AGRICULTURAL POTENTIAL ASSESSMENT

Proposed Development of a Township Establishment on the Remainder of Farm Fouriesrust 2525 District Mangaung Metropolitan Municipality, Bloemfontein Province, Free State

DRAFT REPORT FOR CLIENT REVIEW AND COMMENT

OCTOBER 2016

Malachite Specialist Services (Pty) Ltd

AGRICULTURAL POTENTIAL ASSESSMENT:
Proposed Development of a Township Establishment on the Remainder of Farm Fouriesrust 2525 District Mangaung Metropolitan Municipality, Bloemfontein Province, Free State

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INDEMNITY

Declaration

I **Rowena Harrison,** declare that -

- I act as the independent specialist in this matter;
- I do not have and will not have any vested interest (either business, financial, personal or other) in the undertaking of the proposed activity, other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2014;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the National Environmental Management Act (Act 107 of 1998), (NEMA), regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the NEMA Act, regulations and all other applicable legislation;
- As a registered member of the South African Council for Natural Scientific Professions in terms of the Natural Scientific Professions Act, 2003 (Act No. 27 of 2003), I will undertake my professional duties in accordance with the Code of Conduct of the Council, as well as any other societies of which I am a member; and
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority; all the particulars furnished by me in this report are true and correct.

Signature of the specialist:

Date:

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EXECUTIVE SUMMARY

Malachite Specialist Services (Pty) Ltd was appointed by Thikho Consulting and Projects (Pty) Ltd to undertake an Agricultural Potential Assessment for the proposed establishment of a Township in terms of the Spatial Planning and Land Use Management Act (Act 16 of 2013) on the remainder of the Farm Fouriestrust 2525 District within the Mangaung Metropolitan Municipality, Free State Province. The development area is approximately 15.7ha and entails the development of:

- Housing stands
- Business complex
- Administration block
- Office Park
- Lodge and recreational area

The primary aim of the township development is to address the increased informal settlements within Bloemfontein due to the increased rate of urban migration within this Metropolitan. The development of a formalised middle class residential area will begin to address this issue. The agricultural assessment forms part of the Basic Assessment in compliance with the National Environmental Management Act (Act 107 of 1998) and the Environmental Impact Assessment (EIA) Regulations, 2014, GN R. 983, R. 984 and R.985 in terms of the Spatial Planning and Land Use Management Act (Act 16 of 2013).

The current study was conducted as per the Natural Resources Survey Specifications Standards (2012) and the terms of reference are as follows:

- Conduct a soil survey and mapping exercise of the orchard sites to form and family level;
- Describe the physical properties of the soils sampled;
- Describe the vegetation communities associated with the site;
- Describe the agricultural potential of the soils identified within the site;
- Describe the land use and capability of the site based on the soil forms identified, slope of the site, climatic data, rockiness, surface crusting and wetness; and
- Provide recommendations for the proposed project.

Soil sampling was taken at strategic locations across the site during a field assessment conducted on the 10th October 2016. Soils were assessed in terms of the texture, soil depth, subsoil permeability, slope, rockiness, surface crusting, and wetness.

Information obtained on site indicated that the site is situated on flat terrain with soils of the Shortlands and Sepane form identified on site. Both soil forms are characterised by the presence of a kaolinitic clay which shrinks when dry and swells when wet. The accumulation of this kaolinitic clay in the subsoil of the Sepane form creates the duplex character. Duplex soils have a marked difference in structure between the A and B horizon. This abrupt change in structure makes these soils susceptible to soil erosion as well as reduces their effective rooting depth. The strongly structured B horizon creates an impediment to water movement through the profile as well as the growth of plant roots.

The proposed development site was assessed in terms of its Agricultural and Land Capability Potential and the site has been classified as Class IV as a result of limitations in the soil texture, related to the strongly structured nature of the soil, the effective rooting depth, and the presence of hydric characteristics within some of the soils sampled. Class IV land types are subject to severe limitations and these limitations have an impact on the choice of crop that can be grown on the site. The low effective rooting depth of these soils coupled with an unfavourable climate, limit the use of this site for crop cultivation. The site is however utilised for livestock grazing. This grazing has led to a removal of basal cover affecting the vegetation assemblages within the site.

The impact assessment identified the following negative impacts associated with the proposed development; (i) loss of agricultural land (ii) soil compaction and erosion; (iii) soil pollution as a result of construction activities; and (iv) the continued spread of alien invasive species as a result of the disturbance. Several general and specific measures are proposed to mitigate these impacts on the receiving environment.

Provided the mitigation measures specified in this report are implemented and the continued monitoring and rehabilitation of disturbed areas is undertaken, the proposed development is expected to have a limited long term negative impact on arable agricultural land. The proposed development is however expected to have an impact on the grazing potential within the site's agricultural land, particularly for immediately adjacent properties. The implementation of suggested mitigation measures are needed to limit the identified negative impacts.

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1. INTRODUCTION AND BACKGROUND

1.1. Project Background and Locality

Malachite Specialist Services (Pty) Ltd was appointed by Thikho Consulting and Projects (Pty) Ltd to undertake an Agricultural Potential Assessment on the Remainder of the Farm Fouriesrust 2525 for the proposed establishment of a Township in terms of the Spatial Planning and Land Use Management Act (Act 16 of 2013). The study site is located within the Mangaung Metropolitan Municipality, Free State Province.

The proposed township development is approximately 15.7 hectares and entails the construction of:

- Housing stands
- Business complex
- Administration block
- Office Park
- Lodge and a recreational area

The primary aim of the township development is to address the increased informal settlements within Bloemfontein due to the increased rate of urban migration within this Metropolitan. The development of a formalised middle class residential area will begin to address this issue. The agricultural assessment forms part of the Basic Assessment in compliance with the National Environmental Management Act (Act 107 of 1998) and the Environmental Impact Assessment (EIA) Regulations, 2014, GN R. 983, R. 984 and R.985 in terms of the Spatial Planning and Land Use Management Act (Act 16 of 2013).

The primary aim of the agricultural assessment is to determine the agricultural production potential of the site with regards to the commercial cultivation of crops as well as the use of the site to support livestock production. The site has been zoned as 'holdings' which includes agricultural and residential use. The change in land use to a township development has therefore prompted the need to determine if viable agricultural land will be lost as a result of this development.

The current land use and site activities surrounding the study site are predominantly agricultural practices. The site is bordered by Abrahamskraal Road and Vergezocht Avenue. The study site is situated approximately 15km north-west of Bloemfontein and falls within the quarter degree square 2926AA (**Figure 1**).

The majority of the area surrounding the project is dominated by agricultural development to the west and south, with limited intact Bloemfontein Dry Grassland floral composition.

Importance of soils in South Africa

Soil forms are the primary components creating the pedosphere and are integral in the sustainability of life on earth. The primary attributes of soils forms include:

- Soils are the primary mediums on earth for biological processes and activity; and
- Provide and sustain integral ecological processes including water retention, nutrient cycling and the organic carbon cycle.

The soil characteristics of a particular area determine the botanical and faunal composition. Therefore, soils provide an important system in which the ecology of the area is founded upon.

South African soils can be classified into approximately 73 forms and further categorised into 14 groups (Fey, 2010). The classification and identification of these soils forms are based on the presence of defined diagnostic horizons or materials. Ineffective conservation efforts coupled with increased development within South Africa exert pressure on these vital soil resources. It is imperative that all developments employ techniques to ensure the conservation of soils forms.

1.2. Scope of the assessment

The terms of reference for the current study were conducted as per the Natural Resources Survey Specifications Standards (2012) and were as follows:

- Conduct a soil survey and mapping exercise of the orchard sites to form and family level;
- Describe the physical properties of the soils sampled;
- Describe the vegetation communities associated with the site;
- Describe the agricultural potential of the soils identified within the site;
- Describe the land use and capability of the site based on the soil forms identified, slope of the site, climatic data, rockiness, surface crusting and wetness; and
- Provide recommendations for the proposed project.

1.3. Assumptions and Limitations

It is difficult to apply pure scientific methods within a natural environment without limitations or assumptions. The following apply to this study:

i. The findings, results, observations, conclusions and recommendations provided in this report are based on the author's best scientific and professional knowledge as well as available information regarding the proposed project.

ii. A hand held Garmin eTrex 30x was used to mark the sites where soil samples were taken and this information used in the soil mapping. The GPS has an accuracy of 3-6m.

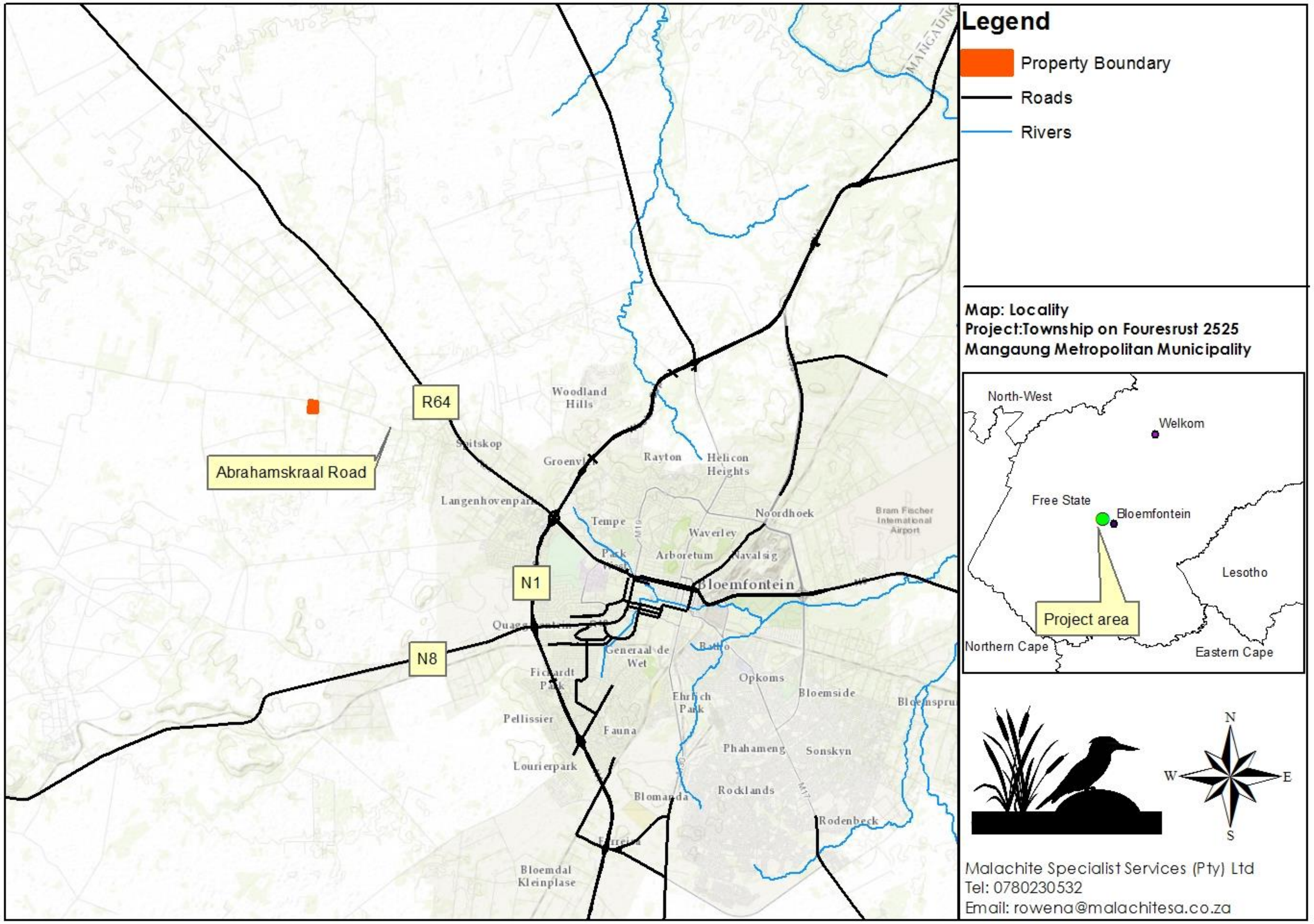

Figure 1: Site locality of the proposed Township on Fouriesrust 2525

2. METHODOLOGY

2.1. Assessment techniques and tools

The following techniques and tools were used in the assessment:

2.1.1. Baseline data

The desktop study conducted for the proposed development involved the examination of aerial photography, GIS databases as well as literature reviews of the study site in order to determine the agricultural potential and land capability of the area.

The study made use of the following data sources:

- Google Earth™ satellite imagery was used at the desktop level;
- Relief dataset from the Surveyor General was used to calculate slope;
- The NFEPA dataset from (Driver, *et al*., 2011) was used in determining any wetlands and watercourses within the study site;
- Climatic data was obtained from (Shulze, 1997)
- Geology dataset was obtained from AGIS[1]
- Vegetation type dataset from (Mucina & Rutherford, 2006) was used in determining the vegetation type of the study area; and
- In field data collection was taken on the 10th October 2016.

Detailed methodology for the soil sampling methods as well as the agricultural and land capability assessment is given in Appendix A.

2.2. Assessment of Impact Significance

Significance scoring both assesses and predicts the significance of environmental impacts through evaluation of the following factors; probability of the impact; duration of the impact; extent of the impact; and magnitude of the impact. The significance of environmental impacts is then assessed taking into account any proposed mitigations. The significance of the impact "without mitigation" is the prime determinant of the nature and degree of mitigation required[2]. Each of the above impact factors have been used to assess each potential impact using ranking scales.

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[1] Land type information was obtained from the Department of Agriculture's Global Information Service (AGIS) January 2014 – www.agis.agric.za

[2] *Impact scores given "with mitigation" are based on the assumption that the mitigation measures recommended in this assessment are implemented correctly and rehabilitation of the site is undertaken. Failure to implement mitigation measures during and after construction will keep the impact at an unacceptably high level.*

Unknown parameters are given the highest score (5) as significance scoring follows the Precautionary Principle. The Precautionary Principle is based on the following statement:

> *'When the information available to an evaluator is uncertain as to whether or not the impact of a proposed development on the environment will be adverse, the evaluator must accept as a matter of precaution, that the impact will be detrimental. It is a test to determine the acceptability of a proposed development. It enables the evaluator to determine whether enough information is available to ensure that a reliable decision can be made.'*

Table 1: Significance scoring used for each potential impact

PROBABILITY	DURATION
1 - very improbable 2 - improbable 3 - probable 4 - highly probable 5 - definite	1 - very short duration (0-1years) 2- short duration (2-5 years) 3 - medium term (5-15 years) 4 - long term (>15 years) 5 - permanent/unknown
EXTENT	**MAGNITUDE**
1 - limited to the site 2 - limited to the local area 3 - limited to the region 4 - national 5 - international	2 – minor 4 – low 6 – moderate 8 – high 10 – very high

The following formula was used to calculate impact significance:

Impact Significance: (Magnitude + Duration + Extent) x Probability

The formula gives a maximum value of 100 points which are translated into 1 of 3 impact significance categories; Low, Moderate and High as per **Table 2**.

Table 2: Impact significance ratings

SIGNIFICANCE POINTS	SIGNIFICANCE RATING
0-30 points	Low environmental significance
31 – 59 points	Moderate environmental significance
60 - 100 points	High environmental significance

The impact assessment is discussed in more detail in **Section 5.**

3. BASELINE BIOPHYSICAL CHARACTERISTICS

3.1. General area description

The Agricultural Potential Assessment was conducted on the 10th of October 2016 on the Remainder of the Farm Fouriesrust 2525. Approximately 15.7 hectares of land which is proposed to be converted into a formalised township development was assessed in terms of its agricultural potential. The site is situated on the corner of Abrahamskraal Road and Vergezocht Avenue. The agricultural land is currently not cultivated and situated within transformed Bloemfontein Dry Grassland areas that are opportunistically utilised for livestock grazing. The site is located approximately 13 337m above sea level.

3.2. Climate

The area is characterised by a summer rainfall pattern with limited rainfall events during the winter months. The mean annual precipitation is approximately 450mm with the majority occurring in summer through convectional origins. High incidences of frost occur during the winter months. The wettest time of the year is January with an average of 68mm and the driest is June with 2mm. The seasonality of precipitation is a driving factor behind the hydrological cycles of rivers and drainage lines within the area. Typically, rivers and drainage lines have a higher flow rate during the summer months.

Temperatures are also relatively high with maximum temperatures ranging from 29.2^{0}C in January to 16.4^{0}C in June. The region is coldest in July with minimum temperatures reaching 0^{0}C.

A description of Climate Capability Class Criteria is shown in **Table 3**.

Table 3: Description of Climate Capability Classes

Description of Climate Capability Class Criteria (Scotney et al. UKZN 1987)		
Climate Capability Class	**Limitation Rating**	**Description**
C1	None to slight	Local climate is favourable for good yields for a wide range of adapted crops throughout the year.
C2	Slight	Local climate is favourable for a wide range of adapted crops and a year round growing season. Moisture stress and lower temperatures increase risk and decrease yields relative to C1.
C3	Slight to Moderate	Slightly restricted growing season due to the occurrence of low temperatures and frost. Good yield potential for a moderate range of adapted crops.
C4	Moderate	Moderately restricted growing season due to low temperatures and severe frost.
C5	Moderate to Severe	Moderately restricted growing season due to low temperatures, frost and/or moisture stress. Suitable crops at risk of some yield loss.
C6	Severe	Moderately restricted growing season due to low temperatures, frost and/or moisture stress. Limited suitable crops which frequently experience yield loss.
C7	Severe to Very Severe	Severely restricted choice of crops due to heat, cold and/or moisture stress.
C8	Very Severe	Very severely restricted choice of crops due to heat, cold and/or moisture stress. Suitable crops at high risk of yield losses.

A Climate Capability Class of 4 to 5 was attributed to the study site during the course of the site visit. This climate type restricts the agricultural potential of the site.

3.3. Vegetation structure and composition

The proposed study area is located within the Dry Highveld Grassland Bioregion (Mucina and Rutherford 2006). According to the National Vegetation Map of Southern Africa (2012), the surrounding vegetation associated with the study area is of the Bloemfontein Dry Grassland vegetation unit (**Figure 2**, **Photograph 1**). This vegetation unit is characterised by slightly undulating bottomland landscape dominated by tall, dense grassland with intermittent patches of Karroid scrub. Karroid scrub and grasslands are formed particularly over calcrete formations. This vegetation supports a moderate-high graminoid diversity dominated by *Aristida congesta*, *Cynodon dactylon*, *Hetropogon contortus* and *Themeda triandra*. The presence of well drained soils supports punctuated communities of shrubs and herbaceous species including *Chrysocoma ciliate*, *Felicia filifolia* subps. *filifolia*, *Asparagus striatus*, *Helichrysum dregeanum* and *Nenax microphylla*. This vegetation type is considered Endangered. It is predicted that more than 40% of this vegetation type has been transformed due to cultivation, crop production and urban expansion (Mucina and Rutherford, 2006). Only a small portion of this vegetation unit has been statutorily conserved within the Soetdoring Nature Reserve.

Despite the study site's categorisation as Endangered, upon ground-truthing the site was assessed as a degraded agricultural landscape dominated by annual weeds and pioneer species. Due to the site's location within the agricultural landscape, the area has been subject to various disturbances and further degradation by livestock overgrazing, infrastructural (roads and residential houses) developments and dryland crop production.

Areas that have been overgrazed (particularly grasslands on shallow gravelly soils) are susceptible to Karoo-bush encroachment. This was evident during the site investigation as large stands of *Acacia karroo* (Sweet Thorn) were noted surrounding the northern portion of the study site.

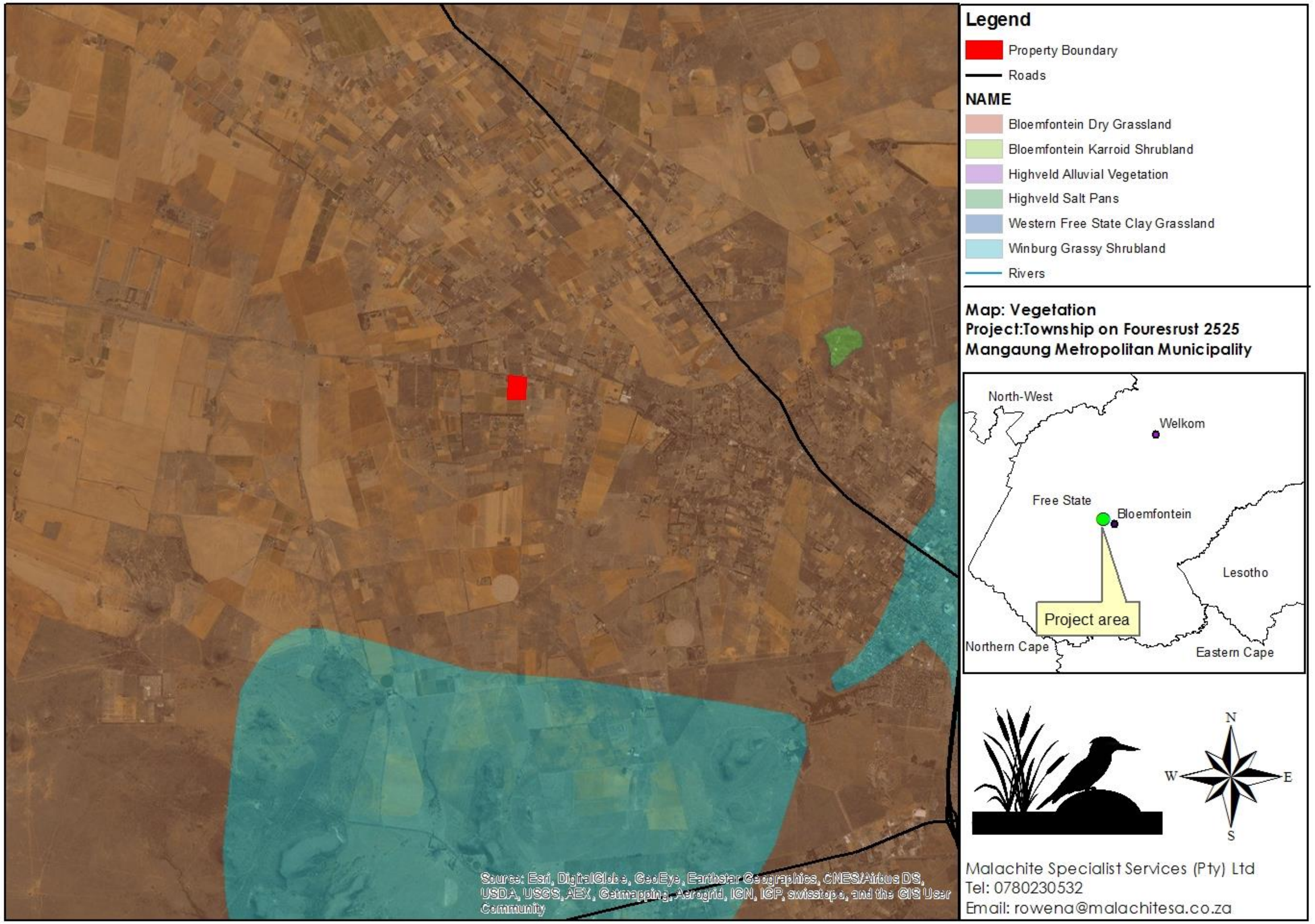


Figure 2: Vegetation Types associated with the site

Vegetation micro-habitat assessment

The vegetation communities identified within the larger study area were classified according to their biophysical characteristics, importance and sensitivity of the habitat unit as well as the ecological integrity and anthropogenic uses of the associated assemblages.

The vegetation composition within the site can be differentiated into two distinct micro-habitat units, namely degraded agricultural land with intermittent patches of alien invasive vegetation and peri-urban vegetation units (**Figure 3**).

Figure 3: Vegetation micro-habitats identified within the study area

Photograph 1: General vegetation composition observed within the larger study area

Degraded agricultural landscape *micro-habitat*

The degraded agricultural land micro-habitat dominated the study area and the vegetation composition was primarily comprised of annual weeds (*Nidorella resedifolia*) and pioneer alien species including *Bidens pilosa* (Common Blackjack) and *Argemone ochroleuca* subsp. *ochroleuca* (White Flowered Mexican Poppy). *A. ochroleuca* formed dense stands within the central portion of the study site, whereas *B. pilosa* was identified surrounding the fringes of the site, adjacent to the road reserve. *A. Ochroleuca* readily establishes populations on bare ground and these pioneer plants often prevent erosion. The presence of these species are indicators of high levels of disturbance. Graminoid species diversity within this habitat was very low with only three species identified namely *Heteropogon contortus* (Spear Grass), *Eragrostis curvula* (Weeping Love Grass) and *Chloris virgata* (Feather-top Chloris). This degraded agricultural habitat was largely devoid of trees, with the exception of agglomerations of *Acacia karroo* (Sweet Thorn) *A. karroo* was observed throughout the larger study area and was the dominant tree species identified. *A. karroo* is a heterogeneous species that often proliferate in overgrazed areas or areas where fires are suppressed (Van Wky and Van Wyk, 2013). Stands of *A. karroo* formed a windbreak area between the western and eastern portions of the site and surrounding adjacent residential houses.

Graminoid cover had a low basal density within the central portion of this micro-habitat (0-15%) with an absence of forbaceous and herbaceous species. The limited grass species were primarily increaser and annual grass species. The presence of cattle within the study site indicate that this area is used for varying degrees of grazing.

SUMMARY OF DOMINANT FLORAL STRUCTURE AND COMPOSITION			
Micro-habitat	Degraded agricultural landscape		
Conservation Status	Low	Sensitivity	Low
Indicative Species	*Acacia karroo, Heteropogon contortus, Eragrostis curvula and Chloris virgata*		
Species of Conservation Concern	None		
Alien species	*Bidens pilosa, Argemone ochroleuca* subsp. *ochroleuca*		
Land Use	Agricultural		
Need for rehabilitation	High		

Photograph 2: Degraded agricultural landscape micro-habitat largely devoid of trees with a low graminoid basal cover

Photograph 3: Encroachment of *Acacia karroo* into the northern portion of the study site

Peri-urban landscape micro-habitat

The study site falls within the urban landscape of Bloemfontein and this area is characterised by residential and infrastructural development. This has resulted in the encroachment of species that dominate disturbed areas, the planting of ornamental species as well as the proliferation of alien invasive vegetation. Within this habitat graminoid and herbaceous species diversity was low and dominated by pioneer species. This is due to the compaction and removal of vegetation attributed to the construction of road and residential infrastructure and agricultural practices. Woody vegetation was the dominant floral assemblage identified adjacent to the study site and included *Acacia karroo* (Sweet thorn), *Searsia lancea* (Willow Crowberry), *Schinus molle* (Pepper Tree), *Melia azedarach* (Syringa), *Pinus patula* (Patula Pine), *Eucalyptus ssp* and *Jacaranda mimosifolia* (Jacaranda).

Summary of dominant floral structure and composition			
Micro-habitat	Degraded agricultural landscape		
Conservation Status	Low	Sensitivity	Low
Indicative Species	*Acacia karoo, Searsia lancea*		
Species of Conservation Concern	None		
Alien species	*Schinus molle, Bidens pilosa, Argemone ochroleuca* subsp. *ochroleuca, Jacaranda mimosifolia, Eucalyptus ssp*		
Land Use	Residential		
Need for rehabilitation	High		

Photograph 4: Peri-urban vegetation micro-habitat dominated by exotic and ornamental species

Due to the severely degraded condition of the site coupled with the transformed nature of the surrounding Bloemfontein Dry Grassland unit due to the current land uses, it is unlikely that the site will contribute to achieving conservation targets within the Mangaung Metropolitan Municipality.

3.4. Geology and topography

Geology associated with the Bloemfontein Dry Grassland unit is composed of sedimentary mudstones and layers of sandstone mainly of the Adelaide Subgroup (Beaufort Group and Karoo Supergroup). A deep layer of red sand (Aeolian origin) covers the more clayed B-horizons. Soil forms include Hutton, Bainsvlei and Bloemdal. Shallow gravelly soils underlain by dolerite sills are characteristic of this vegetation unit (Mucina and Rutherford, 2006, Council for Geoscience 2002).

3.5. Catchment characteristics and Watercourses

The study area falls within the quaternary catchment C52H which is part of the RietModder Sub Water Management Area and the Upper Orange Water Management Area. Land use within the C52H quaternary catchment is generally associated with transformation through agricultural activities, road networks as well as subsistence agriculture. Livestock overgrazing and lack of stormwater control are two major contributors to soil erosion within the catchment.

The major rivers within the Upper Orange Water Management Area are the Modder and Kaalspruit Rivers. These rivers experience significant levels of high water demand related stress, particularly during drought seasons. Many of the surrounding communities rely on fresh water from these rivers throughout the year.

An investigation of the National Freshwater Priority Area wetlands database was undertaken for the site. The National Freshwater Ecosystem Priority Areas (NFEPA) is a project that was developed to provide strategic spatial priorities for conserving South Africa's freshwater ecosystems and supporting sustainable use of water resources. These strategic spatial priorities are known as Freshwater Ecosystem Priority Areas, or FEPAs (Driver, et al., 2011). No FEPA wetlands were identified on the site, however a FEPA wetland system classified as a seep has been delineated to the east of the site on the adjacent property (**Figure 4**). This wetland system has been classified as natural in origin, however an agricultural dam has been created within this system, degrading its health and functional integrity.

Figure 4: FEPA wetland map of the site

4. ASSESSMENT RESULTS

4.1. Soil Descriptions

Augur points were taken throughout the site (**Figure 5**) in order to determine the extent of soil types and this information then utilised to create a soil map for the study site (**Figure 6**).

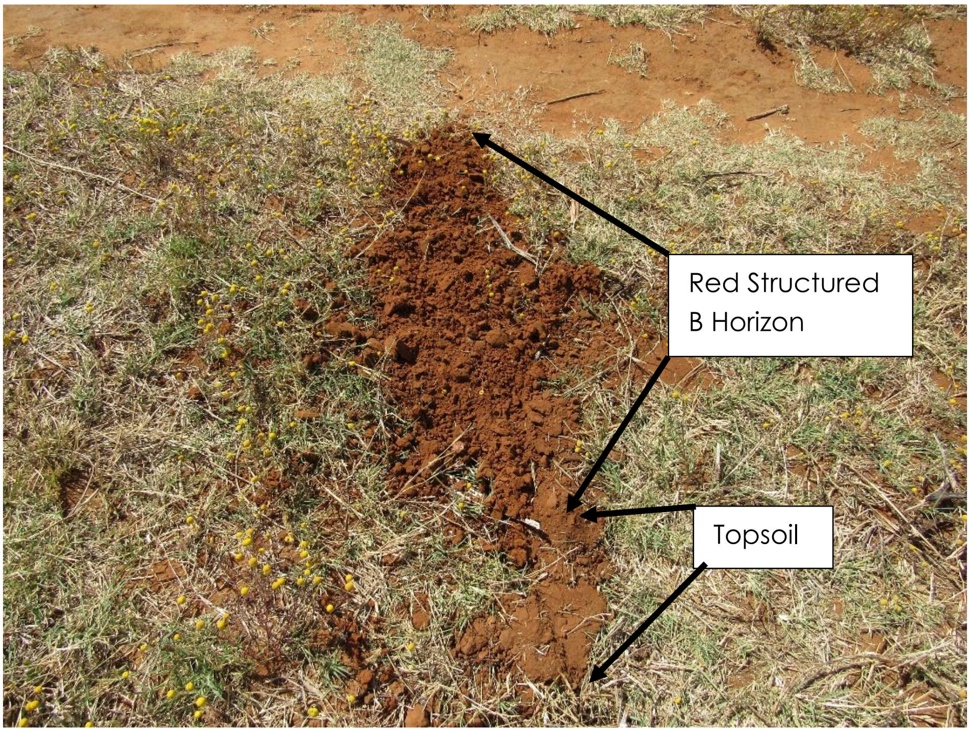
Table 3 below gives information on the different soil characteristics identified at each auger sampling site. These characteristics include:

- Soil form and family
- Slope at sampling location
- Soil colour
- Soil texture
- Effective rooting depth
- Subsoil permeability
- Any other characteristics noted

4.2. General Descriptions

The soils identified within the site were categorised into two soil groups; the Oxidic soils and the Duplex Soils. These two groups were further broken up into the Shortlands soil form which forms part of the Oxidic group and the Sepane soil form which is part of the Duplex soil group. Both soil forms are characterised by the presence of a kaolinitic clay which shrinks when dry and swells when wet. The accumulation of this kaolinitic clay in the subsoil of the Sepane form creates the duplex character. Duplex soils have a marked difference in structure between the A and B horizon. This abrupt change in structure makes these soils susceptible to soil erosion as well as reduces their effective rooting depth. The strongly structured B horizon creates an impediment to water movement through the profile as well as the growth of plant roots (**Photograph 5 and 6**).

On site it was noted that the Shortlands soils had been historically cultivated in the northern portion of the site. This practice has since been abandoned.



Photograph 5: Shortland Soil Form

Photograph 6: Strongly structured subsoil horizon associated with the Sepane Soil Form

Sampling Number (as per Fig 5)	Slope %	Soil Form	Soil Family and code	Soil Colour	Texture	Effective Rooting Depth (mm)	Permeability	Observations
001	1	Shortlands	Empangeni 1210	A: 7.5YR 4/4 B: 5YR 4/6	Clay Loam	600	Restricted	The Shortlands soil form was identified in the northern portion of the site and is associated with a strongly structured red B horizon. Effective rooting depth is limited due to this structure.
002	1	Shortlands	Empangeni 1210	A: 7.5YR 4/6 B: 5YR 4/6	Clay Loam	500	Restricted	The Shortlands soil form was identified in the northern portion of the site and is associated with a strongly structured red B horizon. Effective rooting depth is limited due to this structure.
003	2	Sepane	Katdoorn 1210	A: 7.5YR 3/4 B:7.5YR 3/4	Clay Loam	300	Severely restricted	The Sepane soil form makes up the majority of the site and is characterised by a duplex nature with a marked difference in structure between the A and B horizon.

Sampling Number (as per Fig 5)	Slope %	Soil Form	Soil Family and code	Soil Colour	Texture	Effective Rooting Depth (mm)	Permeability	Observations
004	2	Sepane	Katdoorn 1210	A: 7.5YR 3/4 B: 7.5YR 3/4	Clay Loam	300	Severely restricted	The Sepane soil form makes up the majority of the site and is characterised by a duplex nature with a marked difference in structure between the A and B horizon. Hydric properties were noted in the soil at a depth of approximately 350mm.
005	2	Sepane	Katdoorn 1210	A: 7.5YR 3/4 B: 7.5YR 3/4	Clay Loam	300	Severely restricted	The Sepane soil form makes up the majority of the site and is characterised by a duplex nature with a marked difference in structure between the A and B horizon. Hydric properties were noted in the soil at a depth of approximately 350mm.
006	2	Sepane	Katdoorn 1210	A:7.5YR 3/4	Clay Loam	300	Severely restricted	The Sepane soil form makes up the

Sampling Number (as per Fig 5)	Slope %	Soil Form	Soil Family and code	Soil Colour	Texture	Effective Rooting Depth (mm)	Permeability	Observations
				B:7.5YR 3/4				majority of the site and is characterised by a duplex nature with a marked difference in structure between the A and B horizon. Hydric properties were noted in the soil at a depth of approximately 350mm.
007	1	Sepane	Katdoorn 1210	A: 7.5YR 3/4 B: 7.5YR 3/3	Clay Loam	300	Severely restricted	The Sepane soil form makes up the majority of the site and is characterised by a duplex nature with a marked difference in structure between the A and B horizon. Hydric properties were noted in the soil at a depth of approximately 350mm.
008	1	Sepane	Katdoorn 1210	A:7.5YR 3/4 B:7.5YR 3/3	Clay Loam	300	Severely restricted	The Sepane soil form makes up the majority of the site and is characterised

Sampling Number (as per Fig 5)	Slope %	Soil Form	Soil Family and code	Soil Colour	Texture	Effective Rooting Depth (mm)	Permeability	Observations
								by a duplex nature with a marked difference in structure between the A and B horizon.
009	2	Sepane	Katdoorn 1210	A: 7.5YR 4/4 B: 7.5YR 3/3	Clay Loam	300	Severely restricted	The Sepane soil form makes up the majority of the site and is characterised by a duplex nature with a marked difference in structure between the A and B horizon.
010	1	Sepane	Katdoorn 1210	A: 7.5YR 3/4 B: 7.5YR 3/3	Clay Loam	300	Severely restricted	The Sepane soil form makes up the majority of the site and is characterised by a duplex nature with a marked difference in structure between the A and B horizon.
011	1	Sepane	Katdoorn 1210	A: 7.5YR 3/4 B: 7.5YR 3/3	Clay Loam	300	Severely restricted	The Sepane soil form makes up the majority of the site and is characterised by a duplex nature with a marked difference in structure

Sampling Number (as per Fig 5)	Slope %	Soil Form	Soil Family and code	Soil Colour	Texture	Effective Rooting Depth (mm)	Permeability	Observations
								between the A and B horizon.
012	1	Sepane	Katdoorn 1210	A: 7.5YR 3/4 B: 7.5YR 3/3	Clay Loam	300	Severely restricted	The Sepane soil form makes up the majority of the site and is characterised by a duplex nature with a marked difference in structure between the A and B horizon.
013	1	Shortlands	Empangeni 1210	A: 7.5YR 3/4 B: 5YR 4/6	Clay Loam	400	Restricted	The Shortlands soil form was identified in the northern portion of the site and is associated with a strongly structured red B horizon. Effective rooting depth is limited due to this structure.

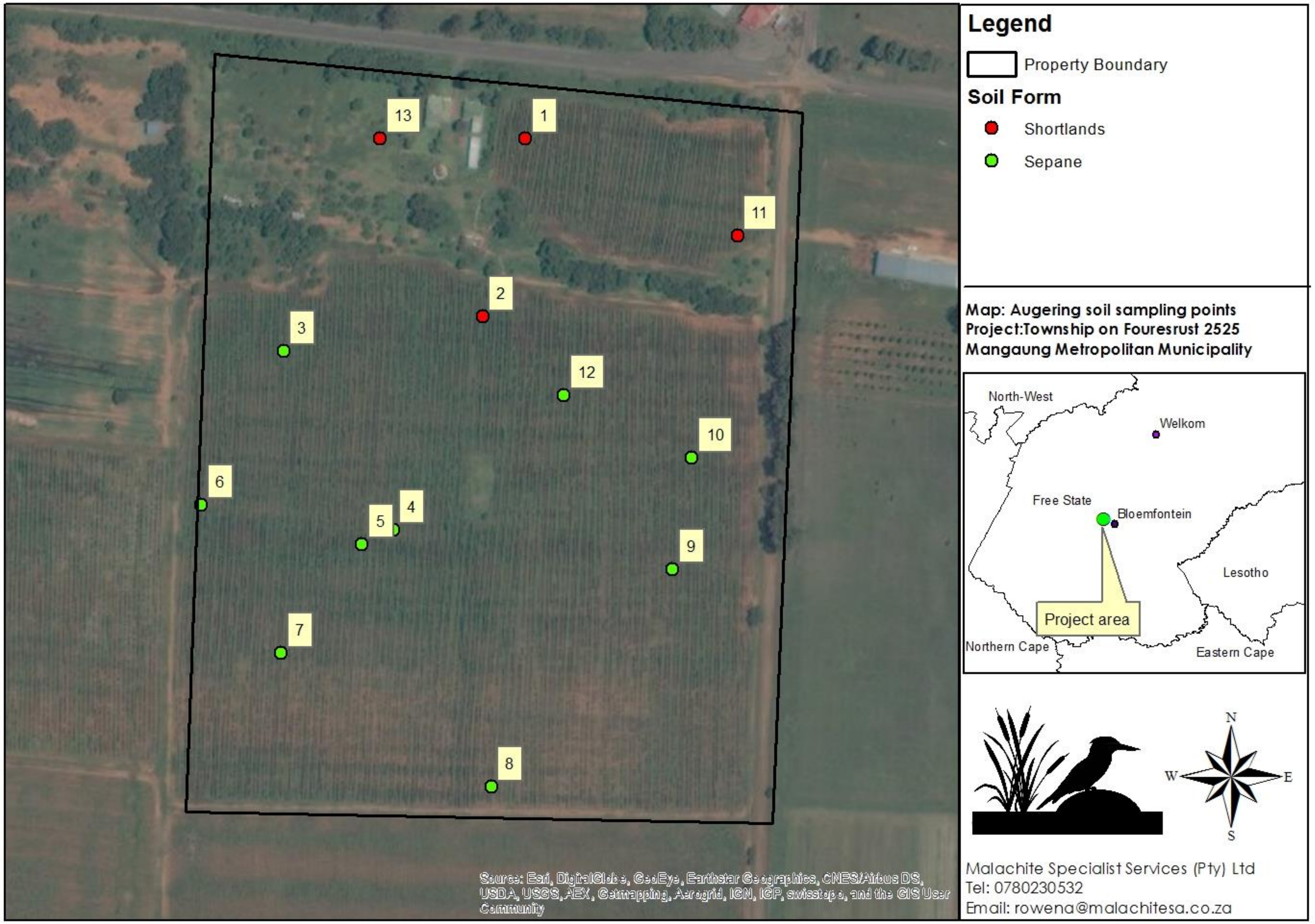


Figure 5: Auger sampling points and associated soil form and family identified

Figure 6: Soil forms associated with the study area

4.3. Agricultural and Land Potential

Land evaluation is the process of estimating the production potential for alternative land uses. The physical data acquired from soil profiles is applied to a flow sheet adapted to South African conditions from the US Department of Agriculture standards and utilised by land usage authorities as the basic template for benchmarking soil quality throughout South Africa.

Land capability evaluation is an attempt to grade the potential of the land in terms of its best and worst uses in an arable situation. The land is classified according to its limitations, either on a permanent or temporary basis. The system is biased towards soil conservation and is based on the negative features of the land. The classification system is categorised on a scale of I to VIII so yield potential matrices can be easily formulated. Land Capability Class (LCC) I soils to LCC III soils are suitable for arable crops. LCC IV soils can sometimes be cultivated for annual crops, but under carefully controlled conditions. LCC V soils are usually wetlands while LCC VII and VIII soils are suited to domestic livestock and wild game only. **Table 4** reflects the LCC of each Class. The flowsheets used to determine Land Capability Class are shown in **Appendix A.**

Table 4: Land capability classification descriptions

CLASS	DESCRIPTION
I	Little to no limitations, high potential for intensive arable use.
II	Land subject to certain limitations or hazards. It is suitable for cropping with adequate protection measures, which may sometimes include special management practices and regular rotations.
III	Land subject to moderate limitations or risk of damage, which is suitable for cropping only with intensive protection measures and special practices, which may include long ley rotations with short cropping periods
IV	Land subject to severe permanent limitations or hazards. Suitable for occasional row cropping in long ley rotations, or for use under perennial vegetation. Limitations may include: steep slopes, shallow soils, soils of very low water-retaining capacity, high erodibility, unfavourable characteristics in the surface soil, and severe, but correctable, wetness.
V	Watercourses and land subject to wetness limitations. These limitations include temporary, periodic and semi-permanent

	wetness. Cultivation is only permitted with very special practices and measures. Vleis and watercourses subject to severe wetness are best left under permanent vegetation.
VI	Land which has such severe soil and/or slope limitations that cropping must be excluded but which is productive under perennial vegetation, but is susceptible to moderate erosion.
VII	Not suited for cultivation, severe limitations for grazing or farming.
VIII	Extremely rough, suited only for wildlife or recreation.

The primary function of land evaluation is to predict the possible effects, both detrimental and beneficial for a change in land use. In order to conduct the land evaluation, the study area is first classified in terms of its Bioresource Unit.

The most important soil and landscape characteristics when applying this system are topsoil texture (Clay %), soil depth, permeability, slope, rockiness, surface crusting and wetness. At the study site these were found to occur according to the following broad patterns:

- **Soil texture:** The majority of the site contains soils with a medium-high clay percentage (between 40%-50%). Soils were classified as clay loam. The accumulation of clay within the subsoil has formed a strongly structured B horizon which forms an impediment to water permeability as well as the growth of plant roots. Clay percentage and clay type (Kaolinitic shrink-swell clays) within the soil is therefore a limitation to crop production within the site.
- **Soil depth:** Soils identified within the study site are deeper than the sampling depth of 1200mm, however the effective rooting depth as a result of the impeding clay layer and strongly structured B horizons is much lower at 300-600mm. The effective rooting depth poses a limitation to crop production.
- **Soil permeability:** The permeability of the soils associated with the majority of samples was found to be restricted and severely restricted as a result of the clay accumulation in the soils and the strong structure of the subsoil which prevents the permeation of water through the profile.
- **Slope:** There is a wide range in slopes, which for the land capability classification, have been grouped as follows:
  - 0-8% - land, which depending on soil profile characteristics is potentially in Class II
  - 8-12% - land, which depending on soil profile characteristics is potentially in Class III

- 12-20% - land, which depending on soil profile characteristics is potentially in Class IV
- >20% - land, which is in Class VI or even VII, on slopes greater than 40%.

The site consisted of flat terrain with all slope percentages recorded in the 0-8% category. Slope is therefore not a limitation to cultivation.

- **Rockiness:** In the field this was not found to be a limitation to cultivation. As a result, there is no need to consider this factor further.
- **Crusting:** In the field this was not found to be a limitation to cultivation. As a result, there is no need to consider this factor further.
- **Wetness:** The Sepane soil is categorised as a wetland soil, as its duplex nature allows it to hold water within the soil profile for prolonged periods of time. Soil hydric characteristics including the presence of mottling as well as Manganese concretions were noted within the soil samples examined. The presence of a borehole on site further gives credence to the fact that water is being held within the soil profile.

Taking into account the above factors, the study site has been classified as **Class IV**. This is due largely to the structure of the soil samples identified, the presence of the impeding kaolinitic clays within the subsoil which form the duplex character of the Sepane soils and cause restricted permeability of the subsoil.

Class IV land types are subject to severe limitations and these limitations have an impact on the choice of crop that can be grown on the site. The low effective rooting depth of these soils coupled with unfavourable climate limit the use of this site for crop cultivation.

The site is however utilised for livestock grazing. This grazing has led to a removal of basal cover affecting the vegetation assemblages occurring within the site.

5. IMPACT DESCRIPTION, ASSESSMENT & MITIGATION

Any development activity in a natural system will have an impact on the surrounding environment, usually in a negative way. The purpose of this phase of the study was to identify and assess the significance of the potential impacts caused by the proposed development and to provide a description of the mitigation required so as to limit the identified negative impacts on the natural environment.

Negative impacts identified during the construction phase are associated with (i) loss of agricultural land (ii) soil compaction and erosion (iii) soil pollution as a result of construction activities; and (iv) the continued spread of alien invasive species as a result of the disturbance.

5.1. Loss of agricultural land

IMPACTS ASSOCIATED WITH THE LOSS OF AGRICULTURAL LAND

Future Impact	Probability		Duration		Extent		Magnitude		Significance scoring without mitigation	Significance scoring with mitigation
	With out	With	With out	With	With out	With	With out	With		
Construction Phase										
Loss of agricultural land – arable land	2	1	2	2	2	1	4	2	16 (low)	5 (low)
Loss of agricultural land – grazing lands	5	5	2	2	2	1	8	4	60 (high)	35 (moderate)
Operational Phase										
Loss of agricultural land – arable land	2	1	5	5	1	1	2	2	16 (low)	8 (low)
Loss of agricultural land – grazing lands	4	3	5	5	2	1	6	2	52 (moderate)	24 (low)

<u>Description of impact</u>

Loss of agricultural land within the site was assessed with regards to loss of arable land as well as loss of grazing land both within the site and within adjacent agricultural properties. Due to the low agricultural potential of the site with regards to arable land (as a result of the strongly structured subsoil and impeding clay layer) the loss of arable land is predicted to be of a low significance. However, given that the site is currently utilised as grazing land and that the proposed development will completely transform the site, a complete loss of grazing land within the site will occur. This is therefore considered a significant impact during the construction phase.

During the operational phase the significance of the development on arable land will also be low. The effects of the development will however be felt on the immediately adjacent properties during the operational phase. The significance of this impact has been recorded as moderate. This is due to an increase in human activity within the site which will lead to disturbances on the adjacent properties. These disturbances could lead to the encroachment of alien invasive species and the dumping of waste on adjacent properties.

Mitigation Options

- During construction, workers must remain within the site and must not affect adjacent properties.
- Dust monitoring during construction must form part of the Environmental Management Programme as dust will reduce the quality of grazing grasses on adjacent properties.
- Management of waste so that it does not impact adjacent properties must take place as per the EMPr particularly during the operational phase.
- The development must be contained within the site, either by a wall or fence structure so that no access to adjacent properties can take place.
- The implementation of an alien invasive control plan must form part of the construction and operational EMPr for the development.

5.2. Soil disturbance and compaction leading to erosion

IMPACTS ASSOCIATED WITH SOIL DISTURBANCE AND EROSION										
Future Impact	Probability		Duration		Extent		Magnitude		Significance scoring without mitigation	Significance scoring with mitigation
	With out	With	With out	With	With out	With	With out	With		
Construction Phase										
Soil erosion and compaction	5	3	2	2	2	1	6	4	50 (moderate)	18 (low)
Operational Phase										
Soil erosion and compaction	5	5	5	5	1	1	4	2	50 (moderate)	40 (moderate)

Description of impact

The use of heavy machinery or vehicles during construction will lead to the compaction of disturbed soils. Further to this the exposure of the soil to environmental factors increases the likelihood of erosion. Compacted soils will erode more quickly than natural soils.

Mitigation Options

- Erosion control measures must be implemented in areas sensitive to erosion such as edges of slopes, exposed soil etc. These measures include but are not limited to - the use of sand bags, hessian sheets, silt fences, retention or replacement of vegetation and geotextiles such as soil cells which must be used in the protection of slopes.
- Do not allow surface water or stormwater to be concentrated, or to flow down slopes without erosion protection measures being in place.
- The entire construction area must not be stripped of vegetation prior to commencing construction activities.
- All disturbed areas must be rehabilitated as soon as construction in an area is complete or near complete and not left until the end of the project to be rehabilitated.
- An indigenous landscaping plan is recommended for garden areas within the development

5.3. Pollution of soil resources

IMPACTS ASSOCIATED WITH THE POLLUTION OF SOIL RESOURCES										
Potential impact	Probability		Duration		Extent		Magnitude		Significance scoring without mitigation	Significance scoring with mitigation
	With out	With	With out	With	With out	With	With out	With		
Construction Phase										
Pollution of water resources and soil	5	4	2	2	2	1	6	2	50 (moderate)	20 (low)
Operational Phase										
Pollution of water resources and soil	3	2	5	5	1	1	4	2	30 (moderate)	16 (low)

Description of the impact

Mismanagement of waste and pollutants like hydrocarbons, construction waste and other hazardous chemicals will result in these substances entering the soil resources and polluting sensitive natural environments either directly through surface runoff during rainfall events, or subsurface water movement through the soil profile.

Mitigation Options

- All waste generated during construction is to be disposed of as per an Environmental Management Programme (EMPr).
- Proper management and disposal of construction waste must occur during the lifespan of the project, including during the operational phase of the project.
- No release of any substance i.e. cement, oil, that could be toxic.
- Place the construction camp or any depot for any substance which causes or is likely to cause pollution outside of sensitive areas including the steep slopes.
- Spillages of fuels, oils and other potentially harmful chemicals must be cleaned up immediately and contaminants properly drained and disposed of using correct solid/hazardous waste facilities (not to be disposed of within the natural environment). Any contaminated soil must be removed and the affected area rehabilitated immediately.
- Domestic waste must be removed through the services of a waste contractor and a municipal waste site must be used for disposal.

5.4. Alien invasive species

IMPACTS ASSOCIATED WITH ALIEN INVASIVE SPECIES										
Impact	Probability		Duration		Extent		Magnitude		Significance scoring without mitigation	Significance scoring with mitigation
	With out	With	With out	With	With out	With	With out	With		
Construction Phase										
Spread of Alien invasive species	5	4	2	2	2	1	6	4	50 (moderate)	28 (low)
Operational Phase										
Spread of Alien invasive species	5	4	5	4	2	2	6	4	65 (high)	48 (moderate)

Description of the impact

The removal of soils and vegetation will lead to a further disturbance within the receiving environment and this will have negative impacts on the functionality of the vegetation community in this area. This makes them more vulnerable to encroachment by invasive alien species and further erosion.
Alien invasive species occur throughout the proposed development and these will quickly encroach into disturbed areas. Alien species generally out-compete indigenous species for water, light, space and nutrients as they are adaptable to changing conditions and are able to easily invade a wide range of ecological niches (Bromilow, 2010). Alien invader plant species pose an ecological threat as they alter habitat structure, lower biodiversity (both number and "quality" of species), change nutrient cycling and productivity, and modify food webs (Zedler, 2004).

<u>Mitigation Options</u>

- Protect as much indigenous vegetation as possible.
- Rehabilitate disturbed areas as soon as construction in this area has ended.
- The following guidelines apply to re-vegetation:

  <u>Site preparation</u>:

  - Utilise erosion and sediment control techniques where needed.
  - Grade the disturbed area to a stable uniform slope. Vegetative cover will not develop on an unstable slope.
  - Loosen the soil by hand.
  - Plant when the weather will permit e.g. suitable temperatures and moisture for plant growth. Spring plantings give the best results.
  - On unstable soils use a soil saver as described above to protect the bare soil before the planted vegetation has become established.
- An alien invasive management programme must be incorporated into an Environmental Management Programme.
- Ongoing alien plant control must be undertaken during the operational phase after the construction phase and particularly in the disturbed areas. Areas which have been disturbed will be quickly colonised by invasive alien species. An ongoing management plan must be implemented for the clearing/eradication of alien species.

6. CONCLUSIONS AND RECOMMENDATIONS

Soil sampling was taken at strategic locations across the site during a field assessment conducted on the 10th October 2016. Soils were assessed in terms of the texture, soil depth, subsoil permeability, slope, rockiness, surface crusting, and wetness.

Information obtained on site indicated that the site is situated on flat terrain with soils of the Shortlands and Sepane form identified on site. Both soil forms are characterised by the presence of a kaolinitic clay which shrinks when dry and swells when wet. The accumulation of this kaolinitic clay in the subsoil of the Sepane form creates the duplex character. Duplex soils have a marked difference in structure between the A and B horizon. This abrupt change in structure makes these soils susceptible to soil erosion as well as reduces their effective rooting depth. The strongly structured B horizon creates an impediment to water movement through the profile as well as the growth of plant roots

The proposed development site was assessed in terms of its Agricultural and Land Capability Potential and the site has been classified as Class IV as a result of limitations in the soil texture, related to the strongly structured nature of the soil, the effective rooting depth, and the presence of hydric characteristics within some of the soils sampled. Class IV land types are subject to severe limitations and these limitations have an impact on the choice of crop that can be grown on the site. The low effective rooting depth of these soils coupled with an unfavourable climate limit the use of this site for crop cultivation. The site is however utilised for livestock grazing. This grazing has led to a removal of basal cover affecting the vegetation assemblages within the site.

The impact assessment identified the following negative impacts associated with the proposed development; (i) loss of agricultural land (ii) soil compaction and erosion; (iii) soil pollution as a result of construction activities; and (iv) the continued spread of alien invasive species as a result of the disturbance. Several general and specific measures are proposed to mitigate these impacts on the receiving environment.

Provided the mitigation measures specified in this report are implemented and the continued monitoring and rehabilitation of disturbed areas is undertaken, the proposed development is expected to have a limited long term negative impact on arable agricultural land. The proposed development is however expected to have an impact on the grazing potential within the site's agricultural land, particularly for immediately adjacent properties. The implementation of suggested mitigation measures are needed to limit the identified negative impacts.

7. REFERENCES

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8. APPENDICES

9. APPENDIX A – AGRICULTURAL POTENTIAL ASSESSMENT METHODOLOGY

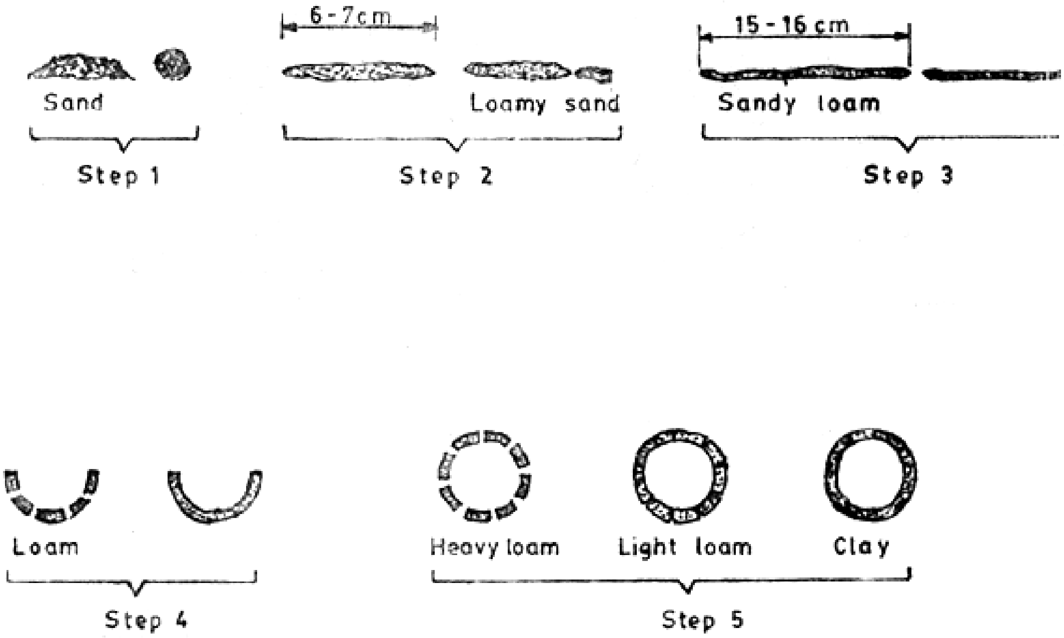
Soil sampling and mapping

Soil sampling was conducted throughout the site during a field assessment in October 2016 using a standard hand-held auger with a depth of 1200mm. At each sampling point the soil was described to form and family level according to "Soil Classification – A Taxonomic System for South Africa" and the following properties were recorded:

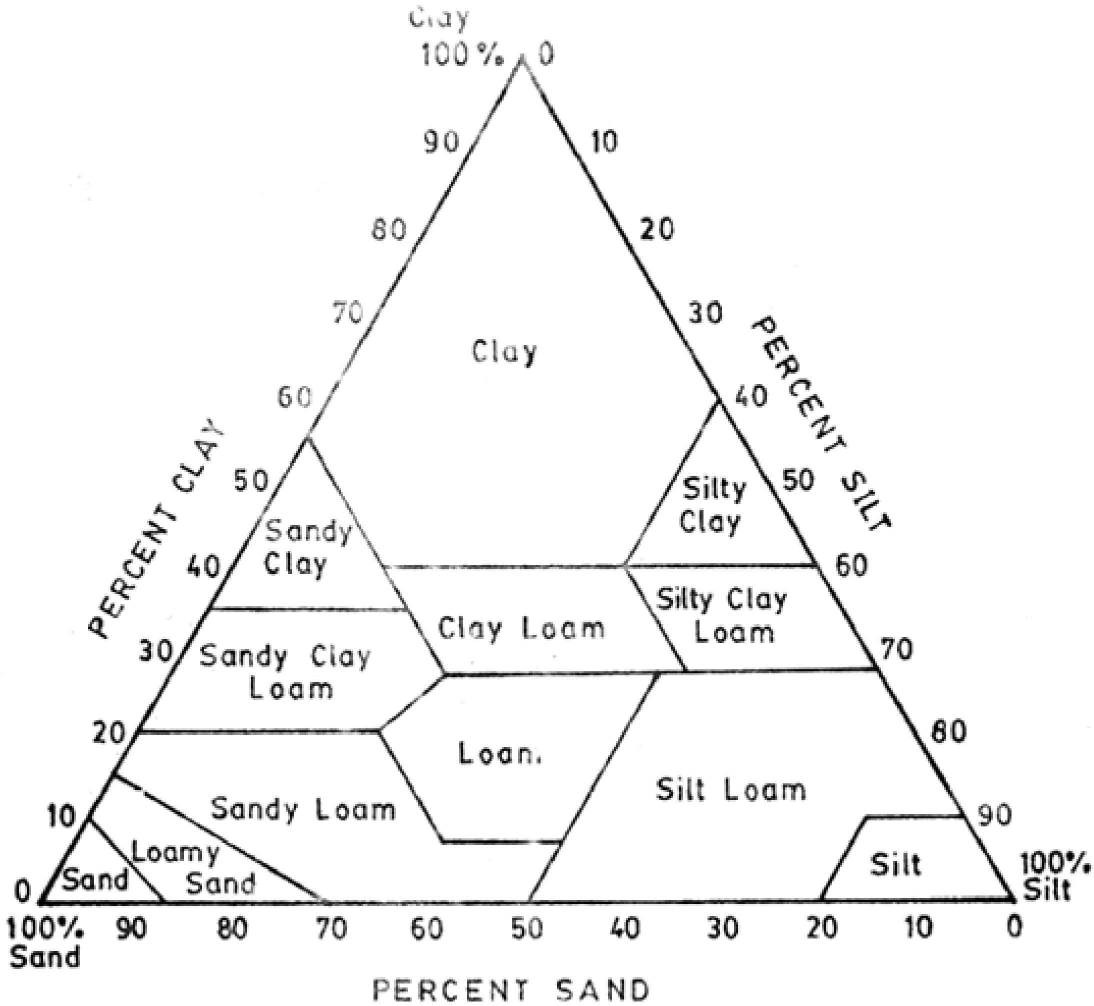
- Soil colour – as per the Munsell System
- Soil texture including clay percentage
- Surface rockiness
- Surface crusting
- Vegetation cover
- Permeability of the B horizon
- Effective rooting depth.

An in-field assessment technique was utilised with the texture triangle to determine soil texture.

FEEL METHOD



BALL AND RIBBON METHOD


Clay
100%
0
90
10
80
20
70
30
60
40
50
50
40
60
30
70
20
80
10
90
0
PERCENT CLAY
PERCENT SILT
Clay
Sandy Clay
Silty Clay
Sandy Clay Loam
Clay Loam
Silty Clay Loam
Loam
Sandy Loam
Silt Loam
Loamy Sand
Sand
Silt
100% Silt
100% Sand
90
80
70
60
50
40
30
20
10
0
PERCENT SAND

Agricultural Potential and Land Capability

All factors regarding the assessment of the agricultural potential and land capability of the site were undertaken including an assessment of the:

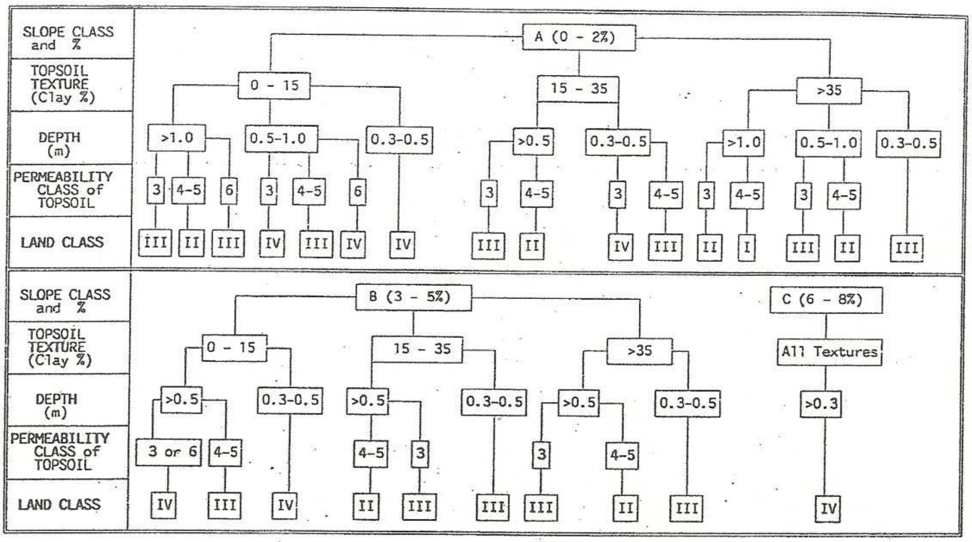
- Topography
- Climate
- Soil texture
- Soil depth
- Subsoil permeability
- Rockiness and Surface Crusting

Using the information gathered at the site as well as during the literature review, a soil form map and soil depth map was produced. Information was also gathered from GIS databases as well as the Land type information. This information was utilised in conjunction with the soil data recorded on site (i.e. soil form, depth, permeability, wetness) to produce the Land Capability Map.

CAPABILITY CLASS DETERMINATION GUIDELINE for BRGs:

Dry Zululand Thornveld (20), Valley Bushveld (21), Lowveld (22), Sandy Bushveld (23) (Average annual rainfall 587-830 mm)

Use the following flow chart to determine the land capability classes for land to be cropped in the above Bioresource Groups.



PERMEABILITY CLASS DESCRIPTION*			
Class	Rate (seconds)	Description	Texture
7	<1	Extremely rapid	Gravel and Coarse Sand. 0 to 10 % clay.
6	1-3	Rapid	5% to 10% clay.
5	4-8	Good	> 10% clay.
4	9-20	Slightly restricted	
3	21-40	Restricted	Strong structure, grey colours, mottles. > 35% clay.
2	41-60	Severely restricted	Strong structure, weathered rock. > 35% clay.
1	>60	Impermeable	Rock and very strong structure. > 35% clay.

* If roots can penetrate the subsoil, test permeability of upper subsoil.
If roots cannot penetrate the subsoil, test the permeability of the mid-topsoil.
Dark structured clay topsoil (vertic & melanic) with a Class 2 permeability should be assessed in the chart as if it has a Class 3 permeability. If permeability is Class 7, downgrade to Land Class IV.

Now refer to the opposite page to make adjustments for wetness, rockiness, crusting or permeability.

USE THE FOLLOWING LAND CHARACTERISTICS TO MODIFY THE LAND CLASS OBTAINED OPPOSITE, IF NECESSARY: The land capability class determined using the "flowchart" cannot be upgraded through consideration of wetness, rockiness, surface crusting or permeability classes given below, but it may be downgraded as indicated.

WETNESS		
Class	Definition	Land Class
W0	Well drained - no grey colour with mottling within 1.5 m of the surface. Grey colour without mottling is acceptable.	No change
W1	There is no evidence of wetness within the top 0.5 m. Occasionally wet - grey colours and mottling begin between 0.5 m and 1.5 m from the surface.	Downgrade Class I to Class II, otherwise no change
W2	Temporarily wet during the wet season. No mottling in the top 0.2 m but grey colours and mottling occur between 0.2 m and 0.5 m from the surface. Included are: soils with G horizons (highly gleyed and often clayey) at depths deeper than 0.5 m; soils with an E horizon overlying a B horizon with a strong structure; soils with an E horizon over G horizons where the depth to the G horizon is more than 0.5 m.	Downgrade to Class IV
W3	Periodically wet. Mottling occurs in the top 0.2 m, and includes soils with a heavily gleyed or G horizon at a depth of less than 0.5 m. Found in bottomlands.	Downgrade to Class Va
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 Vb

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

ROCKINESS		
Class	Definition	Land Class
R0	No rockiness	No change
R1	2 - 10% rockiness	Downgrade Classes I to II, otherwise no change
R2	10 - 20% rockiness	Downgrade Classes I to II, otherwise no change
R3	20 - 30% rockiness	Downgrade to Class IV
R4	> 30% rockiness	Downgrade Classes I, II, III & IV to Class VI

SOIL SURFACE CRUSTING		
Class	Definition	Land Class
t0	No surface crusting when dry	No change
t1	Slight surface crusting when dry	Downgrade Class I to Class II, otherwise no change
t2	Unfavourable surface crusting when dry	Downgrade Classes I & II to Class III, otherwise no change

NB **Any land not meeting the minimum requirements shown is considered non-arable (Class V, VI, VII or VIII).**
Non-arable land in BRGs 2, 4, 6, 9, 12, 14, 15, 16, 17, 18 & 19 includes:
* all land with W3, W4 or R4,
* all land with slope exceeding 20%,
* land with slope 13-20%, if clay < 15% or depth < 0.4m,
* land with slope 8-12% and clay > 15%, if depth < 0.25m,
* land with slope 8-12% and clay < 15%, if depth < 0.5m, and
* land with slope 0-7%, if depth < 0.25m.

20 March 1996