GEOTECHNICAL REPORT

FOR THE PROPOSED 14,5 ML RESERVOIRS PACALTSDORP, GEORGE

29 August 2022 (Rev 0)

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Report review history:

Revision No	Date	Prepared by:	Reviewed by:	Approved by:
0	29.8.2022	I Paton Pr Sci Nat Pr Tech Eng	S Ngema BSc Geol	I Paton Pr Sci Nat Pr Tech Eng

Authors qualifications and affiliations:

Iain Paton has post graduate degrees in Geology and Geotechnical Engineering and over 25 years' experience in the mining, energy and construction industries. Iain Paton is a registered geotechnical professional with the Engineering Council of South Africa (ECSA) and the South African Council for Natural and Scientific Professions (SACNSP). Iain Paton is a member of the Geotechnical Division of the South African Institute of Civil Engineering (SAICE), South African Institute of Engineering and Environmental Geologists (SAIEG), the and the Institute of Municipal Engineering of South Africa (IMESA).

Declaration of independence:

The authors of this report are independent professional consultant with no vested interest in the project, other than remuneration for work associated with the compilation of this report.

General limitations:

1. The investigation has been conducted in accordance with generally accepted engineering practice, and the opinions and conclusions expressed in the report are made in good faith based on the information at hand at the time of the investigation.
2. The contents of this report are valid as of the date of preparation. However, changes in the condition of the site can occur over time as a result or either natural processes or human activity. In addition, advancements in the practice of geotechnical engineering and changes in applicable practice codes may affect the validity of this report. Consequently, this report should not be relied upon after an eclipsed period of one year without a review by this firm for verification of validity. This warranty is in lieu of all other warranties, either expressed or implied.
3. Unless otherwise stated, the investigation did not include any specialist studies, including but not limited to the evaluation or assessment of any potential environmental hazards or groundwater contamination that may be present.
4. The investigation is conducted within the constraints of the budget and time and therefore limited information was available. Although the confidence in the information is reasonably high, some variation in the geotechnical conditions should be expected during and after construction. The nature and extent of variations across the site may not become evident until construction. If variations then become apparent this could affect the proposed project, and it may be necessary to re-evaluate recommendations in this report. Therefore, it is recommended that Outeniqua Geotechnical Services is retained to provide specialist geotechnical engineering services during construction in order to observe compliance with the design concepts, specifications and recommendations and to allow design changes in the event that subsurface conditions differ from those anticipated prior to the start of construction. Any significant deviation from the expected geotechnical conditions should be brought to the author's attention for further investigation.
5. The assessment and interpretation of the geotechnical information and the design of structures and services and the management of risk is the responsibility of the appointed engineer.

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1. Introduction

1.1 Background information

Two new bulk water reservoirs and associated infrastructure has been proposed on a site in the Pacaltsdorp suburban area of the city of George in the Western Cape Province (see locality map in **Figure 1**).

The site was investigated in order to determine the geology and geotechnical properties of the site for the design of new structures and civil engineering services.

Figure 1: Site locality map

1.2 Scope of work

The scope of work was to conduct a broad-scope geotechnical survey and the following methods were proposed and accepted by the client:

- Review all available geotechnical information on the area.
- Conduct a walk-over survey of the site to assess the terrain, surface processes and apparent geotechnical risks.
- Conduct subsurface investigations to determine soil/rock profile and groundwater conditions, consisting of:
    - 4x test pits, excavated with TLB/backhoe to max depth of 2.5m or refusal on rock/boulders.
- Log all test pits in accordance with South African standard methods (SAICE Guidelines for Soil and Rock logging in South Africa, 2002).
- Collect soil samples for testing at SANAS-accredited civil engineering laboratory in accordance with South African and/or American Standard methods (SANS or ASTM).

- Conduct insitu tests as per South African and/or American Standard methods (SANS or ASTM).
- Prepare a concise factual and interpretive report, written by a registered Engineering Geologist/Geotechnical Engineer (SACNASP/ECSA), containing all information from the investigation and including soil classifications and recommendations for the design of foundations for structures and civil services, as required in the scope of works.
- Discuss geotechnical data and recommendations with civil and structural designers as and when required.

1.3 Available information

The following information was available for consultation:

- 1:50 000 & 1:250 000 geological maps of the area, obtained from the Council for Geoscience;
- Topo-cadastral data for the area, obtained from the National Geospatial Institute (NGI).
- Aerial photos of the area, obtained from the NGI and Google Earth.
- Site locality plan provided by RHDHV.
- In-house geotechnical database.

2. Site description

The proposed site was located on Remainder of Erf 325, George and approximately 6.5km southwest of the central business district (CBD). The site was vacant at the time of the investigation and sloped very gently toward the south, draining into tributaries of the Gwaing River (see **Figures 2-3**). The vegetation consisted of long grass, small shrubs, medium to large bushes and clumps of large trees (See **Figures 4-6**). The surface conditions were generally dry at the time of the investigation with only localised puddles of recent rainwater on surface. The ground surface on the site appeared to be irregular/hummocky, possibly indicating some previous ground disturbance (digging/filling, etc). The site was easily accessible from the north along an existing gravel track.

The site was located in an area with a typically wet, temperate climate (Weinert N-value ~1-2) with all-year rain and average monthly minimum winter temperatures of 9°C and average maximum summer temperatures of 25°C. Heavy rainfall events of up to 100mm in a 24hour period have occurred infrequently in the area.

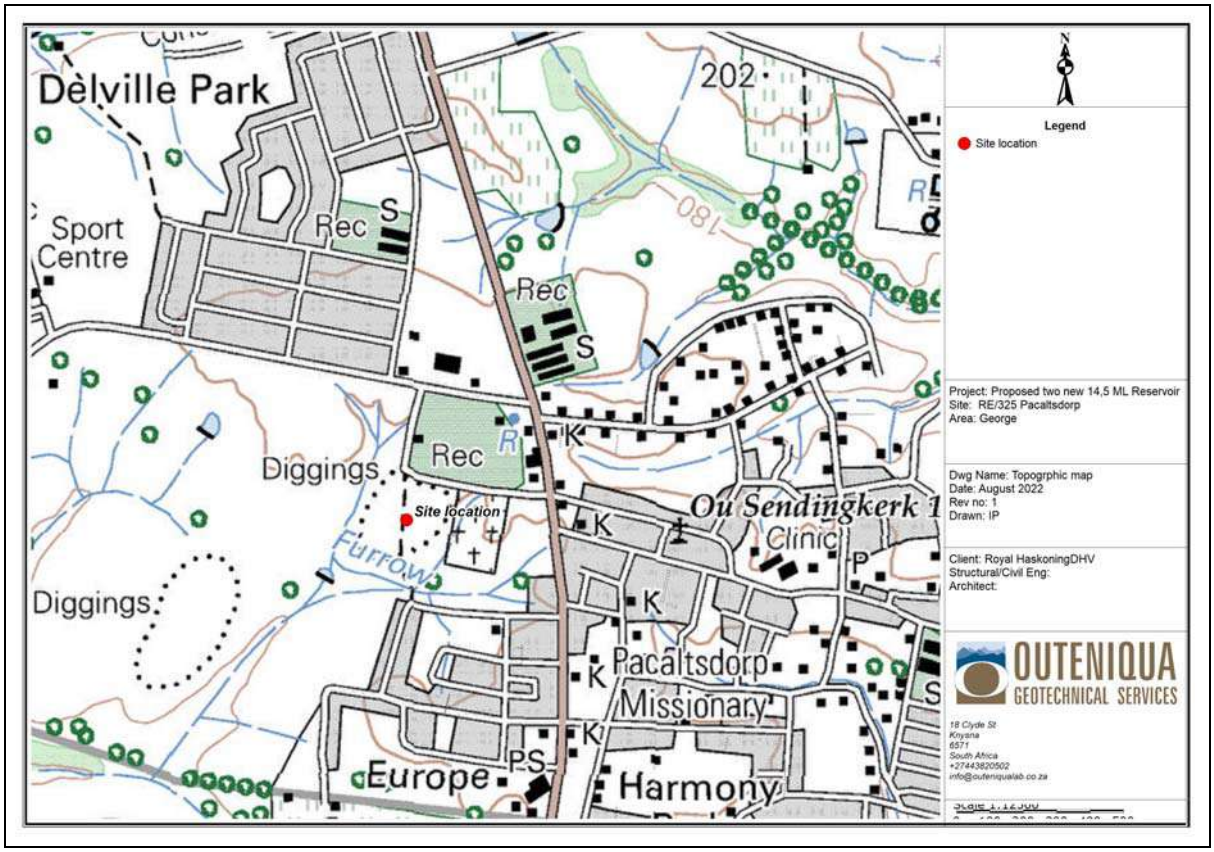


Figure 2: Topographic map of the site

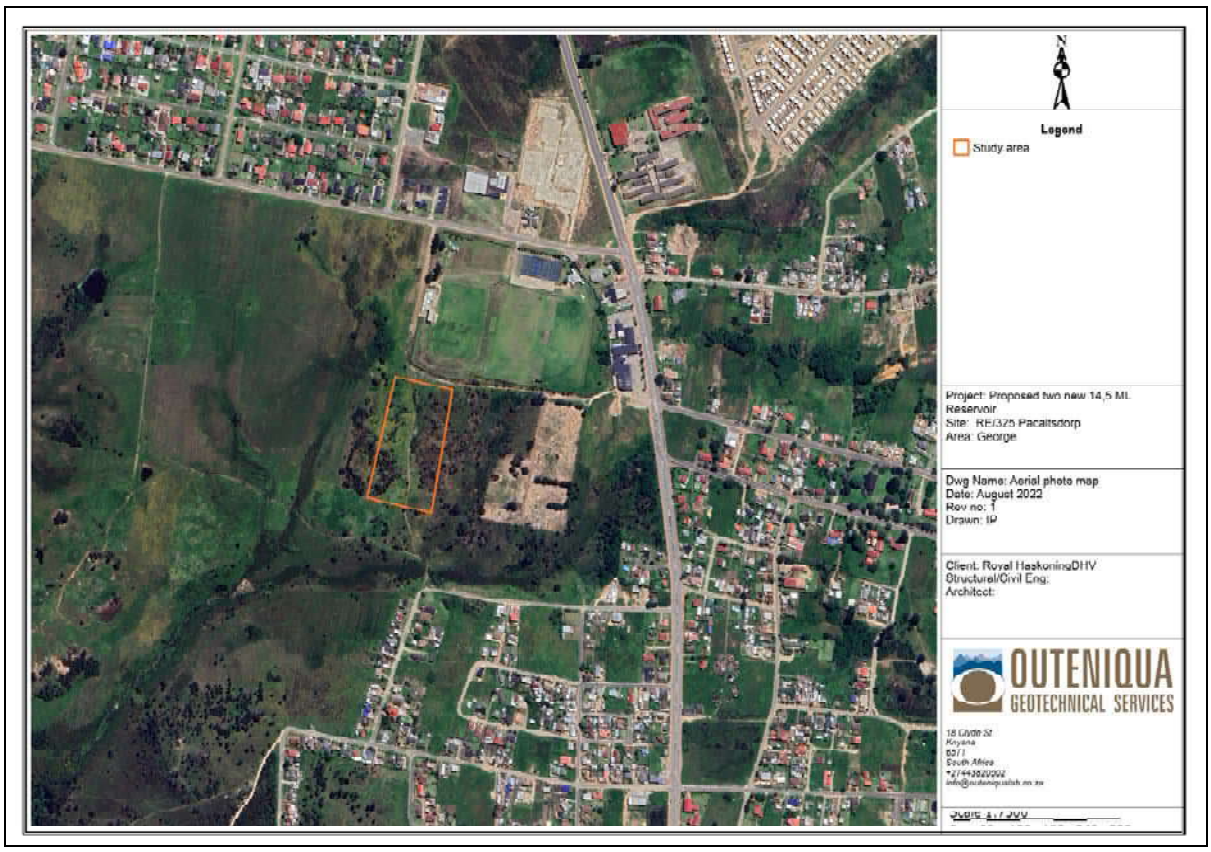


Figure 3: Aerial photo map of the site

Figure 4: View of the site, looking to the northeast

Figure 5: View of the site, looking to the west

Figure 6: View across the site looking to the south

3. Methods of investigation

A walk-over survey of the site was conducted prior to a subsurface investigation. The subsurface investigation consisted of 4 test pits (See **Appendix 1** for a plan of the test positions). The test pits were excavated with a TLB to a maximum depth of approximately 3m. This exercise was conducted in order to investigate the near-surface geology and geotechnical nature of the site, including the soil profile and groundwater conditions. The soil profiles and photographs of the test pits were included in **Appendix 2** of this report.

Samples of insitu soils were collected from test pits for laboratory tests including Foundation Indicator (grading, Atterberg limits and moisture content), Modified AASHTO maximum dry density, optimum moisture content and CBR. The tests were conducted at a SANAS-accredited civil engineering laboratory in accordance with standard South African test methods. See **Appendix 3** for details.

In situ dynamic cone penetrometer (DCP) tests were conducted at each of the test pit positions. The probes penetrated from ground level (GL) to a depth of ~2m or refusal. Details of the tests were included in **Appendix 4** of this report.

An analysis of the information was then conducted to determine geotechnical parameters and recommendations were then formulated based on the available data.

4. Results of the site investigation

4.1 Regional geology

The site was indicated on the regional geological maps to be underlain by granite of the Maalgaten Suite of the George pluton (**Figure 7**). The George pluton consists of several granitic bodies that were intruded into older country rocks of the Kaaimans Group of meta-sediments during the Cambrian era (~525 million years ago). Younger meta-sedimentary rocks of the Peninsula Formation (Table Mountain group) were indicated to the north of the George area.

The George pluton has been subjected to intense deformation, similar to that of the older country rocks of the Kaaimans Formation and typically exhibit strong penetrative planar and linear fabrics (structural features). In some places the granite has been intensely sheared, mainly along its margins. There were no major geological faults indicated on the geological map in the immediate vicinity of the site, and there was a low risk of seismic activity indicated for the George area (max peak horizontal ground acceleration 0.05g).

The Maalgaten granite was the most voluminous lithological unit of the George pluton underlying most of the George area. The granite rock has been poorly exposed in the George area and was typically covered by a thick soil overburden including colluvium, alluvium and residual saprolite.

The geology of the George area has been widely considered macro stable for urban development purposes with due consideration given to potential geotechnical constraints on a site-level.

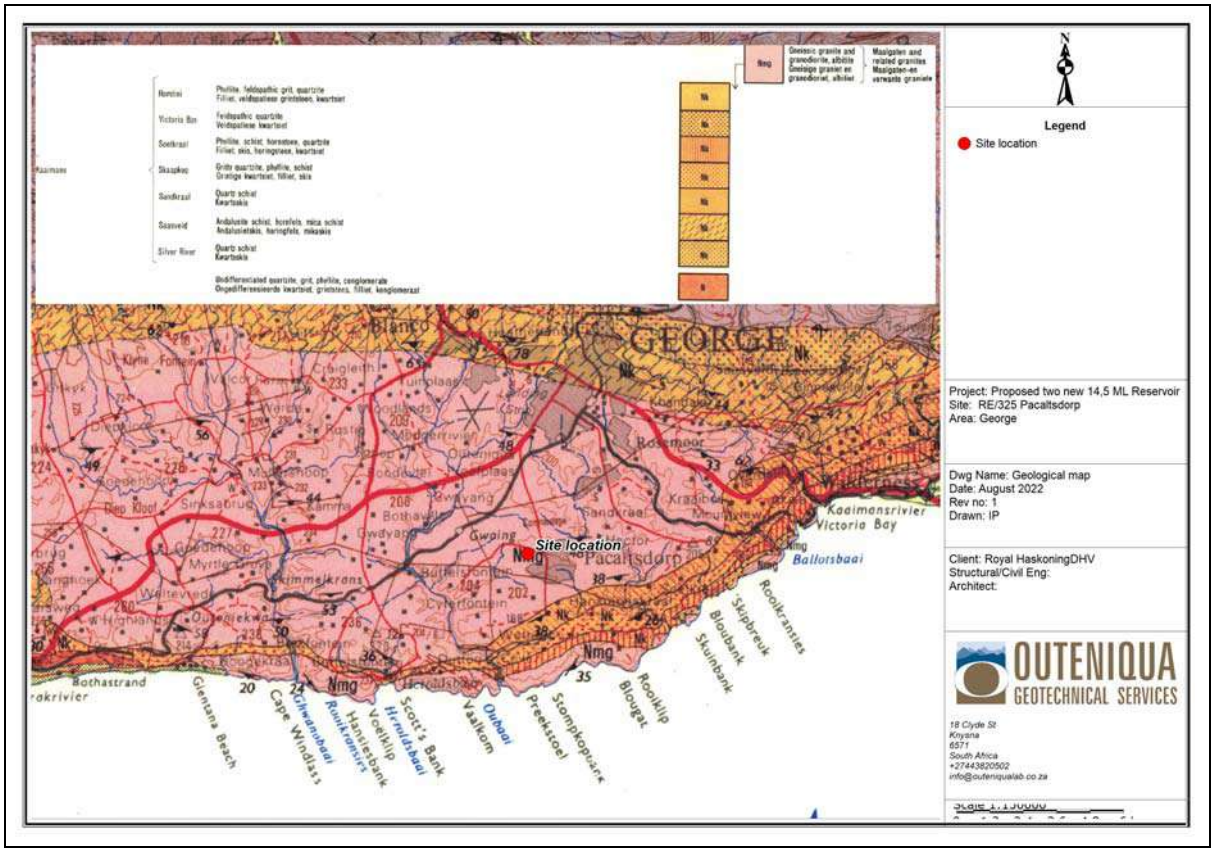


Figure 7: Geological map of site

4.2 Local soil and rock types

The test pits undertaken as part of this investigation indicated that the natural (insitu) soil profile generally consisted of one or more horizons of colluvium (naturally transported soil under the action of water and gravity), which were underlain by a pedogenic horizon of ferricrete nodules (chemically formed soil), which was underlain by residual soil composed of clayey sand/sandy clays (completely decomposed rock).

In a few of the pits, the natural (insitu) soil profile was overlain by a sporadic horizon of fill soil (imported/dumped soil). No bedrock was encountered in any of the pits, and no rock outcrops were observed on surface.

Visual and tactile observations in test pits indicated that the soil moisture contents were generally moist (normal) with sporadic very moist horizons.

The soil profile was broadly defined according to the following generalised horizons:

- 0-1.2m (average): Moist, light red brown blotched black, loose/soft, intact, GRAVELLY SILTY SAND CLAY, imported (fill with rubbish and rubble).
- 1.2-1.4m: Moist, light red brown, medium dense, intact, SILTY SAND, transported (colluvium/natural topsoil).
- 1.4-1.6m: Moist, dark red orange, medium dense, intact, SANDY GRAVEL, pedogenic (ferricrete nodules in soil matrix).
- 1.6-3.0m: Moist, dark reddish orange/dusky red, stiff, fissured & slickensided, SANDY CLAY/CLAYEY SAND, residual. See **Figure 8**.

The approximate depth intervals of the individual soil layers have been provided in **Table 1**.

Table 1: Summary of test pit data (depths in mm)

Test pos. No.	*Imported (fill)*	*Transported / Pedogenic*	*Residual*	*Rock*	*Total depth of test pit*	*Refusal?*
TP1	-	0-800	800-3400	-	3400	None
TP2	0-1700	1700-2000	2000-2800	-	2800	None
TP3	0-500	-	500-3300	-	3300	None
TP4	0-1000	1000-1300	1300-3200	-	3200	None

Figure 8: Typical clayey sand residual soils encountered in the test pits

4.3 Insitu tests

DCP tests indicated variable but generally loose consistency in the upper ~1m of the profile, improving to medium dense to dense (<25mm/blow) conditions below this depth. The tests did not necessarily give a reliable indication of allowable bearing capacity due to the presence of uncontrolled fill.

4.4 Lab tests

Representative samples of the insitu soil types were collected for Foundation Indicator tests to determine the particle size distribution (grading) and Atterberg limits. The results of the Foundation Indicator tests were summarised in **Table 2**.

The particle size analysis indicated a variable mixture of clay, silt, sand with generally low to medium plasticity index, but overall low potential expansiveness. The soils were classified into the following groups under the Unified Soil Classification (USC) system:

- ML - Inorganic non-plastic silts.
- SM – Silty sands.
- CL – Inorganic clays of low plasticity.

Table 2: **Summary of Foundation Indicator test results**

Test Pit No	*Sample Depth (mm)*	*Atterberg Limits*			*Particle Analysis (%)*				*MC **	*PE ***	*USC ****
		PI	*LL*	*LS*	*Clay*	*Silt*	*Sand*	*Gravel*			
TP1	800-3400	3	18	2	40	16	44	0	15.8	Low	ML
TP2	2000-2800	17	35	9	56	8	36	0	15.6	Low	CL
TP3	800-3300	5	21	3	39	10	51	0	10.6	Low	CL
TP4	1300-3200	SP	SP	SP	30	18	52	0	8.8	Low	SM

* Insitu Moisture Content ** Potential Expansiveness *** Unified Soil Classification

Representative samples were collected for Modified AASHTO density (Mod), CBR & Road Indicator tests to determine the potential of the material for structural fill purposes and/or for subgrade fill in road pavement design. The results of the tests were summarised in **Table 3**.

The tests indicate that the insitu ferricrete may meet a G5 specification, but this material was not expected to be consistent or extensive enough to pose as a viable source of material. Other soils were typically poor quality and unsuitable for use as natural construction materials such as road layerworks or even bulk fill material. Further recommendations were provided in **Chapter 6**.

Table 3: Summary of Mod/CBR/Indicator test results

Test Pit No	Sample Depth (mm)	CBR at					Swell (%)	PI (%)	GM	MDD/OMC	TRH14
		100%	98%	95%	93%	90%					
TP1	0-500	58	51	43	38	32	0	2	2.01	2281/8.4	G5
TP2	2000-2800	6	6	5	4	4	0.1	17	0.38	1986/11.4	-
TP3	800-3300	10	8	5	4	3	0.3	5	0.51	2046/10.7	-
TP4	1300-3200	6	5	3	2	1	1.6	SP	0.34	2057/10.0	-

5. Geotechnical assessment

5.1 Terrain mapping

The site was broadly mapped into geotechnical "terrains" or areas, according to the dominant constraints in each area. Each terrain was then classified according to the residential site class designations provided under SANS10400-H, which were discussed in the following chapters. The mapping was presented in **Figure 9**.

Due to the broadly consistent profile and conditions, the entire site was mapped as "Terrain 1" which included potentially compressible or collapsible soils (C1), potentially active soils (H), and uncontrolled fill material (P).

5.2 Bearing capacity and settlement

The test pits and DCP tests indicated potentially highly compressible or collapsible insitu soil and/or uncontrolled fill (P) within the upper 1.0m to 1.7m, which was underlain by generally stiff soils with a safe bearing capacity estimated at 150kPa with less than 10mm potential settlement (C1 category in terms of SANS10400-H). Soil replacement and/or densification (compaction) would be required to improve the upper portion of the profile.

5.3 Heave

The investigations indicated low activity clays, estimated at <7.5mm heave (H category in terms of SANS10400-H).

5.4 Groundwater

Groundwater was not encountered in any of the test pits at the time of the investigation, but seasonal groundwater seepage was deemed likely in the upper 1.5m of the profile. Groundwater seepage may affect shallow excavations for construction of foundations and underground services, requiring dewatering and some improvements.

5.5 Surface drainage and soil permeability

The site had a fairly low slope gradient, and the insitu soils had a low permeability (estimated at 10^{-6} m/s). Accumulation of stormwater on surface was deemed likely after/during peak rainfall events leading to localised flooding, thus requiring good stormwater management systems.

5.6 Natural slope stability

No slope stability issues were identified or expected from the site.

Figure 9: Geotechnical Map

5.7 Excavation classification and stability

All excavations to 3m were classified as "Soft" in terms of SABS1200D. Sidewalls of test pits were marginally stable at near-vertical angles in the short term but would become unstable at angles greater than 1v:2h in the medium to long term.

6. Recommendations

The design of structures and civil services is the responsibility of the appointed civil and structural engineers. The recommendations contained herein are provided as a guideline only and do not supersede any applicable standards, codes, or project specifications.

The following recommendations are based on limited information gained from the site investigation, and although the confidence in the information is high, variation in ground conditions may occur between information points. All geotechnical information should be confirmed during construction and if necessary, additional investigations may have to be commissioned. Any significant variations are to be brought to the attention of the authors for comment or further recommendations. It is recommended that the structural engineer discuss his/her conceptual design with the geotechnical specialist to ensure that any calculations and recommendations are in line with current information.

6.1 Earthworks and civils

Civil works should be designed and constructed in accordance with SABS 1200, COTO, and/or any site-specific specifications provided by the civil engineer.

Some minor bush clearing, including removal of some scattered small to medium trees, and earthworks will be required to clear site in preparation for construction. It is recommended that 150mm of organic-rich topsoil is stripped from the development areas (roads, platforms, etc) and stockpiled separately on site for landscaping purposes. Tree roots should also be grubbed from these areas. Any localised ponding of surface water encountered during site clearance should be pumped dry, ripped and backfilled with suitable compacted fill to reinstate ground levels.

Insitu soil material obtained from excavations for road box cuts, foundations and services trenches is likely to contain significant amounts of fines (clay/silt) and is likely to be poor quality (estimate G10) but some soil with low clay content (compactable soil) can be used for non-structural applications such as general landscaping filling or main backfill over pipe cradles and over foundations. Soil containing high clay content should be cut to spoil or as directed by the engineer.

Recommendations for road design include the cutting of the roadbed to the required line and level, followed by compaction of the road bed to 90% MDD to identify soft spots, which should be removed and replaced with suitable imported compactable fill, such as G7 or G9. Side drainage is important to achieve compaction of the roadbed. Subsoil drains on upslope side or both sides (in the case of flat terrain) are also recommended. The recommended road layerworks include 150mm of G7 SSG (compacted to 93%MDD), followed by 150mm G5 subbase (compacted to 95%MDD), followed by 150mm G1/2 base course and asphalt, or alternatively 80mm concrete pavers. Stabilisation of the subbase can be considered due to the poor subgrade conditions.

Good site landscaping and a piped underground stormwater management system is recommended to collect, divert and control the discharge of stormwater from structures, hard surfaces and roads to prevent flooding and ingress into subsoils, which could affect the stability of the soils below structures and roads, causing settlement or other stability problems.

6.2 Foundations

Foundations for structures should be designed and constructed in accordance with SANS 10400-H or any site-specific specification issued by the structural engineers.

Site testing indicates the presence of potentially problematic soils, mainly including deposits of uncontrolled fill (possibly up to 2m thick in places), which could result in settlement of structures if improperly founded. The impact of this is the requirement for mitigation measures to treat or remove unsuitable soil from below the proposed structures, possibly involving additional excavations and replacement with engineered fill, depending on founding levels. The recommended improvements include removal and replacement of unsuitable fill material where it occurs below foundations, stiffening of foundations with steel reinforcement, and/or improved site drainage measures. Further investigations may be required during construction. Additional systems such as brick-force reinforcement and articulation joints in walls are also recommended.

The recommended foundation system for Type 1 masonry buildings is concrete strips, reinforced with top and bottom steel bars, founded at a minimum depth of 0.7m on well compacted insitu soils or engineered fill, such that a DCP penetrates at less than 25mm/blow. The calculated safe bearing pressure on such compacted soil at this level is 150kPa with expected maximum settlement of <5mm. Allowance should be made in the bill for imported high-quality engineered fill materials, such as G7, G5 crushed rock, or any other materials to facilitate preparation of suitable founding conditions. At-grade concrete slabs/surface beds should be supported on a suitable layer of imported fill, compacted to 95%MDD and reinforced with steel mesh.

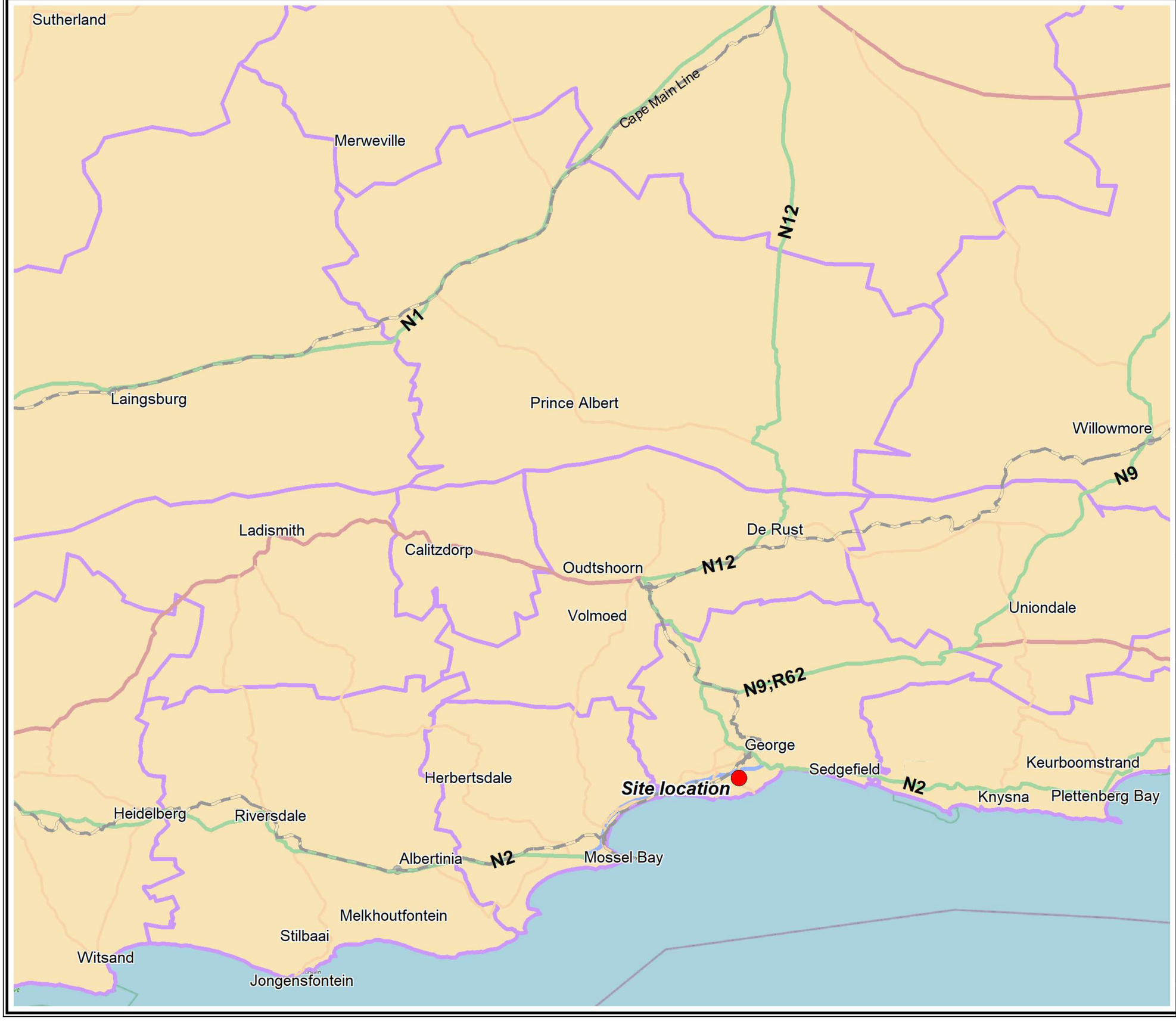
Alternative foundation systems include raft/slab-on-grade foundations (e.g. for tank structures) on an engineered platform, consisting of at least 0.5m of imported G5, compacted to 95%MDD, depending on founding levels.

7. Conclusions

The site is generally considered suitable for the proposed development with some moderate geotechnical constraints expected. Preliminary recommendations have been provided for consideration by the design engineers, but further investigations/inspections may be required during construction.

Appendix 1

Maps



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Legend

Site location

Project: Proposed two new 14,5 ML Reservoir
Site: RE/325 Pacaltsdorp
Area: George

Dwg Name: Locality map
Date: August 2022
Rev no: 1
Drawn: IP

Client: Royal HaskoningDHV
Structural/Civil Eng:
Architect:

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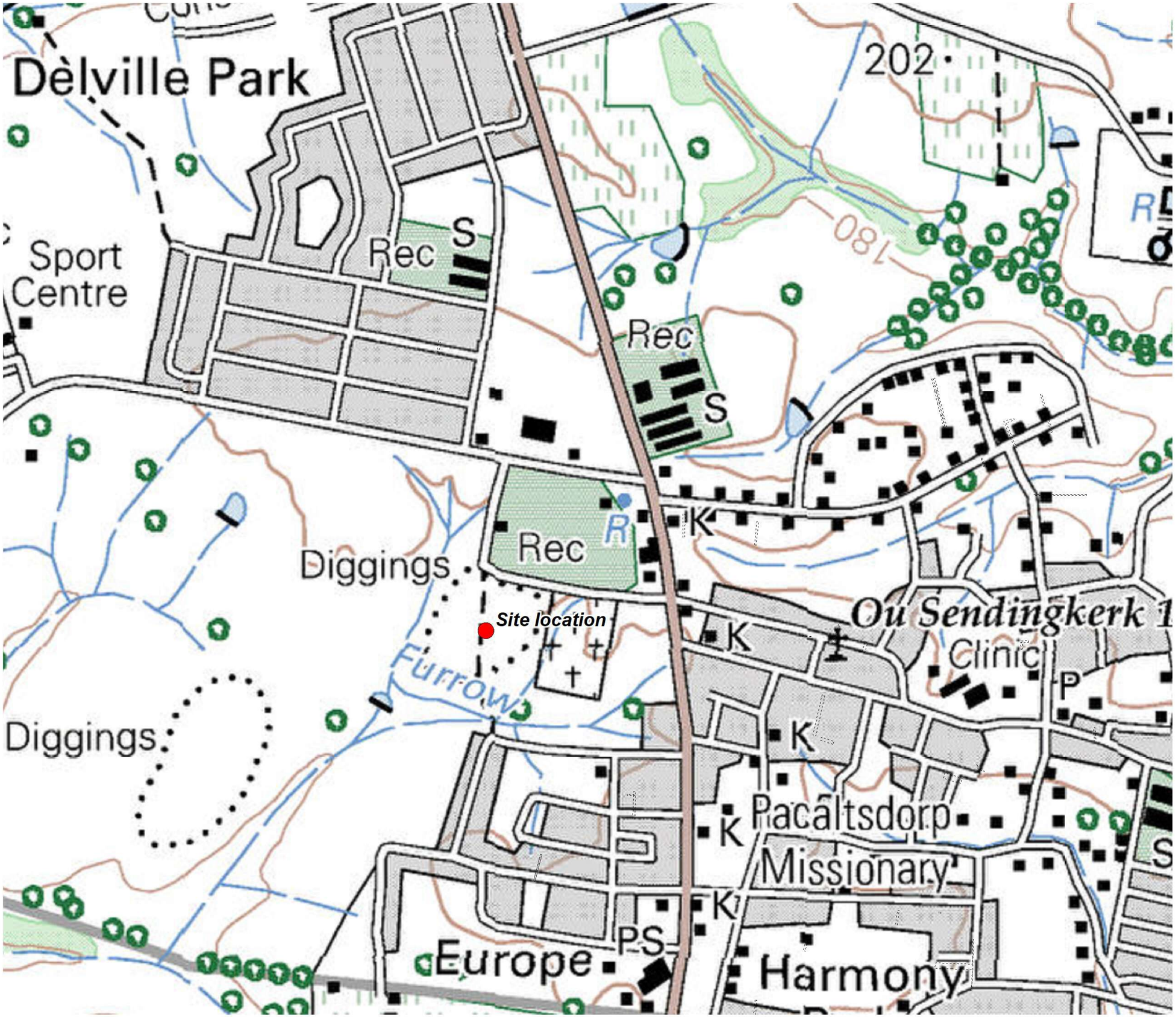
Scale 1:1250000



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Site location

Project: Proposed two new 14,5 ML Reservoir
Site: RE/325 Pacaltsdorp
Area: George

Dwg Name: Topogrphic map
Date: August 2022
Rev no: 1
Drawn: IP

Client: Royal HaskoningDHV
Structural/Civil Eng:
Architect:

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Scale 1:12500

N

Legend

Study area

Project: Proposed two new 14,5 ML Reservoir
Site: RE/325 Pacaltsdorp
Area: George

Dwg Name: Aerial photo map
Date: August 2022
Rev no: 1
Drawn: IP

Client: Royal HaskoningDHV
Structural/Civil Eng:
Architect:

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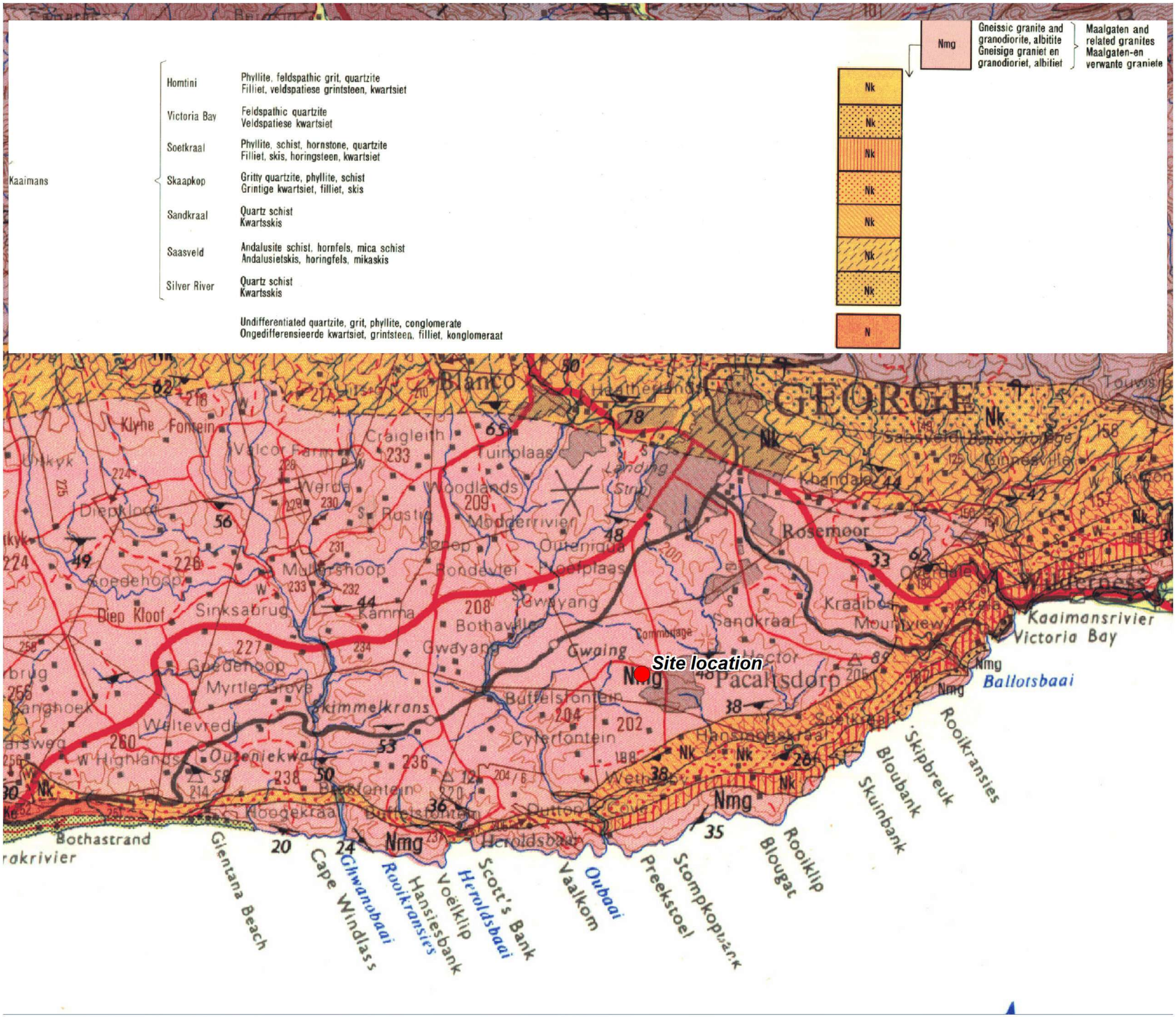

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Site location

Project: Proposed two new 14,5 ML Reservoir
Site: RE/325 Pacaltsdorp
Area: George

Dwg Name: Geological map
Date: August 2022
Rev no: 1
Drawn: IP

Client: Royal HaskoningDHV
Structural/Civil Eng:
Architect:

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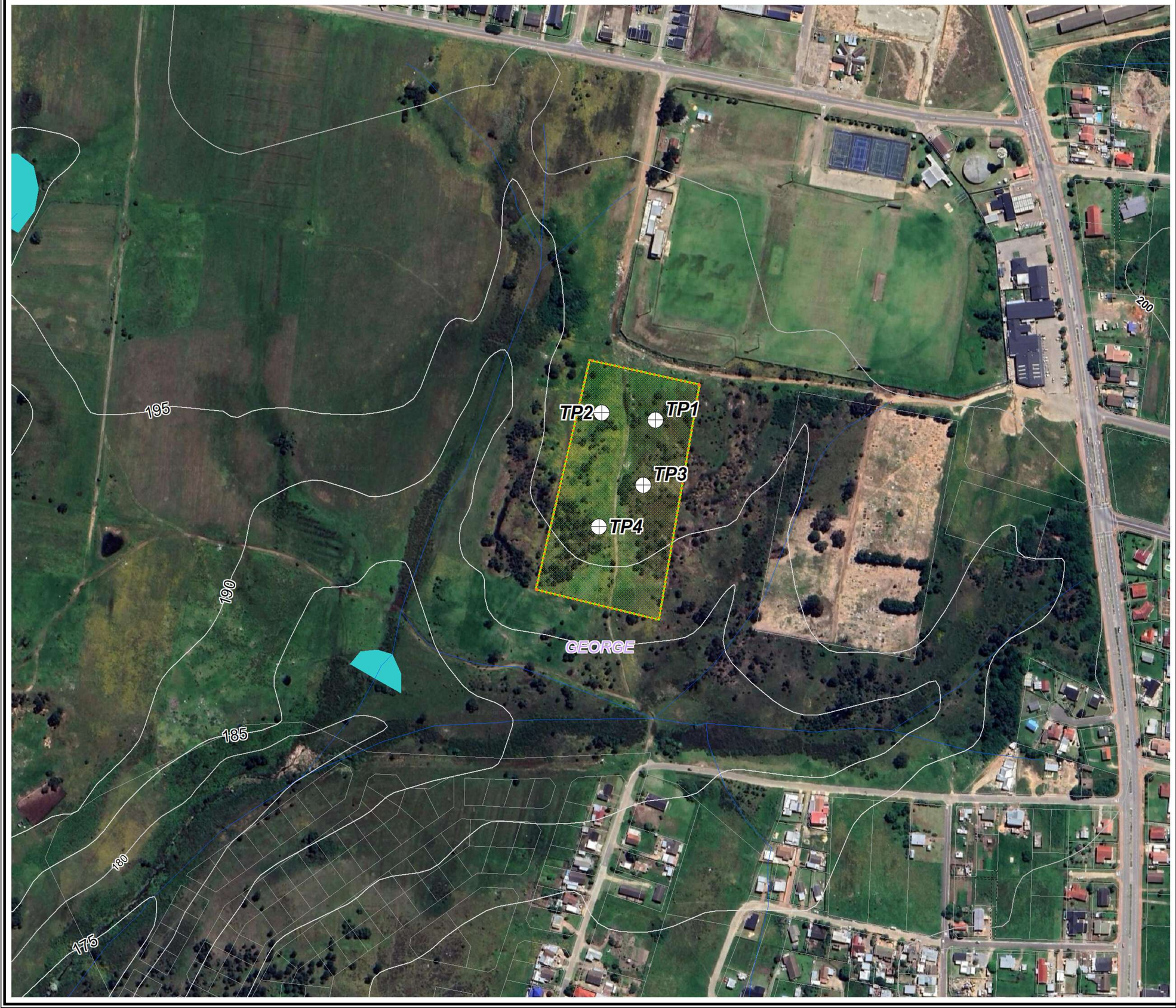

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Legend

- Test Positions
- Study area

Topo Vector

- Drainage
- Inland water
- River

Geotechnical terrain

- Terrain 1(C1/H/P)

Project: Proposed new 14.5 ML Reservoirs
Site: RE/325 Pacaltsdorp
Area: George

Dwg Name: Geotechnical map
Date: August 2022
Rev no: 1
Drawn: IP

Client: Royal HaskoningDHV
Structural/Civil Eng:
Architect:

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Appendix 2

Test pit profiles

Geotechnical Soil Profile

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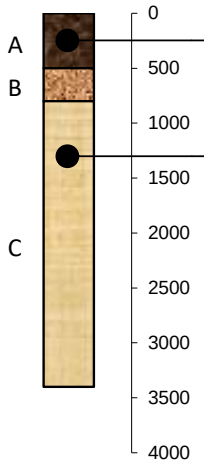
Client:	Royal HaskoningDHV
Project:	Two 14,5 ML Reservoir Pacaltsdorp
Area:	George
Date:	11.07.2022
Excavator:	TLB

TP 1

Datum: NGL | Co-ords: 23 Y0051134 X3765362

Key to symbols: ● Sample taken | Groundwater



(0 to 500)	Moist, pale red, loose, intact, **SANDY GRAVEL**, pedogenic (ferricrete) **MOD/CBR/Indicator**
(500 to 800)	Moist, pale red, medium dense, intact, **SAND**, transported.
(800 to 3400)	Moist, dusk red mottled dark yellow orange, firm, fissured, slickensided, **SILTY CLAYEY SAND**, residual. **Foundation Indicator**

TP Stopped
No Water

Dynamic Cone Penetrometer (DCP)

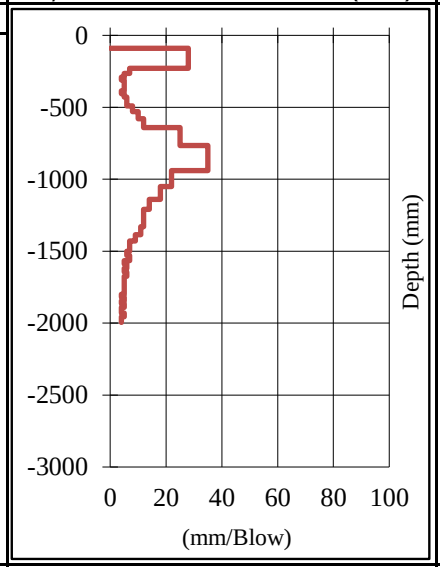
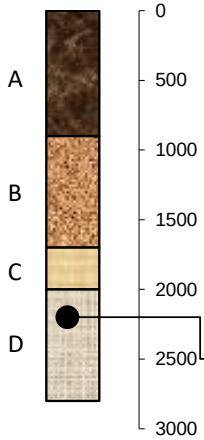


Photo of Test Pit

TP 2

Datum: NGL | Co-ords: 23 Y0051184 X3765356

Key to symbols: ● Sample taken | Groundwater



(0 to 900)	Moist, dark brown mottled dark yellowish orange, firm, intact, **SILTY SANDY CLAY**, imported (fill, with rubbish)
(900 to 1700)	Moist, light brown, medium dense, pinholed, **GRAVELLY SAND**, imported (fill)
(1700 to 2000)	Moist, light brown, medium dense, intact, **GRAVELLY SAND**, transported/pedogenic (ferricrete)
(2000 to 2800)	Moist, dark reddish orange, stiff, fissured, **Slightly GRAVELLY SILTY CLAYEY SAND With ferricrete nodules**, residual. **Foundation Indicator & MOD/CBR/Indicator**

TP Stopped
No Water

Dynamic Cone Penetrometer (DCP)

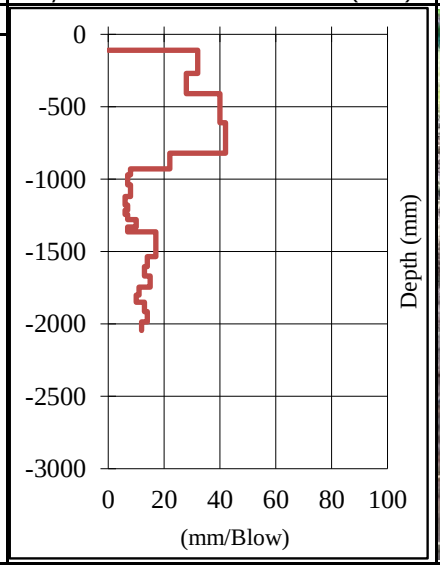
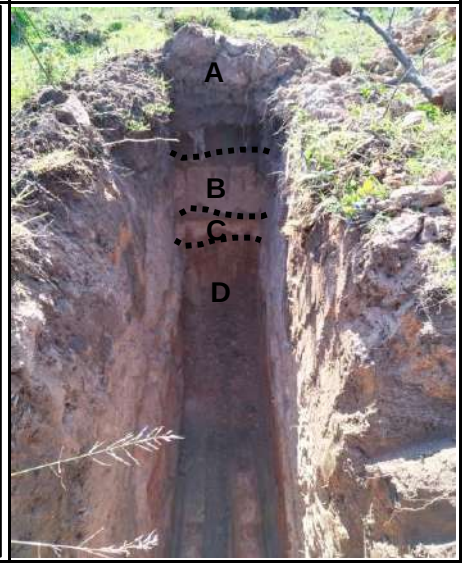


Photo of Test Pit



Geotechnical Soil Profile

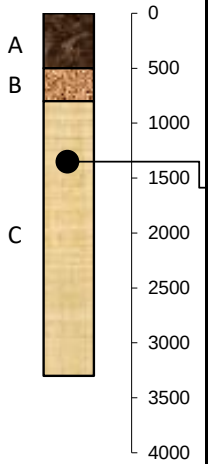
OUTENIQUA GEOTECHNICAL SERVICES

Client:	Royal HaskoningDHV
Project:	Two 14,5 ML Reservoir Pacaltsdorp
Area:	George
Date:	11.07.2022
Excavator:	TLB

TP 3

Datum: NGL | Co-ords: 23 Y0051145 X3765423

Key to symbols: ● Sample taken | Groundwater



(0 to 500)	Moist, dark reddish brown to dark yellowish orange, loose, intact, **GRAVELLY CLAYEY SAND**, imported (fill)
(500 to 800)	Moist, dark reddish orange, medium dense, pinholed, **GRAVELLY SAND**, residual.
(800 to 3300)	Moist, pale red, light yellow, dense, firm, fissured, pinholed, **CLAYEY SAND**, residual.
	Foundation Indicator & MOD/CBR/Indicator

TP Stopped
No Water

Dynamic Cone Penetrometer (DCP)

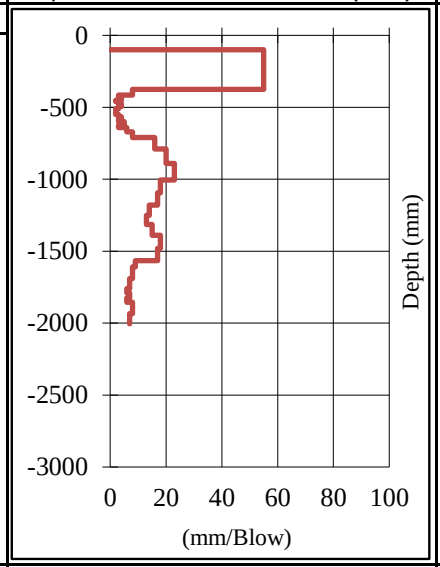
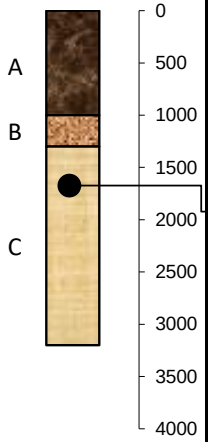


Photo of Test Pit

TP 4

Datum: NGL | Co-ords: 23 Y0051186 X3765462

Key to symbols: ● Sample taken | Groundwater



(0 to 1000)	Moist, dark reddish brown blotched dark yellow orange, soft, intact, **SANDY SILTY CLAY with Rubble & rubbish**, imported (fill)
(1000 to 1300)	Moist, light brown, medium dense, intact, **SAND**, transported.
(1300 to 3200)	Moist, dark yellowish orange to dark reddish brown, stiff, fissured, pinholed, **SANDY CLAY**, residual.
	Foundation Indicator & MOD/CBR/Indicator

TP Stopped
No Water

Dynamic Cone Penetrometer (DCP)

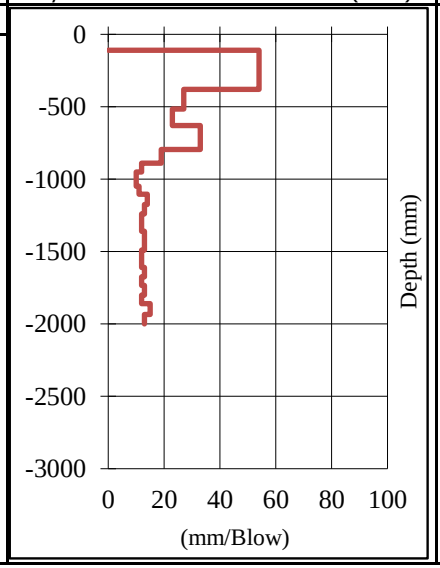
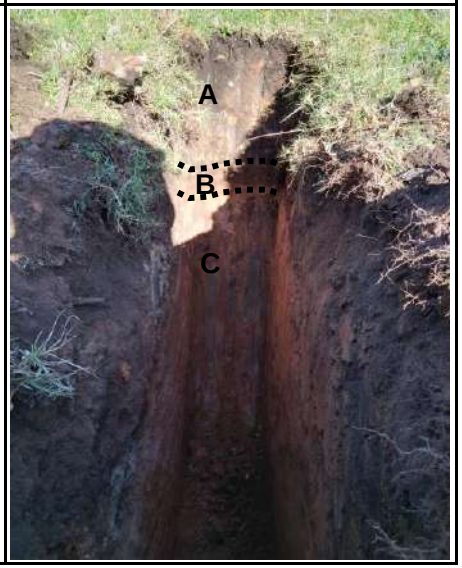


Photo of Test Pit



Appendix 3

Lab test data

OUTENIQUA LAB (Pty) Ltd.

Registration No. 95/07742/07

Materials Testing Laboratory

6 Mirrorball Street, George : PO Box 3186, George Industria, 6536

Tel: 044 8743274 : Fax: 044 8745779 : e-mail: llewelyn@outeniqualab.co.za

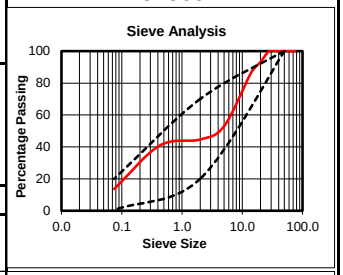
T0347

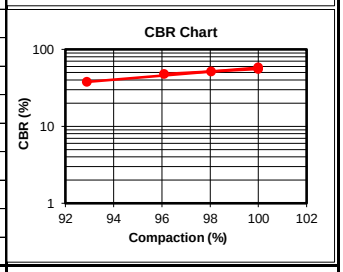
Customer :	Outeniqua Geotechnical Services P O Box 964 Knysna 6570	Project :	Proposed 214.5ML Reservoir in Pacaltsdorp - George
		Date Received :	12/07/2022
		Date Reported :	29/07/2022
		Req. Number :	2431/22
Attention :	Iain Paton	No. of Pages :	1/4

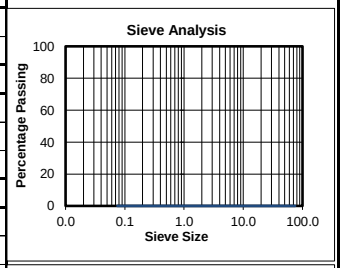
TEST REPORT
CALIFORNIA BEARING RATIO

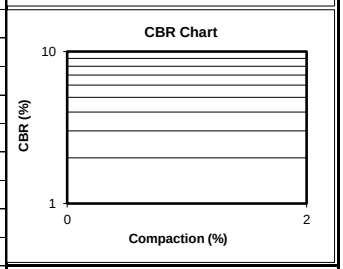
Sample Position (SV)		TP1 - Layer 1	COLTO:		
Depth (mm)		0-500	G5 Subbase		
Sample No		**84360**			
Materials Description	Source	In-situ			
	Colour	Pale Red			
	Soil Type	Sandy Gravel			
	Classification	Existing			
Material Indicators - (SANS 3001 Method GR1)					
Percentage Passing	75 mm	100		Opinion	
	63 mm	100			
	50 mm	100	100 - 100	✳	
	37.5 mm	100			
	28 mm	100			
	20 mm	93			
	14 mm	86			
	5 mm	53			
	2 mm	45	20 - 70	✓	
	0.425 mm	41			
	0.075 mm	13.7	1 - 20	✓	
Material Indicators - (SANS 3001 Method PR5)					
Grading Modulus		2.01	1.50 - 2.50	✓	
Coarse Sand Soil-Mortar (%)		9			
Atterberg Limits - (SANS 3001 Method GR10)					
Liquid Limit (%)		19	≤ 30	✓	
Plasticity Index (%)		2	≤ 10	✓	
Linear Shrinkage (%)		1.0	≤ 5	✓	
Material Strength - (SANS 3001 Method GR30,GR40 - SCALPED)					
MDD	Max Dry Density (kg/m^3)	2281			
	Optimum Moisture Content (%)	8.4			
	Mould Moisture Content (%)	8.6			
A	Relative Compaction (%)	100.0			
	Swell (%)	0.0	≤ 0.5	✓	
B	Relative Compaction (%)	96.1			
	Swell (%)	0.0			
C	Relative Compaction (%)	92.9			
	Swell (%)	0.0			
CBR	@100% Max Dry Density	58			
	@98% Max Dry Density	51			
	@95% Max Dry Density	43	≥ 45	✳	
	@93% Max Dry Density	38			
	@90% Max Dry Density	32			
Material Condition					
Insitu Moisture Content (%)					
Soil Classification Achieved By The Material					
COLTO:		G5 Subbase			
AASHTO System		A-1-b / A-2-4			
Unified System		GM			

84360

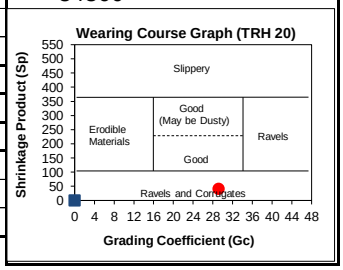








● 84360 ■



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Ruaan Lesch
Technical Signatory
For Outeniqua Lab (Pty) Ltd.

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OUTENIQUA LAB (Pty) Ltd.

Registration No. 95/07742/07

Materials Testing Laboratory

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Tel: 044 8743274 : Fax: 044 8745779 : e-mail: llewelyn@outeniqualab.co.za

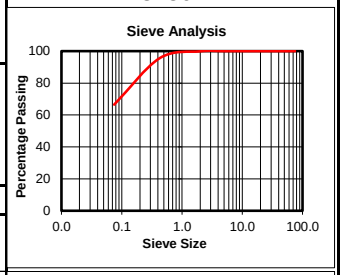
T0347

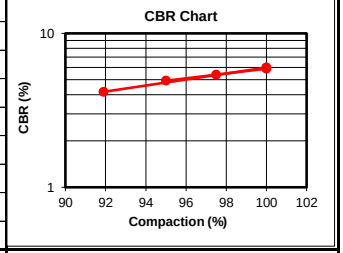
Customer :	Outeniqua Geotechnical Services P O Box 964 Knysna 6570	Project :	Proposed 214.5ML Reservoir in Pacaltsdorp - George
		Date Received :	12/07/2022
		Date Reported :	29/07/2022
		Req. Number :	2431/22
Attention :	Iain Paton	No. of Pages :	2/4

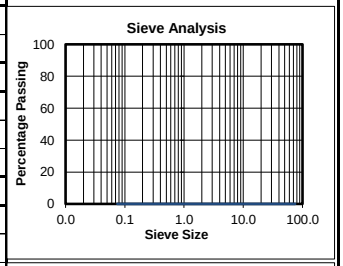
TEST REPORT
CALIFORNIA BEARING RATIO

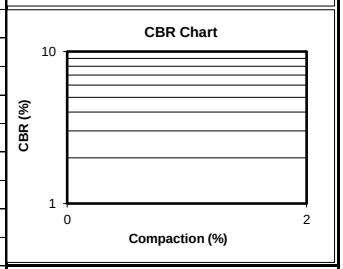
Sample Position (SV)		TP2 - Layer 4	COLTO: Not Classified				
Depth (mm)		2000-2800					
Sample No		**84362**					
Materials Description	Source	In-situ					
	Colour	Dark Reddish Orange					
	Soil Type	Sandy Lean Clay					
	Classification	Trail Pit					
Material Indicators - (SANS 3001 Method GR1)							
Percentage Passing	75 mm	100		Opinion			
	63 mm	100					
	50 mm	100					
	37.5 mm	100					
	28 mm	100					
	20 mm	100					
	14 mm	100					
	5 mm	100					
	2 mm	100					
	0.425 mm	96					
	0.075 mm	66.5					
Material Indicators - (SANS 3001 Method PR5)							
Grading Modulus		0.38					
Coarse Sand Soil-Mortar (%)		4					
Atterberg Limits - (SANS 3001 Method GR10)							
Liquid Limit (%)		35					
Plasticity Index (%)		17					
Linear Shrinkage (%)		8.5					
Material Strength - (SANS 3001 Method GR30,GR40 - SCALPED)							
MDD	Max Dry Density (kg/m^3)	1986					
	Optimum Moisture Content (%)	11.4					
	Mould Moisture Content (%)	11.7					
A	Relative Compaction (%)	100.0					
	Swell (%)	0.1					
B	Relative Compaction (%)	95.0					
	Swell (%)	0.1					
C	Relative Compaction (%)	91.9					
	Swell (%)	0.2					
CBR	@100% Max Dry Density	6					
	@98% Max Dry Density	6					
	@95% Max Dry Density	5					
	@93% Max Dry Density	4					
	@90% Max Dry Density	4					
Material Condition							
Insitu Moisture Content (%)							
Soil Classification Achieved By The Material							
COLTO:		Not Classified					
AASHTO System		A-6					
Unified System		CL					

84362

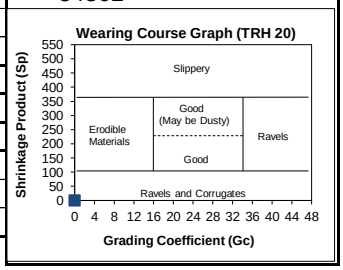








● 84362 ■



- **Specimens delivered to Outeniqua Lab in good order.**

Ruaan Lesch
Technical Signatory
For Outeniqua Lab (Pty) Ltd.

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		Date Received :	12/07/2022
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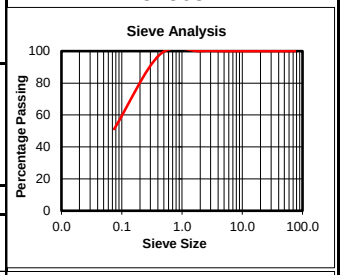
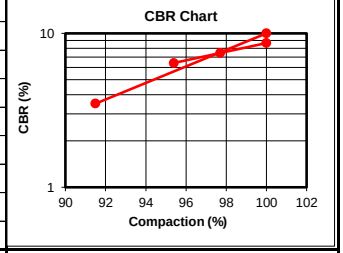
		Req. Number :	2431/22
Attention :	Iain Paton	No. of Pages :	3/4

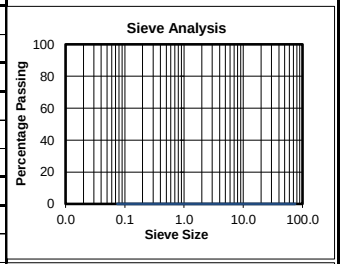
TEST REPORT
CALIFORNIA BEARING RATIO

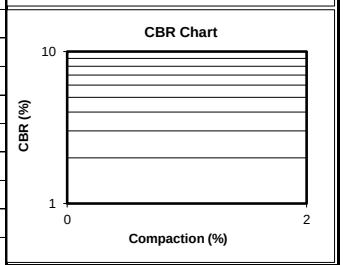
Sample Position (SV)		TP3 - Layer 3	COLTO: Not Classified				
Depth (mm)		800-3300					
Sample No		**84363**					
Materials Description	Source	In-situ					
	Colour	Pale Red to Light Yellowish					
	Soil Type	Silty Sandy Clay					
	Classification	Trail Pit					
Material Indicators - (SANS 3001 Method GR1)							
Percentage Passing	75 mm	100		Opinion			
	63 mm	100					
	50 mm	100					
	37.5 mm	100					
	28 mm	100					
	20 mm	100					
	14 mm	100					
	5 mm	100					
	2 mm	100					
	0.425 mm	98					
	0.075 mm	51.2					
Material Indicators - (SANS 3001 Method PR5)							
Grading Modulus		0.51					
Coarse Sand Soil-Mortar (%)		2					
Atterberg Limits - (SANS 3001 Method GR10)							
Liquid Limit (%)		21					
Plasticity Index (%)		5					
Linear Shrinkage (%)		2.5					
Material Strength - (SANS 3001 Method GR30,GR40 - SCALPED)							
MDD	Max Dry Density (kg/m^3)	2046					
	Optimum Moisture Content (%)	10.7					
	Mould Moisture Content (%)	10.5					
A	Relative Compaction (%)	100.0					
	Swell (%)	0.3					
B	Relative Compaction (%)	95.4					
	Swell (%)	0.6					
C	Relative Compaction (%)	91.5					
	Swell (%)	0.7					
CBR	@100% Max Dry Density	10					
	@98% Max Dry Density	8					
	@95% Max Dry Density	5					
	@93% Max Dry Density	4					
	@90% Max Dry Density	3					
Material Condition							
Insitu Moisture Content (%)							
Soil Classification Achieved By The Material							
COLTO:		Not Classified					
AASHTO System		A-4					
Unified System		CL-ML					

84363

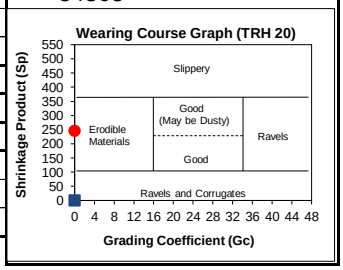








● 84363 ■



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Ruaan Lesch
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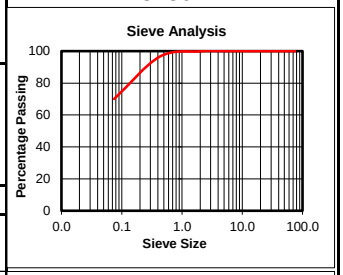
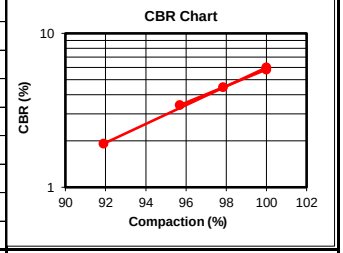
		Req. Number :	2431/22
Attention :	Iain Paton	No. of Pages :	4/4

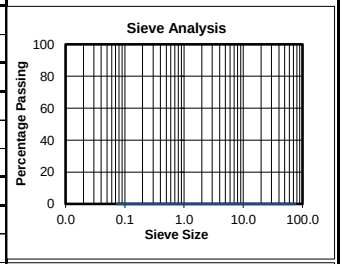
TEST REPORT
CALIFORNIA BEARING RATIO

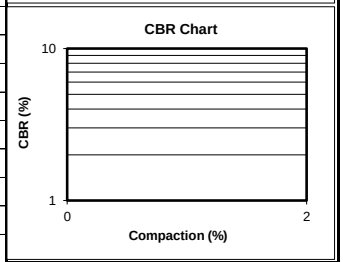
Sample Position (SV)		TP4 - Layer 3	COLTO: Not Classified				
Depth (mm)		1300-3200					
Sample No		**84364**					
Materials Description	Source	In-situ					
	Colour	Dark Yellowish Orange					
	Soil Type	Silty Sand					
	Classification	Trail Pit					
Material Indicators - (SANS 3001 Method GR1)							
Percentage Passing	75 mm	100		Opinion			
	63 mm	100					
	50 mm	100					
	37.5 mm	100					
	28 mm	100					
	20 mm	100					
	14 mm	100					
	5 mm	100					
	2 mm	100					
	0.425 mm	96					
	0.075 mm	70.1					
Material Indicators - (SANS 3001 Method PR5)							
Grading Modulus		0.34					
Coarse Sand Soil-Mortar (%)		3					
Atterberg Limits - (SANS 3001 Method GR10)							
Liquid Limit (%)		Undetermined					
Plasticity Index (%)		SP					
Linear Shrinkage (%)		SP					
Material Strength - (SANS 3001 Method GR30,GR40 - SCALPED)							
MDD	Max Dry Density (kg/m^3)	2057					
	Optimum Moisture Content (%)	10.0					
	Mould Moisture Content (%)	9.7					
A	Relative Compaction (%)	100.0					
	Swell (%)	1.6					
B	Relative Compaction (%)	95.7					
	Swell (%)	1.7					
C	Relative Compaction (%)	91.9					
	Swell (%)	1.9					
CBR	@100% Max Dry Density	6					
	@98% Max Dry Density	5					
	@95% Max Dry Density	3					
	@93% Max Dry Density	2					
	@90% Max Dry Density	1					
Material Condition							
Insitu Moisture Content (%)							
Soil Classification Achieved By The Material							
COLTO:		Not Classified					
AASHTO System		A-4					
Unified System		MH					

84364

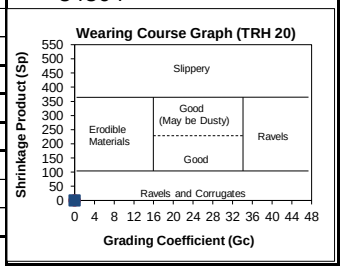








● 84364 ■



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Ruaan Lesch
Technical Signatory
For Outeniqua Lab (Pty) Ltd.

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1. The opinion column is an interpretation of the direct comparison between the quoted specification and the single test sample results obtained. The compliant (✓), non compliant (×) and uncertain (∗) opinion indicators are based on an approximate 95% level of confidence with reference to SAMM GUIDANCE 1, Issue 2 : 20 June 2007 Section 2.
2. The uncertain (∗) indicates that the test result is either equal to or is above / below the specified limit by a margin less than the measurement uncertainty; it is therefore not possible to state compliant (✓) or non compliant (×) based on a 95% level of confidence with reference to SAMM GUIDANCE 1, Issue 2 : 20 June 2007 Section 2.
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Registration No. 95/07742/07

Materials Testing Laboratory

6 Mirrorball Street, George : PO Box 3186, George Industria, 6536

Tel: 044 8743274 : Fax: 044 8745779 : e-mail: llewelyn@outeniqualab.co.za T0347

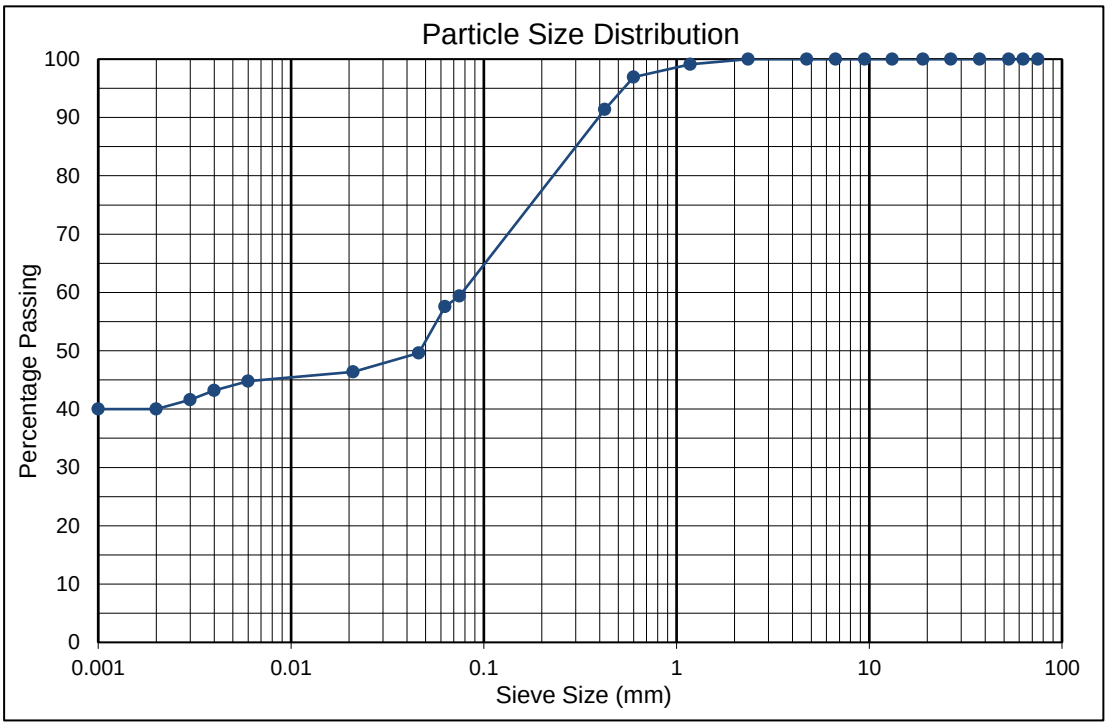
Customer :	Outeniqua Geotechnical Services P O Box 964 Knysna 6570	Project :	Proposed 214.5ML Reservoir in Pacaltsdorp - George
		Date Received :	12/07/2022
		Date Reported :	29/07/2022
		Req. Number :	2431/22
Attention :	Iain Paton	No. of Pages :	1/4

TEST REPORT

FOUNDATION INDICATOR - (ASTM Method D422)

Sample Position (SV)		TP1 - Layer 1
Depth (mm):		800-3400
Sample No.:		84361
Materials Description	Source	In-situ
	Colour	Dark Reddish
	Soil Type	Sandy Silt
	Classification	Trial Pit

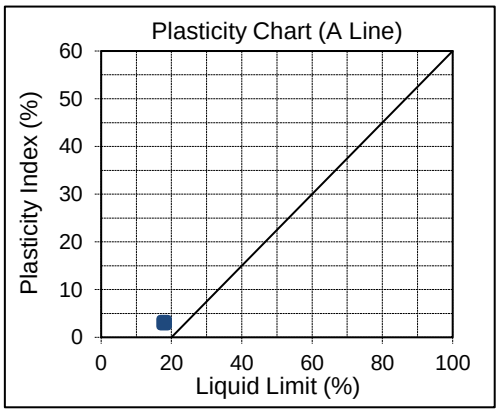
Percentage Passing	
75.0mm	100
63.0mm	100
53.0mm	100
37.5mm	100
26.5mm	100
19mm	100
13.2mm	100
9.5mm	100
6.7mm	100
4.75mm	100
2.36mm	100
1.18mm	99
0.6mm	97
0.425mm	91
0.075mm	59
0.063mm	58
0.046mm	50
0.021mm	46
0.006mm	45
0.004mm	43
0.003mm	42
0.002mm	40
0.001mm	40

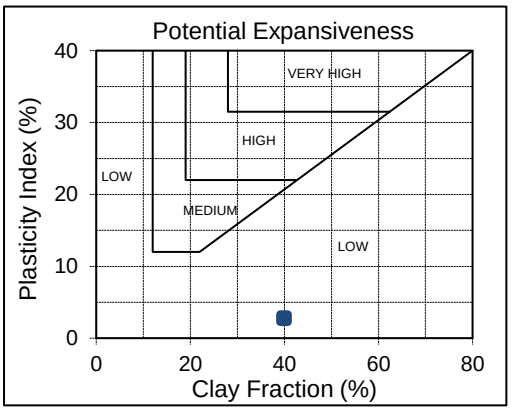


Liquid Limit (%)	18
Plasticity Index (%)	3
Linear Shrinkage (%)	2
Moisture Content (%)	15.8

% Clay	40
% Silt	16
% Sand	44
% Gravel	0

Unified Soil Classification	ML
AASHTO Soil Classification	A-4





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Ruaan Lesch
Technical Signatory
For Outeniqua Lab (Pty) Ltd.

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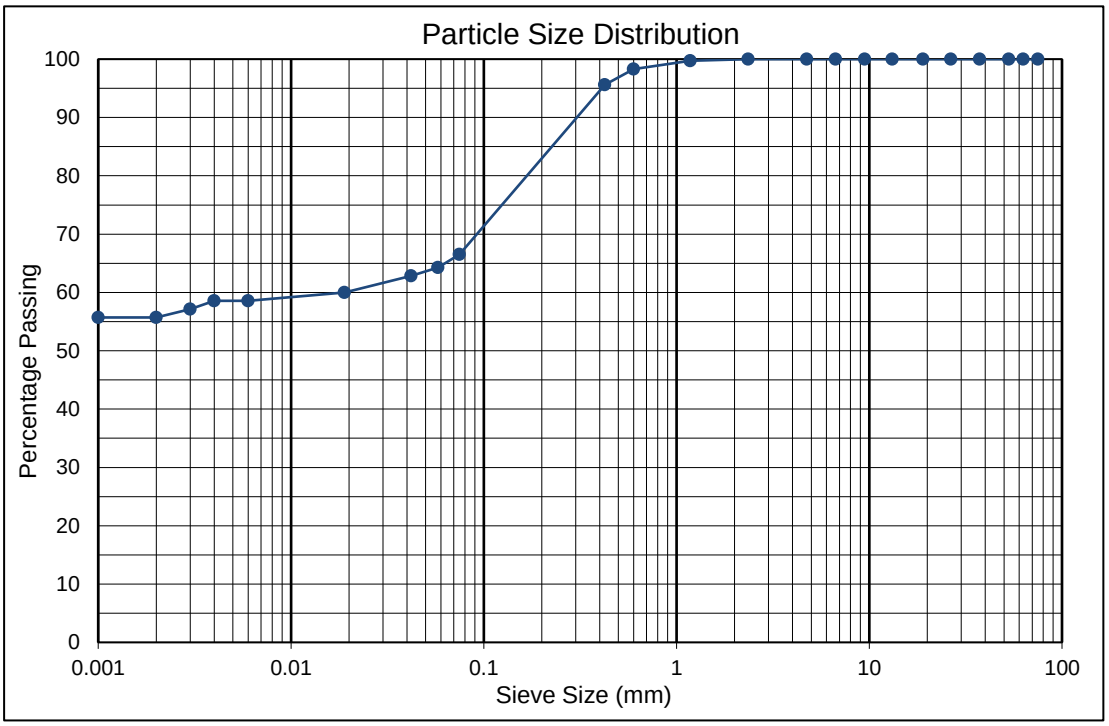
Attention :	Iain Paton	No. of Pages :	2/4

TEST REPORT

FOUNDATION INDICATOR - (ASTM Method D422)

Sample Position (SV)		TP2 - Layer 4
Depth (mm):		2000-2800
Sample No.:		84362
Materials Description	Source	In-situ
	Colour	Dark Reddish Orange
	Soil Type	Sandy Lean Clay
	Classification	Trial Pit

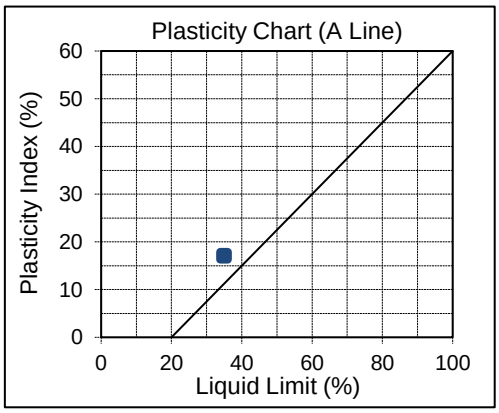
Percentage Passing	
75.0mm	100
63.0mm	100
53.0mm	100
37.5mm	100
26.5mm	100
19mm	100
13.2mm	100
9.5mm	100
6.7mm	100
4.75mm	100
2.36mm	100
1.18mm	100
0.6mm	98
0.425mm	96
0.075mm	67
0.058mm	64
0.042mm	63
0.019mm	60
0.006mm	59
0.004mm	59
0.003mm	57
0.002mm	56
0.001mm	56

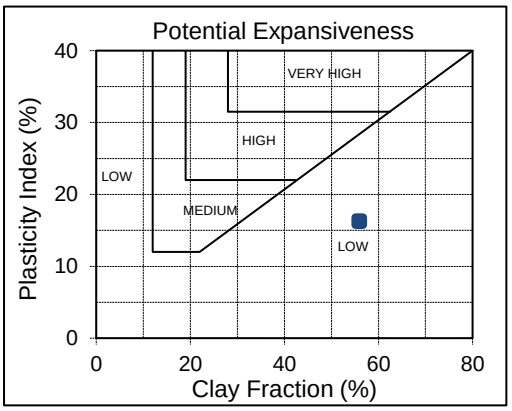


Liquid Limit (%)	35
Plasticity Index (%)	17
Linear Shrinkage (%)	9
Moisture Content (%)	15.6

% Clay	56
% Silt	8
% Sand	36
% Gravel	0

Unified Soil Classification	CL
AASHTO Soil Classification	A-6





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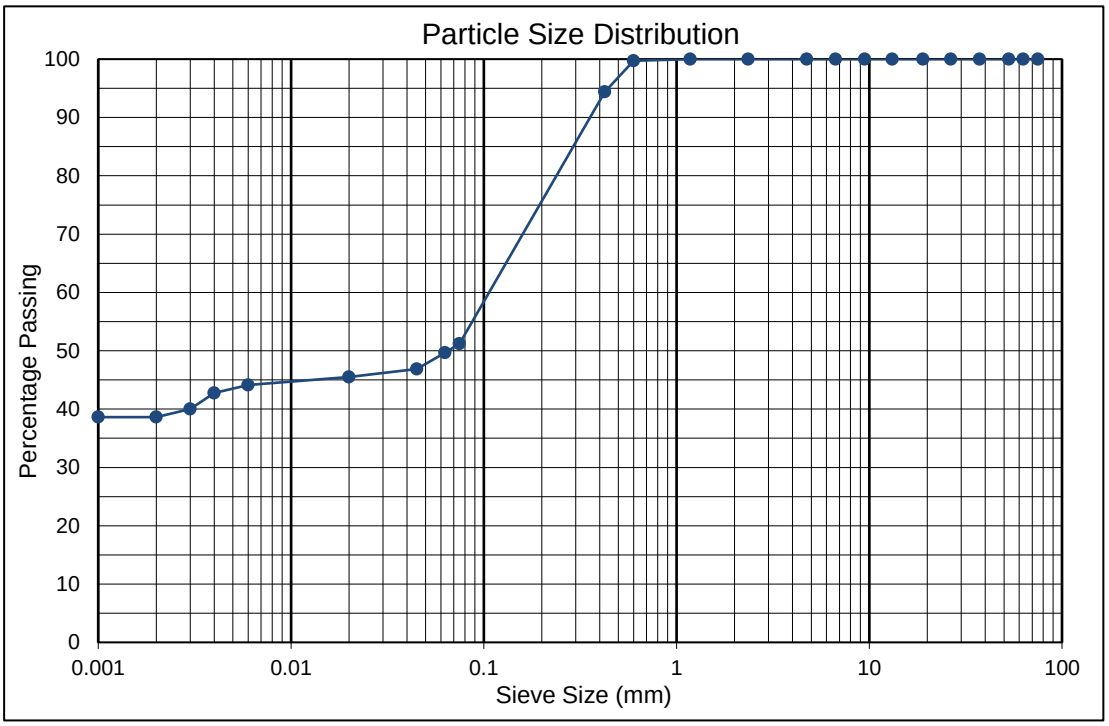
Attention :	Iain Paton	No. of Pages :	3/4

TEST REPORT

FOUNDATION INDICATOR - (ASTM Method D422)

Sample Position (SV)		TP3 - Layer 3
Depth (mm):		800-3300
Sample No.:		84363
Materials Description	Source	In-situ
	Colour	Pale Red to Light Yellowish
	Soil Type	Silt/Silty Clay
	Classification	Trial Pit

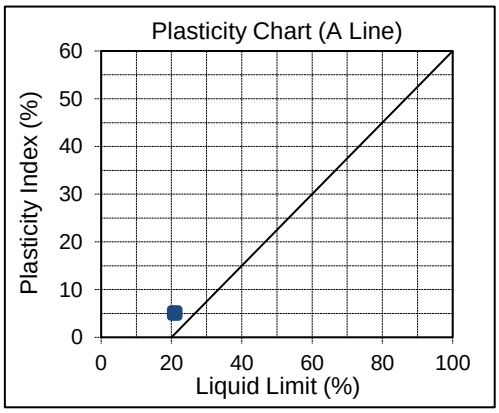
Percentage Passing	
75.0mm	100
63.0mm	100
53.0mm	100
37.5mm	100
26.5mm	100
19mm	100
13.2mm	100
9.5mm	100
6.7mm	100
4.75mm	100
2.36mm	100
1.18mm	100
0.6mm	100
0.425mm	94
0.075mm	51
0.063mm	50
0.045mm	47
0.02mm	46
0.006mm	44
0.004mm	43
0.003mm	40
0.002mm	39
0.001mm	39

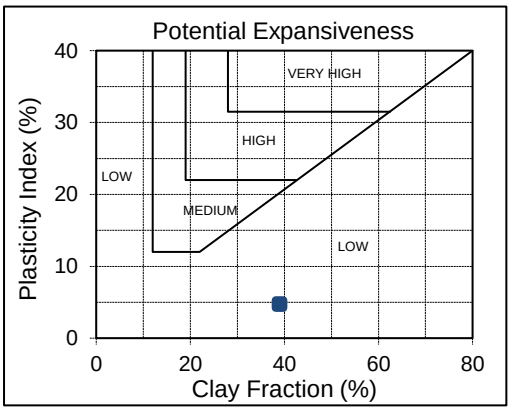


Liquid Limit (%)	21
Plasticity Index (%)	5
Linear Shrinkage (%)	3
Moisture Content (%)	10.6

% Clay	39
% Silt	10
% Sand	51
% Gravel	0

Unified Soil Classification	CL-CM
AASHTO Soil Classification	A-4





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		Date Reported :	29/07/2022
		Req. Number :	2431/22
Attention :	Iain Paton	No. of Pages :	4/4

TEST REPORT

FOUNDATION INDICATOR - (ASTM Method D422)

Sample Position (SV)		TP4 - Layer 3
Depth (mm):		1300-3200
Sample No.:		84364
Materials Description	Source	In-situ
	Colour	Dark Yellowish Orange
	Soil Type	Silty Sand
	Classification	Trial Pit

Percentage Passing	
75.0mm	100
63.0mm	100
53.0mm	100
37.5mm	100
26.5mm	100
19mm	100
13.2mm	100
9.5mm	100
6.7mm	100
4.75mm	100
2.36mm	100
1.18mm	100
0.6mm	99
0.425mm	97
0.075mm	50
0.065mm	49
0.047mm	44
0.021mm	41
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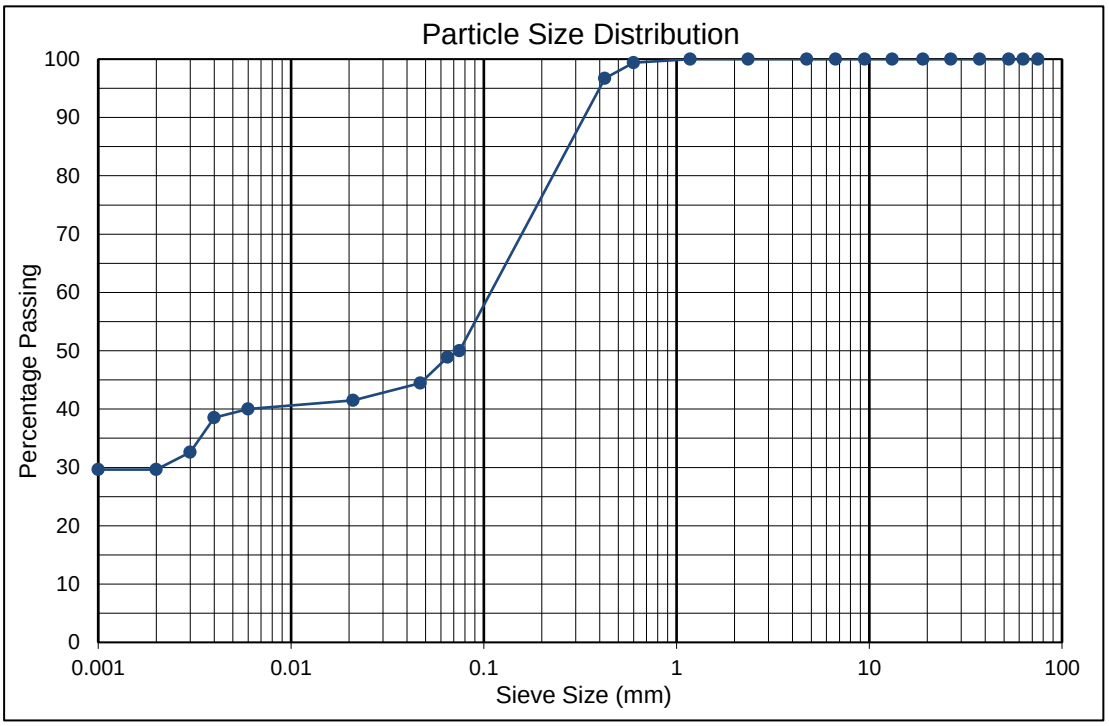
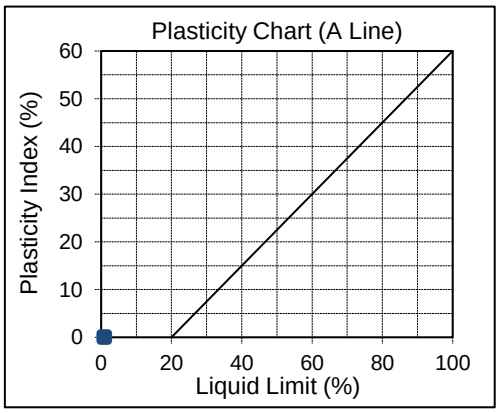
0.002mm	30
0.001mm	30

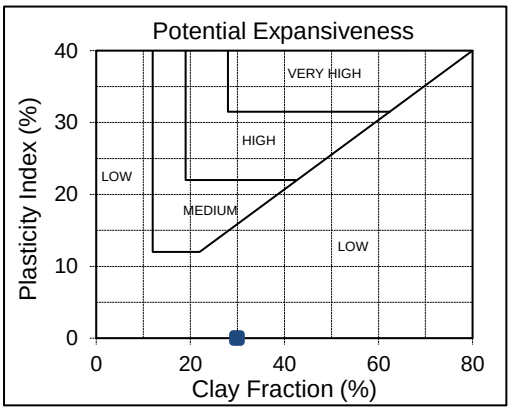


Liquid Limit (%)	SP
Plasticity Index (%)	SP
Linear Shrinkage (%)	SP
Moisture Content (%)	8.8

% Clay	30
% Silt	18
% Sand	52
% Gravel	0

Unified Soil Classification	SM
AASHTO Soil Classification	A-4





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Appendix 4

DCP test data

Outeniqua Geotechnical Services cc.

Geotechnical Engineering Consultants

Registration No. 1999/062743/23

18 Clyde Street, Knysna : PO Box 964, Knysna, 6570

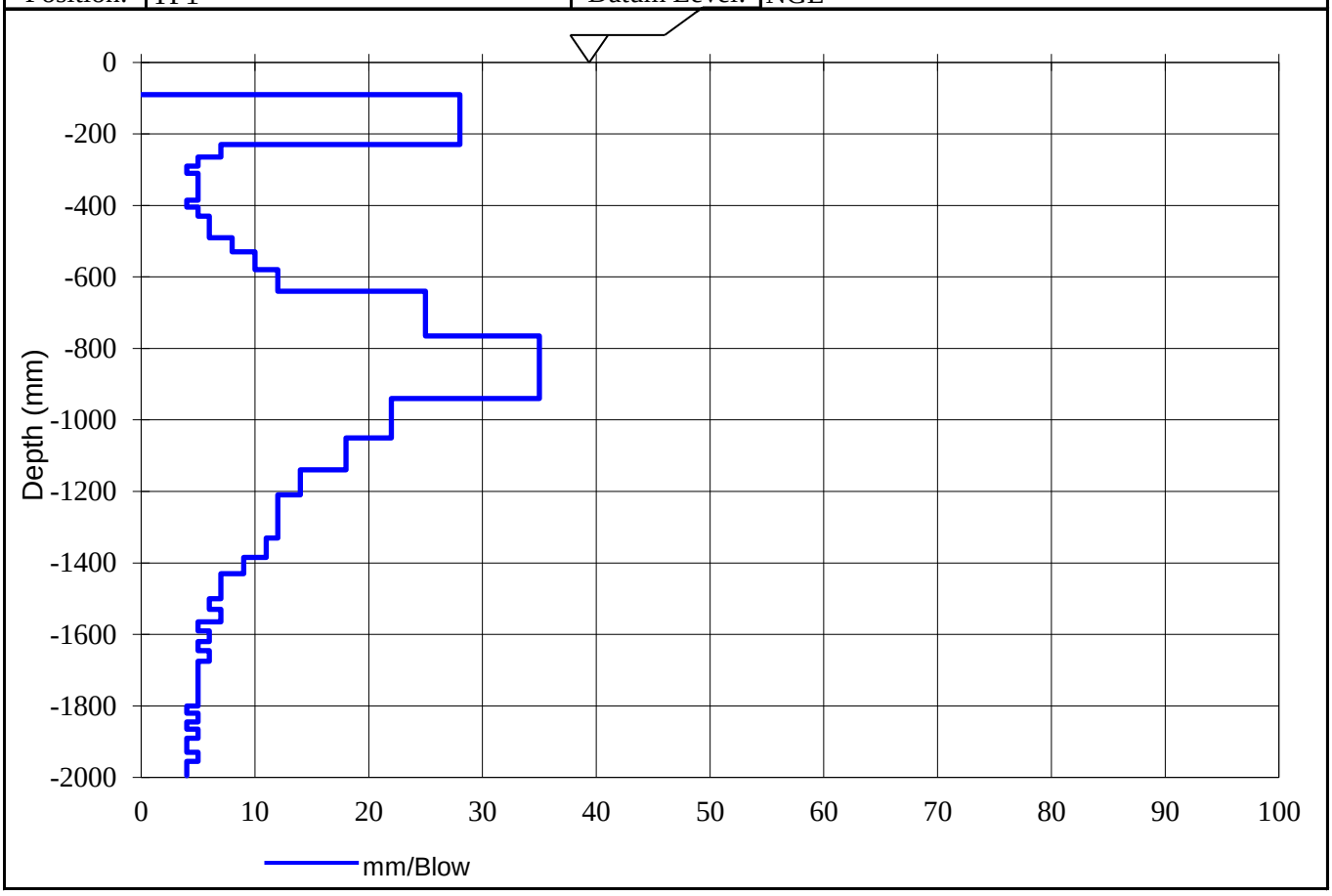
Tel: 044 3820502 : Fax: 044 3820503 : e-mail: iain@outeniqualab.co.za

Customer :	Royal HaskoningDHV 1st Floor Suite 101 Bloemhof Building George 6529	Project :	Two 14.5ML Reservoir Pacaltsdorp George
		Date Received :	23.06.2022
		Date Reported :	11.07.2022
		Req. Number :	
Attention :	Hanry Neethling	No. of Pages :	1 of 4

TEST REPORT

Dynamic Cone Penetrometer (DCP) - (TMH 6 Method ST6)

Position:	TP1	Datum Level:	NGL



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Technical Signatory

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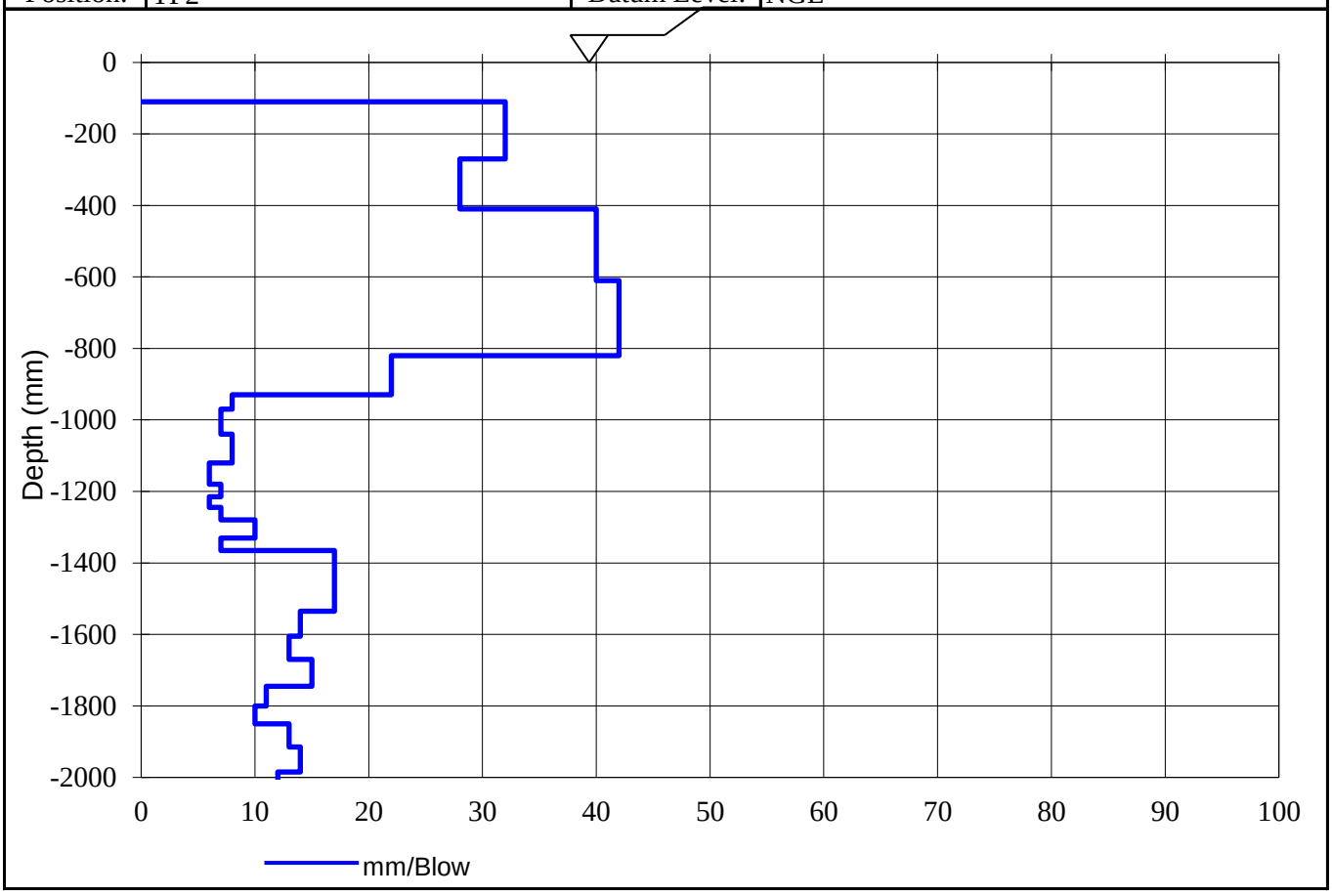
Attention :	Hanry Neethling	No. of Pages :	2 of 4

TEST REPORT

Dynamic Cone Penetrometer (DCP) - (TMH 6 Method ST6)

Position:	TP2	Datum Level:	NGL



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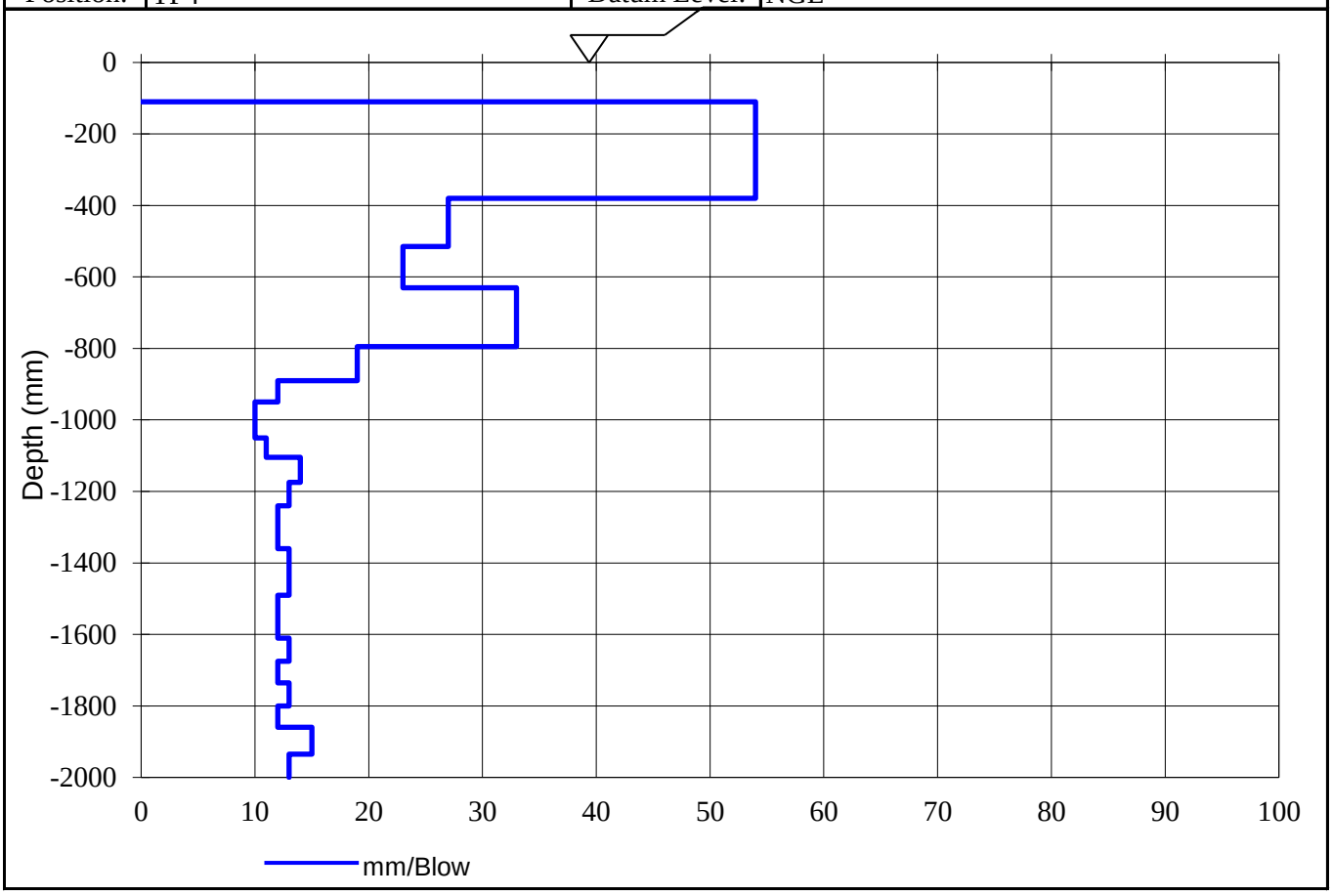
TEST REPORT

Dynamic Cone Penetrometer (DCP) - (TMH 6 Method ST6)

Position:	TP4	Datum Level:	NGL



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