Earth Science Solutions

Project No: WC.KPS.S.12.08.00

ESKOM KUSILE POWER STATION
60 Year Ash DisposalFacility

Alternative Assessment Project

Inclusive of Detail – Site B

SPECIALIST SOILS & LAND CAPABILITY ALTERNATIVES ASSESSMENT

Compiled For

ZITHOLELE CONSULTING

FINAL REPORT

Sustaining the Environment

June 2014

ESKOM KUSILE POWER STATION
60 Year Ash Disposal Facility
Alternative Assessment Project

Compiled for
Zitholele Consulting

Report Number: Draft Baseline report
Client: Zitholele Consulting
Attention: Mr Mathys Vosloo

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Author	Ian Jones	Director ESS (Pty) Ltd		09th June 2014
Project Director	Mathys Vosloo	Project Leader		
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Stonecap Trading 14 (Pty) Ltd

Our Ref: WC.KPS.S.12.08.00
Your Ref: 12712

09th June 2014

Zitholele Consulting
P.O. Box 6002
Halfway House
1685
Gauteng
South Africa

011 2072060, 0866746121, mail@zitholele.co.za

Attention: Mathys Vosloo

Dear Sir,

Re: ESKOM KUSILE POWER STATION – 60 YEAR ASH DISPOSAL FACILITY - SITE SELECTION BASELINE SOIL ASSESSMENT OF ALTERNATIVE SITES

Attached please find the baseline assessment of the soils for the various alternative sites being considered for the 60 Year Ash Disposal Facility to service the Eskom Kusile Power Station that is being constructed.

The report details the results of the reconnaissance field assessment, and offers reason for the selection of the candidate site in terms of the soils. This study includes the findings and additional work undertaken in the more detailed assessment of Site "B", an alternative that was considered viable by the authority.

Should you have any queries in this regard, please do not hesitate to contact us.

Yours sincerely
Earth Science Solutions (Pty) Ltd

Ian Jones
Director

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Soils:

The Eskom Kusile Power Station is under construction and will require as part of its operational infrastructure an Ash Disposal facility for the containment of the by-product produced from the burning of coal.

The purpose of these reconnaissance specialist studies was to assess the pre-development/pre-construction footprint of a number of possible sites that were earmarked by the client as possible sites for the Ash Disposal Facility. The specialist soils and land capability is part of the larger environmental assessment and assimilation of scientific input need for the selection of a candidate site, while the recommended alternative(s) have been further investigated in terms of the EIA (Sites A and B).

With a substantial amount of construction having been undertaken to date at the power station, and with the large footprint that will be impacted by the New Largo Mining Venture (Large Open Cast Dragline Operation) that will supply the Kusile Power Plant with its coal, significant and large areas of ground/land in and around the proposed sites of interest have already been impacted and the soils disturbed.

The five sites and combinations of sites vary in soil characteristics from highly sensitive wet based materials to deep well drained and highly productive materials, with a variety of geomorphological (geological and topographical etc.) having an influence on the conditions mapped.

The soil characteristics considered important in this evaluation comprise, soil depth, soil structure, clay content and soil wetness. The alternative assessment has been considered in terms of the present or existing soil utilisation potential or land capability, and as such does not place large weightings on the utilisation of the soil in terms of rehabilitation and workability, albeit that these aspects have been considered as part of the overall sustainability of a project of this nature.

The mapping and interpretation of this assessment has been undertaken in terms of the South African environmental legislation and the best practise guidelines as specified in terms of the international norms and best practise as a minimum requirement (IFC Principles)

A walk over reconnaissance study of all of the proposed sites was undertaken by a qualified earth scientist as part of the site selection process to assess the soils and land capability of the areas (A, B, C, F & G)

The major findings revealed:

- Marked differences in the geomorphology of the sites;
- Differences in soil depth;
- Differences in the texture of the soils (clay content and grain size);
- Significant differences in the area of wet based soils across the areas of concern and the functionality of/impact on the wet based soils varies;
- Similarities for the most part in soil structure (apedel to weak crumby structures);
- Subtle but significant topographical differences in some of the areas across the site alternatives;
- Significant differences in the land use and social impact on areas surveyed;

The soils are highly influenced by the parent materials from which they are formed (fine to medium grained sediments for the most part, with areas of quartzite) and by the subtle but variable topography that results in a net positive erosive environment. The attitude of the underlying lithologies (generally flat lying/horizontal) and the negative water balance (evaporation is higher than rainfall) has also had an influence on the weathering processes at work and the pedogenetic mechanisms (soil forming) that contribute to the soil forms mapped.

There are soils with varying degrees of structure, from apedel and single grained silty and sandy loams to sandy clay loams, and those with slightly stronger structure (crumby to slight blocky) associated with the more clay rich soils that are generally found as colluvial accumulations in the lower slope and bottom lands, while the alluvial flood plains that make up the wide valley deposits are significantly more clay rich and stronger in structure (glaycutanic and vertic structures with clays typically in excess of 50%).

The hydromorphic soils are also highly variable, with lower mid-slope transitional form soils that comprise sandy clay to loamy subsoils and sandy topsoil, to highly saturated and structured wetland soil forms that are characterised by topsoil's with better than average organic carbon contents well developed hydromorphic characteristics.

It is important to note that the present land use also varies, from areas with little to no cultivation to intensive commercial cropping and intensive livestock grazing and areas of subsistence farming and grazing. These aspects have been taken into account when considering the alternative sites.

Based on the reconnaissance soil, land use and land capability assessments carried out on the alternatives, as tabled by the client (A, B, C, G and F), and the combinations that have been proposed by the lead consultants (A and G and A and F), the best candidate site has been chosen, with Site "C" being considered the most suitable site for an Ash Facility.

Of consequence to the findings of the specialist soils, land cap and land use for Site C as the candidate site are the following:

- There are no formal or active farming activities noted, with subsistence grazing the only land use activity;
- The land capability is considered to be of a "wilderness" or "conservation" status in terms of the land capability rating system, and holds little to no potential for anything other than very low intensity grazing, and this would only be considered viable under very well managed conditions;
- A greater proportion of the area considered for development has soils that are shallow to very shallow;
- The percentage of wet based soils is less than for any of the other sites considered;
- The wetlands in the upper reaches of the site have been impacted;
- The soils are moderately easily worked and stored, albeit that erosion is an issue to be considered and managed.

Of negative concerns are:

- The limited quantities of materials that will be available for rehabilitation purposes;
- The lack of suitable founding materials for barrier layer construction, and
- The possible geotechnical issues that were noted in the form of brecciated material in the south western portion of Site C. This possibly associated with a geological fault/fracture zone (zone of movement/weakness).

On the weighted ratings (all of the earth science and related aspects) - Site "A" was considered the best candidate site. However, the DWA and authorities believed that Site "B" was a better option based on a number of socio economic and environmental factors.

Site "B" ranked as the least acceptable site in terms of the soils and land capability studies, and additional investigation was recommended by ESS as part of the follow up to the DWA decision. The outcomes of the more detailed study confirmed the original findings and, in fact more negatively influenced the ring but a part of the recommendations based on the biophysical and ecological links to the soil water and wetland environments, with the eco system services further compounding the negative recommendation.

GLOSSARY OF TERMS

Alluvium: Refers to detrital deposits resulting from the operation of modern streams and rivers.

Base status: A qualitative expression of base saturation. See base saturation percentage.

Black turf: Soils included by this lay-term are the more structured and darker soils such as the Bonheim, Rensburg, Arcadia, Milkwood, Mayo, Sterkspruit, and Swartland soil forms.

Buffer capacity: The ability of soil to resist an induced change in pH.

Calcareous: Containing calcium carbonate (calcrete).

Catena: A sequence of soils of similar age, derived from similar parent material, and occurring under similar macroclimatic conditions, but having different characteristics due to variation in relief and drainage.

Clast: An individual constituent, grain or fragment of a sediment or sedimentary rock produced by the physical disintegration of a larger rock mass.

Cohesion: The molecular force of attraction between similar substances. The capacity of sticking together. The cohesion of soil is that part of its shear strength which does not depend upon inter-particle friction. Attraction within a soil structural unit or through the whole soil in apedel soils.

Concretion: A nodule made up of concentric accretions.

Crumb: A soft, porous more or less rounded ped from one to five millimetres in diameter. See structure, soil.

Cutan: Cutans occur on the surfaces of peds or individual particles (sand grains, stones). They consist of material which is usually finer than, and that has an organisation different to the material that makes up the surface on which they occur. They originate through deposition, diffusion or stress. Synonymous with clayskin, clay film, argillan.

Desert Plain: The undulating topography outside of the major river valleys that is impacted by low rainfall (<25cm) and strong winds.

Denitrification: The biochemical reduction of nitrate or nitrite to gaseous nitrogen, either as molecular nitrogen or as an oxide of nitrogen.

Erosion: The group of processes whereby soil or rock material is loosened or dissolved and removed from any part of the earth's surface.

Fertilizer: An organic or inorganic material, natural or synthetic, which can supply one or more of the nutrient elements essential for the growth and reproduction of plants.

Fine sand: (1) A soil separate consisting of particles 0,25-0,1mm in diameter. (2) A soil texture class (see texture) with fine sand plus very fine sand (i.e. 0,25-0,05mm in diameter) more than 60% of the sand fraction.

Fine textured soils: Soils with a texture of sandy clay, silty clay or clay.

Hardpan: A massive material enriched with and strongly cemented by sesquioxides, chiefly iron oxides (known as ferricrete, diagnostic hard plinthite, ironpan, ngubane, ouklip, laterite hardpan), silica (silcrete, dorbank) or lime (diagnostic hardpan carbonate-horizon, calcrete). Ortstein hardpans are cemented by iron oxides and organic matter.

Land capability: The ability of land to meet the needs of one or more uses under defined conditions of management.

Land type: (1) A class of land with specified characteristics. (2) In South Africa it has been used as a map unit denoting land, mapable at 1:250,000 scale, over which there is a marked uniformity of climate, terrain form and soil pattern.

Land use: The use to which land is put.

Mottling: A mottled or variegated pattern of colours is common in many soil horizons. It may be the result of various processes *inter alia* hydromorphy, illuviation, biological activity, and rock weathering in freely drained conditions (i.e. saprolite). It is described by noting (i) the colour of the matrix and colour or colours of the principal mottles, and (ii) the pattern of the mottling.

The latter is given in terms of abundance (few, common 2 to 20% of the exposed surface, or many), size (fine, medium 5 to 15mm in diameter along the greatest dimension, or coarse), contrast (faint, distinct or prominent), form (circular, elongated-vesicular, or streaky) and the nature of the boundaries of the mottles (sharp, clear or diffuse); of these, abundance, size and contrast are the most important.

Nodule: Bodies of various shapes, sizes and colour that have been hardened to a greater or lesser extent by chemical compounds such as lime, sesquioxides, animal excreta and silica. These may be described in terms of kind (durinodes, gypsum, insect casts, ortstein, iron, manganese, lime, lime-silica, plinthite, salts), abundance (few, less than 20% by volume percentage; common, 20 – 50%; many, more than 50%), hardness (soft, hard meaning barely crushable between thumb and forefinger, indurated) and size (threadlike, fine, medium 2 – 5mm in diameter, coarse).

Overburden: A material which overlies another material difference in a specified respect, but mainly referred to in this document as materials overlying weathered rock

Ped: Individual natural soil aggregate (e.g. block, prism) as contrasted with a clod produced by artificial disturbance.

Pedocutanic, diagnostic B-horizon: The concept embraces B-horizons that have become enriched in clay, presumably by illuviation (an important pedogenic process which involves downward movement of fine materials by, and deposition from, water to give rise to cutanic character) and that have developed moderate or strong blocky structure. In the case of a red pedocutanic B-horizon, the transition to the overlying A-horizon is clear or abrupt.

Pedology: The branch of soil science that treats soils as natural phenomena, including their morphological, physical, chemical, mineralogical and biological properties, their genesis, their classification and their geographical distribution.

Slickensides: In soils, these are polished or grooved surfaces within the soil resulting from part of the soil mass sliding against adjacent material along a plane which defines the extent of the slickensides. They occur in clayey materials with a high smectite content.

Sodic soil: Soil with a low soluble salt content and a high exchangeable sodium percentage (usually EST > 15).

Swelling clay: Clay minerals such as the smectites that exhibit interlayer swelling when wetted, or clayey soils which, on account of the presence of swelling clay minerals, swell when wetted and shrink with cracking when dried. The latter are also known as heaving soils.

Texture, soil: The relative proportions of the various size separates in the soil as described by the classes of soil texture shown in the soil texture chart (see diagram on next page). The pure sand, sand, loamy sand, sandy loam and sandy clay loam classes are further subdivided according to the relative percentages of the coarse, medium and fine sand subseparates.

Vertic, diagnostic A-horizon: A-horizons that have both, a high clay content and a predominance of smectitic clay minerals possess the capacity to shrink and swell markedly in response to moisture changes. Such expansive materials have a characteristic appearance: structure is strongly developed, ped faces are shiny, and consistence is highly plastic when moist and sticky when wet.

1. INTRODUCTION AND TERMS OF REFERENCE

Earth Science Solutions (Pty) Ltd were asked to submit a proposal and cost estimate to Zitholele Consultants (Lead Consultants) for a pedological, land capability and land use assessment as part of the baseline site selection process and alternatives assessment for the Eskom Kusile 60 Year Ash Disposal Facility being considered as part of the Kusile Power Station infrastructure.

The areas of consideration include five possible sites (Sites A, B, C, F and G), including two combinations A/G, and A/F), situated in close proximity to the present mining infrastructure of New Largo (coal source for Kusile Power Station) and area of disturbance around the Kusile Power Station site (Refer to Figure 1.1 – Locality Plan and Figure 1.2 – Alternative Sites).

Kusile Power Station requires a disposal facility for the ash that will be produced from the burnt coal and have indicated that the facility should cater for at least a sixty (60) year life.

This study is part of the feasibility study and assessment needed to understand were the waste materials that will be produced can be stored/deposited. The quantities of waste material that need to be disposed of are extremely large, and require significantly large areas of land that will be permanently changed.

The area needed to cater for the disposal of the by-products from the power generator will need to be situated as close as possible so as to minimise the area of disturbance, and reduce the costs of transportation/conveyencing.

Due to the topography of the area, and the relative large and wide/open drainage ways, it is important that the potential impacts from river crossings be assessed while the attitude and relative steepness or lack thereof is accounted for in the engineering of the facility (not part of this study).

In line with the EIA process, and in terms of good environmental practices, and before any extensive engineering or economic planning can be undertaken, it is necessary that an alternatives assessment of possible sites (site selection) is undertaken.

As part of the overall environmental assessment, the soils, and land capability need to be investigated and the baseline conditions to the various sites being considered need to be well understood. These studies were undertaken in conjunction with an investigation of the pre development (existing) land use as some of the important receptors that could be impacted by a development the size or a 60 Year Ash Disposal facility.

Earth Science Solutions (PTY) Ltd was commissioned to carry out a comprehensive reconnaissance soil and land capability assessment of the pre depositional environment to help with the selection of the most environmentally sustainable site.

Detailed studies of the candidate site chosen will be recommended as part of the EIA process that will follow.

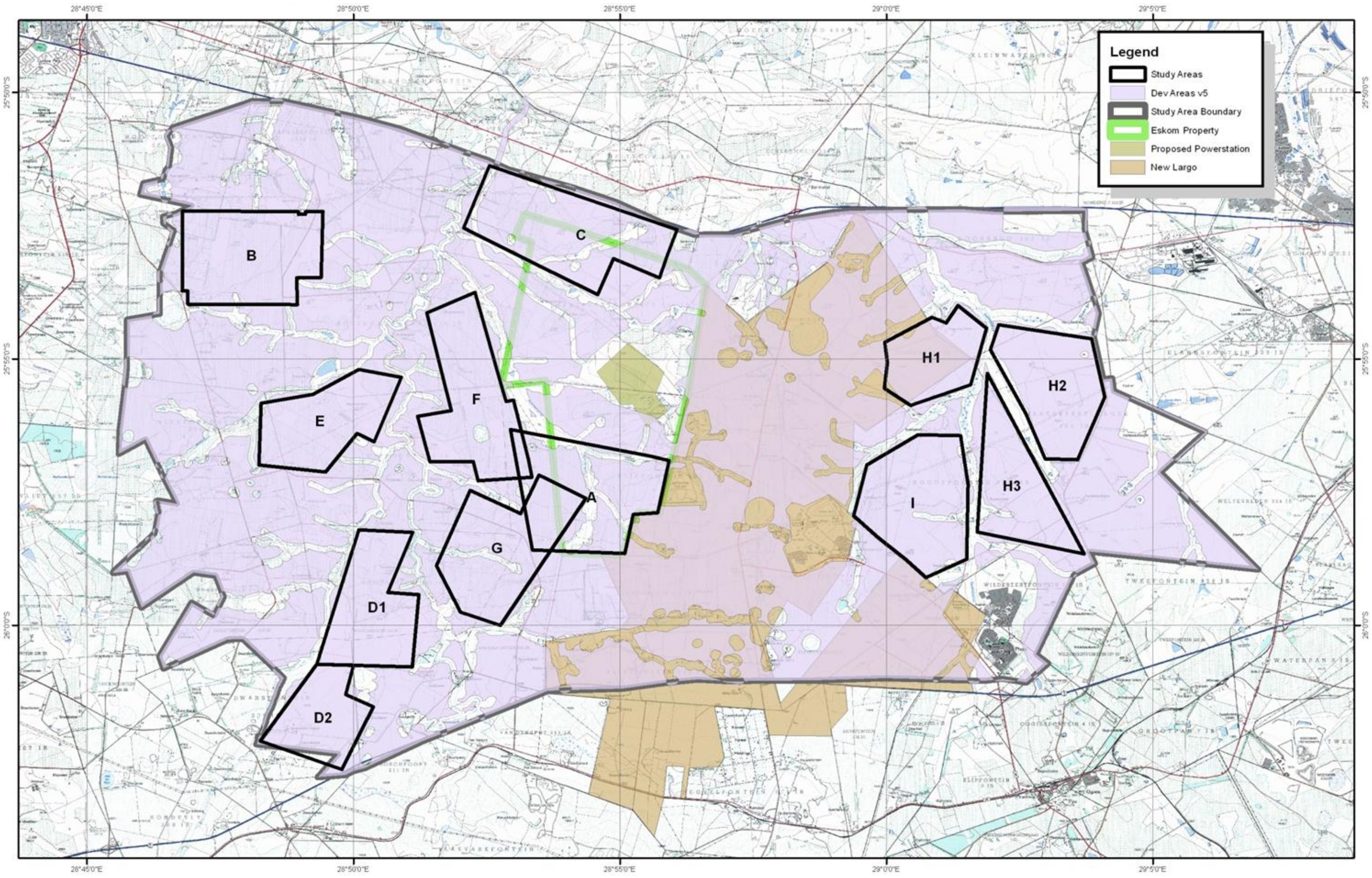


Figure 1.1 Locality Plan

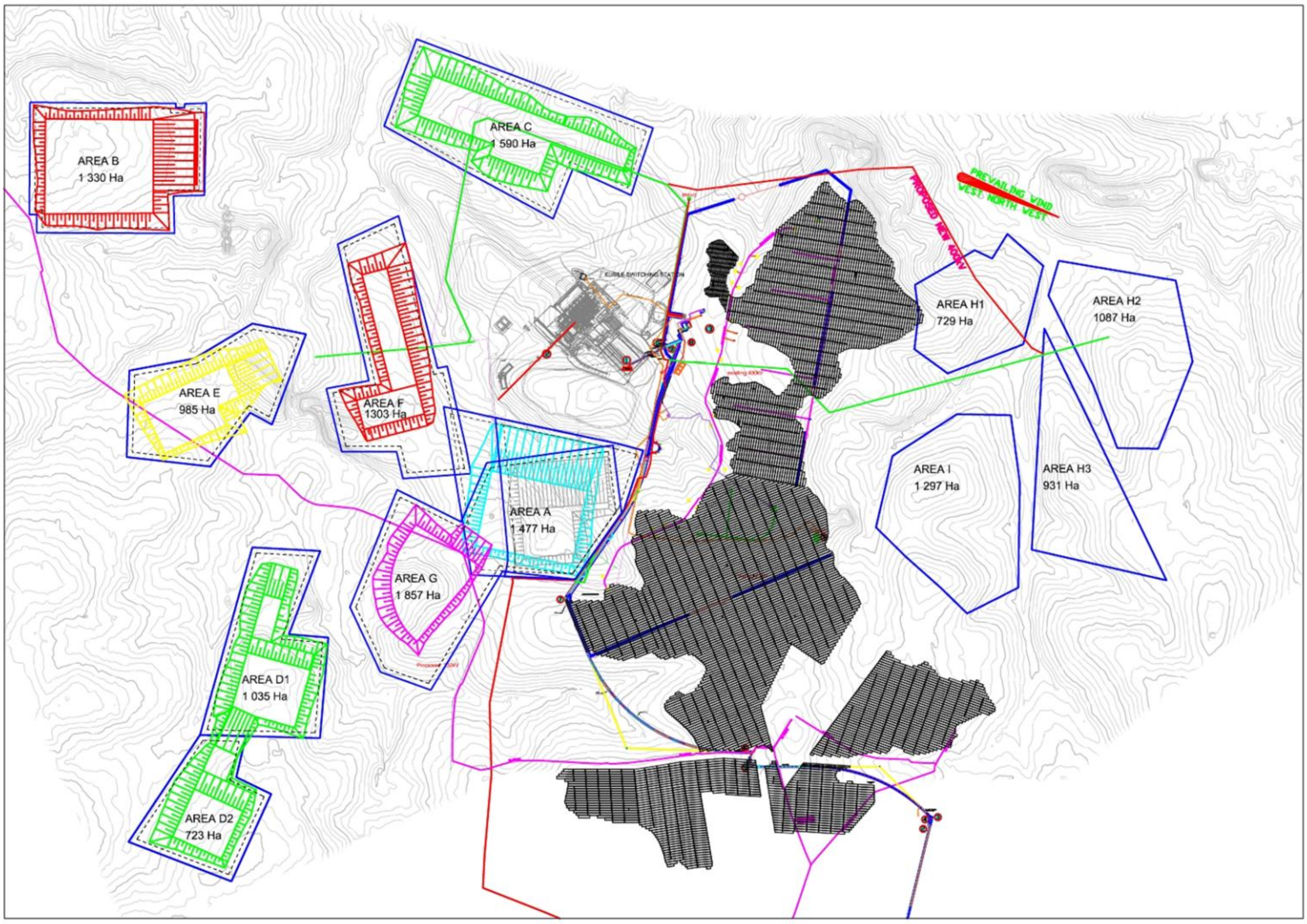


Figure 1.2 Location of Alternative Ash Disposal Sites relative to Mining Lease Area and the Kusile Power Station

The studies carried out investigated the soils in terms of their physical and chemical properties, while other geomorphological aspects were also mapped as part of determining the land capability of the sites. To this end, the ground roughness, topographic features such as altitude, attitude and slope were recorded, and the pre development land use was noted.

The soil wetness and its relative wetland status has been assessed as one of the more important soil features, while the position of the sites relative to the Wilge River and its major tributaries has been left to the Hydrogeologists and ecologists for comment and assessment.

The cumulative impacts will need to be assessed in more detail once the candidate site has been decided. However, any existing impacts such as the Power Station and the New Largo Mining, the main road (N12) and any existing natural pre development conditions have been taken into account as part of the considerations albeit that they have not been listed as soil or land capability considerations.

A more detailed study of Site "B" was commissioned as a follow on to the baseline investigation, Site "B" having been recommended by the DWA as the best alternative ahead of Site "A" as considered by the lead consultants and client, and Site "C" as considered by ESS in their specialist outcomes.

The study was undertaken in two phases, with the site selection being undertaken in terms of a baseline alternatives assessment in phase 1, while phase 2 investigate the impacts of the proposed actions on the candidate site(s).

The site selection alternatives assessment was undertaken for a number of different disciplines, the soils, land capability and land use being but a part of the earth science investigation. This document should be read in conjunction with the ecological and biodiversity studies as these will help to better define the wetland status and natural connections that control the life cycle of the area.

A 60 Year Ash Disposal Facility (ADF) is by its very nature a large and permanent structure that will impact and affect the environment of both its immediate footprint as well as a significant area surrounding the site. The effects of a large and heavy structure of this nature will impact on the soil moisture of the materials, will restrict flows of soil water and alter the dynamics of the distribution of soil water to the base flow of the wetlands and rivers.

In addition, the positioning of such a large facility will potentially have a negative effect on erosion and the retention of colluvial soils, and will require well developed management solutions if these effects are to be mitigated, and a sustainable structure engineered.

This report has been structured so as to satisfying the requirements of the National Environmental Management Act (NEMA) as well as the other related laws and guidelines required in terms of the Department of Agriculture etc. while the Performance Principles used by the World bank in terms of the IFC Guidelines have been taken as best practice principles.

Using these guidelines and policy norms, the project was undertaken to answer the questions asked in terms of the site selection alternatives and the ToR supplied.

These were stated as:

- A high level reconnaissance study of the soils, land capability and land use for the five alternative Ash Disposal sites:
    - Current status of the soils (characterize and classify);
    - Current level of soil disturbance;
    - Agricultural potential/land capability;
    - Assessment of wetland soil and present status;
    - Present land use

To this end, a number of in-field site parameters were noted as part of the reconnaissance study.

Consideration has been given to:

- Soil character, inclusive of average soil depth, structure and wetness;
- Land use inclusive of agricultural use, grazing and the presence of permanent structures;
- Existing impacts due to existing land use practices;
- An assessment of the capability of the land in terms of its arable, grazing or wilderness status.

Historically, the area has been utilized as low intensity subsistence summer grazing lands by the local people, and more recently for commercial agriculture of annual crops and more intensive grazing, with a significant number of coal mines and associated industries within the Wilge catchment. The grazing of livestock is on-going on a small scale and some subsistence farming is still practiced on some of the sites mapped. However, the major activities include maize and potato farming and some intensive livestock farming of cattle.

The existence of formalised dams and water impoundments, and the impacts of the commercial farming activities render the majority of the sites investigated as brownfields sites, with little natural grasslands being encountered for the most part.

With the ever-increasing competition for land, it has become imperative that the full scientific facts for any particular site are known, and the effects/impacts on the land to be used by any other proposed enterprise be evaluated prior to the new activity being implemented. This is no different for an Ash Disposal Facility, and it is of even greater importance that the land capability is understood before a structure as large and as permanent as a 60 Year Ash Disposal Facility is considered.

The areas considered for development are shown in Figure 1.2.

It should be noted, that no intensive or detailed mapping was undertaken in the initial field study, with the results for all but Site "B" being based on a high level reconnaissance site assessment of all possible sites.

A detailed assessment of Site "B" was undertaken as part of a resolution needed in motivation of the best biophysical option.

2. DESCRIPTION OF THE PRE-CONSTRUCTION ENVIRONMENT

2.4 SOILS

2.4.1 Data Collection

In better understanding the sites delineated by the client, all existing information and any Environmental Impact Statements relating to the mining operations at New Largo and or the new Kusile Power Station where used as important baseline information that could have a bearing on or help to influence the assessment of the proposed ash disposal sites.

In addition, the 1:250 000 and 1:50 000 scale topocadastral maps, the Land Type Mapping and any aerial imagery was used to better define and map the baseline conditions across the various sites.

Interaction with the Kusile SHQ manager and his personnel, as well as close interaction with the local farmers and land owners was used to obtain a better understanding of the area and its usage.

The comprehensive reconnaissance walk over study of the five sites gave further site specific information.

The field inspection undertaken involved the examination and understanding of the broad pedological/soil patterns for the sites, while an assessment of the geomorphological character of the areas was important in assessing and rating the capability of the land.

The present land use was noted as part of the field study, and mapped using the aerial imagery available (old orthophotographs).

The soils were characterised and classified according to the Taxonomic Classification System and the soil forms were noted/recorded wherever a profile was examined, and the general soil groupings or major soil forms were mapped based on the site mapping.

The existing geomorphological information (Topo maps and Land Type mapping) was captured as part of the baseline information, and combined with the soil mapping as the basis for the land capability rating and ultimately the alternative assessment.

2.4.2 Description

The major soil types mapped within the study area reflect the host geology/lithologies of the parent materials, while the topography and climatic conditions that prevail have further influenced the pedogenisis and soils forms present.

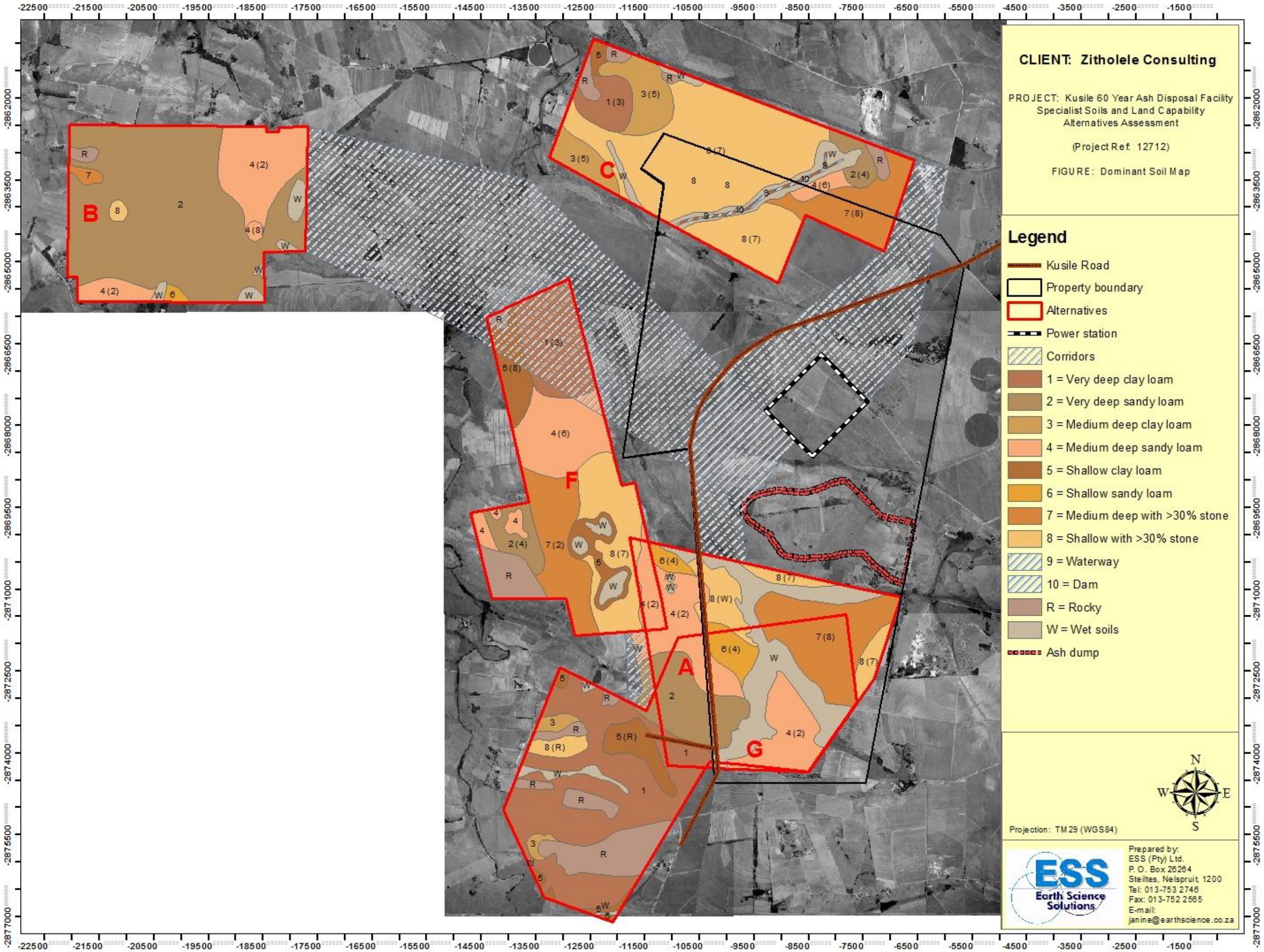
Noticeable to the sites investigated is the presence of Karoo sediments and quartzite's, the structural impacts of intrusive dolerite dykes and sills and the associated fracturing and possibly faulting of the country rock, and the subtle but important influence of the flat to undulating topography, with localised steeper slopes and resultant shallow profiles.

These geomorphological characteristics are further influenced by the negative water balance and semi-arid environment, with the effects of evaporites and the development of laterites being highlighted as aspects of importance to the ecological status, and conditions that will influence the capability of the land.

The major attributes of the groupings of soil include (Refer to Figure 2.4.2 – Dominant Soils Groups):

- Deep (>750mm) clay rich loams;
- Deep (>750mm) sandy and silty loams;
- Moderately (500mm to 750mm) deep clay and sandy clay loams;
- Moderately (500mm to 750mm) deep sandy and silty loams;
- Shallow (<500mm) clay rich sandy loams and sandy clay loams;
- Shallow (<500mm) silty loams;
- Moderately deep (500mm to 750mm) but rocky sandy loams;
- Shallow (<500mm) and rocky (>30% stone and rock in profile);
- Areas of outcrop or sites with >80% rock at surface, and
- Wet based soils with a variety of depths and clay composition.

In terms of the Taxonomic classification use, the major or dominant soil forms mapper include the those of the orthic phase Hutton, Clovelly, Glenrosa and Mispah forms with sub dominant soils of the Valsrivier and Shortlands Form, while the major hydromorphic forms mapped include the Glencoe, Dresden, Avalon, Pinedene, Bainsvlei and Westleigh, with significant area of glaycutanic structure associated with the bottom lands and flood plain environment.



<u>Figure 2.4.2 – Dominant Soils Map</u>

The semi-arid climate and negative water balance combined with the horizontal attitude of the sedimentary host lithologies that characterise the Karoo sediments have resulted in ferricrete or laterite (Ouklip) formation as a dominant feature of many of the soils, with varying degrees of formation and depth of occurrence. The presence of a hard pan ferricrete (Hard plinthic horizon) or soft plinthite is considered of importance to the soil moisture and in many cases is the reason for wet features within the soil profile (barrier layer). This moisture is important to the biodiversity, the presence of pans and water features within the landscape, and the success or failure of the wetland systems in the extreme. These soils classify as highly sensitive.

In addition to the geomorphological aspects mentioned above, soil texture and structure also played a role in the soil classification and the resultant sensitivity of the materials mapped. The fine (sediments) to medium (quartzite's) grained nature of the topsoils, the relatively low clay contents (<15%) and the generally low organic carbon renders the majority of the soils highly sensitive to erosion. This is only tempered by the relative flatness of the topography for all but a few areas, with a resultant moderate to low erosion index for most of the site. These ratings assume that the soils are well protected and the vegetative cover is not disturbed. Once the cover is disturbed or removed, the potential for erosion is increased.

More in-depth analysis of the soil descriptions and relative depths, chemical composition and structure was undertaken as part of the EIA phase.

Effective rooting depths on site vary from as shallow as 200mm on the upper and midslopes to over 1 500mm on the colluvial derived materials in the lower and stream channel accumulations.

The shallow rooting depths (200mm to 400mm), with an orthic topsoil on a lithocutanic subsoil (Glenrosa) are common place across for the candidate site (Site "C"), while Site "B" returned deep apedel and highly productive soil forms for the majority of the area studied. Small but significant areas of wet based soils are also important in understanding the biophysical and ecological conditions and eco system services of the area.

The hydromorphic soils – often associated with wetlands or the transition to the wetlands, are generally found associated with either perched seep zones were the soils have been restricted within a concave land form or with the lower moist grasslands and valley slopes where the major wet zones occur. These conditions are particularly important and significant to Site "B" where, the wet based soils occur downslope of the deep and generally more productive agricultural soils.

Overall, the effective rooting depths of the soils (utilisable soil - to top of mottled horizon) vary from 300mm to over 1,200mm, with Site "C" returning generally shallow to very shallow soils, and Site "B" returning much deeper and significantly much more productive (better nutrient status, depth and water holding capabilities) soils.

In contrast to the transition zone soils described above, the wetland soils are by definition soils with more defined hydromorphic characteristics. These soils are for the most part saturated all year round to a depth of 500mm below surface.

2.4.4 Characteristics of different Soil Groups

2.4.4.1 The Heavy Clay Rich Soils

In general (for the five alternatives) the soils with the higher clay content are generally associated with the colluvial deposits and the weathered/transported materials, and are most often found associated with the lower lying streams and river deposits.

The higher clay contents, and in places the swelling clay (2:1 Montmorillonite clays) have resulted in stronger than average structure to the soils, are expansive showing cracking within the soil profile in the dry state, and indications of slick-n-sides in the wet state. Generally the "C" horizons that underlie these soils are composed of moderately hard weathering rock. Intake rates and drainage of these soils are poor, while the erosion hazard is moderate.

The wet based and wetland soils are often associated with this group of soils

The sensitivity of these soils to being disturbed (worked on or moved) is evident in the ease of erosion that is noted where over grazing or disturbance of the topsoil has occurred, while the wetness factor and their importance in soil water storage and base flow transfer renders these materials as highly sensitive.

2.4.4.2 Light Textured Soils

The light textured soils include the majority of the orthic form soils, as well as some of the deeper hydromorphic soil Forms.

The majority of these Forms are characterised by a humic "A" horizon overlying a red or red-brown apedel (poorly structured) B, with indications of mottling within the lower "B" horizons in the case of the hydromorphic soils.

Depths to the "C" horizon or the plinthic layer vary from less than 400mm on the shallow forms to well over 1,500mm on the deep colluvial soils. The soils generally show a very thin saprolitic horizon, with the sub soils founded directly on hard bedrock.

The sensitivity of these soils is highly variable and depended on the depth and relative texture (clay content) of the materials. However, on average, and for the dry soils that are greater than 500mm these soils are of the least sensitive, are generally more easily worked on and with, and can be stored with relative ease and used for rehabilitation.

2.4.4.3 Shallow soils

A significant proportion of the soils assessed are of a shallow to very shallow rooting depth. These soils are almost always founded directly on a hard rock interface, with little to no saprolite at the base of the "B" horizon and are considered of a poor to very poor land capability rating.

These soils are associated with the more resistant host rock lithologies and often form the ridge lines and upper slope positions. The resultant poor vegetative cover, the generally lower clay content and lower organic carbon contents result in a high sensitivity rating for these materials.

Removal of the vegetative cover and/or disturbance of the topsoils will increase the erosion index to high.

Erosion is the main problem that will need to be managed on these shallow soils.

2.4.5 Soil Erodibility (EI)

The erosion indices for the dominant soil forms on the study sites classify as moderate to high EI. This is largely ascribed to the low, or at best moderate clay content of the "A" horizons, and the low organic carbon content. These factors are tempered somewhat by the relative flatness of the terrain for all but a few areas, and the generally well conserved vegetative cover (all but the shallow soils and over utilised valley bottoms).

It should be noted however, that the vulnerability of the subsoil's to erosion once the vegetative cover and topsoil layer have been disturbed or removed is markedly higher than for undisturbed soils.

Good management of these soils for erosion and compaction will be essential.

2.5 PRE-MINING LAND CAPABILITY

2.5.1 Data Collection

The land capability of the study areas was classified according to the Chamber of Mines Guidelines (1991). The criteria for this classification are set out in Table 2.5.1. The criteria are based on dryland cropping, on an average cropping regime and average climatic conditions for the region.

Table 2.5.1 Criteria for Pre-Mining Land Capability (Chamber of Mines 1991)

Criteria for Wetland

- Land with organic soils or supporting hygrophilous vegetation where soil and vegetation processes are water dependant.

Criteria for Arable land

- Land, which does not qualify as a wetland.
- The soil is readily permeable to a depth of 750 mm.
- The soil has a pH value of between 4.0 and 8.4.
- The soil has a low salinity and SAR
- The soil has less than 10% (by volume) rocks or pedocrete fragments larger than 100 mm in the upper 750 mm.
- Has a slope (in %) and erodibility factor (K) such that their product is <2.0
- Occurs under a climate of crop yields that are at least equal to the current national average for these crops.

Criteria for Grazing land

- Land, which does not qualify as wetland or arable land.
- Has soil, or soil-like material, permeable to roots of native plants, that is more than 250 mm thick and contains less than 50 % by volume of rocks or pedocrete fragments larger than 100 mm.
- Supports, or is capable of supporting, a stand of native or introduced grass species, or other forage plants utilisable by domesticated livestock or game animals on a commercial basis.

Criteria for Wilderness land

- Land, which does not qualify as wetland, arable land or grazing land.

The "land capability classification" as described above was used to classify the land units identified during the pedological survey.

The present day land use has been described from observations made during the site visit, and inspection of the satellite imagery supplied.

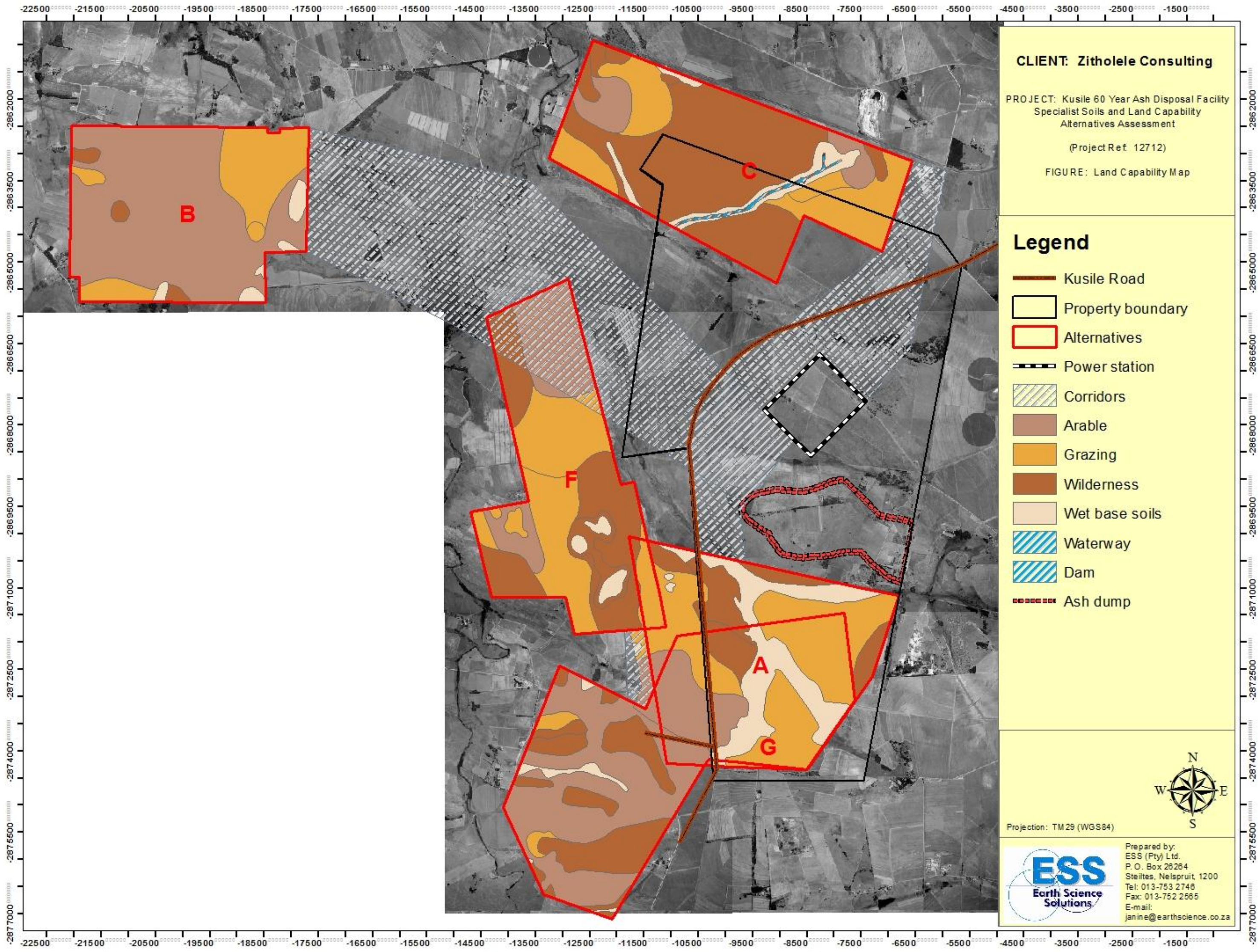


Figure 2.5 – Land Capability Plan

2.6 Alternative Assessment Outcomes

The field data obtained from the walk over assessment as described herein was used as the basis for the alternatives assessment, with the basis for any sustainability equation when considering the soil resource being the concept of "No Net Loss. These findings were confirmed in the detailed study of Site "B", and although no additional infield studies of Site "A" or any of the other sites was undertaken during the follow up investigation, Site "B" is definitely of the most sensitive and risk adverse sites considered.

In attaining an understanding of the different sites, and in order to measure and compare the alternatives a number of differing variables were considered important: These included:

Soils	Sensitivity of Soil Erosion Potential of Soil Soil Depth (ERD) Soil Structure and Workability
Land Capability	Arable potential Grazing Potential Wilderness Potential
Land Use	Presence of dwellings or people on the land Presence of Infrastructure Presence of livestock or cultivation on land

The ability of the earth scientist to assist the development and planners in obtaining the best alternative for a development is not just the outcomes of the specific speciality, but is often found in the understanding of the interrelationship between the various disciplines.

A straight association is not always a true reflection of the sensitivity of a resource to impact, and might require that a weighting is attached to the particular aspect being considered.

However, this is best left to the EAP as he/she has the cross section of the specialist information at hand, and so a straight (un-weighted) comparison of the alternatives has been used for this assessment.

Table 2.6 is a straight comparison of the five sites using a scale of 1 to 9, where 1 = Highly Suitable and 9 = Not Suitable, while Figure 2.6 is a graphic representation of the site sensitivities based primarily on soil and land capability variables.

Based on the soils and land capability/land use assessments alone it is evident that Site "C" is considered to be the best candidate site for an Ash Disposal Facility. However, if all the differing disciplines are considered and weighted (Undertaken by EAP), and after having concluded the impact assessment for all of the different sites, it was concluded that Site "A" is in fact the best alternative.

This submission was found wanting by the authorities (DWA) and alternative Site "B" was tabled as their best candidate site.

With these factors tabled, it was important to better understand why Site "B" had been excluded in the initial assessment, and in fact why Site "B" had scored the worst (highest) rating of all of the sites in terms of the soils and land capability. Site "A" and "B" were therefore considered in the alternative assessment discussed further in this document, with a site specific management plan and soil utilisation guideline being considered for the best alternative/candidate site.

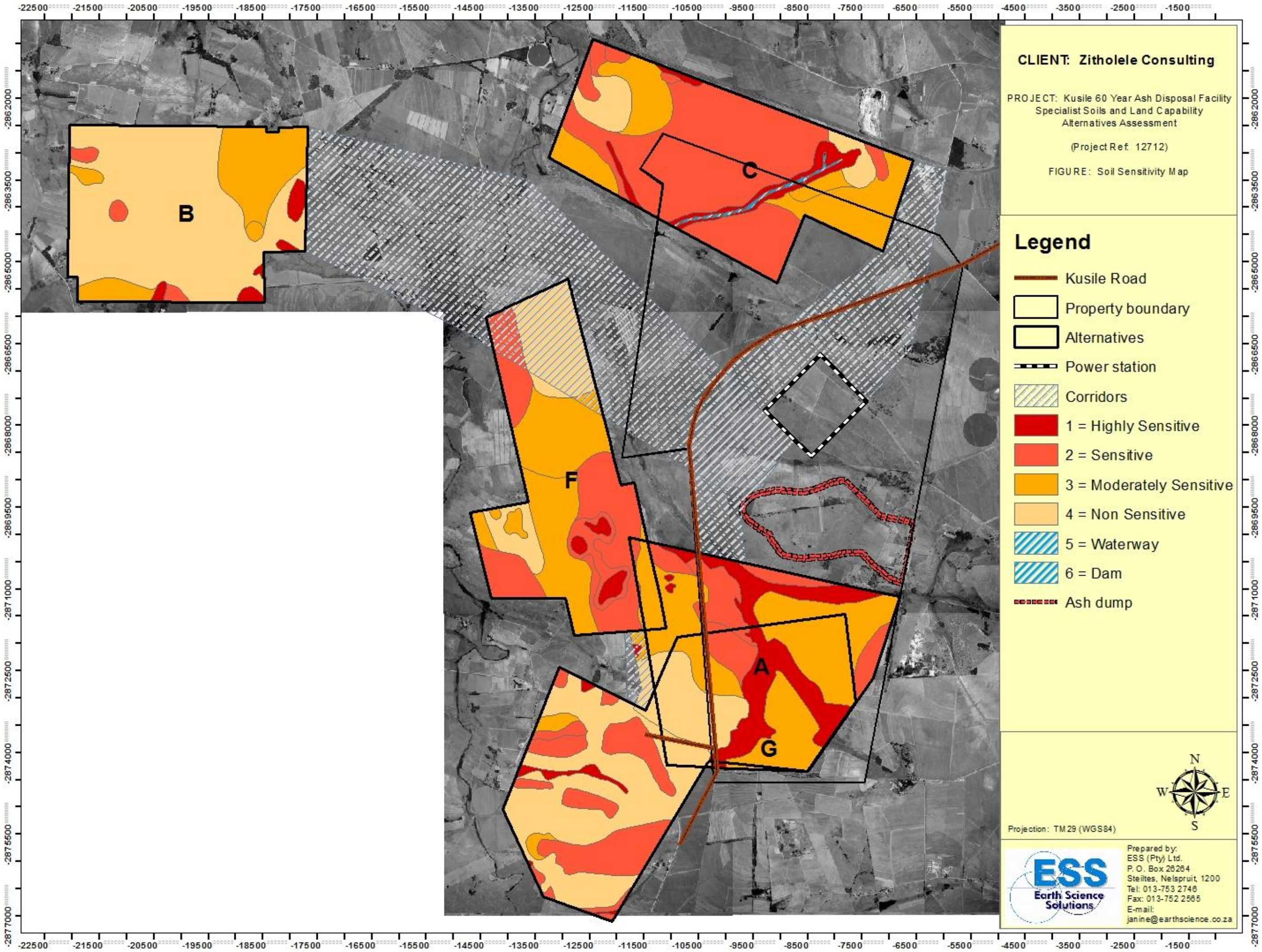


Figure 2.6 – Site Sensitivity

Table 2.6 – Alternative Assessment Matrix

KUSILE ASH DUMP - SITE SELECTION

Ash Storage Facility - Alternatives Analysis Matrix

Considerations				Alternative									
				Site Option A		Site Option B		Site Option C		Site Option F		Site Option G	
Account	Sub-account	Indicator	Indicator weighting	Score	Description	Score	Description	Score	Description	Score	Description	Score	Description
Aspects of Physical Environment	Present Land Use	Habitation	0	7	Limited habitation.	8	Many Small Holdings - significant amount of habitation	3	Limited habitation.	3	Limited habitation.	3	Limited habitation.
		Cultivation or Grazing Usage	0	8	Significant area of cultivated annual pastures and commercial cropping.	8	High % of Cultivation	3	Natural veld grass and limited cultivatin	6	Some cultivated commercial cropping - mostly in northern sector, natural grazing and wet based/transition zone and conservation in south and south west respectivily.	3	Natural veld grass and limited cultivatin
		Subsistance usage	0	4	Limited usage	8	High Usage	2	Limited	3	Limited usage	2	Limited Usage
	Sub-account value		0	19		24		8		12		8	
	Soils	Presence of sensitive soils	0	8	Significant wet based or transitional zone soils - Sensitive and require managemnt inputs.	4	Limited Wet based and/or Transitional Zone Soils - Sensitive - Limited Area	4	Limited wet based and some transitional zone soils associated with the northeast - south west water way. Generally shallow & rocky soil - only moderately sensitive	6	Significant areas of wet based or transitional zone soils - mostly in south and south east, steeper and shallow rocky in south west - Sensitive and require managemnt inputs.	7	Only limited wet based and transitional zone soils associated with the minor water way - only moderately sensitive
		Soil Workability	0	5	Sandy Clay Loams - moderately easily worked for all but the wet based soils (significant area of proposed site	5	Friable sandy loams to sandy clay loams - Easily worked	4	Shallow sandy Clay Loams - Generally easily worked, but limited rehabilitation cover.	5	Sandy Clay Loams - moderately easily worked for all but the wet based soils (significant area of proposed site	7	Moderte to deep sandy clay loams - Generally easily worked, but limited rehabilitation cover.
		Erosion Sensitivity	0	4	Moderate to shallow and flat gradients, moderate clay, but generally poor organic matter content - Moderate to high erosion if not protected	5	Flat to undulating terrain - some increase in gradient in south west, moderate clay, but low organic carbon content to soils - Moderate erosion if not protected.	4	Flat to undulating terrain, shallow rocky profiles with spares grass cover. Unprotected soil are sensitive to erosion.	4	Moderate to shallow and flat gradients for the most part, moderate clay, but generally poor organic matter content - Moderate to high erosion if not protected, and higher on shallow rocky soils in south west	6	Flat to undulating terrain, moderate to deep profiles with moderate to good grazing potential. Unprotected soil are sensitive to erosion.
	Sub-account value		0	17		14		12		15		20	
	Land Capability	Arable Potential of Soils	0	6	Generally shallow or wet based transitional zone soils - Limited Arible Potential	7	Generally moderate to deeper soils - Moderate to Good Arible Potential	4	Shallow - poor arable potential with limited wet based soils associated with the water way.	6	Generally shallow or wet based transitional zone soils - Limited Arible Potential for all but the northern sector - limited arable materials	7	Shallow - poor arable potential with limited wet based soils associated with the water way.
		Grazing Potential of Soils	0	7	Moist grassmands associated with wet based soils - transition zone - difficult to work and considered sensitive -At best moderate grazing potential on areas outside of the valley bottoms - west and estern extremes.	7	Grassland savanha dominant, limited wet based transitional zone soils, generally better than average to good Grazing Potential	5	Moderate grazing potential (low stocking numbers) associated with transition zone soils. Poor grazing on shallow materials.	7	Moist grassmands associated with wet based soils - transition zone - difficult to work and considered sensitive -At best moderate grazing potential on areas outside of the valley bottoms.	6	Moderate grazing potential.
		Conservation Potential of Soils	0	8	Significant wet based and transiton zone soils - Need to be conserved	7	Limited shallow and or wet based or transitional zone soils or soils with sensitive nature that need to be conserved	7	Wet based transitional zone soils associated with the water way. Impacted by grazing of livestock.	8	Significant wet based and transiton zone soils - Need to be conserved (south and south eastern sectors	4	Limited wet based transitional zone soils associated with the minor water way.
	Sub-account value		0	21		21		16		21		17	
	Overall Value		0.0	57	4	59	5	36	1	48	3	45	2

Notes:
The table is a straight comparison of the five sites using a scale of 1 to 9, where 1 = Highly Suitable and 9 = Not Suitable.
Lowest score = Best site for Ash Dump.

3. ENVIRONMENTAL IMPACT ASSESSMENT - PHILOSOPHY

With the baseline for the alternative study of the five sites in hand, and the determination of the existing state of the environment for these areas covered, the relative sensitivities and areas of concern have been highlighted and used as the basis for the Comparative Impact Assessment and the Trade Off Investigation, with the establishment of a Site "A" as the preferred or Candidate site the considered outcome (Refer to Figure 5 – Soil Sensitivity Map). This is still the considered opinion of the author, having completed the additional and more comprehensive study of Site "B" as required in terms of the EIA.

Based on these results and the workshop of views and decisions having been tabled, the assessment of impacts for the preferred/candidate site has been reported with a set of utilisation and management measures being considered for the activities being proposed.

This report has been compiled in line with the South African Integrated Environmental Management Information Series (DEAT 2002), a guideline to the Impact Assessment philosophy and Significance Rating System.

This system aims to identify and quantify the physical environmental and/or social aspects of the proposed activities inclusive of any alternatives, to assess how these aspects will affect the existing state, and link the aspects to variables that have been defined in terms of the baseline study.

In addition, the impact assessment has defined a maximum acceptable level of impact for each of the activities or variables, inclusive of any standards, limits and/or thresholds, and has assessed the impact in terms of the significance rating as defined by the lead consultants.

The environmental aspects are not least of all part of the information that is needed in this decision making, with an understanding of how the soils and land capability will be affected being just part of the overall sustainability equation that needs to be balanced.

The principle of "No Net Loss" has been considered the baseline principle that should be aimed for wherever possible. However, the development/construction and operation of a mega ash disposal facility and its support infrastructure (pipelines, power reticulation, access roads and stormwater control facilities) and the fact that the structure is a permanent feature will challenge this concept.

Based on the outcomes of the impact assessment, the site specific management planning and mitigation measures have been defined and detailed. These include defining what the mitigation will do to reduce the intensity and probability of the impact, specify a performance expectation for the mitigation proposed, and ensure that the prescriptive mitigation proposed is clear, site specific and practical.

In addition, and as part of the practical management plan, a monitoring system has been defined and any legal limits or provisions listed.

As part of understanding the variables and the maximum acceptable levels of impact that will be considered by the authorities, a summary of the national legislation that pertains to soils has been considered. These will aid in setting the permissible standards and limits that can be considered, albeit that there are no prescribed limits available.

The following section outlines a summary of the South African Environmental Legislation that needs to be considered for any new development with reference to management of soil:

- *The law on Conservation of Agricultural Resources (Act 43 of 1983) states that the degradation of the agricultural potential of soil is illegal.*
- *The Bill of Rights states that environmental rights exist primarily to ensure good health and wellbeing, and secondarily to protect the environment through reasonable legislation, ensuring the prevention of the degradation of resources.*
- *The Environmental right is furthered in the National Environmental Management Act (No. 107 of 1998), which prescribes three principles, namely the precautionary principle, the "polluter pays" principle and the preventive principle.*
- *It is stated in the above-mentioned Act that the individual/group responsible for the degradation/pollution of natural resources is required to rehabilitate the polluted source.*
- *Soils and land capability are protected under the National Environmental Management Act 107 of 1998, the Environmental Conservation Act 73 of 1989, the Minerals Act 50 of 1991 and the Conservation of Agricultural Resources Act 43 of 1983.*
- *The National Veld and Forest Fire Bill of 10 July 1998 and the Fertilizer, Farm Feeds, Agricultural Remedies and Stock Remedies Act 36 of 1947 can also be applicable in some cases.*
- *The National Environmental Management Act 107 of 1998 requires that pollution and degradation of the environment be avoided, or, where it cannot be avoided be minimized and remedied.*
- *The Minerals Act of 1991 requires an EMPR, in which the soils and land capability be described.*
- *The Conservation of Agriculture Resources Act 43 of 1983 requires the protection of land against soil erosion and the prevention of water logging and salinization of soils by means of suitable soil conservation works to be constructed and maintained. The utilization of marshes, water sponges and water courses are also addressed*.

In addition to the South African legal compliance as listed, this proposed development has also been assessed in terms of the International Performance Standards as detailed by the International Finance Corporation.

The IFC has developed a series of Performance Standards to assist developers and potential clients in assessing the environmental and social risks associated with a project and assisting the client in identifying and defining roles and responsibilities regarding the management of risk.

Performance Standard 1 establishes the importance of:

- Integrated assessment to identify the social and environmental impacts, risks, and opportunities of projects;
- Effective community engagement through disclosure of project-related information and consultation with local communities on matters that directly affect them; and
- The client's management of social and environmental performance throughout the life of the project.

Performance Standards 2 through 8 establish requirements to avoid, reduce, mitigate or compensate for impacts on people and the environment, and to improve conditions where appropriate. While all relevant social and environmental risks and potential impacts should be considered as part of the assessment, Performance Standards 2 through 8 describe potential social and environmental impacts that require particular attention in emerging markets.

Where social or environmental impacts are anticipated, the client is required to manage them through its Social and Environmental Management System consistent with Performance Standard 1.

Of importance to this report are:

- The requirements to collect adequate baseline data;
- The requirements of an impact/risk assessment;
- The requirements of a management program;
- The requirements of a monitoring program; and most importantly;
- To apply relevant standards (either host country or other).

With regard to the application of relevant standards (either host country or other) there are no specific guidelines relating to soils and land use/capability, either locally or within the World Bank's or IFC's suite of Environmental Health and Safety Guidelines. The World Bank's Mining and Milling, Underground guideline does state, however, that project sponsors are required to prepare and implement an erosion and sediment control plan. The plan should include measures appropriate to the situation to intercept, divert, or otherwise reduce the stormwater runoff from exposed soil surfaces, tailings dams, and waste rock dumps.

Project sponsors are encouraged to integrate vegetative and non-vegetative soil stabilization measures in the erosion control plan.

Sediment control structures (e.g., detention/retention basins) should be installed to treat surface runoff prior to discharge to surface water bodies. All erosion control and sediment containment facilities must receive proper maintenance during their design life. This will be included in the appropriate management plans when they are developed at a later stage in the project's life cycle.

The variation in soil structure, texture and clay content of the soils combined with the presence of a prominent ferricrete (evaporite) layer at the base of many of the soil profiles ("C" Horizon), all make for a complex of natural conditions that are going to be extremely difficult to replicate during the rehabilitation stage and at closure.

The potential and probable loss of soil water and the "perched" aquifer that is believed to occur as a result of the ferricrete inhibiting/barrier layer will need to be assessed and understood as a function of the ecological balance.

The low levels of organic carbon and relatively low nutrient stores noted for many of the soils will also require that a sound management plan is adopted based on the best impact assessment information.

The concept of "**utilisable soil**" storage will be tabled as a basic management tool, and a function of good environment practise.

All of the soils mapped are sensitive to erosion and compaction to varying degrees and, although tempered by the relative flatness of the terrain, they will need a well formulated management plan and adequate engineering if the soils are exposed and disturbed.

In addition, the variable depth profiles of the materials mapped are of concern as the depths of utilisable soil that can be stripped and stored will make for challenging management if all of the utilisable soils are to be harvested (large volumes).

These soils are extremely important to the long term sustainability of the project. Soils will need to be stripped during construction, stored and maintained during the operational stage, and reinstated at closure (rehabilitation and emplacement of stored soils).

The impact of development on the soils and the resultant change in the land capability will be varied due to the unique differences associated with the soil forming processes and the resultant variation in the soil physical and chemical composition. The materials range from well-developed in-situ derived sandy and silty loams associated with the sedimentary lithologies to clay rich and well-structured sandy clays and clay loams associated with the more basic intrusive lithological units. These are contrasted with the more recent colluvial and alluvial derived soils that return less well defined pedogenisis and comprise a range of structure and texture.

These factors will be important in the environmental assessment and final management plan that is tabled, with the “separation” and management of the differing materials at the removal stage (construction) forming the basis for economically and sustainable rehabilitation at closure.

The moderately complex nature of the geology (physical and chemical) and geomorphology of the area (ferricrete land form) and the semi-arid climate, all play a significant role in the soil forming process, and have a bearing on the sensitivity and/or vulnerability of the materials when being worked or disturbed.

These factors are important not only in planning the construction and operational activities, but will determine the success of the rehabilitation planning for the future.

4. ENVIRONMENTAL IMPACT ASSESSMENT METHODOLOGY

Impact Assessment Methodology

Approach to Assessing Impacts:

- Impacts are assessed separately for the **construction**, **operational**, **closure**, and post-closure phases of the project;
- Impacts are described according to the ***Status Quo***, ***Project Impact***, ***Cumulative Impact***, ***Mitigation Measures*** and ***Residual Impact*** as follows:
  - ✓ The Status Quo assesses the existing impact on the receiving environment. The existing impact may be from a similar activity, e.g. an existing ash disposal facility, or other activities e.g. mining or agriculture.
  - ✓ The project impact assesses the potential impact of the proposed development on an environmental element;
  - ✓ The cumulative impact on an environmental element is the description of the project impact combined with the initial status quo impacts that occur;
  - ✓ Mitigation measures that could reduce the impact risk are then prescribed; and
  - ✓ The residual impact describes the cumulative impact after the implementation of mitigation measures.
- Impacts are rated against a predetermined set of criteria including (magnitude, duration, spatial scale, probability, and direction of impact);
- A rating matrix is provided for each environmental element per project phase summarising all the aforementioned in a single table.

More detailed description of each of the assessment criteria and any abbreviations used in the rating matrix is given in the following sections.

Magnitude / Significance Assessment

Significance rating (importance) of the associated impacts embraces the notion of extent and magnitude, but does not always clearly define these since their importance in the rating scale is very relative. For example, the magnitude (i.e. the size) of area affected by atmospheric pollution may be extremely large (1000 km^2) but the significance of this effect is dependent on the concentration or level of pollution. If the concentration is great, the significance of the impact would be HIGH or VERY HIGH, but if it is diluted it would be VERY LOW or LOW. Similarly, if 60 ha of a grassland type are destroyed the impact would be VERY HIGH if only 100 ha of that grassland type were known. The impact would be VERY LOW if the grassland type was common. A more detailed description of the impact significance rating scale is given in Table 4.1 below.

Table 4.1: Description of the significance rating scale

Rating			Description
Score	Code	Category	
7	SEV	SEVERE	Impact most substantive, no mitigation possible
6	VHIGH	VERY HIGH	Impact substantive, mitigation difficult/expensive
5	HIGH	HIGH	Impact substantive, mitigation possible and easier to implement
4	MODH	MODERATE-HIGH	Impact real, mitigation difficult/expensive
3	MODL	MODERATE-LOW	Impact real, mitigation easy, cost-effective and/or quick to implement
2	LOW	LOW	Impact negligible, with mitigation
1	VLOW	VERY LOW	Impact negligible, no mitigation required
0	NO	NO IMPACT	There is no impact at all - not even a very low impact on a party or system.

Spatial Scale

The spatial scale refers to the extent of the impact i.e. will the impact be felt at the local, regional, or global scale. The spatial assessment scale is described in more detail in Table 4.2.

Table 4.2: Description of the spatial rating scale

Rating			Description
Score	Code	Category	
7	NAT	*National*	The maximum extent of any impact.
6	PRO	*Provincial*	The spatial scale is moderate within the bounds of impacts possible, and will be felt at a provincial scale
5	DIS	*District*	The spatial scale is moderate within the bounds of impacts possible, and will be felt at a district scale
4	LOC	*Local*	The impact will affect an area up to 5 km from the proposed route corridor.
3	ADJ	*Adjacent*	The impact will affect the development footprint and 500 m buffer around development footprint
2	DEV	*Development footprint*	Impact occurring within the development footprint
1	ISO	*Isolated Sites*	The impact will affect an area no bigger than the servitude.

Duration / Temporal Scale

In order to accurately describe the impact it is necessary to understand the duration and persistence of an impact in the environment. The temporal scale is rated according to criteria set out in Table 4.3 below.

Table4.3: Description of the temporal rating scale

Rating			Description
Score	Code	Category	
5	PERM	Permanent	The environmental impact will be permanent.
4	LONG	Long term	The environmental impact identified will operate beyond the life of operation.
3	MED	Medium term	The environmental impact identified will operate for the duration of life of the line.
2	SHORT	Short-term	The environmental impact identified will operate for the duration of the construction phase or a period of less than 5 years, whichever is the greater.
1	INCID	Incidental	The impact will be limited to isolated incidences that are expected to occur very sporadically.

Degree of Probability

The probability or likelihood of an impact occurring is described as shown in Table 4.4 below.

Table 4.4: Description of the degree of probability of an impact accruing

Score	Code	Category
5	OCCUR	*It's going to happen / has occurred*
4	VLIKE	*Very Likely*
3	LIKE	*Could happen*
2	UNLIKE	*Unlikely*
1	IMPOS	*Practically impossible*

Degree of Certainty

As with all studies it is not possible to be 100% certain of all facts, and for this reason a standard "degree of certainty" scale is used as discussed in 4.5 below. The level of detail for specialist studies is determined according to the degree of certainty required for decision-making. The impacts are discussed in terms of affected parties or environmental components.

Table 4.5: Description of the degree of certainty rating scale

Rating	Description
Definite	More than 90% sure of a particular fact.
Probable	Between 70 and 90% sure of a particular fact, or of the likelihood of that impact occurring.
Possible	Between 40 and 70% sure of a particular fact or of the likelihood of an impact occurring.
Unsure	Less than 40% sure of a particular fact or the likelihood of an impact occurring.
Can't know	The consultant believes an assessment is not possible even with additional research.

Impact Risk Calculation

To allow for impacts to be described in a quantitative manner in addition to the qualitative description, a rating scale of between 1 and 7 was used for each of the assessment criteria. Thus the total value of the impact is described as the function of magnitude, spatial and temporal scale as described below:

$$Impact\ Risk = \frac{\text{Magnitude} + \text{Spatial} + \text{Temporal}}{2.714} \times \frac{\text{Probability}}{5}$$

The impact risk is classified according to 5 classes as described in 4.7 below.

Table4.7: Impact Risk Classes

Rating	Impact class	Description
6.1 - 7.0	7	SEVERE
5.1 - 6.0	6	VERY HIGH
4.1 - 5.0	5	HIGH
3.1 - 4.0	4	MODERATE-HIGH
2.1 - 3.0	3	MODERATE-LOW
1.1 - 2.0	2	LOW
0.1 - 1.0	1	VERY LOW

Therefore with reference to the example used for greenhouse gas emissions above, an impact rating of 1.8 will fall in the Impact Class 2, which will be considered to be a Low impact.

Notation of Impacts

In order to make the report easier to read the following notation format is used to highlight the various components of the assessment:

- Significance or magnitude- IN CAPITALS
- Spatial Scale – *in italics*
- Duration – <u>in underline</u>
- Probability – *<u>in italics and underlined.</u>*
- Degree of certainty - **in bold**

Of consequence to the soils and land capability of the areas to be affected are the changes that the activities and related support aspects being planned will have on the existing physical and socio economic state of the environment.

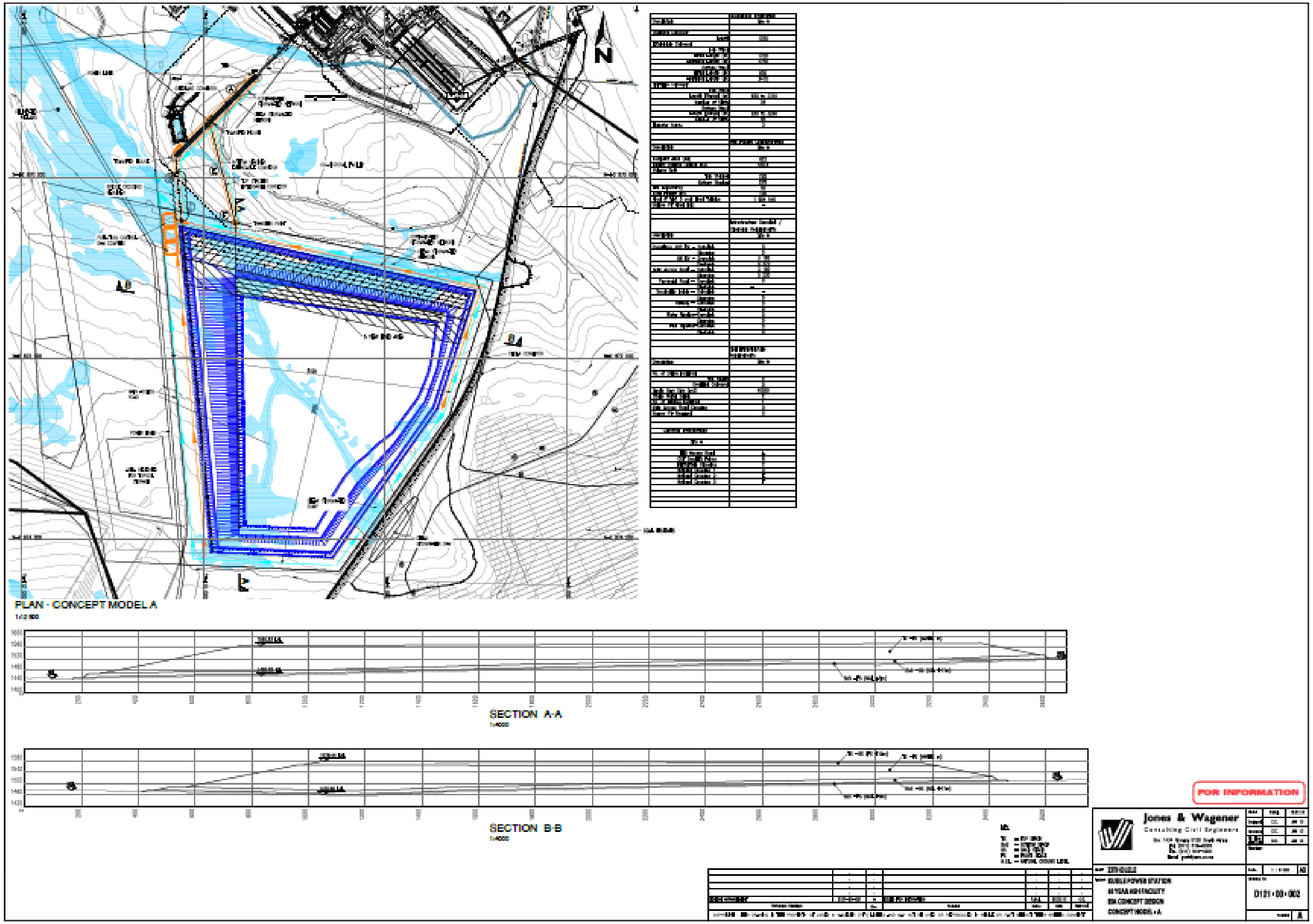


Figure 4.1 – Engineering Design – Site A (Ash Disposal Facility and Associated Conveyencing Infrastructure)

5. ENVIRONMENTAL IMPACT ASSESSMENT/STATEMENT

The EIA methodology and philosophy is covered in the preceding sections, and with a significant amount of information and understanding about the activities and how they will impact the soils and land capability during the construction and operation of the proposed ash conveyencing, and deposition of the ash on the ash disposal facility.

At the outset, it is noted that even after the inclusion of a more comprehensive study of Site "B" (Refer to Appendix C for the Site "B" investigation findings), and with all of the soil, land capability and geomorphological factors considered Site "C" was considered the best alternative, while discussions with the ecologists, wetland scientists and environmental assessment team regarded Site "A" the most feasible and sustainable site for an Ashing Facility of the size required.

Based on these factors and outcomes, an assessment (EIA) of the environmental impacts that these activities might produce has been carried out and measured against the existing environmental state using the significance rating supplied.

The outcomes are tabled as discussion points for the group presentation to the client and EAP's involved in the compilation of the overall EIA for the Kusile 60 Year Ash Disposal Facility.

This section assesses and measures/quantifies the environmental aspects of the **activities** in terms of how they will affect the **existing state/status quo**, and details where possible/available the maximum acceptable level of impact for each of the variables listed.

Based on these findings, the **significance/impact risk** is rated in terms of its unmanaged and managed state, with the management recommendations forming the basis of the Environmental Management Plan (Chapter 6).

Of significance to the proposed development and the sustainability of any project are the sensitivities of many of the soils (Refer to Figure 5).

The sensitivities considered important when assessing the soil environment include, soil depth, soil structure and texture (clay content etc.), the chemical composition (organic carbon etc.) and the soils erodibility and compactability. These variables are often manifest by particular soil features or resultant land forms and variations in the overall geomorphology, and are in almost all cases associated with other ecological aspects or areas of biodiversity importance.

In addition, and of importance in these semi-arid climates that characterise the Kusile area, is the occurrence of evaporite or ferricrete layers. These features are indicative of their having been wetness within a profile, and although many of the ferricrete mapped are believed to be associated with relic land forms, there are a number of areas where these features are associated with topographic low lying areas, pans and present day wetness within the profile.

These features are important to the biodiversity and ecology of the area and need to be understood in the context of the overall systems that sustain the pre development environment.

In terms of the wetland delineation guidelines and the legal status of wetlands the highly sensitive areas need to be considered carefully if they are within the area of proposed impact.

In addition, the noted (baseline study) differences in the texture of the different soils, the soil depth variations, composition of the "C" horizon (ferricrete), wetness of subsoil's and the structure of the different soil groups is of importance in assessing the relative sensitivities and resultant potential impacts that are assigned to the soil groups and land capabilities that are to be effected. The difference in the significance of the expected impacts based on soil form or group alone should influence the site choice and the ultimate design criteria of infrastructure.

There are no off-site activities included in this Environmental Impact Assessment. The assessment is confined to the project footprint and its immediate surroundings, and as such the "spatial extent is regarded as "Site Only" or at worst "Localised" depending on how far the effects of erosion are predicted to extend.

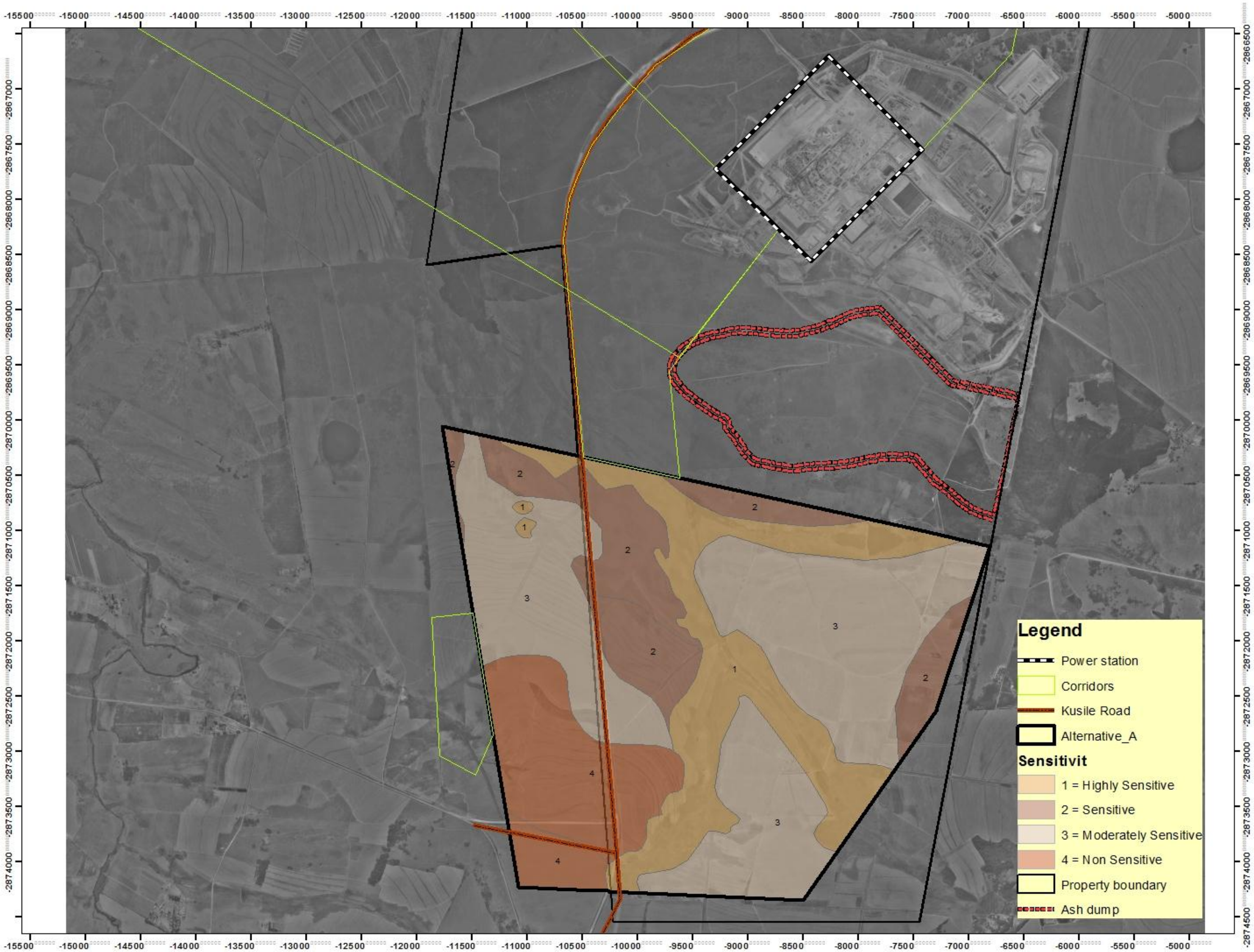


Figure 3 – Soil Sensitivity Map – Site A

The infrastructure planned for the facility will include (Refer to Design Reports) some large and heavy structures and relatively deep excavations (return water dams, ash facility liner and pump installations). These will entail the removal of significant quantities of soil, and possibly the complete removal of soil and soft overburden in places were the foundations for the larger structures (dams) are to be excavated.

The conveyer route and maintenance/access roadways will required less engineering as the size and weight of implements and machinery will be relatively smaller/less, albeit that they will still require strong foundations with well-engineered sub-base for all plinth footings (conveyer and all above ground piping and stream crossings. These soils will however all be sterilized and lost from the system for the life of the operation and possibly beyond in the case of the permanent facility.

A number of site specific baseline (existing environment) conditions are of special significance and need mention here if the relative impacts of the activities being planned are to be understood.

Of significance are:

- The underlying ferricrete layer (inhibiting layer), and its function as a barrier to soil water loss down the profile. This will in almost all cases [deep foundations or facilities (dams etc.)] be destroyed and possibly removed from the system;
- All/any pan structures that classify as wetlands are considered to be ecologically sensitive and important;
- The significant area of wet based soil that is being considered as part of the footprint to the developments;
- The relatively low clay content of all but the more basic derived soils and the low organic carbon render most of the soils susceptible to erosion, while,
- The wet based soils and some of the more basic derived soils will compact if subjected to heavy loads.

These conditions will have a bearing on the ratings being assigned to the overall impact statement as loss of these features will have a definite localised negative impact that is of significance to the ecological functionality of the area. These variables have a bearing on the management recommendations made.

In addition to the baseline soil and land capability for the proposed site is the pre-development conditions or status quo for the area of concern. For the most part the site comprises commercial farmlands that are being cultivated to annual crops (cereals, potatoes and soya beans) or pastures for commercial livestock farming.

The status quo constitutes a brownfields environment, with significant negative impacts associated with the farming ventures. These have been assessed in some detail, albeit that little information is available of the original unaffected environment. The impacts will be associated with:

- The changes to the soil physical and chemical composition, the potential contamination (over supply and thus contamination by fertilisers that cannot be taken up by the plants and which will leach into the soil water and ultimately the groundwater environment),
- Erosion and loss of soils from unprotected cultivation and the effects of wind and water and the impacts of the added sedimentary load on the streams and rivers/dams of the area,
- Compaction by farm vehicles on unprotected lands and

- The contamination of the soils from hydrocarbon spills from farm implements.

These impacts have been taken into account when assessment of the proposed development is considered in its unmanaged and unmitigated state.

5.1 Planned Ash Disposal Facility Activities

The key activities planned for the development include:

- Construction of conveyer from Power Station to the Ash Disposal Facility inclusive of any/all river crossings, and access and service road and stormwater control trenches and berms;
- Construction of the footprint for the Ash Disposal Facility and the laying of the liner;
- Access for light and medium vehicles for maintenance of ash facility (same as for the conveyer presumably);
- Deposition of the ash and management of the water;
- Construction of soil laydown areas. Compaction of soil stockpile pad and construction of clean and dirty water separation trenches and berms.
- Construction and operation of the stormwater control facility, building of clean water dam upstream of the facility, and the discharge of clean water back into the environment, and construction of pollution control dams and cut-off trenches to control and evaporate the dirty water from the facility and its associated activities;
- Monitoring of water and dust, and
- Storage and distribution of hydrocarbons.

With an understanding of the general high level workings of the proposed project and the construction and operational activities and support facilities and infrastructure that will be used to convey the waste materials to the ash disposal site and the management and reticulation of the dirty water, it is evident that the **major** concerns and probable impacts that could affect the soils and associated land capability are confined to:

- The loss of the soil resource due the **change in land use** and the removal of the resource from the existing system (Sterilization). These are generally associated with the construction of the facilities and the use of the footprint area for the development of commercial or recreational activities and support infrastructure. The proposed waste depositional activities will potentially result in the complete loss of the soil resource for the life of the project and in the case of the ash disposal facility footprint, this will be permanent. In addition, the management of waste could potentially sterilize the soils permanently, if not removed/striped, stored and well managed;
- The loss of the soil resource due to **erosion** (wind and water) of unprotected materials due to the removal of vegetative cover and/or topsoil;
- The loss of the utilization potential of the soil and land capability due to **compaction** of areas adjacent to the constructed facilities by vehicle and construction activities;
- Loss of the resource due to **removal** of materials for use in other activities (dam wall construction, development of berms and the storage of the soils in stockpiles);
- The **contamination** of the resource due to spillage of raw materials or final product and the possibility of spillage of reagents that are transported to the site;
- The **contamination** of stored or in-situ materials due to dust or dirty water from the project area and transport routes;
- The loss of the soil utilization potential due to the **disturbance** of the soils and potential loss of nutrient stores through leaching and de-nitrification of the stored or disturbed materials.

5.2 Impact Assessment

5.2.1 Construction Phase

Issue - Loss of utilisable resource (sterilization and erosion), compaction and contamination or salinization.

The construction phase will require:

- The stripping of all utilisable soil (Top 250mm to 700mm depending on activity);
- The preparation (levelling and compaction) of lay-down areas, foundations and pad footprint areas for stockpiling of utilisable soil removed from the footprint to the Ash Disposal Facility, Return Water Dam (RWD) and Soil Stockpiles,
- The stormwater management system (Dams, Water Reservoir etc.), and the foundations for the Site Offices and Site Workshops and all related support infrastructure;
- The clearing, stripping and stockpiling from the construction of all access and Conveyencing and Haulage Ways, Electrical Servitudes and Water Reticulation (pipelines and overhead power lines);
- The use of heavy machinery over unprotected soils;
- The creation of dust and loss of materials to wind and water erosion, and
- The possible contamination of the soils by dirty water, chemicals and hydrocarbons spills (dust and dirty water runoff);

Impact Risk

The loss of the utilization of the soil resource will negatively impact the land use practice of low to moderate intensity livestock grazing and commercial cultivation of cereal crops (major land use activities) being undertaken on the dryland soils at present. These activities are perceived to be of great economic benefit to the local economy and land owners and contribute to the ecosystem services.

The construction for the Ash Disposal Facility and its support activities will, if un-managed and without mitigation have a **definite,** MODERATE to HIGH negative significance, that will affect the *development site and its immediate* surroundings for the medium to long term (life of the project and possibly beyond), and is *going to occur.*

The proposed activities will during construction result in:

- The loss of the soil materials, and as a result the use of the resource;
- Have the potential for contamination (hydrocarbon and reagent chemical spills, raw materials and spillage of coal, etc.), compaction of working/laydown areas and storage facility footprint and the potential for erosion (wind and water – dust and suspended solids) over unprotected areas;
- Have a moderate negative intensity potential ranking based on the confined (limited to footprint of impact) and compact nature of the infrastructure for the relative size of the infrastructure;
- Continue throughout the construction phase and into the operational phase;
- Will be permanent but reversible (can be broken down and rehabilitated), and
- Is confined to the site only - localised.

However, with management, the loss, degree of contamination, compaction and erosion of this resource can be mitigated and reduced to a level that is more acceptable.

The reduction in the risk rating of the impact can be achieved by:

- Limiting the area of impact to as small a footprint as possible, inclusive of the resource (soils) stockpiles and the length of servitudes, access and haulage ways and conveyencing systems wherever possible;
- Construction of the facility and associated infrastructure over the less sensitive soil groups (reduce impact over wetlands and soils sensitive to erosion and/or compaction);
- An awareness of the length of time that the resource will need to be stored and managed;
- The development and inclusion of soil management as part of the general housekeeping operations, and the independent auditing of this management;
- Concurrent rehabilitation of all affected sites that are not required for the operation;
- The rehabilitation of temporary structures and footprint areas used during the feasibility investigation (geotechnical pits, trenching etc.) and the construction phase;
- Effective soil stripping during the less windy months when the soils are less susceptible to erosion;
- Separation of the utilisable soils and ferricrete base materials from each other and from the soft overburden;
- Effective cladding of the berms and soil, ferricrete stockpiles/heaps with vegetation or large rock fragments, and the minimising of the height of storage facilities to 15m and soil berms to 1,5m wherever possible;
- Restriction of vehicle movement over unprotected or sensitive areas, this will reduce compaction;
- Soil amelioration (cultivation) to enhance the oxygenation and growing capability (germination) of natural regeneration and/or seed within the stockpiled soils (maintain the soils viability during storage) and areas of concurrent rehabilitation.

It is evident in the industry, that failure to manage the impacts on this important resource (soil) will result in the total loss of the resource, with a resultant much higher significance rating.

Residual Impact

The above management procedures will **probably** reduce the negative significance rating and resultant risk impact to a MODERATE LOW rating that will be confined to the *development site and its immediate (500m) surroundings* in the medium term. Based on the historical actions of the proponent these actions are *very likely to occur.*

Table 5.2.1 - Construction Phase Risk Impact

Rated By:	Earth Science Solutions (IJ)	Ash Dump - Site A							
IMPACT DESCRIPTION		Direction of Impact	Degree of Certainty	Magnatude	Spatial	Temporal	Probability	Impact Risk
Code	Phase							
	CONSTRUCTION							
STATUS QUO	INITIAL BASELINE IMPACTS TO ENVIRONMENT	Negative	Definite	3 MODL	3 ADJ	4 LONG	5 OCCUR	-3.7 MODH
Project Impact 1	Loss of soil utilisation potential due to perminant nature of the proposed Ash Dump Facility	Negative	Definite	5 HIGH	3 ADJ	5 PERM	5 OCCUR	-4.8 HIGH
Project Impact 2	Loss of vegetative cover and topsoil protection - possibility of erosion, the perminant loss of resource downslope and the impact of sedimentary load on the streams and river systems.	Negative	Definite	4 MODH	2 DEV	4 LONG	5 OCCUR	-3.7 MODH
Project Impact 3	Loss of soil resource and its utilization potential and the possible contamination of the soil resource by waste product, hydrocarbon spils and/or dirty water	Negative	Probable	4 MODH	2 DEV	3 MED	4 VLIKE	-2.7 MODL
Project Impact 4	Loss of soil resource and its utilisation potential due to compaction over unprotected soil.	Negative	Probable	3 MODL	2 DEV	4 LONG	4 VLIKE	-2.7 MODL
Project Impact 5	Loss of soil nutrient status and resultant reduction in land capability potential due to denitrification and leaching from stripping and storage	Negative	Probable	4 MODH	2 DEV	4 LONG	4 VLIKE	-2.9 MODL
CUMULATIVE IMPACT	INITIAL IMPACTS TO ENVIRONMENT + ADDITIONAL IMPACTS FROM PROJECT, **BEFORE MITIGATION**	Negative	Probable	4 MODH	3 ADJ	4 LONG	5 OCCUR	-4.1 HIGH
RESIDUAL IMPACT	INITIAL IMPACTS TO ENVIRONMENT + ADDITIONAL IMPACTS FROM PROJECT, **AFTER MITIGATION**	Negative	Probable	3 MODL	3 ADJ	3 MED	4 VLIKE	-2.7 MODL

5.2.2 Operational Phase

Issue ***Loss of utilisable resource (Sterilization and erosion), compaction, de-nutrification and contamination or salinization.***

The operation of the Ash Disposal Facility development (deposition of ash, management of water and associated activities) will see the impact of the transportation of materials into and out of the waste site (ash and water in, water out), the potential for spillage and contamination of the in-situ and stockpiled materials, contamination due to dirty water run-off and/or contaminated dust deposition/dispersion, the de-nutrification of the stockpiled soils due to excessive through flow and the leaching out of nutrients and metals due to rain water on unconsolidated and poorly protected soils, and, the potential for compaction of the in-situ materials by uncontrolled vehicle movement and the loss to the environment (down-wind and downstream) of soil by wind and water erosion over un-protected ground.

In summary, the operation will potentially result in:

- The sterilization of the soil resource on which the facilities are constructed. This will be an on-going loss for the duration of the operation and beyond;
- The creation of dust and the possible loss (erosion) of utilisable soil down-wind and/or downstream, and the potential for contamination of the soils from dust fallout and overland flow of dirty water;
- The compaction of the in-situ and stored soils and the potential loss of utilisable materials from the system;
- The contamination of the soils by dirty water run-off and or spillage of hydrocarbons from vehicle and machinery or from dust and emissions from the process;
- Contamination of soils by use of dirty water for road wetting (dust suppression) and irrigation of the stockpile vegetation;
- Potential contamination of soils by chemical spills of reagents being transported to site;
- Sterilization and loss of soil nutrient pool, organic carbon stores and fertility of stored soils;
- Impact on soil structure and soil water balance.

Un-managed soil stockpiles and soil that is left uncovered/unprotected will be lost to wind and water erosion, will lose the all-important, albeit moderately poor nutrient content and organic carbon stores (fertility), and will be prone to compaction.

A positive impact will be the rehabilitation of the temporary infrastructure used during the start-up and construction phase.

Impact Significance

In the un-managed scenario these activities will **probably** result in a MODERATE to HIGH negative significance that will affect the *development footprint and adjacent* sites for the medium to long term. These effects are *very* likely to occur.

It is inevitable that some of the soils will be lost during the operational phase if they are not well managed and a mitigation plan is not made part of the general management schedule.

The impacts on the soils during the operational phase (stockpiled, peripheral soils and downstream (wind and water) materials) may be mitigated with well initiated management procedures.

These should include:

- Minimisation of the area that can potentially be impacted (eroded, compacted, sterilized or de-nutrified);
- Timeous replacement of the soils so as to minimise/reduce the area of affect and disturbance;
- Effective soil cover and adequate protection from wind (dust) and dirty water contamination – vegetate and/or rock cladding;
- Regular servicing of all vehicles in well-constructed and bunded areas;
- Regular cleaning and maintenance of all haulage ways, conveyencing routes and service ways, drains and storm water control facilities;
- Containment and management of spillage;
- Soil replacement and the preparation of a seed bed to facilitate and accelerate the re-vegetation program and to limit potential erosion on all areas that become available for rehabilitation (temporary servitudes), and
- Soil amelioration (rehabilitated and stockpiled) to enhance the growth capability of the soils and sustain the soils ability to retain oxygen and nutrients, thus sustaining vegetative material during the storage stage.

It will be necessary as part of the development plan to maintain the integrity of the stored soils so that they are available for rehabilitation at decommissioning and closure. If the soil quantities and qualities (utilisable soils) are managed well throughout the operational phase, rehabilitation costs will be reduced and natural attenuation will more easily and readily take effect. This will result in a more sustainable “End Land Use” being achieved.

Residual Impact

In the *long term* (Life of the operation and beyond) and if implemented correctly, the above mitigation measures will **probably** reduce the negative impact on the utilisable soil reserves (erosion, contamination, sterilization) to a significance rating of MODERATE LOW in the medium term, and is *very likely* to occur.

However, if the soils are not retained/stored and managed, and a workable management plan is not implemented the residual impact will definitely incur additional costs and result in the impacting of secondary areas (Borrow Pits etc.) in order to obtain cover materials etc.

Table 5.2.2 Operational Phase – Impact Significance

Rated By:	*Earth Science Solutions (IJ)*	Ash Dump - Site A						
	IMPACT DESCRIPTION	Direction of Impact	**Degree of Certainty**	Magnatude	Spatial	Temporal	Probability	**Impact Risk**
Code	*Phase*							
	OPERATIONAL PHASE							
STATUS QUO	INITIAL BASELINE IMPACTS TO ENVIRONMENT	Negative	**Definite**	3 MODL	3 ADJ	4 LONG	5 OCCUR	**-3.7** **MODH**
Project Impact 1	Continued loss of soil resource (perminant) and utilization potential, plus possible contamination of footprint soil and loss of land capability due to iposition of the Ash Dump.	Negative	**Definite**	5 HIGH	3 ADJ	5 PERM	5 OCCUR	**-4.8** **HIGH**
Project Impact 2	Loss of resource due to unprotected overland flow of water (suspended solids) and erosion of soil due to wind from dry ash material - potentially off site - dust issue.	Negative	**Probable**	4 MODH	4 LOC	4 LONG	5 OCCUR	**-4.4** **HIGH**
Project Impact 3	Continued loss of soil utilisation due to contamination by operational activities - Ash dumping/deposition and vehicle plus conveyer impacts - hydrocarbons, reagents and natural by products (dirty water and dust).	Negative	**Probable**	4 MODH	4 LOC	3 MED	4 VLIKE	**-3.2** **MODH**
Project Impact 4	The continued loss of resource and utilization potential due to operation of the Ash Dump and its associated infrastructure/facilities (conveyer, pipelines, access road and water management infrastructure (Return Water Dam etc.) and loss of nutrient pool and organic carbon due to leaching over unprotected soils. Loss of land capability potential.	Negative	**Probable**	3 MODL	2 DEV	4 LONG	4 VLIKE	**-2.7** **MODL**
CUMULATIVE IMPACT	INITIAL IMPACTS TO ENVIRONMENT + ADDITIONAL IMPACTS FROM PROJECT, **BEFORE MITIGATION**	Negative	**Probable**	4 MODH	3 ADJ	5 PERM	5 OCCUR	**-4.4** **HIGH**
RESIDUAL IMPACT	INITIAL IMPACTS TO ENVIRONMENT + ADDITIONAL IMPACTS FROM PROJECT, **AFTER MITIGATION**	Negative	**Probable**	3 MODL	3 ADJ	4 LONG	4 VLIKE	**-2.9** **MODL**

5.2.3 Decommissioning & Closure Phase

Issue: Net loss of soil volumes and utilization potential due to change in material status (Physical and Chemical) and loss of nutrient base.

The impacts on the soil resource during the decommissioning and closure phase have both a positive and a negative effect, with:

- The loss of the soils original nutrient status and store and the reduction in the already very low organic carbon by leaching of the soils while in storage;
- Erosion and de-oxygenation of materials while stockpiled;
- Compaction and dust contamination due to vehicle movement and wind impacts on the soil while rehabilitating the area;
- Erosion of soils during slope stabilization and re-vegetation of disturbed areas;
- Contamination of replaced soils by use of dirty water for plant watering and dust suppression on roadways;
- Hydrocarbon or chemical spillage from contractor and supply vehicles.
- Positive impacts of reduction in areas of disturbance and return of soil utilization potential, uncovering of areas of storage and rehabilitation of compacted materials.

Impact Significance

The impact will **probably** remain the net loss of the soil resource if no intervention or mitigating strategy is implemented. The intensity potential will remain MODERATE to LOW and positive for the medium to short term for all of the activities if there is no active management (rehabilitation and intervention) in the decommissioning phase, and closure will not be possible. The impacts will be confined to the *development* area and its *adjacent* buffer, and is *likely* to happen.

This will result in an irreversible impact that is continuous.

However, with interventions and well planned management, there will be a MODERATE to HIGH positive intensity potential as the soils are replaced and fertilization of the soils is implemented after removal of the infrastructure.

Ongoing rehabilitation during the operational and decommissioning phases will bring about a net long-term positive impact on the soils, albeit that the land capability will likely be reduced to grazing status.

The intensity potential of the initial activities during rehabilitation and closure will be moderate and negative due to the necessity for vehicle movement while removing the demolished infrastructure and rehabilitating the operational footprints. Dust will **potentially** be generated and soil will **probably** be contaminated, compacted and eroded to differing extents depending on the degree of management implemented.

The positive impacts of rehabilitation on the area are the reduction in the footprint of disturbance, the amelioration of the affected soils and oxygenation of the growing medium, the stabilizing of slopes and the revegetation of disturbed areas.

Residual Impacts

On closure of the mining operation the *long-term* negative impact on the soils will be reduced from a significance ranking of MODERATE to LOW if the management plan set out in the Environmental Management Plan is effectively implemented. These impacts will be confined to the development site and its adjacent environments, and is *very likely* to occur.

Re-creation of the ferricrete layer effect (inhibiting layer) will require both environmental as well as engineering inputs. This conclusion supposes that the utilisable soils will be available (had been stripped and stored), and the ferricrete layer (where present) had been removed and stored separately from the sandy loams and sandy clay loams.

Chemical amelioration of the soils will have a low but positive impact on the nutrient status (only) of the soils in the medium term.

Table 5.2.3a Decommissioning Phase – Impact Significance

Rated By:	*Earth Science Solutions (IJ)*	Ash Dump - Site A						
	IMPACT DESCRIPTION	Direction of Impact	**Degree of Certainty**	Magnatude	Spatial	Temporal	Probability	**Impact Risk**
Code	*Phase*							
	DECOMMISSIONING/CLOSURE PHASE							
STATUS QUO	INITIAL BASELINE IMPACTS TO ENVIRONMENT	Negative	**Definite**	3 MODL	3 ADJ	4 LONG	5 OCCUR	**-3.7** **MODH**
Project Impact 1	Loss of soils nutrient and organic carbon while in storage	Negative	**Definite**	5 HIGH	2 DEV	4 LONG	4 VLIKE	**-3.2** **MODH**
Project Impact 2	Contamination by dirty water used for watering re-vegetation, and dust from unprotected ash materials.	Negative	**Probable**	4 MODH	4 LOC	4 LONG	4 VLIKE	**-3.5** **MODH**
Project Impact 3	Hydrocarbon spills from rehab vehicles, compaction & Dust	Negative	**Probable**	4 MODH	4 LOC	3 MED	4 VLIKE	**-3.2** **MODH**
CUMULATIVE IMPACT	INITIAL IMPACTS TO ENVIRONMENT + ADDITIONAL IMPACTS FROM PROJECT, **BEFORE MITIGATION**	Negative	**Definite**	4 MODH	3 ADJ	4 LONG	4 VLIKE	**-3.2** **MODH**
RESIDUAL IMPACT	INITIAL IMPACTS TO ENVIRONMENT + ADDITIONAL IMPACTS FROM PROJECT, **AFTER MITIGATION**	Negative	**Probable**	4 MODH	2 DEV	3 MED	4 VLIKE	**-2.7** **MODL**

At closure (obtaining of certificate of closure from authorities) the residual impact should, if all rehabilitation and management efforts have been complied with, result in a positive impact, with the area being returned to a land capability of low intensity grazing or wilderness status, and the use of the land being returned to that of livestock management.

Table 5.2.3b Closure Phase – Impact Significance

Rated By:	*Earth Science Solutions (IJ)*			Ash Dump - Site A				
	IMPACT DESCRIPTION	Direction of Impact	**Degree of Certainty**	Magnatude	Spatial	Temporal	Probability	**Impact Risk**
Code	*Phase*							
	POST CLOSURE PHASE							
STATUS QUO	INITIAL BASELINE IMPACTS TO ENVIRONMENT	Negative	**Definite**	3 MODL	3 ADJ	4 LONG	5 OCCUR	**-3.7** **MODH**
Project Impact 1	Addition of fertilizers (Possible pollutant if over applied)	Positive	**Probable**	3 MODL	2 DEV	3 MED	3 LIKE	**-1.8** **LOW**
Project Impact 2	Animal and vehicle impacts (Compaction, erosion and dust).	Negative	**Probable**	3 MODL	2 DEV	3 MED	3 LIKE	**-1.8** **LOW**
Project Impact 3	Hydrocarbon spills from rehab vehicles and dust	Negative	**Probable**	4 MODH	2 DEV	3 MED	3 LIKE	**-2** **LOW**
CUMULATIVE IMPACT	INITIAL IMPACTS TO ENVIRONMENT + ADDITIONAL IMPACTS FROM PROJECT, **BEFORE MITIGATION**	Negative	**Definite**	3 MODL	2 DEV	3 MED	3 LIKE	**-1.8** **LOW**
RESIDUAL IMPACT	INITIAL IMPACTS TO ENVIRONMENT + ADDITIONAL IMPACTS FROM PROJECT, **AFTER MITIGATION**	Negative	**Probable**	3 MODL	2 DEV	2 SHORT	3 LIKE	**-1.5** **LOW**

6. ENVIRONMENTAL MANAGEMENT PLAN

6.1 General

In accordance with the Equator Principles (IFC Performance Principles), and the concept of sustainability, it is incumbent on any developer to not only assess and understand the possible impacts that a development might cause, but to also propose and table management measures that will aid in minimising and were possible mitigate the effects.

The management of the natural resources (soils and land capability) have been assessed on a phase basis (construction, operation and decommissioning/closure) in keeping with the impact assessment (EIA) philosophy, while the Environmental Management Plan (EMP) has been designed as a working plan and utilization guide for soil and land management.

The results tabled are based on the site specific soil characterisation and classification in conjunction with the geomorphology (topography, altitude, attitude, climate and ground roughness) of the sites that will be impacted or affected.

The plan gives recommendations on the stripping and handling of the soils throughout the life of the development along with recommendations for the utilization of the soils for rehabilitation at closure.

It has been assumed that all infrastructure will be removed and that the areas that were affected will be returned to as close as possible their pre-construction state (topographic levels, wilderness/conservation or low intensity grazing status – Refer to the Chamber of Mines Land Classification System (Refer to Section 2 - Table 2.2.1 of the Baseline Study), albeit that an Ash Disposal Facility will inevitably remain as a permanent feature.

The concept of stripping and storage of all "Utilisable" soil is recommended as a minimum requirement and as part of the overall Soil Utilization Philosophy.

In terms of the "Minimum Requirements", **usable or utilisable soil** is defined here as all soil above an agreed subterranean cut-off depth defined by the project soil scientist, and will vary for different forms of soil encountered in a project area and the type of project being considered. It does not differentiate between topsoil (orthic horizon) and other subsoil horizons necessarily.

The following soil utilization guidelines ***(all be they generic)*** should be adhered to wherever possible:

- Over areas of deep excavation *strip all usable soil* as defined (700mm) in terms of the soil classification and stockpile as berms or low, terraced dumps. Alluvial soils should be stockpiled separately from the colluvial (shallower) and in-situ derived materials, which in turn should be stored separately from any calcrete/ferricrete material, while the soft overburden is stored as a separate unit and as a defined dump of less than 15m in height preferably. Protect from contamination and erosion by rock cladding or vegetation cover and adequate drainage of surface runoff.

  At *rehabilitation* replace the soft overburden followed by the calcrete/ferricrete, compact and replace the soil to appropriate soil depths, and cover areas to achieve an appropriate topographic aspect and attitude that will achieve a free draining landscape as close as possible to the pre-mining/construction land capability rating.

- Over areas planned for less invasive Structures (Offices, Workshops etc) and any material stockpile or storage, *strip the top 500 mm* of usable soil over all affected areas including terraces and *strip remaining usable soil and calcrete (if present in profile)* where founding conditions require further soil removal.

  Store the soil in stockpiles or berms of not more than 1.5 m around infrastructure area ready for closure rehabilitation purposes. Stockpile hydromorphic (wet) soils separately from the dry materials, and the "calcrete" separately from all other materials.

  Protect all stockpiles from water and wind erosion (loss of materials) and contamination by dust and runoff water. Clad stockpiles with larger rock or vegetate the stored materials.

  At closure/rehabilitation, remove all large boulders and gravel from the rehabilitated landscape and place at the base/bottom of the foundations or open pit profile so that they do not interfere with the tillage and cultivation of the final surface. Remove foundations to a maximum depth of 1m. Replace soil to appropriate soil depths, and over disturbed areas and in appropriate topographic position to achieve pre-development land capability and land form where possible.

- Over areas of Tailings Storage facilities, Ash Disposal Facilities, Waste Rock Dumps and all Heavy Vehicle Haulage Roads and Major Access Routes, *strip usable soil* to a *depth of 750 mm where possible and/or* in areas of *arable soils,* and *between 300mm and 500mm* in areas of *soils with grazing land capability.* Stockpile hydromorphic soils separately from the dry and friable materials.

  Before *rehabilitation* remove all gravel and other rocky material and recycle as construction material or place in open voids. Remove foundations to a maximum depth of 1m. Replace soil to appropriate soil depths and in appropriate topographic position so as to achieve pre-mining land capability. Protect the stored materials from erosion and contamination using vegetation or rock cladding.

- Over areas to be utilized for General Access Roads (light delivery vehicles), Laydown Pads and any Conveyencing servitudes (Above ground pipelines and power line servitudes) *strip the top 150 mm* of usable soil over all affected areas and stockpile in longitudinal stockpile or berms upslope of the facilities. Protect from erosion and contamination.

6.2 Construction Phase

The construction methods and final End Land Use (ELU) are important in deciding if the utilisable soils need to be stripped and retained, and ultimately how much of the materials will be needed for the rehabilitation (stripping volumes). Failure to remove and store the utilisable materials will result in the permanent loss of the growth medium.

Making provision for retention of utilisable material for the decommissioning and/or during rehabilitation will not only save significant costs at closure, but will ensure that additional impacts to the environment do not occur.

The depths of utilisable materials on Site “A” vary between 300mm and greater than 1,200mm.

Due to the shallow soil depths on the more rocky areas it is recommended that sufficient materials are removed from the areas were significant soil depths are present and do exist, so that the shallow areas can be adequately resorted during rehabilitation and at closure.

For the Ash Disposal Facility footprint as a whole, and the nature of the activities that will take place as support infrastructure to the ash disposal it is recommended that at least 750mm of soil should be removed/stripped wherever possible.

The conveyencing route and access roads/ways will require that only 500mm of soil is removed and stored.

The areas confirmed as low sensitivity and or outside of the No Go zones are sufficiently similar that they can be stored as one soil group (Refer to Figure 5 – Soil Sensitivity Map). However, the Highly Sensitive and “No Go” areas (wetland areas) should not be impacted unless absolutely necessary, and then only if the necessary permissions have been obtained (licenses etc.).

Table 6.2a describes the proposed environmental management components and possible plan, while 6.2b is a plan for soil utilization during the construction phase.

Table 6.2a – Environmental Management Components and Plan – Construction Phase

Management / Environmental Component:	**EMPr Reference Code:**		
Soil and Land Capability	EMPr-??-Soil		
Primary Objective:			
Remove, store and protect soils			
Limit area of impact			
Store utilizable resource and manage erosion loss and structural deformation, plus compact footprint and engineer a barrier layer			
Implementation	**Responsibility**	**Resources**	**Monitoring / Reporting**
Remove utilizable soils to designed depths before construction (refer to table 5.1), stockpile and protect from erosion and compaction and impacts of contamination by dust or dirty water	Contractors and SHEQ manager + ECO	Truck and shovel, scrapers were feasable	Weekly assessment
Bund the area of possible impact and implement adequate stormwater controls to manage stormwater runoff and sedimentary load.	Contractors and SHEQ manager + ECO	TLB and light earth moving equipment	Monthly site checks & bi-annual audit
Storage of utilisable soil with vegetation intacked (remove only large trees before stripping), and store outside of wetlands or sensitive areas (100m from streams and waterways etc.).	Contractors and SHEQ manager + ECO	Bark chipper and spreader for large vegetation sizing	Monthly site checks & bi-annual audit
Line all channels and trenches (reduce sedimentary load to RWD and the environment.	Contractors and SHEQ manager + ECO	compaction of natural clays.	Monthly site checks & bi-annual audit
Stockpile soils in dumps of <15m height and or berms of less than 1,5m	Contractors and SHEQ manager + ECO	Trck and TLB	Monthly site checks & bi-annual audit
Store hydrocarbons in bunded storage area (Volume = 110%)	Contractors and SHEQ manager + ECO		Monthly site checks & bi-annual audit
Control erosion (vetiver grass or similar stand alone system) on all areas that will be vunerable to impact.	Contractors and SHEQ manager + ECO		Monthly site checks & bi-annual audit
Stockpile soft overburden and the non-utilisable portion of the soil horizon seperately from the utilisable soils, and keep wet based soils seperated from dry soil storage.	Contractors and SHEQ manager + ECO		Monthly site checks & bi-annual audit
Manage soil removal during dry season were possible, with specific control on the more structured soils.	Contractors and SHEQ manager + ECO		Monthly site checks & bi-annual audit
Limit (minimise) area of footprint impact as well as areas cleared of vegetative cover. Well designed road access and haulage ways (conveyers etc.) and policing of off road traffic will reduce compaction and effects of erosion.			
Existing management plans / procedures:			
Feasibility studies			
Monitoring Programme			

Table 6.2 Construction Phase – Soil Utilization Plan

Phase	Step	Factors to Consider	Comments
Construction	Delineation of areas to be stripped		Stripping will only occur where soils are to be disturbed by activities that are described in the design report, and where a clearly defined end rehabilitation use for the stripped soil has been identified.
	Reference to biodiversity action plan		It is recommened that all vegetation is stripped and stored as part of the utilizable soil. However, the requirements for moving and preserving fauna and flora according to the biodiversity action plan should be consulted.
	Stripping and Handling of soils	Handling	Soils will be handled in dry weather conditions so as to cause as little compaction as possible. Utilizable soil (Topsoil and upper portion of subsoil B2/1) must be removed and stockpiled separately from the lower "B" horizon, with the ferricrete layer being seperated from the soft/decomposed rock, and wet based soils seperated from the dry soils if they are to be impacted.
		Stripping	The "Utilizable" soil will be stripped to a depth of 750mm or until hard rock/ferricrete is encountered. These soils will be stockpiled together with any vegetation cover present (only large vegetation to be removed prior to stripping). The total stripped depth should be 750mm, wherever possible.
	Delineation of Stockpiling areas	Location	Stockpiling areas will be identified in close proximity to the source of the soil to limit handling and to promote reuse of soils in the correct areas. All stockpiles will be founded on stabilized and well engineered "pads"
		Designation of Areas	Soils stockpiles will be demarcated, and clearly marked to identify both the soil type and the intended area of rehabilitation.

This "Soil Utilization Plan" is intimately linked to the "development plan", and it should be understood that if the plan of construction changes, these recommendations will probably have to change as well.

6.3 Operational Phase

The operational phase will see very little change in the development requirements, with the footprint of disturbance remaining constant, albeit that the temporary infrastructure might become redundant and rehabilitation of these features might be possible.

Maintenance and care of the soil and land resources will be the main management activity and objective required during the operational phase. Management of material loss, compaction and contamination are the main issues of consideration. Table 6.3a and 6.3b give details and recommendations for the care and maintenance of the resource during the operational phase.

The semi-arid climate and unique character of the soils in the study area require that the site specific and unique natural phenomena should be used to the advantage of the project.

Working with or on the differing soil materials (all of which occur within the areas that are to be disturbed) will require better than average management and careful planning if rehabilitation is to be successful, and it is important that the sensitive and highly sensitive materials are avoided wherever possible.

Care in removal and stockpiling/storage of the "Utilisable" soils, and protection of materials which are derived from the "hardpan ferricrete" layer is imperative to the success of sustainable rehabilitation in these areas, with the soil water (near surface water) held within the profile by this inhibiting layer being of great importance and integral to the success of the biodiversity and ecological systems and services.

Table 6.3a Operational Phase – Environmental Management Components and Plan

Management / Environmental Component:	**EMPr Reference Code:**		
Soil and Land Capability	EMPr-??-Soil		
Primary Objective:			
Maintain/Protect and manage stored and stockpiled soils			
Manage on-going soil stripping and storage			
Manage impacts of dust and dirty water impacts on both stored and in-situ soils adjacent to the operations			
Manage impacts of spillage (product, hydrocarbons and reagents)			
Implementation	**Responsibility**	**Resources**	**Monitoring / Reporting**
Manage waste disposal and treatment. No disposal of any industrial or domestic waste on site - Use reputable and registered waste contractor and control spillage.	SHEQ Manager	Contractor	Quarterly site inspections and bi-annual independent audit
Maintain vegetative cover to all soil storage areas and on exposed faces to control erosion and reduce effects of compaction.	SHEQ Manager	Manual labour	Quarterly site inspections and bi-annual independent audit
Maintain all stormwater controls (berms, trenches and dams), clean out sediment and maintain liner integrety	SHEQ Manager	TLB and manual labour	Quarterly site inspections and bi-annual independent audit
Limit (minimise) area of footprint impact as well as areas cleared of vegetative cover. Well designed road access and haulage ways (conveyers etc.) and policing of off road traffic will reduce compaction and effects of erosion.	SHEQ Manager		Quarterly site inspections and bi-annual independent audit
Existing management plans / procedures:			
Monitoring Programme			

Table 6.3b Operational Phase – Soil Conservation Plan

Phase	Step	Factors to Consider	Comments
Operation	Stockpile management	Vegetation establishment and erosion control	Enhanced growth of vegetation on the Soil Stockpiles and berms will be promoted (e.g. by means of watering and/or fertilisation), or a system of rock cladding will be employed. The purpose of this exercise will be to protect the soils and combat erosion by water and wind.
		Storm Water Control	Stockpiles will be established/engineered with storm water diversion berms in place to prevent run off erosion.
		Stockpile Height and Slope Stability	Soil stockpile and berm heights will be restricted where possible to <1.5m so as to avoid compaction and damage to the soil seed pool. Where stockpiles higher than 1.5m cannot be avoided, these will be benched to a maximum height of 15m. Each bench should ideally be 1.5m high and 2m wide. For storage periods greater than 3 years, vegetative (vetiver hedges and native grass species - refer to Appendix 1) or rock cover will be essential, and should be encouraged using fertilization and induced seeding with water and/or the placement of waste rock. The stockpile side slopes should be stabilized at a slope of 1 in 6. This will promote vegetation growth and reduce run-off related erosion.
		Waste	Only inert waste rock material will be placed on the soil stockpiles if the vegetative growth is impractical or not viable (due to lack of water for irrigation etc.). This will aid in protecting the stockpiles from wind and water erosion until the natural vegetative cover can take effect.
		Vehicles	Equipment, human and animal movement on the soil stockpiles will be limited to avoid topsoil compaction and subsequent damage to the soils and seedbank.

6.4 Decommissioning and Closure

The decommissioning and closure phase will see:

- The removal of all infrastructure;
- The demolishing of all concrete slabs/plinths and the ripping of any hard/compacted surfaces;
- The backfilling of all voids and deep foundations and the reconstruction of the required barrier layer (compaction of ferricrete and clay rich materials) wherever feasible and engineering possible;
- Topdressing of the disturbed and backfilled areas with the stored “utilisable” soil ready for re-vegetation;
- Capping of the final phases of the disposal facility (ash disposal) and waste piles with utilisable soil;
- Vegetation of soil dumps and waste piles;
- Fertilization and stabilization of the backfilled and final cover materials (soil and vegetation) and
- The landscaping of the replaced soils to be free draining.

There will be a positive impact on the soil and land capability environments as the area of disturbance is reduced, the soils are returned to a state that can support low intensity wildlife grazing or sustainable conservation and the impacts of compaction and erosion are mitigated.

Table 6.4a and 6.4b are a summary of the proposed management and mitigation actions recommended.

Table 6.4a Decommissioning/Closure Phase – Environmental Management Components and Plan

Management / Environmental Component:	**EMPr Reference Code:**		
Soils and Land Capability	EMPr-?-Soils		
Primary Objective:			
Return area to as close as possible it's original state			
Implementation	**Responsibility**	**Resources**	**Monitoring / Reporting**
Restrict access to area and reduce vehicle movement will reduce effects of compaction and prevent destruction of vegetative cover - control erosion	SHEQ Manager	Fencing	Quarterly monitoring and Annual Audit
Regular monitoring of vegetative cover and growth, maintenace of weeds and soil testing for nutrient status	SHEQ Manager	Visual site assessment	Quarterly monitoring and Annual Audit
Reinstate soils as closely as possible to their original position and in the correct order of emplacement.	SHEQ Manager	TLB, truck and front end loader. Compaction of subsoil recommended	Quarterly monitoring and Annual Audit
Treat soils with required (analytical test results) pH balance and fertiliser requirements (lime and N;K;P requirements). Retest quarterly for first year and annually thereafter till standalone status reached.	SHEQ Manager		Quarterly monitoring and Annual Audit
External Audits	Independent ECO		Annual AuditAnnual
Existing management plans / procedures:			
Monitoring			
Erosion controls			

Table 6.4b Decommissioning and Closure Phase – Soil Conservation Plan

Phase	Step	Factors to Consider	Comments
Decommissioning & Closure	Rehabilitation of Disturbed land & Restoration of Soil Utilization	Placement of Soils	Stockpiled soil will be used to rehabilitate disturbed sites either ongoing as disturbed areas become available for rehabilitation and/or at closure. The utilizable soil (500mm to 750mm) removed during the construction phase, must be redistributed in a manner that achieves an approximate uniform stable thickness consistent with the approved post development end land use (Conservation land capability and/or Low intensity grazing), and will attain a free draining surface profile. A minimum layer of 300mm of soil will be replaced.
		Fertilization	A representative sampling of the stripped and stockpiled soils will be analysed to determine the nutrient status and chemistry of the utilizable materials. As a minimum the following elements will be tested for: EC, CEC, pH, Ca, Mg, K, Na, P, Zn, Clay% and Organic Carbon. These elements provide the basis for determining the fertility of soil. based on the analysis, fertilisers will be applied if necessary.
		Erosion Control	Erosion control measures will be implemented to ensure that the soil is not washed away and that erosion gulleys do not develop prior to vegetation establishment.
	Pollution of Soils	In-situ Remediation	If soil (whether stockpiled or in its undisturbed natural state) is polluted, the first management priority is to treat the pollution by means of in situ bioremediation. The acceptability of this option must be verified by an appropriate soils expert and by the local water authority on a case by case basis, before it is implemented.
		Off site disposal of soils.	If in situ treatment is not possible or acceptable then the polluted soil must be classified according to the Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste (Local Dept of Water Affairs) and disposed of at an appropriate, permitted, off-site waste facility.

6.5 Monitoring and Maintenance

Nutrient requirements reported in this document are based on the monitoring and sampling of the soils at the time of the baseline survey. These values will definitely alter during the storage stage and will need to be re-evaluated before being used during rehabilitation. Ongoing evaluation of the nutrient status of the growth medium will be needed throughout the life of the project and into the rehabilitation and closure phases.

During the rehabilitation exercise, preliminary soil quality monitoring should be carried out to accurately determine the fertilizer and pH requirements that will be needed. Additional soil sampling should also be carried out annually after rehabilitation has been completed and until the levels of nutrients, specifically magnesium, phosphorus and potassium, are at the required levels for sustainable growth.

Once the desired nutritional status has been achieved, it is recommended that the interval between sampling is increased. An annual environmental audit should be undertaken. If growth problems develop, ad hoc, sampling should be carried out to determine the problem.

Monitoring should always be carried out at the same time of the year and at least six weeks after the last application of fertilizer.

Soils should be sampled and analysed for the following parameters:

pH (H_2O)
Electrical conductivity
Cation exchange capacity
Magnesium mg/kg;
Clay, sand and Silt
Phosphorus (Bray I)
Calcium mg/kg
Sodium mg/kg;
Potassium mg/kg Zinc mg/kg;
Organic matter content (C %)

The following maintenance is recommended:

- The area must be fenced, and all animals kept off the area until the vegetation is self-sustaining;
- Newly seeded/planted areas must be protected against compaction and erosion (Vetiver hedges etc.);
- Traffic should be limited were possible while the vegetation is establishing itself;
- Plants should be watered and weeded as required on a regular and managed basis were possible and practical;
- Check for pests and diseases at least once every two weeks and treat if necessary;
- Replace unhealthy or dead plant material;
- Fertilise, hydro seeded and grassed areas soon after germination, and
- Repair any damage caused by erosion;

LIST OF REFERENCES

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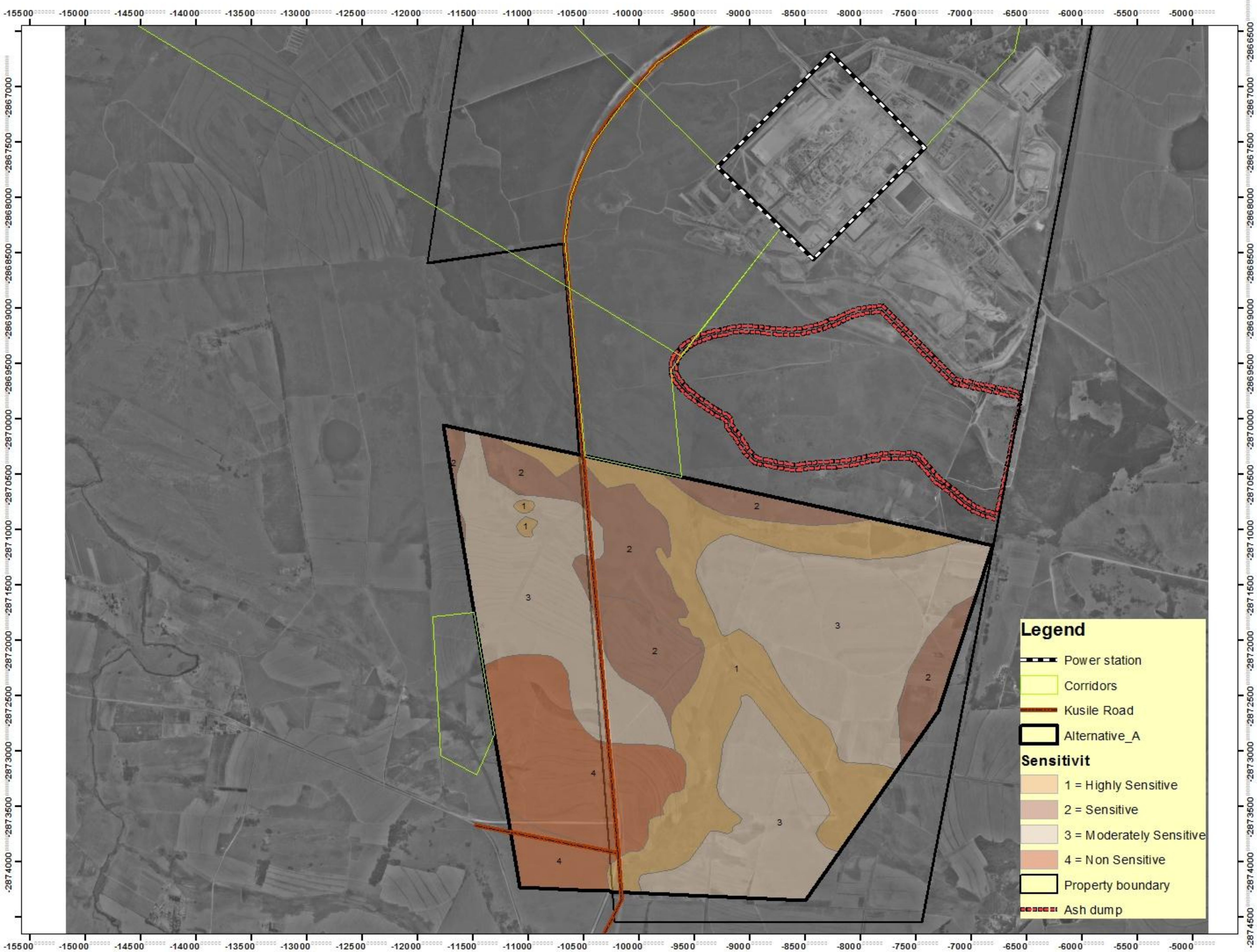
APPENDIX 1

SITE MAPS A3)

(Soils, Soil Groups and Land Capability)


Legend
Power station
Corridors
Kusile Road
Alternative_A
Sensitivit
1 = Highly Sensitive
2 = Sensitive
3 = Moderately Sensitive
4 = Non Sensitive
Property boundary
Ash dump

APPENDIX 2

FERRICRETE CLASSIFICATION

APPENDIX 3

Site "B" INVESTIGATION FINDINGS

Project No: WC.KPS.S.12.08.00

ESKOM KUSILE POWER STATION
60 Year Ash Disposal Facility
Alternative Assessment

Site "B"

SPECIALIST SOILS & LAND CAPABILITY ALTERNATIVES ASSESSMENT

Compiled For

ZITHOLELE CONSULTING

May 2014

BASELINE REPORT

Earth Science Solutions

Sustaining the Environment

ESKOM KUSILE POWER STATION
60 Year Ash Disposal Facility
Alternative Assessment

Site “B”

Compiled for
Zitholele Consulting

Report Number: Draft Baseline report
Client: Zitholele Consulting
Attention: Mr. Warren Kok/Mathys Vosloo

DOCUMENT ISSUE STATUS

Report Name	Eskom Kusile Power Station – 60 Year Ash Disposal Facility Alternatives Assessment - Site “B” Study Baseline Soils Specialist Studies
Report Number	WC.KPS.S.12.08.00
Report Status	Baseline Report – Site “B” Investigation
Carried Out By	Earth Science Solutions (Pty) Ltd
Commissioned By	Zitholele Consulting
Copyright	Earth Science Solutions (Pty) Ltd.

Title	Name	Capacity	Signature	Date
Author	Ian Jones	Director ESS (Pty) Ltd		16th May 2014
Project Director	Mathys Vosloo	Project Leader		
Technical Review				

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Stonecap Trading 14 (Pty) Ltd

Our Ref: WC.KPS.S.12.08.00
Your Ref: 12712

16th May 2014

Zitholele Consulting
P.O. Box 6002
Halfway House
1685
Gauteng
South Africa

011 2072060, 0866746121, mail@zitholele.co.za

Attention: Mathys

Dear Sir,

Re: ESKOM KUSILE POWER STATION – 60 YEAR ASH DISPOSAL FACILITY - SITE SELECTION BASELINE SOIL ASSESSMENT OF ALTERNATIVE SITE "B"

Attached please find the in depth assessment of the baseline soil conditions for Site "B", one of the areas being considered for the 60 Year Ash Dump needed to service the Eskom Kusile Power Station that is being constructed, and the preferred site as indicated by the DWA.

The report details the results of the reconnaissance field assessment, and offers argument for and against the selection of Site "B" as the candidate site in terms of the soils and land capability.

Please note that this document must be read in conjunction with the original baseline report submitted.

Should you have any queries in this regard, please do not hesitate to contact us.

Yours sincerely
Earth Science Solutions (Pty) Ltd

Ian Jones
Director

Nelspruit Office:
Tel: 013-753 2746, Fax: 013-752 2565
E-mail: ess@earthscience.co.za
P. O. Box 26264, Steiltes, Nelspruit, 1200

Middelburg Office:
Tel: 013- 243 5864, Fax: 013-243 5866
E-mail: ian@earthscience.co.za

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Soils:

The Eskom Kusile Power Station is under construction and will require as part of its operational infrastructure an Ash Disposal facility for the containment of the by-product produced from the burning of coal.

The purpose of the additional investigation and reconnaissance specialist study for Site “B” was initiated as part of a resolution by the authorities that Site “B” was favoured over Site “A”. As a result of this conflict in the alternative Assessment outcome, additional assessment was needed of the pre-development/pre-construction footprint as input to the understanding of the conclusions reached in the site selection process.

The specialist soils and land capability is part of the larger environmental assessment and assimilation of scientific input needed for the selection of a candidate site. The recommended alternative will need to be further investigated in terms of the EIA.

With a substantial amount of construction having been undertaken to date at the power station, and with the large footprint that will be impacted by the New Largo mining venture that will supply the Eskom Kusile Power Plant with its coal, significant and large areas of ground/land in and around the proposed sites of interest have already been impacted and the soils disturbed.

The five sites and combinations of sites vary in soil characteristics from highly sensitive wet based materials to deep well drained and highly productive materials, with a variety of geomorphological (geological and topographical etc.) having an influence on the conditions mapped.

The soil characteristics considered important in this evaluation comprise, soil depth, soil structure, clay content and soil wetness. The alternative assessment has been considered in terms of the present or existing soil utilisation potential or land capability, and as such does not place large weightings on the utilisation of the soil in terms of rehabilitation and workability, albeit that these aspects have been considered as part of the overall sustainability of a project of this nature.

The mapping and interpretation of this assessment has been undertaken in terms of the South African environmental legislation and the best practise guidelines as specified in terms of the international norms and best practise as a minimum requirement (IFC Principles)

A walk over reconnaissance study of all of the proposed sites was undertaken by a qualified earth scientist as part of the site selection process to assess the soils and land capability of the areas (A, B, C, F & G), while more intensive and detailed studies of Site “B” were initiated as part of the resolution required in the choice of the candidate site.

The major findings revealed:

- Marked differences in the geomorphology of the sites;
- Differences in soil depth;
- Differences in the texture of the soils (clay content and grain size);
- Significant differences in the area of wet based soils across the areas of concern and the functionality of/impact on the wet based soils varies;
- Similarities for the most part in soil structure (apedel to weak crumby structures);
- Subtle but significant topographical differences in some of the areas across the site alternatives;
- Significant differences in the land use and social impact on areas surveyed;

The soils are highly influenced by the parent materials from which they are formed (fine to medium grained sediments for the most part, with areas of quartzite) and by the subtle but variable topography that results in a net positive erosive environment. The attitude of the underlying lithologies (generally flat lying/horizontal) and the negative water balance (evaporation is higher than rainfall) has also had an influence on the weathering processes at work and the pedogenetic mechanisms (soil forming) that contribute to the soil forms mapped.

There are soils with varying degrees of structure, from apedel and single grained silty and sandy loams to sandy clay loams, and those with slightly stronger structure (crumby to slight blocky) associated with the more clay rich soils that are generally found as colluvial accumulations in the lower slope and bottom lands, while the alluvial flood plains that make up the wide valley deposits are significantly more clay rich and stronger in structure (glaycutanic and vertic structures with clays typically in excess of 50%).

The hydromorphic soils are also highly variable, with lower mid-slope transitional form soils that comprise sandy clay to loamy subsoils and sandy topsoil, to highly saturated and structured wetland soil forms that are characterised by topsoil's with better than average organic carbon contents well developed hydromorphic characteristics.

It is important to note that the present land use also varies, from areas with little to no cultivation to intensive commercial cropping and intensive livestock grazing and areas of subsistence farming and grazing. These aspects have been taken into account when considering the alternative sites.

Based on the reconnaissance soil, land use and land capability assessments carried out on the alternatives tabled by the client (A, B, C, G and F) and the combinations that have been proposed by the lead consultants (A and G and A and F), the best candidate site has been chosen, with Site "C" being considered the most suitable site for an Ash Facility, while Site "B" has been tabled as the optimum site by the authority.

Of consequence to the findings of the specialist soils, land cap and land use for **Site C** as the candidate site are the following:

- There are no formal or active farming activities noted, with subsistence grazing the only land use activity;
- The land capability is considered to be of a "wilderness" or "conservation" status in terms of the land capability rating system, and holds little to no potential for anything other than very low intensity grazing, and this would only be considered viable under very well managed conditions;
- A greater proportion of the area considered for development has soils that are shallow to very shallow;
- The percentage of wet based soils is less than for any of the other sites considered;
- The wetlands in the upper reaches of the site have been impacted;
- The soils are moderately easily worked and stored, albeit that erosion is an issue to be considered and managed.

Of negative concerns are:

- The limited quantities of materials that will be available for rehabilitation purposes;
- The lack of suitable founding materials for barrier layer construction, and
- The possible geotechnical issues that were noted in the form of brecciated material in the south western portion of Site C. This possibly associated with a geological fault/fracture zone (zone of movement/weakness).

However, if "**Site "B**" is to be considered as a possible site, the following aspects need to be highlighted as outcomes of the soil and land capability studies:

- There are **a significant number** of both formal and some informal dwellings in the area of study,
- A **significant amount** of active commercial farming activities noted, with some intensive and high valued commercial farming associated with the proposed development area;
- **Some commercial** grazing and localised natural livestock farming;
- The land capability is considered to be of a **moderate to good grazing** and in places **good arable land rating** potential, and holds better than average potential for commercial utilisation.
- Significant area could, and is being utilised for **high intensity commercial agriculture.** Under well managed conditions;
- The percentage of **wet based soils** is confined almost exclusively to the lower lying areas off the site of proposed development;
- The soils are moderately easily, to easily worked and stored, albeit that erosion is an issue to be considered and managed.

GLOSSARY OF TERMS

Alluvium: Refers to detrital deposits resulting from the operation of modern streams and rivers.

Base status: A qualitative expression of base saturation. See base saturation percentage.

Black turf: Soils included by this lay-term are the more structured and darker soils such as the Bonheim, Rensburg, Arcadia, Milkwood, Mayo, Sterkspruit, and Swartland soil forms.

Buffer capacity: The ability of soil to resist an induced change in pH.

Calcareous: Containing calcium carbonate (calcrete).

Catena: A sequence of soils of similar age, derived from similar parent material, and occurring under similar macroclimatic conditions, but having different characteristics due to variation in relief and drainage.

Clast: An individual constituent, grain or fragment of a sediment or sedimentary rock produced by the physical disintegration of a larger rock mass.

Cohesion: The molecular force of attraction between similar substances. The capacity of sticking together. The cohesion of soil is that part of its shear strength which does not depend upon inter-particle friction. Attraction within a soil structural unit or through the whole soil in apedel soils.

Concretion: A nodule made up of concentric accretions.

Crumb: A soft, porous more or less rounded ped from one to five millimetres in diameter. See structure, soil.

Cutan: Cutans occur on the surfaces of peds or individual particles (sand grains, stones). They consist of material which is usually finer than, and that has an organisation different to the material that makes up the surface on which they occur. They originate through deposition, diffusion or stress. Synonymous with clayskin, clay film, argillan.

Desert Plain: The undulating topography outside of the major river valleys that is impacted by low rainfall (<25cm) and strong winds.

Denitrification: The biochemical reduction of nitrate or nitrite to gaseous nitrogen, either as molecular nitrogen or as an oxide of nitrogen.

Erosion: The group of processes whereby soil or rock material is loosened or dissolved and removed from any part of the earth's surface.

Fertilizer: An organic or inorganic material, natural or synthetic, which can supply one or more of the nutrient elements essential for the growth and reproduction of plants.

Fine sand: (1) A soil separate consisting of particles 0,25-0,1mm in diameter. (2) A soil texture class (see texture) with fine sand plus very fine sand (i.e. 0,25-0,05mm in diameter) more than 60% of the sand fraction.

Fine textured soils: Soils with a texture of sandy clay, silty clay or clay.

Hardpan: A massive material enriched with and strongly cemented by sesquioxides, chiefly iron oxides (known as ferricrete, diagnostic hard plinthite, ironpan, ngubane, ouklip, laterite hardpan), silica (silcrete, dorbank) or lime (diagnostic hardpan carbonate-horizon, calcrete). Ortstein hardpans are cemented by iron oxides and organic matter.

Land capability: The ability of land to meet the needs of one or more uses under defined conditions of management.

Land type: (1) A class of land with specified characteristics. (2) In South Africa it has been used as a map unit denoting land, mapable at 1:250,000 scale, over which there is a marked uniformity of climate, terrain form and soil pattern.

Land use: The use to which land is put.

Mottling: A mottled or variegated pattern of colours is common in many soil horizons. It may be the result of various processes *inter alia* hydromorphy, illuviation, biological activity, and rock weathering in freely drained conditions (i.e. saprolite). It is described by noting (i) the colour of the matrix and colour or colours of the principal mottles, and (ii) the pattern of the mottling.

The latter is given in terms of abundance (few, common 2 to 20% of the exposed surface, or many), size (fine, medium 5 to 15mm in diameter along the greatest dimension, or coarse), contrast (faint, distinct or prominent), form (circular, elongated-vesicular, or streaky) and the nature of the boundaries of the mottles (sharp, clear or diffuse); of these, abundance, size and contrast are the most important.

Nodule: Bodies of various shapes, sizes and colour that have been hardened to a greater or lesser extent by chemical compounds such as lime, sesquioxides, animal excreta and silica. These may be described in terms of kind (durinodes, gypsum, insect casts, ortstein, iron, manganese, lime, lime-silica, plinthite, salts), abundance (few, less than 20% by volume percentage; common, 20 – 50%; many, more than 50%), hardness (soft, hard meaning barely crushable between thumb and forefinger, indurated) and size (threadlike, fine, medium 2 – 5mm in diameter, coarse).

Overburden: A material which overlies another material difference in a specified respect, but mainly referred to in this document as materials overlying weathered rock

Ped: Individual natural soil aggregate (e.g. block, prism) as contrasted with a clod produced by artificial disturbance.

Pedocutanic, diagnostic B-horizon: The concept embraces B-horizons that have become enriched in clay, presumably by illuviation (an important pedogenic process which involves downward movement of fine materials by, and deposition from, water to give rise to cutanic character) and that have developed moderate or strong blocky structure. In the case of a red pedocutanic B-horizon, the transition to the overlying A-horizon is clear or abrupt.

Pedology: The branch of soil science that treats soils as natural phenomena, including their morphological, physical, chemical, mineralogical and biological properties, their genesis, their classification and their geographical distribution.

Slickensides: In soils, these are polished or grooved surfaces within the soil resulting from part of the soil mass sliding against adjacent material along a plane which defines the extent of the slickensides. They occur in clayey materials with a high smectite content.

Sodic soil: Soil with a low soluble salt content and a high exchangeable sodium percentage (usually EST > 15).

Swelling clay: Clay minerals such as the smectites that exhibit interlayer swelling when wetted, or clayey soils which, on account of the presence of swelling clay minerals, swell when wetted and shrink with cracking when dried. The latter are also known as heaving soils.

Texture, soil: The relative proportions of the various size separates in the soil as described by the classes of soil texture shown in the soil texture chart (see diagram on next page). The pure sand, sand, loamy sand, sandy loam and sandy clay loam classes are further subdivided (see diagram) according to the relative percentages of the coarse, medium and fine sand subseparates.

Vertic, diagnostic A-horizon: A-horizons that have both, a high clay content and a predominance of smectitic clay minerals possess the capacity to shrink and swell markedly in response to moisture changes. Such expansive materials have a characteristic appearance: structure is strongly developed, ped faces are shiny, and consistence is highly plastic when moist and sticky when wet.

1. INTRODUCTION AND TERMS OF REFERENCE

Earth Science Solutions (Pty) Ltd were asked to submit a proposal and cost estimate to Zitholele Consultants (Lead Consultants) for a pedological, land capability and land use assessment as part of the baseline site selection process and alternatives assessment for the Eskom Kusile 30 Year Ash Disposal Facility being considered as part of the Kusile Power Station infrastructure.

The areas of consideration include five possible sites (Sites A, B, C, F and G) with two additional combinations A/G, and A/F). The sites are all situated in close proximity to the present mining infrastructure of New Largo (coal source for Kusile Power Station) and area of disturbance around the Kusile Power Station that is under construction(Refer to Figure 1.1 – Locality Plan and Figure 1.2 – Alternative Sites).

After careful consideration and significant consultation between all of the specialists Site A was proposed as the candidate site for the Ash Disposal Facility. This has been rejected by the authorities based primarily on environmental considerations, and Site B was proposed by them as the better option. In considering these findings, it was incumbent on us as the specialists to further deliberate the issue and consider our findings in terms of the stated objectives.

This report has been re-visited and Site b was re-assessed on a more detailed scale as part of the alternative assessment process.

Kusile Power Station require a disposal facility for the ash that will be produced from the burnt coal and have indicated that the facility should cater for at least a thirty (30) year life.

This study is part of the feasibility study and assessment needed to understand were the waste materials that will be produced can be stored/deposited sustainably. The quantities of waste material that need to be disposed of are extremely large, and require significantly large areas of land that will be permanently changed and lost from the system.

The area needed to cater for the disposal of the by-products from the power generator will need to be situated as close as possible to the infrastructure so as to minimise the area of disturbance, and reduce the costs of transportation/conveyencing.

Due to the topography of the area, and the relative large and wide/open drainage ways, it is important that the potential impacts from river crossings be assessed, while the attitude and relative steepness or lack thereof is accounted for in the engineering of the facility (not part of this study). In addition, the issue of eco services and the loss of utilisable soils and land are considered extremely important in a country that is both water and soil scares.

In line with the EIA process, and in terms of good environmental practices, and before any extensive engineering or economic planning can be undertaken, it is necessary that an alternatives assessment of possible sites (site selection) is undertaken.

As part of the overall environmental assessment, the soils, and land capability need to be investigated and the baseline conditions to the various sites being considered need to be well understood. These studies were undertaken in conjunction with an investigation of the pre development (existing) land use as some of the important receptors that could be impacted by a development the size or a 30 Year Ash Disposal Facility.

Earth Science Solutions (PTY) Ltd was commissioned to carry out a comprehensive reconnaissance soil and land capability assessment of the pre depositional environment to help with the selection of the most environmentally sustainable site.

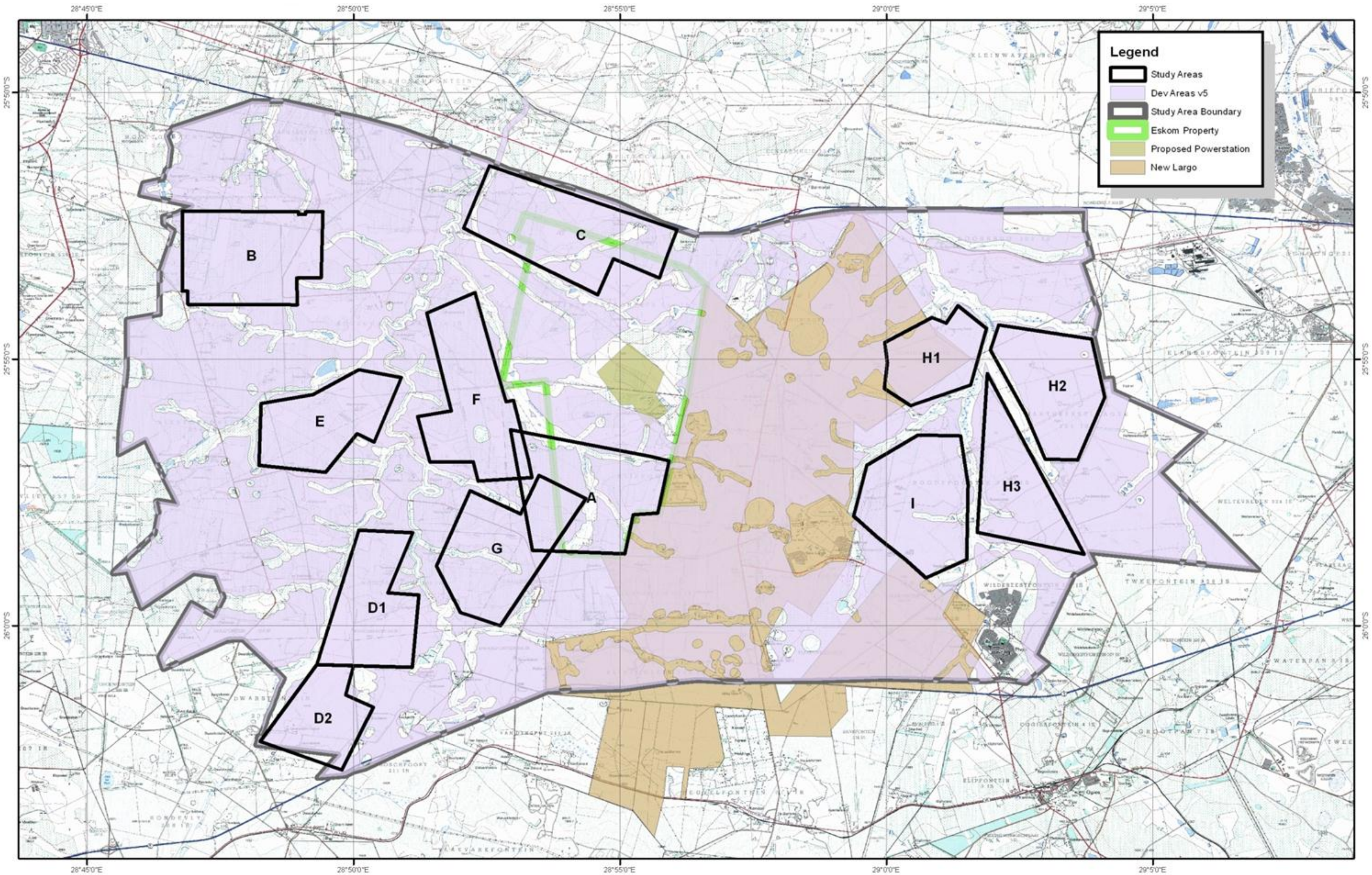


Figure 1.1 Locality Plan

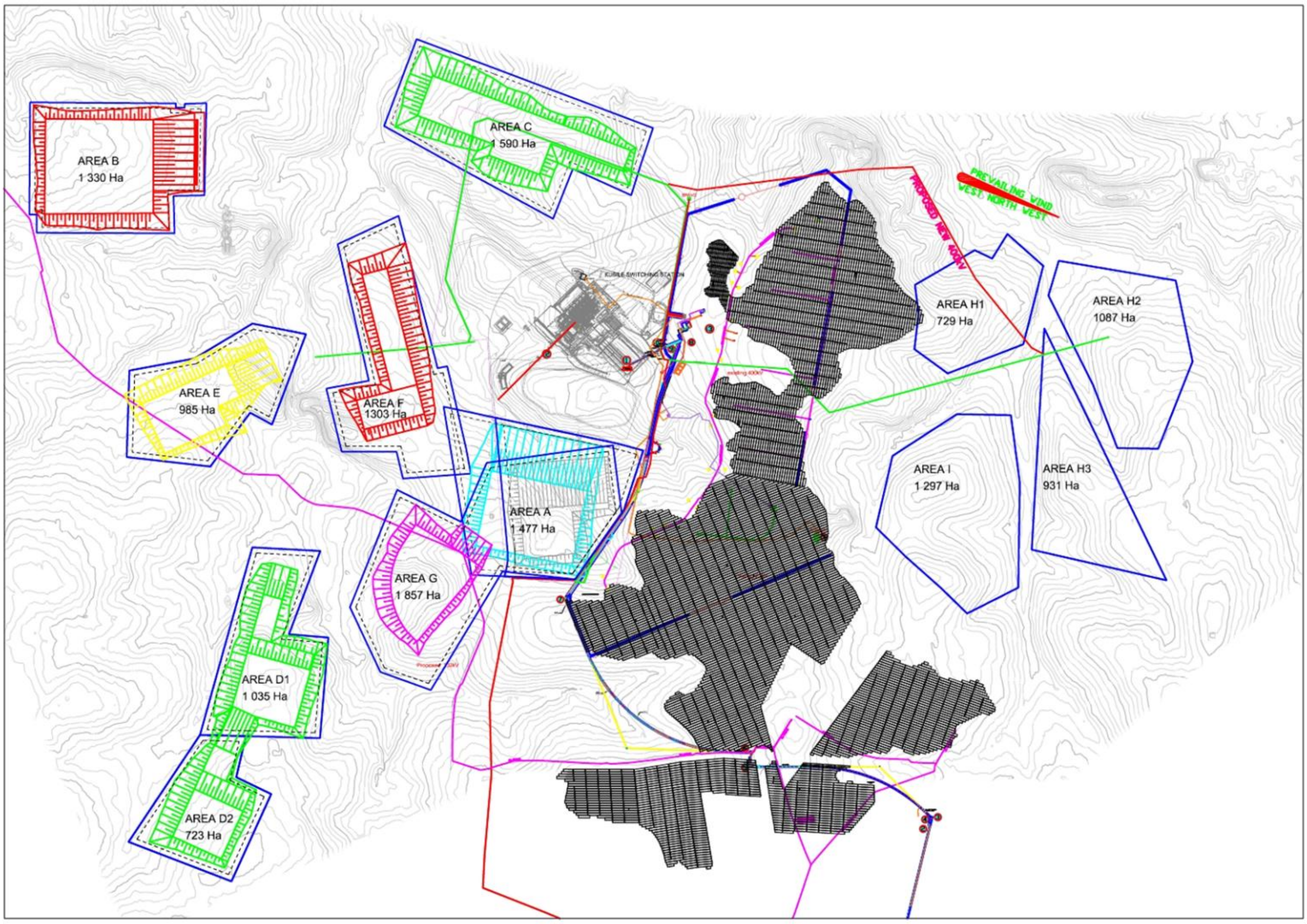


Figure 1.2 Location of Alternative Ash Disposal Sites relative to Mining Lease Area and the Kusile Power Station

The studies carried out investigated the soils in terms of their physical and chemical properties, while other geomorphological aspects were also mapped as part of determining the land capability of the sites. To this end, the ground roughness, topographic features such as altitude, attitude and slope were recorded, and the pre development land use was noted.

The soil wetness and its relative wetland status has been assessed as one of the more important soil features, while the position of the sites relative to the Wilge River and its major tributaries has been left to the Hydrogeologists and ecologists for comment and assessment.

The cumulative impacts will need to be assessed in more detail once the candidate site has been decided. However, any existing impacts such as the Power Station and the New Largo Mining, the main road (N12) and any existing natural pre development conditions have been taken into account as part of the considerations albeit that they have not been listed as soil or land capability considerations.

The study was undertaken in two phases, with the site selection being undertaken in terms of a baseline alternatives assessment in phase 1, while phase 2 investigated the impacts of the proposed actions on the candidate site(s). Further to these studies was the need to re-assess Site "B" in more detail based on the authorities recommendation that this site was more optimal. This idea conflicted with the original findings, with Site "B" rating as the LEAST desirable site for an Ash Disposal Facility based on the high potential grazing and arable soils, intensive soil utilisation and impacts on wet based soils..

The site selection alternatives assessment was undertaken for a number of different disciplines, the soils, land capability and land use being but a part of the earth science investigation.

This document should be read in conjunction with the ecological and biodiversity studies as these will help to better define the wetland status and natural connections that control the life cycle of the area.

A 60 Year Ash Disposal Facility (ADF) is by its very nature a large and permanent structure that will impact and affect the environment of both its immediate footprint as well as a significant area surrounding the site. The effects of a large and heavy structure of this nature will impact on the soil moisture of the materials, will restrict flows of soil water and alter the dynamics of the distribution of soil water to the base flow of the wetlands and rivers.

In addition, the positioning of such a large facility will potentially have a negative effect on erosion and the retention of colluvial soils, with the potential for the impacts of heavy metals and an increase in both suspended and dissolved solids a problem to be managed up front. These potential effects and impacts will require well developed management solutions if these effects are to be mitigated, and a sustainable structure engineered.

This report has been designed and structured to meet and satisfy the requirements of the National Environmental Management Act (NEMA) as well as the other related laws and guidelines that are required in terms of the Department of Agriculture, water Affairs and the Biodiversity Acts etc. In addition, the Performance Principles used by the World Bank in terms of the IFC Guidelines have also been taken into account, and used as a measure of best practice.

Using these guidelines and policy norms, the project was undertaken to answer the questions asked in terms of the site selection alternatives and the ToR supplied.

These were stated as:

- A high level reconnaissance study of the soils, land capability and land use for the five alternative Ash Disposal sites:

  - ✓ Current status of the soils (characterize and classify);
  - ✓ Current level of soil disturbance;
  - ✓ Agricultural potential/land capability;
  - ✓ Assessment of wetland soil and present status;
  - ✓ Present land use

To this end, a number of in-field site parameters were noted as part of the reconnaissance study.

Consideration has been given to:

- Soil character, inclusive of average soil depth, structure and wetness;
- Land use inclusive of agricultural use, grazing and the presence of permanent structures;
- Existing impacts due to existing land use practices;
- An assessment of the capability of the land in terms of its arable, grazing or wilderness status.

Historically, the area has been utilized as low intensity subsistence summer grazing lands by the local people, and more recently for commercial agriculture of annual crops and more intensive grazing, with a significant number of coal mines and associated industries within the Wilge catchment having been commissioned and started over the past thirty to seventy years.

The grazing of livestock is on-going on a small scale and some subsistence farming is still practiced on some of the sites mapped. However, the major activities include irrigated and dryland maize, soya bean and potato farming, some intensive market gardening and some specialised biological farming (Bio-Select) on the better soils of the area.

The existence of formalised dams and water impoundments, and the impacts of the commercial farming activities render the majority of the sites investigated as brownfields sites, with little natural grasslands being encountered for the most part.

With the ever-increasing competition for land, it has become imperative that the full scientific facts for any particular site are known, and the effects/impacts on the land to be used by any other proposed enterprise be evaluated prior to the new activity being implemented. This is no different for an Ash Disposal Facility, and it is of even greater importance that the land capability is understood before a structure as large and as permanent as a 60 Year Ash Storage Facility is considered.

The areas considered for development are shown in Figure 1.2.

It should be noted, that more detailed mapping of Site “B” was undertaken as part of the site selection resolution needed, with the results of the high level study being used in the initial assessment and site selection that resulted in Site “C” being tabled as the best candidate site in terms of the soils and land capability, and Site “A” being selected overall. The more detailed investigation has been considered necessary in evaluating the authority’s decision to recommend Site “B”.

Detailed assessments of the candidate site will be needed before a full understanding of the potential impacts can be reported, and the study used for planning and/or design purposes.

2. DESCRIPTION OF THE PRE-CONSTRUCTION ENVIRONMENT

2.4 SOILS

2.4.1 Data Collection

In better understanding the three sites delineated by the client, all existing information and any Environmental Impact Statements relating to the mining operations at New Largo and or the new Kusile Power Station where used as important baseline information that could have a bearing on, or help to influence the assessment of the proposed Ash Disposal sites. The request by the authorities to consider Site "B" rather than Site "A" required that additional inputs at a smaller scale be considered.

The 1:250 000 and 1:50 000 scale topocadastral maps, Land Type Mapping and any aerial imagery was also used to better define and map the baseline conditions across the various sites.

Interaction with the Kusile SHQ manager and his personnel, as well as close interaction with the local farmers and land owners was used to obtain a better understanding of the area and its usage.

The comprehensive reconnaissance walk over study of the five sites gave further site specific information.

The field inspection undertaken involved the examination and understanding of the broad pedological/soil patterns for the sites, while an assessment of the geomorphological character of the areas was important in assessing and rating the capability of the land. Site "B" was assessed on a slightly more intensive grid base.

The present land use was noted as part of the field study, and mapped using the aerial imagery available (old orthophotographs).

The soils were characterised and classified according to the Taxonomic Classification system and the soil forms were noted/recorded wherever a profile was examined, and the general soil groupings or major soil forms were mapped based on the site mapping.

The existing geomorphological information (Topo maps and Land Type mapping) was captured as part of the baseline information, and combined with the soil mapping as the basis for the land capability rating and ultimately the alternative assessment.

2.4.2 Description

The major soil types mapped within the study area reflect the host geology/lithologies of the parent materials, while the topography and climatic conditions that prevail have further influenced the pedogenisis and soils forms present.

Noticeable to the sites investigated is the presence of Karoo sediments and quartzite's, the structural impacts of intrusive dolerite dykes and sills and the associated fracturing and possibly faulting of the country rock, and the subtle but important influence of the flat to undulating topography, with localised steeper slopes and resultant shallow profiles.

These geomorphological characteristics are further influenced by the negative water balance and semi-arid environment, with the effects of evaporites and the development of laterites being highlighted as aspects of importance to the ecological status, and conditions that will influence the capability of the land.

The major attributes of the groupings of soil include (Refer to Figure 2.4.2a – Dominant Soils Groups of all five sites):

- Deep (>750mm) clay rich loams;
- Deep (>750mm) sandy and silty loams;
- Moderately (500mm to 750mm) deep clay and sandy clay loams;
- Moderately (500mm to 750mm) deep sandy and silty loams;
- Shallow (<500mm) clay rich sandy loams and sandy clay loams;
- Shallow (<500mm) silty loams;
- Moderately deep (%00mm to 750mm) but rocky sandy loams;
- Shallow (<500mm) and rocky (>30% stone and rock in profile);
- Areas of outcrop or sites with >80% rock at surface, and
- Wet based soils with a variety of depths and clay composition.

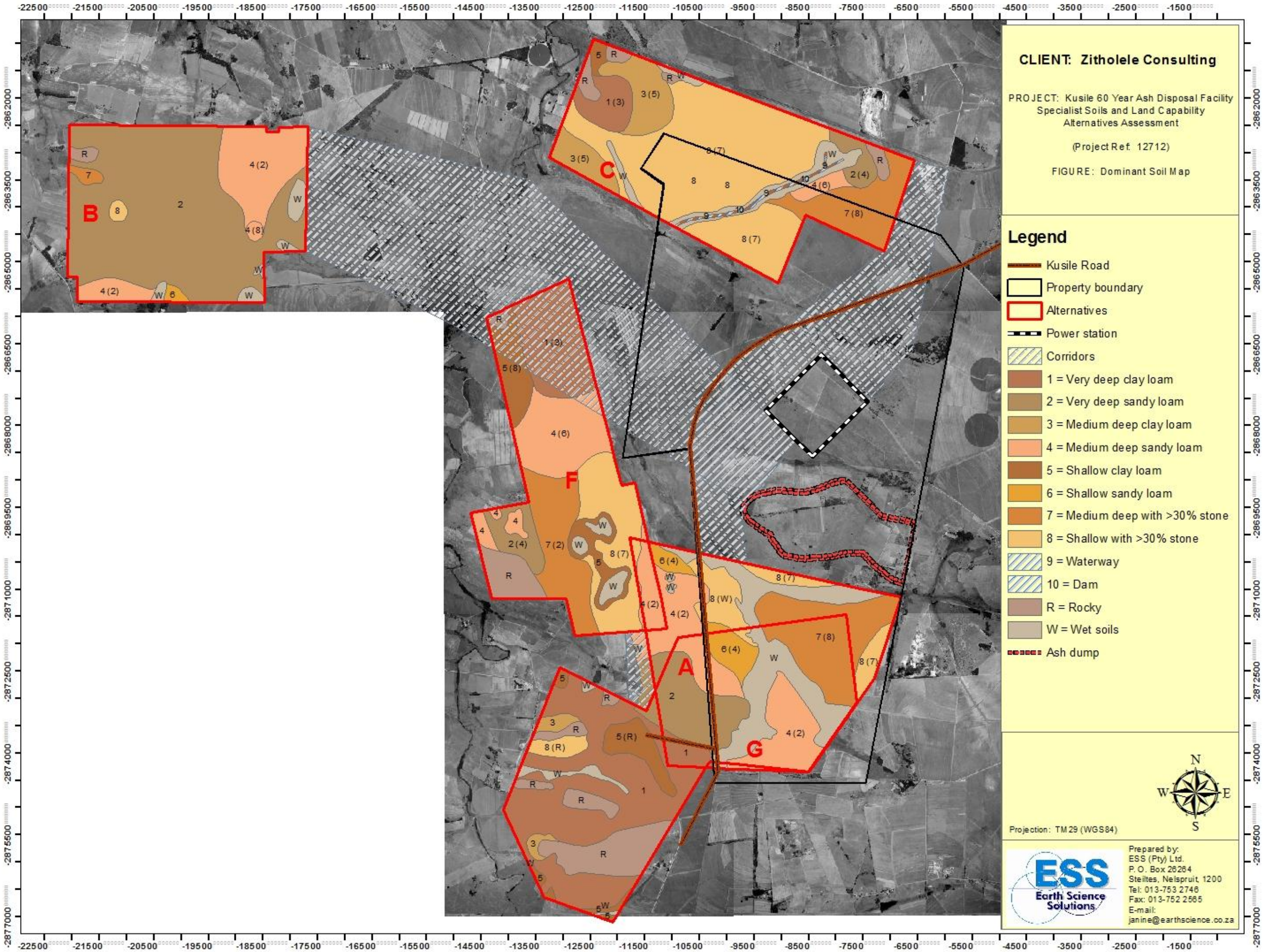
While the outcomes of the mapping undertaken on Site “B” are detailed in Figure 2.4.2b

In terms of the Taxonomic classification use, the major or dominant soil forms mapper include the those of the orthic phase Hutton, Clovelly, Glenrosa and Mispah forms with sub dominant soils of the Valsrivier and Shortlands Form, while the major hydromorphic forms mapped include the Glencoe, Dresden, Avalon, Pinedene, Bainsvlei and Westleigh, with significant area of glaycutanic structure associated with the bottom lands and flood plain environment.

In assessing the detail for Site “B” the following dominant soils were mapped:

- Deep (>750mm) sandy loams and sandy clay loams of the Hutton, Clovelly and Griffin Soil Form, with sub dominant Clovelly, Glencoe and Avalon soil Forms;
- Moderate to deep (500mm to 750mm) sandy clay loams and silty loams of the Hutton, Clovelly and Glencoe soil Forms;
- Minor areas of moderate to shallow (300mm to 500mm) sandy clay loams with minor gravel and stone lines associated;
- Areas of shallow wet based soils comprising clay loams and silty clay loams comprising for the most part Westleigh, shallow Avalon and Kroonstad form soils, and
- Minor areas of shallow (<300mm) to outcropping lithologies that comprise Glenrosa and Mispah form soils.

The majority of the site comprises soils between 500mm and greater than 750mm and comprise good grazing and moderate to good arable potential land capability ratings of greater than 70% of the area. The wet based soils and potential wetlands are all associated with the lower lying areas topographically and are associated with a soft plinthic and/or hard plinthite layer at the “C” horizon (Refer to Figure 2.4.2b).



<u>Figure 2.4.2a – Dominant Soils Map – All sites</u>

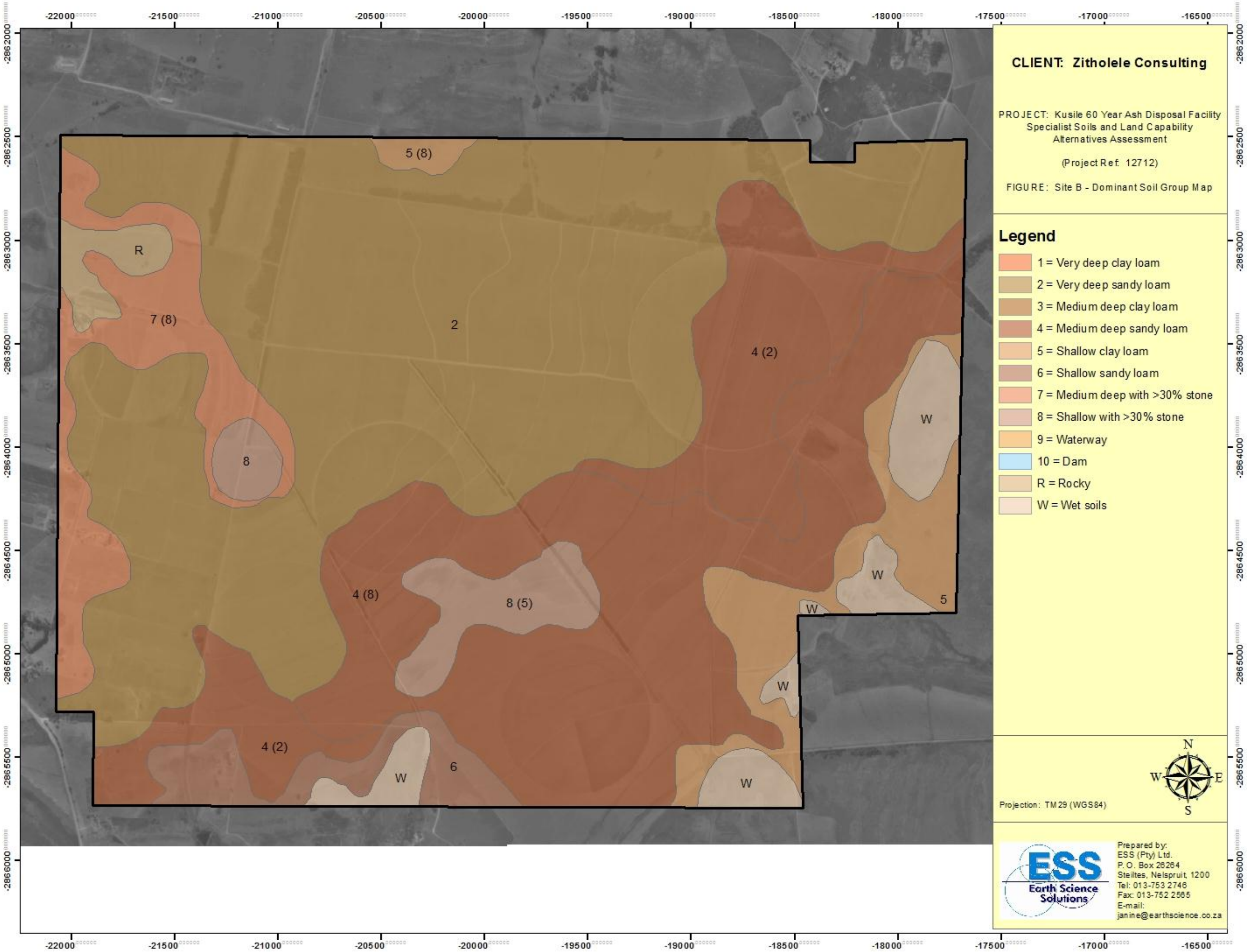


Figure 2.4.2b – Comprehensive Map - Dominant Soils Site "B"

The semi-arid climate and negative water balance combined with the horizontal attitude of the sedimentary host lithologies that characterise the Karoo sediments have resulted in ferricrete or laterite (Ouklip) formation as a dominant feature of many of the soils, with varying degrees of formation and depth of occurrence. The presence of a hard pan ferricrete (Hard plinthic horizon) or soft plinthite is considered of importance to the soil moisture and in many cases is the reason for wet features within the soil profile (barrier layer). This moisture is important to the biodiversity, the presence of pans and water features within the landscape, and the success or failure of the wetland systems in the extreme. These soils classify as highly sensitive.

In addition to the geomorphological aspects mentioned above, soil texture and structure also played a role in the soil classification and the resultant sensitivity of the materials mapped. The fine (sediments) to medium (quartzite's) grained nature of the topsoils, the relatively low clay contents (<15%) and the generally low organic carbon renders the majority of the soils highly sensitive to erosion. This is only tempered by the relative flatness of the topography for all but a few areas, with a resultant moderate to low erosion index for most of the site. These ratings assume that the soils are well protected and the vegetative cover is not disturbed. Once the cover is disturbed or removed, the potential for erosion is increased.

More in-depth analysis of the soil descriptions and relative depths, chemical composition and structure will be undertaken as part of the EIA phase once the candidate site has been decided.

Effective rooting depths on site vary from as shallow as 200mm on the upper and midslopes to over 1 500mm on the colluvial derived materials in the lower and stream channel accumulations.

The shallow rooting depths (200mm to 400mm), with an orthic topsoil on a lithocutanic subsoil (Glenrosa) are common place across for the candidate site (Site "C"), while the complete contrast is noted on Site "B" where the soils are for the most part greater than 600mm deep, and a significant proportion of the site is greater than 800mm.

The hydromorphic soils – often associated with wetlands or the transition to the wetlands, are generally found associated with either perched seep zones were the soils have been restricted within a concave land form, or on the lower moist grasslands and valley slopes were the major wet zones occur.

Depths of utilisable soil (to top of mottled horizon) vary from 300mm to 600mm for the majority of the sites assessed, while Site "B" returned depths of between 600mm and 1,200mm on average.

In contrast to the transition zone soils described above, the wetland soils are by definition soils with more defined hydromorphic characteristics. These soils are for the most part saturated all year round to a depth of 500mm below surface.

2.4.4 Characteristics of different Soil Groups

2.4.4.1 The Heavy Clay Rich Soils

The soils with the higher clay content are generally associated with the colluvial deposits and the weathered/transported sedimentary materials, and are found associated with the streams and river deposits.

The higher clay contents, and in places the swelling nature of the clay has resulted in stronger than average structure to the soils, are expansive as a result, showing cracking within the soil profile in the dry state, and some indications of slick-n-sides in the wet state.

Generally the "C" horizons that underlie these horizons are composed of moderately hard weathering rock. Intake rates and drainage of these soils are poor, while the erosion hazard is moderate.

The soils associated with the wetlands are often associated with this group of soils

The sensitivity of these soils to being disturbed (worked on or moved) is evident in the ease of erosion that is noted where over grazing or disturbance of the topsoil has occurred, while the wetness factor and their importance in the water storage and transfer renders these materials as highly sensitive.

2.4.4.2 Light Textured Soils

The light textured soils include the majority of the orthic form soils, as well as some of the deeper hydromorphic soil Forms.

The majority of these Forms are characterised by a humic "A" horizon overlying a red or red-brown apedel (poorly structured) B, with indications of mottling within the lower "B" horizons in the case of the hydromorphic soils.

Depths to the "C" horizon or the plinthic layer vary from less than 400mm on the shallow forms to well over 1,500mm on the deep colluvial soils. The soils generally show a very thin saprolitic horizon, with the sub soils founded directly on hard bedrock.

The sensitivity of these soils is highly variable and depended on the depth and relative texture (clay content) of the materials. However, on average, and for the dry soils that are greater than 500mm these soils are of the least sensitive, are generally more easily worked on and with, and can be stored with relative ease and used for rehabilitation.

2.4.4.3 Shallow soils

A significant proportion of the soils assessed are of a shallow to very shallow rooting depth. These soils are almost always founded directly on a hard rock interface, with little to no saprolite at the base of the "B" horizon and are considered of a poor to very poor land capability rating.

These soils are associated with the more resistant host rock lithologies and often form the ridge lines and upper slope positions. The resultant poor vegetative cover, the generally lower clay content and lower organic carbon contents result in a high sensitivity rating for these materials.

Removal of the vegetative cover and/or disturbance of the topsoils will increase the erosion index to high.

Erosion is the main problem that will need to be managed on these shallow soils.

2.4.5 Soil Erodibility

The erosion indices for the dominant soil forms on the study site are classified as having a moderate to high erodibility index. This is largely ascribed to the low, or at best moderate clay content of the "A" horizons, and the low organic carbon content. These factors are tempered somewhat by the relative flatness of the terrain for all but a few areas, and the generally well conserved vegetative cover (all but the shallow soils and over utilised valley bottoms)

It should be noted however, that the vulnerability of the subsoil's to erosion once the vegetative cover and topsoil layer have been disturbed is markedly higher than for undisturbed soils.

Good management of these soils for erosion and compaction will be essential.

2.5 PRE-MINING LAND CAPABILITY

2.5.1 Data Collection

The land capability of the study areas was classified according to the Chamber of Mines Guidelines (1991). The criteria for this classification are set out in Table 2.5.1. The criteria are based on dryland cropping, on an average cropping regime and average climatic conditions for the region.

Table 2.5.1 Criteria for Pre-Mining Land Capability (Chamber of Mines 1991)

Criteria for Wetland

- Land with organic soils or supporting hygrophilous vegetation where soil and vegetation processes are water dependant.

Criteria for Arable land

- Land, which does not qualify as a wetland.
- The soil is readily permeable to a depth of 750 mm.
- The soil has a pH value of between 4.0 and 8.4.
- The soil has a low salinity and SAR
- The soil has less than 10% (by volume) rocks or pedocrete fragments larger than 100 mm in the upper 750 mm.
- Has a slope (in %) and erodibility factor (K) such that their product is <2.0
- Occurs under a climate of crop yields that are at least equal to the current national average for these crops.

Criteria for Grazing land

- Land, which does not qualify as wetland or arable land.
- Has soil, or soil-like material, permeable to roots of native plants, that is more than 250 mm thick and contains less than 50 % by volume of rocks or pedocrete fragments larger than 100 mm.
- Supports, or is capable of supporting, a stand of native or introduced grass species, or other forage plants utilisable by domesticated livestock or game animals on a commercial basis.

Criteria for Wilderness land

- Land, which does not qualify as wetland, arable land or grazing land.

The “land capability classification” as described above was used to classify the land units identified during the pedological survey for all of the possible alternatives. Site “C” is considered the most favourable site for an Ash Disposal Facility, while Site “B” is considered the least favourable site in terms of land capability.

Based on the outcomes of the soil study and the geomorphological information gained during the site inspection, the various sites where rated in terms of their land capability (refer to Table 2.5.1 above). Site “B” is rated as having a significant proportion of area that rates as arable land potential. Site “C” in contrast is dominated primarily by soils that rate as wilderness or low intensity grazing land status (Refer to Figures 2.5a and 2.5b).

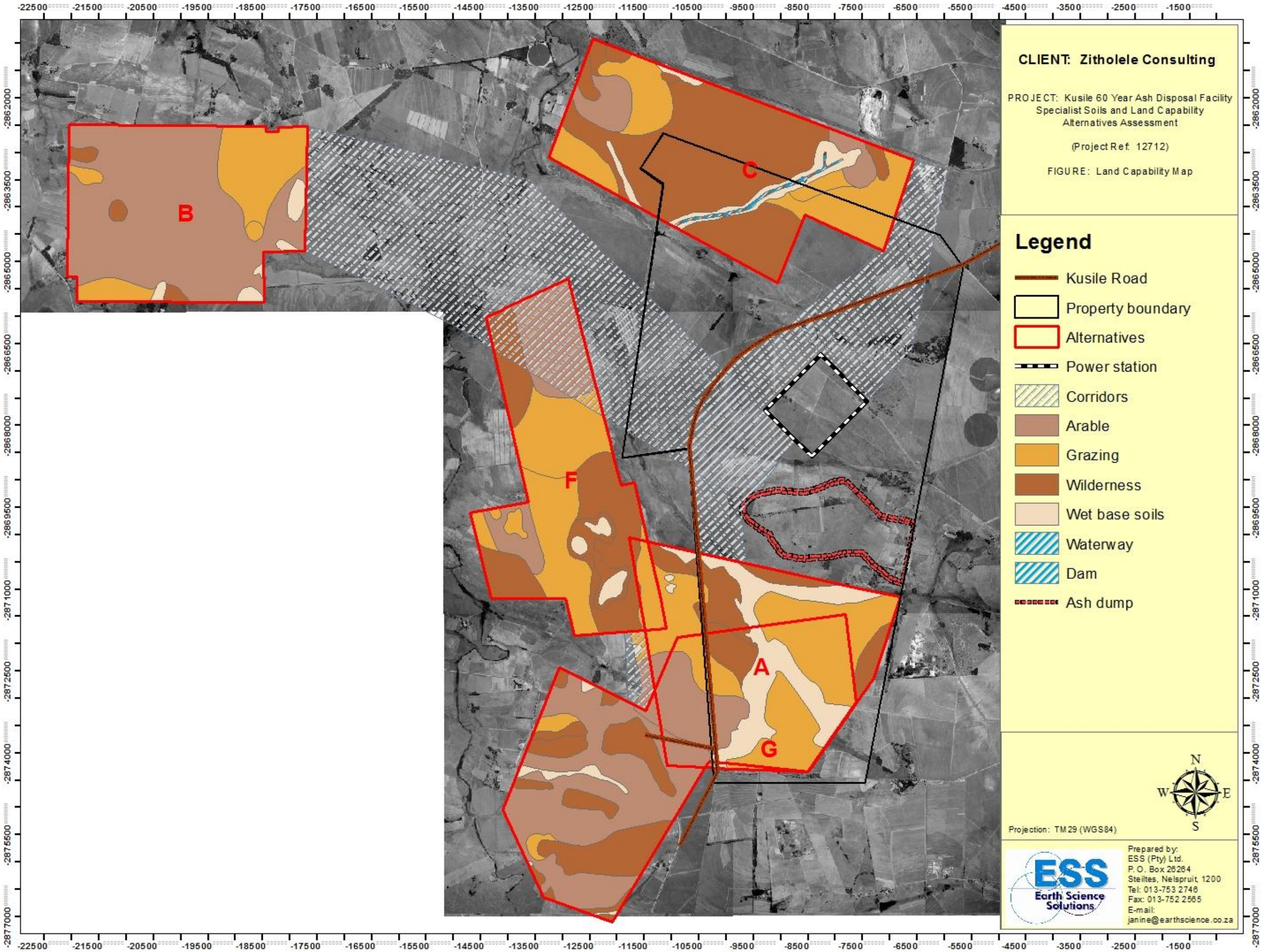


Figure 2.5a – Land Capability Plan – All Alternatives

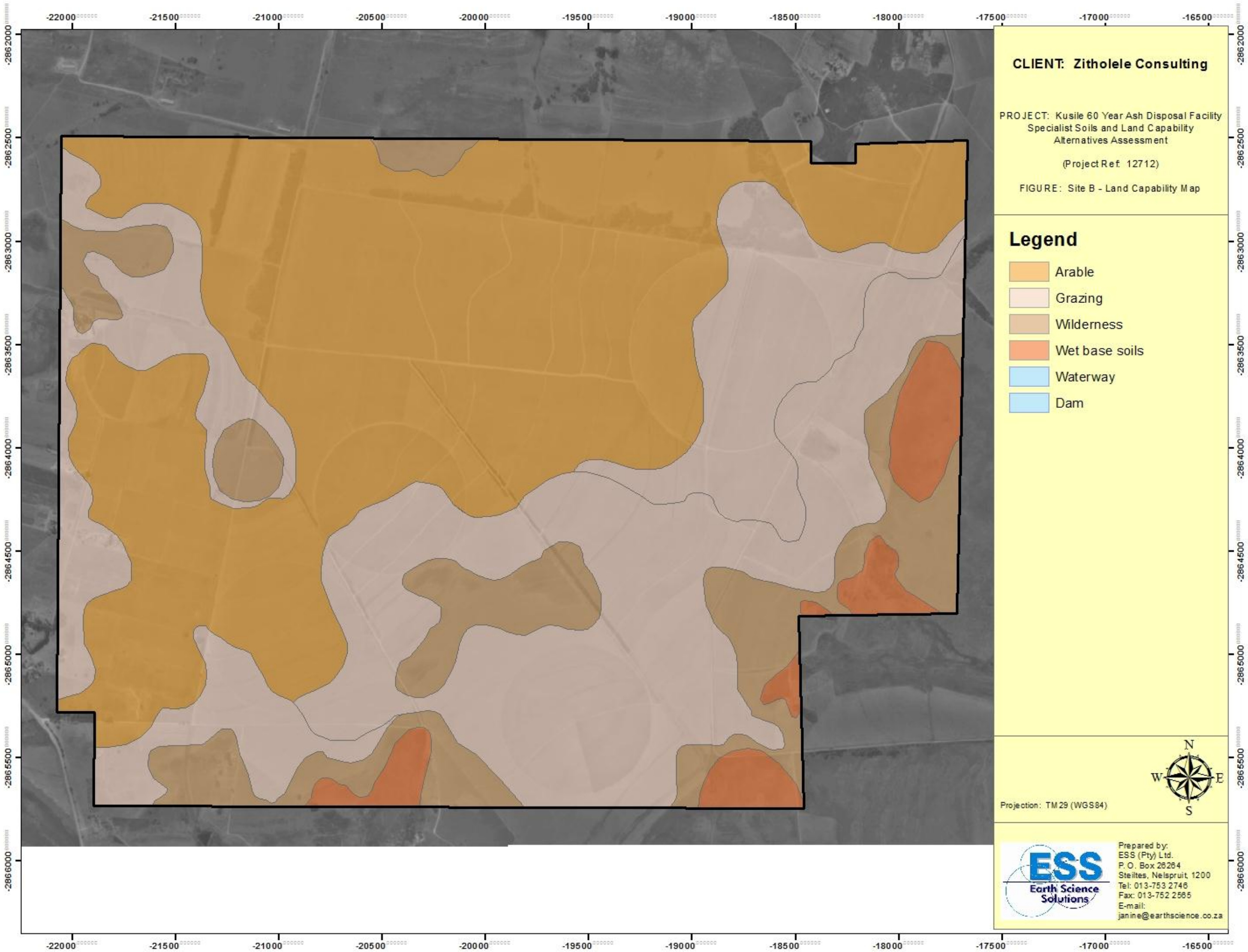


Figure 2.5b – Land Capability Plan – Site “B”

2.6 Alternative Assessment

The field data obtained from the original walk over assessment and the more comprehensive study of Site “B” and the assimilation of the geomorphological information combined with discussions with the wetland ecologists have been used as the basis for the alternatives assessment.

In assessing any environmental aspect for an area it is important to understand the baseline from which the assessment is being considered. The consequence of a structure the size and dominance of an Ash Disposal Facility to the sustainability equation needs to be considered in terms of the permanent nature of the structure. When considering the soil resource, the concept of “No Net Loss has been used as the barometer, and while this is understood to be an extreme position, the loss of soil as a resource and primary medium for food production, we believe it is important enough to warrant its use.

This position is also further emphasised in terms of the ecosystems services (IFC Best Practice) that requires that food security is considered high on the ladder of concerns.

In attempting to summaries the findings of the alternatives assessment, a number of key variables have been used to measure and rank the different sites proposed.

The following variables were considered important:

Soils	Sensitivity of Soil Erosion Potential of Soil Soil Depth (ERD) Soil Structure and Workability
Land Capability	Arable potential Grazing Potential Wilderness Potential
Land Use	Presence of dwellings or people on the land Presence of Infrastructure Presence of livestock or cultivation on land

The ability of the earth scientist to assist the development and planners in obtaining the best alternative for a development is often found in the understanding of the interrelationship between the various disciplines. A straight association is not always a true reflection of the sensitivity of a resource to impact and might require that a weighting is attached to the particular aspect being considered. However, this is best left to the EAP as he/she has the cross section of the specialist information at hand.

Table 2.6 is a straight comparison of the five sites using a scale of 1 to 9, where 1 = Highly Suitable and 9 = Not Suitable, while Figure 2.6 is a graphic representation of the site sensitivities based primarily on soil and land capability variables.

Based on the findings of the soils and land capability assessments, it is evident that Site “C” is considered to be the best candidate site for an Ash Disposal Facility. However, once all of the other disciplines where included into the mix, it was the consensus of the scientific team that Site “A” would be the best candidate for the mega ash disposal facility.

Site "B" was reassessed as part of the change in candidate site recommendations posed by the authorities and the need for further clarity on the outcomes tabled as part of the alternatives assessment process.

Additional information was also available as part of the more intensive study undertaken for Site "B", with communication with Mr. Andreas Moll (telephonic communication and detailed annual audit reports) revealing some details around the land utilisation and the ecosystem services aspects. In summary, the following additional information has been considered in the assessment of the sites proposed and Site "B" in particular:

- The more comprehensive site investigation and soils study revealed that the original findings are indeed correct, and that the majority of the soils are of a better than average quality and considered to be of an arable land capability rating at best, and good quality grazing land potential at worst.;
- The geomorphology of Site "B" has been confirmed, with the convex nature of the land form and drainage of surface water off the site in all directions posing a number of issues around erosion, the containment of dirty water, impacts on the underlying vadose zone and downslope effects on the wetlands;
- The impact of the proposed structure on a high quality crop in the form of the Blackberry Farm and the organic nature of the farming method. Impacts of dirty water, dust and overland flow are issues raised by the land owner with respect to the proposed Ash Disposal Facility, with heavy metals and the impacts of windblown dust being concerns around the soils, while soil water and its migration down slope from the structure would impact on the natural conditions for which this farming venture was chosen;
- The soils are (according to the chemical results presented in the Bio Select Farm audits undertaken by Enviroscientific management and Auditing), better than the average for the area, and are considered of a quality that no additives need to be included into the soils in order to achieve the yields and quality of berries needed to satisfy the quality fruit market (Refer to Appendix 1 – Bio-Select Audit Results);
- The soil water (vadose zone) quality is considered to be ambient and of such quality that the spring utilised by the farming enterprise requires no filtration or quality controls. The presence of a spring is further evidence that the wetlands are feed by soil water from upslope, a factor that needs to be carefully considered if any development or major structures are to be considered on the upper and crest slope positions on Site "B".

The soil sensitivity map (Refer to Figure 2.5) indicates that the soils are considered to be only slightly sensitive to non-sensitive for the most part when considering their workability (ability to be dug up, stripped and stored). However, this is also a reflection of the sandy to sandy loam nature of the soils, with very little structure and low levels of impedance in terms of rocky inclusions, or restrictions to the movement of water into the soils and down the profile. The permeability, or ability of these soils to transmit or transfer water, is a factor to be noted in terms of their catchment contribution to the wetlands down gradient as already emphasised.

It is the considered opinion of this science that Site "B" was originally classified correctly in terms of the Site Selection and Alternatives Assessment process, and that the utilisation of this site ahead of Site "A" or preferably Site "C" is in contravention of the Department of Agricultures (DA) stated aim of preserving the arable land of this country, contravenes the international best practice guidelines as set out in the IFC Performance Standards, and defies the ideals of Ecosystems Services, a science that has great relevance to a country as soil and water scares as South Africa.

There are alternatives that can and should be considered ahead of Site "B".

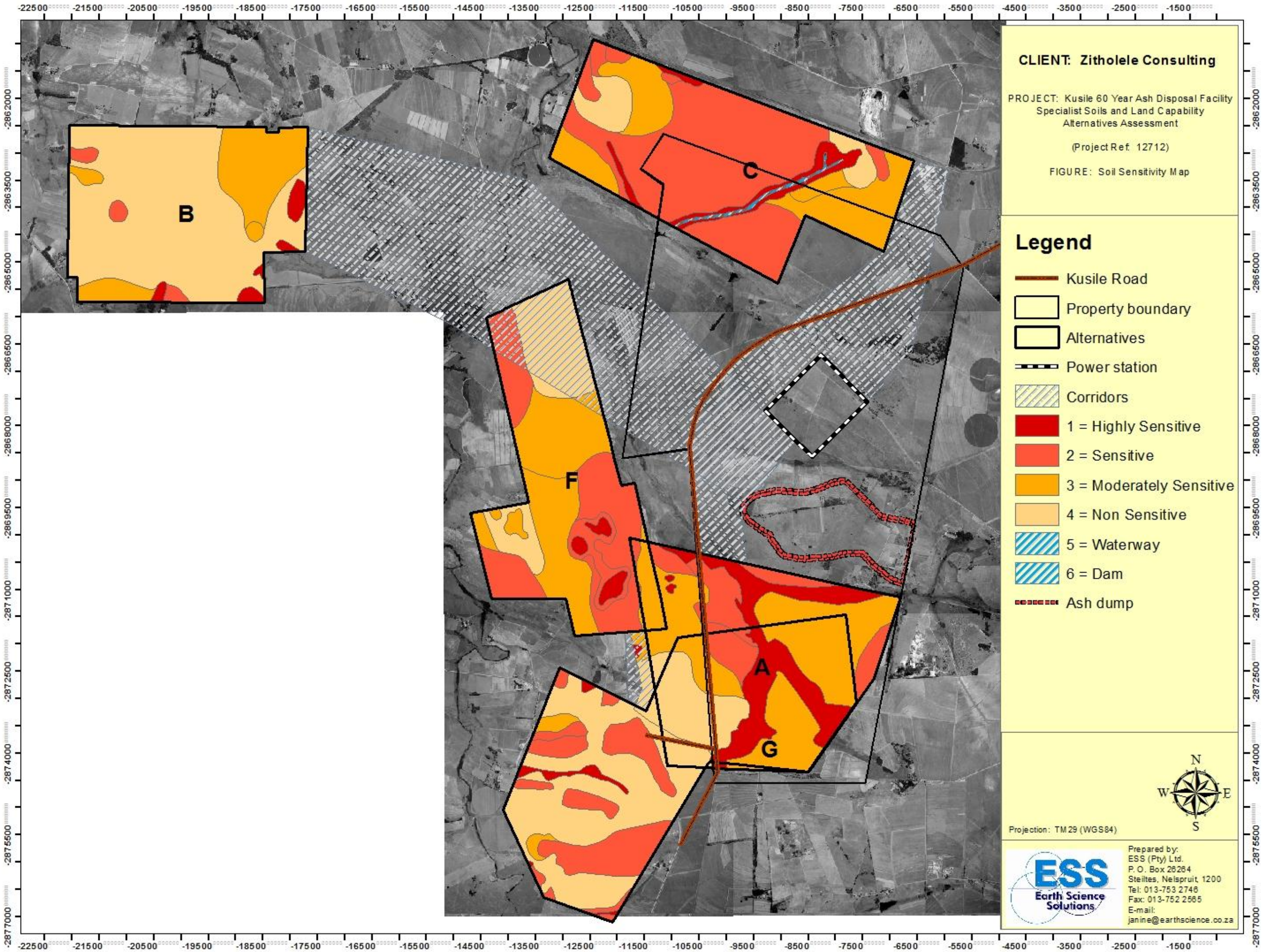


Figure 2.6a – Site Sensitivity

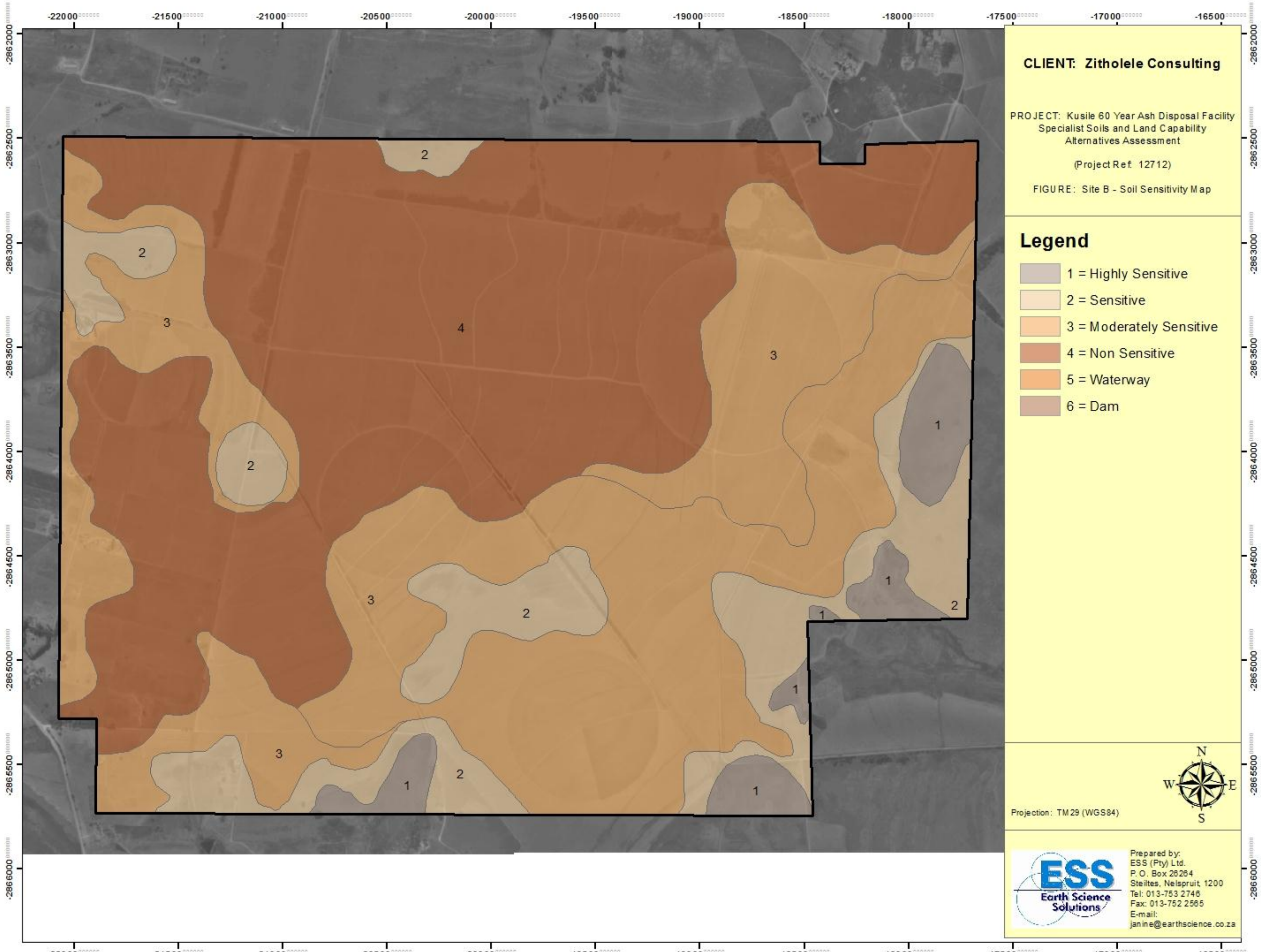


Figure 2.6b – Site Sensitivity – Site "B" Only

Table 2.6 – Alternative Assessment Matrix

KUSILE ASH DUMP - SITE SELECTION

Ash Storage Facility - Alternatives Analysis Matrix

Considerations				Alternative									
				Site Option A		Site Option B		Site Option C		Site Option F		Site Option G	
Account	Sub-account	Indicator	Indicator weighting	Score	Description	Score	Description	Score	Description	Score	Description	Score	Description
Aspects of Physical Environment	Present Land Use	Habitation	0	7	Limited habitation.	8	Many Small Holdings - significant amount of habitation	3	Limited habitation.	3	Limited habitation.	3	Limited habitation.
		Cultivation or Grazing Usage	0	8	Significant area of cultivated annual pastures and commercial cropping.	8	High % of Cultivation	3	Natural veld grass and limited cultivatin	6	Some cultivated commercial cropping - mostly in northern sector, natural grazing and wet based/transition zone and conservation in south and south west respectivily.	3	Natural veld grass and limited cultivatin
		Subsistance usage	0	4	Limited usage	8	High Usage	2	Limited	3	Limited usage	2	Limited Usage
	Sub-account value		0	19		24		8		12		8	
	Soils	Presence of sensitive soils	0	8	Significant wet based or transitional zone soils - Sensitive and require managemnt inputs.	4	Limited Wet based and/or Transitional Zone Soils - Sensitive - Limited Area	4	Limited wet based and some transitional zone soils associated with the northeast - south west water way. Generally shallow & rocky soil - only moderately sensitive	6	Significant areas of wet based or transitional zone soils - mostly in south and south east, steeper and shallow rocky in south west - Sensitive and require managemnt inputs.	7	Only limited wet based and transitional zone soils associated with the minor water way - only moderately sensitive
		Soil Workability	0	5	Sandy Clay Loams - moderately easily worked for all but the wet based soils (significant area of proposed site	5	Friable sandy loams to sandy clay loams - Easily worked	4	Shallow sandy Clay Loams - Generally easily worked, but limited rehabilitation cover.	5	Sandy Clay Loams - moderately easily worked for all but the wet based soils (significant area of proposed site	7	Moderte to deep sandy clay loams - Generally easily worked, but limited rehabilitation cover.
		Erosion Sensitivity	0	4	Moderate to shallow and flat gradients, moderate clay, but generally poor organic matter content - Moderate to high erosion if not protected	5	Flat to undulating terrain - some increase in gradient in south west, moderate clay, but low organic carbon content to soils - Moderate erosion if not protected.	4	Flat to undulating terrain, shallow rocky profiles with spares grass cover. Unprotected soil are sensitive to erosion.	4	Moderate to shallow and flat gradients for the most part, moderate clay, but generally poor organic matter content - Moderate to high erosion if not protected, and higher on shallow rocky soils in south west	6	Flat to undulating terrain, moderate to deep profiles with moderate to good grazing potential. Unprotected soil are sensitive to erosion.
	Sub-account value		0	17		14		12		15		20	
	Land Capability	Arable Potential of Soils	0	6	Generally shallow or wet based transitional zone soils - Limited Arible Potential	7	Generally moderate to deeper soils - Moderate to Good Arible Potential	4	Shallow - poor arable potential with limited wet based soils associated with the water way.	6	Generally shallow or wet based transitional zone soils - Limited Arible Potential for all but the northern sector - limited arable materials	7	Shallow - poor arable potential with limited wet based soils associated with the water way.
		Grazing Potential of Soils	0	7	Moist grassmands associated with wet based soils - transition zone - difficult to work and considered sensitive -At best moderate grazing potential on areas outside of the valley bottoms - west and estern extremes.	7	Grassland savanha dominant, limited wet based transitional zone soils, generally better than average to good Grazing Potential	5	Moderate grazing potential (low stocking numbers) associated with transition zone soils. Poor grazing on shallow materials.	7	Moist grassmands associated with wet based soils - transition zone - difficult to work and considered sensitive -At best moderate grazing potential on areas outside of the valley bottoms.	6	Moderate grazing potential.
		Conservation Potential of Soils	0	8	Significant wet based and transiton zone soils - Need to be conserved	7	Limited shallow and or wet based or transitional zone soils or soils with sensitive nature that need to be conserved	7	Wet based transitional zone soils associated with the water way. Impacted by grazing of livestock.	8	Significant wet based and transiton zone soils - Need to be conserved (south and south eastern sectors	4	Limited wet based transitional zone soils associated with the minor water way.
	Sub-account value		0	21		21		16		21		17	
	Overall Value		0.0	57	4	59	5	36	1	48	3	45	2

Notes:
The table is a straight comparison of the five sites using a scale of 1 to 9, where 1 = Highly Suitable and 9 = Not Suitable.
Lowest score = Best site for Ash Dump.