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GEOTECHNICAL SITE INVESTIGATION REPORT

FOR

THE PROPOSED NEW LINDLEY WWTW (5Ha) AND RISING MAIN LINE (4Km) NKETOANA LOCAL MUNICIPALITY, FREE STATE PROVINCE

FINAL REPORT

Shallow Soil Geotechnical Engineering Assessment

21st February, 2023

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GEOTECHNICAL INVESTIGATION REPORT FOR THE PROPOSED NEW LINDLEY WWTW (5Ha) AND RISING MAIN LINE (4Km) NKETOANA LOCAL MUNICIPALITY, FREE STATE PROVINCE

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Notes:	1) This report serves as a shallow soil Geotechnical engineering assessment with the objectives and limitations as provided in the report. 2) Feel free to contact the author of this report if any questions or uncertainties arise.

Abbreviations

AASHTO	American Association of Highway and Transport Officials
CBR	California Bearing Ratio
GM	Grading Modulus
LL	Liquid Limit
LS	Linear Shrinkage
MDD	Maximum Dry Density
NP	Non-Plastic
OMC	Optimum Moisture Content
PL	Plastic Limit
PI	Plasticity Index
SP	Slightly Plastic
TP	Test Pit
BNGL	Below Natural Ground Level

1. Introduction and Terms of Reference

On the 06th December 2022 Babereki Consulting Engineers appointed Geotechnical Engineering Laboratory (Pty) Ltd referred here as (GEL) to carry out the geotechnical site investigation for the proposed The Proposed New Lindley Wastewater Treatment Works (WWTW) (5ha) And Rising Main Line (4km) Nketoana Local Municipality, Free State Province.

As per the terms of reference and the site visit of 01 February 2023, GEL was to conduct laboratory testing as well as fieldwork procedures for seventeen (17) test pits down to 3.0m below ground level or refuse, whichever came first as per South African National Standard (SANS 634:2012). The test pit Positions were confirmed with GEL Laboratory Technician Rethabile Makateng (GEL representative) as indicated on the site layout below.

The observations, laboratory test results, material properties, geotechnical constraints, and recommendations with regards to foundation options, earthwork and general precautionary measures are provided and discussed in this report.

2. Investigation Objectives

The objectives of the investigation are to:

1. Identify any potential geotechnical hazards;
2. Define the ground conditions and provide provisional site class designations;
3. Comment on possible shallow groundwater conditions;
4. Discuss suitability of on-site materials for general construction purposes;
5. Provide earthwork recommendations;
6. Provide foundation options;
7. Provide the geotechnical basis for planning and conceptual design-level purposes;
8. Discuss any shortcomings identified during this study with recommendations on the way forward.

The objectives are addressed in the relevant report sections.

3. Available information

The following available information was used in the assessment:

- 1:250 000-scale 2723 Kroonstad geological sheets;
- Approximate site boundaries;
- Available Google-Earth satellite images;
- Detailed soil profile descriptions conducted for the purposes of this assessment; Soil profile photographs;
- Soil laboratory test results conducted specifically for the assessment; Site layout plan;
- Local knowledge of the area.

4. Simplified Investigation Methodology

The investigation to date comprises:

- Desk study of readily available information;
- Site walkover survey and visual surficial inspection;
- Excavation of 17 evaluation test pits (~3.0m deep) positioned across the area of interest as indicated by the client;
- Soil profile logging (guided by SANS634:2012);
- Soil profile photography;
- Selective soil sampling;
- Soil testing at accredited laboratories;
- Evaluation of the observations and laboratory test results;
- Technical reporting.

The fieldwork phase was initiated and completed on 01 February 2023. The soil samples were tested by Geotechnical Engineering Laboratory (Pty) Ltd Bloemfontein.

5. Site Description

5.1. Site Locality and Existing Services

The site is situated approximately 70 km to the South-East of Kroonstad, between R725, R76 and R707 road, Lindley (4 km West of town of Lindley). The site is accessible through Gravel Road branching from R707 Road.

The approximate centre site coordinate is (Decimal degrees):

Lat: 27°52'16.12"S
Lon: 27°53'19.16"E

The site has an approximate surface area of ~5.0 Ha.

The site is currently not in use and North of it there is Vals river. Area is not developed without water and electrical services.

The site locality and approximate area of interest is depicted in **Figure 1** and **Figure 2**.

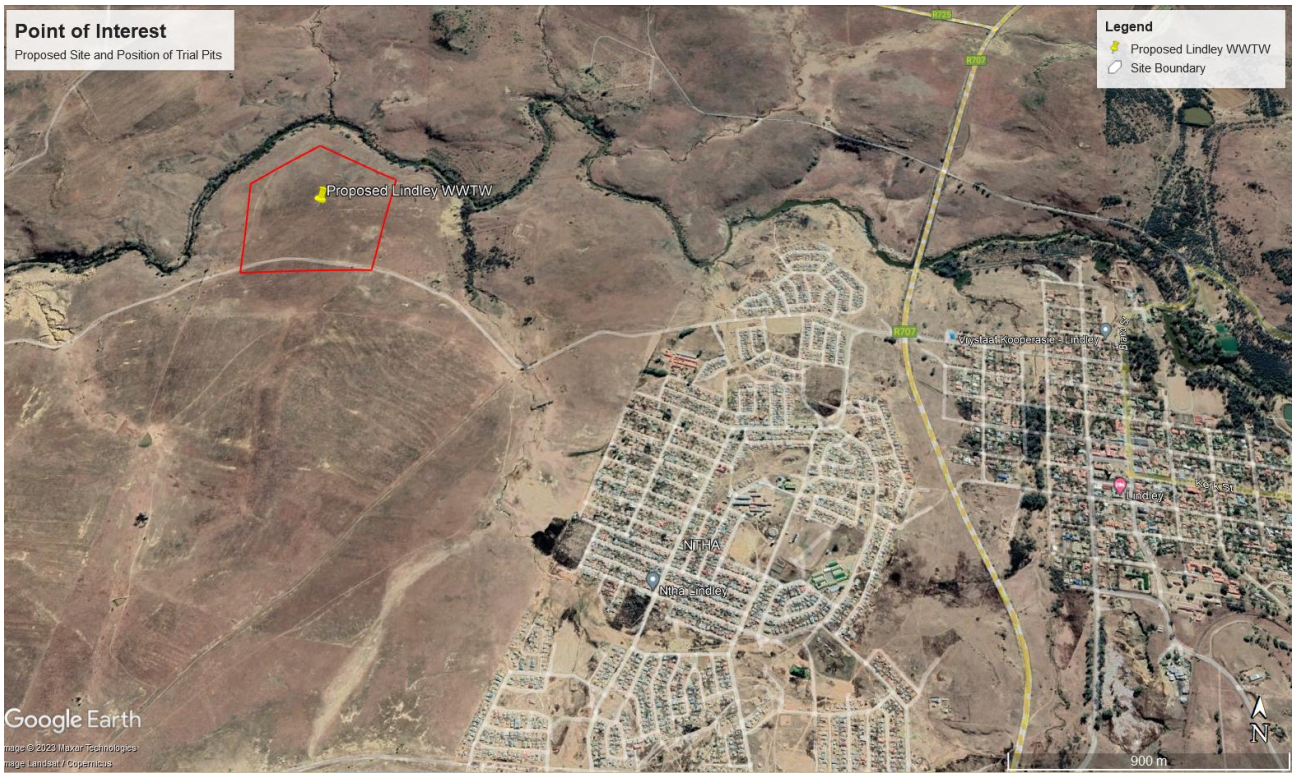

Figure 1: Locality Map of Lindley

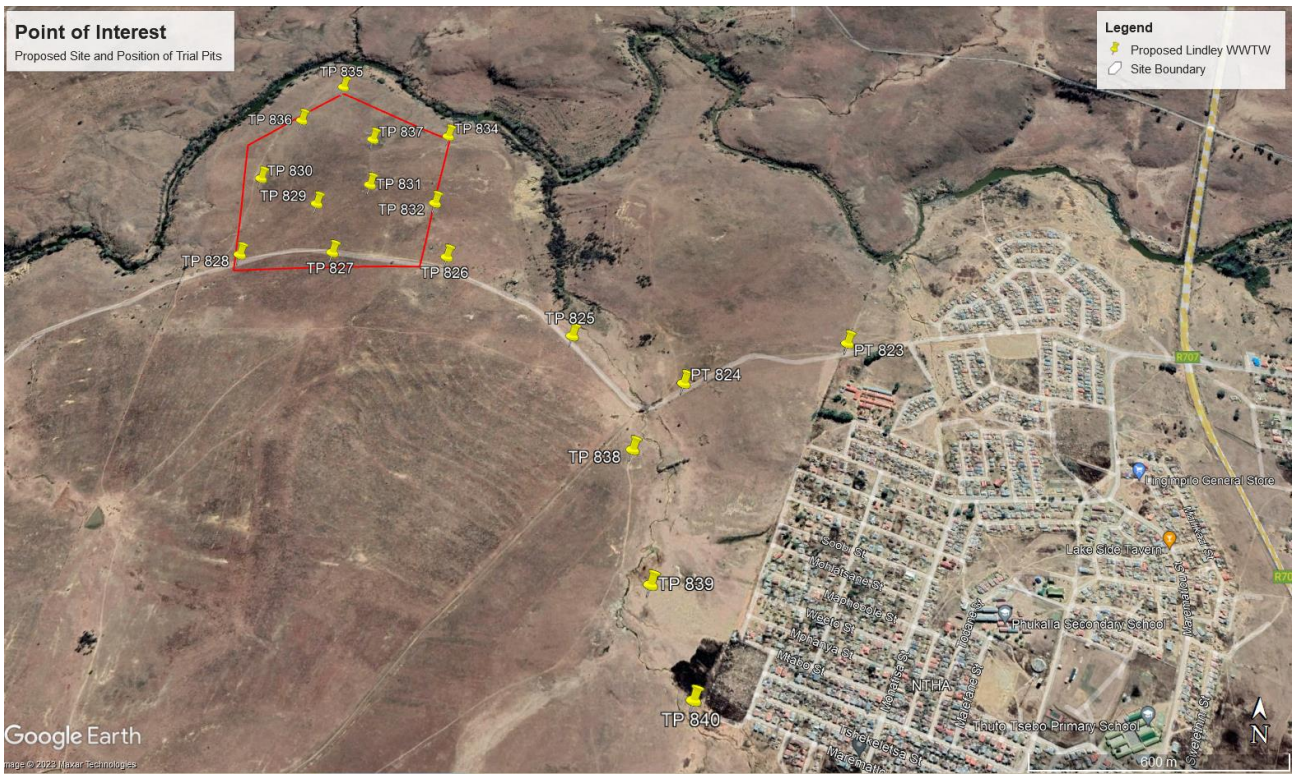

Figure 2: Locality Map of Lindley WWTW with 17 trial pits positions

5.2. Site Topography and Drainage

Based on the detailed survey data provided on the site layout map the site is situated between approximately 1 496 and 1 474m above mean sea level. The planners should refer to the detailed site-specific contour data.

Surface drainage of site is relatively sloping towards Vals river with the highest point of 1496 m on the Southern side and tapering to 1473 in the Northern portion of the site. Shallow surface drainage is expected to be mainly perpendicular to the ground contours.

An elevation difference of approximately 22m exist over the area of interest, with a slope of approximately 4.4%.

Planners/designers should refer to the site-specific contour data for planning and/or design- level purposes.

5.3. Site Vegetation and Climate

The site is currently covered by grass and shrubs indicating that it has not been ploughed for a long time. No trees were recorded on site. The typical on-site conditions and photographs are present in **Appendix B**.

The climate is an important parameter in determining the climatic N-value, which is a function of the rainfall and evaporation rate. The N-value is used to determine the predominant mode of weathering that can be expected in a region.

N=5 represents the boundary between physical and chemical weathering, meaning that for areas with an N-value of less than 5 chemical weathering will predominate, and for areas with an N-value greater than 5 physical weathering processes will be the most pronounced (Weinert, 1980).

The Weinert's N-value is calculated from the climatic data as follows:

$N = (12 \times E_j) / P_a$

Where;
E_j = Evaporation during January
P_a = annual precipitation

According to the contour map of climatic N-values for Southern Africa (Weinert, 1980), the expected N-values for the area of study ranges between 2 - 5.

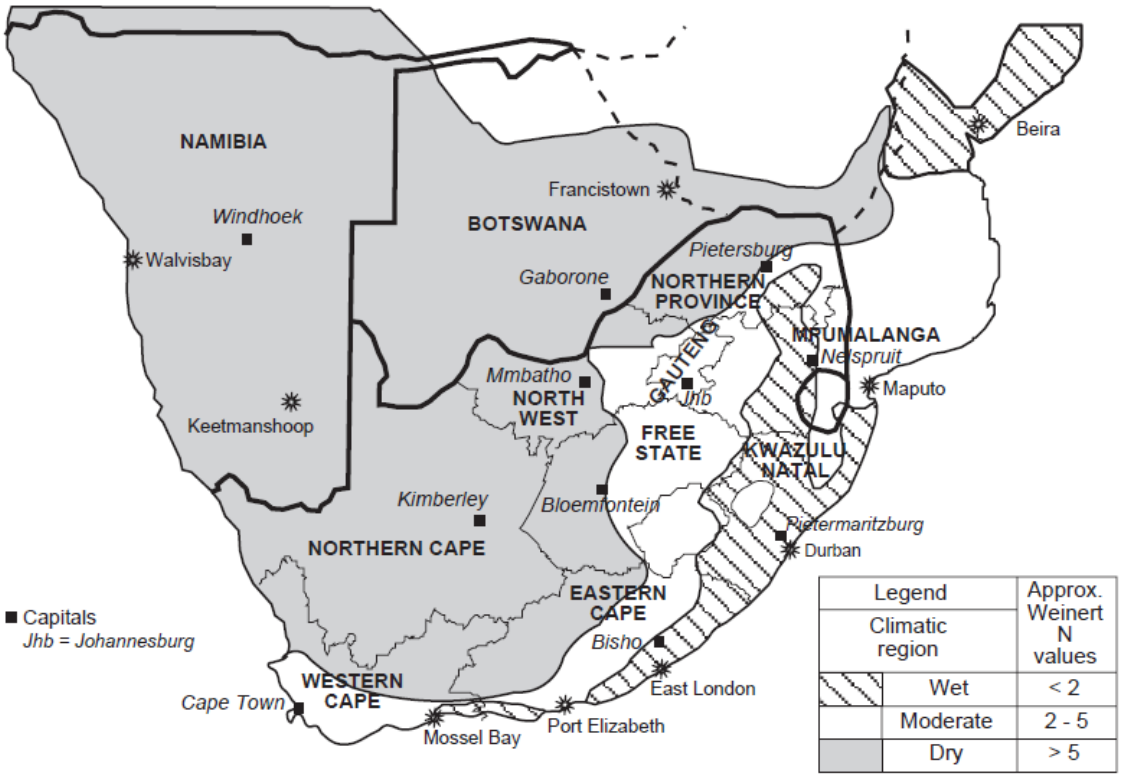

Figure 3: Macro-climatic regions of Southern Africa

The predominant form of weathering in the area are expected to be chemical of nature, with shallow expected soil profiles. The weathering mode is however also influenced by the topography and nature of drainage.

The climate of Lindley; Lindley normally receives about 620 mm of rain per year, with most rainfall occurring mainly during summer (November, December and January). The average rainfall values for Lindley per month; It receives the lowest rainfall (3mm) in July and the highest (106 mm) in December. The monthly distribution of average daily maximum temperatures shows that the average midday temperatures for Lindley range from 1°C in June to 29°C in December. The region is the coldest during July when the mercury drops to -5°C on average during the night.

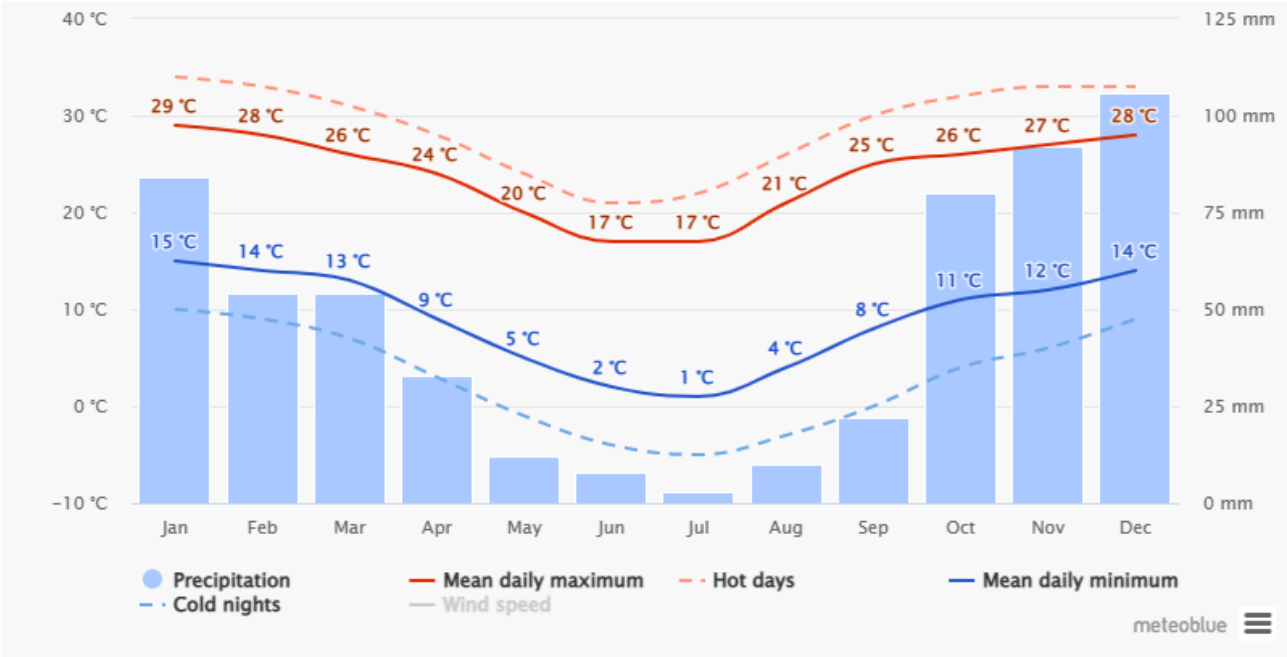

Figure 4: Average temperatures and precipitation

6. Method of Site Investigation

The site investigation was carried out on the 01st February, 2023 and involved excavation of Seventeen (17) test pit by TLB to an approximate depth of 3.0m or refusal, whichever came first. The test pits were profiled using "Revised Guide to Soil Profiling for Civil Engineering Purposes in Southern Africa by Jennings JEB, Brink ABA and Williams AAB (1973)". Three representative soil samples were taken from each test pit and the following tests were carried out

- Sieve Analysis
- Atterberg Limits
- Hydrometer Test
- Mod AASHTO
- CBR

These tests were carried out mainly to classify the soils found on the project area and assess their suitability for use in construction activities (filling and backfilling) as well as determining the classification of the founding material. The test results were also used to determine a suitable founding depth and the foundation type.

7. Regional and Site-Specific Geology

7.1. Regional Geology

Lindley

Based on the Geological Map Series of the Republic of South Africa Sheet 2726 (Kroonstad), and Scale 1:250, 000. The site is expected to be underlain by sandstone, mudstone, siltstone of Adelaide Subgroup

formation of Beaufort group, of Karoo Supergroup. (see **Figure 5**). Prominent dolerite intrusions are also indicated on the proposed site.

No prominent structural features are indicated in close proximity of the site.

The site is not underlain by potentially soluble rock formations such as dolomite and limestone. The site is considered **non-dolomitic** and a dolomite stability investigation is not required.

No economic deposits are indicated in the area of interest or in the surroundings that are expected to affect the developability of the site.

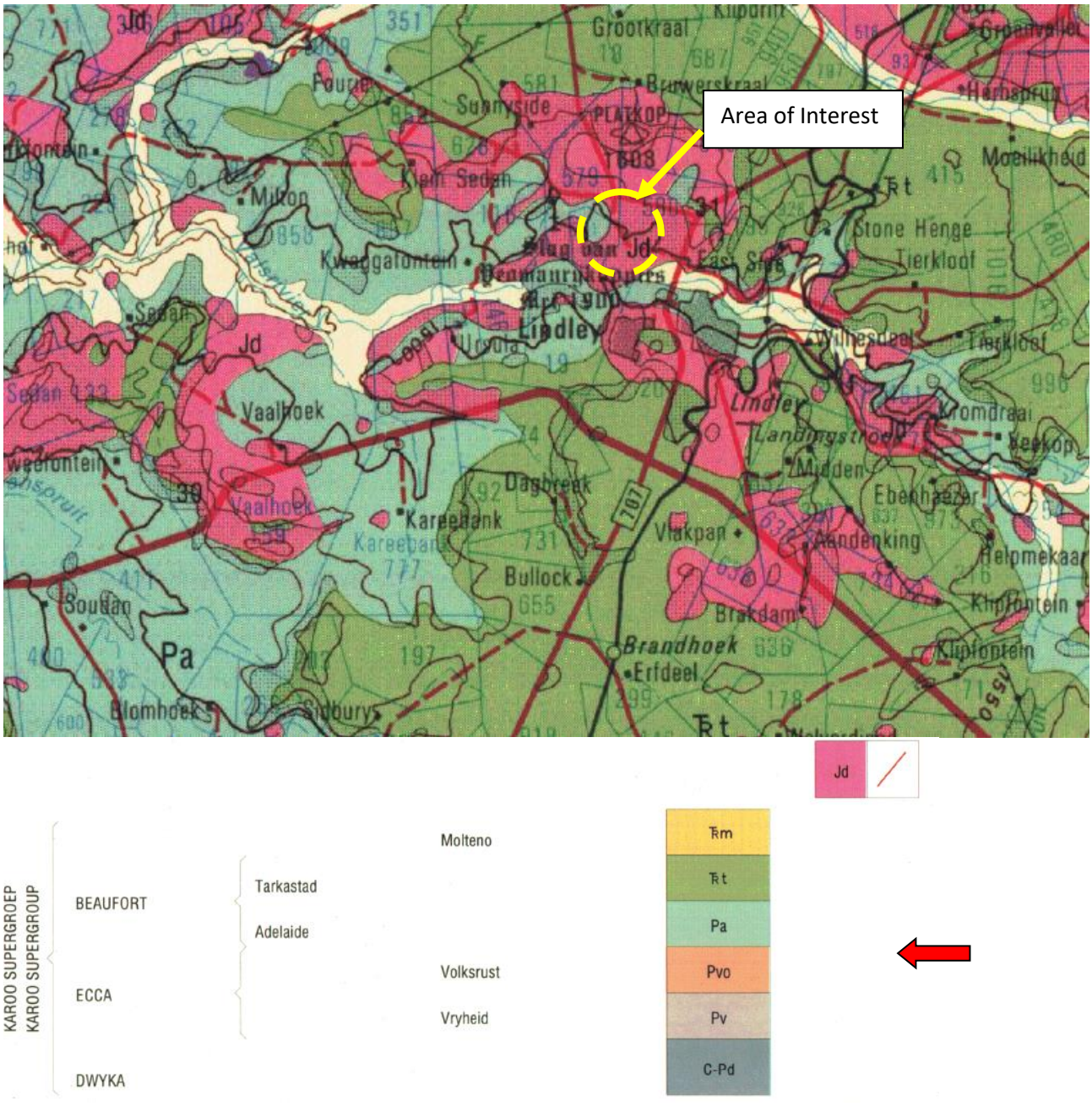

Figure 5: Geological map showing the regional geology of site

7.2. Site-Specific Geology

The site-specific conditions were evaluated by means of excavation of 17 shallow soil evaluation test pits with a JCB LB90B 4x4 TLB (Backhoe) down to practical reach or restricted refusal conditions. The test pit positions are depicted in, **Appendix A**

Yellowish Brown, light brown, speckled brown/yellow mudstone and dark-grey sandstone formations, as indicated on the geological sheets, were confirmed during this assessment. The soil profiles were fairly uniform across the site. Refuse was reached in all of the evaluation test pits. The horizons are briefly discussed below. Refer to the individual soil profile descriptions for detailed descriptions.
The site is generally covered with a relatively thin light Brown/grey silty sand **topsoil** horizon. The thickness varies between 0.0 to 0.80m, with an average thickness of approximately 0.50m. The horizon is generally open structured with a loose in-situ consistency. The topsoil horizon generally represents a “non-cohesive” soil.
The topsoil horizon is underlain by a transported **colluvial** horizon with transported reddish-brown light brown firm/stiff silty clay. This horizon was generally encountered down to 0.3 and 0.8mbgl. This horizon generally represents a “cohesive” soil at a slightly moist in-situ moisture content with a Clayey SILT texture. The is low fraction of **residual siltstone** under the colluvial horizon.

7.1.Soil Profile

The soil layers found on these project sites are attached as ***Appendix A*** of this report and show the following soils

TP 823

27°52'32.57"S
27°54'10.42"E

0-500 mm Very moist, dark-brown, stiff, silty clay
500-900mm Moist, yellowish-brown, silty-clayey sand
Mudrock refusal encountered at 0.90m bngl

TP 824

27°52'37.13"S
27°53'53.98"E

0-350 mm Moist, light-brown, loose, sand
350-600mm Moist, light-brown, stiff, silty-clayey sand

Gravel refusal encountered at 0,60m bngl

TP 825

27°52'32.51"S
27°53'42.56"E

0-500 mm Moist, light-brown, loose, clayey sand
500-730mm Moist, yellow, loose, silty sand
Sandstone refusal encountered at 0.73m bngl

TP 826

27°52'24.41"S
27°53'29.28"E

0-500 mm Moist, dark-brown, stiff, clayey sand
500-760mm Moist, yellow, stiff, speckled brown, silty-clayey sand
Mudrock refusal encountered at 0.760m bngl

TP 827

27°52'24.31"S
27°53'16.39"E

0-510 mm Moist, dark-brown, stiff, silt sand
510-790mm Moist, light-brown, speckled yellow, clayey sand
Mudrock refusal encountered at 0.790m bngl

TP 828

27°52'24.51"S
27°53'6.64"E

0-230 mm Moist, dark-brown, loose sand
230-400mm Moist, yellow speckled orange, medium dense sand
Sandstone refusal encountered at 0.40m bngl

TP 829

27°52'18.42"S
27°53'13.68"E

0-250 mm Moist, light-brown, loose, silty sand
250-840mm Moist, light-brown, speckled yellow, stiff clay
Sandstone refusal encountered at 0.840m bngl

TP 830

27°52'15.24"S
27°53'6.88"E

0-320 mm Moist, light-brown, loose, silty sand
320-840mm Moist, light-brown, speckled yellow, stiff clay
Sandstone refusal encountered at 0.840m bngl

TP 831

27°52'16.12"S
27°53'19.16"E

0-310 mm Moist, dark-brown, loose, sand
310-810mm Moist, dark-brown, stiff, silty sand
Shale refusal encountered at 0.810m bngl

TP 832

27°52'18.13"S
27°53'26.59"E

0-410 mm Dry, light-brown, medium dense, silty sand
410-570mm Moist, reddish-brown, stiff, silty clay
Sandstone refusal encountered at 0.570m bngl

TP 833

27°52'9.35"S
27°53'26.79"E

0-420 mm Moist, light-brown, loose sand
Sandstone refusal encountered at 0.420m bngl

TP 834

27°52'3.05"S
27°53'13.67"E

0-330 mm Moist, light-brown, loose sand
Sandstone refusal encountered at 0.330m bngl

TP 835

27°52'7.75"S
27°53'9.78"E

0-300 mm Moist, light-brown, loose sand
Sandstone refusal encountered at 0.300m bngl

TP 836

27°52'10.07"S
27°53'18.36"E

0-300 mm Moist, light-brown, loose sand
Sandstone refusal encountered at 0.300m bngl

TP 837

27°52'43.74"S
27°53'49.20"E

0-400 mm Moist, dark-brown, stiff, sandy silt
400-1250mm Moist, yellow, dense, clayey sand
Sandstone refusal encountered at 1.25m bngl

TP 838

27°52'55.65"S
27°53'51.34"E

0-510 mm Moist, black, stiff, silty clay
510-1310mm Moist, dark-grey, stiff, silty clay
Sandstone refusal encountered at 1.31m bngl

TP 839

27°53'4.68"S
27°53'55.33"E

0-630 mm Moist, black, stiff, silty clay
630-1380mm Moist, dark-grey, stiff, silty clay
Sandstone refusal encountered at 1.38m bngl

The soil profiles from the project site indicate that the site is dominated by black/dark brown/light brown silty clay/sandy silt underlain by silty clay/clayey sand/stiff clay of various colours.

8. Groundwater Conditions

No groundwater encountered during site investigation.

9. Geotechnical Evaluation

The relevant engineering characteristics were evaluated visually during site investigation and soil profiling. This evaluation was also done from laboratory testing as discussed below.

9.1.Foundation Indicator Test Results

Foundation indicator test results i.e. Hydrometer Test, Sieve Analysis and Atterberg Limits test results are summarized in Table 9.1 below.

Table 9.1 Foundation Indicator Test Results

TP #	Depth (mm)	Sieve Analysis				Atterberg Limits					Hydrometer Test	
		% < 2.00 mm	% < 0.425 mm	% < 75 µm	GM	LL (%)	PL (%)	PI (%)	LS (%)	AASHTO Class	% Clay	Potential Heave
TP 823	500-900	51	34.6	28.7	1.9	31	24	7	8	A-2-4	16.8	LOW
TP 824	350-600	48	44.4	25.5	1.8	28	23	5	6.7	A-2-4	7.4	LOW
TP 825	500-730	88	64.5	30.2	1.2	30	27	3	2.7	A-2-4	13.9	LOW
TP 826	500-760	49	21.6	12.1	2.2	40	35	5	10	A-1-a	5.5	LOW
TP 827	510-790	43	27.8	20	2.1	27	20	7	6	A-1-a	11.1	LOW
TP 828	270-400	99	94.8	28.8	0.8			NP		A-2-4	5.6	LOW
TP 829	250-840	98	95.3	72.1	0.3	43	22	19	7.3	A-7-6	42.9	LOW
TP 830	320-1140	97	96.5	69.7	0.4	42	34	8	8	A-7-6	35.7	MEDIUM
TP 831	310-810	75	69.7	49	1.1	29	24	5	4.7	A-4	16.4	LOW
TP 832	410-570	93	81.6	54	0.7	23	19	4	2.7	A-4	17.5	LOW
TP 833	0-420	85	40.6	20.5	1.5			NP		A-1-b	8.6	LOW
TP 834	0-330	85	70.7	35	1.1			NP		A-2-4	11.2	LOW
TP 835	0-300	89	74.3	66.5	0.7	35	24	11	5.4	A-6	31.2	LOW
TP 836	0-300	68	65.7	40.5	1.3			NP		A-4	20.6	LOW
TP 837	400-1250	91	86.5	45	0.8	37	30	7	6.7	A-4	26	LOW
TP 838	510-1310	96	92	58.1	0.5	42	30	12	7.5	A-7-5	30.5	LOW
TP 839	630-1780	95	89.9	60.4	0.6	41	30	11	7.3	A-7-5	24.5	LOW

The results in Table 9.1 indicate that

Soils from these project site are classified as A-2-4 (Silty and Clayey sands of Low compressibility); A-1-a (Gravel and sand of Low compressibility); A-1-b (Gravel and sand of Low compressibility); A-7-6 (Clayey soils of Medium compressibility); A-4 (Silty Sand of Low compressibility); A-6 (Clayey soils of Medium compressibility); A-7-5 (Clayey soils of Medium compressibility) according to AASHTO classification system.

According to Unified Soil Classification System (USCS), the soil classes from site represent the following **SM, SC, CL, ML, and OL**.

SM: Silty sand, poorly graded silt-sand mixtures **(Silty sands, silt-sand mixtures);**
SC: Clayey sand, poorly graded sand-clay mixtures **(Clayey sands, sand-clay mixtures);**
CL: Inorganic clays of low to medium plasticity **(gravelly clays/sandy clays/silty clays/lean clays.);**

ML: Silts and Clays **(Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity)**
OL: Organic silts and organic silty-clays of low plasticity

The USCS indicates that the project soils **(SM)** consist of Course grained soils with more 50% retained on 0.075 mm sieve, and further split into Sands (with Fines) (50% or more of course fraction passes on the 4.75 mm sieve). These soils (Silty Sand) thus have low Compressibility, low potential heave and low Potential Collapsibility with an expected range of top soil movement between 5-10mm (Silty sands) and as a result the sites are classified as **C1.**

The USCS indicates that the project soils **(SC)** consist of Course grained soils with more 50% retained on 0.075 mm sieve, and further split into Sands (with Fines) (50% or more of course fraction passes on the 4.75 mm sieve). These soils (Clayey Sand) thus have low Compressibility, low potential heave and low plasticity with an expected range of top soil movement between 10-20mm (Clayey sands) and as a result the sites are classified as **S1.**

The USCS indicates that the project soils **(CL)** consist of Fine-grained soils with more 50% passes the 0.075 mm sieve, and further split into Silts and Clays with Liquid Limit 50% or less. These soils (Silts and Clays) thus have Medium to high Compressibility when compacted, medium potential heave with an expected range of top soil movement between 15-30mm (Expansive soil) and as a result the sites are classified as **H2.**

The USCS indicates that the project soils **(ML)** consist of Fine-grained soils with more 50% passes the 0.075 mm sieve, and further split into Silts and Clays with Liquid Limit 50% or less. These soils (Silts and Clays) thus have Medium to high Compressibility when compacted, medium potential heave with an expected range of top soil movement between 10-20mm (Compressible soils) and as a result the sites are classified as **S2/H2.**

The USCS indicates that the project soils **(OL)** consist of Fine-grained soils with more 50% passes the 0.075 mm sieve, and further split into Silts and Clays with Liquid Limit 50% or less. These soils (Silts and Clays) thus have Medium to high Compressibility when compacted and Low Plasticity, medium potential heave with an expected range of top soil movement between 10-20mm (Expansive soils) and as a result the sites are classified as **S2/H2.**

In summary
TP 823, 824, 825, 826, 827, 828, 831, 833, 834, 836, and 837 = **SM/SC** and therefore classify as **S1/S2**
TP 829, 830, and 835 = **CL** and therefore classify as **S1/S2**
TP 832, and 839 = **ML/OL** and therefore classify as **S2/H2**

9.2.Compaction and CBR Test Results

CBR and Compaction tests were carried out on soil samples obtained from the test pits. The results are summarized in Table 9.2 below.

Table 9.2 Compaction and CBR Test Results

TP #	Depth (mm)	CBR @						COLTO Class
		100 %	98 %	97 %	95 %	93 %	90 %	
TP 823	500-900	16.2	15.1	14.6	13.5	12.4	10.8	**Unclassified**
TP 826	500-760	32.2	29.7	28.5	26.0	23.5	19.8	**G6**
TP 828	270-400	60.8	53.1	49.2	41.5	33.7	22.1	**G7**
TP 829	250-840	16.9	16.0	15.5	14.6	13.7	12.3	**Unclassified**
TP 831	310-810	20.4	20.1	19.9	19.6	19.3	18.9	**G7**
TP 837	400-1250	15.7	15.1	14.8	14.1	13.5	12.5	**Unclassified**
TP 838	510-1310	12.6	12.2	12.0	11.6	11.1	10.5	**Unclassified**

Test results in Table 9.2 indicate that soil from Project Site is classified as G6, G7 and unclassified according to COLTO classification systems.
According to COLTO unclassified materials are unsuitable for use as construction material.

9.3.Impact of geotechnical character on the site

The site is dominated by black/dark brown/light brown silty clay/sandy silt underlain by silty clay/clayey sand/stiff clay of various colours. In terms of US Classification System, the site have **SM, SC, CL, ML and OL** soils material.

According to the Unified Soil Classification and the PRA classification, materials classifying as "**SC**" are generally fair for use as subgrade, poor for use as subbase and not suitable for base courses in roads. The material is expected to be fairly impervious when compacted. The in-situ material may have a medium in-situ compressibility with a low compressibility and good to fair shear strength when properly compacted. The material is expected to be reasonable stable as embankment material when compacted with good workability rating and good to fair compaction characteristics.

Material classifying as "**SM**" are generally fair for use as subgrade, poor to fair for use as subbase and not suitable for base courses in roads. The material is expected to be fairly impervious when compacted. The in-situ material may have a medium in-situ compressibility with a low compressibility and good to fair shear strength when properly compacted. The material is expected to be reasonable stable as embankment material when compacted with good workability rating and good to fair compaction characteristics.

Material classifying as "**CL**" are generally fair to poor for use as subgrade, Not suitable for use as both subbase and base courses in roads. The material is expected be impervious when compacted. The in-situ material may have a medium in-situ compressibility with a medium compressibility and good to fair shear strength when properly compacted. The material is expected to have good stability when used as embankment material when compacted with good workability rating and good to fair compaction characteristics.

Material classifying as "**ML**" are generally fair to poor for use as subgrade, Not suitable for use as both subbase and base courses in roads. The material is expected to be semi-pervious to impervious when compacted. The in-situ material may have a medium in-situ compressibility with a low compressibility and

good to fair shear strength when properly compacted. The material is expected to have poor stability when used as embankment material when compacted with good workability rating and good to poor compaction characteristics.

Material classifying as "**OL**" are generally fair to poor for use as subgrade, Not suitable for use as both subbase and base courses in roads. The material is expected be impervious when compacted. The in-situ material may have a medium in-situ compressibility with a medium compressibility and good to fair shear strength when properly compacted. The material is expected to have good stability when used as embankment material when compacted with good workability rating and good to fair compaction characteristics.

All materials from this project were excavated using a TLB Excavation and as such the excavation can be classified as soft to intermediate excavation as per SABS 1200 D-1988 (as amended 1990).

9.4. General Engineering and Material Characteristics

The on-site soils classify as "**SM, SC, CL, ML and OL**" according to the Unified Soil Classification (USC) and American Association of State Highway and Transportation Officials (AASHTO) system. The upper colluvium and residual sandstone are generally as follows.

The soil classes represent the following soil types:

SM Coarse-grained soils (more than 50% retained on the 0.075 mm sieve), sands (50 % or more of course fraction retained on the 4.75 mm sieve), **sands with fines, silty sands, sand-silt mixtures.**

SC Coarse-grained soils (more than 50% retained on the 0.075 mm sieve), sands (50 % or more of course fraction retained on the 4.75 mm sieve), **sands with fines, clayey sands, sand-clay mixtures**.

CL Fine-grained soils (more than 50 % passes the 0.075 mm sieve), silts and clays with Liquid Limit of 50 % or less, inorganic clays of low to medium plasticity, **gravelly/sandy/silty/lean clays**.

ML Fine-grained soils (more than 50 % passes the 0.075 mm sieve), silts and clays with Liquid Limit of 50 % or less, inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity, **inorganic silts/very fine sands/rock flour/silty or clayey fine sands**.

OL Fine-grained soils (more than 50 % passes the 0.075 mm sieve), silts and clays with Liquid Limit of 50 % or less, organic silts and organic silty clays of low plasticity. **organic silts/organic silty clays**

Material classifying as "**CL**" are generally fair to poor for use as subgrade and not suitable for use as subbase and base course in road construction. The material is expected to be practically impervious when compacted. The in-situ material may have a medium to high compressibility with a medium compressibility and fair shear strength when compacted. The material is expected to have a good stability as embankment material when compacted with a good workability rating and good to fair compaction characteristics.

The upper and lower bound limits of the different classes as per this classification system are provided in **Appendix D.**

The on-site soils mainly classify as class **"A-1", "A-2", "A-6" and "A-7"** soils as per the AASHTO Classification System. Different classes represent the following soil types:

A-1 **Granular materials** (35 % or less passing the 0.075 mm sieve), non-liquid, Plasticity Index of maximum 6 with significant constituent: **stone fragments-gravel-sand.**

A-2 **Granular materials** (35 % or less passing the 0.075 mm sieve), different LL and PI for A-2 variances (refer to A-2-4, A-2-5 A-2-6 and A-2-7 sub-groups) with significant constituent: **silty or clayey gravel sand.**

A-4 **Silty materials** (>35 % passing the 0.075 mm sieve), minimum of 36 % passing the 0.075 mm sieve, LL max of 40, PI max of 10, with significant constituent: **Silty soils**.

A-5 **Silty materials** (>35 % passing the 0.075 mm sieve), minimum of 36 % passing the 0.075 mm sieve, LL min of 41, PI max of 10, with significant constituent: **Silty soils**.

A-6 **Silt-clay materials** (>35 % passing the 0.075 mm sieve), minimum of 36 % passing the 0.075 mm sieve, LL max of 40, PI min of 11, with significant constituent: **clayey soils**.

A-7 **Silt-clay materials** (>35 % passing the 0.075 mm sieve), minimum of 36 % passing the 0.075 mm sieve, LL min of 41, PI min of 11*, with significant constituent: clayey soils.

**Note: Plasticity Index of A-7-5 subgroup is equal to or less than the Liquid Limit – 30. Plasticity Index of A-7-6 subgroup is greater than LL – 30.*

The upper topsoil and colluvial on-site soils tested thus generally classify as Silty Sand and Silty Clays which are the main constituents.

9.5. Soil Collapse and Compressibility

The upper transported soils have an open/voided soil structure with a high collapse and consolidation potential. Collapse settlement will be significant if no earthwork precautionary measures are implemented. The lower residuum has medium to high percentages of fines (silt and clay) and the soils will undergo long-term consolidation settlement even if properly compacted as excess soil water will dissipate from the mineral structures till a state of equilibrium is reached. Earthwork and/or foundation precautionary measures will be essential.

The oedometer test was not conducted and therefore collapsibility potential was not determined. However, silty and clayey materials are not ideal and poor for support respectively.

9.6. Soil Heave

Expansive soil may result in surface movement mainly due to shrink and swell movements resulting from varying moisture conditions. Surface movement may result in unwanted damage of inappropriately designed buildings, services and general structures. The amount of swell is directly dependant on the thickness of the active zone, type and percentage of the clay minerals and the swell pressure exerted by the soils.

The potential expansiveness is evaluated by means of a combination of visual assessment of the soil structure, plasticity index and clay percentage, and swell measurements upon sample saturation on all the soils that were subject to compaction testing.

Based on the PI and clay fraction of the soils, the upper colluvial soils are expected to have a low heave potential and the lower residuum soils expected to have a low to medium heave potential (van der Merwe, 1964). Refer to Van der Merwe Chart in the **Appendix C**

9.7. Excavatability

The excavatability was assessed by means of 17 evaluation test pits excavated in confined conditions with a BELL LB90B 4x4 TLB (backhoe).

"Intermediate" excavation conditions (**SANS634:2012**, **Appendix D**) was experienced in all test pits excavated on site. The trial pits were excavated down to between 0.4 and 1.310mbgl with an average depth of 0.6mbgl.

9.8. Compaction Characteristics

The upper transported topsoil and colluvial materials in general contains high percentages of silts and clayey silts. The lower residuum generally contains medium to high percentages of fines (silt and clay). The compressibility and compaction ratings, based on the soil classifications are provided in **Appendix C**

materials classifying as "**SC**" are generally fair for use as subgrade, poor for use as subbase and not suitable for base courses in roads. The material is expected to be fairly impervious when compacted. The in-situ material may have a medium in-situ compressibility with a low compressibility and good to fair shear strength when properly compacted. The material is expected to be reasonable stable as embankment material when compacted with good workability rating and good to fair compaction characteristics.

Material classifying as "**SM**" are generally fair for use as subgrade, poor to fair for use as subbase and not suitable for base courses in roads. The material is expected to be fairly impervious when compacted. The in-situ material may have a medium in-situ compressibility with a low compressibility and good to fair shear strength when properly compacted. The material is expected to be reasonable stable as embankment material when compacted with good workability rating and good to fair compaction characteristics.

Material classifying as "**CL**" are generally fair to poor for use as subgrade, Not suitable for use as both subbase and base courses in roads. The material is expected be impervious when compacted. The in-situ material may have a medium in-situ compressibility with a medium compressibility and good to fair shear strength when properly compacted. The material is expected to have good stability when used as embankment material when compacted with good workability rating and good to fair compaction characteristics.

Material classifying as "**ML**" are generally fair to poor for use as subgrade, Not suitable for use as both subbase and base courses in roads. The material is expected to be semi-pervious to impervious when compacted. The in-situ material may have a medium in-situ compressibility with a low compressibility and good to fair shear strength when properly compacted. The material is expected to have poor stability when used as embankment material when compacted with good workability rating and good to poor compaction characteristics.

Material classifying as "**OL**" are generally fair to poor for use as subgrade, Not suitable for use as both subbase and base courses in roads. The material is expected be impervious when compacted. The in-situ material may have a medium in-situ compressibility with a medium compressibility and good to fair shear strength when properly compacted. The material is expected to have good stability when used as embankment material when compacted with good workability rating and good to fair compaction characteristics.

9.9. Slope Stability and Erosion

No natural steep slopes exist, and natural slope instability cannot occur.

The slopes of the confined vertical inspection trenches were stable during the short period of investigation (+/- 6 hours) with no indications of bulging/toppling/ravelling. It should however be emphasised that instability can be expected in unconfined and confined conditions with an increase in moisture content as expected during the wet season. Any excavations should be inspected by a competent person. Any manned excavations should be inspected and approved by a competent person as per the health and safety regulations.

The general safety regulations (GSR13) which stated that no employer may require or permit any person to and no person shall, work in an excavation more than 1.5m deep and which has not been adequately shored or braced if there is a danger of the sides of the excavation have a potential for collapse, **no longer apply.**

Regulation 13(2)(b) state that no work in unbraced excavations will be allowed unless:

1. Battered to angle of repose or
2. In stable material, and
3. permission in writing by competent person and where uncertain,
4. professional assessment in writing.

A competent person (suitably qualified and experienced preferably geotechnical engineer or and/or engineering geologist) should inspect any excavations to be entered:

1. Daily, prior to each shift;
2. After every blasting operation;
3. After an unexpected fall of ground;
4. After substantial damage to any supports; and
5. After any rain event.

Permission to enter any excavation should be granted in writing by the competent person daily and before/after the events as listed above for each separate pipeline section or excavation. The above is essential in order to evaluate the safety of the excavation to ensure the safety of persons working and around the trenches/excavations. The inspections are to be recorded in a register kept on site and made available to an inspector, client, client's agent, contractor or employee on request.

The excavation work requirements as per the Construction Regulations should be implemented by the client/agent/principal contractor/contractor as stipulated in the regulations or as otherwise specified in writing by the responsible engineer.

The following batter angles can be considered for low height cut slopes (Less than 3 m deep cuts) for planning purposes (the angles should be confirmed by a competent person once excavation details are known).

- Permanent slope batter: 1V:2H to 1V:5H (Height and load dependant for slopes within the residuum. Batters more than 3m should be evaluated).
- Temporary slope batter: Maximum of 1V:2H (Height and load dependant. Batters more than 2m should be evaluated).

The upper soils are expected to have a high susceptibility to erosion once exposed and subject to concentrated water flow. Basic surface water management will be required to avoid concentrated water flow in order to limit excessive soil erosion.

Basic erosion control measures will be recommended. Measures may comprise of one or a combination of the following:

- Construction phasing to limit vast exposed areas that may result in high run-off and concentrated water flow;
- Surface water management to prevent high run-off rates and concentrated water flow;
- Temporary surface protection during construction;
- Permanent surface protection after construction for example grass establishment and/or paving;
- Physical improvement of the upper soils such as compaction in order to increase resistance to erosion;
- Subsurface drainage where pedogenic or expected seasonal perched water contacts are exposed by possible cuts/excavations.

Site water management will be recommended, especially if the construction phase is during the wet season, in order to avoid concentrated water flow that may result in severe erosion of the upper soil horizons and/or undercutting of structures.

10. Construction Material

10.1. Suitability for Use in Soil Mattress Construction

The basic concept behind soil mattresses is that that material should be:

- Workable;
- Have a low compressibility once compacted (within the allowable tolerances of the structure/s);
- Have a low heave once compacted (within the allowable tolerances of the structure/s);
- Have suitable bearing capacity for the proposed foundation loads.

Considering the low expected and assumed induced loads, the following expected performances are assigned to the different soil horizons present on site:

Topsoil: Not ideal due to presence of organic matter and roots. Can be considered if roots are removed.

Colluvium: Considered not a good source for mattress construction due to high percentages of silts and clay. (compressible and heaving respectively)

Reworked residual siltstone/mudstone: The quantities are fairly high and the planners can consider utilising the material mixed with the imported good material for upper mattress construction. A 1:2 mix of reworked residual siltstone/mudstone and selected imported is expected to provide suitable mattress construction material. The physical improvement will improve the compaction characteristics, reduce the swell potential and reduce the consolidation potential.

10.2. Suitability for Use as Pipe Bedding and Backfill

The bedding and blanketing material can be evaluated by SANS or the more relaxed Department of Water Affairs (DWA) specifications. DWA developed a relaxed bedding specification especially for areas where materials with specifications as per SANS cannot be obtained. The specifications are summarized in **Table 10.1.**

Table 10.1: Relaxed Pipe Bedding Specifications (DWA)

Material Description	Percentage by Mass Passing Sieve Size (mm)				Atterberg Limits Shall Not Exceed (%)		
	9,5	4,75	0,425	0,002	LL*	PI*	LS*
Finely Graded A	100	100	80 - 100	0 - 45	30	15	5
Medium Graded B	100	80 - 100	60 - 80	0 - 40	35	18	7,5
Granular C	100	70 - 100	30 - 60	0 - 35	40	20	10

*Notes: * LL, PI and LS on material passing the 0,425mm sieve.*

Selective on-site materials (generally the topsoil) may be considered suitable for pipe bedding "Finely Graded A" as per the DWA relaxed specifications, providing that stones in excess of 10mm are sieved from especially the 75mm of material immediately surrounding the pipe.

The on-site material will be suitable for backfill in areas not subject to traffic loads if properly placed. The design engineer should evaluate the suitability of the material for backfill subject to traffic loads as it will depend on the overall pavement design and expected traffic loads/volumes.

10.3. Suitability for Use in Road Pavement Construction

The design of the road pavement will depend on the expected induced loads, volumes and overall pavement design with reference to type of materials, horizon thicknesses to be incorporated into the pavement and the drainage precautionary measures. The pavement engineer should thus evaluate the suitability of the materials taking into consideration the required parameters and pavement balance. The saturated CBR values are provided in the attached results.

11. General Geotechnical Zonation

This classification system and associated foundation types apply to small masonry structures (single-storey to double-storey light masonry residential type construction with dimensions typically less than 12 by 12 m) such as possible small offices and outbuildings.

Considering the geotechnical constraints and conditions encountered, the site is assigned with two broad geotechnical zones namely (SAICE 1995 // SANS634:2012):

Zone I: H2// 2ABDE 3C

Where H before the "//" refer to:
H - Expansive Soils;
C - Collapse and consolidation settlement
S - Compressible Soils

The A-B-C-D-E and F after the "//" refer to:
A - Collapse settlement;
B - Seasonal shallow seepage water or saturated soil conditions;
C - Low to medium soil heave potential;
D - Consolidation settlement (secondary to the collapse settlement);
E - Erodibility of the soil horizons;
F - Excavatability difficulty from 2.0 meter below surface.

The reference tables are attached in **Appendix D**

12. Conclusions and Recommendations

The earthwork and foundation design should provide for at least the following geotechnical constraints:

1. Low to Medium soil heave potential
2. Expected Estimated Total soil movement (up to 15 – 30 mm total soil movement in areas with 50% assumed differential). Can be refined if individual footing scenarios are assessed by a competent person;
3. Possibility of shallow **seasonal** seepage water conditions, as indicated by the moist colluvium at relatively shallow depths.
4. Erodibility of the upper soils once cleared of vegetation and subject to concentrated water flow.

The possibility of large size boulders and corestones or undulating bedrock conditions should be considered. Earthwork and/or foundation modifications may be required if any composite conditions are encountered.

One or a combination of the following foundation options can be recommended as a generic approach, together with articulation joints in floors and masonry and light reinforcing in masonry:

1. Soil raft constructed of inert material.
2. Stiffened or cellular raft.
3. Deep strip footing with normal construction (Areas of shallow competent rock).
4. Compaction below floors and below individual footings/foundations with modified normal construction. Will only apply towards the far western to south-western extent of the site, where the sandstone formation with low PI, low expansiveness residual sands were encountered.

A generic soil raft approach can be preliminary provided as (Typical as for SAICE 1995, Class "H2" option, **Appendix D**):

- Remove in situ material to 1,0 to 1.5m beyond perimeter of building to a depth and width of 1,5 times the widest foundation and replace with inert material compacted to minimum of 93% to

ideally +95% Mod. AASHTO density at –1% to +1% of optimum moisture content. Soils classifying as **SC** as per the Unified Soil Classification System.

- Lightly reinforced strip footings and light reinforcement in masonry should be considered to cater for the slight differential movements that may result from the soils with a slight heave potential.

Cut-to-fill-to-level preparations are expected to be conducted to form level founding platforms for medium- to large-size structures. Proper compaction will be critical in the fill portion, as well as the voided colluvial the structures. Proper rip and re-compaction and fill of inert material should be implemented across the platforms, in order to prevent composite founding conditions. The concept is illustrated in **Figure 6.**

If pad footings or strip foundations (or a combination of the foundations) are considered, excavation beyond the perimeter and below the foundation with proper re-compaction of the material to ideally +95% Mod. AASHTO compaction effort at or near optimum moisture content will be critical in order to break-down the collapsible soil structure.

For pad footings, the compaction depth should ideally be 1.5 times the width of the footing and for strip footings the ideal compaction depth is at least 2 times the width of the strip footing.

Compaction guidance are visually illustrated in **Figure 7** and **Figure 8** as for pad footings and strip foundations respectively. Scenario B will mostly apply for **Figure 7** and **Figure 8** as thick collapsible/compressible/expansive horizons are mainly present.

It will be recommended that the floors are suspended from the foundations with articulation joints through the lightly reinforced masonry to accommodate some degree of differential movement.

If proper compaction below the floors and foundations are conducted in combination of the soil mattress, suspension will not be critical, however some allowance should be made for the slight heave expected as discussed in the relevant report section. If inert imported fill is used as mattress construction, then the heave allowance will not apply. Special foundation and masonry design will be required if additional loads will act on the foundations and floors.

The design engineer should ideally liaise with the Geotechnical engineer and provide load schedules once available for any structures with expected induced loads of more than ~75kPa. Any retaining walls, high bearing footings or areas of other induced loads such as in-store storage areas should be evaluated on an individual basis.

No details are currently available, so the recommendations are purely generic or nature.

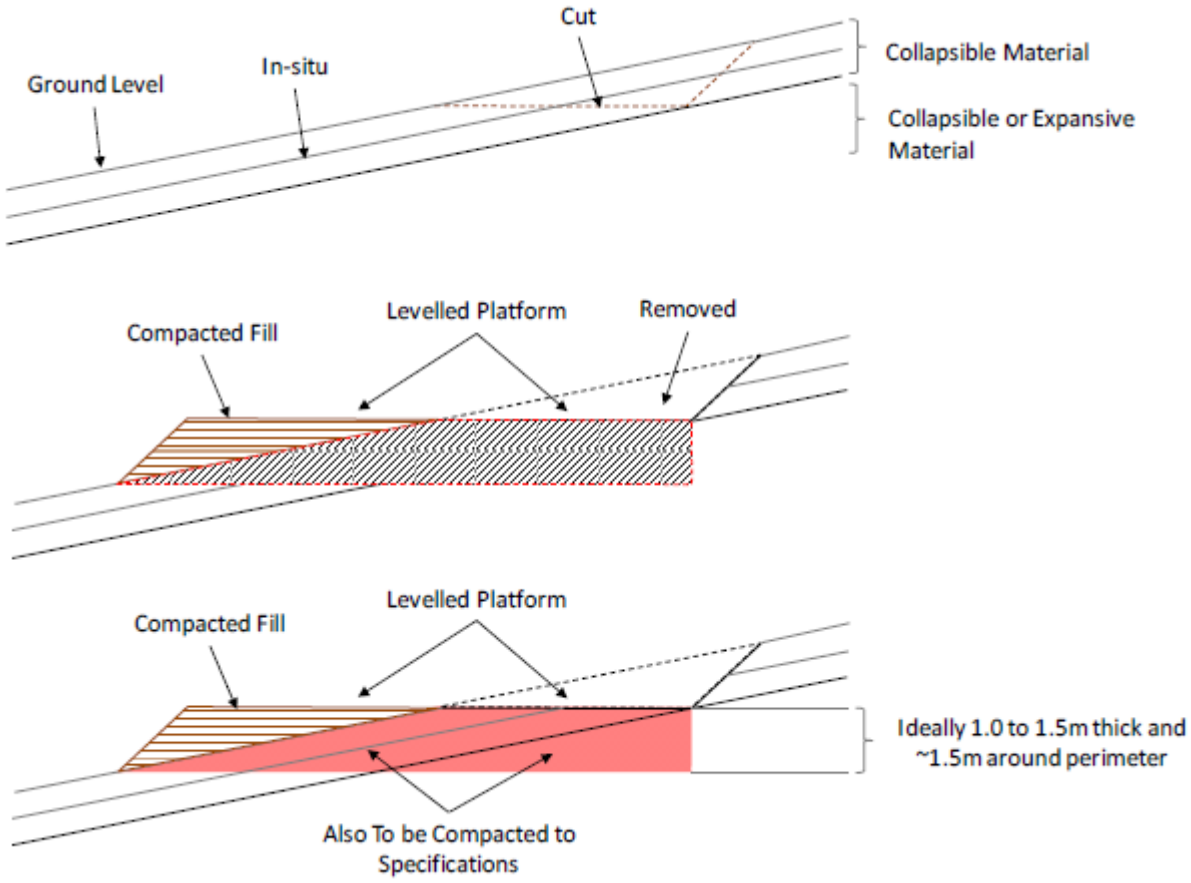

Figure 6: Proper Compaction of In-situ Soils to Form a Uniform Platform

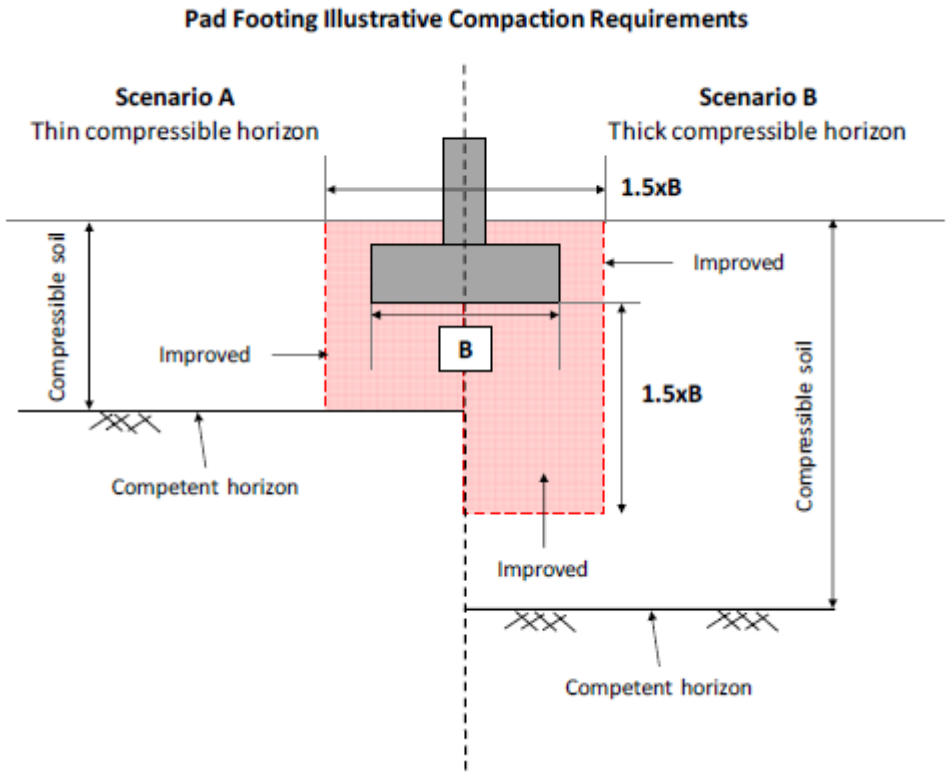

Figure 7: Concept of Compaction below Pad Footing

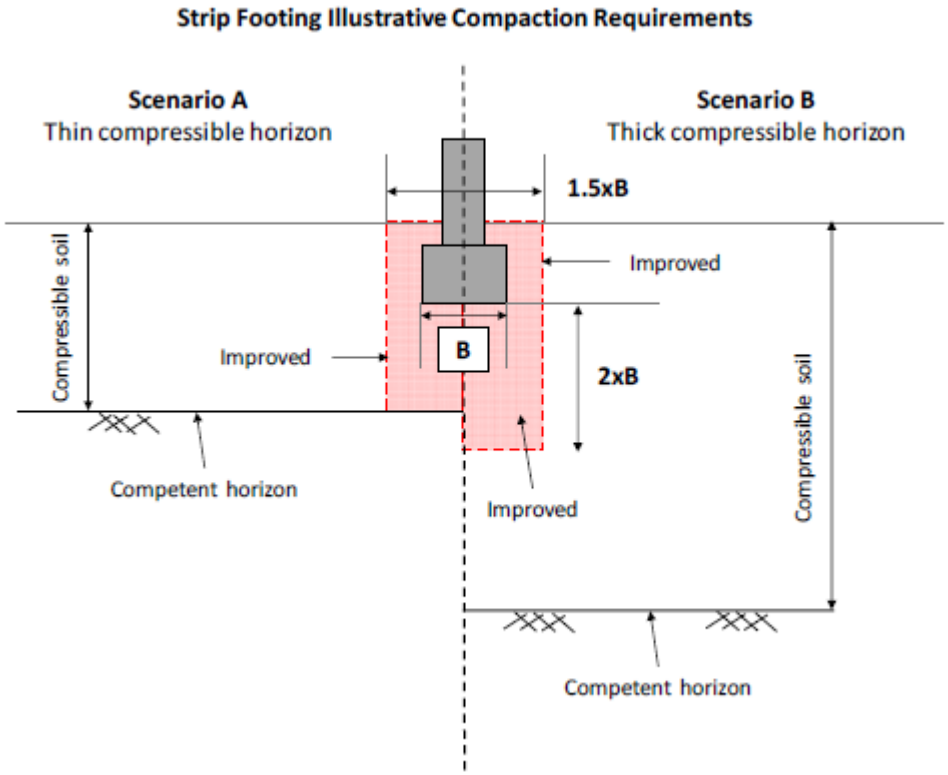

Figure 8: Concept of Compaction Below Strip Footing

The following general additional recommendations can be provided:

1. Pesticide control below and around foundation platforms;
2. Corrosion protection measures for any ferrous services in direct contact with the soil or possible soil-water interface;
3. Basic erosion protection during construction such as surface water management;
4. Consider installation of an up-slope cut-off trenches in order to deal with any possible seasonal shallow seepage water that may be encountered during the wet season. The groundwater movement of the site was not monitored during wet-season cycles and the degree of seasonal seepage are not known. Seepage water are mainly expected in the horizons where the ferruginisation are most prominent, as precipitation of the oxides mainly occur in these zones of seasonal seepage water fluctuation);
5. Implementation of damp-proofing for floors and masonry;
6. Re-instatement of vegetational cover (grass) or paving around structures or any barren/exposed soil that may be subject to erosion.

The importance of open services inspections by a competent person is emphasised in order to modify the generic recommendations provided in this report. Foundations should be evaluated individually as the exact location, material thicknesses and properties at that location and nature of the structure and loading should be incorporated in the recommended earthwork and/or foundation solution.

13. Way Forward

A competent person should inspect all open trenches, cuts and foundation excavations to identify conditions that may vary from the encountered conditions as discussed in this assessment. These inspections and modifications are generally termed the “Phase 2 assessment” or “Construction report”.

It is recommended that a competent person is present during material selection, placement and compaction.

Proper quality control measures should be implemented for the soil mattresses and compaction below floors/foundations. No load schedules or foundation specifications were available at the time of writing this report. The guidelines provided are generic of nature. The design engineer should ideally calculate the necessary or consult with the evaluator of this report if any high load or sensitive footings, structures or foundations with high expected eccentricities are planned. These footings/structures should ideally be evaluated and optimised.

14. Report Provisions

While every effort was made during this assessment to identify the different geological materials, areas subject to a perched water table, hydrogeological conditions, areas of poor drainage and to estimate their distribution, it is impossible to guarantee that isolated zones of significantly different conditions have not been missed. Areas of poorer conditions are however not likely.

The groundwater movement of the site was not monitored during wet-season cycles and the degree of seasonal seepage are not known. Site water management is recommended, especially if the construction

phase is during the wet season, in order to avoid concentrated water flow that may result in severe erosion of the upper soil horizons and/or undercutting of structures

For this reason, this investigation has sought to highlight the significant issues regarding the influence of the proposed development on the geological environment to provide prior warning to the developer and to suggest precautionary measures.

The report may only be distributed in its full context. Engineering Aces (Pty) Ltd. and/or any of its employees or sub-contractors will not be held liable for any damages caused due to misinterpretation of the findings and/or recommendations due to selective data presentation or distribution.

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ECSA Registration 20130335

Tsoeu Mokaloba
Geotechnical Engineer

15. References

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Google Earth Map: 2021 AfrGIS (Lindley) Ltd

https://www.meteoblue.com/en/weather/historyclimate/climatemodelled/Lindley_south-africa_991310 (23/02/2023)

16. Appendices

Appendix A Soil Profile

Appendix B Photos

Appendix C Summary of Results

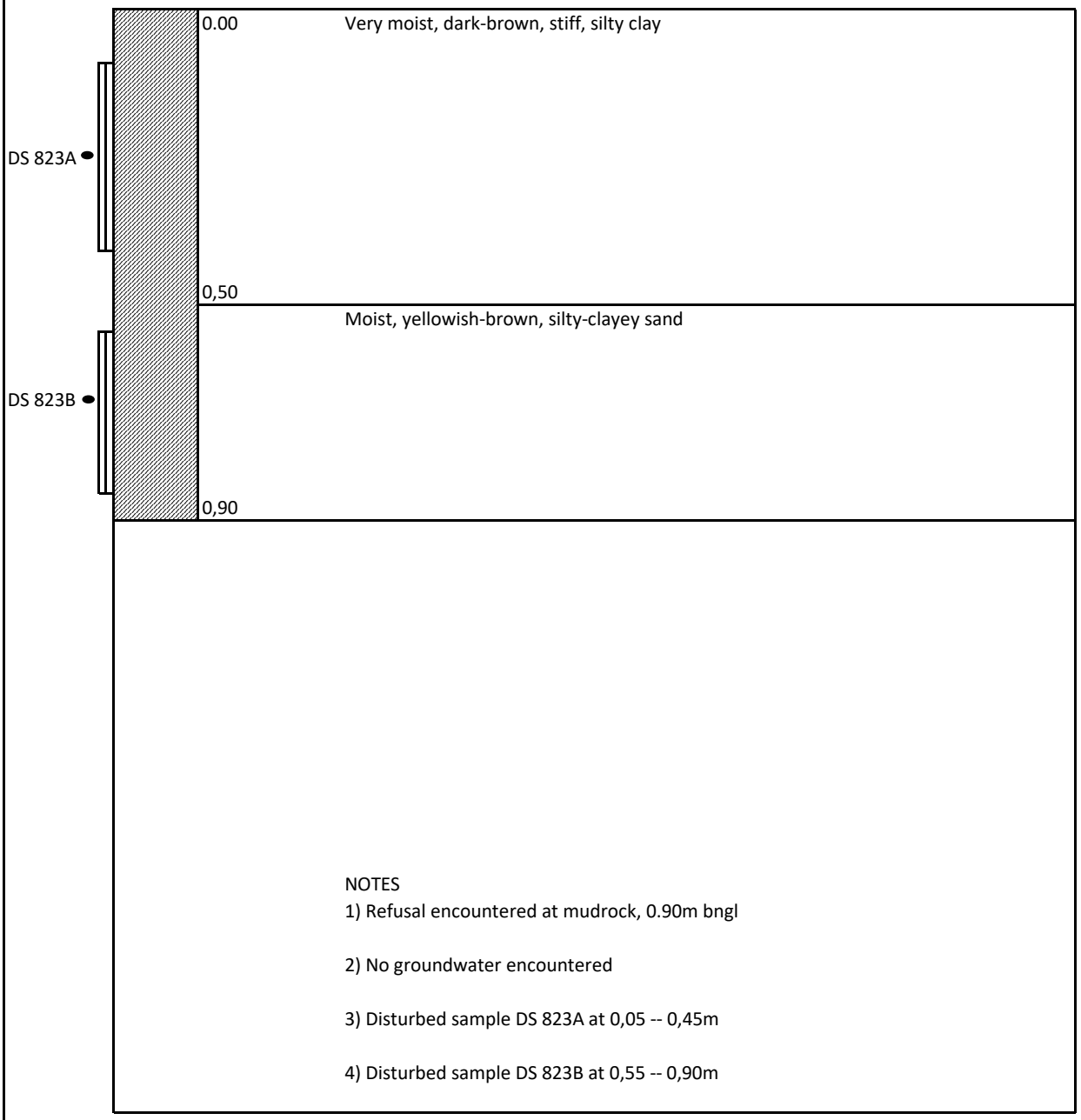
Appendix D Appendix D1

GEOTECHNICAL ENGINEERING LABORATORY (PTY) LTD

BABEREKI CONSULTING ENGINEERS - LINDLEY WASTE WATER TREATMENT WORKS

HOLE No. TP 823
Sheet 1 of 1

JOB NUMBER:



0.00 Very moist, dark-brown, stiff, silty clay

0,50 Moist, yellowish-brown, silty-clayey sand

0,90

NOTES
1) Refusal encountered at mudrock, 0.90m bngl

2) No groundwater encountered

3) Disturbed sample DS 823A at 0,05 -- 0,45m

4) Disturbed sample DS 823B at 0,55 -- 0,90m

CONTRACTOR:
MACHINE: TLB
DRILLED BY
PROFILED BY: LERATO

TYPE SET BY: T J MOKALOBA
SETUP FILE: STANDARD. SET

INCLINATION:
DIAM:
DATE: 01/02/2023
DATE: 01/02/2023

DATE:

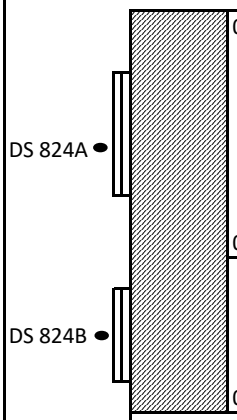
ELEVATION:
X - COORD:
Y - COORD:

HOLE No. TP 823

BABEREKI CONSULTING ENGINEERS - LINDLEY WASTE WATER TREATMENT WORKS

HOLE No. TP 824
Sheet 1 of 1

JOB NUMBER:



0.00	Moist, light-brown, loose, sand
0,35	Moist, light-brown, stiff, silty-clayey sand
0,60	

NOTES
1) Refusal encountered at gravel, 0.60m bngl

2) No groundwater encountered

3) Disturbed sample DS 824A at 0,05 -- 0,30m

4) Disturbed sample DS 824B at 0,40 -- 0,60m

CONTRACTOR:
MACHINE: TLB
DRILLED BY
PROFILED BY: LERATO

TYPE SET BY: T J MOKALOBA
SETUP FILE: STANDARD. SET

INCLINATION:
DIAM:
DATE: 01/02/2023
DATE: 01/02/2023

DATE:

ELEVATION:
X - COORD:
Y - COORD:

HOLE No. TP 824

BABEREKI CONSULTING ENGINEERS - LINDLEY WASTE WATER TREATMENT WORKS

HOLE No. TP 825
Sheet 1 of 1

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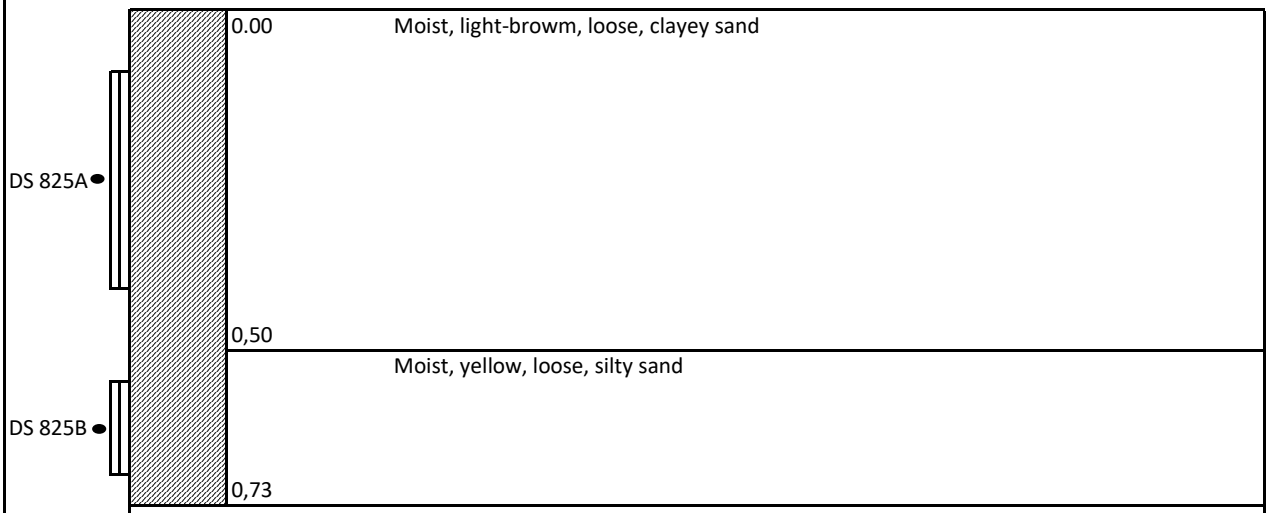


0.00 Moist, light-browm, loose, clayey sand

0,50 Moist, yellow, loose, silty sand

0,73

NOTES

1) Refusal encountered at sand stone, 0,73m bngl

2) No groundwater encountered

3) Disturbed sample DS 825A at 0,05 -- 0,45m

4) Disturbed sample DS 825B at 0,55 -- 0,73m

CONTRACTOR:
MACHINE: TLB
DRILLED BY
PROFILED BY: LERATO

TYPE SET BY: T J MOKALOBA
SETUP FILE: STANDARD. SET

INCLINATION:
DIAM:
DATE: 01/02/2023
DATE: 01/02/2023

DATE:

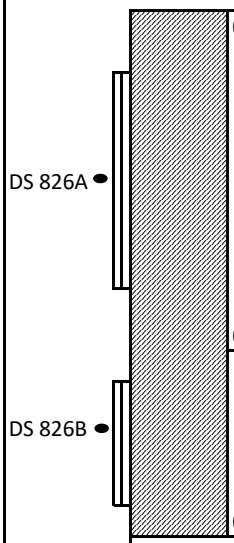
ELEVATION:
X - COORD:
Y - COORD:

HOLE No. TP 825

BABEREKI CONSULTING ENGINEERS - LINDLEY WASTE WATER TREATMENT WORKS

HOLE No. TP 826
Sheet 1 of 1

JOB NUMBER:



0.00	Moist, dark-browm, stiff, clayey sand
0,50	Moist, yellow, stiff, speckled brown, silty-clayey sand
0,76	

NOTES
1) Refusal encountered at mudrock, 0,76m bngl

2) No groundwater encountered

3) Disturbed sample DS 826A at 0,05 -- 0,45m

4) Disturbed sample DS 826B at 0,55 -- 0,76m

CONTRACTOR:
MACHINE: TLB
DRILLED BY
PROFILED BY: LERATO

TYPE SET BY: T J MOKALOBA
SETUP FILE: STANDARD. SET

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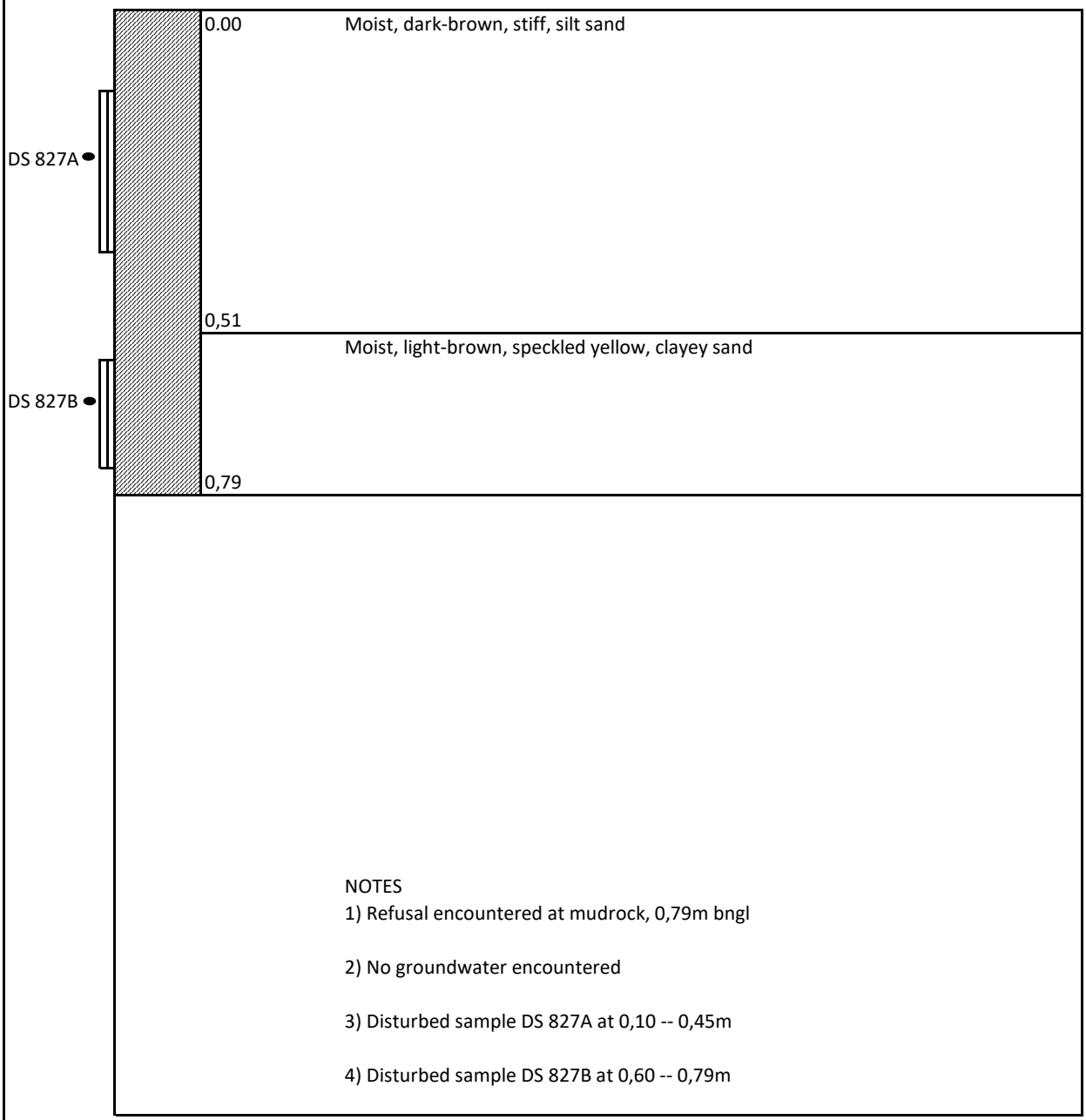
HOLE No. TP 826

GEOTECHNICAL ENGINEERING LABORATORY (PTY) LTD

BABEREKI CONSULTING ENGINEERS - LINDLEY WASTE WATER TREATMENT WORKS

HOLE No. TP 827
Sheet 1 of 1

JOB NUMBER:



NOTES
1) Refusal encountered at mudrock, 0,79m bngl

2) No groundwater encountered

3) Disturbed sample DS 827A at 0,10 -- 0,45m

4) Disturbed sample DS 827B at 0,60 -- 0,79m

CONTRACTOR:
MACHINE: TLB
DRILLED BY
PROFILED BY: LERATO

TYPE SET BY: T J MOKALOBA
SETUP FILE: STANDARD. SET

INCLINATION:
DIAM:
DATE: 01/02/2023
DATE: 01/02/2023

DATE:

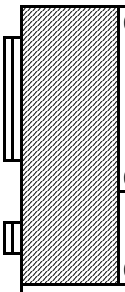
ELEVATION:
X - COORD:
Y - COORD:

HOLE No. TP 827

BABEREKI CONSULTING ENGINEERS - LINDLEY WASTE WATER TREATMENT WORKS

HOLE No. TP 828
Sheet 1 of 1

JOB NUMBER:



DS 828A

DS 828B

0.00	Moist, dark-brown, loose sand
0,23	Moist, yellow speckled orange, medium dense sand
0,40	

NOTES

1) Refusal encountered at sand stone, 0,40m bngl

2) No groundwater encountered

3) Disturbed sample DS 828A at 0,00 -- 0,23m

4) Disturbed sample DS 828B at 0,30 -- 0,40m

CONTRACTOR:
MACHINE: TLB
DRILLED BY
PROFILED BY: LERATO

TYPE SET BY: T J MOKALOBA
SETUP FILE: STANDARD. SET

INCLINATION:
DIAM:
DATE: 01/02/2023
DATE: 01/02/2023

DATE:

ELEVATION:
X - COORD:
Y - COORD:

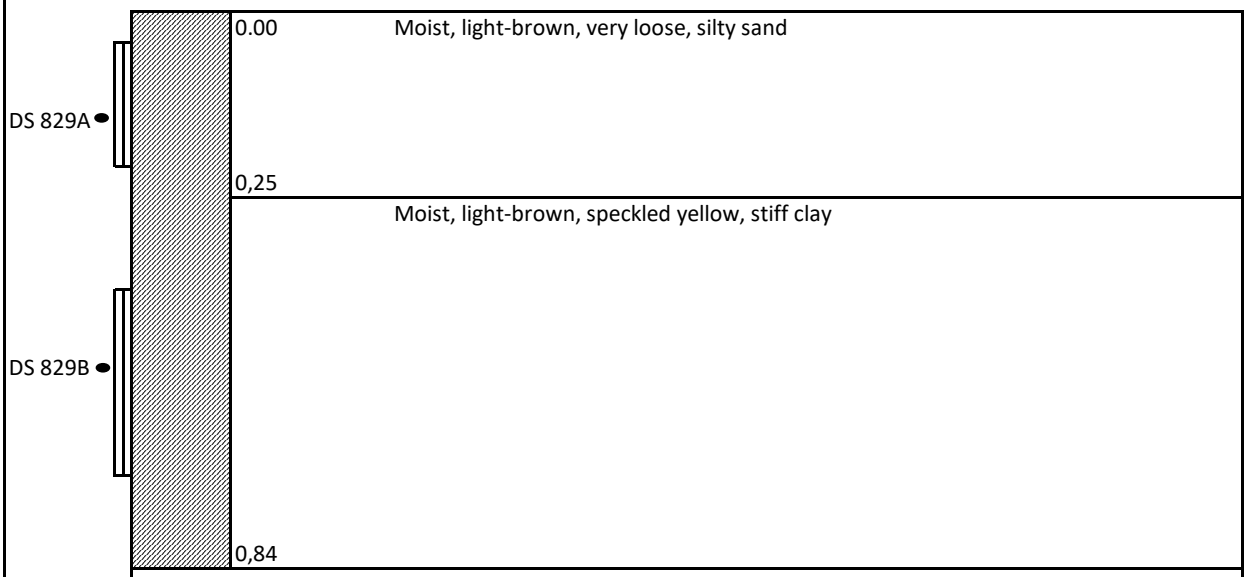
HOLE No. TP 828

GEOTECHNICAL ENGINEERING LABORATORY (PTY) LTD

BABEREKI CONSULTING ENGINEERS - LINDLEY WASTE WATER TREATMENT WORKS

HOLE No. TP 829
Sheet 1 of 1

JOB NUMBER:



0.00 Moist, light-brown, very loose, silty sand

0,25 Moist, light-brown, speckled yellow, stiff clay

0,84

NOTES

1) Refusal encountered at sand stone, 0,84m bngl

2) No groundwater encountered

3) Disturbed sample DS 829A at 0,00 -- 0,25m

4) Disturbed sample DS 829B at 0,35 -- 0,75m

CONTRACTOR:
MACHINE: TLB
DRILLED BY
PROFILED BY: LERATO

TYPE SET BY: T J MOKALOBA
SETUP FILE: STANDARD. SET

INCLINATION:
DIAM:
DATE: 01/02/2023
DATE: 01/02/2023

DATE:

ELEVATION:
X - COORD:
Y - COORD:

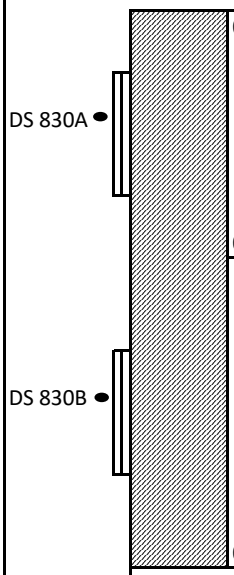
HOLE No. TP 829

GEOTECHNICAL ENGINEERING LABORATORY (PTY) LTD

BABEREKI CONSULTING ENGINEERS - LINDLEY WASTE WATER TREATMENT WORKS

HOLE No. TP 830
Sheet 1 of 1

JOB NUMBER:



0.00 Moist, light-brown, very loose, silty sand

0,32 Moist, light-brown, speckled yellow, stiff clay

0,84

NOTES

1) Refusal encountered at sand stone, 0,84m bngl

2) No groundwater encountered

3) Disturbed sample DS 830A at 0,05 -- 0,30m

4) Disturbed sample DS 830B at 0,50 -- 0,75m

CONTRACTOR:
MACHINE: TLB
DRILLED BY
PROFILED BY: LERATO

TYPE SET BY: T J MOKALOBA
SETUP FILE: STANDARD. SET

INCLINATION:
DIAM:
DATE: 01/02/2023
DATE: 01/02/2023

DATE:

ELEVATION:
X - COORD:
Y - COORD:

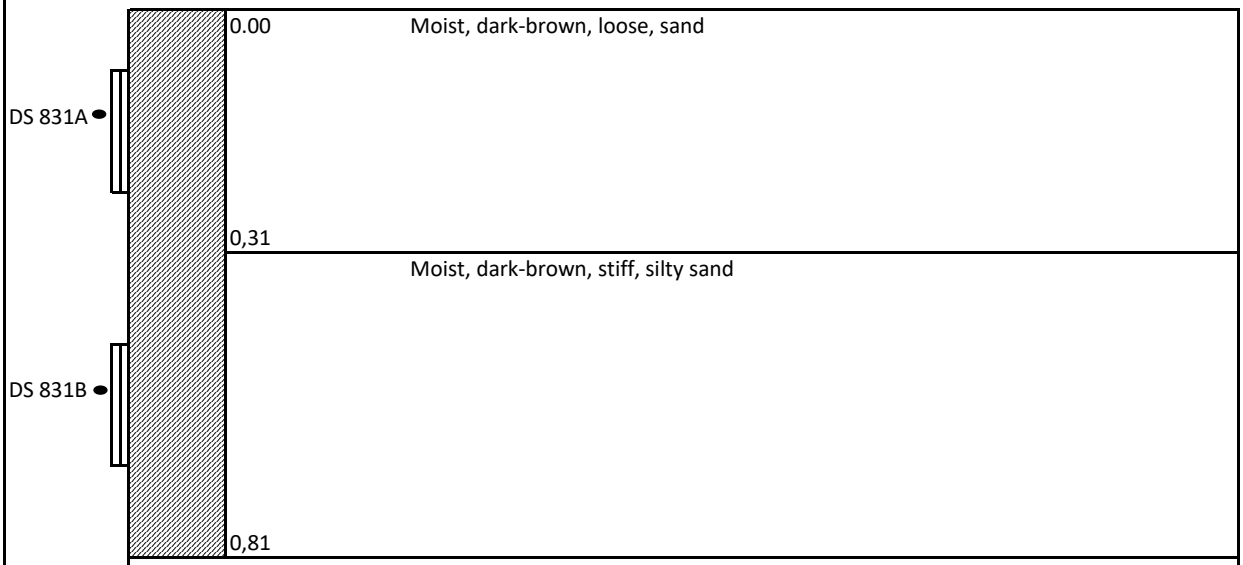
HOLE No. TP 830

GEOTECHNICAL ENGINEERING LABORATORY (PTY) LTD

BABEREKI CONSULTING ENGINEERS - LINDLEY WASTE WATER TREATMENT WORKS

HOLE No. TP 831
Sheet 1 of 1

JOB NUMBER:



0.00 Moist, dark-brown, loose, sand

0,31 Moist, dark-brown, stiff, silty sand

0,81

NOTES
1) Refusal encountered at shale, 0,81m bngl

2) No groundwater encountered

3) Disturbed sample DS 831A at 0,05 -- 0,30m

4) Disturbed sample DS 831B at 0,50 -- 0,75m

CONTRACTOR:
MACHINE: TLB
DRILLED BY
PROFILED BY: LERATO

TYPE SET BY: T J MOKALOBA
SETUP FILE: STANDARD. SET

INCLINATION:
DIAM:
DATE: 01/02/2023
DATE: 01/02/2023

DATE:

ELEVATION:
X - COORD:
Y - COORD:

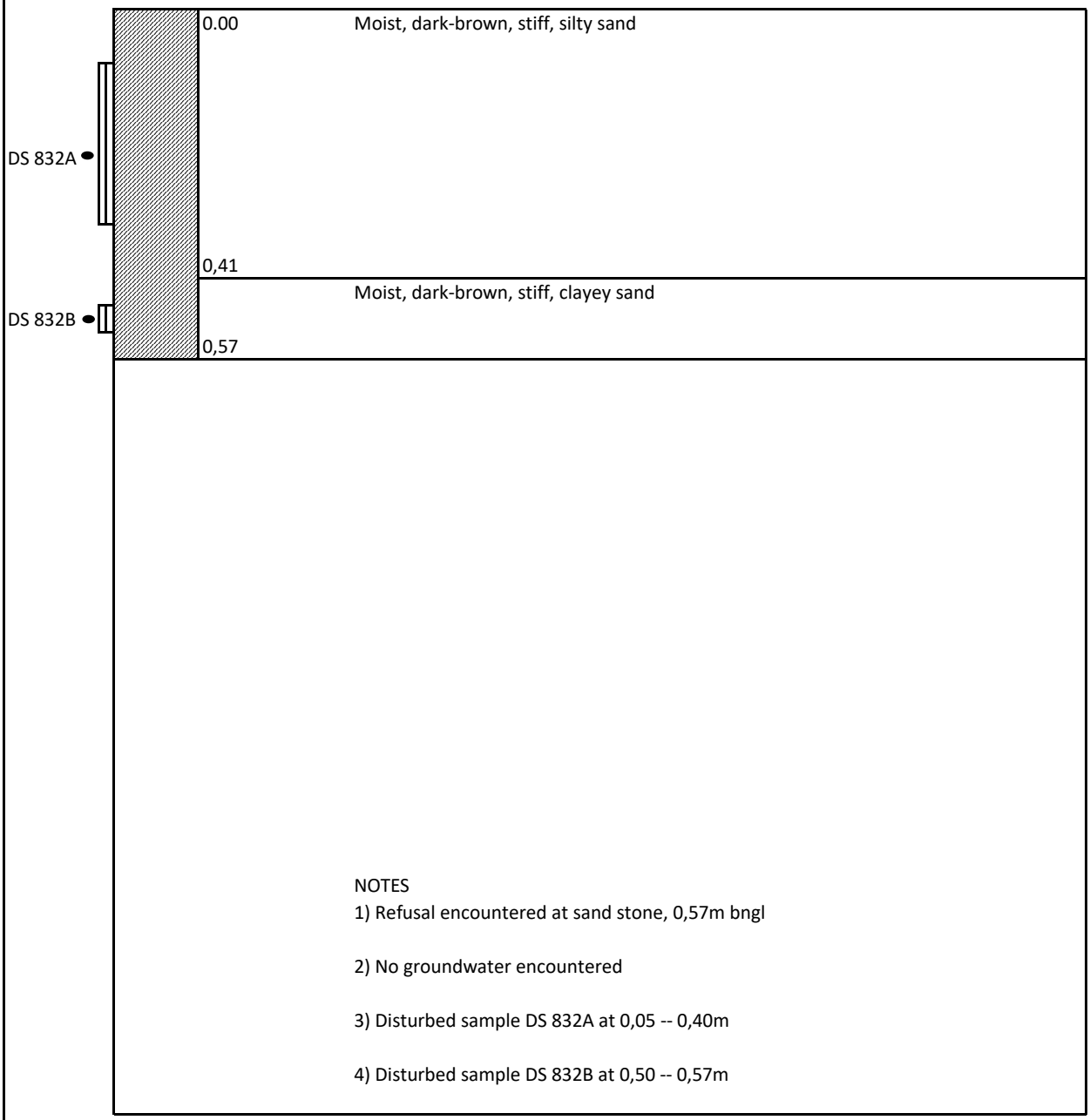
HOLE No. TP 831

GEOTECHNICAL ENGINEERING LABORATORY (PTY) LTD

BABEREKI CONSULTING ENGINEERS - LINDLEY WASTE WATER TREATMENT WORKS

HOLE No. TP 832
Sheet 1 of 1

JOB NUMBER:



NOTES

1) Refusal encountered at sand stone, 0,57m bngl

2) No groundwater encountered

3) Disturbed sample DS 832A at 0,05 -- 0,40m

4) Disturbed sample DS 832B at 0,50 -- 0,57m

CONTRACTOR:
MACHINE: TLB
DRILLED BY
PROFILED BY: LERATO

TYPE SET BY: T J MOKALOBA
SETUP FILE: STANDARD. SET

INCLINATION:
DIAM:
DATE: 01/02/2023
DATE: 01/02/2023

DATE:

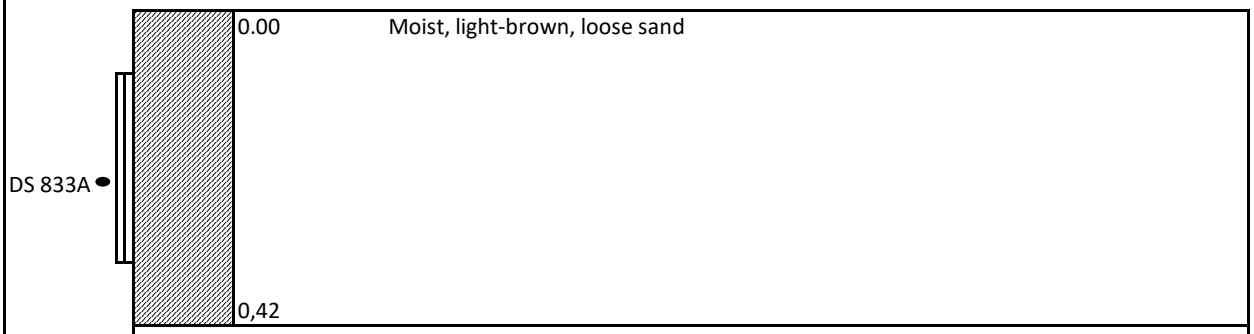
ELEVATION:
X - COORD:
Y - COORD:

HOLE No. TP 832

BABEREKI CONSULTING ENGINEERS - LINDLEY WASTE WATER TREATMENT WORKS

HOLE No. TP 833
Sheet 1 of 1

JOB NUMBER:



0.00 Moist, light-brown, loose sand

0,42

NOTES

1) Refusal encountered at sand stone, 0,42m bngl

2) No groundwater encountered

3) Disturbed sample DS 833A at 0,05 -- 0,40m

CONTRACTOR:
MACHINE: TLB
DRILLED BY
PROFILED BY: LERATO

TYPE SET BY: T J MOKALOBA
SETUP FILE: STANDARD. SET

INCLINATION:
DIAM:
DATE: 01/02/2023
DATE: 01/02/2023
DATE:

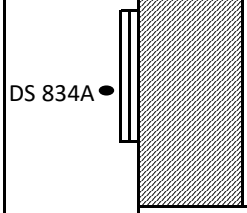
ELEVATION:
X - COORD:
Y - COORD:

HOLE No. TP 833

BABEREKI CONSULTING ENGINEERS - LINDLEY
WASTE WATER TREATMENT WORKS

HOLE No. TP 834
Sheet 1 of 1

JOB NUMBER:



0.00	Moist, light brown, loose sand
0,33	

NOTES
1) Refusal encountered at sand stone, 0,33m bngl

2) No groundwater encountered

3) Disturbed sample DS 834A at 0,05 -- 0,30m

CONTRACTOR:
MACHINE: TLB
DRILLED BY
PROFILED BY: LERATO

TYPE SET BY: T J MOKALOBA
SETUP FILE: STANDARD. SET

INCLINATION:
DIAM:
DATE: 01/02/2023
DATE: 01/02/2023

DATE:

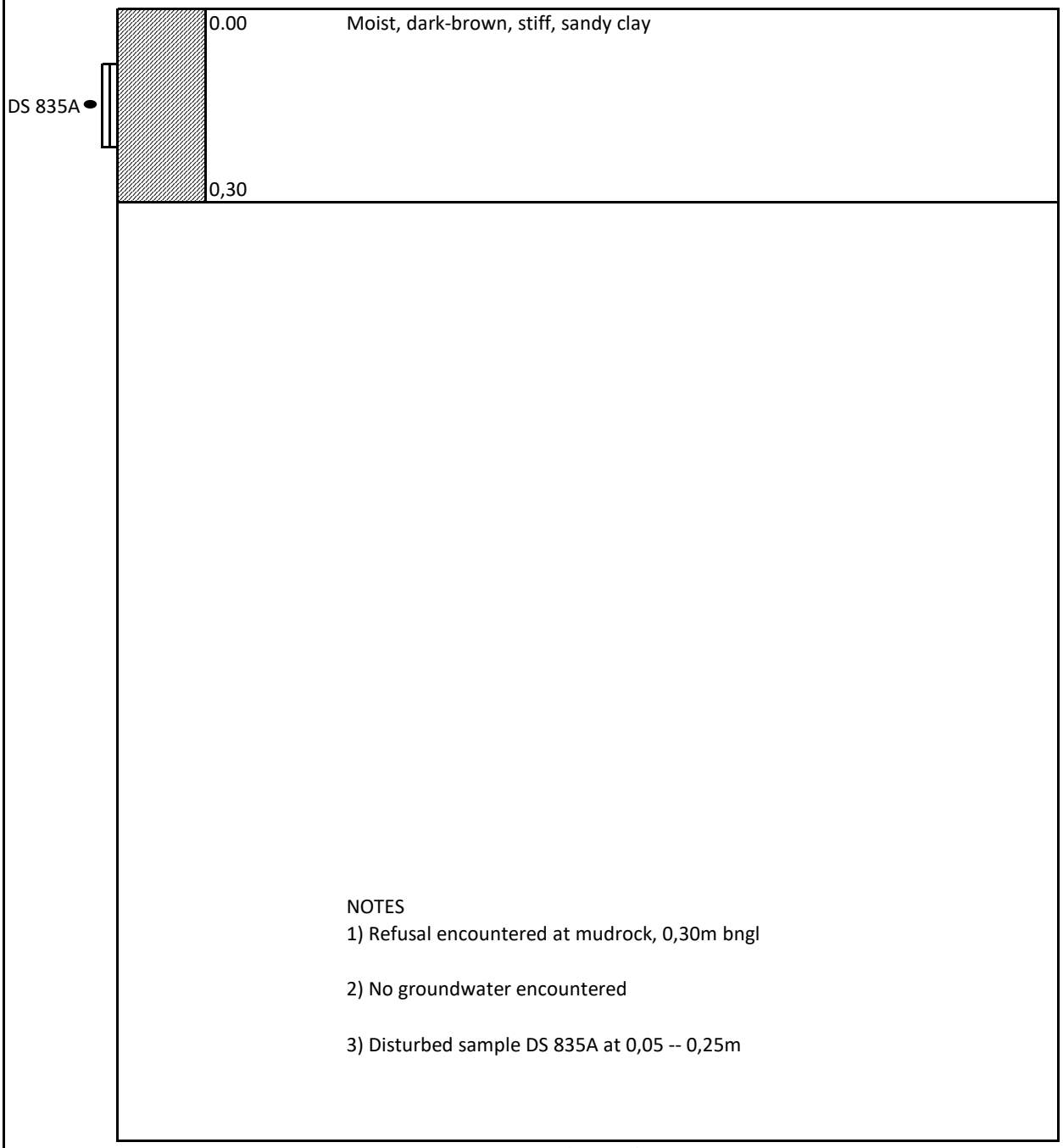
ELEVATION:
X - COORD:
Y - COORD:

HOLE No. TP 834

BABEREKI CONSULTING ENGINEERS - LINDLEY WASTE WATER TREATMENT WORKS

HOLE No. TP 835
Sheet 1 of 1

JOB NUMBER:



NOTES
1) Refusal encountered at mudrock, 0,30m bngl

2) No groundwater encountered

3) Disturbed sample DS 835A at 0,05 -- 0,25m

CONTRACTOR:
MACHINE: TLB
DRILLED BY
PROFILED BY: LERATO

TYPE SET BY: T J MOKALOBA
SETUP FILE: STANDARD. SET

INCLINATION:
DIAM:
DATE: 01/02/2023
DATE: 01/02/2023

DATE:

ELEVATION:
X - COORD:
Y - COORD:

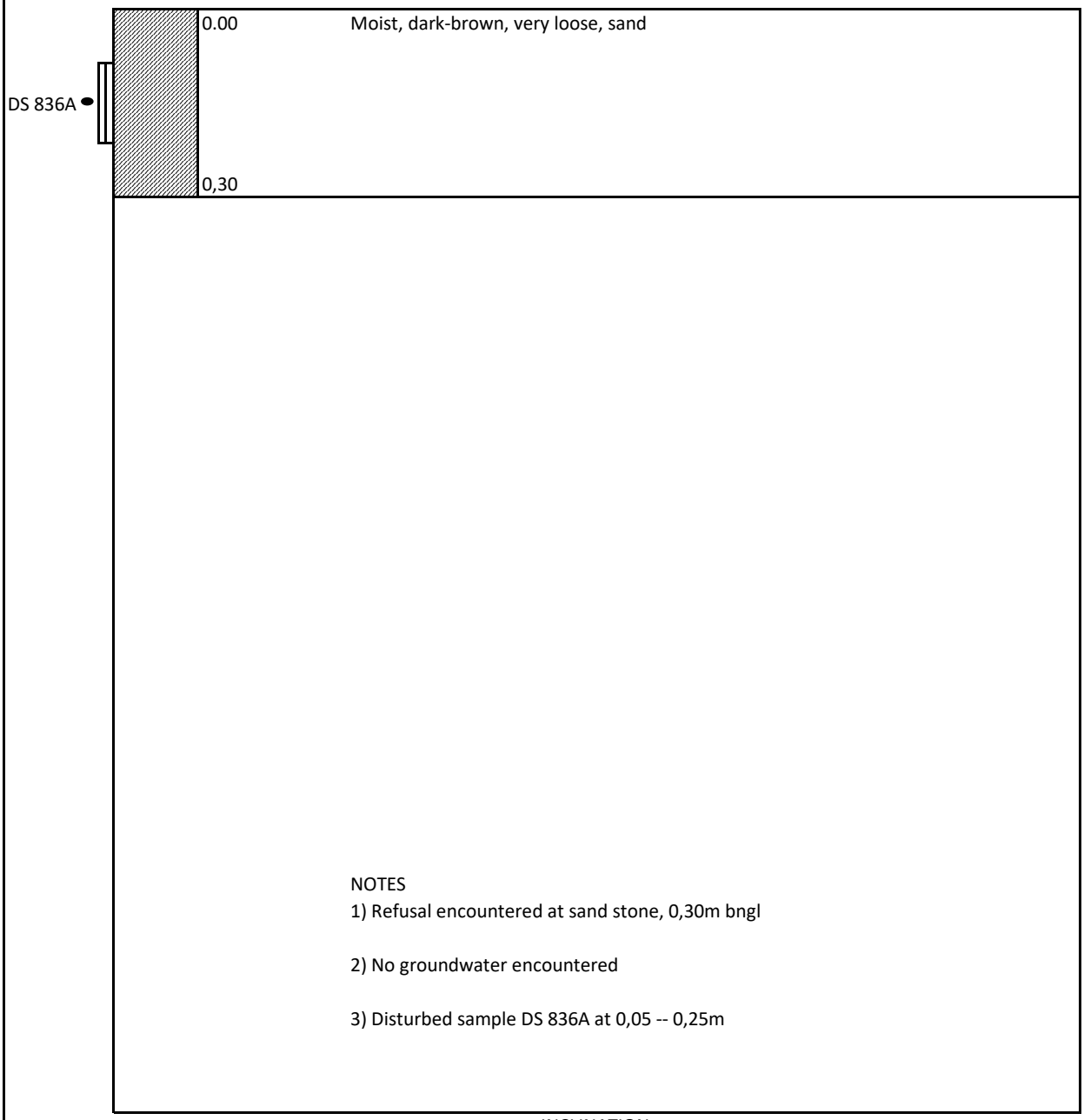
HOLE No. TP 835

GEOTECHNICAL ENGINEERING LABORATORY (PTY) LTD

BABEREKI CONSULTING ENGINEERS - LINDLEY WASTE WATER TREATMENT WORKS

HOLE No. TP 836
Sheet 1 of 1

JOB NUMBER:



NOTES
1) Refusal encountered at sand stone, 0,30m bngl

2) No groundwater encountered

3) Disturbed sample DS 836A at 0,05 -- 0,25m

CONTRACTOR:
MACHINE: TLB
DRILLED BY
PROFILED BY: LERATO

TYPE SET BY: T J MOKALOBA
SETUP FILE: STANDARD. SET

INCLINATION:
DIAM:
DATE: 01/02/2023
DATE: 01/02/2023
DATE:

ELEVATION:
X - COORD:
Y - COORD:

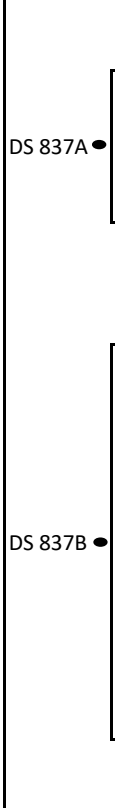
HOLE No. TP 836

GEOTECHNICAL ENGINEERING LABORATORY (PTY) LTD

BABEREKI CONSULTING ENGINEERS - LINDLEY WASTE WATER TREATMENT WORKS

HOLE No. TP 837
Sheet 1 of 1

JOB NUMBER:



0.00 Moist, dark-brown, stiff, sandy silt

0,40 Moist, yellow, dense, clayey sand

1,25

NOTES
1) Refusal encountered at sand stone, 1,25m bngl

2) No groundwater encountered

3) Disturbed sample DS 837A at 0,05 -- 0,35m

4) Disturbed sample DS 837B at 0,50 -- 1,20m

CONTRACTOR:
MACHINE: TLB
DRILLED BY
PROFILED BY: LERATO

TYPE SET BY: T J MOKALOBA
SETUP FILE: STANDARD. SET

INCLINATION:
DIAM:
DATE: 01/02/2023
DATE: 01/02/2023

DATE:

ELEVATION:
X - COORD:
Y - COORD:

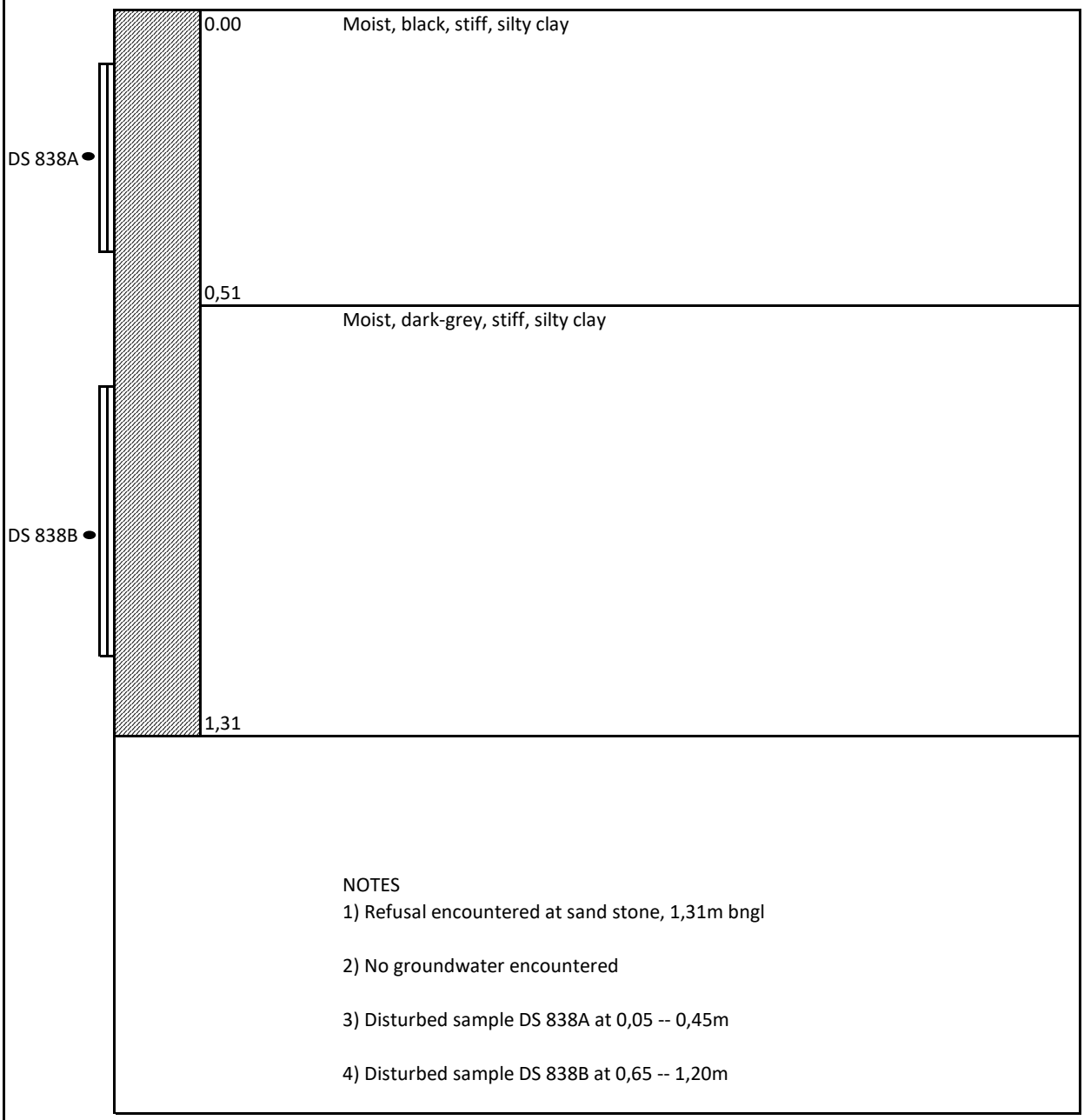
HOLE No. TP 837

GEOTECHNICAL ENGINEERING LABORATORY (PTY) LTD

BABEREKI CONSULTING ENGINEERS - LINDLEY WASTE WATER TREATMENT WORKS

HOLE No. TP 838
Sheet 1 of 1

JOB NUMBER:



NOTES

1) Refusal encountered at sand stone, 1,31m bngl

2) No groundwater encountered

3) Disturbed sample DS 838A at 0,05 -- 0,45m

4) Disturbed sample DS 838B at 0,65 -- 1,20m

CONTRACTOR:
MACHINE: TLB
DRILLED BY
PROFILED BY: LERATO

TYPE SET BY: T J MOKALOBA
SETUP FILE: STANDARD. SET

INCLINATION:
DIAM:
DATE: 01/02/2023
DATE: 01/02/2023

DATE:

ELEVATION:
X - COORD:
Y - COORD:

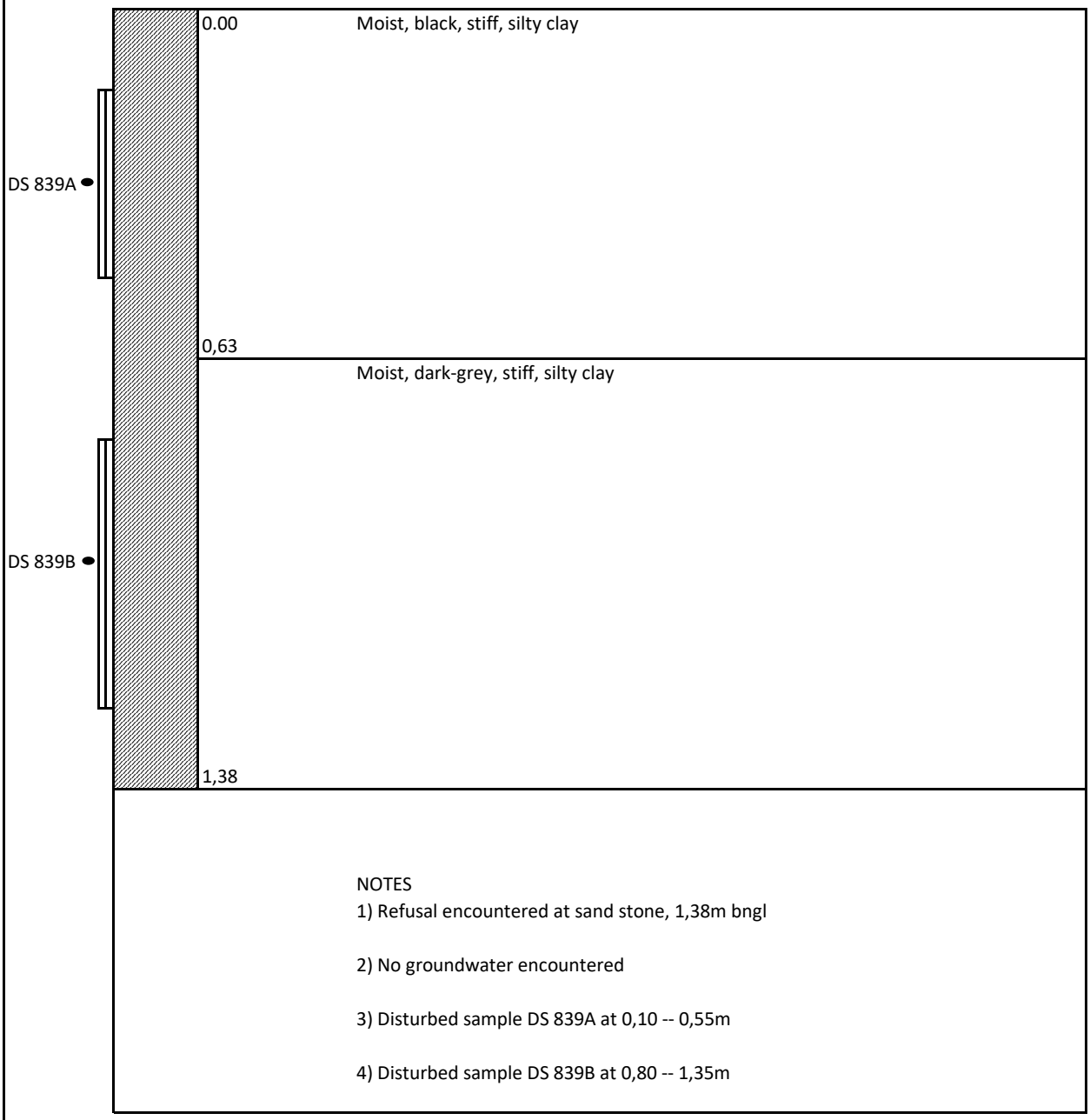
HOLE No. TP 838

GEOTECHNICAL ENGINEERING LABORATORY (PTY) LTD

BABEREKI CONSULTING ENGINEERS - LINDLEY WASTE WATER TREATMENT WORKS

HOLE No. TP 839
Sheet 1 of 1

JOB NUMBER:



NOTES

1) Refusal encountered at sand stone, 1,38m bngl

2) No groundwater encountered

3) Disturbed sample DS 839A at 0,10 -- 0,55m

4) Disturbed sample DS 839B at 0,80 -- 1,35m

CONTRACTOR:
MACHINE: TLB
DRILLED BY
PROFILED BY: LERATO

TYPE SET BY: T J MOKALOBA
SETUP FILE: STANDARD. SET

INCLINATION:
DIAM:
DATE: 01/02/2023
DATE: 01/02/2023

DATE:

ELEVATION:
X - COORD:
Y - COORD:

HOLE No. TP 839

PROFILE PHOTO FOR BABEREKI CONSULTING ENGINEERS IN LINDLEY

TP 823

27°52'32.57" S

27°54'10.42" E

TP 824

27°52'37.13" S

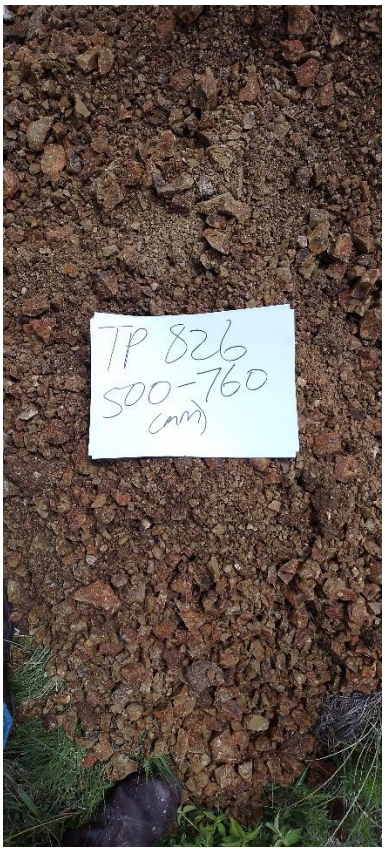
27°53'53.98" E

TP 825

27°52'32.51" S

27°53'42.56" E

TP 826



27°52'24.41° S

27°53'28.73" E

TP 827

27°52'24.31" S

27°53'16.60" E

TP 828

27°52'24.51" S

27°53'6.64" E

TP 829

27°52'18.42" S

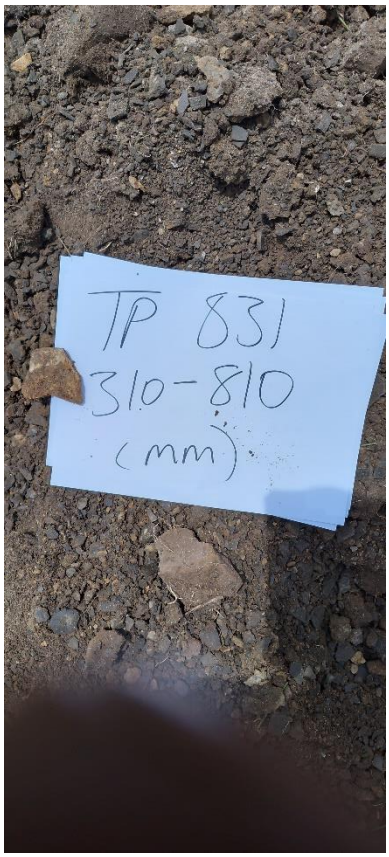
27°53'13.68" E

TP 830

27°52'15.24" S

27°53'6.76" E

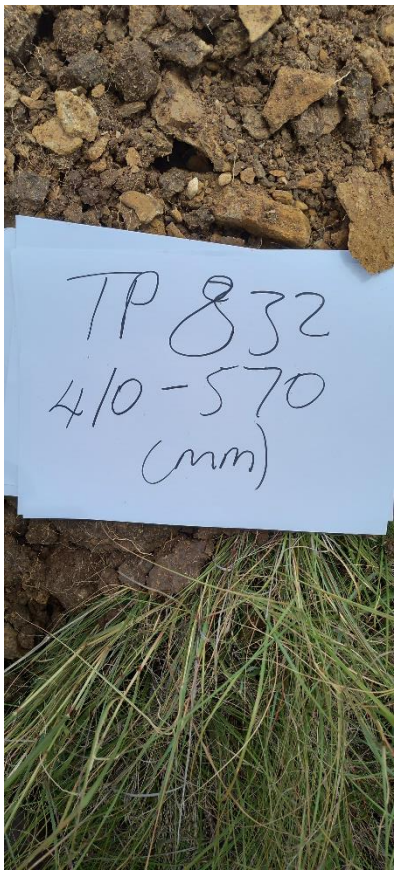
TP 831



27°52'16.12" S

27°53'19.16" E

TP 832



27°52'18.13" S

27°53'26.59" E

TP 833

27°52'9.35" S

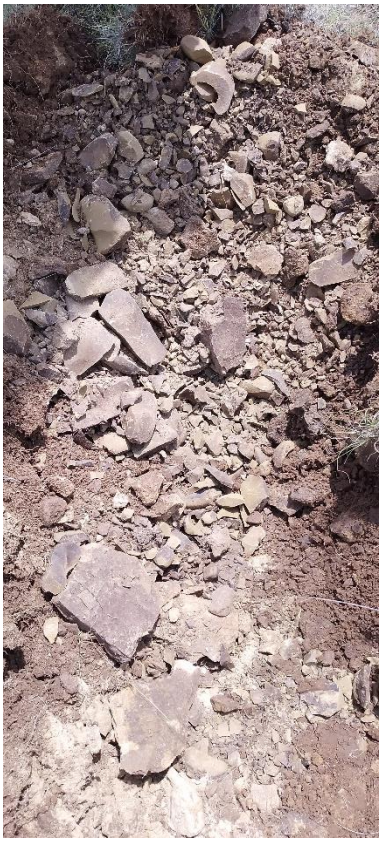
27°53'26.79" E

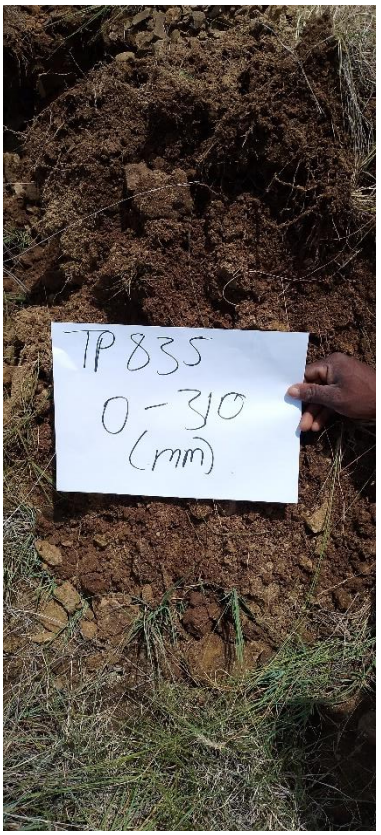
TP 834

27°5'23.05" S

27°53'13.67" E

TP 835





27°52'7.75" S

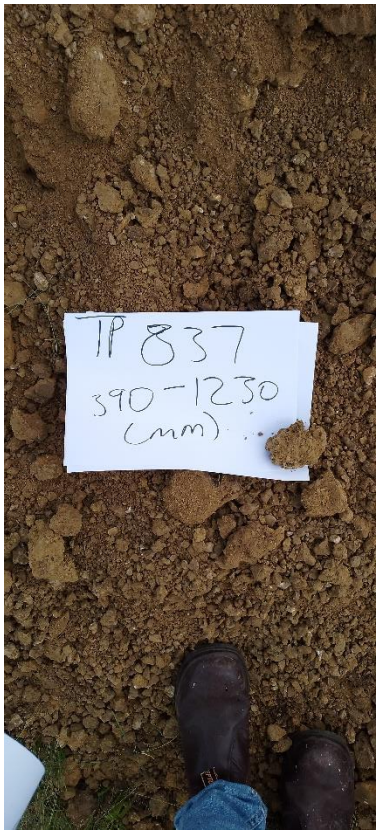
27°53'9.78" E

TP 836

27°52'10.07" S

27°53'18.36" E

TP 837



27°52'43.74" S

27°53'49.20" E

TP 838

27°52'55.65" S

27°53'51.34" E

TP 839

27°53'4.68" S

27°53'55.33" E

OTHER PHOTOS FROM THE SITE, FROM THE ENTRENCE OF THE SITE TO WHERE A PLANT WILL BE STUATED

GEOTECHNICAL ENGINEERING LABORATORY (PTY) LTD

Head Office (Maseru):
Off Kofi Annan Road, Ha Tsolo
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Bloemfontein Office:
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Bayswater
Bloemfontein, 9301

Cell: +27 60 341 0052

E-mail: tsoeujm@hotmail.com

FORM M2.1 - REPORTING FORM FOR SOILS AND GRAVELS **REV 4**

Project Description

Project: Lindley Waste Water Treatment Works **Client:** Babereki Consulting Engineers **Date Reported:** 20/02/2023

Date of Sampling 01/02/2023 **Date Checked:** 20/02/2023 **Reported by:** LERATO

Report #: **Checked by:** R. MAKATENG

Sample Description						
ERF		-	-	-	-	-
Sample No.:		S23 - 030	S23 - 031	S23 - 032	S23 - 033	S23 - 034
Location of Sampling		TP 823	TP 823	TP 824	TP 824	TP 825
Depth in mm		0-500	500-900	0-350	350-600	0-500
Weather Conditions		SUNNY	SUNNY	SUNNY	SUNNY	SUNNY
Material Description		dark brown silty clay	yellowish brown silty-clayey sand	light brown sand	light brown silty-clayey sand	light brown clayey sand
Screen Analysis (% Passing) - SANS 3001 : GR 1						
75,0 mm					100	
63,0 mm					86,6	
50,0 mm					86,6	
37,5 mm			100,0		79,9	
28,0 mm			98,9		75,0	
20,0 mm			98,7		67,1	
14,0 mm		100,0	97,5	100,0	61,4	100
5,00 mm		99,9	80,4	99,4	56,4	100
2,00 mm		98,6	51,3	98,4	48,0	100
0,425 mm		93,3	34,6	89,2	44,4	99
0,075 mm		56,6	28,7	4,4	25,5	48
Soil Mortar Percentages - SANS 3001 : PR 5						
Coarse Sand	2.00-0.450mm	5,4	32,6	9,4	7,6	1,0
Coarse Fine Sand	0.450-0.250mm	14,2	1,7	47,1	4,7	6,7
Medium Fine Sand	0.250-0.150mm	14,8	6,6	24,6	17,8	28,0
Fine Fine Sand	0.150-0.075mm	8,2	3,1	14,5	16,8	15,7
Silt & Clay	<0.075mm	57,4	55,9	4,5	53,0	48,5
Atterberg Constants						
Grading modulus	SANS 3001 : PR 5	0,5	1,9	1,1	1,8	0,5
Liquid limit, %	SANS 3001 : GR 10	49,0	31	32	28	29
Plastic Limit, %		35,0	24	27	23	30
Plasticity Index, %		14	7	5	5	9
Linear Shrinkage,%		12	8	6,7	6,7	8,7
AASHTO Class		**A-7-6**	**A-2-4**	**A-2-4**	**A-2-4**	**A-4**
MOD AASHTO - SANS 3001 : GR 30						
MDD (kg/m³)			2049			
OMC (%)			9			
CBR - SANS 3001 : GR 40						
Mod. AASHTO						
Moulding Moisture Content (%)			8,8			
Dry density (kg/m³)			2049			
% of Max Dry Density			100			
100% MOD CBR			16,7			
% swell			3,57			
NRB						
Dry density (kg/m³)			1890			
% of Max Dry Density			92			
95% MOD CBR			11,4			
% swell			3,27			
Proctor						
Dry density (kg/m³)			1849			
% of Max Dry Density			90			
90% MOD CBR			10,8			
% swell			1,94			
CBR						
100% Mod AASHTO			16,2			
98% Mod AASHTO			15,1			
97% Mod AASHTO			14,6			
95% Mod AASHTO			13,5			
93% Mod AASHTO			12,4			
90% Mod AASHTO			10,8			
COLTO Classification			**UNCLASSIFIED**			

<--------END OF REPORT-------->

GEOTECHNICAL ENGINEERING LABORATORY (PTY) LTD

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Maseru-West 0105, Lesotho

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Cell: +266 62855899

Bloemfontein Office:
40 Normandie Road
Bayswater
Bloemfontein, 9301

Cell: +27 60 341 0052

E-mail: tsoeujm@hotmail.com

FORM M2.1 - REPORTING FORM FOR SOILS AND GRAVELS REV 4

Project Description

Project: Lindley Waste Water Treatment Works **Client:** Babereki Consulting Engineers **Date Reported:** 20/02/2023

Date of Sampling 01/02/2023 **Date Checked:** 20/02/2023 **Reported by:** LERATO

Report #: **Checked by:** R. MAKATENG

Sample Description						
ERF		-	-	-	-	-
Sample No.:		S23 - 035	S23 - 036	S23 - 037	S23 - 038	S23 - 039
Location of Sampling		TP 825	TP 826	TP 826	TP 827	TP 827
Depth in mm		500-730	0-500	500-760	0-510	510-790
Weather Conditions		SUNNY	SUNNY	SUNNY	SUNNY	SUNNY
Material Description		yellow silty sand	dark brown clayey sand	yellow speckled brown silty-clayey sand	dark brown silty sand	light brown speckled yellow clayey sand
Screen Analysis (% Passing) - SANS 3001 : GR 1						
75,0 mm						
63,0 mm						100,0
50,0 mm				100,0		92,3
37,5 mm				96,0		89,5
28,0 mm				92,9		84,2
20,0 mm		100,0	100,0	84,2	100,0	77,1
14,0 mm		97,9	98,5	83,8	99,0	69,9
5,00 mm		94,7	96,5	80,1	89,7	52,8
2,00 mm		88,4	92,2	48,7	78,1	43,3
0,425 mm		64,5	82,1	21,6	70,9	27,8
0,075 mm		30,2	32,5	12,1	33,2	20,0
Soil Mortar Percentages - SANS 3001 : PR 5						
Coarse Sand	2.00-0.450mm	27,1	11,0	55,5	9,3	35,8
Coarse Fine Sand	0.450-0.250mm	12,6	18,7	6,5	10,9	4,9
Medium Fine Sand	0.250-0.150mm	17,9	28,6	9,3	25,8	8,5
Fine Fine Sand	0.150-0.075mm	8,2	6,5	3,7	11,6	4,6
Silt & Clay	<0.075mm	34,2	35,3	24,9	42,5	46,2
Atterberg Constants						
Grading modulus	SANS 3001 : PR 5	1,2	0,9	2,2	1,2	2,1
Liquid limit, %	SANS 3001 : GR 10	30,0	35	40	22	27
Plastic Limit, %		27,0	28	35	18	20
Plasticity Index, %		3	6,9	5	4	7
Linear Shrinkage,%		2,7	6,7	10	3,3	6
AASHTO Class		**A-2-4**	**A-2-4**	**A-1-a**	**A-2-4**	**A-1-a**
MOD AASHTO - SANS 3001 : GR 30						
MDD (kg/m³)				1874		
OMC (%)				11,5		
CBR - SANS 3001 : GR 40						
Mod. AASHTO						
Moulding Moisture Content (%)				11,2		
Dry density (kg/m³)				1870		
% of Max Dry Density				100		
100% MOD CBR				29,3		
% swell				0,12		
NRB						
Dry density (kg/m³)				1724		
% of Max Dry Density				92		
95% MOD CBR				25,2		
% swell				0,95		
Proctor						
Dry density (kg/m³)				1687		
% of Max Dry Density				90		
90% MOD CBR				19,8		
% swell				2,9		
CBR						
100% Mod AASHTO				32,2		
98% Mod AASHTO				29,7		
97% Mod AASHTO				28,5		
95% Mod AASHTO				26,0		
93% Mod AASHTO				23,5		
90% Mod AASHTO				19,8		
COLTO Classification				**G6**		

<--------END OF REPORT-------->

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FORM M2.1 - REPORTING FORM FOR SOILS AND GRAVELS REV 4

Project Description

Project: Lindley Waste Water Treatment Works **Client:** Babereki Consulting Engineers **Date Reported:** 20/02/2023

Date of Sampling 01/02/2023 **Date Checked:** 20/02/2023 **Reported by:** LERATO

Report #: **Checked by:** R. MAKATENG

Sample Description						
ERF		-	-	-	-	-
Sample No.:		S23 - 040	S23 - 041	S23 - 042	S23 - 043	S23 - 044
Location of Sampling		TP 828	TP 828	TP 829	TP 829	TP 830
Depth in mm		0-230	230-400	0-250	250-840	0-320
Weather Conditions		SUNNY	SUNNY	SUNNY	SUNNY	SUNNY
Material Description		dark brown sand	yellow speckled orange sand	light brown silty sand	light brown speckled yellow clay	light brown silty sand
Screen Analysis (% Passing) - SANS 3001 : GR 1						
75,0 mm						
63,0 mm						
50,0 mm				100,0		
37,5 mm				96,5		100
28,0 mm				92,7		97,6
20,0 mm		100,0		90,6		91
14,0 mm		95,2	100,0	82,5	100,0	88
5,00 mm		85,5	99,4	68,3	99,3	68
2,00 mm		80,3	98,9	62,1	98,0	69
0,425 mm		37,3	94,8	56,2	95,3	61
0,075 mm		12,8	28,8	19,4	72,1	19
Soil Mortar Percentages - SANS 3001 : PR 5						
Coarse Sand	2.00-0.450mm	53,6	4,2	9,4	2,8	5,6
Coarse Fine Sand	0.450-0.250mm	7,8	35,3	15,2	6,4	10,5
Medium Fine Sand	0.250-0.150mm	11,4	23,4	22,2	13,4	25,6
Fine Fine Sand	0.150-0.075mm	11,2	8,1	21,9	3,8	22,9
Silt & Clay	<0.075mm	16,0	29,1	31,3	73,6	35,4
Atterberg Constants						
Grading modulus	SANS 3001 : PR 5	1,7	0,8	1,6	0,3	1,5
Liquid limit, %	SANS 3001 : GR 10				43	
Plastic Limit, %					24	
Plasticity Index, %		NP	NP	NP	19	NP
Linear Shrinkage,%					7,3	
AASHTO Class		**A-1-b**	**A-2-4**	**A-2-4**	**A-7-6**	**A-2-4**
MOD AASHTO - SANS 3001 : GR 30						
MDD (kg/m³)			1889		1634	
OMC (%)			11,8		20,6	
CBR - SANS 3001 : GR 40						
Mod. AASHTO						
Moulding Moisture Content (%)			11,1		20,6	
Dry density (kg/m³)			1882		1628	
% of Max Dry Density			100		100	
100% MOD CBR			68,3		17,1	
% swell			0		2,91	
NRB						
Dry density (kg/m³)			1794		1520	
% of Max Dry Density			95		93	
95% MOD CBR			34		13,5	
% swell			0,4		2,61	
Proctor						
Dry density (kg/m³)			1701		1471	
% of Max Dry Density			90		90	
90% MOD CBR			22,1		12,3	
% swell			0,4		3	
CBR						
100% Mod AASHTO			60,8		16,9	
98% Mod AASHTO			53,1		16,0	
97% Mod AASHTO			49,2		15,5	
95% Mod AASHTO			41,5		14,6	
93% Mod AASHTO			33,7		13,7	
90% Mod AASHTO			22,1		12,3	
COLTO Classification			**G7**		**UNCLASSIFIED**	

<--------END OF REPORT-------->

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FORM M2.1 - REPORTING FORM FOR SOILS AND GRAVELS REV 4

Project Description

Project: Lindley Waste Water Treatment Works **Client:** Babereki Consulting Engineers **Date Reported:** 20/02/2023

Date of Sampling 01/02/2023 **Date Checked:** 20/02/2023 **Reported by:** LERATO

Report #: **Checked by:** R. MAKATENG

Sample Description						
ERF		-	-	-	-	-
Sample No.:		S23 - 045	S23 - 046	S23 - 047	S23 - 048	S23 - 049
Location of Sampling		TP 830	TP 831	TP 831	TP 832	TP 832
Depth in mm		320-840	0-310	310-810	0-410	410-570
Weather Conditions		SUNNY	SUNNY	SUNNY	SUNNY	SUNNY
Material Description		light brown speckled yellow clay	dark brown clayey sand	dark brown silty sand	dark brown silty sand	dark brown clayey silt
Screen Analysis (% Passing) - SANS 3001 : GR 1						
75,0 mm						
63,0 mm						
50,0 mm			100			
37,5 mm			97,7			
28,0 mm			96,5			
20,0 mm			96,5	100,0	100,0	
14,0 mm		100,0	91,5	91,8	95,4	100
5,00 mm		99,3	85,4	82,0	87,7	97
2,00 mm		97,1	78,9	75,4	78,9	93
0,425 mm		96,5	73,2	69,7	73,4	82
0,075 mm		69,7	33,3	49,0	45,5	54
Soil Mortar Percentages - SANS 3001 : PR 5						
Coarse Sand	2.00-0.450mm	3,9	7,2	7,6	6,2	15,4
Coarse Fine Sand	0.450-0.250mm	7,6	8,8	5,8	10,6	2,1
Medium Fine Sand	0.250-0.150mm	14,3	25,5	17,1	14,8	11,3
Fine Fine Sand	0.150-0.075mm	5,5	16,3	4,5	7,7	10,6
Silt & Clay	<0.075mm	68,7	42,2	64,9	60,7	60,6
Atterberg Constants						
Grading modulus	SANS 3001 : PR 5	0,4	1,1	1,1	1	0,7
Liquid limit, %	SANS 3001 : GR 10	42,0	18	29	31	23
Plastic Limit, %		23,0	16	24	26	19
Plasticity Index, %		19	3	5	5	4
Linear Shrinkage,%		8	1,3	4,7	4,2	2,7
AASHTO Class		**A-7-6**	**A-2-4**	**A-4**	**A-4**	**A-4**
MOD AASHTO - SANS 3001 : GR 30						
MDD (kg/m³)				1806		
OMC (%)				9		
CBR - SANS 3001 : GR 40						
Mod. AASHTO						
Moulding Moisture Content (%)				9,2		
Dry density (kg/m³)				1806		
% of Max Dry Density				100		
100% MOD CBR				20,3		
% swell				1,5		
NRB						
Dry density (kg/m³)				1680		
% of Max Dry Density				93		
95% MOD CBR				19,4		
% swell				1,6		
Proctor						
Dry density (kg/m³)				1625		
% of Max Dry Density				90		
90% MOD CBR				18,9		
% swell				1,9		
CBR						
100% Mod AASHTO				20,4		
98% Mod AASHTO				20,1		
97% Mod AASHTO				19,9		
95% Mod AASHTO				19,6		
93% Mod AASHTO				19,3		
90% Mod AASHTO				18,9		
COLTO Classification				**G7**		

<--------END OF REPORT-------->

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FORM M2.1 - REPORTING FORM FOR SOILS AND GRAVELS **REV 4**

Project Description

Project: Lindley Waste Water Treatment Works **Client:** Babereki Consulting Engineers **Date Reported:** 20/02/2023

Date of Sampling 01/02/2023 **Date Checked:** 20/02/2023 **Reported by:** LERATO

Report #: **Checked by:** R. MAKATENG

Sample Description						
ERF		-	-	-	-	-
Sample No.:		S23 - 050	S23 - 051	S23 - 052	S23 - 053	S23 - 054
Location of Sampling		TP 833	TP 834	TP 835	TP 836	TP 837
Depth in mm		0-420	0-330	0-300	0-300	0-400
Weather Conditions		SUNNY	SUNNY	SUNNY	SUNNY	SUNNY
Material Description		light brown sand	light brown sand	dark brown sandy clay	dark brown sand	dark brown sandy silt
Screen Analysis (% Passing) - SANS 3001 : GR 1						
75,0 mm						
63,0 mm						
50,0 mm						
37,5 mm					100,0	
28,0 mm					95,7	
20,0 mm		100,0	100,0	100,0	92,3	100
14,0 mm		96,7	94,6	95,7	88,6	97
5,00 mm		90,7	88,5	94,3	70,5	68
2,00 mm		84,7	85,4	88,6	67,5	62
0,425 mm		40,6	70,7	74,3	65,7	60
0,075 mm		20,5	35,0	66,5	40,5	17
Soil Mortar Percentages - SANS 3001 : PR 5						
Coarse Sand	2.00-0.450mm	48,7	9,6	13,0	7,1	4,0
Coarse Fine Sand	0.450-0.250mm	8,7	8,9	10,0	11,2	16,3
Medium Fine Sand	0.250-0.150mm	13,3	23,5	13,0	23,5	33,8
Fine Fine Sand	0.150-0.075mm	10,9	27,3	12,0	21,7	18,4
Silt & Clay	<0.075mm	18,4	30,7	52,0	36,5	27,5
Atterberg Constants						
Grading modulus	SANS 3001 : PR 5	1,5	1,1	0,7	1,3	1,6
Liquid limit, %	SANS 3001 : GR 10			35		18
Plastic Limit, %				24		16
Plasticity Index, %		NP	NP	11	NP	2
Linear Shrinkage,%				5,4		3,3
AASHTO Class		**A-1-b**	**A-2-4**	**A-6**	**A-4**	**A-2-4**
MOD AASHTO - SANS 3001 : GR 30						
MDD (kg/m³)						
OMC (%)						
CBR - SANS 3001 : GR 40						
Mod. AASHTO						
Moulding Moisture Content (%)						
Dry density (kg/m³)						
% of Max Dry Density						
100% MOD CBR						
% swell						
NRB						
Dry density (kg/m³)						
% of Max Dry Density						
95% MOD CBR						
% swell						
Proctor						
Dry density (kg/m³)						
% of Max Dry Density						
90% MOD CBR						
% swell						
CBR						
100% Mod AASHTO						
98% Mod AASHTO						
97% Mod AASHTO						
95% Mod AASHTO						
93% Mod AASHTO						
90% Mod AASHTO						
COLTO Classification						

<--------END OF REPORT-------->

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FORM M2.1 - REPORTING FORM FOR SOILS AND GRAVELS REV 4

Project Description

Project: Lindley Waste Water Treatment Works **Client:** Babereki Consulting Engineers **Date Reported:** 20/02/2023

Date of Sampling 01/02/2023 **Date Checked:** 20/02/2023 **Reported by:** LERATO

Report #: **Checked by:** R. MAKATENG

Sample Description						
ERF		-	-	-	-	-
Sample No.:		S23 - 055	S23 - 056	S23 - 057	S23 - 058	S23 - 059
Location of Sampling		TP 837	TP 838	TP 838	TP 839	TP 839
Depth in mm		400-1250	0-510	510-1310	0-630	630-1780
Weather Conditions		SUNNY	SUNNY	SUNNY	SUNNY	SUNNY
Material Description		yellow clayey sand	black silty clay	dark grey silty clay	black silty clay	dark grey silty clay
Screen Analysis (% Passing) - SANS 3001 : GR 1						
75,0 mm						
63,0 mm						
50,0 mm					100,0	
37,5 mm					96,6	
28,0 mm					94,8	
20,0 mm		100,0			93,6	
14,0 mm		98,9	100,0	100,0	92,2	100
5,00 mm		94,2	99,9	97,4	90,4	100
2,00 mm		90,5	99,5	95,6	89,5	95
0,425 mm		86,5	96,8	92,0	89,0	90
0,075 mm		44,4	61,1	58,1	69,7	60
Soil Mortar Percentages - SANS 3001 : PR 5						
Coarse Sand	2.00-0.450mm	4,5	2,7	3,8	0,6	5,7
Coarse Fine Sand	0.450-0.250mm	15,3	4,9	4,8	12,3	7,8
Medium Fine Sand	0.250-0.150mm	18,4	23,4	23,2	29,1	19,9
Fine Fine Sand	0.150-0.075mm	12,7	7,6	7,5	10,4	10,4
Silt & Clay	<0.075mm	49,1	61,5	60,7	47,5	56,2
Atterberg Constants						
Grading modulus	SANS 3001 : PR 5	0,8	0,4	0,5	0,5	0,6
Liquid limit, %	SANS 3001 : GR 10	37,0	44	42	46	41
Plastic Limit, %		30,0	32	30	29	30
Plasticity Index, %		7	12	12	17	11
Linear Shrinkage,%		6,7	6,7	7,5	10,4	7,3
AASHTO Class		**A-4**	**A-7-5**	**A-7-5**	**A-7-6**	**A-7-5**
MOD AASHTO - SANS 3001 : GR 30						
MDD (kg/m³)		1754		1728		
OMC (%)		14,8		10,2		
CBR - SANS 3001 : GR 40						
Mod. AASHTO						
Moulding Moisture Content (%)		14,7		9,9		
Dry density (kg/m³)		1746		1726		
% of Max Dry Density		100		100		
100% MOD CBR		14,8		12,4		
% swell		4,17		6,7		
NRB						
Dry density (kg/m³)		1631		1624		
% of Max Dry Density		93		94		
95% MOD CBR		14,4		11,6		
% swell		3,19		6,1		
Proctor						
Dry density (kg/m³)		1586		1555		
% of Max Dry Density		90		90		
90% MOD CBR		12,5		10,5		
% swell		1,45		2,4		
CBR						
100% Mod AASHTO		15,7		12,6		
98% Mod AASHTO		15,1		12,2		
97% Mod AASHTO		14,8		12,0		
95% Mod AASHTO		14,1		11,6		
93% Mod AASHTO		13,5		11,1		
90% Mod AASHTO		12,5		10,5		
COLTO Classification		**UNCLASSIFIED**		**UNCLASSIFIED**		

<--------END OF REPORT-------->

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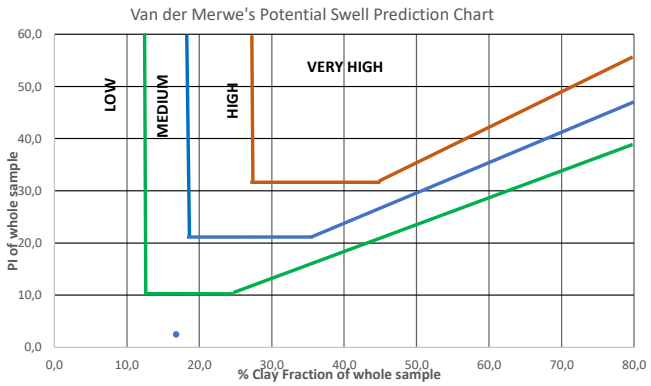
PARTICLE SIZE ANALYSIS

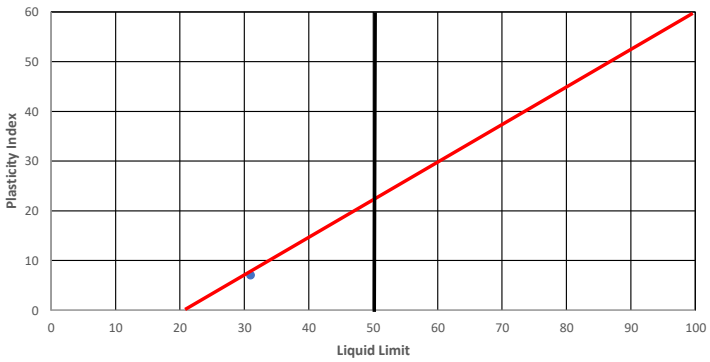
Date of Sampling:	2023/02/01
GEL Sample No.:	S23 - 031
Depth (m):	500-900
Position:	TP 823
Material Descrption:	yellowish brown silty-clayey sand
Relative Density on <2mm **(SANS 5844)**	2,43
Organic Material:	-
Moisture (%) Dispersion (%):	-
SCREEN ANALYSIS (% PASSING) **(SANS 3001: GR1)**	
63 mm	100
50 mm	100
37,5 mm	100
28 mm	99
20 mm	99
14 mm	98
5 mm	80
2 mm	51
0,425 mm	34,6
0,075 mm	28,7
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001: GR3)**	
0,061 mm	25,6
0,036 mm	24,5
0,015 mm	23,5
0,007 mm	20,1
0,002 mm	16,8
SOIL MORTAR PERCENTAGES(%) **(SANS 3001: PR5)**	
Coarse Sand	2,00-0,425mm	32,6
Coarse Fine Sand	0,425-0,250mm	1,7
Medium Fine Sand	0,250mm-0,150mm	6,6
Fine Fine Sand	0,150-0,075mm	3,1
Silt & Clay	<0,075mm	55,9
ATTERBERG LIMITS **(SANS 3001: GR10)**	
Liquid Limit (%)	31
Plasticity Index (%)	7
Linear Shrinkage (%)	8
Grading Modulus	1,9
AASHTO Classification	A-2-4
Unified Classification	SM+SC
COLTO Classification	-

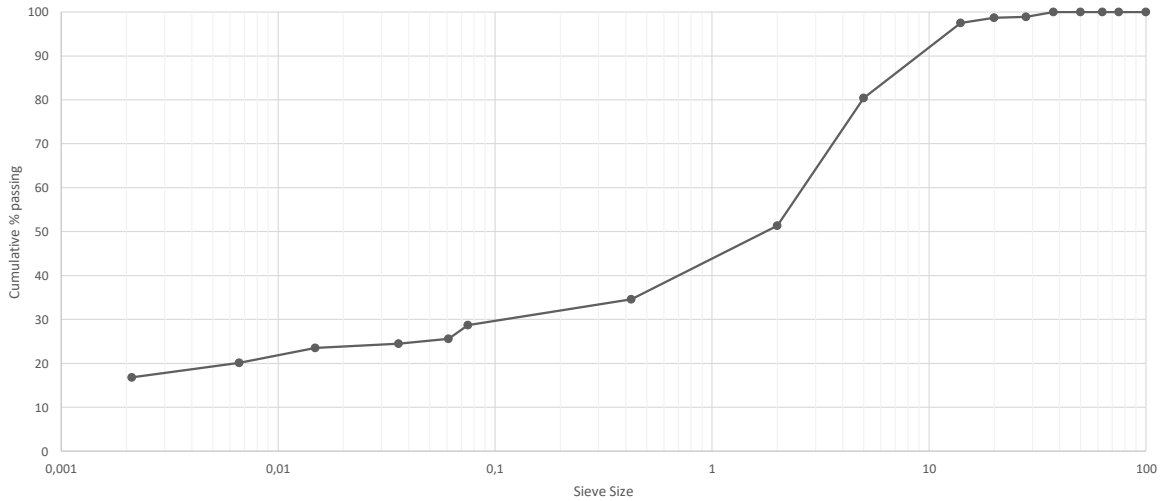
Client:	Babereki Consulting Engineers
Project:	Lindley Waste Water Treatment Works
Date:	2023/02/20

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





CLAY	SILT	SAND	GRAVEL

GEL (Pty) Ltd
STAMP

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PARTICLE SIZE ANALYSIS

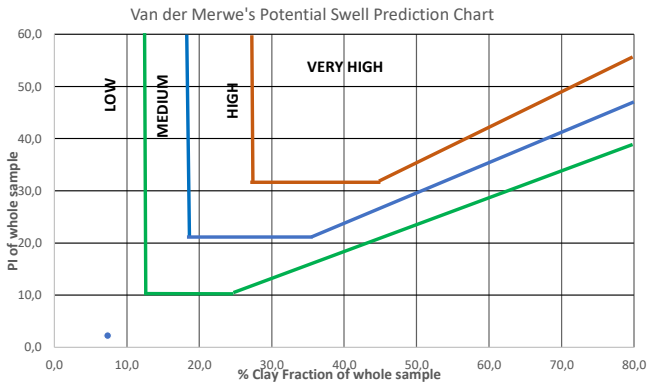
Date of Sampling:	2023/02/01
GEL Sample No.:	S23 - 033
Depth (m):	350-600
Position:	TP 824
Material Descrption:	light brown silty-clayey sand
Relative Density on <2mm **(SANS 5844)**	2,73
Organic Material:	-
Moisture (%) Dispersion (%):	-
SCREEN ANALYSIS (% PASSING) **(SANS 3001: GR1)**	
63 mm	87
50 mm	87
37,5 mm	80
28 mm	75
20 mm	67
14 mm	61
5 mm	56
2 mm	48
0,425 mm	44,4
0,075 mm	25,5
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001: GR3)**	
0,055 mm	17,4
0,033 mm	14,8
0,014 mm	12,2
0,006 mm	9,1
0,002 mm	7,4

SOIL MORTAR PERCENTAGES(%) **(SANS 3001: PR5)**		
Coarse Sand	2,00-0,425mm	7,6
Coarse Fine Sand	0,425-0,250mm	4,7
Medium Fine Sand	0,250mm-0,150mm	17,8
Fine Fine Sand	0,150-0,075mm	16,8
Silt & Clay	<0,075mm	53,0

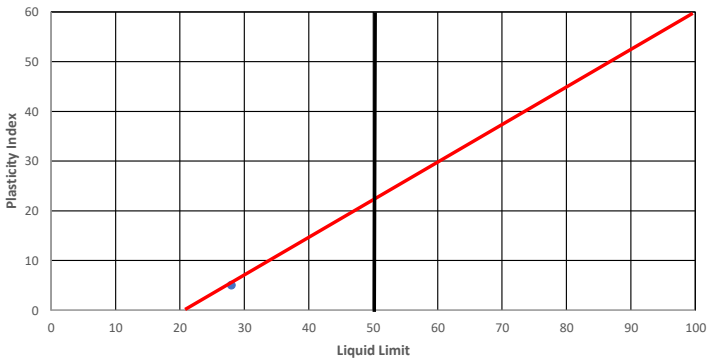
ATTERBERG LIMITS **(SANS 3001: GR10)**	
Liquid Limit (%)	28
Plasticity Index (%)	5
Linear Shrinkage (%)	6,7
Grading Modulus	1,8
AASHTO Classification	A-2-4
Unified Classification	SM+SC
COLTO Classification	-

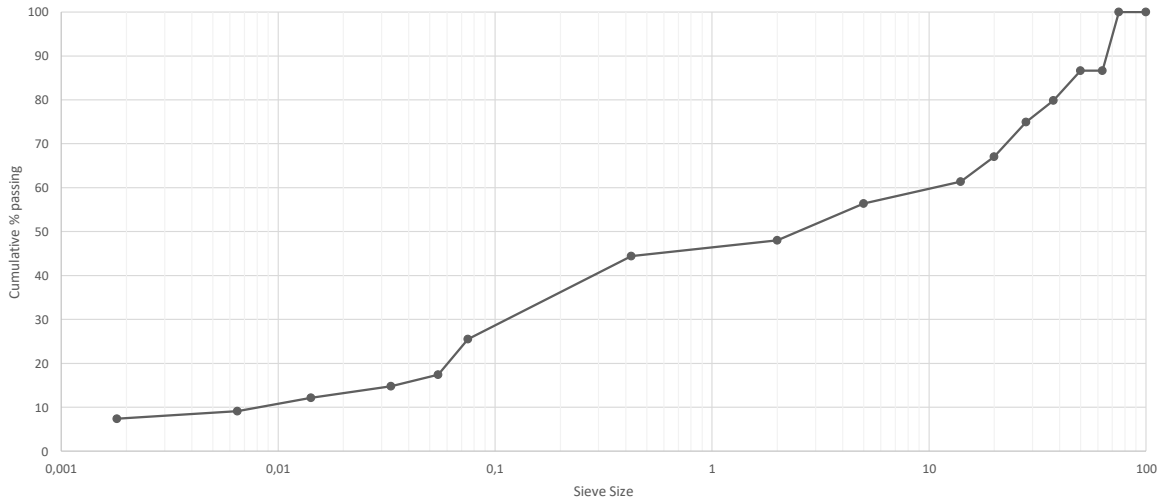
Client:	Babereki Consulting Engineers
Project:	Lindley Waste Water Treatment Works
Date:	2023/02/20

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





CLAY	SILT	SAND	GRAVEL

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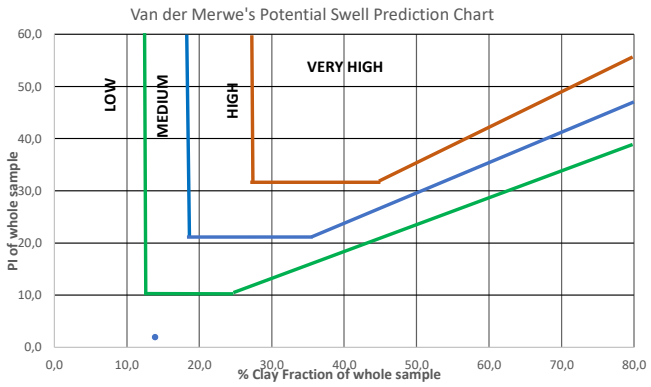
E - m a i l : t s o e u j m @ h o t m a i l . c o m

PARTICLE SIZE ANALYSIS

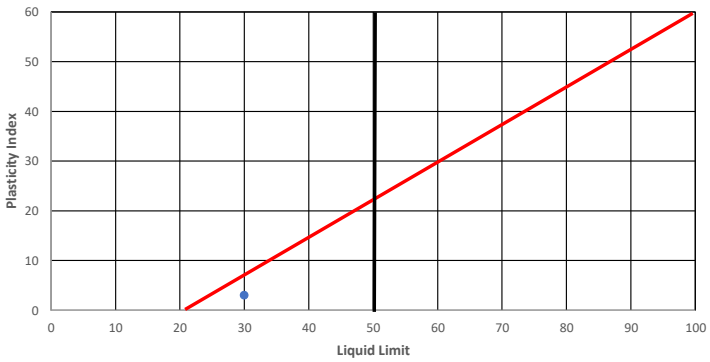
Date of Sampling:	2023/02/01
GEL Sample No.:	S22 - 034
Depth (m):	500-730
Position:	TP 825
Material Descrption:	yellow silty sand
Relative Density on <2mm **(SANS 5844)**	2,71
Organic Material:	-
Moisture (%) Dispersion (%):	-
SCREEN ANALYSIS (% PASSING) **(SANS 3001: GR1)**	
63 mm	100
50 mm	100
37,5 mm	100
28 mm	100
20 mm	100
14 mm	98
5 mm	95
2 mm	88
0,425 mm	64,5
0,075 mm	30,2
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001: GR3)**	
0,047 mm	24,7
0,028 mm	20,9
0,012 mm	18,3
0,005 mm	17,1
0,002 mm	13,9
SOIL MORTAR PERCENTAGES(%) **(SANS 3001: PR5)**	
Coarse Sand	2,00-0,425mm	27,1
Coarse Fine Sand	0,425-0,250mm	12,6
Medium Fine Sand	0,250mm-0,150mm	17,9
Fine Fine Sand	0,150-0,075mm	8,2
Silt & Clay	<0,075mm	34,2
ATTERBERG LIMITS **(SANS 3001: GR10)**	
Liquid Limit (%)	30
Plasticity Index (%)	3
Linear Shrinkage (%)	2,7
Grading Modulus	1,2
AASHTO Classification	A-2-4
Unified Classification	SM
COLTO Classification	-

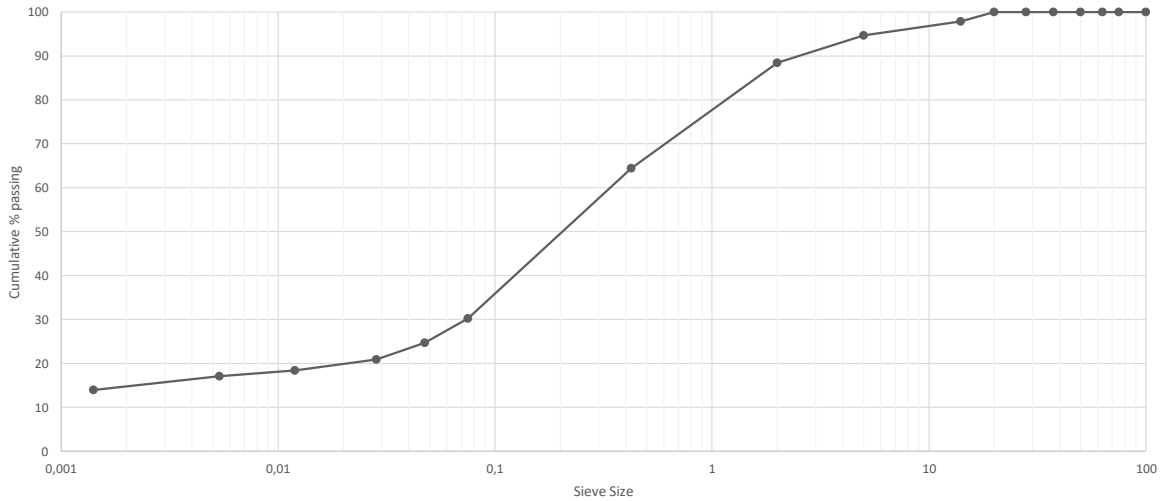
Client:	Babereki Consulting Engineers
Project:	Lindley Waste Water Treatment Works
Date:	2023/02/20

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





CLAY	SILT	SAND	GRAVEL

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PARTICLE SIZE ANALYSIS

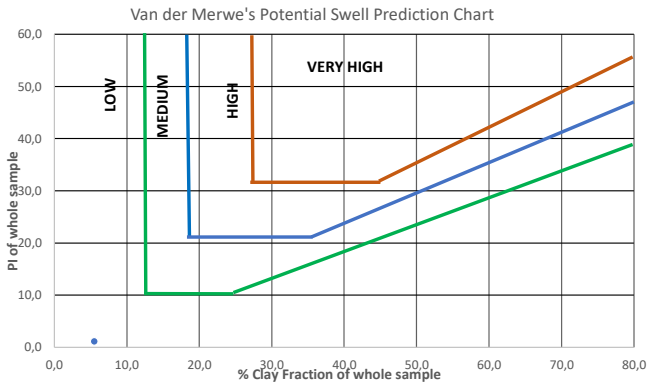
Date of Sampling:	2023/02/01
GEL Sample No.:	S23 - 037
Depth (m):	500-760
Position:	TP 826
Material Descrption:	yellow speckled brown silty clayey sand
Relative Density on <2mm **(SANS 5844)**	2,71
Organic Material:	-
Moisture (%) Dispersion (%):	-
SCREEN ANALYSIS (% PASSING) **(SANS 3001: GR1)**	
63 mm	100
50 mm	100
37,5 mm	96
28 mm	93
20 mm	84
14 mm	84
5 mm	80
2 mm	49
0,425 mm	21,6
0,075 mm	12,1
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001: GR3)**	
0,046 mm	10,0
0,028 mm	8,9
0,011 mm	8,1
0,005 mm	6,8
0.002 mm	5,5

SOIL MORTAR PERCENTAGES(%) **(SANS 3001: PR5)**		
Coarse Sand	2,00-0,425mm	55,5
Coarse Fine Sand	0,425-0,250mm	6,5
Medium Fine Sand	0,250mm-0,150mm	9,3
Fine Fine Sand	0,150-0,075mm	3,7
Silt & Clay	<0,075mm	24,9

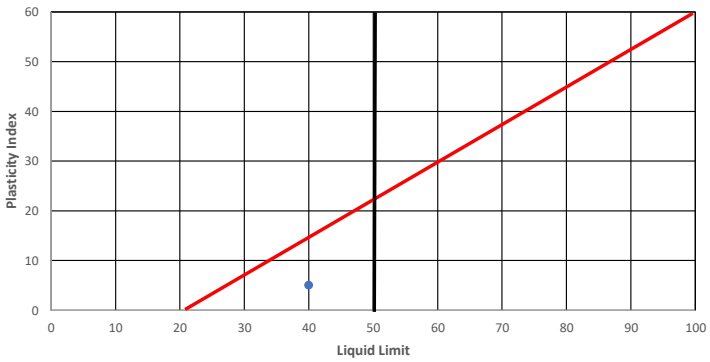
ATTERBERG LIMITS **(SANS 3001: GR10)**	
Liquid Limit (%)	40
Plasticity Index (%)	5
Linear Shrinkage (%)	10
Grading Modulus	2,2
AASHTO Classification	A-1-a
Unified Classification	SM+SC
COLTO Classification	-

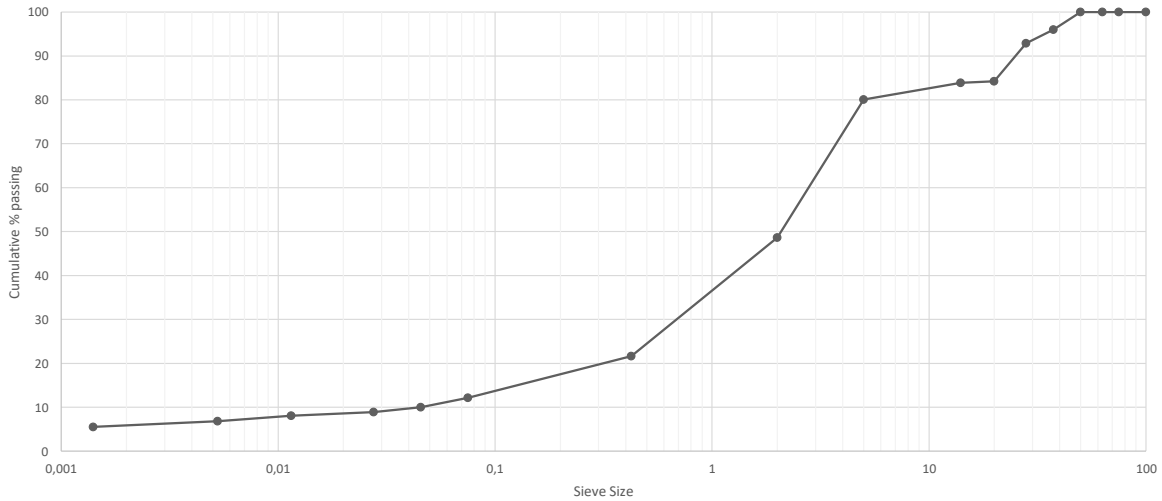
Client:	Babereki Consulting Engineers
Project:	Lindley Waste Water Treatment Works
Date:	2023/02/20

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





CLAY	SILT	SAND	GRAVEL

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PARTICLE SIZE ANALYSIS

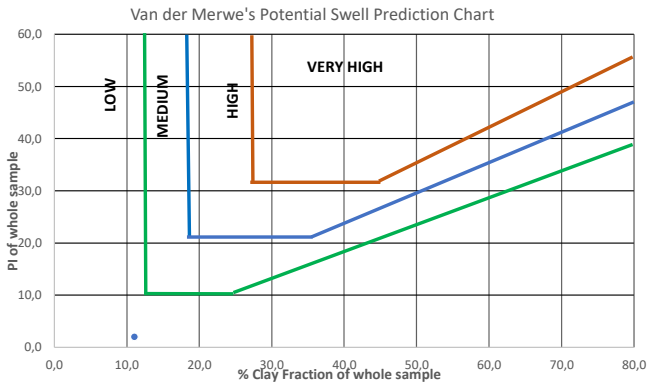
Date of Sampling:	2023/02/01
GEL Sample No.:	S23 - 039
Depth (m):	510-790
Position:	TP 827
Material Descrption:	light brown speckled yellow clayey sand
Relative Density on <2mm **(SANS 5844)**	2,54
Organic Material:	-
Moisture (%) Dispersion (%):	-
SCREEN ANALYSIS (% PASSING) **(SANS 3001: GR1)**	
63 mm	100
50 mm	92
37,5 mm	89
28 mm	84
20 mm	77
14 mm	70
5 mm	53
2 mm	43
0,425 mm	27,8
0,075 mm	20,0
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001: GR3)**	
0,044 mm	15,6
0,026 mm	15,1
0,011 mm	12,8
0,005 mm	11,9
0,002 mm	11,1

SOIL MORTAR PERCENTAGES(%) **(SANS 3001: PR5)**		
Coarse Sand	2,00-0,425mm	35,8
Coarse Fine Sand	0,425-0,250mm	4,9
Medium Fine Sand	0,250mm-0,150mm	8,5
Fine Fine Sand	0,150-0,075mm	4,6
Silt & Clay	<0,075mm	46,2

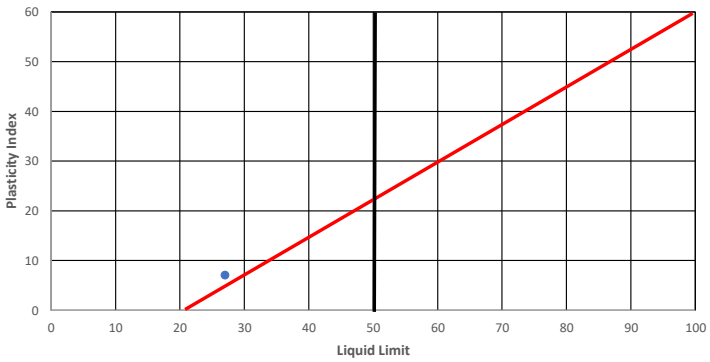
ATTERBERG LIMITS **(SANS 3001: GR10)**	
Liquid Limit (%)	27
Plasticity Index (%)	7
Linear Shrinkage (%)	6
Grading Modulus	2,1
AASHTO Classification	A-1-a
Unified Classification	SC
COLTO Classification	-

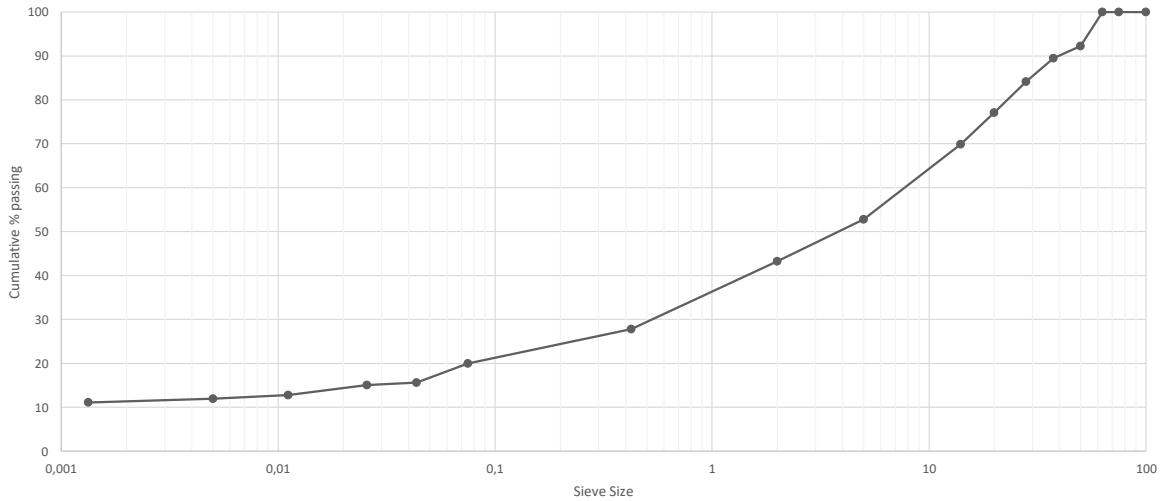
Client:	Babereki Consulting Engineers
Project:	Lindley Waste Water Treatment Works
Date:	2023/02/20

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





CLAY	SILT	SAND	GRAVEL

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PARTICLE SIZE ANALYSIS

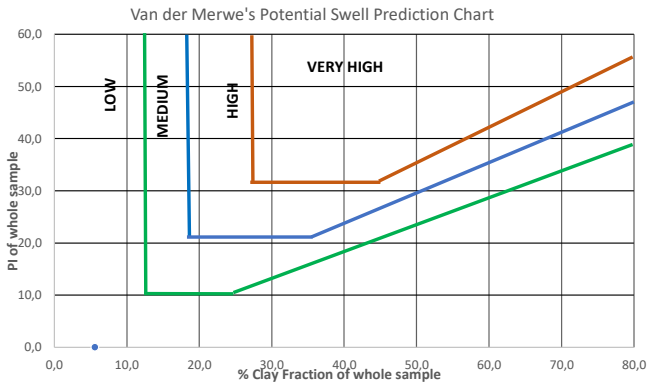
Date of Sampling:	2023/02/01
GEL Sample No.:	S22 - 041
Depth (m):	270-400
Position:	TP 828
Material Descrption:	yellow speckled orange sand
Relative Density on <2mm **(SANS 5844)**	2,43
Organic Material:	-
Moisture (%) Dispersion (%):	-
SCREEN ANALYSIS (% PASSING) **(SANS 3001: GR1)**	
63 mm	100
50 mm	100
37,5 mm	100
28 mm	100
20 mm	100
14 mm	100
5 mm	99
2 mm	99
0,425 mm	94,8
0,075 mm	28,8
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001: GR3)**	
0,061 mm	23,6
0,036 mm	18,7
0,015 mm	15,6
0,007 mm	12,4
0,002 mm	5,6

SOIL MORTAR PERCENTAGES(%) **(SANS 3001: PR5)**		
Coarse Sand	2,00-0,425mm	4,2
Coarse Fine Sand	0,425-0,250mm	35,3
Medium Fine Sand	0,250mm-0,150mm	23,4
Fine Fine Sand	0,150-0,075mm	8,1
Silt & Clay	<0,075mm	29,1

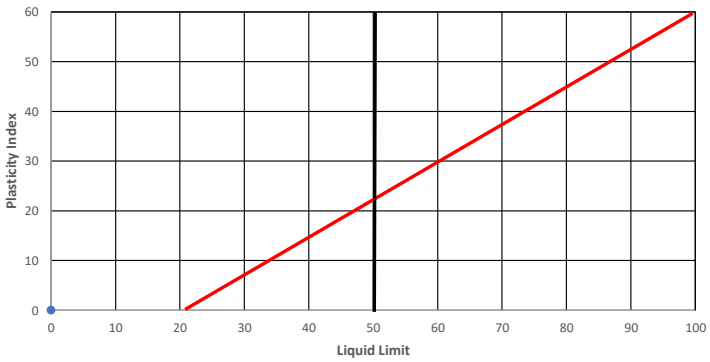
ATTERBERG LIMITS **(SANS 3001: GR10)**	
Liquid Limit (%)	-
Plasticity Index (%)	NP
Linear Shrinkage (%)	-
Grading Modulus	0,8
AASHTO Classification	A-2-4
Unified Classification	SM
COLTO Classification	-

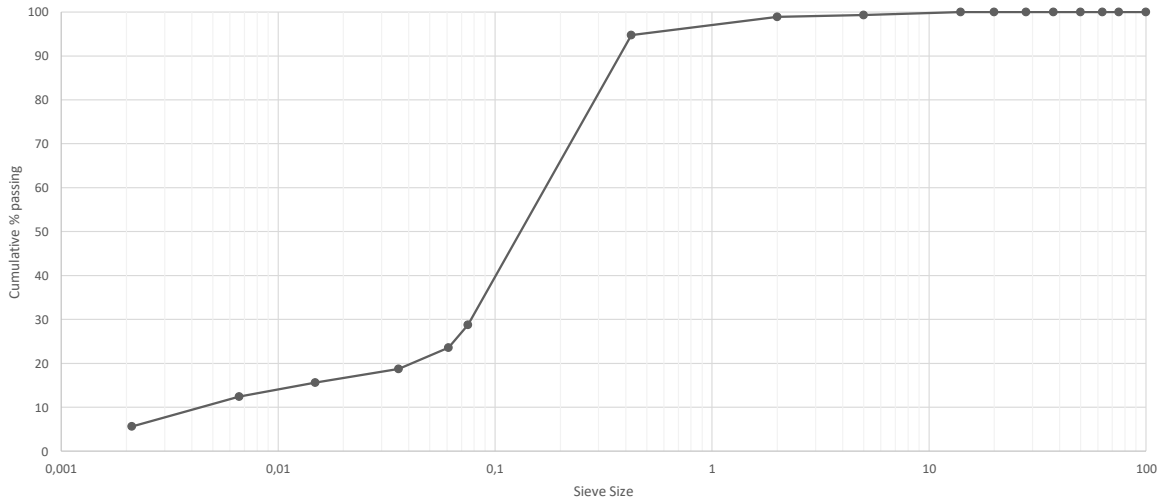
Client:	Babereki Consulting Engineers
Project:	Lindley Waste Water Treatment Works
Date:	2023/02/20

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





CLAY	SILT	SAND	GRAVEL

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PARTICLE SIZE ANALYSIS

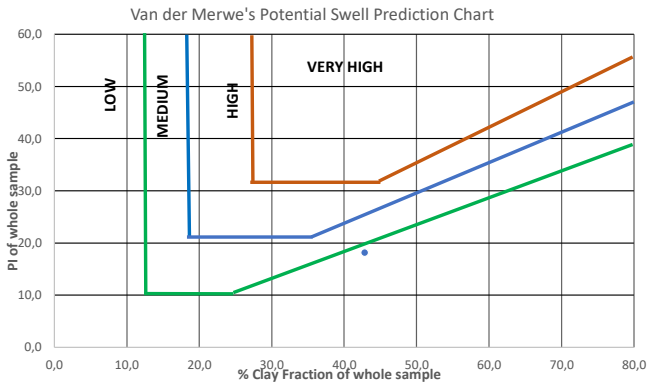
Date of Sampling:	2023/02/01
GEL Sample No.:	S23 - 043
Depth (m):	250-840
Position:	TP 829
Material Descrption:	light brown speckled yellow clay
Relative Density on <2mm **(SANS 5844)**	2,48
Organic Material:	-
Moisture (%) Dispersion (%):	-
SCREEN ANALYSIS (% PASSING) **(SANS 3001: GR1)**	
63 mm	100
50 mm	100
37,5 mm	100
28 mm	100
20 mm	100
14 mm	100
5 mm	99
2 mm	98
0,425 mm	95,3
0,075 mm	72,1
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001: GR3)**	
0,060 mm	65,9
0,034 mm	65,9
0,014 mm	65,9
0,006 mm	59,3
0,002 mm	42,9

SOIL MORTAR PERCENTAGES(%) **(SANS 3001: PR5)**		
Coarse Sand	2,00-0,425mm	2,8
Coarse Fine Sand	0,425-0,250mm	6,4
Medium Fine Sand	0,250mm-0,150mm	13,4
Fine Fine Sand	0,150-0,075mm	3,8
Silt & Clay	<0,075mm	73,6

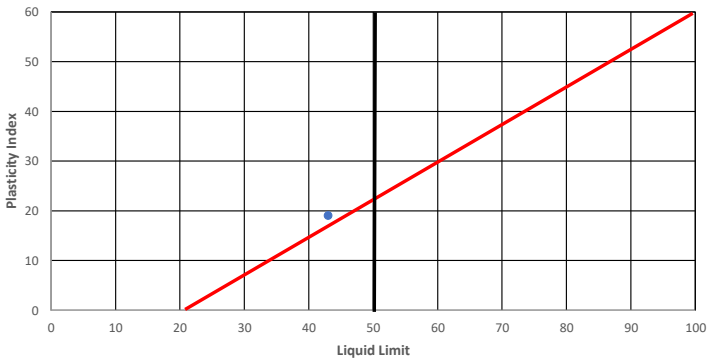
ATTERBERG LIMITS **(SANS 3001: GR10)**	
Liquid Limit (%)	43
Plasticity Index (%)	19
Linear Shrinkage (%)	7,3
Grading Modulus	0,3
AASHTO Classification	A-7-6
Unified Classification	CL
COLTO Classification	-

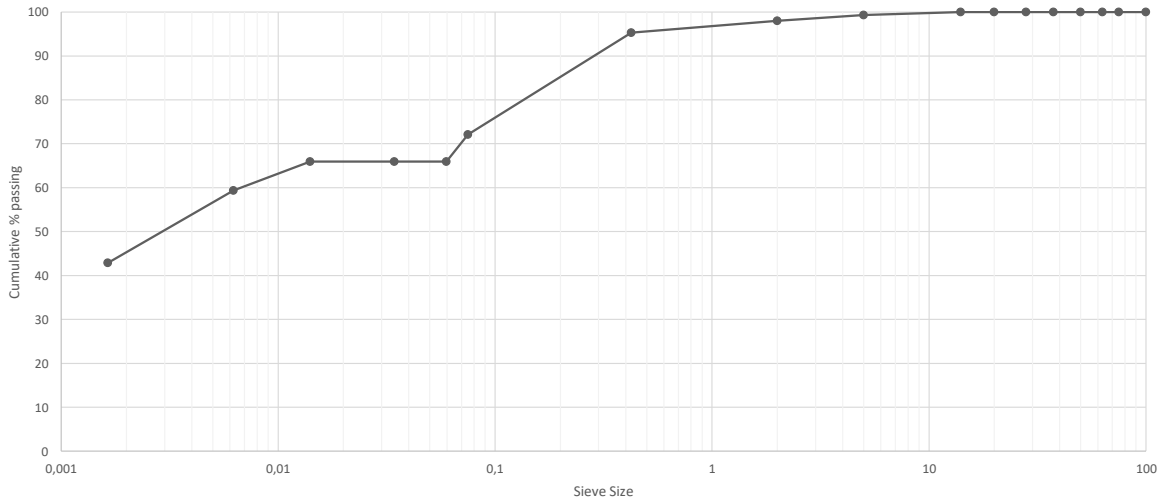
Client:	Babereki Consulting Engineers
Project:	Lindley Waste Water Treatment Works
Date:	2023/02/20

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





CLAY	SILT	SAND	GRAVEL

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PARTICLE SIZE ANALYSIS

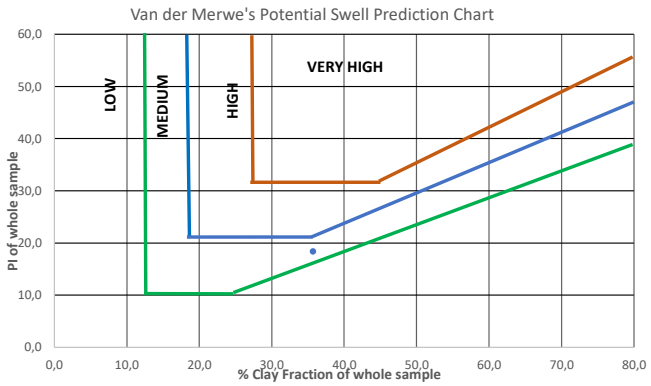
Date of Sampling:	2023/02/01
GEL Sample No.:	S23 - 045
Depth (m):	320-1140
Position:	TP 830
Material Descrption:	light brown speckled yellow clay
Relative Density on <2mm **(SANS 5844)**	2,43
Organic Material:	-
Moisture (%) Dispersion (%):	-
SCREEN ANALYSIS (% PASSING) **(SANS 3001: GR1)**	
63 mm	100
50 mm	100
37,5 mm	100
28 mm	100
20 mm	100
14 mm	100
5 mm	99
2 mm	97
0,425 mm	96,5
0,075 mm	69,7
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001: GR3)**	
0,061 mm	55,7
0,036 mm	47,6
0,015 mm	41,2
0,007 mm	36,5
0,002 mm	35,7

SOIL MORTAR PERCENTAGES(%) **(SANS 3001: PR5)**		
Coarse Sand	2,00-0,425mm	3,9
Coarse Fine Sand	0,425-0,250mm	7,6
Medium Fine Sand	0,250mm-0,150mm	14,3
Fine Fine Sand	0,150-0,075mm	5,5
Silt & Clay	<0,075mm	68,7

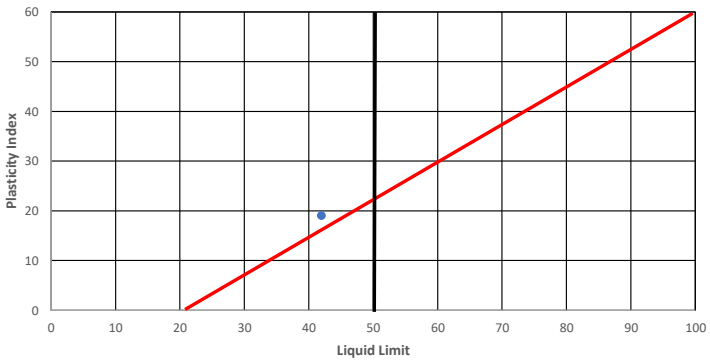
ATTERBERG LIMITS **(SANS 3001: GR10)**	
Liquid Limit (%)	42
Plasticity Index (%)	19
Linear Shrinkage (%)	8
Grading Modulus	0,4
AASHTO Classification	A-7-6
Unified Classification	CL
COLTO Classification	-

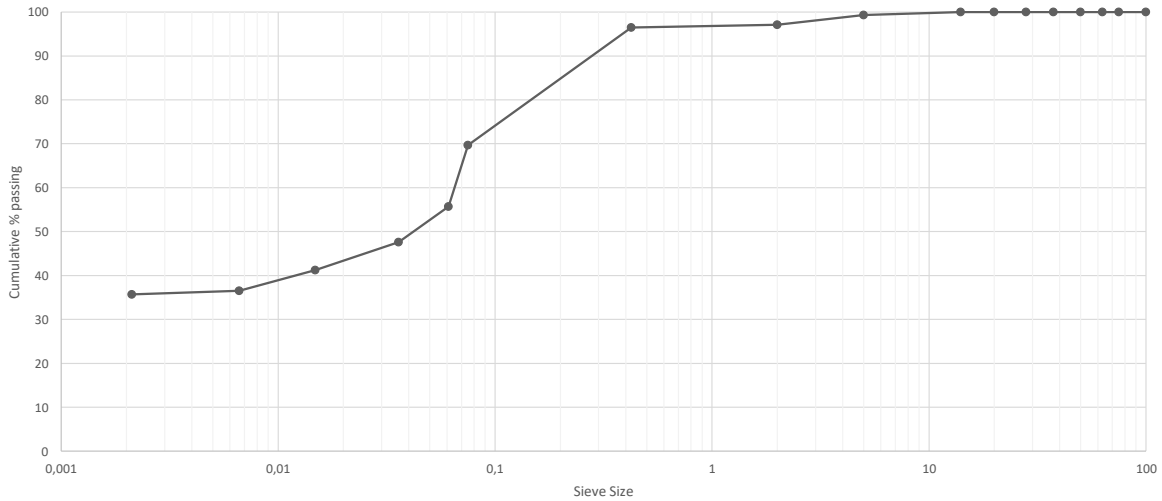
Client:	Babereki Consulting Engineers
Project:	Lindley Waste Water Treatment Works
Date:	2023/02/20

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





CLAY	SILT	SAND	GRAVEL

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PARTICLE SIZE ANALYSIS

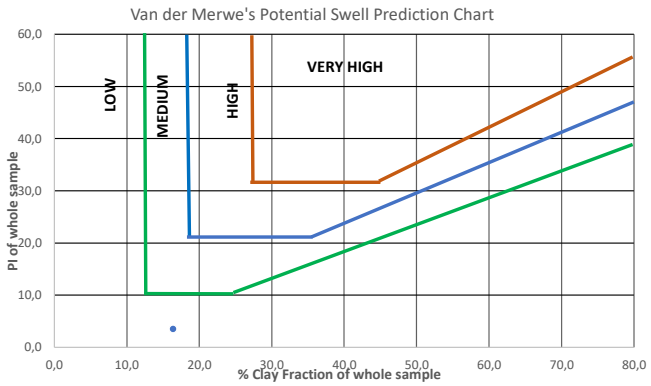
Date of Sampling:	2023/02/01
GEL Sample No.:	S23 - 047
Depth (m):	310-810
Position:	TP 831
Material Descrption:	dark brown silty sand
Relative Density on <2mm **(SANS 5844)**	2,53
Organic Material:	-
Moisture (%) Dispersion (%):	-
SCREEN ANALYSIS (% PASSING) **(SANS 3001: GR1)**	
63 mm	100
50 mm	100
37,5 mm	100
28 mm	100
20 mm	100
14 mm	92
5 mm	82
2 mm	75
0,425 mm	69,7
0,075 mm	49,0
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001: GR3)**	
0,041 mm	42,1
0,024 mm	40,7
0,011 mm	34,3
0,005 mm	25,7
0,002 mm	16,4

SOIL MORTAR PERCENTAGES(%) **(SANS 3001: PR5)**		
Coarse Sand	2,00-0,425mm	7,6
Coarse Fine Sand	0,425-0,250mm	5,8
Medium Fine Sand	0,250mm-0,150mm	17,1
Fine Fine Sand	0,150-0,075mm	4,5
Silt & Clay	<0,075mm	64,9

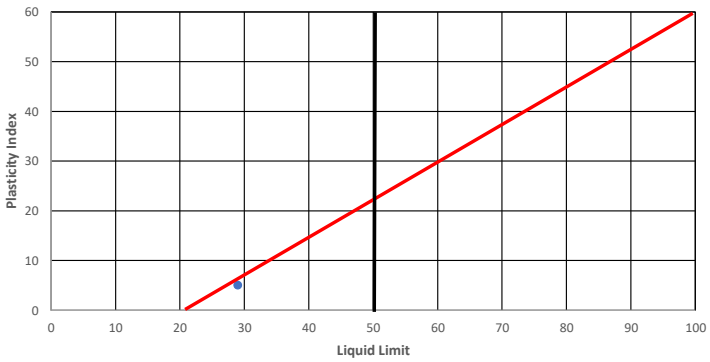
ATTERBERG LIMITS **(SANS 3001: GR10)**	
Liquid Limit (%)	29
Plasticity Index (%)	5
Linear Shrinkage (%)	4,7
Grading Modulus	1,1
AASHTO Classification	A-4
Unified Classification	SM
COLTO Classification	-

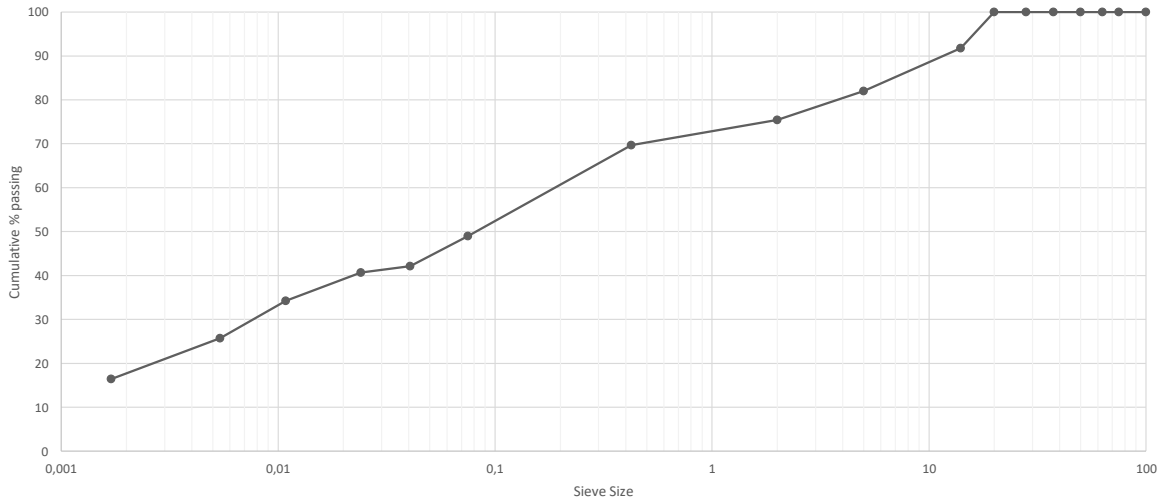
Client:	Babereki Consulting Engineers
Project:	Lindley Waste Water Treatment Works
Date:	2023/02/20

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





CLAY	SILT	SAND	GRAVEL

GEL (Pty) Ltd
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GEL GEOTECHNICAL ENGINEERING LABORATORY (PTY) LTD

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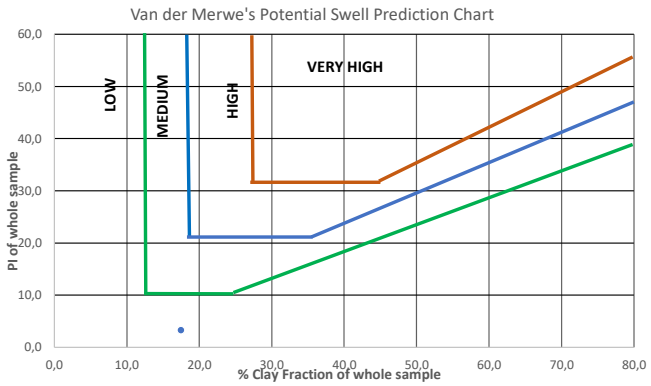
PARTICLE SIZE ANALYSIS

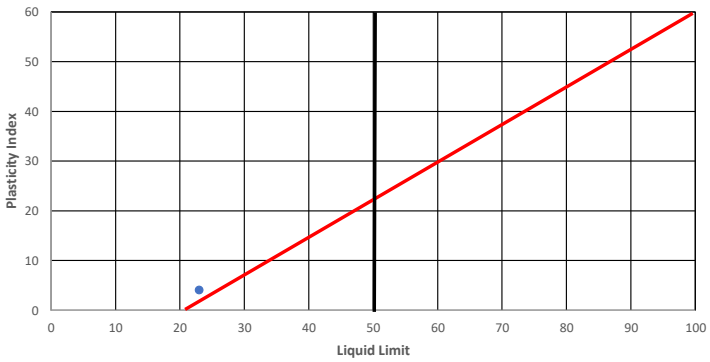
Date of Sampling:	2023/02/01
GEL Sample No.:	S23 - 049
Depth (m):	410-570
Position:	TP 832
Material Descrption:	dark brown clayey silt
Relative Density on <2mm **(SANS 5844)**	2,45
Organic Material:	-
Moisture (%) Dispersion (%):	-
SCREEN ANALYSIS (% PASSING) **(SANS 3001: GR1)**	
63 mm	100
50 mm	100
37,5 mm	100
28 mm	100
20 mm	100
14 mm	100
5 mm	97
2 mm	93
0,425 mm	81,6
0,075 mm	54,0
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001: GR3)**	
0,061 mm	45,6
0,036 mm	35,7
0,015 mm	33,2
0,007 mm	25,6
0,002 mm	17,5
SOIL MORTAR PERCENTAGES(%) **(SANS 3001: PR5)**	
Coarse Sand / 2,00-0,425mm	15,4
Coarse Fine Sand / 0,425-0,250mm	2,1
Medium Fine Sand / 0,250mm-0,150mm	11,3
Fine Fine Sand / 0,150-0,075mm	10,6
Silt & Clay / <0,075mm	60,6
ATTERBERG LIMITS **(SANS 3001: GR10)**	
Liquid Limit (%)	23
Plasticity Index (%)	4
Linear Shrinkage (%)	2,7
Grading Modulus	0,7
AASHTO Classification	A-4
Unified Classification	ML
COLTO Classification	-

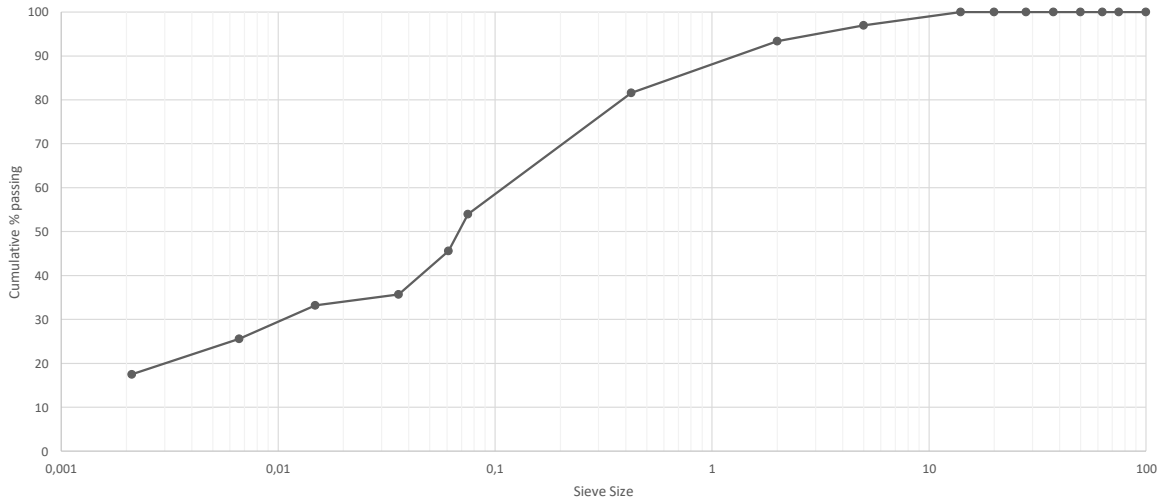
Client:	Babereki Consulting Engineers
Project:	Lindley Waste Water Treatment Works
Date:	2023/02/20

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





CLAY	SILT	SAND	GRAVEL

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PARTICLE SIZE ANALYSIS

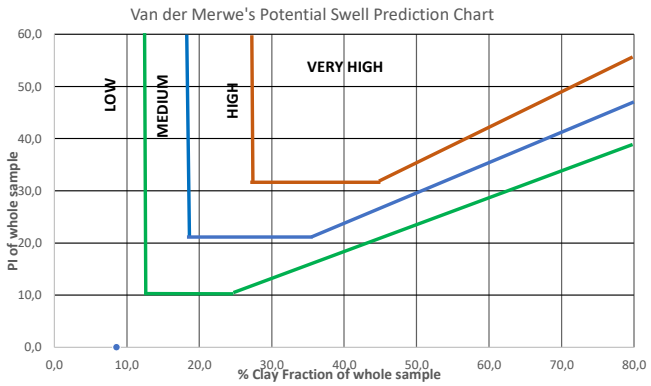
Date of Sampling:	2023/02/01
GEL Sample No.:	S23 - 050
Depth (m):	0-420
Position:	TP 833
Material Descrption:	light brown sand
Relative Density on <2mm **(SANS 5844)**	2,43
Organic Material:	-
Moisture (%) Dispersion (%):	-
SCREEN ANALYSIS (% PASSING) **(SANS 3001: GR1)**	
63 mm	100
50 mm	100
37,5 mm	100
28 mm	100
20 mm	100
14 mm	97
5 mm	91
2 mm	85
0,425 mm	40,6
0,075 mm	20,5
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001: GR3)**	
0,061 mm	18,6
0,036 mm	17,0
0,015 mm	14,5
0,007 mm	12,3
0,002 mm	8,6

SOIL MORTAR PERCENTAGES(%) **(SANS 3001: PR5)**		
Coarse Sand	2,00-0,425mm	48,7
Coarse Fine Sand	0,425-0,250mm	8,7
Medium Fine Sand	0,250mm-0,150mm	13,3
Fine Fine Sand	0,150-0,075mm	10,9
Silt & Clay	<0,075mm	18,4

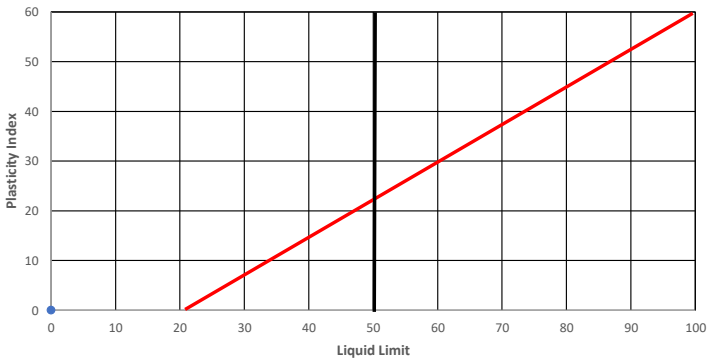
ATTERBERG LIMITS **(SANS 3001: GR10)**	
Liquid Limit (%)	-
Plasticity Index (%)	NP
Linear Shrinkage (%)	-
Grading Modulus	1,5
AASHTO Classification	A-1-b
Unified Classification	SM
COLTO Classification	-

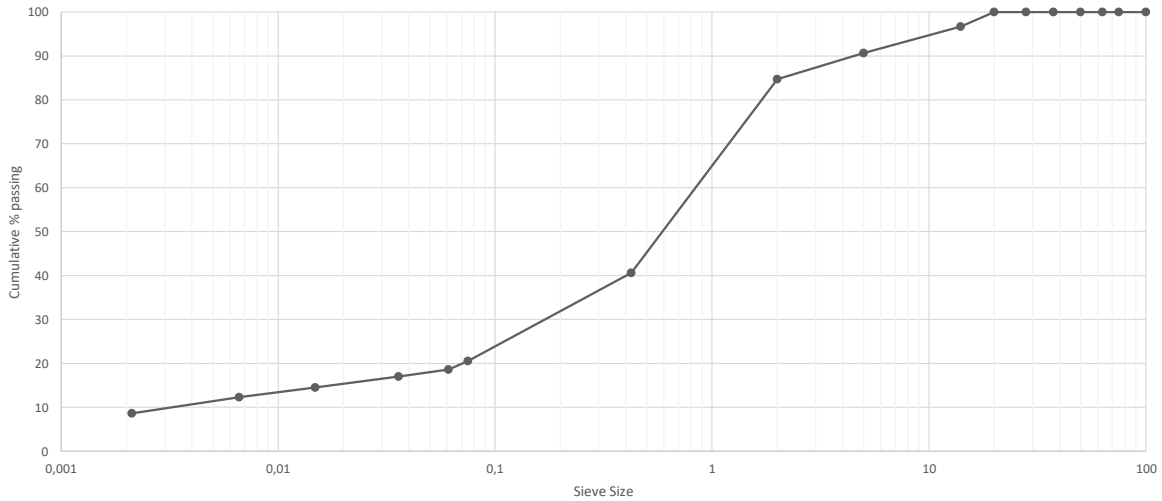
Client:	Babereki Consulting Engineers
Project:	Lindley Waste Water Treatment Works
Date:	2023/02/20

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





CLAY	SILT	SAND	GRAVEL

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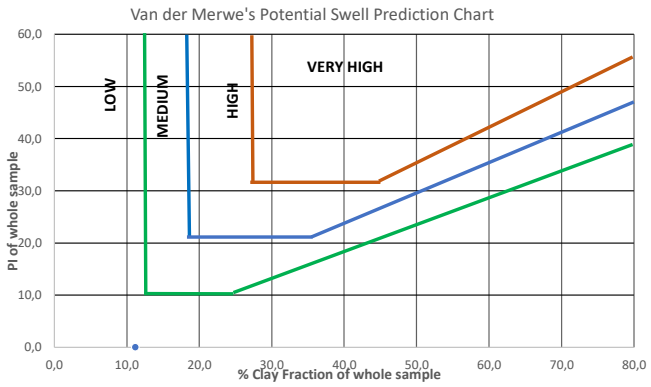
PARTICLE SIZE ANALYSIS

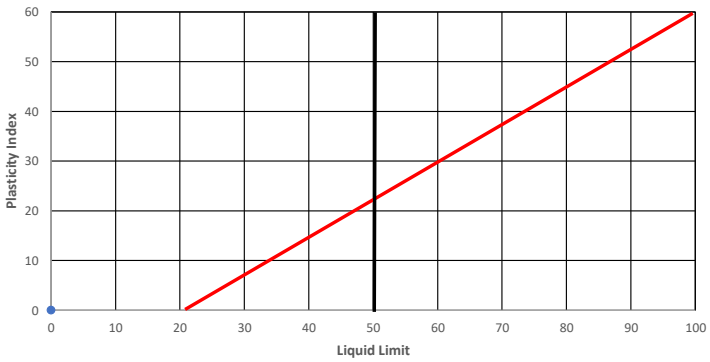
Date of Sampling:	2023/02/01
GEL Sample No.:	S23 - 051
Depth (m):	0-330
Position:	TP 834
Material Descrption:	light brown sand
Relative Density on <2mm **(SANS 5844)**	2,43
Organic Material:	-
Moisture (%) Dispersion (%):	-
SCREEN ANALYSIS (% PASSING) **(SANS 3001: GR1)**	
63 mm	100
50 mm	100
37,5 mm	100
28 mm	100
20 mm	100
14 mm	95
5 mm	89
2 mm	85
0,425 mm	70,7
0,075 mm	35,0
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001: GR3)**	
0,061 mm	30,5
0,036 mm	24,7
0,015 mm	20,7
0,007 mm	14,3
0,002 mm	11,2
SOIL MORTAR PERCENTAGES(%) **(SANS 3001: PR5)**	
Coarse Sand / 2,00-0,425mm	9,6
Coarse Fine Sand / 0,425-0,250mm	8,9
Medium Fine Sand / 0,250mm-0,150mm	23,5
Fine Fine Sand / 0,150-0,075mm	27,3
Silt & Clay / <0,075mm	30,7
ATTERBERG LIMITS **(SANS 3001: GR10)**	
Liquid Limit (%)	-
Plasticity Index (%)	NP
Linear Shrinkage (%)	-
Grading Modulus	1,1
AASHTO Classification	A-2-4
Unified Classification	SM
COLTO Classification	-

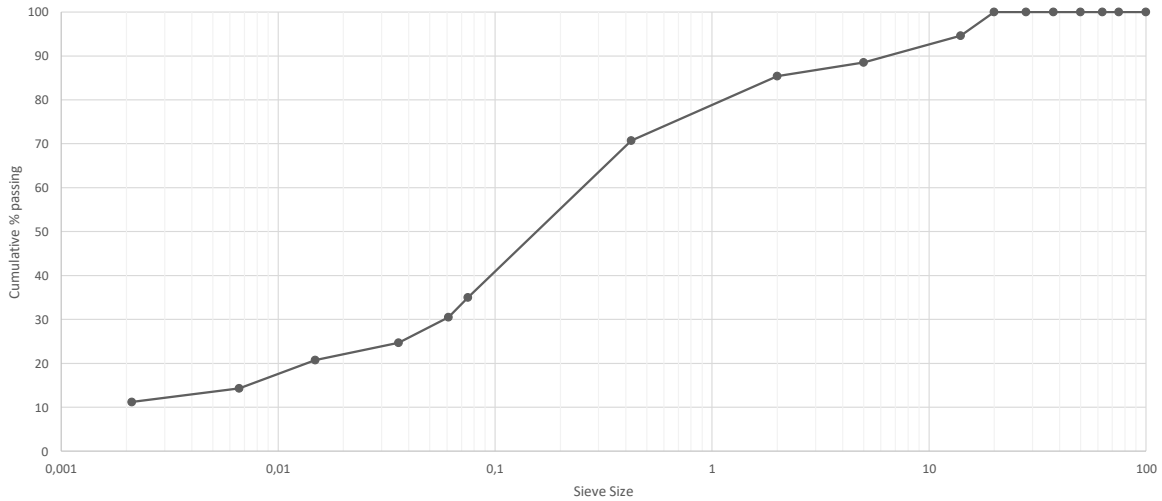
Client:	Babereki Consulting Engineers
Project:	Lindley Waste Water Treatment Works
Date:	2023/02/20

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





CLAY	SILT	SAND	GRAVEL

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PARTICLE SIZE ANALYSIS

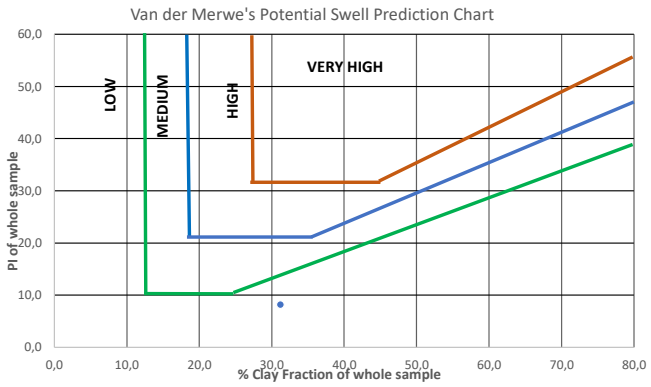
Date of Sampling:	2023/02/01
GEL Sample No.:	S23 - 052
Depth (m):	0-300
Position:	TP 835
Material Descrption:	dark brown sandy clay
Relative Density on <2mm **(SANS 5844)**	2,43
Organic Material:	-
Moisture (%) Dispersion (%):	-
SCREEN ANALYSIS (% PASSING) **(SANS 3001: GR1)**	
63 mm	100
50 mm	100
37,5 mm	100
28 mm	100
20 mm	100
14 mm	96
5 mm	94
2 mm	89
0,425 mm	74,3
0,075 mm	66,5
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001: GR3)**	
0,061 mm	55,1
0,036 mm	47,5
0,015 mm	43,6
0,007 mm	37,6
0,002 mm	31,2

SOIL MORTAR PERCENTAGES(%) **(SANS 3001: PR5)**		
Coarse Sand	2,00-0,425mm	13
Coarse Fine Sand	0,425-0,250mm	10
Medium Fine Sand	0,250mm-0,150mm	13
Fine Fine Sand	0,150-0,075mm	12
Silt & Clay	<0,075mm	52

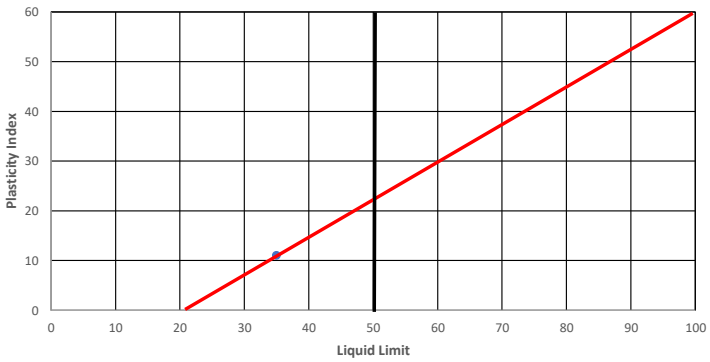
ATTERBERG LIMITS **(SANS 3001: GR10)**	
Liquid Limit (%)	35
Plasticity Index (%)	11
Linear Shrinkage (%)	5,4
Grading Modulus	0,7
AASHTO Classification	A-6
Unified Classification	CL
COLTO Classification	-

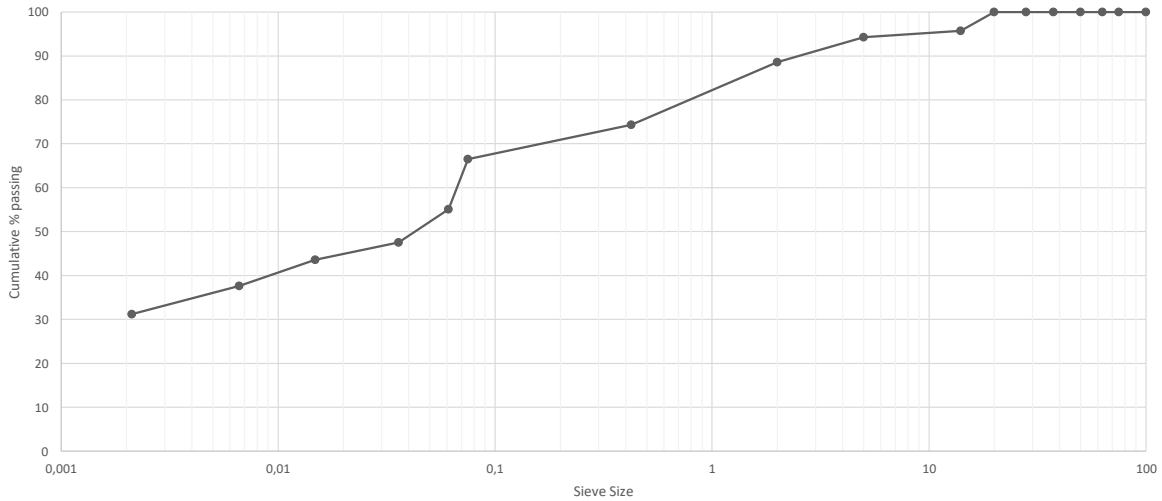
Client:	Babereki Consulting Engineers
Project:	Lindley Waste Water Treatment Works
Date:	2023/02/20

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





CLAY	SILT	SAND	GRAVEL

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E-mail: tsoeujm@hotmail.com

PARTICLE SIZE ANALYSIS

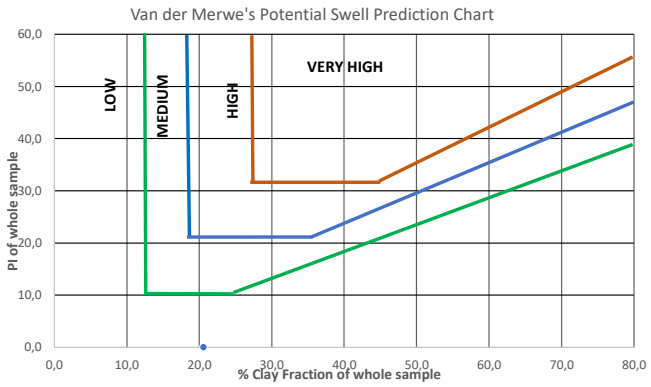
Date of Sampling:	2023/02/01
GEL Sample No.:	S22 - 053
Depth (m):	0-300
Position:	TP 836
Material Descrption:	dark brown sand
Relative Density on <2mm **(SANS 5844)**	2,43
Organic Material:	-
Moisture (%) Dispersion (%):	-
SCREEN ANALYSIS (% PASSING) **(SANS 3001: GR1)**	
63 mm	100
50 mm	100
37,5 mm	100
28 mm	96
20 mm	92
14 mm	89
5 mm	71
2 mm	68
0,425 mm	65,7
0,075 mm	40,5
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001: GR3)**	
0,061 mm	34,6
0,036 mm	31,2
0,015 mm	27,8
0,007 mm	24,7
0,002 mm	20,6

SOIL MORTAR PERCENTAGES(%) **(SANS 3001: PR5)**		
Coarse Sand	2,00-0,425mm	7,1
Coarse Fine Sand	0,425-0,250mm	11,2
Medium Fine Sand	0,250mm-0,150mm	23,5
Fine Fine Sand	0,150-0,075mm	21,7
Silt & Clay	<0,075mm	36,5

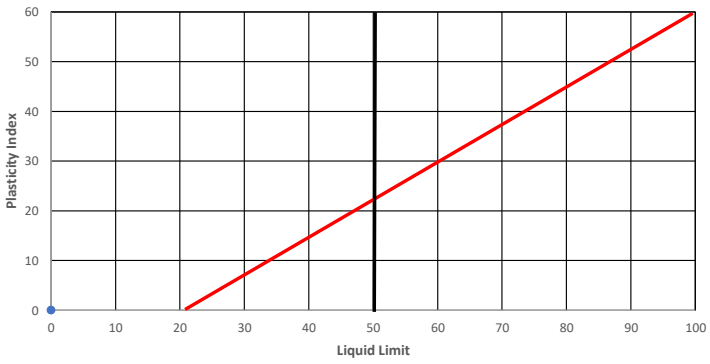
ATTERBERG LIMITS **(SANS 3001: GR10)**	
Liquid Limit (%)	-
Plasticity Index (%)	NP
Linear Shrinkage (%)	-
Grading Modulus	1,3
AASHTO Classification	A-4
Unified Classification	SM
COLTO Classification	-

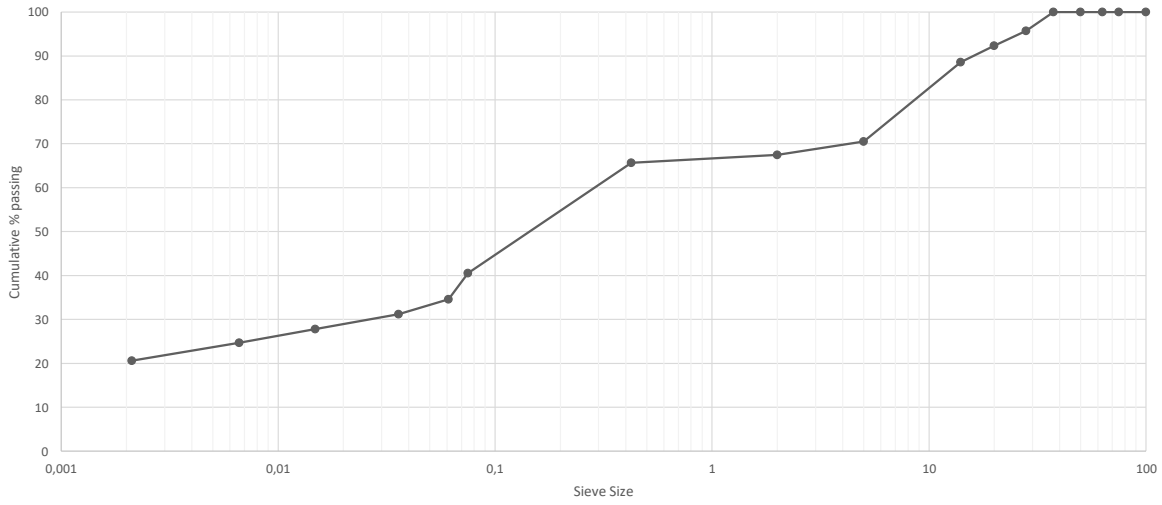
Client:	Babereki Consulting Engineers
Project:	Lindley Waste Water Treatment Works
Date:	2023/02/20

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





CLAY	SILT	SAND	GRAVEL

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PARTICLE SIZE ANALYSIS

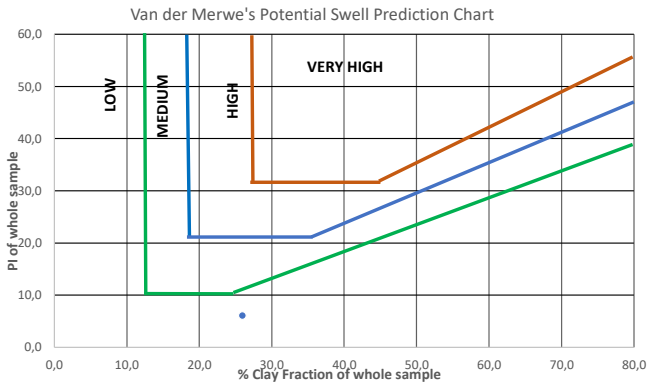
Date of Sampling:	2023/02/01
GEL Sample No.:	S23 - 055
Depth (m):	400-1250
Position:	TP 837
Material Descrption:	yellow clayey sand
Relative Density on <2mm **(SANS 5844)**	2,37
Organic Material:	-
Moisture (%) Dispersion (%):	-
SCREEN ANALYSIS (% PASSING) **(SANS 3001: GR1)**	
63 mm	100
50 mm	100
37,5 mm	100
28 mm	100
20 mm	100
14 mm	99
5 mm	94
2 mm	91
0,425 mm	86,5
0,075 mm	45,0
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001: GR3)**	
0,048 mm	43,5
0,030 mm	38,9
0,012 mm	37,1
0,006 mm	33,4
0,002 mm	26,0

SOIL MORTAR PERCENTAGES(%) **(SANS 3001: PR5)**		
Coarse Sand	2,00-0,425mm	4,5
Coarse Fine Sand	0,425-0,250mm	15,3
Medium Fine Sand	0,250mm-0,150mm	18,4
Fine Fine Sand	0,150-0,075mm	12,7
Silt & Clay	<0,075mm	49,1

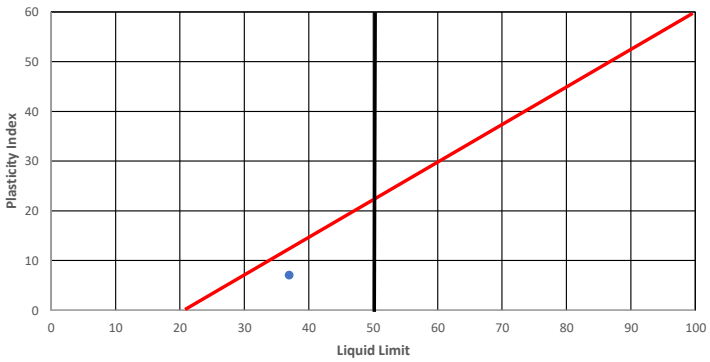
ATTERBERG LIMITS **(SANS 3001: GR10)**	
Liquid Limit (%)	37
Plasticity Index (%)	7
Linear Shrinkage (%)	6,7
Grading Modulus	0,8
AASHTO Classification	A-4
Unified Classification	SC
COLTO Classification	-

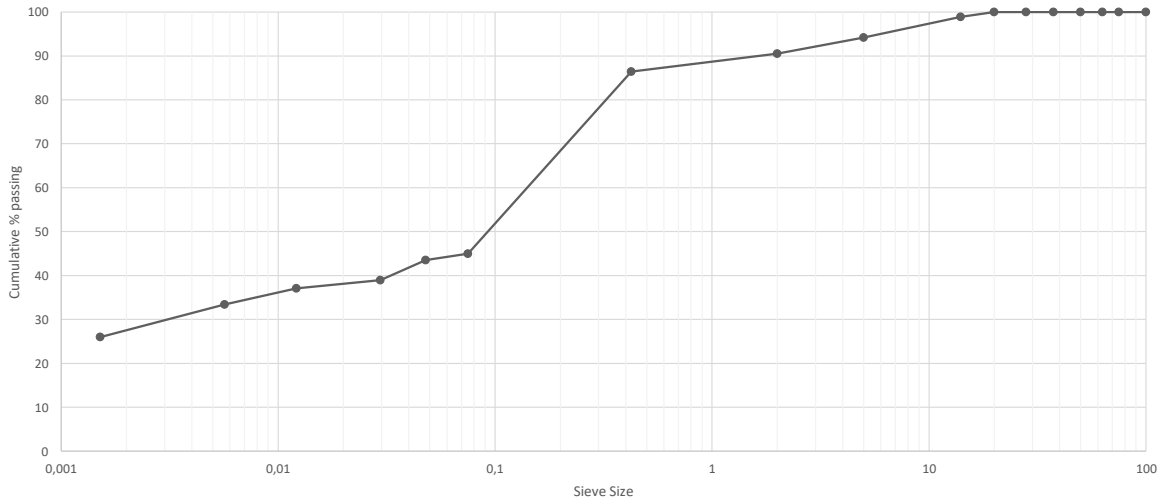
Client:	Babereki Consulting Engineers
Project:	Lindley Waste Water Treatment Works
Date:	2023/02/20

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





CLAY	SILT	SAND	GRAVEL

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PARTICLE SIZE ANALYSIS

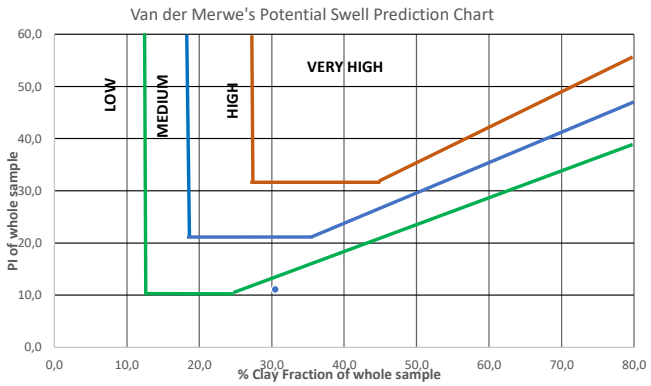
Date of Sampling:	2023/02/01
GEL Sample No.:	S23 - 057
Depth (m):	510-1310
Position:	TP 838
Material Descrption:	dark grey silty clay
Relative Density on <2mm **(SANS 5844)**	2,59
Organic Material:	-
Moisture (%) Dispersion (%):	-
SCREEN ANALYSIS (% PASSING) **(SANS 3001: GR1)**	
63 mm	100
50 mm	100
37,5 mm	100
28 mm	100
20 mm	100
14 mm	100
5 mm	97
2 mm	96
0,425 mm	92,0
0,075 mm	58,1
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001: GR3)**	
0,057 mm	55,4
0,033 mm	53,0
0,014 mm	47,0
0,006 mm	44,3
0,002 mm	30,5

SOIL MORTAR PERCENTAGES(%) **(SANS 3001: PR5)**		
Coarse Sand	2,00-0,425mm	3,8
Coarse Fine Sand	0,425-0,250mm	4,8
Medium Fine Sand	0,250mm-0,150mm	23,2
Fine Fine Sand	0,150-0,075mm	7,5
Silt & Clay	<0,075mm	60,7

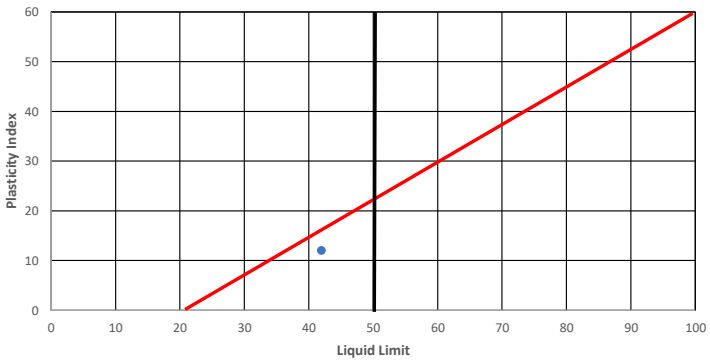
ATTERBERG LIMITS **(SANS 3001: GR10)**	
Liquid Limit (%)	42
Plasticity Index (%)	12
Linear Shrinkage (%)	7,5
Grading Modulus	0,5
AASHTO Classification	A-7-5
Unified Classification	OL
COLTO Classification	-

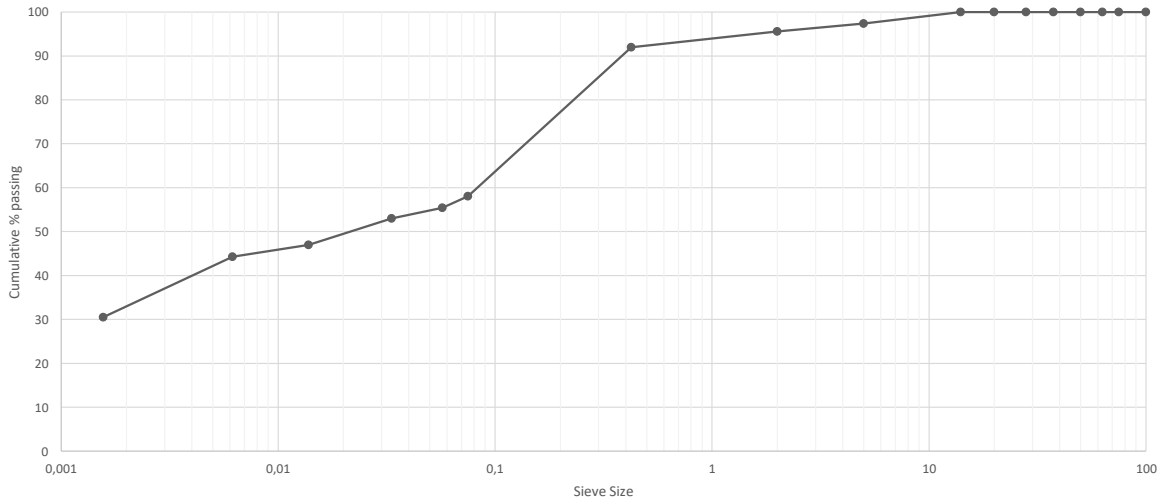
Client:	Babereki Consulting Engineers
Project:	Lindley Waste Water Treatment Works
Date:	2023/02/20

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





CLAY	SILT	SAND	GRAVEL

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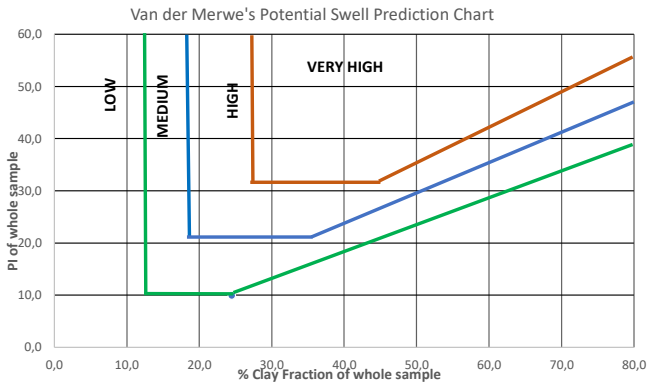
PARTICLE SIZE ANALYSIS

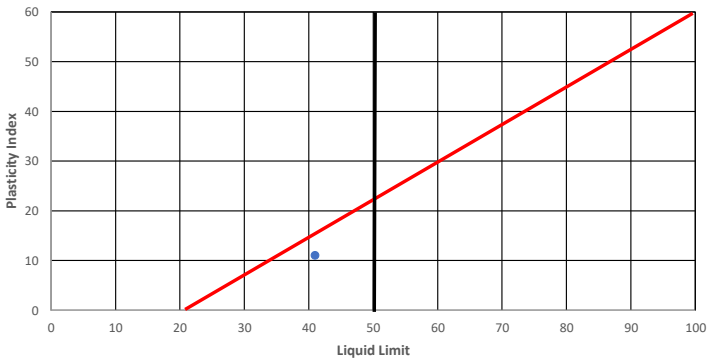
Date of Sampling:	2023/02/01
GEL Sample No.:	S22 - 059
Depth (m):	630-1780
Position:	TP 839
Material Descrption:	dark grey silty clay
Relative Density on <2mm **(SANS 5844)**	2,43
Organic Material:	-
Moisture (%) Dispersion (%):	-
SCREEN ANALYSIS (% PASSING) **(SANS 3001: GR1)**	
63 mm	100
50 mm	100
37,5 mm	100
28 mm	100
20 mm	100
14 mm	100
5 mm	100
2 mm	95
0,425 mm	89,9
0,075 mm	60,4
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001: GR3)**	
0,061 mm	45,7
0,036 mm	40,2
0,015 mm	35,7
0,007 mm	32,6
0,002 mm	24,5
SOIL MORTAR PERCENTAGES(%) **(SANS 3001: PR5)**	
Coarse Sand / 2,00-0,425mm	5,7
Coarse Fine Sand / 0,425-0,250mm	7,8
Medium Fine Sand / 0,250mm-0,150mm	19,9
Fine Fine Sand / 0,150-0,075mm	10,4
Silt & Clay / <0,075mm	56,2
ATTERBERG LIMITS **(SANS 3001: GR10)**	
Liquid Limit (%)	41
Plasticity Index (%)	11
Linear Shrinkage (%)	7,3
Grading Modulus	0,6
AASHTO Classification	A-7-5
Unified Classification	OL
COLTO Classification	-

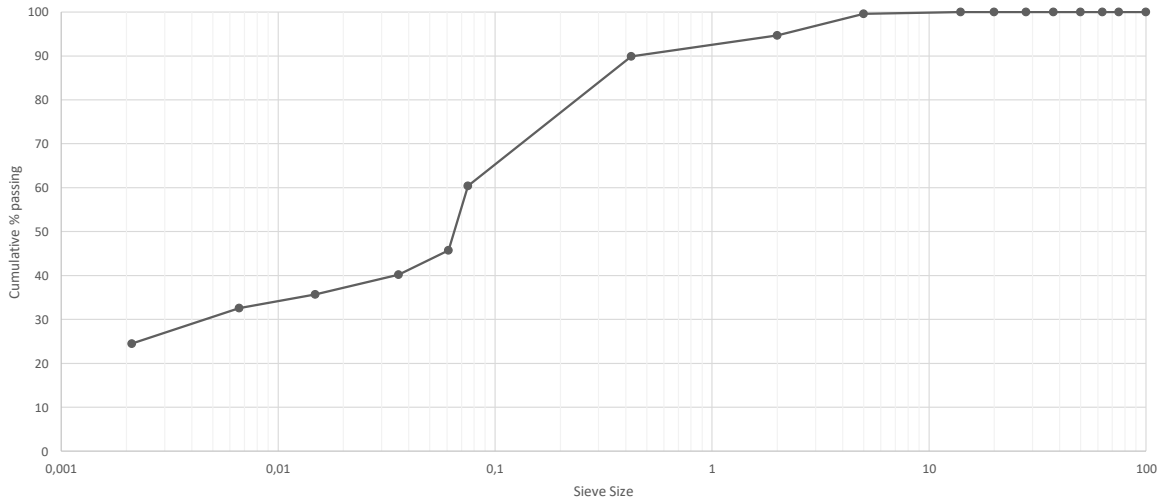
Client:	Babereki Consulting Engineers
Project:	Lindley Waste Water Treatment Works
Date:	2023/02/20

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





CLAY	SILT	SAND	GRAVEL

GEL (Pty) Ltd
STAMP

Table D1: Unified Soil Classification System (from ASTM D 2487)

Major Divisions			Group Symbols	Typical Names
Course-Grained Soils More than 50% retained on the 0.075 mm (No. 200) sieve	**Gravels** 50% or more of course fraction retained on the 4.75 mm (No. 4) sieve	Clean Gravels	GW	Well-graded gravels and gravel-sand mixtures, little or no fines
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines
		Gravels (with Fines)	GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	Sands 50% or more of course fraction passes the 4.75 (No. 4) sieve	Clean Sands	SW	Well-graded sands and gravelly sands, little or no fines
			SP	Poorly graded sands and gravelly sands, little or no fines
		Sands (with Fines)	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
Fine-Grained Soils More than 50% passes the 0.075 mm (No. 200) sieve		**Silts and Clays** Liquid Limit 50% or less	ML	Inorganic silts, very fine sands, rock four, silty or clayey fine sands
			CL	Inorganic clays of low to medium plasticity, gravelly/sandy/silty/lean clays
			OL	Organic silts and organic silty clays of low plasticity
		Silts and Clays Liquid Limit greater than 50%	MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts
			CH	Inorganic clays or high plasticity, fat clays
			OH	Organic clays of medium to high plasticity
Highly Organic Soils			PT	Peat, muck, and other highly organic soils

Prefix: G = Gravel, S = Sand, M = Silt, C = Clay, O = Organic

Suffix: W = Well Graded, P = Poorly Graded, M = Silty, L = Clay, LL < 50%, H = Clay, LL > 50%

Note: These definitions are Unified Soil Classification system definitions and are slightly different than those of AASHTO.

Table D2: AASHTO Soil Classification System (from AASHTO M 145 or ASTM D3282)

General Classification	Granular Materials (35% or less passing the 0.075 mm sieve)							Silt-Clay Materials (>35% passing the 0.075 mm sieve)			
Group Classification	A-1		A-3	A-2				A-4	A-5	A-6	A-7
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5 A-7-6
Sieve Analysis (% passing)											
2.00 mm (No. 10)	50 max	-	-	-	-	-	-	-	-	-	-
0.425 (No. 40)	30 max	50 max	51 min	-	-	-	-	-	-	-	-
0.075 (No. 200)	15 max	25 max	10 max	35 max	35 max	35 max	35 max	36 min	36 min	36 min	36 min
Characteristics of fraction passing 0.425 mm (No. 40)											
Liquid Limit	-		-	40 max	41 min	40 max	41 min	40 max	41 min	40 max	41 min
Plasticity Index	6 max		N.P.	10 max	10 max	11 min	11 min	10 max	10 max	11 min	11 min*
Group index	0		0	0		4 max		8 max	12 max	16 max	20 max
Usual types of significant constituent materials	Stone fragments, gravel and sand		Fine sand	Silty or clayey gravel and sand				Silty soils		Clayey soils	
General rating as a subgrade	Excellent to Good							Fair to Poor			

* Plasticity index of A-7-5 subgroup is equal to or less than the LL - 30. Plasticity index of A-7-6 subgroup is greater than LL - 30

Table D3: Engineering suitability ratings based upon Unified Soil Classification groups

USCS group symbol	Typical description	Source of borrow			Resources	Suitability for:					
		Embankments		Fill	Clean sand / gravel	Road subgrade	Building foundations	Slope stability	Trenching/ tunneling	Septic tanks	Untreated roads
		Water retaining	None-water retaining								
GW	Well-graded gravels, gravel-sand mixtures, little or no fines.	Unsuitable	Excellent	Excellent	Good	Excellent	Excellent	Excellent	Shoring	Good	Average
GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.	Unsuitable	Average	Excellent	Good	Excellent	Excellent	Average	Shoring	Excellent	Unsuitable
GM	Silty gravels, poorly graded gravel-sand-silt mixtures.	Unsuitable	Average	Good	Average	Excellent	Excellent	Average	Shoring	Average	Average
GC	Clayey gravels, poorly graded gravel-sand-clay mixtures.	Suitable	Average	Good	Poor	Excellent	Excellent	Average	Good	Unsuitable	Excellent
SW	Well-graded sands, gravelly sands, little or no fines.	Unsuitable	Excellent	Excellent	Good	Good	Excellent	Average	Shoring	Good	Average
SP	Poorly graded sands, gravelly sands, little or no fines.	Unsuitable	Average	Good	Good	Good	Excellent	Excellent	Shoring	Good	Unsuitable
SM	Silty sands, poorly graded silt-sand mixtures.	Suitable (with compaction)	Average	Average	Average	Average	Good (density important)	Average	Mostly good, but shoring may be required	Poor	Poor
SC	Clayey sands, poorly graded sand-clay mixtures.	Suitable	Average	Average	Poor	Average	Good (density important)	Average	Good	Unsuitable	Good
ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity.	Unsuitable	Poor	Average	N/A	Average	Good (Liquifaction problem)	Average	Shoring	Average	Unsuitable
CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	Suitable (erosion protection required)	Good	Average	N/A	Average	Average (Swell?)	Poor	Good	Unsuitable	Poor
OL	Organic silts and organic silt-clays of low plasticity	Unsuitable	Unsuitable	Poor	N/A	Average	Poor (Swell)	Good	Shoring	Poor	Unsuitable
MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic soils.	Unsuitable	Poor	Poor	N/A	Poor	Unsuitable (Swell?)	Unsuitable	Shoring	Average	Unsuitable
CH	Inorganic clays of high plasticity, fat clays, silty soils, elastic soils.	Suitable (erosion protection required)	Average	Unsuitable	N/A	Poor	Poor (Swell?)	Poor	Good	Unsuitable	Unsuitable
OH	Organic clays of medium to high plasticity.	Unsuitable	Unsuitable	Unsuitable	N/A	Unsuitable	Unsuitable (Swell?)	Average	Shoring	Unsuitable	Unsuitable
PT	Peat or other highly organic soils.	Unsuitable	Unsuitable	Unsuitable	N/A	Unsuitable	Unsuitable (Swell?)	Unsuitable	Shoring	Average	Unsuitable

Source: Finlayson (1982)

Note: These recommendations are based on the construction of earthworks with adequate access to compaction and engineering equipment. They are based solely on the USCS classification, which does not take account of the full effects of particle size, dispersion or the conditions under which soil conservation earthworks are constructed. This then in not a DLWC based set of recommendations for the construction of soil conservation earthworks.

Table D4: Typical material properties (Unified Soil Classification System)

Class:	Material description	Subgrade	Subbase	Base	Drainage when compacted	Compaction characteristics	Embankment material	Compressibility when compacted
GW	Well-graded gravel	Good to Excellent	Good	Fair to good	Excellent	Good	Reasonably stable	Low
GC	Clayey gravel (>12% fines)	Good	Fair	Poor to not suitable	Poor to practically impervious	Good to fair	Reasonably stable	Low
SM	Silty sand (sand with fines PI<4)	Fair to good	Fair to good	Poor to not suitable	Fair to practically impervious to impervious	Good	Reasonably stable	Low
SC	Clayey sand (>12% fines PI>7)	Fair	Poor	Not suitable	Poor, impervious when compacted	Good to fair	Reasonably stable	Low
CL	Silts and clays (LL<50 & PI>7)	Fair to poor	Not suitable	Not suitable	Practically impervious	Good to fair	Good stability	Medium
ML	Silts and clays (LL<50 & PI<4)	Fair to poor	Not suitable	Not suitable	Semi-pervious to impervious	Good to poor	Poor stability	Medium

Table D5: Residential Site Class Designations (SAICE, 1995)

Typical Founding Material	Character of Founding Material	Expected Range of Total Soil Movements (mm)	Assumed Differential Movement (% of total)	Site Class
Rock (excluding mud rocks which exhibit swelling to some depth)	Stable	NEGLIGIBLE	-	R
Fine-grained soils with moderate to very high plasticity (clays, silty clays, clayey silts and sandy clays)	Expansive Soils	< 7,5 7,5 – 15 15 – 30 > 30	50% 50% 50% 50%	H H1 H2 H3
Silty sands, sands, sandy and gravelly soils	Compressible and Potentially Collapsible Soils	< 5,0 5,0 – 10 > 10	75% 75% 75%	C C1 C2
Fine-grained soils (clayey silts and clayey sands of low plasticity), sands, sandy and gravelly soils	Compressible Soils	< 10 10 – 20 > 20	50% 50% 50%	S S1 S2
Contaminated soils Controlled fill Dolomitic areas Land fill Marshy areas Mine waste fill Mining subsidence Reclaimed areas Very soft silt/silty clays Uncontrolled fill	Variable	Variable		P

NOTES:

1. The classifications C, H, R and S are not intended for dolomitic area sites unless specific investigations are carried out to assess the stability (risk of sinkholes and doline formation) of the dolomites. Where this risk is found to be acceptable, the site shall be designated as Class P (dolomitic areas).
2. Site classes are based on the assumption that differential movements, experienced by single-storey residential buildings, expressed as a percentage of the total movements are equal to about 50% for soils that exhibit expansive or compressive characteristics and 75% for soils that exhibit both compressible and collapse characteristics. Where this assumption is incorrect or inappropriate, the total soil movements must be adjusted so that the resultant different movements implied by the table are equal to that which is expected in the field.
3. In some instances, it may be more appropriate to use a composite description to describe a site mote fully e.g. C1/H2 or S1 and/or H2. Composite Site Classes may lead to higher differential movements and result in design solutions appropriate to a higher range of differential movement e.g. a Class R/C1 site. Alternatively, a further site investigation may be necessary since the final design solution may depend on the location of the building on a particular site.
4. Where it is not possible to provide a single site designation and a composite description is inappropriate, sites may be given multiple descriptions to indicate the range of possible conditions e.g. H-H1-H2 or C1-C2.
5. Soft silts and clays usually exhibit high consolidation and low bearing characteristics. Structures founded on these horizons may experience high settlements and such sites should be designated as being Class S1 or S2 as relevant and appropriate.
6. Sites containing contaminated soils include those associated with reclaimed mine land, land down-slope of mine tailings and old land fills.
7. Where a site is designated as Class P, full particulars relating to the founding conditions on the site must be provided.
8. Where sites are designated as being Class P, the reason for such classification shall be placed in brackets immediately after the suffix – i.e. P(contaminated soils). Under certain circumstances, composite description may be more appropriate – e.g. P(dolomite areas)-C1.
9. Certain fills may contain contaminates which present a health risk. The nature of such fill should be evaluated and should be clearly demarcated as such.

Table D6: Residential Site Class Designations (SAICE, 1995)

Site Class	Estimated Total Settlement	Construction Type	Foundation Design and Building Procedures
S	<10 mm	Normal	- Normal construction (strip footing or slab-on-the-ground foundations) - Good site drainage
S1	10-20 mm	Modified normal	- Reinforced strip footings - Articulation joints at some internal and all external doors - Light reinforcement in masonry - Site drainage and service/plumbing precautions - Foundation pressure not to exceed 50 kPa
		Compaction of in situ soils below individual footings	- Remove in situ material below foundations to a depth and width of 1,5 times the foundation width or to a competent horizon and replace with material compacted to 93% MOD AASHTO density at –1% to +2% of optimum moisture content. - Normal construction with lightly reinforced strip foundations and light reinforcement in masonry.
		Deep strip foundations	- Normal construction with drainage requirements. - Founding on a competent horizon below the problem horizon
		Soil raft	- Remove in situ material to 1,0m beyond perimeter of building to a depth and width of 1,5 times the widest foundation or to a competent horizon and replace with material compacted to 93% MOD AASHTO density at –1% to +2% of optimum moisture content. - Normal construction with lightly reinforced strip footings and light reinforcement in masonry.
S2	>20 mm	Stiffened strip footings, stiffened or cellular raft	- Stiffened strip footing or stiffened or cellular raft with articulation joints or solid lightly reinforced masonry. - Bearing pressure not to exceed 50kPa. - Fabric reinforcement in floor slabs. - Site drainage and service/plumbing precautions.
		Deep strip foundations	- As for S1 but with fabric reinforcement in floor slabs
		Compaction of in-situ soils below individual footings	- As for S1.
		Piled or pier foundations	- Reinforced concrete ground beams or solid slabs on piled or pier foundations. - Ground slabs with fabric reinforcement. - Good site drainage.
		Soil raft	- As for S1.

Notes:

1. Differential settlement assumed to equal 50% of total settlement.
2. The relaxation of some of these requirements, e.g. the reduction or omission of steel or articulation joints, may result in a Category 2 level of expected damage.
3. Account must be taken on sloping site since differential fill heights may lead to greater differential settlements.
4. Settlements induced by loads imposed by deep filling beneath surface beds may necessitate the adoption of a construction type appropriate to a more severe site class.

Table D6: Residential Site Class Designations (SAICE, 1995)

Site Class	Estimated Total Settlement	Construction Type	Foundation Design and Building Procedures
C	<5 mm	Normal	- Normal construction (strip footing or slab-on-the-ground foundations) - Good site drainage
C1	5 – 10 mm	Modified normal	- Reinforced strip footings - Articulation joints at some internal and all external doors - Light reinforcement in masonry - Site drainage and service/plumbing precautions - Foundation pressure not to exceed 50 kPa
		Compaction of in situ soils below individual footings	- Remove in situ material below foundations to a depth and width of 1,5 times the foundation width or to a competent horizon and replace with material compacted to 93% MOD AASHTO density at –1% to +2% of optimum moisture content. - Normal construction with lightly reinforced strip foundations and light reinforcement in masonry.
		Deep strip foundations	- Normal construction with drainage requirements. - Founding on a competent horizon below the problem horizon
		Soil raft	- Remove in situ material to 1,0m beyond perimeter of building to a depth and width of 1,5 times the widest foundation or to a competent horizon and replace with material compacted to 93% MOD AASHTO density at –1% to +2% of optimum moisture content. - Normal construction with lightly reinforced strip footings and light reinforcement in masonry.
C2	>10 mm	Stiffened strip footings, stiffened or cellular raft	- Stiffened strip footing or stiffened or cellular raft with articulation joints or solid lightly reinforced masonry. - Bearing pressure not to exceed 50kPa. - Fabric reinforcement in floor slabs. - Site drainage and service/plumbing precautions.
		Deep strip foundations	- As for C1 but with fabric reinforcement in floor slabs
		Compaction of in situ soils below individual footings	- As for C1.
		Piled or pier foundations	- Reinforced concrete ground beams or solid slabs on piled or pier foundations. - Ground slabs with fabric reinforcement. - Good site drainage.
		Soil raft	- As for C1.

Notes:

1. Differential settlement assumed to equal 75% of total settlement
2. The relaxation of some of these requirements, e.g. the reduction or omission of steel or articulation joints, may result in a Category 2 level of expected damage.

Table D7: Foundation design, building procedures and precautionary measures for single-storey residential buildings founded on expansive soil horizons (SAICE, 1995)

Site Class	Estimated Total Heave	Construction Type	Foundation Design and Building Procedures
H	<7,5 mm	Normal	- Normal construction (strip footing or slab-on-the-ground foundations) - Good site drainage and service/plumbing precautions recommended.
H1	7,5 – 15 mm	Modified normal	- Lightly reinforced strip footings - Articulation joints at all internal/external doors - Light reinforcement in masonry - Site drainage and service/plumbing precautions
		Soil raft	- Remove in situ material to 1,0m beyond perimeter of the structure and replace with inert backfill, compacted to 93% MOD AASHTO density at –1% to +2% of optimum moisture content. - Normal construction with lightly reinforced strip footings and light reinforcement in masonry if residual movements are <7,5mm, or construction type appropriate to residual movements. - Site drainage and plumbing/service precautions.
H2	15-30 mm	Stiffened or cellular raft	- Stiffened or cellular raft with articulation joints or lightly reinforced masonry. - Site drainage and plumbing/service precautions.
		Piled construction	- Piled foundations with suspended floor slabs with or without ground beams. - Site drainage and plumbing/service precautions.
		Split construction	- Combination of reinforced brickwork/block work and full movement joints. - Suspended floors of fabric-reinforced ground slabs acting independently from the structure. - Site drainage and plumbing/service precautions.
		Soil raft	- As for H1.
H3	>30 mm	Stiffened or cellular raft	- As for H2.
		Piled construction	- As for H2.
		Soil raft	- As for H1.

Notes:

1. Differential movement assumed to equal 50% of total heave.
2. The relaxation of some of these requirements, e.g. the reduction or omission of steel or articulation joints, may result in a Category 2 level of expected damage.

Table D8: SANS634-1: Geotechnical Constraints in Urban Development (SANS 634:2012 Edition 1)

1	2	3	4	5
Constraint		Descriptor		
Letter	Description	1 (most favourable)	2 (intermediate)	3 (least favourable)
A	Collapsible soil	Any collapsible horizon or consecutive horizons totalling a depth of less than 750 mm in thickness*	Any collapsible horizon or consecutive horizons with a depth of more than 750 mm in thickness	A " least favourable situation for this constraint does not occur
B	Seepage	Permanent or perched water table more than 1,5 m below ground below	Permanent or perched water table less than 1,5 m ground surface surface	Swamps and marshes
C	Active soil	Low soil-heave potential anticipated*	Moderate soil-heave potential anticipated	High soil-heave potential anticipated
D	Highly compressible soil	Low soil compressibility anticipated*	Moderate soil compressibility anticipated	High soil compressibility anticipated
E	Erodability of soil	Low	Intermediate	High
F	Difficulty of excavation to 1,5 m depth	Scattered or occasional boulders less than 10 % of the total volume*	Rock or hardpan pedocretes between 10 % and 40 % of the total volume	Rock or hardpan pedocretes more than 40 % of the total volume
G	Undermined ground	Undermining at a depth greater than 200 m below surface (except where total extraction mining has not occurred)	Old undermined areas to a depth of 200 m below surface where stope closure has ceased	Mining within less than 200 m of surface or where total extraction mining has taken place
H	Stability (dolomite land)	Possibly stable. Areas of dolomite overlain by Karoo rocks or intruded by sills. Areas of Black Reef rocks. Anticipated inherent hazard class 1 (see SANS 1936-2)	Potentially characterized by instability. Anticipated inherent classes 2 to 5 (see SANS 1936-2)	Known sinkholes and dolines. Anticipated inherent hazard classes 6 to 8 (see SANS 1936-2)
I	Steep slopes	Between 2° and 6° (all regions)	Slopes between 6° and 18° and less than 2° (Natal and Western Cape) Slopes between 6° and 12°and less than 2° (all other regions)	More than 18° (Natal and Western Cape) More than 12° (all other regions)
J	Areas of unstable natural slopes	Low risk	Intermediate risk	High risk (especially in areas subject to seismic activity)
K	Areas subject to seismic activity	10 % probability of an event less than 100 cm/s² within 50 years	Mining-induced seismic activity more than 100 cm/s²	Natural seismic activity more than 100 cm/s²
L	Areas subject to flooding	A" "most favourable" situation for this constraint does not occur	Areas adjacent to a known drainage channel or floodplain with slope less than 1 %	Areas within a known drainage channel or floodplain

Note 1: Areas should be designated by the numeral associated with the most appropriate descriptor in columns 3 to 5 followed by the letter associated with the constraint. For example, an area designated as Zone 2BF would be an intermediate class with anticipated seepage and excavation problems while an area designated as Zone 3B would be least favourable and not recommended for development due to surface water inundation.

Note 2: More detailed information on undermined land can be obtained from Stacey, T.R. and Bakker, D. The erection or construction of buildings and other structures on undermined ground. NOTE 3 Undermining assessments should be carried out by persons with expert knowledge of such conditions.

* *These areas are designated as 1A, 1C, 1D, or 1F where localized occurrences of the constraint might arise.*