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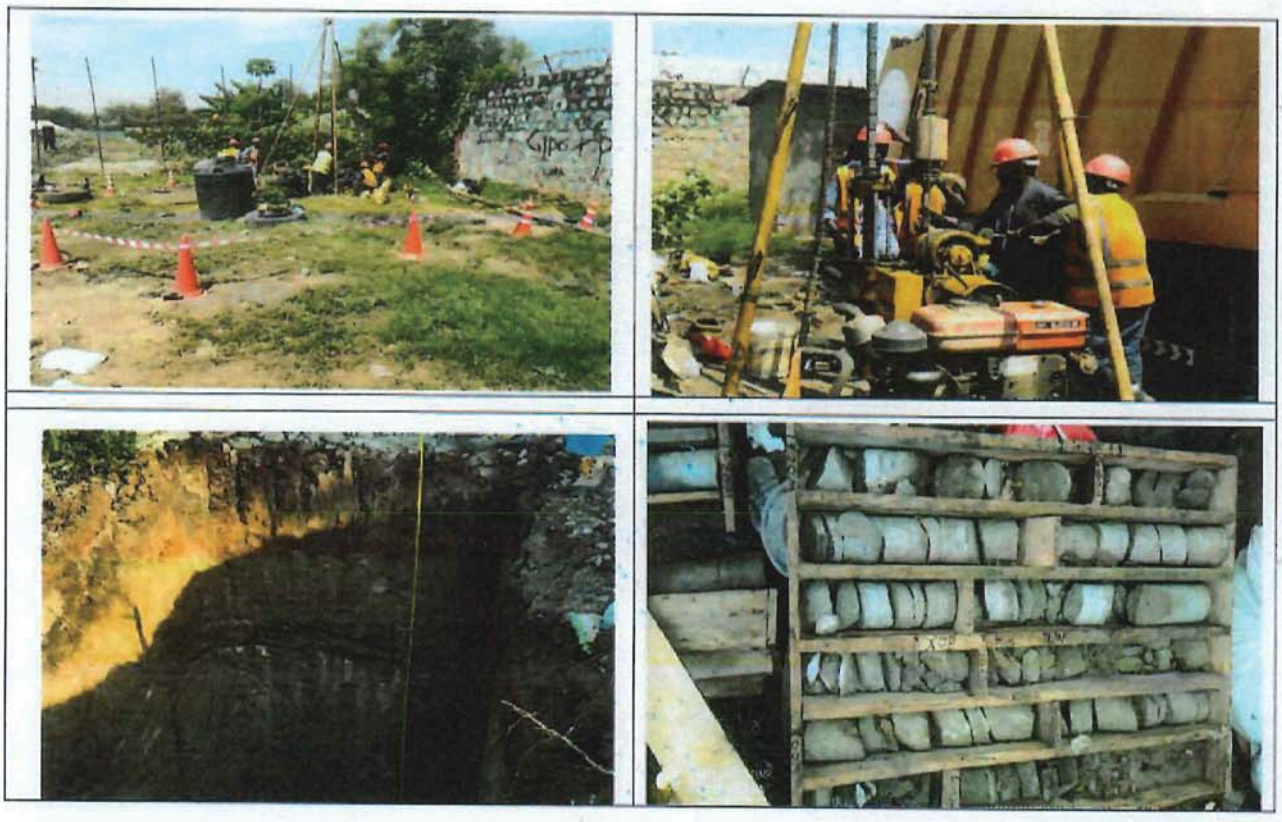
GEOTECHNICAL INVESTIGATION REPORT

FOR

THE PROJECT FOR IMPROVEMENT OF WASTE MANGEMENT IN JUBA, THE REPUBLIC OF SOUTH SUDAN

PREPARED BY

AB HARAMBE ENGINEERING AND CONSTRUCTION LTD



FOR: Yachiyo Engineering Co., Ltd. (yec)

FEBRUARY 2021

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AB HARAMBE ENGINEERING & CONSTRUCTION LTD ★ SOUTH SUDAN ★

MINISTRY OF LOCAL GOVERNMENT GOVERMENT OF SOUTH SUDAN

Geo technical investigation report for the Project for Improvement of Waste Management in Juba, the Republic of South Sudan.

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Contractor：

AB HARAMBEE ENGINEERING AND CONSTRUCTION LTD.

DRECO-MATTS
Drilling, Engineering & Construction Technical Support

Laboratory Contractor：

DRECOMATTS LIMITED

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1.0 INTRODUCTION

1.1 Background

Juba is the capital of Republic of South Sudan and serves as the Head quarter of Central Equatorial state. It has spectacular rugged high relief landscape and plains recording an average altitude of 468 meter above sea level. The mountain covers the East, west and north part of Juba forming sharp scenic peaks and wide valley. The project area is situated 400 meters from the **White Nile River plains.**

In November 2020 **AB HARAMBE ENGINEERING AND CONSTRUCTION Ltd** Was contracted by **Yachiyo Engineering Co., Ltd. (yec)** to carry out ground investigation for the proposed development of Building for maintenance of waste collection vehicle in down town Juba. The ground investigations were required to determine Geo technical information including design parameters for the proposed structural foundations and any associated infrastructure. The Geo technical investigations were conducted taking into account BS 5930: 1999 "Code of Practice for Site Investigations".

AB HARAMBE ENGINEERING AND CONSTRUCTION Ltd sub contracted a professional Geo technical and Material Engineering firm trading as **Drecomatts Limited** based in Nairobi Kenya, to undertake the laboratory tests and analysis.

The Geotechnical investigations were performed from the 09^{the} of November to 19th of December 2020 and **4** boreholes were drilled to a maximum depth of 20m and 2 excavated pits to a depth of 2m below ground level. In total, 70 m were drilled & 4 m were excavated, Standard Penetration Tests were performed. Disturbed soil samples were abstracted for each change of layer in each borehole for further laboratory analyses.

The Geotechnical contractor's responsibility under this contract is to carry intrusive sampling, collection of field data, laboratory testing and interpretation of ground conditions encountered during the ground investigation (and any results of the desk study) to aid in the design of the proposed underground structures. AB Harambe Engineering and Construction Ltd personnel are not the designers and are not responsible for validation of any proposed design. The information

provided is however expected to be sufficient for a competent designer to undertake the design of all relevant parts of the structures.

1.2 Objective

The purpose of this report is to investigate and provide reliable, specific and detailed information about the physical, mechanical properties, thickness of the foundation ground, as well as to provide the designer with the necessary information which will be required for a safe and economic design and excavation of the engineering works, such as the soil bearing capacity, recommended foundation depth and type and other special recommendation which depends on the nature of the site .The overall purpose was to evaluate the conditions of the existing soils to generate necessary data for foundation structural design.

The specific objectives are to:

- Ascertain the soil profiles at the locations of the proposed substructure (foundation).
- Establish strength (allowable bearing capacities) and classify soils of proposed project area.

1.3 Scope of Geotechnical Investigation

The scope of the Ggeotechnical investigations comprised of the following:

1. Review of available data pertinent to the site.

2. Making visits to the site in order to collect information about site nature, topography of the site, geological features and other properties concerning the project site.

3. Drilling of Four boreholes (BH) and sampling of disturbed and undisturbed samples. Excavating two inspection trenches (EP) in addition to the above 4 bore holes. Logging of all the boreholes and inspection pits for strata profiling.

4. Performing the necessary field and laboratory tests, and carrying out the geological description of the obtained materials including Logging of all the boreholes and inspection pits for strata profiling;Carrying out Standard Penetration Tests at 1.5m intervals; Registering the ground water occurrence (depth of water table) for each borehole and inspection pit and

Laboratory testing of disturbed and undisturbed samples for classification properties i.e. particle size distribution and grading curve,Atterberg limit, moisture content, triaxial test and Unconfined Comprehensive strength;

5. Applying engineering analysis of field findings and laboratory results.

6. Developing conclusions and recommendations concerning design and construction of the safest and economical foundations.

1.4 Site Description

The project is intended for the construction of the new workshop building which is to maintain the condition of waste collection vehicle at Juba Town. The project area is located inside the premises of the Ministry of Local Government opposite Juba prison.

The six test points are located at the following coordinates

BH1: - lcoated at Easting's: 346592.67 and Northings: 536232.032) at elevation of 460.124

BH2: - llocated at easting: 346226.944 and Northings: 536226.841) at elevation of 460.137

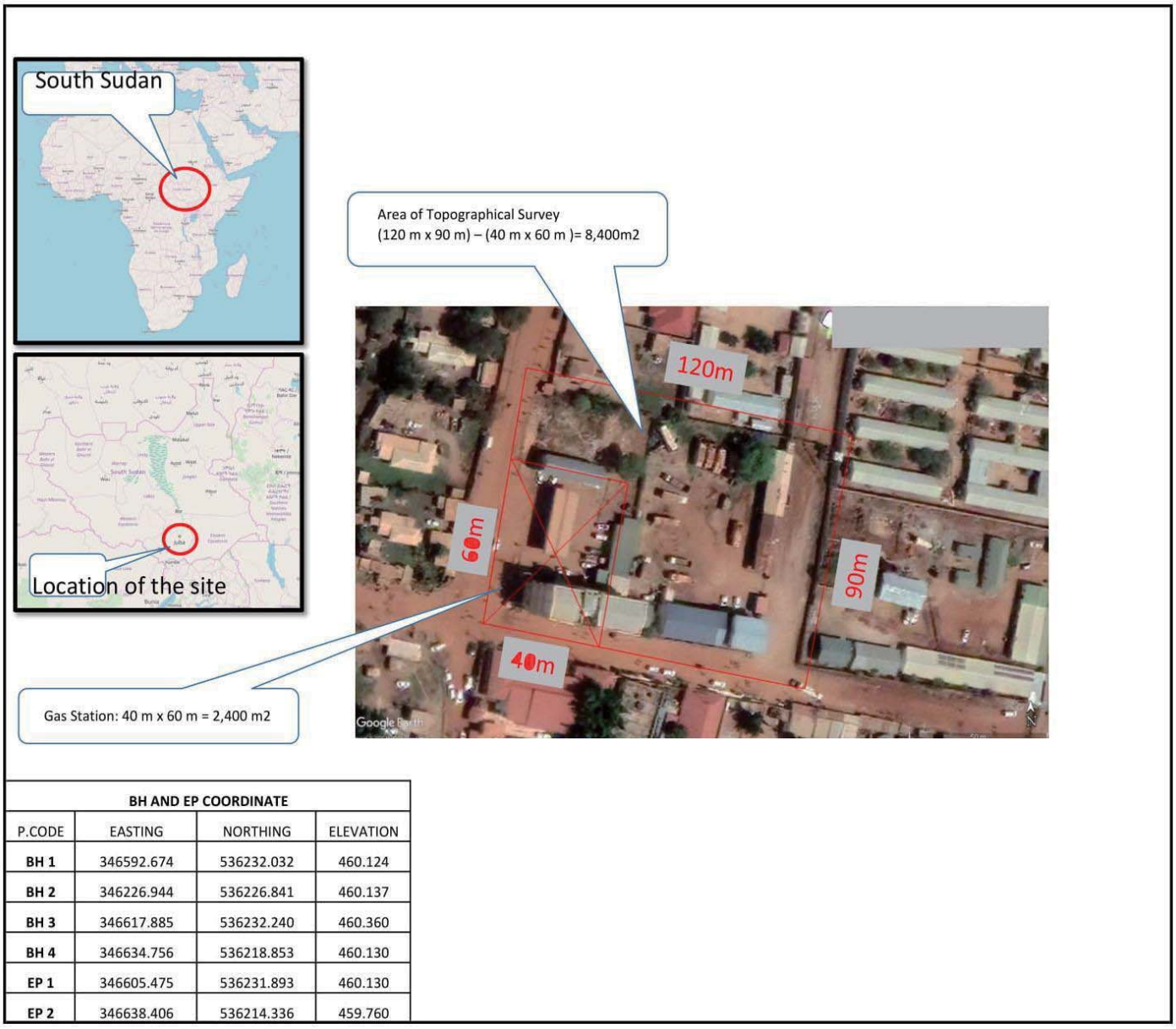
BH3: - located at easting: 346617.885 and Northings: 536232.24) at elevation of 460.360

BH4: - llocated at easting: 346634.756 and Northings: 536218.853) at elevation of 460.130

EP1: - llocated at easting: 346605.475 and Northings: 536231893) at elevation of 460.130

EP2: - llocated at easting: 346638.406 and Northings: 536214.336) at elevation of 459.760

The site location map/view is depicted in **Figure 1** and **Figure 2** below.



BH AND EP COORDINATE			
P.CODE	EASTING	NORTHING	ELEVATION
BH 1	346592.674	536232.032	460.124
BH 2	346226.944	536226.841	460.137
BH 3	346617.885	536232.240	460.360
BH 4	346634.756	536218.853	460.130
EP 1	346605.475	536231.893	460.130
EP 2	346638.406	536214.336	459.760

Figure 1: Map of The Project Site of the Republic of South Sudan

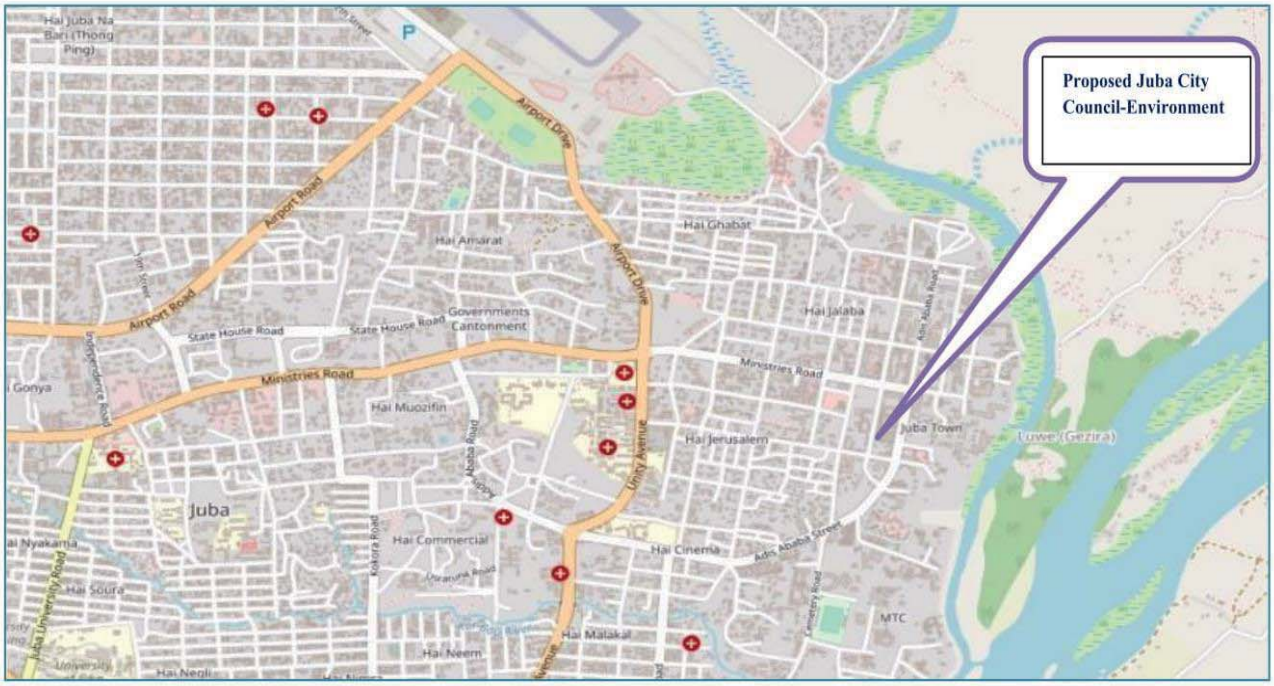
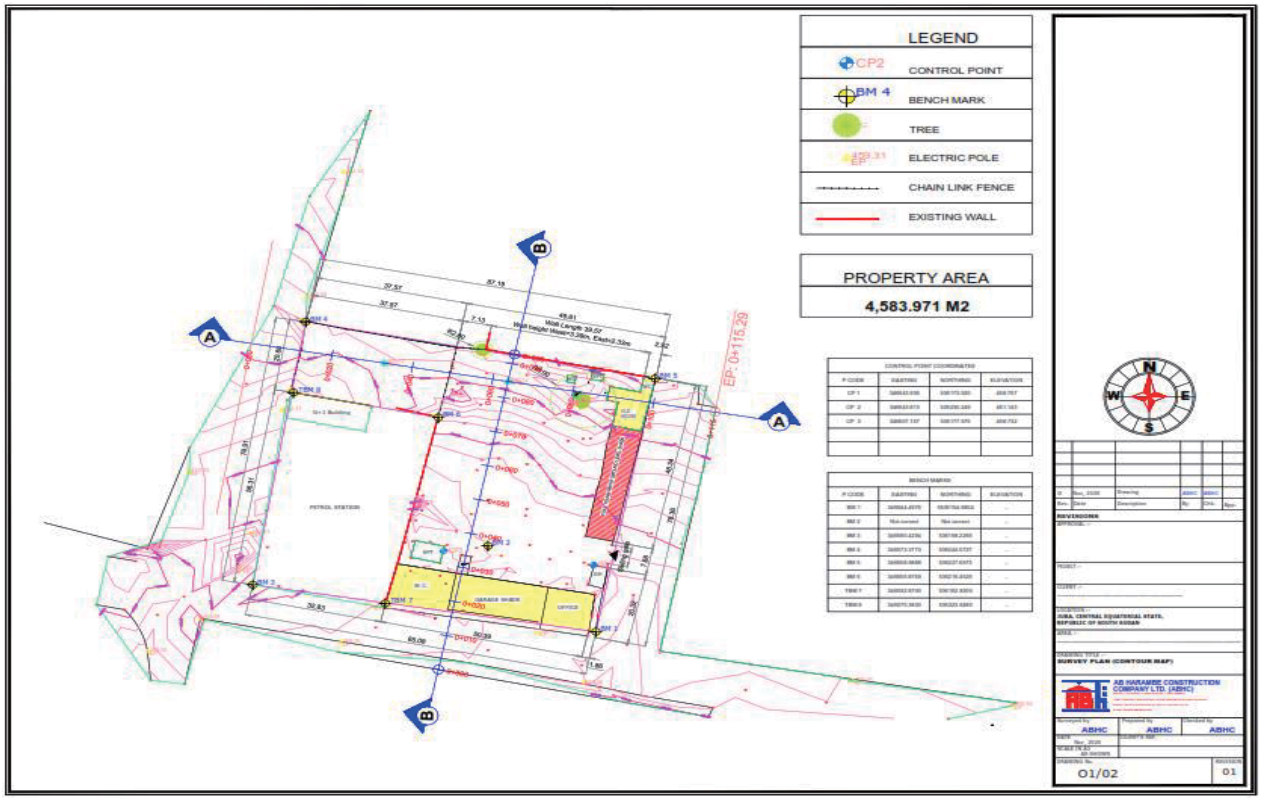


Figure 2: Map of Juba City



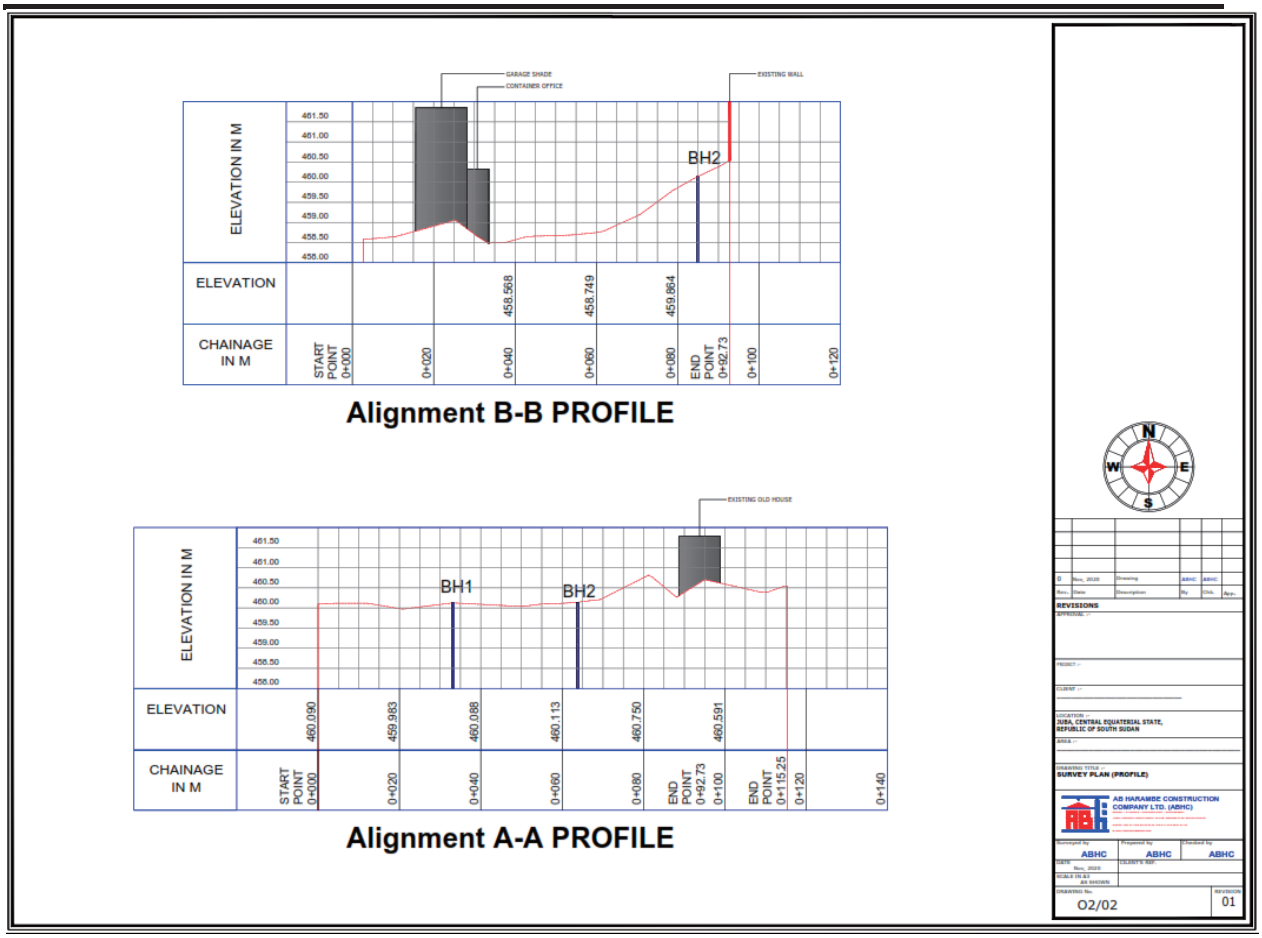


Figure 3: Topographic Map of the proposed site

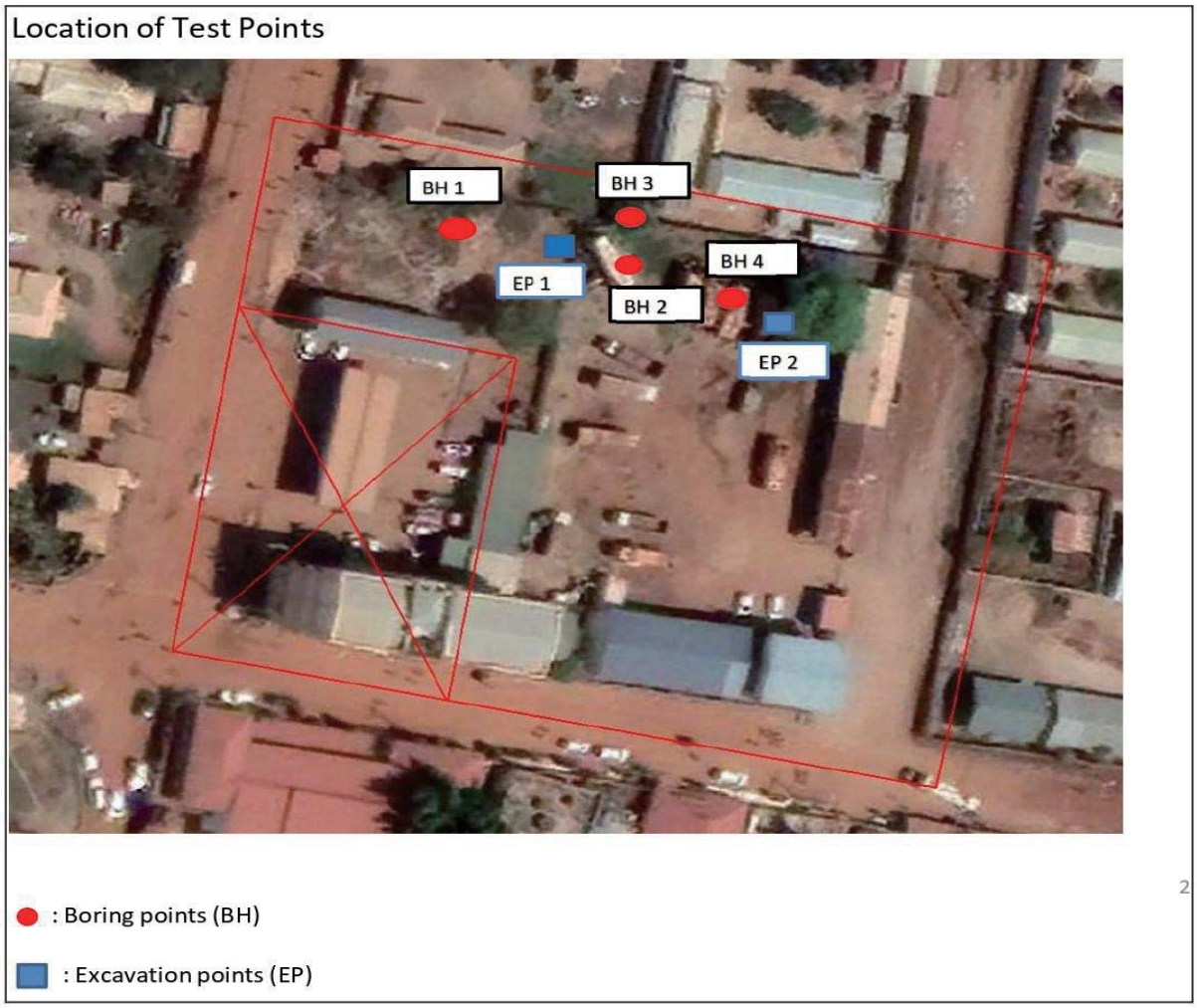


Figure 4: Site location map of the boreholes (BH) and Excavation pits (EP)

1.5 Geology

The geological maps (e.g. **Figure 4**) indicate the site is underlain by a metamorphic complex which forms basement complex intruded by granitic and dolerite rocks. The basement is overlain by alluvial and surficial deposits. The geophysical study that was done by University f Juba, Geology & Mining College of Natural Resources and Environmental Studies reveals the basement complex comprises of four types of Gneiss i.e. 1) banded Gneiss, 2) Biotitic gneiss, 3) augend gneiss and 4) Nile gneiss.

1) The Banded Gneiss has clear bands which are light Grey on fresh surface and light brown on weathered surface. They are composed principally of quartz, feldspar mica and pyroxenes with

subordinate amphiboles. They are high grade metamorphic rock that occurs as parent rock hosting many intrusions such as granitic, plutons and dykes. Foliations and quartz veins are highly visible. The texture is medium to coarse grained.

2) Biotitic Gneisshey looks Grey on the fresh surface and dark on weathered surface. It is composed of Biotitic, amphiboles, hornblende, quartz, feldspar and it has a coarse-grained texture.

3) Amgen Gneiss they form very large exposure associated with quartz-Feld spathic with some which are wholly porphyroblastic. The main constituents of Augend are the quartz, feldspar or amphiboles. Weathered surface of this Amgen gneiss is greyish to brownish and fresh surface is light Grey.

4) Nile gneisses are composed principally of gneisses of amphibolite facies with subordinate meta-sediments and amphibolite. Foliations trends are poorly defined but generally in Northerly direction.

Site geology: The site falls in a pre-cabrian shield underlain by metamorphic rock composed dominantly of Gneisses and granitic rocks that are medium to high grade metamorphic deformed during end pre-cabrian Pan African organic even. The rocks are generally hard and impermeable and occurs at shallow depths (2.5 to 10m) mainly underlain by predominantly alluvial cays and silts with some particles of sand and gravel. The depth of groundwater in Juba remain constant at 1.5-2m during the drilling period. The water level was take about 10-35 days on completion of drilling exercise and after heavy rains had hit the area. This water table will vary during the rainy season and it might disappear completely during the dry season yet it’s the longest.

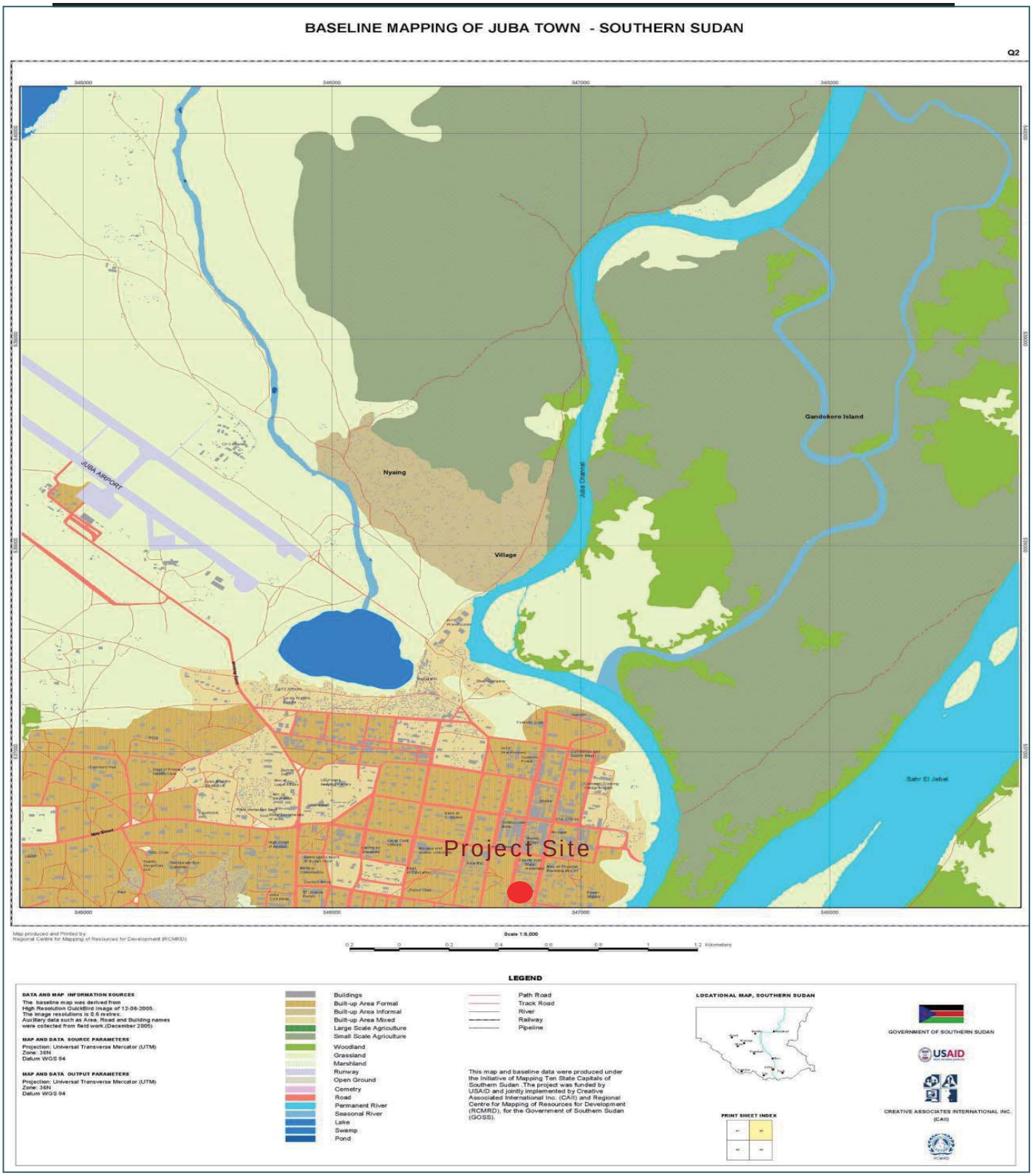


Figure 5: Baseline map of Juba City

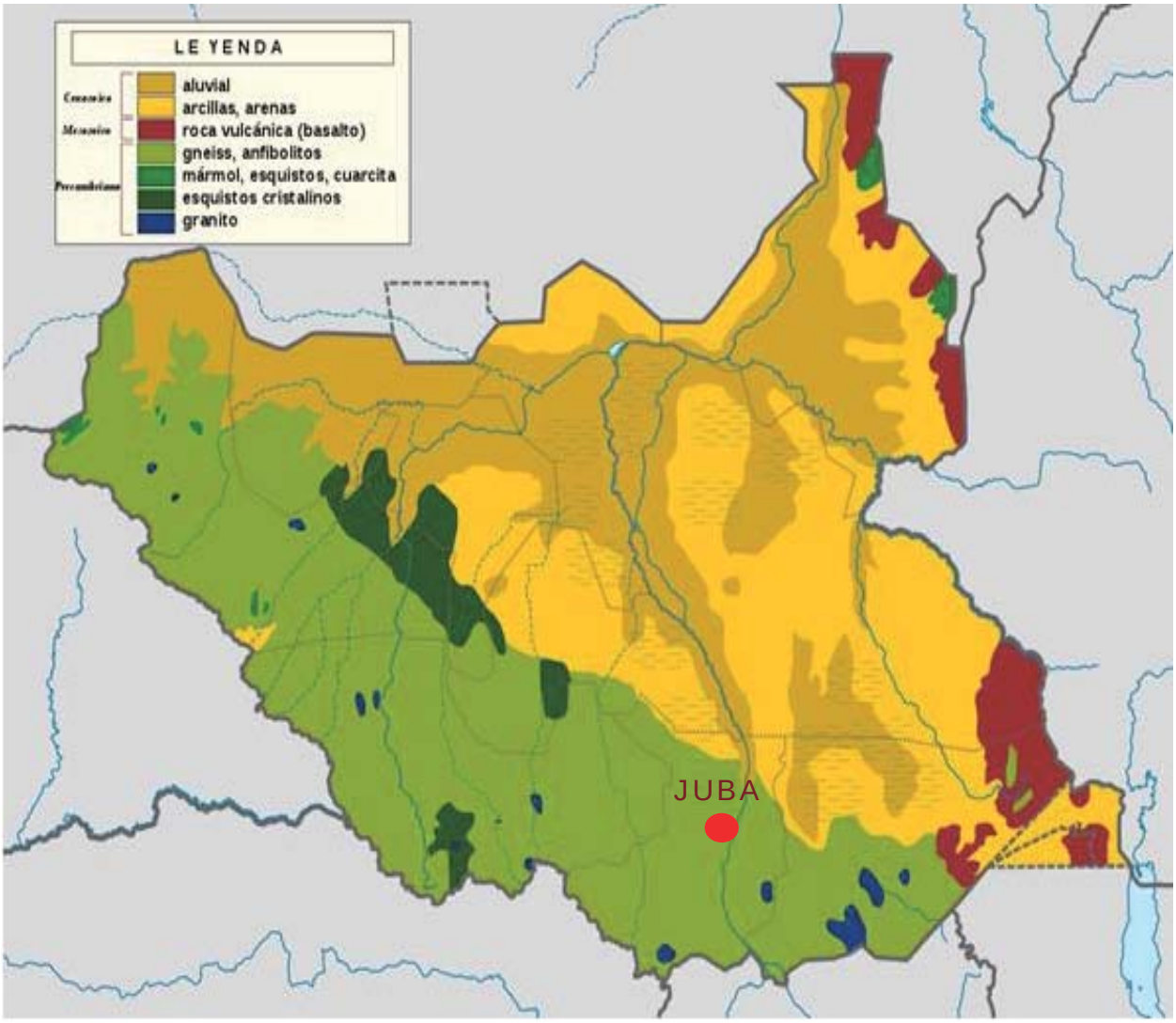


Figure 6: Geological map of Republic of South Sudan

2.0 GEOTECHNICAL INVESTIGATION

2.1 Introduction

All exploratory activities were conducted in accordance with BS 5930: 1990 "Code of Practice for Site Investigations" and included Excavation of 2 inspection pits and drilling of **4** Boreholes using XY-100 rotary drilling rig, sampling, logging, backfilling of the boreholes, SPT testing and laboratory testing of the recovered samples. Subsequent sections of this report show the details recorded during the investigation. The boreholes field-work summary is presented in **Table 1**

below. The exact location of the drilling points is shown on a site drawing attached in **Appendix1**.

2.2 Boring, Sampling and Logging

Each borehole was profiled according to 'A Guide to Practical Geotechnical Engineering in Southern Africa: 1995' and BS 5930:1990, sampled as instructed by the client. The test points were later backfilled. Detailed soil profiles of the exploratory boreholes are presented in **Appendix 3** of this report. The photographic record of the investigation is shown in **Appendix 3** and **Appendix 14**.

Table 1: Borehole Coordinates, Depth Investigated & Position of GWT

BH No.	Elevation(m)	Coordinates		Started Date	Finished Date	Drilling /excavation Depth (m)	No. of Disturbed Samples	No. of Undisturbed Samples	No. of SPTs
		X	Y						
BH1	460.124	346592.67	536232.032	23-11-20	26-11-20	15.0	5	0	3
BH2	460.137	346226.944	536226.841	16-12-20	20-12-20	15.0	5	0	2
BH3	460.360	346617.885	536232.24	16-11-20	18-11-20	20.0	5	0	4
BH4	460.130	346634.756	536218.853	18-12-20	20-12-20	20.0	5	0	2
EP1	460.130	346602.475	536231.893	15-12-20	15-12-20	2.0	2	0	0
EP2	459.760	346634.756	536218.853	15-12-20	15-12-20	2.0	2	0	0

2.3 Ground Water Table

Ground water table (GWT) was not recorded during the drilling period but after 9-30 days it was recorded. On BH1 it stood at 2.0m, BH2 at 1.5m, BH3 at 1.3m, BH4 at 1.2, at EP1 at 1.1m and EP2 at 1.4m below ground level.

Table 2; -Water level

Location	**Water level (m)**	**Elapsed time (days)**	
BH1	2.0	20	
BH2	1.5	30	
BH3	1.3	14	
BH4	1.2	16	
EP1	1.1	10	
EP2	1.4	10	

2.4 Field Investigation Challenges

Two challenges were encountered in the field, on bore hole one (BH1) the upper layers collapsed on the drilling tool at 15m.The drilling head gear systems and associated jaws holding the spindle rod broke down while trying to remove the stuck tools. Two drillers left work mid-way without notice.

Another challenge was accessing drilling spare parts and experienced Engineering Workshop in Juba. The problem was solved with experts for drilling machine, who was able to get a solution with capability to fabricate the gear systems.

2.5 Standard Penetration Tests (SPT)

Standard Penetration Tests (SPTs) were performed in each borehole at intervals presented in **Table 3** below and comprised of the following:

- Conducted using a 63.5 kg driving hammer falling ("free fall") from a height of 760 mm.
- Driving the standard split-barrel sampler of internal and external diameters 35mm and 50mm respectively to reach a distance of 450 mm into the soil at the bottom of the boring at every 1.5m depth interval.
- Counting the number of blows required to drive the sampler each 150 mm increment of a total of 450 mm penetration. The blow count for the first 150 mm increment was discarded and the sum of the blow counts for the last 300 mm increment was recorded as the SPT ‘N’ value.

According to Clayton (1993), apart from the soil conditions in which the test is made, the result of the SPT test is influenced by three main groups of factors associated with: drilling or boring technique, SPT test equipment and test procedure. The influence of these factors is considered below.

The measured SPT ‘N’ values were corrected for the overburden, equipment and borehole to establish the corrected SPT ‘N_{cor}’ values, from which estimated soil design parameters were ascertained and presented in **Appendix 6** of this report. The overburden correction factor for clayey soil is 1.0. The equipmentt and borehole factor correction factors used are highlighted below.

- Equipment correction and borehole size correction factors apply.
- The effect of overburden is negligible for cohesive soils, and no overburden correction factor C_N is required.
- The energy ratio is normalized to 60% of total energy, N_{60}.
- Corrected SPT 'N' value, $N_{cor} = N_{60} = C_N C_{ER} N$. Where, N is measured SPT 'N' value and C_{ER} is equipment & borehole correction factor given by:
- $C_{ER} = C_H C_R C_s C_B$.

Energy ratio correction factors to be applied to SPT value to account for equipment and borehole size (Adapted from Skempton, 1986 and Takimatsu and Seed, 1987). Extracted from "Hand book of Geotechnical investigation and design tables 2nd Edition page 51 table 4.9

To account for	Parameter	Correction factor
Hammer – release – country		
Hammer (C_H)		
Donut – free fall (Tombi) – Japan		1.3
Donut – rope and pulley – Japan		1.1
Safety – rope and pulley – USA		1.0
Donut – free fall (Trip) – Europe, China, Australia		1.0
Donut – rope and pulley – China		0.8 ●
Donut – rope and pulley – USA		0.75
Rod length (C_R)		
>10m		1.0
10m to 6m		0.95
6m to 4m		0.85 ●
4m to 3m		0.75 ●
Sampler (C_s)		
Standard		1.0 ●
US sampler without liners		1.2
Borehole Diameter (C_B)	65mm – 115mm	1.0
	150mm	1.05 ●
	200mm	1.15

Note: The corrected (Ncor) values of 0.6 was determined between rod lengths of 0-4m while a corrected Ncor value of 0.68 was used between 6-4m.

2.5.1 Bearing Capacity Determination

The corrected SPT 'N' values (N_{cor}) in **Table 3** were averaged for the entire depth investigated from the borehole logs, the borehole soils are generally Sands in nature, mixed with significant amounts of gravel; silts were also present. For the purpose of computing the soils' bearing

capacities, all soils were considered cohesive soils. Thus the empirical relationship established by Peck et al., (1974) between corrected SPT 'N' values (N_{cor}) and unconfined compressive strength (q_u) holds and is given below.

$$q_u = kN_{cor}\ kPa$$

Where, k is the proportionality factor established from empirical correlations between the unconfined compressive strength (q_u) and the corrected SPT 'N' values (N_{cor})

A value of *k = 12* has been recommended by Bowles (1996) for a standard energy ratio, R_{es} = 70%. However, based on the 60% standard energy ratio adopted in United Kingdom, a value of *k = 13.27* has been recommended and was used in the computation of the unconfined compressive strength. Thereafter the undrained cohesion (c_u) was obtained from the unconfined compressive strength (q_u) as,

$$c_u = q_u/2\ kPa$$

The ultimate bearing capacity (q_{ult}) was computed from the relationship,

$$q_{ult} = c_u N_c\ kPa$$

Where N_c is the bearing capacity factor for clay/silt soils

Skempton (1951) gives different bearing capacity factor N_c for clay soil with respect to depth and foundation width ratio for different shapes of foundations. For purposes of computations, the least bearing capacity factor N_c of 5.14 was used.

The approximate allowable bearing capacity (q_{all}) in **Table 3** was obtained by dividing the ultimate bearing capacity (q_{ult}) by the Factor of Safety (Fs) of 3.0 irrespective of the site conditions.

$q_{all} = q_{ult}/Fs$ *where stands for Factor of Safety.*

For comparison purposes, Clayton (1993) stated that it is better to always make a rapid, albeit crude estimate of the allowable bearing capacities using more than one method. In this report a quick approximation of the allowable bearing capacities is given by the Terzaghi and Peck (1948) relationship below:

$$\mathbf{q_a = 10N}$$

Where q_a is in kPa.

The allowable bearing capacities from the two methods were identical as shown in **Table 3.** Detailed results for bearing capacities are shown in **Appendix 6.**

Table 3: Approximate Allowable Bearing Capacity from Corrected SPT 'N' Values

BH No.	Depth (m)	Corrected SPT 'N' Value, $(N_{1)60}$	Unconfined Compressive Strength q_u (kPa)	Undrained Cohesion C_u (kPa)	Allowable Bearing Capacity- Terzaghi and Peck (1948) $Q_{all=Ncor}$ (kPa)	Allowable Bearing Capacity Terzaghi and Peck, 1967 Q_{all} (kPa)
BH 1	1.5	>30	>390	>195	>300	>341
	3.0	>30	>390	>195	>300	>341
BH 2	1.5	>30	>390	>195	>300	>341
	2.5	>30	>390	>195	>300	>341
BH 3	1.5	>30	>390	>195	>300	>341
	3.0	>30	>390	>195	>300	>341
	4.5	>34	>398	>226	>340	>387
	5.8	>34	>398	>226	>340	>387
BH 4	1.5	>30	>390	>195	>300	>341
	3.0	>30	>390	>195	>300	>341

2.6 Stratigraphy

The site investigation indicates that the geological sequence at the site generally comprises of mainly clays, silts and sands. **Figure 7** shows drilling logs to a maximum depth of 20m. It shows that ground is very variable across the site.

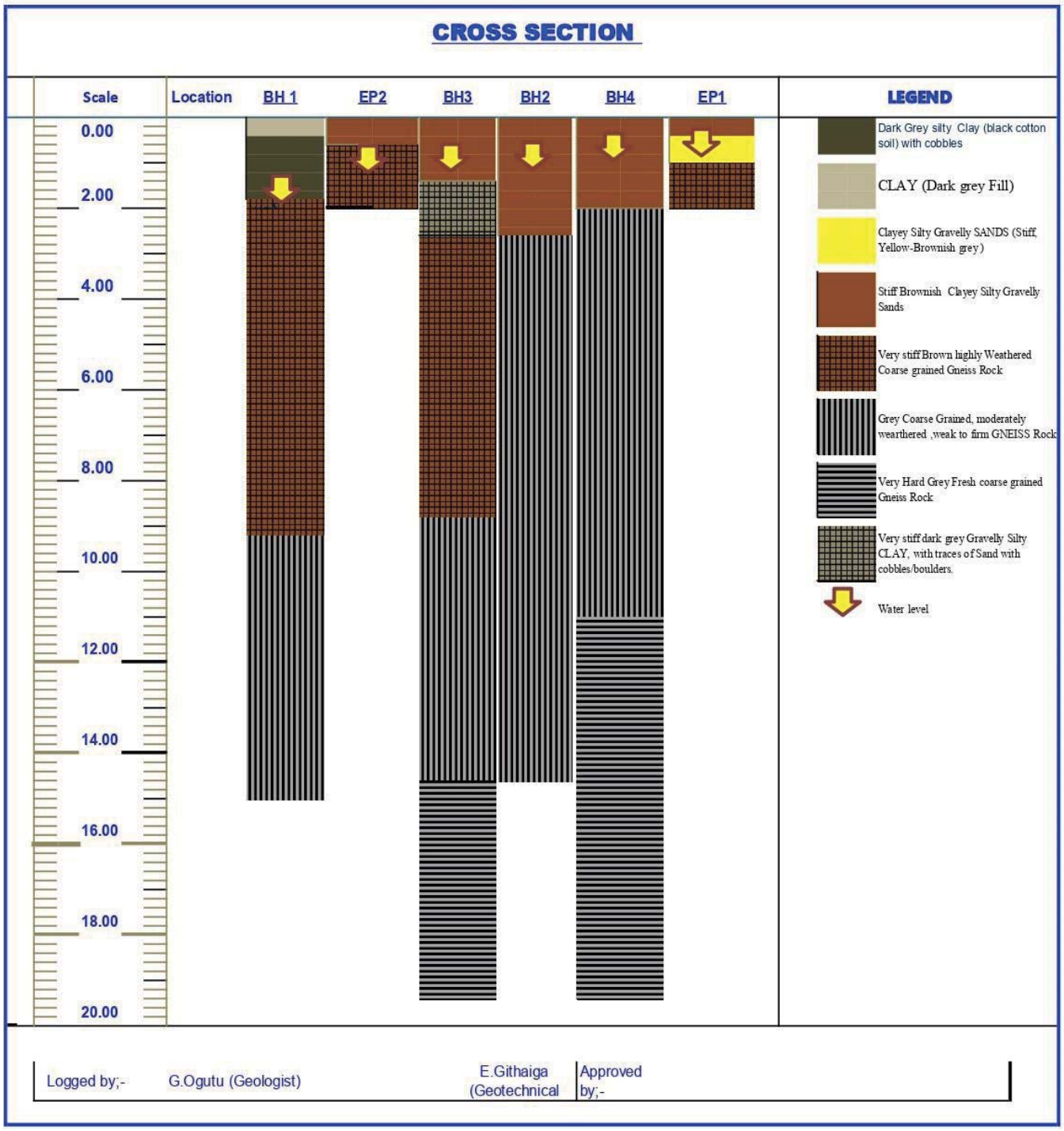


Figure 7: Borehole profiles

3.0 LABORATORY WORK

Soil samples recovered from the boreholes were tested in accordance with the test standard procedures listed in **Table 4** below.

Table 4: Tests on Samples from the Boreholes.

Test Description	International Standard
1. Disturbed Samples	
In-situ Moisture Content	BS 1377: Part 2, Clause 3:1990
Particle Size Distribution	BS 1377: Part 2, Sub cl. 9.2: 1990
Plastic Limit & Plasticity Index	BS 1377: Part 2, Clause 4,5&6:1990
Specific gravity	BS 1377:Part 2, Clause 8: 1990
Compaction test	BS 1377 part 4 1990
2. Undisturbed Samples	
Unconfined Compression	BS 1377:Part 7: 1990
Consolidation test	BS 1377:Part 51990
Triaxial Shear Test	BS 1377:Part 7: 1990
Unconfined compression test-Rock	BS 5930 :Part 7: 2015

3.1 Borehole Laboratory Test Results

Laboratory tests included index property tests and triaxial compression tests.

3.1.1 Moisture content Test Results

Natural moisture content values ranges from 0.3% to 19.5%. A detailed assessment of the data reveals that moisture contents are low. From visual examination, the water content of the stone fraction alone was found to be negligible. Moisture content results are shown on the summary for classification test results attached in **appendix 7**.

3.1.2 Classification Test Results

Borehole soils were classified according to their particle size distribution (PSD) and Natural moisture test results. The summary of the laboratory results is attached in **appendix 7** of the report.

3.1.3 Particle size distribution

Particle size distribution curves for the formations at the site are shown on **Appendix 8**. Results show that the site is underlain by Sandstone, Gravels, Sands and some silts. This is indicated by majority of the grading curves.

3.1.4 Atterberg Limit test results.

A paste specimen made from 150 gm thoroughly mixed portion of air dried material passing 425 micron IS sieve is used to determine the Liquid Limit (LL). This is repeated at least to have four sets of values of penetration in the range of 14 to 28 mm. The plastic limit (the moisture at which the specimen changes from liquid state to solid is determined. The difference between the liquid limit and plastic limit is calculated and reported as Plasticity Index (PI).

PI=LL-PL

The fine grained portions of the material showed a range of plasticity from PI zero to 8.2% as shown on **Appendix 9**.Majority of the samples tested plotted below the A-line on the plasticity chart. It can therefore be concluded that all the fine grained portion of the materials on site predominantly behave as sand and gravel of vary plasticity.

3.1.5 Triaxial tests

a) **Triaxial tests included the Undrained Unconsolidated Triaxial test (UU).** UU test was carried out in accordance with BS1377:1975 and ASTM D 2850 standard procedure. The nominal specimen sizes were 38mm diameter by 76mm length. Compression was carried out at a rate of about 1.5 mm/min (2 % per minute). Disturbed soil samples were remoulded to attain a maximum dry density (MDD) of 70-80% and optimum moisture content (OMC). The resultant specimen was subjected to a confining fluid pressure of 0.5, 1.5 and 2.5Kg/cm2 in a triaxial chamber. Visual classification had shown the soils on test points E1 and E2 to be clays silt and hence adapted UU test method. The laboratory gradation and Atterberg tests classified the soils as Sands and hence the adaption of Direct shear test in the later samples. Test results are as summarised in **Table 6**. Detailed results are attached as **Appendix 11.**

EP1 (0.0-1.0M)	Cell pressure (kg/cm²) σ3	Deviator stress (kg/cm²) (σ1 - σ3)	Major Princ.stress kg/cm²) σ1
TEST 1	0.5	0.94	1.44
TEST 2	1.5	2.18	3.68
TEST 3	2.5	3.42	5.92

EP2 (0.0-1.0M)	Cell pressure (kg/cm²) σ3	Deviator stress (kg/cm²) (σ1 - σ3)	Major Princ.stress kg/cm²) σ1
TEST 1	0.5	0.97	1.47
TEST 2	1.5	2.01	3.51
TEST 3	2.5	3.15	5.65

b) **Direct shear test**. The bulk samples (disturbed) were prepared in the same way as UU (above) and applied a load of 1.02, 2.04 and 3.04Kg/cm2 and shear force at failure recorded in the shear box apparatus. The shear parameters were determined from remoulded specimen to attain 70-80% of, MDD/OMC.

Note two (2) compaction tests were carried out to determine the MDD/OMC for the calculation remolded soils.

The number of test trials carried out on each sample is as summarised in **Table 5**. It should be noted that as a result of the nature of the soils at site, in some cases, the quantity of the sample was inadequate to carry out all test. In all cases no undisturbed samples were recovered.

Location	Depth (m)	Number of Test Trials per sample	
		UU	Direct Shear
EP1	0.00-1.00	1	
BH1	0.00-1.00		1
BH2	1.00-1.50		1
BH3	0.00-1.00		1
BH4	0.00-1.00		1
EP2	0.00-1,00	1	

Table 5: Summary of Triaxial and shear box tests carried out- (Remoulded specimens).

Specimen diameter = 38mm		Bulk Density (kg/m^3	Average Moisture Content (%)	Angle of Internal friction (degrees).	Cohesion (Kg/cm2)
Location	Depth(m)				
EP1	0.0 1.00	2183	9.4	21	0.12
EP2	0.00 - 1.00	1878	19.5	20	0.16
BH1	0.00 - 1.00	1712		27	0.02
BH2	0.00 - 1.00	1680		23	0.12
BH2	1.00 – 2.00	1680		25	0.13
BH3	0.00 - 1.00	1565		26	0.03
BH4	0.00 - 1.00	1580		25	0.09

Table 6: Undrained Unconsolidated triaxial compression and Shear box test results.

Results show the bulk densities for Sands are relatively high ranging between 1565 and 2183kg/m^3. This is attributed to unsaturated soil conditions at site. The angle of internal friction was generally moderate ranging between 20 to 27^o. This is attributed to the fact that the site is underlain by mainly silt sands. The Undrained cohesion was ranging between 0.03 to 0.16 kg/cm2.

Note; In practice undisturbed soil samples (i.e. U100) usually gives reliable results but it was practically impossible to recovered this type of sample) and hence the adoption of remoulded specimens.

3.1.6 Water Table

Occurrence of ground water was monitored in all the Boreholes and water was encountered in all the 6 test points (refer table 2 above).

4 CONCLUSIONS AND RECOMMENDATION

4.1 Conclusion

According to the field exploration, laboratory testing, subsurface conditions and engineering analysis, it can be concluded that the existing ground at the proposed site for Juba City Council Sanitary and Environmental Building is strong enough to support the expected building loads without special modifications and the following recommendations are given:

Ground water table (GWT) was encountered in all the boreholes.

The site is predominantly underlain by Silky-Reddish brown grey clayey silt Sands and highly weather gravelly, Salty Sand.

The drilling logs and bearing capacity results show that the ground is marginally/minimal variable both in the lateral and vertical direction. The consistency for cohesive soils varies from firm to very stiff and that for cohesion less soils varies from dense to very dense.

The soils have a moisture content ranging from 5.6% – 19.5% and the plasticity index is deduced as Non Plastic with LL ranging from from 28.5% to 45.5% which indicates sands/silts of low to none to plasticity tendency.

Less than twenty percent of the soil particles passed sieve 75mm which confirms that the type of soils found in Juba town predominantly silts and sands.

The bearing capacities computed using the two empirical relationships are fairly identical. Estimates of allowable bearing capacities derived from corrected SPT 'N' values vary from each borehole location. There is no direct correlation of the magnitude of SPT N-values with depth especially due to changes in the type of material encountered. In all cases refusal(N-Value>50 was attained at1.5m below ground level giving, allowable bearing capacity of greater than 334Kpa.Abearing capacity of 350 can be adopted for this site.

The soil has angle of internal friction in the range between 20º 23º. The cohesion is in the range between 0.03-0.16 kg/cm and the unconfined compressive strength of underlying weathered rock between 13 to 53N/mm2. The soils at the site are well draining but the rock is impervious.

4.2 Recommendations

1. Depending on the applied stresses from the structures intended to be placed, suitable founding depths should be chosen in such a way that the total net foundation pressure is less than the allowable bearing capacity.

2. Foundation ground; -Based on our findings and analyses of the encountered material, it is recommended that the foundations of the proposed building be laid on moderately weathered Gneiss rock.
3. Foundation depth; - Found at 1.5m across the site.
4. Type of foundation; - Pad type of foundation is recommended (The Engineer to use his preferred type of foundation).
5. Riperbility and method of excavation; - The congenital excavation equipment such as Loaders and Dozers will be needed for excavation works.
6. Surface run off; - It is recommended to protect the foundation ground and excavation from surface water both during and after construction by providing proper drainage and protection system. Surface water, if existed, should be diverted away from the edges of the excavations.
7. All excavations should be supervised by a competent person.

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資料 8 車両整備ワークショップ建設予定地

地盤・地質調査結果

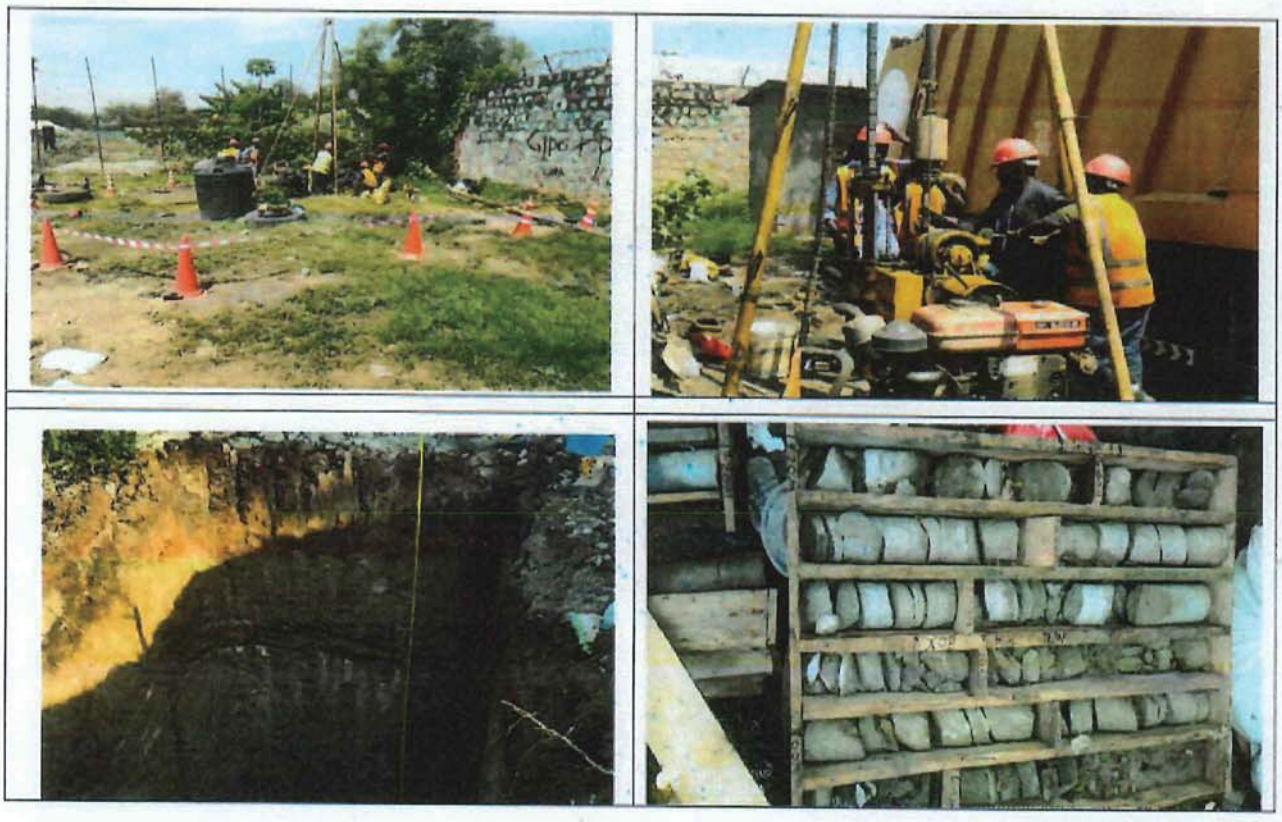
GEOTECHNICAL INVESTIGATION REPORT

FOR

THE PROJECT FOR IMPROVEMENT OF WASTE MANGEMENT IN JUBA, THE REPUBLIC OF SOUTH SUDAN

PREPARED BY

AB HARAMBE ENGINEERING AND CONSTRUCTION LTD



FOR: Yachiyo Engineering Co., Ltd. (yec)

FEBRUARY 2021

南直行

AB HARAMBE ENGINEERING & CONSTRUCTION LTD ★ SOUTH SUDAN ★

MINISTRY OF LOCAL GOVERNMENT GOVERMENT OF SOUTH SUDAN

Geo technical investigation report for the Project for Improvement of Waste Management in Juba, the Republic of South Sudan.

Document No.: DD20-SI-SE-JMC-005

Period of study: 12/11/2020 to 20/12/2020

REV.	DATE	PREPARED	CHECKED	ENDORSED	PAGE(S)	Description
0	15th,February, 2021	ABHEC	ABHEC		149	First submission

Owner：

JUBA CITY COUNCIL.

Contractor：

AB HARAMBEE ENGINEERING AND CONSTRUCTION LTD.

DRECO-MATTS
Drilling, Engineering & Construction Technical Support

Laboratory Contractor：

DRECOMATTS LIMITED

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1.0 INTRODUCTION

1.1 Background

Juba is the capital of Republic of South Sudan and serves as the Head quarter of Central Equatorial state. It has spectacular rugged high relief landscape and plains recording an average altitude of 468 meter above sea level. The mountain covers the East, west and north part of Juba forming sharp scenic peaks and wide valley. The project area is situated 400 meters from the **White Nile River plains.**

In November 2020 **AB HARAMBE ENGINEERING AND CONSTRUCTION Ltd** Was contracted by **Yachiyo Engineering Co., Ltd. (yec)** to carry out ground investigation for the proposed development of Building for maintenance of waste collection vehicle in down town Juba. The ground investigations were required to determine Geo technical information including design parameters for the proposed structural foundations and any associated infrastructure. The Geo technical investigations were conducted taking into account BS 5930: 1999 "Code of Practice for Site Investigations".

AB HARAMBE ENGINEERING AND CONSTRUCTION Ltd sub contracted a professional Geo technical and Material Engineering firm trading as **Drecomatts Limited** based in Nairobi Kenya, to undertake the laboratory tests and analysis.

The Geotechnical investigations were performed from the 09^{the} of November to 19th of December 2020 and **4** boreholes were drilled to a maximum depth of 20m and 2 excavated pits to a depth of 2m below ground level. In total, 70 m were drilled & 4 m were excavated, Standard Penetration Tests were performed. Disturbed soil samples were abstracted for each change of layer in each borehole for further laboratory analyses.

The Geotechnical contractor's responsibility under this contract is to carry intrusive sampling, collection of field data, laboratory testing and interpretation of ground conditions encountered during the ground investigation (and any results of the desk study) to aid in the design of the proposed underground structures. AB Harambe Engineering and Construction Ltd personnel are not the designers and are not responsible for validation of any proposed design. The information

provided is however expected to be sufficient for a competent designer to undertake the design of all relevant parts of the structures.

1.2 Objective

The purpose of this report is to investigate and provide reliable, specific and detailed information about the physical, mechanical properties, thickness of the foundation ground, as well as to provide the designer with the necessary information which will be required for a safe and economic design and excavation of the engineering works, such as the soil bearing capacity, recommended foundation depth and type and other special recommendation which depends on the nature of the site .The overall purpose was to evaluate the conditions of the existing soils to generate necessary data for foundation structural design.

The specific objectives are to:

- Ascertain the soil profiles at the locations of the proposed substructure (foundation).
- Establish strength (allowable bearing capacities) and classify soils of proposed project area.

1.3 Scope of Geotechnical Investigation

The scope of the Ggeotechnical investigations comprised of the following:

1. Review of available data pertinent to the site.

2. Making visits to the site in order to collect information about site nature, topography of the site, geological features and other properties concerning the project site.

3. Drilling of Four boreholes (BH) and sampling of disturbed and undisturbed samples. Excavating two inspection trenches (EP) in addition to the above 4 bore holes. Logging of all the boreholes and inspection pits for strata profiling.

4. Performing the necessary field and laboratory tests, and carrying out the geological description of the obtained materials including Logging of all the boreholes and inspection pits for strata profiling;Carrying out Standard Penetration Tests at 1.5m intervals; Registering the ground water occurrence (depth of water table) for each borehole and inspection pit and

Laboratory testing of disturbed and undisturbed samples for classification properties i.e. particle size distribution and grading curve,Atterberg limit, moisture content, triaxial test and Unconfined Comprehensive strength;

5. Applying engineering analysis of field findings and laboratory results.

6. Developing conclusions and recommendations concerning design and construction of the safest and economical foundations.

1.4 Site Description

The project is intended for the construction of the new workshop building which is to maintain the condition of waste collection vehicle at Juba Town. The project area is located inside the premises of the Ministry of Local Government opposite Juba prison.

The six test points are located at the following coordinates

BH1: - lcoated at Easting's: 346592.67 and Northings: 536232.032) at elevation of 460.124

BH2: - llocated at easting: 346226.944 and Northings: 536226.841) at elevation of 460.137

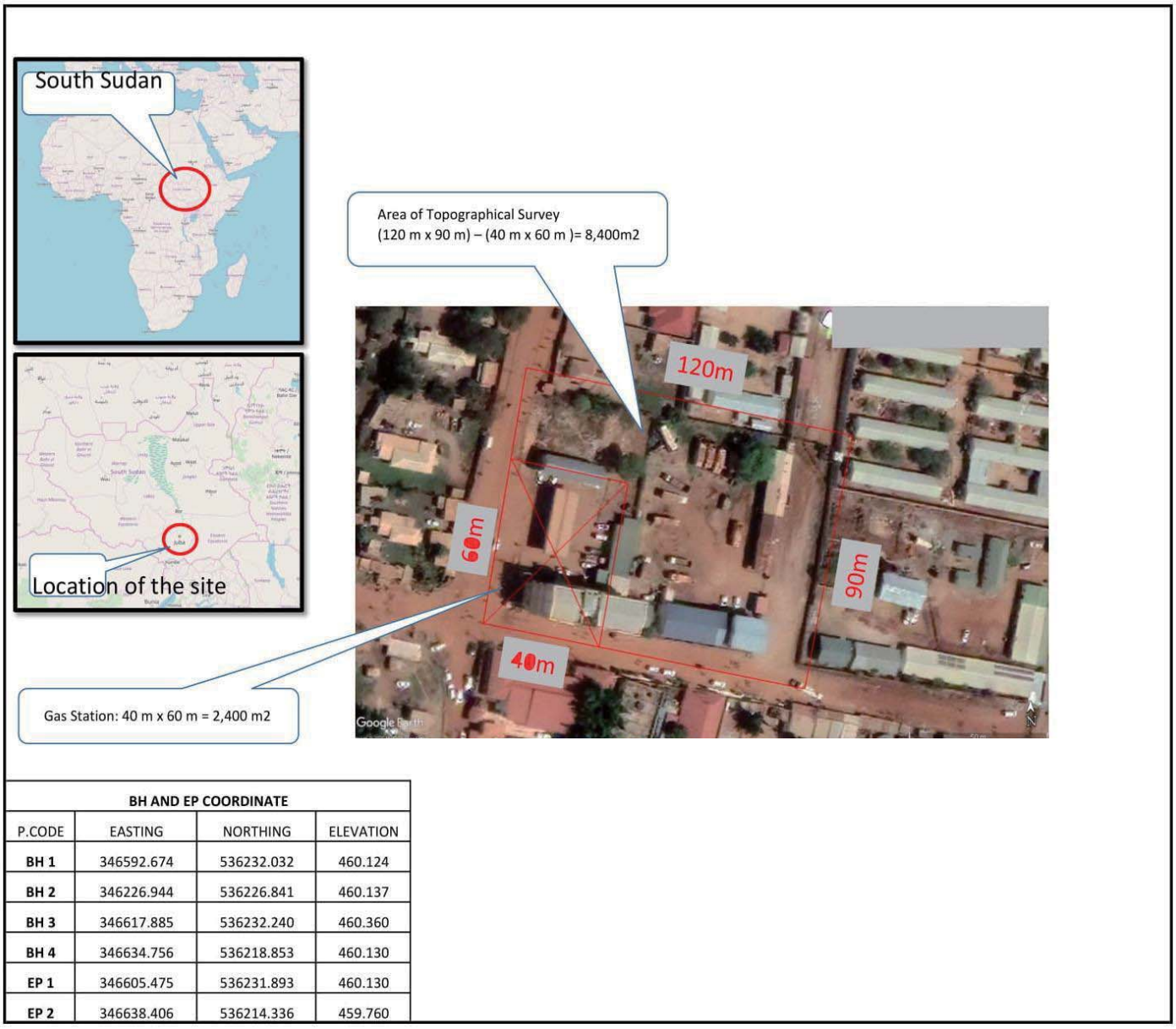
BH3: - located at easting: 346617.885 and Northings: 536232.24) at elevation of 460.360

BH4: - llocated at easting: 346634.756 and Northings: 536218.853) at elevation of 460.130

EP1: - llocated at easting: 346605.475 and Northings: 536231893) at elevation of 460.130

EP2: - llocated at easting: 346638.406 and Northings: 536214.336) at elevation of 459.760

The site location map/view is depicted in **Figure 1** and **Figure 2** below.



BH AND EP COORDINATE			
P.CODE	EASTING	NORTHING	ELEVATION
BH 1	346592.674	536232.032	460.124
BH 2	346226.944	536226.841	460.137
BH 3	346617.885	536232.240	460.360
BH 4	346634.756	536218.853	460.130
EP 1	346605.475	536231.893	460.130
EP 2	346638.406	536214.336	459.760

Figure 1: Map of The Project Site of the Republic of South Sudan

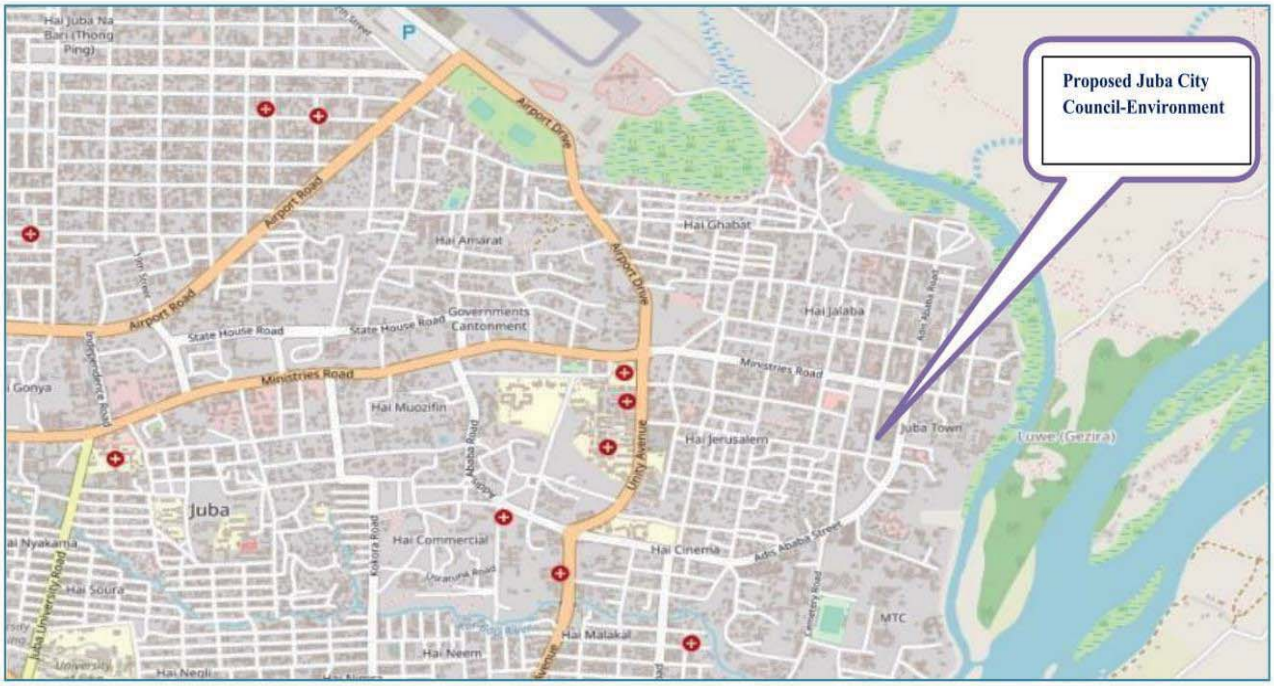
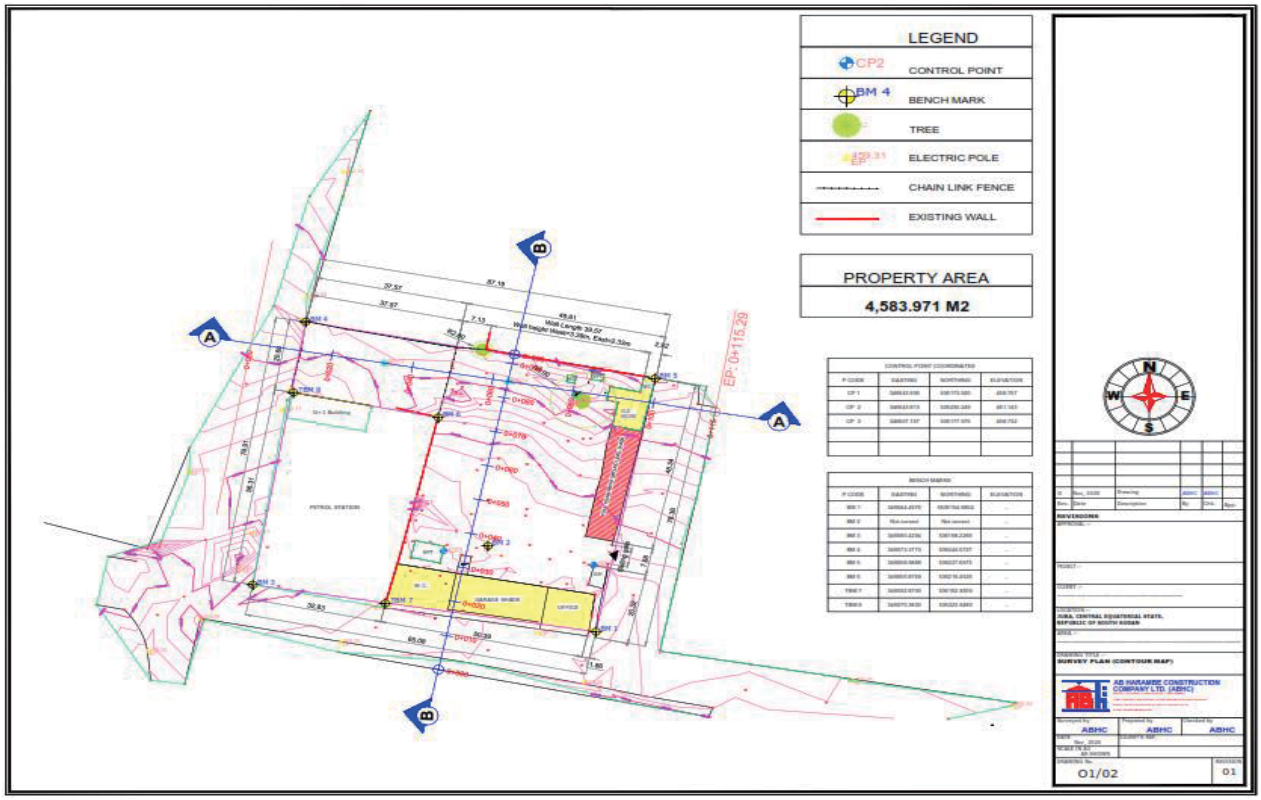


Figure 2: Map of Juba City



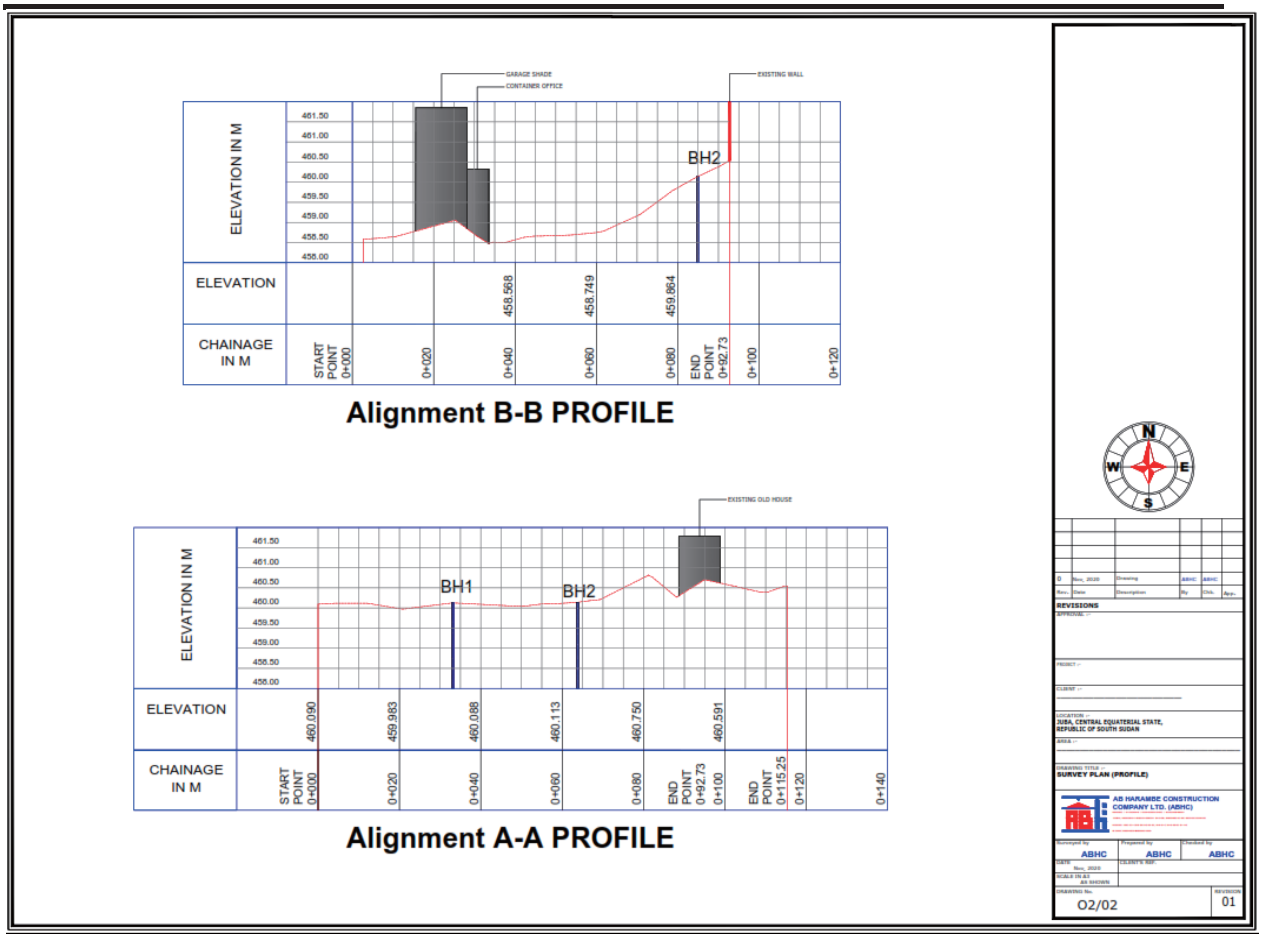


Figure 3: Topographic Map of the proposed site

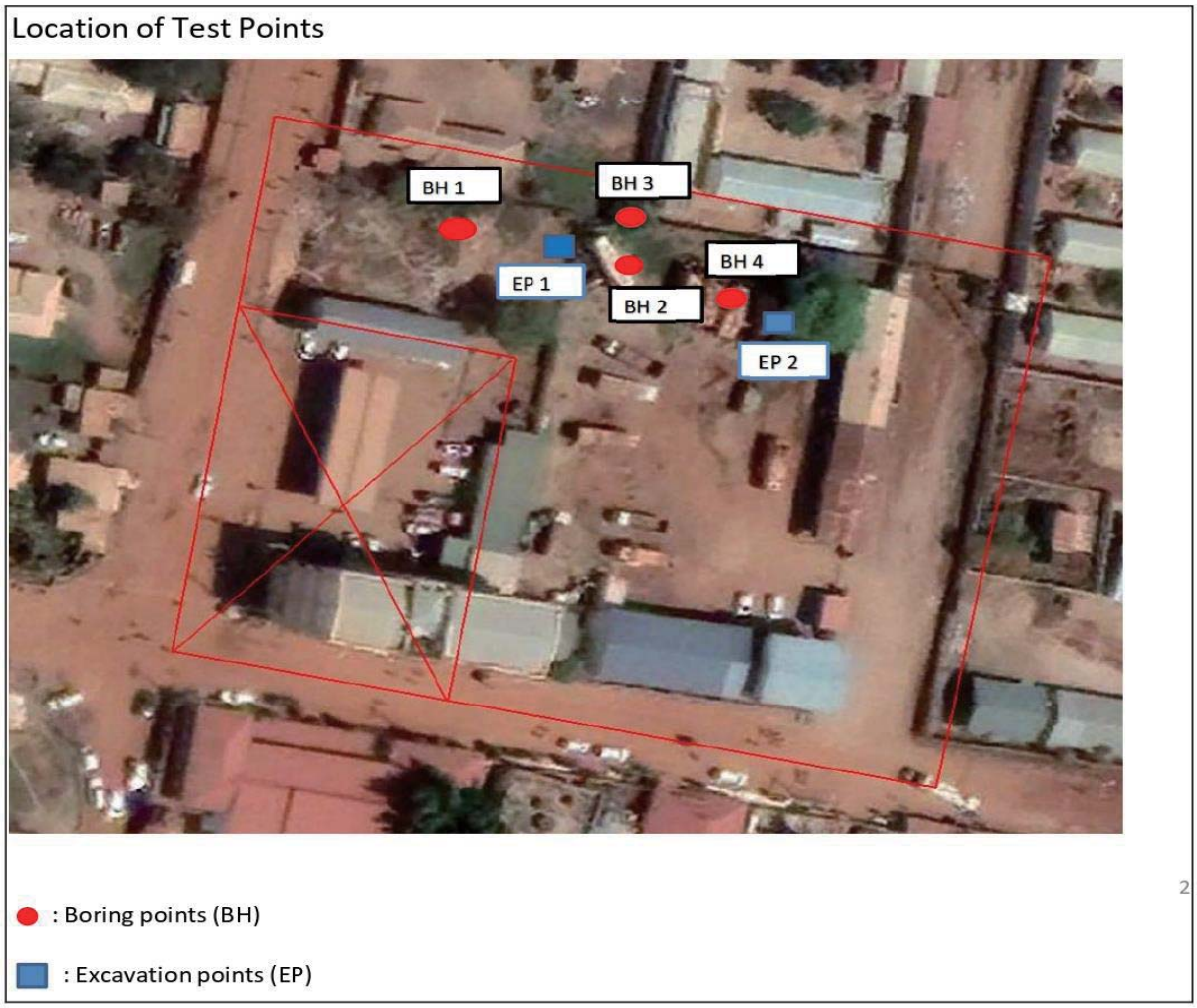


Figure 4: Site location map of the boreholes (BH) and Excavation pits (EP)

1.5 Geology

The geological maps (e.g. **Figure 4**) indicate the site is underlain by a metamorphic complex which forms basement complex intruded by granitic and dolerite rocks. The basement is overlain by alluvial and surficial deposits. The geophysical study that was done by University f Juba, Geology & Mining College of Natural Resources and Environmental Studies reveals the basement complex comprises of four types of Gneiss i.e. 1) banded Gneiss, 2) Biotitic gneiss, 3) augend gneiss and 4) Nile gneiss.

1) The Banded Gneiss has clear bands which are light Grey on fresh surface and light brown on weathered surface. They are composed principally of quartz, feldspar mica and pyroxenes with

subordinate amphiboles. They are high grade metamorphic rock that occurs as parent rock hosting many intrusions such as granitic, plutons and dykes. Foliations and quartz veins are highly visible. The texture is medium to coarse grained.

2) Biotitic Gneisshey looks Grey on the fresh surface and dark on weathered surface. It is composed of Biotitic, amphiboles, hornblende, quartz, feldspar and it has a coarse-grained texture.

3) Amgen Gneiss they form very large exposure associated with quartz-Feld spathic with some which are wholly porphyroblastic. The main constituents of Augend are the quartz, feldspar or amphiboles. Weathered surface of this Amgen gneiss is greyish to brownish and fresh surface is light Grey.

4) Nile gneisses are composed principally of gneisses of amphibolite facies with subordinate meta-sediments and amphibolite. Foliations trends are poorly defined but generally in Northerly direction.

Site geology: The site falls in a pre-cabrian shield underlain by metamorphic rock composed dominantly of Gneisses and granitic rocks that are medium to high grade metamorphic deformed during end pre-cabrian Pan African organic even. The rocks are generally hard and impermeable and occurs at shallow depths (2.5 to 10m) mainly underlain by predominantly alluvial cays and silts with some particles of sand and gravel. The depth of groundwater in Juba remain constant at 1.5-2m during the drilling period. The water level was take about 10-35 days on completion of drilling exercise and after heavy rains had hit the area. This water table will vary during the rainy season and it might disappear completely during the dry season yet it’s the longest.

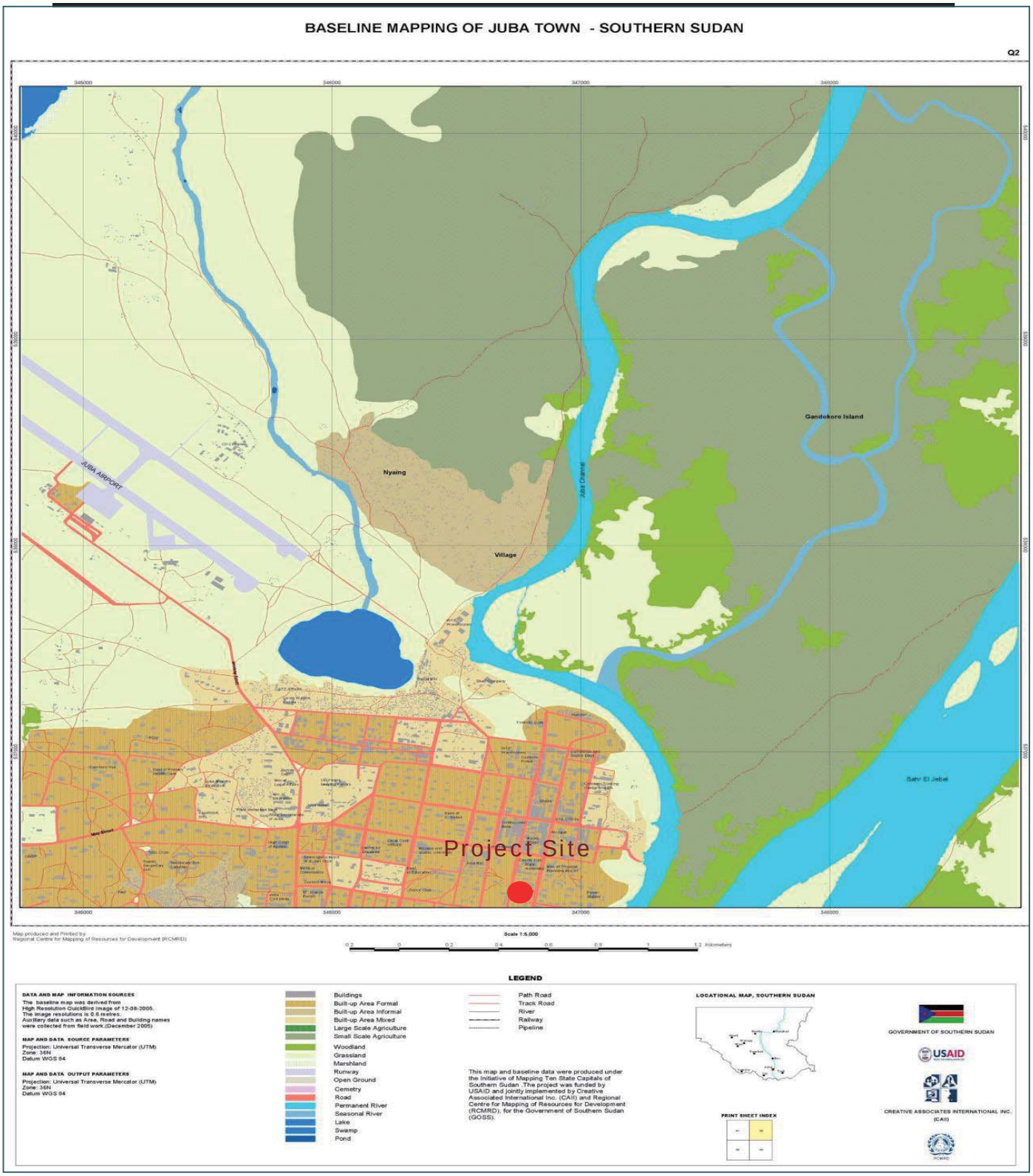


Figure 5: Baseline map of Juba City

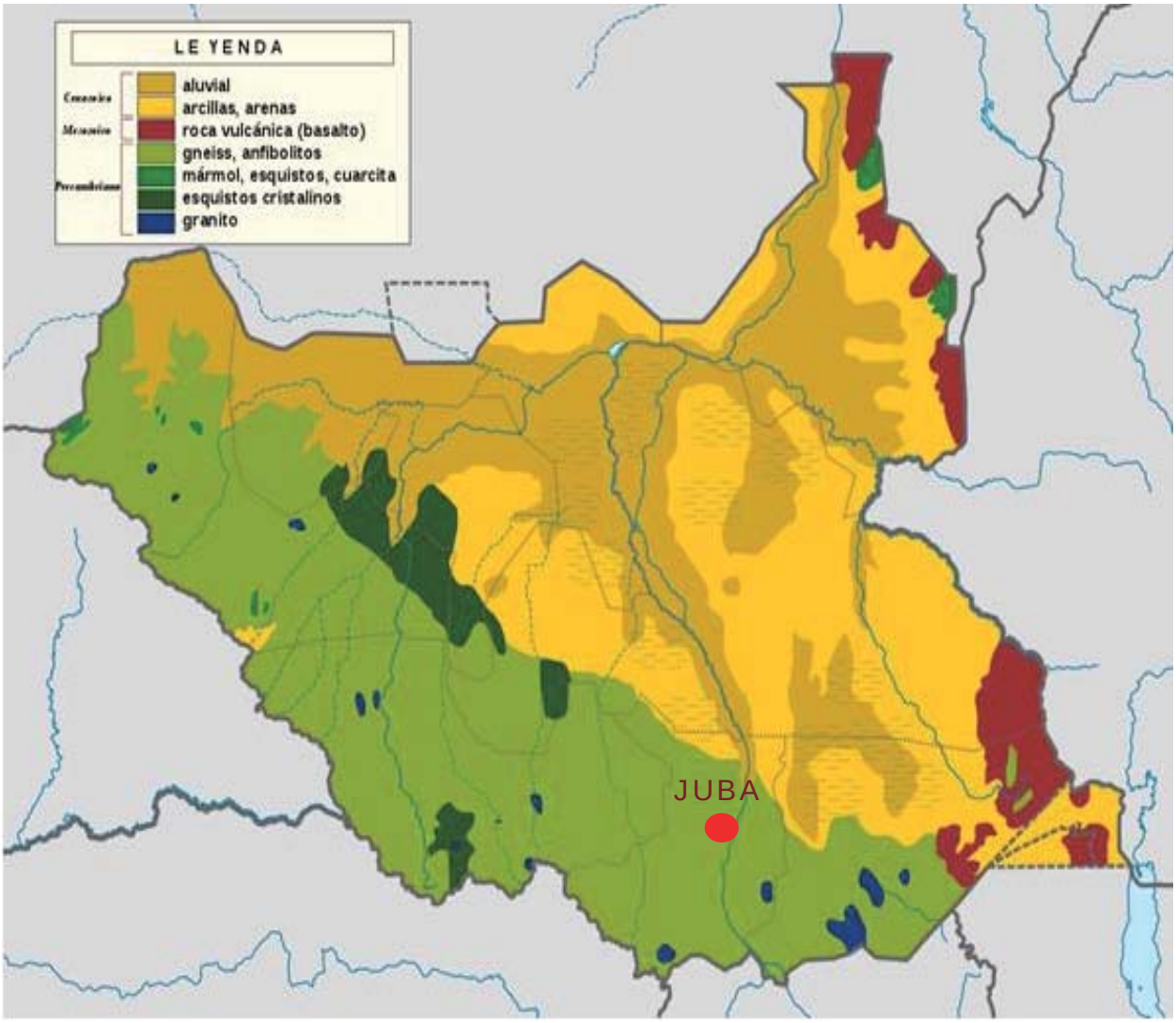


Figure 6: Geological map of Republic of South Sudan

2.0 GEOTECHNICAL INVESTIGATION

2.1 Introduction

All exploratory activities were conducted in accordance with BS 5930: 1990 "Code of Practice for Site Investigations" and included Excavation of 2 inspection pits and drilling of **4** Boreholes using XY-100 rotary drilling rig, sampling, logging, backfilling of the boreholes, SPT testing and laboratory testing of the recovered samples. Subsequent sections of this report show the details recorded during the investigation. The boreholes field-work summary is presented in **Table 1**

below. The exact location of the drilling points is shown on a site drawing attached in **Appendix1**.

2.2 Boring, Sampling and Logging

Each borehole was profiled according to 'A Guide to Practical Geotechnical Engineering in Southern Africa: 1995' and BS 5930:1990, sampled as instructed by the client. The test points were later backfilled. Detailed soil profiles of the exploratory boreholes are presented in **Appendix 3** of this report. The photographic record of the investigation is shown in **Appendix 3** and **Appendix 14**.

Table 1: Borehole Coordinates, Depth Investigated & Position of GWT

BH No.	Elevation(m)	Coordinates		Started Date	Finished Date	Drilling /excavation Depth (m)	No. of Disturbed Samples	No. of Undisturbed Samples	No. of SPTs
		X	Y						
BH1	460.124	346592.67	536232.032	23-11-20	26-11-20	15.0	5	0	3
BH2	460.137	346226.944	536226.841	16-12-20	20-12-20	15.0	5	0	2
BH3	460.360	346617.885	536232.24	16-11-20	18-11-20	20.0	5	0	4
BH4	460.130	346634.756	536218.853	18-12-20	20-12-20	20.0	5	0	2
EP1	460.130	346602.475	536231.893	15-12-20	15-12-20	2.0	2	0	0
EP2	459.760	346634.756	536218.853	15-12-20	15-12-20	2.0	2	0	0

2.3 Ground Water Table

Ground water table (GWT) was not recorded during the drilling period but after 9-30 days it was recorded. On BH1 it stood at 2.0m, BH2 at 1.5m, BH3 at 1.3m, BH4 at 1.2, at EP1 at 1.1m and EP2 at 1.4m below ground level.

Table 2; -Water level

Location	**Water level (m)**	**Elapsed time (days)**	
BH1	2.0	20	
BH2	1.5	30	
BH3	1.3	14	
BH4	1.2	16	
EP1	1.1	10	
EP2	1.4	10	

2.4 Field Investigation Challenges

Two challenges were encountered in the field, on bore hole one (BH1) the upper layers collapsed on the drilling tool at 15m.The drilling head gear systems and associated jaws holding the spindle rod broke down while trying to remove the stuck tools. Two drillers left work mid-way without notice.

Another challenge was accessing drilling spare parts and experienced Engineering Workshop in Juba. The problem was solved with experts for drilling machine, who was able to get a solution with capability to fabricate the gear systems.

2.5 Standard Penetration Tests (SPT)

Standard Penetration Tests (SPTs) were performed in each borehole at intervals presented in **Table 3** below and comprised of the following:

- Conducted using a 63.5 kg driving hammer falling ("free fall") from a height of 760 mm.
- Driving the standard split-barrel sampler of internal and external diameters 35mm and 50mm respectively to reach a distance of 450 mm into the soil at the bottom of the boring at every 1.5m depth interval.
- Counting the number of blows required to drive the sampler each 150 mm increment of a total of 450 mm penetration. The blow count for the first 150 mm increment was discarded and the sum of the blow counts for the last 300 mm increment was recorded as the SPT ‘N’ value.

According to Clayton (1993), apart from the soil conditions in which the test is made, the result of the SPT test is influenced by three main groups of factors associated with: drilling or boring technique, SPT test equipment and test procedure. The influence of these factors is considered below.

The measured SPT ‘N’ values were corrected for the overburden, equipment and borehole to establish the corrected SPT ‘N_{cor}’ values, from which estimated soil design parameters were ascertained and presented in **Appendix 6** of this report. The overburden correction factor for clayey soil is 1.0. The equipmentt and borehole factor correction factors used are highlighted below.

- Equipment correction and borehole size correction factors apply.
- The effect of overburden is negligible for cohesive soils, and no overburden correction factor C_N is required.
- The energy ratio is normalized to 60% of total energy, N_{60}.
- Corrected SPT 'N' value, $N_{cor} = N_{60} = C_N C_{ER} N$. Where, N is measured SPT 'N' value and C_{ER} is equipment & borehole correction factor given by:
- $C_{ER} = C_H C_R C_s C_B$.

Energy ratio correction factors to be applied to SPT value to account for equipment and borehole size (Adapted from Skempton, 1986 and Takimatsu and Seed, 1987). Extracted from "Hand book of Geotechnical investigation and design tables 2nd Edition page 51 table 4.9

To account for	Parameter	Correction factor
Hammer – release – country		
Hammer (C_H)		
Donut – free fall (Tombi) – Japan		1.3
Donut – rope and pulley – Japan		1.1
Safety – rope and pulley – USA		1.0
Donut – free fall (Trip) – Europe, China, Australia		1.0
Donut – rope and pulley – China		0.8 ●
Donut – rope and pulley – USA		0.75
Rod length (C_R)		
>10m		1.0
10m to 6m		0.95
6m to 4m		0.85 ●
4m to 3m		0.75 ●
Sampler (C_s)		
Standard		1.0 ●
US sampler without liners		1.2
Borehole Diameter (C_B)	65mm – 115mm	1.0
	150mm	1.05 ●
	200mm	1.15

Note: The corrected (Ncor) values of 0.6 was determined between rod lengths of 0-4m while a corrected Ncor value of 0.68 was used between 6-4m.

2.5.1 Bearing Capacity Determination

The corrected SPT 'N' values (N_{cor}) in **Table 3** were averaged for the entire depth investigated from the borehole logs, the borehole soils are generally Sands in nature, mixed with significant amounts of gravel; silts were also present. For the purpose of computing the soils' bearing

capacities, all soils were considered cohesive soils. Thus the empirical relationship established by Peck et al., (1974) between corrected SPT 'N' values (N_{cor}) and unconfined compressive strength (q_u) holds and is given below.

$$q_u = kN_{cor}\ kPa$$

Where, k is the proportionality factor established from empirical correlations between the unconfined compressive strength (q_u) and the corrected SPT 'N' values (N_{cor})

A value of *k = 12* has been recommended by Bowles (1996) for a standard energy ratio, R_{es} = 70%. However, based on the 60% standard energy ratio adopted in United Kingdom, a value of *k = 13.27* has been recommended and was used in the computation of the unconfined compressive strength. Thereafter the undrained cohesion (c_u) was obtained from the unconfined compressive strength (q_u) as,

$$c_u = q_u/2\ kPa$$

The ultimate bearing capacity (q_{ult}) was computed from the relationship,

$$q_{ult} = c_u N_c\ kPa$$

Where N_c is the bearing capacity factor for clay/silt soils

Skempton (1951) gives different bearing capacity factor N_c for clay soil with respect to depth and foundation width ratio for different shapes of foundations. For purposes of computations, the least bearing capacity factor N_c of 5.14 was used.

The approximate allowable bearing capacity (q_{all}) in **Table 3** was obtained by dividing the ultimate bearing capacity (q_{ult}) by the Factor of Safety (Fs) of 3.0 irrespective of the site conditions.

$q_{all} = q_{ult}/Fs$ *where stands for Factor of Safety.*

For comparison purposes, Clayton (1993) stated that it is better to always make a rapid, albeit crude estimate of the allowable bearing capacities using more than one method. In this report a quick approximation of the allowable bearing capacities is given by the Terzaghi and Peck (1948) relationship below:

$$\mathbf{q_a = 10N}$$

Where q_a is in kPa.

The allowable bearing capacities from the two methods were identical as shown in **Table 3.** Detailed results for bearing capacities are shown in **Appendix 6.**

Table 3: Approximate Allowable Bearing Capacity from Corrected SPT 'N' Values

BH No.	Depth (m)	Corrected SPT 'N' Value, $(N_{1)60}$	Unconfined Compressive Strength q_u (kPa)	Undrained Cohesion C_u (kPa)	Allowable Bearing Capacity- Terzaghi and Peck (1948) $Q_{all=Ncor}$ (kPa)	Allowable Bearing Capacity Terzaghi and Peck, 1967 Q_{all} (kPa)
BH 1	1.5	>30	>390	>195	>300	>341
	3.0	>30	>390	>195	>300	>341
BH 2	1.5	>30	>390	>195	>300	>341
	2.5	>30	>390	>195	>300	>341
BH 3	1.5	>30	>390	>195	>300	>341
	3.0	>30	>390	>195	>300	>341
	4.5	>34	>398	>226	>340	>387
	5.8	>34	>398	>226	>340	>387
BH 4	1.5	>30	>390	>195	>300	>341
	3.0	>30	>390	>195	>300	>341

2.6 Stratigraphy

The site investigation indicates that the geological sequence at the site generally comprises of mainly clays, silts and sands. **Figure 7** shows drilling logs to a maximum depth of 20m. It shows that ground is very variable across the site.

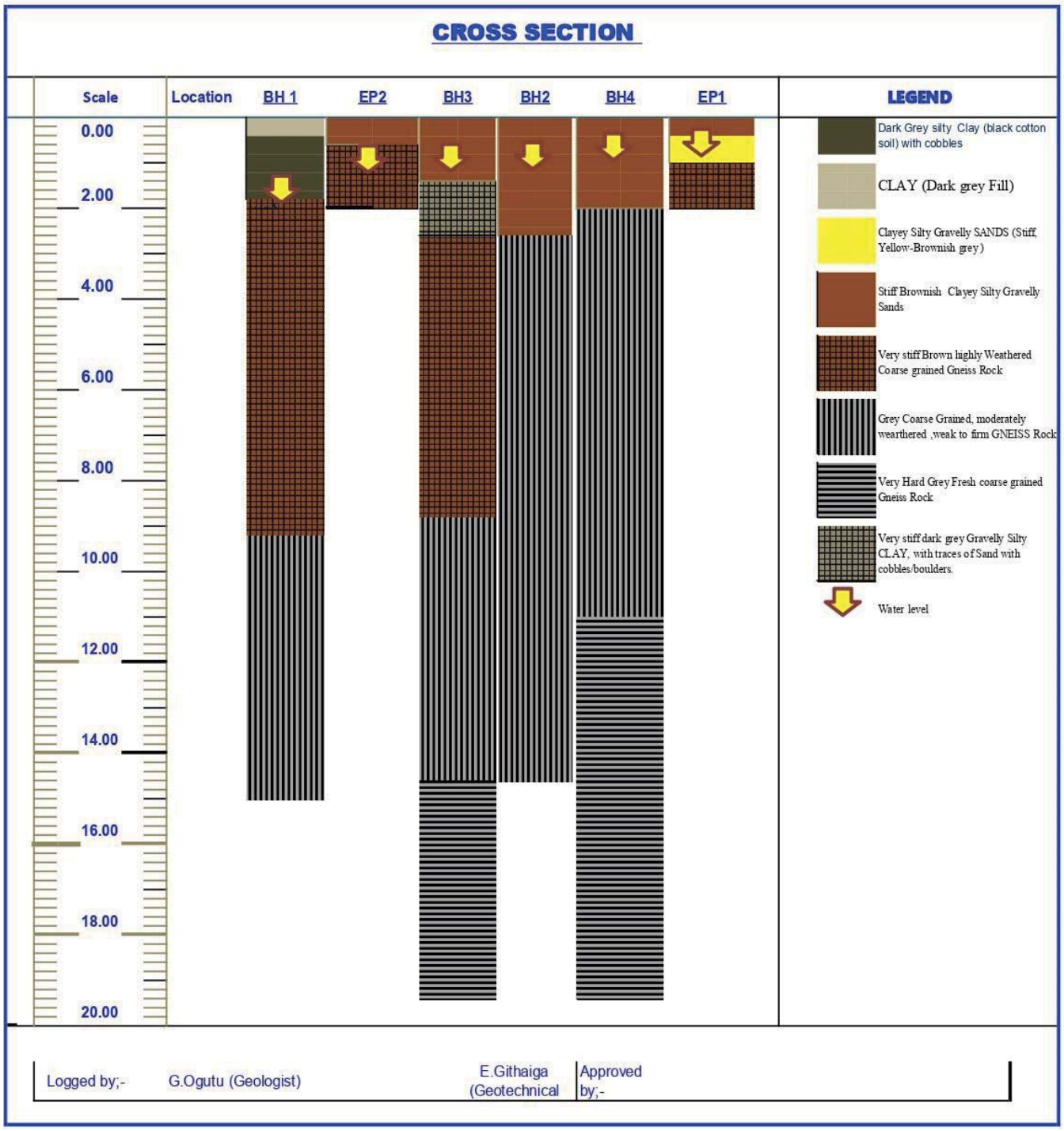


Figure 7: Borehole profiles

3.0 LABORATORY WORK

Soil samples recovered from the boreholes were tested in accordance with the test standard procedures listed in **Table 4** below.

Table 4: Tests on Samples from the Boreholes.

Test Description	International Standard
1. Disturbed Samples	
In-situ Moisture Content	BS 1377: Part 2, Clause 3:1990
Particle Size Distribution	BS 1377: Part 2, Sub cl. 9.2: 1990
Plastic Limit & Plasticity Index	BS 1377: Part 2, Clause 4,5&6:1990
Specific gravity	BS 1377:Part 2, Clause 8: 1990
Compaction test	BS 1377 part 4 1990
2. Undisturbed Samples	
Unconfined Compression	BS 1377:Part 7: 1990
Consolidation test	BS 1377:Part 51990
Triaxial Shear Test	BS 1377:Part 7: 1990
Unconfined compression test-Rock	BS 5930 :Part 7: 2015

3.1 Borehole Laboratory Test Results

Laboratory tests included index property tests and triaxial compression tests.

3.1.1 Moisture content Test Results

Natural moisture content values ranges from 0.3% to 19.5%. A detailed assessment of the data reveals that moisture contents are low. From visual examination, the water content of the stone fraction alone was found to be negligible. Moisture content results are shown on the summary for classification test results attached in **appendix 7**.

3.1.2 Classification Test Results

Borehole soils were classified according to their particle size distribution (PSD) and Natural moisture test results. The summary of the laboratory results is attached in **appendix 7** of the report.

3.1.3 Particle size distribution

Particle size distribution curves for the formations at the site are shown on **Appendix 8**. Results show that the site is underlain by Sandstone, Gravels, Sands and some silts. This is indicated by majority of the grading curves.

3.1.4 Atterberg Limit test results.

A paste specimen made from 150 gm thoroughly mixed portion of air dried material passing 425 micron IS sieve is used to determine the Liquid Limit (LL). This is repeated at least to have four sets of values of penetration in the range of 14 to 28 mm. The plastic limit (the moisture at which the specimen changes from liquid state to solid is determined. The difference between the liquid limit and plastic limit is calculated and reported as Plasticity Index (PI).

PI=LL-PL

The fine grained portions of the material showed a range of plasticity from PI zero to 8.2% as shown on **Appendix 9**.Majority of the samples tested plotted below the A-line on the plasticity chart. It can therefore be concluded that all the fine grained portion of the materials on site predominantly behave as sand and gravel of vary plasticity.

3.1.5 Triaxial tests

a) **Triaxial tests included the Undrained Unconsolidated Triaxial test (UU).** UU test was carried out in accordance with BS1377:1975 and ASTM D 2850 standard procedure. The nominal specimen sizes were 38mm diameter by 76mm length. Compression was carried out at a rate of about 1.5 mm/min (2 % per minute). Disturbed soil samples were remoulded to attain a maximum dry density (MDD) of 70-80% and optimum moisture content (OMC). The resultant specimen was subjected to a confining fluid pressure of 0.5, 1.5 and 2.5Kg/cm2 in a triaxial chamber. Visual classification had shown the soils on test points E1 and E2 to be clays silt and hence adapted UU test method. The laboratory gradation and Atterberg tests classified the soils as Sands and hence the adaption of Direct shear test in the later samples. Test results are as summarised in **Table 6**. Detailed results are attached as **Appendix 11.**

EP1 (0.0-1.0M)	Cell pressure (kg/cm²) σ3	Deviator stress (kg/cm²) (σ1 - σ3)	Major Princ.stress kg/cm²) σ1
TEST 1	0.5	0.94	1.44
TEST 2	1.5	2.18	3.68
TEST 3	2.5	3.42	5.92

EP2 (0.0-1.0M)	Cell pressure (kg/cm²) σ3	Deviator stress (kg/cm²) (σ1 - σ3)	Major Princ.stress kg/cm²) σ1
TEST 1	0.5	0.97	1.47
TEST 2	1.5	2.01	3.51
TEST 3	2.5	3.15	5.65

b) **Direct shear test**. The bulk samples (disturbed) were prepared in the same way as UU (above) and applied a load of 1.02, 2.04 and 3.04Kg/cm2 and shear force at failure recorded in the shear box apparatus. The shear parameters were determined from remoulded specimen to attain 70-80% of, MDD/OMC.

Note two (2) compaction tests were carried out to determine the MDD/OMC for the calculation remolded soils.

The number of test trials carried out on each sample is as summarised in **Table 5**. It should be noted that as a result of the nature of the soils at site, in some cases, the quantity of the sample was inadequate to carry out all test. In all cases no undisturbed samples were recovered.

Location	Depth (m)	Number of Test Trials per sample	
		UU	Direct Shear
EP1	0.00-1.00	1	
BH1	0.00-1.00		1
BH2	1.00-1.50		1
BH3	0.00-1.00		1
BH4	0.00-1.00		1
EP2	0.00-1,00	1	

Table 5: Summary of Triaxial and shear box tests carried out- (Remoulded specimens).

Specimen diameter = 38mm		Bulk Density (kg/m^3	Average Moisture Content (%)	Angle of Internal friction (degrees).	Cohesion (Kg/cm2)
Location	Depth(m)				
EP1	0.0 1.00	2183	9.4	21	0.12
EP2	0.00 - 1.00	1878	19.5	20	0.16
BH1	0.00 - 1.00	1712		27	0.02
BH2	0.00 - 1.00	1680		23	0.12
BH2	1.00 – 2.00	1680		25	0.13
BH3	0.00 - 1.00	1565		26	0.03
BH4	0.00 - 1.00	1580		25	0.09

Table 6: Undrained Unconsolidated triaxial compression and Shear box test results.

Results show the bulk densities for Sands are relatively high ranging between 1565 and 2183kg/m^3. This is attributed to unsaturated soil conditions at site. The angle of internal friction was generally moderate ranging between 20 to 27^o. This is attributed to the fact that the site is underlain by mainly silt sands. The Undrained cohesion was ranging between 0.03 to 0.16 kg/cm2.

Note; In practice undisturbed soil samples (i.e. U100) usually gives reliable results but it was practically impossible to recovered this type of sample) and hence the adoption of remoulded specimens.

3.1.6 Water Table

Occurrence of ground water was monitored in all the Boreholes and water was encountered in all the 6 test points (refer table 2 above).

4 CONCLUSIONS AND RECOMMENDATION

4.1 Conclusion

According to the field exploration, laboratory testing, subsurface conditions and engineering analysis, it can be concluded that the existing ground at the proposed site for Juba City Council Sanitary and Environmental Building is strong enough to support the expected building loads without special modifications and the following recommendations are given:

Ground water table (GWT) was encountered in all the boreholes.

The site is predominantly underlain by Silky-Reddish brown grey clayey silt Sands and highly weather gravelly, Salty Sand.

The drilling logs and bearing capacity results show that the ground is marginally/minimal variable both in the lateral and vertical direction. The consistency for cohesive soils varies from firm to very stiff and that for cohesion less soils varies from dense to very dense.

The soils have a moisture content ranging from 5.6% – 19.5% and the plasticity index is deduced as Non Plastic with LL ranging from from 28.5% to 45.5% which indicates sands/silts of low to none to plasticity tendency.

Less than twenty percent of the soil particles passed sieve 75mm which confirms that the type of soils found in Juba town predominantly silts and sands.

The bearing capacities computed using the two empirical relationships are fairly identical. Estimates of allowable bearing capacities derived from corrected SPT 'N' values vary from each borehole location. There is no direct correlation of the magnitude of SPT N-values with depth especially due to changes in the type of material encountered. In all cases refusal(N-Value>50 was attained at1.5m below ground level giving, allowable bearing capacity of greater than 334Kpa.Abearing capacity of 350 can be adopted for this site.

The soil has angle of internal friction in the range between 20º 23º. The cohesion is in the range between 0.03-0.16 kg/cm and the unconfined compressive strength of underlying weathered rock between 13 to 53N/mm2. The soils at the site are well draining but the rock is impervious.

4.2 Recommendations

1. Depending on the applied stresses from the structures intended to be placed, suitable founding depths should be chosen in such a way that the total net foundation pressure is less than the allowable bearing capacity.

2. Foundation ground; -Based on our findings and analyses of the encountered material, it is recommended that the foundations of the proposed building be laid on moderately weathered Gneiss rock.
3. Foundation depth; - Found at 1.5m across the site.
4. Type of foundation; - Pad type of foundation is recommended (The Engineer to use his preferred type of foundation).
5. Riperbility and method of excavation; - The congenital excavation equipment such as Loaders and Dozers will be needed for excavation works.
6. Surface run off; - It is recommended to protect the foundation ground and excavation from surface water both during and after construction by providing proper drainage and protection system. Surface water, if existed, should be diverted away from the edges of the excavations.
7. All excavations should be supervised by a competent person.

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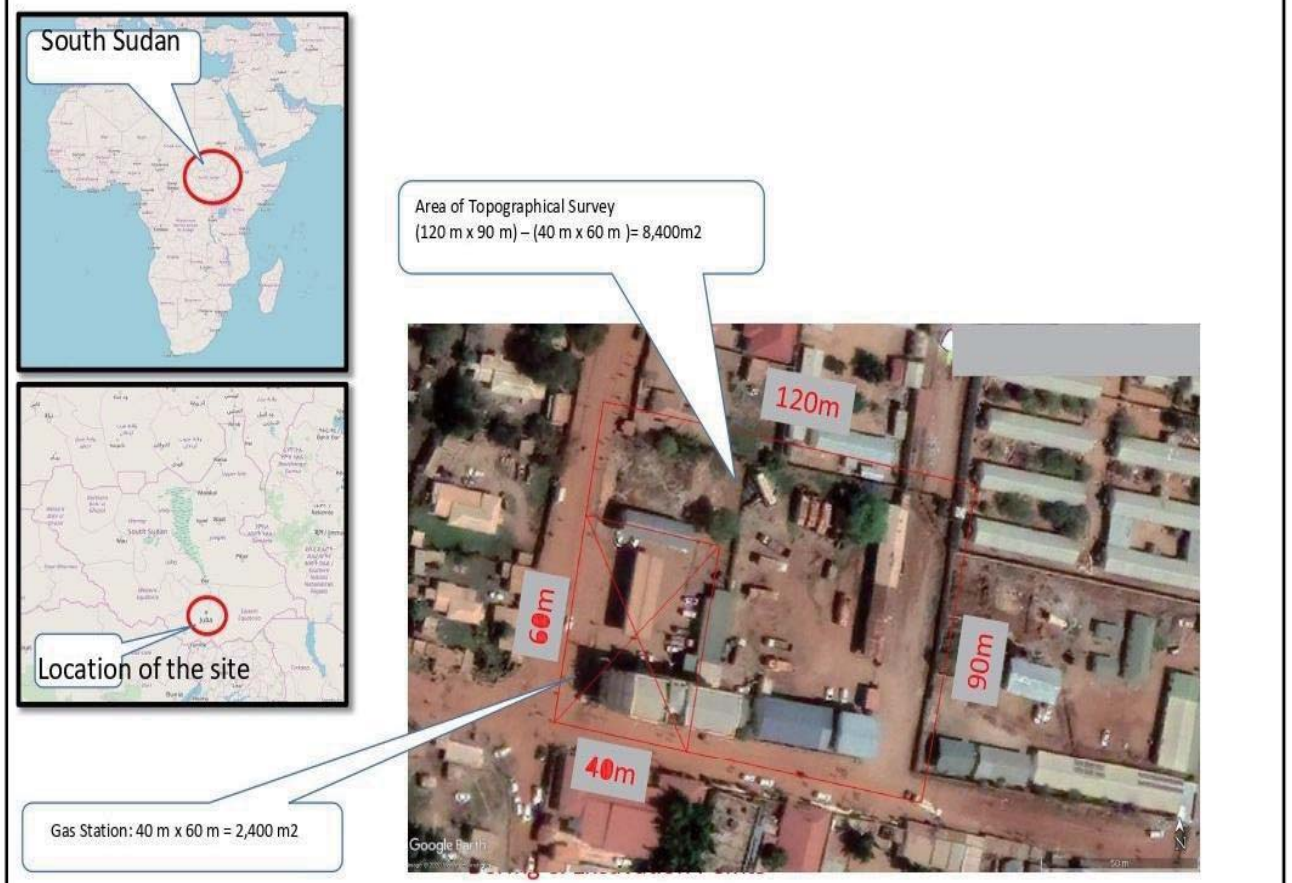
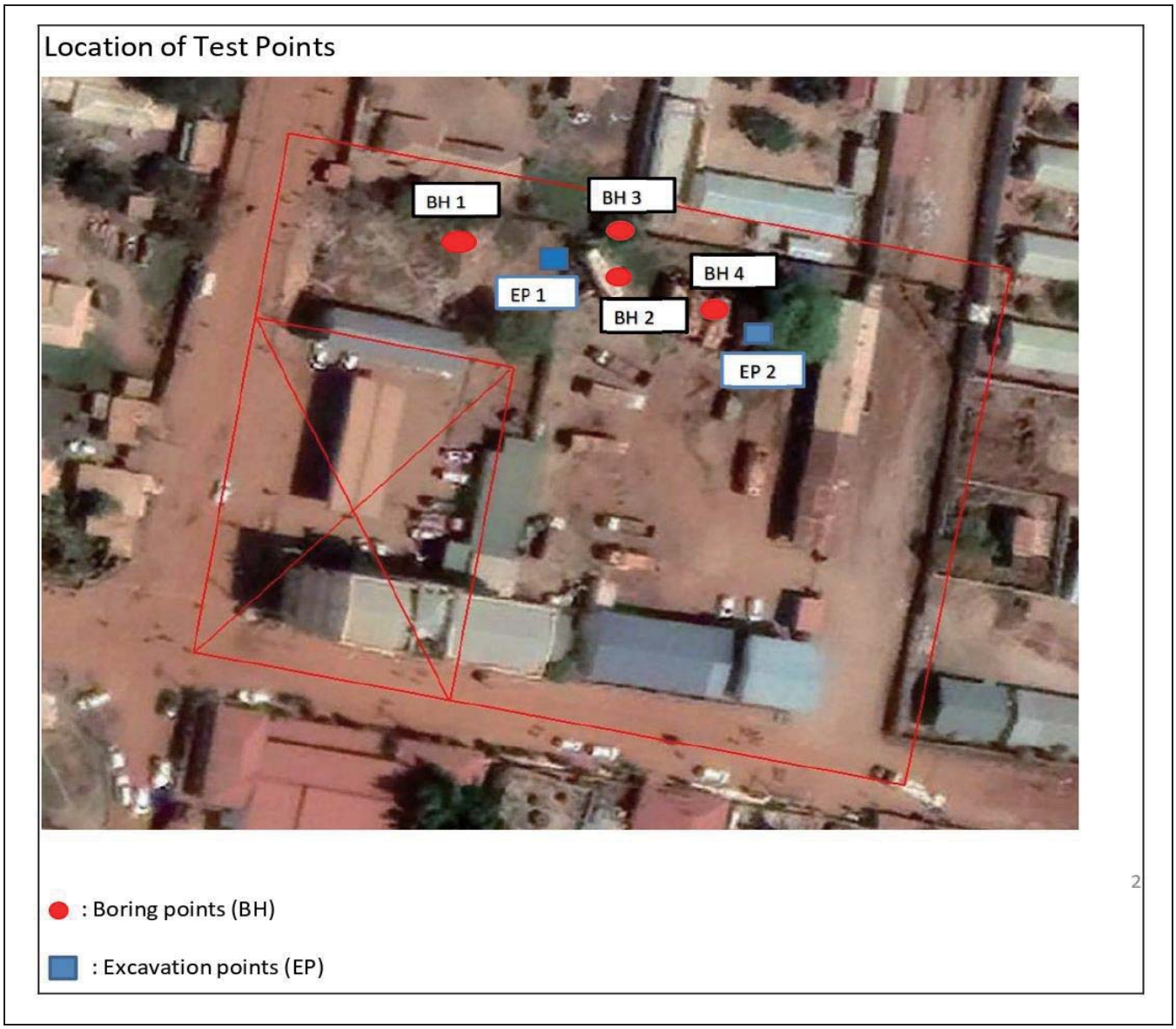
APPENDICES

Appendix 1 – Site Layout

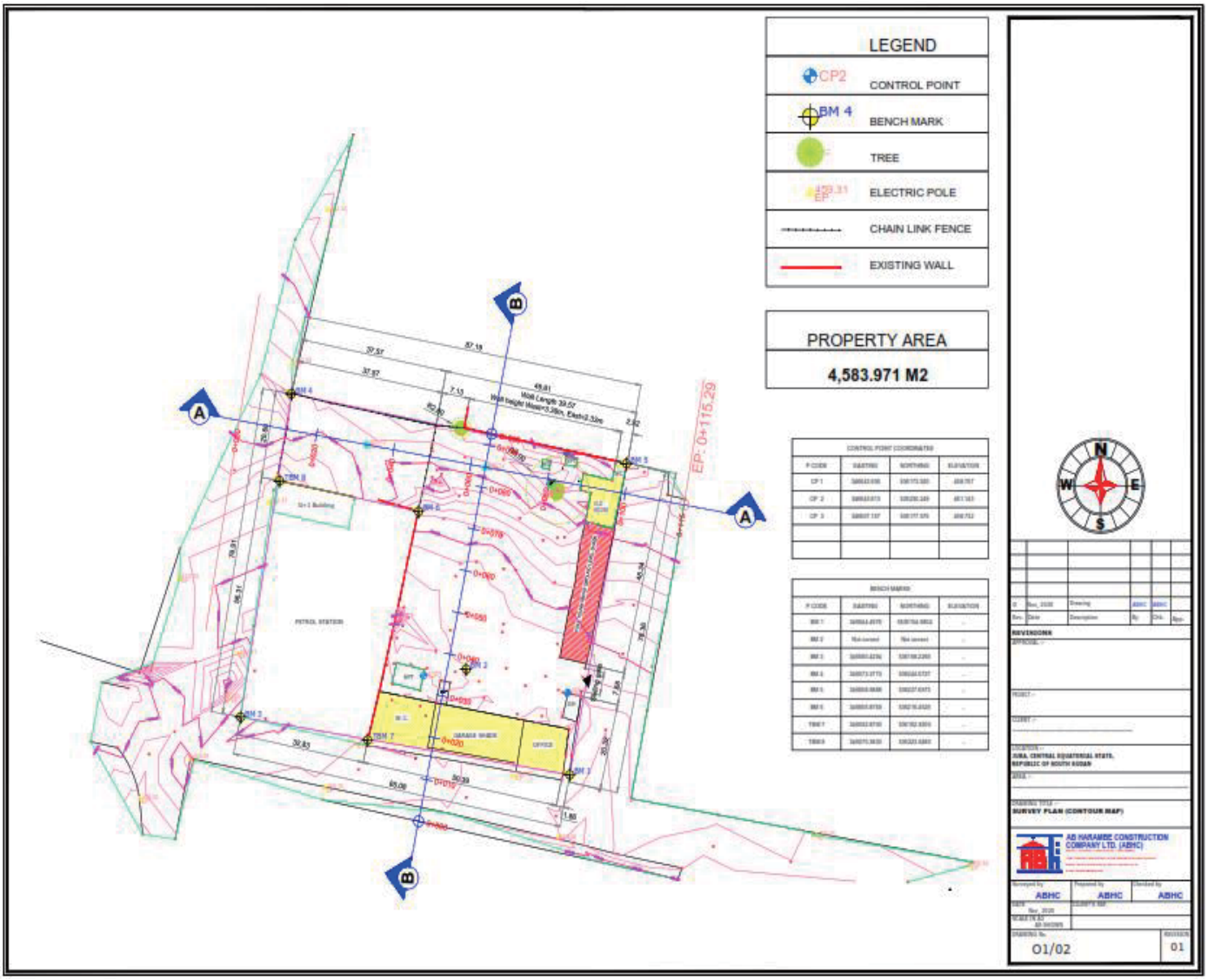


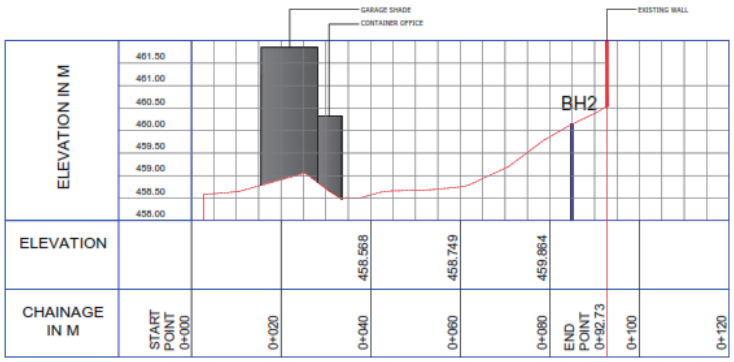
BH AND EP COORDINATE			
P.CODE	EASTING	NORTHING	ELEVATION
BH 1	346592.674	536232.032	460.124
BH 2	346226.944	536226.841	460.137
BH 3	346617.885	536232.240	460.360
BH 4	346634.756	536218.853	460.130
EP 1	346605.475	536231.893	460.130
EP 2	346638.406	536214.336	459.760

Appendix 2 – Test Points Layout

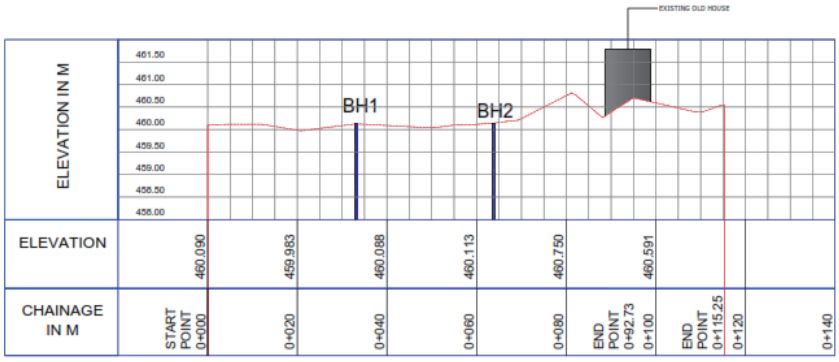


Appendix 3 – Topographic map

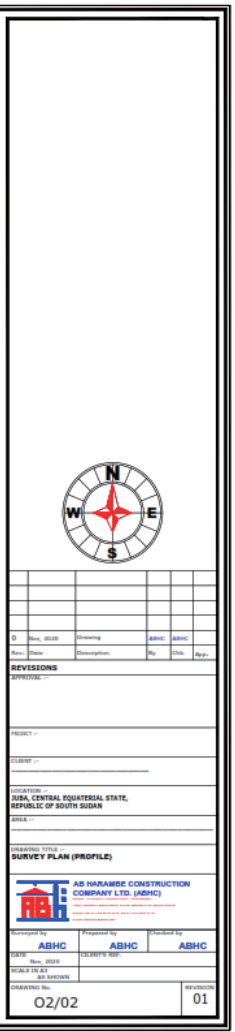




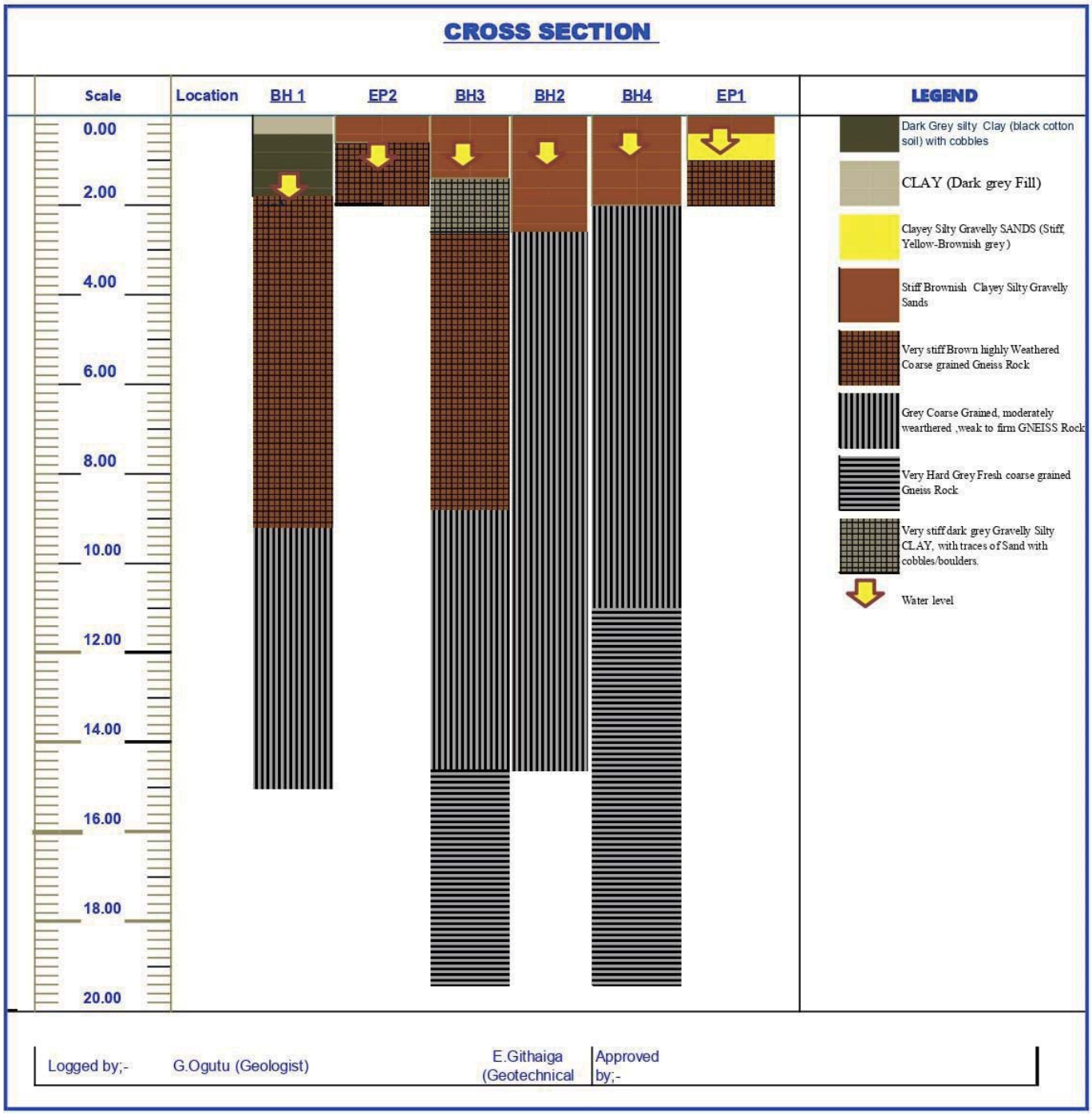
Alignment B-B PROFILE



Alignment A-A PROFILE



Appendix 4 – Cross section/Bore hole profile



Appendix 5 – Drilling Logs

BH1 log

Client:	JUBA MUNICIPAL COUNCIL SANITATION AND ENVIRONMENTA PROJECT	Lab Tested :	DRECO-MATTS Drilling, Engineering & Construction Technical Support info@drecomatts.co.ke
Contractor :	AB HARAMBE CONSTRUCTION COMPANY		

BORE HOLE RECORD

Project:	Geotechnical Investigation: Juba City Council Sanitary & Environmental.	**Bore Hole No:**	BH1
Location :	Juba South Sudan	**Water table : 2.0m**	Isaac
Elevation:	460.124	**Test Method :**	BS 5930:1990
Coordinates:	E:- 346592.67 N:- 536232.032	**Date: Start**	12-11-2020
		End :	16-11-2020

Ground water	Depth (m)	Description of strata	Legend	Level	Sample &Test Depth (m)	Type	No	ROCK % CR	SPT 150	75	75	75	75	N	Remarks
	0.00	Back fill soil		0.00											
		Dark Grey silty Clay (black cotton soil) with cobbles			1.5	D	1	NA							
	2.00			2.00		D	1	NA	7	12	18	22	Refusal	N>50	
	4.00	Stiff Brownish Grey high to completely weathered grading to light brown gravelly sand.		4.00	3.5	R	1	27	11	13	14	14	Refusal	N>50	
	6.00			6.00		R	1	13							
	8.00			8.00		R	1	27							
	10.00			10.00		R	1	33							
	12.00	Grey weak to firm. moderately Weathered Gneiss Rock		12.00		R	11	40							
	14.00		End of BH	14.00		R	1	47							
	16.00			16.00		R	1	53							
	18.00			18.00											
	20.00			20.00											

Water Table

Sample Types

U:Undisturbed

D:Disturbed

W Water sample

R Rock sample

CR Rock recovery

Rock sample

SPT Standard Penetration Test

Brownish Grey high-completely Gneiss rock grading Gravelly

Brownish Grey higly Weathered decomposed Gneiss Rock grading to gravelly sands

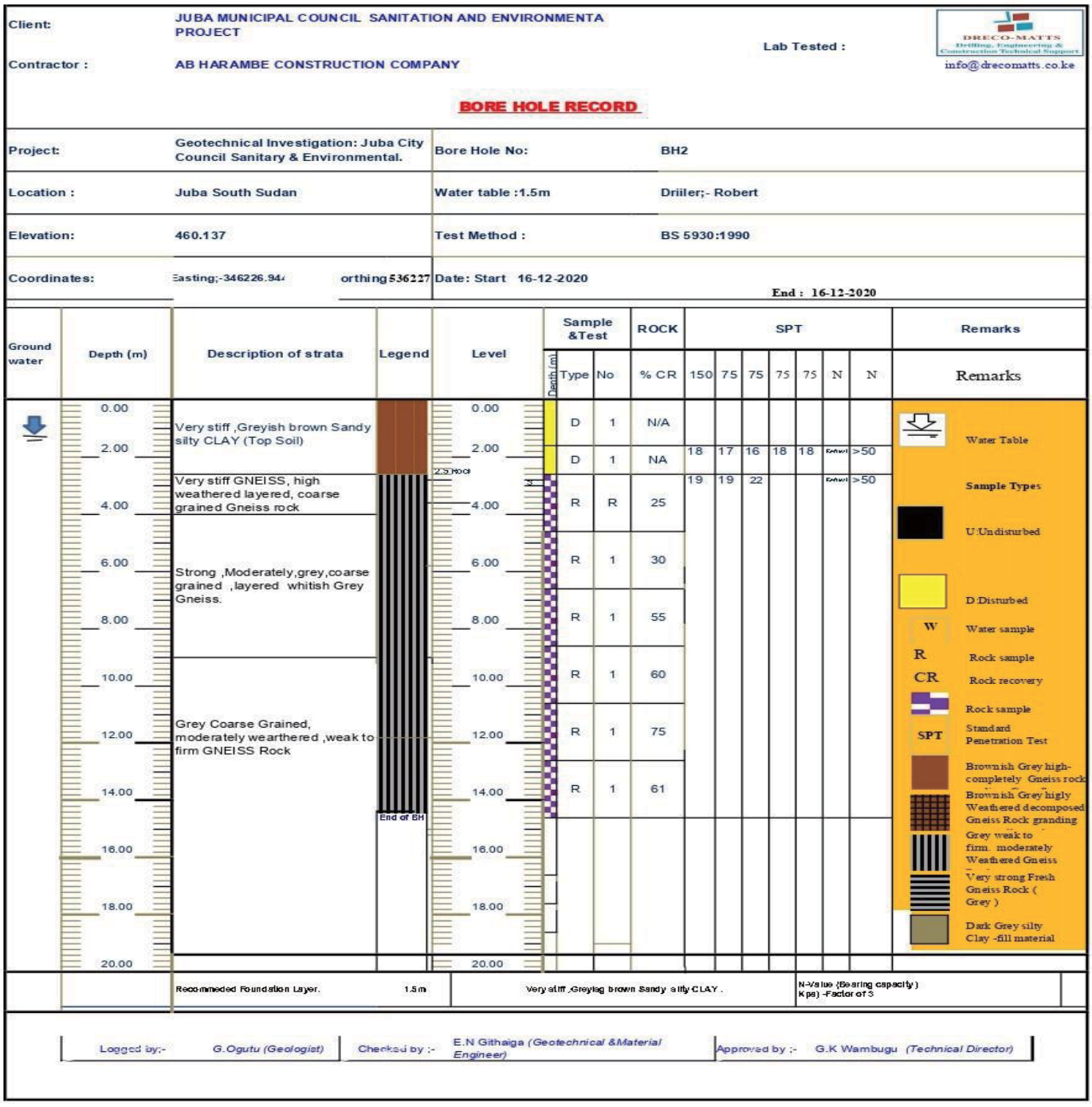
Grey weak to firm moderately Weathered Gneiss Rock

Very strong Fresh Gneiss Rock (Grey)

Dark Grey silty Clay -fill material

Logged by:- G.Ogutu (Geologist) | Checked by :- E.N Githaiga (Geotechnical &Material Engineer) | Approved by :- G.K Wambugu (Technical Director)

BH2 log



Client: JUBA MUNICIPAL COUNCIL SANITATION AND ENVIRONMENTA PROJECT

Lab Tested :

Contractor : AB HARAMBE CONSTRUCTION COMPANY

DRECO-MATTS Drilling, Engineering & Construction Technical Support info@drecomatts.co.ke

BORE HOLE RECORD

Project:	Geotechnical Investigation: Juba City Council Sanitary & Environmental.	Bore Hole No:	BH2
Location :	Juba South Sudan	Water table :1.5m	Driiler;- Robert
Elevation:	460.137	Test Method :	BS 5930:1990
Coordinates:	Easting;-346226.94/ orthing 536227	Date: Start 16-12-2020	End : 16-12-2020

Ground water	Depth (m)	Description of strata	Legend	Level	Sample &Test Depth (m)	Type	No	ROCK % CR	SPT 150	75	75	75	75	N	N	Remarks
	0.00	Very stiff ,Greyish brown Sandy silty CLAY (Top Soil)		0.00		D	1	N/A								
	2.00			2.00		D	1	NA	18	17	16	18	18	Refusal	>50	
		Very stiff GNEISS, high weathered layered, coarse grained Gneiss rock		2.3 Rock		R	R	25	19	19	22			Refusal	>50	
	4.00			4.00		R	1	30								
	6.00	Strong ,Moderately,grey,coarse grained ,layered whitish Grey Gneiss.		6.00		R	1	55								
	8.00			8.00		R	1	60								
	10.00			10.00		R	1	75								
	12.00	Grey Coarse Grained, moderately wearthered ,weak to firm GNEISS Rock		12.00		R	1	61								
	14.00		End of BH	14.00												
	16.00			16.00												
	18.00			18.00												
	20.00			20.00												

Water Table

Sample Types

U:Undisturbed

D:Disturbed

W Water sample

R Rock sample

CR Rock recovery

Rock sample

SPT Standard Penetration Test

Brownish Grey high-completely Gneiss rock

Brownish Grey higly Weathered decomposed Gneiss Rock granding

Grey weak to firm. moderately Weathered Gneiss

Very strong Fresh Gneiss Rock (Grey)

Dark Grey silty Clay -fill material

Recommeded Foundation Layer. 1.5m | Very stiff ,Greyish brown Sandy silty CLAY . | N-Value (Bearing capacity) Kpa) -Factor of 3

Logged by:- G.Ogutu (Geologist) | Checked by :- E.N Githaiga (Geotechnical &Material Engineer) | Approved by :- G.K Wambugu (Technical Director)

BH3 Log

Client:	JUBA MUNICIPAL COUNCIL SANITATION AND ENVIRONMENTA PROJECT	**Lab Tested :**	DRECO-MATTS Drilling, Engineering & Construction Technical Support info@drecomatts.co.ke
Contractor :	AB HARAMBE CONSTRUCTION COMPANY		

BORE HOLE RECORD

Project:	Geotechnical Investigation: Juba City Council Sanitary & Environmental.	**Bore Hole No:**	BH3 - formr BH 2
Location :	Juba South Sudan	**Water table :**	**Driller ;-** ISAAC
Elevation:		**Test Method :**	BS 5930:1990
Coordinates:		**Date: Start** 7-11-2020	**End :** 13-11-2020

Ground water	Depth (m)	Description of strata	Legend	Level	Depth (m)	Sample & Test Type	Sample & Test No	Rock % CR	SPT 150	SPT 75	SPT 75	SPT 75	SPT 75	SPT N	Allowable Bearing capacity (Kpa) F=2	Remarks
	0.00	Very stiff ,Greyisg brown Sandy silty CLAY (Top Soil)		0.00		D	1	NA								
	2.00	Very stiff dark grey Gravelly Silty CLAY, with traces of Sand with cobbles/boulders.		2.00	1.5	D	1	NA	18	17	Refusal			N>50		
	4.00	Very stiff GNEISS, high weathered / decomposedGneiss , grading to Gravelly SAND, greyish Brown		4.00	2.8 Rock 3.0	Rock cuttings	1	Nil	22	18	Refusal			N>50		
	6.00			6.00	4.5		1	Nil	23	17	Refusal			N>50		
	8.00	Hard GNEISS, high to completely weathered, grading to Gravelly SAND, greyish Brown		8.00	6.0 7.5	R	1	13	23	17	Refusal			N>50		
	10.00			10.00	8.8		1	23								
	12.00	Grey corase grained Gneiss rock , slightly weathered,Moderatelt strong with sections between 12.00 to 12.80m completely weartherd grading to Greyish brown Gravelly SANDS cuttinf=gs		12.00	11.0 13.0	R	1	8								
	14.00			14.00		R	1	30								
	16.00	Grey Coarse grained ,Strong Fresh Gneiss Rock with fissures		16.00	15.0 17.0	R	1	20								
	18.00			18.00		Cuttings	1	20								
	20.00		End of	20.00	19.5	Rock	1	25								
						R	1	15								
						R	1	25								
								100								

Remarks: Water Table; Sample Typ; U:Undisturbed; F Factor of safety; D:Disturbed; W Water sample; R Rock sample; CR Rock recove; Rock sample; SPT Standard Penetration; Brownish Grey Silty Clay ; Weathered Gneiss Rock (Brownish Grey); Weathered Gneiss Rock (Grey); Fresh Gneiss Rock (Grey); Grey Silty CLAY

Recommeded Foundation Layer. 1.5m — Very stiff dark grey Gravelly Silty CLAY, with traces of Sand with cobbles/boulders. — N-Value (Bearing capacity) Kpa) - Factor of 3

Logged by;- G.Ogutu (Geologist) | Checked by ;- E.N Githaiga (Geotechnical &Material Engineer) | Approved by ;- G.K Wambugu (Technical Director)

BH4 Log

Client:	JUBA MUNICIPAL COUNCIL SANITATION AND ENVIRONMENTA PROJECT	**Lab Tested :**	DRECO-MATTS Drilling, Engineering & Construction Technical Support info@drecomatts.co.ke
Contractor :	AB HARAMBE CONSTRUCTION COMPANY		

BORE HOLE RECORD

Project:	Geotechnical Investigation: Juba City Council Sanitary & Environmental.	**Bore Hole No:**	BH4
Location :	Juba South Sudan	**Water table :**	Driiler;- Robert
Elevation:		**Test Method :**	BS 5930:1990
Coordinates:		**Date: Start**	18-12-2020
		End :	19-12-2020

Ground water	Depth (m)	Description of strata	Legend	Level	Sample &Test Depth (m)	Type	No	ROCK % CR	SPT 150	75	75	75	75	N	N	Remarks
	0.00	Very stiff ,Greyisg brown Sandy silty CLAY .		0.00		D	1	N/A								
	2.00	Stiff, high weathered caorse grained Gneiss disintegrating grading to Grey Gravelly SAND		2.00				NA	21	18	18	18	18	93	>50	
	4.00			4.00		R	1	34								
	6.00			6.00		R	1	27								
	8.00	Very stiff, weathered highly fissured coarse grained dark grey Gneiss rock		8.00		R	1	26								
	10.00			10.00		R	1	32								
	12.00			12.00		R	1	50								
	14.00			14.00		R	1	40								
	16.00	Moderatelt strong slightly weathered, whitish Grey coarse grained Gneiss rock ,		16.00		R	1	40								
	18.00			18.00		R	1	80								
	20.00		End of BH	20.00	18.8											

Water Table

Sample Types

U:Undisturbed

D:Disturbed

W Water sample

R Rock sample

CR Rock recovery

Rock sample

SPT Standard Penetration Test

Brownish GreySilty Clay .

Weathered Gneiss Rock (Brownish Grey)

Weathered Gneiss Rock (Grey)

Fresh Gneiss Rock (Grey)

Recommeded Foundation Layer. 1.5m

Very stiff ,Greyisg brown Sandy silty CLAY .

N-Value (Bearing capacity) Kpa) -Factor of 3

Logged by;- G.Ogutu (Geologist) | Checked by ;- E.N Githaiga (Geotechnical &Material Engineer) | Approved by ;- G.K Wambugu (Technical Director)

EP1

Client:	JUBA MUNICIPAL COUNCIL SANITATION AND ENVIRONMENTA PROJECT	Lab Tested :	DRECO-MATTS Drilling, Engineering & Construction Technical Support info@drecomatts.co.ke
Contractor :	AB HARAMBE CONSTRUCTION COMPANY		

EXCAVATION PIT RECORD

Project:	Geotechnical Investigation: Juba City Council Sanitary & Environmental.	Bore Hole No:	EP1
Location :	Juba South Sudan	Water table :	
Elevation:		Test Method :	BS 5930:1990
Coordinates:		Date: Start 19-12-2020	End : 19-12-2020

Ground water	Depth (m)	Description of strata	Legend	Level	Sample &Test Depth (m)	Sample &Test Type	Sample &Test No	ROCK % CR	SPT 150	SPT 75	SPT 75	SPT 75	SPT 75	SPT N	SPT N	Remarks
	0.00	Firm Light brown sandy silty CLAY (Top Soil)		0.00												
	0.50	Stiff, whitish yellow/Brownish grey weathered caarse grained Gneiss disintegrating grading to Grey Gravelly SAND		0.50												
	1.00	Very stiff, moderately weathered fissured caorse grained dark grey Gneiss		1.00												
	1.50			1.50												
	2.00		End of EP	2.00												
	2.50			2.50												
	3.00			3.00												
	14.00			14.00												
	16.00			16.00												
	18.00			18.00												
	20.00			End of BH 20.00												

Water Table

Sample Types

U:Undisturbed

D:Disturbed

W Water sample

R Rock sample

CR Rock recovery

Rock sample

SPT Standard Penetration Test

Brownish Grey Silty Clay

Weathered Gneiss Rock (Brownish Grey)

Weathered Gneiss Rock (Grey)

Fresh Gneiss Rock (Grey)

Recommeded Foundation Layer. 1.5m Stiff, whitish yellow/Brownish grey weathered caarse grained Gneiss disintegrating grading to Grey Gravelly SAND

Logged by;- G.Ogutu (Geologist) | Checked by ;- E.N Githaiga (Geotechnical &Material Engineer) | Approved by ;- G.K Wambugu (Technical Director)

EP2

Client:	JUBA MUNICIPAL COUNCIL SANITATION AND ENVIRONMENTA PROJECT	**Lab Tested :**	DRECO-MATTS Drilling, Engineering & Construction Technical Support info@drecomatts.co.ke
Contractor :	AB HARAMBE CONSTRUCTION COMPANY		

EXCAVATION PIT RECORD

Project:	Geotechnical Investigation: Juba City Council Sanitary & Environmental.	**Bore Hole No:**	EP2
Location :	Juba South Sudan	**Water table :**	
Elevation:		**Test Method :**	BS 5930:1990
Coordinates:		**Date: Start**	19-12-2020
		End :	19-12-2020

Ground water	Depth (m)	Description of strata	Legend	Level	Sample &Test Depth (m)	Sample &Test Type	Sample &Test No	ROCK % CR	SPT 150	SPT 75	SPT 75	SPT 75	SPT 75	SPT N	SPT N	Remarks
	0.00	Firm Light brown sandy silty CLAY (Top Soil)		0.00												
	0.50	Stiff, Yellow/Brownish grey Clayey silty Gravel SAND		0.50												
	1.00	Stiff, whitish yellow/Brownish grey weathered caarse grained Gneiss disintegrating grading to Grey Gravelly SAND		1.00												
	1.50			1.50												
	2.00		End of EP	2.00												
	2.50			2.50												
	3.00			3.00												
	14.00			14.00												
	16.00			16.00												
	18.00			18.00												
	20.00			20.00												

Water Table

Sample Types

U:Undisturbed

D:Disturbed

W Water sample

R Rock sample

CR Rock recovery

Rock sample

SPT Standard Penetration Test

Brownish GreySilty Clay .

Weathered Gneiss Rock (Brownish Grey)

Weathered Gneiss Rock (Grey)

Fresh Gneiss Rock (Grey)

Recommeded Foundation Layer. 1.5m Stiff, whitish yellow/Brownish grey weathered caarse grained Gneiss disintegrating grading to Grey Gravelly SAND

Logged by;- G.Ogutu (Geologist) | Checked by ;- E.N Githaiga (Geotechnical &Material Engineer) | Approved by ;- G.K Wambugu (Technical Director)

Appendix 6 – Photographic Records

BH1 core box Photo

BH2 core box photo.

BH3 core box photo.

BH4 core box photo

EP1 Excavation Pit Photo

EP2 Excavation Pit Photo

Appendix 7– Bearing capacity

a) N-Values

PROJECT: JUBA CITY COUNCIL SANITARY AND ENVIRONMENTAL MULTI USE BUILDING

Doc -04

CLIENT: AB HARAMBER CONTRACTORS

LOCATION: JUBA ,SOUTH SUDAN

Date: 21/12/2020

GEOTECHNICAL CONTRACTOR DRECOMATTS LIMITED

EVALUATION OF ALLOWABLE BEARING CAPACITY BASED ON FIELD SPT 'N' VALUES

BH No.	Depth (m)	Predominant Soil Fraction	Measured SPT 'N' Value N	Overburden Correction Factor C_N	Hammer Donut rope and pulley Correction Factor CH	Rod length factor (4-3m) 4-1.5m CR	Sampler factor Standard CS	Bore hole Diamete correction CB	Equipment & Borehole Correction C_{EQ-BH}	Corrected SPT 'N' Value Ncor $(N1)_{60-CER}$	Correction for Water Table Position C_W	Unconfined Compressive Strength $q_u=N_{cor}*13.27$ (kPa)	Undrained Cohesion $C_u=q_u/2$ (kPa)	Allowable Bearing Capacity By Terzaghi and Peck (1948) $Q_{all}=N_{cor}*10$ (kPa)	Allowable Bearing Capacity Terzaghi and Peck, 1967 $Q_{all}=5.14*c_u/3$ (kPa)
BH 1	1.50	Gravels,Sands ,Silts & Clays	50	1.00	0.80	0.75	1.00	1.00	0.60	30	1.00	398	199	300	341
	3.00		50	1.00	0.80	0.75	1.00	1.00	0.60	30	1.00	398	199	300	341
BH 2	1.50	Sands ,Silts & Clays	50	1.00	0.80	0.75	1.00	1.00	0.60	30	1.00	398	199	300	341
	2.50		50	1.00	0.80	0.75	1.00	1.00	0.60	30	1.00	398	199	300	341
BH 3	1.50	Gravels,Sands ,Silts & Clays	50	1.00	0.80	0.75	1.00	1.00	0.60	30	1.00	398	199	300	341
	3.00		50	1.00	0.80	0.75	1.00	1.00	0.60	30	1.00	398	199	300	341
	4.50		50	1.00	0.80	0.85	1.00	1.00	0.68	34	1.00	451	226	340	387
	5.80		50	1.00	0.80	0.85	1.00	1.00	0.68	34	1.00	451	226	340	387
BH 4	1.50	Gravels,Sands ,Silts & Clays	50	1.00	0.80	0.75	1.00	1.00	0.60	30	1.00	398	199	300	341

NB:In all the 4 test location refusal was attained at 1.5m with N-Value greater than 50 recorded.Hence the bearing capacity for this site can be deduced to be higher than 341Kpa .

For cohesive soils, the relationship qu = 13.00 x Design N-value is used for evaluation of the Unconfined Compressive Strength qu, the cohesion Cu = qu/2 and qult = 5.14 x Cu. qall is evaluated using a factor of safety of 3.0

Allowable bearing capacity with settlement limited to approximately 25mm for cohesionless soils read off directly from the Chart (Published by Terzaghi and Peck, 1967). (For 2m width footing)

Estimates of presumed allowable bearing capacity values for scheme design not detail design

Ncor of 0.6 is adapted for rod length 0-4m and 0.68 for depth ranges 4-6m in accordance to Peck et al
Ncor = N60 =CN CER
CER =CH CR Cs CB.

Vincent Kimeu
Laboratory Manager
Drecomatts Limited

b) UCS-Rock

DRECOMATTS LIMITED

FORM 12

CLIENT	AB HARAMBE CONSTRUCTION COMPANY
PROJECT	PROPOSED JUBA CITY COUNCIL SANITARY AND ENVIRONMENT BUILDING .
LOCATION	JUBA TOWN
Date	9/2/2021

UNCONFINED COMPRESSION TEST (UCS)-ROCK

Bore hole	Bore hole Depth range (m)		sample length	Diameter	cross sectional area	Volume	Height:Diameter ratio	Weight	Unit weight	Load	Unconfined Compressive Strength
No	From	To	mm	mm	mm2	mm3		g	kg/m3	KN	N/mm2
BH 1	10.65	10.75	80	70	3850	308000	1.14	540	1,753	54	14.03
	12.00	12.15	85	70	3850	327250	1.21	560	1,711	75	19.48
	13.60	13.75	80	70	3850	308000	1.14	900	2,922	107	27.79
	14.80	15.00	100	70	3850	385000	1.43	1105	2,870	125	32.47
BH 2	4.65	4.75	80	80	5029	402286	1.00	650	1,616	80	15.91
	6.05	6.15	75	80	5029	377143	0.94	535	1,419	70	13.92
	8.90	9.10	110	80	5029	553143	1.38	980	1,772	130	25.85
	9.52	9.68	160	80	5029	804571	2.00	1,770	2,200	153	30.43
	10.30	10.50	100	80	5029	502857	1.25	1,110	2,207	160	31.82
	11.40	11.60	145	80	5029	729143	1.81	1,515	2,078	145	28.84
	13.20	13.80	160	80	5029	804571	2.00	1,730	2,150	142	28.24
	18.40	18.60	160	80	5029	804571	2.00	1,730	2,150	170	33.81
BH 3	5.80	5.90	95	70	3850	365750	1.36	670	1,832	158	41.04
	10.40	10.60	110	70	3850	423500	1.57	845	1,995	140	36.36
	15.10	15.30	90	70	3850	346500	1.29	630	1,818	168	43.64
	16.70	16.80	85	70	3850	327250	1.21	630	1,925	185	48.05
	19.30	19.50	130	70	3850	500500	1.86	980	1,958	205	53.25
BH 4	3.80	4.00	70	70	3850	269500	1.00	400	1,484	65	16.88
	6.80	7.00	90	70	3850	346500	1.29	420	1,212	105	27.27
	11.40	11.60	110	83	5413	595406	1.33	845	1,419	140	25.86
	13.60	13.80	140	83	5413	757790	1.69	1,132	1,494	125	23.09
	17.20	17.40	140	83	5413	757790	1.69	1,405	1,854	165	30.48

The specimens were cut into testable sizes,the surfaces were made flat by grinding.

The specimens were tested whilst in dry condition.

	Tested by AB Ayub	*Checked by John*	*Approved by G.K Wambugu*

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Appendix 8– Summary of classification results.

LAB TEST RESULTS SUMMARY-ROCL/SOIL

DRECO-MATTS Drilling, Engineering & Construction Technical Support

CLIENT: AB HARAAMBE CONSTRUCTION

PROJECT: JUBA CITY COUNCIL SANITARY AND ENVIRONMENTAL MUILT-PURPOSE BUILDING

LOCATION: JUBA CITY; REPUBLIC OF SOUTH SUDAN

12/2/2021

	BH/TP no	Depth(m)		Soil Index Properties																						Soil Density				Shear strength				Comments	
				% Passing Sieve (mm)																GM	NM	Plasticity					MDD	OMC	Bulk Density	SG	φ	c	Bulk density	Remolded		
				75.0	50.0	37.5	28.0	20.0	14.0	10.0	6.3	5.0	4.0	2.0	1.18	0.600	0.425	0.300	0.150	0.075			LL	PL	PI	LS	PM	Kg/m3	%	Kg/m3		(°)	Kg/m2	Kg/m3	%		
1	BH1	0.00	1.00					100	97.7	96.6	94.9	94.1	90.1	89.6	75.2	59.5	46.7	33	8.9	0.4		16.8	NP	NP	NP	NILL	0	1930	15.3	2225.29	2.595	27	0.02	1712	77		
2	BH1	1.00	2.00						100	99.7	99.1	89.7	97.4	95.3	84.1	67.2	51	36.3	12.1	1.8		9.4	NP	NP	NP	NILL	0				2.500						
3	BH1	2.00	3.00							100	99.7	98.1	96.3	94.8	84.3	67.9	51.5	36.7	12.1	0.9		6.7	NP	NP	NP	NILL	0				2.595						
4	BH1	3.00	4.00							100	99.3	98.9	96.9	95.7	85	68.6	51.9	36.2	10.1	0.3		2.0	NP	NP	NP	NILL	0				2.660						
5	BH1	4.00	5.00							100	99.5	99.2	97.5	96.6	86.4	69.0	52.2	36.8	9.3	0.2		1.8	NP	NP	NP	NILL	0				2.660						
6	BH1	5.00	6.00								100	99.5	97.6	96.8	86.8	69.9	53.2	37.8	10.4	0.6		2.2	NP	NP	NP	NILL	0				2.569						
7	BH2	0.00	1.00				100	96.7	95.7	94.1	91.2	89.0	82.3	79.3	68.8	57.2	46.8	35.1	14.1	8.1		13.0	28.7	23.12	5.58	2.79	261.14				2.605						
8	BH2	1.00	1.50												100	96.6	89.0	83.1	75.7	56.5		6.7	NP	NP	NP	NILL	0	1930	15.3	2225.29	2.500	25	0.13	1680	75		
9	BH2	1.50	2.30							100	99.8	99.5	97.6	96.5	86.5	69.4	52.8	37.1	15.0	0.3		15.5	27.40	14.29	13.11	6.555	692.21				2.625						
10	BH2	2.30	3.50							100	99.8	99.7	97.9	97.1	86.7	67.4	58.8	37.3	10.2	0.7		2.3	NP	NP	0	NILL	NILL				2.76						
11	BH3	0.00	1.00					100	96.5	54.4	54.5	91.2	89.3	82.6	86.6	69.3	58	47.2	35.2	14.6		2.00	34.6	25	9.6	4.8	556.80	1930	15.3	2225.29	2.47	26	0.03	1565	70		
12	BH3	1.00	2.00							100	98.7	95.4	93.8	95.9	89.9	70.8	57.9	46.2	33.5	10		1.7	NP	NP	0	NILL	NILL				2.625						
13	BH3	2.00	3.00								100	97.1	95.6	88	88	71.5	56.8	44.9	31.7	8.8		2.2	NP	NP	0	NILL	NILL				2.66						
14	BH3	12.20	12.50								100	98.7	96.4	86.5	89.5	72.6	57.7	46.8	32.6	9.1		1.4	NP	NP	0	NILL	NILL				2.715						
15	BH4	0.00	1.00				100	92.1	92	90.4	86.6	83.9	73.1	68.9	63.7	51.9	41.4	31.6	14.6	9		4.3	31.3	19.3	12	6	496.80	1680	11.9	1937.04	2.50	25	0.09	1580	82		
16	BH4	1.00	2.00						100	98.7	94.7	90.9	76.8	72	66.4	52.4	30.3	27.4	6.6	0.4		0.3	NP	NP	0	NILL	NILL				2.565						
17	EP1	0.00	1.00						100	98.6	94	84.5	79.4	65.8	61.4	48.5	39.6	33.2	27	18.4		9.4	31.2	18.97	12.23	NILL	NILL	1930	15.3	2225.29	2.595	23	0.12	1599	72		
18	EP1	1.00	2.00					100	96.6	96.6	95.4	87.5	82.3	68.6	64	50.1	40.8	34.3	28	19.4		5.6	NP	NP	0	NILL	NILL				2.625						
19	EP2	0.00	1.00					100	93.5	87.4	82.2	77.2	69.4	61.6	58.6	50.5	44.9	40.6	35.9	26.9		19.5	NP	NP	0	NILL	NILL	1680	11.9	1937.04	2.53	20	0.16	1723	89		
20	EP2	1.00	2.00					100	94	91.9	87.1	82.7	80	72.1	69.4	61.4	54.6	49.3	44	34.4		10.3	NP	NP	0	NILL	NILL				2.53						

Keys:

LL	Liquid Limit	LS	Linear Shrinkage	USCS	Unified Soil Classification System	MH	Elastic Silt (High plasticity)	CH	Fat Clay (High plasticity)	NA	Not Applicable
PL	Plastic Limit	PM	Plasticity Modulus (producr of Passing 0.425 a	GM	Grading modulus	ML	Silt	SC	Clayey Sand	NS	Not Specified
PI	Plasticity Index	PI=	LL-PL	BH	Borehole	CL	Clean Clay (Low plasticity)	SM	Silty Sand	φ	Angle of internal friction
NP	Non-Plastic	MV	Silts of very high plasticity	NM	Natural Moisture			SP	Poorly graded Sand	(°)	Degrees
SG	Specific gravity	CV	Clays of very high plasticity	CE	Clays of extramely high plasticity			LS	Linear shrinkage	UCS	Unconfined compressive strength

Vincent Kimeu
Laboratory Manager
Drecomatts Limited

Appendix 9– Grading results.

BH1 0.0 - 1.0m

SOIL CLASSIFICATION

Sieve Analysis Laborarory Test Result -BSS 1377

DRECO-MATTS Drilling, Engineering & Construction Technical Support

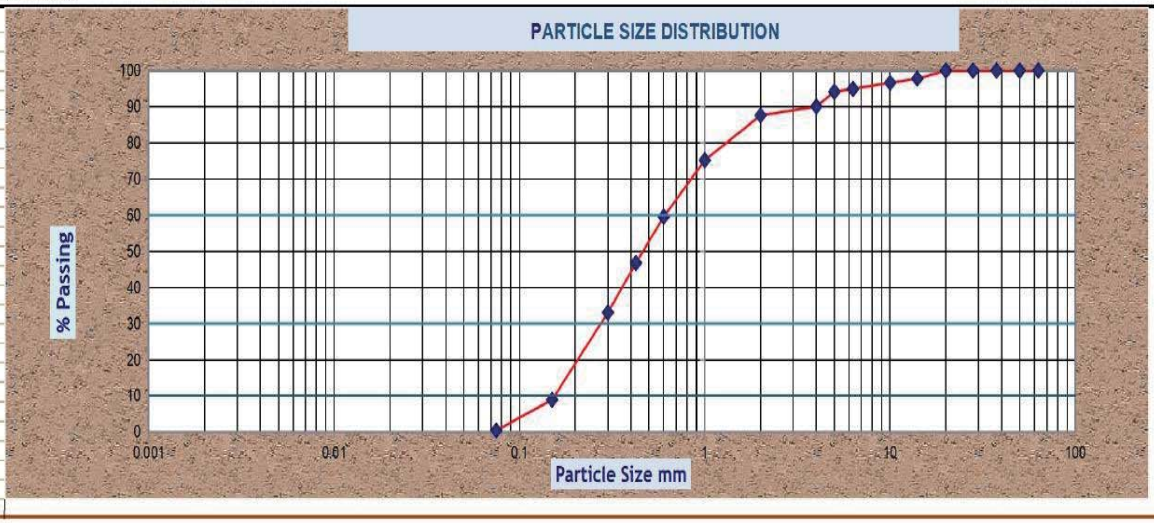
CLIENT	AB HARAMBE CONSTRUCTION			Date	7/2/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE				
Location	BH 1	Depth (m)	0.0-1.0m	sample no	

CLAY	SILT				SAND				GRAVEL					Cobbles
	Fine	Medium	Coarse	% Silt	Fine	Medium	Coarse	% Sand	Fine	Medium	Coarse	% Gravel	0	0
0.0	0.0	0.0	0.4	0	32.6	26.5	28.07	87	7.3107	2.87	0	10	0	

% passing 0.425 sieve	47	Slightly gravelly	
% passing 0.075 sieve	0		

Grading+ Hydrometer

Sieve	%
75	100
63	100
50	100
37.5	100
28	100
20	100
14	97.78
10	96.61
6.3	94.91
5	94.13
4	90.08
2	87.6
1	75.2
0.6	59.53
0.425	46.74
0.3	33.03
0.15	8.877
0.075	0.392



Description ;- Light brown /yellowish FINE-MEDIUM COARSE SAND -NON PLASTIC

Tested By	AB	Checked	Esther Githiga	Approved by	GK

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BH1 1.0 - 2.0m

SOIL CLASSIFICATION

Sieve Analysis Laborarory Test Result -BSS 1377

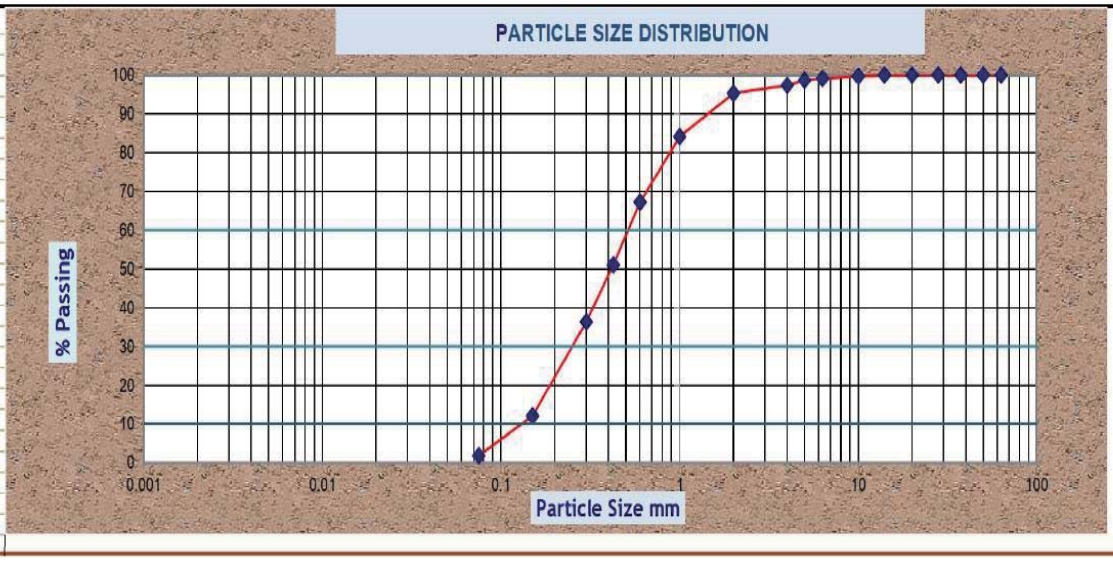
DRECO-MATTS Drilling, Engineering & Construction Technical Support

CLIENT	AB HARAMBE CONSTRUCTION	Date	7/2/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	BH 1	Depth (m)	1.0-2.0m
	sample no		

CLAY		SILT				SAND				GRAVEL							Cobbles
		Fine	Medium	Coarse	% Silt	Fine	Medium	Coarse	% Sand	Fine	Medium	Coarse	% Gravel	0			0
	0.0	0.0	0.0	1.8	2	34.6	30.9	28.09	94	3.824	0.88	0	5	0			
		% passing 0.425 sieve						51									
		% passing 0.075 sieve						2									

Grading+ Hydrometer

Sieve	%
75	100
63	100
50	100
37.5	100
28	100
20	100
14	100
10	99.71
6.3	99.12
5	98.68
4	97.35
2	95.29
1	84.12
0.6	67.21
0.425	51.03
0.3	36.32
0.15	12.06
0.075	1.765



Description ;- Grey Silty SAND -NON PLASTIC

Tested By	AB	Checked	Esther Githiga	Approved by	GK

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BH1 2.0 - 3.0m

SOIL CLASSIFICATION

Sieve Analysis Laborarory Test Result -BSS 1377

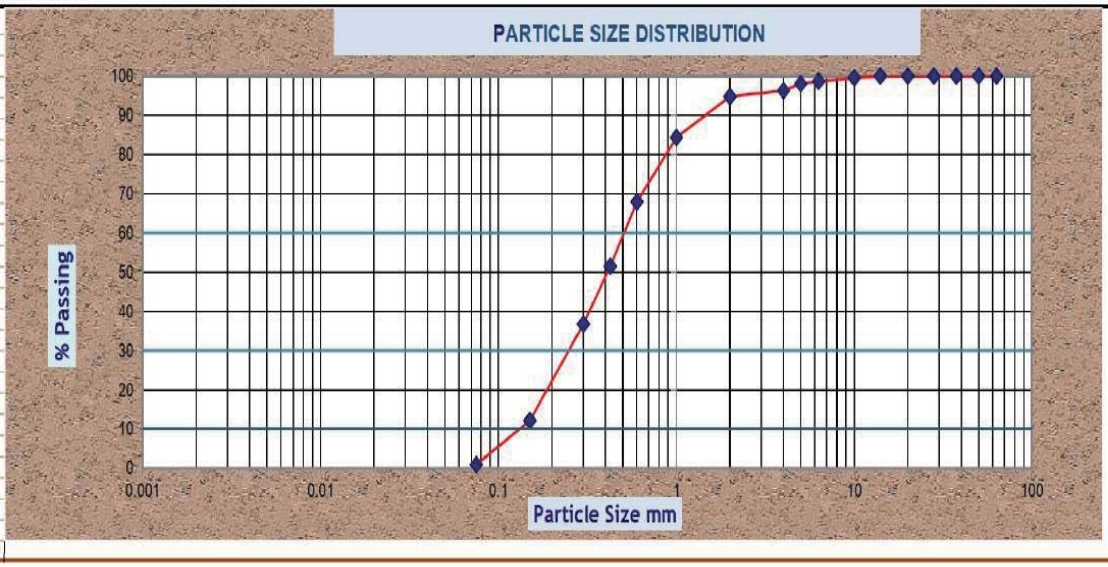
DRECO-MATTS Drilling, Engineering & Construction Technical Support

CLIENT	AB HARAMBE CONSTRUCTION	Date	7/2/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	BH 1	Depth (m)	2.0-30m
	sample no		

CLAY		SILT				SAND				GRAVEL							Cobbles
		Fine	Medium	Coarse	% Silt	Fine	Medium	Coarse	% Sand	Fine	Medium	Coarse	% Gravel	0			0
	0.0	0.0	0.0	0.9	1	35.8	31.2	26.87	94	3.881	1.34	0	5	0			
		% passing 0.425 sieve						51									
		% passing 0.075 sieve						1									

Grading+ Hydrometer

Sieve	%
75	100
63	100
50	100
37.5	100
28	100
20	100
14	100
10	99.55
6.3	98.66
5	98.06
4	96.27
2	94.78
1	84.33
0.6	67.91
0.425	51.49
0.3	36.72
0.15	12.09
0.075	0.896



Description ;- Grey Silty SAND -NON PLASTIC

Tested By	AB	Checked	Esther Githiga	Approved by	GK

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BH1 3.0 - 4.0m

SOIL CLASSIFICATION

Sieve Analysis Laborarory Test Result -BSS 1377

DRECO-MATTS Drilling, Engineering & Construction Technical Support

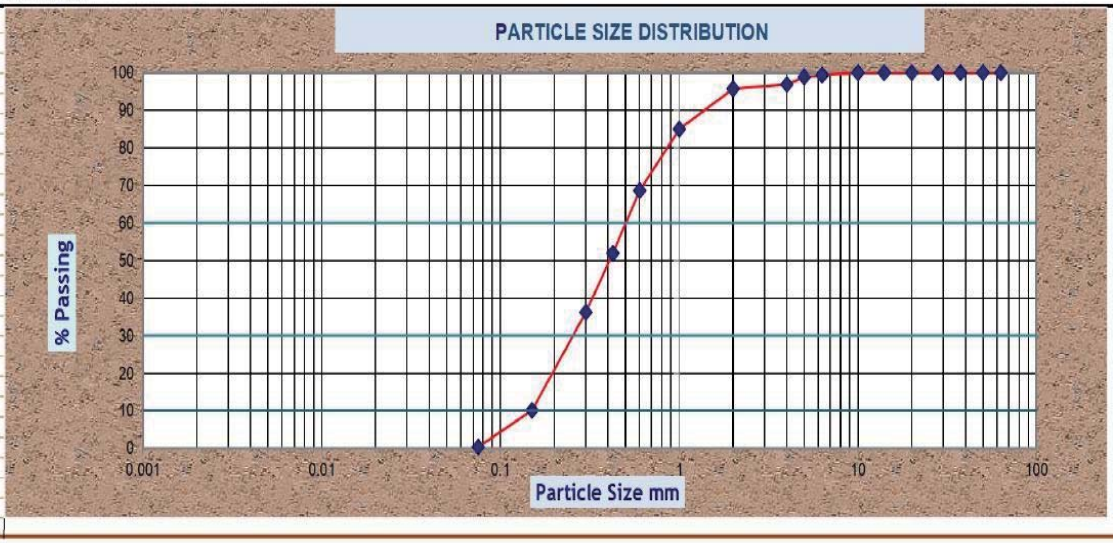
CLIENT	AB HARAMBE CONSTRUCTION			Date	7/2/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE				
Location	BH 1	Depth (m)	3.0-4.00m	sample no	

CLAY	SILT				SAND				GRAVEL					Cobbles
	Fine	Medium	Coarse	% Silt	Fine	Medium	Coarse	% Sand	Fine	Medium	Coarse	% Gravel	0	0
0.0	0.0	0.0	0.3	0	35.9	32.4	27.11	95	3.636	0.66	0	4	0	

% passing 0.425 sieve	52
% passing 0.075 sieve	0

Grading+ Hydrometer

Sieve	%
75	100
63	100
50	100
37.5	100
28	100
20	100
14	100
10	100
6.3	99.34
5	98.84
4	96.86
2	95.7
1	84.96
0.6	68.6
0.425	51.9
0.3	36.2
0.15	10.08
0.075	0.331



Description ;- Grey FINE-MEDIUM SAND -NON PLASTIC

Tested By	AB	Checked	Esther Githiga	Approved by	GK

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BH1 4.0 -5.0m

SOIL CLASSIFICATION

Sieve Analysis Laborarory Test Result -BSS 1377

DRECO-MATTS Drilling, Engineering & Construction Technical Support

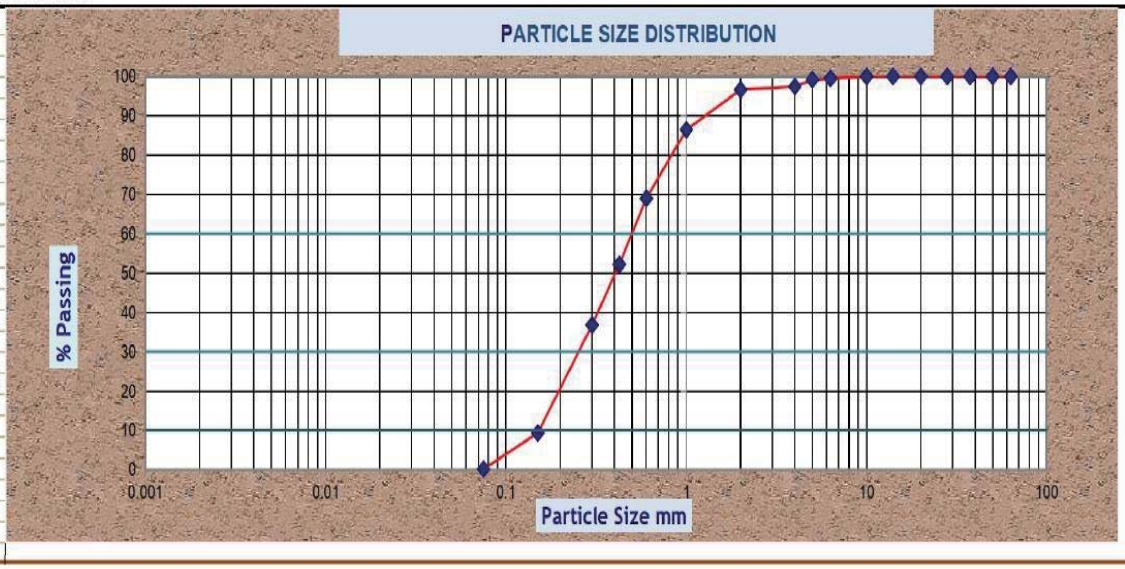
CLIENT	AB HARAMBE CONSTRUCTION	Date	7/2/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	BH 1	Depth (m)	4.0-5.0m
sample no			

CLAY	SILT				SAND				GRAVEL					Cobbles
	Fine	Medium	Coarse	% Silt	Fine	Medium	Coarse	% Sand	Fine	Medium	Coarse	% Gravel	0	0
0.0	0.0	0.0	0.2	0	36.6	32.2	27.63	96	2.881	0.51	0	3	0	

% passing 0.425 sieve	52
% passing 0.075 sieve	0

Grading+ Hydrometer

Sieve	%
75	100
63	100
50	100
37.5	100
28	100
20	100
14	100
10	100
6.3	99.49
5	99.15
4	97.46
2	96.61
1	86.44
0.6	68.98
0.425	52.2
0.3	36.78
0.15	9.322
0.075	0.169



Description ;- Grey FINE-MEDIUM SAND -NON PLASTIC

Tested By	AB	Checked	Esther Githiga	Approved by	GK

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BH1 5.0 -6.0m

SOIL CLASSIFICATION

Sieve Analysis Laborarory Test Result -BSS 1377

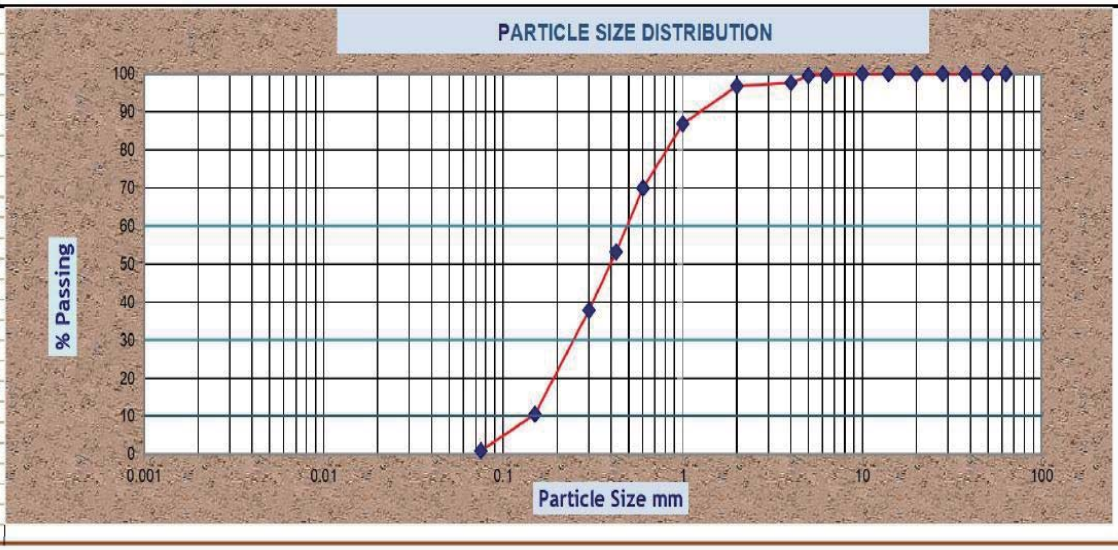
DRECO-MATTS Drilling, Engineering & Construction Technical Support

CLIENT	AB HARAMBE CONSTRUCTION	Date	7/2/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	BH 1	Depth (m)	5.0-6.0m
	sample no		

CLAY		SILT				SAND				GRAVEL							Cobbles
		Fine	Medium	Coarse	% Silt	Fine	Medium	Coarse	% Sand	Fine	Medium	Coarse	% Gravel	0			0
	0.0	0.0	0.0	0.9	1	36.9	32.1	26.84	96	2.906	0.34	0	3	0			
		% passing 0.425 sieve						53									
		% passing 0.075 sieve						1									

Grading+ Hydrometer

Sieve	%
75	100
63	100
50	100
37.5	100
28	100
20	100
14	100
10	100
6.3	99.66
5	99.49
4	97.61
2	96.75
1	86.84
0.6	69.91
0.425	53.16
0.3	37.78
0.15	10.43
0.075	0.855



Description ;- Grey FINE-MEDIUM SAND -NON PLASTIC

Tested By	AB	Checked	Esther Githiga	Approved by	GK

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BH 2 0.0-1.0m

SOIL CLASSIFICATION

Sieve Analysis Laborarory Test Result -BSS 1377

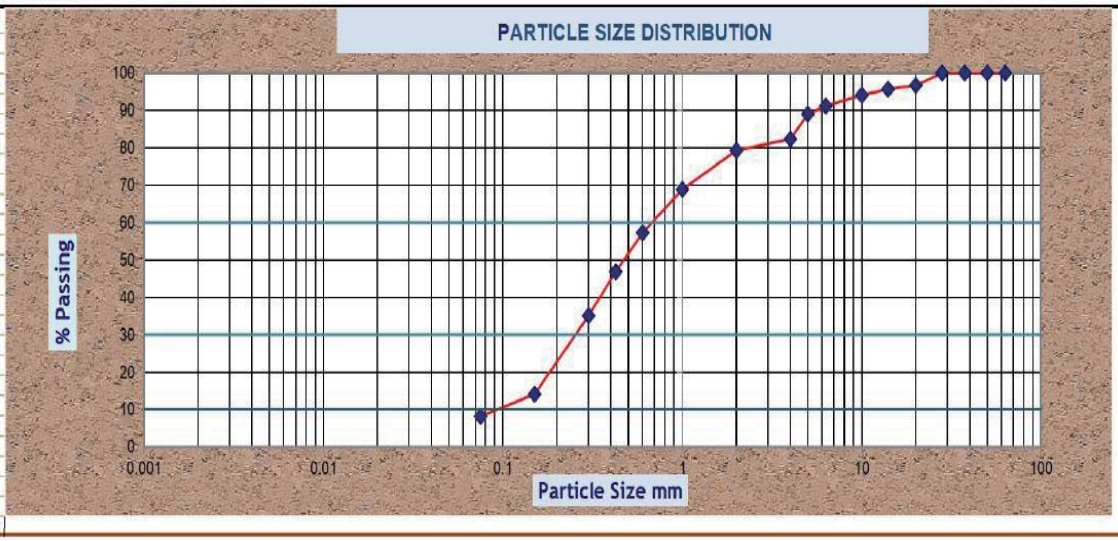
DRECO-MATTS Drilling, Engineering & Construction Technical Support

CLIENT	AB HARAMBE CONSTRUCTION	Date	7/2/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	BH 2	Depth (m)	0.0-1.0m
	sample no		

CLAY		SILT				SAND				GRAVEL							Cobbles
		Fine	Medium	Coarse	% Silt	Fine	Medium	Coarse	% Sand	Fine	Medium	Coarse	% Gravel	0			0
	0.0	0.0	0.0	8.1	8	27.0	22.2	22.03	71	11.88	4.49	3	20	0			
		% passing 0.425 sieve						47									
		% passing 0.075 sieve						8	gravelly								

Grading+ Hydrometer

Sieve	%
75	100
63	100
50	100
37.5	100
28	100
20	96.7
14	95.7
10	94.1
6.3	91.2
5	89.0
4	82.3
2	79.3
1	68.8
0.6	57.2
0.425	46.8
0.3	35.1
0.15	14.1
0.075	8.1



Description ;- Light brown /yellowish FINE MEDIUM SAND -NON PLASTIC

Tested By	AB	Checked	Esther Githiga	Approved by	GK

BPC &Engineering Services Ltd Email;- bpcengineering@gmail.com info@bpcengineering.co.ke web;- www;bpcengineering.co.ke

BH 2 1.0-1.5m

SOIL CLASSIFICATION

Sieve Analysis Laborarory Test Result -BSS 1377

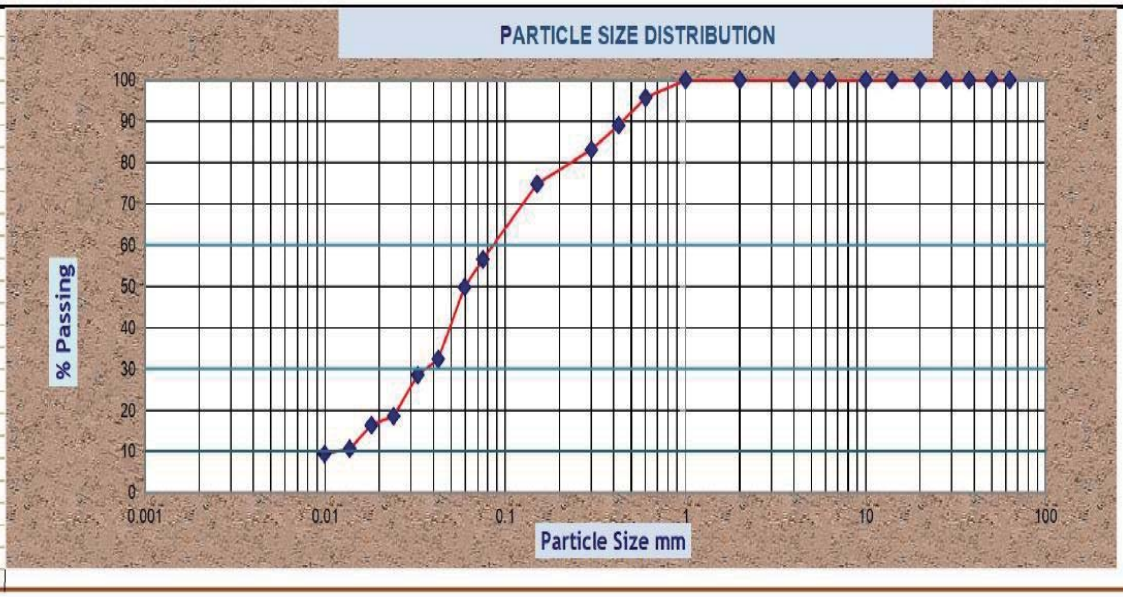
DRECO-MATTS
Drilling, Engineering & Construction Technical Support

CLIENT	AB HARAMBE CONSTRUCTION	Date	15/1/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	BH 2	Depth (m)	1.0-1.5
	sample no		

CLAY		SILT				SAND				GRAVEL							Cobbles
		Fine	Medium	Coarse	% Silt	Fine	Medium	Coarse	% Sand	Fine	Medium	Coarse	% Gravel	0			0
	0.0	0.0	28.5	28.0	57	26.6	12.6	4.27	43	0	0.00	0	0	0			
		% passing 0.425 sieve							89								
		% passing 0.075 sieve							57								

Grading+ Hydrometer

Sieve	%
75	100
63	100
50	100
37.5	100
28	100
20	100
14	100
10	100
6.3	100
5	100
4	100
2	100
1	100
0.6	95.7
0.425	89.0
0.3	83.1
0.15	74.8
0.075	56.5
0.059	49.8
0.042	32.3
0.033	28.5
0.024	18.5
0.018	16.3
0.014	10.6
0.01	9.3



Description ;- Light brown /yellowish SAND SILT with some clay

Tested By	AB	Checked	Esther Githiga	Approved by	GK

BPC &Engineering Services Ltd Email;- bpcengineering@gmail.com info@bpcengineering.co.ke web;- www;bpcengineering.co.ke

BH 2 1.5-2.3m

SOIL CLASSIFICATION

Sieve Analysis Laborarory Test Result -BSS 1377

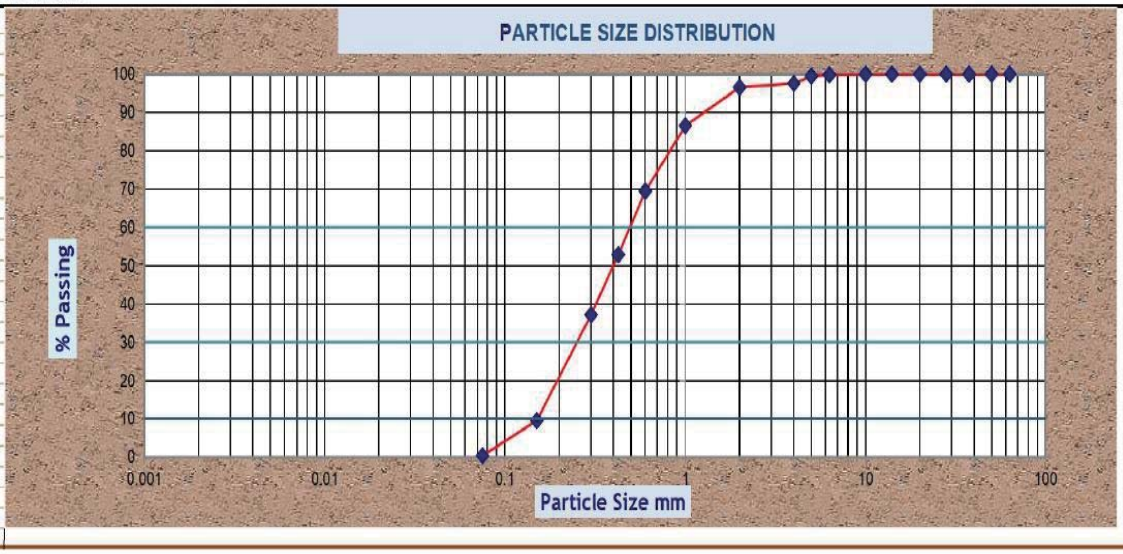
DRECO-MATTS Drilling, Engineering & Construction Technical Support

CLIENT	AB HARAMBE CONSTRUCTION	Date	7/2/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	BH 2	Depth (m)	1.5-2.3m
	sample no		

CLAY		SILT				SAND				GRAVEL							Cobbles
		Fine	Medium	Coarse	% Silt	Fine	Medium	Coarse	% Sand	Fine	Medium	Coarse	% Gravel	0			0
	0.0	0.0	0.0	0.3	0	36.8	32.3	27.12	96	3.282	0.17	0	3	0			
		% passing 0.425 sieve						53									
		% passing 0.075 sieve						0									

Grading+ Hydrometer

Sieve	%
75	100
63	100
50	100
37.5	100
28	100
20	100
14	100
10	100
6.3	99.8
5	99.5
4	97.6
2	96.5
1	86.5
0.6	69.4
0.425	52.8
0.3	37.1
0.15	9.5
0.075	0.3



Description ;- Light brown /yellowish FINE MEDIUM SAND -NON PLASTIC

Tested By	AB	Checked	Esther Githiga	Approved by	GK

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BH 2 2.3-3.5m

SOIL CLASSIFICATION

Sieve Analysis Laborarory Test Result -BSS 1377

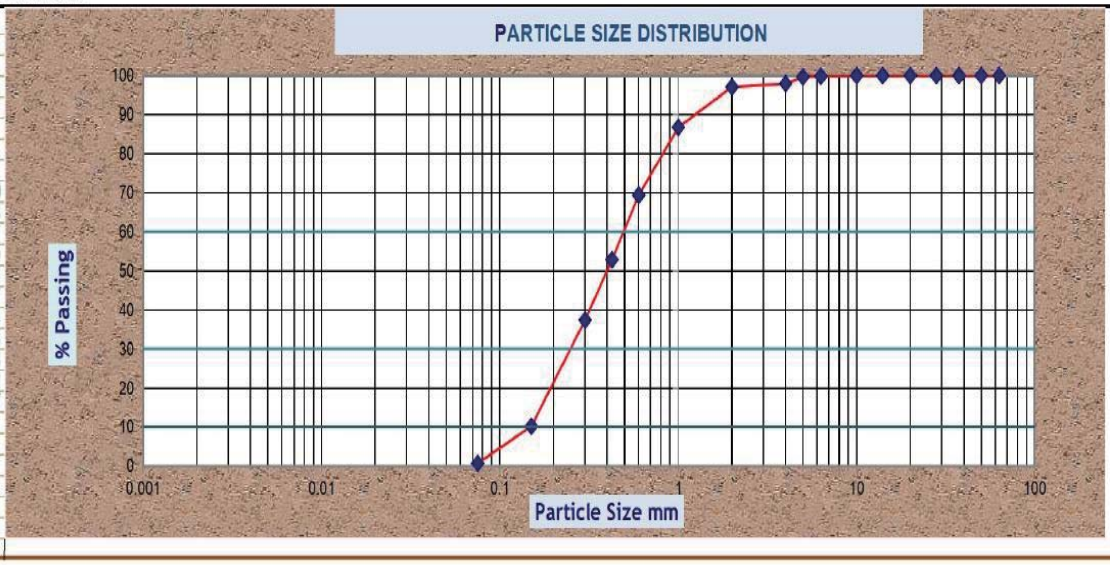
DRECO-MATTS Drilling, Engineering & Construction Technical Support

CLIENT	AB HARAMBE CONSTRUCTION	Date	7/2/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	BH 2	Depth (m)	2.3-3.5m
	sample no		

CLAY		SILT				SAND				GRAVEL							Cobbles
		Fine	Medium	Coarse	% Silt	Fine	Medium	Coarse	% Sand	Fine	Medium	Coarse	% Gravel	0			0
	0.0	0.0	0.0	0.7	1	36.7	32.0	27.71	96	2.754	0.17	0	3	0			
		% passing 0.425 sieve						53									
		% passing 0.075 sieve						1									

Grading+ Hydrometer

Sieve	%
75	100
63	100
50	100
37.5	100
28	100
20	100
14	100
10	100.0
6.3	99.8
5	99.7
4	97.9
2	97.1
1	86.7
0.6	69.4
0.425	52.8
0.3	37.3
0.15	10.2
0.075	0.7



Description ;- Light brown /yellowish FINE-MEDIUM SAND -NON PLASTIC

Tested By	AB	Checked	Esther Githiga	Approved by	GK

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BH 3 0.0-1.0m

SOIL CLASSIFICATION

Sieve Analysis Laborarory Test Result -BSS 1377

DRECO-MATTS Drilling, Engineering & Construction Technical Support

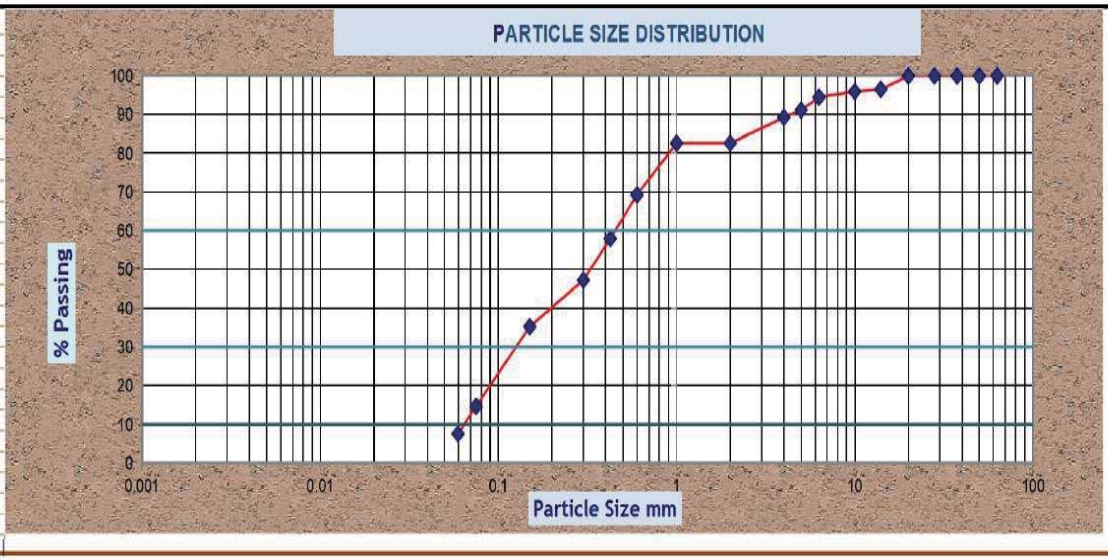
CLIENT	AB HARAMBE CONSTRUCTION	Date	15/1/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	BH 3	Depth (m)	0.0-1.0
	sample no		

CLAY		SILT				SAND				GRAVEL							Cobbles
		Fine	Medium	Coarse	% Silt	Fine	Medium	Coarse	% Sand	Fine	Medium	Coarse	% Gravel	0			0
	0.0	0.0	0.0	14.6	15	32.6	22.0	13.33	68	11.88	2.03	0	14	0			

% passing 0.425 sieve	58	Slightly gravelly	
% passing 0.075 sieve	15		

Grading+ Hydrometer

Sieve	%
75	100
63	100
50	100
37.5	100
28	100
20	100
14	96.5
10	95.9
6.3	94.5
5	91.2
4	89.3
2	82.6
1	82.6
0.6	69.3
0.425	58.0
0.3	47.2
0.15	35.2
0.075	14.6
0.059	7.5



Description ;- Light brown /yellowish Gravelly FINE SAND

Tested By	AB	Checked	Esther Githiga	Approved by	GK

BPC &Engineering Services Ltd Email;- bpcengineering@gmail.com info@bpcengineering.co.ke web;- www;bpcengineering.co.ke

BH 3 1.0-2.0m

SOIL CLASSIFICATION

Sieve Analysis Laborarory Test Result -BSS 1377

DRECO-MATTS
Drilling, Engineering & Construction Technical Support

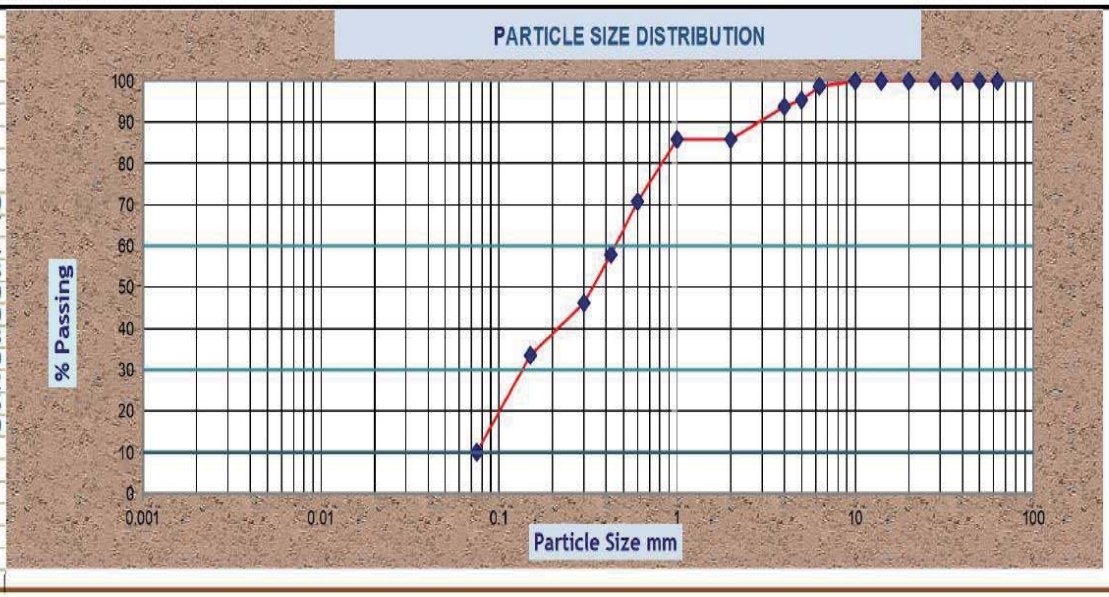
CLIENT	AB HARAMBE CONSTRUCTION	Date	15/1/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	BH 3	Depth (m)	1.0-2.0
	sample no		

CLAY		SILT				SAND				GRAVEL							Cobbles
		Fine	Medium	Coarse	% Silt	Fine	Medium	Coarse	% Sand	Fine	Medium	Coarse	% Gravel	0			0
	0.0	0.0	0.0	10.0	10	36.2	24.6	15.08	76	12.86	1.27	0	14	0			

% passing 0.425 sieve	58	Slightly gravelly	
% passing 0.075 sieve	10		

Grading+ Hydrometer

Sieve	%
75	100
63	100
50	100
37.5	100
28	100
20	100
14	100
10	100.0
6.3	98.7
5	95.4
4	93.8
2	85.9
1	85.9
0.6	70.8
0.425	57.9
0.3	46.2
0.15	33.5
0.075	10.0



Description ;- Light brown /yellowish Gravelly FINE SAND

Tested By	AB	Checked	Esther Githiga	Approved by	GK

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BH 3 2.0-3.0m

SOIL CLASSIFICATION

Sieve Analysis Laborarory Test Result -BSS 1377

DRECO-MATTS
Drilling, Engineering & Construction Technical Support

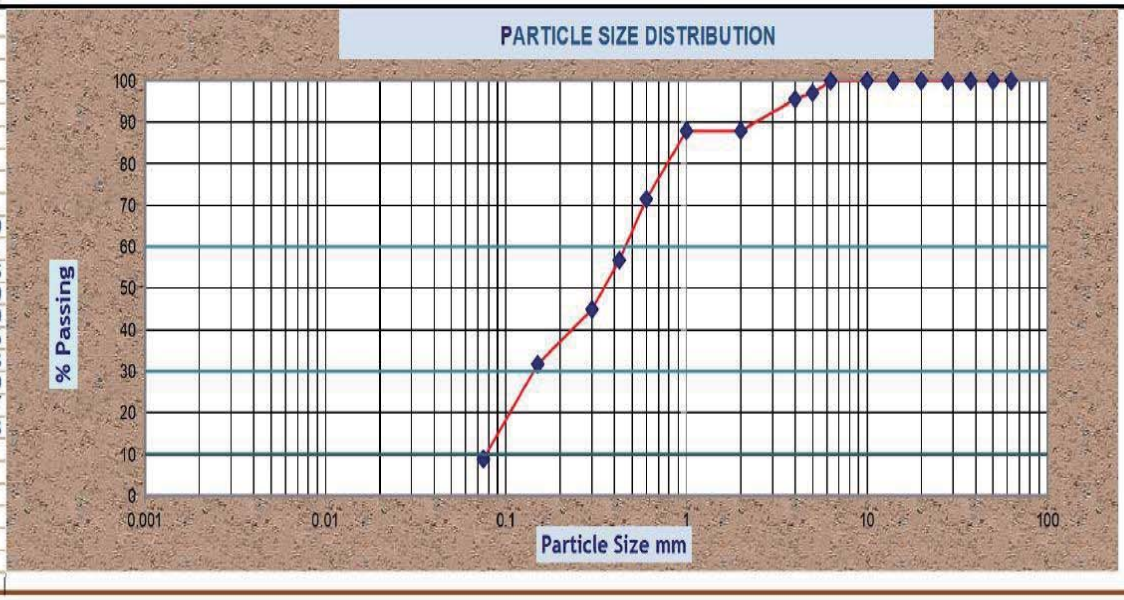
CLIENT	AB HARAMBE CONSTRUCTION	Date	15/1/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	BH 3	Depth (m)	2.0-3.9M
	sample no		

CLAY		SILT				SAND				GRAVEL							Cobbles
		Fine	Medium	Coarse	% Silt	Fine	Medium	Coarse	% Sand	Fine	Medium	Coarse	% Gravel	0			0
	0.0	0.0	0.0	8.8	9	36.1	26.6	16.44	79	12.03	0.00	0	12	0			

% passing 0.425 sieve	57	Slightly gravelly	
% passing 0.075 sieve	9		

Grading+ Hydrometer

Sieve	%
75	100
63	100
50	100
37.5	100
28	100
20	100
14	100
10	100
6.3	100.0
5	97.1
4	95.6
2	88.0
1	88.0
0.6	71.5
0.425	56.8
0.3	44.9
0.15	31.7
0.075	8.8



Description ;- Light brown /yellowish Gravelly FINE SAND

Tested By	AB	Checked	Esther Githiga	Approved by	GK

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BH 3 12.2-12.5m

SOIL CLASSIFICATION

Sieve Analysis Laborarory Test Result -BSS 1377

DRECO-MATTS
Drilling, Engineering & Construction Technical Support

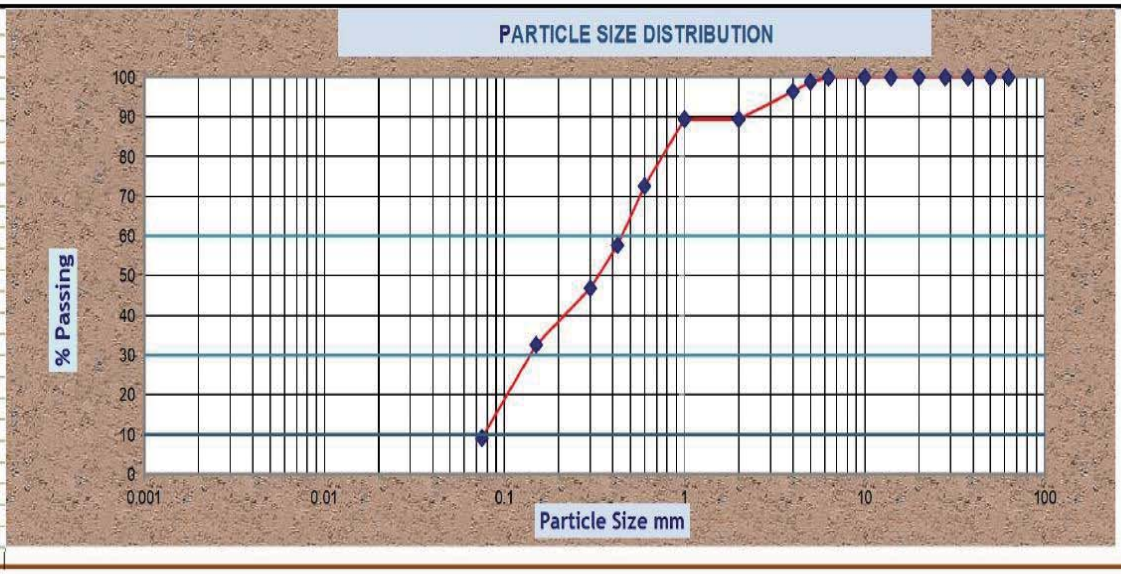
CLIENT	AB HARAMBE CONSTRUCTION	Date	15/1/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	BH 3	Depth (m)	12.2-12.5M
	sample no		

CLAY		SILT				SAND				GRAVEL							Cobbles
		Fine	Medium	Coarse	% Silt	Fine	Medium	Coarse	% Sand	Fine	Medium	Coarse	% Gravel	0			0
	0.0	0.0	0.0	9.1	9	37.8	25.8	16.86	80	10.53	0.00	0	11	0			

% passing 0.425 sieve	58	Slightly gravelly	
% passing 0.075 sieve	9		

Grading+ Hydrometer

Sieve	%
75	100
63	100
50	100
37.5	100
28	100
20	100
14	100
10	100
6.3	100
5	98.87
4	96.43
2	89.47
1	89.47
0.6	72.61
0.425	57.7
0.3	46.84
0.15	32.58
0.075	9.076



Description ;- Light brown /yellowish Gravelly FINE SAND

Tested By	AB	Checked	Esther Githiga	Approved by	GK

BPC &Engineering Services Ltd Email;- bpcengineering@gmail.com info@bpcengineering.co.ke web;- www;bpcengineering.co.ke

BH 4 0.0-1.0m

SOIL CLASSIFICATION

Sieve Analysis Laborarory Test Result -BSS 1377

DRECO-MATTS
Drilling, Engineering & Construction Technical Support

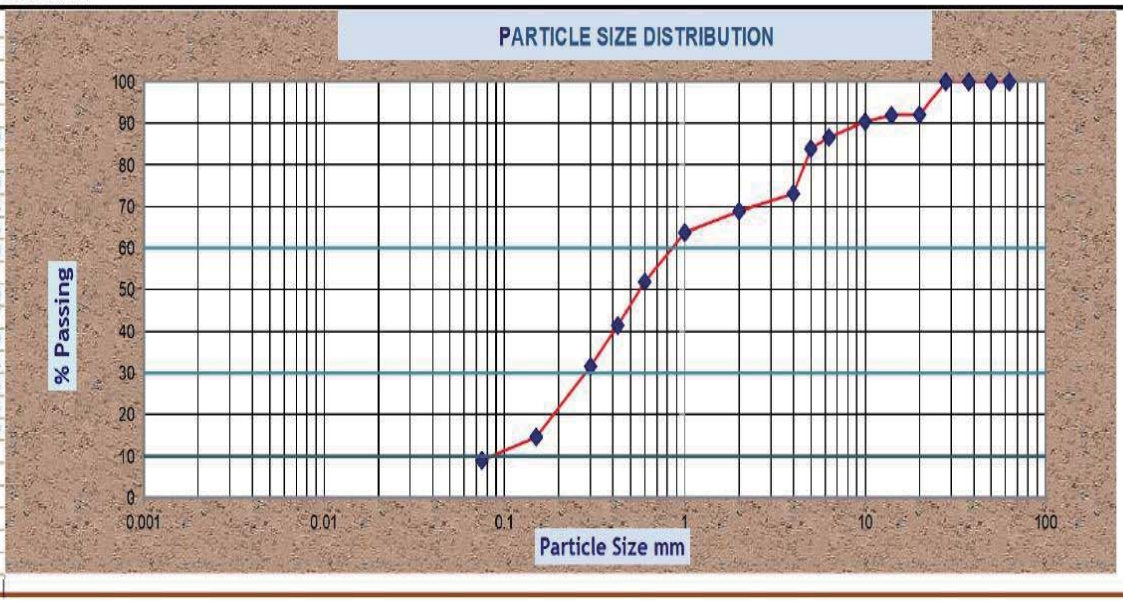
CLIENT	AB HARAMBE CONSTRUCTION	Date	7/2/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	BH 4	Depth (m)	0.0-1.0m
	sample no		

CLAY		SILT				SAND				GRAVEL							Cobbles
		Fine	Medium	Coarse	% Silt	Fine	Medium	Coarse	% Sand	Fine	Medium	Coarse	% Gravel	0			0
	0.0	0.0	0.0	9.0	9	22.6	20.3	17.00	60	17.75	5.31	8	31	0			

% passing 0.425 sieve	41	very gravelly	
% passing 0.075 sieve	9		

Grading+ Hydrometer

Sieve	%
75	100
63	100
50	100
37.5	100
28	100.0
20	92.1
14	92.0
10	90.4
6.3	86.6
5	83.9
4	73.1
2	68.9
1	63.7
0.6	51.9
0.425	41.4
0.3	31.6
0.15	14.6
0.075	9.0



Description ;- Light brown /yellowish Gravelly SAND -NON PLASTIC

Tested By	AB	Checked	Esther Githiga	Approved by	GK

BPC &Engineering Services Ltd Email;- bpcengineering@gmail.com info@bpcengineering.co.ke web;- www;bpcengineering.co.ke

BH 4 1.0-2.0m

SOIL CLASSIFICATION

Sieve Analysis Laborarory Test Result -BSS 1377

DRECO-MATTS
Drilling, Engineering & Construction Technical Support

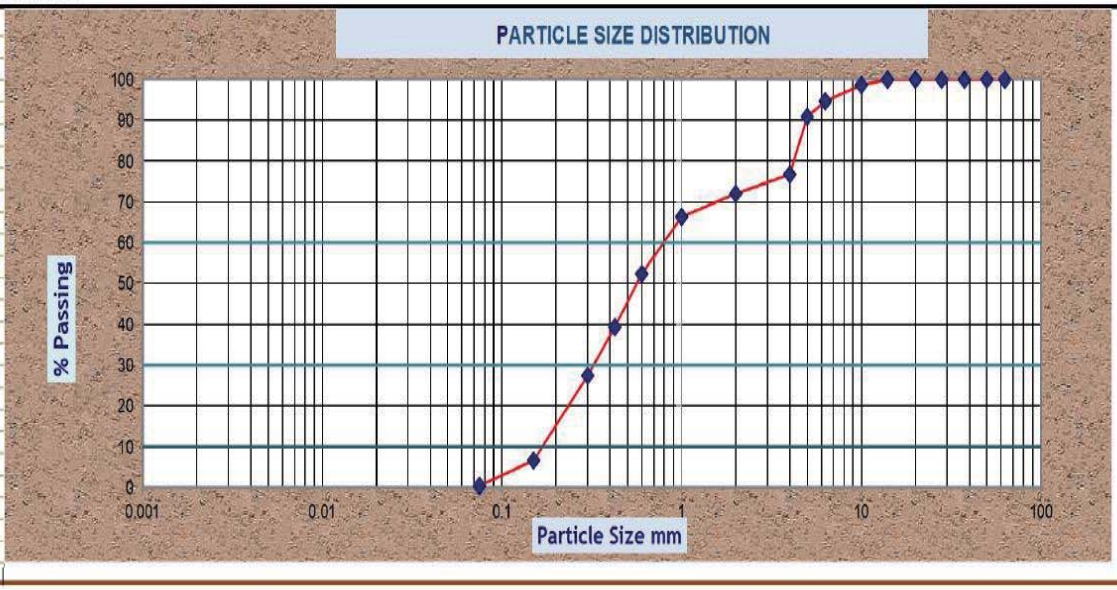
CLIENT	AB HARAMBE CONSTRUCTION	Date	7/2/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	BH 4	Depth (m)	1.0-2.0m
	sample no		

CLAY	SILT				SAND				GRAVEL						Cobbles
	Fine	Medium	Coarse	% Silt	Fine	Medium	Coarse	% Sand	Fine	Medium	Coarse	% Gravel	0		0
0.0	0.0	0.0	0.4	0	27.0	25.0	19.66	72	22.68	5.29	0	28	0		

% passing 0.425 sieve	39	very gravelly	
% passing 0.075 sieve	0		

Grading+ Hydrometer

Sieve	%
75	100
63	100
50	100
37.5	100
28	100
20	100
14	100
10	98.68
6.3	94.71
5	90.93
4	76.75
2	72.02
1	66.35
0.6	52.36
0.425	39.32
0.3	27.41
0.15	6.616
0.075	0.378



Description ;- Light brown /yellowish Gravelly SAND -NON PLASTIC

Tested By	AB	Checked	Esther Githiga	Approved by	GK

BPC &Engineering Services Ltd Email;- bpcengineering@gmail.com info@bpcengineering.co.ke web;- www;bpcengineering.co.ke

EP1 00.0-1.0m

SOIL CLASSIFICATION

DRECO-MATTS Drilling, Engineering & Construction Technical Support

Sieve Analysis Laborarory Test Result -BSS 1377

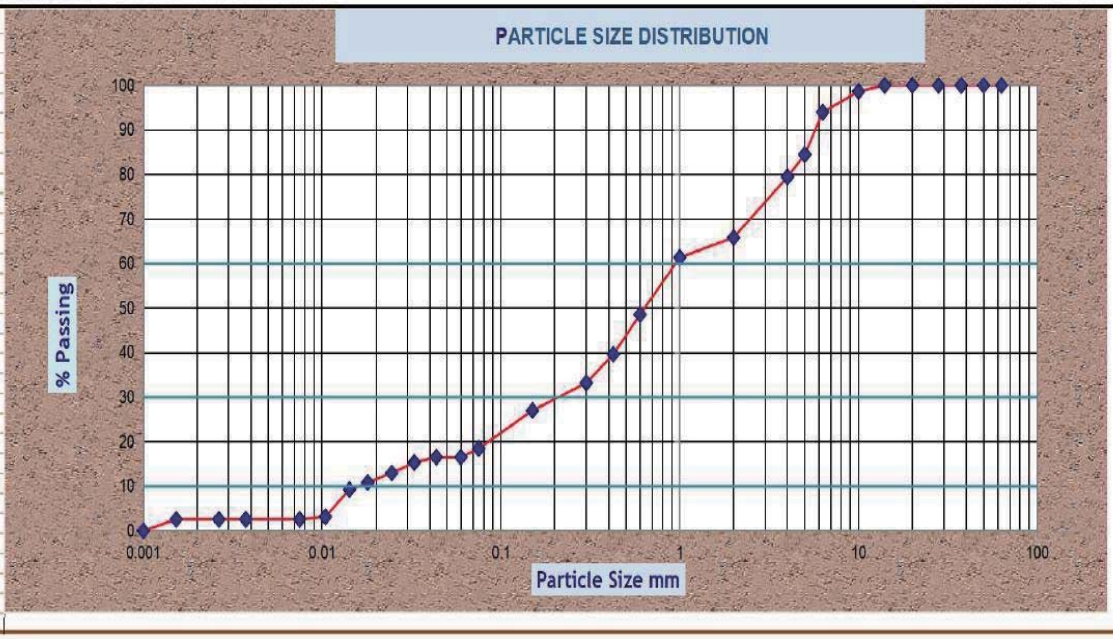
CLIENT	AB HARAMBE CONSTRUCTION	Date	15/1/2021
PROJECT	PROPOSED JUBA CITY COUNCIL SANITARY AND ENVIRONMENTAL BUILDING		
Location	TP-1	Depth (m)	0.0-1.0M
	sample no		

CLAY		SILT				SAND				GRAVEL							Cobbles
		Fine	Medium	Coarse	% Silt	Fine	Medium	Coarse	% Sand	Fine	Medium	Coarse	% Gravel	0			0
	2.6	0.0	12.8	3.1	16	14.8	15.3	17.28	47	28.16	6.02	0	34	0			

% passing 0.425 sieve	40	very gravelly	CLAY ACTIVITY (%)	
% passing 0.075 sieve	18			0

Grading+ Hydrometer

Sieve	%
75	100
63	100
50	100
37.5	100
28	100
20	100
14.0	100.0
10.0	98.6
6.3	94.0
5.0	84.5
4.0	79.4
2.000	65.8
1.000	61.4
0.600	48.5
0.425	39.6
0.300	33.2
0.150	27.0
0.075	18.4
0.060	16.5
0.043	16.5
0.033	15.3
0.0	13.0
0.0	10.8
0.0	9.2
0.0	3.1
0.0	2.6
0.0	2.6
0.0	2.6
0.0	2.6
0.0	0.0



Description ;- Grey Silky Silty Gravelly SAND

Tested By	AB	Checked	Esther Githiga	Approved by	GK

BPC &Engineering Services Ltd Email;- bpcengineering@gmail.com info@bpcengineering.co.ke web;- www;bpcengineering.co.ke

EP1 1.0-2.0m

SOIL CLASSIFICATION

DRECO-MATTS Drilling, Engineering & Construction Technical Support

Sieve Analysis Laborarory Test Result -BSS 1377

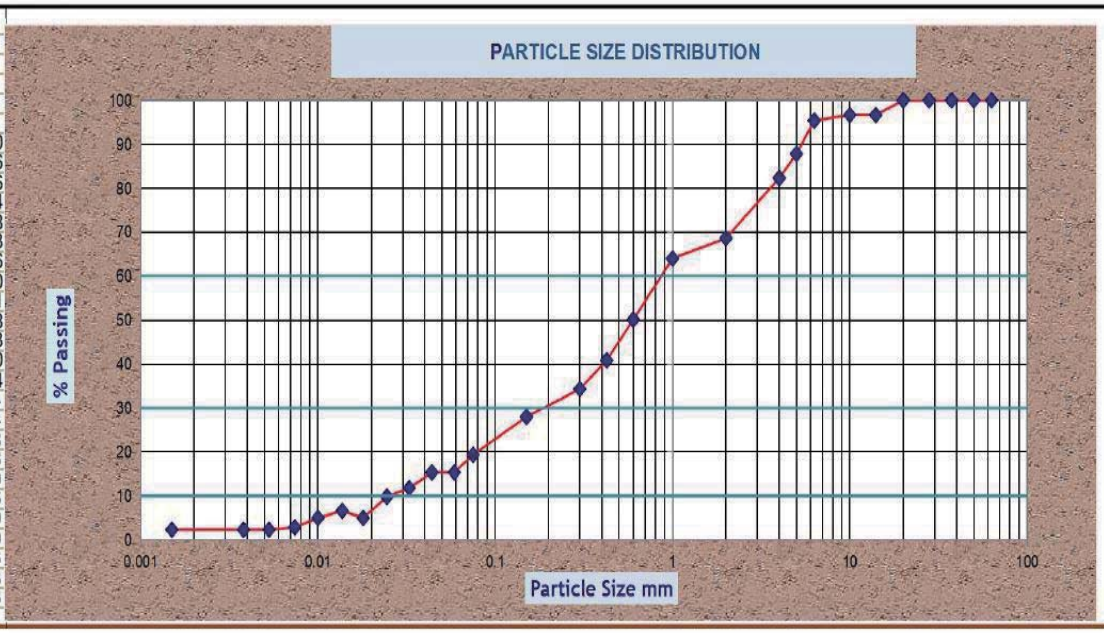
CLIENT	AB HARAMBE CONSTRUCTION	Date	15/1/2021
PROJECT	PROPOSED JUBA CITY COUNCIL SANITARY AND ENVIRONMENTAL BUILDING		
Location	TP-1	Depth (m)	1.0-2.0m
	sample no		

CLAY		SILT				SAND				GRAVEL							Cobbles
		Fine	Medium	Coarse	% Silt	Fine	Medium	Coarse	% Sand	Fine	Medium	Coarse	% Gravel	0			0
	2.3	0.5	9.5	7.6	18	14.9	15.8	18.53	49	26.74	1.26	0	28	0			

% passing 0.425 sieve	41	very gravelly	CLAY ACTIVITY (%)	'NO CLAY'
% passing 0.075 sieve	19			0

Grading+ Hydrometer

Sieve	%
75	100
63	100
50	100
37.5	100
28	100
20	100.0
14	96.6
10	96.6
6.3	95.4
5	87.8
4	82.3
2	68.6
1	64.0
0.6	50.1
0.425	40.8
0.3	34.3
0.15	28.0
0.075	19.4
0.059	15.4
0.044	15.4
0.033	11.8
0.025	9.8
0.018	5.0
0.014	6.6
0.01	5.0
0.007	2.9
0.005	2.3
0.004	2.3
0.002	2.3
0.001	



Description ;- Grey Silky Silty Gravelly SAND-Non plastic

Tested By	AB	Checked	Esther Githiga	Approved by	GK

BPC &Engineering Services Ltd Email;- bpcengineering@gmail.com info@bpcengineering.co.ke web;- www;bpcengineering.co.ke

AB Harambe Engineering and Construction February 2021

EP2 0.0-1.0m

SOIL CLASSIFICATION

Sieve Analysis Laborarory Test Result -BSS 1377

DRECO-MATTS Drilling, Engineering & Construction Technical Support

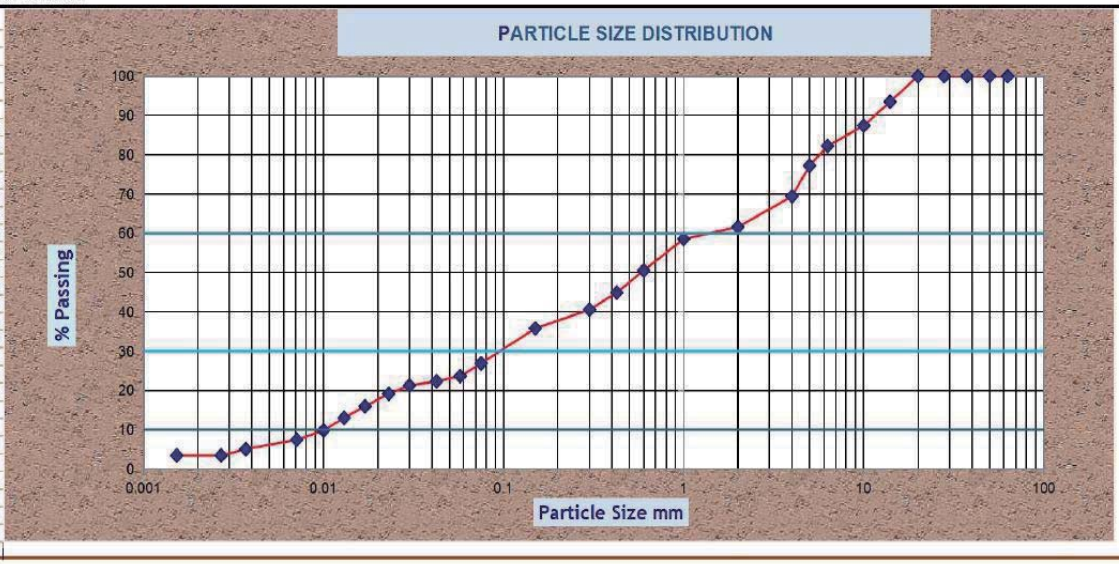
CLIENT	AB HARAMBE CONSTRUCTION	Date	15/1/2021
PROJECT	PROPOSED JUBA CITY COUNCIL SANITARY AND ENVIRONMENTAL BUILDING		
Location	TP-2	Depth (m)	0.0-1.0M
sample no			

CLAY	SILT				SAND				GRAVEL				COBLES/BOULDERS			
	Fine	Medium	Coarse	% Silt	Fine	Medium	Coarse	% Sand	Fine	Medium	Coarse	% Gravel				% Cobbles
3.5	4.0	17.8	5.6	27	13.7	10.0	11.06	35	20.61	11.28	0	32	0			0

% passing 0.425 sieve	45	very gravelly	CLAY ACTIVITY (%)	'NO CLAY'
% passing 0.075 sieve	27			0

Grading+ Hydrometer

Sieve	%
75	100
63	100
50	100
37.5	100
28	100
20.0	100.0
14.0	93.5
10.0	87.4
6.3	82.2
5.0	77.2
4.0	69.4
2.0	61.6
1.0	58.6
0.600	50.5
0.425	44.9
0.300	40.6
0.150	35.8
0.075	26.9
0.057	23.6
0.042	22.3
0.030	21.3
0.023	19.1
0.0	15.9
0.0	13.0
0.0	9.8
0.0	7.4
0.0	5.0
0.0	3.5
0.0	3.5



Description ;- Reddish Brown Silty GRAVELLY SAND ;NON PLASTIC

Tested By	AB	Checked	Esther Githiga	Approved by	GK

BPC &Engineering Services Ltd Email;- bpcengineering@gmail.com info@bpcengineering.co.ke web;- www;bpcengineering.co.ke

AB Harambe Engineering and Construction February 2021

EP2 1.0-2.0m

SOIL CLASSIFICATION

Sieve Analysis Laborarory Test Result -BSS 1377

DRECO-MATTS Drilling, Engineering & Construction Technical Support

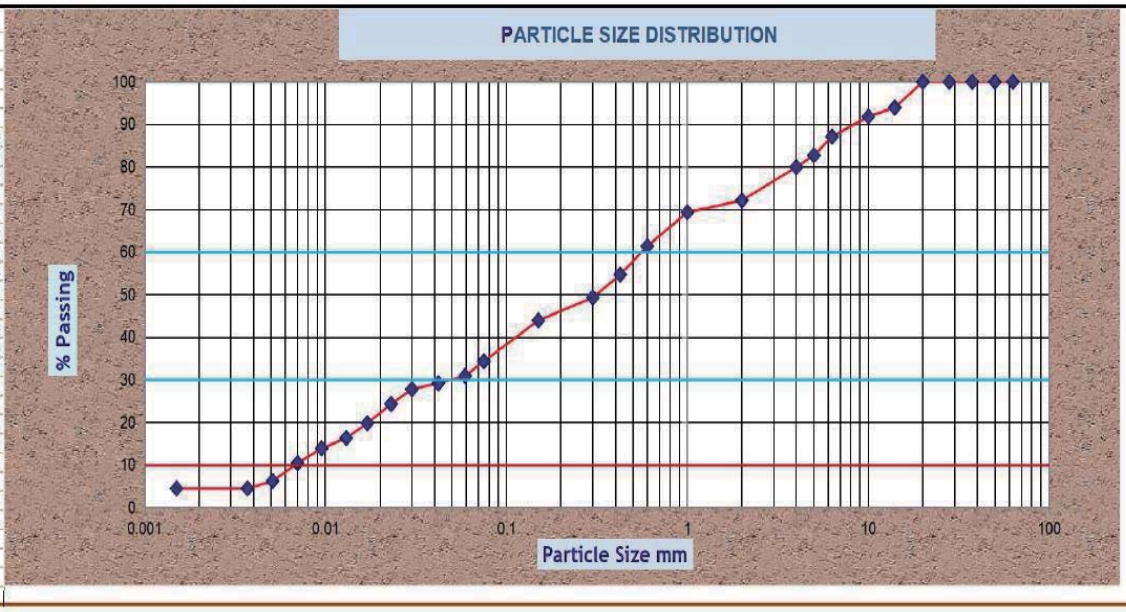
CLIENT	AB HARAMBE CONSTRUCTION	Date	15/1/2021
PROJECT	PROPOSED JUBA CITY COUNCIL SANITARY AND ENVIRONMENTAL BUILDING		
Location	TP-2	Depth (m)	1.0-2.0M
	sample no		

CLAY		SILT				SAND				GRAVEL				COBLES/BOULDERS			
		Fine	Medium	Coarse	% Silt	Fine	Medium	Coarse	% Sand	Fine	Medium	Coarse	% Gravel				% Cobbles
	4.5	5.9	23.3	6.5	36	15.0	12.1	10.75	38	14.98	6.84	0	22	0			0

% passing 0.425 sieve	55	very gravelly	CLAY ACTIVITY (%)	'NO CLAY'
% passing 0.075 sieve	34			0

Grading+ Hydrometer

Sieve	%
75	100
63	100
50	100
37.5	100
28	100
20	100.0
14	94.0
10	91.9
6.3	87.1
5	82.7
4	80.0
2	72.1
1	69.4
0.6	61.4
0.425	54.7
0.3	49.3
0.15	44.0
0.075	34.4
0.059	30.9
0.042	29.2
0.03	27.8
0.023	24.3
0.017	19.8
0.013	16.3
0.01	13.9
0.007	10.4
0.005	6
0.004	5
0.002	5



Description ;- Reddish Brown Clayey silty Gravelly SAND

Tested By	AB	Checked	Esther Githiga	Approved by	GK

BPC &Engineering Services Ltd Email;- bpcengineering@gmail.com info@bpcengineering.co.ke web;- www;bpcengineering.co.ke

Appendix 10– Plasticity Index results.

BH1 0.0-1.0m

SOIL PLASTICITY

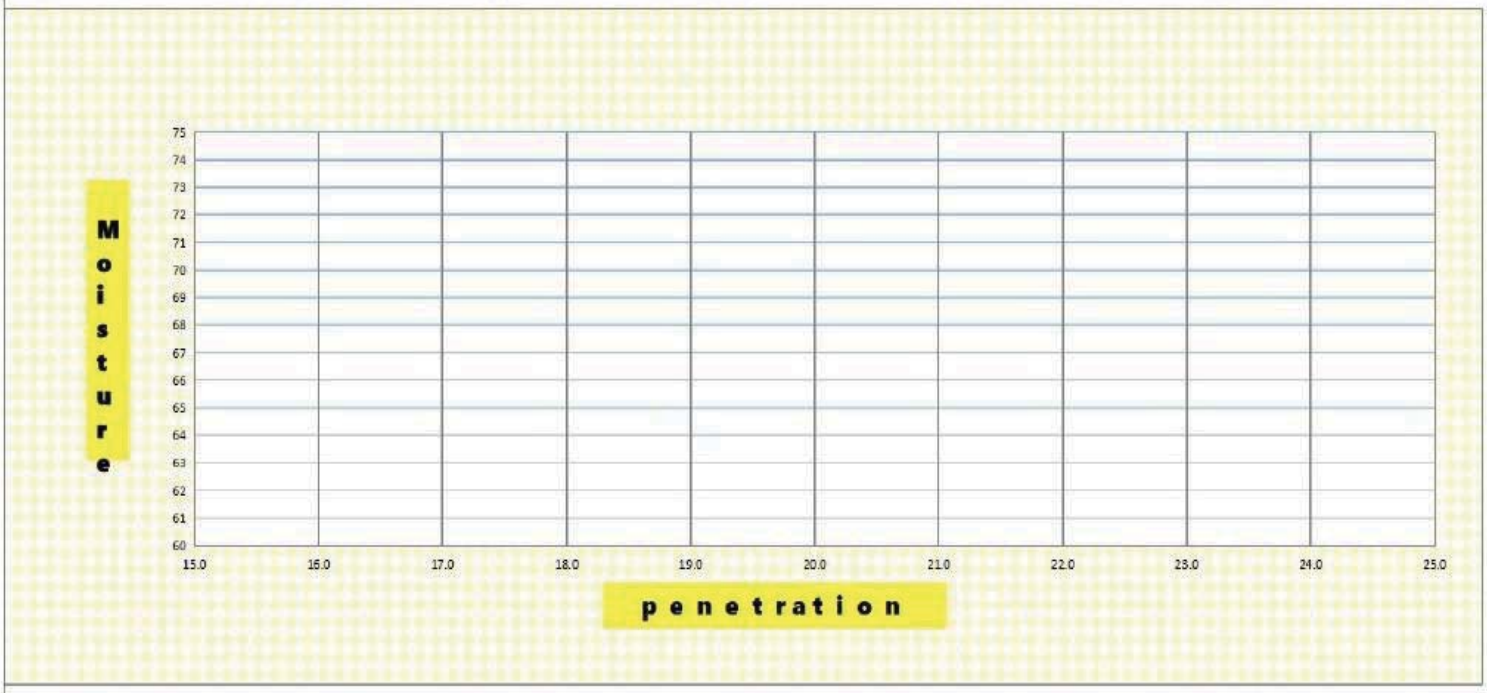
Atterbergs Limit Laborarory Test Result -BSS 1377 part 2

DRECO-MATTS Drilling, Engineering & Construction Technical Support

CLIENT	AB HARAMBE CONSTRUCTION	Date	8/2/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	BH 1	Depth (m)	0.0-1.0M

Preparation;-Air dried, passing 0.0425 BS Sieve

TEST	LIQUID LIMIT					PLASTIC LIMIT		PLASTICITY INDEX	DEDUCTIONS	
	LL				LL read from the graph at penetration of 20.	PL		LL-PL	0-5	None Plastic
PENETRATION	15.0	17.0	19.4	21.0		1	2		,6-10	Low
									,11-18	Moderate
M C %	NP	NP	NP	NP	NONE PLASTIC	Av.			>19	High



Testeed By	A Bulemi	Checked by	Esther Githiga	Approved by	GK Wambugu
Tittle	Technitian	Engineer (Geotech&Materials)		Director(Technical)	
Sign					

Stamp

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BH1 1.0-2.0m

SOIL PLASTICITY

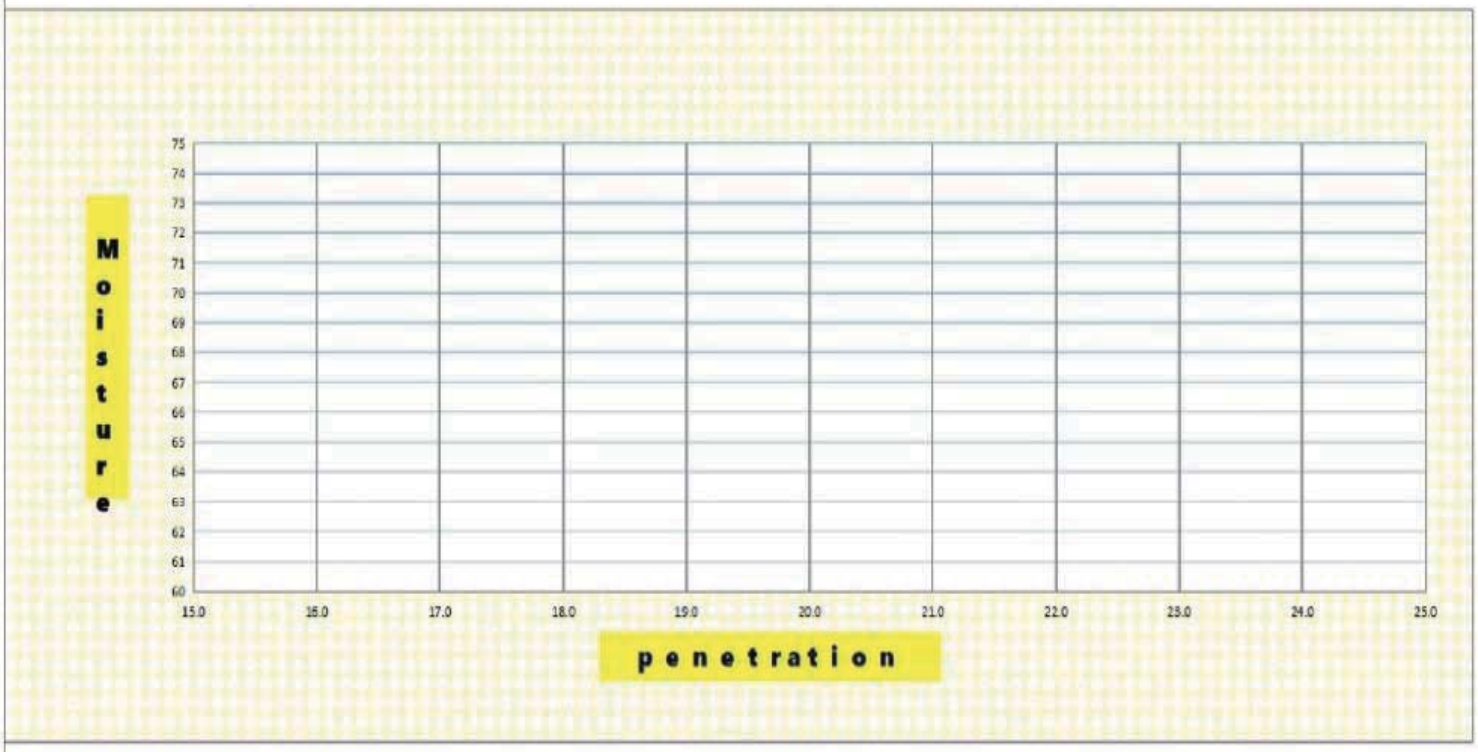
Atterbergs Limit Laborarory Test Result -BSS 1377 part 2

DRECO-MATTS Drilling, Engineering & Construction Technical Support

CLIENT	AB HARAMBE CONSTRUCTION	Date	8/2/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	BH 1	Depth (m)	1.0-2.0M

Preparation;-Air dried, passing 0.0425 BS Sieve

TEST	LIQUID LIMIT					PLASTIC LIMIT		PLASTICITY INDEX	DEDUCTIONS	
	LL				LL read from the graph at penetration of 20.	PL		LL-PL	0-5	None Plastic
PENETRATION	15.0	17.0	19.4	21.0		1	2		,6-10	Low
									,11-18	Moderate
M C %	NP	NP	NP	NP	NONE PLASTIC	Av.			>19	High



Testeed By	A Bulemi	Checked by	Esther Githiga	Approved by	GK Wambugu
Tittle	Technitian	Engineer (Geotech&Materials)		Director(Technical)	
Sign					

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BH1 2.0-3.0m

SOIL PLASTICITY

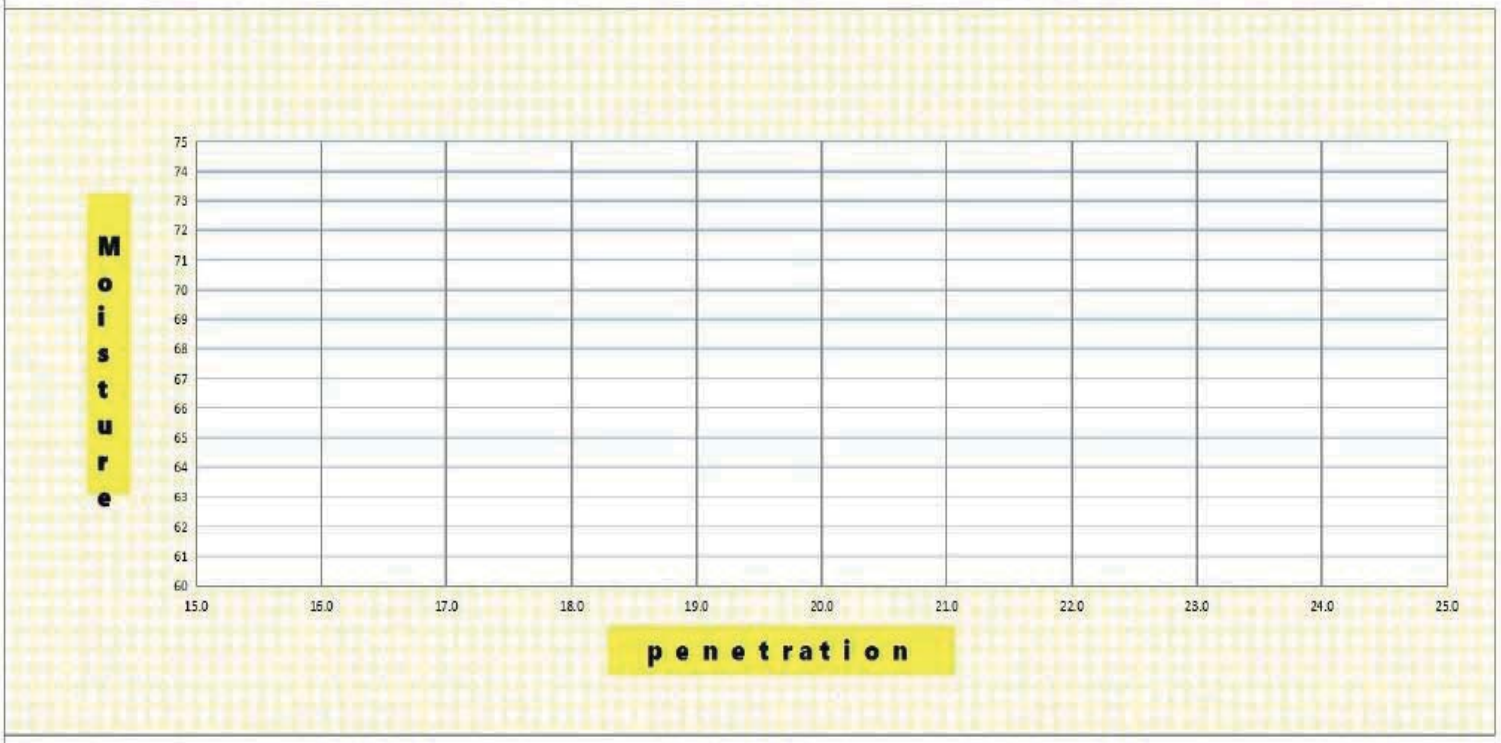
Atterbergs Limit Laborarory Test Result -BSS 1377 part 2

DRECO-MATTS Drilling, Engineering & Construction Technical Support

CLIENT	AB HARAMBE CONSTRUCTION	Date	8/2/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	BH 1	Depth (m)	2.0-3.0M

Preparation;-Air dried, passing 0.0425 BS Sieve

TEST	LIQUID LIMIT					PLASTIC LIMIT			PLASTICITY INDEX	DEDUCTIONS	
	LL					PL			LL-PL	0-5	None Plastic
PENETRATION	15.0	17.0	19.4	21.0	LL read from the graph at penetration of 20.	1	2			,6-10	Low
										,11-18	Moderate
M C %	NP	NP	NP	NP	NONE PLASTIC	Av.				>19	High



Testeed By	A Bulemi	Checked by	Esther Githiga	Approved by	GK Wambugu
Tittle	Technitian	Engineer (Geotech&Materials)		Director(Technical)	
Sign					

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BH1 3.0-4.0m

SOIL PLASTICITY

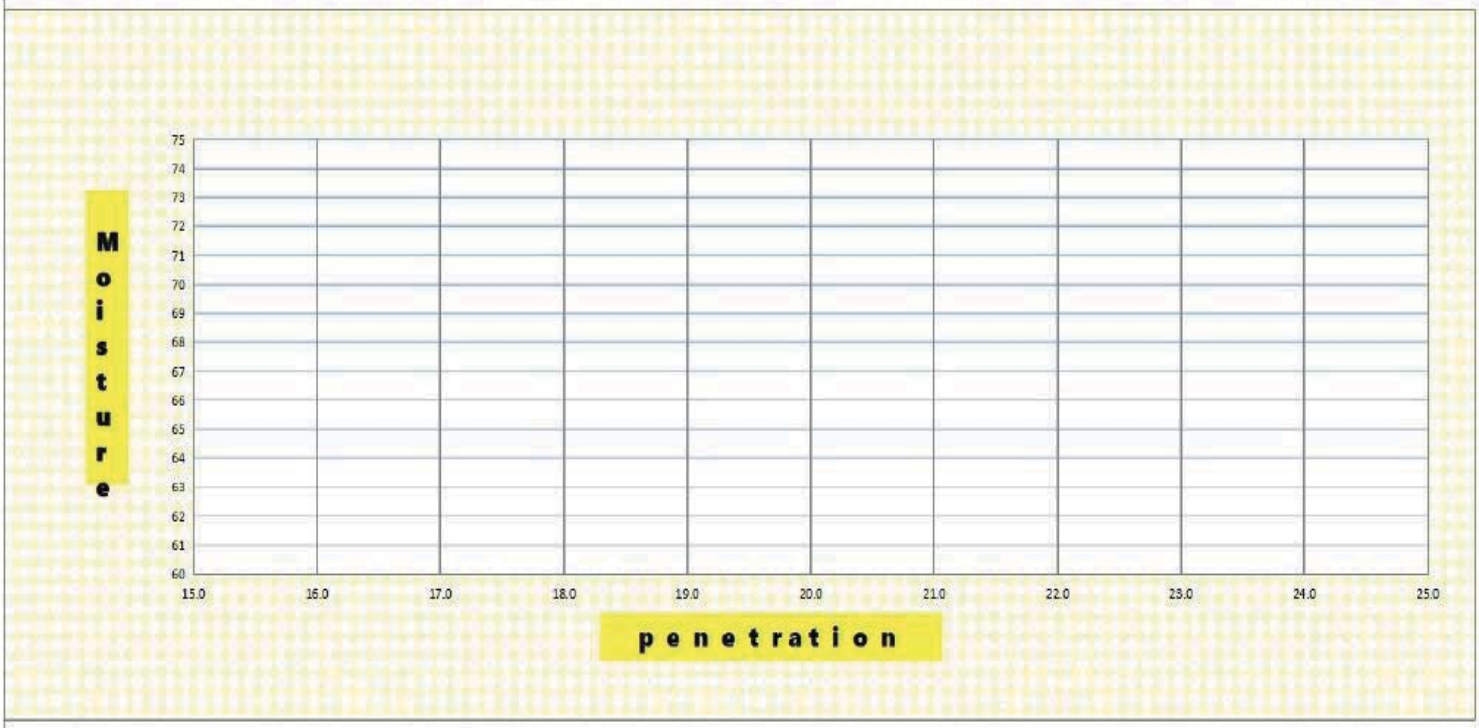
Atterbergs Limit Laborarory Test Result -BSS 1377 part 2

DRECO-MATTS Drilling, Engineering & Construction Technical Support

CLIENT	AB HARAMBE CONSTRUCTION	Date	8/2/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	BH 1	Depth (m)	3.0-4.0M

Preparation;-Air dried, passing 0.0425 BS Sieve

TEST	LIQUID LIMIT					PLASTIC LIMIT		PLASTICITY INDEX	DEDUCTIONS	
	LL				LL read from the graph at penetration of 20.	PL		LL-PL	0-5	None Plastic
PENETRATION	15.0	17.0	19.4	21.0		1	2		,6-10	Low
									,11-18	Moderate
M C %	NP	NP	NP	NP	NONE PLASTIC	Av.			>19	High



Testeed By	A Bulemi	Checked by	Esther Githiga	Approved by	GK Wambugu
Tittle	Technitian	Engineer (Geotech&Materials)		Director(Technical)	
Sign					Stamp

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BH1 4.0-5.0m

SOIL PLASTICITY

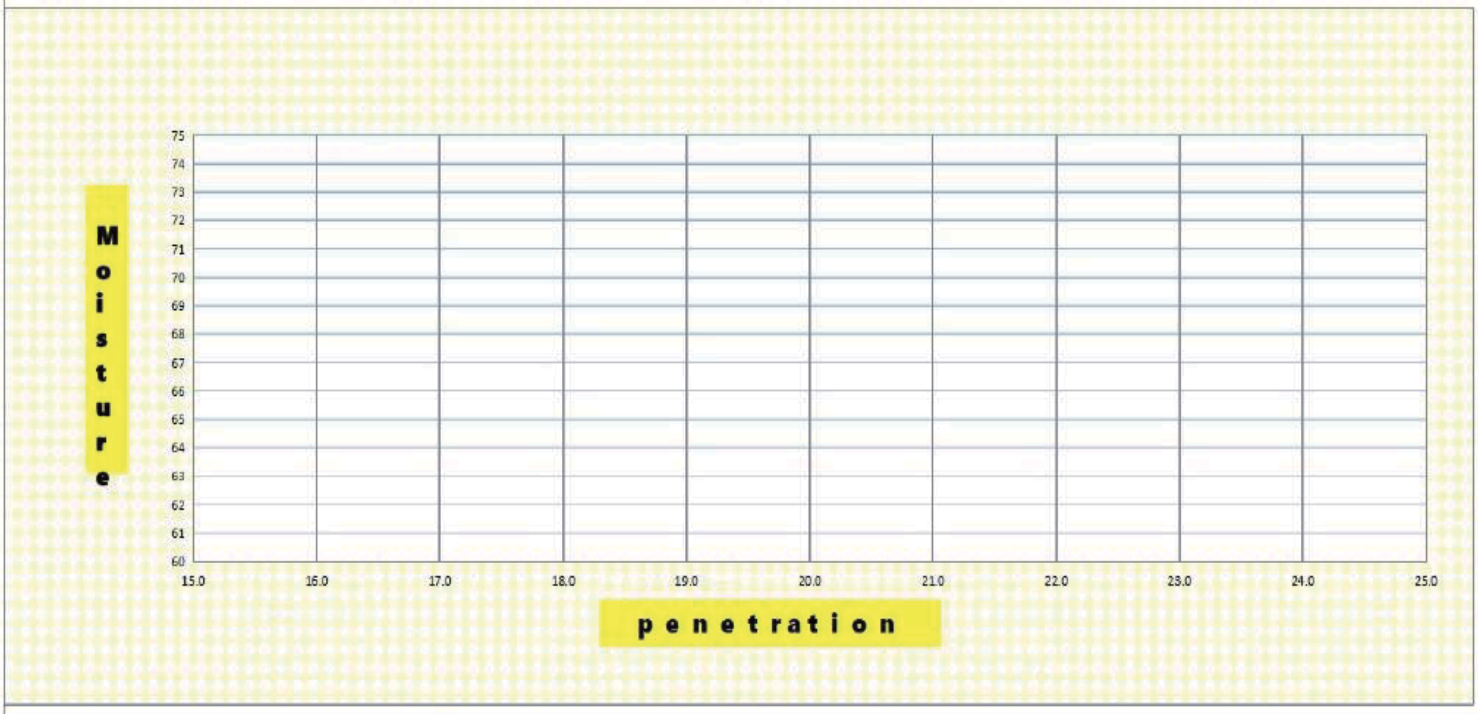
Atterbergs Limit Laborarory Test Result -BSS 1377 part 2

DRECO-MATTS Drilling, Engineering & Construction Technical Support

CLIENT	AB HARAMBE CONSTRUCTION	Date	8/2/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	BH 1	Depth (m)	4.0-5.0M

Preparation;-Air dried, passing 0.0425 BS Sieve

TEST	LIQUID LIMIT					PLASTIC LIMIT		PLASTICITY INDEX	DEDUCTIONS	
	LL					PL		LL-PL	0-5	None Plastic
PENETRATION	15.0	17.0	19.4	21.0	LL read from the graph at penetration of 20.	1	2		,6-10	Low
									,11-18	Moderate
M C %	NP	NP	NP	NP	NONE PLASTIC	Av.			>19	High



Testeed By	A Bulemi	Checked by	Esther Githiga	Approved by	GK Wambugu
Tittle	Technitian	Engineer (Geotech&Materials)		Director(Technical)	
Sign					

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BH1 5.0-6.0m

SOIL PLASTICITY

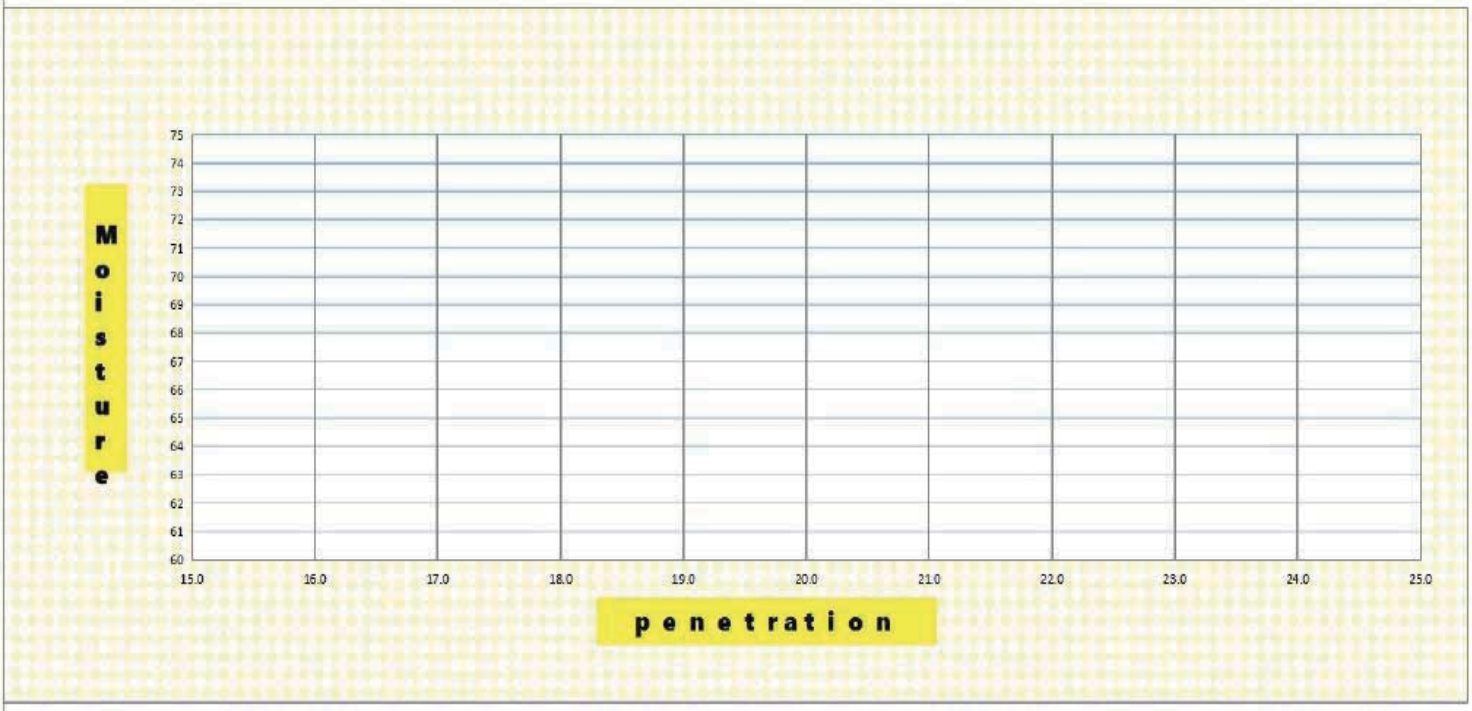
Atterbergs Limit Laborarory Test Result -BSS 1377 part 2

DRECO-MATTS Drilling, Engineering & Construction Technical Support

CLIENT	AB HARAMBE CONSTRUCTION	Date	8/2/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	BH 1	Depth (m)	5.0-6.0M

Preparation:-Air dried, passing 0.0425 BS Sieve

TEST	LIQUID LIMIT					PLASTIC LIMIT		PLASTICITY INDEX	DEDUCTIONS	
	LL					PL		LL-PL	0-5	None Plastic
PENETRATION	15.0	17.0	19.4	21.0	LL read from the graph at penetration of 20.	1	2		,6-10	Low
									,11-18	Moderate
M C %	NP	NP	NP	NP	NONE PLASTIC	Av.			>19	High



Testeed By	A Bulemi	Checked by	Esther Githiga	Approved by	GK Wambugu
Tittle	Technitian	Engineer (Geotech&Materials)		Director(Technical)	
Sign					

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BH2 0.0-1.0m

SOIL PLASTICITY

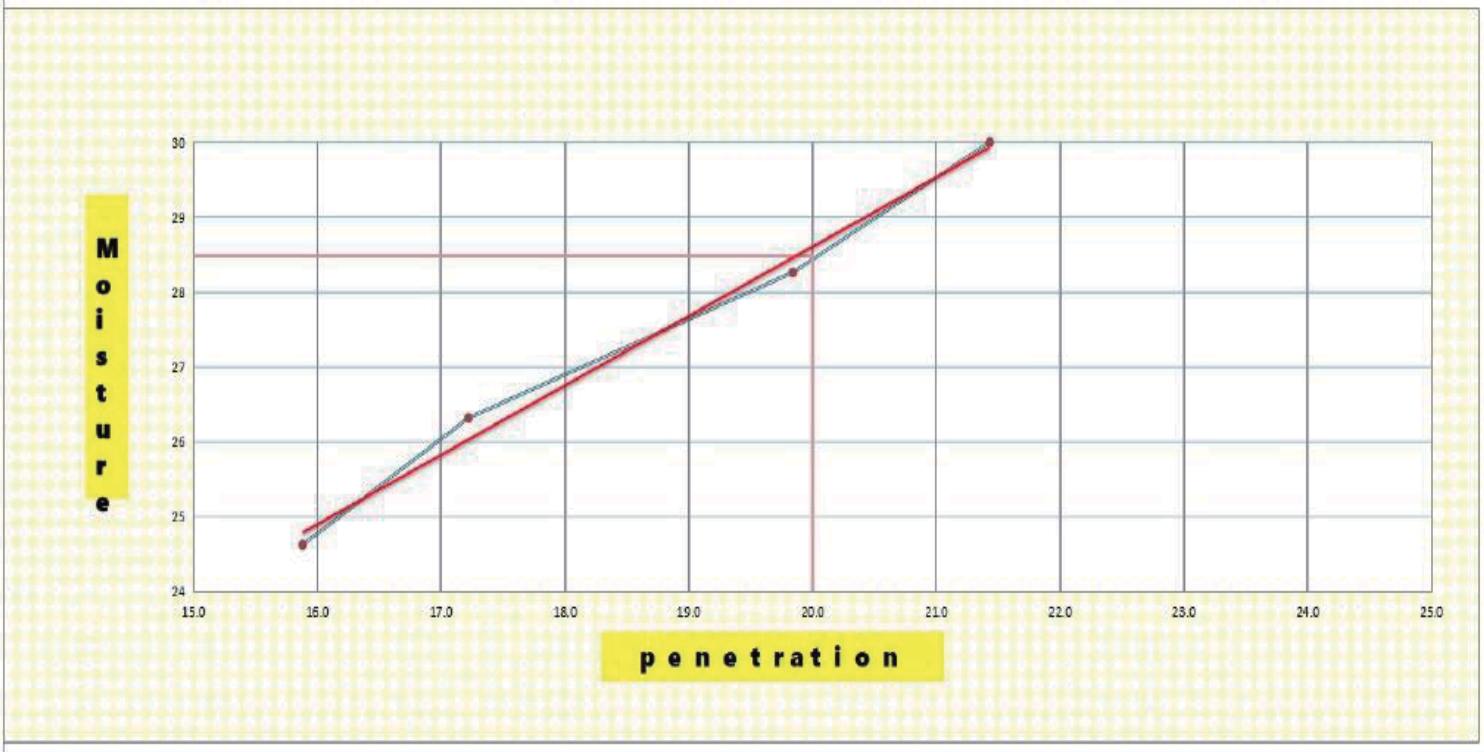
Atterbergs Limit Laborarory Test Result -BSS 1377 part 2

DRECO-MATTS Drilling, Engineering & Construction Technical Support

CLIENT	AB HARAMBE CONSTRUCTION	Date	8/2/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	BH 2	Depth (m)	0.0-1.0M

Preparation;-Air dried, passing 0.0425 BS Sieve

TEST	LIQUID LIMIT					PLASTIC LIMIT		PLASTICITY INDEX	DEDUCTIONS	
	LL				LL read from the graph at penetration of 20.	PL		LL-PL	0-5	None Plastic
PENETRATION	15.9	17.2	19.8	21.4		1	2	5.6	,6-10	Low
						20.5	25.735	6	,11-18	Moderate
M C %	24.6231156	26.3158	28.2609	30	28.7	Av.	23.118		>19	High



Testeed By	A Bulemi	Checked by	Esther Githiga	Approved by	GK Wambugu
Tittle	Technitian	Engineer (Geotech&Materials)		Director(Technical)	
Sign					

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AB Harambe Engineering and Construction **February 2021**

BH2 1.5-2.3m

SOIL PLASTICITY

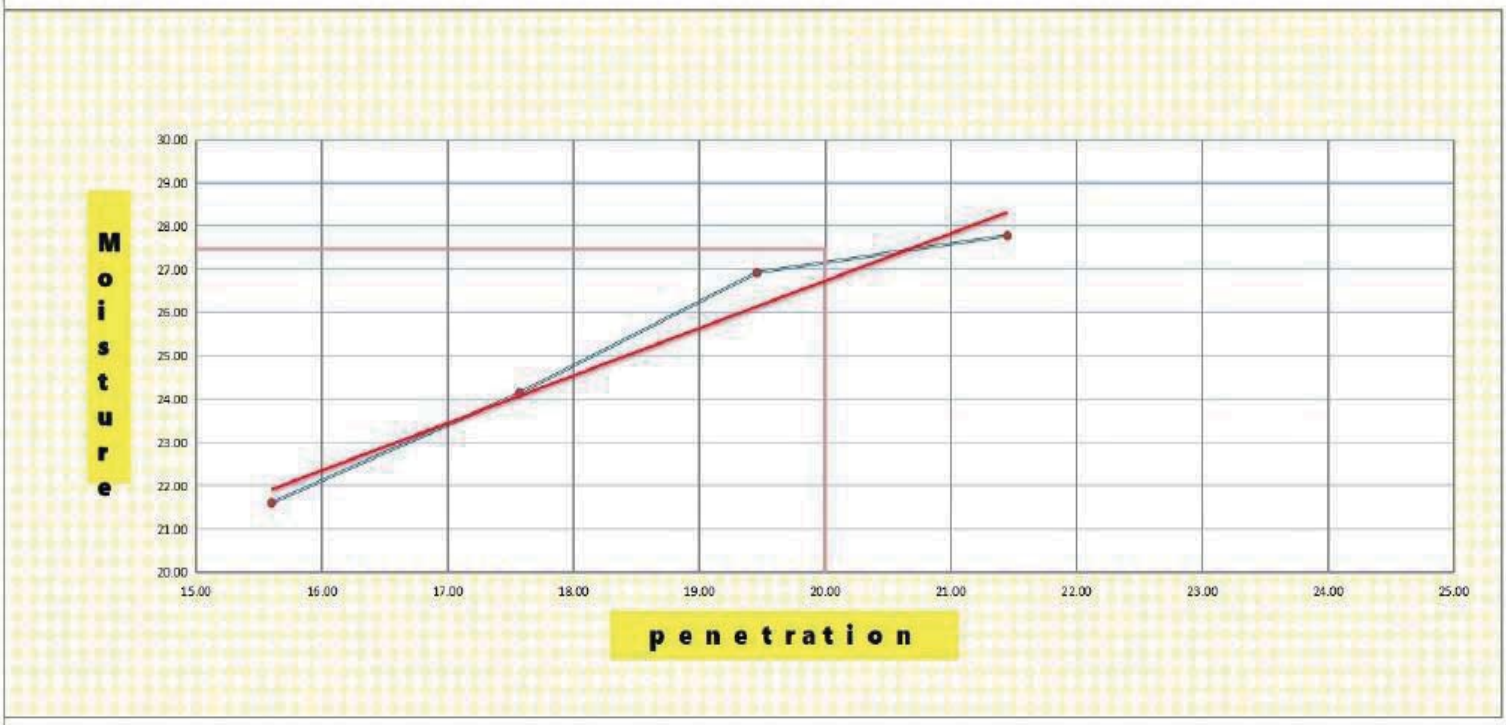
Atterbergs Limit Laborarory Test Result -BSS 1377 part 2

DRECO-MATTS Drilling, Engineering & Construction Technical Support

CLIENT	AB HARAMBE CONSTRUCTION	Date	8/2/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	BH 2	Depth (m)	1.5-2.3M

Preparation;-Air dried, passing 0.0425 BS Sieve

TEST	LIQUID LIMIT					PLASTIC LIMIT		PLASTICITY INDEX	DEDUCTIONS	
	LL					PL		LL-PL	0-5	None Plastic
PENETRATION	15.60	17.57	19.46	21.45	LL read from the graph at penetration of 20.	1	2	13.1	,6-10	Low
						14.2857	14.286	13	,11-18	Moderate
M C %	21.60	24.14	26.92	27.78	27.4	Av.	14.286		>19	High



Testeed By	A Bulemi	Checked by	Esther Githiga	Approved by	GK Wambugu
Tittle	Technitian	Engineer (Geotech&Materials)		Director(Technical)	
Sign					

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BH2 2.3-3.5m

SOIL PLASTICITY

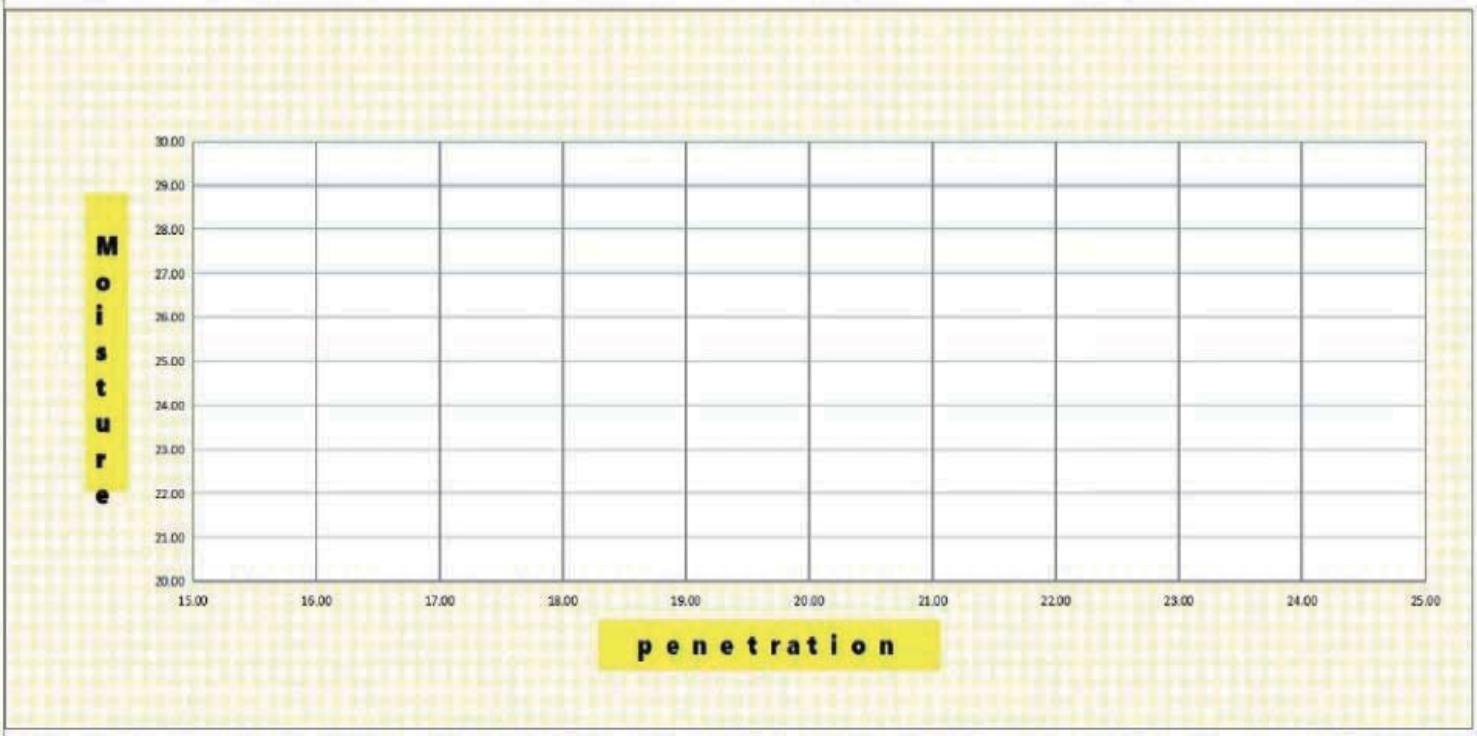
Atterbergs Limit Laborarory Test Result -BSS 1377 part 2

DRECO-MATTS Drilling, Engineering & Construction Technical Support

CLIENT	AB HARAMBE CONSTRUCTION	Date	8/2/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	BH 2	Depth (m)	2.3-3.5M

Preparation;-Air dried, passing 0.0425 BS Sieve

TEST	LIQUID LIMIT					PLASTIC LIMIT		PLASTICITY INDEX	DEDUCTIONS	
	LL				LL read from the graph at penetration of 20.	PL		LL-PL	0-5	None Plastic
PENETRATION	15.60	17.57	19.46	21.45		1	2	#VALUE!	,6-10	Low
						NP	NP		,11-18	Moderate
M C %	NP	NP	NP	NP	NONE PLASTIC	Av.			>19	High



Testeed By	A Bulemi	Checked by	Esther Githiga	Approved by	GK Wambugu
Title	Technitian	Engineer (Geotech&Materials)		Director(Technical)	
Sign					

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AB Harambe Engineering and Construction **February 2021**

BH 3 0.0-1.0m

SOIL PLASTICITY

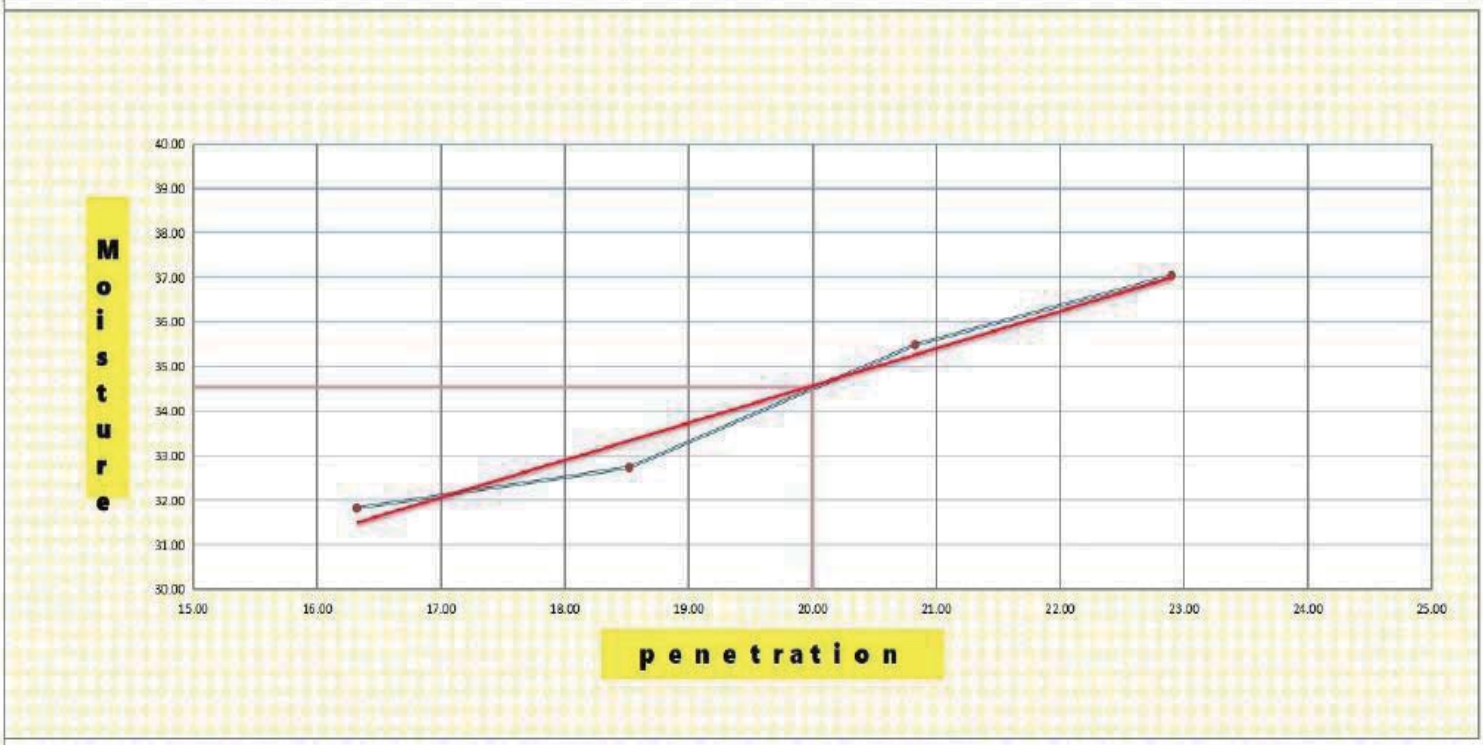
Atterbergs Limit Laborarory Test Result -BSS 1377 part 2

DRECO-MATTS Drilling, Engineering & Construction Technical Support

CLIENT	AB HARAMBE CONSTRUCTION	Date	8/2/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	BH3	Depth (m)	0.0-1.0M

Preparation;-Air dried, passing 0.0425 BS Sieve

TEST	LIQUID LIMIT					PLASTIC LIMIT		PLASTICITY INDEX	DEDUCTIONS	
	LL					PL		LL-PL	0-5	None Plastic
PENETRATION	16.32	18.52	20.83	22.90	LL read from the graph at penetration of 20.	1	2	9.6	,6-9	Low
						25.00	25.00	10	,10-18	Moderate
M C %	31.82	32.73	35.48	37.04	34.6	Av.	25		>19	High



Testeed By	A Bulemi	Checked by	Esther Githiga	Approved by	GK Wambugu
Tittle	Technitian	Engineer (Geotech&Materials)		Director(Technical)	
Sign					

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BH 3 1.0-2.0m

SOIL PLASTICITY

Atterbergs Limit Laborarory Test Result -BSS 1377 part 2

DRECO-MATTS Drilling, Engineering & Construction Technical Support

CLIENT	AB HARAMBE CONSTRUCTION	Date	8/2/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	BH3	Depth (m)	1.0-2.0M

Preparation;-Air dried, passing 0.0425 BS Sieve

TEST	LIQUID LIMIT					PLASTIC LIMIT		PLASTICITY INDEX	DEDUCTIONS	
	LL				LL read from the graph at penetration of 20.	PL		LL-PL	0-5	None Plastic
PENETRATION	16.32	18.52	20.83	22.90		1	2	#VALUE!	,6-9	Low
						NP	NP		,10-18	Moderate
M C %	NP	NP	NP	NP	none plastic				>19	High

Testeed By	A Bulemi	Checked by	Esther Githiga	Approved by	GK Wambugu
Tittle	Technitian	Engineer (Geotech&Materials)		Director(Technical)	
Sign					

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BH 3 2.0-3.0m

SOIL PLASTICITY

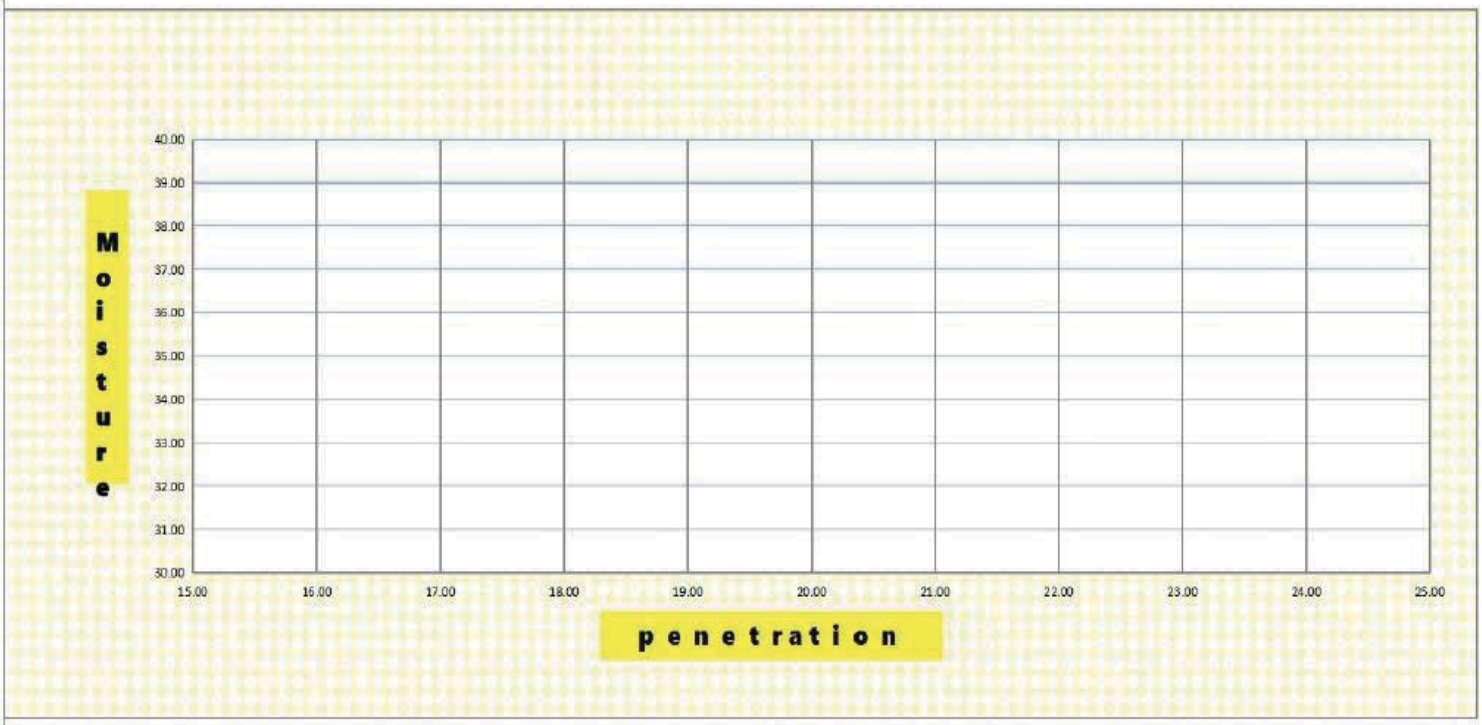
Atterbergs Limit Laborarory Test Result -BSS 1377 part 2

DRECO-MATTS Drilling, Engineering & Construction Technical Support

CLIENT	AB HARAMBE CONSTRUCTION	Date	8/2/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	BH3	Depth (m)	2.0-3.0M

Preparation;-Air dried, passing 0.0425 BS Sieve

TEST	LIQUID LIMIT					PLASTIC LIMIT		PLASTICITY INDEX	DEDUCTIONS	
	LL				LL read from the graph at penetration of 20.	PL		LL-PL	0-5	None Plastic
PENETRATION	16.32	18.52	20.83	22.90		1	2	#VALUE!	,6-9	Low
						NP	NP		,10-18	Moderate
M C %	NP	NP	NP	NP	none plastic				>19	High



Testeed By	A Bulemi	Checked by	Esther Githiga	Approved by	GK Wambugu
Tittle	Technitian	Engineer (Geotech&Materials)		Director(Technical)	
Sign					

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BH 3 12.2-12.5m

SOIL PLASTICITY

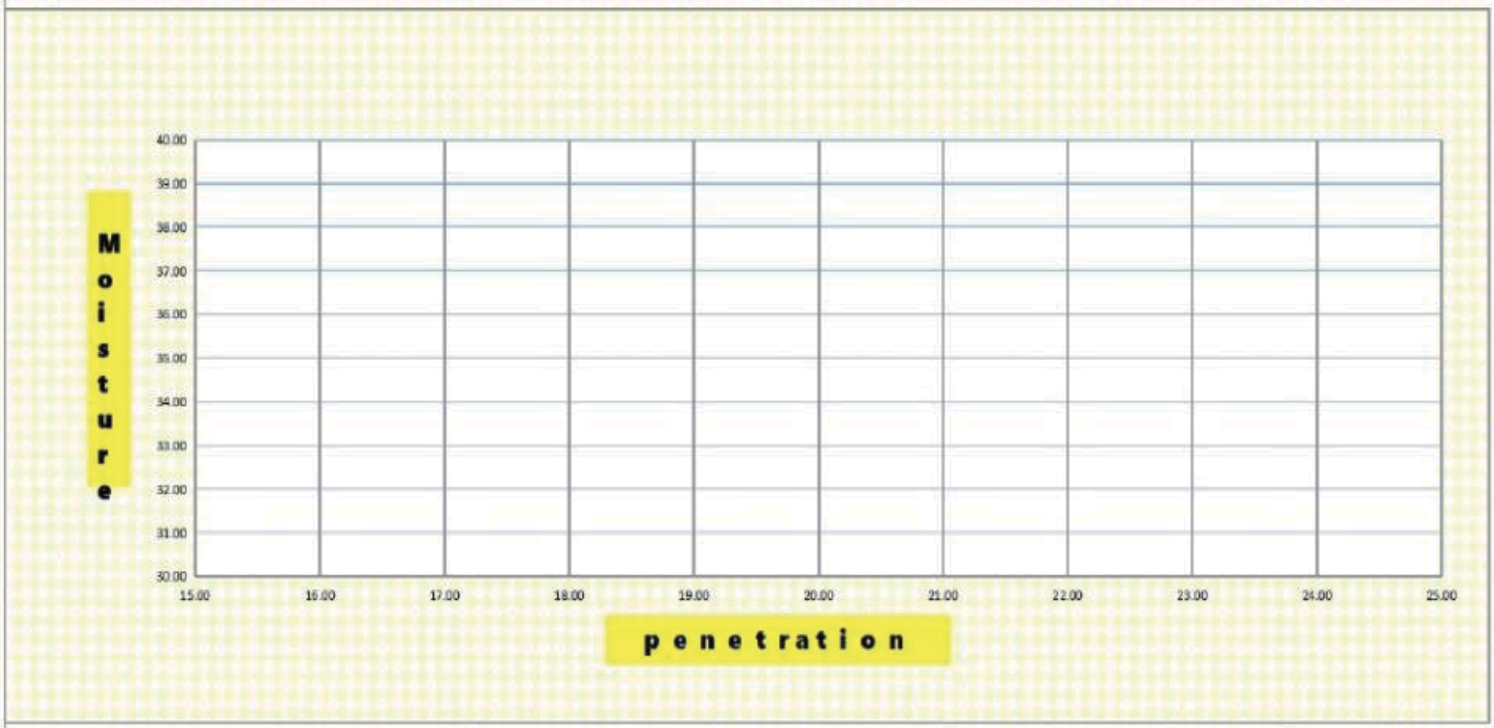
Atterbergs Limit Laborarory Test Result -BSS 1377 part 2

DRECO-MATTS Drilling, Engineering & Construction Technical Support

CLIENT	AB HARAMBE CONSTRUCTION	Date	8/2/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	BH3	Depth (m)	12.2-12.5M

Preparation;-Air dried, passing 0.0425 BS Sieve

TEST	LIQUID LIMIT					PLASTIC LIMIT		PLASTICITY INDEX	DEDUCTIONS	
	LL					PL		LL-PL	0-5	None Plastic
PENETRATION	16.32	18.52	20.83	22.90	LL read from the graph at penetration of 20.	1	2	#VALUE!	,6-9	Low
						NP	NP		,10-18	Moderate
M C %	NP	NP	NP	NP	none plastic				>19	High



Testeed By	A Bulemi	Checked by	Esther Githiga	Approved by	GK Wambugu
Tittle	Technitian	Engineer (Geotech&Materials)		Director(Technical)	
Sign					

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BH 4 0.0-0.1m

SOIL PLASTICITY

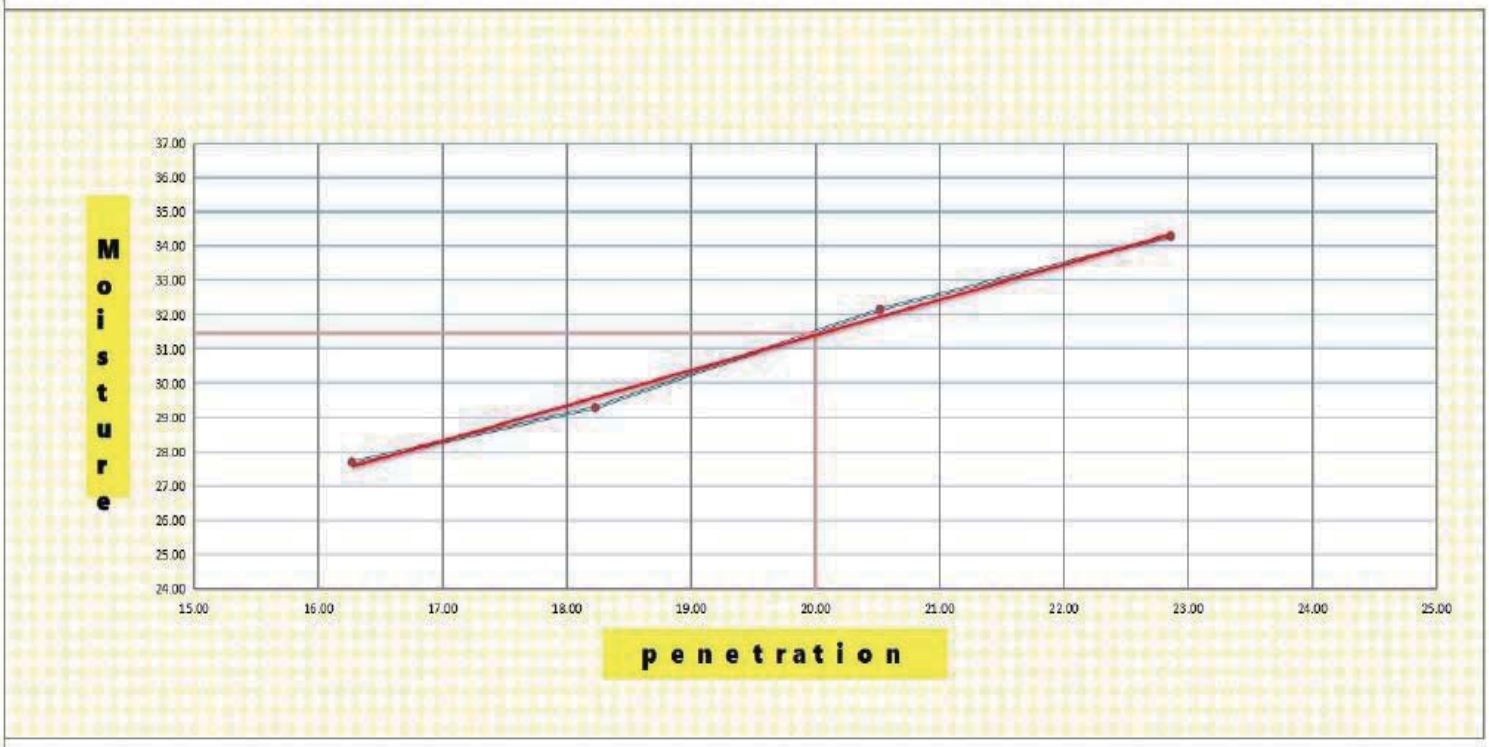
Atterbergs Limit Laborarory Test Result -BSS 1377 part 2

DRECO-MATTS Drilling, Engineering & Construction Technical Support

CLIENT	AB HARAMBE CONSTRUCTION	Date	8/2/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	BH4	Depth (m)	0.0-1.0M

Preparation;-Air dried, passing 0.0425 BS Sieve

TEST	LIQUID LIMIT					PLASTIC LIMIT		PLASTICITY INDEX	DEDUCTIONS	
	LL					PL				
PENETRATION	16.27	18.23	20.52	22.86	LL read from the graph at penetration of 20.	1	2	LL-PL	0-5	None Plastic
						18.63	20.00	12.0	,6-9	Low
M C %	27.69	29.29	32.14	34.29	31.3	Av.	19.313	12	,10-18	Moderate
									>19	High



Testeed By	A Bulemi	Checked by	Esther Githiga	Approved by	GK Wambugu
Tittle	Technitian	Engineer (Geotech&Materials)		Director(Technical)	
Sign					

Stamp

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BH 4 1.0-2.0m

SOIL PLASTICITY

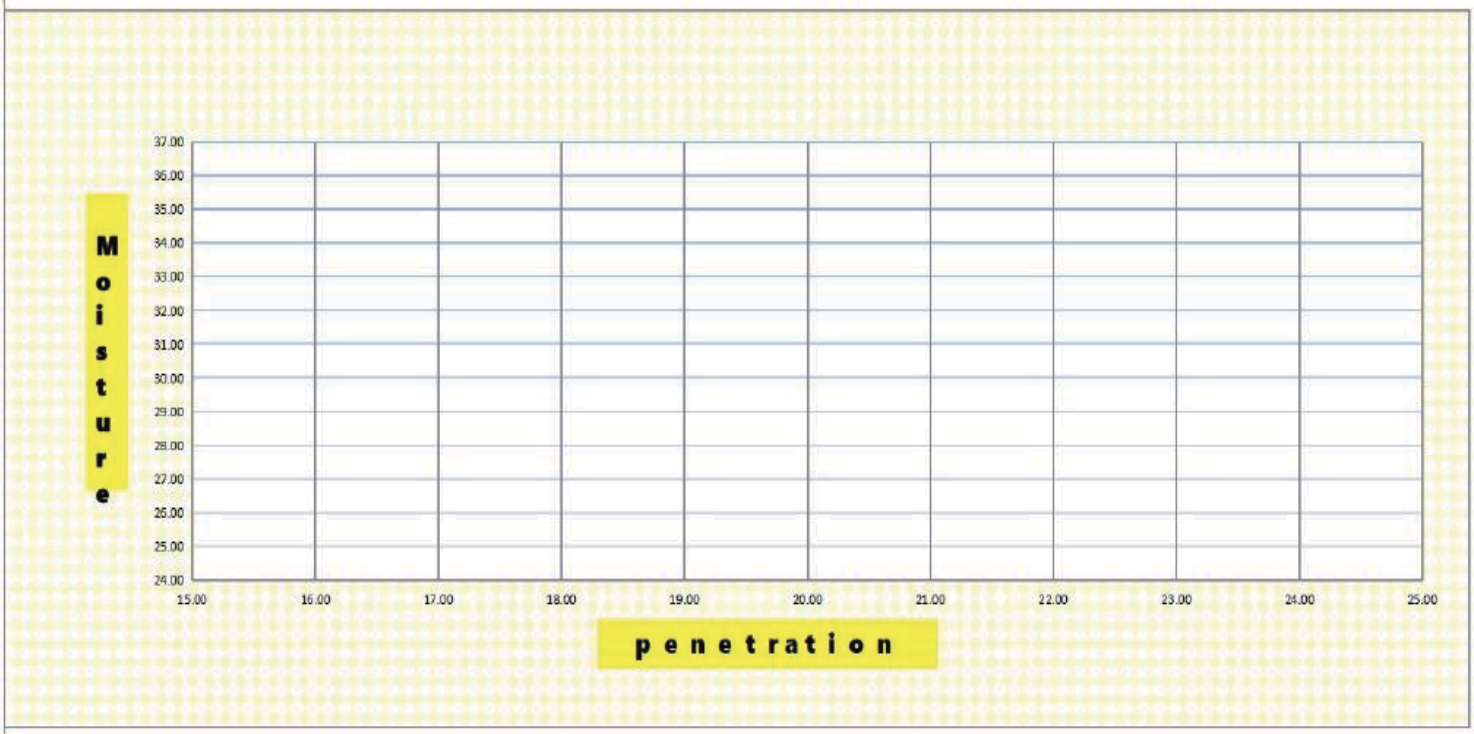
Atterbergs Limit Laborarory Test Result -BSS 1377 part 2

DRECO-MATTS Drilling, Engineering & Construction Technical Support

CLIENT	AB HARAMBE CONSTRUCTION	Date	8/2/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	BH4	Depth (m)	1.0-2.0M

Preparation;-Air dried, passing 0.0425 BS Sieve

TEST	LIQUID LIMIT					PLASTIC LIMIT		PLASTICITY INDEX	DEDUCTIONS	
	LL				LL read from the graph at penetration of 20.	PL		LL-PL	0-5	None Plastic
PENETRATION	16.27	18.23	20.52	22.86		1	2	#VALUE!	,6-9	Low
						np	np		,10-18	Moderate
M C %	NP	NP	NP	NP	NONE PLASTIC	Av.			>19	High



Testeed By	A Bulemi	Checked by	Esther Githiga	Approved by	GK Wambugu
Tittle	Technitian	Engineer (Geotech&Materials)		Director(Technical)	
Sign					

Stamp

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AB Harambe Engineering and Construction **February 2021**

EP1 0.0- 1.0m

SOIL PLASTICITY

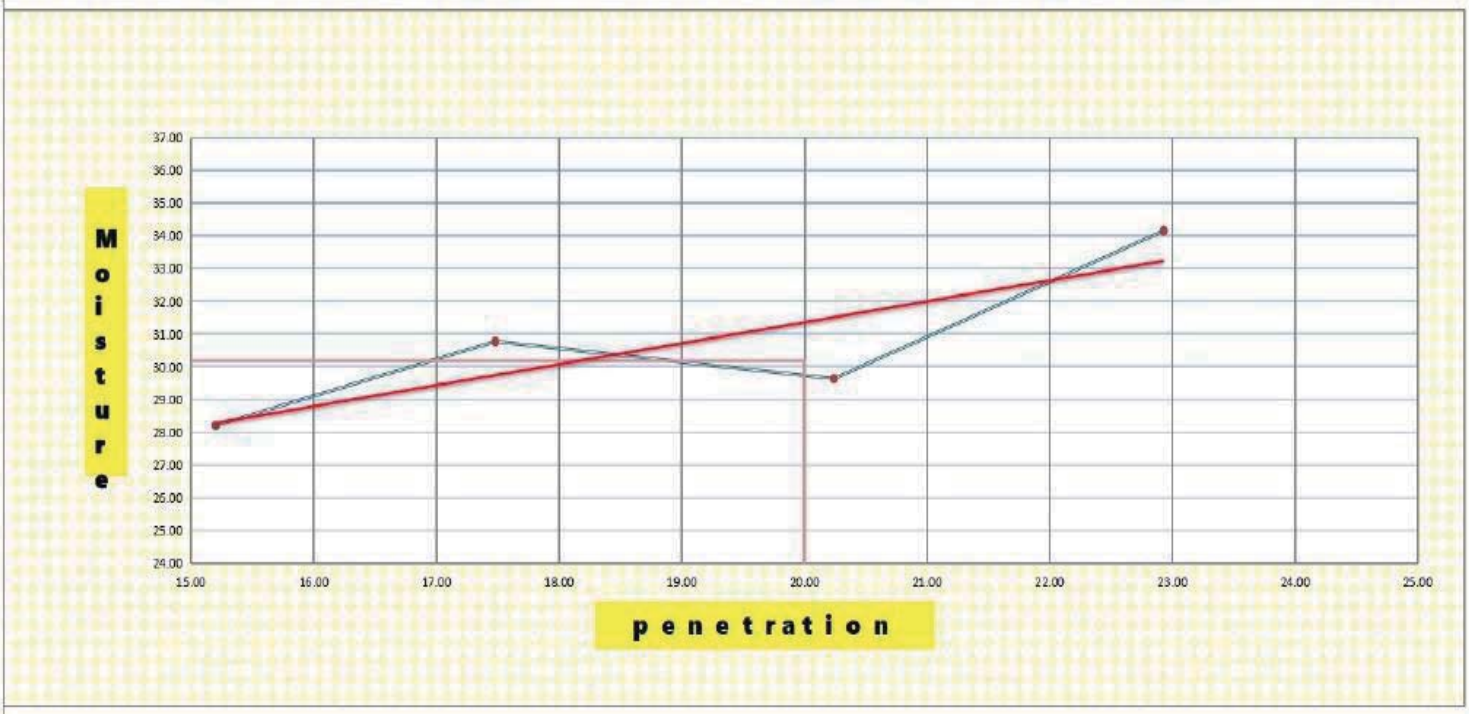
Atterbergs Limit Laborarory Test Result -BSS 1377 part 2

DRECO-MATTS Drilling, Engineering & Construction Technical Support

CLIENT	AB HARAMBE CONSTRUCTION	Date	8/2/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	EP1	Depth (m)	0.0-1.0M

Preparation;-Air dried, passing 0.0425 BS Sieve

TEST	LIQUID LIMIT					PLASTIC LIMIT		PLASTICITY INDEX	DEDUCTIONS	
	LL					PL				
PENETRATION	15.20	17.48	20.24	22.93	LL read from the graph at penetration of 20.	1	2	LL-PL	0-5	None Plastic
								11.2	,6-9	Low
						18.12	19.82		,10-18	Moderate
M C %	28.21	30.77	29.83	34.15	30.2	Av.	18.966	11	>19	High



Testeed By	A Bulemi	Checked by	Esther Githiga	Approved by	GK Wambugu
Tittle	Technitian	Engineer (Geotech&Materials)		Director(Technical)	
Sign					

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EP1 1.0-2.0m

SOIL PLASTICITY

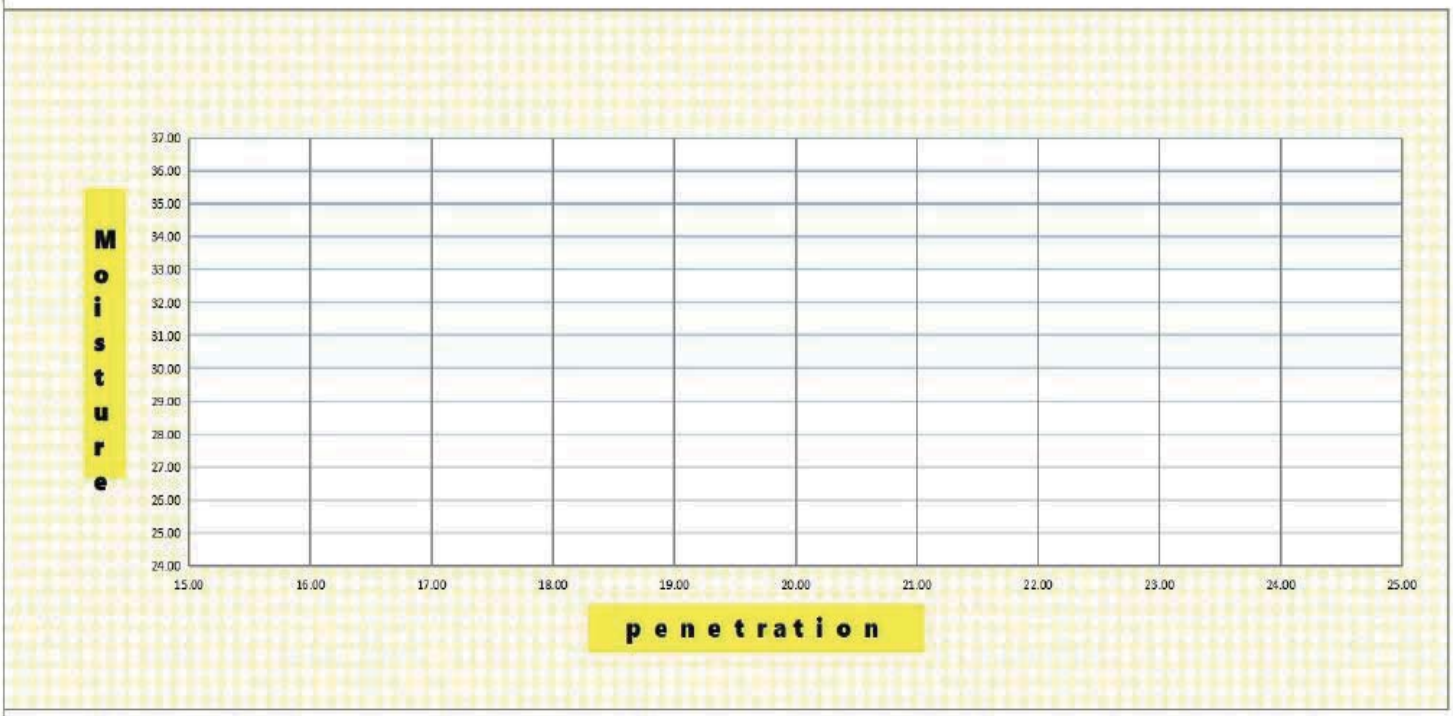
Atterbergs Limit Laborarory Test Result -BSS 1377 part 2

DRECO-MATTS Drilling, Engineering & Construction Technical Support

CLIENT	AB HARAMBE CONSTRUCTION	Date	8/2/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	EP1	Depth (m)	1.0-2.0M

Preparation;-Air dried, passing 0.0425 BS Sieve

TEST	LIQUID LIMIT					PLASTIC LIMIT		PLASTICITY INDEX	DEDUCTIONS	
	LL				LL read from the graph at penetration of 20.	PL		LL-PL	0-5	None Plastic
PENETRATION	15.20	17.48	20.24	22.93		1	2		,6-9	Low
						NP	NP		,10-18	Moderate
M C %	NP	NP	NP	NP	NONE PLASTIC	Av.			>19	High



Testeed By	A Bulemi	Checked by	Esther Githiga	Approved by	GK Wambugu
Tittle	Technitian	Engineer (Geotech&Materials)		Director(Technical)	
Sign					

Stamp

BPC& Engineering Services Ltd Plot 4 School Grove OFF School Lane P.O. BOX 20598 -00100 Nairobi Tel:+254 721394530 www.bpcengineering.co.ke

EP2 0.0-1.0m

SOIL PLASTICITY

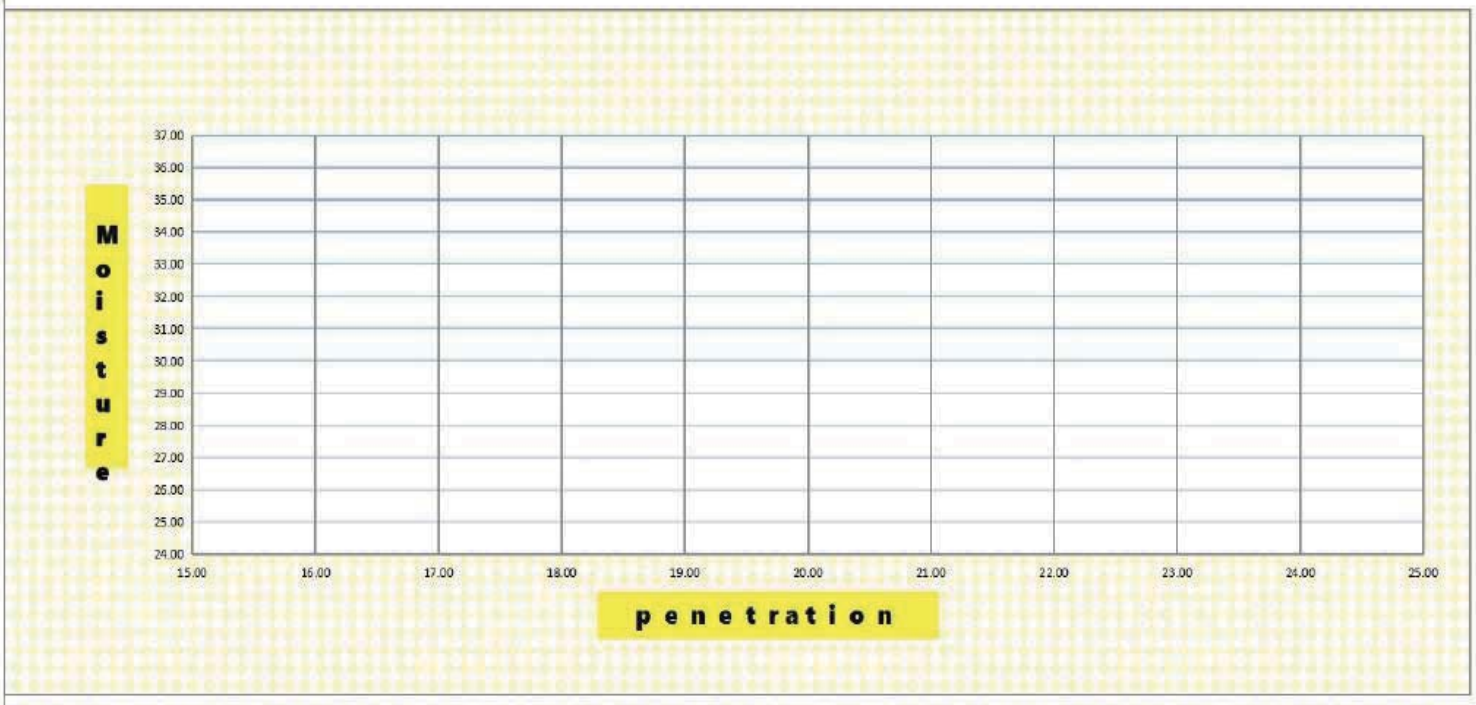
Atterbergs Limit Laborarory Test Result -BSS 1377 part 2

DRECO-MATTS Drilling, Engineering & Construction Technical Support

CLIENT	AB HARAMBE CONSTRUCTION	Date	8/2/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	EP2	Depth (m)	0.0-1.0M

Preparation;-Air dried, passing 0.0425 BS Sieve

TEST	LIQUID LIMIT					PLASTIC LIMIT		PLASTICITY INDEX	DEDUCTIONS	
	LL				LL read from the graph at penetration of 20.	PL		LL-PL	0-5	None Plastic
PENETRATION	15.20	17.48	20.24	22.93		1	2		,6-9	Low
						NP	NP		,10-18	Moderate
M C %	NP	NP	NP	NP	NONE PLASTIC	Av.			>19	High



Testeed By	A Bulemi	Checked by	Esther Githiga	Approved by	GK Wambugu
Tittle	Technitian	Engineer (Geotech&Materials)		Director(Technical)	
Sign					

Stamp

BPC& Engineering Services Ltd Plot 4 School Grove OFF School Lane P.O. BOX 20598 -00100 Nairobi Tel:+254 721394530 www.bpcengineering.co.ke

EP2 1.0-2.0m

SOIL PLASTICITY

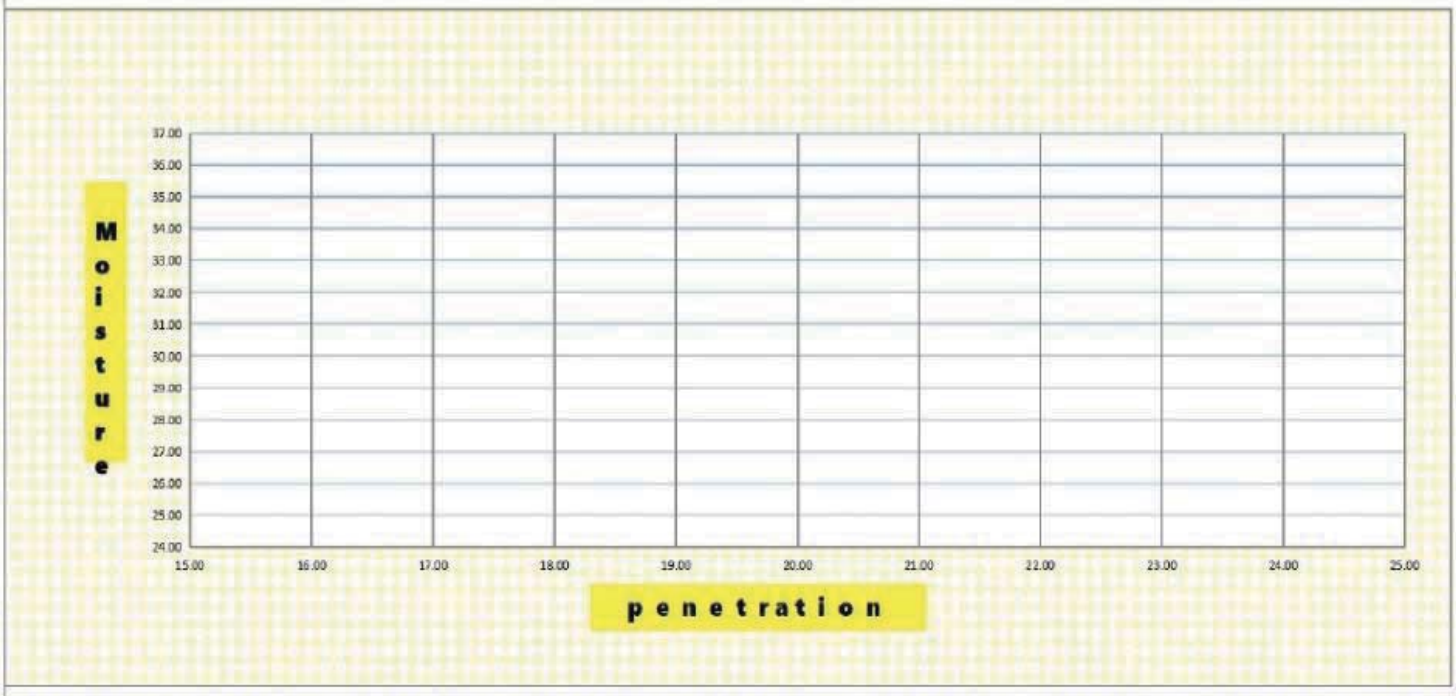
Atterbergs Limit Laborarory Test Result -BSS 1377 part 2

DRECO-MATTS Drilling, Engineering & Construction Technical Support

CLIENT	AB HARAMBE CONSTRUCTION	Date	8/2/2021
PROJECT	PROPOSED JUBA CITY BUILDING AND GARAGE		
Location	EP2	Depth (m)	1.0-2.0M

Preparation;-Air dried, passing 0.425 BS Sieve

TEST	LIQUID LIMIT					PLASTIC LIMIT		PLASTICITY INDEX	DEDUCTIONS	
	LL					PL		LL-PL	0-5	None Plastic
PENETRATION	15.20	17.48	20.24	22.93	LL read from the graph at penetration of 20.	1	2		,6-9	Low
						NP	NP		,10-18	Moderate
M C %	NP	NP	NP	NP	NONE PLASTIC	Av.			>19	High



Testeed By	A Bulemi	Checked by	Esther Githiga	Approved by	GK Wambugu
Tittle	Technitian	Engineer (Geotech&Materials)		Director(Technical)	
Sign					

Stamp

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Appendix 11–Compaction MDD/OMC results

BH 1 +EP1 Combined

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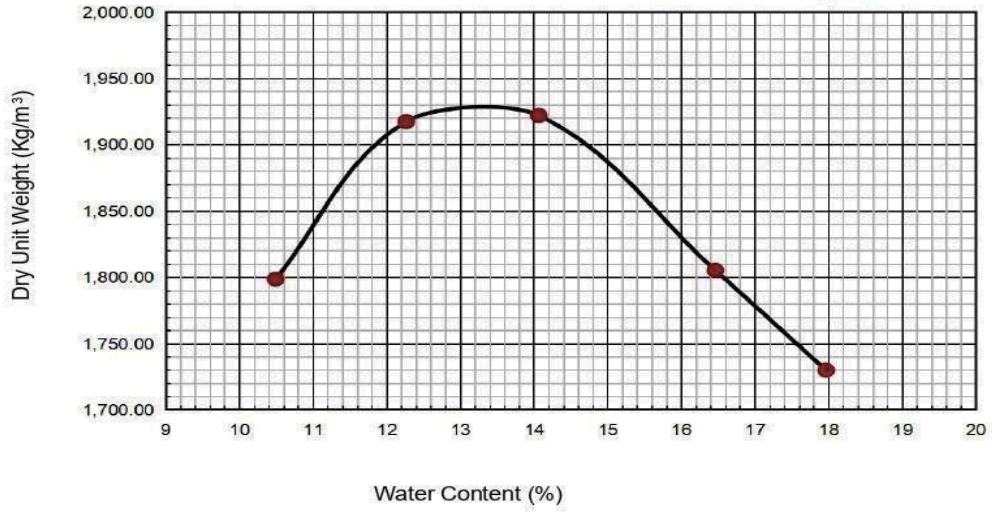
P.O BOX 20598-00100 NAIROBI
Email: bpcengineering@gmail.com, www.bpcengineering.com

Test	Compaction Test;T180			
Project:	JUBA CITY COUNCIL SANITARY & ENVIRONMENTAL BUILDING PROJECT			
Client:	AB HARAMBE			
Date:	23/1/2021	Max Dry Density	1930	kg/m^3
Location	BH1+EP1	OMC	13.20	%
Position:	0.0-1.0 m	Bulk Density	2185	kg/m^3



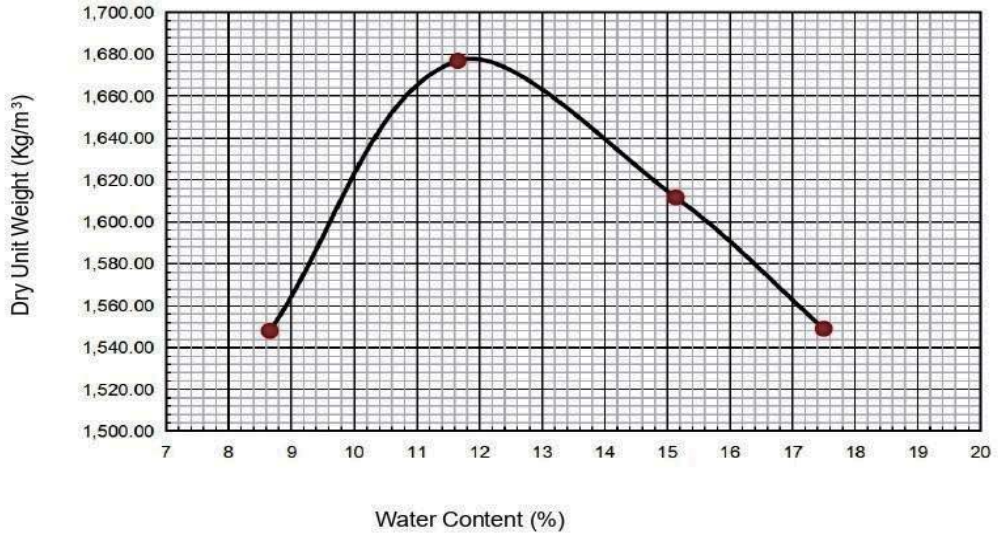
Test No:		1	2	3	4			
Tin No:		197	208	106	98	112		
Wt. of Tin	gm.	78.30	79.00	111.70	110.70	111.70		
Wt. of Tin + Wet Soil	gm.	239.50	231.00	249.60	289.00	292.30		
Wt. of Tin + Dry Soil	gm.	224.20	214.40	232.60	263.80	264.80		
Wt. of Water	gm.	15.30	16.60	17.00	25.20	27.50		
Wt. of Dry Soil	gm.	145.90	135.40	120.90	153.10	153.10		
Water Content	%	**10.5**	**12.3**	**14.1**	**16.5**	**18.0**		
Wt. of Mold	gm.	4700	4700	4700	4700	4700		
Wt. of Mold + Comp. Soil	gm.	6600.00	6758.00	6796.00	6710.00	6651.00		
Dry soil	gm	1900	2058.00	2096.0	2010.00	1951.00		
Total Unit Weight	Kg/m^3	**1987.45**	**2152.72**	**2192.5**	**2102.51**	**2040.79**		
Dry Unit Weight	Kg/m^3	**1798.81**	**1917.62**	**1922.2**	**1805.35**	**1730.04**		

Tested by	V.Kmeu	Checked by	E.Githaiga	Approved by	GK.Wambugu

BH 4 +EP2 Combined

Blue Pyramid Contractors and Engineering Services Limited
House NO 04 School Groove OFF School Lane , Westlands, Nairobi
Telephone:+254721394530
P.O BOX 20598-00100 NAIROBI
Email: bpcengineering@gmail.com, www.bpcengineering.com

Test	Compaction Test;T180			
Project:	JUBA CITY COUNCIL SANITARY & ENVIRONMENTAL BUILDING PROJECT			
Client:	AB HARAMBE			
Date:	23/1/2021	Max Dry Density	1680	kg/m^3
Location	BH4+EP2	OMC	11.80	%
Position:	0.0-1.0 m	Bulk Density	1878	kg/m^3



Test No:		1	2	3	4			
Tin No:		61	222	62	50			
Wt. of Tin	gm.	94.10	79.40	94.90	92.90			
Wt. of Tin + Wet Soil	gm.	223.40	218.30	244.00	225.20			
Wt. of Tin + Dry Soil	gm.	213.10	203.80	224.40	205.50			
Wt. of Water	gm.	10.30	14.50	19.60	19.70			
Wt. of Dry Soil	gm.	119.00	124.40	129.50	112.60			
Water Content	%	**8.7**	**11.7**	**15.1**	**17.5**			
Wt. of Mold	gm.	4700	4700	4700	4700			
Wt. of Mold + Comp. Soil	gm.	6308.00	6490.00	6474.00	6440.00			
Dry soil	gm	1608	1790.00	1774.0	1740.00			
Total Unit Weight	Kg/m^3	**1682.01**	**1872.38**	**1855.6**	**1820.08**			
Dry Unit Weight	Kg/m^3	**1548.02**	**1676.92**	**1611.7**	**1549.07**			

Tested by	V.Kmeu	Checked by	E.Githaiga	Approved by	GK.Wambugu

Appendix 12–TRI-AXIAL UU results

BH1 0.0-1.0m

DRECOMATTS LIMITED

Department of Civil & Construction Engineering-Soil &Rock Mechanics Laboratory

DRECO-MATTS Drilling, Engineering & Construction Technical Support

Client : AB Harambe Construction Company
Project :Juba City Council Sanitary and Environmental Building
Sample no:BH1
Depth:0.0-1.0m Date: 6/02/2021
Specification: According to BS 1377:1990

Direct Shear Test

Loads applied
weight of hanger = 4.5 kg
1st load = 32.2 kg
Total = 1st load + weight of hanger = 36.7 kg

2nd load =68.9 kg
Total = 2nd load + weight of hanger = 73.4 kg

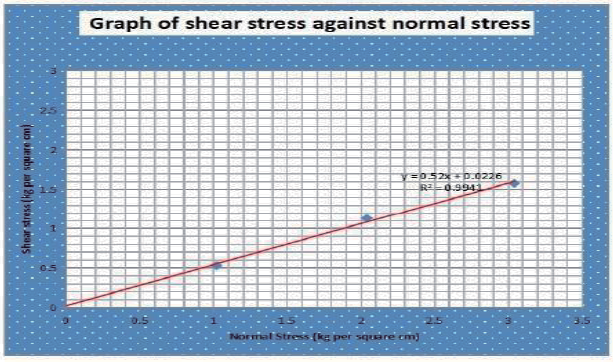
3rd load = 105kg
Total = 3rd load + weight of hanger = 109.5 kg
Bulk density 1712Kg/m2

Area of shear box = 36 square cm

Normal stress = applied load/area of shear box

shear stress = shear force at failure/ area of shear box

Normal stress =	1.02	kg per square cm	Shear stress =	0.53 kg per square cm
Normal stress =	2.04	kg per square cm	Shear stress =	1.13 kg per square cm
Normal stress =	3.04	kg per square cm	Shear stress =	1.58 kg per square cm



C = 0.02 kg/cm²

Ø = 27°

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info@bpoengineering.co.ke info@drecomatts.co.ke gkwambugu1989@gmail.com WEB:www:bpoengineering.co.ke www:drecomatts.co.ke

BH2 1.0-1.50m

DRECOMATTS LIMITED

Department of Civil & Construction Engineering-Soil &Rock Mechanics Laboratory

DRECO-MATTS Drilling, Engineering & Construction Technical Support

Client : AB Harambe Construction Company
Project :Juba City Council Sanitary and Environmental Building
Sample no:BH 2
Depth:1.0-1.5m Date: 10/02/2021
Specification: According to BS 1377:1990

Direct Shear Test

Loads applied

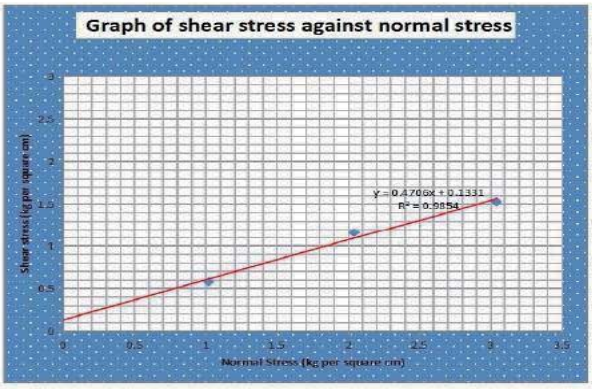
weight of hanger = 4.5 kg **Area of shear box =** 36 square cm
1st load = 32.2 kg
Total = 1st load + weight of hanger = 36.7 kg

2nd load =68.9 kg
Total = 2nd load + weight of hanger = 73.4 kg

3rd load = 105kg
Total = 3rd load + weight of hanger = 109.5 kg
Bulk density 1680Kg/m2

Normal stress = applied load/area of shear box **shear stress = shear force at failure/ area of shear box**

Normal stress =	1.02	kg per square cm	Shear stress =	0.58 kg per square cm
Normal stress =	2.04	kg per square cm	Shear stress =	1.16 kg per square cm
Normal stress =	3.04	kg per square cm	Shear stress =	1.53 kg per square cm



C = 0.13 kg/cm²

Ø = 25°

BH3 0.0-1.0m

DRECOMATTS LIMITED

Department of Civil & Construction Engineering-Soil &Rock Mechanics Laboratory

DRECO-MATTS Drilling, Engineering & Construction Technical Support

Client : AB Harambe Construction Company
Project :Juba City Council Sanitary and Environmental Building
Sample no:BH 3
Depth:0.0-1.0m Date: 6/02/2021
Specification: According to BS 1377:1990

Direct Shear Test

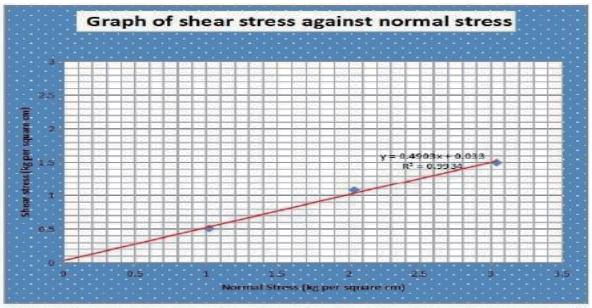
Loads applied
weight of hanger = 4.5 kg **Area of shear box =** 36 square cm
1st load = 32.2 kg
Total = 1st load + weight of hanger = 36.7 kg

2nd load =68.9 kg
Total = 2nd load + weight of hanger = 73.4 kg

3rd load = 105kg
Total = 3rd load + weight of hanger = 109.5 kg
Bulk density 1565Kg/m2

Normal stress = applied load/area of shear box **shear stress = shear force at failure/ area of shear box**

Normal stress =	1.02	kg per square cm	Shear stress =	0.51 kg per square cm
Normal stress =	2.04	kg per square cm	Shear stress =	1.08 kg per square cm
Normal stress =	3.04	kg per square cm	Shear stress =	1.5 kg per square cm



C = 0.03 kg/cm²

Ø = 26°

BH4 0.0-1.1m

DRECOMATTS LIMITED

Department of Civil & Construction Engineering-Soil &Rock Mechanics Laboratory

DRECO-MATTS Drilling, Engineering & Construction Technical Support

Client : AB Harambe Construction Company
Project :Juba City Council Sanitary and Environmental Building
Sample no:BH 4
Depth:0.0-1.1m Date: 6/02/2021
Specification: According to BS 1377:1990

Direct Shear Test

Loads applied
weight of hanger = 4.5 kg
1st load = 32.2 kg
Total = 1st load + weight of hanger = 36.7 kg

2nd load =68.9 kg
Total = 2nd load + weight of hanger = 73.4 kg

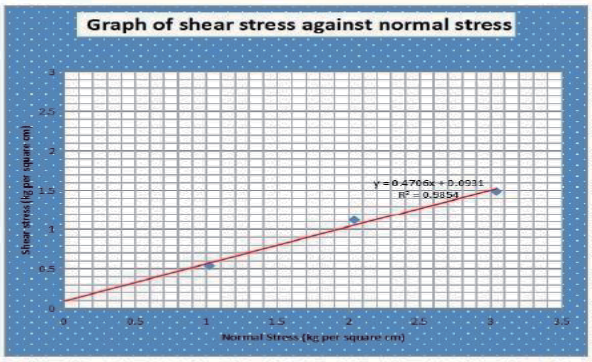
3rd load = 105kg
Total = 3rd load + weight of hanger = 109.5 kg
Bulk density 1580Kg/m2

Area of shear box = 36 square cm

Normal stress = applied load/area of shear box

shear stress = shear force at failure/ area of shear box

Normal stress =	1.02	kg per square cm	Shear stress =	0.54 kg per square cm
Normal stress =	2.04	kg per square cm	Shear stress =	1.12 kg per square cm
Normal stress =	3.04	kg per square cm	Shear stress =	1.49 kg per square cm



C = 0.09 kg/cm²

Ø = 25°

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EP1 0.0-2.0m

DRECOMATTS LABS

Department of Civil & Construction Engineering
(Soil Mechanics Laboratory)

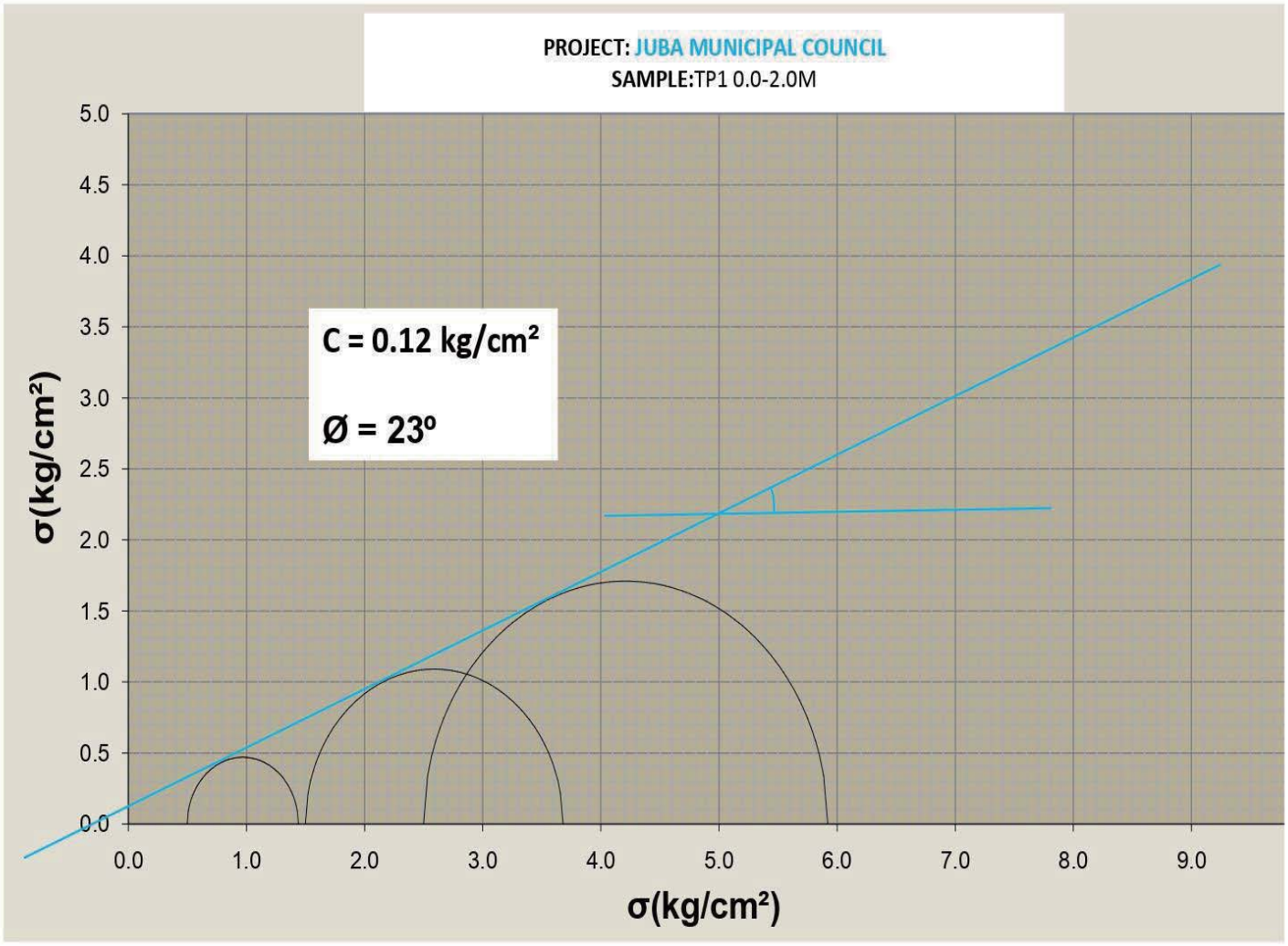
TRIAXIAL TEST-UU

CLIENT	AB HARAMBE CONSTRUCTION		
PROJECT	JUBA MUNICIPAL COUNCIL		
Depth (m)	0.0-1.0M	Test pit ID:	EP 1
Test date:	26-Jan-21		
Specification	According to BS 1377:1990		

SOIL TYPE		MEAN DIAMETER Do=	38mm
PROVING RING No.	63171	HEIGHT Lo=	76mm
CALIBRATION FACTOR	0.421kg/Div	MEAN AREA Ao=	11.3cm²
WEIGHT OF SPECIMEN	(gm)	VOLUME Vo=AoLo=	86cm³
CELL PRESSURE	0.50,1.50 & 2.50 Kg/cm²	UNCONSOLIDATED UNDRAINED TRIAXIAL (QUICK TEST)	

DIAL READING (in)	DIAL READING (mm)	E=L/Lo	1-E	A=Ao/1-E	DIAL READING	LOAD P kgf	Q=P/A kgf/cm²
0	0	0	1.00	11.30	0	0	0
150	3.81	0.05	0.95	11.90	18	7.6	0.64
300	7.62	0.10	0.90	12.56	28	11.8	0.94
450	11.43	0.15	0.85	13.30	28	11.8	0.89
600	15.24	0.20	0.80	14.13			
750	19.05	0.25	0.75	15.08			
0	0	0	1.00	11.30	0	0	0.0
150	3.81	0.05	0.95	11.90	45	18.9	1.59
300	7.62	0.10	0.90	12.56	65	27.4	2.18
450	11.43	0.15	0.85	13.30	58	24.4	1.84
600	15.24	0.20	0.80	14.13			
750	19.05	0.25	0.75	15.08			
0	0	0	1.00	11.30	0	0	0.0
150	3.81	0.05	0.95	11.90	87	36.6	3.08
300	7.62	0.10	0.90	12.56	102	42.9	3.42
450	11.43	0.15	0.85	13.30	94	39.6	2.98
600	15.24	0.20	0.80	14.13			
750	19.05	0.25	0.75	15.08			

	Cell pressure (kg/cm²) σ3	Deviator stress (kg/cm²) (σ1 - σ3)	Major Princ.stress kg/cm²) σ1
TEST 1	0.5	0.94	1.44
TEST 2	1.5	2.18	3.68
TEST 3	2.5	3.42	5.92


PROJECT: JUBA MUNICIPAL COUNCIL
SAMPLE:TP1 0.0-2.0M
C = 0.12 kg/cm²
Ø = 23°
σ(kg/cm²)
σ(kg/cm²)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0

EP2 0.0-2.0m

DRECOMATTS LABS

Department of Civil & Construction Engineering
(Soil Mechanics Laboratory)

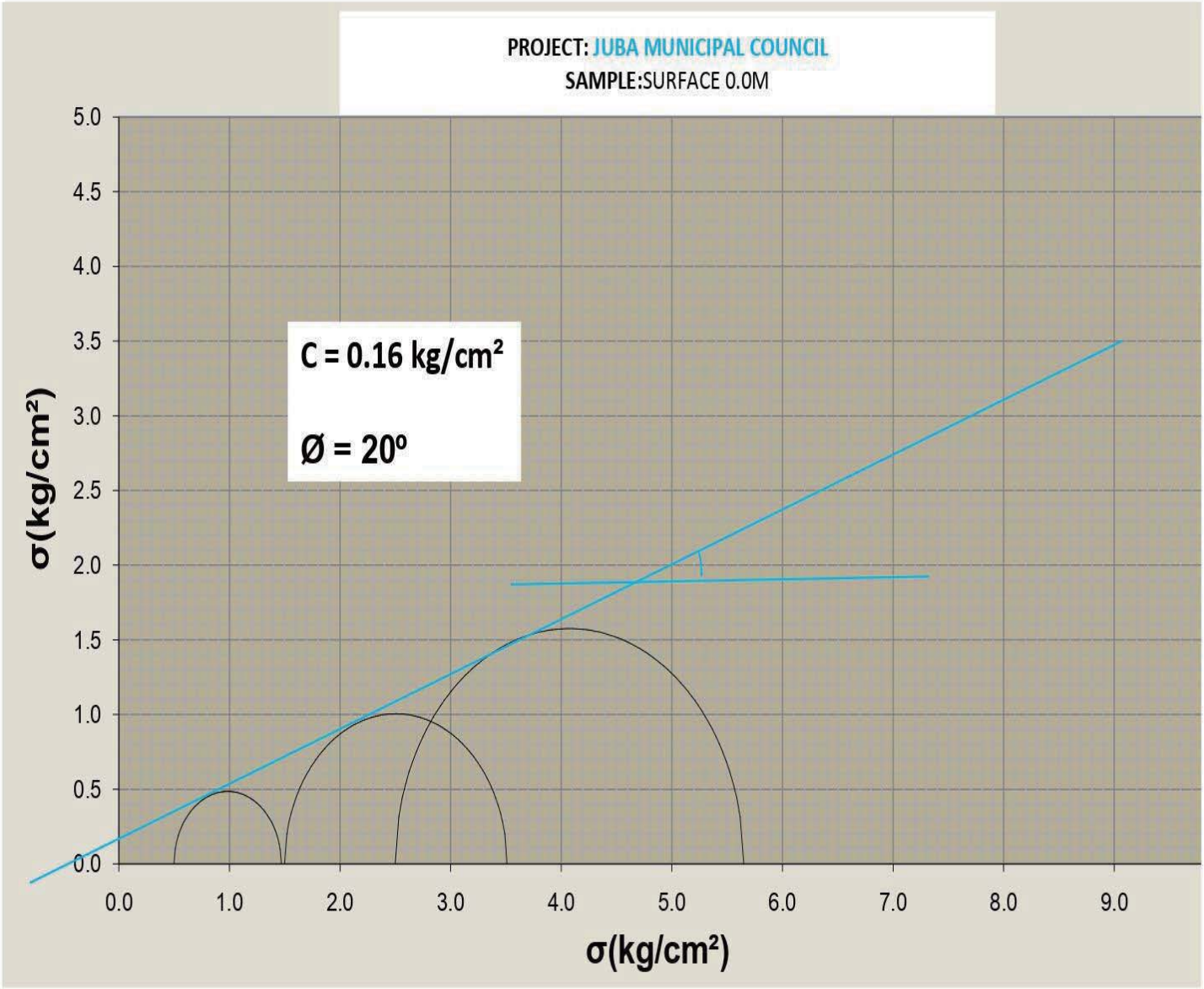
TRIAXIAL TEST-UU

CLIENT	AB HARAMBE CONSTRUCTION		
PROJECT	JUBA MUNICIPAL COUNCIL		
Depth (m)	0.0-1.0M	Test pit ID:	EP2
Test date:	26-Jan-21		
Specification	According to BS 1377:1990		

SOIL TYPE		MEAN DIAMETER Do=	38mm
PROVING RING No.	63171	HEIGHT Lo=	76mm
CALIBRATION FACTOR	0.421kg/Div	MEAN AREA Ao=	11.3cm²
WEIGHT OF SPECIMEN	(gm)	VOLUME Vo=AoLo=	86cm³
CELL PRESSURE	50,150 & 250 KN/m²	UNCONSOLIDATED UNDRAINED TRIAXIAL (QUICK TEST)	

DIAL READING (in)	DIAL READING (mm)	E=L/Lo	1-E	A=Ao/1-E	DIAL READING	LOAD P kgf	Q=P/A kgf/cm²
0	0	0	1.00	11.30	0	0	0
150	3.81	0.05	0.95	11.90	18	7.6	0.64
300	7.62	0.10	0.90	12.56	29	12.2	0.97
450	11.43	0.15	0.85	13.30	23	9.7	0.73
600	15.24	0.20	0.80	14.13			
750	19.05	0.25	0.75	15.08			
0	0	0	1.00	11.30	0	0	0.0
150	3.81	0.05	0.95	11.90	55	23.2	1.95
300	7.62	0.10	0.90	12.56	60	25.3	2.01
450	11.43	0.15	0.85	13.30	54	22.7	1.71
600	15.24	0.20	0.80	14.13			
750	19.05	0.25	0.75	15.08			
0	0	0	1.00	11.30	0	0	0.0
150	3.81	0.05	0.95	11.90	86	36.2	3.04
300	7.62	0.10	0.90	12.56	94	39.6	3.15
450	11.43	0.15	0.85	13.30	92	38.7	2.91
600	15.24	0.20	0.80	14.13	88	37.0	2.62
750	19.05	0.25	0.75	15.08			

	Cell pressure (kg/cm²) σ3	Deviator stress (kg/cm²) (σ1 - σ3)	Major Princ.stress kg/cm²) σ1
TEST 1	0.5	0.97	1.47
TEST 2	1.5	2.01	3.51
TEST 3	2.5	3.15	5.65


PROJECT: JUBA MUNICIPAL COUNCIL
SAMPLE:SURFACE 0.0M
C = 0.16 kg/cm²
Ø = 20°
σ(kg/cm²)
σ(kg/cm²)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0

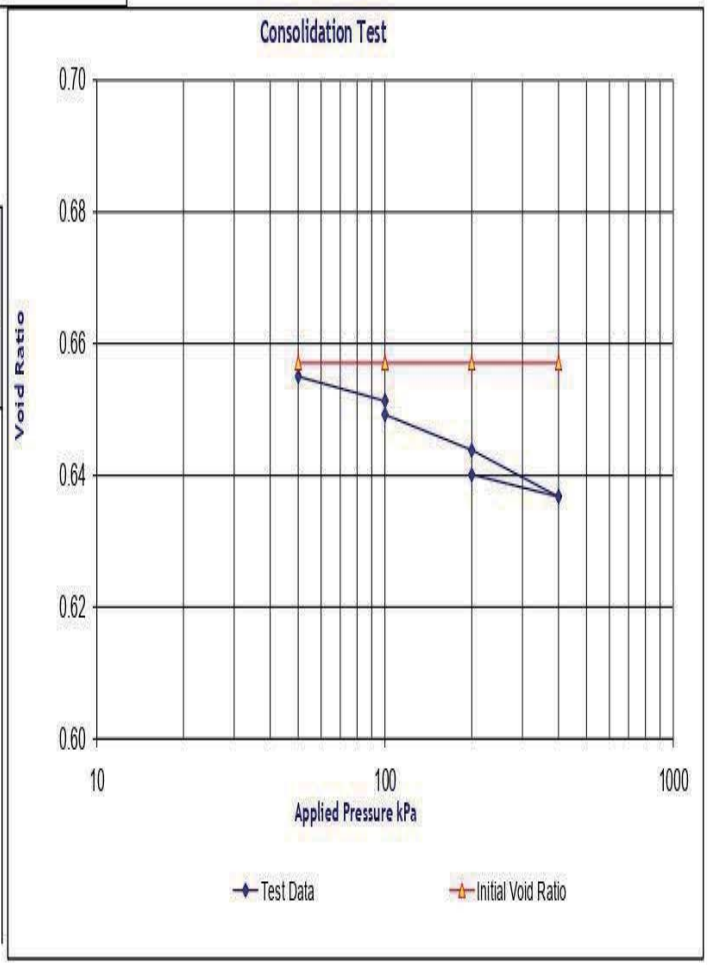
Appendix 13–Consolidation results

EP1 0.0-2.0m

PROJECT: JUBA MUNICIPAL COUNCIL **Sno.** TP 1 0.0-2.0M **DATE:** Monday, January 25, 2021

Relative density of soil:-	2.65 g/cc	**Dry mass of specimen:-**	62.8 g	**Surface area of specimen:-**	1963.5 mm^2
Initial height of specimen:-	20 mm	**Proving Ring Dial Readings**	0.01 mm		
Bulk Dry Density of Specimen:-	1599 kg/m3				
Initial Void Ratio:-	0.66				
Void Ratio Reduction Factor	0.0829				

Vertical Pressure kPa	Dial Reading	Height Change (mm)	Void Change	Void Ratio	Square Root Time sqr(min)	cv m^2/yr	mv m^2/MN
	2300			0.66			
50	2297.5	0.03	0.002	0.66	10.0	4.5	0.03
100	2293	0.07	0.006	0.65	14.1	3.1	0.05
100	2290.5	0.10	0.008	0.65	17.3	2.6	0.07
200	2284	0.16	0.013	0.64	20.0	2.2	0.05
400	2275.5	0.25	0.020	0.64	22.4	2.0	0.02
200	2279.5	0.21	0.017	0.64	23.4	1.9	0.01
	2288	0.12	0.010	0.65	24.4	1.8	0.02



Compressibility Index on last loading cycle (Cc) 0.023 **cv:** coefficient of consolidation **mv:** modulus of volume compressibility

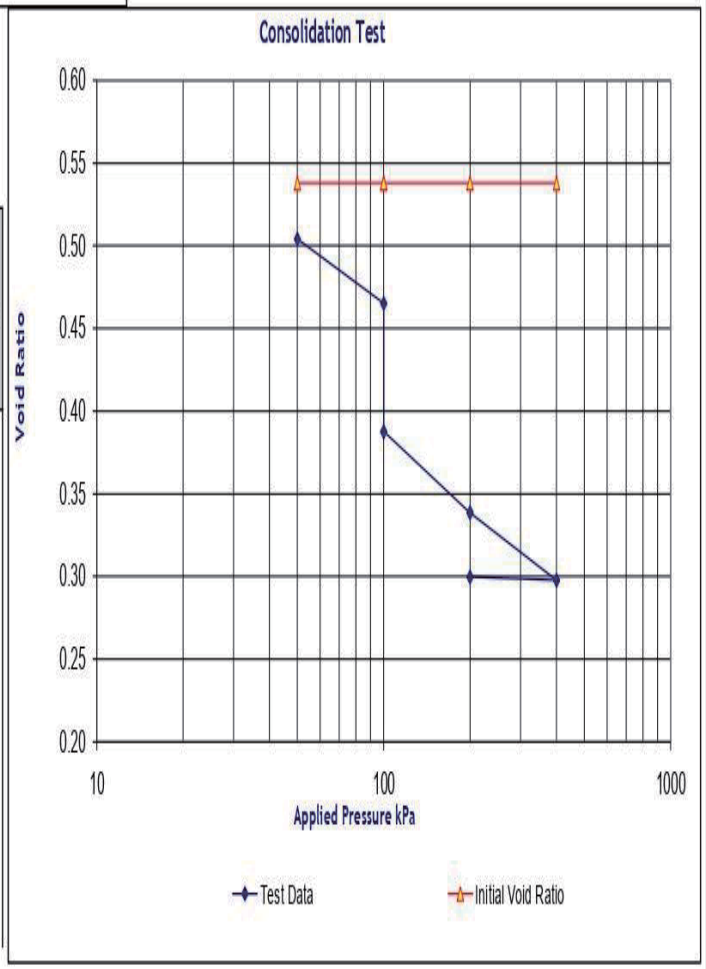
NOTE: Initially loaded without water surround.Water added after 100kpa had been applied.

EP2 0.00-2.0m

PROJECT: JUBA MUNICIPAL COUNCIL **Sno.** SURFACE 0.0M **DATE:** Monday, January 25, 2021

Relative density of soil:-	2.65 g/cc	**Dry mass of specimen:-**	148.5 g	**Surface area of specimen:-**	4536.5 mm^2
Initial height of specimen:-	19 mm	**Proving Ring Dial Readings**	0.01 mm		
Bulk Dry Density of Specimen:-	1723 kg/m3				
Initial Void Ratio:-	0.54				
Void Ratio Reduction Factor	0.0810				

Vertical Pressure kPa	Dial Reading	Height Change (mm)	Void Change	Void Ratio	Square Root Time sqr(min)	cv m^2/yr	mv m^2/MN
	1500			0.54			
50	1458	0.42	0.034	0.50	10.0	3.9	0.44
100	1410	0.90	0.073	0.47	14.1	2.7	0.52
100	1314	1.86	0.151	0.39	17.3	2.0	1.55
200	1253.5	2.47	0.200	0.34	20.0	1.6	0.86
400	1203	2.97	0.240	0.30	22.4	1.3	0.15
200	1205.5	2.95	0.238	0.30	23.4	1.2	0.01
	1223	2.77	0.224	0.31	24.4	1.2	0.05



Compressibility Index on last loading cycle (Cc) 0.136 **cv:** coefficient of consolidation **mv:** modulus of volume compressibility

NOTE: Initially loaded without water surround.Water added after 100kpa had been applied.

Appendix 14–Summary of Specific gravity results

SPECIFIC GRAVITY (SOILS);-BS 1377							Lab Form	11
CLIENT	AB HARAMBE CONSTRUCTION COMPANY							
PROJECT	PROPOSED JUBA CITY COUNCIL SANITARY AND ENVIRONMENTAL BUILDI					DATE	8/2/2021	
Material Descliption:	SOILS							
Locations	DEPTH (M)	BOTTLE No.	MASS OF BOTTLE + STOPPER (M1)g	MASS OF BOTTLE + STOPPER + SOIL (M2)g	MASS OF BOTTLE + STOPPER + SOIL + WATER (M3)g	MASS OF BOTTLE + STOPPER + WATER (M4)g	(M2 - M1)	S.G .	AV. S.G .
BH1	0.0-1.0	1	2.00	3.05	5.40	4.75	1.05	2.50	2.595
		B	2.00	3.05	5.41	4.75	1.05	2.69	
	1.0-2.0	C	2.00	3.05	5.40	4.75	1.05	2.50	2.500
		4	2.00	3.05	5.40	4.75	1.05	2.50	
	2.0-3.0	PS4	1.85	2.85	9.02	8.4	1.00	2.63	2.595
		PS19	1.85	2.85	9.01	8.4	1.00	2.56	
	3.0-4.0	2	2.00	3.05	5.42	4.75	1.05	2.76	2.660
		96	1.85	2.85	9.01	8.4	1.00	2.56	
	4.0-5.0	h	2.00	3.05	5.42	4.75	1.05	2.76	2.660
		ho.	2.05	3.05	5.36	4.75	1.00	2.56	
	5.0-6.0	z	2.00	3.05	5.42	4.75	1.05	2.76	2.690
		m	2.00	2.85	5.40	8.4	0.85	2.62	
	6.0-7	2	2.00	3.05	5.42	4.75	1.05	2.76	2.690
		m4	2.00	2.85	5.40	8.4	0.85	2.62	
EP1	0.0-1.0	2	2.05	3.05	5.37	4.75	1.00	2.63	2.595
		1Q	2.05	3.05	5.36	4.75	1.00	2.56	
	1.0-2.0	1	2.00	3.05	5.39	4.75	1.05	2.56	2.625
		93	2.00	3.05	5.41	4.75	1.05	2.69	
BH2	0.0-1.5	W4	18.62	28.62	91.02	84.83	10.00	2.62	2.605
		W5	18.5	28.57	90.88	84.74	10.07	2.59	
	1.5-2.3	2	2.00	3.05	5.41	4.75	1.05	2.69	2.625
		H	2.00	3.05	5.39	4.75	1.05	2.56	
	2.3-3.5	p	2.00	3.05	5.42	4.75	1.05	2.76	2.760
		2	2.00	3.05	5.42	4.75	1.05	2.76	
BH3	0.0-1.0	1	2.05	3.05	5.39	4.75	1.00	2.44	2.470
		F	2.05	3.05	5.4	4.75	1.00	2.50	
	1.0-2.0	60P	2.05	3.05	5.39	4.75	1.00	2.56	2.625
		Q	2.05	3.05	5.41	4.75	1.00	2.69	
	2.0-3.0	O	2.00	3.05	5.41	4.75	1.05	2.70	2.660
		1	2.00	3.05	5.4	4.75	1.05	2.62	
	12.2-12.5	M	2.05	3.05	5.42	4.75	1.00	2.80	2.715
		C1	2.05	3.05	5.37	4.75	1.00	2.63	
EP2	0.0-1.0	1	2.00	3.05	5.38	4.75	1.05	2.50	2.530
		3	2.00	3.05	5.39	4.75	1.05	2.56	
	1.0-2.0	5	2.05	3.05	5.39	4.75	1.00	2.56	2.530
		T	2.05	3.05	5.4	4.75	1.00	2.50	
BH4	0.0-1.0	D	2.05	3.05	5.40	4.75	1.00	2.50	2.500
		EF	2.05	3.05	5.40	4.75	1.00	2.50	
	1.0-2.0	C	2.05	3.05	5.41	4.75	1.00	2.69	2.565
		1	2.05	3.05	5.39	4.75	1.00	2.44	
Tested by					Approved by				

DRECO-MATTS
Drilling, Engineering & Construction Technical Support

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Appendix 15–Summary of Moisture Content results

DRECO-MATTS
Drilling, Engineering & Construction Technical Support

MOISTURE CONTENT -BSS 1377

Laborarory Test Result -BSS 1377

Project:	AB HARAMBE CONSTRUCTION
Client:	JUBA CITY COUNCIL SANITARY AND ENVIRONMENTAL BUILDING
Date:	23/1/2021

TECHNICAL DATA

		1	2	3	4	5	6	1	2	1	2	3	4	5	1	2	3	4	1	2	1	2
Location		BH1	BH1	BH1	BH1	BH1	BH1	EP1	EP1	BH2	BH2	BH2	BH2	BH2	BH3	BH3	BH3	BH3	EP2	EP2	BH4	BH4
Depth (m)		0.0-1.0	1.0-2.0	2.0-3.0	3.0-4.0	4.0-5.0	5.0-6.0	0.0-1.0	1.0-2.0	0.0-1.50	1.5-2.3	2.3-3.5	1.5-2.3	2.3-3.5	0.0-1.0	1.0-20	2.0-3.0	12.2-12.5	0.0-1.0	1.0-2.0	0.0-1.0	1.0-1.5
Tin No:		103	47	32	141	83	4A	47	8B	15	381	5B	J27	KO	MNP	63	CM	116	166	69X	24	63
Wt. of Tin	gm.	10.00	25.50	22.00	15.50	16.50	22.50	25.50	22.00	22.50	16.50	42.50	22.00	23.50	23.00	22.50	22.50	9.50	9.50	16.50	22.50	22.50
Wt. of Tin + Wet Soil	gm.	83.00	83.50	62.00	77.60	56.20	46.00	83.50	87.50	96.50	71.50	110.50	111.50	75.10	68.10	114.50	68.30	116.50	87.50	79.00	90.50	86.50
Wt. of Tin + Dry Soil	gm.	72.50	78.50	59.50	76.40	55.50	45.50	78.50	84.00	88.00	64.00	109.00	110.00	74.20	67.20	113.00	67.30	115.00	83.00	77.50	82.00	80.50
Wt. of Water	gm.	10.50	5.00	2.50	1.20	0.70	0.50	5.00	3.50	8.50	7.50	1.50	1.50	0.90	0.90	1.50	1.00	1.50	4.50	1.50	8.50	6.00
Wt. of Dry Soil	gm.	62.50	53.00	37.50	60.90	39.00	23.00	53.00	62.00	65.50	47.50	66.50	88.00	50.70	44.20	90.50	44.80	105.50	73.50	61.00	59.50	58.00
Water Content	%	**16.8**	**9.4**	**6.7**	**2.0**	**1.8**	**2.2**	**9.4**	**5.6**	**13.0**	**15.8**	**2.3**	**1.7**	**1.8**	**2.0**	**1.7**	**2.2**	**1.4**	**6.1**	**2.5**	**14.3**	**10.3**

Tested by	V.Kmeu	Checked by	E.Githaiga	Approved by	GK.Wambugu

Drecomatts Ltd /BPC & Engineering Services Ltd , School grove off school laane Westland Nairobi Kenya bpcengineering@gmail.com Drecomatts Serekat Juba info@drecomatts.co.ke

Appendix 16–Implementation Photographs

BH2 Implementation photographs

BH2 Daily Progress Photo


JUBA CITY
COUNCIL
SANITARY &
ENVIRONMENTAL
SITE
B/H N:- 2
S.P.T. 1.50m - 1.95
22/18/17/18/18 N/V
=71, D2
DATE:- 09/11/20


JUBA CITY COUNCIL SITE
1000M
CORE BOX N 1
BH N 2
DATE: 11/11/20
19.00M
DEPTH: 2.50M-19.50M

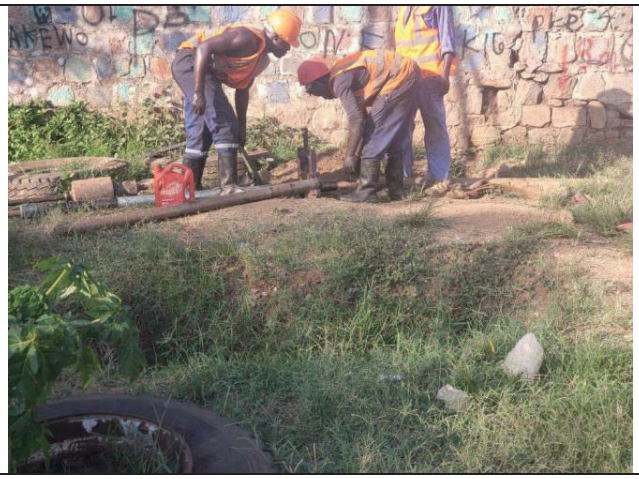
BH1 Implementation photographs

BH1 Daily Progress Photo


JUBA MUNCIPAL CONCIL
DATE 23/12/2020

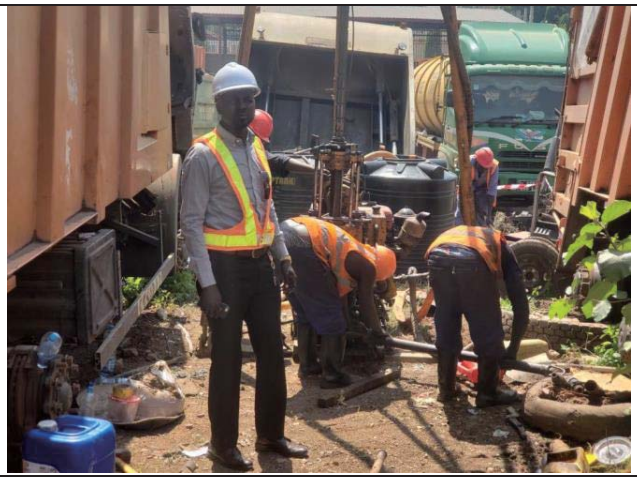
BH3 Implementation photographs

BH3 Daily Progress Photo



BH4 Implementation photographs

BH4 Daily Progress Photo



EP1 Implementation photographs

EP1 Daily Progress Photo

EP2 Implementation photographs

EP2 Daily Progress Photo