ENERTRAG South Africa (Pty) Ltd

IGOLIDE WIND ENERGY FACILITY ELECTRICAL GRID INFRASTRUCTURE

Geotechnical Desktop Study

41104282
OCTOBER 2024

CONFIDENTIAL

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PROJECT NO. 41104282

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DATE: OCTOBER 2024

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Geotechnical Desktop Study

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EXECUTIVE SUMMARY

ENERTRAG South Africa (Pty) Ltd is proposing to develop a 132kV switching station, a 132kV single or double circuit powerline, and upgrading the existing East Drie Five Substation. The Project is intended to feed the electricity generated by the approved 100MW Igolide Wind Energy Facility (DFFE reference number: 14/12/16/3/3/2/2385, EA date 31 January 2024) to the national energy grid.

The southern part of the Igolide Grid route is underlain by andesite, agglomerate and tuff of the Hekpoort Andesite Formation. The central and northern parts of the route are underlain by ferruginous shale, hornfels and ferruginous quartzite of the Timeball Hill Formation.

According to the Council for Geosciences Engineering Geohazards map and considering the distance, the depth and the dip of the rocks of the Malmani Subgroup that is located north of the route, the Igolide WEF electrical grid route is not underlain by dolomitic land.

A “negative low to moderate” impact was assessed, from a geotechnical perspective, for the pre-mitigation situation. Post-mitigation, the assessed impact decreases to “negative very low to low”.

The proposed route is suitable, from a geotechnical perspective, for the development of the Igolide grid and associated infrastructure. It is, however, essential that a detailed geotechnical investigation be conducted along the route and at all associated grid infrastructure in order to confirm the geotechnical condition of the underlying materials prior to the construction phase.

Contact name Heather Davis

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1 INTRODUCTION

WSP Group Africa (Pty) was appointed by ENERTRAG South Africa (Pty) Ltd to undertake a geotechnical desktop study for the proposed Igolide Wind Energy Facility (WEF) Electrical Grid Infrastructure, hereafter “Igolide Grid”. The Project is intended to feed the electricity generated by the approved 100MW Igolide Wind Energy Facility (” WEF”) (DFFE reference number: 14/12/16/3/3/2/2385), EA dated 31 January 2024) to the national energy grid, with the point of connection being the existing East Drie Five Substation. The proposed Igolide Grid comprises the following:

- A 132kV overhead single or double circuit powerline
- A 132kV Eskom Switching Station
- Upgrading the East Drie Five Substation.

The main objective of the desktop study is to perform a general assessment of the impacts of the proposed Igolide Grid development on the geotechnical conditions on and around the site. This geotechnical assessment will form part of the Basic Assessment Application for the proposed Igolide Grid project.

This report presents the findings from the geotechnical desktop study.

1.1 PROJECT DESCRIPTION

The Igolide grid project will comprise the following:

Component	Description
Development	WEF Electrical Grid Infrastructure
Municipality	Merafong City Local Municipality in the Gauteng Province of South Africa

<table>
<tr><th>Component</th><th>Description</th></tr>
<tr><td>132kV powerline (single or double)</td><td>Single or double circuit 132kV between the proposed switching station and the existing East Drie Five Substation. The powerline design may include:
Intermediate self-supporting monopole
Inline or angle-strain self-supporting monopole
Suspension self-supporting monopole
Triple pole structure
Steel lattice structure, or
Similar powerline design at 132kV specification
The above designs may require anchors with guywires or be anchorless. For up to 132kV structures, concrete foundation sizes may vary depending on design type up to 80m^2, with depths reaching up to 3.5m typically in a rectangular ‘pad’ shape.
A working area of approximately 100m x 100m is needed for each of the proposed structures to be constructed.
Gridline length: approximately 4km
Height of powerline: Up to 40m
Width of gridline servitude: 32m
A 250m wide corridor (125m on either side of the centre line) has been identified for the assessment and micro-siting of the powerline to avoid sensitivities and ensure technical feasibility.</td></tr>
<tr><td>Eskom Switching Station</td><td>Development footprint (permanent infrastructure area): approximately 2.5ha as the switching station will be located adjacent to the approved 33/132kV on-site IPP substation (DFFE reference number: 14/12/16/3/3/2/2385, EA dated 31 January 2024) which was assessed as part of the Igolide WEF Environmental Authorisation process.
Capacity: 132kV
Standard substation electrical equipment, including, but not limited to, busbars, control building, telecommunication infrastructure, office area, operation and control room, workshop and storage area, feeder bays, stringer strain breams, insulators, arrestors, relays, capacitor banks, batteries, wave trappers, switchyard, metering and indication instruments, equipment for carrier current, surge protection and outgoing feeders, as may be required.
Associated infrastructure, including, but not limited to, lighting, fencing (~2m high), gating, parking area, and buildings required for operation (ablutions, office, workshop and control room, concrete batching plant (if required), waste storage/disposal and storerooms).</td></tr>
<tr><td>Termination point Upgrades</td><td>Upgrades to the existing East Drie Five Substation will also be required, including possible expansion within the yard, where required, with a footprint of up to 4ha. This includes the installation of additional feeder bays to accommodate the power being evacuated from the proposed Igolide WEF and transformer upgrades.</td></tr>
</table>

Component	Description
Access Roads	▪ During construction, a permanent access road along the length of the powerline corridor, between 4 – 6m wide will be established to allow for large crane movement. This track will then be utilised for maintenance during operation. ▪ Permanent access roads to and within the substation, up to 8m wide, will be established.
Affected farm portions	▪ Portion 20 of Kraalkop 147 IQ ▪ Portion 31 of Kraalkop 147 IQ ▪ Portion 45 of Kraalkop 147 IQ ▪ Porton 46 of Kraalkop 147 IQ ▪ Portion 53 of Kraalskop 147 IQ ▪ Portion 68 of Kraalkop 147 IQ ▪ Portion 11 of Leeuwpoort 356 IQ ▪ Portion 77 of Leeuwpoort 356 IQ

1.2 SCOPE OF WORK

The scope of work is limited to a desktop review and interpretive reporting on the findings. The desktop assessment included the following:

- Literature reviews of available published and unpublished information including, but not limited to, geological data, geological maps, topographical maps, aerial images and any existing geotechnical investigation reports of the study area.
- Assessment of the relevant geotechnical and geological information and to indicate any fatal flaws within the study area.
- Assessment of the excavation conditions across the sites.
- Site reconnaissance

1.3 SPECIALIST CREDENTIALS

The geotechnical desktop assessment was undertaken by a geotechnical engineer and the work was overseen by a professionally registered senior geotechnical engineer.

Nthabiseng Mashego is a geotechnical engineer with a Bachelor of Engineering degree in Civil Engineering and an Honours degree in Geotechnical Engineering from the University of Pretoria. Nthabiseng has three years of experience in geotechnical engineering including geotechnical site investigations.

The desktop assessment was reviewed and authorized by Heather Davis. Heather is a qualified Professional Engineer (Pr.Eng 960229) with 40 years of experience. She obtained a BSc Honours degree in Engineering Geology and Geotechnics from the University of Portsmouth (UK) in 1982. A post graduate diploma was obtained from the University of the Witwatersrand in 1993 which focused on geotechnical engineering and rock mechanics. She is currently the Geotechnical Team Lead at WSP. Her responsibilities include providing geotechnical inputs to various projects, quality assurance on all geotechnical work and provision of reports. She has accumulated extensive experience in Sub Saharan Africa which has included work on the Medupi and Kusile Power Plants and on renewable projects such as the Sere Wind Farm, for Eskom, in the Northern Cape.

The CV's for Nthabiseng Mashego and Heather Davis are included in APPENDIX A.

2 STUDY AREA INFORMATION

The proposed Igolide Grid is located approximately 6km northeast of Fochville in the West Rand area of Gauteng. The site can be accessed via the National Road, N12, and the Regional Road, R500. The location of the site is indicated on Figure 2-1.

The Fochville area receives a Mean Annual Precipitation (MAP) of 711mm with the highest precipitation occurring during the month of December and the lowest during the month of June. The area experiences a Mean Annual Evaporation of 1454mm which is approximately double the MAP (Kongiwe, 2021). The area experiences its hottest temperatures during the months of January and December, with temperatures reaching an average of 28°C.

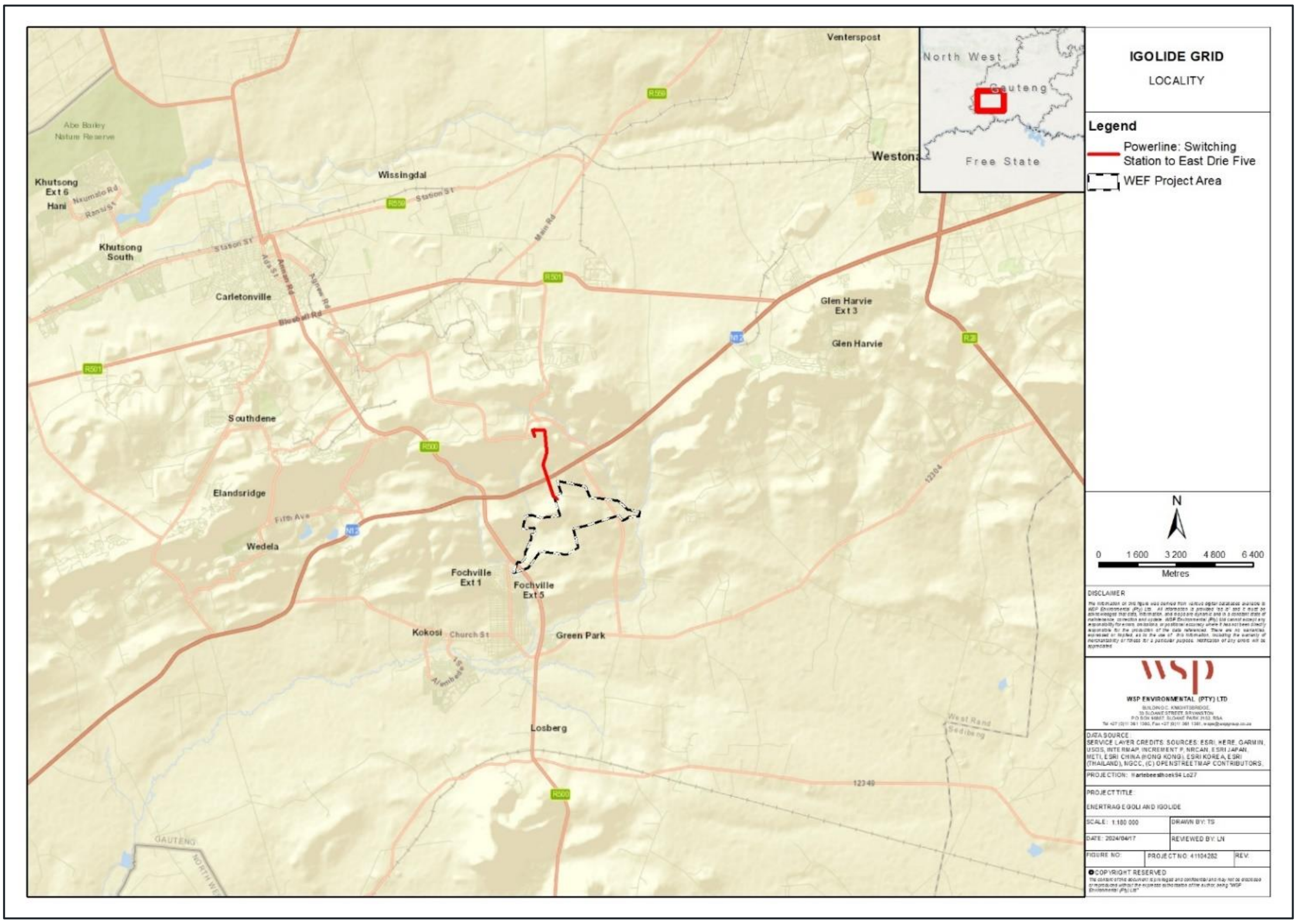

Figure 2-1 - Location of the Igolide Grid

3 GEOLOGY

According to the published 1:250 000 geological map, Sheet 2626 West Rand, the Igolide Grid route is underlain by the Hekpoort Andesite Formation and Timeball Hill Formation of the Pretoria Group, which form part of the Transvaal Supergroup. An excerpt of the published geological map showing the project area is represented in Figure 3-1 and the lithostratigraphy is shown in Table 3-1.

The geological map indicates that most of the route is underlain by the Timeball Hill Formation comprising ferruginous shale, hornfels and ferruginous quartzite. The southwest portion of the site in underlain by the Hekpoort Andesite Formation, a volcanic suite of the Pretoria Group which comprises andesite, agglomerate and tuff.

Figure 3-1 shows that the dolomite and dolomitic residuum of the Malmani Subgroup, Chuniespoort Group, Transvaal Supergroup, lie approximately 3.5km north of the Igolide Grid route and are older than the Pretoria Group and, hence, underly the Pretoria Group. The development of dolomitic land is required to be in accordance with SANS 1936. This document defines dolomitic land as follows: -

"Land underlain by dolomite or limestone residuum or bedrock (or both) within the Malmani Subgroup and Campbell Rand Supergroup, typically at depths of no more than: -

a) 60m in areas where no de-watering has taken place and the local authority has jurisdiction, is monitoring and has control over the groundwater levels in the are under consideration; or
b) 100m in areas where de-watering has taken place or where the local authority has no jurisdiction or control over groundwater levels.

The regional dip of the rocks in the vicinity of the Igolide grid is approximately 20° to the south as shown (Figure 3-3) in a paper by Abbot D and Ferguson (1961) citing work done by Bisschoff AA (1962) and Borchers R (1961).

Considering the distance from the northernmost end of the route and the dip of the rocks, the Malmani Subgroup is at a depth greater than 100m below the route and is not, therefore, considered dolomitic land and development is not required to take into account SANS 1936 Parts 1 to 4.

In addition, the Council for Geosciences Engineering Geohazards map (Figure 3-2), verifies that the Igolide WEF electrical grid route is not underlain by dolomitic land.

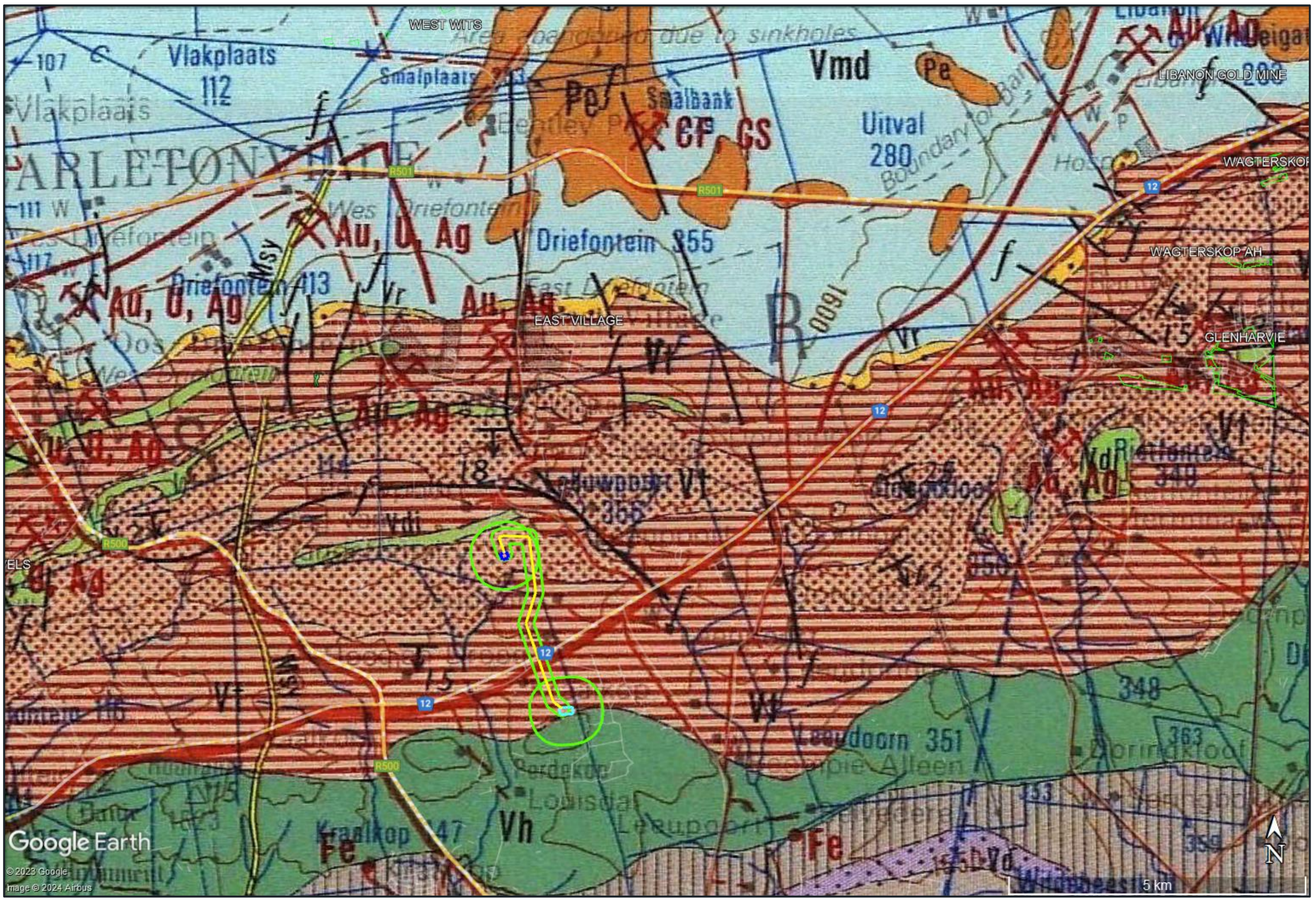

Figure 3-1 – Regional geology of the area

Table 3-1 – Lithostratigraphy of the area

Supergroup	Group	Subgroup	Formation	Lithology	Map Symbol
Transvaal	Pretoria		Hekpoort Andesite	Andesite, Agglomerate, Tuff	Vh
			Timeball Hill	Ferruginous shale, Hornfels, Ferruginous Quartzite	Vt
	Chuniespoort	Malmani		Dolomite and dolomitic residuum	Vmd

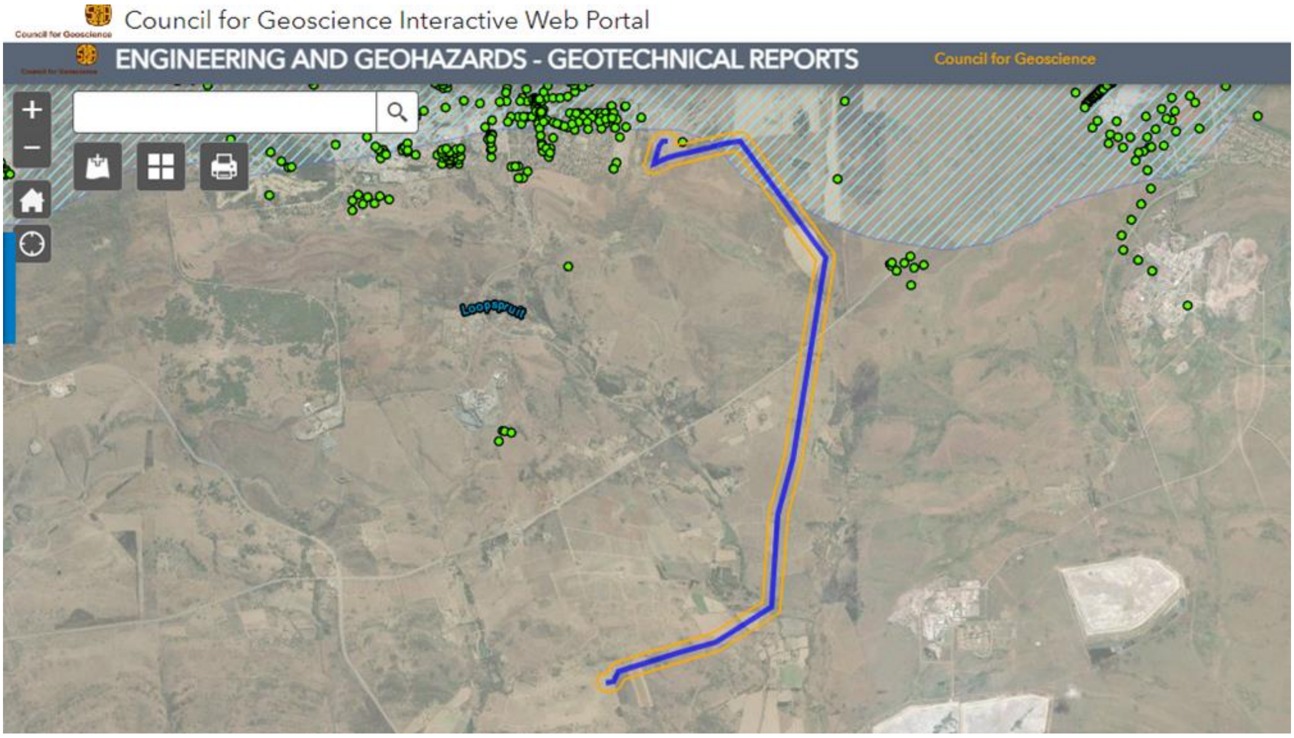

Figure 3-2 - CGS Geohazards map along the Igolide electrical grid

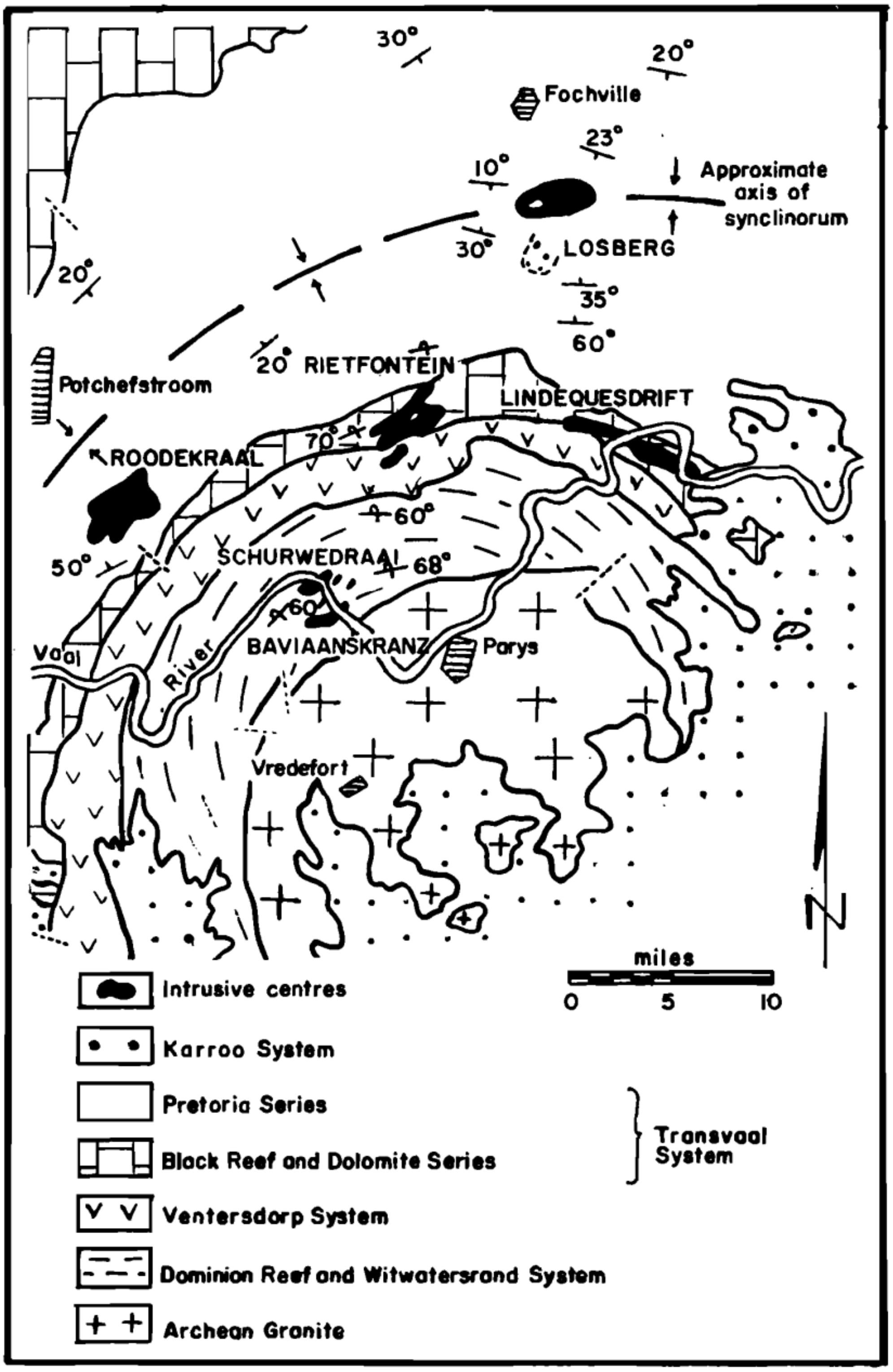

Figure 3-3 - Geology north of the Vredefort Dome

4 RESULTS OF THE DESKTOP STUDY

4.1 WEATHERING

The type and rate of rock weathering, and hence the soil profile, is determined by the climate of an area. Weinert (1980) developed an N-value system, which is used to derive the type of weathering likely to occur in an area based on macro-climatic conditions including evaporation and rainfall.

The study area falls within the temperate highland sub-tropical region of South Africa where the N value is between 2 and 5 as illustrated in Figure 4-1. This indicates that moderate climatic conditions occur on the site and that the rock and soil are, therefore, expected to be subject to, predominantly, chemical disintegration.

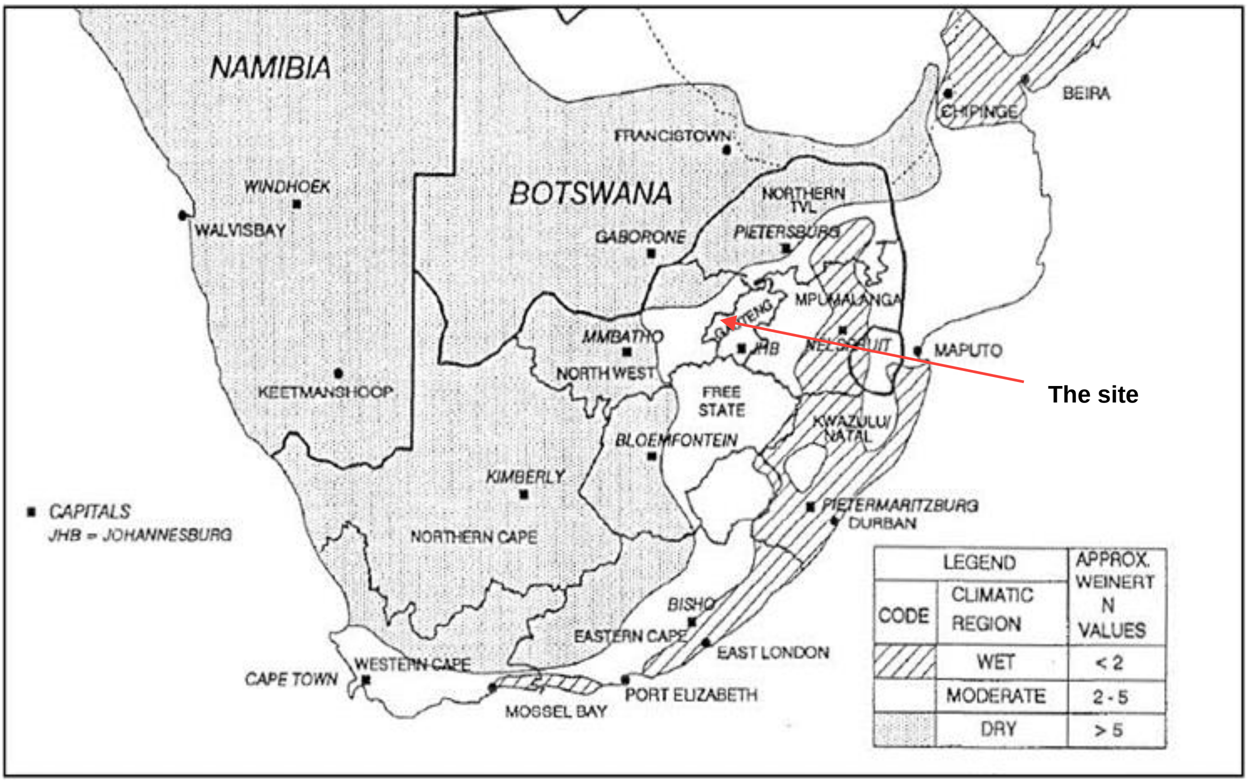

Figure 4-1 - Macro-climatic regions of Southern Africa (Weinert, 1980)

4.2 EXPECTED GROUND CONDITIONS

4.2.1 TIMEBALL HILL FORMATION

The Pretoria Group generally dips 20° to the south in the Igolide Grid area. The Pretoria Group sedimentary rocks, including the shale and quartzite, are notorious for instability in cut slopes. The rock is generally well bedded and, especially with the shale, some deterioration along the bedding planes has led to clay infill being present. Failure along the bedding planes and along the clay bedding planes is common. In general, any south facing slope should be assumed as being susceptible to failure until the rock has been assessed appropriately to determine the site-specific dip of the rock.

Shale

The shale of the Pretoria Group, including that of the Timeball Hill Formation, commonly weathers into relatively shallow residual profiles of less than 2 to 4m in thickness. The residual soil generally comprises clayey silt to silty clay which is generally compressible and occasionally expansive. Notwithstanding this, a shale rock outcrop was seen in the south portion of the site at the location indicated in Figure 4-2. The shale is olive green weathered red, highly weathered, very fine grained, intensely bedded, slightly fractured, soft rock and can be seen in Figure 4-3.

Quartzite

Quartzite of the Pretoria Group is generally highly resistant to weathering and is often present as outcrop, often forming ridges, or is present at a shallow depth. The residual soil developed above the quartzite is, therefore, thinly developed and is usually sandy in nature. In some cases, the residual sand may be collapsible but is generally easily remediated due to their limited thickness.

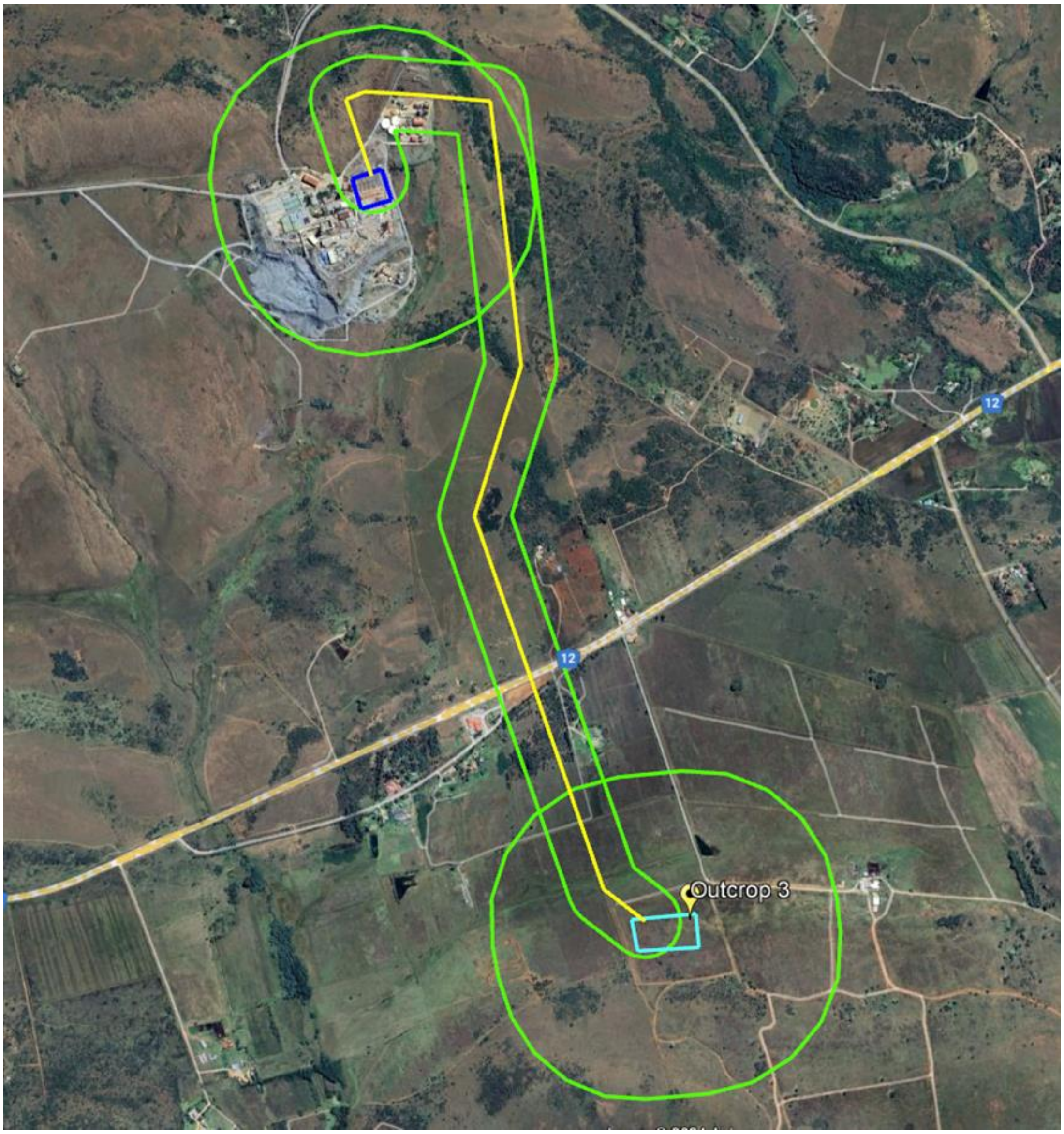

Figure 4-2 - Location of Timeball hill shale encountered on the site

Figure 4-3 - Shale rock encountered on site

4.2.2 HEKPOORT ANDESITE

Andesite and agglomerate were observed in outcrops on the southern portion of the route as shown in Figure 4-4. Outcrop 1 refers to the andesite rock outcrop encountered, while Outcrop 2 refers to the agglomerate rock outcrop that was observed. The andesite rock and agglomerate rock, respectively, are shown in Figure 4-5 and were described as follows: -

- Dark grey weathered red and light grey, slightly weathered, fine grained, slightly fractured, hard rock andesite with 10mm to 12mm diameter amygdale crystals.
- Dark grey weathered red, slightly to moderately weathered, medium to fine grained, moderately to highly fractured, medium hard rock agglomerate with 2mm to 40mm diameter, opaque white to greyish white, subrounded, hard rock calcite fragments in rock matrix.

As stated by Brink ABA (1979) "an interesting feature of the Hekpoort andesite is the extreme variability in depth and in degree of decomposition across relatively short distances.". This is as illustrated in Figure 4-6.

Therefore, although outcrops are present, a more thickly developed profile may be present within a very short distance. It is therefore of significant importance, that the depth of the residual profile directly below any proposed structure foundations be investigated and determined prior to design and construction.

Rock of the Hekpoort Andesite Formation generally weathers into a clayey soil which is generally compressible and often expansive. Care in the design of any foundations or infrastructure needs to take cognizance of this. Drainage control in these residual profiles is also of significant importance, as localised seepage from sources such as leaky pipes can result in deferential heave of structures.

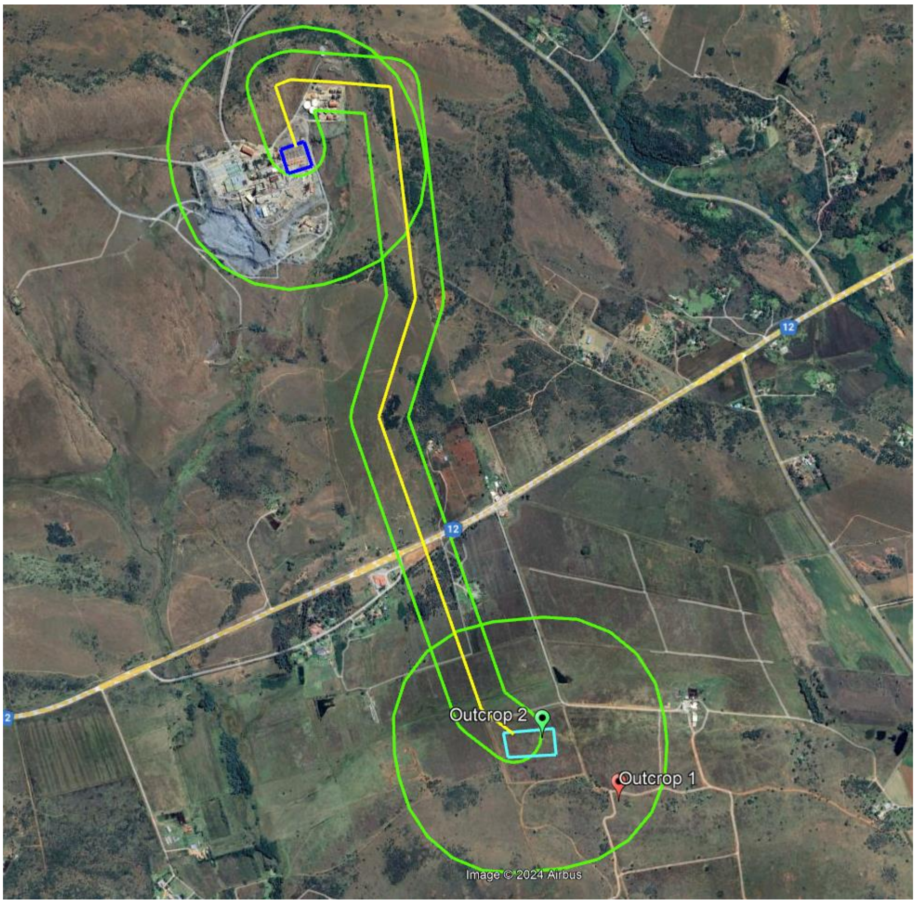

Figure 4-4 - Location of Hekpoort Andesite rock outcrops encountered on site

Figure 4-5 - Hekpoort Andesite rocks encountered on site

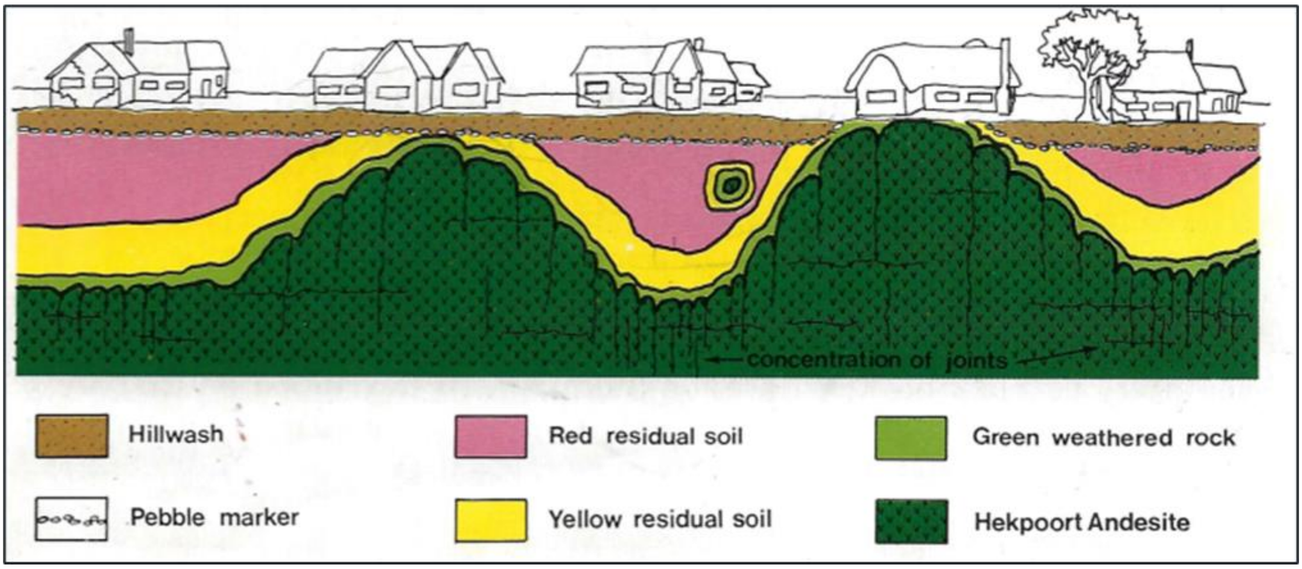

Figure 4-6 - Variability of depth of decomposition in the Hekpoort Andesite

5 GEOTECHNICAL EVALUATION

5.1 SURFACE DRAINAGE

Flooding affects flat lying areas, areas confined to drained channels and flood plains. Some non-perennial rivers pass through and around the site which can pose potential problems during wet periods especially in areas where shallow rock or clay is present. Stormwater management is recommended on areas of the site along these rivers to facilitate water run-off and to alleviate the possibility of standing water at the foundation positions.

5.2 EROSION

The slope on site, as well as the soil structure will influence the amount of erosion that occurs on site. The site is situated on an undulating gradient which makes the probability of erosion likely although this is reduced by the presence of tall grass that was observed to cover large portions of the site. Construction might increase the likelihood of erosion due to the disturbance of natural vegetation. This should be mitigated by revegetation after construction.

5.3 SUITABILITY OF INSITU MATERIAL FOR USE IN CONSTRUCTION

Shale rock can be used during construction as backfill and in layer-works. However, some shale material breaks down on exposure to air and water and this can cause severe problems. Should the shale be indicated for use as a construction material, its durability properties would need to be assessed.

Quartzite rock is generally inert and of use as a construction material. However, it is generally hard rock or harder in situ and blasting and crushing is generally required.

Quartzitic sand is of use in construction but is likely to be available only in very small quantities.

The soils developed on the Hekpoort Andesite Formation are unlikely to be suitable for use as a construction material due to their potential expansivity. The rock, however, is often used as general fill and in layer works, once crushed.

5.4 EXCAVATIBILITY

The excavation characteristics of the soil horizons has been evaluated according to the South African Bureau of Standards standardized excavation classification for earthworks (SABS –1200D).

The definition of the excavation classes is indicated in Table 5-1 and the assessment of the in-situ profile in Table 5-2.

The ease of excavation is a critical financial factor for any development.

Table 5-1 – SABS 1200D Excavation Classes

Class of Excavation	General Definition
Soft	Excavation in material which can be efficiently removed or loaded by any of the following plant without prior ripping: A bulldozer with a mass of at least 22 tons (which includes the mass of the ripper, if fitted) and an engine developing approximately 145kW at the flywheel. Or A tractor-scraper unit with a mass of at least 28 tons and an engine developing approximately 245kW at the flywheel, pushed during loading by a bulldozer as specified for intermediate excavation. Or, A track type front end loader with a mass of at least 22 tons and an engine developing approximately 140kW at the flywheel
Intermediate	Excavation (excluding soft excavation) in material which can be efficiently ripped by a bulldozer with a mass of at least 35 tons when fitted with a single tine ripper and an engine developing approximately 220kW at the flywheel.
Hard	Excavation (excluding boulder excavation) in material which cannot be efficiently ripped by a bulldozer with properties equivalent to those described for intermediate excavation. This type of excavation generally includes excavation in material such as formations of unweathered rock, which can be removed only after blasting.
Boulder Class A	▪ Excavation in material containing in excess of 40% by volume of boulders between 0.03m^3 and 20m^3 in size, in a matrix of softer material or smaller boulders. ▪ Excavation of fissured or fractured rock shall not be classed as boulder excavation but as hard or intermediate excavation according to the nature of the material.
Boulder Class B	Where material contains 40% or less by volume of boulders in a matrix or soft material or smaller boulders.

Table 5-2 – Excavatability on Site

Material	Excavation Class
Timeball Hill Formation	Soft excavation in residual shale, quartzite and hornfels and in very soft rock. Intermediate to hard excavation in medium hard and hard rock.
Hekpoort Andesite Formation	Soft excavation in residual andesite, agglomerate and tuff, and in very soft rock. Intermediate to hard excavation in medium hard and hard rock.

5.5 SLOPE STABILITY

Development on the site is unlikely to cause any slope instability as no significant cut slopes will be developed. Where excavations are required, up to a depth of 3m, excavations should be excavated at a batter of 1:1.5 in soil where no water or seepage is evident and to 1:2, or flatter, where water is encountered. Rock can be excavated at a batter of 1:0.5 or vertically in the temporary case up to a depth of 3m.

Care should be taken when excavating through the Pretoria Group as this formation is prone to sliding as stated in Section 4.2.2 and repeated below: -

“The Pretoria Group is generally dipping 20° to the south in the Igolide Grid area. The Pretoria Group sedimentary rocks, including the shale and quartzite, are notorious for instability in cut slopes. The rock is generally well bedded and, especially with the shale, some deterioration along the bedding planes has led to clay infill being present. Failure along the bedding planes and along the clay lubricated bedding planes is common. In general, any south facing slope should be assumed as being susceptible to failure until the rock has been assessed appropriately to determine the site-specific dip of the rock”.

5.6 SEISMIC HAZARD

According to the Seismic Hazard Map of South Africa (Kijko et al., 2003), the peak ground acceleration is between 0.16g and 0.20g for the site. The peak ground acceleration may be described as the maximum acceleration of the ground shaking during an earthquake, which has a 10% probability of being exceeded in a 50-year period (Figure 5-1).

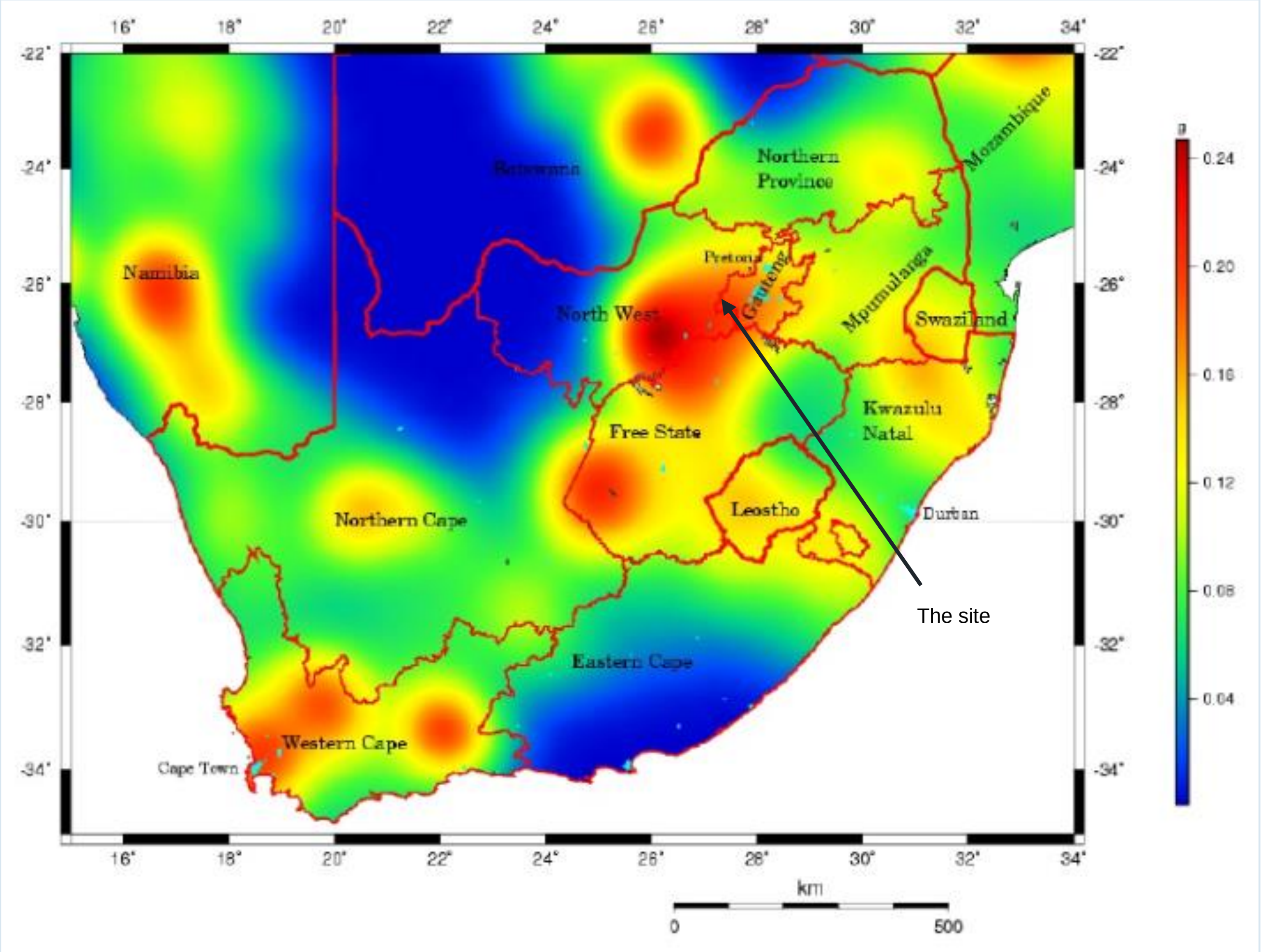

Figure 5-1 - Probabilistic seismic hazard map of South Africa

Mining induced seismicity is the failure of the earth’s crust or rock mass as a result of mining induced changes in rock stress levels. Seismic events range in size from barely discernible ground motions to very large tremors. There are three types of mining induced seismicity namely:

- Failure at pre-existing geological weaknesses such as faults, dykes and joints which result in medium to large events often far away from workings.
- Failure of the intact rock mass in the form of shear fractures that result in larger events close to workings.
- Localized bursting or failure of brittle rock types often referred to as strain bursting or face bursting (small events at the working face).

According to SANS 10160-4:2017, and as shown in Figure 5-2, the site is situated in a zone were mining induced and natural seismic activity is possible. The last significant seismic event in the area was recoded on the 30th of July 2023 with a magnitude of 3.1 (Discovery, 2023). SANS 10160-4 2017 should be consulted to ensure structural design of the proposed grid infrastructure meets the minimum requirements for buildings in this seismic zone.

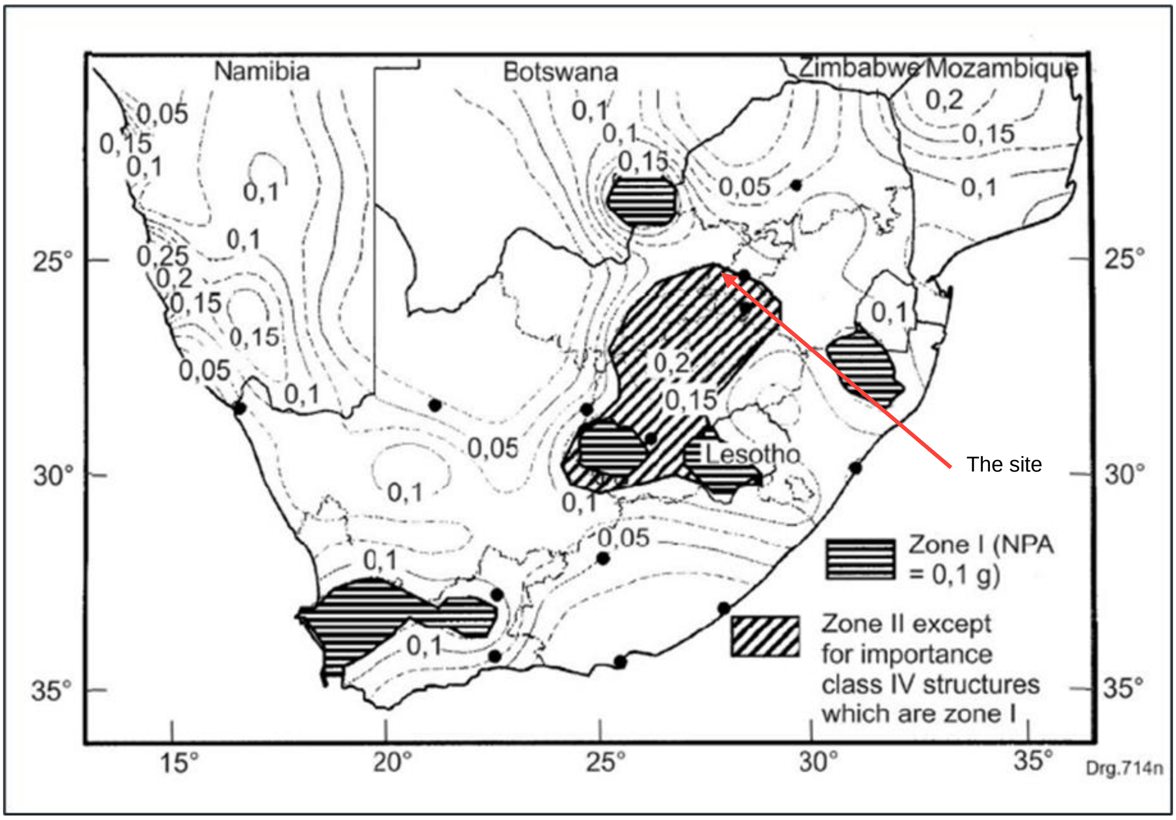

Figure 5-2 - Seismic zones of South Africa

5.7 UNDERMINING

Subsidence at surface in undermined areas is caused by the collapse and failure of the underground mining voids relatively close to the surface (Heath and Engelbrecht, 2011). The extent of mining activity in South Africa is shown in Figure 5-3, It can be seen from this figure that the site is located in an area with a significant number of gold mines.

Kloof mine is an underground gold mine located approximately 6km west of the site and could potentially pose problems for the proposed grid infrastructure with the possibility of a mine induced seismic event. The extent of any undermining below the site should be assessed, in detail, prior to development.

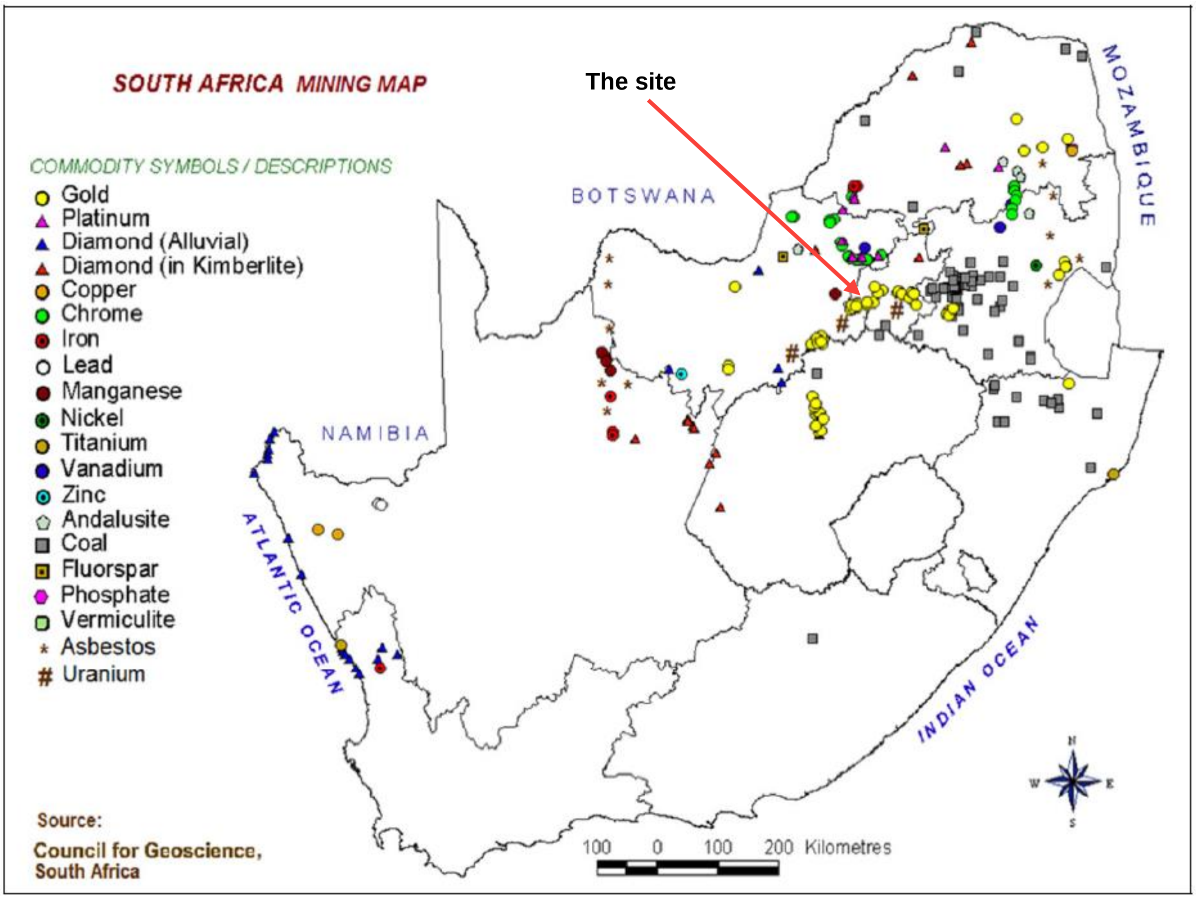

Figure 5-3 - Map indicating mining areas in South Africa

5.8 STRUCTURAL FOUNDATIONS

The grid and the associated infrastructure exert both a static load and a dynamic load on the founding material and competent material is required for founding to ensure stability and serviceability of the structures in the in the long term.

Outcrops and shallow rock are expected below parts of the site underlain by rocks of the Timeball Hill Formation. The depth to rock in those areas underlain by the Hekpoort Andesite Formation is expected to be highly variable over a very small distance.

Structure specific investigation is, therefore, required to determine the conditions below the footprint of the structures. Test pits will be required and possibly boreholes being required where the rock is at depth.

For lightly loaded and non-sensitive structures, shallow founding is likely to be possible. However, the potential expansiveness and compressibility of the residual clays and silts, residual of the shale and andesite, will need to be taken account of. Modified foundations and remediation of the subgrade may be required.

6 GEOTECHNICAL IMPACT ASSESSMENT

The geotechnical impact assessment of the proposed Igolide Grid was performed according to the methodology included in APPENDIX B.

Geotechnical impacts need to be taken into account as part of the proposed development. The identified risks can typically be mitigated by the implementation of an appropriate and effective plan. Mitigation measures must be implemented to avoid or reduce negative impacts during the construction, operation and decommissioning phases.

The assessment considers the entire development but the three main parts of the development, namely the grid and associated structures, cable trenches and access roads, are the primary consideration. Based on the impact assessment matrix undertaken for this project, from a geotechnical perspective the impact of the Igolide Grid was found to be “Negative low to moderate impact - The anticipated impact will have negative effects and will require mitigation.” With mitigation measures the impact will be “Negative very low to low”. The assessment impact assessment matrix is presented in APPENDIX B

The proposed application is considered suitable for the proposed development provided that the recommendations presented in this report are adhered to and which need to be verified by more detailed geotechnical investigations during detailed design.

7 FURTHER GEOTECHNICAL RECOMMENDATIONS

The information contained in this report is considered adequate for this stage in the planning phase of the facility. Prior to the design and the construction phase of the Igolide Grid project, a detailed intrusive site investigation is required.

Based on the current lack of previous geotechnical investigation data, the primary objectives of the proposed intrusive investigation must include:

- Determination of the founding conditions for all structures. The scope of the intrusive investigation should comprise the excavation of test pits with an excavator and possibly the drilling of a representative number of boreholes.
- Laboratory testing to determine the behavioural characteristics of the in-situ materials.
- Investigation of subgrade conditions for service roads.
- Investigation of materials to be used during construction.
- Non-intrusive investigation techniques, such as geophysical surveys including thermal and electrical resistivity for ground earthing requirement.

8 CONCLUSIONS

The desktop assessment of the geotechnical conditions at the proposed development site for the Igolide Grid has shown the site to be generally suitable for the proposed development.

A "negative low to moderate" impact was assessed, from a geotechnical perspective, for the pre-mitigation situation. Post-mitigation, the assessed impact decreases to "negative very low to low".

A geotechnical site investigation must be undertaken to provide detailed and site-specific geotechnical information prior to the design and construction phase of the proposed structures and roads.

The proposed development should, from a geotechnical impact perspective, be authorized. The most significant geotechnical condition that will affect the development is the possibility of hard excavation conditions as shallow rock is anticipated in some areas.

Your attention is drawn to Appendix C: Document Limitations

The statements presented in this document are intended to advise you of what your realistic expectations of this report should be, and to present you with recommendations on how to minimize the risks associated with the groundworks for this project. The document is not intended to reduce the level of responsibility accepted by WSP, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.

9 REFERENCES

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Appendix A

CURRICULA VITAE

Nthabiseng Mashego

Earth and Environment, Mine Waste – Junior Geotechnical Engineer

CAREER SUMMARY

Undergraduate qualification in Civil Engineering with an honour's degree in geotechnical engineering. 1 and ½ years of experience in geotechnical field investigations from a variety of sites including tailing's facilities and ash dams.

1 year with WSP

3 years of experience

Area of expertise

Geotechnical Investigations

Language

English – Fluent

EDUCATION

Undergraduate Degree (BEng) in Civil Engineering, University of Pretoria.	2019
Honours Degree (BEngHons) in Geotechnical Engineering, University of Pretoria	2022

PROFESSIONAL HISTORY

WSP Group Africa (Pty) Ltd	2023 – present
Mukona Consulting Engineers, Junior Geotechnical Engineer	April 2020 – February 2022

PROFESSIONAL EXPERIENCE

Geotechnical Investigations

Davies Lynn and Partners, Richards Bay Minerals CPTu testing, South Africa
2021
Junior Engineer
Cone penetration testing with dissipation test at Richard's Bay Minerals to locate depth of slimes layers.

ARQ Geotech (Pty) Ltd, Booysendal TSF CPTu and SCPT Testing, South Africa
2021
Overseeing on site operations
Conduction Cone penetration tests with dissipation tests and seismic cone penetration tests at the Booysendal Tailings Storage Facility in Mpumalanga.

ARQ Geotech (Pty) Ltd, Nkomati mine CPTu and SCPT Testing, South Africa
2021
Overseeing on site operations
Conduction Cone penetration tests and seismic cone penetration tests at the Nkomati mine in Mpumalanga.

Jones and Wagener, Grootegeluk coal mine Rotary Core Drilling, South Africa
2021
Junior Engineer
Rotary core drilling at Grootegeluk coal mine in the Limpopo province.

Eskom Kriel Power Station, Kriel Ash Dam Rotary Core Drilling, South Africa
2021

Nthabiseng Mashego

Earth and Environment, Mine Waste – Junior Geotechnical Engineer

Junior Engineer
Rotary core drilling at Kriel Ash Dam near Secunda.

Eskom Duvha power station, Duvha Ash Dam CPTu Testing, South Africa
2020
Overseeing on site operations
Conducting Cone Penetration tests with dissipation tests and collecting mostap samples at the Duvha power station ash dam.

Bazi Dukhan, Unizulu Campus CPT Testing, South Africa
2020
Overseeing on site operations
Conducting Cone Penetration tests at Unizulu campus in KwaZulu Natal.

Trans Africa Projects, Kadett power station, South Africa
2020
Junior Engineer
Test pitting, DPL testing and laboratory sampling for the construction of a substation platform and access road at the Kadett power station.

Tsholetso Projects, Sand River Bridge, South Africa
2020
Junior Engineer
Rotary Core Drilling and Test Pitting for the widening of the Sand River Bridge in the Limpopo Province.

Arup (Pty) Ltd, Neo1 Power Station Geohydrological Investigation, Lesotho
2020
Overseeing on site operations
Water borehole drilling, pump testing and laboratory sampling for the Neo1 Power station in Lesotho.

Heather Davis

Earth & Environment, Mine Waste, Geotechnical & Material Services – Senior Geotechnical Engineer

CAREER SUMMARY

Forty years of experience within the fields of geotechnical engineering and engineering geology. Most of the work has been gained in Sub Saharan Africa including South Africa, Swaziland, Botswana, Malawi, and Angola. A wide range of projects have been handled ranging from investigations for large projects such as coal fired power stations, hydroelectric power schemes, mine processing plants, major freeways and major pipelines to smaller scale projects for commercial developments and residential buildings. Forensic investigations have, also, been completed for failed tailings facilities, structures and slopes.

Responsibility has been taken for all facets of the geotechnical investigation including the site investigation planning, procurement, drilling supervision, fieldwork, in situ testing, analysis, reporting and supervision during construction. Contract documentation and administration for geotechnical investigations has, also, been handled.

Extensive experience in dolomitic terrain and was involved in the re-drafting of SANS 1936 Parts 1 and 2 and subsequent revisions to the standard. Also, involved in the ECSA feasibility study to have a specified category of registration for D4 level dolomite geo-professionals. Dolomite assessments for large facilities such as the Telkom site in Centurion, the Mispah tailings facility as well as for residential complexes and individual units have been carried out. Linear dolomitic assessments for roads and pipelines have been completed.

Heather is a registered professional engineer, a fellow of the South African Institution of Civil Engineers and served as Treasurer of the Geotechnical Division from 2006 to 2020.

>1 year with WSP

40 years of experience

Area of expertise

Site Investigations

Forensic Assessments

Dolomitic Terrain Assessments

Problem Soil Assessments

Language

English – Fluent

EDUCATION

Graduate Diploma in Civil Engineering in the field of Geotechnical Engineering, University of the Witwatersrand SA	1993
BSc (Honours) Engineering Geology and Geotechnics, Portsmouth University, England	1982

PROFESSIONAL MEMBERSHIPS

ECSA – Professional Engineer, Engineering Council of South Africa – Member No. 960229	1996
SAICE - Fellow of the South African Institution of Civil Engineering	1998

PROFESSIONAL HISTORY

WSP Group Africa (Pty) Ltd	April 2022 – present

Heather Davis

Earth & Environment, Mine Waste, Geotechnical & Material Services – Senior Geotechnical Engineer

Jones & Wagener (Pty) Ltd (following the merger with Verdi Consulting)	January 2018 – March 2022
Verdi Consulting Engineers (Pty) Ltd	March 2014 – December 2017
AECOM SA (Pty) Ltd (formerly BKS (Pty) Ltd.	February 2007 – February 2014
ARQ (Pty) Ltd	January 2003 – January 2007
Knight Hall Hendry (Pty) Ltd	January 2001 – December 2003
VKE Engineers (Pty) Ltd	November 1987 – December 2000
National Building Research Institute of the CSIR	November 1985 – October 1987
Geological Survey of South Africa	November 1982 – October 1985

PROFESSIONAL EXPERIENCE

SANRAL, N1 Sections 20 and 21 Geotechnical Investigation, Brakfontein, South Africa
2008 to 2012
Lead Geotechnical Engineer
Upgrade, extensions and additions to the N1 Ben Schoeman Freeway, Sections 20 and 21, between the Brakfontein and Allandale Interchanges as part of the Gauteng Freeway Improvement Project (GFIP) carried out for South African National Roads Agency SOC Ltd (SANRAL). Contract documentation for the subsurface investigation was drafted and all components of the project management of the SANRAL contract were handled. The site investigation included extensive rotary core drilling, percussion drilling and test pitting. Work included the analysis, assessment and provision of founding recommendations for the 22km of dual carriageway. Design components included culverts, retaining walls, cut slopes, embankments and bridges founded on ancient granite, sedimentary rocks of the Pretoria Group along with dolomite and dolomitic residuum. Both conventional and piled foundations were used for the various bridge structures and elements.

SANRAL, N11 Section 9, Hendrina, South Africa
2015 to 2016
Lead Geotechnical Engineer
Upgrade of National route N11 Section 9 between Hendrina and Hendrina Power Station. Planning and supervision of the linear investigation, by means of rotary drilling and test pitting, of 18.56km of roadway including two river bridges, cuts, fills and culverts. Full report complied including recommendations for all facets of the project. All work carried out as per the current SANRAL requirements and all contract administration for the drilling investigation handled.

SANRAL, National Route N5, between Harrismith and Kestell, Harrismith and Kestell, Orange Free State, South Africa
2011 to 2013
Lead Geotechnical Engineer
Carried out for SANRAL, which included drafting the contract documentation for the subsurface investigation which included extensive rotary core drilling and test pitting. The project includes the rehabilitation of the National Route 5 involving extending existing bridges, design and construction of new bridges and design of significant culvert structures. The bridge structures included river bridges, road over rail and road over road structures. Work carried out included supervision of the site investigation, analysis and provision of founding recommendations for all structures, contract administration and arbitration of claims.

Anglo Platinum. Mogalakwena Platinum Mine, New Northern Concentrator, Limpopo, South Africa.
2020 to 2021
Lead Geotechnical Engineer

Pre-feasibility and feasibility level investigations for the New Northern Concentrator. Supervision of all field work and provision of recommendations for all the structural elements. Additional design level investigation carried out for the M3C BOS Low Grade Stockpile.

NMPP/ Transnet, Multi Products Pipeline, Geotechnical Investigation, Johannesburg. South Africa
2008 to 2009
Section Lead Geotechnical Engineer
Geotechnical input for pipeline section running from Kendal to Waltloo and Jameson Park to Langlaagte in Johannesburg. Investigations have included test pitting; in situ testing and borehole have included test pitting, in situ testing and borehole drilling. The assessment of the route underlain by dolomite and dolomitic residuum was, also undertaken.

TCTA, Vaal River Eastern Sub-System Augmentation, Vaal, South Africa
2006 to 2008
Lead Geotechnical Investigation
Geotechnical investigation for TCTA for a pipeline to carry water from the Vaal Dam to Secunda for use by SASOL and ESKOM. Planning and preparation of contract documentation for drilling, trenching programmes, laboratory and in situ testing. Extensive field work was completed, and recommendations provided for trench sidewall stability, excavatability, construction through problem areas and recommendations for design and construction of the surge tanks, pipe bridges, abstraction works, de-silting works and access roads.

Aquarius Mining. Marikana, Mine Processing Plant, Rustenburg, South Africa
2001 to 2002
Geotechnical Engineer – Plant side
Several candidate sites and the detailed Geotechnical investigation of the final site for the processing plant for new platinum mine. Foundation recommendations for all plant elements were provided including those for silos, mills, crushers and conveyor trestles. Foundation design for large vibratory plant elements. Ongoing foundation inspections and providing geotechnical advice and recommendations to the client throughout construction.

Eskom, Medupi and Kusile Power Stations, Investigations and Foundation Assessments, Limpopo, South Africa
2008 to 2014
Lead Geotechnical engineer for AECOM
Assessment carried out for Hitachi/Eskom of existing information regarding the founding conditions. Provision of structure specific foundation recommendations which included settlement analysis, assessment of bearing capacity and determination of parameters for dynamic design. Site inspections and assessment of ground conditions during construction for both Kusile and Medupi. Also, project manager for an additional geotechnical investigation carried out at Medupi Power Station due to unforeseen ground conditions. Investigation included percussion drilling with the Jean Lutz computerised system along with triple tube rotary drilling. Analysis of data allowing optimisation of the power station design.

Harmony Goldfields, Mispah, Tailings Storage Facility, Far West Rand
2017 to 2018
Geotechnical Team Lead
Failure of a section of the Mispah Tailings Storage Facility (TSF) which is underlain by dolomite, dolomitic residuum and rocks of the Karoo Supergroup. The initial assessment lead to the entire facility being re-assessed and candidate sites for new facilities being investigated. Of specific note was the liaison with several other geotechnical/engineering geological consulting firms regarding the failure.

Eskom. Medupi, Flue Gas De-sulphurisation Project, Limpopo
2017 to 2018
Lead Geotechnical Engineer

Construction of Units 1 to 6. The investigation comprises test pitting, geophysical surveys and drilling. Foundation recommendations for all facets of the project were provided.

Irene Village, Mall Extensions, Centurion, South Africa
2015 to 2018
Dolomite Specialist
In depth assessment of existing information applicable to the Irene Village Mall retail development in Irene. Dolomite stability assessments for extensions to the existing shopping mall including the addition of a multi-level parkade and additional retail space. Provision of founding recommendations for all facets of the development including earthworks, roadways and foundations.

Gautrans. Gautrain Project, Centurion, South Africa
2007 to 2014
Geotechnical Engineer
Input and comment on aspects of the route underlain by dolomite including the Centurion Gautrain Station were provided. Assessment of the efficacy of the remedial measures utilised at the station including an extensive programme of grouting. Also, investigation of dolomite related subsidence and a sinkhole adjacent to the Gautrain route and below a raised section of the train line in the Centurion area. Subsequent design of the remedial measures for the sinkhole, drainage measures and long-term monitoring of the area.

Africa Kingdom Holdings. Serengeti Golf and Wildlife Estate, Estate Developments, Kempton Park, South Africa
2016 to 2022
Dolomite Specialist
Dolomite stability assessments, coupled with near surface investigations, of parcels of land throughout the Serengeti Golf and Wildlife Estate. Developments have included single, double and triple storey residential units, Hotel, Club House and artificial lake. All reports have been submitted to the Council for Geoscience (CGS) and have included IHC to IHC7 conditions with Dolomite Area Designations of D2 to D4 being represented. NHBRC applications have been made for all the residential developments.

Aerosud, Manufacturing Facility, Pierre van Ryneveld Park, Centurion . South Africa
2016 to 2018
Dolomite Specialist
Various dolomite stability investigations and reviews have been undertaken for warehouses, ablution blocks, workshops, parking areas and other infrastructure elements across the Aerosud manufacturing facility. All work has, and is, being carried out according to SANS 1936 Parts 1 to 4 of 2012. A Dolomite Risk Management Plan was drafted for the Aerosud Facility and is updated on a regular basis. The site manly classifies as IHC4 to IHC7 with Dolomite Area Designation D2 and D3 being applicable to most of the site.

Atterbury Properties. Erasmuspark/ Castlegate, Multi Use Development, Erasmuspark, South Africa
2016 to 2020
Geotechnical Engineer and Dolomite Specialist
Existing information in line with SANS 1936 on a site underlain by dolomite and dolomitic residuum and non-dolomitic formations. Programme of drilling and near surface investigation, to feasibility level, to de-lineate those areas underlain by dolomite and provision of recommendations for a mixed-use development which will include retail and residential components. Subsequent design level investigations have been completed for various large structures across the site and further de-lineation of developable and non-developable areas.

Appendix B

IMPACT ASSESSMENT METHODOLOGY AND IMPACT ASSESSMENT

IMPACT ASSESSMENT METHODOLOGY

SCOPING PHASE

REPORTING REQUIREMENTS

- Project Description
- Legislative Context (as applicable)
- Assumptions and limitations
- Description of Baseline Environment
- Site Sensitivity Verification – including sensitivity mapping
- Identification and high-level screening of impacts and mitigation measures
- Plan of Study for EIA

Ensure that all reports fulfil the requirements of the relevant Protocols.

HIGH-LEVEL SCREENING OF IMPACTS AND MITIGATION

Appendix 2 of GNR 982, as amended, requires the identification of the significance of potential impacts during scoping. To this end, an impact screening tool has been used in the scoping phase. The screening tool is based on two criteria, namely probability; and, consequence (**Table 0-3**), where the latter is based on general consideration to the intensity, extent, and duration.

The scales and descriptors used for scoring probability and consequence are detailed in **Table 0-3** and **Table 0-2** respectively.

Table 0-1: Probability Scores and Descriptors

SCORE	DESCRIPTOR
4	**Definite**: The impact will occur regardless of any prevention measures
3	**Highly Probable**: It is most likely that the impact will occur
2	**Probable**: There is a good possibility that the impact will occur
1	**Improbable:** The possibility of the impact occurring is very low

Table 0-2: Consequence Score Descriptions

SCORE	NEGATIVE	POSITIVE

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4	Very severe: An irreversible and permanent change to the affected system(s) or party(ies) which cannot be mitigated.	Very beneficial: A permanent and very substantial benefit to the affected system(s) or party(ies), with no real alternative to achieving this benefit.
3	Severe: A long term impacts on the affected system(s) or party(ies) that could be mitigated. However, this mitigation would be difficult, expensive or time consuming or some combination of these.	Beneficial: A long term impact and substantial benefit to the affected system(s) or party(ies). Alternative ways of achieving this benefit would be difficult, expensive or time consuming, or some combination of these.
2	Moderately severe: A medium to long term impacts on the affected system(s) or party (ies) that could be mitigated.	Moderately beneficial: A medium to long term impact of real benefit to the affected system(s) or party(ies). Other ways of optimising the beneficial effects are equally difficult, expensive and time consuming (or some combination of these), as achieving them in this way.
1	Negligible: A short to medium term impacts on the affected system(s) or party(ies). Mitigation is very easy, cheap, less time consuming or not necessary.	Negligible: A short to medium term impact and negligible benefit to the affected system(s) or party(ies). Other ways of optimising the beneficial effects are easier, cheaper and quicker, or some combination of these.

Table 0-3: Significance Screening Tool

CONSEQUENCE SCALE

PROBABILITY SCALE		**1**	**2**	**3**	**4**
	1	**Very Low**	**Very Low**	**Low**	**Medium**
	2	**Very Low**	**Low**	**Medium**	**Medium**
	3	**Low**	**Medium**	**Medium**	**High**
	4	**Medium**	**Medium**	**High**	**High**

The nature of the impact must be characterised as to whether the impact is deemed to be positive (+ve) (i.e. beneficial) or negative (-ve) (i.e. harmful) to the receiving environment/receptor. For ease of reference, a colour reference system (**Table 0-4**) has been applied according to the nature and significance of the identified impacts.

Table 0-4: Impact Significance Colour Reference System to Indicate the Nature of the Impact

Negative Impacts (-ve)	**Positive Impacts (+ve)**
Negligible	**Negligible**
Very Low	**Very Low**
Low	**Low**
Medium	**Medium**
High	**High**

EIA PHASE

REPORTING REQUIREMENTS

- Project Description
- Legislative Context (as applicable)
- Assumptions and limitations
- Description of methodology (as required)
- Update and/or confirmation of Baseline Environment – including update and / or confirmation of sensitivity mapping
- Identification and description of Impacts
- Full impact assessment (including Cumulative)
- Mitigation measures
- Impact Statement

Ensure that all reports fulfil the requirements of the relevant Protocols.

ASSESSMENT OF IMPACTS AND MITIGATION

The assessment of impacts and mitigation evaluates the likely extent and significance of the potential impacts on identified receptors and resources against defined assessment criteria, to develop and describe measures that will be taken to avoid, minimise or compensate for any adverse environmental impacts, to enhance positive impacts, and to report the significance of residual impacts that occur following mitigation.

The key objectives of the risk assessment methodology are to identify any additional potential environmental issues and associated impacts likely to arise from the proposed project, and to propose a significance ranking. Issues / aspects will be reviewed and ranked against a series of significance criteria to identify and record interactions between activities and aspects, and resources and receptors to provide a detailed discussion of impacts. The assessment considers direct[1], indirect[2], secondary[3] as well as cumulative[4] impacts.

A standard risk assessment methodology is used for the ranking of the identified environmental impacts pre-and post-mitigation (i.e. residual impact). The significance of environmental aspects is determined and ranked by considering the criteria[5] presented in **Table 0-5**.

[1] Impacts that arise directly from activities that form an integral part of the Project.
[2] Impacts that arise indirectly from activities not explicitly forming part of the Project.
[3] Secondary or induced impacts caused by a change in the Project environment.
[4] Impacts are those impacts arising from the combination of multiple impacts from existing projects, the Project and/or future projects.
[5] The definitions given are for guidance only, and not all the definitions will apply to all the environmental receptors and resources being assessed. Impact significance was assessed with and without mitigation measures in place.

Table 0-5: Impact Assessment Criteria and Scoring System

CRITERIA	SCORE 1	SCORE 2	SCORE 3	SCORE 4	SCORE 5
Impact Magnitude (M) The degree of alteration of the affected environmental receptor	Very low: No impact on processes	Low: Slight impact on processes	Medium: Processes continue but in a modified way	High: Processes temporarily cease	Very High: Permanent cessation of processes
Impact Extent (E) The geographical extent of the impact on a given environmental receptor	Site: Site only	Local: Inside activity area	Regional: Outside activity area	National: National scope or level	International: Across borders or boundaries
Impact Reversibility (R) The ability of the environmental receptor to rehabilitate or restore after the activity has caused environmental change	Reversible: Recovery without rehabilitation		Recoverable: Recovery with rehabilitation		Irreversible: Not possible despite action
Impact Duration (D) The length of permanence of the impact on the environmental receptor	Immediate: On impact	Short term: 0-5 years	Medium term: 5-15 years	Long term: Project life	Permanent: Indefinite
Probability of Occurrence (P) The likelihood of an impact occurring in the absence of pertinent environmental management measures or mitigation	Improbable	Low Probability	Probable	Highly Probability	Definite
Significance (S) is determined by combining the above criteria in the following formula:	$[S = (E + D + R + M) \times P]$ $Significance = (Extent + Duration + Reversibility + Magnitude) \times Probability$				
IMPACT SIGNIFICANCE RATING					
Total Score	**4 to 15**	**16 to 30**	**31 to 60**	**61 to 80**	**81 to 100**
Environmental Significance Rating (Negative (-))	**Very low**	**Low**	**Moderate**	**High**	**Very High**
Environmental Significance Rating (Positive (+))	**Very low**	**Low**	**Moderate**	**High**	**Very High**

IMPACT MITIGATION

The impact significance without mitigation measures will be assessed with the design controls in place. Impacts without mitigation measures in place are not representative of the proposed development's actual extent of impact and are included to facilitate understanding of how and why mitigation measures were identified. The residual impact is what remains following the application of mitigation and management measures and is thus the final level of impact associated with the development. Residual impacts also serve as the focus of management and monitoring activities during Project implementation to verify that actual impacts are the same as those predicted in this report.

The mitigation measures chosen are based on the mitigation sequence/hierarchy which allows for consideration of five (5) different levels, which include avoid/prevent, minimise, rehabilitate/restore, offset and no-go in that order. The idea is that when project impacts are considered, the first option should be to avoid or prevent the impacts from occurring in the first place if possible, however, this is not always feasible. If this is not attainable, the impacts can be allowed, however they must be minimised as far as possible by considering reducing the footprint of the development for example so that little damage is encountered. If impacts are unavoidable, the next goal is to rehabilitate or restore the areas impacted back to their original form after project completion. Offsets are then considered if all the other measures described above fail to remedy high/significant residual negative impacts. If no offsets can be achieved on a potential impact, which results in full destruction of any ecosystem for example, the no-go option is considered so that another activity or location is considered in place of the original plan.

The mitigation sequence/hierarchy is shown in **Figure 1** below.

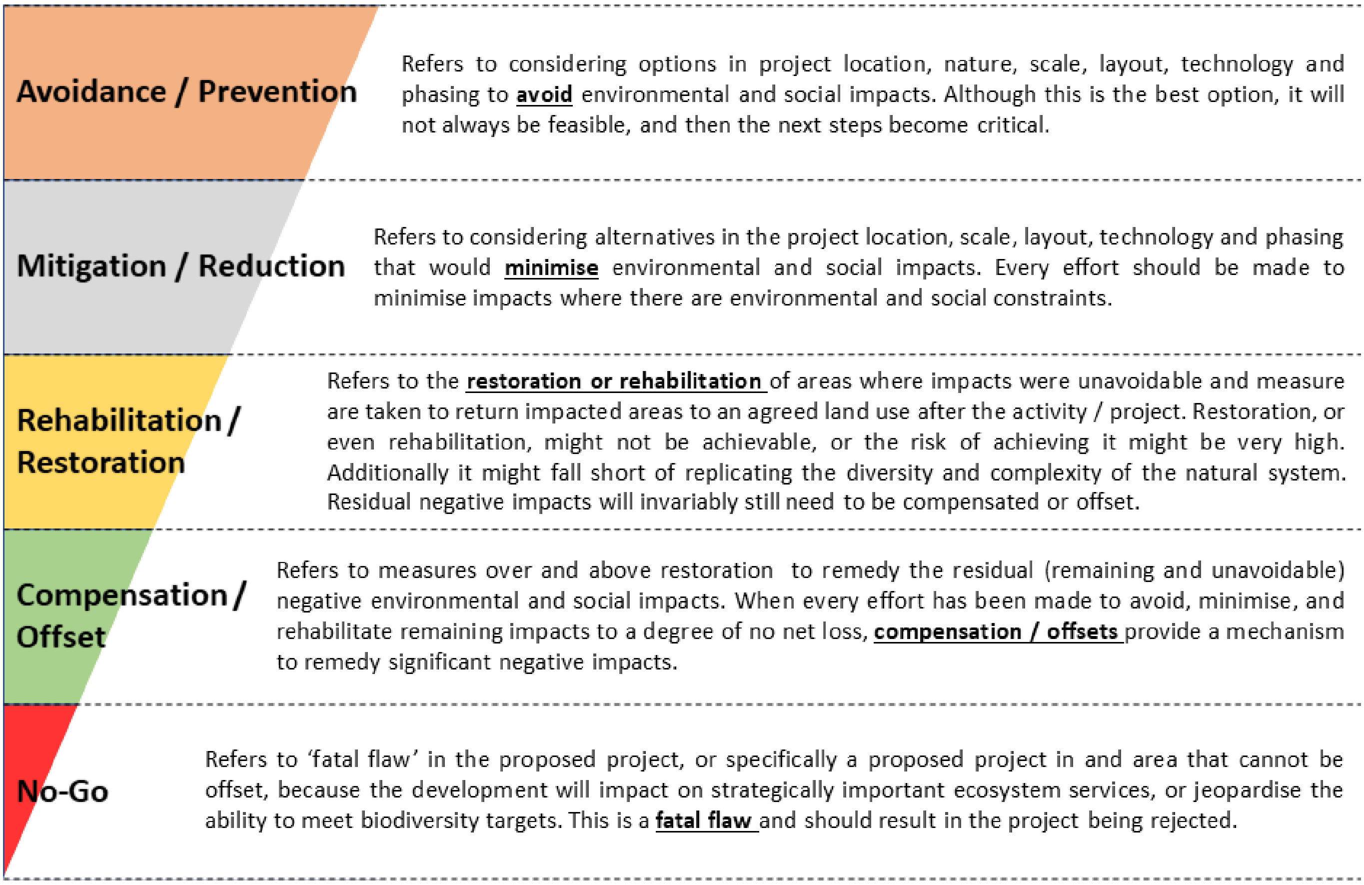

Figure 1: Mitigation Sequence/Hierarchy

Project Name	41104282 - Igolide grid																			
Impact Assessment																				
CONSTRUCTION																				
Impact number	**Aspect**	**Description**	**Stage**	**Character**	**Ease of Mitigation**	**Pre-Mitigation**							**Post-Mitigation**							**Mitigation Measures**
						(M+	**E+**	**R+**	**D)x**	**P=**	**S**	**Rating**	**(M+**	**E+**	**R+**	**D)x**	**P=**	**S**	**Rating**	
Impact 1:	Soil Erosion	• Increased stormwater velocity. • Increase in soil and wind erosion due to clearing of vegetation. • Creation of drainage paths along access tracks. • Sedimentation of non-perennial features and excessive dust.	Construction	Negative		3	3	3	3	4	**48**	**N3**	2	1	1	2	2	**12**	**N1**	• Rehabilitate affected areas (such as revegetation). • Use temporary berms and drainage channels to divert surface water. • Limit excavations to what is necessary. • Where possible, use existing road network and access track • Ensure correct engineering design and construction of gravel roads and water crossings. •Ensure adequate control of stormwater flow.
					Significance	**N3 - Moderate**							**N1 - Very Low**							
Impact 2:	Oil Spillages	Contamination of ground and surface water resources from heavy plant leading to quality deterioration of the water resources.	Construction	Negative		3	3	3	3	4	**48**	**N3**	2	2	1	1	2	**12**	**N1**	• Vehicle and construction machinery repairs to be undertaken in designated areas with proper soil protection. • Frequent checks of vehicles and construction machinery for oil leaks
					Significance	**N3 - Moderate**							**N1 - Very Low**							
Impact 3:	Disturbance of fauna and flora	The displacement of natural earth material and overlying vegetation leading to erosion.	Construction	Negative		3	1	3	3	3	**30**	**N2**	2	1	1	2	2	**12**	**N1**	• Limit excavations to what is necessary.
					Significance	**N2 - Low**							**N1 - Very Low**							
Impact 4:	Slope stability	Slope instability around structures.	Construction	Negative		2	1	3	3	2	**18**	**N2**	1	1	3	2	2	**14**	**N1**	• Avoid steep slope areas. • Design cut slopes according to detailed geotechnical analysis.
					Significance	**N2 - Low**							**N1 - Very Low**							
Impact 5:	Seismic activity	Damage of proposed development.	Construction	Negative		4	3	3	2	3	**36**	**N3**	2	2	3	3	3	**30**	**N2**	• Design all infrastructure according to SANS 10160-4 to ensure the proposed development meets the minimum requirements for infrastructure in a seismic zone.
					Significance	**N3 - Moderate**							**N2 - Low**							
OPERATIONAL																				
Impact number	**Receptor**	**Description**	**Stage**	**Character**	**Ease of Mitigation**	**Pre-Mitigation**							**Post-Mitigation**							
						(M+	**E+**	**R+**	**D)x**	**P=**	**S**		**(M+**	**E+**	**R+**	**D)x**	**P=**	**S**		
Impact 1:	Soil Erosion	• Increase in soil and wind erosion due to clearance of structures. • Displacement of soil and damage to vegetation by vehicles	Operational	Negative		2	1	3	2	2	**16**	**N2**	1	1	1	1	1	**4**	**N1**	• Where possible, use existing road network and access tracks. • Use temporary berms and drainage channels to divert surface water. • Minimize earthworks and demolish footprints. • Rehabilitate affected areas (such as revegetation). • Reinstate channelized drainage features. • Strip, stockpile and re-spread topsoil.
					Significance	**N2 - Low**							**N1 - Very Low**							
Impact 2:	Potential Oil Spillages	Potential oil spillages from service vehicles and heavy plant.	Operational	Negative		3	2	5	5	3	**45**	**N3**	2	1	3	1	1	**7**	**N1**	• Vehicle repairs to be undertaken in designated areas.
					Significance	**N3 - Moderate**							**N1 - Very Low**							
Impact 3:	Seismic activity	Damage of proposed development.	Operational	Negative		4	3	3	2	3	**36**	**N3**	2	2	3	3	3	**30**	**N2**	• Design all infrastructure according to SANS 10160-4 to ensure the proposed development meets the minimum requirements for infrastructure in a seismic zone.
					Significance	**N3 - Moderate**							**N2 - Low**							
DECOMISSIONING																				
Impact number	**Receptor**	**Description**	**Stage**	**Character**	**Ease of Mitigation**	**Pre-Mitigation**							**Post-Mitigation**							
						(M+	**E+**	**R+**	**D)x**	**P=**	**S**		**(M+**	**E+**	**R+**	**D)x**	**P=**	**S**		
Impact 1:	Soil Erosion	• Increase in soil and wind erosion due to clearance of structures. • Displacement of soil and damage to vegetation by vehicles	Decommissioning	Negative		4	2	3	3	4	**48**	**N3**	2	1	1	2	2	**12**	**N1**	• Where possible, use existing road network and access tracks. • Use temporary berms and drainage channels to divert surface water. • Minimize earthworks and demolish footprints. • Rehabilitate affected areas (such as revegetation). • Reinstate channelized drainage features. • Strip, stockpile and re-spread topsoil.
					Significance	**N3 - Moderate**							**N1 - Very Low**							
Impact 2:	Potential oil spillages	• Potential oil spillages due to clearance of structures.	Decommissioning	Negative		3	3	3	3	4	**48**	**N3**	2	1	3	1	2	**14**	**N1**	• Vehicle and construction machinery repairs to be undertaken in designated areas with proper soil protection. • Frequent checks of vehicles and construction machinery for oil leaks.
					Significance	**N3 - Moderate**							**N1 - Very Low**							
Impact 3:	Disturbance of fauna and flora	The displacement of natural earth material and overlying vegetation leading to erosion.	Decommissioning	Negative		3	1	3	3	3	**30**	**N2**	2	1	1	2	2	**12**	**N1**	• Limit excavations to what is necessary.
					Significance	**N2 - Low**							**N1 - Very Low**							
Impact 4:	Slope stability	Slope instability around structures.	Decommissioning	Negative		2	1	3	3	2	**18**	**N2**	1	1	3	2	2	**14**	**N1**	• Avoid steep slopes areas. • Design cut slopes according to detailed geotechnical analysis.
					Significance	**N2 - Low**							**N1 - Very Low**							
CUMULATIVE																				

Impact number	Receptor	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation							Post-Mitigation							
						(M+	E+	R+	D)x	P=	S		(M+	E+	R+	D)x	P=	S		
Impact 1:	Erosion	The displacement of natural earth material and overlying vegetation leading to: • Exposure of upper soil layer. • Increase in stormwater velocity. • Soil washed downslope into drainage channels leading to sedimentation. •The erosion of these slopes will be exacerbated during periods of heavy rainfall.	Cumulative	Negative		3	2	3	3	4	**44**	**N3**	2	1	1	2	2	**12**	**N1**	• Where possible, use existing road network and access tracks. • Use temporary berms and drainage channels to divert surface water. • Minimize earthworks and demolish footprints. • Rehabilitate affected areas (such as revegetation). • Develop a chemical spill response plan. • Reinstate channelized drainage features.
					Significance	**N3 - Moderate**							**N1 - Very Low**							
Impact 2:	Potential Oil Spillages	Contamination of ground and surface water resources from heavy plant leading to quality deterioration of the water resources.	Cumulative	Negative		3	3	3	3	4	**48**	**N3**	2	1	3	1	2	**14**	**N1**	• Vehicle and construction machinery repairs to be undertaken in designated areas with proper soil protection. • Frequent checks of vehicles and construction machinery for oil leaks.
					Significance	**N3 - Moderate**							**N1 - Very Low**							
Impact 3:	Disturbance of fauna and flora	The displacement of natural earth material and overlying vegetation leading to erosion.	Cumulative	Negative		3	1	3	3	3	**30**	**N2**	2	1	1	2	2	**12**	**N1**	• Limit excavations to what is necessary.
					Significance	**N2 - Low**							**N1 - Very Low**							
Impact 4:	Slope stability	Slope instability around structures.	Cumulative	Negative		2	1	3	3	2	**18**	**N2**	1	1	3	2	2	**14**	**N1**	• Avoid steep slopes areas. • Design cut slopes according to detailed geotechnical analysis.
					Significance	**N2 - Low**							**N1 - Very Low**							
Impact 5:	Seismic activity	Damage of proposed development.	Cumulative	Negative		4	3	3	4	3	**42**	**N3**	2	2	3	3	3	**30**	**N2**	• Design all infrastructure according to SANS 10160-4 to ensure the proposed development meets the minimum requirements for infrastructure in a seismic zone.
					Significance	**N3 - Moderate**							**N2 - Low**							

Appendix C

DOCUMENT LIMITATIONS

DOCUMENT LIMITATIONS

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