Appendix G

SPECIALIST STUDIES

Public

Appendix G.1

GEOTECHNICAL DESKTOP ASSESSMENT

Kromhof Wind Power (Pty) Ltd

KROMHOF WIND ENERGY FACILITY

Geotechnical Impact Assessment Report

41106427_REP-00006
DECEMBER 2024

CONFIDENTIAL

Kromhof Wind Power (Pty) Ltd

KROMHOF WIND ENERGY FACILITY

Geotechnical Impact Assessment Report

FINAL REPORT (REV0) CONFIDENTIAL

PROJECT NO. 41106427

OUR REF. NO. 41106427_REP-00006

DATE: DECEMBER 2024

WSP

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QUALITY CONTROL

Issue/revision	First issue	
Remarks	Kromhof Wind Energy Facility Geotechnical Impact Assessment Report	
Date	10 December 2024	
Prepared by	Khuthadzo Bulala	
Signature		
Checked by	Heather Davis	
Signature	 Digitally signed by Davis, Heather (ZAHD05193) Date: 2024.12.11 11:11:41 +02'00'	
Authorised by	Heather Davis	
Signature	 Digitally signed by Davis, Heather (ZAHD05193) Date: 2024.12.11 11:12:02 +02'00'	
Project number	41106427	
Report number	41106427-REP-00006 Rev 0	
File reference	41106427_REP_0006_WSP_Kromhof WEF_Final_Rev0_20241210+S.pdf	

CONTENTS

TABLES

FIGURES

APPENDICES

1 INTRODUCTION

WSP Group Africa (Pty Ltd (WSP) has been appointed to undertake an Environmental Impact Assessment (EIA) to meet the requirements under the National Environmental Management Act (Act 107 of 1998) (NEMA) for the various applications associated with the proposed Verkykerskop Wind Energy Facility (WEF) Cluster in the Free State Province.

The Verkykerskop WEF is divided into three projects:-

- Groothoek Wind Power
- Kromhof Wind Power
- Normandien Wind Power

WSP has been appointed to undertake the necessary geotechnical impact assessment studies. The objective of the desktop study is to perform a high-level assessment of the environmental impacts of the proposed WEF on the geotechnical conditions on and around the site. This report details the findings of the geotechnical desktop study undertaken for the Kromhof WEF and electrical grid infrastructure including the substation and the overhead lines. The Kromhof WEF (Figure 1-1) will have a proposed export capacity of up to 300MW and the grid connection will be a 132kV connection.

1.1 PROJECT DESCRIPTION

The proposed activity is defined as establishing the development of a WEF and associated infrastructure as detailed in Table 1-1.

Table 1-1 – Kromhof WEF Technical Details

Component	Description
Applicant Name	Kromhof Wind Power (Pty) Ltd
Development	Wind energy facility
Municipality	Thabo Mofutsanyana District Municipality, Phumelela Local Municipality
Extent	7269ha
Buildable area	150ha
Export Capacity	Up to 300MW
Power system technology	Wind
Number of Turbines	Up to 55
Rotor Diameter	200m
Hub Height	140m

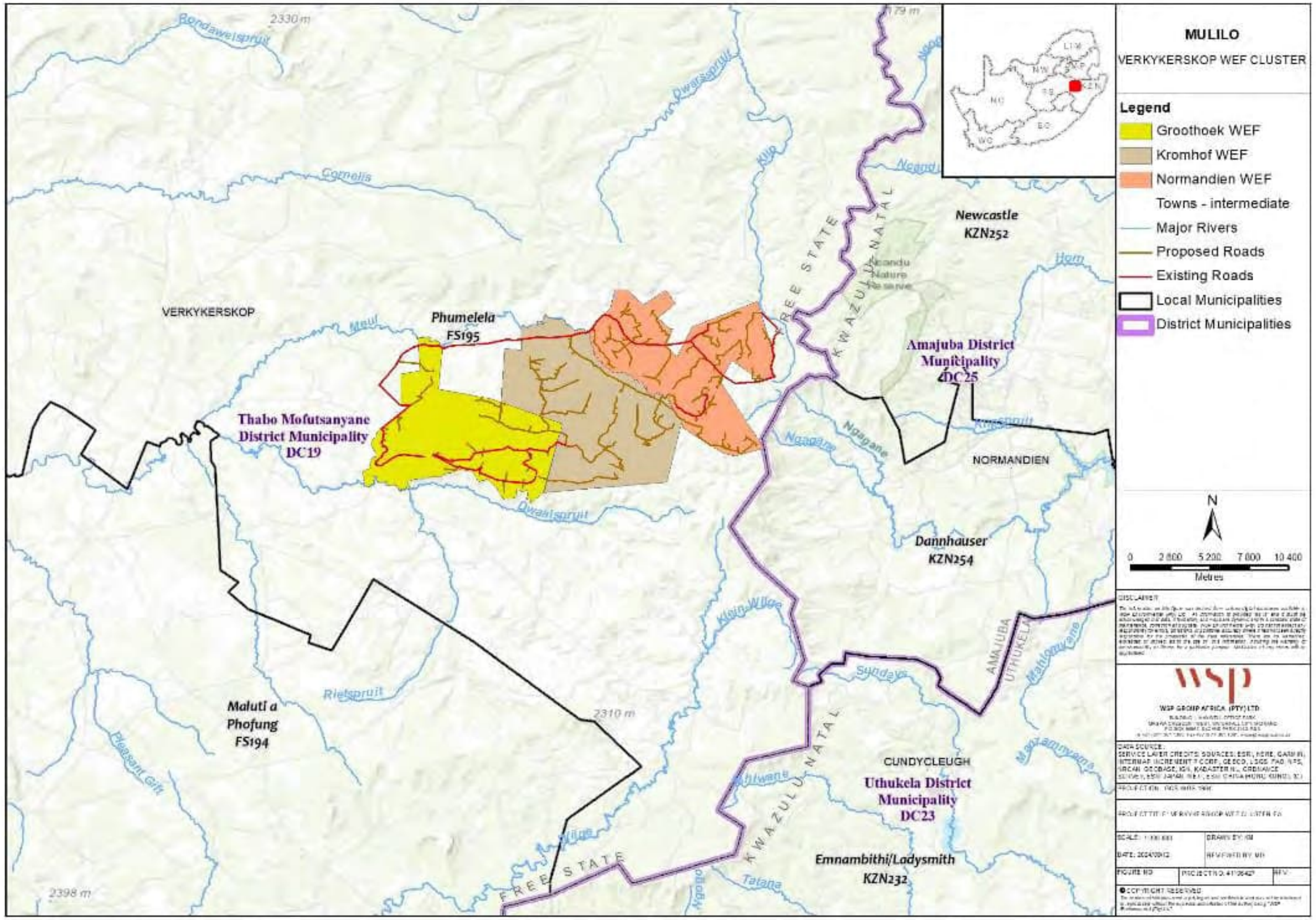
Component	Description
Hard Standing Dimensions	Up to 0.8 ha per turbine
Turbine Foundations	▪ Area of 0,07ha per turbine and crane platform/pad – 0,5ha. ▪ Excavation up to 4 m deep, constructed of reinforced concrete to support the mounting ring. ▪ Once tower established, footprint of foundation is covered with soil.
Substations	▪ 4 x 33kV/132kV onsite collector substation (IPP Portion), each being up to 2ha.
Powerlines	▪ 33kV cabling to connect the wind turbines to the onsite collector substations, to be laid underground where practical.
Construction camp and laydown area	▪ Construction compounds including site office inclusive of ▪ Concrete Batching plant of up to 1ha ▪ Site office of 4 ha ▪ laydown area of 8ha
Internal Roads	Up to 8m in width
Operations and Maintenance (O&M) building footprint	O&M of up to 1ha.
BESS	▪ Battery Energy Storage System (BESS) (200MW/800MWh). ▪ Li-ion solid state batteries ▪ Export Capacity of up to 800MWh ▪ Total storage capacity 200MW ▪ Storage capacity of up to 6-8 hours ▪ The BESS will be housed in containers covering a total approximate footprint of up to 7ha

1.2 SPECIALIST CREDENTIALS

The geotechnical desktop study was undertaken by an experienced professionally registered engineering geologist and the work was overseen by a professionally registered senior geotechnical engineer. The CV's for Khuthadzo Bulala and Heather Davis are included in Appendix A.

Khuthadzo Bulala is an engineering geologist with a Bachelor of Science Honors Degree from the University of Limpopo. She is registered as a Professional Scientist (PrSciNat 116482). Khuthadzo has eight years of experience in engineering geology, geotechnical engineering, environmental geology, and soil surveys. She has extensive experience in conducting renewable energy geotechnical assessments and detailed geotechnical investigations. The desktop studies were reviewed and authorized by **Heather Davis**. Heather is a qualified Professional Engineer (PrEng 960229) with over 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.

Figure 1-1 - Location of the Verkykerskop WEF Cluster.



2 STUDY AREA INFORMATION

The proposed Kromhof WEF site is located approximately 20km south-east of the small town of Verkykerskop in the Thabo Mofutsanyana District Municipality, Phumelela Local Municipality, in the Free State Province. The location of the site is shown in Figure 2-1.The site can be accessed via the R77 and the Normandie Pass from Verkykerskop .

The natural topography is characterised mainly by rolling plains and low hills in most areas which are locally interspersed by small ridges and flat plateaus. At the proposed development area, ground elevation ranges between approximately 1730m and 2070m above mean sea level. There are many non-perennial streams throughout the study area. General views of the terrain across the WEF area are shown in Figure 2-2.

The proposed WEF will be developed within a project area of approximately 7 269 hectares.

The majority of the northern section of the WEF site is currently utilized for crop farming. The proposed WEF site will affect a total of twelve property portions across its extent including state owned land. The affected farms are listed in Table 2-1.

Table 2-1 – Kromhof WEF Affected Farm Portions

Farm Name	Portion Number	SG 21 CODE
Farm Leiden No. 2	0	F01500000000000200000
Farm Myn-Burg No. 3	0	F01500000000000300000
Farm Naauw Kloof No. 4	0	F01500000000000400000
Farm Krom Hof No. 530	0	F01500000000053000000
Farm Puntje No. 1240	0	F01500000000124000000
Farm Aanfield No. 253	0	F01500000000025300000
Farm Aanfield No. 253	1	F01500000000025300001
Farm Ox Hoek No. 98	0	F01500000000009800000
Farm Ox Hoek No. 98	1	F01500000000009800001
Farm Ox Hoek No. 98	2	F01500000000009800002
Farm Ox Hoek No. 98	3	F01500000000009800003
Farm Markgraaff's Rest No. 478	0	F01500000000047800000

Figure 2-1 – Locality of the Kromhof WEF site

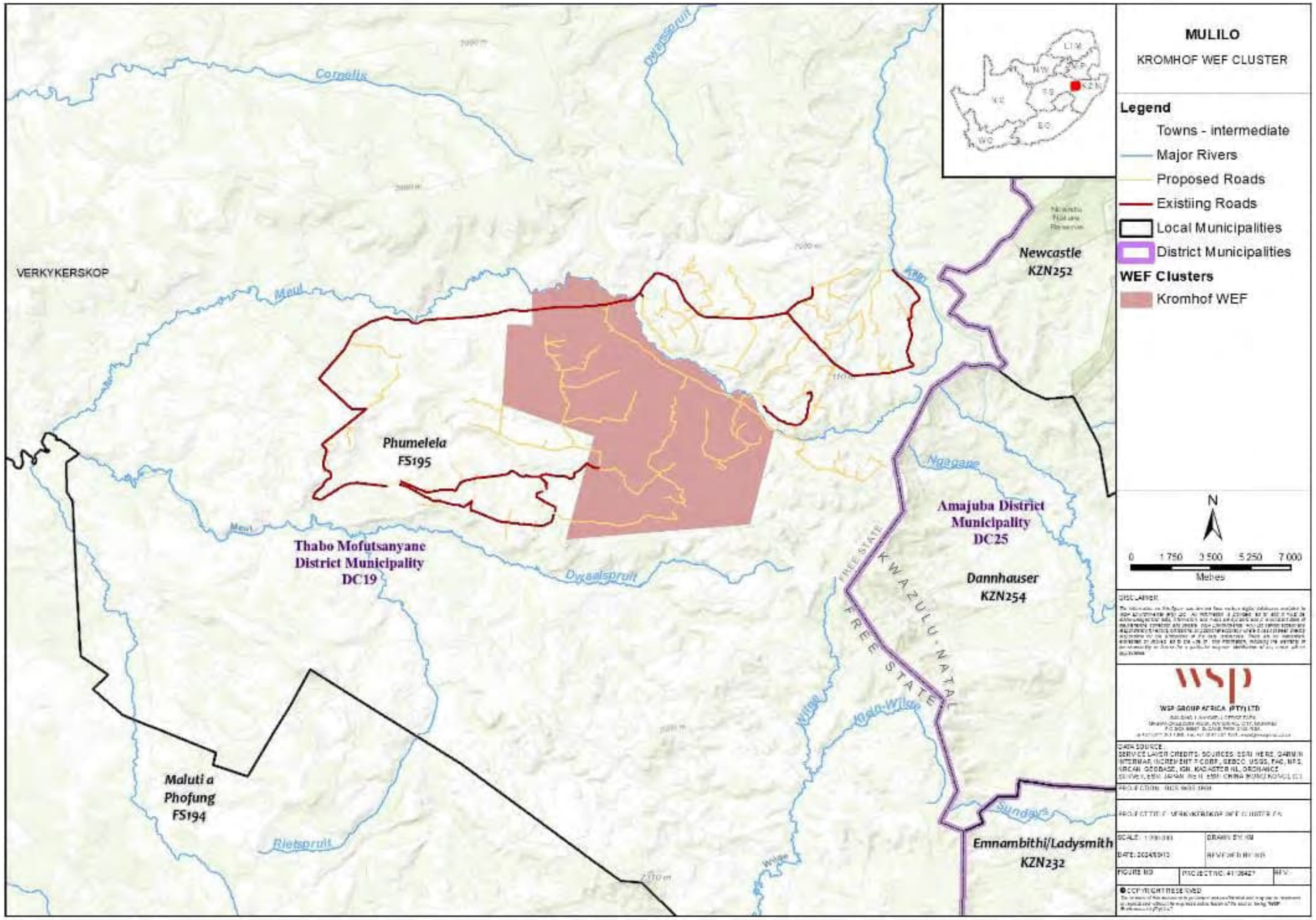


Figure 2-2 - Terrain across the Kromhof WEF site

3 GEOLOGY

According to the published 1: 250 000 geological maps (Sheet 2728 Frankfort and 2828 Harrismith), the study area is underlain by rocks of the Adelaide and Tarkastad Subgroup, Beaufort Group of the Karoo Supergroup.

The Adelaide and Tarkastad Subgroups have been extensively intruded by Jurassic age dolerite (Jd).

Minor areas of recent surficial deposits, alluvium, blanket areas along the Meul River along the northern border of the site.

An excerpt of the published geological map showing the project area is presented as Figure 3-1 and the lithostratigraphy is presented as Table 3-1.

Figure 3-1 – Geological Map of the Project Area

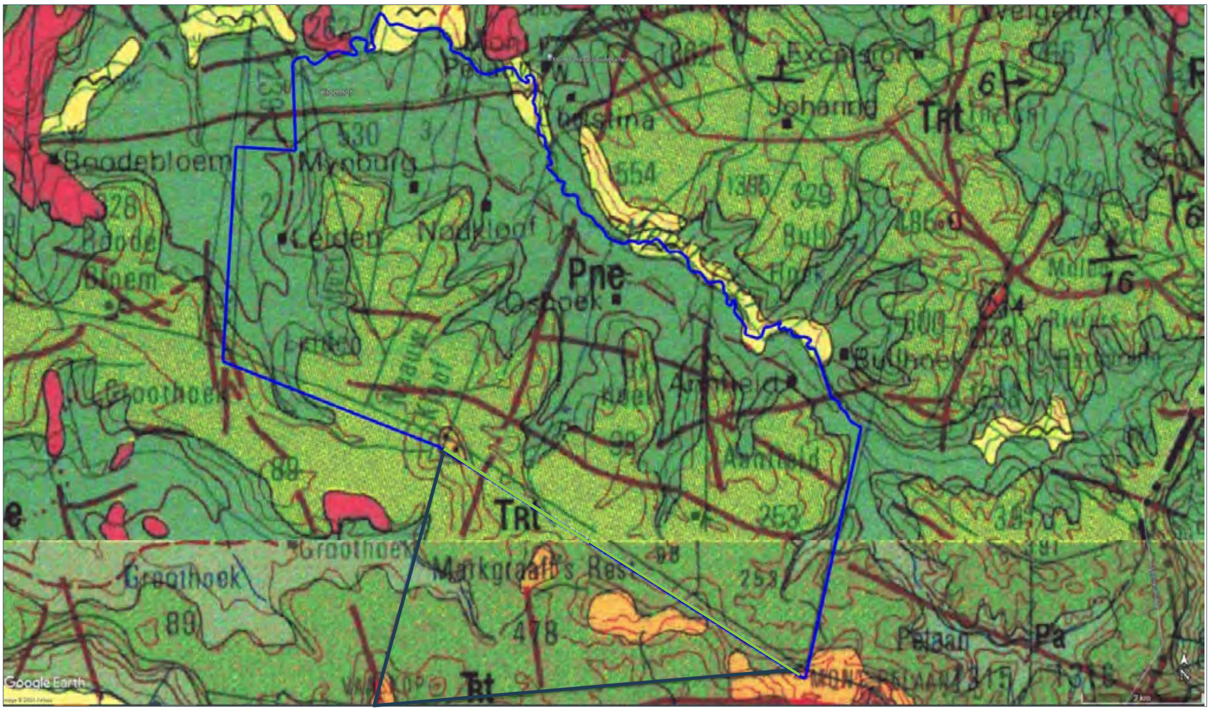


Table 3-1 – Lithostratigraphy of the Study Area

Supergroup	Group	Subgroup	Formation	Lithology	Map Symbol
				Alluvium	
				Dolerite, Dolerite dyke	Jd
Karoo	Beaufort	-	Molteno	Medium to coarse grained glittering sandstone, gritstone, subordinate green and red mudstone, carbonaceous shale.	TRm
		Tarkastad	Driekoppen Formation	Brownish-red mudstone, interbedded fine grained reddish sandstone.	
			Verkykerskop Formation	Fine to coarse grained feldspathic sandstone, subordinate sandstone and brown-red mudstone.	TRt
			-	Fine to medium grained sandstone, red, green and blue mudstone.	
		Adelaide	Normandien Formation	Olive green and grey mudstone, subordinate sandstone.	Pne
			Estcourt Formation	Fine to coarse grained sandstone, grey shale	
			-	Grey mudstone, dark grey shale (carbonaceous in places), siltstone and sandstone	Pa

4 SITE RECONNAISSANCE

A site reconnaissance was carried out on the 9th of July 2024 during the winter season. The season over which the site visit was conducted does not affect the outcome of the assessment as the geotechnical impacts are more of a technical nature rather than environmental.

The reconnaissance comprised a drive over the site within areas that were accessible by a 4x4 vehicle, profiling of geological exposures and documenting by taking photographs.

A total of three geological exposures, K2 to K4, were observed in the northern part of the site and were profiled according to the current South African standards and guidelines (SANS 633). This was done to confirm or dispute the baseline geological information.

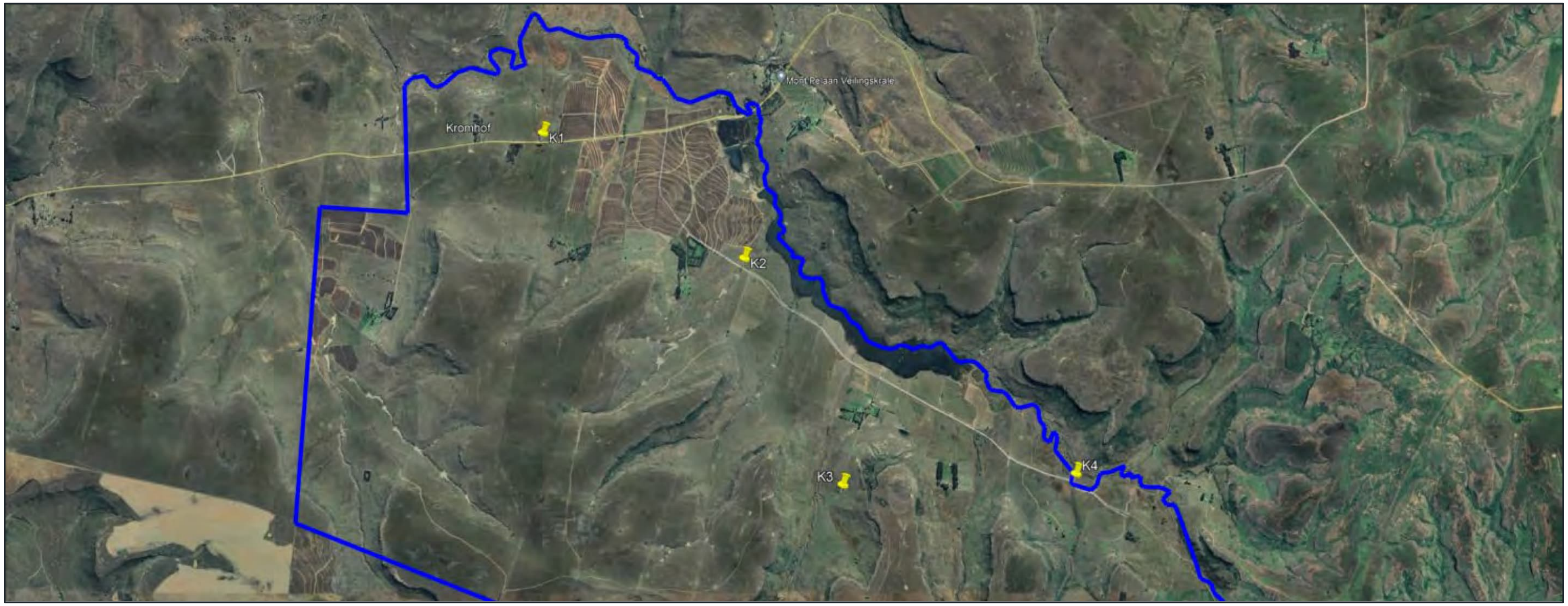
The positions of the exposures across the site are indicated on Figure 4-1. The exposure profiles are presented in Appendix B and photographs, thereof, are presented in Appendix C.

A summary of the description of the exposures e is presented in Table 4-1.

Table 4-1 –Summary of the profiled cuts and exposures

Exposure No.	Talus	Colluvium	Alluvium	Residual shale
	Silty sand with gravel, cobbles and boulders	Sandy clay with cobbles and boulders	Sandy clay with gravel and cobbles	Silty clay
K2		0.00 – 0.40		0.40 – 0.80
K3	0.00 – 5.00			
K4			0.00 – 1.00	

Figure 4-1 - Location of geological exposures across the Kromhof WEF site

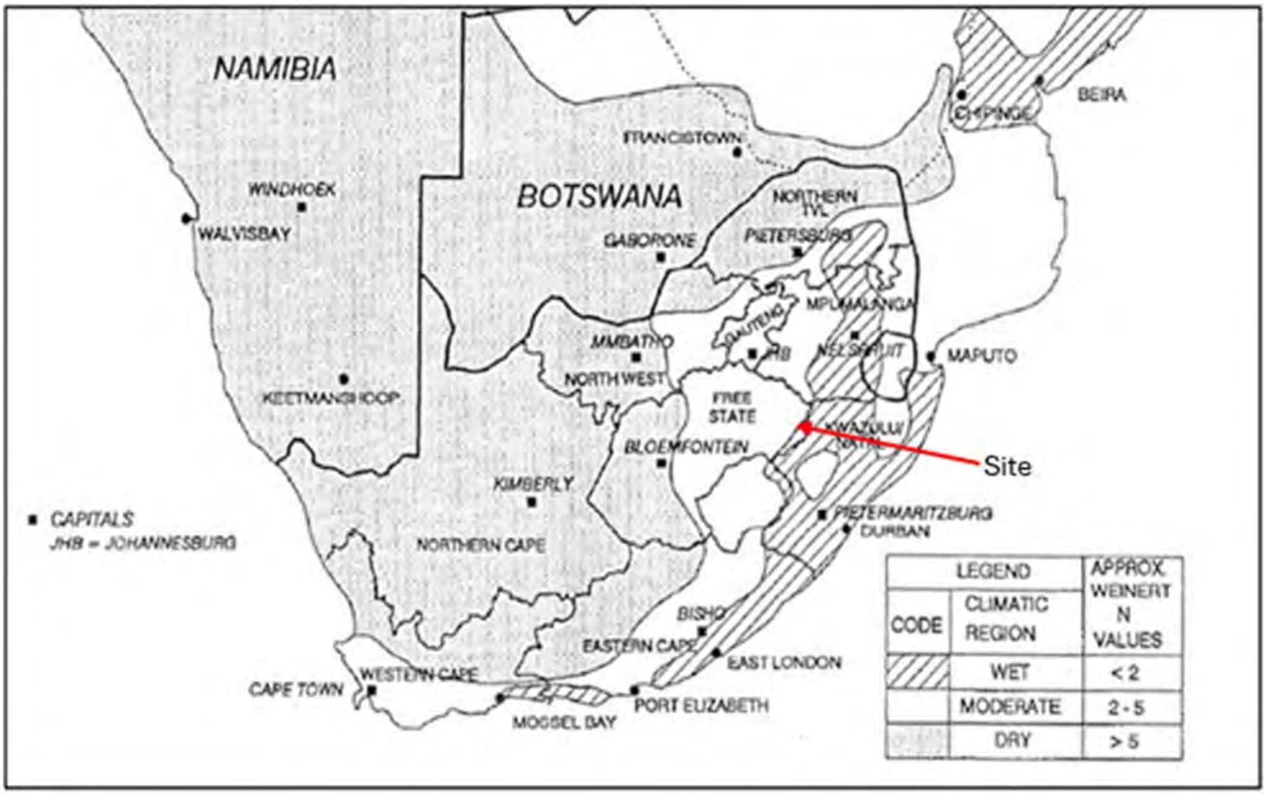


5 RESULTS OF THE DESKTOP STUDY

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 less than 2 as illustrated in **Figure 5-1**. This indicates that wet climatic conditions occur on the site and that the rock and soil are, therefore, expected to be subject to, predominantly, chemical disintegration.

Figure 5-1 - Macro climatic regions of South Africa



5.1 EXPECTED GROUND CONDITIONS

Karoo Supergroup Mudrock

Mudrock such as siltstone, mudstone and “mud-shales” are not considered suitable for use as construction material, due to their swelling characteristics, excessive absorption of water, poor engineering performance and lack of durability. Slope stability issues can arise in areas where closely intercalated sandstones and mudrock exist. When mudrock slake or disintegrate the exposed sandstone layers are undercut, this can result in rockfalls (Brink, 1983). Karoo Supergroup shale generally weathers to a clayey residual soil which is often compressible and potentially expansive. Expansive soils are those materials that exhibit volume change with a change in moisture content. These materials “shrink” when the moisture content decreases and “heave” or “expand” when the moisture content increases. Where the residual clay profile is thinly developed, it is recommended that the material should be stripped. Where thickly developed, the structural design needs to take cognizance of the potential expansiveness and compressibility of this material.

Shale rock and excavated shale, which presents as a gravel, often deteriorates on exposure. Although shale material can be considered for use in construction, the potential for deterioration needs to be pre-determined in the laboratory. If suitable, the gravel can be used in selected layers in road construction, but seldom as base course. Gravelly shales are occasionally used in the wearing course of gravel roads but not all types are suitable.

Slope instability may occur when sliding occurs on bedding planes which are inclined sufficiently. Ingress of water into layers and the resulting high pore-water pressure plays a key role in sliding failures. This is considered highly unlikely as the strata are mostly horizontally disposed.

Karoo Supergroup Sandstone

Karoo Supergroup sandstone generally weathers into sandy residual soils. Residual sandstone does not weather uniformly which often leads to dense layers being underlain by less dense layers of the same soil. In some cases, the residual sandstone may develop a potentially collapsible grain structure.

Collapsible soils exhibit additional settlement upon wetting without any change in the load. This can occur many years after construction as a result of any inundation and can even occur as a results of a broken water pipe. If recognised at investigation stage, these collapsible materials can be easily dealt with during construction with some remediation being required.

Slope stability issues can arise in areas where closely intercalated sandstones and mudrock (shale and siltstone) exist. When shales and siltstones slake or disintegrate the exposed sandstone layers are undercut, this can result in rockfalls. Intercalated siltstone layers are relatively impermeable, and impede the flow of water, which leads to pore pressure build up and sliding along the interface. This can only happen if the rock is dipping at an angle, towards the slope face, greater than the friction angle of the material.

Where material is required for the construction of roads and laydown areas, natural sandstone gravel or crushed sandstone bedrock can potentially be a suitable source. Consideration must be given to the presence of excessive pyrite and muscovite which can cause distress where sandstone is used as basecourse. In addition, where chemical stabilization is required the potential clay matrix of some sandstones make them suitable for stabilization with lime. The material quality will have to be assessed during the detailed geotechnical investigation.

Dolerite

Generally, residual dolerite soil is relatively thickly developed above dolerite rock with the profile becoming coarser with depth. Cobbles and boulders are often present above the rock grading into gravel, sand and finally residual clay at the top of the profile. Cobbles and boulders of dolerite, however, can be present throughout the residual profile. Residual dolerite comprising clay is generally compressible and potentially expansive in the “medium to high” range. Where a structure straddles residual dolerite and a different soil type, the structure should be moved to avoid differential settlement or designed accordingly.

Dolerite rock, cobbles, boulders and gravel are generally durable and are suitable for a variety of purposes. Dolerite rock is commonly quarried and used as a construction material such as for concrete aggregate and road construction materials.

6 GEOTECHNICAL EVALUATION

6.1 FOUNDATIONS

The turbines are relatively heavily loaded structures and have a very low tolerance for differential movement. The structures exert a static load. However, it is loading as a result of the high wind shear that drives the selection of founding medium. A high strength material is required for founding to provide sufficient bearing capacity and strength. Foundations on or in rock are recommended. This will require the depth to rock to be established and testing of the rock to provide parameters for design.

Where structures are underlain by quartzite, rock is expected at a depth of, generally, less than 3m. Therefore, founding in rock should be possible. Where structures are underlain by shale, dolerite or andesite the residual profile may be more thickly developed with rock expected at a depth of, generally, more than 3m. Dolerite and andesite boulders in the profile must not be mistaken for solid dolerite rock.

It is recommended that test pits be excavated at each turbine position during the geotechnical site investigation to determine the depth to rock and the strength characteristics thereof. Some rotary cored boreholes would be required to determine the depth to rock and the rock strength with depth in, particularly, the areas underlain by andesite, shale and dolerites.

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.

6.2 SURFACE DRAINAGE

Flooding affects flat lying areas, areas confined to drainage channels and flood plains. All the turbines are located on flat hill tops where water ponding is a possibility. Stormwater management is recommended at all flat areas to facilitate water run-off and to alleviate the possibility of standing water at the positions of foundations.

6.3 SLOPE STABILITY

Up to a depth of 3m, all 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. Should permanent excavations or deep excavations be proposed for the site, a slope assessment will be required.

For the most part the strata of the Karoo Supergroup, in this area, are horizontally disposed. Instability is, therefore, not expected in rock slopes.

6.4 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 6-1 and the assessment of the in-situ profile in Table 6-2. The ease of excavation is a critical financial factor for any development.

Table 6-1 – SABS 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 0.03m3 and 20m3 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 6-2 – Excavation on site

Material	Excavation Class
Alluvium/Hillwash	▪ Soft excavations. Some boulder excavation may be required.
Karoo Supergroup sandstone, shale and mudrock	▪ Soft excavations in residual shale, sandstone and mudrock and in very soft rock. ▪ Intermediate to hard excavation in medium hard and hard rock.
Dolerite	▪ Soft excavations in residual dolerite and in very soft rock. Some boulder excavation may be required. ▪ Intermediate to hard excavation in medium hard and hard rock.

6.5 SEISMIC HAZARD

According to the Seismic Hazard Map of South Africa (Council for Geoscience report No. 2003-0053.), the peak ground acceleration is 0.08g 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 as per **Figure 6-1**. This basically suggests that the area is expected to have low levels of seismic hazard.

There are two seismic activity zones according to SANS 10160-4 (2011):

- Zone I – Regions of natural seismic activity
- Zone II – Regions of mining-induced and natural seismic activity

In accordance with the seismic zones contained in SANS 10160-4, the site does not fall within either zone (Figure 6-2). However, the site is not located on either zone.

Figure 6-1 - Probabilistic seimic hazard map South Africa

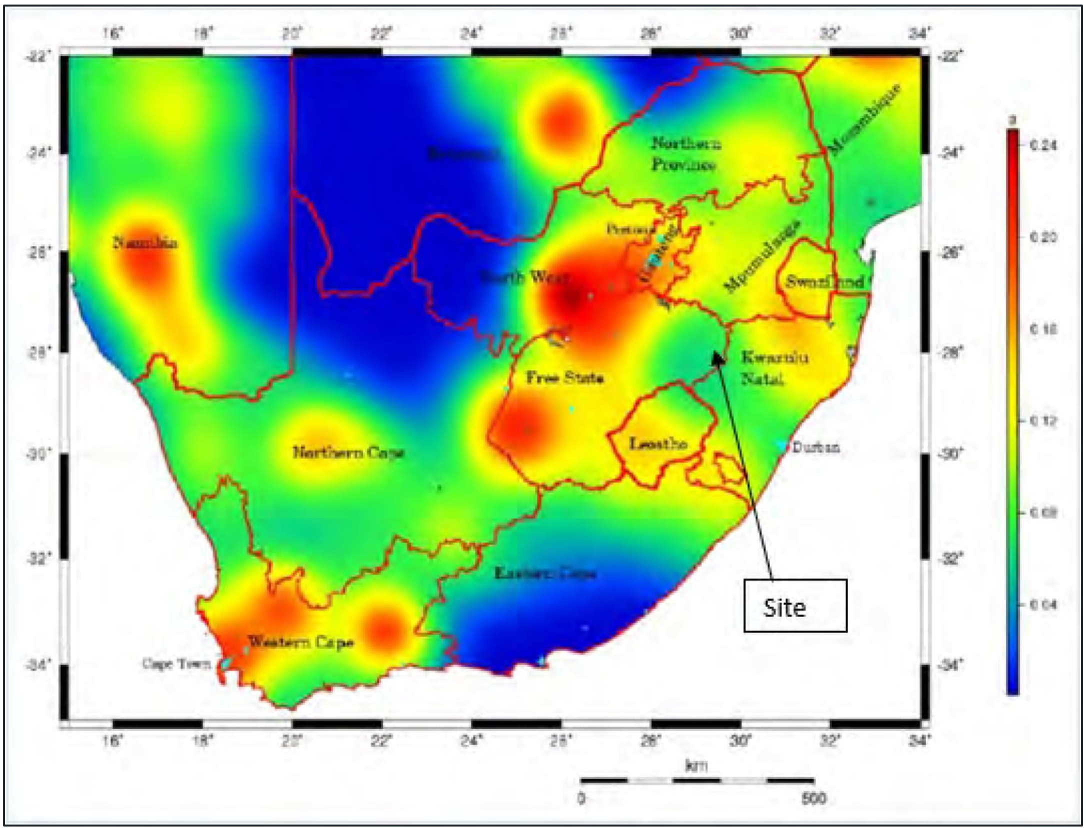
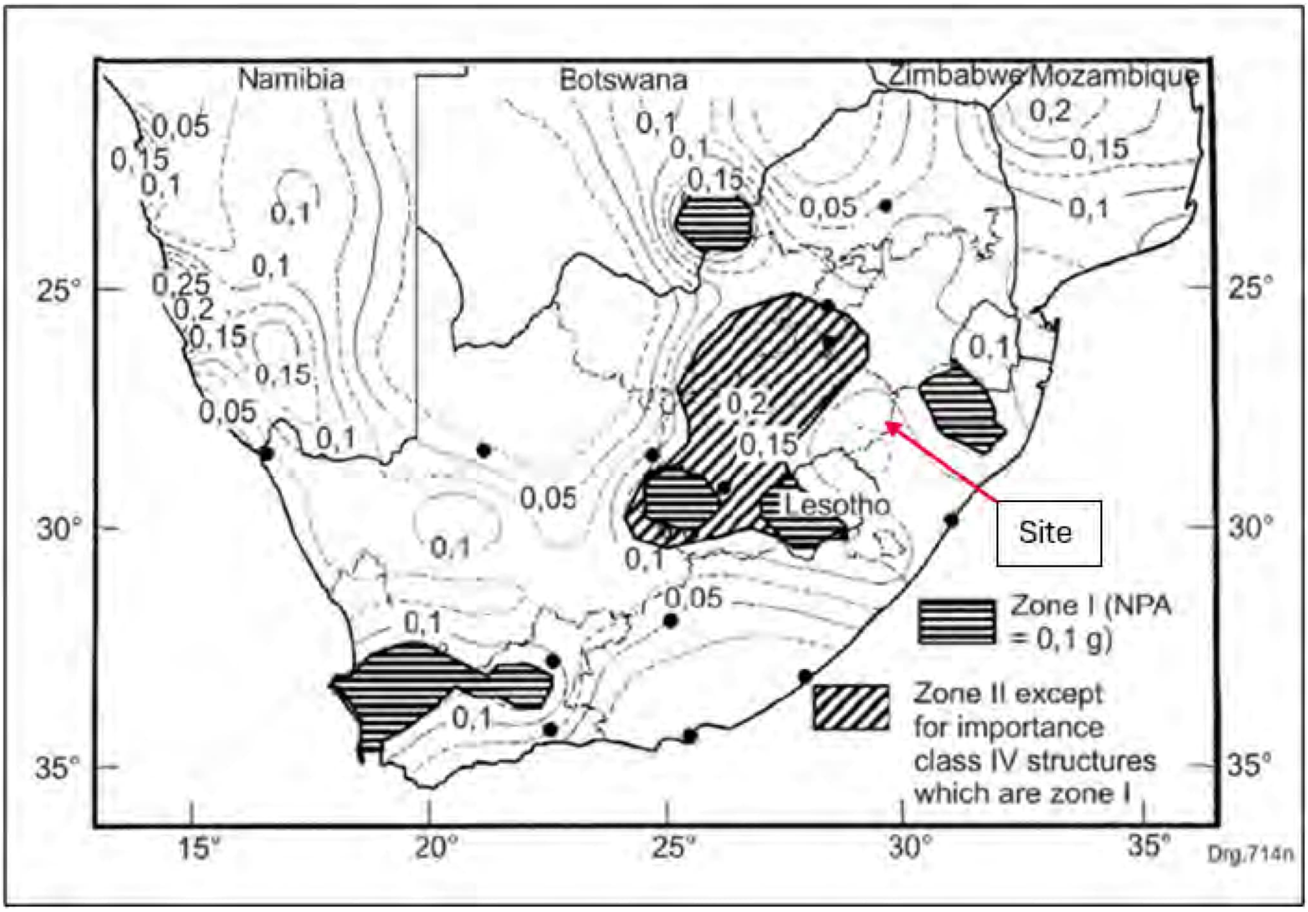


Figure 6-2 - Seismic zones



6.6 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 6-5, 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 WEF 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 as the possibility of surface subsidence cannot be discounted should the site be undermined.

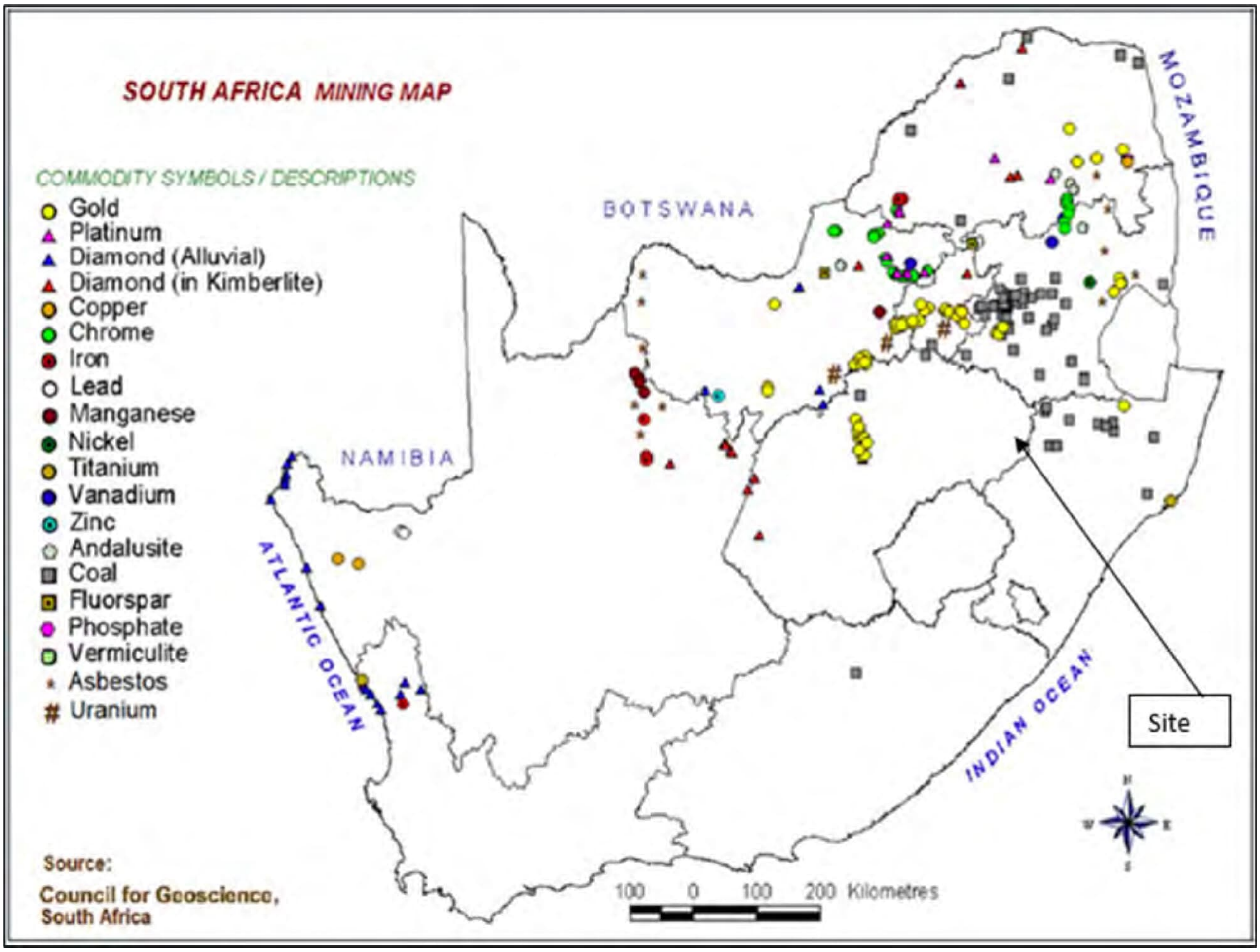


Figure 6-3 - Location of mine areas in South Africa

7 FURTHER GEOTECHNICAL INVESTIGATIONS

A detailed intrusive site investigation is recommended to further characterize site conditions, to better understand the key geotechnical risks characteristics and optimise the design of the WEF operations.

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, especially the depth to rock, 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 GEOTECHNICAL IMPACT ASSESSMENT

The geotechnical impact assessment of the proposed Kromhof WEF was performed according to the methodology included in Appendix D.

Geotechnical impacts need to be taken into account as part of the WEF 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 Wind turbines, 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 Kromhof WEF 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 D.

The WEF application site 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.

9 CONCLUSIONS

The desktop assessment of the geotechnical conditions at the proposed development site for Kromhof WEF 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 for the design 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.

9.1 ASSUMPTIONS AND LIMITATIONS

Your attention is drawn to Appendix E: 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.

10 REFERENCES

- 1:250 000 Geological Map Series (2728 Frankfort). Published by the Council of Geoscience
- 1:250 000 Geological Map Series (2828 Harrismith). Published by the Council of Geoscience
- Brink. A.B.A (1983). Engineering Geology of Southern Africa: Volume 3. Building Publications, Pretoria.
- Council for Geoscience. Report Number 2011-065. (2011). Deformation due to Mining Activities by Heath G. and Engelbrecht J.
- Council for Geoscience. Report No. 2003-0053. (2003). Probabilistic Peak Ground Acceleration and Spectral Seismic Hazard Maps for South Africa. Kijko A., Graham G., Bejaichund M., Roblin D, Brand M.B.C.,
- South African National Standard SANS 10160-4:2017. Seismic action and general requirement for buildings
- South African National Standards SANS 1200D: Earthworks, (1998).
- Weinert, H.H (1980). The Natural Road Construction Materials of Southern Africa. H& Academia Publication, Pretoria, pp298.

Appendix A

CURRICULUM VITAE

Heather Davis

Earth & Environment, Mine Waste, Geotechnical & Material Services – Geotechnical Team Lead

CAREER SUMMARY

Over 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.

2 years 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 – Geotechnical Team Lead

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

Western Range Iron Ore Mine Development, Liberia
2022 - 2023
Lead Geotechnical Engineer: South Africa Team
Design level geotechnical investigations for the Processing Plant, Quarries and several Tailings Residual Facilities were undertaken. The investigations included rotary core drilling, Cone Penetration testing and test pitting. All the data was analysed and assessed with recommendations provided for founding and required remedial measures. A challenging project due to the shallow water table which reaches the surface during the wet season.

Wessels and Mamotwan Mine Geotechnical Investigations, Hotazel, South Africa
2022 – 2024
Lead Geotechnical Engineer.
Geotechnical investigations carried out to allow the Mine to comply with International Standards with regard to information pertaining to the Tailings Residue Facilities (TSF). In addition, rail lines are to be constructed across the TSFs in places. Investigations including rotary core drilling, Cone Penetration Testing, test pitting and sampling of the tailings streams were undertaken. Comprehensive reports issued.

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.

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.

Khuthadzo Bulala

Earth & Environment, Mine Waste, Geotechnical & Engineering Services – Senior Consultant

CAREER SUMMARY

Khuthadzo Bulala is an Engineering Geologist with 8 years' experience in geotechnical investigations. Her experience and technical skills include:

- Compilation of geotechnical investigation reports
- Geotechnical core logging
- Core orientation for inclines boreholes
- Planning, managing, and executing in-situ testing (test-pitting, geotechnical drilling operations, DCP testing and piezometer installations) for geotechnical investigations
- Laboratory testing selection and liaison with laboratories
- Analysis and interpretation of laboratory and in-situ test data
- Geological mapping and sourcing of construction materials and aggregates
- Sourcing, testing and specification of construction materials and aggregates
- Health and safety documentation for fieldwork projects
- Project management including resource management and client liaison

3 years with WSP

Area of expertise

Geotechnical Investigations

Geotechnical Core Logging

Geotechnical Report Writing

Laboratory Sampling Selection

Geological Mapping

H&S Documentation

Project Management

8 years of experience

Language

English – Fluent

Tshivenda – Fluent

EDUCATION

BSc. (Honours) in Geological Sciences, University of Limpopo South Africa	2013
BSc. Degree in Geological Sciences, University of Johannesburg (Auckland Park Campus)	2011

ADDITIONAL TRAINING

Civil Engineering and Renewable Energy, Geopile Africa	2020
Geotubes and Dewatering, Kaytech	2019
Site Monitoring Workshop, JG Afrika	2019

Khuthadzo Bulala

Earth & Environment, Mine Waste, Geotechnical & Engineering Services – Senior Consultant

ArcGIS1, Introduction to Geographic Information System, JG Africa 2018

PROFESSIONAL MEMBERSHIPS

South African Council for Natural Professions – Pr. Sci Nat Member No. 116482 2021

PROFESSIONAL HISTORY

WSP Group Africa (Pty) Ltd	September 2021 – present
JG Afrika (Pty) Ltd	September 2016 – September 2021
Lesotho Highlands Development Agency (LHDA)	March 2016 – August 2016

PROFESSIONAL EXPERIENCE

Geotechnical Investigations

Ib vogt (Pty) Ltd, Ngonyama Solar Energy Facility Detailed Geotechnical Investigation, Bloemfontein, Free State, South Africa
March 2023 – ongoing
Engineering Geologist
Field investigation including test pitting, DCP and sampling and report writing.

South32 Mamatwan Mine, Tailings Storage Facility Geotechnical Investigation, Hotazel, Northern Cape, South Africa
January 2023 – ongoing
Engineering Geologist
Field investigation including test pitting, sampling and report writing.

Sasol Secunda Operations, Inside Ash Geotechnical Inside Ash Seepage Analysis, Secunda, Mpumalanga, South Africa
October 2022 – Ongoing
Geotechnical Desktop Study
Gap analysis and additional investigation executions plans for Inside Ash Seepage Analysis.

Enertrag South Africa (Pty) Ltd, Impumelelo Wind Energy Facility Geotechnical Desktop Study, Secunda, Mpumalanga, South Africa
October 2022 – January 2023
Field Engineering Geologist
Field investigation including test pitting, DCP and sampling. Report writing and foundation recommendation.

Enertrag South Africa (Pty) Ltd, Mukondeleli Wind Energy Facility Geotechnical Desktop Study, Secunda, Mpumalanga, South Africa
October 2022 – December 2022
Field Engineering Geologist
Field investigation including test pitting, DCP and sampling. Report writing and foundation recommendation.

Enertrag South Africa (Pty) Ltd, Vhuvhili Solar Energy Facility Geotechnical Desktop Study, Secunda, Mpumalanga, South Africa
June – August 2022
Project Management and Client Liaison

Khuthadzo Bulala

Earth & Environment, Mine Waste, Geotechnical & Engineering Services – Senior Consultant

Geotechnical desktop study for the Vhuvhili Solar Energy Facility and the associated structures to supplement a project Environmental Impact Assessment.

Enertrag South Africa (Pty) Ltd, Vhuvhili Solar Energy Facility Detailed Geotechnical Investigation, Secunda, Mpumalanga, South Africa
October 2020 – July 2021
Field Engineering Geologist
Field investigation including test pitting, DCP and sampling. Report writing and foundation recommendation.

Scaw South Africa (Pty) Ltd, Union Junction Hill Borrow Pit Geotechnical Investigation, Johannesburg, South Africa
February 2022 – May 2022
Project Management and Client Liaison
Geotechnical investigation for clay lining material that is needed for the development of the landfill site for their operations and

ArcelorMittal Mine Extensions, Geotechnical Investigation, Tokadeh, Liberia
January 2022
Geotechnical Report Writing
For the ArcelorMittal facilities; Tokadeh pit, Tokadeh infrastructure, Gangra Pit, Water Storage Dam, Tailings Management Facility, and Bucanan Port.

Debswana Diamond Company, Debswana Mine Facilities, Central District, Botswana
November 2021
Geotechnical Desktop Study
Gap analysis and additional investigation executions plans for Damtshaa, Orapa and Letlhakane mine facilities.

Lesotho Highlands Development Agency (LHDA), Polihali Dam, the Diversion Tunnel and the Transfer Tunnel, Tlokeng, Lesotho
March 2016 – December 2017
Site Supervision
Drilling, water pressure tests, installation of piezometers, rotary core logging for the dam site, the saddle dam, the coffer dam, the diversion tunnel, the Katse Dam transfer tunnel and the proposed borrow pits.

Calvus Properties (Pty) Ltd, Rietfontein Dam, Eastern Cape, South Africa
May 2019 – September 2021
Project Manager
Trial pitting for the dam foundation, spillway construction and the construction material at the site. Evaluation of engineering properties of subsurface material. Geotechnical reporting for dam design purposes. Geotechnical investigation and reporting for construction material borrow pits.

Umgeni Water, Darvil Dam, Pietermaritzburg, Kwa-Zulu Natal, South Africa
August 2018 – December 2018
In-Situ Investigation
Including test pitting for geotechnical soil profiles of the proposed dam site to determine the dam foundation depth. Project management and selection of laboratory tests for study objectives subsequent to the fieldwork. Compilation of a geotechnical report for the dam design and fr the construction material.

Sivest SA (Pty) Ltd, Gluckstadt Water Supply Scheme, Tugela Ferry, Kwa-Zulu Natal, South Africa
November 2019 – March 2020
Field Geologist

Evaluation along the proposed water supply pipeline, at the proposed borehole structures and at the proposed reservoir. Assessment of geotechnical properties of potential bedding material for construction. Ntabamhlophe Tank –Responsible for the field investigation and the report writing for the proposed tank.

JG Afrika Water Division, Ntabamhlophe Tank, Wembezi, Kwa-Zulu Natal, South Africa
January – April 2021
Project Manager and Client Liaison
Field investigation including test pitting and sampling. Report writing and foundation recommendation. Foundation assessment during construction.

Scatec Solar South Africa, Kenhardt Solar Farm, Kenhardt, Northern Cape, South Africa
October 2020 - July 2021
Project and Subcontract Management
Drilling supervision, in-situ investigation for site characterization. Management and selection of laboratory tests for study objectives. Client liaison and geotechnical report for pylon foundations, substation foundation and access road construction.

Enertrag SA (Pty) Ltd, Dalmanutha Wind Energy Facility, Belfast, Mpumalanga, South Africa
December 2021 – May 2022
Project Manager and Client Liaison
Geotechnical desktop study for three wind energy facilities and their associated structures to supplement a project Environmental Impact Assessment.

G7 Renwable Energies (Pty) Ltd, Oya and Yemaya Solar and Wind Energy Facility, Maitjiesfontein, Western Cape, South Africa
August 2019 – July 2020
Geotechnical Desktop Study Reports
For the two sites for the two solar sites. Test pitting and sample selection for required tests for the Oya site. Analysing and interpreting fieldwork data and laboratory results.

Sivest SA (Pty) Ltd, Client, Koup 1 and Koup 2 Wind Energy Facility, Leeu Gamka, Western Cape, South Africa
February 201 – July 2021
Project Manager and Client Liaison
Geotechnical desktop study for two wind energy facilities and their associated structures to supplement a project Environmental Impact Assessment.

WSP Africa, Client, Three Wind Energy Facilities, Northern and Western Cape, South Africa
May – September 2021
Project Manager and Client Liaison
Project management and client liaison. Geotechnical desktop studies for the proposed Brandvalley, Karreebosch and Rietkloof wind farm energy facilities and three 33kV powerlines and their associated structures.

WSP Africa Group, Uvuvuselela Railway Line Extensions, South Africa
October 201 – December 2021
Project Manager and Client Liaison
Geotechnical desktop studies for the proposed Transnet Railway Loop extensions, Port Elizabeth Port extensions and loading yards in Gauteng.

South African National Road Agency Limited, N2 Pongola to Kangela, Kwa-Zulu Natal, South Africa
2017 – 2021
Field Geologist

Responsible for trial pitting, logging, and sample collection for laboratory analysis for the N2 construction borrow pits. Collation of field data and laboratory data.

HHO Consulting Engineers, N3 Borrow Pits, Kwa-Zulu Natal, South Africa
November 2018 – April 2019
Field Engineering Geologist
Rotary core logging and percussion chips logging for the proposed borrow pits located between Durban and Pietermaritzburg for the N3 construction.

ZVK Holdings (Pty) LtdMfulamuni Access Road and Aggregates, Pomeroy, Kwa-Zulu Natal, South Africa
January – June 20221
Project Manager andClient Liaison
Fieldwork for the realignment and the re-gravelling of the Mfulamuni access road. Ensuring adequate laboratory testing for the road and the potential borrow pits. Report compilation for the road and the material investigation.

Naidu Consulting, P77 Culverts, Dududu, Kwa-Zulu Natal, South Africa
January – July 2020
Project Manager and Client Liaison

Responsible for trial pitting, logging and DPL testing to determine the subsurface characteristics for the proposed seven culverts. Compilation of an interpretive geotechnical report highlighting the foundation depths for each culvert and the geotechnical constraints thereof.

Royal HaskoningDHV, Kikwood to Addo Borrow Pit and Retaining Walls, Kirkwood, Eastern Cape, South Africa
April – December 2019
Project Manager and Client Liaison
Soil profiling and interpretation of the field profiles and laboratory results for the borrow pit and retaining walls. Material volume calculations for the borrow pits. Dynamic cone penetration and interpretation for the competent foundations for the retaining walls. Data assimilation and assessment for report writing.

High End Construction, Eastwood Pedestrian Bridge, Pietermaritzburg, Kwa-Zulu Natal, South Africa
February – May 2019
Project Manager and Client Liaison
Construction of a pedestrian bridge. Fieldwork including test pitting and DPL testing. Analysing and interpreting the field data to recommend foundation levels.

Eskom, Refurbishment of 9 Eskom Towers, Eastern Cape, South Africa
August 2019 – September 2019
Engineering Geologist
Test pitting for geotechnical ground profiles of each site. Management and selection of laboratory tests for study objectives. Foundation recommendations for each site. Geotechnical report for design purposes.

KZN Department of Public Works, Nkweletsheni Primary School, Richmond, Kwa-Zulu Natal, South Africa
January – March 2020
Project Manager and Client Liaison
School refurbishment. Test pitting, percolation testing and DPL testing for geotechnical ground profiles of the site. Management and selection of laboratory tests for study objectives. Geotechnical report for foundations, recommendations for the soak-away and for the multipurpose sports ground.

JG Afrika (Pty) Ltd Water Department, Zwelisha Moyeni Water Treatment Works, Bergville, Kwa-Zulu Natal, South Africa

Khuthadzo Bulala

Earth & Environment, Mine Waste, Geotechnical & Engineering Services – Senior Consultant

January – March 2021
Project Manager and Client Liaison
Test pitting and DPL testing for geotechnical ground profiles of the site. Management and selection of laboratory tests for study objectives. Geotechnical report for foundations of treatment works structure founded at depth of 4-5m below NGL.

JG Afrika (Pty) Ltd Water Department, Hammersdale Waste-Water Treatment Works, Hammersdale, Kwa-Zulu Natal, South Africa
May 2020 – March 2021
Engineering Geologist
Subsurface profiling and DPL testing for the extensions to the existing Hammersdale WWTW. Analysis of the profiles and selection of laboratory tests for study objectives. Data analysis and report compilation for structure foundations.

Sultex Holdings (Pty) Ltd, Proposed Giba Industrial Development, Pinetown, Kwa-Zulu Natal, South Africa
May 2019 – July 2019
Engineering Geologist
Test pitting for soil profiling, disturbed and undisturbed sampling, delineation of groundwater seepage areas. Management and selection of laboratory tests. Analysing and interpretation of laboratory test results. Compilation of geotechnical report for foundations and groundwater management recommendations.

Smec, Cornubia Fills, Cornubia, Kwa-Zulu Natal, South Africa
March 2020 – January 2021
Project Manager and Client Liaison
In-situ testing for geotechnical soil profiles of the site and general site characterization for fills for the proposed housing development. Engineering geological report for the study for the fills. Reviewing the rotary drilling report for the client.

Mariswe (Pty) Ltd, Ward 7 Community Hall, Taylors Halt, Kwa-Zulu Natal, South Africa
January 2020 – March 2020
Project Manager and Client Liaison
Conducting the geotechnical investigation that included trial pitting, laboratory testing and percolation testing. Fieldwork and laboratory data processing for geotechnical report compilation.

Dartingo Consulting Engineers (Pty) Ltd, Mandalathi Community Hall, Kwa-Zulu Natal, South Africa
2020
Project Manager and Client Liaison
Conducting the geotechnical investigation that included trial pitting, laboratory testing and percolation testing. Fieldwork and laboratory data processing for geotechnical report compilation.

Ethekwini Municipality: Human Settlements and Infrastructure, Austerville Sites, Durban, Kwa-Zulu Natal, South Africa
February 2021 – June 2021
Project Manager and Client Liaison
In situ soil profiling and interpretation of the profiles. Consistency tests (DPL) and interpretation of the results evaluate the EASPB. Data compilation and report writing to determine the site’s suitability for temporary housing development and recommending relevant foundation measures.

JG Afrika (Pty) Ltd Agricultural Engineering Division, Five ADA Rabbitry Sites, Kwa-Zulu Natal, South Africa
August 2019 – October 2019
Project Manager and Client Liaison

In situ soil profiling and interpretation of the profiles. Consistency tests (DPL) and interpretation of the results evaluate the EASPB and sample collection for laboratory analysis. Report compilation with foundation recommendations.

Private Developers, Several Intaba Ridge Estate Houses Pietermaritzburg, Kwa-Zulu Natal, South Africa
2017 – 2020
Project Manager and Client Liaison with Property Developers
In situ soil profiling, conducting in-situ consistency tests (DPL) and sampling for laboratory analysis. Report writing to determine the site's suitability for the house developments and recommending foundation depths and types as per NHBRC guidelines.

Private Developer, Student Accommodation, Pietermaritzburg, Kwa-Zulu Natal, South Africa
April 2019 – July 2019
Project Manager and Client Liaison
For the proposed three storey student accommodation development. In situ soil profiling, conducting in-situ consistency tests (DPL) and sampling for laboratory analysis. Report writing to determine the site's suitability for the housing development and recommending foundation depths and type as per NHBRC guidelines.

Green Door Environmental, 220 Murray Road Development, Pietermaritzburg, Kwa-Zulu Natal, South Africa
June 2019 – August 2019
Project Manager and Client Liaison
Report writing and field data analysis for the infill geotechnical investigation report for a multi-story development in Hayfields. The development includes a school, a shopping complex, a drive through, a petrol filling station and a residential area.

Marang Environmental and Associates (Pty) Ltd, Heidelberg Cemetery Extension, Heidelberg, Gauteng, South Africa
June 2020 – December 2020
Project Manager and Client Liaison
For the extension of the existing Heidelberg cemetery. Subsurface profiling and interpretation of the profiles. Field sampling for laboratory analysis. Geotechnical report writing and evaluating the site as per the South African Council for Geoscience Guidelines for Cemeteries.

Ziphelele Planning and Environmental Consultancy, Three Proposed Umhlathuze Cemeteries, Empangeni, Kwa-Zulu Natal, South Africa
May 2018 – February 2019
Project Manager and Client Liaison
For the development of three cemetery sites. Subsurface profiling, percolation testing and field sampling for laboratory analysis. Geotechnical report writing, evaluating and rating the sites as per the South African Council for Geoscience Guidelines for Cemetery Development.

Ziphele Planning and Environmental Consultancy, Alfred Duma Cemeteries, Ladysmith, Kwa-Zulu Natal, South Africa
June 2019 – October 2019
Project Manager and Client Liaison
For the development of cemetery sites in the municipality. Geotechnical desktop studies to evaluate and rate the proposed sites in Colenso, Ladysmith and Ezakheni. The desktop study reports were written as per the South African Council for Geoscience Guidelines for Cemeteries.

Alfred Duma Municipality, Closure of Acaciavale Landfill Site, Ladysmith, Kwa-Zulu Natal, South Africa
2018 – 2020
Engineering Geologist

Fieldwork including test pit profiling and interpretation from test pitting and sampling for study objectives. Data analysis and report compilation for the closure of the landfill site and recommendations on closure material.

Alfred Duma Municipality, Danskraal Landfill Site, Ladysmith, Kwa-Zulu Natal, South Africa
2020
Project Manager and Client Liaison

Including GIS work to identify and shortlist potential landfill sites. Fieldwork including test pit profiling and interpretation from test pitting for landfill site development investigation. Data analysis and report compilation.

Department of Rural Development and Land Reform, UMgungundlovu Landfill Site, Pietermaritzburg, Kwa-Zulu Natal, South Africa
March 2020
Site Supervision
For the percussion drilling contract for the proposed new landfill site. Subcontractor management and client liaison. Percussion chip logging. Borehole water level and yield measurements. Hydrocensus and sampling existing boreholes in a 1km radius.

Department of Rural Development and Land Reform, Agricultural Potential Assessment for the Ground Truthing: New Irrigation Schemes Survey in Harry Gwala District, Umzimkhulu, Kwa-Zulu Natal, South Africa
July 2017 – August 2019
Project Manager and Client Liaison
Agricultural soil survey and sampling. Data analysis and report compilation for the agricultural potential and the irrigation potential of 7500ha land in the district municipality. Presentation of the final findings to the client.

Appendix B

EXPOSURE PROFILE LOGS

TEST PIT PROFILE

CLIENT: Kromhof Wind Power (Pty) Ltd
PROJECT: Kromhof Wind Energy Facility
LOCATION: Free State Province
PROJECT NO: 41106427

HOLE No: K2
X COORD: 3100545.00
Y COORD: - 53206.00
DATUM: WGS84
ELEVATION: 1918.0

Scale	Legend	Depth	Description
		0.00 – 0.40	Dry, reddish brown, very stiff, sandy CLAY containing minor rounded dolerite gravel, cobbles and boulders up to 300mm diameter. Also contains roots **Colluvium**.
0.5		0.40 – 0.80	Dry, dark grey stained white, very stiff, sandy silty CLAY **Residual**.
1.0			**End of exposure**
			End of log
1.5			
2.0			
2.5			
3.0			
3.5			
4.0			
4.5			

NOTES:
1: No groundwater seepage
2: No sidewall collapse
3: Cutting adjacent to culvert
4: Photo's taken facing south

WSP Group Africa Pty Ltd
Maxwell Office Park, Magwa Cres
Waterfall City, Midrand, 1685
Telephone: 011 254 4800

CONTRACTOR: WSP
MACHINE: Exposure
PIT LxB:
FILE REF: KROMHOF WEF PROFILE LOGS.GPJ

DATE EXCAVATED: 2024/07/10
DATE PROFILED: 2024/07/10
PROFILED BY: DG
CHECKED BY: KB

TEST PIT PROFILE

CLIENT: Kromhof Wind Power (Pty) Ltd
PROJECT: Kromhof Wind Energy Facility
LOCATION: Free State Province
PROJECT NO: 41106427

HOLE No: K3
X COORD: 3100532.00
Y COORD: - 53495.00
DATUM: WGS84
ELEVATION: 1917.0

Scale	Legend	Depth	Description
0.0 – 5.0		0.00 – 5.00	Dry to slightly moist, reddish brown, loose to medium dense, silty SAND containing abundant sub-angular to rounded sandstone gravel, cobbles and boulders up to 1200mm diameter. **Talus**.
5.0 – 5.5			**End of exposure** End of log

NOTES:
1: No groundwater seepage
2: No sidewall collapse
3: Cutting
4: Photo's taken facing east

WSP Group Africa Pty Ltd
Maxwell Office Park, Magwa Cres
Waterfall City, Midrand, 1685
Telephone: 011 254 4800

CONTRACTOR: WSP
MACHINE: Exposure
PIT LxB:
FILE REF: KROMHOF WEF PROFILE LOGS.GPJ

DATE EXCAVATED: 2024/07/10
DATE PROFILED: 2024/07/10
PROFILED BY: DG
CHECKED BY: KB

TEST PIT PROFILE

CLIENT:	Kromhof Wind Power (Pty) Ltd
PROJECT:	Kromhof Wind Energy Facility
LOCATION:	Free State Province
PROJECT NO:	41106427

HOLE No:	**K4**
X COORD:	3100532.00
Y COORD:	- 53495.00
DATUM:	WGS84
ELEVATION:	

Scale	Legend	Depth	Description
		0.00	Slightly moist, dark greyish brown, firm, sandy CLAY containing abundant sub-angular to rounded sandstone and dolerite gravel and cobbles. **Alluvium**.
0.5			
1.0		1.00	**End of exposure**
			End of log
1.5			
2.0			
2.5			
3.0			
3.5			
4.0			
4.5			

NOTES:
1: Perched groundwater table at 1.0m
2: No sidewall collapse
3: Exposure from a drainage ditch
4: Photo's taken facing north

WSP Group Africa Pty Ltd
Maxwell Office Park, Magwa Cres
Waterfall City, Midrand, 1685
Telephone: 011 254 4800

CONTRACTOR:	WSP	DATE EXCAVATED:	2024/07/10
MACHINE:	Exposure	DATE PROFILED:	2024/07/10
PIT LxB:		PROFILED BY:	DG
FILE REF:	KROMHOF WEF PROFILE LOGS.GPJ	CHECKED BY:	KB

Appendix C

EXPOSURE PHOTOGRAPHS

K1

Project: Kromhof Wind Energy Facility
Project No: 41106427

K2

Project: Kromhof Wind Energy Facility
Project No: 41106427


K3

K4

Project: Kromhof Wind Energy Facility
Project No: 41106427

Appendix D

IMPACT ASSESSMENT

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

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 0-1**.

Table 0-1: 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

[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.

CRITERIA	SCORE 1	SCORE 2	SCORE 3	SCORE 4	SCORE 5
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.

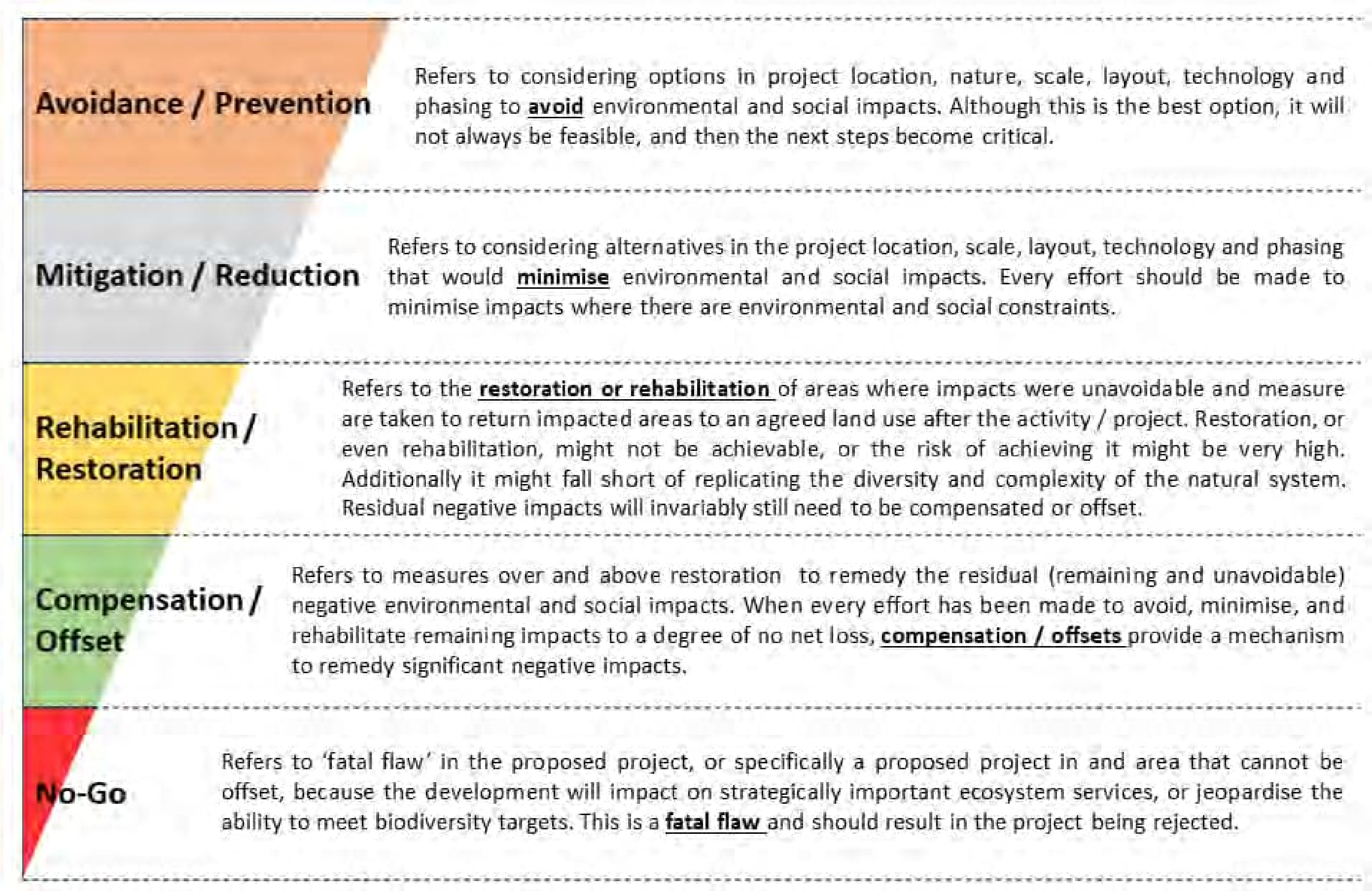


Figure 1: Mitigation Sequence/Hierarchy

Project Name	41106427 - Kromhof Wind Energy Facility Geotechnical Impact Assessment

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	• Rehabilitation of affected areas (such as revegetation). • Construction of temporary berms and drainage channels to divert surface water. • Minimize earthworks and fills. • Use existing road network and access tracks. • Correct engineering design and construction of gravel roads and water crossings. • Control 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 and conditional monitoring
					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 and control excavations
					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 8:	Seismic activity	Damage of proposed development.	Construction	Negative		4	1	3	4	1	12	N1	2	1	3	3	1	9	N1	Design according to expected peak ground acceleration.
					Significance	N1 - Very Low							N1 - Very 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:	Seismic activity	Damage of proposed development.	Operational	Negative		4	1	3	4	1	12	N1	2	1	3	3	1	9	N1	Monitor seismic activity in the area
					Significance	N1 - Very Low							N1 - Very 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	• Use existing road network and access tracks. • Use of temporary berms and drainage channels to divert surface water. • Minimize earthworks and demolish footprints. • Rehabilitation of affected areas (such as revegetation). • Reinstate channelized drainage features. • Strip, stockpile and re-spread topsoil
					Significance	N3 - Moderate							N1 - Very Low							
Impact 2:	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 and conditional monitoring
					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 excavation
					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**	• Use existing road network and access tracks. • Use of temporary berms and drainage channels to divert surface water. • Minimize earthworks and demolish footprints. • Rehabilitation of 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 and conditional monitoring
					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**	Limited excavations
					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	1	3	4	1	**12**	**N1**	2	1	3	3	1	**9**	**N1**	Design according to expected peak ground acceleration.
					Significance	**N1 - Very Low**							**N1 - Very Low**							

Appendix E

DOCUMENT LIMITATIONS

DOCUMENT LIMITATIONS

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