and 4 farm dams as shown on the Land use maps Figures 4a and 4b.

6. WETLANDS

Soil types **Dr1**, **Lo1**, and **Ka** (Figure 2a and 2b) were classified as wetland and is shown on the Land Capability maps, Figures 3a and 3b. These units represent the outer edge of the wetland (see section 2, Methodology). These wetlands play a very important part in the ecosystem which is already largely disturbed by agricultural activities. It function as a surface drainage system, an important habitat and a mechanism to recharge the ground water system as well as open water sources downstream.

7. SENSITIVE LANDSCAPES

Four of the seasonal and permanent wetland zones (soil types **Ka** and **Lo1**) which forms part of drainage lines and are linked to open water sources needs to be protected and was excluded from the proposed opencast area (See figure 5). These wetland zones should also be protected by means of a 50m buffer zone as indicated in figure 5. Degraded seepage zones of soil types **Lo1** and **Dr1** were included in the proposed opencast area.

8. CONCLUSION

Soils, land capability and land use

Red and yellow, well- to moderately drained soils with arable land capability and moderate to high agricultural potential comprises 71.71% (362.68 ha) of the surveyed area. These soils consists of soils types **Hu1**, **Hu2**, **Hu3**, **Cv1**, **Av1** and **Gc1.**

Shallow, yellow brown and stony soils with grazing land capability and moderate to low agricultural potential comprises 16.43% (67.83 ha) of the surveyed area. These soils consists of soils types **Gc2**, **Dr2**, **Ms**/**R** and **Hu**/**R**.

Temporary wetland zones dominated by the Dresden soil type (**Dr1**) comprises 4.28% (21.63 ha) of the surveyed area. Seasonal wetland zones dominated by the Longlands soil type (**Lo1**) comprises 10.26% (51.91 ha) and permanent wetland zones dominated by the Katspruit soil type (**Ka**) comprises 0.33% (1.67 ha) of the surveyed area.

The majority of the surveyed area is utilized for maize production which comprises 51.99% (262.93 ha) of the surveyed area. Areas permanently used for grazing purposes (mainly cattle farming) comprises 33.85% (171.20 ha) of the surveyed area.

9. RECOMMENDATIONS

The wetlands excluded from the opencast area in Figure 5 are sensitive because pollution within these zones can impact on water sources far beyond the mining area.

Stripping of topsoil to the specified depths as stated in the report is crucial. It is the only way to ensure that proper rehabilitation of high standards is possible. Failure to do this will result in failure to restore soil potential, land capability and land use close to pre-mining conditions which implies deterioration of the most important natural resource which provide national food security. Proper stockpiling of soil types on stockpiles or berms as specified is crucial.

Failure to shape spoils to the original topography and elevation occurs at almost all mines in South Africa and is one of the main reason for degradation of post-mining land capability and deterioration of rehabilitated land shortly after rehabilitation took place.

Proper management of the total rehabilitation process starting at the planning phase up to supervision of the dozer operators is the key to successful rehabilitation and so-called sustainable development.

Agricultural land in South Africa cannot be sacrificed for mining purposes. Therefore, if rehabilitation of the highest standards cannot be guaranteed then mining authorization should not be granted.

It is therefore recommended that the rehabilitation process is monitored progressively by a competent third party to ensure that the original land capability is restored as far as possible.

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FIGURES

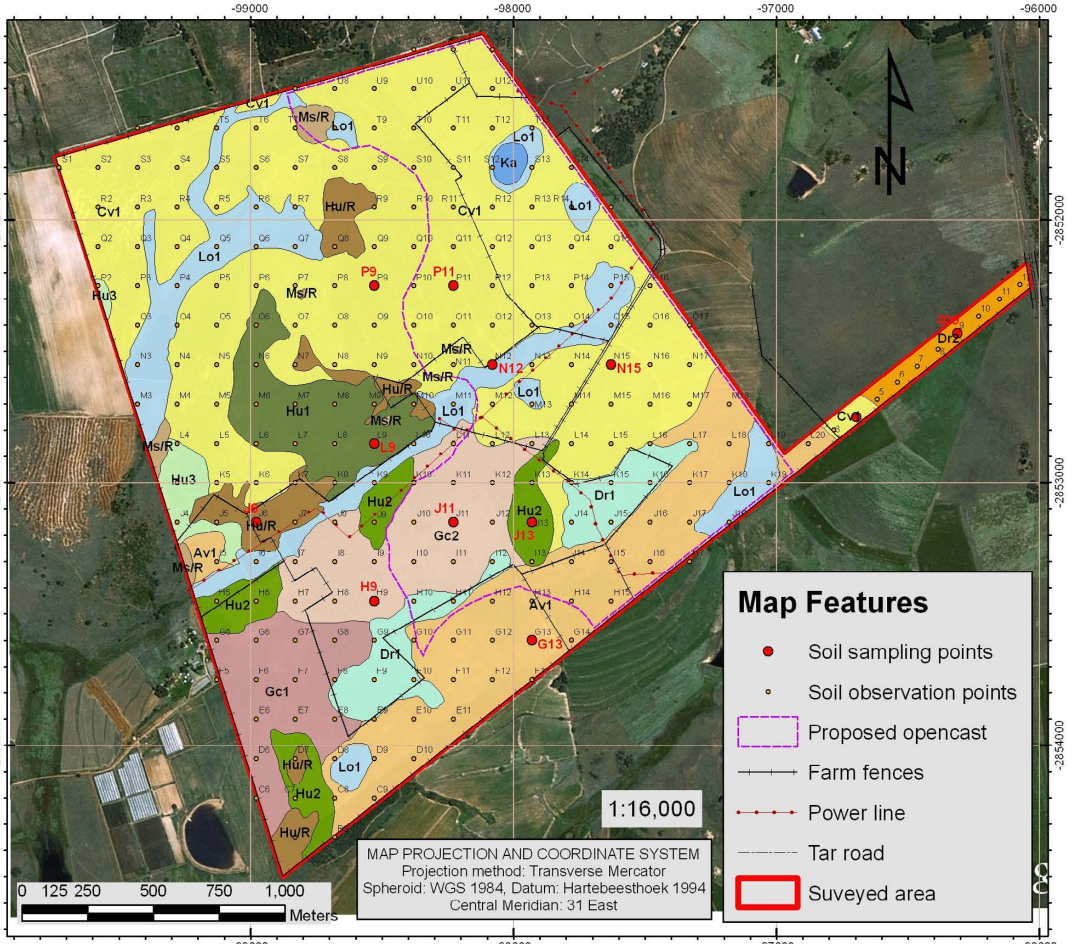
Maps were compiled on aerial photo background. However, to display information more effectively the data of each map was superimposed on aerial photos in polygon and line format. The extent and distribution of units in polygon format are easy to visualize but it cover the visual aerial photo information. Line data are more difficult to visualize but retain all visual aerial photo information. The soil, land capability and land use information was therefore each displayed on 2 maps (eg. Figure 2a and 2b) where Figure 2a display data in polygon format and 2b in line format.

NB! All Figures in this report are compiled for A3 size printing and should be printed on A3 size paper. Printouts on A4 or smaller size papers might cause that some of the labeling to become illegible.

The electronic file sizes of the Figures are big because of aerial photo background and cause the total file size of the report to be too large to be emailed. Should the report need to be emailed the Figures can be removed and send as separate files.

Figure 2a: Soil map of portion 15 and16 of the farm Weltevreden (Polygon format)
Figure 2b: Soil map of portion 15 and16 of the farm Weltevreden (Line format)
Figure 3a: Land capability map of portion 15 and16 of the farm Weltevreden (Polygon format)
Figure 3b: Land capability map of portion 15 and16 of the farm Weltevreden (Line format)
Figure 4a: Current land use map of portion 15 and16 of the farm Weltevreden (Polygon format)
Figure 4b: Current land use map of portion 15 and16 of the farm Weltevreden (Line format)
Figure5: Soil utilization guide map

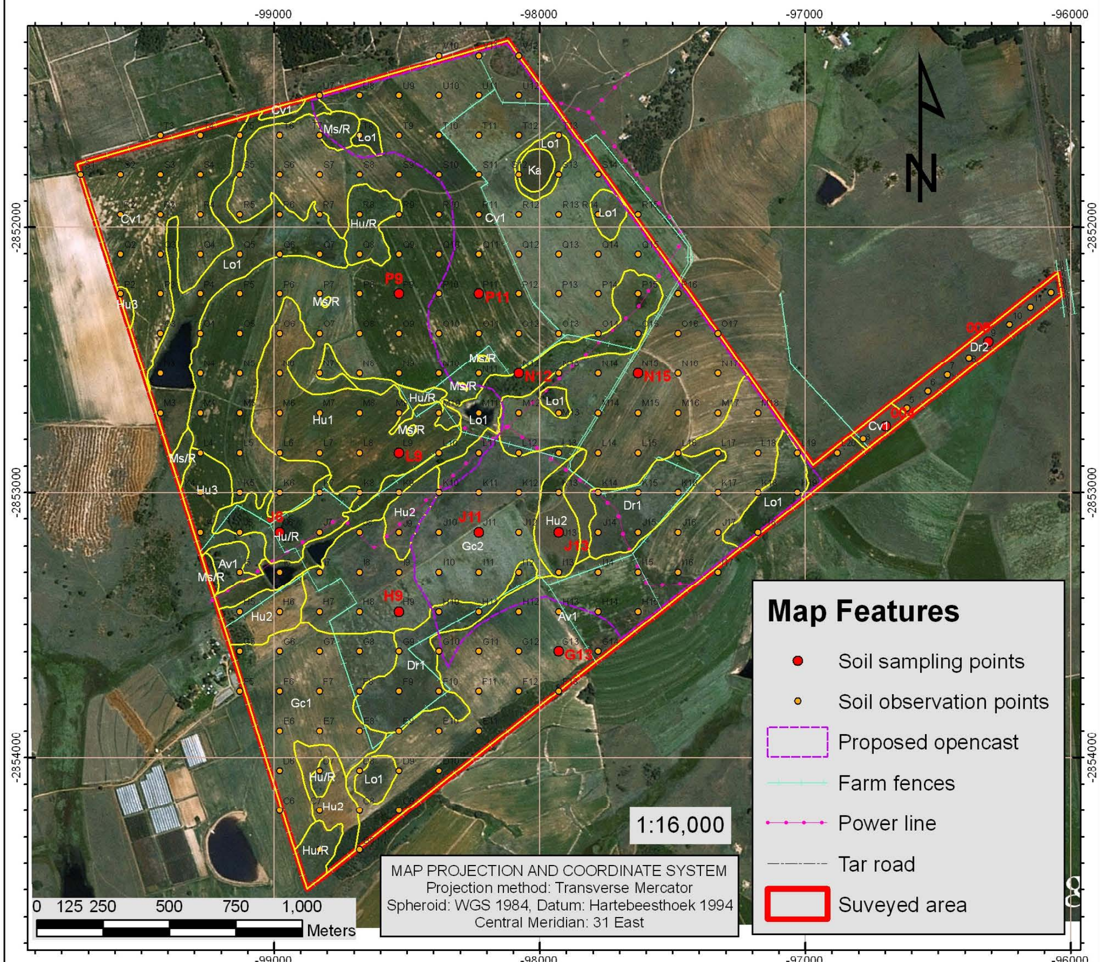
Figure 2a: Soil Map of Portion 15 and 16 of the Farm Weltevreden 381 JT for the Proposed Weltevreden Opencast



SOIL LEGEND

Soil Type Code	Dominant Soil Form and Family	Subdominant Soil Form and Family	Effective Depth (mm)	Clay % A-horizon B/E/G-horizon	Texture Class	Summarized Description of Dominant Soil Form	Agricultural Potential	Land Capability	Area (ha)	Area (%)
Hu1	Hutton 2100	Bainsvlei	1100-1500	A: 15-20 B: 15-25	Sandy loam-Sandy clay	Very deep, red, structureless, well drained, sandy loam to sandy clay loam soils.	High	Arable	24.73	4.89
Hu2	Hutton 2100	Bainsvlei	800-1200	A: 15-20 B: 15-20	Sandy loam	Moderately deep to deep, red, structureless, well drained, sandy loam soils.	High	Arable	19.34	3.83
Hu3	Hutton 2100	Bainsvlei	450-600	A: 15-20 B: 15-20	Sandy loam	Shallow to moderately deep, red, structureless, well drained, sandy loam soils.	Moderate	Arable	6.67	1.32
Cv1	Clovelly 2100	Avalon, Glencoe	600-1000	A: 11-14 B: 12-18	Loamy sand	Moderately deep to deep, yellow brown, structureless, well drained, loamy sand soils underlain by hard or weathered rock.	Moderate	Arable	218.65	43.22
Av1	Avalon 2100	Clovelly, Glencoe	700-1000	A: 10-13 B: 12-15	Loamy sand	Moderately deep to deep, yellow brown, structureless, moderately drained, loam sand soils underlain by soft plinthite.	Moderate	Arable	67.48	13.35
Gc1	Glencoe 2100	Avalon, Clovelly	500-900	A: 10-12 B: 10-14	Loamy sand	Moderately deep, yellow brown, structureless, moderately drained, sandy loam soils underlain by hard plinthite.	Moderate	Arable	25.81	5.1
Gc2	Glencoe 2100	Dresden, Avalon, Wasbank	400-600	A: 10-12 B: 10-14	Loamy sand	Shallow, yellow brown, structureless, moderately drained, sandy loam soils underlain by hard plinthite.	Low	Grazing	39.07	7.73
Dr1	Dresden 2000	Longlands, Wasbank, Cartref	100-300	A: 7-10	Sandy	Temporary seepage zone. Very shallow, greyish yellow, imperfectly drained, loamy sand soils underlain by hard plinthite.	Low	Temporary wetland	21.63	4.28
Lo1	Longlands 1000	Dresden, Wasbank, Kroonstad	400-1000	A: 5-10 E: 2-8	Sandy	Moderately deep, grey, imperfectly drained soils underlain by soft plinthite, with signs of wetness and lateral movement of water in the soil profile.	Low	Seasonal wetland	51.91	10.25
Ka	Katspruit 1000	Kroonstad, Longlands, Wasbank	200-300	A: 20-30 G: 50-60	Clay	Shallow, grey, poorly drained soils underlain by gleyed clay, with signs of long term wetness or permanent saturated conditions.	Low	Permanent wetland	1.67	0.33
Dr2	Dresden 1000	Longlands, Wasbank, Cartref	100-300	A: 7-10	Sandy	Relict seepage zone. Very shallow, greyish yellow, imperfectly drained, loamy sand soils underlain by hard plinthite.	Low	Grazing	5.97	1.18
Ms/R	Miapah 1100	Glenrosa	0-400	A: 10-15	Loamy sand	Shallow rocky areas. Shallow yellowish brown, loamy sand soils in association with exposed surface rock.	Low	Grazing	3.54	0.71
Hu/R	Hutton 2100	Mispah, Shortlands, Glenrosa	200-1000	A: 20-25 B: 20-35	Sandy clay loam	Dolerite outcrops. Shallow to deep, red, sandy clay loam soils in association with exposed surface rock.	Low	Grazing	19.25	3.81
								Total	505.72	100.0

Figure 2b: Soil Map of Portion 15 and 16 of the Farm Weltevreden 381 JT for the Proposed Weltevreden Opencast



SOIL LEGEND										
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Cv1	Clovelly 2100	Avalon, Glencoe	600-1000	A: 11-14 B: 12-18	Loamy sand	Moderately deep to deep, yellow brown, structureless, well drained, loamy sand soils underlain by hard or weathered rock.	Moderate	Arable	218.65	43.22
Av1	Avalon 2100	Clovelly, Glencoe	700-1000	A: 10-13 B: 12-15	Loamy sand	Moderately deep to deep, yellow brown, structureless, moderately drained, loam sand soils underlain by soft plinthite.	Moderate	Arable	67.48	13.35
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Ka	Katspruit 1000	Kroonstad, Longlands, Wasbank	200-300	A: 20-30 G: 50-60	Clay	Shallow, grey, poorly drained soils underlain by gleyed clay, with signs of long term wetness or permanent saturated conditions.	Low	Permanent wetland	1.67	0.33
Dr2	Dresden 1000	Longlands, Wasbank, Cartref	100-300	A: 7-10	Sandy	Relict seepage zone. Very shallow, greyish yellow, imperfectly drained, loamy sand soils underlain by hard plinthite.	Low	Grazing	5.97	1.18
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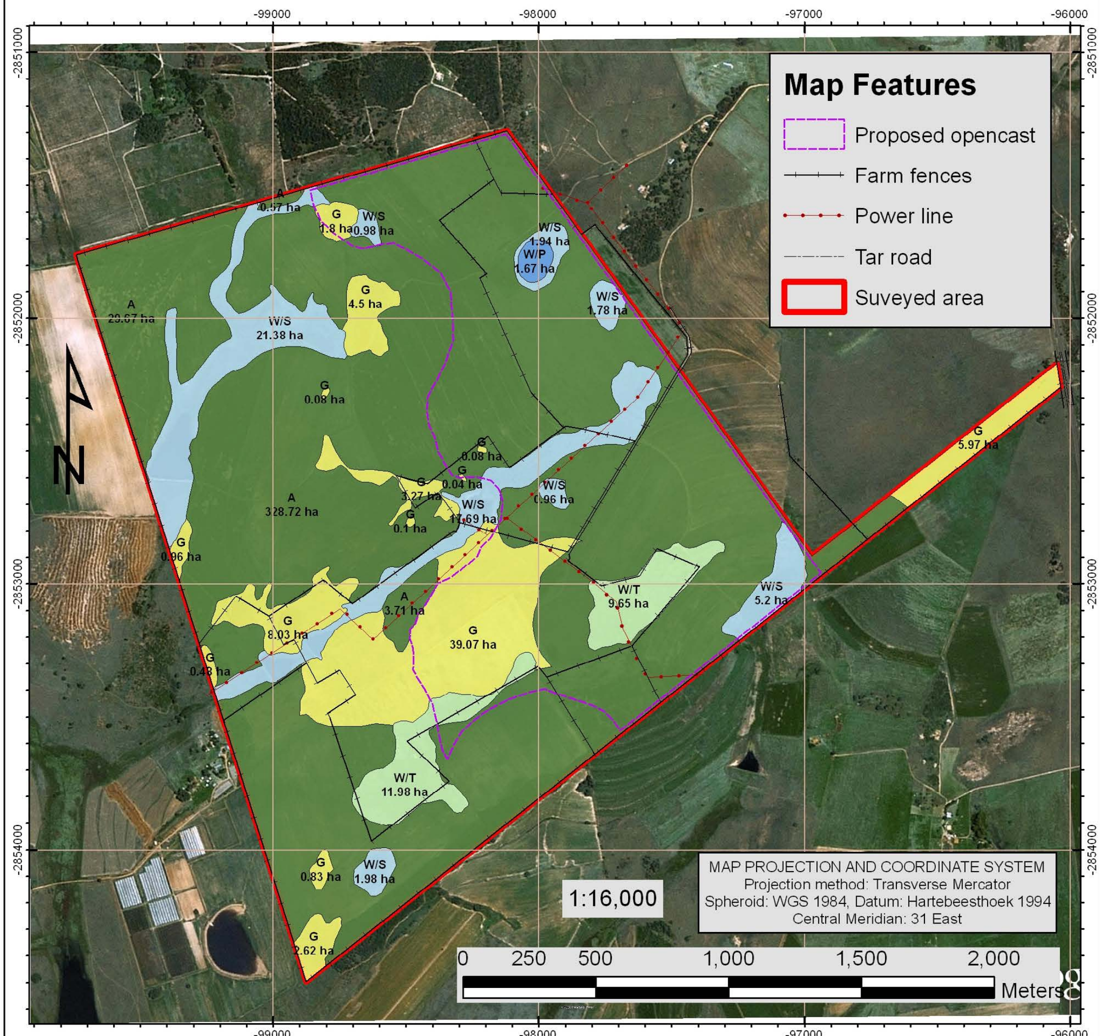
								Total	**505.72**	**100.0**

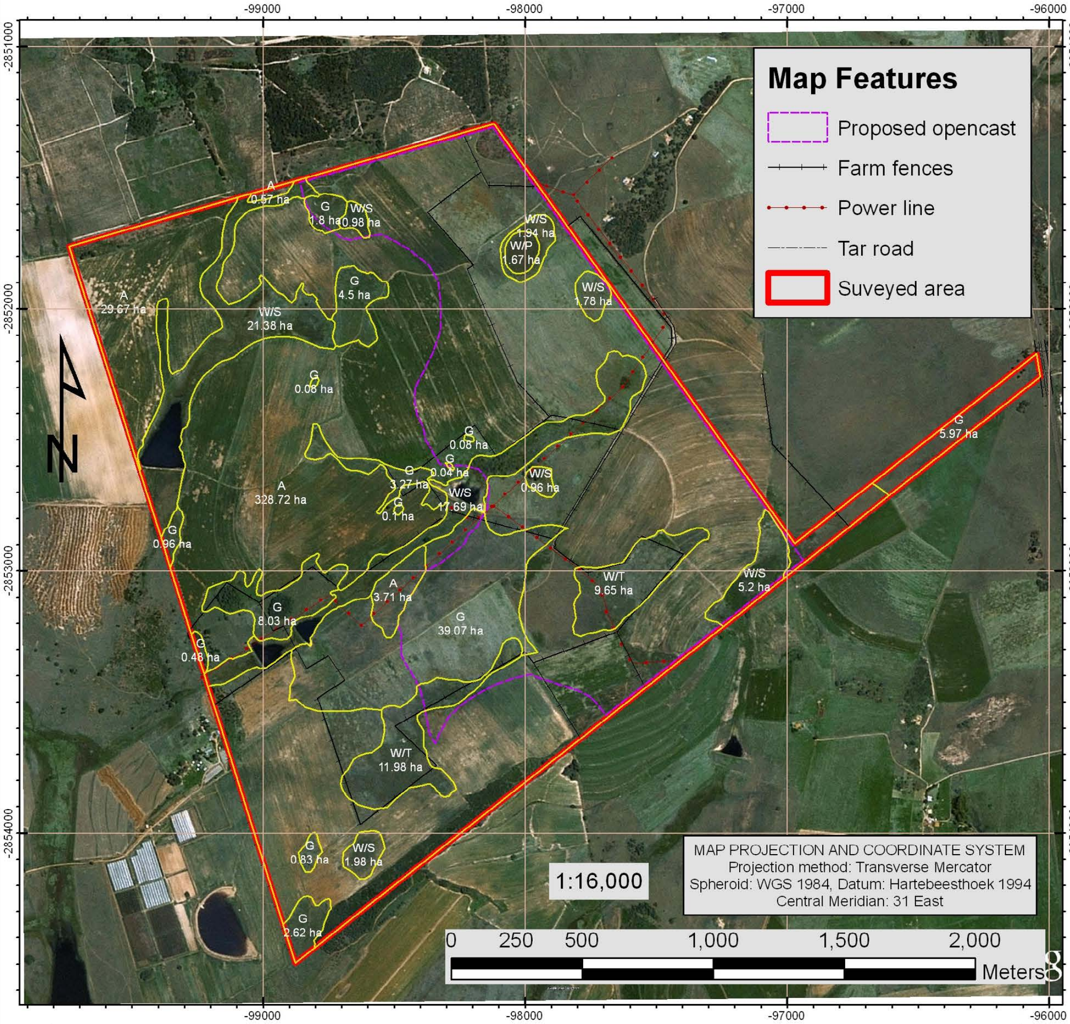
Figure 3a: Land Capability Map of Portion 15 and 16 of the Farm Weltevreden 381 JT - Proposed Weltevreden Opencast



LEGEND: LAND CAPABILITY						
Areas and Percentages Comprised by Land Capability Classes						
Land Capability Code	**Land Capability Class**	***Soil Types**	**Broad Soil Description**	**Unit Count**	**Area (ha)**	**Area (%)**
A	**Arable**	Hu1, Hu2, Hu3, Cv1, Av1, Gc1	Moderately deep to deep red and yellow soils with moderate to high agricultural potential.	4	362.67	71.71
G	**Grazing**	Gc2, Dr2, Ms/R, Hu/R	Shallow, stony soils within soil-rock complexes with low agricultural potential.	14	67.83	13.43
W/T	**Temporary Wetland**	Dr1	Temporary seepage zones. Shallow, greyish, imperfectly drained, sandy soils underlain by hardpan ferricrete.	2	21.63	4.28
W/S	**Seasonal Wetland**	Lo1	Seepage zones and drainage lines. Grey, leached, imperfectly drained sandy soils.	8	51.91	10.26
W/P	**Permanent Wetland**	Ka	Pan. Grey, mottled soils underlain by gleyed clay showing signs of prolonged wetness.	1	1.67	0.33
W	**Wilderness**	None	-	0	0.00	0.00
			Total	**29**	**505.71**	**100.01**

*See soil map Figure 2

Figure 3b: Land Capability Map of Portion 15 and 16 of the Farm Weltevreden 381 JT - Proposed Weltevreden Opencast



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Land Capability Code	**Land Capability Class**	***Soil Types**	**Broad Soil Description**	**Unit Count**	**Area (ha)**	**Area (%)**
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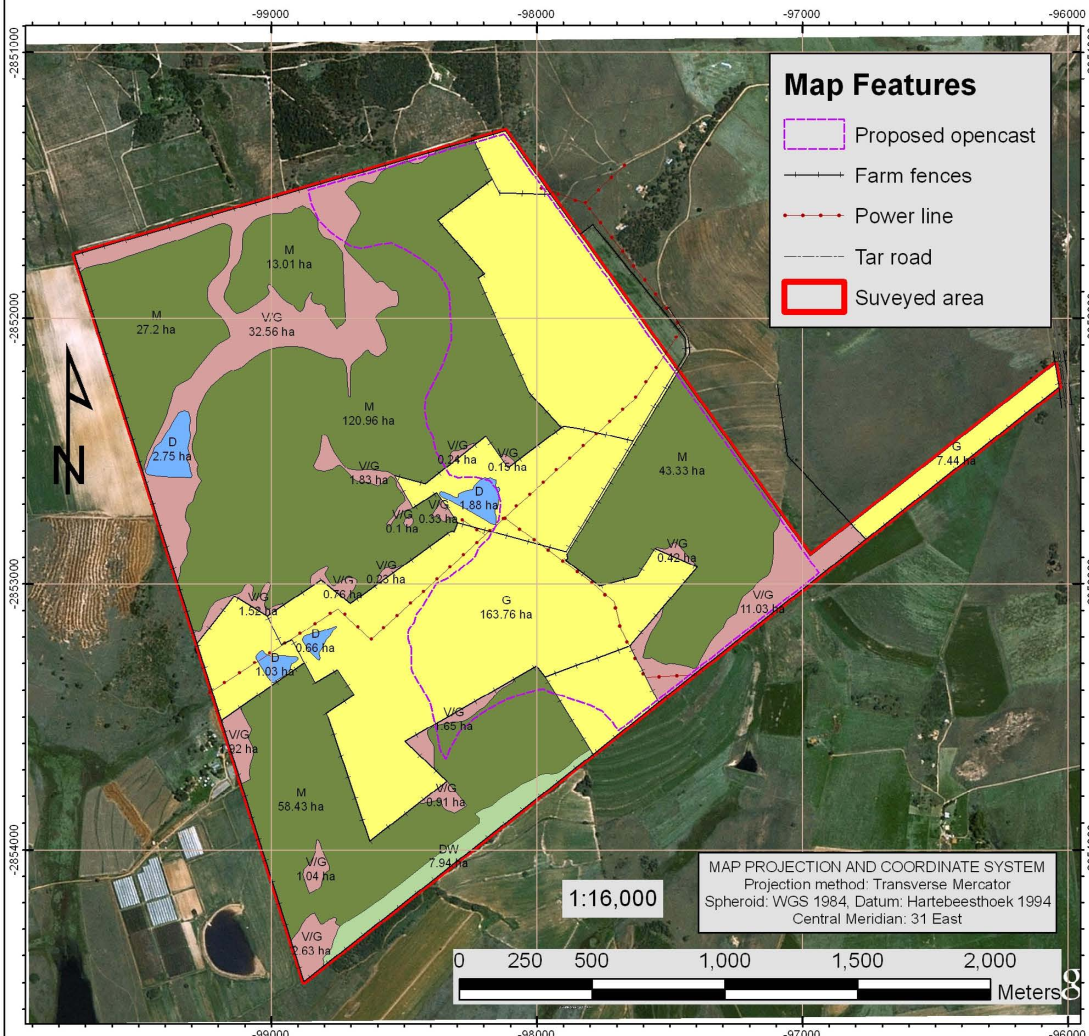
W	**Wilderness**	None	-	0	0.00	0.00
			Total	**29**	**505.71**	**100.01**

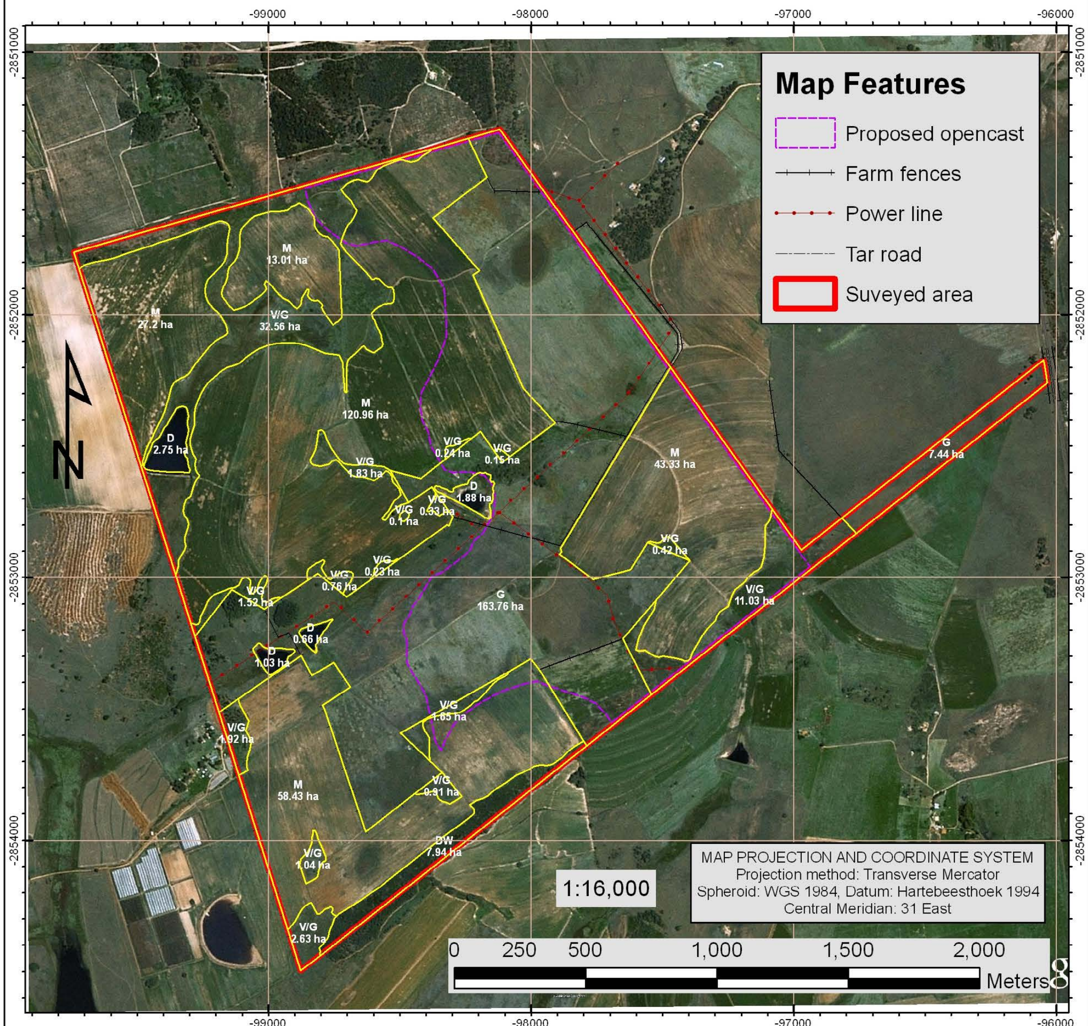
*See soil map Figure 2

Figure 4a: Current Land Use Map of Portion 15 and 16 of the Farm Weltevreden 381 JT - Proposed Weltevreden Opencast



LEGEND – CURRENT LAND USE				
Land Use Code	**Current Land Use**	**Unit Count**	**Area (ha)**	**Area (%)**
M	Dry land maize production.	5	262.93	51.99
G	Grazing – Areas properly fenced off and permanently used for grazing purposes. Mainly commercial cattle farming.	2	171.20	33.85
DW	Dense wattle infestation – no specific land use.	1	7.94	1.57
D	Local farm dams.	4	6.32	1.24
V/G	Mainly small patches within maize fields which are wet or shallow but not fenced off and there not grazed. Probably grazed during winter together with maize rests.	16	57.32	11.34
	TOTAL	**28**	**505.71**	**100.0**

Figure 4b: Current Land Use Map of Portion 15 and 16 of the Farm Weltevreden 381 JT - Proposed Weltevreden Opencast



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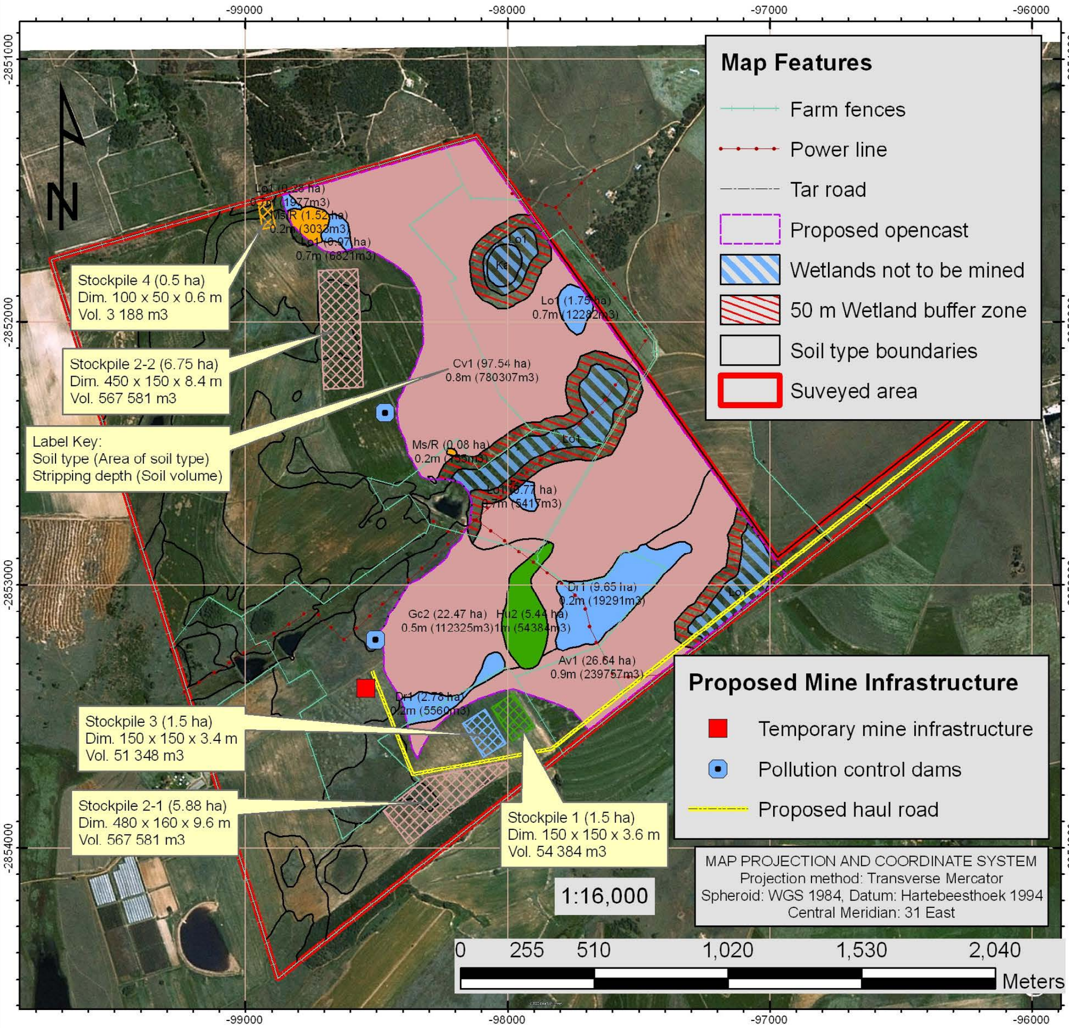
	TOTAL	**28**	**505.71**	**100.0**

Figure 5: Soil Utilization Guide Map - Proposed Weltevreden Opencast



Legend

Soil Stripping and Storage Guide

- Stockpile 1 - Red well-drained soils
- Stockpile 2 - Yellow well- and moderately drained soils
- Stockpile 3 - Grey imperfectly drained soils
- Stockpile 4 - Shallow stony soils

Legend: Areas, Percentages and Soil Stripping Volumes Available for Rehabilitation

Soil Types	Stripping Depth (m)	Unit Count	Area (ha)	Area (%)	Volume (m^3)
Stockpile 1 – Red well-drained soils					
Hu2	1.0	1	5.44	3.19	54384
Total Stockpile 1		**1**	**5.44**	**3.19**	**54384**
Stockpile 2 – Yellow moderate to well-drained soils					
Cv1	0.8	2	97.89	57.50	783080
Av1	0.9	1	26.64	15.65	239757
Gc2	0.5	1	22.47	13.20	112325
Total Stockpile 2		**4**	**147.00**	**86.35**	**1135162**
Stockpile 3 - Wetlands – Grey imperfectly drained soils					
Dr1	0.2	2	12.43	7.30	24851
Lo1	0.7	4	3.77	2.22	26497
Total Stockpile 3		**6**	**16.20**	**9.52**	**51348**
Stockpile 4 – Shallow stony soils					
Ms/R	0.2	2	1.60	0.94	3188
Total – Stockpile 4		**2**	**1.60**	**0.94**	**3188**
Grand Total		**13**	**170.24**	**100.00**	**1244082**

APPENDIX 1:

SOIL ISSUES RELATED TO MINING ACTIVITIES AND IMPACTS

1. GUIDELINES FOR STRIPPING AND HANDLING OF SOILS DURING THE CONSTRUCTION AND OPERATIONAL PHASES

1.1 CONSTRUCTION PHASE

Stripping and stockpiling of topsoil within the footprint of the proposed opencast area might commence during the construction phase but will be an ongoing action during the operational phase as the opencast expands.

1.2 OPERATIONAL PHASE

1.2.1 Soil utilization guide

1.2.1.1 Stripping and stockpiling

The geographic location and extent of each soil type, wetland zones and wetland buffer zones (see Figures 2a and 5) should be surveyed and staked at 50 m intervals before any stripping commences. Soils should be stored on 4 stockpiles based on soil potential and soil type to prevent frequent soil variation and fragmented patterns with varying land capability after rehabilitation as follows:

Red well drained soils of soil type **Hu2** should be stored on Stockpile 1 and yellow brown well- and moderately drained soils of soil types **Cv1**, **Av1** and **Gc2** on stockpile 2. Imperfectly drained soils of degraded temporary and seasonal wetland zones (soil types **Dr1** and **Lo1**) should stored on stockpile 3. Wetland soils of soil types **Ka** and **Lo1** that should not be disturbed are indicated in Figure 5. Shallow and stony soils of soil type **Ms**/**R** should be stored on stockpile 4.
Stockpiles should be located as far as possible on low potential soils or where it can serve as protection for wetland zones.

Table 8: Area, percentage and soil stripping volumes for rehabilitation

Legend: Areas, Percentages and Soil Stripping Volumes Available for Rehabilitation					
Soil Types	Stripping Depth (m)	Unit Count	Area (ha)	Area (%)	Volume (m^3)
Stockpile 1 – Red well-drained soils					
Hu2	1.0	1	5.44	3.19	54384
Total Stockpile 1		**1**	**5.44**	**3.19**	**54384**
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Cv1	0.8	2	97.89	57.50	783080
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Ms/R	0.2	2	1.60	0.94	3188
Total – Stockpile 4		**2**	**1.60**	**0.94**	**3188**
Grand Total		**13**	**170.24**	**100.00**	**1244082**

Table 8 shows the area, percentage of the total area, stripping depth and available soil volume of each soil type as well as the total soil volume per stockpile.

Figure 5 shows the soil types within the proposed opencast area that should be stripped and stockpiled together as well as the area, stripping depth and available soil volume of each soil type. It also shows the positions, areas, dimensions and volumes of the stockpiles. The stockpile dimensions were calculated based on a square shape and will therefore somewhat exceed the indicated heights to compensate for sloped edges. The footprint sizes should remain the same as far as possible.

Should the topsoil be stored as a berm the same stripping and stockpiling principle should be followed. Soil types as specified in Figure 5 and Table 8 should be placed together as a section of the berm and marked with a sign. Stockpiles should by no means be contaminated with coal, discard or overburden material.

1.2.1.2 Rehabilitation (Replacing of topsoil)

Proper stripping and stockpiling of the original soil types is the first key to proper rehabilitation which will enable the reconstruction of the pre-mining land capability as far as possible.

Proper shaping of the spoil layer to a freely drained surface and as close to the original topography as possible is the second key to proper rehabilitation. Failing in these 2 critical requirements will definitely adversely affect the post-mining land capability even with other rehabilitation requirements at its best.

The soils should be placed back in consolidated blocks with a pre-assigned land capability class for each block to prevent frequent varying depths which lead to small fragmented land capability units. The land capability class will be determined by the soil type and the thickness of the soil layer placed back on the spoil surface.

Topsoil should be dumped in sufficient quantities to allow a once-off leveling on top to prevent compaction in the lower soil profile which cannot be alleviated with normal agricultural equipment. Topsoil should not be spread over distances with dozers and bowl scrapers should not be used. These precautions will ensure that the rehabilitation process meet the EMPR commitments for closure purposes. Post-mining land capability classes in terms of soil depth are as follows:

Arable: >900 mm (moderate to high agricultural potential)
Arable: 600-900 mm (moderate agricultural potential)
Grazing: 300-600 mm
Wilderness: 100-300 mm
Wetland: > 300 mm

The opencast area should be rehabilitated to the following proportions of land capability:
Arable: >900 mm - 3.19 % (Soils on stockpile 1)
Arable: 600-900 mm - 73.15% (Soils on stockpile 2)
Grazing: 300-600 mm - 13.2% (Soils on stockpile 2)
Wetland: > 300 mm - 9.52% (Soils n stockpile 3)
Wilderness: 100-300 mm – 0.94% (Soils on stockpile 4)

Soils of stockpile 1 should be placed on the post-mining higher lying terrain units (crests and upper midslopes) and soils of stockpiles 2 and 4 below that on lower lying terrain units (mid- and lower midslopes). Soils of stockpile 3 soils should be placed in the post mining drainage zones.

The soil fertility status of the rehabilitated land should be determined and soil amelioration should be take place accordingly before re-vegetation takes place.

2. ENVIRONMENTAL IMPACT ASSESSMENT

2.1 CONSTRUCTION PHASE

Stripping and stockpiling of topsoil within the footprint of the proposed opencast area might commence during the construction phase but will be an ongoing action during the operational phase as the opencast expands. The impacts are therefore described in Section 2.2

2.2 OPERATIONAL PHASE

2.2.1 Soil

Nature of impact – Opencast (Stripping and stockpiling of topsoil)

Stripping and stockpiling of topsoil will result in:

- Loss of the original spatial distribution of soil types and natural soil horizon sequences.
- Loss of original soil fertility
- Loss of original topography and drainage pattern.
- Loss of original soil depth and soil volume.
- Loss of the natural functioning of the soil
- Compaction of soil during replacing by heavy mechanical equipment.

Status of impact

The impact will be negative and a cost to the holistic environment.

Extent

The impact will be confined to the opencast area or wherever topsoil will be removed.

Duration

The impacts will probably be of medium term nature (5-25years) depending when the rehabilitation process commences. Some impacts such as loss of natural soil horizon sequences and original soil depth will be of permanent nature. Most impacts will commence during the construction phase and will remain until rehabilitation takes place. Rehabilitation will commence during the operational phase and will be completed during the decommissioning phase. Some permanent impacts will remain after rehabilitation.

Severity of impact

The impact on soil will be severe because the natural functioning of the soil will cease until rehabilitation takes place and the original horizons sequences can not be reconstructed during rehabilitation. Even with rehabilitation at its best the post-mining land capability definitely decrease to some degree.

Certainty of impact

Impacts will definitely occur if the mining operation takes place.

Mitigation

- The location of soil types, wetland zone and wetland buffer zones will be surveyed and staked at 50 m intervals before any stripping takes place.
- The areas to be stripped will be contained as far as possible.
- Topsoil will be stored on 4 stockpiles according to soil potential and soil type.
- Topsoil will be replaced in consolidated blocks to avoid varying soil depth and fragmented land capability.
- Soil will be placed back at depths as specified in section 1.2.1.2
- Spoil and cover-soil surfaces will be shaped to original topography and elevation to restore the original drainage pattern which will prevent water logging and subsidence of the spoil material and consequently the soil surface.
- Soil amelioration will be done after rehabilitation according to soil analyses.
- Soil compaction will be minimize by dumping sufficient soil per square unit to allow a once-off leveling on top, which will prevent compaction lower down in the soil profile.
- Wetland areas will protected by means of a 50m buffer zone.

2.2.2 Land capability

Nature of impact – Opencast (Stripping and stockpiling of topsoil)

Land capability is largely determined by soil properties and therefore the impact on land capability will be determined by impacts on the soil. All adverse affects on soils will probably adversely affect post-mining land capability. Stripping and stockpiling of topsoil will result in the original land capability classified as arable, grazing and wetland to cease completely until rehabilitation takes place.

Status of impact

The impact will be negative and a cost to the holistic environment.

Extent

The impact will be confined to the opencast area, the footprint of facilities or wherever topsoil will be removed.

Duration

The impacts will probably be of medium term nature (5-25years) depending when the rehabilitation process commences. Most impacts will commence during the construction phase and will remain until rehabilitation takes place. Rehabilitation will commence during the operational phase and will be completed during the decommissioning phase. Some permanent impacts will remain after rehabilitation.

Severity of impact

The severity of the impact will be high until rehabilitation takes place because the total land capability and all natural functioning of the soil will temporarily cease and no agricultural utilization of the land will be possible.

Certainty of impact

The impacts will definitely occur.

Mitigation

Replacing of topsoil as describe in the mitigation measure of the soils will restore the original land capability to some extent depending on the standard of rehabilitation.

2.2.3 Land use

Nature of impact – Opencast (Stripping and stockpiling)

Stripping of topsoil will result in the current possible land uses to cease completely.

Status of impact

The impact will be negative and a cost to the holistic environment.

Extent

The impact will definitely affect the opencast area. It might however affect the total property purchased by the mine. Mine property is often rent by farmers but mostly become unproductive after a while due to impacts such as theft of crops and farming equipment. It will therefore probably affect the total mine property. Other mining activities in the close vicinity often have a cumulative impact that affect all neighboring farms.

Duration

The impacts will be of medium term and will commence during the construction phase and will remain until rehabilitation takes place. Possible adverse affects on soils such as disturbance of the natural soil horizon sequence and loss of soil depth and volume may influence land use permanently.

Severity of impact

The severity of the impact will be high until rehabilitation takes place because the total land use potential and all natural functioning of the soil will temporarily cease and no agricultural utilization of the land will be possible. Poor rehabilitation might lower the current land capability significantly and cause current land uses such as maize production to cease permanently.

Certainty of impact

The impacts will definitely occur.

Mitigation

The land use will be mitigated and restored by the rehabilitation process of the soil and by applying the mitigation measures of the soil. Possible post-mining land uses will be determined by the standard of rehabilitation.