SOIL, LAND USE, LAND CAPABILITY AND AGRICULTURAL POTENTIAL ASSESSMENT REPORT:

PROPOSED TSHIVHASO COAL-FIRED POWER PLANT, NEAR LEPHALALE, LIMPOPO PROVINCE

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Reviewed by:

ARC-Institute for Soil, Climate and Water
Garry Patterson

EXECUTIVE SUMMARY

Savannah Environmental (Pty) Ltd has been appointed by Cennergi (Pty) Ltd, to undertake the required environmental studies for the establishment of the proposed Tshivhaso Coal-fired Power Plant and ash dump, situated in the Lephalale Local Municipality (Waterberg District Municipality) in the Limpopo Province. The proposed power plant and ash dump are situated approximately 25km west of Lephalale in the Limpopo Province.

This report discusses the approach, findings and conclusion of a desktop study carried out for the proposed area, taking into consideration existing information and findings of previous studies completed in the project area. The main objective of this investigation is to assess the likelihood of soil and agricultural sensitivities occurring on the study area in an effort to identify any issues regarding land use, land capability and erosion potential that may arise from the proposed development.

The purpose of the study is to:

- Provide a description of the environment that may be affected by the proposed activity and also provide a detailed description of the manner in which the environment may be affected by the proposed facility.
- Provide a description and assessment of the potential environmental issues associated with the proposed facility and identify required mitigation measures.
- Provide a reasoned opinion as to whether the proposed activity or portions thereof should be authorised.

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PROPOSED TSHIVHASO COAL-FIRED POWER PLANT AND ASH DUMP NEAR LEPHALALE, LIMPOPO PROVINCE.

1. INTRODUCTION

One site is being considered for the Power Station (Graaffwater/Goedehoop), along with a power line (Matimba-Medupi Loop-In). Various alternatives are being proposed for the placement of an ash dump.

The EIA level assessment includes the following:

- Legislative information.
- Collection of all available soil and land use data from sources such as AGRIS and detailed studies completed within the study area.
- Land type and topographical interpretation of the site and surrounding area.
- Describe the erosion and degradation status of the land.
- Determine the agricultural potential across the site.
- Identify and assess all potential direct, indirect and cumulative impacts of the proposed development on soils and agricultural potential.
- Provide recommendations for mitigation.

1.1 SPECIALIST DETAILS

The report was prepared by Jaco Jansen of Savannah Environmental, a Soil Scientist with an Honours degree in Environmental Geology and a BSc. in Geology and Chemistry from the University of the North West. This report was peer reviewed by Mr. Garry Patterson from the Agricultural Research Council.

1.2 DECLARATION OF INDEPENDENCE

A signed declaration of independence for both Jaco Jansen of Savannah Environmental and Garry Patterson are attached in Appendix A.

2. LEGISLATION

A review of the policy environment provides valuable insight into the government's priorities and plans. The review of the relevant planning and policy documents were undertaken as a part of the process. The key documents reviewed included:

- Conservation of Agricultural Resources (CARA) Act, No 43 of 1983; and
- Sub-division of Agricultural Land (SALA) Act, No 70 of 1970.

For the long term lease, or consent use of the properties proposed for the project, if leasing of portions or the subdivision of land is required for the project, an approval in terms of SALA is required. If the land (project site properties) is zoned as Agriculture, then an approval in terms of land use planning regulations may be required where the Department of Agriculture, Fisheries and Forestry (DAFF) is commenting authority.

DAFF is the custodian of all agricultural land and a commenting authority in terms of the planning regulation and EIA process. A separate CARA permit application is not required for this specific development proposal, but the project must be assessed for agricultural impacts during the EIA process.

The legislative and policy context plays an important role in identifying and assessing the potential soil and agricultural impacts associated with a proposed development. In this regards a key component of the process is to assess the proposed development in terms of its suitability with regards to the key planning and policy documents.

3. METHODOLOGY

This EIA report was conducted as a desktop study without any practical field investigation. Cognisance was however taken of previous studies undertaken in the area, including the agricultural potential impact assessment completed for the Thabametsi Power Station located just north of the proposed project site (and within the same land type) (Lanz, 2014). The findings and statements are based on existing information including that from the online Agricultural Geo-Referenced Information System (AGIS) website and the land type data along with its memoirs, produced by the Institute of Soil, Climate and Water (ISCW) which is part of the Agricultural Research Council (http://www.agis.agric.za/). Climate data was also obtained from the ISCW. Where the possibility of high potential soils for ***dryland cultivation*** exists, or where there is a reasonable probability of significant soil variation, a more detailed soil investigation would not only be desirable, but mandatory. However, neither of these conditions exist for the study area, so that the level of soil information obtained should be sufficient to allow the investigation to proceed.

The soil data is classified according to the Binomial Systems (Land Type Survey Staff, 1972-2006), used by the ISCW for land type data. All Maps included were attained from Google maps. Google Earth was used to acquire the most recent aerial photographs of the area and the site layout.

All potential impacts were assessed in terms of the following criteria:

- The **extent**, wherein it was indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 was assigned as appropriate (with 1 being low and 5 being high);
- The **duration**, wherein it was indicated whether:
- the lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1;
- the lifetime of the impact will be of a short duration (2-5 years) -

assigned a score of 2;
- medium-term (5–15 years) – assigned a score of 3;
- long term (> 15 years) - assigned a score of 4; or
- permanent - assigned a score of 5;
- The **magnitude**, quantified on a scale from 0-10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes;
- The **probability** *of occurrence*, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1–5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures);
- The **significance**, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high;

The **significance** is calculated by combining the criteria in the following formula:

S=(E+D+M)P
S = Significance weighting
E = Extent
D = Duration
M = Magnitude
P = Probability

The **significance weightings** for each potential impact are as follows:

- < 30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),
- 30-60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
- 60 points: High (i.e. where the impact must have an influence on the decision process to develop in the area).

4. DESCRIPTION OF THE AREA

The survey area is situated approximately 25km west of Lephalale in the Limpopo Province.

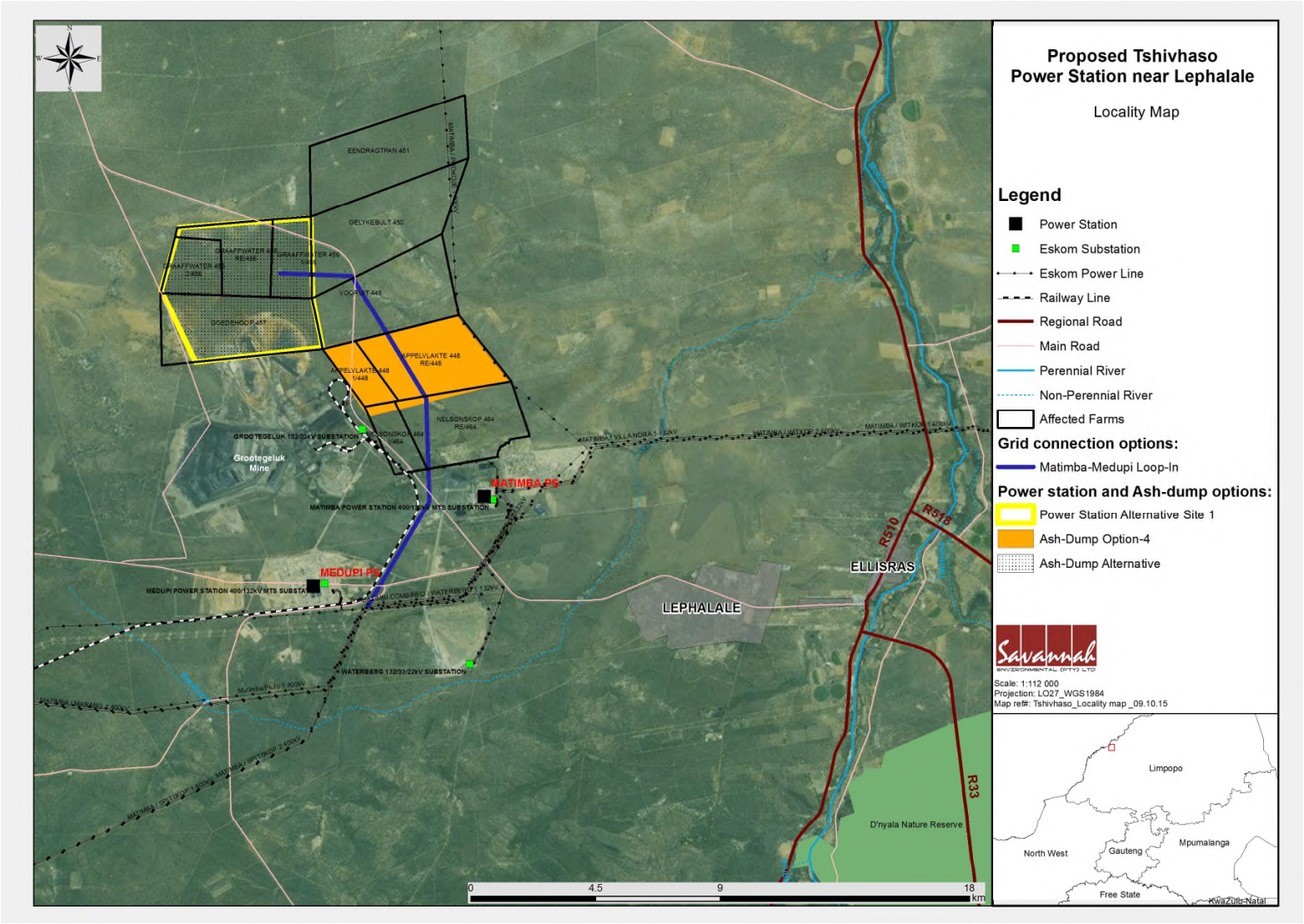

Figure 1: Map of the study area.

4.1 TERRAIN

The site has a relatively flat topography that varies between 880m and 920m. The proposed development is located on the terrain type A1 and A2: level plains and plains with some relief (Kruger, Terrain map of SA). The area has a uniform gradient below 5% (Land Type Survey Staff, 1972-2006).

4.2 CLIMATE

The average annual rainfall for the site is in the region of 350 – 400mm. This amount of rain and high temperatures, combined with the vegetation give the area a bushveld climate with long hot summers and short dry winters. Moisture availability is classified into 6 categories across the country (see Table 1). The proposed development site falls within class 4 which is described as a moderate to severe limitation to agriculture.

Table 1: The classification of moisture availability climate classes for summer rainfall areas across South Africa (Agricultural Research Council, Undated)

Climate class	Moisture availability (Rainfall/0.25 PET)	Description of agricultural limitation
C1	>34	None to slight
C2	27-34	Slight
C3	19-26	Moderate
C4	12-18	Moderate to severe
C5	6-12	Severe
C6	<6	Very severe

4.3 SOILS & GEOLOGY

The underlying geology is dominated by sedimentary rocks such as sandstone and siltstone. Different soil properties are all available on the AGIS website. The most relevant properties are described here:

The generalised soil pattern for the area is CM which is red soils with a high base status, and AR2 which may be described as red and yellow, sandy well drained soils with a high base status and minimal development, with or without intermittent diverse soils.

Oxidic soils have a B horizon that has a colour directly related to the mineralogy of the area. Soil classes provided by the source indicate that freely drained, unstructured soils occur on more than 60% of the site. Soil horizons indicative of the group are Clovelly and Hutton.

There are also cumilic soils present which are complementary to the lithosols but are found in lower areas of the landscape where deposition is ongoing (Fey, 2010). Soil horizons indicative of the cumulic group are neocutanic or neocarbonate B, regic sand, deep E or stratified alluvium and carbonate which occur in Tukulu, Oakleaf, Montagu, Augrabies, Namib, Vilafontes, Kinkelbos, Fernwood, Coega, Plooysburg and Dundee soil

forms (Fey, 2010). It is unlikely that most of these cumulic soil forms are present on site.

Land type Ah85 and AH86 covers the largest area within the study area. Red and yellow well-drained sandy soils with a high base status occur. The main soil forms present are Clovelly and Hutton. An Orthic A horizon rarely deeper than 200mm is found directly on top of a Red Apedal B or Yellow-Brown Apedal B. There are plinthic horizons present and sandy soil occurs at depth in the area.

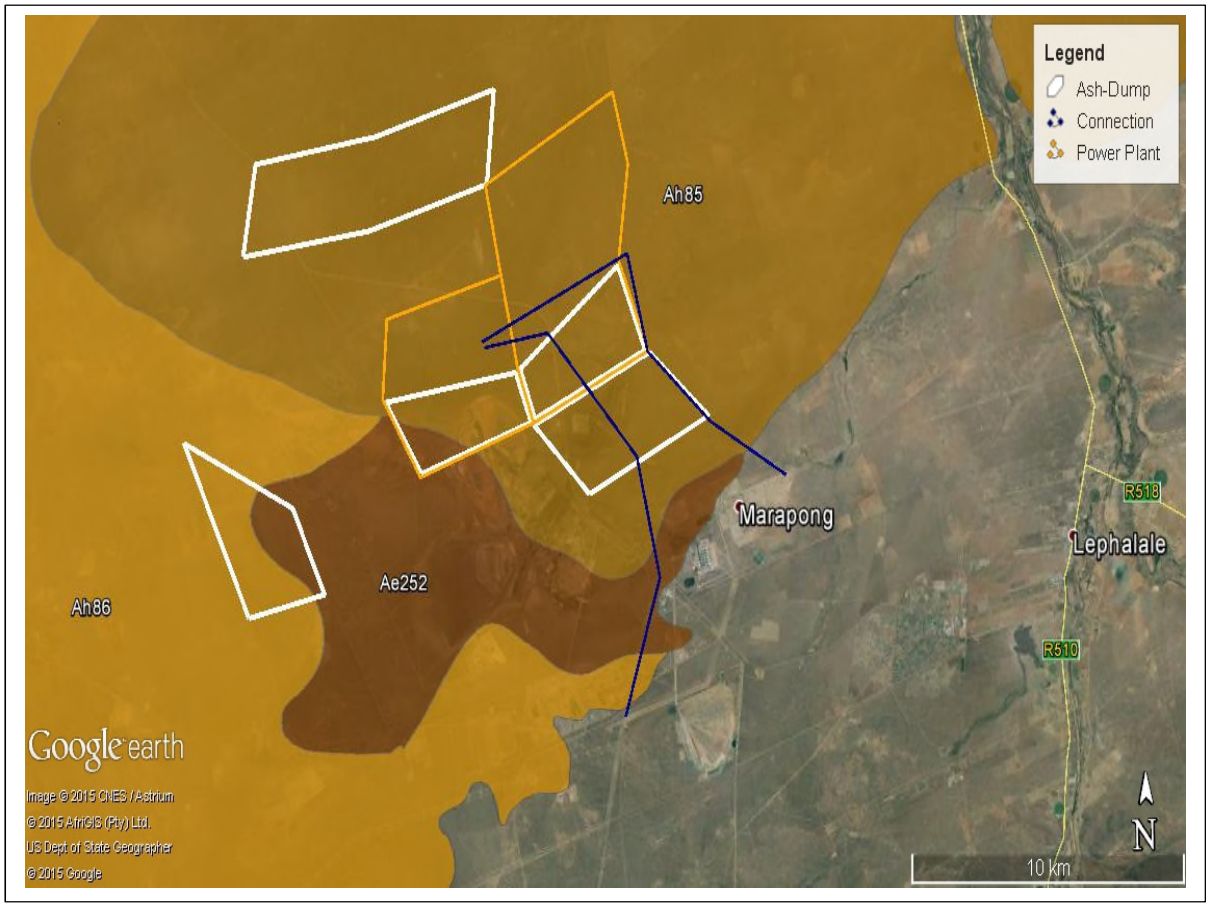

Figure 2: *Land types of the proposed area*

Land type Ae252 covers a small area of the site and is very similar to the land type Ah. The land type does not contain plinthic Longlands soil form such as Ah. The unshaded area is not considered in the study as it has no development proposed on it. Soils in this area are fairly similar to the other two areas which are described.

4.4 AGRICULTURAL POTENTIAL

Table 1: Land Type Survey Staff: Land capability/Agricultural Potential

Class	Concepts
I	Land in Class I has few limitations that restrict its use; it may be used safely and profitably for cultivated crops; the soils are nearly level and deep; they hold water well and are generally well drained; they are easily worked, and are either fairly well supplied with plant nutrients or are highly responsive to inputs of fertilizer; when used for crops, the soils need ordinary management practices to maintain productivity; the climate is favourable for growing many of the common field crops.
II	Land in Class II has some limitations that reduce the choice of plants or require moderate conservation practices; it may be used for cultivated crops, but with less latitude in the choice of crops or management practices than Class I; the limitations are few and the practices are easy to apply.
III	Land in Class III has severe limitations that reduce the choice of plants or require special conservation practices, or both; it may be used for cultivated crops, but has more restrictions than Class II; when used for cultivated crops, the conservation practices are usually more difficult to apply and to maintain; the number of practical alternatives for average farmers is less than that for soils in Class II.
IV	Land in Class IV has very severe limitations that restrict the choice of plants, require very careful management, or both; it may be used for cultivated crops, but more careful management is required than for Class III and conservation practices are more difficult to apply and maintain; restrictions to land use are greater than those in Class III and the choice of plants is more limited.
V	Land in Class V has little or no erosion hazard but has other limitations which are impractical to remove that limit its use largely to pasture, range, woodland or wildlife food and cover. These limitations restrict the kind of plants that can be grown and prevent normal tillage of cultivated crops; it is nearly level; some occurrences are wet or frequently flooded; others are stony, have climatic limitations, or have some combination of these limitations.
VI	Land in Class VI has severe limitations that make it generally unsuited to cultivation and limit its use largely to pasture and range, woodland or wildlife food and cover; continuing limitations that cannot be corrected include steep slope, severe erosion hazard, effects of past erosion, stoniness, shallow rooting zone, excessive wetness or flooding, low water-holding capacity; salinity or sodicity and severe climate.
VII	Land in Class VII has very severe limitations that make it unsuited to cultivation and that restrict its use largely to grazing, woodland or wildlife; restrictions are more severe than those for Class VI because of one or more continuing limitations that cannot be corrected, such as very steep slopes, erosion, shallow soil, stones, wet soil, salts or sodicity and unfavourable climate.
VIII	Land in Class VIII has limitations that preclude its use for commercial plant production and restrict its use to recreation, wildlife, water supply or aesthetic purposes; limitations that cannot be corrected may result from the effects of one or more of erosion or erosion hazard, severe climate, wet soil, stones, low water-holding capacity, salinity or sodicity.

Land capability is the combination of soil suitability and climate factors. The eight-class land capability system from Klingebiel & Montgomery which was drafted in 1961, provides a way in which agricultural potential data for the country can be measured on a macro scale, grouping similar areas together. The available data was adapted for use with GIS in South Africa and made available by the Land Type Survey Staff under the ISCW.

The entire area for the proposed Power Plant is Land Class V – little or no erosion hazard but has other limitations which are impractical to remove that limit its use mainly to grazing and habitat for wildlife. Agricultural limitations are the sandy texture of the soils, which limits their water and nutrient holding capacity, and the limited climatic moisture availability. . The area proposed for the power line and ash dump have the same agricultural potential as the power plant.

Moisture availability is an aridity index which provides desktop understanding of the susceptibility to dryness and desertification across an area. Information may be processed to assume with what degree of ease potential evapotranspiration takes place whilst bearing in mind measured rainfall set against potential evaporation, providing clarity and practical understanding of the plant available water. The area has a moisture availability of class 4 which equates to moderate to severe limitations accompanied by low and unreliable rainfall. Temperature and rainfall variations are high and restrict regular crop production. Various factors have constraints that prohibit crop production and lead to insignificant agricultural activities except that of grazing.

4.5 SUSCEPTIBILITY TO EROSION

The soils are highly susceptible to wind erosion where pure sands are strongly dominant. The measure as to how easy soil may erode by means of wind transportation is given below:

- Fine silt and clay (<0.01 mm) offer strong resistance to movement.
- Coarse silt and very fine sand (0.01-0.1 mm) .
- Very fine to medium sand (0.1-0.5 mm) is subjected to saltation.
- Coarse sand (0.5-1.0 mm) moves as surface creep

Soils on the site have below 10% dominant clay in the top soils.

The soils have a low susceptibility to water erosion which varies across the site. The general assumption is that the erosion susceptibility increases with an increase in the slope angle and/if the slope length is constant.

5. POTENTIAL ENVIRONMENTAL IMPACTS

According to the NEMA Regulations, a significant impact means an impact that by its magnitude, duration, intensity or probability of occurrence will have a notable effect on one or more aspects on the environment.

In line with the Regulations, and based on qualitative findings of the activities, each potentially significant impact is therefore assessed with regard to:

- The nature of the impact (status which may be positive, negative or neutral);

- The extent and the duration of the impact;
- The probability of the impact occurring;
- The degree to which the impact can be reversed;
- The degree to which the impact may cause irreplaceable loss of resources;
- The degree to which the impact can be mitigated; and
- Cumulative and residual impacts.

Within this framework, there is a responsibility to propose mitigation or enhancement measures where relevant in order to reduce the significance of the negative impact and increase the significance of a positive impact.

The construction phase of the proposed Power Plant will have some potential negative environmental impacts on the soil of the area such as:

- The loss of agricultural grazing land due to the direct impact by the infrastructure's footprint during the developmental stage of the project and thereafter, i.e. all phases.
- A change in the natural condition of the site may lead to significant erosion of the soils unless appropriate management is implemented. Once the surface characteristics are changed through anthropogenic means, wind and water will change the land surface of the site. Construction of roads – gravel or tar - will subject moderate - large surface areas of the land to erosion and transportation vulnerability and this could potentially be the biggest impact during the construction phase.
- Vegetation removal will definitely occur and may lead to open patches which are susceptible to the elements. Erosion can result in great loss and deterioration of soil resources and may occur during all phases of the project unless appropriate management is implemented.
- Poor topsoil management may lead to the loss of nutrient rich topsoil. Levelling of slopes/topographical high points, excavations for discharge water and building rubble storage.
- Soil contamination due to accidental spills of fuel and hydraulic fluid when drilling into soil etc.
- Soil compaction by heavy vehicle movement, excavation operations, soil removal and restoration
- Wind erosion through disturbance of topsoil which leads to structural degradation.

Based on the above, the major potential impacts on the natural resources of the study area would be: 1) the loss of land available for agricultural activities due to the construction of the various types of infrastructure, 2) potential increased risk of soil erosion, and 3) impacts on soil resources as a result of contamination. As previously mentioned, the loss of agricultural land would be permanent, but the prevailing low dryland production potential would lessen the impact somewhat. Wind erosion would be limited in significance if properly mitigated.

The impacts can be summarized as follows:

Table 3 Impact significance

Nature of impact	**Loss of agricultural land**	Land that is no longer able to be utilized due to construction of infrastructure
Extent of impact	Site only	Confined to areas within the site where infrastructure will be located
Duration of impact	Permanent	Rehabilitation to pre-construction conditions will not be possible
Probability of impact	Highly probable	
Severity of impact	Low	
Significance of impact	Low	Mainly due to low potential of area, as well as nature of infrastructure
Mitigation factors	The main mitigation would be to ensure that as little pollution or other non-physical disturbance occurs, especially with the construction of storage areas, such as ash dumps etc. Before such structures are established, topsoil to a depth of at least 300 mm should be removed and stockpiled for later rehabilitation purposes.	

The low rainfall and hot conditions in the area, despite the generally deep loamy sand soils, mean that the prevailing dryland arable agricultural potential is low, so any impacts on this will be minimal.

Table 4 Impact significance

Nature of impact	**Increased risk of soil erosion by wind**	Removal of topsoil by the action of wind due to removal of vegetation
Extent of impact	Local	Possibly occurring on areas around project site
Duration of impact	Long-term	Will cease only when operation of activity ceases
Probability of impact	Highly probable	Especially if vegetation is removed over a wide area
Severity	Low	Especially if mitigation measures are put in

of impact		place and applied
Significance of impact	Low	Mainly due to low potential of area, as well as nature of infrastructure
Mitigation factors	The main mitigation would be to ensure that the footprint for vegetation removal is restricted to the minimum necessary for the various construction phases of the project. In addition, appropriate soil conservation measures to combat wind erosion (windbreaks, geotextiles on the soil surface and immediate re-establishment of vegetation) should be implemented and monitored on at least a six-monthly basis.	

Due to the predominance of very sandy soils, often with a fine grade of sand, the hazard of ***wind erosion*** when the topsoil is disturbed may be significant if not mitigated, as these areas are mapped as "highly susceptible" (ARC-ISCW, 2004).

Table 5 Impact significance

Nature of impact	**Cumulative impacts**	Impacts that may be exacerbated due to adjacent or nearby developments, or due to other facets of proposed development on site
Extent of impact	Regional	Possibly occurring on areas around project site
Duration of impact	Long-term	Will cease if operation of activity ceases
Probability of impact	Highly probable	Especially if vegetation is removed over a wider area than the proposed project site
Severity of impact	Low	Especially if mitigation measures are put in place and applied for all projects in the area
Significance of impact	Low	Mainly due to low potential of area, as well as nature of infrastructure
Mitigation factors	The main mitigation would be to ensure that the footprint for vegetation removal is as restricted as possible. In addition, appropriate soil conservation measures to combat wind erosion (windbreaks, geotextiles on the soil surface and immediate re-establishment of vegetation) should be implemented and monitored on at least a six-monthly basis	

The main potential cumulative impact would be soil removal due to wind erosion caused by developments off site. Due to the nature of the soil removal process, once topsoil is taken up into the atmosphere, wind action can deposit it over a large area and at a considerable distance, depending on the strength and duration of the wind acting upon the soils.

6. OVERALL SOIL IMPACTS

The overall impacts of the proposed facility on agricultural potential and soil conditions will be moderate but permanent. Mainly because of the climatic conditions and the low agricultural and grazing potential of the site the impacts are reduced. There have never been any substantial commercial farming practices on the property because of the dominant climatic conditions and prevailing soil conditions.

Soil and rock type properties tend to be very homogenous in the area and the whole site can be more efficiently utilised for power generation than any other practise. This is not regarded as a viable commercial dryland farming site and would be suited to house the Power Plant and Ash dump.

8. CONCLUSION & RECOMMENDATIONS

In conclusion, this assessment found that the proposed development of the Power Plant, Ash dump and connection has no fatal flaws and will not have a large enough impact on the current land use to warrant its rejection. The main reason for the project not having a large impact is that the land use is currently limited to grazing and has limitations in terms of agricultural potential.

Although the area is currently classified as grazing land, there is evidence that the capacity to support livestock is very small and surrounding areas would suffice for grazing alternatives were this facility to be developed. Dust generation from construction would be a significant and ongoing impact requiring management.

Soil erosion is likely to be the most significant impact on soils. Loose topsoil has to be managed as well, or wind will lead to surface creep of the sand and loss of nutrient rich top soil. Mitigation procedures will ensure that medium to long term impacts may be avoided or at least reduced.

No preference can be given for the alternative areas to be occupied by either the plant or ash dump at this stage.

9. REFERENCES

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APPENDIX A: LAND TYPE DATA

LAND TYPE / *LANDTIPE* .... : **Ah85**
CLIMATE ZONE / *KLIMAATSONE* .... : 884S
Area / *Oppervlakte* .... : 114065 ha
Estimated area unavailable for agriculture
Beraamde oppervlakte onbeskikbaar vir landbou : 500 ha

Occurrence (maps) and areas / *Voorkoms (kaarte) en oppervlakte* :
2326 Ellisras (114065 ha)

Inventory by / *Inventaris deur* :
D G Paterson & D Haarhoff

Modal Profiles / *Modale profiele* :
P1447
1309

Terrain unit / *Terreineenheid*	1	3	4	5
% of land type / *% van landtipe*	5	30	60	5
Area / *Oppervlakte (ha)*	5703	34220	68439	5703
Slope / *Helling (%)*	1 - 2	1 - 3	0 - 1	1 - 2
Slope length / *Hellingslengte (m)*	200 - 600	500 - 3000	3000 - 8000	50 - 250
Slope shape / *Hellingsvorm*	Y	Z	Z	X
MB0, MB1 (ha)	5532	33193	68439	4848
MB2 - MB4 (ha)	171	1027	0	855

Soil series or land classes *Grondseries of landklasse*	Depth *Diepte* (mm)	MB:	1 ha	1 %	3 ha	3 %	4 ha	4 %	5 ha	5 %	Total *Totaal* ha	Total %	Clay content % *Klei-inhoud %* A	E	B21	Hor	Texture *Tekstuur* Class / *Klas*	Depth limiting material *Diepte-beperkende materiaal*
Roodepoort Hu30, Gaudam Hu31, Mangano Hu33, Zwartfontein Hu34	>1200	0	1654	29	16426	48	31482	46			49561	43.5	2-5		4-12	B	fi/meSa-LmSa	
Sunbury Cv30, Sandspruit Cv31, Annandale Cv33, Makuya Cv34	>1200	0	1141	20	9239	27	22585	33			32965	28.9	2-7		4-12	B	fi/meSa-LmSa	
Moriah Hu32, Portsmouth Hu35	>1200	0	1597	28	4106	12	5475	8			11178	9.8	2-4		4-8	B	coSa-LmSa	
Maputa Fw10, Fernwood Fw11	>1200	0			1027	3	3422	5			4449	3.9	1-3		2-6	B	fi/meSa	
Heidelberg Av34	300-1000	0			1027	3	2738	4	399	7	4163	3.7	4-8		8-12	B	LmmeSa-SaLm	sp
Denhere Cv35	>1200	0	1141	20	1369	4	1369	2			3878	3.4	6-10		6-15	B	coSa-LmSa	
Levubu Oa34, Jozini Oa36, Limpopo Oa46	800-1200	0							2623	46	2623	2.3	10-15		12-30	B	meSaLm-SaClLm	so
Herschel Va30, Arniston Va31, Katspruit Ka10, Longlands Lo21	200-800	0							1825	32	1825	1.6	8-12	8-12	15-40	B	fi/meSaLm-SaCl	sp,gc
Shorrocks Hu36, Shigalo Hu46	>1200	0					1369	2			1369	1.2	10-15		18-25	B	meSaLm-SaClLm	
Mispah Ms10, Loskop Ms12, Muden Ms20	50-150	3	171	3	1027	3					1198	1.1	5-15			A	fi/meSa-SaLm	R,ca
Stream beds/Stroombeddings		4							855	15	855	0.8						

LAND TYPE / *LANDTIPE* .... : **Ah85** Continued / *Vervolg*
Terrain type / *Terreintipe* : A2
Terrain form sketch / *Terreinvormskets*

For an explanation of this table consult LAND TYPE INVENTORY (table of contents)
Ter verduideliking van hierdie tabel kyk LANDTIPE - INVENTARIS (inhoudsopgawe)

Geology: Karoo Sequence: sandstone and siltstone of the Clarens Formation as well as undifferentiated shale, sandstone, mudstone and coal.

Geologie: Opeenvolging Karoo: sandsteen en sliksteen van die Formasie Clarens asook ongedifferensieerde skalie, sandsteen, moddersteen en steenkool.

LAND TYPE / *LANDTIPE* : **Ah86**

CLIMATE ZONE / *KLIMAATSONE* : 884S

Area / *Oppervlakte* : 193890 ha

Estimated area unavailable for agriculture

Beraamde oppervlakte onbeskikbaar vir landbou : 1000 ha

Occurrence (maps) and areas / *Voorkoms (kaarte) en oppervlakte* :

2326 Ellisras (193890 ha)

Inventory by / *Inventaris deur* :

D G Paterson & D Haarhoff

Modal Profiles / *Modale profiele* :

P1449 P1453

1311 1315

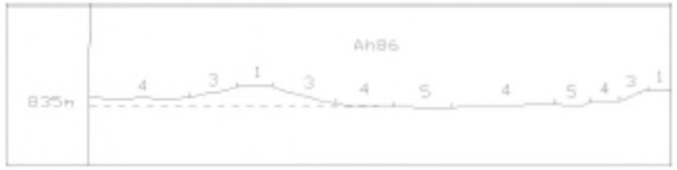
Terrain unit / *Terreineenheid*	1	3	4	5
% of land type / *% van landtipe*	2	10	83	5
Area / *Oppervlakte (ha)*	3878	19389	160929	9694
Slope / *Helling (%)*	1 - 2	1 - 2	0 - 1	1 - 3
Slope length / *Hellingslengte (m)*	250 - 800	500 - 1600	3000 - 8000	50 - 300
Slope shape / *Hellingsvorm*	Y	Z	Z	X
MB0, MB1 (ha)	3878	19389	160929	8240
MB2 - MB4 (ha)	0	0	0	1454

Soil series or land classes *Grondseries of landklasse*	**Depth** *Diepte* (mm)	MB	ha	%	ha	%	ha	%	ha	%	**Total** *Totaal* ha	%	**Clay content %** *Klei-inhoud %* A	E	B21	Hor	**Texture** *Tekstuur* Class / *Klas*	*Diepte-beperkende materiaal*
Bonfberg Hu25, Portsmouth Hu35	>1200	0	2327	60	10664	55	69199	43			82190	42.4	2-6		6-12	B	coSa-LmSa	
Sebakwe Cv22, Soweto Cv15	>1200	0	1551	40	8725	45	61153	38			71429	36.8	2-6		5-12	B	coSa-LmSa	
Shorrocks Hu36	>1200	0					6437	4	2424	25	8861	4.6	8-15		15-25	B	me/coSaLm-SaClLm	
Tweefontein Cv20, Ofuzi Cv23, Annandale Cv33, Maputa Fw10	>1200	0					8046	5			8046	4.2	2-6		5-12	B	fiSa-LmSa	
Chester Hu22, Moriah Hu32	>1200	0					8046	5			8046	4.2	2-4		3-6	B	coSa	
Vaalsand Lo31	500-900	0					3219	2	1939	20	5157	2.7	4-8	6-12	15-25	E	coSa-LmSa	sp
Windmeul Av35, Newcastle Av25, Soetmelk Av36, Uitskot Gc35	600-1200	0					3219	2	485	5	3703	1.9	2-8		8-20	B	Lmme/coSa-SaLm	sp,hp
Lindley Va41, Limpopo Oa46, Mutale Oa47, Killarney Ka20	400-1200	0							2908	30	2908	1.5	20-30		30-50	B	SaClLm-Cl	gc
Blinkklip Cv36	>1200	0					1609	1	485	5	2094	1.1	6-12		15-25	B	me/coSaLm-SaClLm	
Pans/Panne		4							1454	15	1454	0.8						

Depth limiting material

Terrain type / *Terreintipe* : A2

Terrain form sketch / *Terreinvormskets*



For an explanation of this table consult LAND TYPE INVENTORY (table of contents)

Ter verduideliking van hierdie tabel kyk LANDTIPE - INVENTARIS (inhoudsopgawe)

Geology: Sandstone and mudstone of the Matlabas Subgroup, Waterberg Group; undifferentiated shale, sandstone and coal of the Karoo Sequence; also alluvium.

Geologie: Sandsteen en moddersteen van die Subgroep Matlabas, Groep Waterberg; ongedifferensieerde skalie, sandsteen, moddersteen en steenkool van die Opeenvolging Karoo; ook alluvium.

LAND TYPE / *LANDTIPE* ..... : **Ae252**

CLIMATE ZONE / *KLIMAATSONE* ..... : 884S

Area / *Oppervlakte* ..... : 7951 ha

Estimated area unavailable for agriculture
Beraamde oppervlakte onbeskikbaar vir landbou : 50 ha

Occurrence (maps) and areas / *Voorkoms (kaarte) en oppervlakte* :
2326 Ellisras (7951 ha)

Inventory by / *Inventaris deur* :
D G Paterson & D Haarhoff

Modal Profiles / *Modale profiele* :
None / Geen

Terrain unit / *Terreineenheid* ..... :	4	5
% of land type / *% van landtipe* ..... :	95	5
Area / *Oppervlakte (ha)* ..... :	7553	398
Slope / *Helling (%)* ..... :	0 - 1	1 - 2
Slope length / *Hellingslengte (m)* ..... :	1000 - 5000	50 - 100
Slope shape / *Hellingsvorm* ..... :	Z	Z-X
MB0, MB1 (ha) ..... :	6723	358
MB2 - MB4 (ha) ..... :	831	40

Soil series or land classes *Grondseries of landklasse*	**Depth** *Diepte* (mm)	MB:	ha	%	ha	%	**Total** *Totaal* ha	%	**Clay content %** *Klei-inhoud %* A	E	B21	Hor	**Texture** *Tekstuur* Class / *Klas*	**Depth limiting material** *Diepte-beperkende materiaal*
Shigalo Hu46	900-1200	0 :	5967	79			5967	75.1	8-15		15-25	B	me/coSaLm-SaClLm	so
Mispah Ms10, Muden Ms20	50-250	3 :	831	11	40	10	871	11.0	12-20			A	me/coSaLm	R,ca
Portsmouth Hu35	>1200	0 :	604	8			604	7.6	4-8		10-15	B	LmcoSa-SaLm	
Levubu Oa34, Jozini Oa36,		:												
Limpopo Oa46	>1200	0 :			279	70	278	3.5	6-12		12-25	B	meSaLm-SaClLm	
Shorrocks Hu36	1000-1200	0 :	151	2	80	20	231	2.9	8-16		15-20	B	me/coSaLm	ca

Terrain type / *Terreintipe* : A2

Terrain form sketch / *Terreinvormskets*

For an explanation of this table consult LAND TYPE INVENTORY (table of contents)
Ter verduideliking van hierdie tabel kyk LANDTIPE - INVENTARIS (inhoudsopgawe)

Geology: Shale, sandstone, mudstone and coal of the Karoo Sequence.

Geologie: Skalie, sandsteen, moddersteen en steenkool van die Opeenvolging Karoo.

APPENDIX B: DATA SHEETS

SUSCEPTIBILITY TO WATER EROSION

Soil erodibility index

Basic Index	Criterion	Class limits	Value subtracted from basic index
10	Clay Content (%)	0-6	4
		7-15	3
		16-35	2
		36-55	1
		>55	0
	Leaching status	Dystrophic	0
		Mesotrophic	1
		Eutrophic and undifferentiated	2
		Calcareous	3
	Structure and transition	Orthic A	1
		E horizon	1
		Neocutanic B	1
		Clear transition from A to B	1
		Abrupt transition from A to B	2
	Depth (m)	Soil depth >0.4	0
		Soil depth <0.4	1

Erosion susceptibility classes

Class	Class description	Slope gradient (%)	Water Erodibility Index
1	Land with low susceptibility to water erosion. Generally level to gently sloping.	0-5	8-10
	Soils have favourable erodibility index.	0-3	5-10
2	Land with low to moderate susceptibility to water erosion.	5-8	8-10
	Generally gently to moderately sloping. Soils have low to moderate erodibility.	3-5	5-10
3	Land with moderate susceptibility to water erosion.	8-12	8-10
	Generally moderately sloping land. Soils have low to moderate erodibility.	5-8	4-10
4	Land with moderate to high water or wind erosion hazard. Generally moderately to strongly sloping land.	12-20	8-10
	Soils have low to moderate erodibility	5-12	3-10
5	Land with low to moderate water or wind erosion hazard. Generally level to gently sloping land; soils may have low to very high erodibility.	0-5	0-10
6	Very steep slopes with soils with low water erodibility	20-40	8-10
	Moderately to strongly sloping land with soils of low to high water erodibility	12-20	0-10
	Moderately sloping land with soils of very high erodibility.	5-12	0-2
7	Land with very steep slopes, causing severe erosion hazard or past erosion. Soils may have low to very high erodibility.	20-40	0-10
8	Land with extremely steep slopes. Soils may have low to very high erodibility.	40-100	0-10

SUSCEPTIBILITY TO WIND EROSION

Class	Class description	Dominant clay % of qualifying topsoils	Percentage qualifying soil in land type
1a	Pure sands strongly dominant	0-5	75-100
1b	Pure sands dominant		50-75
1c	Pure sands sub-dominant		25-50
1d	Pure sands present		10-25
2a	Sands strongly dominant	6-10	75-100
2b	Sands dominant		50-75
2c	Sands sub-dominant		25-50
2d	Sands present		10-25
3a	Loamy sands strongly dominant	11-15	75-100
3b	Loamy sands dominant		50-75
3c	Loamy sands sub-dominant		25-50
3d	Loamy sands present		10-25
4a	Sandy loams strongly dominant	15-20	75-100
4b	Sandy loams dominant		50-75
4c	Sandy loams sub-dominant		25-50
4d	Sandy loams present		10-25
5	Sandy clay loams to clays	>20	<10

MOISTURE AVAILABILITY

Class	Limitation Rating	Description	Moisture availability class	
			Summer rainfall area: Oct-Mar TMR10. 0.25 $PE10^{-1}$	Winter rainfall area: Apr-Sep TMR10. 0.40 $PE10^{-1}$
1	None to slight	Favourable for growing a wide range of adapted crops.	>50	>58
2	Slight	Less favourable than Class 1 and may limit choice of crops or yields.	36-50	34-58
3	Moderate	Water stress, extremes of temperature and/or damage from frost, wind or hail restrict choice of crops and yield potential.	26-36	24-34
4	Moderate to severe	Less favourable than Class 3. Low and unreliable rainfall, extremes in temperature and severe damage from frost or wind restrict regular crop production. Risks in cropping are high.	18-26	16-24
5	Severe	Unfavourable (mainly rainfall) for growing crops.	10-18	10-16
6	Very severe	Unfavorable for plant production. One or more of the following extremes occur: - Severe aridity - Extremes in temperature	<10	<10

GENERALIZED SOIL PATTERNS

Red-yellow well drained soils generally lacking a strong texture contrast	
FR	Red and yellow soils with a humic horizon

AC	Red and yellow, massive or weakly structured soils with low to medium base status
CM	Red, massive or weakly structured soils with high base status
Soils with a plinthic catena	
PT1	Red, yellow and greyish soils with low to medium base status
PT2	Red, yellow and greyish soils with high base status
Well-structured soils generally with a high clay content	
LV1	Soils with a marked clay accumulation, strongly structured and a reddish colour
LV2	Soils with a marked clay accumulation, strongly structured and a non-reddish colour. In addition one or more of vertic, melanic and plinthic soils may be present
Soils with limited pedological development	
VR	Dark coloured, strongly structured soils dominated by cracking and swelling clays (vertic soils). In addition, one or more of melanic and red structured soils may be present
PH/KS	Soils with dark coloured, well-structured topsoil with high base status (melanic soils). In addition, one or more of vertic and red structured soils may be present
NT	Deep, well drained, dark reddish soils having a pronounced shiny, strong blocky structure (nutty), usually fine (red structured soils). In addition, one or more of vertic and melanic soils may be present
Sandy soils	
LP1	Soils with minimal development, usually shallow on hard or weathering rock, with or without intermittent diverse soils. Lime rare or absent in the landscape
LP2	Soils with minimal development, usually shallow on hard or weathering rock, with or without intermittent diverse soils. Lime generally present in part or most of the landscape
FL	Soils with negligible to weak profile development, usually occurring on deep deposits
Sandy soils	
AR1	Red, excessively drained sandy soils with high base status - dunes are present
AR2	Red and yellow, sandy well drained soils with high base status
AR3	Greyish, sandy excessively drained soils
Strongly saline soils	
SC	Strongly saline soils generally occurring in deep deposits on flat lands
Podzolic soils	
PZ	Soils with a sandy texture, leached and with sub-surface accumulation of organic matter and aluminum with or without iron oxides, either deep or on hard or weathering rock
Rocky areas	
R	Rock with limited soils