PROPOSED UMSOBOMVU WIND ENERGY FACILITY,
NORTHERN CAPE & EASTERN CAPE PROVINCES

AGRICULTURAL AND SOIL IMPACT ASSESSMENT

DEA Reference: 14/12/16/3/3/2/730

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## REVISIONS TRACKING TABLE

**EOH Coastal and Environmental Services**

**Report Title:** Proposed Umsobomvu Wind Energy Facility, Northern Cape & Eastern Cape Provinces: Agricultural and Soil Assessment

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INFORMATION REQUIRED BY THE COMPETENT AUTHORITY

In terms of Appendix 6 of the Environmental Impact Assessment Regulations (G. NR. 982) as regulated by the National Environmental Management Act (Act nr. 107 of 1998 and amended in 2014; NEMA), a Specialist Report must contain all the information necessary for a proper understanding of the nature of issues identified, and must include—

1. (1) A specialist report prepared in terms of the NEMA 2014 Regulations must contain-

   (a) details of-

      (i) the specialist who prepared the report; and

      (ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;

   (b) a declaration that the specialist is independent in a form as may be specified by the competent authority;

   (c) an indication of the scope of, and the purpose for which, the report was prepared;

   (d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment;

   (e) a description of the methodology adopted in preparing the report or carrying out the specialised process;

   (f) the specific identified sensitivity of the site related to the activity and its associated structures and infrastructure;

   (g) an identification of any areas to be avoided, including buffers;

   (h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;

   (i) a description of any assumptions made and any uncertainties or gaps in knowledge;

   (j) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment;

   (k) any mitigation measures for inclusion in the EMPr;

   (l) any conditions for inclusion in the environmental authorisation;

   (m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;

   (n) a reasoned opinion-

      (i) as to whether the proposed activity or portions thereof should be authorised; and

      (ii) if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;
(o) a description of any consultation process that was undertaken during the course of preparing the specialist report;

(p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and

(q) any other information requested by the competent authority.
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1 THE PROJECT TEAM

In terms of Appendix 6 of the EIA Regulations (2014) a specialist report must contain-

(a) details of-
   (iii) the specialist who prepared the report; and
   (iv) the expertise of that specialist to compile a specialist report including a curriculum vitae;

(b) a declaration that the specialist is independent in a form as may be specified by the competent authority;

1.1 Details of specialist

Mr Roy de Kock M.Sc., Cand. Nat. Sci.  
(Agricultural and Soil Specialist)

Roy is a Senior Consultant holding a BSc Honours in Geology and an MSc in Botany from the Nelson Mandela Metropolitan University in Port Elizabeth. His MSc thesis focused on Rehabilitation Ecology using an open-cast mine as a case study. He has been working for CES since 2010, and is based at the East London branch where he focuses on Ecological and Agricultural Assessments, Geological and Geotechnical analysis, Environmental Management Plans, mining applications and various environmental impact studies. Roy has worked on numerous projects in South Africa, Mozambique and Malawi. Roy is registered with the South African Council for Natural Scientific Professional (SACNASP).

Dr Alan Carter Pri. Nat Sci.  
(Report reviewer)

As Director of the East London Office Alan has extensive training and experience in both financial accounting and environmental science disciplines with international accounting firms in South Africa and the USA. He is a member of the American Institute of Certified Public Accountants and holds a PhD in Plant Sciences. He is also a certified ISO14001 EMS auditor with the American National Standards Institute. Alan is registered with both the South African Council for Natural Scientific Professional (SACNASP).

1.2 Expertise

Projects Roy and Alan have worked on include:

<table>
<thead>
<tr>
<th>Name of project</th>
<th>Description of responsibility</th>
<th>Date completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mainstream Waaihoek WEF EIA (KZN)</td>
<td>Agricultural, Soil &amp; Land use Assessment</td>
<td>October 2014</td>
</tr>
<tr>
<td>Ecofarm Sugarcane ESHIA (Zambezi, Mozambique)</td>
<td>Agricultural &amp; Soil Assessment</td>
<td>June 2014</td>
</tr>
<tr>
<td>Dassiesridge WEF EIA (EC)</td>
<td>Agricultural &amp; Soil Assessment</td>
<td>November 2014</td>
</tr>
<tr>
<td>Zirco Minerals Mining EIA (NC)</td>
<td>Agricultural, Soil &amp; Land use Assessment</td>
<td>February 2014</td>
</tr>
<tr>
<td>Baobab Iron Ore Mining ESHIA (Tete, Mozambique)</td>
<td>Agricultural, Soil &amp; Land use Assessment</td>
<td>May 2014</td>
</tr>
<tr>
<td>Middelton WEF EIA (EC)</td>
<td>Agricultural &amp; Soil Assessment</td>
<td>November 2013</td>
</tr>
<tr>
<td>Syrah Graphite Mining ESHIA (Montepuez, Mozambique)</td>
<td>Agricultural, Soil &amp; Land use Assessment</td>
<td>August 2013</td>
</tr>
</tbody>
</table>
1.3 Declaration


− I act as the independent specialist in this application;
− I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
− I declare that there are no circumstances that may compromise my objectivity in performing such work;
− I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
− I will comply with the Act, Regulations and all other applicable legislation;
− I have no, and will not engage in, conflicting interests in the undertaking of the activity;
− I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
− all the particulars furnished by me in this report are true and correct; and
− I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.
INTRODUCTION

In terms of Appendix 6 of the EIA Regulations (2014) a specialist report must contain-

(c) an indication of the scope of, and the purpose for which, the report was prepared;

(d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment;

(e) a description of the methodology adopted in preparing the report or carrying out the specialised process;

(i) a description of any assumptions made and any uncertainties or gaps in knowledge;

(o) a description of any consultation process that was undertaken during the course of preparing the specialist report;

(p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and

(q) any other information requested by the competent authority.

2.1 Project location

Umsobomvu Wind Power is proposing to construct a Wind Energy Facility (WEF) to be developed between Middelburg (Eastern Cape) and Noupoort (Northern Cape) on the provincial border (Figure 1.1). The WEF will host a maximum of 80 wind turbines located on 18 properties (Table 1.1), each generating between 1.5 – 4 megawatts (MW) of electricity, with total combined potential power output of approximately 140MW.

Figure 1.1. Locality map indicating the location of proposed Umsobomvu WEF.
Table 1.1. Property portions and farm names associated with the project area.

<table>
<thead>
<tr>
<th>Farm Name</th>
<th>Farm number</th>
<th>21 digit SG Code</th>
<th>Size (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Klip Krands</td>
<td>60/1</td>
<td>C048000000000600001</td>
<td>934 ha</td>
</tr>
<tr>
<td>Holle Fountain</td>
<td>133/0</td>
<td>C0300000000001330000</td>
<td>1876 ha</td>
</tr>
<tr>
<td></td>
<td>133/1</td>
<td>C0300000000001330001</td>
<td>672 ha</td>
</tr>
<tr>
<td></td>
<td>133/3</td>
<td>C0300000000001330003</td>
<td>150 ha</td>
</tr>
<tr>
<td>Leeuw Hoek</td>
<td>61/0</td>
<td>C0480000000006100000</td>
<td>1110 ha</td>
</tr>
<tr>
<td></td>
<td>61/2</td>
<td>C0480000000006100002</td>
<td>1765 ha</td>
</tr>
<tr>
<td></td>
<td>61/4</td>
<td>C0480000000006100004</td>
<td>538 ha</td>
</tr>
<tr>
<td></td>
<td>61/6</td>
<td>C0480000000006100006</td>
<td>148 ha</td>
</tr>
<tr>
<td>Elands Kloof</td>
<td>135/1</td>
<td>C0300000000001350001</td>
<td>16 ha</td>
</tr>
<tr>
<td>Uitzicht</td>
<td>3/0</td>
<td>C0480000000000300000</td>
<td>1765 ha</td>
</tr>
<tr>
<td></td>
<td>3/2</td>
<td>C0480000000003000002</td>
<td>1076 ha</td>
</tr>
<tr>
<td></td>
<td>3/3</td>
<td>C0480000000003000003</td>
<td>1101 ha</td>
</tr>
<tr>
<td></td>
<td>3/4</td>
<td>C0480000000003000004</td>
<td>1069 ha</td>
</tr>
<tr>
<td></td>
<td>3/7</td>
<td>C0480000000003000007</td>
<td>1298 ha</td>
</tr>
<tr>
<td></td>
<td>3/8</td>
<td>C0480000000003000008</td>
<td>903 ha</td>
</tr>
<tr>
<td>Leuwe Kop</td>
<td>120/0</td>
<td>C0300000000012000000</td>
<td>2321 ha</td>
</tr>
<tr>
<td>Elands Kloof</td>
<td>135/0</td>
<td>C0300000000001350000</td>
<td>358 ha</td>
</tr>
<tr>
<td>Winterhoek</td>
<td>136/0</td>
<td>C0300000000001360000</td>
<td>1163 ha</td>
</tr>
</tbody>
</table>

2.2 Alternatives

Alternatives include consideration of all possible means by which the purpose and need of the proposed activity could be accomplished. The no-go alternative is included in the assessment as the baseline against which the impacts of the other alternatives are assessed. The determination of whether site or activity (including different processes etc.) or both is appropriate was informed by the specific circumstances of the activity and its environment.

Alternatives, in relation to the proposed Umsobomvu WEF and associated infrastructure, means different means of meeting the general purpose and requirements of the activity:

- The identified properties (Table 1.1) on which the Umsobomvu WEF are proposed as well as the proposed location has been selected based on good wind resource potential and proximity to available grid. Therefore no alternative location will be assessed.
- Wind turbines will be the only type of activity to be undertaken onsite. The activity is not mutually exclusive i.e. Intensive farming can still take place between turbines.
- The turbine layout will be assessed based on a preliminary layout of a maximum of 80 turbines. The final turbine layout will be informed by this and other specialist studies (Ecological, Visual, Socio-economic, Noise, Avifaunal, Bat, Archaeological, & Paleontological Assessments). Thus, no turbine layout alternative will be considered.
- Access route layout refers to the route/road used to access to the site from either the N9 or the N10. Three access route layouts will be considered.
- Turbine technology alternatives refer to the output generating value of each turbine. Turbine technology alternatives will range between 1.5 – 4 MW but will be assessed as a single technology alternative option in this report.
- The option of not implementing the activity.

Based on the above, the following alternatives were assessed:
<table>
<thead>
<tr>
<th>Alternatives</th>
<th>Advantages</th>
<th>Disadvantages</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alternative 1:</strong></td>
<td>The three alternative access routes to the WEF site are all aligned along existing gravel roads.</td>
<td>There may be impacts associated with upgrading and expanding road reserves in sensitive environments.</td>
<td>Assessed and compared as 3 different alternatives</td>
</tr>
<tr>
<td><strong>Alternative access route 1</strong></td>
<td>WEF access route from Middelburg</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Alternative 2:</strong></td>
<td>WEF shorter access route from The N10</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Alternative access route 2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Alternative 3:</strong></td>
<td>WEF longer access route from the N10</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Alternative access route 3</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Turbine &amp; internal access routes</strong></td>
<td>The preferred access route and switching station has been selected according to the most appropriate technical design.</td>
<td>There may be impacts associated with upgrading and expanding road reserves in sensitive environments.</td>
<td>Considering the WEF layout: A maximum of 80 turbine structures will be assessed. The preferred layout will be assessed by the EIA process and associated specialist assessments. Thus the final proposed WEF layout included in the EIR will be the optimal layout from an environmental perspective, where all environmentally sensitive areas have been designated as NO-GO areas.</td>
</tr>
<tr>
<td><strong>(No alternative turbine and internal route layout will be assessed)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>No-Go</strong></td>
<td>The environment will remain undisturbed</td>
<td>No contribution towards the national renewable energy target.</td>
<td>Assessed as an alternative to the project proceeding.</td>
</tr>
</tbody>
</table>

The 3 different access route alternatives are shown in Figure 1.2 below.
Figure 1.2: Layout of the 3 different access routes for the proposed Umsobomvu WEF.

Table 1.3: Showing the layout of the 3 different access route alternatives for the Umsobomvu WEF

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Layout</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access route 1</td>
<td>Access along an existing gravel road from Middelburg to the site.</td>
</tr>
</tbody>
</table>
Alternative access route 2
Access along an existing gravel road from the N10 to the site.

Alternative access route 3
A second, but longer alternative access from the N10 to the site along existing gravel roads.
2.3 No-Go alternative

It is mandatory to consider the no-go (no development) alternative in the EIA process. The no development option assumes the site remains in its current state, i.e. agricultural land. The no-go alternative will be used as a baseline throughout the assessment process against which potential impacts will be compared in an objective manner.

2.4 Infrastructure

Wind energy is a form of solar energy. Winds are caused by the uneven heating of the atmosphere by the sun, the irregularities of the earth's surface, and rotation of the earth. Wind flow patterns are modified by the earth's terrain, bodies of water, and vegetation. This wind flow or motion energy (kinetic energy) can be used for generating electricity. The term “wind energy” describes the process by which wind is used to generate mechanical power or electricity. Wind turbines convert the kinetic energy in the wind into mechanical power and a generator can then be used to convert this mechanical power into electricity. The components of a typical wind turbine subsystem are:

- **A rotor, or blades**, which are the portion of the wind turbine that collect energy from the wind and convert the wind's energy into rotational shaft energy to turn the generator. The speed of rotation of the blades is controlled by the nacelle, which can turn the blades to face into the wind ('yaw control'), and change the angle of the blades ('pitch control') to make the most use of the available wind,

- **A nacelle** (enclosure) containing a drive train, usually including a gearbox (some turbines do not require a gearbox) and a generator. The generator is what converts the turning motion of a wind turbine's blades (mechanical energy) into electricity. Inside this component, coils of wire are rotated in a magnetic field to produce electricity. The nacelle is also fitted with brakes, so that the turbine can be switched off during very high winds, such as during storm events. This prevents the turbine from being damaged. All this information is recorded by computers and is transmitted to a control centre, which means that operators don't have to visit the turbine very often, but only occasionally for a mechanical check,

- **A tower**, to support the rotor and drive train; The tower on which a wind turbine is mounted is not only a support structure, but it also raises the wind turbine so that its blades safely clear the ground and so can reach the stronger winds at higher elevations. The tower must also be strong enough to support the wind turbine and to sustain vibration, wind loading, and the overall weather elements for the life time of the turbine, and;

- **Electronic equipment** such as controls, electrical cables, ground support equipment, and interconnection equipment.

Additional infrastructure required will include the following:

- A maximum of 10,000m² temporary lay down area;
- Internal access roads;
- A contractor’s site office of up to 5,000m²;
- Administration and warehouse buildings with a footprint of 5,000m²;
- Fencing, linking station and borrow pits if required;
- Hard stand areas associated with each turbine base for crane operation during construction; and
- An onsite substation.

2.5 Terms of reference

The following terms of reference was used as a guideline for the objectives of this agricultural assessment:

- Identify and assess all potential impacts (direct, indirect and cumulative) and economic consequences of the proposed development on soils and agricultural potential.
- Describe and map soil types (soil forms) and characteristics (soil depth, soil colour, limiting factors, and clay content of the top and sub soil layers.
- Describe the slope of the site.
- Determine the agricultural potential of the site.
- Describe current land use as well as possible alternative land use options.
- Provide recommended mitigation measures, monitoring requirements, and rehabilitation guidelines.

2.6 Approach

A desktop analysis and a field survey were undertaken. The methodology used is described below.

2.6.1 Desktop analysis

The desktop analysis was based on existing published data on soil and agricultural potential for the site. The source of data was the AGIS online database, produced by the Institute of Soil, Climate and Water of the Agricultural Research Council of South Africa (AGIS, 2007). This information was largely compiled from a nationwide survey of land types conducted since the 1970s. Satellite imagery of the site available on Google Earth™ was also used for evaluation.

The following specialist reports have been prepared as part of the EIA process and should also be read in conjunction with this report:
- Ecological Impact Assessment
- Socio-economic Impact Assessment

Where relevant, summary content sourced from these documents is provided in this report.

2.6.2 Field survey

A field survey was conducted from 23rd to the 26th of September 2014 in order to assess land-use, current soil conditions and agricultural use onsite.

Soil samples were also collected and sent to Brookside Laboratories Inc. in Heidelberg, Mpumalanga for analysis (see Appendix A for results).

The Guidelines for Soil Description (FAO 4th Ed. 2006) were used to assess the soils data according to international guidelines as set out in the second edition of the World Reference Base for Soil Resources (Deckers et al, 2006).

2.7 Limitations and assumptions

This report is based on currently available information and, as a result, the following limitations and assumptions are implicit –

- The report is based on a project description taken from design specifications for the proposed Umsobomvu WEF project that have not yet been finalised, and which are likely to undergo a number of iterations and refinements before they can be regarded as definitive;
- Descriptions of the surrounding environment are based on limited fieldwork and available literature.
3 RELEVANT LEGISLATION

The following legislation and other regulatory instruments are directly relevant when considering impacts on the existing soil and agricultural uses identified for the Umsobomvu WEF project.

Table 3.1. Legislation and other regulatory instruments considered in the preparation of the Umsobomvu WEF Soil and Agricultural Report.

<table>
<thead>
<tr>
<th>Title of relevant legislation, policy or guideline</th>
<th>Date</th>
<th>Implications for proposed Umsobomvu WEF project</th>
</tr>
</thead>
<tbody>
<tr>
<td>The National Environmental Management Act (NEMA) (107 of 1998)</td>
<td>1998</td>
<td>The developer must apply the NEMA principles, the fair decision-making and conflict management procedures that are provided for in NEMA. The developer must apply the principles of Integrated Environmental Management and the consideration, investigation and assessment of the potential impact of existing and planned activities on the environment, socio-economic conditions; and the cultural heritage.</td>
</tr>
<tr>
<td>Conservation of Agricultural Resources Act (CARA)(No. 43 of 1983)</td>
<td>1983</td>
<td>The proposed project must conserve natural agricultural resources; Must assess the impacts of the proposed development on the existing agricultural environment; Must maintain the production potential of the land by:- o Combating and preventing erosion; o Preventing the weakening or destruction of water sources; o Protecting vegetation; o Combating weeds and invader plants. o Cultivation of virgin soil. o Protection of cultivated land. o Utilisation and protection of the veld. o Control of weed and invader plants. o Prevention and control of veld fires and the restoration and reclamations of eroded land.</td>
</tr>
<tr>
<td>National Water Act (No. 36 of 1998)</td>
<td>1998</td>
<td>Provides details of measures intended to ensure the comprehensive protection of all water resources, including the ecological reserve (quantity and quality) for surface and underground water.</td>
</tr>
<tr>
<td>The Subdivision of Agricultural Land Act (No. 70 of 1970)</td>
<td>1970</td>
<td>This Act controls the subdivision of all agricultural land in South Africa and prohibits certain actions relating to agricultural land. In terms of the Act, the owner of agricultural land is required to obtain consent from the Minister of Agriculture in order to subdivide agricultural land. The purpose of the Act is to prevent uneconomic farming units from being created and degradation of prime agricultural land. The Act also regulates leasing and selling of agricultural land as well as registration of servitudes.</td>
</tr>
</tbody>
</table>

3.1 Municipal Policy

Umsobomvu & Inxuba Yethemba Local Municipality Municipal by-laws Certain activities related to the proposed development may, in addition to National legislation, be subject to control by municipal by-laws. These will need to be confirmed with both the Umsobomvu & Inxuba Yethemba Local Municipalities prior to construction.

Spatial Development Frameworks (SDF) Both the Pixley ka Seme & the Chris Hani District Municipalities SDF’s identifies land use categories. The proposed Umsobomvu WEF fall within...
| | an area designated for agricultural land use in both SDF’s. Since the WEF activities are not mutually exclusive from farming activities, the proposed Umsobomvu WEF is not in conflict with the future spatial planning in either District Municipality |
4 DESKTOP ANALYSIS

In terms of Appendix 6 of the EIA Regulations (2014) a specialist report must contain:

(f) the specific identified sensitivity of the site related to the activity and its associated structures and infrastructure;

(g) an identification of any areas to be avoided, including buffers;

(h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;

This section provides a brief of the current state of the natural environment of the proposed Umsobomvu WEF project.

4.1 Climate

The Middelburg/Noupoort area typically receives between 234 and 261mm of rain per year, with most rainfall occurring during autumn. The area receives the lowest rainfall (2mm) in July and the highest (56mm) in March. The average midday temperatures range from 13.6°C in June to 30.2°C in January. The region is the coldest during July when temperatures drop to 0.2°C on average during the night.

4.2 Geology

The dominant geological feature within the affected farm portions of the proposed Umsobomvu WEF consists of sedimentary deposits of the Tarkastad Subgroup of rocks which makes up part of the much larger Karoo Supergroup of geological formations (Figure 4.1). The Tarkastad Subgroup is further divided into the Katberg Formation which represents all rocks found within the WEF site.

Figure 4.1. Simplified geology of the proposed Umsobomvu WEF.
The Katberg Formation is a sandstone-rich layer consisting of light brownish grey to greenish grey, fine-to medium-grained sandstones containing scattered pebbles of up to 15 cm in diameter. Oval to spherical calcareous concretions, 3-10 cm in diameter, as well as intraformational mud-pellet conglomerates are also common. The alternating mudstone units are predominantly red in colour with reptile, amphibian and fish fossils occurring relatively common.

4.3 Soils

Soils consist mostly of shallow profiles with minimal development overlying rock. Steeper elevations consist of rock with minimal soil development grading into rocky outcrops.

Water holding capacity are low (<20–40mm) on the low lying plains to very low on the steeper koppies, buts & tafelbergs (>20mm) while the potential for water erosion is moderate on the plains to high on mountainous landscapes.

Below is a table of generalised soil status for the Umsobomvu WEF. This information will be compared to the laboratory analysis of soil samples collected onsite during the site visit.

Table 4.1. Generalised soil status for the Umsobomvu WEF (Source: www.agis.agric.za)

<table>
<thead>
<tr>
<th>Soil condition</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential for soil regeneration</td>
<td>Low potential for soil regeneration when badly eroded for the entire site</td>
</tr>
<tr>
<td>Natural soil organic carbon content</td>
<td>0.6 – 1 % C</td>
</tr>
<tr>
<td>pH</td>
<td>6.5 – 7.4</td>
</tr>
<tr>
<td>Acidification</td>
<td>Not susceptible to acidification</td>
</tr>
<tr>
<td>Cation exchange capacity</td>
<td>6.1 – 10 cmolc.kg⁻¹ of soil</td>
</tr>
<tr>
<td>Soil zinc status</td>
<td>6.1 mg.kg⁻¹</td>
</tr>
<tr>
<td>Soil copper status</td>
<td>1 – 2 mg.kg⁻¹</td>
</tr>
<tr>
<td>Soil cobalt status</td>
<td>2 – 10 mg.kg⁻¹</td>
</tr>
</tbody>
</table>

4.4 Topography

The Umsobomvu WEF site consists of average to steep sloped koppies, buts and tafelbergs surrounded by flat to gently sloping plains. The site has an average altitude of 1 750m.
4.5 Vegetation

Mucina and Rutherford (2006) define the following vegetation types that occur within the Umsobomvu WEF site and associate infrastructure and from which source these descriptions are derived:

4.5.1 Besemkaree Koppies Shrubland

Besemkaree Koppies Shrubland occurs along the slopes of koppies, butts and tafelbergs onsite. This vegetation type comprises of two layers; the lower layer is dominated by dwarf small-leaved shrubs, and in years with high rainfall, grasses. The upper layer is dominated by tall shrubs such as Sersia erosa, Sersia burchelli, Sersia cilliata, Euclea crispa, Diospyros austro-africana and Olea europaea subsp. africana. This vegetation type is classified as Least Threatened as it is largely excluded from agricultural practices. The conservation target is 28% with 5% being conserved in the various reserves such as the Gariep Dam, Rolfontein, Tussen Die Riviere, Caledon and Kalkfontein Dam Nature Reserve.

This vegetation type dominates the project area and occurs on slopes and high lying areas of the ridges (Figure 4.3). All turbine sites occur within this vegetation type.
4.5.2 Eastern Upper Karoo

The Eastern Upper Karoo vegetation type is associated with a flat to gently sloping topography. It is dominated by dwarf microphyllus shrubs and grasses belonging to the *Aristida* and *Eragrostis* genera. This vegetation type is classified as Least Threatened with a conservation target of 21%. A portion of this vegetation type has been conserved in Mountain Zebra and Karoo National Parks as well as in Oviston, Commando Drift, Rolfontein and Gariep Dam Nature Reserves.

This vegetation type occurs in the low lying, flat areas of the project area and will be impacted by access roads and powerlines only (Figure 4.3).

4.6 Surface hydrology

Surface hydrology refers to all surface waters found onsite and includes overland flows, rivers, lakes, wetlands, estuaries and oceans, excluding atmospheric and groundwater.

4.6.1 Rivers

No perennial rivers are located within the Umsobomvu WEF site. The closest river to the site is the Seekoei River to the west (approx. 15km from the nearest turbine), and will not be impacted by the proposed Umsobomvu WEF development.

Various non-perennial drainage systems transect the proposed Umsobomvu WEF site (Figure 4.4) and may be impacted by the proposed development.
4.7 Current land use

Land uses in the landscape within and adjacent to the proposed Umsobomvu WEF include:

- Horse breeding and horse riding shows (Saddle Horse and Boerperd)
- Commercial farming and subsistence farming
- Cattle, sheep and goat grazing and breeding
- Livestock feeding crops (such as Lucerne)
- Fruit trees
5 SOILS

This section presents the procedure to describe the different morphological and other characteristics of soils found within the Umsobomvu WEF site. Seven random points (shown in Figure 5.1 and Table 5.1) were identified within the Umsobomvu WEF area. These site selections were based on accessibility to the site. Soil samples were collected from each of these sites for laboratory assessment while the sites were visually assessed. The following procedure was followed during the field assessment:

1. Soil forms were confirmed as described in the World Reference Base (WRB) for Soil Resources (Deckers et al 2006).
2. Soil families were identified as per the Soil Classification workbook, 1991.
3. The master horizons present in the profile were demarcated.
4. Diagnostic horizons or materials were identified.
5. The texture class of the A horizons were determined and added to the name or code of the soil family as per the Soil Classification workbook, 1991.

![Figure 5.1. Locations of the 4 soil sample sites.](image)

<table>
<thead>
<tr>
<th>Site #</th>
<th>GPS coordinates</th>
<th>Latitude</th>
<th>Longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>S 31°22.965'</td>
<td>E 24°48.788'</td>
<td></td>
</tr>
<tr>
<td>S2</td>
<td>S 31°23.383'</td>
<td>E 24°38.531'</td>
<td></td>
</tr>
<tr>
<td>S3</td>
<td>S 31°20.855'</td>
<td>E 24°51.145'</td>
<td></td>
</tr>
<tr>
<td>S4</td>
<td>S 31°23.444'</td>
<td>E 24°49.941'</td>
<td></td>
</tr>
</tbody>
</table>
5.1 Soil classification

Based on a visual survey conducted during the site visit as well as soil samples collected from each area that was visually classified, the dominant soil forms (as per the WRB for Soil Resources) were identified within the Umsobomvu WEF site (Figure 5.2).

![Soil map of the Dassiesridge WEF site.](image)

**5.1.1 Leptosols**

A Leptosol is a very shallow young soil overlaying hard rock or a deeper soil that is extremely gravelly and/or stony. They are found mainly in mountainous and undulating regions and in areas where soil has been eroded to the extent that hard rock comes near to the surface.

Leptosols are unsuitable soils for rain fed or irrigation agriculture because of their inability to hold water, but have potential for tree crops or extensive grazing. These soils are extremely susceptible to surface erosion and active mitigation is sometimes required.

Within the Umsobomvu WEF area, leptosols are extensively utilised for sheep, cattle, game and goat grazing.

All the proposed turbines will be located on leptosols.

Average soil depth ranges between 0 – 60cm with soil colours ranging between orange to red-brown.

Below are visual representations of the soil type found within the Umsobomvu WEF site (Plate 5.1).
5.1.2 **Hard rock**

This is a solid parent rock layer underlying soils and unconsolidated surface material, also called bedrock. All steep slopes also consist of bare bedrock.

Below are visual representations of bedrock found within the Umsobomvu WEF site (Plate 5.2).

Plate 5.1. Shallow grey and light orange topsoil is typical of found within the Umsobomvu WEF site.
5.2 Soil forms

The South African soil classification system (per the Soil Classification workbook, 1991) classifies soils into two main categories or levels of classes namely an upper or general level containing SOIL FORMS and a lower, more specific class containing SOIL FAMILIES.

Soil forms are defined by their unique vertical sequence of diagnostic horizons and materials, while soil families have common properties within the form but are differentiated within the form on the basis of defining properties.
Two soil forms were identified within the Umsobomvu WEF site namely:

- Mispah Form
- Glenrosa Form

### 5.2.1 Mispah Form

This soil form consists of a shallow orthic A horizon overlying hard rock.

In this case, hard rock is classified as horizontally orientated, hard, fractured sediments which do not have any distinct vertical channels containing soil material, and bedrock.

The A horizon are non-calcareous and not bleached and therefore are classified as MYHILL SOIL FAMILY

Plate 5.3 below illustrates a typical Mispah soil form.

![Mispah Form Image](image-url)

**Plate 5.3. Typical Mispah soil type found within the Umsobomvu WEF.**
5.2.2 Glenrosa form

This soil form consists of a surface horizon that cannot be classified as organic, humic, vertic or melanic although it is sometimes darkened by organic matter. It is therefore classified as an orthic A horizon.

Subsoil directly underlies the orthic A horizon and merges into the underlying rock. This layer consists mostly of fresh or weathered parent rock and therefore is classified as a lithocutanic B horizon.

The A horizon are not bleached while the B horizon are hard, non-calcareous with no sign of wetness, and therefore are classified as TSENDE SOIL FAMILY.

Plate 5.4 below illustrates a typical Glenrosa soil form.

Plate 5.4. Typical Glenrosa soil type found within the Umsobomvu WEF.
5.3 Laboratory results

See Appendix A for laboratory results.

All soil samples were collected on leptosols (shallow soils) as this was the only soil type identified onsite. Two (2) varieties of leptosols were identified namely leptosols overlying hard rock (Mispah Soil Form) and leptosols overlying a hard lithocutanic horizon (Glenrosa Soil Form).

The Total Exchange Capacity (TEC) measured in ME/100g (see Laboratory results) was used to compare soil characteristics of the different soil samples. This was done as TEC is an inherent soil characteristic and is difficult to alter.

TEC refers to the total capacity of a soil to hold exchangeable cations. It influences the soil’s ability to hold onto essential nutrients and to provide a buffer against soil acidification therefore influencing soil structure stability, nutrient availability and soil pH. Soils with a higher clay and organic material content will have a higher TEC when compared to sandy soils. The following table reflects the TEC for the different soil types.

Table 5.2. Total Exchange Capacity (TEC) for the different soil types (Moore et al, 1998).

<table>
<thead>
<tr>
<th>Soil type</th>
<th>TEC (ME/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand with low organic content</td>
<td>3-5</td>
</tr>
<tr>
<td>Sand with high organic content</td>
<td>10-20</td>
</tr>
<tr>
<td>Loam</td>
<td>10-15</td>
</tr>
<tr>
<td>Silty loam</td>
<td>15-25</td>
</tr>
<tr>
<td>Clay &amp; clay loams</td>
<td>20-50</td>
</tr>
<tr>
<td>Peat</td>
<td>50-100</td>
</tr>
</tbody>
</table>

Based on Table 5.2, all soils within the Umsobomvu WEF site all range from sand with a high organic content to loam soils, all located in shallow soiled Karoo shrubland.

Based on the low levels of calcium (ranging between 3 649 kg/ha and 1 812 kg/ha), potassium (161 kg/ha and 491 kg/ha) and magnesium (363 kg/ha and 1 463 kg/ha), these soils are not considered as optimal for crops and will require active soil management to improve soil conditions for potential future crops.

5.4 Impacts identified

The following issues were identified in this section:

<table>
<thead>
<tr>
<th>ISSUE</th>
<th>IMPACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase in erosion potential</td>
<td>An increase in hard surfaces (concrete foundations and roads) will increase run-off and potentially lead to soil erosion.</td>
</tr>
<tr>
<td>Soil profile disturbance and resultant decrease in soil agricultural capability</td>
<td>Excavations for the construction of the turbines and associated infrastructure will disturb the soil profile. If topsoil becomes buried, or subsoil rock, that is less suitable for root growth, remains at the surface, the agricultural suitability of the soil, that will become available for agriculture again after decommissioning of the WEF, will be reduced.</td>
</tr>
<tr>
<td>Management of hazardous chemicals</td>
<td>Soil contamination as a result of spillages &amp; leakages will result in a loss of fertile soils.</td>
</tr>
<tr>
<td>Soil stockpiling management</td>
<td>Incorrect stockpiling of soil will result in a decrease of agricultural viability / potential.</td>
</tr>
</tbody>
</table>
6 AGRICULTURE

6.1 Agriculture in South Africa

Agriculture employ around 9% of the formal employment in South Africa, as well as providing work for casual labourers and contributing around 2.6% to the GDP for the nation (Stats SA, 2011 census). Due to the aridity of the land in general, only 13.5% of all land can be used for crop production, of that only 3% is considered high potential agricultural land (Mohamed, 2000).

According to Stats SA (2011 census), South Africa is one of world’s largest producers of: chicory roots (4th); grapefruit (4th); cereals (5th); green maize and maize (7th); castor oil seed (9th); pears (9th); sisal (10th); fibre crops (10th). The dairy industry consists of around 4,300 milk producers providing employment for 60,000 farm workers and contributing to the livelihoods of around 40,000 others.

6.2 Agriculture in the Umsobomvu WEF site

Historical agricultural practices in the area consist mainly of sheep & wool industry with some cattle & goat farming occurring. Where irrigation is possible lucerne, ryegrass, clover and fescue are grown as winterfeed. Game is common with hunting occurring on various farms to supplement income.

6.3 Site assessment

A field survey was conducted between the 23rd to the 26th of September 2014 in order to assess agricultural practises onsite.

6.3.1 Vegetation

SANBI classified the vegetation found on the mountainous areas where the Umsobomvu WEF infrastructure will be located as Eastern Upper Karoo scrubland. The site visit confirmed that the average species composition reflect a combination of perennial and annual sub climax species dominating the veld. These species e.g. Eragrostis lehmaniana, Aristida diffusa and Tragus koelerioides, as well as annual pioneer grasses like Aristida congesta has low grazing values.

The sub-shrub component varies from the palatable (Pentzia incana), less palatable (Eriocephalus spinescens) to those with variable palatability like the Eberlanzia ferox.

6.3.2 Livestock

Sheep & wool production is the main type of agricultural practice in the Middelburg area. Some cattle & goat ranging was also observed as well as some dairy farms close to town.

6.3.3 Game ranging

Game is now also considered to be an agricultural product as defined in the Marketing of Agricultural Products Act, 1996 (Act 47 of 1996). Game ranching in South Africa is one of the fastest-growing sectors of the agricultural industry. Since the 1970’s, there has been a huge shift from cattle & sheep farming to game ranching. Provided they observe approved game-fencing rules, registered game ranches have permission to hunt throughout the year.
There are approximately 15,000 farms in South Africa on which game freely occur. On about 8,000 game-fenced ranches, some form of income-generating commercial game ranching is practised, earning some R767 million. The total surface area on which game is kept in South Africa amounts to more than 21 million ha of which 15 million ha of this land under wildlife are in the hands of the private sector, with the rest belonging to government institutions such as national parks and nature reserves. Approximately 200,000 local hunters use game on game ranches and conservation areas and earn a further income of approximately R113 million annually from an estimated 5,000 foreign trophy hunters. The total local market in live game trade is estimated at R100 million annually. Marketing of venison in South Africa is estimated at R20 million annually, but a large potential for growth is envisaged, also for venison exports. The game industry generates about R1,073 million annually, which amounts to 2.3% of the South African agricultural sector’s contribution to the country’s GDP. Game ranches in South Africa supply work for approximately 56,000 people, paying salaries of about R410 million annually.

Large game occurring within the Umsobomvu WEF site includes:
- Kudu
- Impala
- Springbok
- Warthog

### 6.3.4 Irrigation

No irrigation was observed within the farm portions where the Umsobomvu WEF infrastructure occurs. Some of the surrounding farms do irrigate lucerne, ryegrass, clover and fescue on low productions as winterfeed.

### 6.3.5 Crops

Although no crops were observed within the farm portions where the Umsobomvu WEF infrastructure occurs, some crops were noted on surrounding farms, mainly close to rivers where irrigation methods are used to grow winterfeed.

### 6.4 Agricultural potential

Agricultural potential in the Umsobomvu WEF area is classified according to the land potential classification system of the Department of Agriculture (part of the Department of Agriculture, Forestry and Fisheries). This classification system takes factors such as climate, soil and slope into consideration to determine agricultural potential. Although it provides only a macro perception of the agricultural potential in the region, it is still a fair indication of what the broader agricultural potential of the area is.

DAFF has classified the Umsobomvu WEF into the following agricultural potential class:
- Non-arable land with a low to moderate potential for grazing on the plains & low potential on the mountainous areas.
- Land unsuitable for crops.

Based on the agricultural potential onsite, DAFF has determined the grazing capacity to be between 18-25 hectare per large stock unit (ha/LSU). Grazing capacity potential was determined in 1995 by DAFF to be:
- Between 18-25 ha/LSU on the mountain tops
- Between 14-17 ha/LSU on the plains

This indicates that, grazing onsite is utilised to its fullest potential capacity.
6.5 Impacts identified

The following issues were identified in this section:

<table>
<thead>
<tr>
<th>ISSUE</th>
<th>IMPACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establishment of renewable energy infrastructure on agricultural land</td>
<td>Loss of up to 23ha of low to moderate potential agricultural land as a result of new WEF infrastructure development.</td>
</tr>
<tr>
<td></td>
<td>Gradual reduction of available agricultural land as a consequence of an increase in renewable energy development in the local area.</td>
</tr>
<tr>
<td>Increased risk of fires from construction activities</td>
<td>Potential loss of crops, grazing and livestock as a result of fires originating from the construction site.</td>
</tr>
</tbody>
</table>
7 IMPACT IDENTIFICATION AND ASSESSMENT

In terms of Appendix 6 of the EIA Regulations (2014) a specialist report must contain-

(j) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment;

(k) any mitigation measures for inclusion in the EMPr;

7.1 Introduction

This chapter details the potential soils and agricultural impacts identified. For each issue identified, details are provided, followed by the mitigation measures required to minimise the negative impacts associated with the issue.

7.2 Impacts on soils and agriculture

Impacts on the agricultural potential of the affected land were identified during the Construction and Operation Phase of the proposed Umsobomvu WEF project and are described below. These included the consideration of direct, indirect and cumulative impacts that may occur. Issues and impacts are summarised in Table 7.1.

Table 7.1 Impacts to soil and agriculture associated with different phases of the proposed Umsobomvu WEF.

<table>
<thead>
<tr>
<th>Development Phase</th>
<th>Issue</th>
<th>Nature of Impact</th>
<th>Description of Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>1. Management of hazardous chemicals</td>
<td>Direct Cumulative</td>
<td>1.1. Soil contamination and a loss of fertile soils as a result of hazardous chemical spills and leakages.</td>
</tr>
<tr>
<td></td>
<td>2. Increased risk of fires from construction activities</td>
<td>Direct Cumulative</td>
<td>2.1. Potential loss grazing and game as a result of fires originating from the construction site.</td>
</tr>
<tr>
<td></td>
<td>3. Soil stockpiling management</td>
<td>Direct Indirect Cumulative</td>
<td>3.1. Incorrect stockpiling of soil will result in a decrease of agricultural viability/potential.</td>
</tr>
<tr>
<td></td>
<td>4. Soil profile disturbance and resultant decrease in soil agricultural capability</td>
<td>Direct Cumulative</td>
<td>4.1. Excavations for the construction of the turbines and associated infrastructure will disturb the soil profile. If topsoil becomes buried, or subsoil rock, that is less suitable for root growth, remains at the surface, the agricultural suitability of the soil, that will become available for agriculture again after decommissioning of the WEF, will be reduced</td>
</tr>
<tr>
<td>Operation</td>
<td>5. Increase in erosion potential</td>
<td>Direct Indirect Cumulative</td>
<td>5.1. An increase in hard surfaces (concrete foundations and roads) will increase run-off and potentially lead to soil erosion.</td>
</tr>
<tr>
<td></td>
<td>6. Establishment of renewable energy infrastructure on</td>
<td>Direct Cumulative</td>
<td>6.1. Loss of up to 23ha of low to moderate agricultural land as a result of new WEF infrastructure development.</td>
</tr>
</tbody>
</table>
Agriculture & Soil Impact Assessment – February 2015

EOH Coastal & Environmental Services

Umsobomvu WEF

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7.3 Assessment methodology

Five factors need to be considered when assessing the significance of impacts, namely:

1. Relationship of the impact to **temporal scales** - the temporal scale defines the significance of the impact at various time scales, as an indication of the duration of the impact.

2. Relationship of the impact to **spatial scales** - the spatial scale defines the physical extent of the impact.

3. The **severity** of the impact - the severity/beneficial scale is used in order to scientifically evaluate how severe negative impacts would be, or how beneficial positive impacts would be on a particular affected system (for ecological impacts) or a particular affected party. The severity of impacts can be evaluated with and without mitigation in order to demonstrate how serious the impact is when nothing is done about it. The word ‘mitigation’ means not just ‘compensation’, but also the ideas of containment and remedy. For beneficial impacts, optimization means anything that can enhance the benefits. However, mitigation or optimization must be practical, technically feasible and economically viable.

4. The **likelihood** of the impact occurring - the likelihood of impacts taking place as a result of project actions differs between potential impacts. There is no doubt that some impacts would occur (e.g. loss of vegetation), but other impacts are not as likely to occur (e.g. vehicle accident), and may or may not result from the proposed development. Although some impacts may have a severe effect, the likelihood of them occurring may affect their overall significance.

Each criterion is ranked with scores assigned as presented in Table 7.1 to determine the overall significance of an activity. The criterion is then considered in two categories, viz. effect of the activity and the likelihood of the impact. The total scores recorded for the effect and likelihood are then read off the matrix presented in Table 7.2, to determine the overall significance of the impact. The overall significance is either negative or positive.

**Table 7.2. Ranking of Evaluation Criteria**

<table>
<thead>
<tr>
<th>Temporal Scale</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short term</td>
<td>Less than 5 years</td>
</tr>
<tr>
<td>Medium term</td>
<td>Between 5-20 years</td>
</tr>
<tr>
<td>Long term</td>
<td>Between 20 and 40 years (a generation) and from a human perspective also permanent</td>
</tr>
<tr>
<td>Permanent</td>
<td>Over 40 years and resulting in a permanent and lasting change that will always be there</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spatial Scale</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Localised</td>
<td>At localised scale and a few hectares in extent</td>
</tr>
<tr>
<td>Study Area</td>
<td>The proposed site and its immediate environs</td>
</tr>
<tr>
<td>Regional</td>
<td>District and Provincial level</td>
</tr>
<tr>
<td>National</td>
<td>Country</td>
</tr>
<tr>
<td>International</td>
<td>Internationally</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Severity</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slight impacts on the affected system(s) or party(ies)</td>
<td>Slightly beneficial to the affected system(s) and party(ies)</td>
</tr>
<tr>
<td>Moderate impacts on the affected system(s) or party(ies)</td>
<td>Moderately beneficial to the affected system(s) and party(ies)</td>
</tr>
<tr>
<td>Severe impacts on the affected system(s) or party(ies)</td>
<td>A substantial benefit to the affected system(s) and party(ies)</td>
</tr>
<tr>
<td>Very severe change to the affected system(s) or party(ies)</td>
<td>A very substantial benefit to the affected system(s) and party(ies)</td>
</tr>
</tbody>
</table>
Unlikely  | The likelihood of these impacts occurring is slight | 1
May Occur | The likelihood of these impacts occurring is possible | 2
Probable  | The likelihood of these impacts occurring is probable | 3
Definite  | The likelihood is that this impact will definitely occur | 4

* In certain cases it may not be possible to determine the severity of an impact thus it may be determined: Don’t know/Can’t know

Table 7.2a. Matrix used to determine the overall significance of the impact based on the likelihood and effect of the impact.

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>7</td>
</tr>
</tbody>
</table>

Table 7.2b. Description of Environmental Significance Ratings and associated range of scores

<table>
<thead>
<tr>
<th>Significance Rate</th>
<th>Description</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>An acceptable impact for which mitigation is desirable but not essential. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in either positive or negative medium to short term effects on the social and/or natural environment.</td>
<td>4-8</td>
</tr>
<tr>
<td>Moderate</td>
<td>An important impact which requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in either a positive or negative medium to long-term effect on the social and/or natural environment.</td>
<td>9-12</td>
</tr>
<tr>
<td>High</td>
<td>A serious impact, if not mitigated, may prevent the implementation of the project (if it is a negative impact). These impacts would be considered by society as constituting a major and usually a long-term change to the (natural &amp;/or social) environment and result in severe effects or beneficial effects.</td>
<td>13-16</td>
</tr>
<tr>
<td>Very High</td>
<td>A very serious impact which, if negative, may be sufficient by itself to prevent implementation of the project. The impact may result in permanent change. Very often these impacts are unmitigable and usually result in very severe effects, or very beneficial effects.</td>
<td>17-20</td>
</tr>
</tbody>
</table>

The environmental significance scale is an attempt to evaluate the importance of a particular impact. This evaluation needs to be undertaken in the relevant context, as an impact can either be ecological or social, or both. The evaluation of the significance of an impact relies heavily on the values of the person making the judgment. For this reason, impacts of especially a social nature need to reflect the values of the affected society.

Prioritising
The evaluation of the impacts, as described above is used to prioritise which impacts require mitigation measures.
Negative impacts that are ranked as being of “VERY HIGH” and “HIGH” significance will be investigated further to determine how the impact can be minimised or what alternative activities or mitigation measures can be implemented. These impacts may also assist decision makers i.e. lots of HIGH negative impacts may bring about a negative decision.

For impacts identified as having a negative impact of “MODERATE” significance, it is standard practice to investigate alternate activities and/or mitigation measures. The most effective and practical mitigations measures will then be proposed.

For impacts ranked as “LOW” significance, no investigations or alternatives will be considered. Possible management measures will be investigated to ensure that the impacts remain of low significance.

7.4 Impact Assessment

The impacts identified in Section 7.2 are assessed in terms of the criteria described in Section 7.3 and are summarised below.
Table 7.3 Assessment and mitigation of impacts identified in the Construction Phase.

<table>
<thead>
<tr>
<th>IMPACTS</th>
<th>SPATIAL SCALE</th>
<th>TEMPORAL SCALE (DURATION)</th>
<th>CERTAINTY SCALE ( LIKELIHOOD)</th>
<th>SEVERITY/ BENEFICIAL SCALE</th>
<th>SIGNIFICANCE PRE-MITIGATION</th>
<th>MITIGATION MEASURES</th>
<th>SIGNIFICANCE POST-MITIGATION</th>
</tr>
</thead>
</table>
| Issue 1: Management of hazardous chemicals                             | Study area    | Long-term                  | Probable                       | Severe                    | MODERATE NEGATIVE           | • Machinery must be properly maintained to keep oil leaks in check.  
  • If a spill occurs on a permeable surface (e.g. Soil), a spill kit must be used to immediately reduce the potential spread of the spill.  
  • If a spill occurs on an impermeable surface such as cement or concrete, the surface spill must be contained using oil absorbent materials.  
  • Contaminated remediation materials must be carefully removed from the area of the spill so as to prevent further release of hazardous chemicals to the environment, and stored in adequate containers until appropriate | LOW NEGATIVE   |
### Issue 2: Increased risk of fires from construction activities

Potential loss of crops, grazing and livestock as a result of fires originating from the construction site.

<table>
<thead>
<tr>
<th>IMPACTS</th>
<th>SPATIAL SCALE</th>
<th>TEMPORAL SCALE (DURATION)</th>
<th>CERTAINTY SCALE (LIKELIHOOD)</th>
<th>SEVERITY/ BENEFICIAL SCALE</th>
<th>SIGNIFICANCE PRE-MITIGATION</th>
<th>MITIGATION MEASURES</th>
<th>SIGNIFICANCE POST-MITIGATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Regional</td>
<td>Long-term</td>
<td>Probable</td>
<td>Very severe</td>
<td>HIGH NEGATIVE</td>
<td>disposal in a licenced landfill site.</td>
<td></td>
</tr>
</tbody>
</table>

- Ensure that all personnel are aware of the fire risk and the need to extinguish cigarettes before disposal, in appropriate waste disposal containers.
- Smoking will only be allowed in demarcated areas with easy access to firefighting equipment.
- Welding and other construction activities requiring open flames shall be done in a designated area containing firefighting equipment.
- The risk of fire is highest in the late summer and autumn months, during high wind velocities and dry periods. To avoid and manage fire risk...
<table>
<thead>
<tr>
<th>IMPACTS</th>
<th>SPATIAL SCALE</th>
<th>TEMPORAL SCALE (DURATION)</th>
<th>CERTAINTY SCALE (LIKELIHOOD)</th>
<th>SEVERITY/BENEFICIAL SCALE</th>
<th>SIGNIFICANCE PRE-MITIGATION</th>
<th>MITIGATION MEASURES</th>
<th>SIGNIFICANCE POST-MITIGATION</th>
</tr>
</thead>
</table>

The following steps should be implemented:

- Have on site fire-fighting equipment and ensure that all personnel are educated how to use it and procedures to be followed in the event of a fire.
- Identify the relevant authorities and structures responsible for fighting fires in the area and shall liaise with them regarding procedures should a fire commence.
- Ensure that all the necessary telephone numbers etc. are posted at conspicuous and relevant
<table>
<thead>
<tr>
<th>IMPACTS</th>
<th>SPATIAL SCALE</th>
<th>TEMPORAL SCALE (DURATION)</th>
<th>CERTAINTY SCALE (LIKELIHOOD)</th>
<th>SEVERITY/BENEFICIAL SCALE</th>
<th>SIGNIFICANCE PRE-MITIGATION</th>
<th>MITIGATION MEASURES</th>
<th>SIGNIFICANCE POST-MITIGATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>locations in the event of an emergency.</td>
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<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>• No open fires shall be allowed on site for the purpose of cooking or warmth. Cooking fires must only be lit in designated cooking areas.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• The contractor shall take all reasonable steps to prevent the accidental occurrence or spread of fire.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• The contractor shall appoint a fire officer who shall be responsible for ensuring immediate and appropriate action in the event of a fire.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• The contractor shall ensure that all site personnel are aware of the procedure to be followed in the event of a fire. The appointed fire officer shall notify the Fire</td>
<td></td>
</tr>
<tr>
<td>IMPACTS</td>
<td>SPATIAL SCALE</td>
<td>TEMPORAL SCALE (DURATION)</td>
<td>CERTAINTY SCALE (LIKELIHOOD)</td>
<td>SEVERITY/ BENEFICIAL SCALE</td>
<td>SIGNIFICANCE PRE-MITIGATION</td>
<td>MITIGATION MEASURES</td>
<td>SIGNIFICANCE POST-MITIGATION</td>
</tr>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>and Emergency Services in the event of a fire and shall not delay doing so until such time as the fire is beyond his / her control.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• The contractor shall ensure that there is basic fire-fighting equipment on site at all times. This equipment shall include fire extinguishers and beaters.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Any work that requires the use of fire may only take place within designated areas. Fire-fighting equipment shall be available in these areas.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• The contractor shall ensure that the correct emergency call numbers for the nearest fire department and the local Farmers</td>
<td></td>
</tr>
</tbody>
</table>

EOH Coastal & Environmental Services

Umsobomvu WEF
<table>
<thead>
<tr>
<th>IMPACTS</th>
<th>SPATIAL SCALE</th>
<th>TEMPORAL SCALE (DURATION)</th>
<th>CERTAINTY SCALE (LIKELIHOOD)</th>
<th>SEVERITY/BENEFICIAL SCALE</th>
<th>SIGNIFICANCE PRE-MITIGATION</th>
<th>MITIGATION MEASURES</th>
<th>SIGNIFICANCE POST-MITIGATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Association Fire Marshall are easily accessible at all times, and that in the event that a fire becomes unmanageable, these people are notified as a matter of urgency.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Issue 3: Soil stockpiling management**

Incorrect stockpiling methods of soil will result in a decrease of agricultural viability/potential of these soils and may even cause sterilization of these soils due to a decrease in viable seedbank.

<table>
<thead>
<tr>
<th>Localised</th>
<th>Medium-term</th>
<th>Probable</th>
<th>Moderate</th>
<th>MODERATE NEGATIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Develop and implement a Rehabilitation and Monitoring Plan to monitor rehabilitated areas.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Implement measures such as wind-breaks, swales and watering to aid the initial grown of primary vegetation.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Fertile topsoil must not be stockpiled for periods exceeding 12 months or exceeding 2m in height.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Topsoil may be supplemented with an indigenous seed mix.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Impact 4: Soil profile disturbance and resultant decrease in soil agricultural capability**
<table>
<thead>
<tr>
<th>IMPACTS</th>
<th>SPATIAL SCALE</th>
<th>TEMPORAL SCALE (DURATION)</th>
<th>CERTAINTY SCALE (LIKELIHOOD)</th>
<th>SEVERITY/BENEFICIAL SCALE</th>
<th>SIGNIFICANCE PRE-MITIGATION</th>
<th>MITIGATION MEASURES</th>
<th>SIGNIFICANCE POST-MITIGATION</th>
</tr>
</thead>
</table>
| Excavations for the construction of the turbines and associated infrastructure will disturb the soil profile. If topsoil becomes buried, or subsoil and rock that is less suitable for root growth, remains at the surface, the agricultural suitability of the soil, that will become available for agriculture again after decommissioning of the WEF, will be reduced | Study area    | Permanent                 | Definite                    | Very severe                | VERY HIGH NEGATIVE          | • The upper 15-20 cm of top soil must be stripped and stockpiled as topsoil. It should be retained for re-spreading over disturbed surfaces during rehabilitation.  
• All other soil excavated will be stockpiled separately from topsoil as subsoil.  
• Ensure that topsoil does not get buried by subsoil during backfilling. Failure to comply will result in topsoil sterilisation.  
• An ECO must monitor all excavations to ensure backfilling with subsoil first and then topsoil afterwards takes place.  
• An ECO must monitor depth and cover of topsoil spreading during rehabilitation to ensure a 30cm depth. | LOW NEGATIVE   |
### Table 7.4 Assessment and mitigation of impacts identified in the Operation Phase.

<table>
<thead>
<tr>
<th>IMPACTS</th>
<th>SPATIAL SCALE</th>
<th>TEMPORAL SCALE (DURATION)</th>
<th>CERTAINTY SCALE (LIKELIHOOD)</th>
<th>SEVERITY/ BENEFICIAL SCALE</th>
<th>SIGNIFICANCE PRE-MITIGATION</th>
<th>MITIGATION MEASURES</th>
</tr>
</thead>
</table>
| Issue 5: Increase in erosion potential | Study area    | Long term                 | Definite                     | Severe                     | HIGH NEGATIVE                 | • All run-off water must be collected, channelled and disposed of in an appropriate manner.  
• Anti-erosion features must be installed where required.  
• Ensure that all cleared and impacted land is rehabilitated and re-vegetated. |
|                          |               |                           |                              |                            |                              | **LOW NEGATIVE**                                                               |

An increase in hard surfaces (concrete foundations and roads) will increase run-off and potentially lead to soil erosion.
<table>
<thead>
<tr>
<th>IMPACTS</th>
<th>SPATIAL SCALE</th>
<th>TEMPORAL SCALE (DURATION)</th>
<th>CERTAINTY SCALE (LIKELIHOOD)</th>
<th>SEVERITY/BENEFICIAL SCALE</th>
<th>SIGNIFICANCE PRE-MITIGATION</th>
<th>MITIGATION MEASURES</th>
<th>SIGNIFICANCE POST-MITIGATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Issue 6: Establishment of renewable energy infrastructure on agricultural land</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Do not fence off any WEF infrastructure. This will allow maximum movement &amp; grazing of livestock &amp; game within current camps.</td>
<td>LOW NEGATIVE</td>
</tr>
<tr>
<td>Loss of 3ha of moderate to low potential agricultural land as a result of new WEF infrastructure development.</td>
<td>Localised</td>
<td>Long-term</td>
<td>Definite</td>
<td>Slight</td>
<td>MODERATE NEGATIVE</td>
<td>• Avoid developing on high potential agricultural land.  • If unavoidable, ensure that all development footprints are kept at a minimum.</td>
<td>MODERATE NEGATIVE</td>
</tr>
<tr>
<td>Gradual reduction of available agricultural land as a consequence of an increase in renewable energy development in the local area.</td>
<td>Regional</td>
<td>Long-term</td>
<td>Definite</td>
<td>Severe</td>
<td>HIGH NEGATIVE</td>
<td></td>
<td>MODERATE NEGATIVE</td>
</tr>
</tbody>
</table>
8 IMPACT STATEMENT, CONCLUSION & RECOMMENDATIONS

In terms of Appendix 6 of the EIA Regulations (2014) a specialist report must contain-

(I) any conditions for inclusion in the environmental authorisation;

(m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;

(n) a reasoned opinion-

(i) as to whether the proposed activity or portions thereof should be authorised; and

(ii) if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;

Umsobomvu Wind Power is proposing to construct a WEF to be developed between Middelburg (Eastern Cape) and Noupoort (Northern Cape) on the provincial border. The WEF will host a maximum of 80 wind turbines located on 18 properties (Table 1.1), each generating between 1.5 – 4 MW of electricity, with total combined potential power output of approximately 140MW. The 3 different access route alternatives are proposed.

An agricultural and soil impact assessment was commissioned in order to predict and assess the significance of identified impacts associated with the proposed activity on the agricultural potential of the affected land.

The proposed development’s primary impact on agricultural activities will involve the construction of the wind turbines and associated infrastructure (access roads and cables). The construction of these turbines and associated infrastructure will only influence an area of around 23ha of the total local agricultural portion.

It is expected that the entire site will be reverted back to agricultural land during decommissioning of the Umsobomvu WEF site.

The No-Go alternative would mean abandoning the proposed development and as such there will be no negative impact on the environment as identified in Section 5. Furthermore it may also result in none of the positive impacts of renewable energy in terms of climate change mitigation being realised from this area.

The construction entails the clearing of vegetation within the proposed footprint of the wind turbine, as well as creating service roads and laydown areas. Grazing may be permitted around and underneath the wind turbines while crop fields may be grown around the turbine sites (if so required). The impact of the proposed Umsobomvu WEF development on the study area’s agricultural potential will be low, with the loss of agricultural land mostly being attributed to the creation of the service roads, wind turbine foundations and a laydown area. The total loss of grazing land will be less than 1 % of the total estimated agricultural area of 15 000 ha.

8.1 Recommendations for the proposed Umsobomvu WEF

None of the three (3) route alternatives are considered as the preferred access route as all the alternatives are existing gravel roads and none of them will directly or indirectly impact on agricultural activities onsite. None of the access routes alternatives (1, 2, 3) are considered as “fatally flawed”.

All the mitigation measures provided below are to be implemented in the Planning & Design, Construction and Operation Phases of the proposed Umsobomvu WEF.
8.1.1 Planning and Design

- Develop and implement a Rehabilitation and Monitoring Plan to monitor stockpiles.
- Anti-erosion features must be installed where required.
- Avoid developing on moderate potential agricultural land.

8.1.2 Construction

- Machinery must be properly maintained to keep oil leaks in check.
- If a spill occurs on a permeable surface (e.g. Soil), a spill kit must be used to immediately reduce the potential spread of the spill.
- If a spill occurs on an impermeable surface such as cement or concrete, the surface spill must be contained using oil absorbent materials.
- Contaminated remediation materials must be carefully removed from the area of the spill so as to prevent further release of hazardous chemicals to the environment, and stored in adequate containers until appropriate disposal in a licenced landfill site.
- Ensure that all personnel are aware of the fire risk and the need to extinguish cigarettes before disposal, in appropriate waste disposal containers.
- Smoking will only be allowed in demarcated areas with easy access to firefighting equipment.
- Welding and other construction activities requiring open flames shall be done in a designated area containing firefighting equipment.
- The risk of fire is highest in the late summer and autumn months, during high wind velocities and dry periods. To avoid and manage fire risk the following steps should be implemented:
  - Have on site fire-fighting equipment and ensure that all personnel are educated how to use it and procedures to be followed in the event of a fire.
  - Identify the relevant authorities and structures responsible for fighting fires in the area and shall liaise with them regarding procedures should a fire commence.
  - Ensure that all the necessary telephone numbers etc. are posted at conspicuous and relevant locations in the event of an emergency.
  - No open fires shall be allowed on site for the purpose of cooking or warmth. Cooking fires must only be lit in designated cooking areas.
  - The contractor shall take all reasonable steps to prevent the accidental occurrence or spread of fire.
  - The contractor shall appoint a fire officer who shall be responsible for ensuring immediate and appropriate action in the event of a fire.
  - The contractor shall ensure that all site personnel are aware of the procedure to be followed in the event of a fire. The appointed fire officer shall notify the Fire and Emergency Services in the event of a fire and shall not delay doing so until such time as the fire is beyond his / her control.
  - The contractor shall ensure that there is basic fire-fighting equipment on site at all times. This equipment shall include fire extinguishers and beaters.
  - Any work that requires the use of fire may only take place within designated areas. Fire-fighting equipment shall be available in these areas.
  - The contractor shall ensure that the correct emergency call numbers for the nearest fire department and the local Farmers Association Fire Marshall are easily accessible at all times, and that in the event that a fire becomes unmanageable, these people are notified as a matter of urgency.
- Ensure that topsoil does not get buried by subsoil during stockpiling. Failure to comply will result in topsoil sterilisation.
- Implement measures such as wind-breaks, swales and watering as required to ensure no wind or stormwater erosion occurs.
- Fertile topsoil must not be stockpiled for periods exceeding 12 months or exceeding 2m in height.
- The upper 15-20 cm of top soil must be stripped and stockpiled as topsoil. It should be retained for re-spreading over disturbed surfaces during rehabilitation.
• All other soil excavated will be stockpiled separately from topsoil as subsoil.
• Ensure that topsoil does not get buried by subsoil during backfilling. Failure to comply will result in topsoil sterilisation.
• An ECO must monitor all excavations to ensure backfilling with subsoil first and then topsoil afterwards takes place.
• An ECO must monitor depth and cover of topsoil spreading during rehabilitation to ensure a 30cm depth.
• Topsoil allocated for rehabilitation must not be mixed with other materials, such as building rubble, rock, subsoil, etc.
• Topsoil stockpiles are to be handled only twice – once during clearing and stockpiling and once during rehabilitation/backfilling.

8.1.3 Operation

• All run-off water must be collected, channelled and disposed of in an appropriate manner.
• Ensure that all cleared and impacted land is rehabilitated and re-vegetated.
• Do not fence off any WEF infrastructure. This will allow maximum grazing and movement of game within the site.
• If unavoidable, ensure that all development footprints are kept at a minimum.

8.2 Agricultural statement and Opinion of the Specialist

The agricultural impacts of all the aspects of the proposed Umsobomvu WEF were considered and deemed to be acceptable, provided that the mitigation measures provided in this report are implemented.

Although limited agricultural output (livestock and game only) within the affected area will be impacted by the proposed development, no problematic areas or fatal flaws were identified for the site.

Although access route alternatives 1 & 2 are much shorter routes compared to access route alternatives 3, none were considered as preferred as they all existing gravel roads that should not impact on any agricultural activities onsite. There were no other significant impact identified on agriculture and soils other that the size of the footprints of the different access route alternative options. Therefore all 3 options are considered as acceptable.

All the identified impacts on agriculture are considered to have high reversibility because the land will be able to be returned to agriculture after closure, with very little change in agricultural potential. Impacts on agriculture are also considered to have low irreplaceability of resource loss because:
1. of the small area of land involved,
2. low suitability for crops
3. it is highly unlikely to be irreplaceably lost to agriculture.
4. Low to medium agricultural potential
9 REFERENCES


National Environmental Management Act (No 107 of 1998) as amended in 2010

National Water Act (No 36 of 1998)


## APPENDIX A
### SOIL LABORATORY RESULTS

**Brookside Laboratories, Inc.**

**Soil Audit and Inventory Report**

**Name**: De Kock Roy  
**City**: Heidelberg  
**State**: GP  
**Date**: 10/15/2014

<table>
<thead>
<tr>
<th>Independent Consultant</th>
<th>Vermi Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sample Location</strong></td>
<td><strong>Lab Number</strong></td>
</tr>
<tr>
<td>Innowind Umsobomvu</td>
<td>0073-1</td>
</tr>
<tr>
<td><strong>Sample Identification</strong></td>
<td>0074-1</td>
</tr>
<tr>
<td>WEF 126</td>
<td>0075-1</td>
</tr>
<tr>
<td>WEF 126</td>
<td>0076-1</td>
</tr>
</tbody>
</table>

**Total Exchange Capacity (ME/100 g)**

<table>
<thead>
<tr>
<th></th>
<th>WEF 126</th>
<th>WEF 126</th>
<th>WEF 126</th>
<th>WEF 126</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffer (SMP/Sikora)</td>
<td>13.94</td>
<td>9.39</td>
<td>5.53</td>
<td>10.62</td>
</tr>
<tr>
<td>pH</td>
<td>7.2</td>
<td>8.3</td>
<td>6.7</td>
<td>5.9</td>
</tr>
</tbody>
</table>

**Organic Matter (humus) %**

<table>
<thead>
<tr>
<th></th>
<th>WEF 126</th>
<th>WEF 126</th>
<th>WEF 126</th>
<th>WEF 126</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.06</td>
<td>0.53</td>
<td>0.74</td>
<td>2.77</td>
</tr>
</tbody>
</table>

### SOLUBLE SULFUR

<table>
<thead>
<tr>
<th></th>
<th>ppm</th>
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<tbody>
<tr>
<td>MEHLICH III</td>
<td>41</td>
<td>123</td>
<td>21</td>
<td>41</td>
</tr>
<tr>
<td>BRAY II</td>
<td>108</td>
<td>841</td>
<td>31</td>
<td>15</td>
</tr>
<tr>
<td>OLSEN</td>
<td>21</td>
<td>164</td>
<td>6</td>
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### ANIONS

<table>
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</thead>
<tbody>
<tr>
<td>CALCIUM*</td>
<td>3649</td>
<td>3380</td>
<td>1812</td>
<td>2536</td>
</tr>
<tr>
<td>MAGNESIUM*</td>
<td>1464</td>
<td>361</td>
<td>515</td>
<td>634</td>
</tr>
<tr>
<td>POTASSIUM*</td>
<td>244</td>
<td>345</td>
<td>161</td>
<td>491</td>
</tr>
<tr>
<td>SODIUM*</td>
<td>18</td>
<td>47</td>
<td>45</td>
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### EXCHANGEABLE CATIONS

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<tbody>
<tr>
<td>ALUMINUM (KCl Ext.)</td>
<td>&lt; 1</td>
<td>&lt; 1</td>
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### BASE SATURATION PERCENT

<table>
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</thead>
<tbody>
<tr>
<td>Calcium %</td>
<td>58.43</td>
<td>80.35</td>
<td>61.94</td>
<td>53.30</td>
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<tr>
<td>Magnesium %</td>
<td>39.04</td>
<td>14.38</td>
<td>29.35</td>
<td>22.21</td>
</tr>
<tr>
<td>Potassium %</td>
<td>2.00</td>
<td>4.21</td>
<td>2.83</td>
<td>5.29</td>
</tr>
<tr>
<td>Sodium %</td>
<td>0.56</td>
<td>0.97</td>
<td>1.33</td>
<td>1.23</td>
</tr>
<tr>
<td>Aluminum %</td>
<td>0.00</td>
<td>0.12</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Hydrogen %</td>
<td>0.00</td>
<td>0.00</td>
<td>4.50</td>
<td>18.00</td>
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### EXTRACTABLE MINORS

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</thead>
<tbody>
<tr>
<td>Boron* (ppm)</td>
<td>0.48</td>
<td>0.39</td>
<td>0.21</td>
<td>0.35</td>
</tr>
<tr>
<td>Iron* (ppm)</td>
<td>196</td>
<td>75</td>
<td>100</td>
<td>130</td>
</tr>
<tr>
<td>Manganese* (ppm)</td>
<td>107</td>
<td>99</td>
<td>60</td>
<td>64</td>
</tr>
<tr>
<td>Copper* (ppm)</td>
<td>5.98</td>
<td>1.27</td>
<td>1.25</td>
<td>2.33</td>
</tr>
<tr>
<td>Zinc* (ppm)</td>
<td>1.07</td>
<td>0.97</td>
<td>0.69</td>
<td>1.58</td>
</tr>
<tr>
<td>Aluminum* (ppm)</td>
<td>633</td>
<td>328</td>
<td>404</td>
<td>575</td>
</tr>
</tbody>
</table>

### OTHER TESTS

- **Soluble Salts (meq/100g)**
- **NO-N (ppm)** < 0.5
- **NH-N (ppm)** < 2.0
- **Total Acidity (ME/100 g)** < 0.5

* Mehlich III Extractable

**a - alkaline soil**