6 BASELINE RECEIVING ENVIRONMENT

The regional environment is described in the section below. For the context of this report the regional environment refers to a 50 km radius around the study area. Additionally to the regional description each element is described in terms of the site / corridor in greater detail.

6.1 Bio-physical Environment

6.1.1 Climate

Data Collection and Methodology

Climate information was attained using the climate of South Africa database, as well as from Air Quality Impact Assessment for the Kusile Power Station by Airshed Planning Professionals[5].

Regional Description[6]

The study area displays warm summers and cold winters typical of the Highveld climate. The region falls within the summer rainfall region of South Africa, rainfall occurs mainly as thunderstorms (Mean Annual Precipitation 662 mm) and drought conditions occur in approximately 12% of all years. The mean annual potential evaporation of 2 060 mm indicates a loss of water out of the system.

The region experiences frequent frosts, with mean frost days of 41 days. In addition to frost the area is prone to hail storms during the summer time. Winds are usually light to moderate, with the prevailing wind direction north-westerly during the summer and easterly during winter.

Ambient Temperature

The long-term average (2003) maximum, mean and minimum temperatures for the area are presented in Table 6-1.

TABLE 6-1: LONG TERM TEMPERATURE DATA FOR AREA (AIRSHED, 2006)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Maximum	31	32	32	29	24	20	22	24	29	30	30	32
Mean	21	22	20	18	13	10	10	12	18	20	21	22
Minimum	15	15	12	11	6	4	3	4	10	13	14	15

5 Air Quality Impact Assessment for the Proposed New Coal-fired Power Station (Kendal North) in the Witbank Area. Report No.: APP/06/NMS-01 Rev 0.2, 2006.

6 When referring to a regional description a 20 kilometer radius around the proposed corridors is taken into consideration.

The annual maximum, minimum and mean temperatures for the study area are given as 32°C, 3°C and 17°C, respectively, based on the 2003 record. The average daily maximum temperatures range from 32°C in December to 20°C in July, with daily minima ranging from 15°C in January to 3°C in July.

6.1.2 Geology

<u>Data Collection and Methodology</u>

The geological analysis was undertaken through the desktop evaluation using a Geographic Information System (GIS) and relevant data sources (April 2009). The geological data was taken from the Environmental Potential Atlas Data from the Department of Environmental Affairs (DEA).

Additionally a specialist, *Mr Jan Arkert* of *Africa Exposed Consulting Engineering Geologists*, undertook a geological evaluation of the corridors and study area based on a literature search and site investigations. For additional information please refer to the Geotechnical specialist study in Appendix L.

<u>Regional Description</u>

The main rock types found in the region are sandstone, tillite and shale. The corridors exclusively fall in the shale geology.

None of these geologies provide any sensitivity to the construction of a railway line. The shale is known to weather into soils with relatively high clay contents, which in turn could provide stability issues, but these would be limited to the drainage lines and watercourses on site.

The sandstone geology found on site forms part of the Mpumalanga coal fields which is almost exclusively overlain by sandstone. The geology includes Wilgerivier sandstone (Waterberg Group) and defines a richer biodiversity than south of this outcrop. The geologies described above are illustrated in **FIGURE 6-1** below.

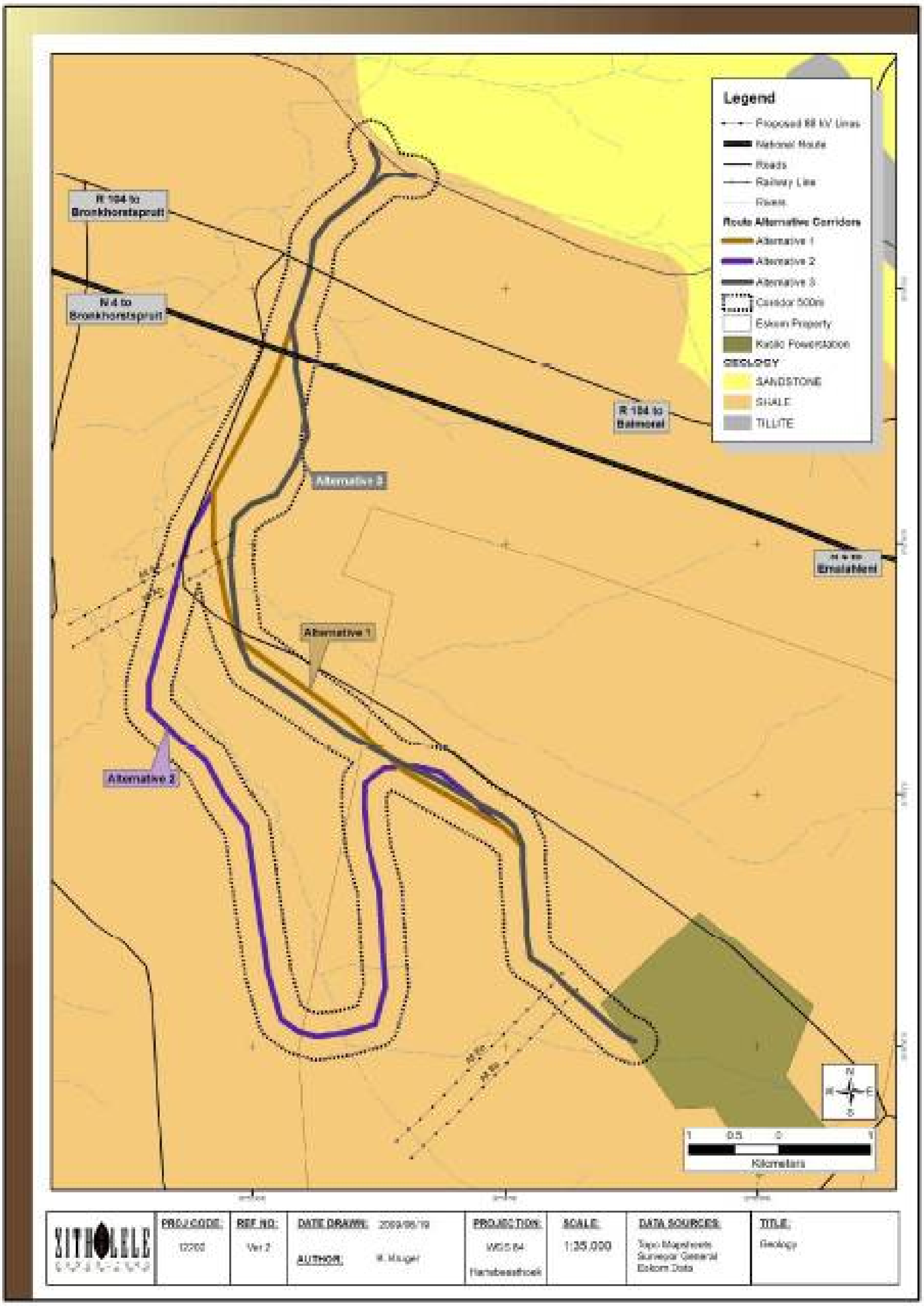


Figure 6-1: Regional Geology of the area.

Site Description

Large portions of the southern side of the study area are underlain by flat dipping sediments that belong to the Dwyka Group of the Karoo Sequence, however the geology of the site changes towards the north, where shale of the Silverton formation, Pretoria Group of the Transvaal Sequence are extensively exposed. These formations are juxtaposed with sandstone and conglomerate of the Wilgerivier formation of the Waterberg Group, which form the prominent ridges north of the R 104 provincial road.

Post Transvaal age (2050Ma) diabase intrusions are identified at the extreme northern limits of the study area in the vicinity of the proposed railway tie in with the existing Pretoria-Witbank railway line and at the southern terminal point at the Kusile Power Station (Figure 6-2).

FIGURE 6-2: GEOLOGY OF THE STUDY AREA.

The geological lithologies identified on the site belong to the following stratigraphic unit: (Table 6-2)

TABLE 6-2: GEOLOGICAL LITHOLOGIES AND STRATIGRAPHIC UNITS.

Lithology	Formation	Unit
Diabase intrusions	-	Post Transvaal age
Siltstone diamictite	Dwyka formation	Karoo Sequence
Sandstone conglomerate	Wilgerivier formation	Waterberg Group
Shale	Silverton formation	Pretoria Group

Dwyka formation

The late Carboniferous to early Permian age Dwyka formation in the area occurs beneath approximately the southern two thirds of the area and are characterised by shallow dipping, almost flat sedimentary rocks that consists almost exclusively of shale. The area falls within the stratified mudrock facies, which consists of dark coloured carbonaceous mudrock and shale.

These rocks were deposited unconformably on-top of the older Precambrian formations, and exposures of the older formations are seen to the west and east of the proposed railway alignments. The Dwyka formation in the area rests on a complex pre-Karoo age topography of high relief, with deep valleys and elongated ridges, and therefore this formation is highly variable in thickness that varies from less than 10m thick to an anticipated maximum of less than 100m.

Wilgerivier formation

The Wilgerivier formation consists of clastic sedimentary rocks, which include sandstone and conglomerate. The rocks form the only stratigraphic unit in the Middelburg basin of the Waterberg group and extend from just east of Pretoria to beyond Middelburg.

The rocks consist of red to red-brown sandstone and quartzite, with grit bands that dip towards the north at angles of 10º to 15º. Cross bedding frequently occurs and is usually well exposed in rock cuttings.

These rocks rest unconformably on the older Transvaal Sequence formations and the age of the Wilgerivier formation is approximately 1920 ±30 Ma.

Diabase Sills and Dykes

East to west striking post-Transvaal Sequence age diabase dykes traverses across the extreme southern and northern portions of the site. The northern most exposure of diabase represents a dyke that is intruded into the Wilgerivier formation and underlies a very limited portion of the proposed alignments at the northern terminus.

The southern most limit of the proposed route at the position of the Unloading Facility is also underlain by diabase. This represents a sill that has been intruded into the Silverton shales and limited exposures diabase are usually noted and the presence of the intrusive features are alluded to by the accumulation of well rounded igneous boulders at ground surface.

Silverton formation.

Shale belonging to the Silverton formation of the Pretoria Group, Transvaal Sequence occurs along the northern portions of the site, where the proposed railway alignments cross the N4 freeway and the R104 provincial roads.

These fine grained argillaceous sediments are usually very finely bedded and dip towards the south west at angles of 20º to 30º. The rock is described as comprising alternating light orange brown to dark brown shale and siltstone with subordinate interbedded fine grained sandstone.

<u>Sensitivities</u>

Geological sensitivities are outlined below and divided into two types: transported material and residual soils.

Transported Materials

The entire area is covered by transported soil which may vary in thickness from a few centimetres up to several metres. Due to the transported origin of the soils the geotechnical characteristics are typically highly variable and difficult to predict.

The transported soils that occur on the lower slopes of the undulating topography are described as silty sand and gravels, of colluvial (hillwash) origin. The soils are generally of loose to medium dense consistency, and are rich in organic matter.

The base of the transported soils is defined by the pebble marker which consists of a thin horizon (usually 20 to 40cm thick) that contains sub-rounded and angular quartz gravels, in a matrix of greyish brown silty sand.

i) Alluvium

Within the low lying portions of the site that are occupied by the Wilgerivier, the Klipfonteinspruit and several un-named tributaries areas of recently deposited alluvial sediments do occur. These soils are derived from the proximal rocks that occur in the area and the soil texture and mechanical properties are characterised by the lithologies from which they are derived. Typically the soils will be characterised by unconsolidated sediments that consist of sandy silt and clay with a high organic content. The thickness of these soils will vary considerably, and it must be anticipated that the soils may be potentially expansive as well as highly compressible.

ii) Pedogenic Soils

The base of the transported soils is usually defined by the pebble marker that has been subjected to pedogenesis in places. The degree of cementation of the pedogenic material varies from scattered ferricrete nodules, honeycomb ferricrete to hardpan ferricrete. The consistency of the horizon is dependant on the degree pedogenisis, varying from dense to very soft rock consistency and is approximately from 0.3 to 0.5m thick.

Residual soils

A brief description of the residual soils derived from each of the geological formations is also presented.

i) Diabase Intrusions.

The post Transvaal age diabase intrusions that occur in the area generally consists of completely weathered, coarse grained, closely jointed, medium hard rock, diabase. In the sub humid and humid warm climatic regions of the country, falling within the Wienert's climatic N value of less than 5 (Bronkhorstspruit has a value of 2.5) such as the area investigated, the diabase undergoes chemical decomposition, which produces residual soils which are commonly expansive. A particularly interesting feature about the diabase intrusions sills in the eastern parts of South Africa is the extreme variability in the depth and degree of decomposition over a relatively short distance. Within a few meters of an outcrop of solid rock a test pit may disclose a substantial depth of decomposition.

ii) Dwyka Formation

The Dwyka Formation (diamictite and shales) sediments have been interpreted as being deposited in a glacial environment. As such the rock consists of a wide variety of rock fragments assembled by the glaciers as they move over the original host rock. Upon melting the fragments which vary in size from clay fraction to boulders are deposited into fluvial and lacustrine environments that ultimately consolidated to form diamictite, conglomerate, varvite and shale and a direct consequence of the environment of deposition, it is not unusual for a lenticular body of competent, shale to occur within a predominantly weaker and weathered diamictite horizon, or vice versa.

This rock type does not generally weather to great depths, however the weathered residual soil is described as a sandy clay or clayey sand that contains gravel of varying proportions, and may be potentially expansive.

Diamictite exposed in cuttings have presented significant slope stability problems in the past. Differential weathering and mechanical disintegration of the rock in humid area falling within the Wienert's $N<5$ climatic zone (see 4.2.1 above) does result in exposed cut faces constructed within this rock type being subjected to wedge type failure.

iii) Wilgerivier formation

The residual sandstone soils derived from the Wilgerivier formation are expected to consist of silty and gravelly sand that typically shows relic jointing and bedding as seen in the parent rock. The residual soil horizon is generally of a suitable thickness and consistency to provide an adequate founding medium for lightly loaded structures, such as single and double storey buildings.

The depth of weathering will be shallow and it may be anticipated that very soft to soft rock consistency material will be exposed within 2.0 to 3.0m of ground surface. The rock within the upper weathered zone will be highly jointed and closely bedded, resulting in a blocky structure that may result in some slope instability, as well as over break during blasting operations.

iv) Silverton formation

The residual soils derived from the Pretoria Group shale weather to form fine grained sandy silt and clayey silt that is usually weathered to a shallow depth, grading into very soft rock shale within 1.5 to 2.5m of the surface. These soils are usually described as stiff to very stiff with bearing capacities in the order of 200kPa within the upper 1.0n of the soil profile.

The bedding planes of these rocks are however unusually smooth, which induces a high risk for slope failure, particularly in deep cuttings in which the shale dips into the excavation. Many documented failures are recorded due to an inflow of moisture along the bedding planes. The introduction of the water in some cases occurred at a considerable distance away from the excavation and migration of water along fractures and joints in the rockmass induced instability in the cuttings.

Furthermore, although weathered shale is generally considered to be inert and is not expansive, it is known that residual Silverton shale contain a higher proportion of montmorillonite and lesser amounts of kaolinite, mica and quartz, which imply that these soils may be highly expansive.

6.1.3 Topography

Data Collection and Methodology

The topography data was obtained from the Surveyor General’s 1:50 000 toposheet data for the region, namely 2528DD. Contours were combined from the topographical mapsheets to form a combined contours layer. Using the Arcview GIS software the contour information was used to develop a digital elevation model of the region as shown in Figure 6-3 below.

Regional Description

The topography of the region is gently undulating to moderately undulating landscape of the Highveld plateau. Some small scattered wetlands and pans occur in the area, rocky outcrops and ridges also form part of significant landscape features in the area. The altitude ranges between 1 360 – 1 600 metres above mean sea level (mamsl). Figure 6-3 provides an illustration of the topography of the site, while Figure 6-4 shows the ridges found on site. With regards to ridges, all the corridors avoid the ridges found on site, but it should be noted that in various places the corridors do come quite close to ridges.

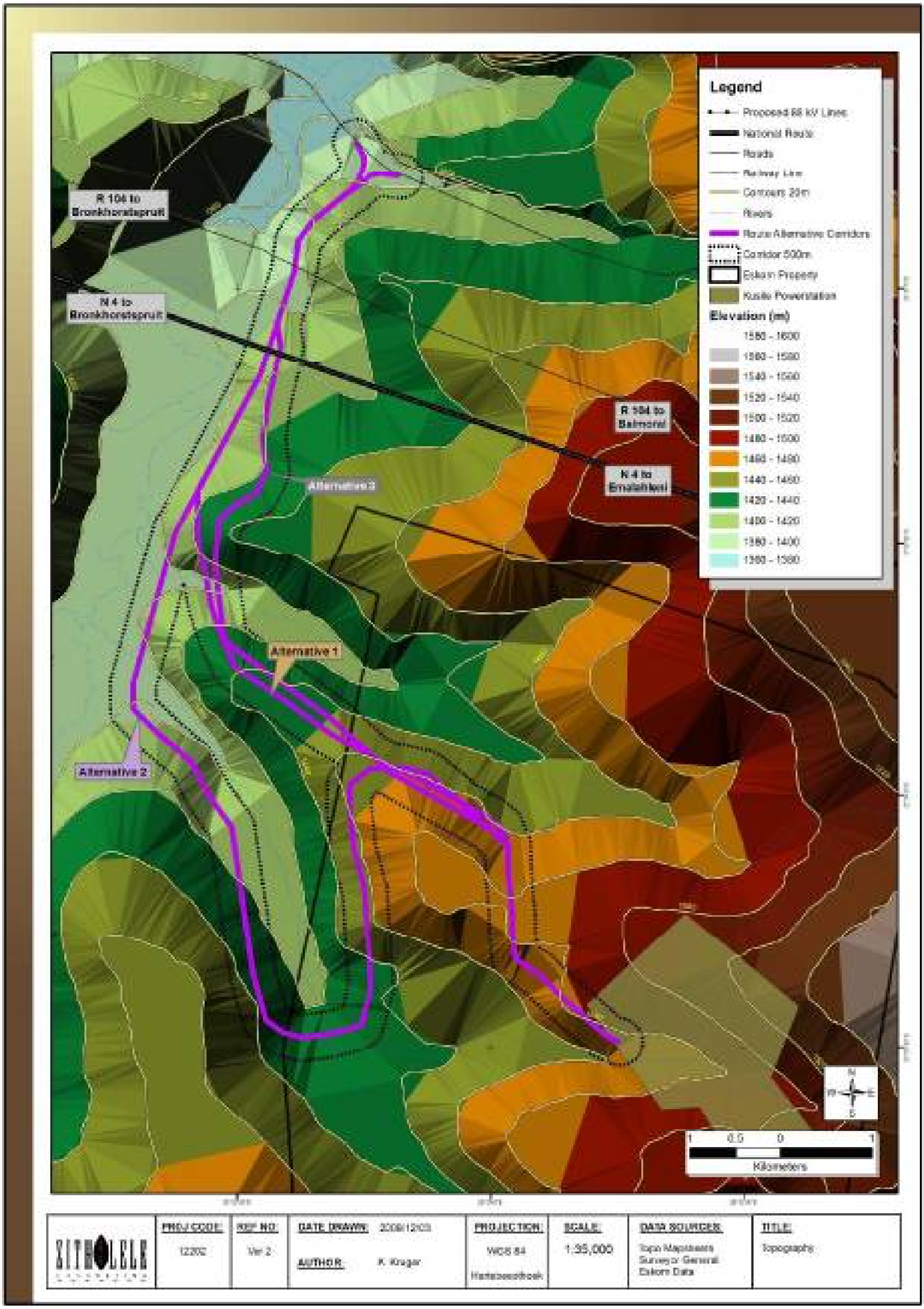


FIGURE 6-3: TOPOGRAPHY OF THE AREA.

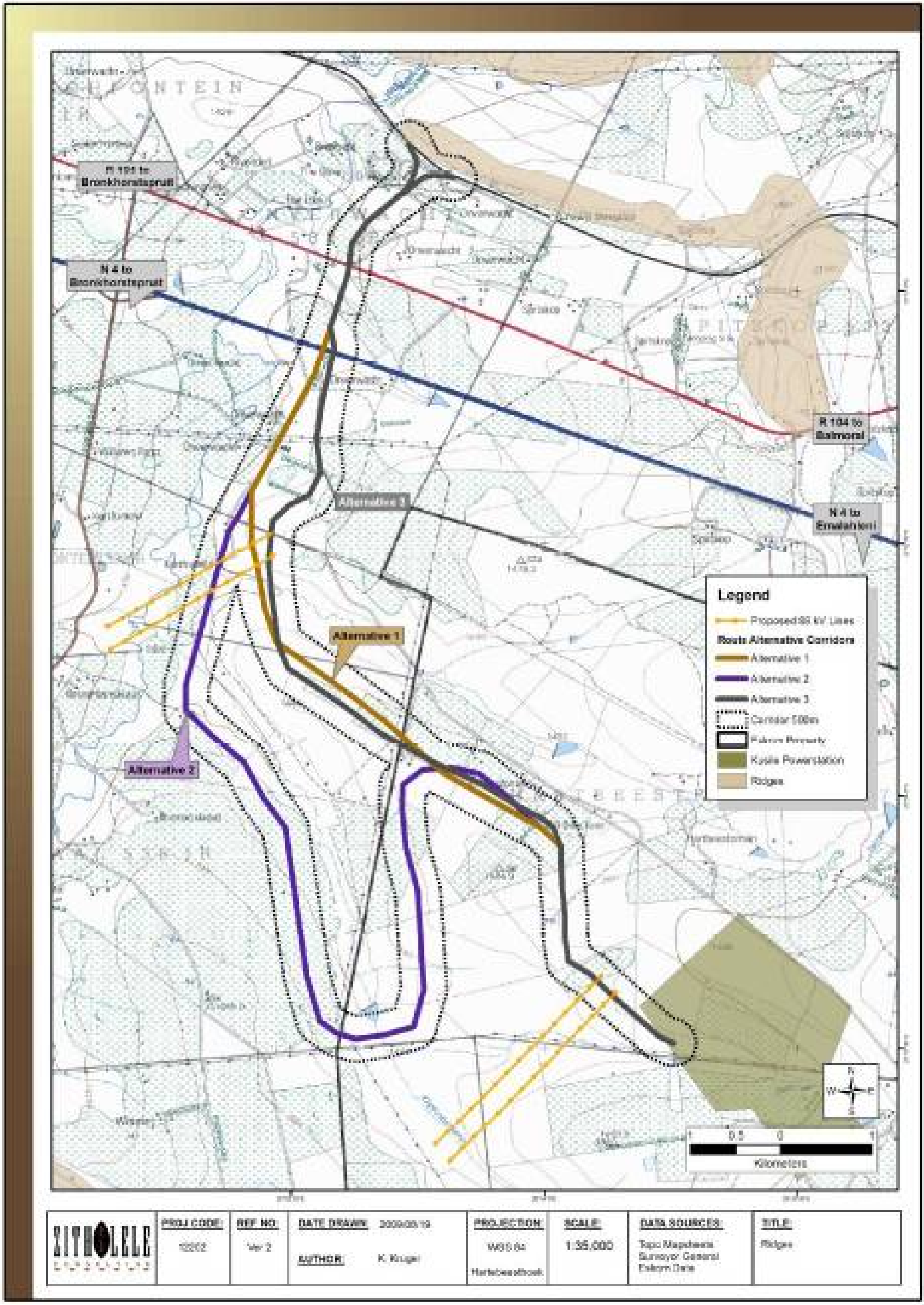


FIGURE 6-4: RIDGES FOUND IN THE AREA.

Sensitivities

The railway design requires a gradient of one degree in order to operate efficiently. All ridges must be avoided and wherever slopes are encountered along the corridor cut and fill operations will be required during construction. Therefore from a topography perspective the corridor with the least cut and fill operation required will be the least sensitive and preferred alternative. The three dimensional figure below illustrates how the alternative corridors that are being assessed in this EIA run along contours in order to maintain the one degree gradient required.

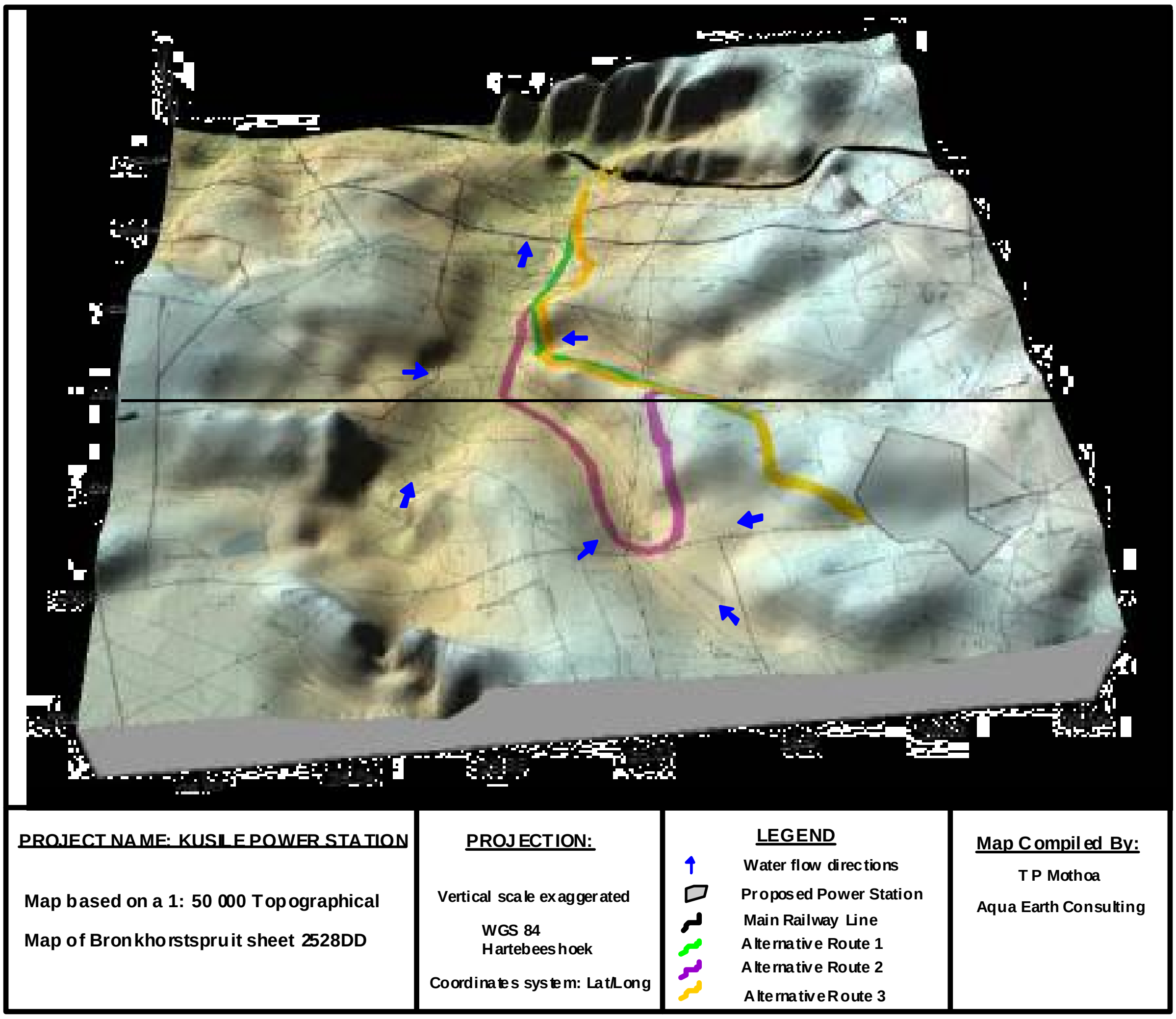


FIGURE 6-5: 3-DIMENSIONAL ILLUSTRATION OF THE STUDY AREA.

6.1.4 Soils

Data Collection and Methodology

A site visit was conducted by a specialist from *Zitholele Consulting* (*Mr Konrad Kruger*) in July 2009. Soils were augered at 150m intervals along the proposed railway line corridors using a 150 mm bucket auger, up to refusal or 1.2 m. Soils were identified according to Soil Classification; a taxonomic system for South

Africa (Memoirs on the Natural Resources of South Africa, no. 15, 1991). The following soil characteristics were documented:

- Soil horizons;
- Soil colour;
- Soil depth;
- Soil texture (Field determination);
- Wetness;
- Occurrence of concretions or rocks; and
- Underlying material (if possible).

Regional Description

The soils in the region are mostly derived from the geology of the region namely, predominantly shale (Silverton formation), sandstone conglomerate (Wilgerivier formation), siltstone (Dwyka formation) or diabase intrusions which feature prominently in the area, as mentioned above. The soils are generally shallow with a yellow-brown colour.

Site Description

During the site visit large quantities of soil forms were identified. The soils forms were grouped into management units and are described in detail in the sections below and Figure 6-6 illustrates the location of the soil types. The land capability (agricultural potential) of the abovementioned soil form is described in more detail in Section 7.1.6.

The management units are broken up into:

- Deep Soils;
- Clay Soils;
- Rocky Soils;
- Transitional Soils; and
- Disturbed Soils.

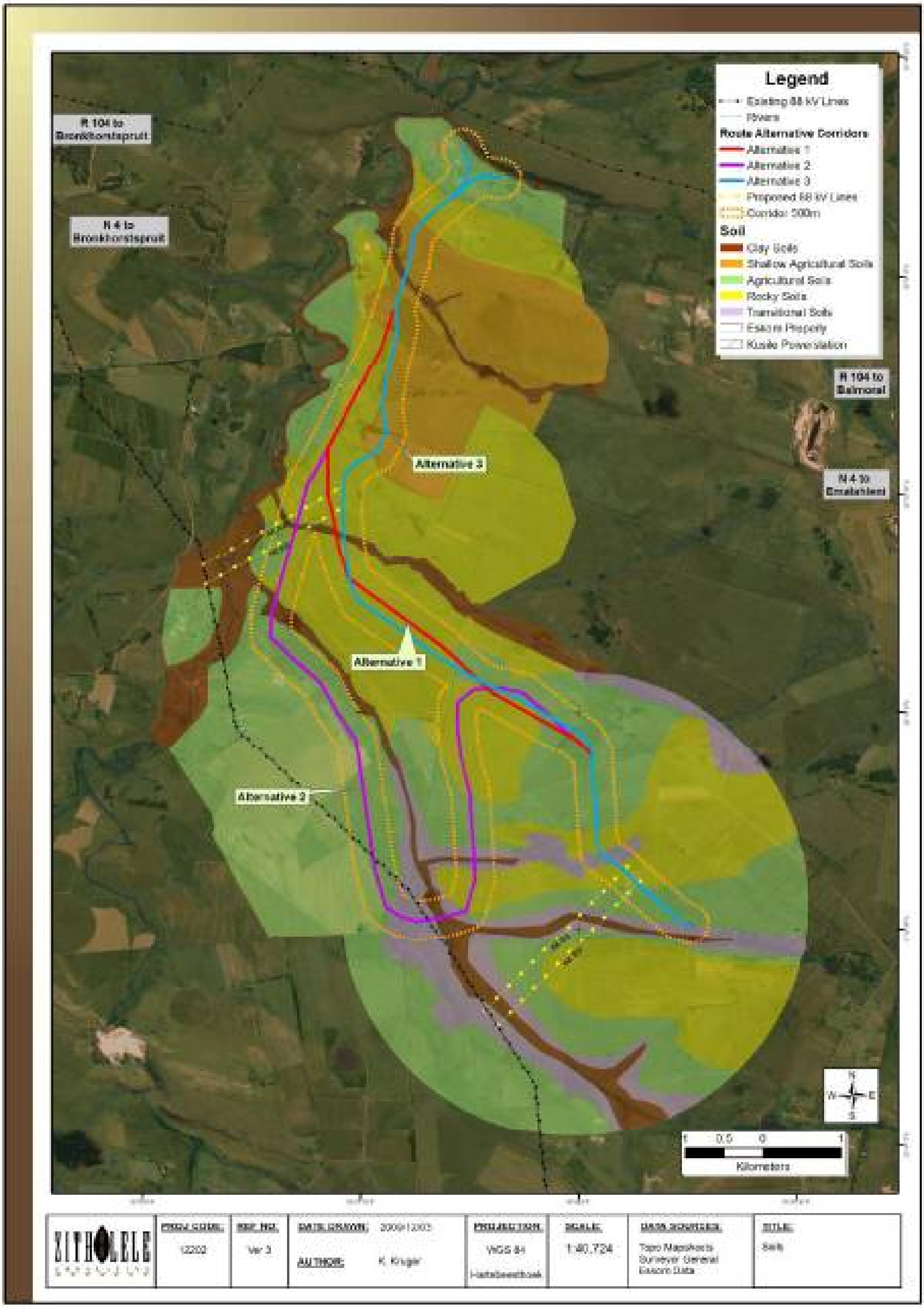


FIGURE 6-6: SOIL TYPE MAP

Rocky Soils

The rocky soils are generally shallow and that overlie an impeding layer such as hard rock or weathering saprolite. These soils are not suitable for cultivation and in most cases are only usable as light grazing. The main soil forms found in rocky soils were Mispah (Figure 6-7) and Glenrosa (Figure 6-8). These soils are discussed in more detail in the Soil Assessment Study provided in Appendix L.

FIGURE 6-7: MISPAH SOIL FORM (SOIL CLASSIFICATION, 1991).

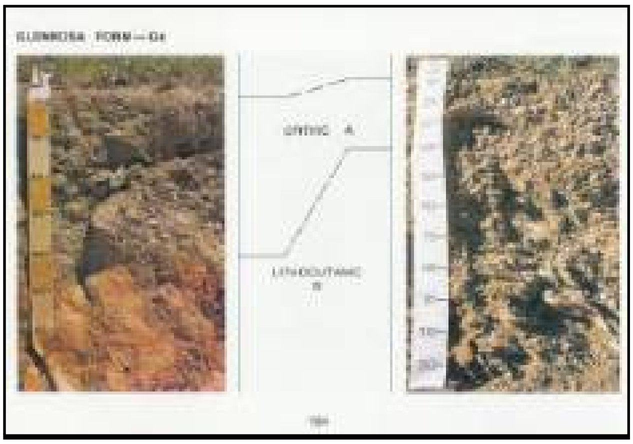


FIGURE 6-8: GLENROSA SOIL FORM (SOIL CLASSIFICATION, 1991)

Agricultural Soils

The agricultural soils found on site support an industry of commercial maize production. These soils include Clovelly (Figure 6-9) and Avalon (Figure 6-10). These soils have deep yellow-brown B-horizons with minimal structure. These soils drain well and provide excellent to moderate cultivation opportunities. Each of the soils is described in detail inAppendix L.

FIGURE 6-9: CLOVELLY SOIL FORM (SOIL CLASSIFICATION, 1991)

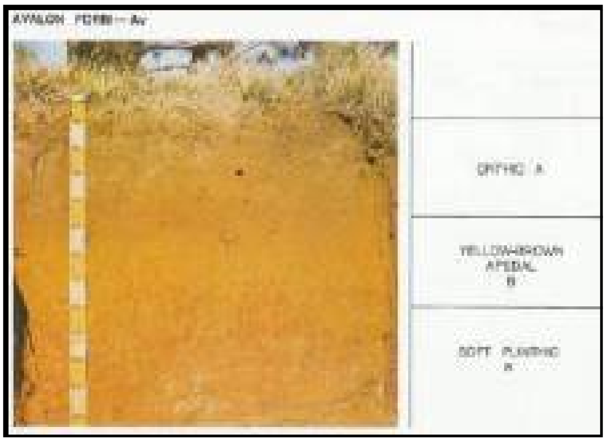


FIGURE 6-10: AVALON SOIL FORM (SOIL CLASSIFICATION, 1991)

Transitional Soils

The transitional soil management unit comprises the soils found between clay soils and the agricultural soils. These soils often have signs of clay accumulation or water movement in the lower horizons. These soils are usually indicative of seasonal or temporary wetland conditions. The main soil forms found in transitional soils were Kroonstad (Figure 6-11), Wasbank (Figure 6-14), Longlands (Figure 6-13) and Westleigh (Figure 6-15), each form is described in more detail in Appendix L.

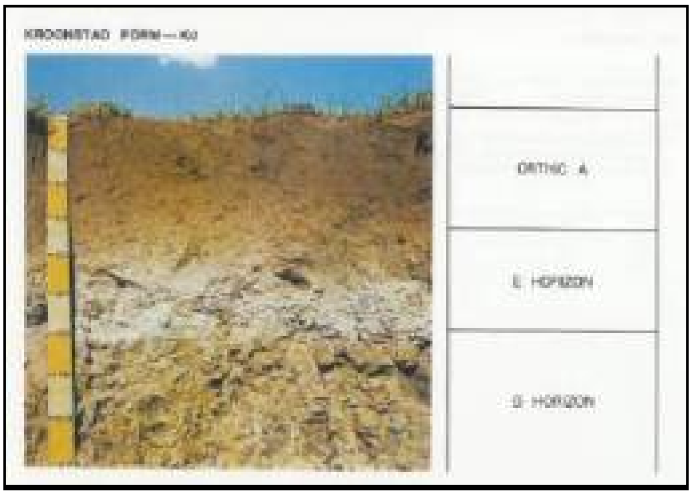


FIGURE 6-11: KROONSTAD SOIL FORM (SOIL CLASSIFICATION, 1991)

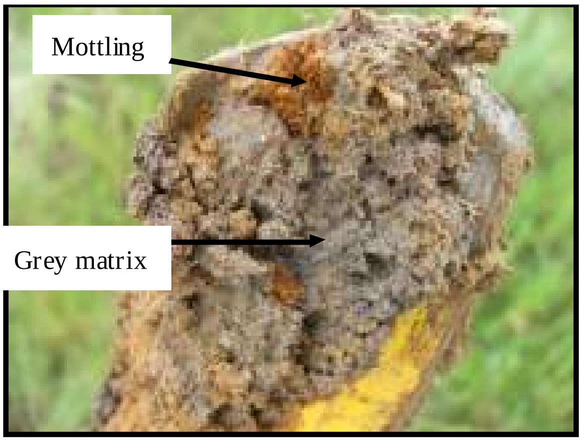


FIGURE 6-12: SOFT PLINTHIC B-HORIZON.

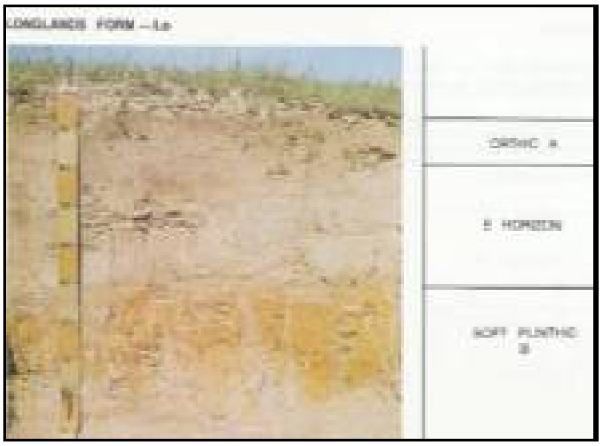


FIGURE 6-13: LONGLANDS SOIL FORM (SOIL CLASSIFICATION, 1991)

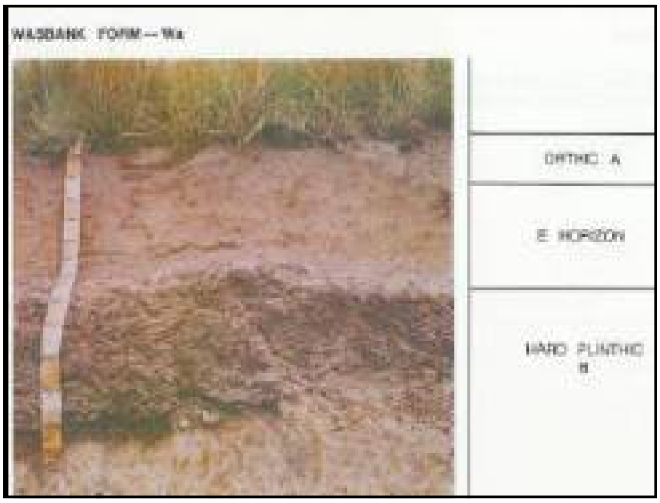


FIGURE 6-14: WASBANK SOIL FORM (SOIL CLASSIFICATION, 1991)

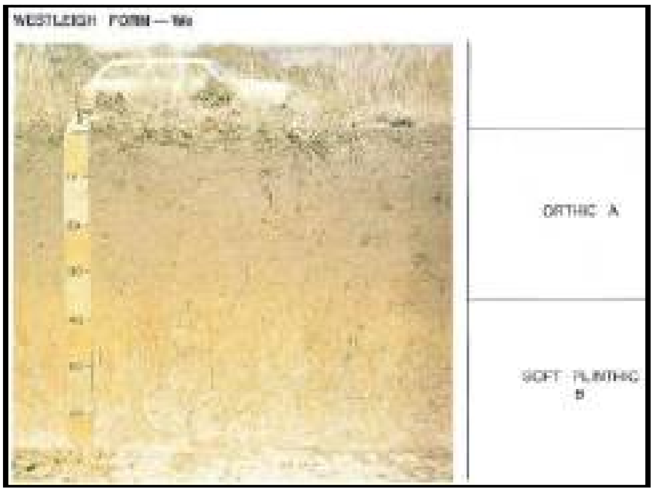


FIGURE 6-15: WESTLEIGH SOIL FORM (SOIL CLASSIFICATION 1991)

Clay Soils

The clay soil management unit is found in areas where clays have accumulated to such an extent that the majority of the soil matrix is made up of clay particles. These soils are usually indicative of seasonal or permanent wetland conditions. The main soil forms found in clay soils were Katspruit (Figure 6-16) and Willowbrook (Figure 6-17), each form is described in Appendix L. These soils are saturated with water and must be noted to be unstable for construction and are sensitive.

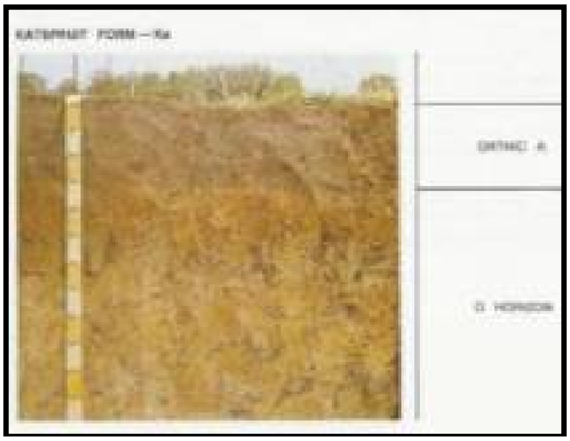


FIGURE 6-16: KATSPRUIT SOIL FORM (SOIL CLASSIFICATION, 1991)

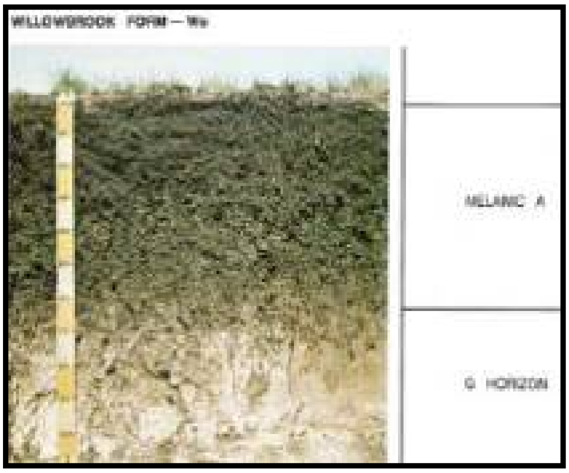


FIGURE 6-17: WILLOWBROOK SOIL FORM (SOIL CLASSIFICATION 1991)

6.1.5 Land Use

Data Collection and Methodology

The land use data was obtained from the CSIR Land Cover database and supplemented with visual observations on site.

Regional Description

The land use is dominated by maize, grazed fields, coal mines and power stations. From the map below (Figure 6-18) it can be seen that the proposed corridors traverse only cultivation / unimproved grassland land uses and some water bodies. Water bodies are the only land use regarded as sensitive. In addition the area of the Kusile Power Station is currently a construction site.

From Figure 6-18 below it can be seen that all the alternatives aim to avoid agricultural land as far as possible by following the drainage lines found in the area.

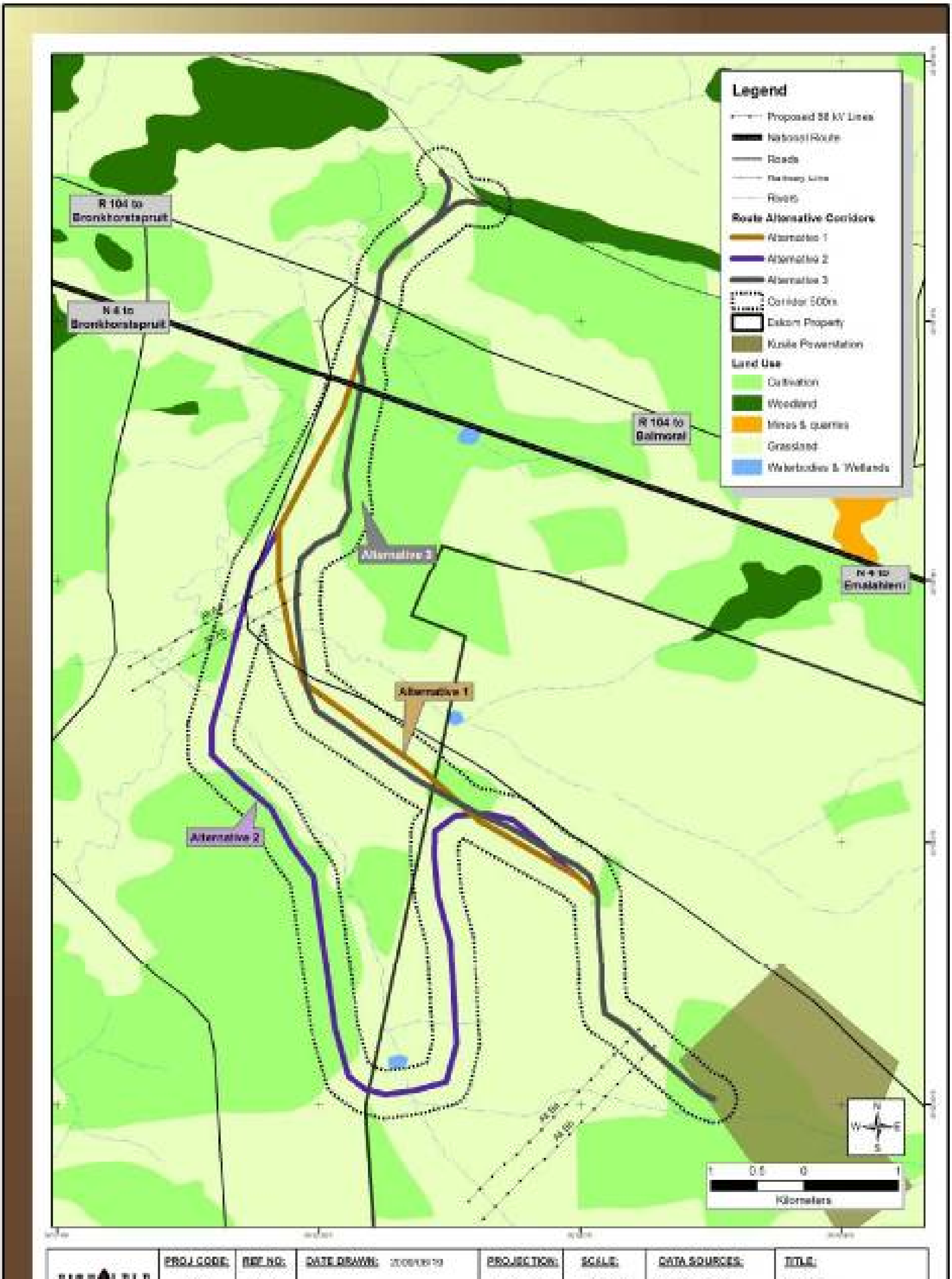


FIGURE 6-18: LAND USE MAP OF THE NORTHERN SECTION OF THE AREA.

6.1.6 Agricultural Potential (Land Capability)

Data Collection and Methodology

A literature review was conducted in order to obtain any relevant information concerning the area, including information from the Environmental Potential Atlas (ENPAT), Weather Bureau and Department of Agriculture. Results from the soil study were taken into account when determining the agricultural potential also known as the land capability of the site. The land capability assessment methodology as outlined by the National Department of Agriculture was used to assess the soil's capability to support agriculture on site.

Regional Description

The regional land capability is mostly class II soils with few limitations (please refer to Appendix L for more detailed explanation). This is evident in the large number of cultivated lands found in the region. In the areas where the soil is too shallow or too wet to cultivate, livestock are grazed.

Site Description

According to the land capability methodology, the potential for a soil to be utilised for agriculture is based on a wide number of factors. These are listed in the table below along with a short description of each factor.

TABLE 6-3: AGRICULTURAL POTENTIAL CRITERIA

Criteria	Description
Rock Complex	If a soil type has prevalent rocks in the upper sections of the soil it is a limiting factor to the soil's agricultural potential
Flooding Risk	The risk of flooding is determined by the closeness of the soil to water sources.
Erosion Risk	The erosion risk of a soil is determined by combining the wind and water erosion potentials.
Slope	The slope of the site could potentially limit the agricultural use thereof.
Texture	The texture of the soil can limit its use by being too sandy or too clayey.
Depth	The effective depth of a soil is critical for the rooting zone for agricultural crops.
Drainage	The capability of a soil to drain water is important as most grain crops do not tolerate submergence in water.
Mechanical Limitations	Mechanical limitations are any factors that could prevent the soil from being tilled or ploughed.
pH	The pH of the soil is important when considering soil nutrients and hence fertility.
Soil Capability	This section highlights the soil type's capability to sustain agriculture.
Climate Class	The climate class highlights the prevalent climatic conditions that could influence the agricultural use of a site.
Land Capability / Agricultural Potential	The land capability or agricultural potential rating for a site combines the soil capability and the climate class to arrive at the sites potential to support agriculture.

The soils identified in Section 7.1.4 above were classified according to the methodology proposed by the Agricultural Research Council – Institute for Soil, Climate and Water (2002). The criteria mentioned above were evaluated in the table below. The site is made up of two main land capability classes, namely class II and III – cultivation and class VI – grazing. The class II and III soils are suitable for cultivation and can be used for a range of agricultural applications. The class VI soils have continuing limitations that cannot be corrected; in this case rock complexes, flood hazard, stoniness, and a shallow rooting zone constitute these limitations. Figure 6-19 illustrates the various land capability units on site.

TABLE 6-4: LAND CAPABILITY OF THE REGIONAL SOILS FOR AGRICULTURAL USE

Soil	Cultivated	Transitional	Rocky	Clay
% on Site	37.4 % (2088 ha)	10,3 % (575 ha)	43.9 % (2446 ha)	8.4 % (468 ha)
Rock Complex	None	None	Yes	None
Flooding Risk	No	Moderate	No	Very Limiting
Erosion Risk	Low	High	High	Very Low
Slope %	3.9	3.7	4.0	0.5
Texture	Loam	Loam	Loam	Clay
Effective Depth	> 100 cm	> 60 cm	< 60 cm	< 60 cm
Drainage	Good drainage	Imperfect	Good drainage	Poorly drained
Mech Limitations	None	None	Rocks	None
pH	> 5.5	> 5.5	> 5.5	> 5.5
Soil Capability	Class II	Class III	VI	VI
Climate Class	Mild	Mild	Mild	Mild
Land Capability	Class II – Arable Land	Class III – Moderately Arable Land	Class VI – Moderately Grazing Land	Class VI – Moderately Grazing Land

No limitation	Low	Moderate	High	Very Limiting

6.1.7 Groundwater

Data Collection and Methodology

A field investigation was undertaken by *Mr Albert Lombaard of Aqua Earth* between the 29 and 30 September 2009. The field activities involved: locating, surveying, sampling, taking water level measurements and acquiring borehole information of privately owned boreholes within the study area. Additionally all existing and available geological and hydrogeological information was reviewed by the specialist team.

Regional Description

According to the information obtained from the hydrogeological map of Johannesburg, toposheet 2526, groundwater in the study area occurs within the Dwyka or Silverton Formations.

The Dwyka tillites are known to have a low permeability. In most cases groundwater in this formation occurs within the weathered zone and sometimes in the contact zone between this formation and other formations.

The yield potential is classed as low on the basis that 76 % of boreholes on record produce less than two l/s. There is no information regarding the depth of groundwater level for this unit (formation).

The Silverton Formation which comprises mainly of the shales has a larger groundwater yield potential than that of the overlying Dwyka Formation. Groundwater occurrence in this formation favours weathered shale, brecciated or jointed zones and especially the contact zone between the intrusive diabase sheets and the shale. The groundwater yield potential is classed as good on the basis that 40 % of boreholes on record produce more than two l/s and 22 % produce more than five l/s. The groundwater rest level occurs between 10 and 30 mbgl (meters below ground level).

6.1.8 Surface Water

Data Collection and Methodology

The surface water data was obtained from the WR90 database from the Water Research Council. The data used included catchments, river alignments and river names. In addition water body data was obtained from the CSIR land cover database (1990) to illustrate water bodies and wetlands. This data was supplemented with site observations during the various site visits.

Site Description

The main drainage feature of the area is the Wilge River which drains northwards. Several tributaries are also found on site including the Klipfonteinspruit and several unnamed streams. In addition to the streams several dams can also be found on site as illustrated in Figure 6-20 and Figure 6-21 below. The streams and their associated dams support a number of faunal and floral species uniquely adapted to these aquatic ecosystems and therefore all surface water bodies are earmarked as sensitive features and should be avoided as far as possible.

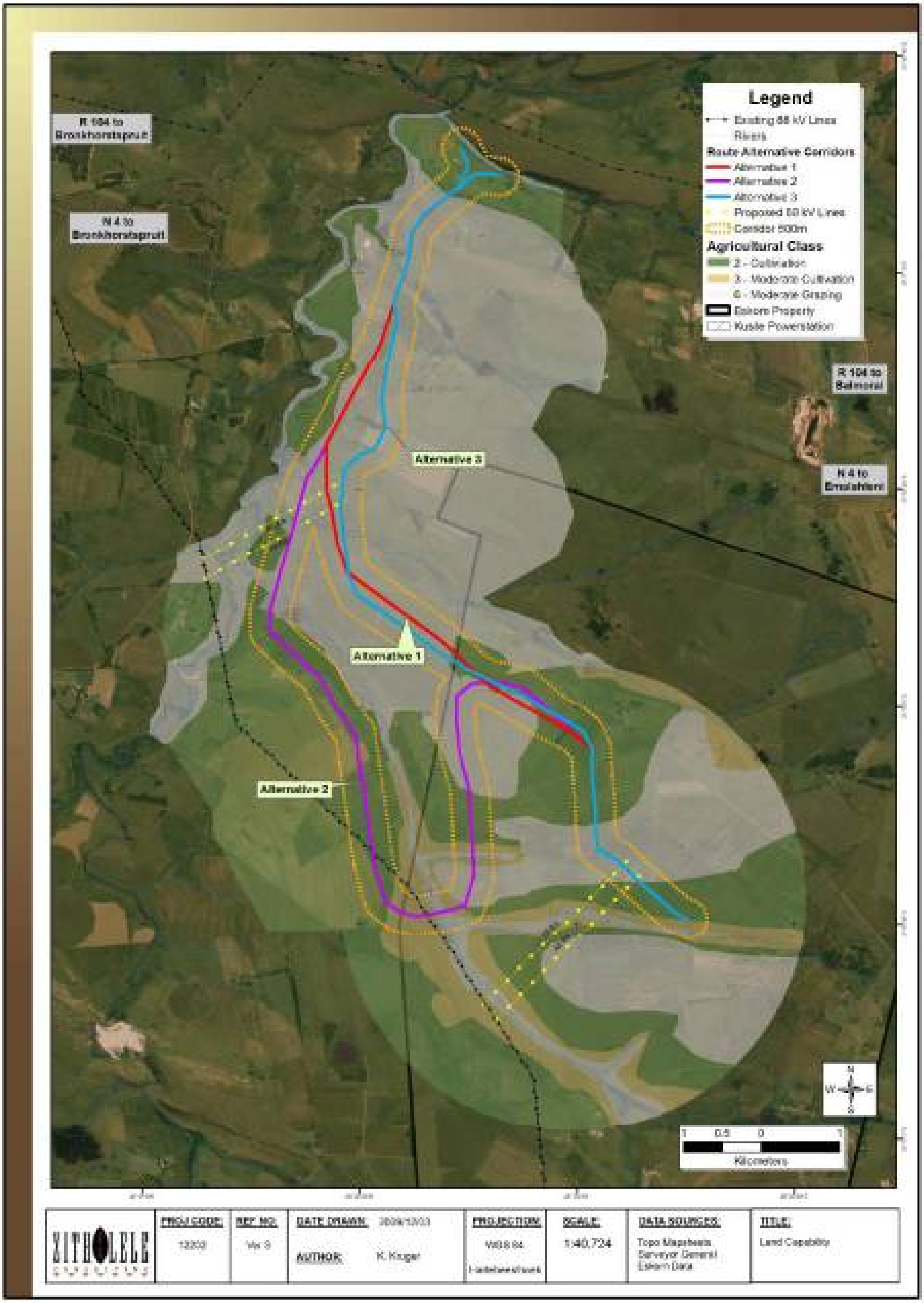


FIGURE 6-19: AGRICULTURAL POTENTIAL MAP

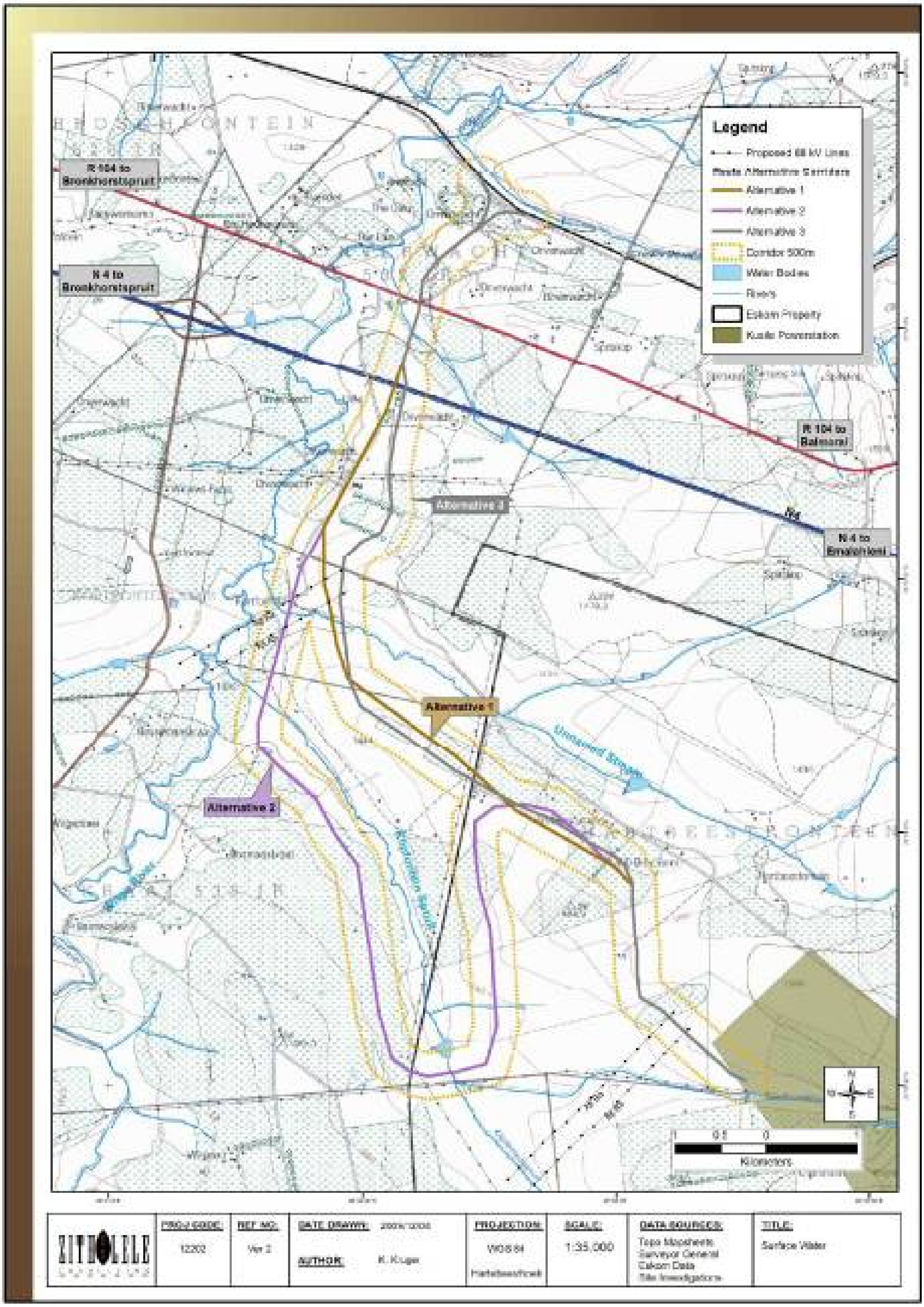


FIGURE 6-20: SURFACE WATER AND DRAINAGE FEATURES

FIGURE 6-21: DAMS AND WETLANDS WITHIN THE STREAMS ON SITE (KLIPFONTEINSPRUIT).

From Figure 6-20 above, it is clear that all the alternatives cross a stream or river at some point. Table 6-5 below provides an indication of the number of river crossings per alternative. From the table it is evident that Alternatives 1 and 3 have the least crossings (2 each), while Alternatives 2 has 5 crossings.

TABLE 6-5: NUMBER OF STREAM CROSSINGS PER ALTERNATIVE

Alternative	Number of Stream Crossings
Alternative 1	2 x tributaries
Alternative 2	3 x tributaries and the Klipfonteinspruit twice (5 crossings)
Alternative 3	2 x tributaries

6.1.9 Wetland Delineation

Data Collection and Methodology

The riparian zone and wetlands were delineated according to the Department of Water Affairs (DWA, previously known as the Department of Water Affairs and Forestry -DWAF) guideline, 2003: A practical guideline procedure for the identification and delineation of wetlands and riparian zones. According to the DWA guidelines *a wetland* is defined by the National Water Act as:

"land which is transitional between terrestrial and aquatic systems where the water table is usually at or near surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."

In addition the guidelines indicate that wetlands must have one or more of the following attributes:

- Wetland (hydromorphic) soils that display characteristics resulting from prolonged saturation;
- The presence, at least occasionally, of water loving plants (hydrophytes); and
- A high water table that results in saturation at or near surface, leading to anaerobic conditions developing in the top 50 centimetres of the soil.

Site Description

During the site investigation the following indicators of potential wetlands were identified:

- Terrain unit indicator;
- Soil form indicator;
- Soil wetness indicator; and
- Vegetation indicator.

Riparian Areas

According to the DWA guidelines *a riparian area* is defined by the National Water Act as:

"Riparian habitat includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas"

As per the DWA guidelines the difference between a wetland and a riparian area is:

"Many riparian areas display wetland indicators and should be classified as wetlands. However, other riparian areas are not saturated long enough or often enough to develop wetland characteristics, but also perform a number of important functions, which need to be safeguarded… Riparian areas commonly reflect the high-energy conditions associated with the water flowing in a water channel, whereas wetlands display more diffuse flow and are lower energy environments."

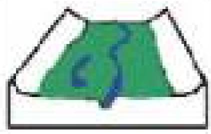
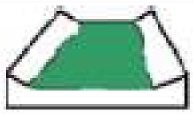
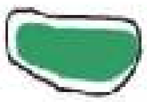
Delineation

The site was investigated for the occurrence / presence of wetlands and riparian areas, using the methodology described in more detail in the wetland delineation study provided in Appendix L. According to this methodology there are wetlands present on site. It should however be noted that several of the so-called wetlands could also be classified as riparian zones as they follow the drainage path of the non-perennial streams on site. Wetlands perform critical ecosystem functions and also provide habitat for sensitive species. It is suggested that a 50m buffer be placed from the edge of the temporary zone in order to sufficiently protect the wetlands and riparian zones. Figure 6-22 below illustrates the various wetland zones as well as the buffer placed along the edge of the temporary zone.

Classification of Wetlands

The classification of the wetlands in the study area into different wetland types was based on the WET-EcoServices technique (Kotze *et al*, 2007). The WET-EcoServices technique identifies seven main types of wetland based on hydro-geomorphic characteristics (Table 6-6).

TABLE 6-6: WETLAND TYPES BASED ON HYDRO-GEOMORPHIC CHARACTERISTICS (KOTZE *ET AL*, 2007).

Hydrogeomorphic types		Description	Source of water maintaining the wetland[1]	
			Surface	Sub-surface
Floodplain		Valley bottom areas with a well defined stream channel, gently sloped and characterized by floodplain features such as oxbow depressions and natural levees and the alluvial (by water) transport and deposition of sediment, usually leading to a net accumulation of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.	***	*
Valley bottom with a channel		Valley bottom areas with a well defined stream channel but lacking characteristic floodplain features. May be gently sloped and characterized by the net accumulation of alluvial deposits or may have steeper slopes and be characterized by the net loss of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.	***	*/ ***
Valley bottom without a channel		Valley bottom areas with no clearly defined stream channel, usually gently sloped and characterized by alluvial sediment deposition, generally leading to a net accumulation of sediment. Water inputs mainly from channel entering the wetland and also from adjacent slopes.	***	*/ ***
Hillslope seepage linked to a stream channel		Slopes on hillsides, which are characterized by the colluvial (transported by gravity) movement of materials. Water inputs are mainly from sub-surface flow and outflow is usually via a well defined stream channel connecting the area directly to a stream channel.	*	***
Isolated Hillslope seepage		Slopes on hillsides, which are characterized by the colluvial (transported by gravity) movement of materials. Water inputs mainly from sub-surface flow and outflow either very limited or through diffuse sub-surface and/or surface flow but with no direct surface water connection to a stream channel.	*	***
Depression (includes Pans)		A basin shaped area with a closed elevation contour that allows for the accumulation of surface water (i.e. it is inward draining). It may also receive sub-surface water. An outlet is usually absent, and therefore this type is usually isolated from the stream channel network.	*/ ***	*/ ***

[1] Precipitation is an important water source and evapotranspiration an important output in all of the above settings

Water source: * Contribution usually small

*** Contribution usually large — Wetland

*/ *** Contribution may be small or important depending on the local circumstances

*/ *** Contribution may be small or important depending on the local circumstances.

Using the methodology above the following wetland types were identified on site as shown below in Figure 6-22:

- VB Valley Bottom;
- VBC Valley Bottom with a channel;
- HS Hillslope Seepage Wetland; and
- HSW Hillslope Seepage linked to stream.

Wetland Integrity

The Present Ecological Status (PES) Method (DWA 2005) was used to establish the integrity of the wetlands in the study area and was based on the modified Habitat Integrity approach developed by Kleynhans (1996, 1999 In DWA 2005). The delineated wetland units were used as the basis to divide the wetlands into different segments to increase the resolution of the integrity assessment.

Ecosystem Services Supplied by Wetlands

The assessment of the ecosystem services supplied by the identified wetlands was conducted according to the guidelines as described by Kotze *et* al (2009). A Level 2 assessment was undertaken which examines and rates the following services:

- Flood attenuation;
- Stream flow regulation;
- Sediment trapping;
- Phosphate trapping;
- Nitrate removal;
- Toxicant removal;
- Erosion control;
- Carbon storage;
- Maintenance of biodiversity;
- Water supply for human use;
- Natural resources;
- Cultivated foods;
- Cultural significance;
- Tourism and recreation; and
- Education and research.

The characteristics were scored according to the following general levels of services provided:

TABLE 6-7: LEVEL OF SERVICE RATINGS.

Score	Services Rating
0	Low
1	Moderately Low
2	Intermediate
3	Moderately High
4	High

The different wetland units were used as the basis for the level 2 assessment. The assessment was further focussed on those wetland units within the segments of likely impact associated with the different proposed site layouts. The relative importance of the different units, in relation to one another and between the three alternative railway alignments, were then evaluated by summing the number of services regarded as high (scoring levels higher than intermediate). The wetland units with the highest number of important functions were then delineated to facilitate decision making as shown in Figure 6-23. This map indicates that only one area can be deemed pristine with a high integrity rating. This area is only crossed by Alternative 2.

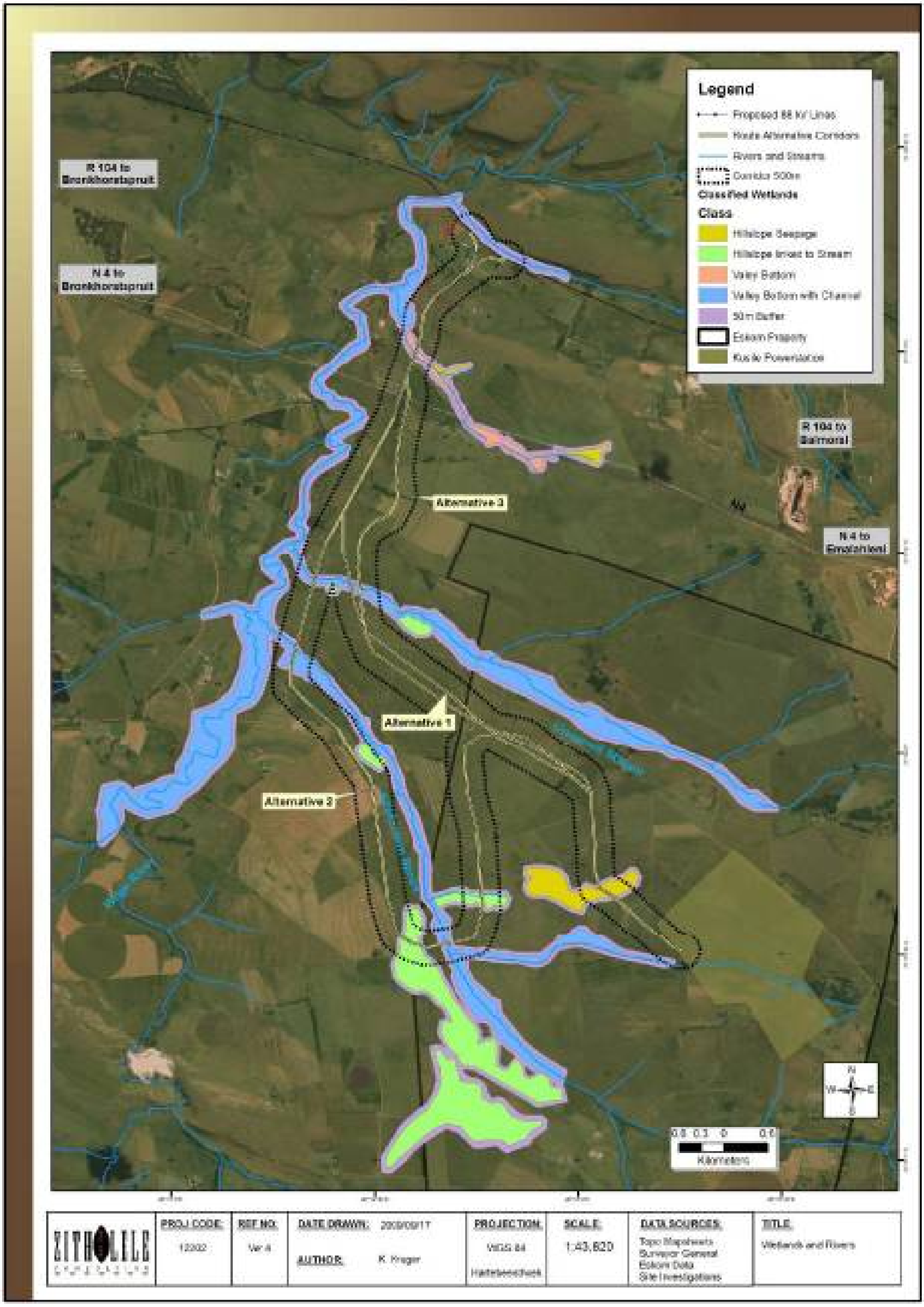


FIGURE 6-22: WETLANDS DELINEATED AND CLASSIFIED.

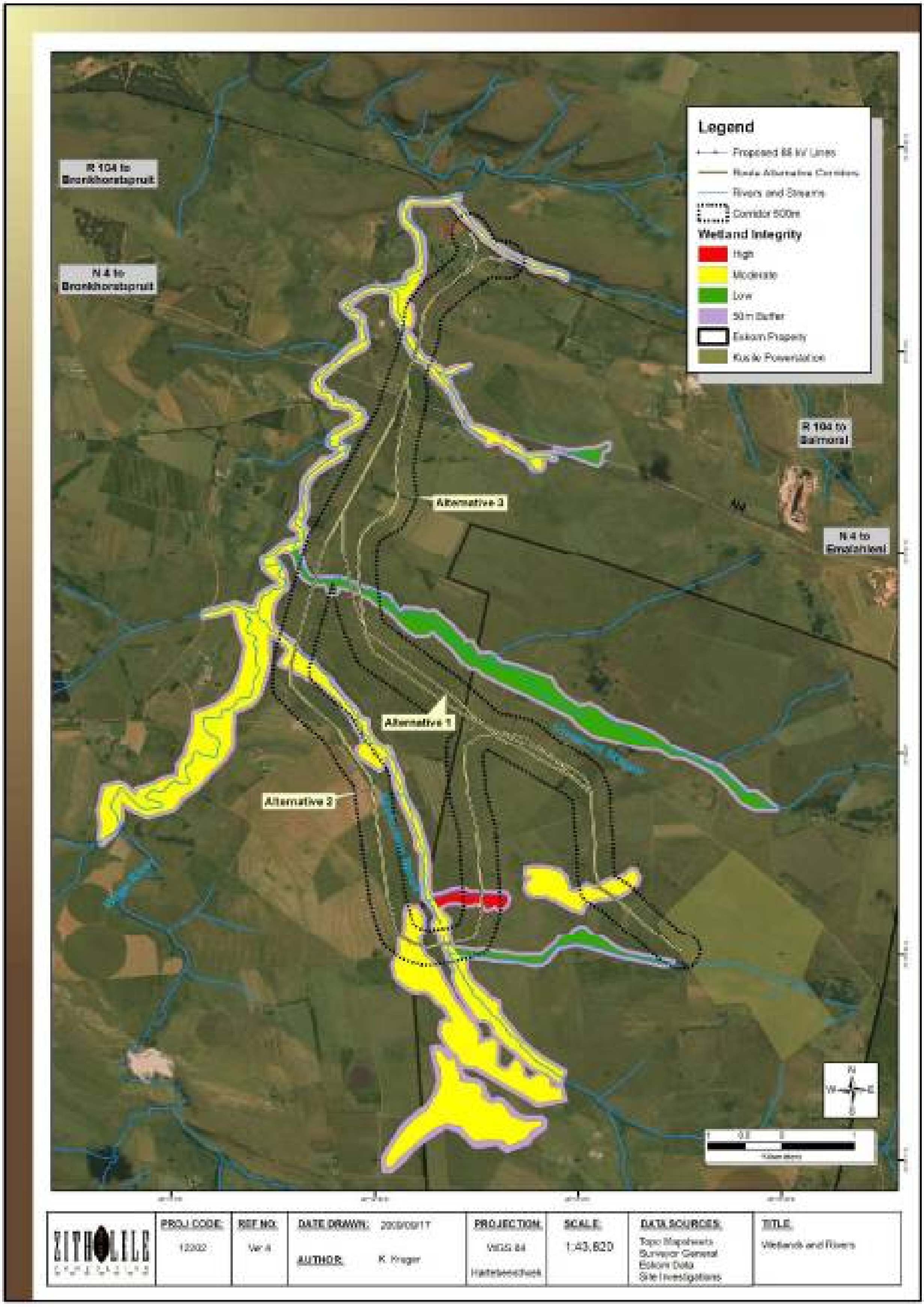


FIGURE 6-23: WETLAND INTEGRITY.

6.1.10 Terrestrial Ecology - Flora

Data Collection and Methodology

A literature review of the floral species that could occur in the area was conducted. C-Plan data provided from the Mpumalanga provincial department was used to conduct a desktop study of the area. This data consists of flora components; ratings provide an indication as to the importance of the area with respect to biodiversity.

The floral study involved extensive fieldwork, a literature review and a desktop study utilizing GIS. The site was investigated during two one week site visits, conducted from the 10^{th}-14^{th} March and from the 17^{th}-20^{th} of November 2008, in late summer and early spring respectively. The area within the servitude was sampled using transects placed at 300 m intervals. At random points along the transect an area of 20 m x 20 m was surveyed. All species within the 20 m x 20 m quadrant were identified, photographed and their occurrence noted. Sensitive features such as ridges or wetlands were sampled by walking randomly through the area concerned and identifying all species within the area.

The floral data below is taken from The Vegetation of South Africa, Lesotho and Swaziland (Mucina and Rutherford 2006). Also, while on site, the following field guides were used:

- Guide to Grasses of Southern Africa (Frits van Oudtshoorn, 1999);
- Field Guide to Trees of Southern Africa (Braam van Wyk and Piet van Wyk, 1997);
- Field Guide to the Wild Flowers of the Highveld (Braam van Wyk and Sasa Malan, 1998);
- Problem Plants of South Africa (Clive Bromilow, 2001); and
- Medicinal Plants of South Africa (Ben-Erik van Wyk, Bosch van Oudtshoorn and Nigel Gericke, 2002)

Regional Description

The biodiversity rating for the bulk of the site (Figure 6-24) is rated as least concern and no natural habitat remaining. The initial stages of Alternatives 1 – 3 are on areas rated as important. It should be noted that the area at the end of the corridors is currently the construction site for the Kusile Power Station and therefore sensitivities in this area can be ignored.

The area under investigation straddles two Biomes, namely the Savanna and the Grassland Biomes. Each biome comprises several bioregions which in turn has various vegetation types within the bioregion. The Grassland Biome is represented by Mesic Highveld Grassland bioregion. Vegetation descriptions in this section of the report are adapted from Mucina and Rutherford, 2006.

Mesic Highveld Grassland

Mesic Highveld Grassland is found mainly in the eastern, high rainfall regions of the Highveld, extending all the way to the northern escarpment. These are considered to be "sour" grasslands and are dominated by primarily andropogonoid grasses. The different grassland types are distinguished on the basis of geology, elevation, topography and rainfall. Shrublands are found on outcrops of rock within the bioregion, where the surface topography creates habitat in which woody vegetation is favoured above grasses.

As mentioned above the railway line corridors were visited for a lengthy period of time and the following vegetation types were identified along the corridor:

- Rand Highveld Grassland
- Eastern Highveld Grassland; and
- Eastern Temperate Freshwater Wetlands

The vegetation types identified on site are indicated in Figure 6-24 below and described in detail below.

Site Description

At the time of the site visit it was found that a large section of the site is already being developed as part of the Kusile Power Station construction phase. In addition large sections of the site have been burned and the vegetation in these areas could not be identified. Information was supplemented with the specialist ecological report[7] undertaken for the Kusile Power Station EIA.

Three main vegetation types were identified, namely rocky grassland (45% of Rand Highveld Grassland), moist grassland (21% of Rand Highveld Grassland; 69% of Eastern Highveld Grassland) and grazed/cultivated fields. Each of these vegetation types are described in more detail below and illustrated in Figure 6-24. The species list for the site is attached in as appendix to the Terrestrial Ecology Specialist Report which is provided as Appendix L. The species that could occur in the quarter degree grid was obtained from the Plants of Southern Africa (POSA) online database upheld by the South African National Botanical Institute (SANBI) and supplemented with field notes. The list provides species names, common names, as well as notes on which species were observed on site. In total 136 species could occur in the area with 43 confirmed species.

[7] Proposed Coal-Fired Power Station Near Kendal, Witbank Area Ecological Report, Dr. P.J. Du Preez, 2006.

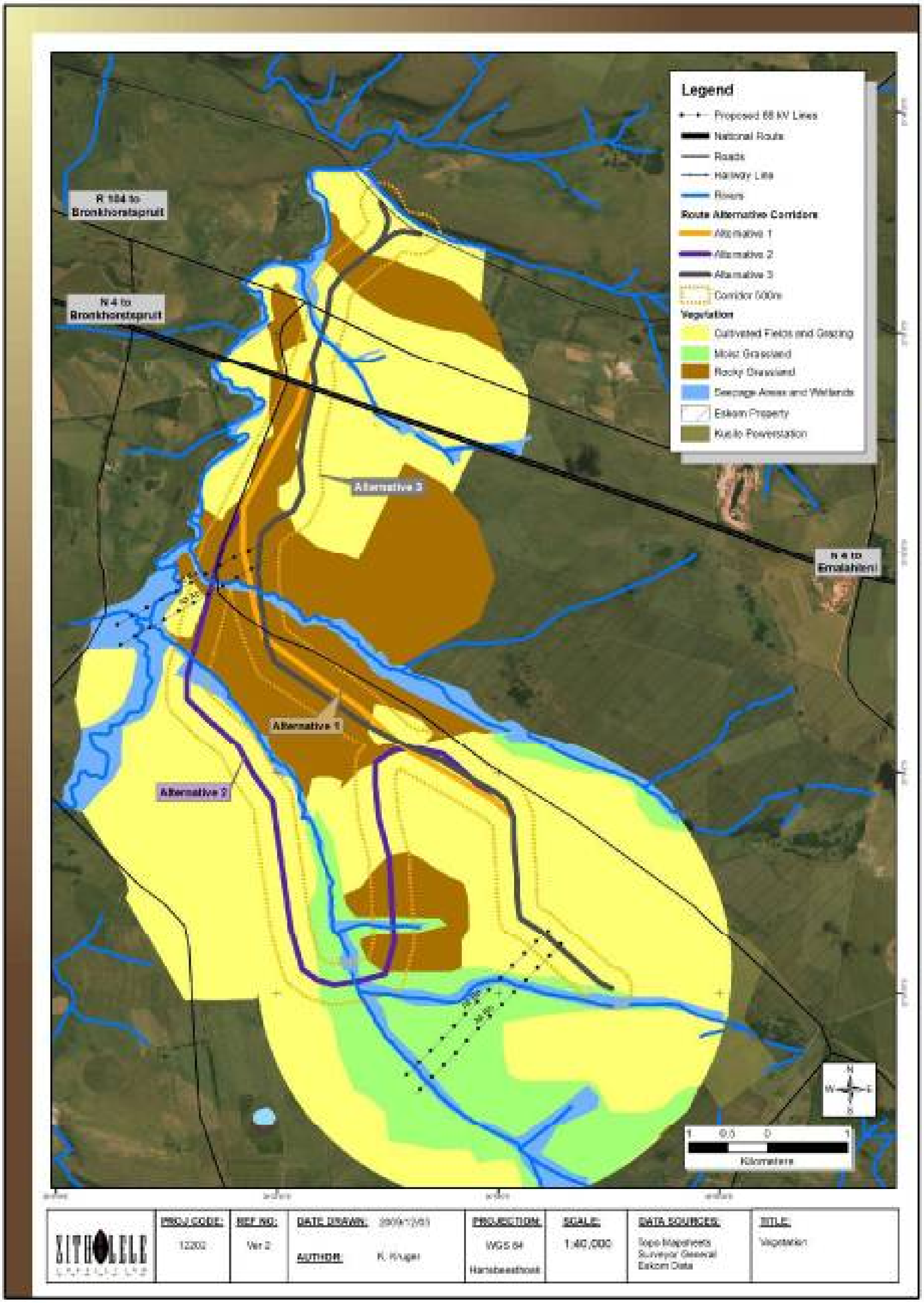


FIGURE 6-24: VEGETATION TYPES IN THE STUDY AREA.

i. *Hyparrhenia hirta* Anthropogenic Grassland (Grazed and Cultivated Fields)

This tall grassland occurs over vast areas, usually on shallow, leached soils on the Johannesburg granite dome, and on undulating north-facing warm andesitic lava slopes of the Suikerbosrand, Witwatersrand and Klipriviersberg areas. Disturbed grassland or other disturbed areas such as road reserves or fallow fields, not cultivated for some years, are also usually *Hyparrhenia* dominated (Coetzee et al. 1995; Bredenkamp & Brown 2003).

This *Hyparrhenia* – dominated grassland may appear to be quite natural, but they are mostly associated with an anthropogenic influence from recent or even iron-age times. This grassland is characterised by the tall growing dominant Thatch grass (*Hyparrhenia hirta*), and Bankrupt Bush (*Stoebe vulgaris*), an invader dwarf shrub which usually indicates grassland's degraded condition (Bredenkamp & Brown 2003).

This grassland mostly has low species richness, with only a few other species able to establish or survive in the shade of the dense sward of tall grass. Most of these species are relict pioneers or early seral species. The most prominent species include the grasses *Cynodon dactylon, Eragrostis plana, E. racemosa, E. curvula* and *Aristida congesta*. Forbs are rarely encountered, though a few individuals of species such as *Anthospermum rigidum, Conyza podocephala, Crabbea angustifolia* and *Helichrysum rugulosum* are often present (Bredenkamp & Brown 2003).

Figure 6-25 below provides an illustration of the *Hypparrhenia* grassland unit with the current Kusile Power Station construction works underway in the background.

FIGURE 6-25: HYPARRHENIA GRASSLAND.

ii. *Schizachyrium sanguineum* -Loudetia simplex Grassland (Rocky Grassland)

This high altitude grassland is found throughout the study area on rocky midslopes of ridges and hills. The soils are often shallow with high rock cover (up to 60% in some cases). This vegetation is found mostly on cooler aspects, but also occur on the warmer north-facing aspects where scattered individuals of dwarf shrubs are present. In some degraded areas *Aristida junciformis, A. congesta* and *Cynodon dactylon* are more prominent (Coetzee et al. 1995; Bredenkamp & Brown 2003).

This grassland is dominated by the *grasses Digitaria monodactyla, Loudetia simplex, Trachypogon spicatus, Eragrostis racemosa, Andropogon shirensis, Schizachyrium sanguineum, Brachiaria serrata* and *Themeda triandra (*Figure 6-26*).*

The woody layer consists mainly of a few scattered individuals of the dwarf shrubs *Protea welwitschii, Lopholaenia coriifolia,* and the *geoxylophyte Parinari capensis*, that are locally prominent. The grasses *Alloteropsis semialata, Panicum natalense, Urelytrum agropyroides, Tristachya leucothrix, Monocymbium ceresiiforme, Digitaria monodactyla, Sporobolus pectinatus, Alloteropsis semialata, Bewsia biflora* and *Elionurus muticus* are also abundant together with the forbs *Cyanotis speciosa, Bulbostylis burchellii, Senecio venosus, Sphenostylus angustifolia* and *Pentanissia angustifolia* (Coetzee et al. 1995; Bredenkamp & Brown 2003).

FIGURE 6-26: ROCKY GRASSLAND.

iii. *Eragrostis plana* - Moist Grassland (Moist Grassland)

The *Eragrostis plana* Grassland is well represented occurring mainly in high rainfall parts. This grassland type is a moist grassland, usually restricted to flat plains or bottomlands, mostly on moist, deep, clayey and poorly drained, seasonally wet soils, adjacent to wetlands , seasonal as well as perennial rivers. These habitats are often fairly unstable due to seasonal flooding and drying, which, together with frequent overgrazing, cause degradation of the vegetation (Bezuidenhout & Bredenkamp 1990).

Eragrostis plana is conspicuous, often dominant member of this grassland type (Figure 6-27). *Paspalum dilatatum,* and the rhizomatous *Cynodon dactylon*, often presents in degraded sites, are also diagnostic, as well as the forbs *Crabbea acaulis, Berkheya radula, B. pinnatifida* and *Trifolium africanum.* Grass species such as *Eragrostis curvula, Themeda triandra, Setaria sphacelata* and *Digitaria eriantha* are often abundantly present, and may be locally dominant, while forbs are generally quite rare (Coetzee et al. 1995; Bredenkamp & Brown 2003).

FIGURE 6-27: ERAGROSTIS PLANA MOIST GRASSLAND.

iv. Seepage areas and wetland communities

Seepage areas are seasonally wet areas that occur in sandy areas where water seeps into lowlying drainage lines after rains. These areas are usually covered by hygrophytes such as sedges and reeds. The dominant sedge in the study area is *Juncus rigidus*. Sometimes bulrush (*Typha capensis*) and reeds (*Phragmites australis*) also occurs.

Wetlands are of a more permanent nature and occur in low-lying areas such as tributaries of streams and rivers. Here hydrophytes can be found. Typical plants are the Orange River Lily (*Crinum bulbispermum*), bulrush (*Typha capensis*) and reeds (*Phragmites australis*), sedges of the *Cyperus, Fuirena* and *Scirpus* genera also occur (Figure 6-28).

FIGURE 6-28: SEEPAGE AREA.

v. Red data Flora Species

The findings of the ecological assessment undertaken for the Kusile Power Station identified *Cyrtanthus breviflorus* within the non-perennial drainage line running just south of the current Kusile Power Station site. None of the proposed railway line alternatives are in close proximity to this area. Table 6-8 below illustrates the potential red data species that could occur in the area.

TABLE 6-8: POSSIBLE RED DATA PLANT SPECIES OCCURRING IN THE STUDY AREA.

Biological Name
Delosperma gautengense
Delosperma macellum
Encephalartos brevifoliolatus
Encephalartos middelburgensis
Eulophia coddii
Frithia pulchra
Habenaria mossii
Khadia beswickii
Melolobium subspicatum

6.1.11 Terrestrial Ecology - Fauna

Data Collection and Methodology

This section was adapted from the Golder Associates Africa Report "*Ecological Follow-up Surveys for the Proposed Eskom Bravo (Kusile) Power Station near Kendal, Mpumalanga*, 2008". In order to enable a characterization of the environment, as well as floral and faunal species that may be impacted by the proposed Kusile railway line, faunal and floral groups were investigated. The groups of species investigated were:

- Vegetation;
- Arthropoda;
- Mammals;
- Herpetofauna (Reptiles); and
- Amphibia.

Avifauna is excluded from this section as it is discussed in Section 7.1.12 below separately. Methods implemented during this investigation are based on accepted scientific investigative techniques and principles and were performed to acceptable standards and norms, taking the limitations of this investigation into consideration. The Precautionary Principle was applied throughout the assessments. For further information please refer to the Terrestrial Ecology Specialist Study Report provided in Appendix L.

Site Description

The following sections outline the findings from the site investigations. Additionally the following were identified by a stakeholder in the study area: kolgans, swartsterretjie, lepelaar, wilde makou, reier, kiewiet, slanghalsvoël, witborsduiker, gewone duiker, bleshoender, dobbertjie, eende (Mr. P. Meulenbeld).

Arthropoda

A total of 67 arthropods were recorded during the site investigation and are given in Table 6-9. All of the species recorded during the survey were common grassland species and are not restricted in terms of habitat or distribution. It is likely that more species may occur in the area. However it is unlikely that Red Data arthropod species, such as *Aloeides dentatis* or *Aloeides merces*, occur on this site as the host plants for these species are not present.

TABLE 6-9: ARTHROPODA RECORDED ON SITE.

Family	Genus	Species
Gomphidae	*Ictinogomphus*	*ferox*
Aeshnidae	*Aeshna*	*miniscula*
	Anax	*imperator*
Libellulidae	*Nothiothemis*	*jonesi*
	Trithemis	*stictica*
Blattidae	*Deropeltis*	*erythrocephala*
	Periplenata	*americana*
Blatellidae	*Blatella*	*germanica*
Blaberidae	*Derocalymma*	
Pseudophyllodromiidae	*Supella*	*dimidiata*
Termitidae	*Macrotermes*	*natalensis*
Hymenopodidae	*Harpagomantis*	*tricolor*
Mantidae	*Sphodromantis*	*gastrica*
	Miomantis	
Empusidae	*Empusa*	*guttula*
Libiduridae	*Euborellia*	*annuplipes*
Anostostomatidae	*Onosandrus*	
Bradyporidae	*Hetrodes*	*pupus*
Tettigonidae	*Phaneroptera*	
	Eurycorypha	*sp.*
	Phaneroptera	*sp.*
Gryllidae	*Gryllus*	*bimaculatus*
	Gryllotalpidae	*sp.*
Pamphagidae	*Hoplolopha*	
Pyrgomorphidae	*Zonocerus*	*elegans*
Lentulidae	*Lentula*	
Acrididae	*Acrida*	*acuminata*
	Truxaloides	
	Cyrtacnthacris	*aeruginosa*
Phasmatidae	*Palophus*	*reyi*
Miridae	*Deraeocoris*	
Reduviidae	*Etrichodia*	*crux*
	Glymmatophora	
	Lopodytes	*grassator*
Plataspidae	*Solenostethium*	*lilligerum*
Alydidae	*Mirperus*	*faculus*
Pentatomidae	*Nezara*	*viridula*
Scarabidae	*Gymnopleurus*	*humanus*
	Anachalcos	*convexus*
	Copris	*mesacanthus*
Cerambycidae	*Prosopocera*	*lactator*
Carabidae	*Passalidius*	*fortipes*

Family	Genus	Species
	Acanthoscelis	*ruficornis*
Melirydae	*Melyris*	
Tennebrionidae	*Psammodes*	*striatus*
	Stenocara	*dentata*
	Dichtha	*incantatoris*
Meloidae	*Actenoidia*	*curtula*
Curculionidae	*Prionorhinus*	*canus*
Myrmeleontidae	*Centroclisi*	*sp.*
	Hagenomyia	*tristis*
Tabanidae	*Philoliche*	*rostrata*
Culicidae	*Aedes*	
	Culex	
Bombyliidae	*Exoprosopa*	
Calliphoridae	*Chrysomya*	*chloropyga*
Saturniidae	*Bunaea*	*alcinoe*
Pieridae	*Eurema*	*brigitta*
Nymphalidae	*Hamanumida*	*daedalus*
	Danaus	*chrysippus*
Vespidae	*Ropalidia*	
	Belonogaster	*dubia*
Apidae	*Apis*	*mellifera*
Formicidae	*Camponotus*	*sp.*
Arachnidae		
Araneidae	*Argiope*	*australis*
	Gasteracanthus	*sanguinolenta*

Reptilia

Nine reptilian species were recorded during the site survey (Table 6-10). None of the recorded species are restricted in terms of habitat and distribution, or classified as Red Data Species. It is likely that more species may occur in the area but unlikely that any of the species occurring on this site are classified as Red Data species.

TABLE 6-10: REPTILIA RECORDED AT SITE RAILWAY 04.

Scientific Name	Common Name
Chammaesaura aenea	Transvaal Grass Lizard
Lamprophis fuliginosus	Brown House Snake
Mabuya striata punctatissima	Striped Skink
Psammophylax rhombeatus	Rhombic Skaapsteker
Mabuya striata punctatissima	Striped Skink
Mabuya varia	Variable Skink
Pelomedusa subrufa	Marsh Terrapin
Philothamnus hoplogaster	Green Water Snake
Varanus niloticus	Water monitor

Amphibia

Seven species of amphibians were recorded as occurring within the study area and are given in Table 6-11. These species are not restricted in terms of habitat or distribution and none of the species recorded are classified as Red Data species. It is possible that more species may occur in the area but, due to the fact that no Red Data amphibian species are known to occur in this vegetation type, it is unlikely that any Red Data amphibian species occur at this site.

TABLE 6-11: AMPHIBIA RECORDED ON SITE.

Species	Revised Status
Bufo gutturalis	Not Listed
Schismaderma carens	Not Listed
Tomopterna cryptotis	Not Listed
Kassina senegalensis	Not Listed
Xenopus laevis	Not Listed
Cacosternum boettgeri	Not Listed
Afrana angolensis	Not Listed

Mammalia

Mammal species diversity was very low at this site, with only 17 species being recorded (Table 6-12). Although no individuals of these species were found during this survey, *Mystromys albicaudatus,* White-tailed mouse, are Red Data species that may utilize this habitat type.

TABLE 6-12: MAMMALIA RECORDED AT SITE RAILWAY 04.

Biological Name	Common Name
Elephantulus myurus	Rock elephant shrew
Lepus saxatilis	Scrub hare
Hystrix africaeaustralis	Porcupine
Rhabdomys pumilio	Striped mouse
Mastomys natalensis	Natal multimammate mouse
Dendromus melanotis	Grey climbing mouse
Dendromus mystacalis	Chestnut climbing mouse
Ictonyx striatus	Striped polecat
Cynictis penicillata	Yellow mongoose
Raphicerus campestris	Steenbok
Crocidura cyanea	Reddish grey musk shrew
Otomys angoniensis	Angoni vlei rat
Otomys irroratus	Vlei rat
Dendromus mystacalis	Chestnut climbing mouse
Aonyx capensis	Cape clawless otter
Lutra maculicollis	Spotted-necked otter
Atilax paludinosus	Water mongoose

Red Data Faunal Species

Red Data faunal species that may occur in the area are listed in Table 6-13. A total of 11 Red Data faunal species may occur in the area.

TABLE 6-13: RED DATA FAUNAL SPECIES THAT MAY OCCUR IN THE STUDY AREA.

Biological Name	Common Name
Aloeides dentatis	-
Aloeides merces	-
Amblysomus septentrionalis	Highveld golden mole (eng)
Chrysospalax villosus	Rough-haired golden mole
Circus maurus	Black harrier
Coracias garrulus	European roller
Crex crex	Corncrake
Falco naumanni	Lesser kestrel
Grus carunculatus	Wattled crane
Grus paradisea	Blue crane
Mystromys albicaudatus	White-tailed mouse

The Red Data species that may occur in the study area consist of 2 arthropod species, 1 reptilian species, 0 amphibian species, 6 avian species and 3 mammal species. The habitat suitability for Red Data species ranges from low to medium with a 16 species for which the habitat suitability can be classified as high. Although no individuals of these species were found during this survey, *Grus paradisea,* Blue Crane, *Grus carunculatus,* Wattled Crane, *Tyto capensis,* Grass owl and *Mystromys albicaudatus,* White-tailed mouse are Red Data species that may utilize this habitat type.

6.1.12 Avi-fauna

Data Collection and Methodology

A ornithology specialist, *Mr Chris van Rooyen,* was appointed by Zitholele Consulting to undertake a avi-fauna specialist study. The avi-fauna data was obtained from various published literature sources and a site visit was undertaken in September 2009 to groundtruth the findings.

Regional Description

It is widely accepted that vegetation structure, rather than the actual plant species, influences bird species' distribution and abundance. Therefore, the vegetation description used in the Harrison *et al* (1997) in the Atlas of Southern African Birds (the Bird Atlas) does not focus on lists of plant species, but rather on factors which are relevant to bird distribution. It is important to note that no new boundaries were created and use was made only of previously published data.

As mentioned in Section 7.1.10 the study area is dominated by the grassland biome. Many grassland bird species show a preference for sour grassland over sweet or mixed grasslands. The grassland biome is very important from a Red Data perspective, as it is the preferred habitat of several grassland "specialists" birds. The region has been transformed to a large degree by intensive cultivation, which has placed it (and the species dependant on it) under severe pressure.

The Woodland (or savanna biome) also occurs in the study area (marginally due to extensive clearing of woodland for agriculture) and it is defined as having a grassy under-storey and a distinct woody upper-storey of trees and tall shrubs (Harrison *et al.* 1997). Savanna is relatively well conserved compared to grassland and contains a large variety of bird species (it is the most species-rich community in Southern Africa) although very few bird species are restricted to this biome. The biome is particularly rich in large raptors, and forms the stronghold of Red Data species such as White-backed Vulture *Gyps africanus*, Martial Eagle *Polemaetus bellicosus*, Tawny Eagle *Aquila rapax*, and Lappet-faced Vulture *Torgos tracheliotis*. Apart from Red Data species, it also serves as the stronghold of several non-Red Data raptor species, such as the Brown Snake-Eagle *Circaetus cinereus*, Black-chested Snake-Eagle *Circaetus pectoralis*, and a multitude of medium-sized raptors for example the migratory Steppe Buzzard *Buteo vulpinus*, African Harrier- Hawk (Gymnogene) *Polyboroides typus*, Wahlberg's Eagle *Aquila wahlbergi* and African Hawk-Eagle *Aquila spilogaster*. Apart from raptors, woodland in its undisturbed state is suitable for a wide range of other power line sensitive birds, including the Kori Bustard *Ardeotis kori*.

<u>Site Description</u>

In the study area natural woodland is virtually non-existent. The majority of the "woodland" in the area consists of invader species, particularly Eucalyptus and Australian *Acacia* species, of which substantial pockets are evident. Generally, the original woodland has been cleared to make way for agricultural activity and the absence of woodland in the study area is reflected in the bird species composition, with very few typical woodland species having been recorded in the study area during the Atlas period. Woodland species that may be attracted to the copses of alien trees in the study area are mainly raptors such as Black Sparrowhawk *Accipiter melanoleucus*, Ovambo Sparrowhawk *Accipiter ovampensis* and African Harrier-hawk *Polyboroides typus*.

Although much of the distribution and location of bird species within the study area can be explained by vegetation as discussed briefly above, it is necessary to look more closely at the smaller habitat niches available to birds, namely the microhabitats, in order to determine where the relevant species will most likely occur within the study area. These microhabitats do not always correspond to vegetation types and are determined by a combination of vegetation type, topography, land use, food sources and other factors. Additionally it was noted by a stakeholder that the African Spoonbill is a typical visitors in the area (Mr. P. Meulenbeld).

The following distinct bird microhabitats were identified in the study area during the field visit in September 2009. Please refer to the Avi-fauna Specialist Study Report in Appendix L for detailed information.

Wetlands and dams

This habitat is represented in the study area by several man-made impoundments (dams), three of which occur in the immediate study area, as well as a few watercourses (as discussed in Section 7.1.9). Amongst large terrestrial birds it is especially the three cranes species that depend on shallow, vegetated wetlands that are unpolluted and not excessively disturbed by live-stock and fire.

The data from the Co-ordinated Road Count project (CAR) of the Avian Demography Unit shows that the wetlands in the Mpumalanga highveld are extensively used by Spurwing Goose *Plectropterus gambensis*, Black-headed Heron A*rdea melanocephala* and Grey Crowned Crane *Balearica regulorum*. Grey Crowned Cranes do not occur in the area anymore (Harrison *et.al.* 1997), not only because of habitat modification, but also because of disturbance and the proliferation of power lines which no doubt have taken their toll on birds over the years. However, the dams, wetlands and associated floodplains in the study area are still suitable for other Red Data species such as African Marsh-harriers *Circus ranivorus* and African Grass-owl *Tyto capensis*.

Non-threatened species that may from time to time occur on the wetlands, especially in quiet secluded areas of the dams in the study area, include Little Bittern *Ixobrychus minutus*, White-backed Duck *Thalassornis leuconotus*, African Rail *Rallus caerulescens*, Red-chested Flufftail *Sarothrura rufa*, Black Crake *Amaurornis flavirostris*, Common Moorhen *Gallinula chloropus*, African Purple Swamphen *Porphyrio madagascariensis*, Green-backed Heron *Butorides striata*, and various kingfishers (Marais & Peacock 2008). Open water may attract grebes, cormorants, darters and various species of ducks, as well as Red-knobbed Coot *Fulica cristata*. Areas with reeds, sedges or grassy tangles are suitable for Orange-breasted Waxbill *Amandava subflava* and Common Waxbills *Estrilda astrild* and various warblers (Marais & Peacock 2008).

Agriculture

Parts of the study area have been extensively transformed through dryland cultivation. The farm land in the study area is used for a variety of mixed farming practices. Grazing is developed in parallel with crop farming.

Data from the CAR project indicates that agricultural land is used to a limited extent by large terrestrial birds in the Mpumalanga highveld (and presumably also in the similar eastern Gauteng highveld), as they prefer natural grassland. Fallow fields are used to a limited extent by Blue Cranes in summer, and pastures are used by Southern Bald Ibis *Geronticus calvus* (**not recorded in the study area**). Blue Cranes also use recently ploughed fields in winter

(Young *et.al.* 2003). Indications are that Blue Korhaan *Eupodotis caerulescens* may also utilise agricultural fields to a limited extent (Young *et.al* 2003). A Red Data species that could also occur in this habitat from time to time is the Black-winged Partincole *Glareola nordmanni*. Overall though, agricultural lands are not as important for birds in the study area as natural grassland.

Grassland

Large areas of untransformed natural grassland have remained in the study area, as well as abandoned lands that have reverted back to grassland.

The CAR data indicate that natural grassland remains the preferred habitat of large terrestrial birds in the Mpumalanga highveld (Young *et.al.* 2003), and one can safely assume the same for similar habitat in Gauteng. Generally reporting rates for large terrestrial grassland species such as Blue Crane are low, which could be the result of the extensive fragmentation of natural grassland by agriculture, opencast mining and associated infrastructure, particularly power lines and roads. On the other hand, several typical grassland species were recorded in 2528DD by the Atlas Project, including White-bellied Korhaan *Eupodotis senegalensis*, Blue Korhaan *Eupodotis caerulescens,* Secretarybird *Sagittarius serpentarius* and Lesser Kestrel *Falco naumanni*.

It is important to note that while no records of African Grass-owl *Tyto capensis* were made by the Atlas project, the habitat at the site is very suitable for this species (as well as the non-threatened Marsh Owl *Asio capensis*) and it almost definitely occurs in tall grassland patches on the fringes of wetlands and in shorter grass (40-50cm) in association with dried sedges (*Cyperus* sp.) which forms an impenetrable thicket which provide enough substrate for the African Grass-owls' characteristic "tunnels". Another Red Data species that could conceivably occur in the study area in the wetland habitat along the Wilge River is the African Marsh-harrier *Circus ranivorus*. Non-threatened species that may from time to time frequent the grassland habitat in the study area are Swainson's Spurfowl *Pternistis swainsonii*, African Pipit *Anthus cinnamomeus*, Cape Longclaw *Macronyx capensis*, Yellow-crowned Bishop *Euplectes afer*, several cisticola species, Rufous-naped Lark *Mirafra africana,* Spike-heeled Lark *Chersomanes albofasciata,* Long-tailed Widowbird *Euplectes progne* and Black-shouldered Kite *Elanus caeruleus* (Marais & Peacock 2008).

6.1.13 Aquatic Ecology

<u>Data Collection and Methodology</u>

The aquatic ecology specialist study was undertaken by *Mr Warren Aken* of *Golder Associates Africa*. In order to enable adequate description of the aquatic environment it was recommended that at least two, or preferably three, indicators be selected to represent each of the stressor, habitat and response components involved in the aquatic environment. The broad methodologies utilised to characterise these components are described below. These methodologies are generally applied and accepted (DWA and USEPA) and are as follows:

- Stressor Indicators: *In situ* water parameters;
- Habitat Indicators: General habitat assessment; and Invertebrate Habitat Assessment System (IHAS, v*ersion 2*);
- Response Indicators: Aquatic macroinvertebrates (SASS, *version 5*); and Ichthyofauna (FAII).

For the detailed methodology followed by the specialist please refer to the Aquatic Ecology specialist study appended as **Appendix L.**

Regional Description

Please refer to Section 7.1.8 and 7.1.9 for the surface water and wetland regional environment descriptions respectively.

Site Description

Five sites were selected in accordance with the three proposed rail alternatives (See Figure 6-29 below). Sites were selected at points where the proposed routes crossed drainage lines. Following is a brief description to those sites:

- **RKUS1:** This is located in the Klipfontein where Rail Alternative 2 crosses above a small dam. It is located below the overhead power line servitude.
- **RKUS2:** This site is located in an unnamed tributary of the Klipfonteinspruit just below the dam which is situated below site RKUS1. Rail alternative 2 passes through on its way to site RKUS1.
- **RKUS3:** This site is located in the Klipfonteinspruit just before the confluence with the Wilge River. It is situated downstream of reminisce of an old dam wall. This is the last site, before rail alternative 2 joins the other two alternative routes.
- **RKUS4:** This site is located north of the Klipfonteinspruit in an unnamed tributary, situated before the confluence with the Wilge River. This is a broad site as all three rail alternatives pass through this area.
- **RKUS5:** This site is located in an unnamed tributary just north of the N4 highway. All three rail alternatives pass through this section.

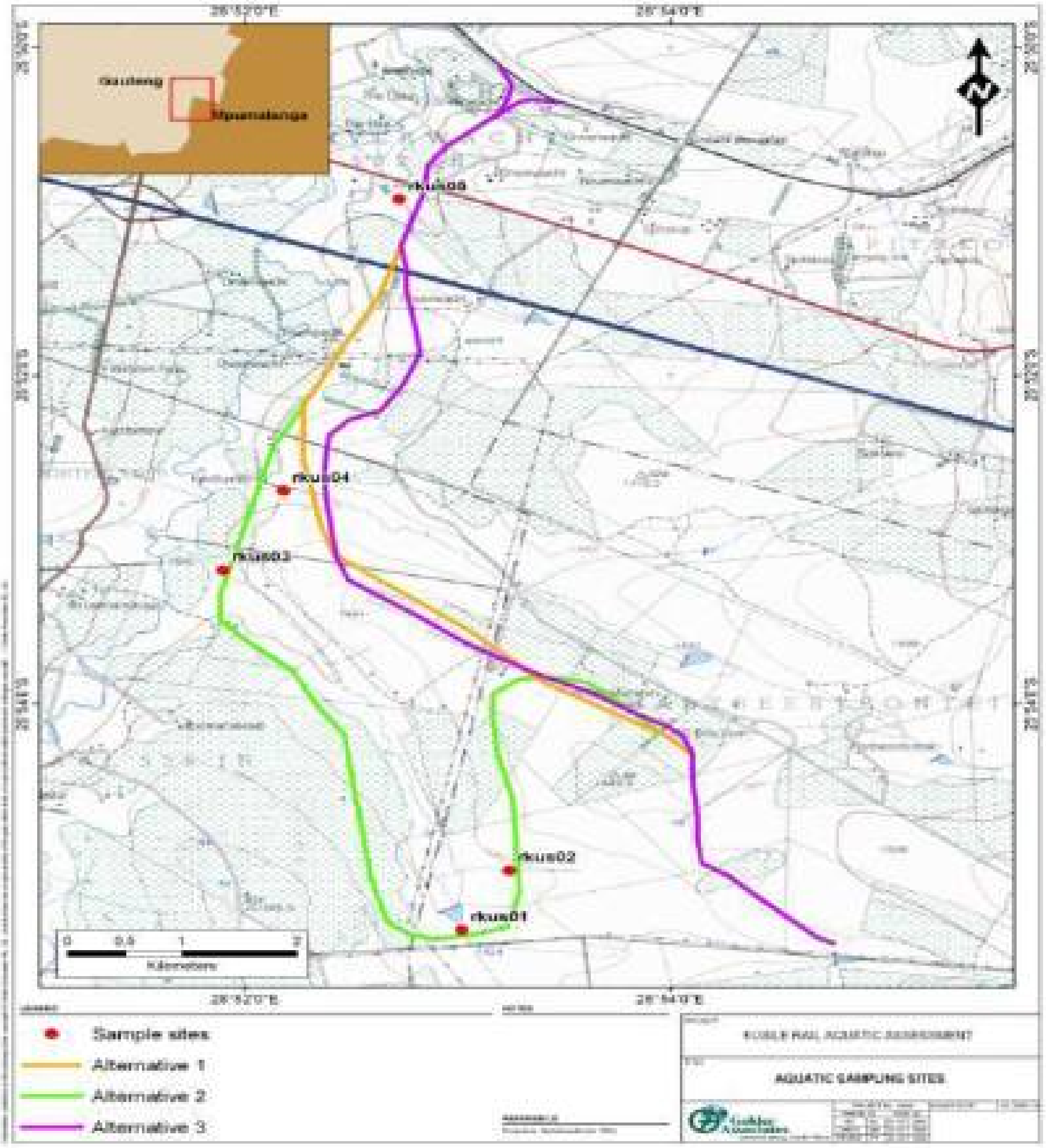


FIGURE 6-29: LOCATION OF AQUATIC BIO-MONITORING SITES.

6.2 Socio-Economic Environment

6.2.1 Infrastructure

Methodology and Data Sources

Infrastructure was identified using the 1:50 000 topocadastral maps of the area, and information provided by Eskom regarding existing services. A site visit to the area was undertaken to verify this information.

Regional Description

Access to the proposed project area is via the N4 national road. The study area is traversed to the west by the Bossemanskraal road. The primary infrastructure within the study area is:

- The N4 national road between Bronkhorstspruit (towards Pretoria) and Emalahleni (Witbank);
- The R 104 road between Bronkhorstspruit and Balmoral;
- The R545 between Kendal and Balmoral;
- The new Eskom road (currently under construction) between the N12 and the R545 (running along the western boundary of the Kusile Power Station);
- The existing railway line between Bronkhorstspruit (towards Pretoria) and Emalahleni (Witbank);
- Numerous 400 kV power lines traversing the area;
- Existing 88kv power line from Groopan Substation to Witbank
- Several dirt farm roads; and
- The current Kusile Power Station construction site.

Sensitivities

Due to the rural nature of the area, very few roads are available to travellers and residents. If any of these roads becomes non-accessible or are damaged as a result of project activities, access in the area would be limited. The same case is applicable for the existing railway line. Furthermore the power lines on site form part of the national power grid. Therefore all access corridors, railway lines and power lines are regarded as sensitive features.

6.2.2 Social Setting

Data Collection and Methodology

A Social Impact Assessment was undertaken by *Nthalepa Management*. This included the collection of primary data as well as a review of data and information from other sources to gather secondary data (e.g. census 2001, eMalahleni Local Municipality Integrated Development Plan (IDP) and those generated through the public participation process). The methodology was based on quantitative and qualitative techniques, to capture the perceptions, preferences and concerns of the various landowners, other stakeholder groups, as well as to collect data about the current socio-economic profile in the areas surrounding the proposed railway line. Data was collected by means of observations during site visits, interviews with key stakeholders, focus group meetings and a perception assessment survey of a sample of affected landowners.

Regional Description

This section focuses on the socio-demographic characteristics of Ward 32 of the Emalahleni Local Municipality - the ward within which the proposed Eskom railway line will be located (the northern most portion of the study area falls within the Kungwini). This analysis is based on information sourced from 2001 survey and may have change considerably.

Population grouped, household gender and size

The table below represents the total population grouped in ward 32. Black African represents approximately 88% of the entire population grouped in the ward. Table 6-15 illustrates the male female ratio in the ward. In terms of the 2001 survey, men constitute 83% of the household gender in the ward. This can be attributed to the migrant labour patterns in South Africa.

TABLE 6-14: POPULATION GROUPED IN THE WARD.

Description	2001
Black African	9585
Coloured	87
Indian or Asian	56
White	1189

TABLE 6-15: HOUSEHOLD GENDER IN THE WARD.

Description	2001
Male	3127
Female	622

Work status

From the 2001 survey, approximately 45% of household sizes in the ward have at least one member. This means 45% of the households in the ward may be able to better provide for their households due to the manageable number of household members. This also constitutes the biggest percentage in terms of household size in the ward.

TABLE 6-16: NUMBER OF MEMBERS PER HOUSEHOLD IN THE WARD.

Description	2001
One	1677
Two	629
Three	381
Four	334
Five	244
Six	167
Seven	99
Eight	91
Nine	46
Ten and over	84

Employment status

Approximately 73% of the economically active people are employed and 22% are not employed. This is however, not reflective of the Province in general which accounts to over 34% of economically active persons being employed.

TABLE 6-17: EMPLOYMENT STATUS IN THE WARD

Description	2001
Employed	3863
Unemployed	1442
Not economically Active	2596

TABLE 6-18: WORK STATUS IN THE WARD

Description	2001

Paid employee	3717
Paid family worker	25
Self-employed	99
Employer	13
Unpaid worker	11
Not applicable	4038

Occupation

From the 2001 survey, just over 22% are engaged as plant operators. Approximately 30% of the employed do other work that is not listed. This represents the biggest percentage of those with occupation in the ward.

TABLE 6-19: OCCUPATION IN THE WARD

Description	2001
Senior Officials	76
Professionals	128
Tech/Assoc Prof	143
Clerks	189
Service workers	226
Skilled agric work	150
Other	1124
Elementary occup	831
Occupations NEC	148
Plant Operators	850

Educational Institutions

From the 2001 survey, schools represent 66% of educational institutions in the ward and those could signal high levels of education in the ward, provided that those in schools are able to complete their schooling and do not drop-out.

TABLE 6-20: EDUCATIONAL INSTITUTIONS IN THE WARD

Description	2001
None	1371
Pre - school	105
School	2123
College	72
Technikon	16
University	5
Adult education	4

Other	6

Education ungrouped

From the education ungrouped analysis undertaken, about 46% has acquired Grade 12 / Std 10 and / or NTC 3. This attests to the availability of schools in the ward and the enthusiasm of students / apprentices to complete their high school education.

TABLE 6-21: EDUCATION UNGROUPED IN THE WARD

Description	2001
No schooling	1848
Grade 1/Sub A	380
Grade 2/Sub B	308
Grade 3/Std 1	405
Grade 4/Std 2	489
Grade 5/Std 3	500
Grade 6/Std 4	598
Grade 7/Std 5	821
Grade 8/Std 6	718
Grade 9/Std 7	591
Grade10/Std 8/NTCI	858
Grade11/Std9/NTCII	579
Grade12/St10/NTC3	1310
Cert.noGrade12	27
Dip.noGrade12	8
Cert.withGrade12	138
Dip.with Grade12	140
Bachelor's degree	29
B Degree, dip	34
Honour's degree	4
Higher degree	4
Not applicable	1129

Site Description

Figure 6-30 below illustrates the portions on land that are directly affected by the proposed development. Table 6-22 below represents the directly affected landowners.

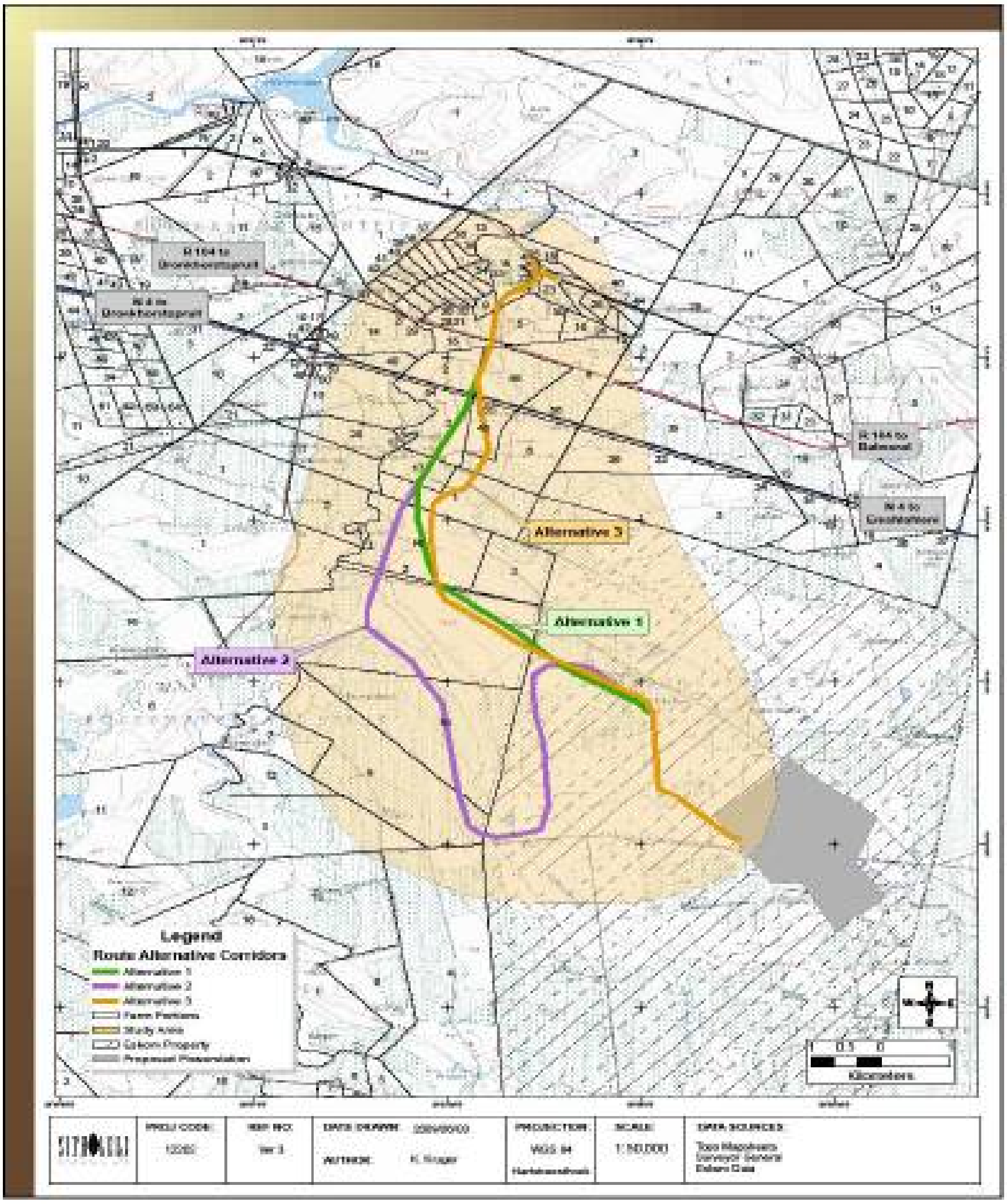


FIGURE 6-30: STUDY AREA INDICATING THE DIRECTLY AFFECTED LANDOWNERS.

TABLE 6-22: DIRECTLY AFFECTED LANDOWNERS

No	Farm Name	Portion No.	Owner	Municipality
1	JR 537	0	Eskom	Delmas Municipality
2	JR 537	1	Eskom	Delmas Municipality
3	JR 537	2	Eskom	Delmas Municipality
4	Bossemanskraal 538 JR	2	Mr Ernst Johann Kotze	Kungwini Local Municipality
5	Bossemanskraal 538 JR	8	Mr Buys Joerne	Kungwini Local Municipality
6	Bossemanskraal 538 JR	9	Topigs SA (Dr Danie Visser)	Kungwini Local Municipality
7	Bossemanskraal 538 JR	10	Topigs SA (Dr Danie Visser)	Kungwini Local Municipality
8	Kortfontein 530 JR	0	Mr Ernst Johann Kotze	Kungwini Local Municipality
9	Onverwacht 532 JR	1	R M Kgosana Family Trust (Mr Moses Kgosana)	Kungwini Local Municipality
10	Onverwacht 532 JR	2	Circle Way Trading 20 (Pty) Ltd |Mr Herman van Vuuren|	Kungwini Local Municipality
11	Onverwacht 532 JR	4	Mr Coertze Johannes Petrus Louis	Kungwini Local Municipality
12	Onverwacht 532 JR	5	Dr Paul Meulenbeld	Kungwini Local Municipality
13	Onverwacht 532 JR	6	R M Kgosana Family Trust (Mr Moses Kgosana)	Kungwini Local Municipality
14	Onverwacht 532 JR	9	Mr Hendrikus Gerardus Rutten	Kungwini Local Municipality
15	Onverwacht 532 JR	15	Mr Hermann Family Trust (Mr Buks Herman)	Kungwini Local Municipality
16	Onverwacht 532 JR	17	Mr Venter Hendrik Frederik Christoffel	Kungwini Local Municipality
17	Onverwacht 532 JR	18	Republic of South Africa	Kungwini Local Municipality
18	Onverwacht 532 JR	22	Republic of South Africa	Kungwini Local Municipality
19	Onverwacht 532 JR	25	Mr Coertze Johannes Petrus Louis	Kungwini Local Municipality
20	Onverwacht 532 JR	45	R M Kgosana Family Trust (Mr Moses Kgosana)	Kungwini Local Municipality
21	Onverwacht 532 JR	54	South African National Roads Agency Ltd	Kungwini Local Municipality
22	Onverwacht 532 JR	55	South African National Roads Agency Ltd	Kungwini Local Municipality

There are twenty two portions of land on different farms that are directly affected by various components of the alternatives of the proposed railway project. Some landowners own more than one portion and this brings to a total of thirteen directly affected landowners. The affected landowners were identified through site visits, WinDeed deeds search, satellite photographs, a list compiled through the public participation process and the map information from Chief Surveyor General. It should be noted that once the Environmental Impact Assessment process has been completed and alternatives assessed, with the best alternative identified, fewer landowners may be affected.

6.2.3 Noise

Data Collection and Methodology

A Noise Impact Assessment was undertaken by ***Mr John Hassall of JH Consulting.*** Confirmatory site measurements were carried out on Wednesday 2 and Sunday 6 September 2009.

The approach used in the noise assessment was to identify all the characteristic noise-generating operations and make predictions of each. This approach has the advantage that realistic noise values representing actual equipment maintenance condition and actual operating conditions and durations are used in the later predictions.

This section of the report outlines the ambient noise levels in the study area.

Site Description

The proposed siding is situated in a rural environment, with typically low levels of noise, dominated by the natural sounds of rustling vegetation, wildlife (primarily birdsong), and man-influenced sounds such as livestock, farming activities, domestic activity and very occasional road and air traffic. Therefore it is to be expected that the noise from the suggested operation could potentially have an impact on the surrounding area. In order to be able to assess both the quantitative and geographical extent of the potential impact, it is necessary to predict the noise levels generated by the operation of the siding and compare these with the zone noise level for the type of district backed up by confirmatory noise measurements on site. The extent of community response can then be assessed according to national and international standards which take into account sociological factors as well as the estimated change in noise climate. These impacts are discussed in detail in Appendix M and in Section 10.1.10.

6.2.4 Visual

Data Collection and Methodology

The methodology adopted for the visual assessment includes the following tasks:

- Examine the baseline information (contours, building dimensions, vegetation, inter alia);
- Determine the area from which the proposed railway may be visible (viewshed);
- Identify the locations from which views of the proposed railway may be visible (observation sites), which include buildings and roads;

- Analyse the observation sites to determine the potential level of visual impact that may result from the proposed railway; and
- Identify measures available to mitigate the potential impacts.

Each component of the assessment process is explained in detail in the Visual Impact Assessment (Appendix L).

Site Description

The site and surrounding area may be characterised as agricultural land utilised mainly for the grazing of cattle. The topography of the region and study site is gently undulating to moderately undulating landscape of the Highveld plateau.

The proposed railway lines are located in the area immediately west of the Kusile Power Station with the power station construction site and other infrastructures like existing power lines and roads featuring prominently in the landscape. Figure 6-31 to Figure 6-3 illustrate the visual senstitivity in the study area to the proposed infrastructure by highlighting the areas where the greatest visual impact will result.

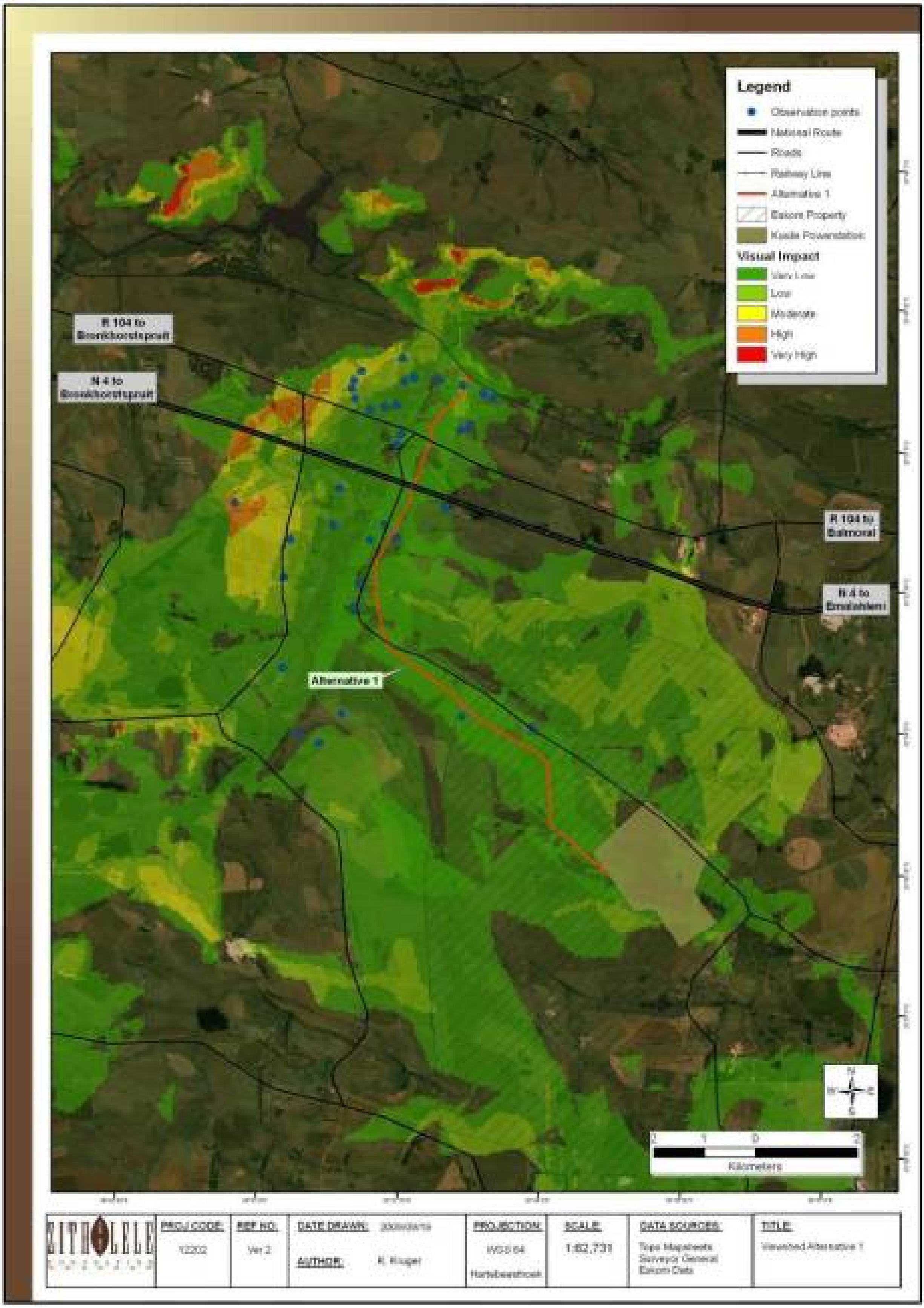


FIGURE 6-31: VISUAL IMPACT FROM THE RAIL ALTERNATIVE 1 ALIGNMENT.

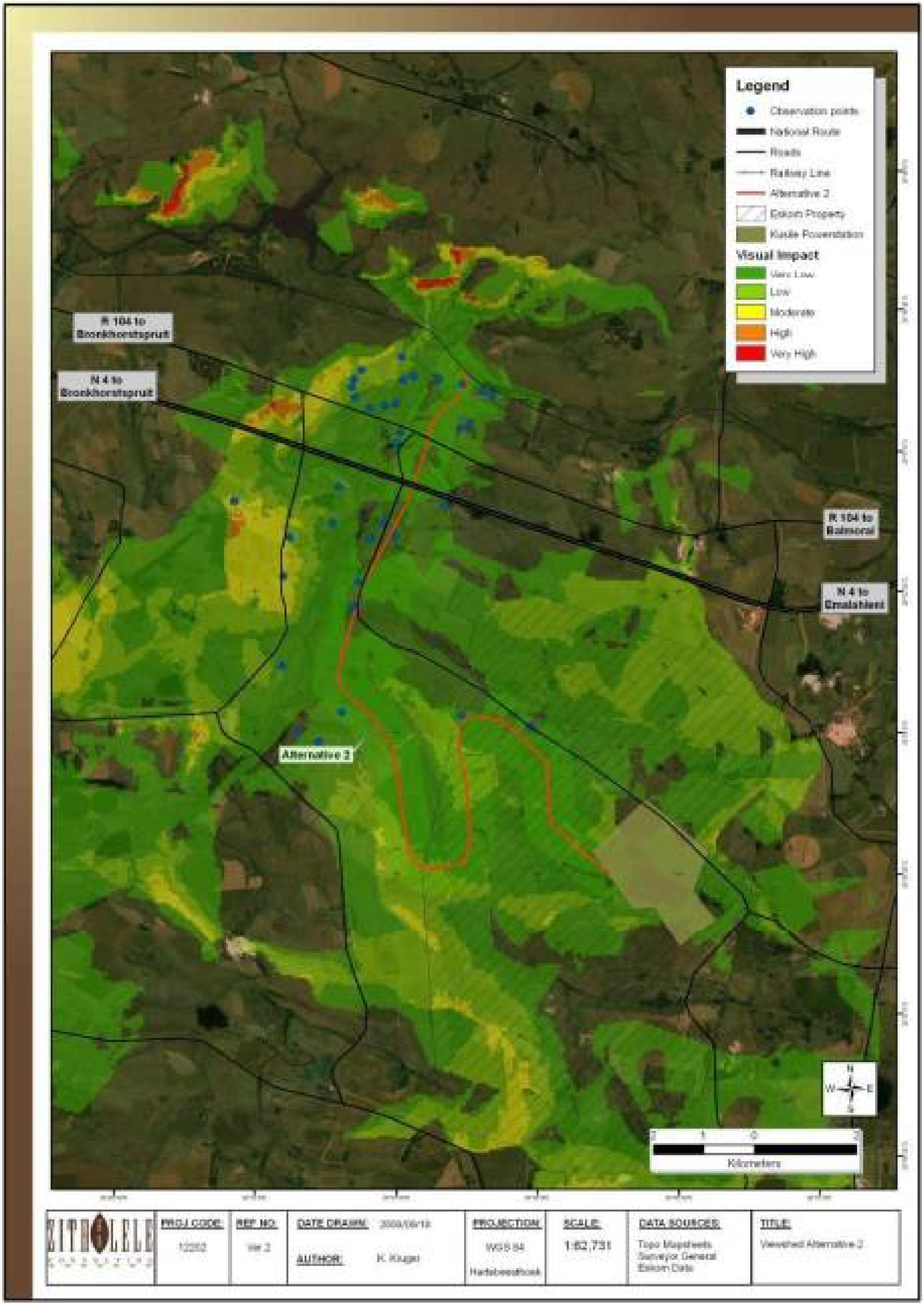


FIGURE 6-32: VISUAL IMPACT FROM THE RAIL ALTERNATIVE 2 ALIGNMENT

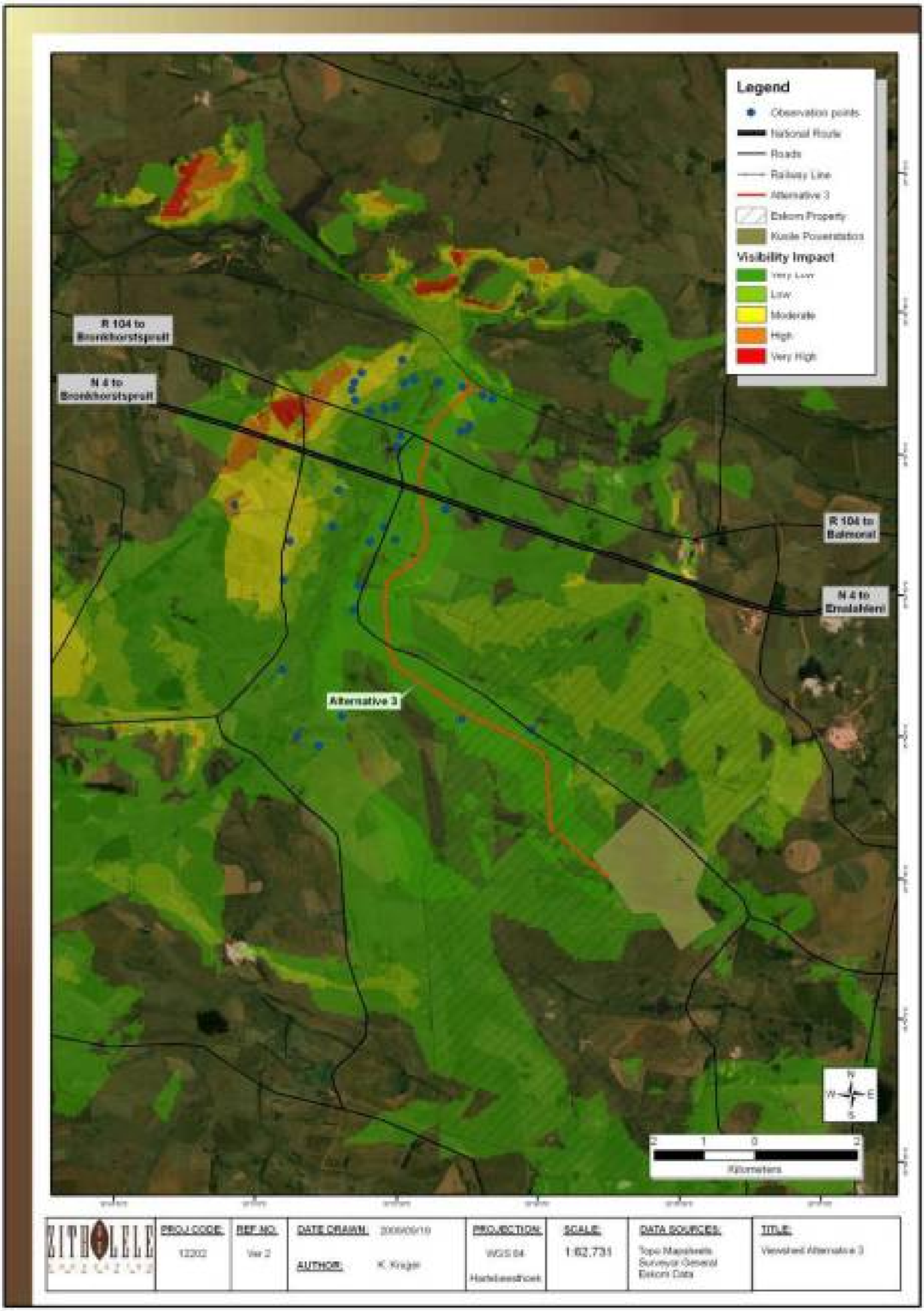


FIGURE 6-33: VISUAL IMPACT FROM THE RAIL ALTERNATIVE 3 ALIGNMENT.

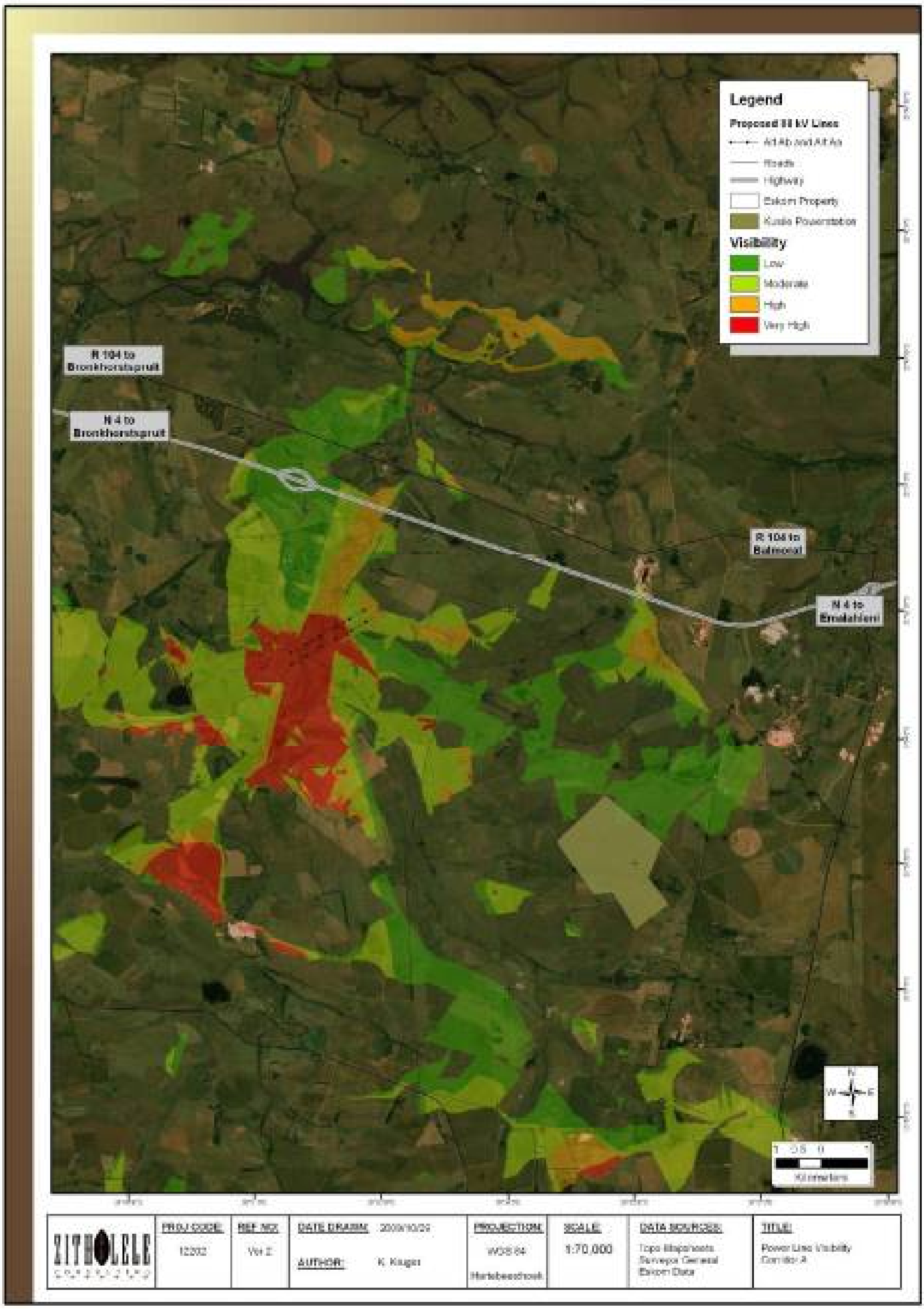


FIGURE 6-34: VISUAL IMPACT FROM THE POWER LINE ALTERNATIVE A ALIGNMENT.

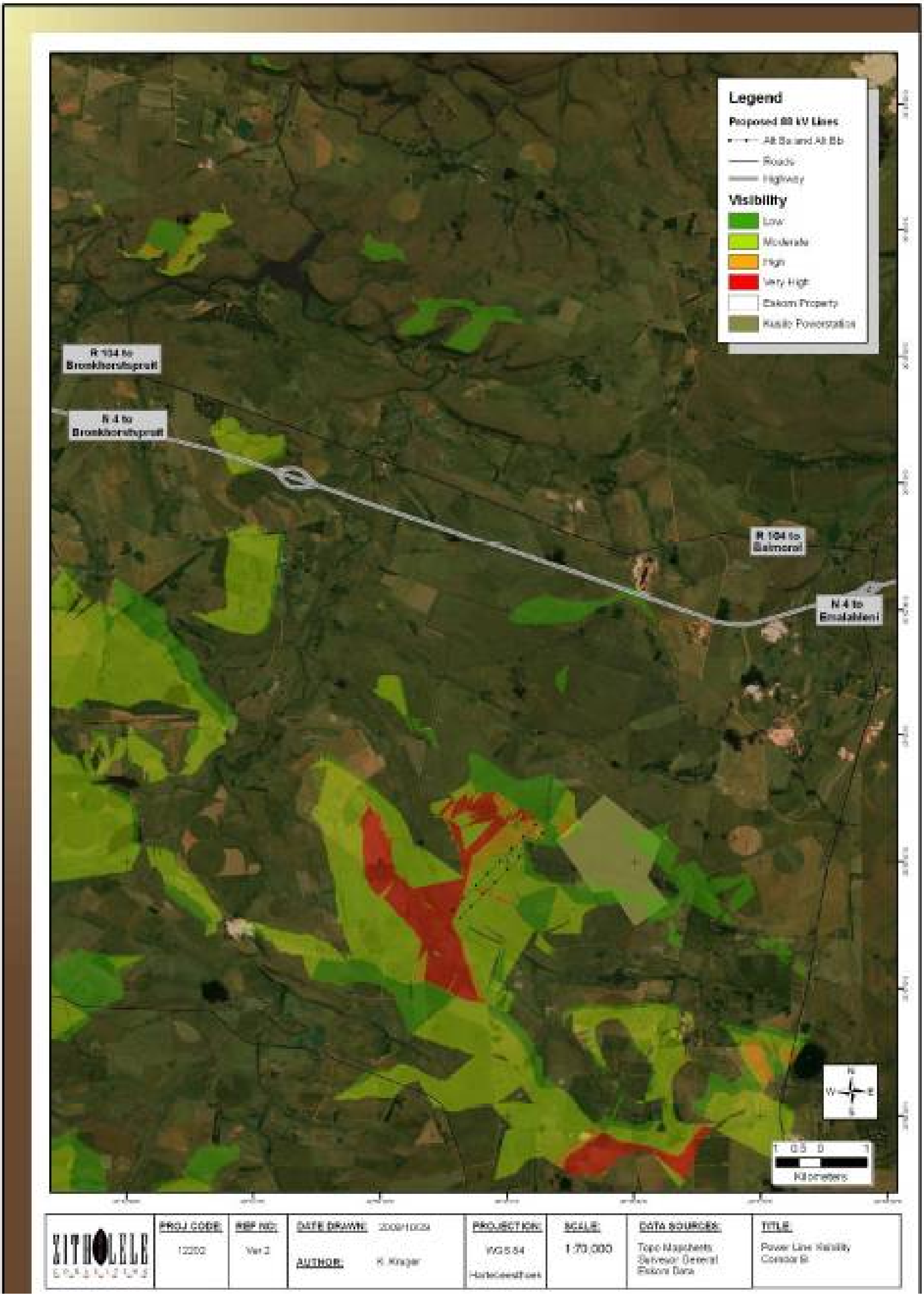


FIGURE 6-35: VISUAL IMPACT FROM THE POWER LINE ALTERNATIVE B ALIGNMENT.

6.3 Cultural Environment

6.3.1 Heritage Impact Assessment

Data Collection and Methodology

A Phase I Heritage Impact Assessment study was conducted by *Mr Julius Pistorius*, by means of the following:

- Surveying the proposed railway study area with a vehicle and selected spots on foot considering the size of the study area;
- Briefly surveying literature relating to the pre-historical and historical context of the proposed railway study area;
- Consulting maps of the proposed railway study area;
- Consulting archaeological (heritage) data bases;
- Consulting spokespersons regarding the possible presence of graves and graveyards in the study area; and
- Synthesising all information obtained from the data bases, fieldwork, maps and literature survey.

Regional Description

The following brief overview of pre-historical, historical, cultural and economic evidence will help to contextualise the proposed railway study area.

Stone Age sites

Stone Age sites are marked by stone artefacts that are found scattered on the surface of the earth or as parts of deposits in caves and rock shelters. The Stone Age is divided into the Early Stone Age (covers the period from 2.5 million years ago to 250 000 years ago), the Middle Stone Age (refers to the period from 250 000 years ago to 22 000 years ago) and the Late Stone Age (the period from 22 000 years ago to 200 years ago).

The Later Stone Age is also associated with rock paintings and engravings which were done by the San, Khoi Khoi and in more recent times by Iron Age farmers.

Heritage surveys up to now have recorded few Stone Age sites, rock paintings and engravings in the Eastern Highveld.

Iron Age remains

The Iron Age is associated with the first agro-pastoralists who lived in semi-permanent villages and who practised metal working during the last two millennia. The Iron Age is usually divided into the Early Iron Age (covers the 1st millennium AD) and the Later Iron Age (covers the first 880 years of the 2nd millennium AD).

The Eastern Highveld has not been occupied by Early Iron Age communities but was occupied by Late Iron Age communities such as the Sotho, Swazi and Ndebele who established settlement complexes that are associated with stone walls.

The historical period

Towns closest to the proposed railway study area include Bronkhorstspruit in the north-west, Ogies in the south-east and Witbank in the north-east. A brief historical background to each of these towns is provided below.

Bronkhorstspruit was laid out by Cornelius Erasmus on a part of his farm Hondsrivier in 1904. The town was named Erasmus for a number of years. From July 1935, the town's name, which is derived from a water-cress called 'bronkhors' by early settlers, was changed to Bronkhorstspruit.

Bronkhorstspruit is rich in heritage resources. The town and its outskirts were occupied from the earliest times by Stone Age peoples while Iron Age farmers, who preferred the rocky ridges and outcrops exposed in the rolling landscape, occupied the area from the 17^{th} century onwards. The first Colonists who moved north of the Vaal River during the second half of the 20^{th} century also established farm homesteads, outbuildings and infrastructure across the landscape. The first railroad line between Pretoria and Delagoa Bay passed through Donkerpoort, close to Eskom's study area. Important battles between the Boers and British forces were fought close to Bronkhorstspruit during the Anglo Boer Wars. Blockhouses and other military infrastructure therefore occur close to the study area.

Ogies serves as an important link in the running railway line running between Pretoria and Maputo which was built in 1896. It is also linked via Broodsnyersplaas, 35km south of Middelburg to join the railway line between Ermelo and Piet Retief to Richards Bay. This railway line carries some of the longest and heaviest trains in the world**.** The town of Ogies developed around the railway station which was built on the farm Ogiesfontein in 1928.

Witbank came into being as the railway line between Pretoria and Lourenzo Marques which was built in 1894 passed close to where Witbank is located today. The first Europeans who came to the area observed the abundance of coal, which is evident on the surface or in the beds of streams. A stage post for wagons close to a large outcrop of whitish stones (a 'white ridge') gave the town its name. Witbank was established in 1903 on a farm known as Swartbos which belonged to Jacob Taljaard.

A coal mining heritage

Coal mining on the Eastern Highveld is now older than one century and has become the most important coal mining region in South Africa**.** Whilst millions of tons of high-grade coal are annually exported overseas more than 80% of the country's electricity is generated on low-grade coal in Eskom's power stations on the Eastern Highveld.

The earliest use of coal (charcoal) in South Africa was during the Iron Age (300-1880 AD) when metal workers used charcoal, iron and copper ores and fluxes (quartzite stone and bone) to smelt iron and copper in clay furnaces.

Colonists are said to have discovered coal in the French Hoek Valley near Stellenbosch in the Cape Province in 1699. The first reported discovery of coal in the interior of South Africa was in the mid-1830 when coal was mined in Kwa-Zulu/Natal.

The first exploitation for coal was probably in Kwa-Zulu/Natal as documentary evidence refers to a wagon load of coal brought to Pietermaritzburg to be sold in 1842. In 1860 the coal trade started in Dundee when a certain Pieter Smith charged ten shillings for a load of coal dug by the buyer from a coal outcrop in a stream. In 1864 a coal mine was opened in Molteno. The explorer, Thomas Baines mentioned that farmers worked coal deposits in the neighbourhood of Bethal (Transvaal) in 1868. Until the discovery of diamonds in 1867 and gold on the Witwatersrand in 1886, coal mining only satisfied a very small domestic demand.

With the discovery of gold in the Southern Transvaal and the development of the gold mining industry around Johannesburg came the exploitation of the Boksburg-Spring coal fields, which is now largely worked out. By 1899, at least four colliers were operating in the Middelburg-Witbank district, also supplying the gold mining industry. At this time coal mining also started in Vereeniging. The Natal Collieries importance was boosted by the need to find an alternative for imported Welsh anthracite used by the Natal Government Railways.

By 1920 the output of all operating colliers in South Africa attained an annual figure of 9,5 million tonnes. Total in-situ reserves were estimated to be 23 billion tonnes in Witbank-Springs, Natal and Vereeniging. The total in-situ reserves today are calculated to be 121 billion tonnes. The largest consumers of coal are Sasol, Iscor and Eskom.

A vernacular stone architectural heritage

A unique stone architectural heritage was established in the Eastern Highveld from the second half of the 19th century well into the early 20th century. During this time period stone was used to build farmsteads and dwellings, both in urban and in rural areas. Although a contemporary stone architecture also existed in the Karoo and in the Eastern Free State Province of South Africa a wider variety of stone types were used in the Eastern Highveld. These included sandstone, ferricrete (‘ouklip’), dolerite (‘blouklip’), granite, shale and slate.

The origins of a vernacular stone architecture in the Eastern Highveld may be ascribed to various reasons of which the ecological characteristics of the region may be the most important. Whilst this region is generally devoid of any natural trees which could be used as timber in the construction of farmsteads, outbuildings, cattle enclosures and other structures, the scarcity of fire wood also prevented the manufacture of baked clay bricks. Consequently stone served as the most important building material in the Eastern Highveld.

Late Iron Age communities who contributed to the Eastern Highveld's stone walled architecture were the Sotho, Pedi, Ndebele and Swazi. The tradition set by these indigenous groups may have influenced the first settlers from Natal and the Cape Colony to utilize the same resources that their predecessors did. Many farmers from Scottish, Irish, Dutch, German and Scandinavian descend settled and farmed in the Eastern Highveld. These colonials brought the knowledge of stone masonry from Europe which compensated for the lack of fire wood necessary to manufacture baked clay bricks.

Site Description

The study area is located in the midst of a cultural landscape that is marked by heritage remains dating from the pre-historical into the historical (colonial) period. Stone Age sites, Iron Age sites and colonial remains occur in the Eastern Highveld.

The north of the study area is dotted with farmstead complexes which are usually associated with Blue Gum avenues or with smaller plantations of these trees. Some of these farmstead complexes incorporate historical houses with associated outbuildings as well as graveyards. An additional grave was identified by Mr. P. Meulenbeld next to the R104 on the property of Mr Buks Herman.

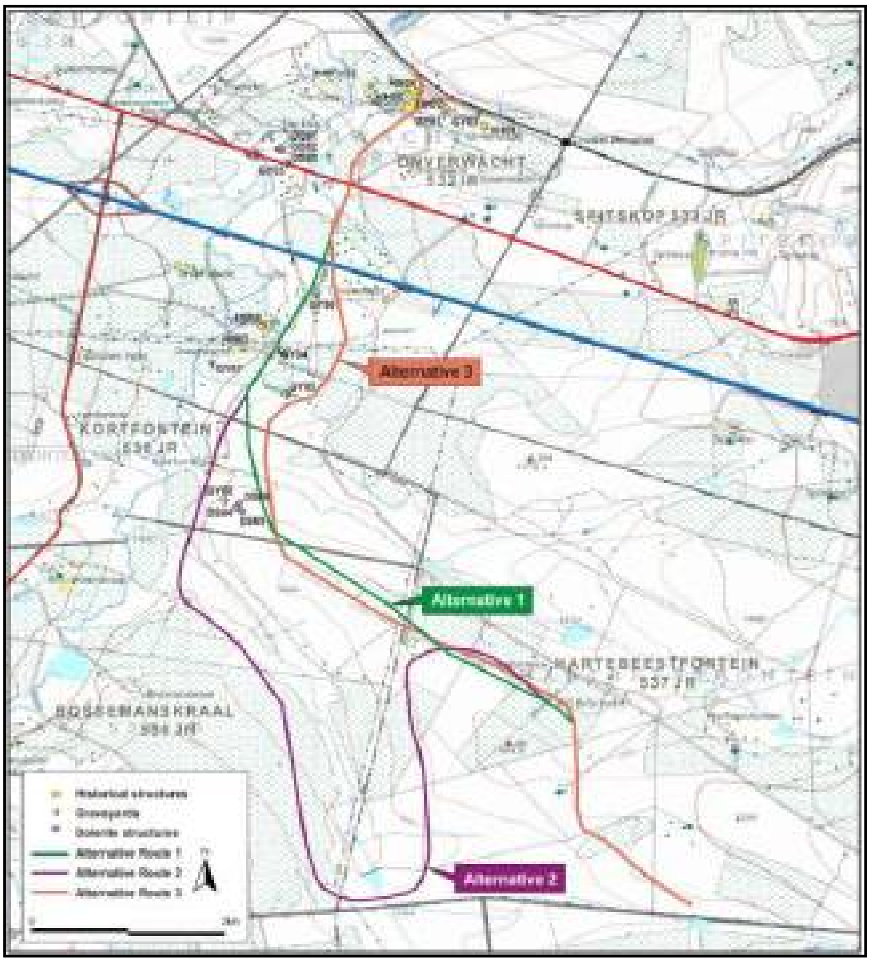


FIGURE 6-36: LOCATION OF THE HISTORICAL STRUCTURES IN RELATION TO THE CORRIDOR ALTERNATIVES

Historical structures

Several farmstead complexes are scattered across the study area. Most are confined to the northern part of the study area, to the north and to the south of Road 104 which runs across the northern part of the study area. The predecessor of this road used to serve as the main link between Pretoria and Belfast. Consequently, some of the oldest colonial dwellings were established along this road.

Most of the farm homesteads in the railway study area consist of a mixture of a number of structures which usually include at least one historical structure. Many of these historical buildings (older than sixty years), which used to consist of main dwellings with outbuildings, have been altered in the past, or have been abandoned, and many have fallen beyond repair or renovation.

The following farmstead complexes with historical buildings have been identified. Their locations in relation with the alternatives for the railway alternatives are indicated in Figure 6-36.

i. Farmstead complex 01

This farmstead complex consists of two remaining structures of which one is a historical house. This complex has been abandoned and used to incorporate a number of structures which now have been demolished. At least one dwelling, which qualifies as a historical structure, namely Historical House 01 (HH01), still remains.

HH01 is a rectangular dwelling with a pitched corrugated roof and was probably constructed during the 1920's. The house has been extended during the more recent past when a room constructed with face bricks was added to the frontal part of this house. These alterations do not affect its historical status.

FIGURE 6-37:- HISTORICAL HOUSE 01 IS PART OF FARMSTEAD COMPLEX 01.

ii. Farmstead complex 02

This farmstead complex is relatively modern and includes at least seven buildings. Only one of these buildings qualifies as a historical house. Historical House 02 (HH02) was constructed during the 1930's or 1940's and is currently still used by the Coertze family.

HH02 is a square building which was constructed with bricks and cement and is fitted with a pitched corrugated iron roof.

iii. Historical House 03

Historical House 03 (HH03) is more or less an identical structure to HH04. Both were constructed during the 1930's. HH03 has been abandoned and is falling into disrepair.

This dwelling is a square structure which was constructed with clay bricks and which was fitted with a corrugated iron roof. HH03 was altered and renovated several times in the past. These alterations incorporate construction work with clay and cement bricks as well as with dolerite stone.

FIGURE 6-38: HISTORICAL HOUSE 03 IS SITUATED NEXT TO HH04 AND IS IN A SEVERELY DILAPIDATED CONDITION.

iv. Historical House 04

HH04 and HH03 are more or less identical dwellings which were constructed during the 1930's. HH04 has been abandoned and is falling into disrepair. It is a square structure which was constructed with clay bricks and which was fitted with a corrugated iron roof.

v. Farmstead complex 03

This farmstead complex is associated with a number of buildings. The main residence qualifies as a Historical House (HH05) and is associated with a rondavel which also has historical significance.

HH05 is a square dwelling with a pitched corrugated iron roof. A rondavel which was used as an additional bedroom or as a cool room is situated next to HH05.

FIGURE 6-39: HH05 AND A RONDAVEL (NOT VISIBLE ON PHOTO) QUALIFY AS HISTORICAL SIGNIFICANT STRUCTURES IN THE NORTHERN PART OF THE RAILWAY STUDY AREA.

vi. Farmstead complex 04

Historical House 06 (HH06) is situated in Farmstead Complex 04 which incorporates a number of structures. HH06 in this complex qualifies as a historical significant building. This building with its Cape Dutch gables probably dates from the Victorian or Edwardian period and is therefore older than sixty years.

FIGURE 6-40: HISTORICAL HOUSE 06 DATES FROM THE VICTORIAN/EDWARDIAN PERIOD AND QUALIFIES AS A HISTORICAL SIGNIFICANT STRUCTURE.

Graveyards

Eight graveyards were recorded in the railway study area. Their locations in relation with the alternatives for the railway alternatives are indicated in Figure 6-36.

vii. Graveyard 01

This historical graveyard holds the remains of at least ten individuals. Most of the graves are decorated and fitted with tombstones. Inscriptions on two of the tombstones reflect the historical nature of this graveyard, namely:

- 'Stille rusplek van Gideon Andries Brenkman Geb 6 Jan 1917 Oorl 12 Jul 1936'
- 'In liefdevolle herinnering aan ons dierbare moeder Beatrix Jeanette Isabelle de Bruin Geb Janeke Geb 8-6-1878 Oorl 15-4-?? Ges 180 Vers 5 Rykaart'

FIGURE 6-41: HISTORICAL GRAVEYARD (GY01) ON ONVERWACHT 265LS WITH TEN GRAVES BELONGING TO COLONIALS WHO SETTLED NEAR THE TRANSPORT ROAD BETWEEN PRETORIA AND BELFAST DURING THE LATE 19TH CENTURY AND THE EARLY PART OF THE 20TH CENTURY.

viii. Graveyard 02

This informal graveyard next to the existing Pretoria – Witbank railway line holds the remains of at least five to six graves. All the graves are covered with piles of stone. None of the graves have any tombstones with inscriptions.

ix. Graveyard 03

This historical graveyard is located on the northern shoulder of Road104. It may contain as many as eight graves. A few are fitted with headstones. Inscriptions on two of these read as follow:

- 'Hier rus ons lief seuntjie PDF van den Berg Geb 4-9-1929 Oorl 26-5-1932'
- 'Rus in vrede vader Matthues Thores Mey Geb 10-12-1871 Oorl 22-9-1944 moeder ? Catharina Mey (gebore Pretotrius) Geb 5-12-1861 Oorl 7-9-1944'

FIGURE 6-42: GY04 NEAR PETRUS NKOSI'S HOME HOLDS AT LEAST SIX UNMARKED GRAVES.

x. Graveyard 04

GY04 is an informal graveyard with as many as six graves near the home of Peter Nkosi. All the graves are covered with piles of stone. None of the graves has any tombstones with inscriptions.

xi. Graveyard 05

GY05 may hold as many as seven graves in a blue gum bush. At least three of the graves are fitted with cement headstones. One has the inscription 'Martha' on it.

xii. Graveyard 06

This informal graveyard in a Blue Gum bush contains six graves which are edged with upright stones. None of the graves have any headstones with inscriptions.

FIGURE 6-43: IN A BLUE GUM BUSH HOLDS SIX GRAVES WHICH ARE DEMARCATED WITH UPRIGHT STONES.

xiii. Graveyard 07

This graveyard which is located in a Blue Gum bush on Onverwacht 562LS holds an unknown number of graves. Two of the graves which are visible are merely edged with upright stones. Both have been vandalised and are partly exhumed.

xiv. Graveyard 08

GY08 is located on a slight slope above a tributary of the Wilge Spruit. It is associated with remnants from the recent past which consist of low dolerite stone walls (some of which can be confused with graves). GY08 holds eight graves which are fitted with cement headstones. Some of the graves are edged with cement sides. GY08 is neatly demarcated with a dolerite wall. A large upright dolerite boulder (monolith) serves as an important beacon in the wall of the graveyard.

FIGURE 6-44: GY08 HOLDS THE REMAINS OF EIGHT INDIVIDUALS AND IS DEMARCATED WITH A DOLERITE WALL.

Three of the graves bear the following decipherable inscriptions on the cement headstones:

- ‘Mr Abram Mabena 4-10-67’
- ‘Mrs Johanna Mabena’
- ‘Evelyn Mabena’.

6.4 Dolerite structures (dwellings) with historical significance

At least four structures which were constructed with dolerite stone occur near GY03. It seems as if these remains may represent the outer boundary walls of homesteads which were probably built during the 20th century and qualify as historical remains as they are probably older than sixty years.

FIGURE 6-45: DOLERITE STRUCTURES WHICH WERE PROBABLY USED AS DWELLINGS BY FARM WORKERS DURING THE EARLIER PART OF THE 20TH CENTURY (ABOVE).

FIGURE 6-46: A SQUARE STRUCTURE CONSTRUCTED WITH DOLERITE WHICH WERE PROBABLY USED AS A CATTLE ENCLOSURE BY FARM WORKERS DURING THE EARLIER PART OF THE 20TH CENTURY OR PERHAPS EVEN EARLIER.

The structures comprise of the following:

- A rectangular constructed dolerite wall which may have served as a cattle kraal or which may have served as the outer boundary wall of a homestead.
- The foundation of a dilapidated dolerite structure which may have been a dwelling.
- A small square dilapidated dolerite structure which probably served as a dwelling.
- A second rectangular dolerite wall which incorporates two smaller structures, most probably dwellings. The rectangular dolerite wall probably served as the outer boundary wall of a homestead complex where a number of families lived together.

It is highly likely that these dolerite structures served as homesteads for farm workers who lived and worked on this part of the Eastern Highveld during the early decades of the 20th century.

Similar types of structures constructed with dolerite occur near GY08 but is not as elaborate as those north of the N4 and Road 104. It is possible that some of these structures, which include relatively neat and well preserved low stone walls, some of which are short, man be confused with graves.

However, it is not impossible that single, isolated undiscovered graves may occur in close proximity of these structures.

TABLE 6-23: COORDINATES FOR HISTORICAL STRUCTURES IN THE PROPOSED RAILWAY STUDY AREA.

Historical structures	Coordinates	Significance
FC01. Historical House (HH01) in Farmstead Complex 01.	25º 50.472' 28º 53.600'	**MED-HIGH**
FC02. Historical House (HH02) in Farmstead Complex 02.	25º 50.364' 28º 53.382'	**MED-HIGH**
HH03. Isolated and abandoned dwelling.	25º 50.256' 28º 53.173'	**MED-HIGH**
HH04. Isolated and abandoned dwelling.	25º 50.262' 28º 53.221'	**MED-HIGH**
FC03. Historical House (HH05) with rondavel in Farmstead Complex 03.	25º 51.885' 28º 52.247'	**MED-HIGH**
FC03. Historical House (HH06) in Farmstead Complex 04.	25º 51.737' 28º 52.356'	**MED-HIGH**

TABLE 6-24: COORDINATES FOR GRAVEYARDS IN THE PROPOSED RAILWAY STUDY AREA

Graveyards	Coordinates	Significance
GY01. Historical graveyard with approximately 10 graves.	25º 50.391' 28º 53.372'	**HIGH**
GY02. Informal graveyard next to railway line. Approximately 5 or 6 children graves	25º 50.386' 28º 53.563'	**HIGH**
GY03. Historical graveyard next to R104. Holds as many as 8 graves.	25º 50.723' 28º 52.489'	**HIGH**
GY04. Informal graves at Petrus Nkosi's house	25º 51.889' 28º 52.435'	**HIGH**
GY05. Informal graves in Blue Gum bush	25º 52.187' 28º 52.485'	**HIGH**
GY06. Neat informal graveyard in Blue Gum bush	25º 51.540' 28º 52.659'	**HIGH**
GY07. Two vandalised graves in a Blue Gum bush.	25º 51.993' 28º 52.069'	**HIGH**
GY08. Neatly demarcated with dolerite wall. Holds eight graves and monolith	25º 52.868' 28º 52.146'	**HIGH**

TABLE 6-25: COORDINATES FOR DOLERITE STRUCTURES IN THE PROPOSED RAILWAY STUDY AREA.

Dolerite structures	Coordinates	Significance
North of the N4 and R104		
DS01. A rectangular constructed dolerite wall	25º 50.624' 28º 52.442'	MED-HIGH
DS02. The foundation of a dilapidated dolerite structure	25º 50.628' 28º 52.450'	MED-HIGH
DS03. A small square dilapidated dolerite structure	25º 50.629' 28º 52.469'	MED-HIGH
Southern part of Project Area		
DS04. Dolerite structure with walls and square compartments	25º 52.917' 28º 52.216'	MED-HIGH
DS05. Dolerite structure with walls and square compartments	25º 52.936' 28º 52.237'	MED-HIGH
DS06. Dolerite structure with walls and square compartments	25º 52.894' 28º 52.222'	MED-HIGH