GEOTECHNICAL REPORT

PROPOSED NEW FILLING STATION ON PORTION 4 OF FARM 135 GREAT BRAK, WESTERN CAPE

22 May 2017

Revision 0

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Report review history:

Revision No	Date	Prepared by:	Authorised by:
0 22.5.2017		I.Paton Pr.Sci.Nat BSc Hons MEng	I.Paton Pr.Sci.Nat BSc Hons MEng
			

Authors qualifications and affiliations:

Iain Paton is a professionally registered engineering geologist with 18 years' experience in the mining, energy and construction industries. Iain Paton is a registered with the South African Council for Natural and Scientific Professions (Pr Sci Nat # 400236/07), the South African Institute of Engineering and Environmental Geologists (SAIEG), the Geotechnical Division of the South African Institute of Civil Engineering (SAICE) and the Institute of Municipal Engineering of South Africa (IMESA).

Declaration of independence:

The author of this report is 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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List of Appendices

1. Introduction

1.1 Background information

A new fuel filling station is proposed on Portion 4 of Farm 135 Great Brak in the Western Cape (see **Figure 1** for locality map). The proposed development includes underground fuel storage tanks (USTs), fuel pumps, a canopy and single storey buildings for convenience shop, office and ablutions, a paved forecourt and parking areas. The geotechnical nature of the site needs to be investigated in order to facilitate the design of earthworks, foundations and civil engineering services.

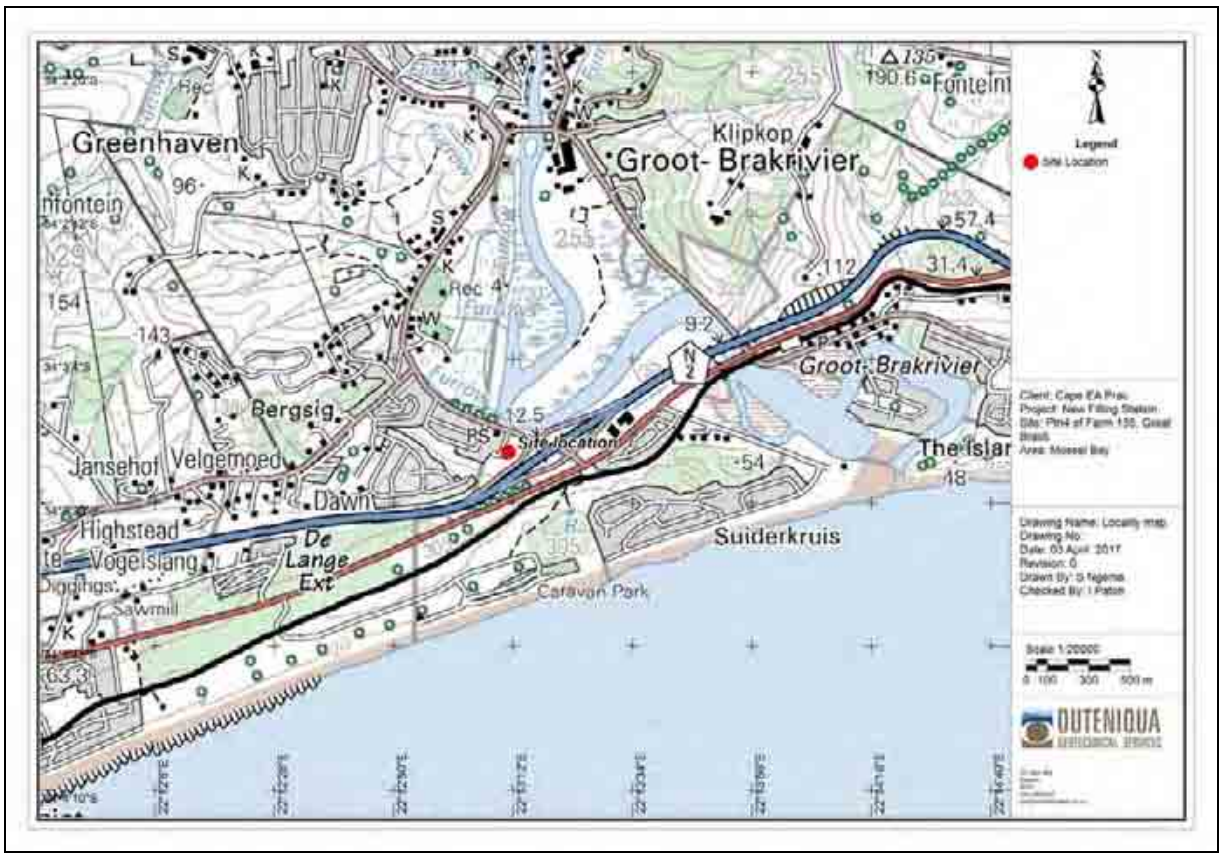


Figure 1: Locality map

1.2 Terms of reference

The scope of work for the investigation is as follows:

Site Work:

- Excavate and profile 6 test pits to ~2.5m deep or refusal with a TLB;
- Collect soil samples for laboratory testing;
- Conduct DCP tests at each test position.

Laboratory Tests:

- Foundation Indicator tests;
- Mod AASHTO/CBR/Indicator tests;
- pH & Conductivity tests.

Assessment report:

Preparation of a report giving a geotechnical assessment of the soil conditions and recommendations on:

- Earthworks design;
- Foundation design for the proposed structures (including founding depths, estimated allowable safe bearing pressures);
- Design of roads and civil services;
- Any other precautions to be taken with regards to the geotechnical conditions for the proposed development.

2. Site description

The site is located on the southern side of Great Brak, at the intersection of Long St and the N2 National Road (see **Figure 2**). The site is also located approximately 40m south of the Great Brak River. The topography on the site is very gently sloping to the north at a gradient of between 1:20 and 1:50, becoming slightly steeper towards the southwest.

The climate of the area is temperate with an average annual rainfall of 450mm. The vegetation on the site has been completely transformed by historical activity on the site and is very sparse, mainly occurring around the edges of the site (see **Figure 3**).

3. Regional geology

The 1:250000-scale geological map indicates that the site is entirely underlain by alluvial sediments, deposited on the banks of the Great Brak River (yellow on map in **Figure 4**). Large parts of the town are developed on these alluvial sediments, which are known to be several meters thick.

The Uitenhage Group (Enon Formation, Kirkwood Formation & similar younger deposits – red on map) occur to the north and west of the site. Granite rocks of the Maalgaten Suite occur to the north and east of the town (pink on map).

There are no geological faults near the site and the seismic risk is generally low. The geology is generally considered stable for urban development, although periodic flooding of the river is well known.

Figure 2: Aerial photo map

Figure 3: View to the north across the site

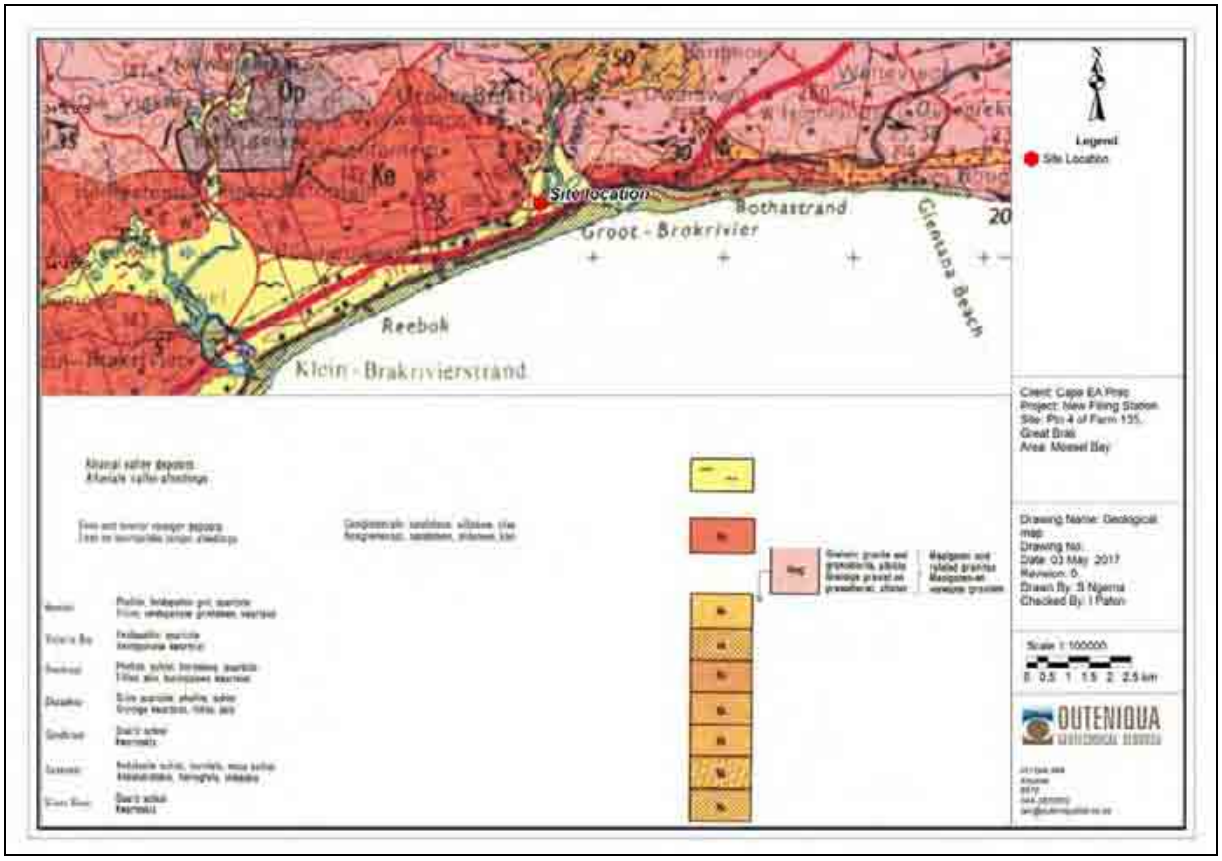


Figure 4: Geological map of site

4. The site investigation

4.1 Available information

The following maps & plans were available for consultation:

- 1:250 000 Geological map 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.
- Conceptual site layout plan, provided by Bruyncon;

Geotechnical reports done by this company for nearby developments were also available for reference purposes.

4.2 Geotechnical tests

Six test pits were excavated across the site to a max depth 3m, using a TLB/back-actor at the positions indicated in **Figure 5**. This enabled a study of the subsoil conditions (soil types, moisture levels, etc.) and depth to the water table. The soil profiles and photographs of the test pits are included in **Appendix 2** of this report. All test pits were excavated to below the water table, where the test pit was terminated due to collapsing sidewalls.

Samples of the soil were collected for Foundation Indicator and Mod.AASHTO/CBR tests, which were conducted at an SANAS-Accredited Civil Engineering laboratory (Outeniqua Lab), in accordance with TMH1 and ASTM methods. Additional tests (Shear box and soil chemistry) were carried out at Geoscience Labs in Cape Town. Details of the tests are included in **Appendix 3** of this report.

In situ dynamic cone penetrometer (DCP) tests were conducted at each test position from NGL to a depth of ~4m or refusal. Details of the tests are included in **Appendix 4** of this report.

5. Results of the investigation

5.1 Local soil and rock types

The natural soil profile underlying the site consists of a dark brown silty sand horizon (original topsoil), which is underlain by alluvial/estuarine sand (see **Figure 6**). The natural soil profile is overlain by one or more horizons of imported gravel & rubble material (uncontrolled fill), which covers most of the site, and increases in thickness to the south. The fill exposed in test pits was generally benign with no sign of contamination or significant deleterious materials, such as rubbish or organic matter, and is unlikely to pose a problem (see **Figure 7** – taken at TP6).

No rock or residual soil was encountered in any of the test positions. The test pits were easily excavated and the consistency of the soil is generally medium dense to dense but cohesionless. The insitu estuarine soils are potentially compressible.

The soil moisture is generally moist and the permanent water table was encountered at a depth ranging between 2.2m and 2.8m. A summary of the test pit data is given in **Table 1**.

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

Test pos. No.	*Imported (fill) soil*	*Transported soil*	*Residual soil*	*Rock*	*Total depth of test pit*	*Refusal?*	*Water table*
TP1	500	1900	-	-	2400	No	2200
TP2	600	2200	-	-	2800	No	2600
TP3	800	1800	-	-	2600	No	2400
TP4	1000	1800	-	-	2800	No	2600
TP5	1200	1600	-	-	2800	No	2600
TP6	2000	1000	-	-	3000	No	2800

Figure 5: Geotechnical map of site indicating test positions and soil classification

Figure 6: Typical test pit showing water table and soil types (TP5)

Figure 7: Gravel/sand fill material exposed at TP6

5.1.1 Laboratory tests

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

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			
TP3	1700-2100	NP	NP	0	1	0	98	1	4.7	Low	SP
TP4	1600-2600	NP	NP	0	2	1	95	2	12.7	Low	SP
TP5	1600-2600	NP	NP	0	1	0	99	0	15.3	Low	SP

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

The lab results indicate that the insitu estuarine soils below the original topsoil horizon, are dominated by sand-sized particles, with very little fines (silt and clay), and a low plasticity index. Samples tested are classified under the Unified Soil Classification (USC) system as poorly graded sands with little or no fines (SP).

Representative samples of different soil horizons were collected for Mod/CBR/Indicator tests to determine the subgrade potential for pavement design and general filling under and around structures. The results of the tests are summarised in **Table 3**.

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

Test Pit No	Sample Depth (mm)	CBR at					Swell (%)	PI (%)	GM	MDD/ OMC	TRH14 Class
		100 %	98%	95%	93%	90%					
TP3	0-400	132	124	102	61	28	0.00	NP	2.28	2274/5.4	G5
TP4	0-600	36	33	29	24	18	0.25	6	2.14	2162/6.7	G7
TP5	1600-2600	26	22	17	15	12	0.00	NP	1.04	1656/13.8	G7

The test results indicate that the fill material (sampled at TP3 & 4) is variable quality (G7-G5, i.e. marginal to good) and may be suitable for use as a filling material under structures, and/or as a selected subgrade layer for the construction of the forecourt and parking areas. The tests indicate that the underlying estuarine sands (sampled at TP5) are G7 quality. Recommendations are given in **Chapter 7**.

Samples of the estuarine sands were collected for pH & Conductivity tests to determine the aggressiveness towards buried structures. The results of the tests are summarised in **Table 4**.

Table 4: Summary of soil chemistry test results

Test Position	Depth	pH	Conductivity (mS/m)
TP1	900-2200	8.3	26
TP4	1600-2600	7.7	42
TP5	1600-2600	7.5	26

The tests indicate that the soil has a high conductivity due to dissolved salts and may be corrosive towards buried metallic fittings. The pH is generally neutral to slightly alkaline.

5.1.2 Bearing capacity and settlement

Observations made during the test pitting and analysis of DCPs indicates that the consistency of the insitu soil below the fill is generally dense. Shear box tests indicate a friction angle (φ) of 31° (c=0kPa) for sand that is recompacted to 95% of Proctor density. This can be used as a conservative design parameter. Bearing capacity is unlikely to be a problem for the proposed single storey structures, and if the foundation trenches are well compacted, total settlement is likely to be less than 10mm. Foundation design recommendations are given in **Chapter 7**.

5.1.3 Heave

There is no active clay expected on this site.

5.2 Groundwater and site drainage

The groundwater table was encountered in all the test pits at a depth ranging from 2.2m

below GL (north side) to 2.8m (south side). Samples of groundwater were taken for analysis by the groundwater consultants.

5.3 Slopes

The site has a very gentle slope gradient and no global slope instability is anticipated.

5.4 Excavations

All excavations to a depth of 3m are classified as “Soft” in terms of SABS 1200D. The sidewalls of test pits collapsed once the water table was reached due to the cohesionless nature of the soil.

6. Geotechnical assessment

The soil conditions were generally suitable for the founding of light structures, requiring only conventional compaction to minimise settlement, but deep excavations for USTs may be hampered by the water table, requiring dewatering. A summary of geotechnical constraints that potentially may affect the development of the site is tabulated in **Table 5**.

Table 5: Assessment of potential geotechnical constraints

Geotechnical Constraint	*Effect on the proposed development*	*Severity*	*Comment*
Collapsible and/or compressible soil	Soil horizons with a potentially collapsible and/or compressible fabric which may affect stability of foundations	Low-medium	Silty sands/sands may be compressible under load and will require compaction minimise settlement.
Differential settlement	Foundations placed in different soil types or rock may settle differentially.	Medium	Some variation can be expected in alluvial deposits. Uniform compaction is important.
Bearing capacity	Foundations placed on soils with low bearing capacity will display unsuitable settlement.	Low	Bearing capacity generally not a problem if foundations are placed on dense, well compacted insitu soil
Groundwater	Seepage, permanent or perched water tables affecting excavations.	Medium-high	Groundwater may affect deep excavations
Active soil	Heaving clays affecting foundation stability	Low	No active clay expected
Excavations	Boulders or rock affecting excavations	Low	No boulders and/or rock expected
	Unstable excavations requiring shoring	High	Excavations will be unstable at steep angles. Lateral support will be required for deep excavations for USTs.
Slope stability	Geological instability causing damage to structures founded on slopes	Low	No steep natural slopes.
	Soil creep or erosion by storm water	Low	Erosion unlikely to pose a significant threat but contractors should monitor erosion from site.
Flood potential	Low lying areas affected by poor drainage.	Med-high	Part of the site is located below the 1:50yr floodline
Unconsolidated fill	Uncontrolled fill material affecting foundations	Medium	Uncontrolled fill occurs across the entire site, but this is mainly gravel material which can be recompacted to support loads
Sources of construction material	Distance to sources of construction material affecting costs	Low	The soils are mainly G7, with minor G5 expected, but nothing better is expected on the site. Insitu soils and fill can be used for backfilling if approved by the engineer and compaction can be achieved. Commercial sources of better material are readily available in the area.

The site has been classified according to the Code of Practice for Foundations and Superstructures issued by the Joint Structural Division (JSD) of the South African Institution of Civil Engineering and Institution of Structural Engineers (SAICE/IStructE). This classification is given in **Table 7**.

Table 7: SAICE soil classification

Terrain unit	*Geotechnical Constraint*	*Soil Class*	*Total expected heave (mm)*	*Total expected settlement (mm)*
Terrain 1 (entire site)	Potentially compressible soils	S-S1	-	<20
	Uncontrolled/ controlled fill	P	-	-

7. Recommendations

The design of foundations and services lies within the consulting engineer's responsibility and the following recommendations are based on limited information gained from the site investigation and although the confidence in the information is high, some variations can occur between information points. All geotechnical information must be confirmed during the design and construction process and 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.

7.1 Earthworks

The terrain on the site is fairly gentle and minor earthworks are envisaged to clear and level the site. On average, the upper 1m of soils is uncontrolled fill (mainly gravel, some rubble & minor rubbish) that is potentially useful as a general filling material (assume G7) and can be stripped off, selectively stockpiled and replaced under foundations. The test pits indicate some minor foreign matter (rubbish, oversize rubble) in this fill and therefore excavation and selection of material is important. Any significant amounts of unsuitable material exposed during earthworks, such as clay, foreign matter and organics, should be replaced with suitable granular fill, as directed by the engineer.

The underlying insitu estuarine soils are also suitable for general filling purposes around USTs. All materials should be inspected and approved by the engineer prior to placement. Compaction of materials on engineered platforms should be tested and approved by the engineer.

All temporary excavations below 1.5m will require effective dewatering and lateral support, such as steel I-Beams and timber lagging with cross bracing. Deep excavations must be designed and supervised by the engineer. The potential effect of dewatering on neighbouring structures should be considered by the engineers.

7.2 Foundations

The site investigation indicates that the site is underlain by potentially compressible fill material and insitu soils, which will require controlled selection and compaction to safely carry load and minimise differential settlement of structures.

The recommended foundation type for the envisaged single structures (& canopy) is lightly reinforced concrete strip or pad foundations on well compacted selected fill material or insitu soils at a nominal depth of 0.6m below GL. A conservative estimate of safe bearing capacity at this level for preliminary foundation sizing is 100kPa. Foundations with heavier loads will require deeper improvement below the footing, possibly including the placement and compaction of a G5 engineered fill layer. Raft foundations on an engineered platform may also be considered as a suitable alternative method to strips/pads. It is recommended that allowance is made for importation of engineered fill materials (G5) for local improvement, if necessary to achieve compaction on local soft/weak spots.

7.3 Roads and pavement design

In terms of pavement design, the present-level subgrade is a marginal-good quality and may suffice as a selected subgrade layer (assume G7 quality). The recommended layerworks are given in **Table 6**.

Table 6: Pavement design recommendations

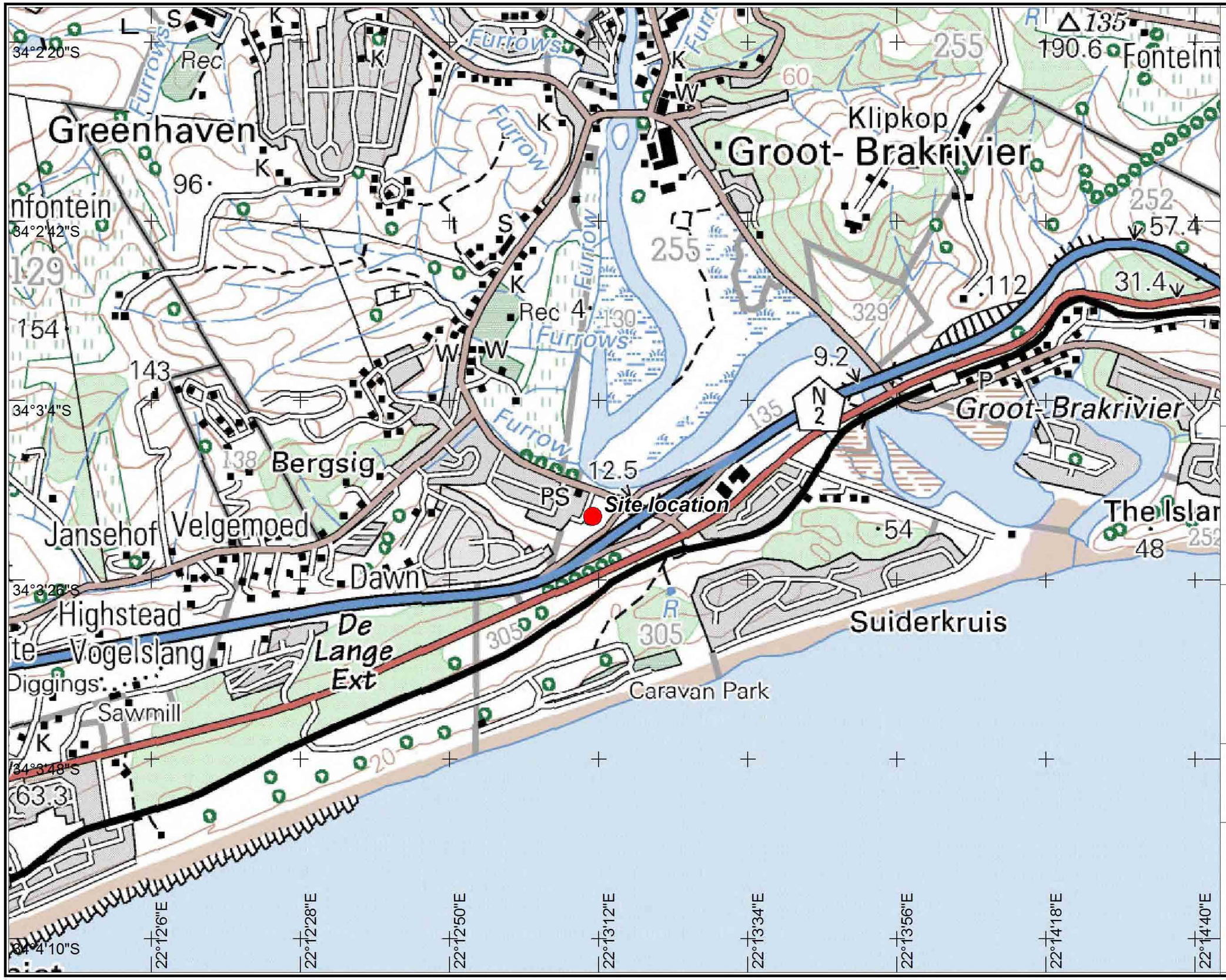
Layer	***Material***	***Thickness***	***Required Compaction***
Pavers	Cement interlock paving on 25mm sand bedding	80 mm	25 / 35 MPa
Subbase	Imported G4/5 gravel	150mm	95% Mod AASHTO
SSG	Insitu/fill G7	300mm	93% Mod AASHTO
OR			
Seal	40mm HMA		
Base course	Imported G2/4	150mm	98% Mod AASHTO
Subbase	Imported G4/5 gravel	150mm	95% Mod AASHTO
SSG	Insitu/fill G7	300mm	93% Mod AASHTO

8. Conclusions

The site is generally suitable for the proposed development in terms of the geology and geotechnical conditions. There are some moderate geotechnical risks, which are typical for the area, but the conditions are unlikely to be severely problematic, and conventional earthworks and foundation designs are anticipated. Some precautionary measures are recommended for the design of earthworks, foundations and roads. The recommendations are generally considered standard procedure and should not significantly affect project feasibility. Regular testing and site supervision by the engineer is essential to ensure that the recommendations are followed.

Appendix 1

Maps



N

Legend

Site Location

Client: Cape EA Prac
Project: New Filling Station
Site: Ptn4 of Farm 135, Great Brack
Area: Mossel Bay

Drawing Name: Locality map
Drawing No:
Date: 03 April 2017
Revision: 0
Drawn By: S Ngema
Checked By: I Paton

Scale 1:20000

0 100 300 500 m

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N

Legend

Topo vector

- River
- Site boundary

Client: Cape EA Prac
Project: New Filling Station
Site: Ptn4 of Farm 135, Great Brack
Area: Mossel Bay

Drawing Name: Aerial map
Drawing No:
Date: 03 April 2017
Revision: 0
Drawn By: S Ngema
Checked By: I Paton

Scale 1:7500

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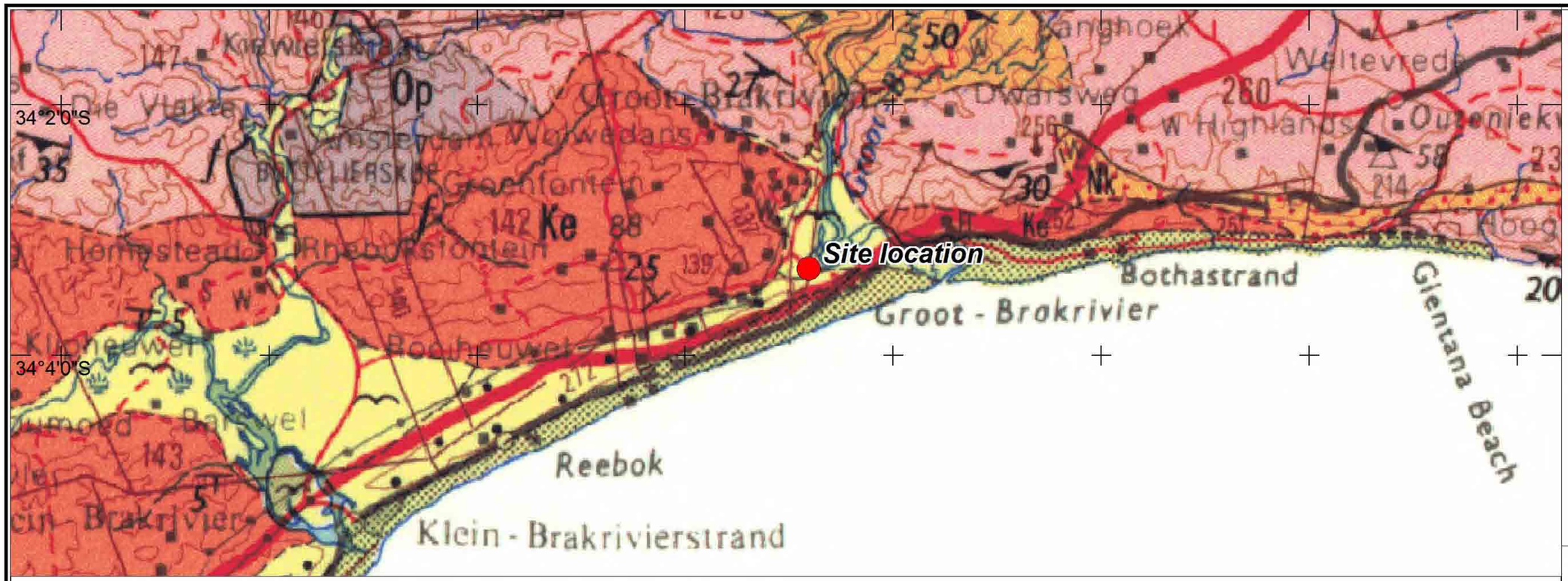

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Legend

Site Location

Alluvial valley deposits
Alluviale vallei-afsettings

Enon and similar younger deposits
Enon en soortgelyke jonger afsettings

Conglomerate, sandstone, siltstone, clay
Konglomeraat, sandsteen, sliksteen, klei

Homtini	Phyllite, feldspathic grit, quartzite Filliet, veldspatiese grintsteen, kwartsiet
Victoria Bay	Feldspathic quartzite Veldspatiese kwartsiet
Soetkraal	Phyllite, schist, hornstone, quartzite Filliet, skis, horingsteen, kwartsiet
Skaapkop	Gritty quartzite, phyllite, schist Grintige kwartsiet, filliet, skis
Sandkraal	Quartz schist Kwartsskis
Saasveld	Andalusite schist, hornfels, mica schist Andalusietskis, horingfels, mikaskis
Silver River	Quartz schist Kwartsskis

Ke

Nmg — Gneissic granite and granodiorite, albitite
Gneisige graniet en granodioriet, albitiet } Maalgaten and related granites
Maalgaten-en verwante graniete

Nk

Client: Cape EA Prac
Project: New Filling Station
Site: Ptn 4 of Farm 135, Great Brak
Area: Mossel Bay

Drawing Name: Geological map
Drawing No:
Date: 03 May 2017
Revision: 0
Drawn By: S Ngema
Checked By: I Paton

Scale 1:100000

0 0.5 1 1.5 2 2.5 km

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N

Legend

Topo vector

- River
- Test positions
- Site boundary
- Terrain 1 (S-S1/P(C/U))

Client: Cape EA Prac
Project: New Filling Station
Site: Ptn 4 of Farm 135, Great Brack
Area: Mossel Bay

Drawing Name: Geotechnical map
Drawing No:
Date: 03 April 2017
Revision: 0
Drawn By: S Ngema
Checked By: I Paton

Scale 1:2500

0 12 24 36 48 60 m

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Appendix 2

Test pit profiles

OUTENIQUA GEOTECHNICAL SERVICES

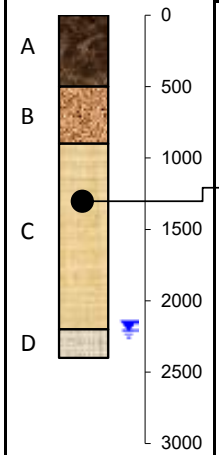
Geotechnical Soil Profile

Client:	Cape EA Prac
Project:	New Filling Station Erf 135
Area:	Great Brak
Date:	04.04.17
Excavator:	TLB

TP 1

Datum: NGL | Co-ords: 23 Y0072022 X3769994

Key to symbols: ● Sample taken | Groundwater



(0 to 500)	Moist, light brown, medium dense, intact, **SAND**, imported (fill, with minor cobbles)
(500 to 900)	Moist, dark grey, medium dense, intact, **SLIGHTLY CLAYEY SILTY SAND**, transported (topsoil)
(900 to 2200)	Moist to wet, dark brown to dark red brown, medium dense, intact, **SILTY SAND**, estuarine.
	pH & Conductivity
(2200 to 2400)	Wet, dark grey, medium dense, intact, **SAND & SHELLS**, estuarine.
	TP stopped
	Water table @ 2200mm

Dynamic Cone Penetrometer (DCP)

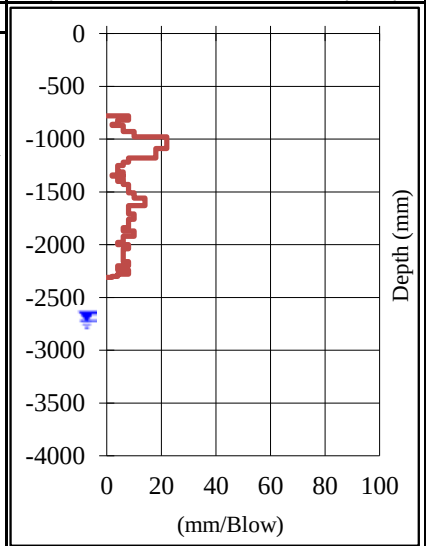
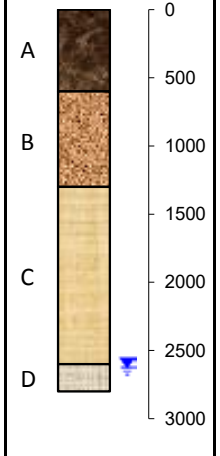


Photo of Test Pit

TP 2

Datum: NGL | Co-ords: 23 Y0072059 X3770021

Key to symbols: ● Sample taken | Groundwater



(0 to 600)	Slightly moist, light brown to dark red brown, dense, intact, **SILTY SANDY GRAVEL**, imported (fill)
(600 to 1300)	Slightly moist, dark grey to dark red brown, medium dense, intact, **SILTY SAND**, imported (topsoil)
(1300 to 2600)	Very moist, light brown, medium dense, intact, **SAND**, estuarine.
(2600 to 2800)	Wet, dark grey, medium dense, intact, **SAND & SHELLS**, estuarine.
	TP stopped - side walls collapsed
	Water table @ 2600mm

Dynamic Cone Penetrometer (DCP)

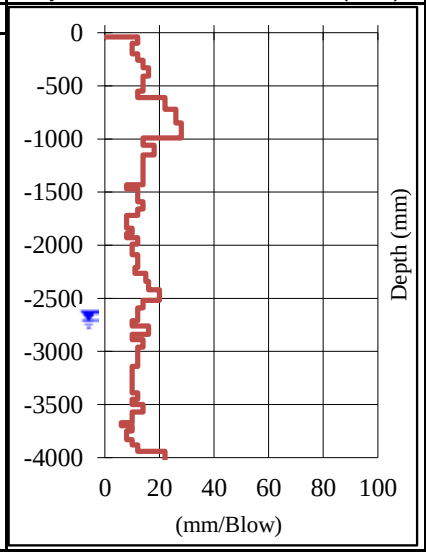


Photo of Test Pit

OUTENIQUA GEOTECHNICAL SERVICES

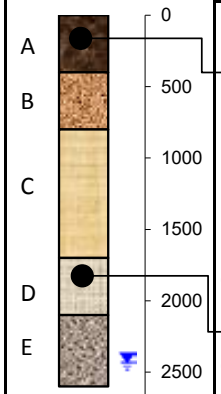
Geotechnical Soil Profile

Client:	Cape EA Prac
Project:	New Filling Station Erf 135
Area:	Great Brak
Date:	04.04.17
Excavator:	TLB

TP 3

Datum: NGL | Co-ords: 23 Y0071999 X3770015

Key to symbols: Sample taken | Groundwater



(0 to 400) Slightly moist, light grey, very dense, intact, **SANDY GRAVEL**, imported (fill)

MOD/CBR/Indicator

(400 to 800) Moist, dark red orange to light brown, medium dense, intact, **GRAVELLY SILTY SAND**, transported (fill)

(800 to 1700) Moist, dark grey to dark red brown, medium dense, intact, **SLIGHTLY CLAYEY SILTY SAND**, transported (topsoil)

(1700 to 2100) Very moist, dark red brown, medium dense, intact, **SAND**, estuarine.

Foundation Indicator

(2100 to 2600) Very moist to wet, dark grey, medium dense, intact, **SAND & SHELLS**, estuarine.

TP stopped - side walls collapsed

Water table @ 2400mm

Dynamic Cone Penetrometer (DCP)

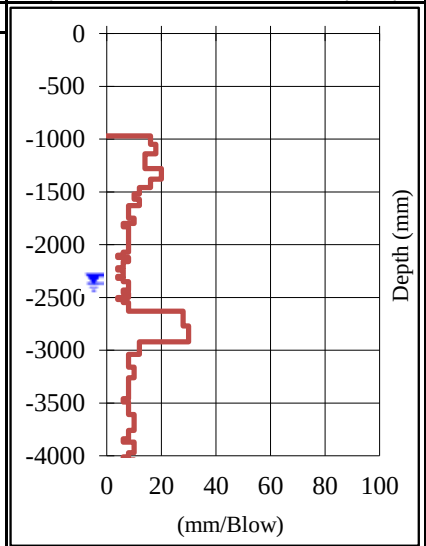
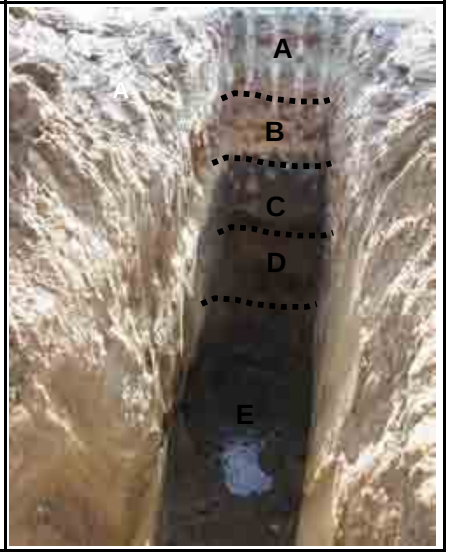


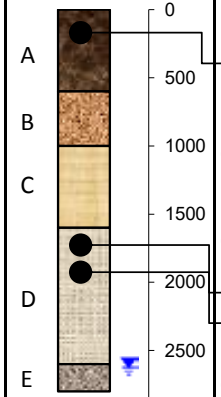
Photo of Test Pit



TP 4

Datum: NGL | Co-ords: 23 Y0071991 X3770037

Key to symbols: Sample taken | Groundwater



(0 to 600) Moist, dark red orange, very dense, intact, intact, **SILTY CLAYEY SANDY GRAVEL**, imported (fill)

MOD/CBR/Indicator

(600 to 1000) Moist, dark red orange, medium dense, intact, **SILTY SAND**, imported (fill)

(1000 to 1600) Moist, dark grey, loose, intact, **SILTY SAND**, transported (topsoil)

(1600 to 2600) Very moist, light brown, medium dense, intact, **SAND & SHELLS**, estuarine.

Foundation Indicator

pH & Conductivity

(2600 to 2800) Wet, dark grey, dense, intact, **SAND**, estuarine.

TP stopped - side walls collapsed

Water table @ 2600mm

Dynamic Cone Penetrometer (DCP)

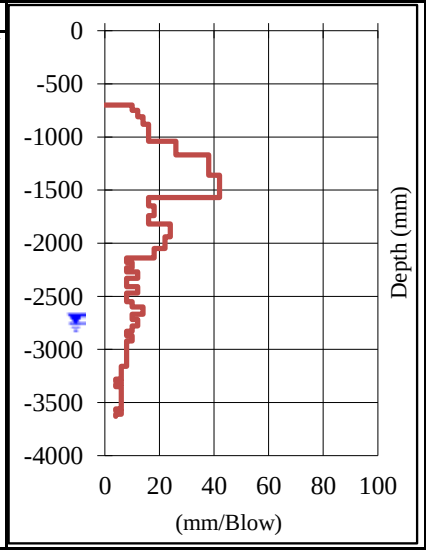
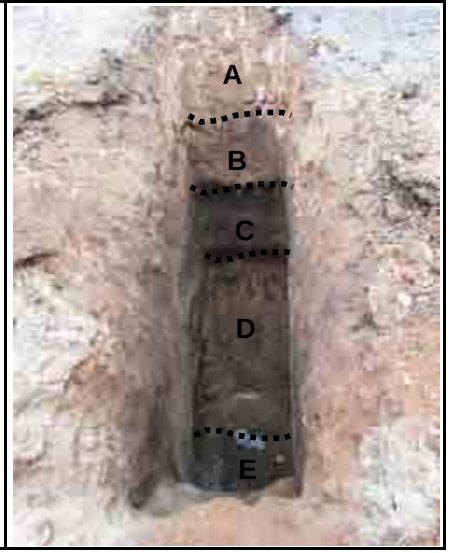


Photo of Test Pit



OUTENIQUA GEOTECHNICAL SERVICES

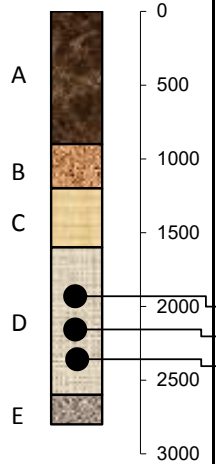
Geotechnical Soil Profile

Client:	Cape EA Prac
Project:	New Filling Station Erf 135
Area:	Great Brak
Date:	04.04.17
Excavator:	TLB

TP 5

Datum: NGL | Co-ords: 23 Y0072030 X3770045

Key to symbols: ● Sample taken | Groundwater



(0 to 900)	Slightly moist, light brown to dark red orange, very dense, intact, **SILTY SANDY GRAVEL**, imported (fill)
(900 to 1200)	Moist, dark red brown, very dense, intact, **SILTY SAND**, imported (fill)
(1200 to 1600)	Moist, dark grey, medium dense, intact, **SILTY SAND**, transported (topsoil)
(1600 to 2600)	Very moist, light brown, medium dense to very dense, intact, **SAND**, estuarine.
	MOD / CBR / Indicator
	pH & Conductivity
	Shearbox
(2600 to 2800)	Wet, light grey, medium dense, intact, **SAND & SHELLS**, estuarine.
	TP stopped - side walls collapsed
	Water table @ 2600mm

Dynamic Cone Penetrometer (DCP)

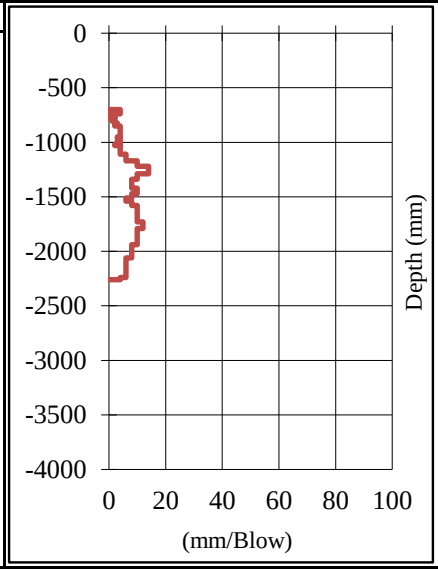
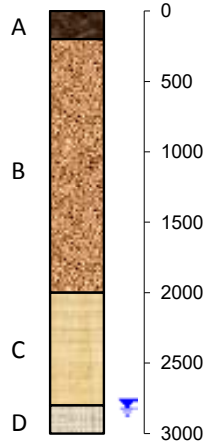


Photo of Test Pit

TP 6

Datum: NGL | Co-ords: 23 Y0072066 X3770067

Key to symbols: ● Sample taken | Groundwater



(0 to 200)	Slightly moist, light grey, very dense, intact, **SANDY GRAVEL**, imported (fill)
(200 to 2000)	Moist, dark red orange, dense, intact, **CLAYEY SILTY SANDY GRAVEL**, imported (fill & rubble & rubbish)
(2000 to 2800)	Very moist, light brown, medium dense, intact, **SAND & SHELLS**, estuarine.
(2800 to 3000)	Wet, dark grey, medium dense, intact, **SAND & SHELLS**, estuarine.
	TP stopped
	Water table @ 2800mm

Dynamic Cone Penetrometer (DCP)

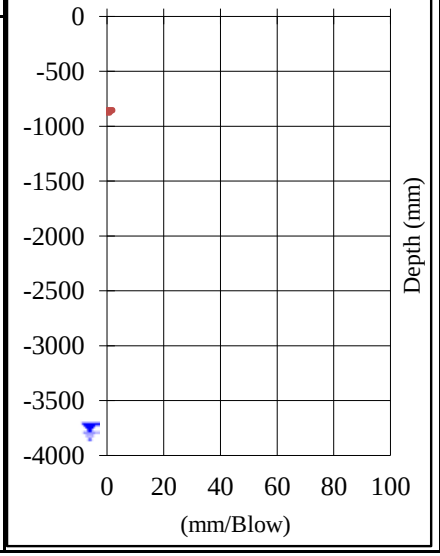
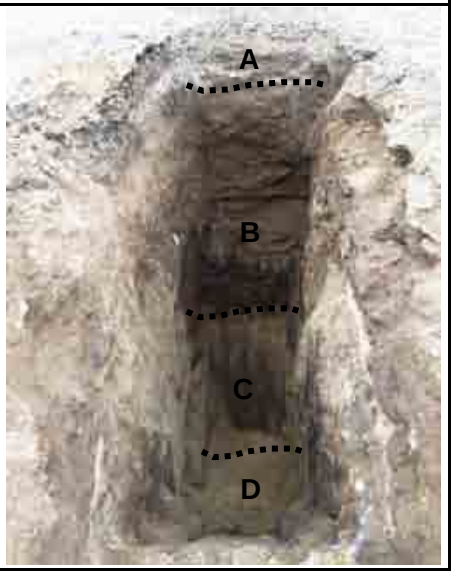


Photo of Test Pit



Appendix 3

Lab test data

OUTENIQUA LAB (Pty) Ltd
Materials Testing Laboratory
Registration No. 95/07742/07
6 Mirrorball Street, George : PO Box 3186, George Industria, 6536
Tel: 044 8743274 : Fax: 044 8745779 : e-mail: llewelyn@outeniqualab.co.za

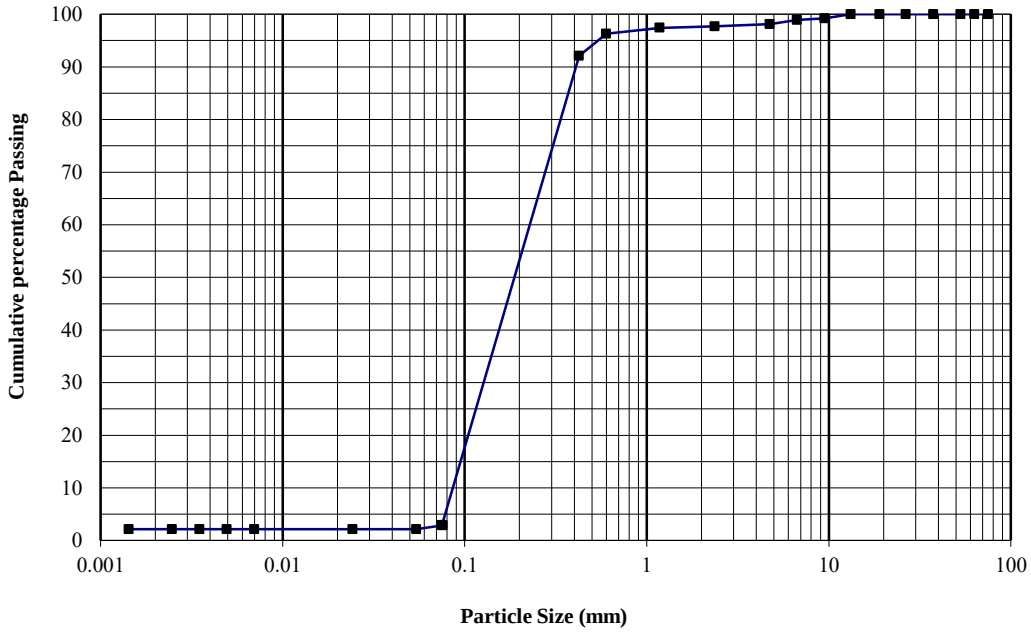
Customer :	Cape EA Proc	Project :	New Filling Station - Erf 135 - Great Brak River
	P O Box 2070	Date Received :	04/04/17
	George	Date Reported :	11/04/17
	6530	Req. Number :	1009/17
Attention :	Louise Mari van Zyl	No. of Pages :	2/3

TEST REPORT
FOUNDATION INDICATOR - (TMH 1 Method A1(a),A2,A3,A4,A5) & (ASTM Method D422)

Material Description:	Light Brown Sand	Sample Number:	66088		
Position:	TP 4 Layer 4	Liquid Limit	NP	Linear Shrinkage	0
Depth:	1600-2600	Plasticity Index	NP	Insitu M/C%	12.7

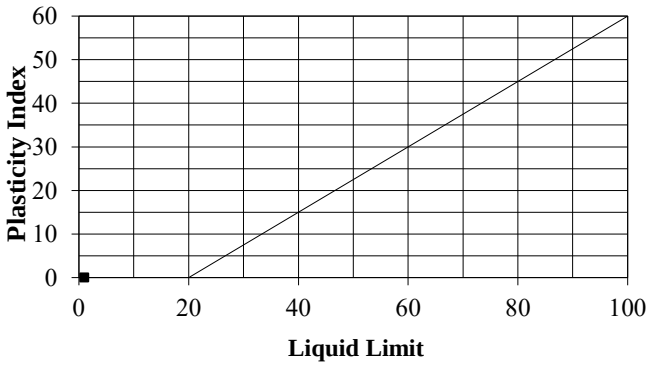
Sieve Size(mm)	% Passing
75.0	100
63.0	100
53.0	100
37.5	100
26.5	100
19.0	100
13.2	100
9.5	99
6.7	99
4.75	98
2.36	98
1.18	97
0.600	96
0.425	92
0.075	3
0.0759	3
0.0542	2
0.0242	2
0.0070	2
0.0049	2
0.0035	2
0.0025	2
0.0014	2

Particle Size Distribution

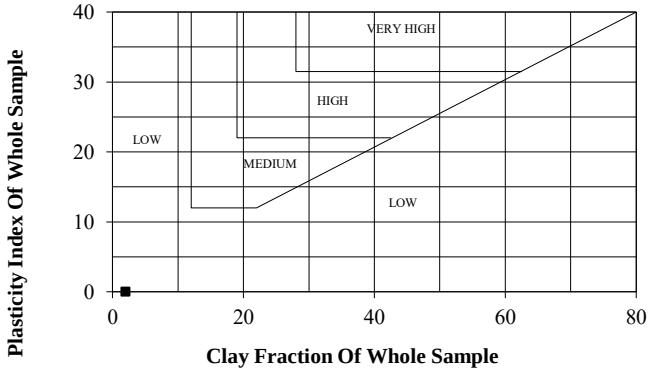


% Clay	2	% Silt	1	% Sand	95	% Gravel	2
Unified Soil Classification		SP		PRA Soil Classification		A-3 / A-2-4	

Plasticity Chart
A Line



Potential Expansiveness



Notes:

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

L Heathcote (Director)
For Outeniqua Lab (Pty) Ltd.

1. **Sampling falls outside the scope of Outeniqua Lab's SANAS accreditation.**
2. The test results are reported with an approximate 95% level of confidence.
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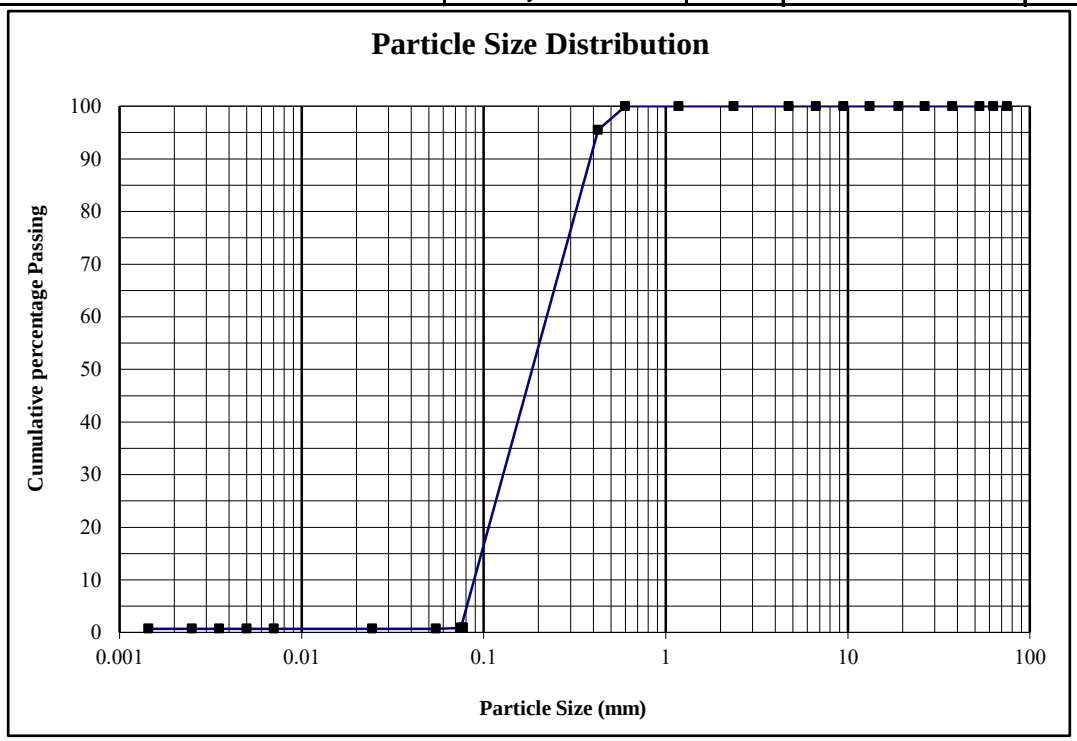
	P O Box 2070	Date Received :	04/04/17
	George	Date Reported :	11/04/17
	6530	Req. Number :	1009/17
Attention :	Louise Mari van Zyl	No. of Pages :	3/3

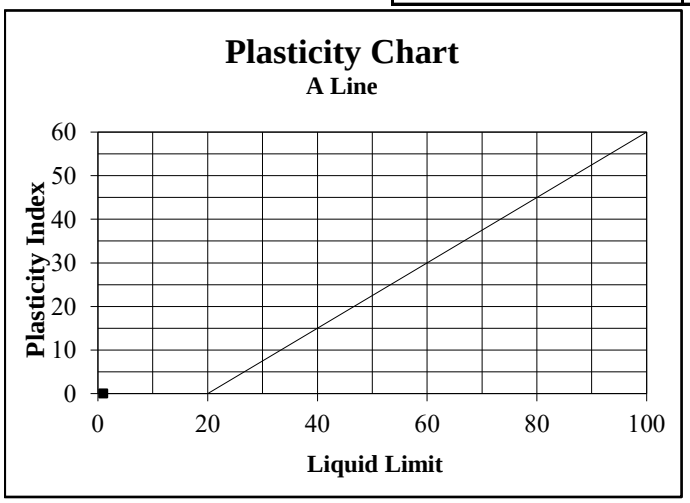
TEST REPORT
FOUNDATION INDICATOR - (TMH 1 Method A1(a),A2,A3,A4,A5) & (ASTM Method D422)

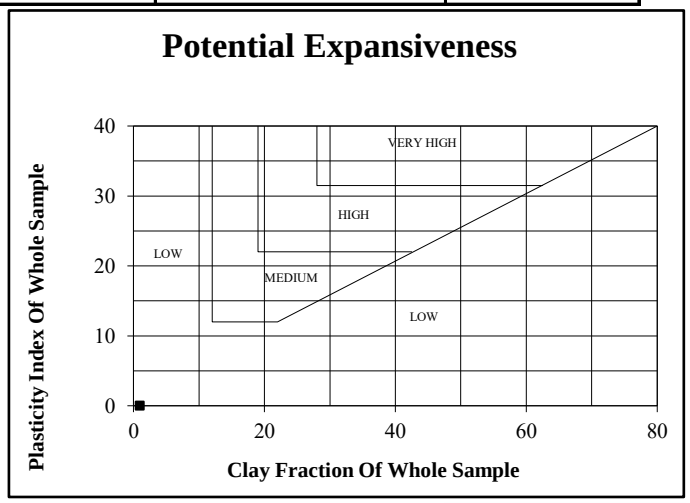
Material Description:	Light Brown Sand	Sample Number:	66090		
Position:	TP 5 Layer 4	Liquid Limit	NP	Linear Shrinkage	0
Depth:	1600-2600	Plasticity Index	NP	Insitu M/C%	15.3

Sieve Size(mm)	% Passing
75.0	100
63.0	100
53.0	100
37.5	100
26.5	100
19.0	100
13.2	100
9.5	100
6.7	100
4.75	100
2.36	100
1.18	100
0.600	100
0.425	96
0.075	1
0.0772	1
0.0547	1
0.0245	1
0.0071	1
0.0050	1
0.0035	1
0.0025	1
0.0014	1



% Clay	1	% Silt	0	% Sand	99	% Gravel	0
Unified Soil Classification		SP		PRA Soil Classification		A-3 / A-2-4	





Notes:

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

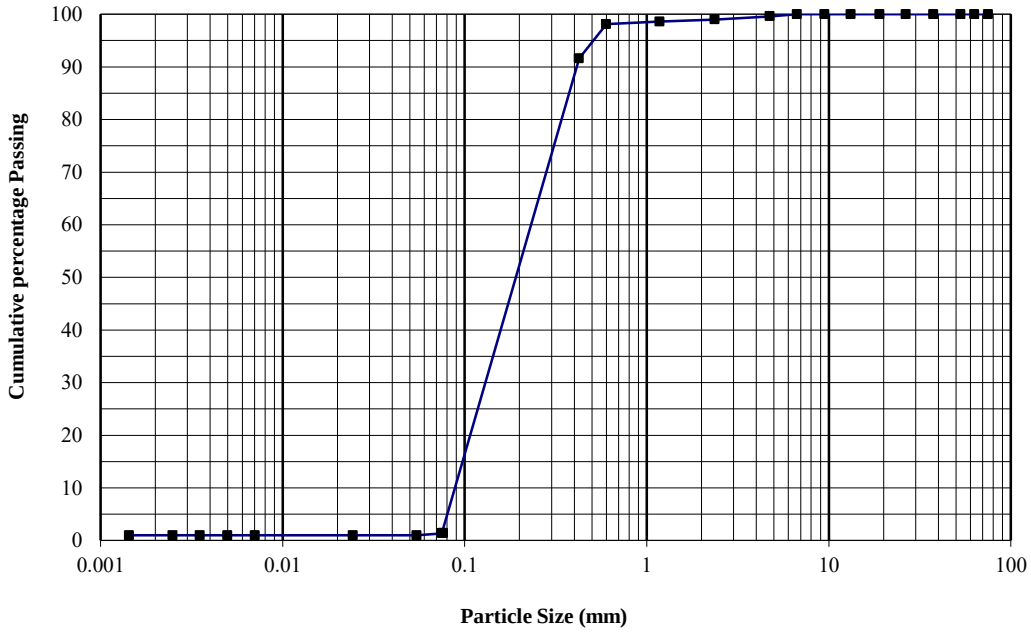
Customer :	Cape EA Proc	Project :	New Filling Station - Erf 135 - Great Brak River
	P O Box 2070	Date Received :	04/04/17
	George	Date Reported :	11/04/17
	6530	Req. Number :	1009/17
Attention :	Louise Mari van Zyl	No. of Pages :	1/3

TEST REPORT
FOUNDATION INDICATOR - (TMH 1 Method A1(a),A2,A3,A4,A5) & (ASTM Method D422)

Material Description:	Dark Brown Sand	Sample Number:	66086		
Position:	TP 3 Layer 4	Liquid Limit	NP	Linear Shrinkage	0
Depth:	1700-2100	Plasticity Index	NP	Insitu M/C%	4.7

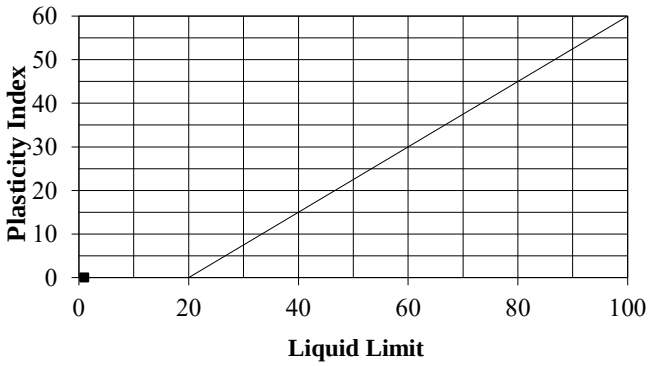
Sieve Size(mm)	% Passing
75.0	100
63.0	100
53.0	100
37.5	100
26.5	100
19.0	100
13.2	100
9.5	100
6.7	100
4.75	100
2.36	99
1.18	99
0.600	98
0.425	92
0.075	1
0.0764	1
0.0546	1
0.0244	1
0.0070	1
0.0050	1
0.0035	1
0.0025	1
0.0014	1

Particle Size Distribution

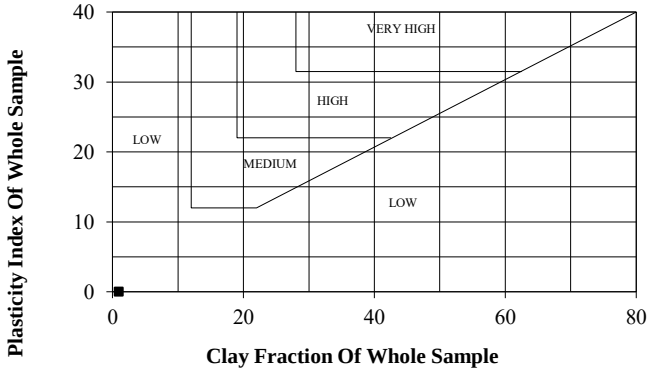


% Clay	1	% Silt	0	% Sand	98	% Gravel	1
Unified Soil Classification		SP		PRA Soil Classification		A-3 / A-2-4	

Plasticity Chart
A Line



Potential Expansiveness



Notes:

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

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For Outeniqua Lab (Pty) Ltd.

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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

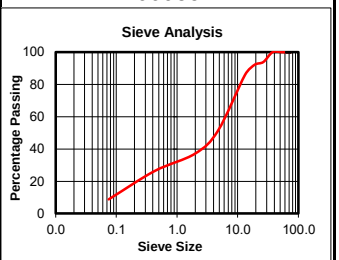
Customer :	Cape EA Prac	Project :	New Filling Station - Erf 135 - Great Brak River
	P O Box 2070	Date Received :	04/04/17
	George	Date Reported :	21/04/17
	6530	Req. Number :	1009/17
Attention :	Louise Mari van Zyl	No. of Pages :	1/2

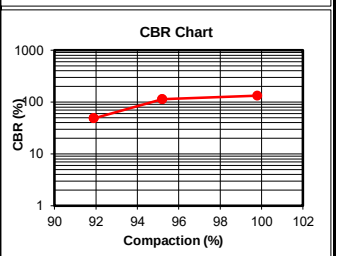
TEST REPORT

CALIFORNIA BEARING RATIO - (TMH 1 Method A1(a),A2,A3,A4,A5,A7,A8)

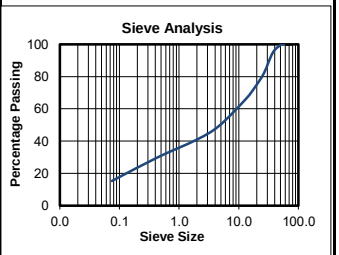
Material Indicators							
Sample Position (SV)		TP 3 - Layer 1			TP 4 - Layer 1		
Depth (mm)		0-400			0-600		
Sample No		**66085**			**66087**		
Materials Description	Source	In-Situ			In-Situ		
	Colour	Light Greyish Yellow			Light Brown		
	Soil Type	Sandy Gravel			Silty Clay Sandy Gravel		
	Classification	Exciting			Exciting		
Max. Stone size in hole (mm)							
Percentage Passing	75.0mm	100			100		
	63.0mm	100			100		
	53.0mm	100			100		
	37.5mm	100			95		
	26.5mm	94			82		
	19.0mm	92			74		
	13.2mm	86			66		
	4.75mm	51			50		
	2.00mm	37			41		
	0.425mm	26			30		
	0.075mm	8.8			15.3		
Soil Mortar & Constants							
Grading Modulus		2.28			2.14		
Coarse Sand (%)		29			28		
Fine Sand (%)		47			35		
Silt & Clay (%)		24			37		
Liquid Limit (%)		NP			20		
Plasticity Index (%)		NP			6		
Linear Shrinkage (%)		0.0			3.0		
CBR / Density Relationship							
MOD	Max Dry Density (kg/m^3)	2274			2162		
	Opt Moisture Content (%)	5.4			6.7		
	Mould Moisture Con. (%)	5.6			7.0		
	@100% Mod AASHTO	99.8			100.2		
	Swell (%)	0.00			0.25		
Proc NRB	100% NRB	95.2			95.5		
	Swell (%)	0.00			0.33		
Proc	100% Proctor	91.9			90.8		
	Swell (%)	0.00			0.43		
CBR	@ 100% Mod AASHTO	132			36		
	@ 98% Mod AASHTO	124			33		
	@ 95% Mod AASHTO	102			29		
	@ 93% Mod AASHTO	61			24		
	@ 90% Mod AASHTO	28			18		
Insitu Moisture Content (%)							
Soil Classification Achieved By The Material							
TRH 14:		G5 Subbase			G7 SSG		
AASTHO System		A-1-a / A-1-b / A-2-4			A-1-a / A-1-b / A-2-4		
Unified System		GP-GM			GM-GC		

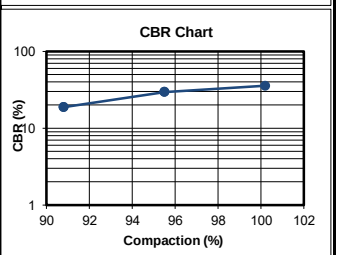
66085



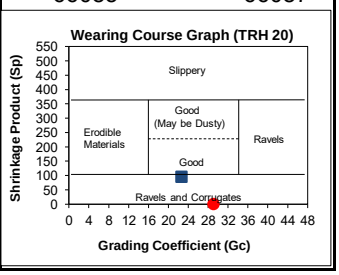


66087





● 66085 ■ 66087



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

Llewelyn Heathcote
Technical Signatory
For Outeniqua Lab (Pty) Ltd.

1. The opinion column is an interpretation of the direct comparison between the quoted specification and the single test sample results obtained. The compliant (P), non compliant (Í) and uncertain (Ú) 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 (Ú) 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 (P) or non compliant (Í) 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

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

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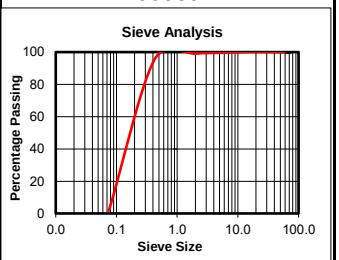
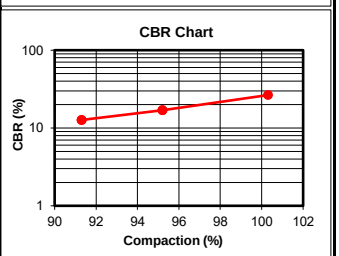
	P O Box 2070	Date Received :	04/04/17
	George	Date Reported :	21/04/17
	6530	Req. Number :	1009/17
Attention :	Louise Mari van Zyl	No. of Pages :	2/2

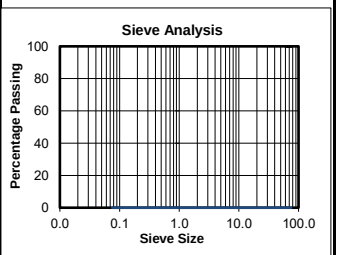
TEST REPORT

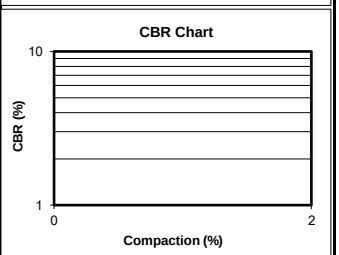
CALIFORNIA BEARING RATIO - (TMH 1 Method A1(a),A2,A3,A4,A5,A7,A8)

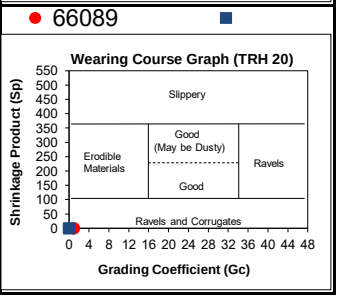
Material Indicators								66089
Sample Position (SV)		TP5 - Layer 4	TRH 14:					
Depth (mm)		1600-2600	G7 SSG					
Sample No		66089						
Materials Description	Source	In-Situ						
	Colour	Light Brown						
	Soil Type	Sand						
	Classification	Existing						
Max. Stone size in hole (mm)				Opinion				
Percentage Passing	75.0mm	100						
	63.0mm	100						
	53.0mm	100						
	37.5mm	100						
	26.5mm	100						
	19.0mm	100						
	13.2mm	100						
	4.75mm	100						
	2.00mm	99						
	0.425mm	96						
	0.075mm	1.7						
Soil Mortar & Constants								
Grading Modulus		1.04	0.75 - 2.70	✓				
Coarse Sand (%)		4						
Fine Sand (%)		95						
Silt & Clay (%)		2						
Liquid Limit (%)		NP						
Plasticity Index (%)		NP	≤ 12	✓				
Linear Shrinkage (%)		0.0						
CBR / Density Relationship								
MOD	Max Dry Density (kg/m^3)	1656						
	Opt Moisture Content (%)	13.8						
	Mould Moisture Con. (%)	13.7						
	@100% Mod AASHTO	100.3						
	Swell (%)	0.00	≤ 1.5	✓				
Proc NRB	100% NRB	95.2						
	Swell (%)	0.00						
Proc	100% Proctor	91.3						
	Swell (%)	0.00						
CBR	@ 100% Mod AASHTO	26						
	@ 98% Mod AASHTO	22						
	@ 95% Mod AASHTO	17						
	@ 93% Mod AASHTO	15	≥ 15	✳				
	@ 90% Mod AASHTO	12						
Insitu Moisture Content (%)								
Soil Classification Achieved By The Material								
TRH 14:		G7 SSG						
AASTHO System		A-3 / A-2-4						
Unified System		SP						











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

Llewelyn Heathcote
Technical Signatory
For Outeniqua Lab (Pty) Ltd.

1. The opinion column is an interpretation of the direct comparison between the quoted specification and the single test sample results obtained. The compliant (P), non compliant (Í) and uncertain (Ú) 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 (Ú) 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 (P) or non compliant (Í) based on a 95% level of confidence with reference to SAMM GUIDANCE 1, Issue 2 : 20 June 2007 Section 2.
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5. While every care is taken to ensure the correctness of all tests and reports, neither Outeniqua Lab (Pty) Ltd nor its employees shall be liable in any way whatever for any error made in the execution or reporting of tests or any erroneous conclusions drawn therefrom or for any consequence thereof.

GEOSCIENCE LABORATORIES (PTY) LTD

CLIENT: Outeniqua Geptechnical Services

PROJECT: New Filling Station
Erf 135 Great Brak

REF: L170408

CHEMICAL ANALYSIS RESULT SUMMARY

SAMPLE NO:	29055	29056	29057		
POSITION:	PHGB 1	PHGB4A	PHGB5C		
	TP 1	TP 4	TP 5		
	900-2200mm	1600-2600mm	1600-2600mm		

pH	8.3	7.7	7.5		
CONDUCTIVITY mS/m	26	42	26		

REMARKS: Samples tested by Bemlab

GEOSCIENCE LABORATORIES (PTY) LTD

CLIENT: Outeniqua Geotechnical Services

PROJECT: New Filling Station
Erf 135 Great Brak

JOB NO: L170408

DIRECT SHEAR TEST

Sample Number	29058	**Test type**	Undrained Consolidated
Sample Type	Remoulded	**Sample Position**	GB5 TP5 @ 1600-2600mm
Description	brown sand		
Displacement Rate mm/min	0.24 mm/min		

RESULTS AT START OF TEST

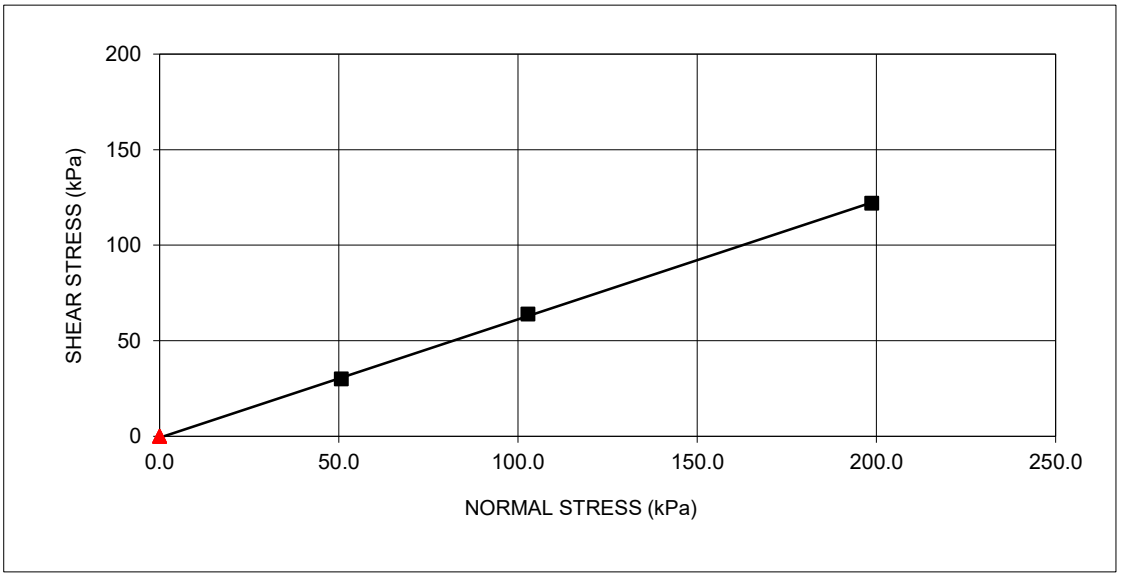
Void Ratio	0.53	0.52	0.50
Moisture Content %	13.80	13.80	13.80
Dry Density	1581	1575	1576

RESULTS AT END OF TEST

Void Ratio	0.50	0.48	0.48
Moisture Content %	26.33	25.99	25.16

PEAK SHEAR STRENGTH

Shear Stress kPa	30.00	64.00	122.00
Normal Stress kPa	50.71	102.79	198.72



	C kPa	Degrees
Peak	-0.7	31.8

Apparent angle of internal shearing resistance given by regression (°)	31.8
Apparent cohesion given by regression (kPa)	-0.7

Appendix 4

DCP test data

Outeniqua Geotechnical Services cc.

Geotechnical Engineering Consultants

Registration No. 1999/062743/23

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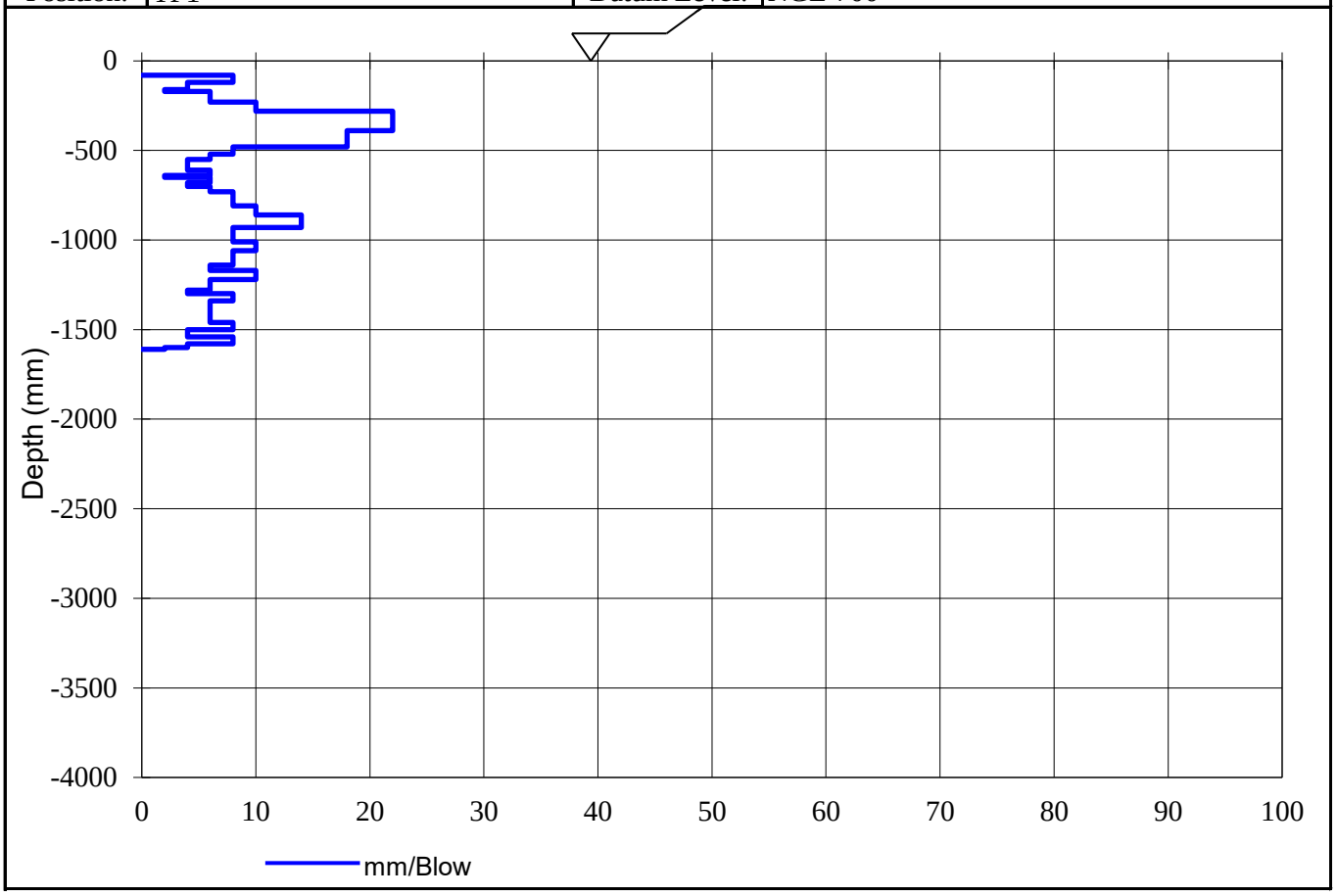
Tel: 044 3820502 : Fax: 044 3820503 : e-mail: iain@outeniqualab.co.za

Customer :	Cape EA Prac P.O. Box 2070 George 6530	Project :	New Filling Station, Erf 135, Great Brak
		Date Received :	23.03.17
		Date Reported :	04.04.17
		Req. Number :	
Attention :	Louise-Mari van Zyl	No. of Pages :	1 of 6

TEST REPORT

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

Position: TP1 Datum Level: NGL-700



I Paton (Member)
For Outeniqua Geotech. Services cc.
Technical Signatory

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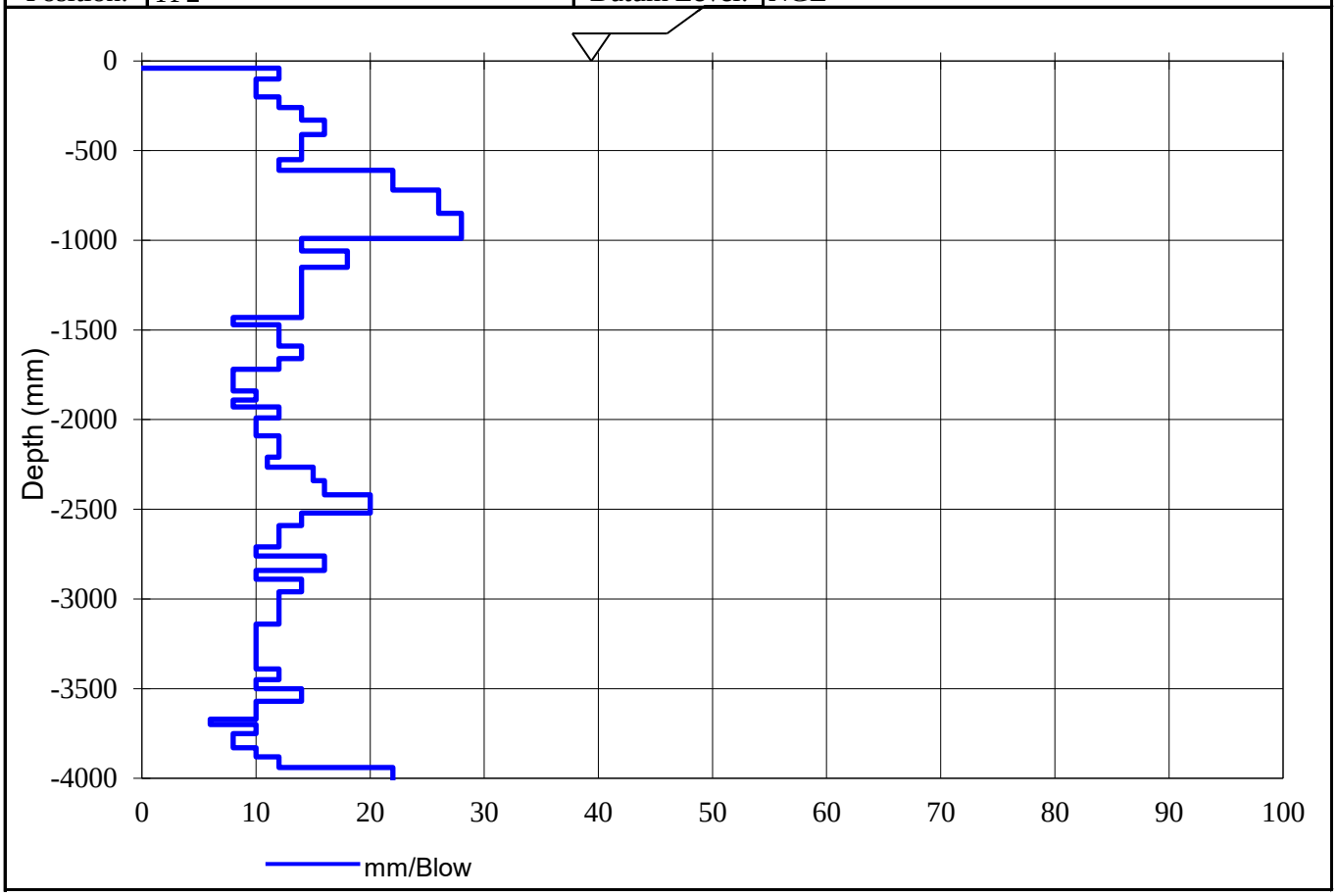
		Date Reported :	04.04.17
		Req. Number :	
Attention :	Louise-Mari van Zyl	No. of Pages :	2 of 6

TEST REPORT

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

Position: TP2 Datum Level: NGL



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For Outeniqua Geotech. Services cc.
Technical Signatory

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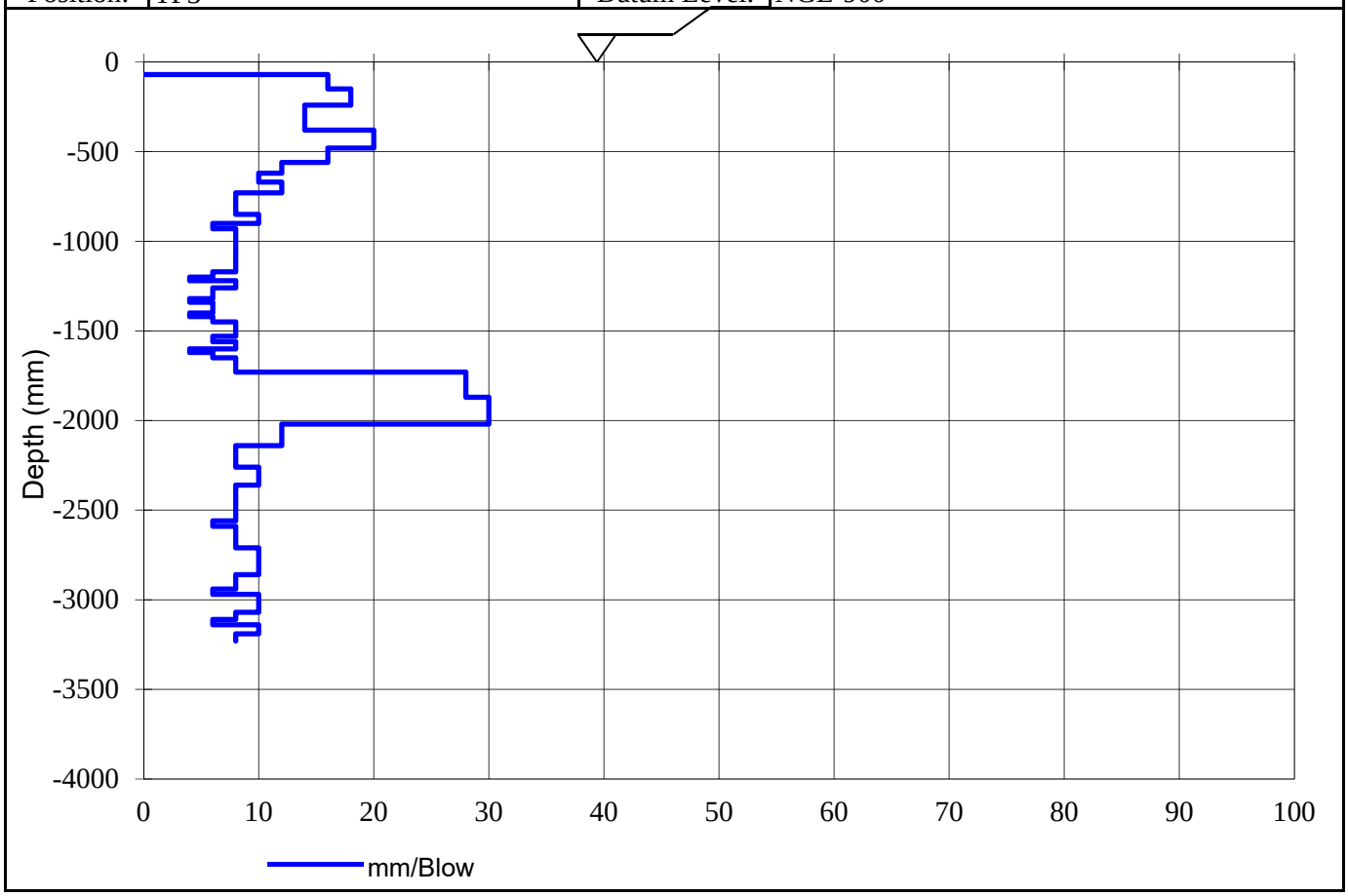
		Date Received :	23.03.17
		Date Reported :	04.04.17
		Req. Number :	
Attention :	Louise-Mari van Zyl	No. of Pages :	3 of 6

TEST REPORT

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

Position:	TP3	Datum Level:	NGL-900



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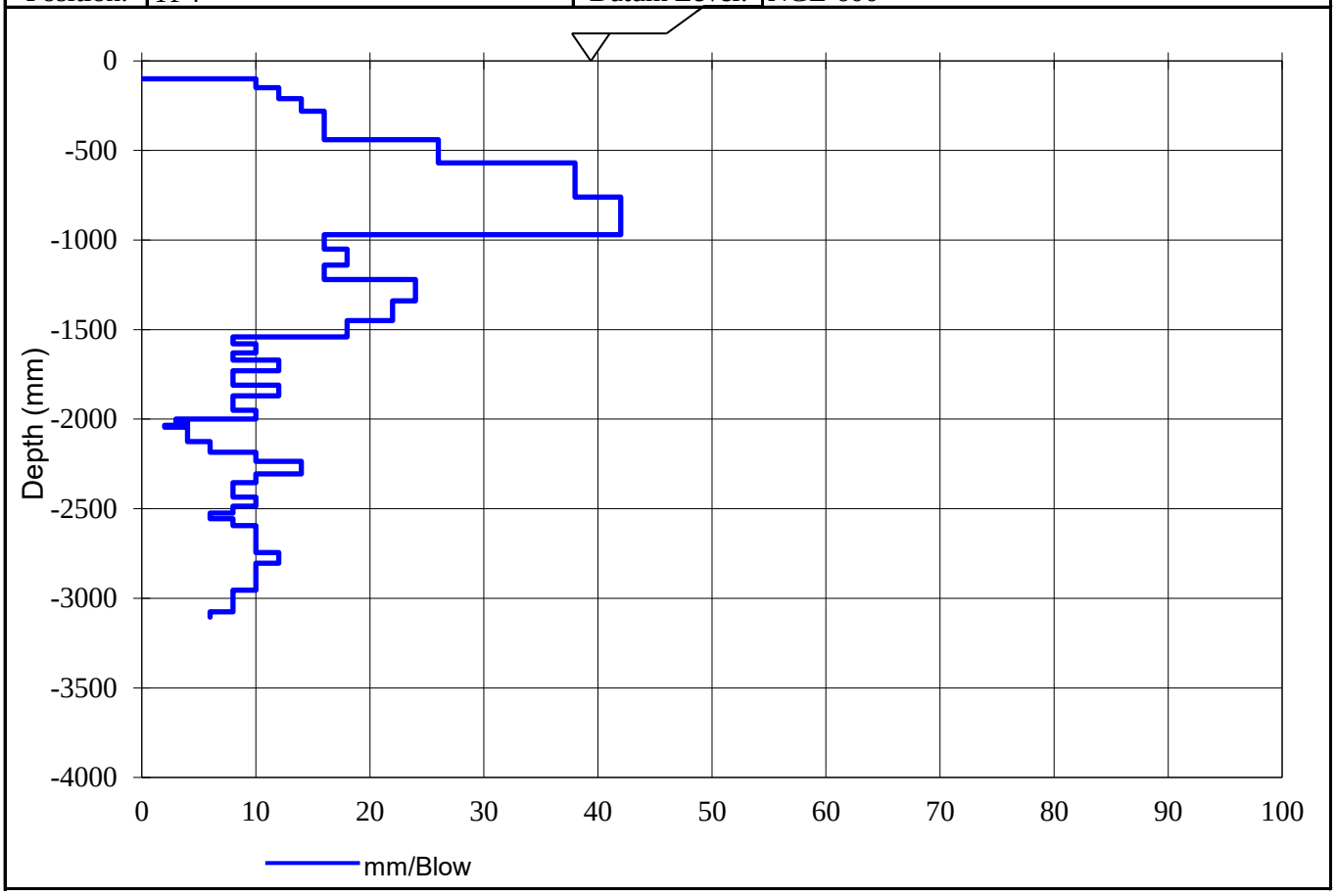
		Date Received :	23.03.17
		Date Reported :	04.04.17
		Req. Number :	
Attention :	Louise-Mari van Zyl	No. of Pages :	4 of 6

TEST REPORT

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

Position:	TP4	Datum Level:	NGL-600



I Paton (Member)
For Outeniqua Geotech. Services cc.
Technical Signatory

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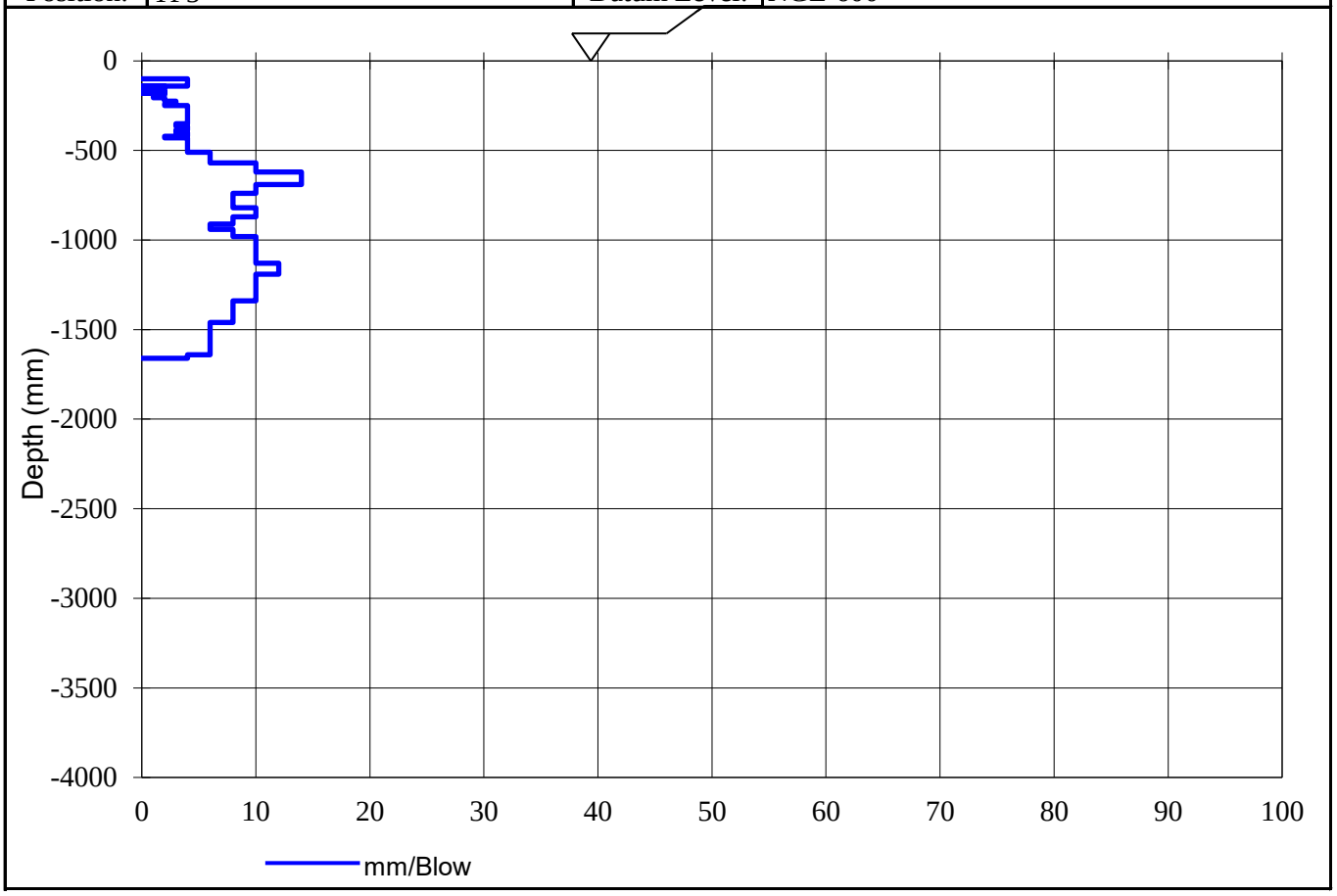
		Req. Number :	
Attention :	Louise-Mari van Zyl	No. of Pages :	5 of 6

TEST REPORT

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

Position: TP5 Datum Level: NGL-600



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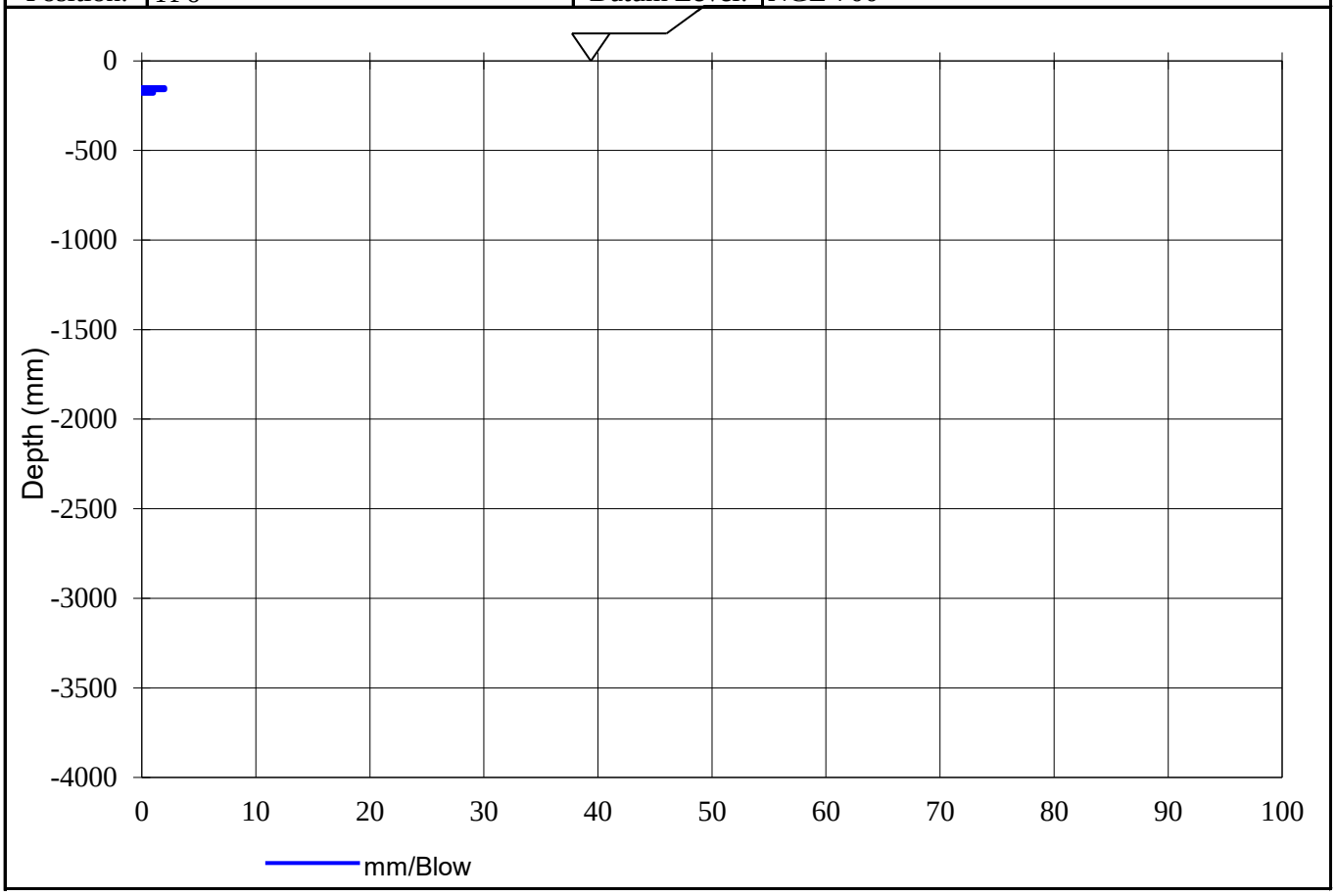
Attention :	Louise-Mari van Zyl	No. of Pages :	6 of 6

TEST REPORT

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

Position:	TP6	Datum Level:	NGL-700



I Paton (Member)
For Outeniqua Geotech. Services cc.
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4. THE SPECIALIST

Note: Duplicate this section where there is more than one specialist.

I IAIN PATON, as the appointed Specialist hereby declare/affirm the correctness of the information provided or to be provided as part of the application, and that I:

- in terms of the general requirement to be independent:
  - other than fair remuneration for work performed in terms of this application, have no business, financial, personal or other interest in the development proposal or application and that there are no circumstances that may compromise my objectivity; or
  - am not independent, but another specialist (the "Review Specialist") that meets the general requirements set out in Regulation 13 has been appointed to review my work (Note: a declaration by the review specialist must be submitted);
- in terms of the remainder of the general requirements for a specialist, have throughout this EIA process met all of the requirements;
- have disclosed to the applicant, the EAP, the Review EAP (if applicable), the Department and I&APs all material information that has or may have the potential to influence the decision of the Department or the objectivity of any report, plan or document prepared or to be prepared as part of the application; and
- am aware that a false declaration is an offence in terms of Regulation 48 of the EIA Regulations, 2014 (as amended).

Signature of the Specialist:	
Name of Company:	OUTENIQUA GEOTECHNICAL SERVICES CC
Date:	6/3/2019

OUTENIQUA
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iain@outeniqualab.co.za

29 May 2017

Sian Holder
Cape EA Prac

RE: ALTERNATIVE DEVELOPMENT FOOTPRINTS – PROPOSED FILLING STATION ON PTN 4 OF FARM 135, GREAT BRAK

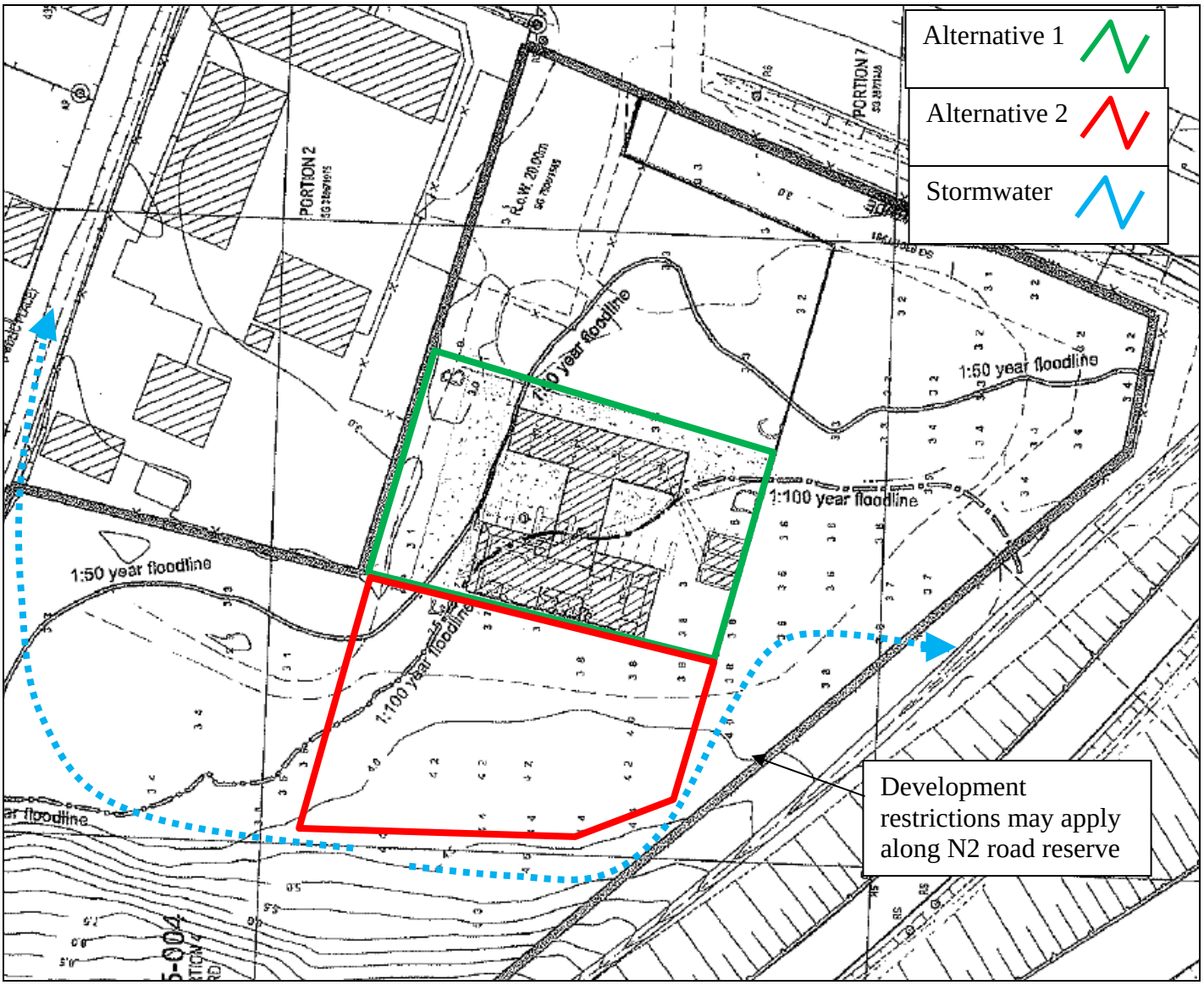
Your email dated 23 May 2017 refers.

The proposed area for the filling station is indicated in Appendix A as “Alternative 1”. This area has been investigated in our report dated 22 May 2017. In terms of geotechnical constraints, other feasible alternative footprint areas within the property boundary could include the area indicated as “Alternative 2”. The geotechnical conditions in this area are not expected to vary considerably from those outlined in our report, as this area forms part of the same alluvial terrace, but this should be checked during construction. This alternative area (Alternative 2) should preferably not encroach further south than the 4.5m contour line, as this may have potential impacts on the stability of the slope to the south. This slope is presently stable and not expected to have any influence on the development potential of “Alternative 2”.

The civil engineers need to consider the effect of any deep excavations on adjacent properties. Excavations between 1.5m and 3m deep, should not take place within 10m of the boundary, as this could affect stability of adjacent properties. Any development within 60m of the national road reserve requires special authorisation from SANRAL.

Other considerations should include site drainage and the management of potential seepage and stormwater from the slope to the south of the site, and how this is handled and discharged from the site. It is recommended that seepage and stormwater is diverted around the eastern and western side of the site into existing stormwater channels, as indicated in Appendix A.

Iain Paton Pr Sci Nat



Appendix A: Site development alternatives

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14 April 2018

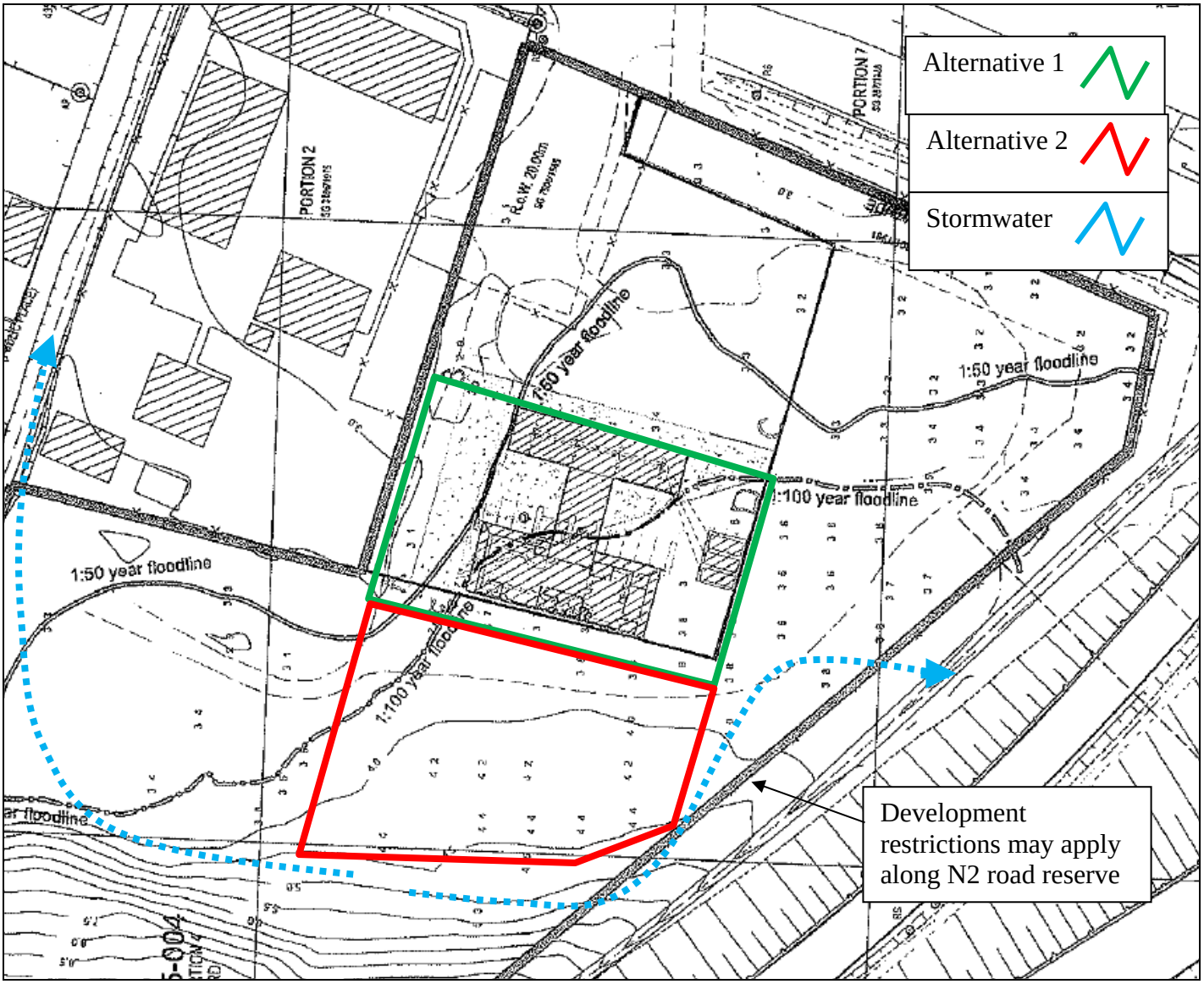
Sian Holder
Cape EA Prac

RE: PREFERRED DEVELOPMENT ALTERNATIVE FOR THE PROPOSED FILLING STATION ON PTN 4 OF FARM 135, GREAT BRAK

Your email dated 13 April 2018 refers.

The proposed area for the filling station as indicated as "Option 1 - preferred" falls within the area covered in our investigations and therefore does not require any further geotechnical investigations for EIA and preliminary engineering design purposes. Our recommendations for the development of the site remain valid.

Iain Paton Pr Sci Nat



Appendix A: Site development alternatives