Report to SiVEST

Desktop Geotechnical Specialist Study for the:

PROPOSED CONSTRUCTION AND OPERATION OF THE BATTERY ENERGY STORAGE SYSTEM (BESS) AND ASSOCIATED INFRASTRUCTURE FOR THE AUTHORISED LOERIESFONTEIN 3 PV SOLAR ENERGY FACILITY LOCATED NEAR LOERIESFONTEIN IN THE HANTAM LOCAL MUNICIPALITY, NAMAKWA DISTRICT IN THE NORTHERN CAPE PROVINCE OF SOUTH AFRICA

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Report to:	SiVEST Environmental Division 51 Wessel Road, Rivonia, 2129
Project name:	Loeriesfontein 3 PV Facility Battery Energy Storage System (BESS)
Report title:	Desktop Geotechnical Specialist Study
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Revision Details:	

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LOERIESFONTEIN 3 PV SOLAR ENERGY FACILITY LOCATED NEAR LOERIESFONTEIN IN THE HANTAM LOCAL MUNICIPALITY, NAMAKWA DISTRICT IN THE NORTHERN CAPE PROVINCE OF SOUTH AFRICA

Executive Summary

This desktop geological and geotechnical specialist study assed the proposed development of a Battery Energy Storage System (BESS) and associated infrastructure for the Loeriesfontein 3 Photovoltaic (PV) Energy Facility (12/12/20/2321/2/AM4), located near Loeriesfontein in the Hantam Local Municipality, Namakwa District Municipality, in the Northern Cape Province of South Africa.

The assessment area is located in a relativity flat area with a very slight slope (0.74° to 0.50°; 0.88% to 1.43%; less than 1:20) towards the northwest. Drainage is expected to occur in this direction towards an endoreic basin, named Kareedoringpan. There are no continuous and distinct drainage features on the site, although signs of concentrated overland surface flow and occasional rills and are noted to exist throughout the site area. It is expected that localised undulations and erosional features occur throughout the site. The nature of the drainage features could not be confirmed in the desk study. The site falls within a hot desert climate (BWk) according to the Köppen-Geiger climate classification.

The assessment area has been divided into two Ground Units, namely Zone I, underlain by a thin transported horizon covering rock units of the Whitehall Formation and those underlain by relativity thicker alluvial deposits, identifiable by erosion paths or rills defined as Zone II. Founding conditions will be adequate for founding the proposed infrastructure at shallow depths on conventional footings, although a deeper footing depth will be required where alluvium is encountered.

No faults, lineaments or other geological features were identified. The Permian-aged Whitehill Formation is known to contain plant, palaeoniscoid fish and anthropod fossils and remains of two species of the swimming reptile Mesosaurus.

No fatal flaws have been identified that would render the proposed BESS site unsuitable from a geological and geotechnical perspective. No geologically or geotechnically sensitive areas were identified within or near the assessment area. While certain sections of the assessment area considered marginally more suitable for development from a geotechnical perspective other areas, other factors are likely to be more critical in determining the final BESS layout. No preferences for the final BESS layout within the assessment area are therefore provided.

The proposed BESS is assessed to have a “Negative Low impact - the anticipated impact will have negligible negative effects and will require little to no mitigation” from a geological and geotechnical viewpoint. The mitigation measures provided in this report to minimise the impacts relate to the appropriate engineering design of earthworks and site drainage, erosion control and topsoil and spoil material management. These do not exceed civil engineering and construction best practice. It is recommended that the proposed activity be authorised.

NATIONAL ENVIRONMENTAL MANAGEMENT ACT, 1998 (ACT NO. 107 OF 1998) AND ENVIRONMENTAL IMPACT REGULATIONS, 2014 (AS AMENDED) - REQUIREMENTS FOR SPECIALIST REPORTS (APPENDIX 6

Regulation GNR 326 of 4 December 2014, as amended 7 April 2017, Appendix 6	**Section of Report**
1. (1) A specialist report prepared in terms of these Regulations must contain- a) details of- i. the specialist who prepared the report; and ii. the expertise of that specialist to compile a specialist report including a curriculum vitae;	 1.3 Appendix B
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Appendix A
c) an indication of the scope of, and the purpose for which, the report was prepared;	1.1, 1.2
(cA) an indication of the quality and age of base data used for the specialist report;	1.4, References
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	5, 6
d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Not applicable
e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	1.4, Appendix C
f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	3, 6, 7
g) an identification of any areas to be avoided, including buffers;	None identified
h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	No sensitivities identified
i) a description of any assumptions made and any uncertainties or gaps in knowledge;	2
j) a description of the findings and potential implications of such findings on the impact of the proposed activity, (including identified alternatives on the environment) or activities;	5,6,7
k) any mitigation measures for inclusion in the EMPr;	6.1 Table 6-1
l) any conditions for inclusion in the environmental authorisation;	6.1 Table 6-1
m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	6.1 Table 6-1
n) a reasoned opinion- i. (as to) whether the proposed activity, activities or portions thereof should be authorised; (iA) regarding the acceptability of the proposed activity or activities; and ii. if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	6.1, 8 6.1 Table 6-1
o) a description of any consultation process that was undertaken during the course of preparing the specialist report;	Not applicable
p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	None
q) any other information requested by the competent authority.	None
2) Where a government notice *gazetted* by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	Not applicable

Table of Contents

Figures

Tables

1. Introduction

GaGE Consulting (Pty) Ltd has been appointed by SiVEST (Pty) Ltd, on behalf of South Africa Mainstream Renewable Power Loeriesfontein 3 (Pty) Ltd, to undertake the assessment of the proposed development of a Battery Energy Storage System (BESS) and associated infrastructure for the authorised Loeriesfontein 3 Photovoltaic (PV) Energy Facility (12/12/20/2321/2/AM4), located near Loeriesfontein in the Hantam Local Municipality, Namakwa District Municipality, in the Northern Cape Province of South Africa.

In terms of the Environmental Impact Assessment (EIA) Regulations, which were published on 04 December 2014 and amended on 07 April 2017 [promulgated in Government Gazette 40772 and Government Notice (GN) R326, R327, R325 and R324 on 7 April 2017], various aspects of the proposed development are considered listed activities under GNR 327 and GNR 324 which may have an impact on the environment and therefore require authorisation from the National Competent Authority (CA), namely the Department of Environment, Forestry and Fisheries (DEFF), prior to the commencement of such activities. This desktop geological and geotechnical specialist study has been commissioned to assess and verify the BESS under the applicable specialist protocols.

1.1. Scope and Objectives

Assess the impacts associated with the installation of a BESS on the Loeriesfontein 3 Photovoltaic (PV) Energy Facility (12/12/20/2321/2/AM4), as well as including potential fatal flaws, if any.

The following key considerations were taken into account during the desktop study:

- The geological and geotechnical conditions (ground conditions) and the influence thereof on the competency of founding of civil infrastructure and structures
- Site topography and influence thereof on the site stability and suitability
- The presence of geological or geomorphological features such as faults, lineaments and unstable ground
- The presence of problem soils, geotechnical constraints, shallow groundwater conditions
- Geologically significant or sensitive features such as ridges, outcrops and exposures

1.2. Terms of Reference

The terms of reference were provided by SiVEST to allow a consistent approach to the various specialist studies and allow enable comparison of environmental impacts, efficient review, and collation of the specialist studies into their Basic Assessment report. This study is undertaken in accordance with the requirements provided in Regulation GNR 326 of 4 December 2014, as amended 7 April 2017, Appendix 6.

A detained description of the infrastructure required for the BESS including layouts of the proposed development were provided by SiVEST.

1.3. Specialist Credentials

This study has been undertaken by Steven Bok, a Professional Natural Scientist registered by the South African National Council for Natural Scientific Professions (SACNASP) registration number 400279/07 (Geological Science). Mr Bok’s CV is attached in Appendix B.

1.4. Assessment Methodology

The assessment involved a review of the following information:

i) 1:250 000 Scale Geological Map 3018 Loeriesfontein (Council for Geoscience, 2011)
ii) Aerial photographs (Google Earth imagery, current and historical)

iii) Technical report titled "Factual Report on Preliminary Geotechnical Investigation Loeriesfontein Wind & Solar PV Project" published by Vela VKE Consulting Engineers and produced by Mainstream Renewable Power dated July 2012
iv) Technical report titled "Factual Geotechnical Report for Loeriesfontein Wind Power Project" published by Vela VKE Consulting Engineers and produced by Mainstream Renewable Power dated July 2014
v) Screening Report for Environmental Authorisation (national web based environmental screening tool)
vi) General site photographs provided by SiVEST
vii) Literature as referenced within this report

The geotechnical investigation report referenced in bullet iii provides covers an area to the south of the site with the closest test pits located approximately 750 m from the proposed BESS assessment area. This area is underlain by the similar stratigraphic units.

An Environmental Impact Assessment matrix was used to quantify the impacts of the project on the receiving environment (provided by SiVEST and attached as Appendix C).

2. Assumptions and Limitations

The services performed by GaGE Consulting (Pty) Ltd were conducted in a manner consistent with the level of care and skill ordinarily exercised by members of the geotechnical profession practising under similar conditions in the locality of the project. The interpretation of the site conditions is based on available information, experience in the general project area and professional judgement and is considered to provide sufficient confidence to meet the objectives of this specialist study. The nature of geotechnical engineering is such that conditions at variance with those described may be encountered on site. Engineering recommendations provided in this report are preliminary and must be confirmed through further intrusive investigations.

Third party information has been utilised in good faith.

A site visit was not undertaken.

3. Technical Description

3.1. Project Location

The BESS is located on the authorised Loeriesfontein 3 Photovoltaic (PV) Energy Facility (12/12/20/2321/2/AM4), located near Loeriesfontein in the Hantam Local Municipality, Namakwa District in the Northern Cape Province of South Africa.

The Loeriesfontein 3 PV BESS will be located adjacent to the approved Loeriesfontein 3 PV substation associated with the approved Loeriesfontein 3 PV. To reduce electrical losses the BESS must be in close proximity to the on-site 33/132 kV substation. A ~5 ha study site has been established around the approved substation (500 m zone) to allow for the micrositing / specialist guidance regarding placement can be made. The location of the study area is presented in Figure 3-1.

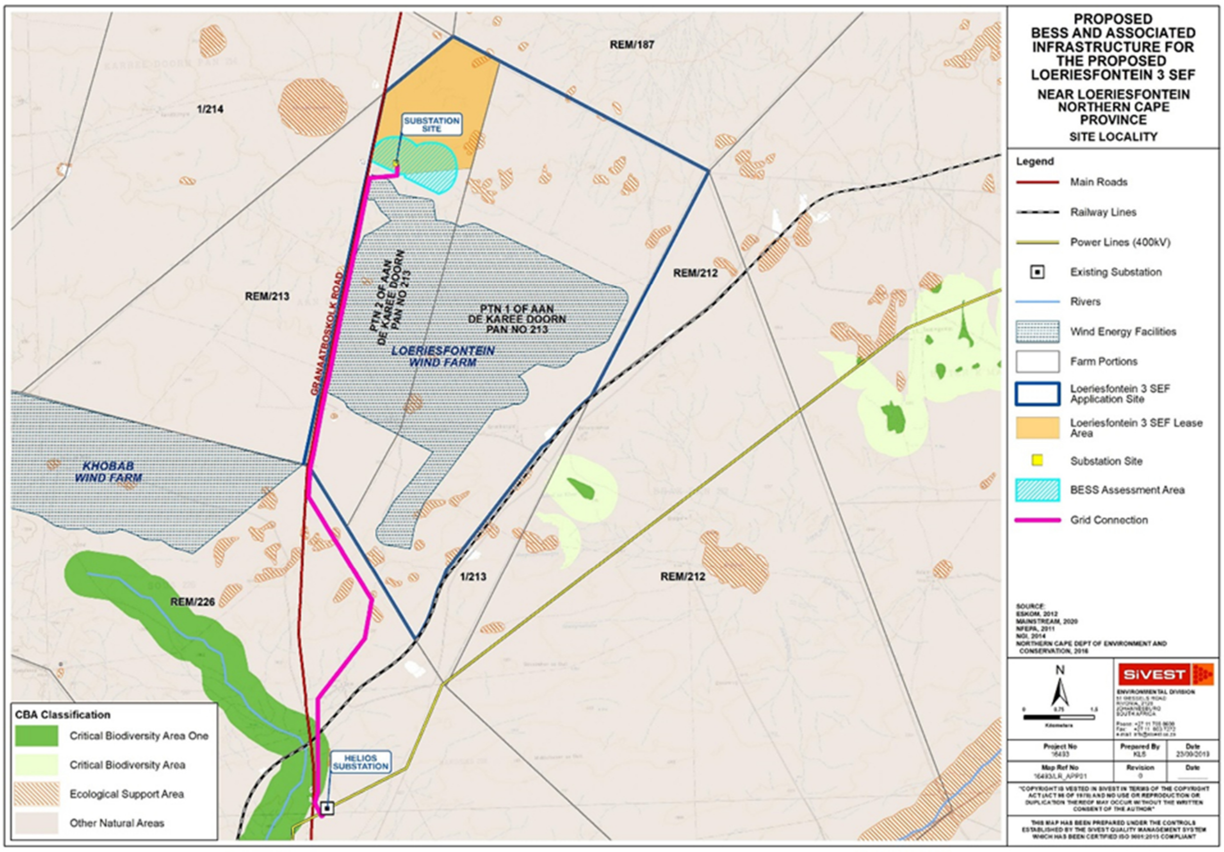

Figure 3-1 BESS is located on the authorised Loeriesfontein 3 Photovoltaic (PV) Energy Facility

3.2. Project Description

South Africa Mainstream Renewable Power Loeriesfontein 3 (Pty) Ltd is proposing the construction and operation of Battery Energy Storage System (BESS) and associated infrastructure for the authorised Loeriesfontein 3 PV (12/12/20/2321/2/AM4), located near Loeriesfontein in the Hantam Local Municipality, Namakwa District in the Northern Cape Province of South Africa. The need for a BESS stems from the fact that electricity is only produced by the Renewable Energy Facility while the sun is shining, while the peak demand may not necessarily occur during the day-time. Therefore, the storage of electricity and supply thereof during peak-demand will mean that the facility is more efficient, reliable and electricity supply more constant.

The BESS will:

- Store and Integrate a greater amount of renewable energy from the Renewable Energy Facility into the electricity grid;
- This will assist with the objective to generate electricity by means of renewable energy to feed into the National Grid which will be procured under either the Renewable Energy Independent Power Producer Procurement Program (REIPPPP), other government run procurement programmes or for sale to private entities if required

The need for a BESS stems from the fact that electricity is only produced by the Renewable Energy Facility (REF) while the sun is shining, while the peak demand may not be necessarily occur during day-time. Therefore, the storage of electricity and supply thereof during peak-demand will mean that the facility is more efficient, reliable and stable electricity supply.

3.2.1. Alternatives

No site alternatives for this proposed development were considered as the placement of the proposed BESS is dependent on the location of the Loeriesfontein 3 Photovoltaic (PV) Energy Facility (12/12/20/2321/2/AM4).

Technology alternatives are limited to battery types, namely Redox flow batteries and Solid State Batteries. No other activity alternatives are being considered.

The BESS alternatives are:

BESS Specifications	
BESS Footprint	Up to 2Ha
BESS Capacity	200MWh
BESS Technology	Lithium Ion
BESS Type Alternative- Solid State Batteries	Containerised systems assembled within shipping containers and delivered to the project site. Dimensions are approximately 17 m long x 3.5 m wide x 4 m high. Containers will be placed on a raised concrete plinth (30 cm) and may be stacked on top of each other to a maximum height of approximately 15 m. Additional instrumentation, including inverters and temperature control equipment, may be positioned between the battery containers.

The 'no-go' alternative is the option of not constructing and operating a BESS in support of the authorised Renewable Energy (RE) facility. This alternative would result in no additional environmental impact other than that assessed during the EIA for the RE facility

The 'no-go' option is an option; however, this would prevent the Loeriesfontein 3 PV from contributing to the environmental, social and economic benefits associated with the development of the renewables sector.

The above-mentioned alternatives (including 'no-go' alternative) will all be assessed by the appointed specialists as part of the BA process. All the above-mentioned location alternatives will be informed by the identified environmental sensitive and/or 'no-go' areas (i.e. status quo). Micro-site alternatives within the assessment are being considered and comparatively assessed as part of the BA process for the proposed development.

4. Legal Requirement and Guidelines

The desktop study was undertaken according to the guidelines provided by The South African Institution of Civil Engineering Site Investigation (SAICE) Code of Practice published by The Geotechnical Division of SAICE, 2010.

This report has been prepared to meet the requirements for a specialist report as provided in Regulation GNR 326 of 4 December 2014, as amended 7 April 2017, Appendix 6.

5. Description of the Receiving Environment

The following description of the receiving environment is relevant to assessing the geological and geotechnical impacts.

5.1. Climate

The area surrounding Loeriesfontein is considered to have a desert climate with little rainfall all year long. The area can be classified as hot desert climate (BWk) according to the Köppen-Geiger climate classification. The average annual rainfall is 224 mm with the average maximum and minimum temperatures of 22.8°C and 9.9°C, respectively.

Climate plays a fundamental role in rock weathering and soil development. The effect of climate on the weathering processes (i.e. soil formation) in a particular area can be determined from the climatic N-value, defined by Weinert (1980). A climatic N-Value of 5 or less implies a water surplus and the dominant mode of weathering is chemical decomposition. These climatic conditions are favourable for the development of a deep residual soil profile. Where the climatic N-value is greater than 5, mechanical disintegration is the predominant mode of rock weathering. In these drier areas residual soils are typically shallow.

Weinert's climatic N-value for the site is greater than 10, approximately 22, which indicates a scarcity of water. Physical disintegration will dominate resulting in a thin gravelly residual soil and a shallow bedrock (unless covered with transported soils). This climate is conducive to the formation of pedogenic calcrete.

5.2. Topography and Drainage

The topography of the BESS assessment area is flat with a very slight slope (0.74° to 0.50°; 0.88% to 1.43%; less than 1:20) towards the northwest. Drainage is expected to occur in this direction towards an endoreic basin, named Kareedoringpan. Based on topo-cadastral sheet 3019DA, the area to the south of site is scattered with non-perennial drainage features. There are no continuous and distinct drainage features on the site, although signs of overland surface flow and occasional rills and are noted to exist throughout the site area. It is expected that localised undulations and erosional features occur throughout the site. The nature of the drainage features could not be confirmed in the desk study. A map extracted from Google Earth (2020) showing site information is presented in Figure 5-1.

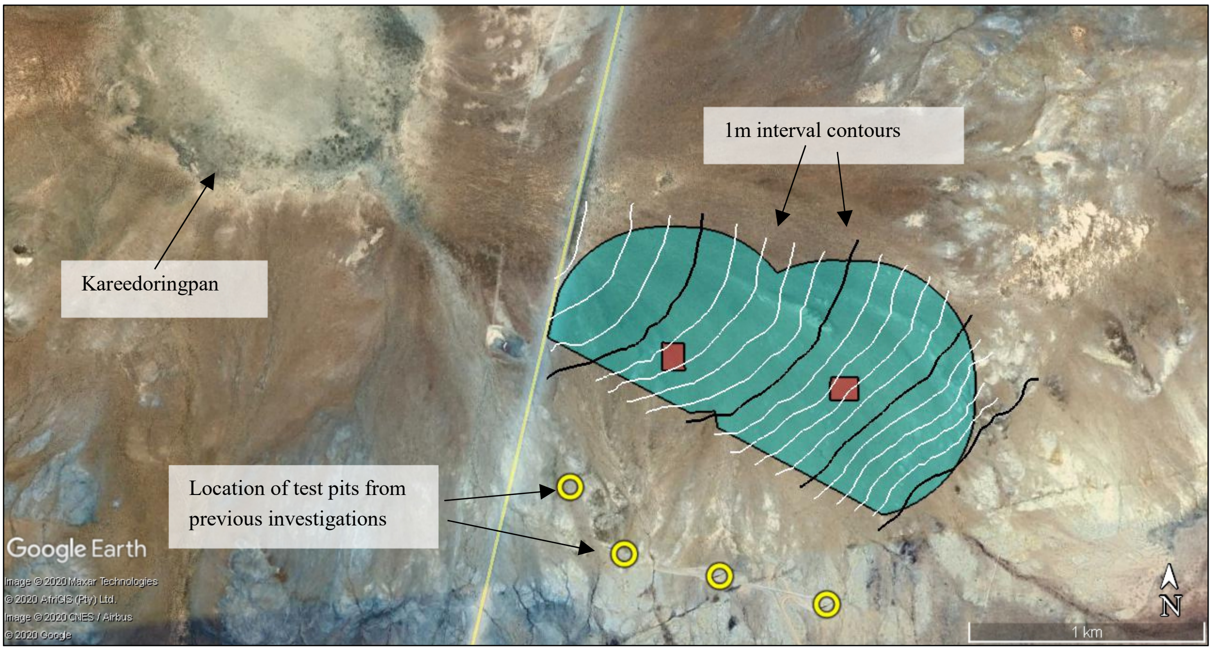

Figure 5-1 A map showing simplified contours and location of trial pits from previous investigations

5.3. Seismicity

The Northern Cape can generally be considered a region with a low hazard (peak ground acceleration of 0 – 0.2 m/s^2). According to the Seismic Hazard Map of South Africa contained in the new South African Loading Code - SANS 10160 the peak ground acceleration (g) with a 10% probability of being exceeded in a 50 year period for the site is in the order of 0.12 – 0.16 g.

5.4. Bedrock Geology

According to the 1:250 000 scale geological map 3018 Loeriesfontein (2011), the bedrock geology beneath the site comprises black to light grey weathering, dark grey carbonaceous, pyrite bearing, shale of the Whitehill Formation (designated ***Pw***) found in the Ecca Group. The mudrocks weathered to white on surface making them easily identifiable (Johnson et al, 206). The shale is very thinly laminated and contain relatively high organic carbon (up to 17%).

The local geological map shows the bedrock is overlain by extensive deposits of Quaternary-aged alluvium (designated by yellow shaded area) assumed to be associated with the drainage features in the area. The surrounding area of the site is seemingly underlain by dolerite sills that intruded into the shale during the Jurassic age (designated ***Jd***), which may extend to beneath the area of interest.

No faults, lineaments or other geological features are illustrated on the geological map or are visible from aerial photography.

The Permian-aged Whitehill Formation is known to contain plant, palaeoniscoid fish and anthropod fossils and remains of two species of the swimming reptile Mesosaurus (Johnson et al 2006). This rock unit may be classified as "High Sensitivity" for the palaeontology theme. The volcanic rocks, namely dolerite, are not fossiliferous.

The geological map indicates that a gypsum source is located to the south west of the site. Gypsum is an evaporite deposit and usually occurs on surface. No mining activities have taken place on or close to the BESS assessment area.

An extract from the 1:250 000 scale geological map 3018 Loeriesfontein is provided in Figure 5-2.

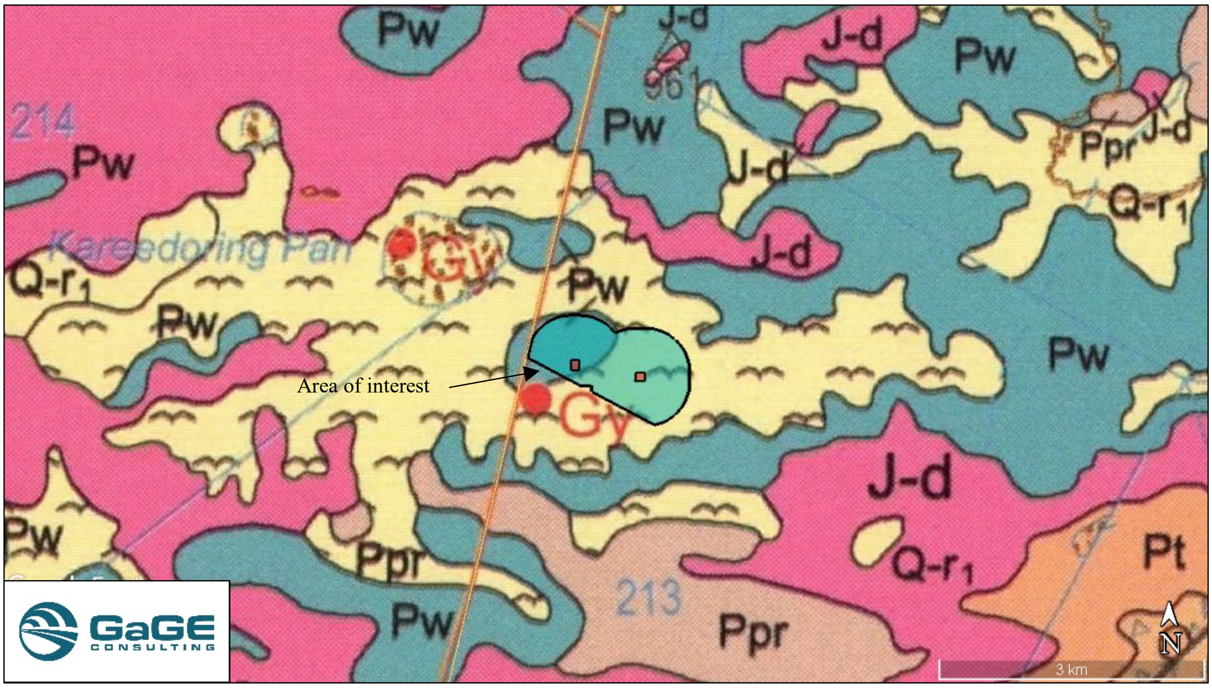

Figure 5-2 Extract of 1:250 000 scale Geological Map 3018 Loeriesfontein (Google Earth, 2020)

5.5. Engineering Geology

The shale is expected to occur from a very shallow depth below ground level (BGL). Review of the pervious geotechnical investigation in the vicinity of the site indicates that shale bedrock was encountered from an average depth of approximately 0.20 m below ground level (BGL) in eight (8 No.) test pits at the four locations indicated in Figure 5-1 (two test pits at each location). The test pits were terminated at a maximum depth of 4.00m BGL and at an average depth of 2.10m BGL, mainly refusing on hard rock shale. The shale material is thinly laminated and highly fractured, allowing the TLB to rip the material and excavate to great depths.

The pervious investigation revealed that the bedrock is covered by a relatively thin alluvium horizon, existing from surface to an average depth of 0.20 m BGL, that comprises a loose, silty gravelly sand, being sandier within local drainage features and within the vicinity of pans, and occasionally overlain by a very weakly cemented calcrete horizon. The formation of duripan (in the form of a variable calcrete horizon ranging from nodules to hardpan calcrete) is expected to occur locally in parts of the site, which is characteristic of the Namaqualand soils.

No test pits from the previous investigation were excavated within the area of interest, or in drainage or erosion features. It can be expected that the alluvial material may thicken in portions within the BESS assessment area, especially in rills and erosion features seemingly present on site. The alluvial material in this area exhibits collapsible fabric according to pervious geotechnical investigations. Soils with a collapsible structure have an open-voided texture with individual grains being separated or weakly bonded by bridging material such as clay, iron oxides, calcium, or other bridges (Brink, 1985). While these soils have a high to moderate strength and can withstand fairly large loads under low soil moisture conditions, an increasing moisture content can weaken the bridging materials. Increasing the soil moisture content under load can cause a decrease in the soil volume, resulting in large settlements with no increase in the applied stress. This can lead to sudden settlements beneath foundations and structures.

5.6. Desktop Geotechnical Appraisal

Based on the desktop study, the proposed BESS assessment area may be divided into two Ground Units, **I** and **II**, as presented in Figure 5-3, where similar geotechnical conditions are anticipated. These correspond to areas underlain by a thin transported horizon covering rock units of the Whitehall Formation and those underlain by relativity thicker alluvial deposits, identifiable by erosion paths or rills. The boundary of the two zones is approximate only and will need to be confirmed on site through intrusive investigations. The boundaries of Ground Unit II were drawn with the assistance of the satellite imagery and available contour data.

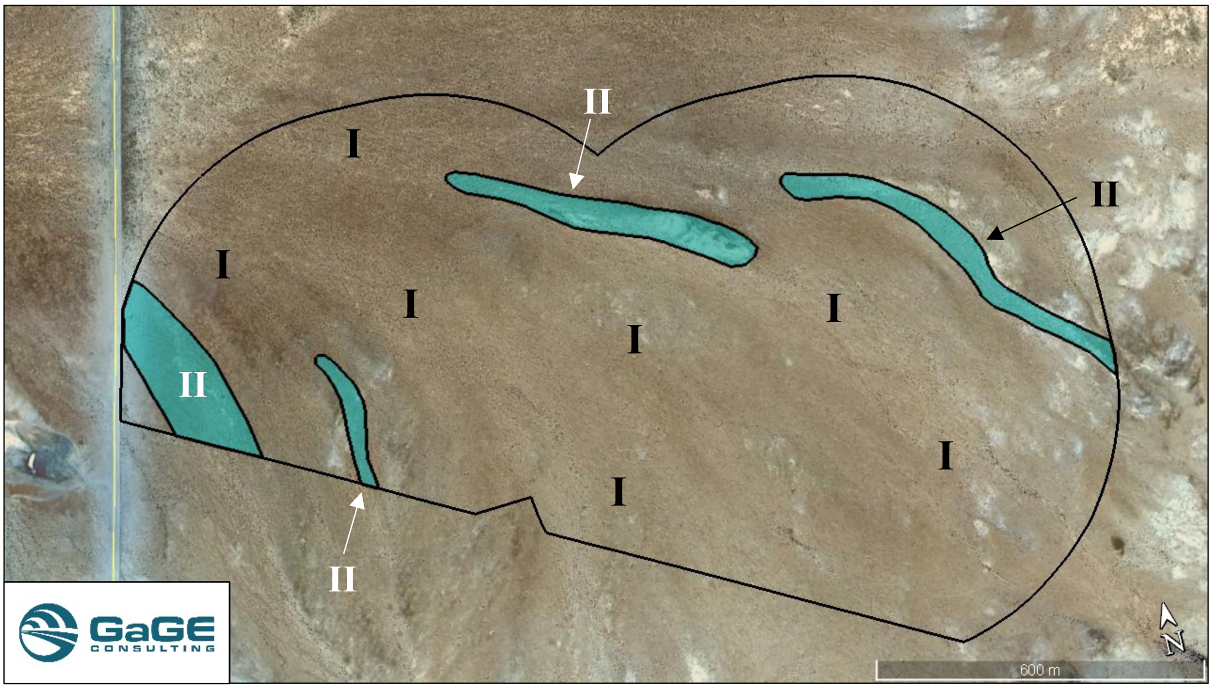

Figure 5-3 Inferred Ground Units (Google Earth, 2020)

Both ground units are considered suitable for the development of the BESS infrastructure, from a geotechnical viewpoint, provided that standard engineering design and construction measures are implemented to mitigate the identified geotechnical constraints. While Zone I is considered marginally more suitable for development from a geotechnical perspective, other factors are likely to be more critical in determining the final BESS layout.

The anticipated geotechnical constraints and mitigation measures are summarised in Table 2-1.

Table 5-1 Summary of Geotechnical Conditions

Ground Unit	Geology	Geotechnical Conditions / Constraints	Impacts on Engineering Design and Construction
I	Shale	• Shallow bedrock • Thin soil cover	• Good founding conditions for structures at shallow depths • Conventional shallow foundations suitable

Ground Unit	Geology	Geotechnical Conditions / Constraints	Impacts on Engineering Design and Construction
		• Intermediate to hard excavation conditions with depth • Overlain by alluvial soils of variable thickness in some areas	• Conventional subgrade preparation for roads • Intermediate to hard excavation conditions for trenching / earthworks
II	Alluvium	• Loose sandy soils • Potentially collapsible soils • Moderate soil cover • Moderate bedrock depth • Increased erosion potential	• Deeper spread footings (found below alluvial sands) • Soft excavation conditions becoming intermediate with depth • Unstable trench sidewalls – shoring/battering required • Surface drainage measures required

6. Identification and Assessment of Impacts

No fatal flaws have been identified that would render the proposed BESS site unsuitable from a geological and geotechnical perspective.

The BESS is containerised and the impact of the activity on the geological environment is limited to topsoil stripping, excavations for plinth foundations, trenching, the construction of access roads and associated light infrastructure. Bulk earthworks, where required for the construction of platforms and access roads on the undulating sections of the site, may be a more significant impact.

6.1. Impact of the Project on the Geological Environment

The main impact of the BESS development from a geological perspective is the displacement and possible removal of soil and rock materials. These activities will predominantly take place during the construction phase. The degree of disturbance is largely dependent on the topography of the project site and the nature of the proposed infrastructure. Steep slopes are unfavourable as these require bulk earthworks to create working platforms and access roads. Earthworks on steep slopes increases the risk of soil movements or slope failure.

The risk of soil erosion is also increased during construction activities, by the removal of vegetation and by possible disturbance to the natural surface drainage environment. These activities may prevent infiltration of rainwater, increase surface runoff and cause concentration of surface water flow. Erosion will increase the disturbance and displacement of soils and the impact may extend beyond the infrastructure footprint/s over time.

The effects of BESS development on the geological environment was evaluated using an Environmental Impact Assessment (EIA) Methodology, provided by SiVEST, which aids in determining the significance of an environmental impact on an environmental parameter through a systematic analysis. The EIA methodology is attached as Appendix C.

Based on the impact significance ratings presented in Table 6-1, the development of the proposed BESS on the Loeriesfontein 3 PV, from a geological and geotechnical perspective, will be "Negative Low impact", provided that the recommended mitigation measures are implemented.

The topography of the major portion of the site is gentle and significant earthworks are not anticipated in these areas. However, local undulations may occur.

The soils do not render the site particularly susceptible to soil erosion, though mitigation measures need to be implemented, particularly within the lower-lying sections of the site where concentrated surface flow is anticipated after heavy rainfall events.

The topography of the site is gentle and significant earthworks are not anticipated (although some minor earthworks are anticipated where local undulations occur). The soils and topography render the site moderately susceptible to soil erosion. No ridges or rock outcrops which may be of geological importance were identified.

Table 6-1 Impact Assessment Methodology Matrix

ENVIRONMENTAL PARAMETER	ISSUE / IMPACT / ENVIRONMENTAL EFFECT/ NATURE	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION									RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION								
		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S
Construction Phase																				
Disturbance/ displacement/ removal of soil and rock	Ground disturbance during platform earthworks, road subgrade preparation, trenching	1	4	2	2	3	1	12	-	Low	1) Design facility layout to minimise earthworks and levelling based on high resolution ground contour information 2) Correct topsoil and spoil management	1	4	2	1	3	1	11	-	Low
Soil Erosion	Increased erosion due to vegetation clearing, alteration of natural drainage	1	4	2	2	2	1	11	-	Low	1) Avoid development in preferential drainage paths 2) Temporary berms and drainage channels to divert surface runoff where needed 3) Landscape and rehabilitate disturbed areas timeously (e.g. regrassing) 4) Correct engineering design of road and site drainage	1	2	1	1	2	1	7	-	Low

ENVIRONMENTAL PARAMETER	ISSUE / IMPACT / ENVIRONMENTAL EFFECT/ NATURE	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION									RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION								
		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S
											5) Use designated access and laydown areas only to minimise disturbance to surrounding areas									
Operational Phase																				
Soil Erosion	Increased erosion due to alteration of natural drainage	1	2	1	1	2	1	7	-	Low	1) Maintain drainage channels 2) Monitor for erosion and remediate and rehabilitate timeously	1	1	1	1	2	1	6	-	Low
Decommissioning Phase																				
Disturbance/ displacement/ removal of soil and rock	Ground disturbance during platform earthworks, road rehabilitation, removal of subsurface infrastructure	1	4	2	2	2	1	11	-	Low	1) Restore natural site topography 2) Landscape and rehabilitate disturbed areas timeously (e.g. regrassing)	1	4	2	1	2	1	10	-	Low

ENVIRONMENTAL PARAMETER	ISSUE / IMPACT / ENVIRONMENTAL EFFECT/ NATURE	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION									RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION								
		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S
Soil Erosion	Increased erosion due to ground disturbance during rehabilitation activities	1	2	2	2	2	1	9	-	Low	1) Temporary berms and drainage channels to divert surface runoff where needed 2) Restore natural site topography 3) Use designated access and laydown areas only to minimise disturbance to surrounding areas	1	1	1	1	2	1	6	-	Low
Cumulative																				
Disturbance/ displacement/ removal of soil and rock Soil Erosion	No cumulative effect																			

7. Comparative Assessment of Alternatives

Layout alternatives which subsequently informed the area for the potential construction of the proposed substation and subsequent BESS assessment area were identified and comparatively assessed as part of the BA process undertaken in 2016.

No geologically or geotechnically sensitive areas were identified within or near the assessment area. While Zone I is considered marginally more suitable for development from a geotechnical perspective than Zone II (as per Figure 5-3), other factors are likely to be more critical in determining the final BESS layout. No preferences for the final BESS layout within the assessment area are therefore provided.

8. Conclusion and Summary

8.1. Summary of Findings

This desktop geotechnical specialist study was undertaken for the installation of a BESS on the Loeriesfontein 3 Photovoltaic (PV) Energy Facility (12/12/20/2321/2/AM4). The assessment area is seemingly underlain by a thin surficial alluvial horizon transgressing into a variably cemented calcrete horizon that overlays soft to hard rock shale at a shallow depth. Some geotechnical constraints have been identified, including the presence of shallow bedrock and loose/collapsible sands. These constraints may be mitigated via standard engineering design and construction measures. Shallow spread footings are considered suitable to support the structures.

No fatal flaws have been identified that would render the proposed BESS site unsuitable from a geological and geotechnical perspective.

The proposed BESS is assessed to have a "Negative Low impact - the anticipated impact will have negligible negative effects and will require little to no mitigation". The recommended mitigation measures provided to minimise the impacts relate to the appropriate engineering design of earthworks and site drainage, erosion control and topsoil and spoil material management. These do not exceed civil engineering and construction best practice.

Further intrusive geotechnical investigations should be undertaken to confirm the engineering recommendations provided in this report.

8.2. Impact Statement and Conclusion

From a geotechnical and geological perspective, no fatal flaws, sensitivities, or areas to be avoided have been identified within or close to the BESS assessment area. It is therefore recommended that the proposed activity be authorised.

References

Brink, A.B.A. Engineering Geology of Southern Africa, Karoo Sequence, Volume 3. Building Publications, 1983

Johnson, M.R. Anhaeusser, C.R. Thomas, R.J. The Geology of South Africa. Council for Geoscience, 2006.

Appendix A. Specialist Declaration of Interest and Undertaking Under Oath

Appendix B. Specialist CV

Appendix C. Environmental Impact Assessment (EIA) Methodology