GEOTECHNICAL INVESTIGATION

PROPOSED MERU NTUTU MIXED DEVELOPMENT PHASE 1 ON MERU MUNICIPALITY PARCEL NO. BLOCK 1/357, MERU COUNTY.

Prepared for: N P

National Housing Corporation, P.O Box 30257-00100, Nairobi.

Attention: Eng. Wilfred Makutha and Eng. Judith G. Limungi

2 copies -National Housing Corporation1 copy -Terraconsult Kenya Limited, Nairobi

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1. INTRODUCTION

Terraconsult was retained by National Housing Corporation to carry out a detailed geotechnical investigation and provide design advice for Proposed Meru Ntutu Mixed Development Phase 1 on Meru Municipality Parcel No. Block 1/357, Meru County.

Engineers Wilfred Makutha and G. Limungi provided all communication on the proposed scope of the subsurface investigation.

This report presents the findings of geotechnical survey carried out at the proposed project site. It primarily contains results from field borehole drilling, insitu tests and laboratory tests. It also includes analysis of the test results, field observations and presentation of factual geotechnical findings.

All the fieldwork was carried out according to BS 5930: 2015 (code of practice for site investigations). Laboratory tests were done as stipulated in the British Standards (BS 1377); the American Society for Testing Materials (ASTM) designated D 2938-79 and D 2845-00. Design recommendations are in adherence to the Manual for the Geotechnical Design of Structures to Euro code 7(2013) and BS 8004.

2. SITE AND PROJECT DESCRIPTION

The subject property is located on Meru-Nairobi Highway, Meru. A topographic map of the area is subsequently appended as Figure 1.

According to GPS data, the project site is at an elevation of approximately 1686.5m above sea level.

The project entailed rotary drilling of geotechnical boreholes to obtain core samples for analysis.

3. FIELD AND LABORATORY PROCEDURE

The fieldwork for this investigation was conducted from 10^{th} to 23^{rd} February 2019. It consisted of drilling and sampling six (6) exploratory boreholes to a maximum depth of 25m below existing grade.

The drilling equipment consisted of a rotary drilling rig (GY-150) equipped with conventional soil sampling and testing tools.

The supervising technician logged the borings and examined the samples as they were obtained. The samples were properly identified by visual inspection, catalogued in wooden core boxes/sealed sample containers and transferred to the laboratory for testing. A geotechnical engineer later reviewed the samples for consistency of description. The photographs of the samples are presented in Appendix B of this report.

Water level measurements were conducted in the open borehole upon completion of drilling. The water was allowed to equilibrate for about 30 minutes before taking the final measurement. The final water rest level is

recorded in the borehole logs (Appendix A). It should be noted that the ground water conditions reported above may not necessarily represent stabilized conditions or conditions expected during construction. In addition, assistive drilling water contributes to the level observed in boreholes.

The recovered intact core samples, representative samples from the anticipated foundation depths and the zone of influence of the foundation loadings, were soaked in water for four (4) days to achieve saturation, trimmed to specifications before either uniaxial compressive strength (UCS), point load tests (PLT) or ultrasonic pulse velocity tests were carried out. The test results are appended to this report. They include computed bearing capacity values from rock cores irrespective of any settlement obtained by use of R. E. Goodman's Formula (Goodman, R.E., 1989) and are applicable at the respective depths indicated.

4. SUBSURFACE CONDITIONS

The borehole elevations and coordinates are provided relative to geodetic datum. The datum for all heights in Kenya is the mean sea level referred to a tide gauge at Kilindini harbour in Mombasa. The horizontal coordinates are reported relative to the Universal Transverse Mercator geographic coordinate system (UTM WGS84). The boreholes were surveyed for horizontal coordinates and geodetic elevations with a hand-held Garmin navigator connected to the Global Navigation Satellite System.

The subsurface soil, rock and ground water conditions encountered in the boreholes are presented on the attached Log of Borehole sheets. The stratigraphic boundaries indicated on the Log of Borehole sheets are inferred from non-continuous samples and observations of drilling resistance and typically represent a transition from one soil or rock type to another. These boundaries should not be interpreted to represent exact planes of geological change. The subsurface conditions have been confirmed in a series of widely spaced boreholes, and will vary between and beyond the borehole locations. The discussion has been simplified in terms of the major soil and rock strata for the purposes of geotechnical design.

4.1Stratigraphy

The following stratigraphy is based on the borehole findings, as well as the geotechnical laboratory testing conducted on selected representative soil samples.

All boreholes encountered a surficial layer of clay soils that extends to depths of 6 to 20 meters below existing grade (Elev. $1675 \pm m$ to $1665.0 \pm m$). The native soils generally consist of clayey silt some sand with traces of gravel, reddish brown, dark brown, whitish brown to yellowish brown, wet to dry, medium to low plasticity.

Underlying the native deposits all boreholes encountered layers of trachyte of different colors ranging from light grey to reddish grey, highly weathered to moderately weathered at different depths. These trachyte's extend to different thickness and depths in all boreholes. The trachyte extends approximately 2.5 to 15 m

below grade (Elev. 1665 \pm m1675 \pm m). These trachyte layers are underlain by layers of pale grey, relatively hard phonolites of different degrees of weathering which extend up to the final depth of the investigation.

4.2 Ground Water

The stabilized ground water table was reported at about 13-14 m below grade.

Borehole	Depth of Boring	Ground Water Table (m)
		After drilling
Bh 101	25	13.13
Bh 102	25	14.1
Bh 103	25	13.1
Bh 104	25	*
Bh 105	25	13.3
Bh 106	25	13.14

Table 1 Ground water table levels

* No water

It should be noted that the ground water levels may fluctuate seasonally depending on the amount of precipitation and surface runoff. The depth of unsterilized ground water and caving were measured in each of Boreholes after the drilling work was completed. The apparent ground water level for Bh 104 was not recorded because there was a broken water pipe that was leaking into the borehole.

4.3 Geotechnical Laboratory Test Results

4.3.1 Clayey Silt

The geotechnical laboratory testing consisted of sieve and hydrometer analysis, Atterberg Limits, permeability, triaxial and consolidation tests on selected native soil samples.

A summary of the results and estimated permeability of the samples analyzed is presented below.

Test	Samples	Results
Sieve and hydrometer	Bh 101(6.0-7.5)m	Clayey SILT with some sand and traces of gravel
analysis and Atterberg		with medium plasticity

1	DI 101 (10 5 15 0)	
limits	Bh 101 (13.5-15.0)m	Clayey SILT with some sand and traces of gravel
		with medium plasticity
	Bh 103(3.0-4.5)m	Clayey SILT with some sand and traces of gravel
		with medium plasticity
	Bh 104(4.5-6.0) m	Clayey SILT with some sand and traces of gravel
		with medium plasticity
	Bh 104(9.0-13.5) m	Clayey SILT with some sand and traces of gravel
		with medium plasticity
	Bh 105(1.5-3.0) m	Clayey SILT with some sand and traces of gravel
		with medium plasticity
		T T T T
	Bh 106(0.0-1.5) m	Clayey SILT with some sand and traces of gravel
		with medium plasticity
	Bh 106(13.5-15.0) m	Clayey SILT with some sand and traces of gravel
		with medium plasticity
		with medium plasticity
Permeability	Bh 101(1.5-3.0) m	2.217*10 ⁻⁴ cm/sec
Termeubling	Dir 101(1.5 5.0) in	2.217 10 011/500
	Bh 101(5.5-6.0) m	8.220*10 ⁻⁵ cm/sec
	, , , , , , , , , , , , , , , , , , ,	
	Bh 102(4.0-4.5) m	3.759*10 ⁻⁴ cm/sec
	Bh 103(4.5-6.0) m	5.271*10 ⁻⁴ cm/sec
	Bh 105(1.0-1.5) m	6.926*10 ⁻⁵ cm/sec
	Bh 106(7.5-9.0) m	2.218*10 ⁻⁴ cm/sec
Triaxial and	Bh 101(2.0-2.5) m	= 15.07°
Consolidation		
		$c = 0.20 \text{kg/cm}^2$
		$2 (245 - 10^4 - 24)$
		$m_v = 2.6345 \times 10^{-4} m^2 / kN$
	Dh 102(1 0 1 5)	= 15.99°
	Bh 102(1.0-1.5) m	- 13.77
		$c = 0.20 \text{kg/cm}^2$
		c – 0.20kg/cm

	4 2
	$m_v = 2.7495 \times 10^{-4} m^2 / kN$
D1 102(5.5.6.0)	11.040
Bh 102(5.5-6.0) m	= 11.84°
	$c = 0.30 \text{kg/cm}^2$
	c = 0.50 kg/cm
	$m_v = 2.9292 \text{ x } 10^{-4} \text{ m}^2/\text{kN}$
	$m_{\rm V} = 2.5252 \times 10^{-111}$ / KIV
Bh 103(4.0-4.5) m	= 12.51°
	12.01
	$c = 0.20 \text{kg/cm}^2$
	č
	$m_v = 1.7830 \times 10^{-4} m^2/kN$
Bh 105(2.5-3.0) m	= 13.40°
	2201 + 2
	$c = 0.20 kg/cm^2$
	$m_v = 3.0553 \times 10^{-4} m^2/kN$
	$III_v = 3.0333 \times 10^{-111} / KIN$
Bh 106(4.0-4.5) m	= 10.53°
BII 100(4.0-4.3) III	- 10.55
	$c = 0.20 \text{kg/cm}^2$
	$m_v = 2.8520 \text{ x } 10^{-4} \text{ m}^2/\text{kN}$

Table 2 Summary of Clayey Silt Tests

4.3.2 Trachytes

The laboratory tests done on trachyte was only point load test since the samples could not achieve a length to diameter ratio of two (2).

4.3.3 Phonolites

The tests carried out for phonolites were uniaxial compressive strength (UCS), modulus and ultrasonic pulse velocity.

5. DISCUSSION AND RECOMMENDATIONS

The following are based on the factual data obtained from this investigation and are intended for use of National Housing Corporation and their consultants. Contractors bidding or providing services on this project should review the factual data and determine their own conclusions regarding construction methods and scheduling.

This report is provided based on these terms of reference and on the assumption that the design features relevant to the geotechnical analysis will be in accordance with applicable codes, standards and guidelines of practice.

5.1 Foundations

Laboratory results are subsequently appended in the report. Atterberg's limits portray the clay soils as of low to medium plasticity. The permeability results show the clay soils to have a low degree of permeability.

Depending on the depth where the foundation will be founded, the bearing pressure can be computed using either the equations by Terzaghi for the native soils or the Goodman (1989) formula for the rocks.

5.1.1 Foundation on Native Soils

The Standard Penetration test results ('N' Values) obtained weathered/disturbed soil zone varied from about 6 to 26 blows per 300 mm of penetration indicating a firm to very stiff consistency at a depth of 2 to 12 m.

If the foundation will be founded between depths of 2.0m to 6.0m, then using the foundation dimensions (width, B, and length, L) and the foundation depth, D_{f} the ultimate bearing capacity, q_u , for various footing shapes can be calculated using the equations below:

Strip footings:	$q_u = cN_c + \gamma D_f N_q + 0.5\gamma BN_\gamma$
Square foundations:	$q_u = 1.3cN_c + \gamma D_f N_q + 0.4\gamma B N_\gamma$
Circular foundations:	$q_u = 1.3cN_c + \gamma D_f N_q + 0.3\gamma BN_\gamma$
Rectangular foundations:	$q_u = cN_c(1 + 0.3\frac{B}{L}) + \gamma D_f N_q + 0.5\gamma BN_{\gamma}(1 - 0.2\frac{B}{L})$

Where,

$$c =$$
Cohesion (19.61 kN/m²)

 ϕ° = Angle of internal friction (13.40°, see appended triaxial test results).

 γ = Effective unit weight of soil (16.28 kN/m³)

 N_c , N_q , N_γ = Terzaghi' s bearing capacity factors for general shear failure (Appendix D)

A minimum factor of safety of 3 (F = 3) is recommended to obtain the safe bearing pressure from the computed ultimate bearing capacity using the equation below;

$$q_s = \frac{q_u}{F}$$

where,

 q_s = Safe bearing capacity and,

F = Factor of safety

For a typical 2.5 x 2.5 m spread foundation at 4.0m depth and, the allowable safe bearing capacity will be 100kN/m² using a factor of safety of 3.

5.1.2 Foundations on Rock

Bearing Capacities where computed from the Uniaxial Compressive Strength (UCS) using the Goodman (1989) formula. The maximum allowable bearing capacity of trachyte is 250kN/m² while that of phonolite is 800kN/m².

$$q_a = q_{ur}(N\emptyset + 1)$$

Where

$$N\emptyset = tan^2(45 + \frac{\emptyset}{2})$$

 $q_{\rm a}$ is the allowable bearing capacity;

 q_{ur} is the UCS value of the rock;

Ø is the angle of internal friction

The UCS, point load index (Is (50)) and bearing capacity values at various depths of the boreholes are presented in Appendix C.

A summary of properties with respect to the bedrock below the native soils is presented below.

	Point Load Index Is ₍₅₀₎ (MPa)	Uniaxial Compressive Strength (MPa)	Dynamic Modulus (GPa)	Poisson's Ratio
	Trachyte	Phonolite	Phonolite	Phonolite
Average	0.074	138.05	56.25	0.3469
Range	0.01-0.23	76.39-176.52	49.24-63.81	0.3142-0.3940

Table 3 Summary of Properties - the Bedrock

There is typically a zone of weathering at the contact between the bedrock of the trachyte and the native soil overburden. All foundations should be placed on dry, undisturbed rock which has been cleaned of any topsoil or other deleterious matter, loosened material/debris and with the recommended contact pressure.

5.2 Settlement 5.2.1 Foundations on Native Soil

Settlement of foundations in clay soil can be computed using the coefficient of volume compressibility (m_v) obtained from one dimensional consolidation test. Consolidation settlement of clay due to changes in vertical stress can be computed using the equation below;

$$\rho = \int_0^H m_v \times \Delta \sigma \times H$$

Where,

= Consolidation settlement (m).

 $m_v = \text{Coefficient of compressibility } (m^2/kN). (2.6345 \text{ x } 10^{-4} \text{ m}^2/kN).$

 $\Delta \sigma$ = Change in vertical stress (kN/m²).

H = Height under stress (m).

5.2.2 Foundations on Rock

A wide range of over-consolidated rocks can be treated as 'elastic' for predicting the total settlement. The magnitude of settlement that will occur when foundation loads are applied to the ground depends on the rigidity of the structure, the type and duration of the loading, and the deformation characteristics of the ground. For footings on rocks, elastic settlement should generally be less than 0.5% of the foundation width.

The settlement of a rigid foundation or average settlement of a flexible foundation at the surface of a homogeneous elastic layer can be computed using the following equation

$$s = \frac{q_a B(1-v^2)l}{E_m}$$

Where

 $q_{\rm a}$ is the average pressure on the rock;

B is the width or diameter of the footing;

v is the Poisson's ratio of the rock mass (see Appendix B)

 $E_{\rm m}$ is the modulus of the rock mass

l is the influence value dependent upon the shape of the footing and the rigidity of the footing relative to the rock mass; typical values are (Lysmer and Duncan 1969):

Shape	Circular	Square	Re	Rectangular		
			2	5	10	
Rigid	0.79	0.82	1.1	1.6	2.0	
Flexible (mean value)	0.85	0.95	1.3	1.8	2.2	

Table 4 Influence factors for various shapes of footings.

5.3 Excavations

5.3.1 Excavations on Native Soils

Excavations slopes in clay soil must be supported using proper shoring systems. Shoring methods depend on the loadings and type of structures in the adjoining plots. Proper design is required to preserve the integrity of the slope and surrounding properties. Temporary slope protection may be necessary to prevent sloughing

of soil materials into the excavation. Direct rainfall on such slopes causes rapid erosion. To prevent slope erosion in rainstorms, spray-on product is recommended to bind the soil particles on the surface. Plastic covering can be used to minimize changes in moisture content on the surface of the slope and maintain stability. It should be noted that excavation in saturated clay will result in heave at the bottom of the excavation due to swelling of the clay. It is always important that care should be taken when working in unsupported excavations extending below any ground.

5.3.2 Excavations on Rocks

Excavation faces in highly weathered rock have a considerable risk of failure due to low shear resistance along the potential slip surface, more so if there is significant surcharge in the adjoining plot. Slightly angled excavations have a reduced risk of failure due to an increased factor of safety against sliding failure. In the event unstable rock wedges are detected on the excavation face, they must be stabilized using designed rock bolts or rock anchors. Loose, weathered rock fragments on the excavated face that susceptible to falling can be temporarily restrained using sprayed concrete to protect the work area. Generally, it is always important that care should be taken when working in unsupported excavations extending below any ground.

5.4 Base Slab on Drainage

The lowest floor slab can be supported on the clayey silt but must be compacted. The concrete floor slab must be provided with a capillary moisture barrier and drainage layer. The capillary moisture barrier can be made by placing the slab on a minimum 200 mm layer of clear 19 mm stone compacted by vibration to a dense state. This stone serves also as the drainage media for the subfloor drainage system, which is required. Any aggregate fill placed beneath the floor slab must be compacted to not less than 98% of Standard Proctor maximum dry density.

5.5 Backfilling

The excavated areas should be backfilled with selected approved hard-core or similar material. Backfill below settlement sensitive areas for purposes of levelling the working area should be compacted in lifts 150 mm thick or less, to at least 95 percent Standard Proctor maximum dry density.

6. LIMITATIONS AND RISK

This geotechnical examination has been carried out using investigation techniques and engineering analysis methods consistent with those ordinarily exercised by Terraconsult Kenya Limited and other engineering practitioners, working under similar conditions and subject to the time, financial and physical constraints applicable to this project. The discussions and recommendations that have been presented are based on the factual data obtained from this investigation. It must be recognized that there are special risks whenever engineering or related disciplines are applied to identify subsurface conditions. A comprehensive sampling and testing programme implemented in accordance with the most stringent level of care may fail to detect certain conditions. Terraconsult Kenya Limited has assumed for the purposes of providing design

parameters and advice, that the conditions that exist proximal to the sampling point are similar to those found at the sample location. These conditions may differ from those that actually exist. It may not be possible to drill sufficient number of boreholes or sample and report them in a way that would provide all the subsurface information that could affect construction costs, techniques, equipment and scheduling. Contractors and Quantity Surveyors bidding on or undertaking work on this project should be directed to draw their own conclusions as to how the subsurface conditions may affect them, based on their own investigations and their own interpretations of the factual investigation results, cognizant of the risks implicit in the subsurface investigation activities. It must be recognized that the passage of time, natural occurrences, and direct or indirect human intervention at or near the site have the potential to alter subsurface conditions. The design parameters provided and the engineering discussion are based on the factual data obtained from this investigation made at the site by Terraconsult Kenya Ltd and are intended for use by the owner and his retained designers in the design phase of the project. If there are changes to the project scope and development features the interpretations made from the subsurface information, the geotechnical design parameters and comments relating to constructability issues and quality control may not be relevant to the revised project. This report was prepared for the express use of National Housing Corporation and is not for use by others. This report is copyright of Terraconsult Kenya Limited and no part of this report may be reproduced by any means, in any form, without the prior written permission of Terraconsult Kenya Limited, National Housing Corporation and their retained design consultants are authorized users.

We trust this report provides sufficient information for your present purposes. If you have any questions concerning this report or if we may be of further services to you please do not hesitate to contact our offices.

Sincerely, Terraconsult Kenya Limited

Issa Ismail, PhD.

Geotechnical Engineer



7.APPENDIX A-Borehole Logs and Section

PROJECT				UTU MIXED		TEDD		-	ELEVAT		E	034908	ZONE	
DEVELOPMENT PHASE 1 LOCATION:MERU.						TERRACONSULT			(UTM-V		N	0005812	100000000	
CLIENT:	NATION	AL HOU	SING C	ORPORATIO	N.	KENYA LIMITED				DATE(S) START END Sheet No: 1 of 3				
						BOREI	HOLE LOG	1000						
File No:	: 3-19-	10			Logged	By: Winnie	Munene	Chec	ked By	: Dr. I	ssa Isma	ail		
Drilling					Drill Bit	Type: 86-1	01mm Diamond	Bore	hole N	o: 101				
Drill Ri						By: Justus	Owino	Dept	h: 25	.00 m				
Apparen	t Deptl			ater: 13.1	3 m	-		Incli	nation	From V	ertical:	0°		
(1	-	F	ROCK (CORE				ning rade)						
Depth (m)	Run (m)	TCR (%)	RQD (%)	RMR (RQD) D	RAPHIC LOG	MATER	IAL DESCRIPTION	Weathering Grade	RMR (Weathering Grade)	Fracture Asperities	Fracture Frequency	Rock Mass Quality	SPT (N-Value)	
1	1.5			K	AVEY SILT	brown clay	e grained, stiff, reddish rey SILT with some sand s of gravel Has medium plasticity.	VI						
2	1.5				AYEY SILT	brown clay	e grained, stiff, reddish rey SILT with some sand s of gravel Has medium plasticity.	VI					8	
3 4 4	1.5			GL	AYEY SILT	brown clay	ne grained, stiff, reddish yey SILT with some sand s of gravel. Has medium plasticity.	থা					9	
- - - - - -	1.5				AYFY SILT	brown clay	ne grained, stiff, reddish yey SILT with some sand s of gravel. Has medium plasticity.	VI					8	
6 7 7	1.5			d	AVEN SILT	reddish b	ine grained, stiff, light rown clayey SILT with and traces of gravel. Has low plasticity.	VI						
8 8 	1.5			cı	AVEY SILT	reddish b	ñne grained, stiff, light rown clayey SILT with and traces of gravel, Has low plasticity.	VI					10	
II: Sli III: Me IV: Hi V: Co	esh & H ghtly W oderatel ghly W	lard /eathere y Weatl eathered y Weatl	ed hered 1	RI: Rou	URE ASPE gh and Irreg ugh and Und	ular	ROCK MASS QU E: Excellent G: Good Fa: Fair P: Poor VP: Very Poor	ALITY	R	QD: Ro MR: Ro	ck Qual	Recover ity Desig Rating i (1989)	nation	

PROJECT	DEVEL	OPMEN			XED			ACONSULT		ELEVAT COORD	INATES	EN	034908		
LOCATIO CLIENT:			SING C	ORPOR	ATION.	IC	KENY	A LIMITED			TE(S)	STAR	T 10	02/19	
								IOLE LOG	END 23/02/19 Sheet No: 2 of 3						
File No:	3-19-	10				Logged F	By: Winnie	5- A	-		: Dr. I	The second second	ม่ไ		
Drilling	10	1992	urv					01mm Diamond				rehole No: 101			
Drill Rig Type: GY 150T Drilled By: Justus Owino De							Dept	h: 25	.00 m						
Apparent Depth of Ground Water: 13.13						0	-		-	nation	From V	ertical:	0°		
1)	ROCK CORE								ng	rade)	es es	ecy	ass /	()	
Depth (m)	Run (m)	TCR (%)	RQD (%)	RMR (RQD)		PHIC OG	MATER	IAL DESCRIPTION	Weathering Grade	RMR (Weathering Grade)	Fracture Asperities	Fracture Frequency	Rock Mass Quality	SPT (N-Value)	
9 10 	2.5				CLAYI	EY SILT	Firm, rec with some	ldish brown clayey SILT and and trace gravel. Has low plasticity.	থা		6.)				
- - 11 - - -	0.5				CLAVI	SY SILT	Firm, rec with some	ldish brown clayey SILT and and trace gravel. Has low plasticity.	থা					7	
12 13 	1.5				CLAVI	EVSILT		ldish brown clayey SILT and and trace gravel. Has low plasticity.	vī					6	
- - - 14 - -	1.5				CLAVI	SY SILT	Firm, reddish brown clayey SILT with some sand and trace gravel. Has low plasticity.								
15 16 	1.5				clau	EYSILT		ldish brown clayey SILT and and trace gravel. Has low plasticity.	থা						
17 17 	1.5				CLANI	AV SILT		ldish brown clayey SILT and and trace gravel. Has low plasticity.	vī						
I: Fre II: Sli III: Me IV: Hij V: Co	I: Fresh & Hard RI: Rough				Rough	RE ASPERITIES and Irregular ROCK MASS QU and Undulating E: Excellent G: Good G: Good Fa: Fair P: Poor VP: Very Poor				R	QD: Ro MR: Ro	ck Qual	Recover ity Desig Rating i (1989)	nation	

LLENT: NATIONAL HOUSING CORPORATION NATE (No. 1 + 4 + 4 + 4 + 4 + 4 + 4 + 4 + 4 + 4 +
Tile No: 3-19-10 Logged By: Winnie Munene Checked By: Dr. Issa Ismail Drilli Rig Type: GV 150T Drill Bit Type: 86-101nm Diamond Borehole No: 101 Drill Rig Type: GV 150T Drille By: Justus Owino Depth: 25.00 m Dargent Depth of Ground Water: 13.13 m Inclination From Vertical: 0° ROCK CORE ROCK CORE Breeche No: 101 Rigged Rigg
Image of the second of the
Hill Rig Type: GY 150T Drilled By: Justus Owino Depth: 25.00 m parent Depth of Ground Water: 13.13 m Inclination From Vertical: 0* (i) (i) </td
parent Depth of Ground Water: 13.13 m Inclination From Vertical: 0* Image: Colspan="6">ROCK CORE Image: Colspan="6">Image: Colspan="6" Image:
ROCK CORE (II) (II) (II) (III)
13 2 13 14 3 PHONOLITE Firm, reddish brown clayey SLT with some saud and trace gravel. Has, low plasticity. VI I I I 19 2 15 66 20 3 Itsteps thinks one saud and trace gravel. Has, low plasticity. VI I RI >20 VP 20 15 66 20 3 Itsteps thinks Light grey, highly weathered, fine grained, moderately soft TRACHYTE. Characterised by open, rough and aregular fracture surfaces. IV 1 RI >20 VP 21 2 60 15 3 PHONOLITE Place Grey, fine grained, moderately weathered, and PHONOLITE. Characterised by both vertical and horizontal open fractures. III 3 RI >20 VP 23 2 60 15 3 PHONOLITE Place Grey, fine grained, moderately weathered, and PHONOLITE. Characterised by both vertical and horizontal open fractures. III 3 RI >20 VP 24 1 51 14 3 PHONOLITE Characterised by both vertical and horizontal open fractures. III 3 RI >20 VP
13 2 13 14 3 PHONOLITE Firm, reddish brown clayey SLT with some saud and trace gravel. Has, low plasticity. VI I I I 19 2 15 66 20 3 Itsteps thinks one saud and trace gravel. Has, low plasticity. VI I RI >20 VP 20 15 66 20 3 Itsteps thinks Light grey, highly weathered, fine grained, moderately soft TRACHYTE. Characterised by open, rough and aregular fracture surfaces. IV 1 RI >20 VP 21 2 60 15 3 PHONOLITE Place Grey, fine grained, moderately weathered, and PHONOLITE. Characterised by both vertical and horizontal open fractures. III 3 RI >20 VP 23 2 60 15 3 PHONOLITE Place Grey, fine grained, moderately weathered, and PHONOLITE. Characterised by both vertical and horizontal open fractures. III 3 RI >20 VP 24 1 51 14 3 PHONOLITE Characterised by both vertical and horizontal open fractures. III 3 RI >20 VP
- 23 - 24 1 51 14 3 PHONOLITE Pale Grey, fine grained, moderately weathered, hard PHONOLITE. Characterised by both vertical and horizontal open fractures. III 3 RI >20 VP
0.5 30 30 8 PHONOLITE Veathered, hard PHONOLITE. III 3 RI 0 P Characterised by both vertical and horizontal open fractures

PROJECT	DEVEL	OPMEN				TERR	ACONSULT	-	ELEVAT COORD (UTM-V		EN	0349110	_		
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		AL HOC	SLIG C	OR OR	110.4.	BOREHOLE LOG			No:			END 23/02/19			
File No	. 2 10	10				A 1000 00 00				CONTRACT NAME	an all the second				
Drilling	30	1997				By: Winnie				o: 102	ssa Isma	m			
Drill Ri		_				Type: 00-J By: Justus	01mm Diamond		h: 25		-				
Apparen				Vater:	14.10 m	y. Justus	owino	-			Vertical	0°			
-			ROCK		14.10 Ш			-	Inclination From Vertical: 0°						
Depth (m)	Run (m)	TCR (%)	RQD (%)	RMR (RQD)	GRAPHIC LOG	MATER	IAL DESCRIPTION	Weathering Grade	RMR (Weathering Grade)	Fracture Asperities	Fracture Frequency	Rock Mass Quality	SPT (N-Value)		
- - - - - 1 -	1.5				CLAYEV SILT	clayey S	ff, dark reddish brown ILT with some sand and of gravel. Has medium plasticity.	vī							
2 2 3	1.5				CLAVEY SILT	clayey S	ff, dark reddish brown ILT with some sand and of gravel. Has medium plasticity.	VI					9		
3 4 4	1.5				CLAYEY SILT	SILT with	ff, reddish brown clayey 1 some sand and traces of Has medium plasticity.	vī					10		
- - 5 - -	1.5				CLAYEY SILT	Dry, stiff, reddish brown to dark brown clayey SILT with some sand and traces of gravel. Is slightly plasticity.		VI					13		
— 6 -													12		
- - - 7 -	1.5	27	0	3	TRACHYTE	Light grey, highly weathered, fine grained, relatively soft TRACHYTE. Characterised by open, rough and irregular fracture surfaces. Rubbled.		IV	1	RI	RUB BLE D	VP			
_					and the second								9		
8 	2	34	0	3	TRACAVIE	non-vesi highly fi TRACHY vertica	Grey, fine grained, cular, highly weathered, ractured, relatively soft TE. Characterised by both al and horizontal open actures. Rubbled.	īV	1	RI	RUB BLE D	VP			
II: Sh III: M IV: Hi V: Ce	HERIN esh & H ightly W oderatel ghly W ompletel ssidual/S	lard /eathere y Weatl eathered y Weatl	ed hered 1	RI:	ACTURE ASPE Rough and Irreg Rough and Und	ular	ROCK MASS QU E: Excellent G: Good Fa: Fair P: Poor VP: Very Poor	ALITY	R	QD: Ro MR: Ro	tal Core ock Quali ock Mass eniawski	ity Desig Rating	nation		

ROJECT	DEVEL	OPMEN			XED		TERR	ACONSULT	-	ELEVAT	INATES	E	034911	_
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							BOREH	IOLE LOG	-		of			
File No:	5						By: Winnie					ssa Isma	nil	
Drilling								01mm Diamond	-		o: 102			
		GY 1				rilled B	y: Justus	Owino	-	h: 25				
pparen	t Deptl				14.10 m	1	-		-	nation	From V	ertical:	0°	
Depth (m)	Run (m)	TCR (%)	RQD (%)	CORE ((D))	GRAP		MATER	IAL DESCRIPTION	Weathering Grade	RMR (Weathering Grade)	Fracture Asperities	Fracture Frequency	Rock Mass Quality	SPT (N-Value)
- 10 - 11 - 12	3.5				TRACE	No. A	non-vesic highly fr TRACHYT vertica	Grey, fine grained, ular, highly weathered, actured, relatively soft E. Characterised by both I and horizontal open ompletely decomposed to soil.	IV	1	RI	DEC OMP OSE D	VP	
- 13 - 14 - 15	2	35	0	3	TRACH	NTE.	non-vesic highly fr TRACHYT vertica	Grey, fine grained, ular, highly weathered, actured, relatively soft (E. Characterised by both 1 and horizontal open actures. Rubbled.	IV	1	RI	RUB BLE D	VP	
- 16	2	23	0	3	HRACH	NIE .	non-vesic highly fr TRACHYT vertica	Grey, fine grained, ular, highly weathered, actured, relatively soft TE. Characterised by both I and horizontal open actures. Cobbled.	IV	1	RI	COB BLE D	VP	
- 17 - 18 - 19 -						gnation								

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					BOREI	IOLE LOG	Shee	t No:	of	100000		
3-19-	10			Log	ged By: Winnie	Munene	-			ssa Isma	nil	
Ietho	d: Rota	ary					_					
Type	GY 1	50T					Dept	h: 25	.00 m			
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Run (m)	TCR (%)	RQD (%)	RMR (RQD)	GRAPHI LOG	C MATER	IAL DESCRIPTION	Weathen Grade	RMR Weathering G	Fractur Asperiti	Fractua Frequen	Rock M Qualit	TAS
2	30	0	3	TRACHY	TRACHY	E. Characterised by both l and horizontal open	IV	Ī	RI	BLE D	VP	
2	25	0	3	IRACHY	III Inon-vesi highly fi TRACHY vertica	cular, highly weathered, actured, relatively soft IE. Characterised by both I and horizontal open	IV	1	RI	RUB BLE D	VP	1
1.5	66	0	3	PHONOLI	non-vesicul highly fract Character	ar, moderately weathered, ured, hard PHONOLITE. ised by both vertical and	ш	3	RI	RUB BLE D	VP	e E
1.5	30	0	3	PHONOLI	Weathered PHONOLI	l, highly fractured, hard TE. Characterised by both	ш	3	RI	RUB BLE D	VP	
1	28	10	3	PHONOLT	modera fracture Character	tely weathered, highly d, hard PHONOLITE. ised by both vertical and	ш	3	RI	>20	VP	
	Image: Apple of the second system Image: Apple of the second system <td>Image: Control of Contro</td> <td>Idethod: Rotary Type: GY 150T ROCK Image: Colspan="2">ROCK Image: Colspan="2">Image: Colspan="2" Image: Colspan="2" Image:</td> <td>Internal Rotary Type: GY 150T ROCK CORE Image: Colspan="3">ROCK CORE Image: Colspan="3">Image: Colspan="3" Image: Colspan="3" Image:</td> <td>Image: Image: Image:</td> <td>Degree By: Winner Degree By: Winner Drill Bit Type: 86-1 Drilled By: Justus Depth of Ground Water: 14.10 m ROCK CORE Image: Second Second</td> <td>Designed Dy Printer Architect Depth of Ground Water: 14.10 m ROCK CORE MATERIAL DESCRIPTION Image: Dy Image: Dy Matterial and horizontal open fractures, cobbled. Image: Dy <thimage: dy<="" th=""> <thimage: dy<="" th=""></thimage:></thimage:></td> <td>Intervention of Ground Water: Intervention of Ground Water: 14.10 m Incli ROCK CORE Image: GY 150 Optille By: Justus Owino Depth of Ground Water: 14.10 m Incli ROCK CORE MATERIAL DESCRIPTION Depth of Ground Water: 14.10 m Incli 2 30 0 3 (Fig. GRAPHIC LOG MATERIAL DESCRIPTION Depth of Ground Water: 14.446411112 2 30 0 3 (Fig. GRAPHIC LOG MATERIAL DESCRIPTION Depth of Ground Water: Intel Material Anterval Anterial Description 2 30 0 3 (Fig. GRAPHIC LOG MATERIAL DESCRIPTION Depth of Ground Water: Intel Material Description 2 30 0 3 (Fig. GRAPHIC LOG Log Intel KACEIVIE Intel KacEIVIE Material Anterval A</td> <td>Interface of a state of the state of the</td> <td>Itehod: Rotary Drill Bit Type: 86-101mm Diamond Borehole No: 102 Type: GY 150T Drille Bit Type: 86-101mm Diamond Depth: 25.00 m ROCK CORE Image: Stress of the stress of th</td> <td>Itethod: Rotary Drill Bit Type: 86-101mm Diamond Borehole No: 102 Type: GY 150T Drilled By: Justus Owino Depth: 25.00 m Depth GC CORE Inclination From Vertical: Inclination From Vertical: Inclination From Vertical: 2 30 0 3 IstMeliviti MATERIAL DESCRIPTION Iv 1 RI BLE 2 30 0 3 IstMeliviti Inclination From Vertical: Iv 1 RI BLE 2 30 0 3 IstMeliviti Inclination from Vertical: Iv 1 RI BLE 2 25 0 3 IstMeliviti Inclinational open fractures, Cobbled. Iv 1 RI BLE 1 25 0 3 Inclination From Vertical: Iv 1 RI BLE 1 25 0 3 Inclination From Vertical: Iv 1 RI BLE 1 25 0 3 Inclination From Vertical: Iv 1 RI BLE 1 25 0 3 Inclination From Vertical: Iv 1 RI BLE 15</td> <td>Iethod: Rotary Drill Bit Type: 86-101mm Diamond Borehole No: 102 Type: GY 150T Drilled By: Justus Owino Depth: 2.500 m Depth of Ground Water: 14.10 m Inclination From Vertical: 0* Image: Strategy of Ground Water: 14.10 m Inclination From Vertical: 0* Image: Strategy of Ground Water: 14.10 m MATERIAL DESCRIPTION Image: Strategy of Ground Water: 14.10 m MATERIAL DESCRIPTION Image: Strategy of Ground Water: 14.10 m MATERIAL DESCRIPTION Image: Strategy of Ground Water: 14.10 m MATERIAL DESCRIPTION Image: Strategy of Ground Water: 14.10 m MATERIAL DESCRIPTION Image: Strategy of Ground Water: 14.10 m MATERIAL DESCRIPTION Image: Strategy of Ground Water: 14.10 m MATERIAL DESCRIPTION Image: Strategy of Ground Water: 14.10 m MATERIAL DESCRIPTION Image: Strategy of Ground Water: 14.10 m Image: Strategy of Ground Water: 14.10 m Image: Strategy of Ground Water: 14.10 m Image: Strategy of Ground Water: 14.10 m Image: Strategy of Ground Water: 14.10 m Image: Strategy of Ground Water: 14.10 m Image: Strategy of Ground Water: 14.10 m Image: Strategy of Ground Water: 14.10 m Image: Strategy of Ground Water: 14.10 m Image: Strategy of Ground Water: 14.10 m Image: Strategy of Ground Water: 14.10 m Image: Strategy of Ground Watering Image: 14.10 m Image: Strategy o</td>	Image: Control of Contro	Idethod: Rotary Type: GY 150T ROCK Image: Colspan="2">ROCK Image: Colspan="2">Image: Colspan="2" Image:	Internal Rotary Type: GY 150T ROCK CORE Image: Colspan="3">ROCK CORE Image: Colspan="3">Image: Colspan="3" Image:	Image:	Degree By: Winner Degree By: Winner Drill Bit Type: 86-1 Drilled By: Justus Depth of Ground Water: 14.10 m ROCK CORE Image: Second	Designed Dy Printer Architect Depth of Ground Water: 14.10 m ROCK CORE MATERIAL DESCRIPTION Image: Dy Image: Dy Matterial and horizontal open fractures, cobbled. 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Depth (m)	Run (m)	(%)	KQD (%) UD3		APHIC	MATER	IAL DESCRIPTION	Weathering Grade	RMR (Weathering Grade)	Fracture Asperities	Fracture Frequency	Rock Mass Quality	SPT (N-Value)
Dej	Run	TCR	RQI	NN 1	LOG			We	I (Weath	As As	Field	Ro Ro	Ę
- - - - - 1 -	1.5				VEY SILT	SILT with	lark reddish brown clayey some sand and traces of Has medium plasticity.	vī		1			
2	1.5				VEY SILT	SILT with	m, reddish brown clayey 1 some sand and traces of Has medium plasticity.	VI					8
3 4 4	1.5			GLA	VEVSILT	SILT with	m, reddish brown clayey a some sand and traces of Has medium plasticity.	থা					12
- - - - - -	1.5				VEY SILT	SILT with	m, reddish brown clayey some sand and traces of Has medium plasticity.	থা					Refusal
6 7 	1.5			A. E. K	CHVTE	non-vesio relativ Character horiz	t Grey, fine grained, cular, highly weathered, ely soft TRACHYTE ised by both vertical and ontal open fractures. tely decomposed to soil.	IV	1	RI			
- - 8 - -	2				CHIVIE	non-vesio relativ Character horiz	t Grey, fine grained, ular, highly weathered, ely soft TRACHYTE. ised by both vertical and ontal open fractures. tely decomposed to soil.	IV	1	RI			
II: SI III: M IV: Hi V: Co	HERIN esh & H ightly W oderatel ighly W ompletel esidual/S	Iard Veathere ly Weat eathered ly Weat	ed hered 1	RI: Rougi	RE ASPE h and Irregu h and Und	ular	ROCK MASS QU E: Excellent G: Good Fa: Fair P: Poor VP: Very Poor	ALITY	R	QD: Ro MR: Ro	ck Qual	Recover ity Desig Rating i (1989)	nation

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Depth (m)	Run (m)	TCR (%)	RQD (%)	RMR (RQD)	GRAP LO		MATER	IAL DESCRIPTION	Weathering Grade	RMR (Weathering Grade)	Fracture Asperities	Fracture Frequency	Rock Mass Quality	SPT (N-Value)
- 10 - 10 - 11 - 11 - 12 - 12	2				TRACE	「「「」」、「」、	non-vesia relativ Character horiz Complet Ligh non-vesia relativ Character	t Grey, fine grained, ular, highly weathered, ely soft TRACHYTE. ised by both vertical and ontal open fractures. tely decomposed to soil.	IV	1	RI			
- 13 	1.5				HRACH	ANTE A	Complet Ligh non-vesic relativ Character horiz	t Grey, fine grained, ular, highly weathered, ely soft TRACHYTE. ised by both vertical and ontal open fractures. lely decomposed to soil.	IV	1	RI			
15 16 	1.5				IIRACE	IVIE	non-vesio relativ Character horiz	t Grey, fine grained, ular, highly weathered, ely soft TRACHYTE. ised by both vertical and ontal open fractures. lely decomposed to soil.	IV	1	RI			1
17 17 	2	50	25	3	PHONO	No. of Contraction of	weathere PHONOLI vertical and	ey, fine grained, highly d, highly fractured, hard TE. Characterised by both l horizontal open fractures.	IV	1	RI	>20	VP	
II: Shi III: Ma IV: Hi V: Co	esh & H ightly W oderatel ghly W	Iard /eathere ly Weatl eathered ly Weatl	ed hered 1	RI:	ACTURH Rough ar	nd Irregu	ılar	ROCK MASS QU E: Excellent G: Good Fa: Fair P: Poor VP: Very Poor		R	QD: Ro MR: Ro	tal Core ock Qual ock Mass eniawsk	ity Desig Rating	gnation

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â		_	ROCK	CORE	í i			e ung	Grade	re	ure	fass	
Depth (m)	Run (m)	TCR (%)	RQD (%)	RMR (RQD)	GRAPH LOG	IC MATER	IAL DESCRIPTION	Weathering Grade	RMR (Weathering Grade)	Fracture Asperities	Fracture Frequency	Rock Mass Quality	SPT
- 18					and and					20			2
19 20	2	50	10	3	PHONOL	weather Character	, fine grained, moderately ed, hard PHONOLITE. rised by both vertical and zontal open fractures.	ш	3	RI	>20	VP	
21	1	100	100	20	PHONOL	weather Character	, fine grained, moderately ed, hard PHONOLITE rised by both vertical and zontal open fractures.	ш	3	RI	E	100 A	
22	1.5	25	0	3	PHONOL	weather Character	, fine grained, moderately ed, hard PHONOLITE rised by both vertical and zontal open fractures.	ш	3	RI	>20	VP	
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- 24 - 25	2	25	0	3	PHONOL	weather Character	ed, hard PHONOLITE. rised by both vertical and	ш	3		RI	RI >20	RI >20 VP
i i	esh & H ightly W oderatel ghly W	Veathere ly Weath eathered ly Weath	ed hered 1	RI	Rough and	ASPERITIES Irregular d Undulating	ROCK MASS QU E: Excellent G: Good Fa: Fair P: Poor VP: Very Poor		R	QD: Ro MR: Ro	ck Qual	Recover ity Desig Rating i (1989)	natio

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Depth (m)	Run (m)	TCR (%)	RQD (%)	1000000	RAPHIC LOG	MATER	IAL DESCRIPTION	Weathering Grade	RMR (Weathering Grade)	Fracture Asperities	Fracture Frequency	Rock Mass Quality	SPT (N-Value)
- - - - - - 1 -	1.5			d	VYEY SILT	brown cla	m, fine grained, reddish yey SILT wth some sand s of gravel. Has medium plasticity.	3)					
2	1.5			1000	VEY SILT	brown cla	m, fine grained, reddish yey SILT wth some sand s of gravel. Has medium plasticity.	VI				5	7
3 4 4	1.5			and a	AVEY SILT	brown cla	m, fine grained, reddish yey SILT wth some sand s of gravel. Has medium plasticity.	থা					11
5	1.5			a	WEY SILT	brown cla	m, fine grained, reddish yey SILT wth some sand s of gravel. Has medium plasticity.	থা					
6 - - - - - - -	1.5			d	WEYSILT	brown clay	f, fine grained, reddish yey SILT with some sand s of gravel. Has medium plasticity.	থা					
- - - - -	1.5			家族な	WEY SLT	Firm, dry, Dark brownish clayey SILT with some sand and traces of VI gravel. Has medium plasticity.			6				
II: SI III: M IV: Hi V: Co	HERIN esh & H ightly W oderatel ghly W ompletel ssidual/S	lard /eathere y Weat eathered y Weat	ed hered 1	RI: Rou	URE ASPE gh and Irreg agh and Und	ular	ROCK MASS QU E: Excellent G: Good Fa: Fair P: Poor VP: Very Poor		R	QD: Ro MR: Ro	ck Qual	Recover ity Desig Rating i (1989)	nation

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		T	ROCK	COPE			r			nation	1	1 6000 ¹¹	[
Depth (m)	Run (m)	TCR (%)	RQD (%)	RMR (RQD)	GRAP LO		MATER	IAL DESCRIPTION	Weathering Grade	RMR (Weathering Grade)	Fracture Asperities	Fracture Frequency	Rock Mass Quality	SPT (N-Value)
— 9 — 10	1.5				CLAVES	y sut	SILT with	r, Dark brownish clayey some sand and traces of Has medium plasticity.	vī					3
- 11 - 12 - 13	3				CLAVE	ra v sut	SILT with	r, Dark brownish clayey some sand and traces of Has medium plasticity.	VI					
- 14 - 15 - 16	3	25	14	3	TRACE	AVIE	grained, p TRACHYI	v, highly weathered, fine orphyritic, relatively soft E. Characterised by open, megular fracture surfaces.	IV	1	RI	>20	VP	
- 17	1.5	33	0	3	TRACE		fine to co relative Character	grey, highly weathered, arse grained, porphyritic, sly soft TRACHYTE. ised by open, rough and lar fracture surfaces.	IV	1	RI	RUB BLE D	VP	4
I: Fro II: Shi III: Mo IV: Hi V: Co	1.5 33 0 3 ATHERING GRADES FRACT : Fresh & Hard RI: Roug : Slightly Weathered RU: Roug : Moderately Weathered RU: Roug : Completely Weathered Ruile Roug : Completely Weathered Residual/Soil					nd Irregu	ılar	ROCK MASS QU E: Excellent G: Good Fa: Fair P: Poor VP: Very Poor		R	QD: Ro MR: Ro	tal Core ock Quali ock Mass eniawski	ity Desig Rating	ination

DCATIO	DEVEL N:MER		T PHA	SE 1	TC		ACONSULT A LIMITED	-	ELEVAT COORDI (UTM-V DA	INATES	E N STAR END		-
						BOREI	IOLE LOG	Sheet	t No:	of	10000100		
ile No:	3-19-	10			Logged	By: Winnie	Munene	Chec	ked B	v: Dr. I	ssa Isma	ail	
rilling	Metho	d: Rota	iry				01mm Diamond			o: 104			
		GY 1				By: Justus		Dept	h: 25	.00 m			
									nation		vertical:	0°	
2		F	ROCK	CORE	<i>a:</i>			50	ade)	0.8	a 8	8	
Depth (m)	Run (m)	TCR (%)	RQD (%)	RMR (RQD)	GRAPHIC LOG	MATER	IAL DESCRIPTION	Weathering Grade	RMR (Weathering Grade)	Fracture Asperities	Fracture Frequency	Rock Mass Quality	SPT Of Using)
- 18 - 19	1.5	66	15	3	TRACHYTE	fine to co relative Character	grey, highly weathered, arse grained, porphyritic, ely soft TRACHYTE ised by open, rough and ular fracture surfaces.	IV	1	RI	>20	VP	2
20	1.5	80	75	17	TRACHYTE	fine to co relative Character	grey, highly weathered, arse grained, porphyritic, ely soft TRACHYTE. ised by open, rough and ilar fracture surfaces.	IV	1	RI	8	G	8
21	1.5	100	80	17	TRACHYTE	grained, p TRACHYT	rey, highly weathered, fine orphyritic, relatively soft E. Characterised by open, irregular fracture surfaces.	IV	1	RI	5	G	
23	1	80	65	13	PHONOLITE	weathere	fine grained, moderately ed, hard PHONOLITE. ised by both vertical and ontal open fractures.	ш	3	RI	7	Fa	
24	1.5	66	60	13	PHONOLITE	weather Character	fine grained, moderately ed, hard PHONOLITE. ised by both vertical and ontal open fractures.	ш	3	RI	7	Fa	
- 24 - 25	1.5	66	60	13	PHONOLITE	horiz Pale Grey, weathere Character	ontal open fractures. fine grained, moderately ed, hard PHONOLITE. ised by both vertical and	ш	3	RI	7	Fa	

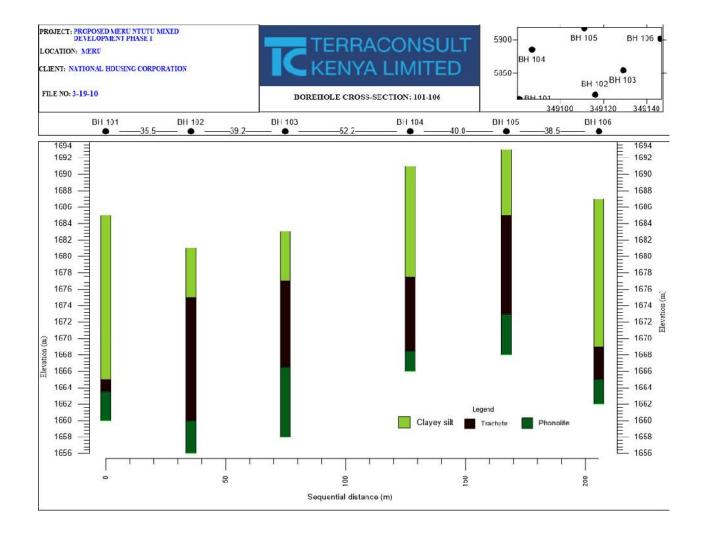
PROJECT				UTU MIXED				-		TON (m)		1693	1 700
OCATIC	DEVEI DN:MERI	LOPMEN	T PHAS	SE 1			ACONSULT		(UTM-V	INATES VGS84)	E N	034911	-
			SING C	ORPORATIO	N. IC	KENY	A LIMITED		DA	TE(S)	STAR END	T 10	N02/19 N02/19
						BOREI	HOLE LOG	Sheet	t No:	l of	3		
File No	: 3-19-	10			Logged 1	By: Winnie	Munene	Chec	ked B	y: Dr. I	ssa Isma	nil	
Drilling	g Metho	d: Rota	iry		Drill Bit	Type: 86-1	01mm Diamond	Bore	hole N	o: 105			
Drill Ri	ig Type:	: GY 1	50T		Drilled H	By: Justus	Owino	Dept	h: 25	.00 m			
Apparen	nt Depth	1 of Gro	ound W	ater: 13.3	0 m	200		Incli		From V	ertical:	0°	
B		1	ROCK (CORE				ting le	R Grade)	ire	ure	Aass ity	(en
Depth (m)	Run (m)	TCR (%)	RQD (%)	RMR (RQD)	RAPHIC LOG	MATER	IAL DESCRIPTION	Weathering Grade	RMR (Weathering Grade)	Fracture Asperities	Fracture Frequency	Rock Mass Quality	SPT (N-Value)
0 - - - - - -	1.5			d	AVEVSET	reddish b some sand	fine grained, stiff dark rown clayey SILT with and traces of gravel. Has aedium plasticity.	থা			5		
2	1.5			a start	ALEY SILT	reddish b some sand	fine grained, stiff dark brown clayey SILT with and traces of gravel. Has nedium plasticity.	থা					9
3 4 4	1.5			14	AVEYSILT	reddish b some sand	fine grained, stiff dark prown clayey SILT with and traces of gravel. Has nedium plasticity.	VI		6-14 (mmm 8-2	(1		10
- - 5 - - -	1.5			d	AVEY SILT	reddish b some sand	fine grained, stiff dark rown clayey SILT with and traces of gravel. Has aedium plasticity.	থা					13
6 7 7 7 7 7 7	2			J.	ATEXSIT	with some	ldish brown clayey SILT e sand and trace gravels. : medium plasticity.	VI					
- - - - - 9 -	1.5	30	0	A H THE A	RACHVIE	non-vesio relativ Character horiz	Brown, fine grained, cular, highly weathered, ely soft TRACHYTE. ised by both vertical and ontal open fractures. tely decomposed to soil.	IV	1	RI	RUB BLE D	VP	
II: Sh III: M IV: Hi V: Co	HERIN esh & H ightly W oderatel ghly W ompletel esidual/S	lard /eathere ly Weatl eathered ly Weatl	ed hered 1	RI: Rou	TURE ASPE ogh and Irreg ugh and Und	ular	ROCK MASS QU E: Excellent G: Good Fa: Fair P: Poor VP: Very Poor	ALITY	R	QD: Ro MR: Ro	tal Core ock Quali ock Mass eniawski	ity Desig Rating	gnation

PROJECT LOCATIO CLIENT: 1	DEVEL N:MER	LOPMEN U.	NT PHAS	SE 1		C		ACONSULT A LIMITED	-	ELEVAT COORDI (UTM-V DA	INATES	E N STAR END		-
	10000		0.000.00				BORFI	IOLE LOG	Sheet	Net	of			
File No:	. 1 10	10				and R	A. 10157.55 425		-		Part Note	ssa Isma	a	
Drilling	10 A 10 T 100	1997	1111				By: Winnie	01mm Diamond			0: 105	354 15111	in .	
Drill Ri							y: Justus			h: 25				
		100 H 14 C 14	10 10 10 10 10 10 10 10 10 10 10 10 10 1	ater	13.30 m	riffed D	Justus	Owino	-			ertical:	00	
100	Depu		ROCK		10.00 11	-				action Cal		1 CO24	Concerne and Concerne and	
Depth (m)	Run (m)	TCR (%)	RQD (%)	RMR (RQD)	GRAPI LOC		MATER	IAL DESCRIPTION	Weathering Grade	RMR (Weathering Grade)	Fracture Asperities	Fracture Frequency	Rock Mass Quality	SPT (N-Value)
10 10 	1.5	25	0		TRACH	HE C	non-vesio relativo Character	Brown, fine grained, ular, highly weathered, ely soft TRACHYTE. ised by both vertical and ontal open fractures.	IV	1	RI	RUB BLE D	VP	
11 12 12	1.5	36	0		IRACH	STE C	non-vesio relativo Character	Brown, fine grained, ular, highly weathered, ly soft TRACHYTE ised by both vertical and open fractures. Rubbled.	IV	1	RI	RUB BLE D	VP	
- - 13 - - - - - 14	1.5	21	0		IRACH	YIE	non-vesio relativo Character	Brown, fine grained, ular, highly weathered, ly soft TRACHYTE. ised by both vertical and open fractures. Rubbled.	IV	1	RI	RUB BLE D	VP	
14 15 	1.5	30	0		TRACH	よ 世	non-vesio relativo Character	Brown, fine grained, ular, highly weathered, ely soft TRACHYTE. ised by both vertical and open fractures. Rubbled.	IV	1	RI	RUB BLE D	VP	6
- 	1.5	36	0		TRACH	A A	non-vesio relativo Character	Brown, fine grained, ular, highly weathered, ely soft TRACHYTE. ised by both vertical and open fractures. Rubbled.	IV	1	RI	RUB BLE D	VP	3
1/ 18 18	1.5	24	0		TRACH	VIE VIE	non-vesio relativo Character	Brown, fine grained, ular, highly weathered, ily soft TRACHYTE. ised by both vertical and open fractures. Rubbled.	IV	1	RI	RUB BLE D	VP	
- - 19						E P	T ight	Brown, fine grained,						
WEATI I: Fre II: Shi III: Ma IV: Hi V: Co	resh & Hard RI: Ro					ASPE d Irregu nd Undu	RITIES dar	ROCK MASS QU E: Excellent G: Good Fa: Fair P: Poor VP: Very Poor	ALITY	R	QD: Ro MR: Ro	tal Core ck Quali ock Mass eniawski	ity Desig Rating	nation

PROJECT				UTU MIXED				-	ELEVAT			1687	
LOCATIO		OPMEN	T PHAS	SE 1			ACONSULT		(UTM-V		E N	034914	
			SING C	ORPORATION	IC	KENY	A LIMITED			TE(S)	STAR END	.T 10	/02/19 /02/19
57 55						BOREI	HOLE LOG	Sheet	No:	of	3		
File No:	: 3-19-	10			Logged 1	By: Winnie	Munene	Chec	ked By	r: Dr. I	ssa Isma	nil	
Drilling	Metho	d: Rota	nry				01mm Diamond	Bore	hole N	o: 106			
Drill Ri	g Type:	GY 1	50T			By: Justus		Dept	h: 25	.00 m			
Apparen	t Depth	of Gro	ound W	ater: 13.14	m			Incli	nation	From V	ertical:	0°	
0		F	ROCK	CORE				50	ade)	a 91	. 2	82	-
Depth (m)	Run (m)	TCR (%)	RQD (%)		APHIC LOG	MATER	IAL DESCRIPTION	Weathering Grade	RMR (Weathering Grade)	Fracture Asperities	Fracture Frequency	Rock Mass Quality	SPT (N-Value)
1	1.5			cLA	VEV SILT	brown, cla	iff, fine grained, reddish yey SILT with some sand s of gravel. Has medium plasticity.	VI					
2	1.5			CIA	YEY SILT	brown, cla	iff, fine grained, reddish yey SILT with some sand s of gravel. Has medium plasticity.	VI					10
3 4 4	1.5			CLA	YEY SILT	brown, cla	iff, fine grained, reddish yey SILT with some sand s of gravel. Has medium plasticity.	থা				12	
5 5 	1.5			CLA	YEY SILT	brown to re with some	iff, fine grained, darkish kldish brown, clayey SILT sand and traces of gravel medium plasticity.	VI					
6 7 7	1.5			CLA	YEY SILT	brown to re with some	iff, fine grained, darkish eddish brown, clayey SILT sand and traces of gravel medium plasticity.	VI					15
	1.5			ctA	VEV SILT	brown to re with some	iff, fine grained, darkish eddish brown, clayey SILT sand and traces of gravel medium plasticity.	vī					16
II: Shi III: Ma IV: Hi V: Co	HERIN esh & H ightly W oderatel ghly W mpletel sidual/S	lard /eathere y Weatl eathered y Weatl	ed hered 1	RI: Roug	J <u>RE ASPE</u> h and Irreg gh and Und	ular	ROCK MASS QU E: Excellent G: Good Fa: Fair P: Poor VP: Very Poor	ALITY	R	QD: Ro MR: Ro	ck Qual	Recover ity Desig Rating i (1989)	nation

PROJECT: PROPOSED MERU NTUTU MIXED DEVELOPMENT PHASE 1 LOCATION:MERU. CLIENT: NATIONAL HOUSING CORPORATION.						TERRACONSULT KENYA LIMITED			ELEVATION (m) COORDINATES (UTM-WGS84) DATE(S)			I687 E 0349146 Z0 N 0005902 3 START 10/02/19 3			
CLIENT	AHON	AL HOU	SINGC	ORFOR	anos.		HOLE LOG	Sheet			END	23	/02/19		
File No:	3.10	10			1	Logged By: Winnie Munene			Sheet No: 2 of 3 Checked By: Dr. Issa Ismail						
Drilling	10.00000000		1.1-17			Drill Bit Type: 86-101mm Diamond			Borehole No: 106						
Drill Ri						Drilled By: Justus Owino			Depth: 25.00 m						
Apparen				ator		med by: Justu	s Owino		A.A. 10		Intical	00			
rpparen	Depu		ROCK		13.14 11			Inclination From Vertical: 0°							
Depth (m)	Run (m)	TCR (%)	RQD (%)	RMR (RQD)	GRAPH LOG		LIAL DESCRIPTION	Weathering Grade	RMR (Weathering Grade)	Fracture Asperities	Fracture Frequency	Rock Mass Quality	SPT (N-Value)		
9 	1.5				CLAVEV S	SILT wit	: brown to blackish clayey h some sand and traces of Has medium plasticity.	vī				,	13		
- - - - - - - - 12	1.5				CLAVEY S	SILT wit	: brown to blackish clayey h some sand and traces of Has medium plasticity.	VI					13		
13 14 15	3				CLAVEY S	SILT MI SILT wit	: brown to blackish clayey h some sand and traces of Has medium plasticity.	VI					26		
- - - - - - - - - - - - - - - - - - -	3				CLAVEY S	SILT M SILT wit	; brown to blackish clayey h some sand and traces of Has medium plasticity.	VI							
I: Fre II: Shi III: Me IV: Hi V: Co	I: Fresh & Hard RI: Roug			Rough and	ASPERITIES Irregular I Undulating	E: Excellent			TCR: Total Core Recovery Ratio RQD: Rock Quality Designation RMR: Rock Mass Rating after Bieniawski (1989)						

MERI	LOPMEN		UTU MI: SE 1	XED	TERRACONSULT KENYA LIMITED			ELEVATION (m) COORDINATES (UTM-WGS84) DATE(S)			I687 E 0349146 N 0005902 START 10/02/1		
ATION	AL HOU	SING C	ORPOR.	ATION.								k/02/19 k/02/19	
					BOREI	HOLE LOG	Shee	t No: 3	d of	3			
3-19-	-10			Logge	d By: Winnie	Munene					nil		
Metho	d: Rota	ary											
					d By: Justus	Owino	Dept	h: 25	.00 m				
Depth				13.14 m			Inclination From Vertical: 0°						
							ass y						
Run (m)	TCR (%)	RQD (%)	RMR (RQD)	GRAPHIC LOG	C MATER	IAL DESCRIPTION	Weatheri Grade	RMR Weathering Gr	Fracture Asperitie	Fractur	Rock Ma Quality	SPT	
4	40	0		TRACHVIE	grained, p TRACHYT	orphyritic, relatively soft E. Characterised by open,	IV	1	RI	RUB BLE D	VP		
2	47	20		PHONOLITE	weather Character	Pale Grey, fine grained, moderately weathered, hard PHONOLITE. Characterised by both vertical and horizontal open fractures.		3	RI	>20	VP		
1	70	40		PHONOLITE	weather Character	Pale Grey, fine grained, moderately weathered, hard PHONOLITE. Characterised by both vertical and horizontal open fractures.		3	RI	9	Р		
	4 4 4 4 4 4 4	Method: Rot: Type: GY I Depth of Gro I II III III IIII IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	Method: Rotary Type: GY 150T ROCK (ii) (iv) (iv) (iii) (iv) (iv) (iv) (iv) (iv) (iv) (iv) (iv)	Method: Rotary Type: GY 150T ROCK CORE (0) (0) (0) (1)	Double Drill H Type: GY 150T Drill H ROCK CORE (II) (II) (III) (IIII) (IIIIIIIII) (IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	Independent of Cround Water: 13.14 m Prilled By: Justus Drilled By: Justus Original Bit Type: 86-1 Origin Bit Type: 86-1 <th cols<="" td=""><td>Method: Rotary Drill Bit Type: S6-101mm Diamond Type: GY 150T Drill Bit Type: S6-101mm Diamond Depth of Ground Water: 13.14 m ROCK CORE MATERIAL DESCRIPTION IIII IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII</td><td>Index Opt. International Distribution of Distribution Distrestrest Distribution Distr.</td><td>Method: Rotary Drill Bit Type: S6-101mm Diamond Borehole N Type: GY 150T Drill Bit Type: S6-101mm Diamond Borehole N ROCK CORE Image: Sector Colspan="2">Intermediate Sector Colspan="2">Intermediate Sector Colspan="2">Sector Colspa</td><td>Diage Up / Mathematical program in the program in th</td><td>Method: Rotary Drille Bit Type: \$6-101mm Diamond Borehole No: 106 Type: GY 150T Drilled By: Justus Owino Depth: 25.00 m Inclination From Vertical: Rock CORE Surger of graph of Ground Water: 13.14 m Inclination From Vertical: ROCK CORE Surger of graph of Ground Water: 13.14 m Inclination From Vertical: ROCK CORE Surger of graph of Ground Water: 13.14 m Inclination From Vertical: ROCK CORE Surger of graph of Ground Water: 13.14 m Inclination From Vertical: MATERIAL DESCRIPTION Surger of graph of</td><td>Method: Rotary Drilled By: Type: 86-101mm Diamond Borehole No: 106 Type: GY 150T Drilled By: Justus Owino Depth: 25.00 m Inclination From Vertical: 0* Rock CORE Image: State State</td></th>	<td>Method: Rotary Drill Bit Type: S6-101mm Diamond Type: GY 150T Drill Bit Type: S6-101mm Diamond Depth of Ground Water: 13.14 m ROCK CORE MATERIAL DESCRIPTION IIII IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII</td> <td>Index Opt. International Distribution of Distribution Distrestrest Distribution Distr.</td> <td>Method: Rotary Drill Bit Type: S6-101mm Diamond Borehole N Type: GY 150T Drill Bit Type: S6-101mm Diamond Borehole N ROCK CORE Image: Sector Colspan="2">Intermediate Sector Colspan="2">Intermediate Sector Colspan="2">Sector Colspa</td> <td>Diage Up / Mathematical program in the program in th</td> <td>Method: Rotary Drille Bit Type: \$6-101mm Diamond Borehole No: 106 Type: GY 150T Drilled By: Justus Owino Depth: 25.00 m Inclination From Vertical: Rock CORE Surger of graph of Ground Water: 13.14 m Inclination From Vertical: ROCK CORE Surger of graph of Ground Water: 13.14 m Inclination From Vertical: ROCK CORE Surger of graph of Ground Water: 13.14 m Inclination From Vertical: ROCK CORE Surger of graph of Ground Water: 13.14 m Inclination From Vertical: MATERIAL DESCRIPTION Surger of graph of</td> <td>Method: Rotary Drilled By: Type: 86-101mm Diamond Borehole No: 106 Type: GY 150T Drilled By: Justus Owino Depth: 25.00 m Inclination From Vertical: 0* Rock CORE Image: State State</td>	Method: Rotary Drill Bit Type: S6-101mm Diamond Type: GY 150T Drill Bit Type: S6-101mm Diamond Depth of Ground Water: 13.14 m ROCK CORE MATERIAL DESCRIPTION IIII IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	Index Opt. International Distribution of Distribution Distrestrest Distribution Distr.	Method: Rotary Drill Bit Type: S6-101mm Diamond Borehole N Type: GY 150T Drill Bit Type: S6-101mm Diamond Borehole N ROCK CORE Image: Sector Colspan="2">Intermediate Sector Colspan="2">Intermediate Sector Colspan="2">Sector Colspa	Diage Up / Mathematical program in the program in th	Method: Rotary Drille Bit Type: \$6-101mm Diamond Borehole No: 106 Type: GY 150T Drilled By: Justus Owino Depth: 25.00 m Inclination From Vertical: Rock CORE Surger of graph of Ground Water: 13.14 m Inclination From Vertical: ROCK CORE Surger of graph of Ground Water: 13.14 m Inclination From Vertical: ROCK CORE Surger of graph of Ground Water: 13.14 m Inclination From Vertical: ROCK CORE Surger of graph of Ground Water: 13.14 m Inclination From Vertical: MATERIAL DESCRIPTION Surger of graph of	Method: Rotary Drilled By: Type: 86-101mm Diamond Borehole No: 106 Type: GY 150T Drilled By: Justus Owino Depth: 25.00 m Inclination From Vertical: 0* Rock CORE Image: State



8. APPENDIX B-Sample Photographs

Typical U100 (undisturbed) Samples





Borehole 101: 1.00-1.50m





Borehole 102: 3.00-3.50m





Borehole 103: 5.50-6.00m





Borehole 106: 8.50-9.00m



Borehole 101: 20.00-25.00m



Borehole 102: 6.00-25.00m



Borehole 103: 6.00-18.50m



Borehole 103: 18.50-25.00m



Borehole 104: 13.50-23.50m



Borehole 104: 23.50-25.00m



Borehole 105: 8.00-20.00m



Borehole 105: 20.00-25.50m



Borehole 106: 18.00-24.50m



Borehole 101: 20.00-25.00m



Borehole 102: 6.00-25.00m



Borehole 103: 6.00-18.50m



Borehole 103: 18.50-25.00m



Borehole 104: 13.50-23.50m



Borehole 104: 23.50-25.00m



Borehole 105: 6.00-20.00m



Borehole 105: 20.00-25.50m

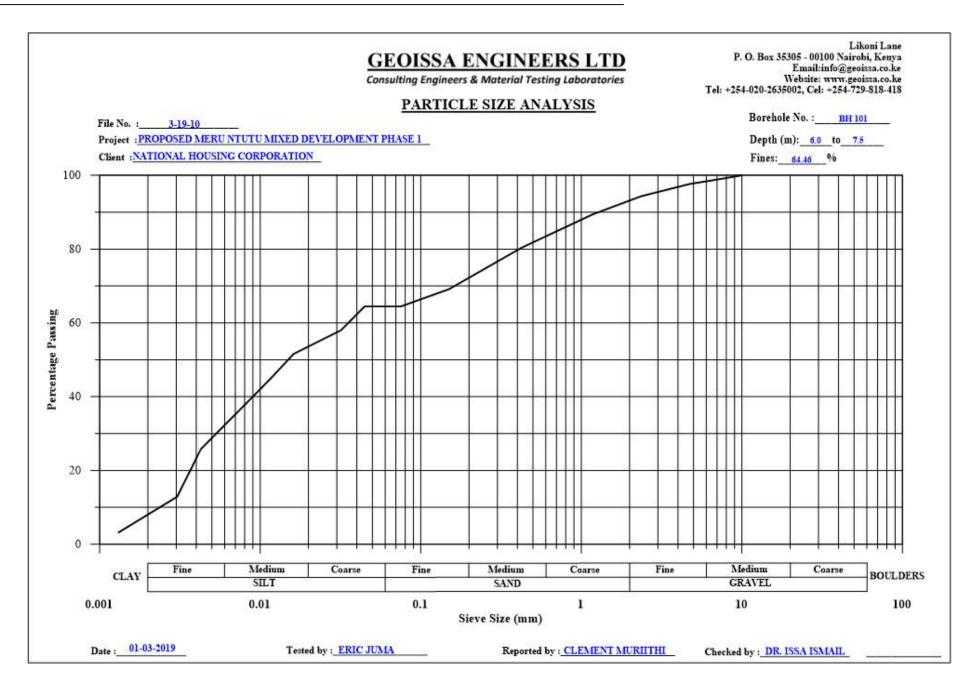


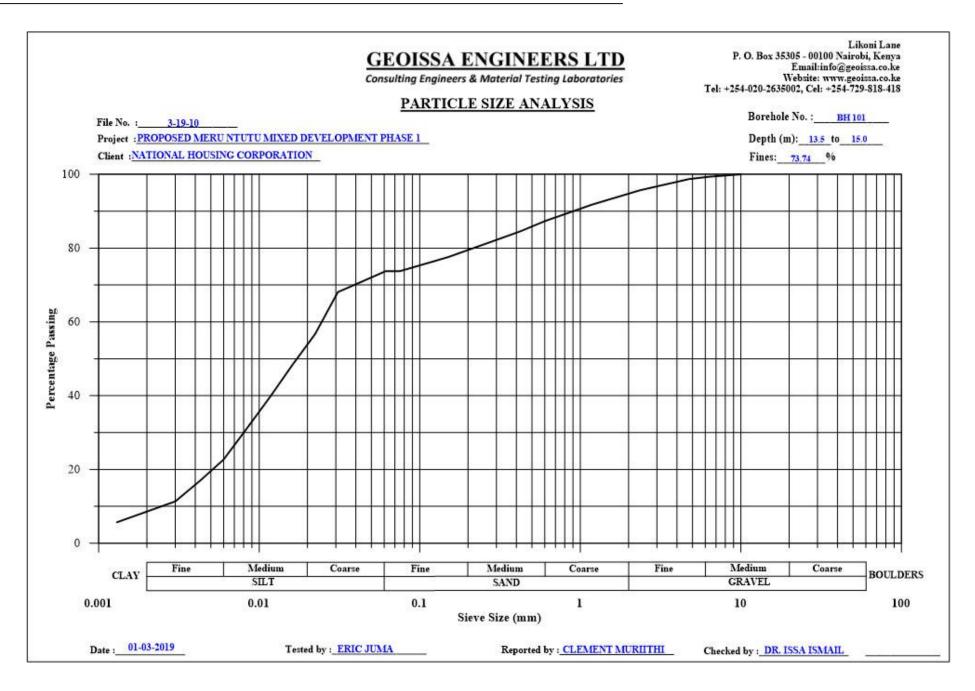
Borehole 106: 18.00-24.50m

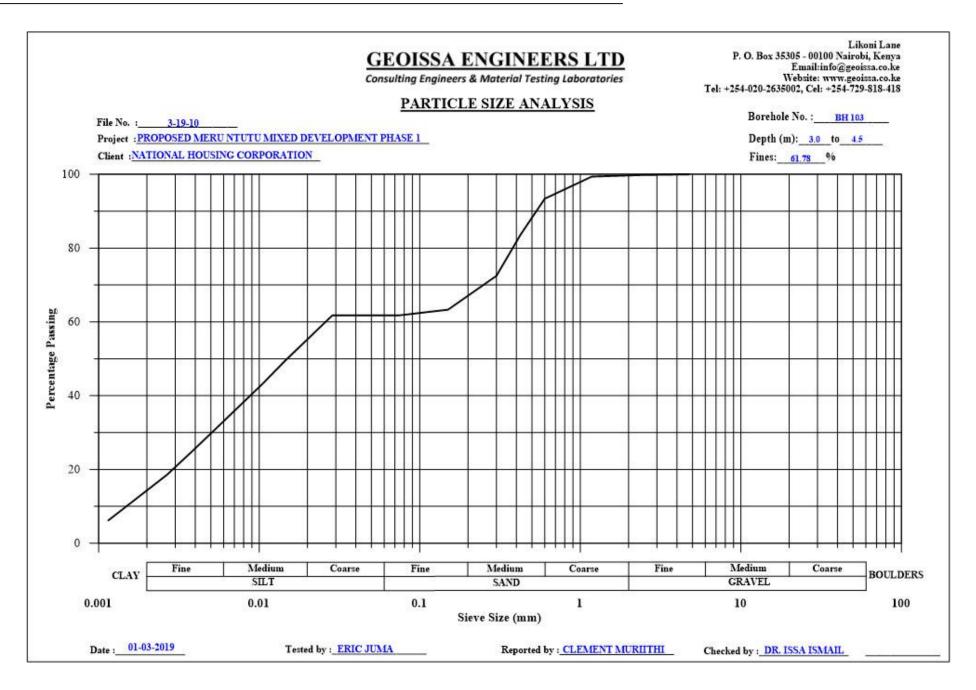


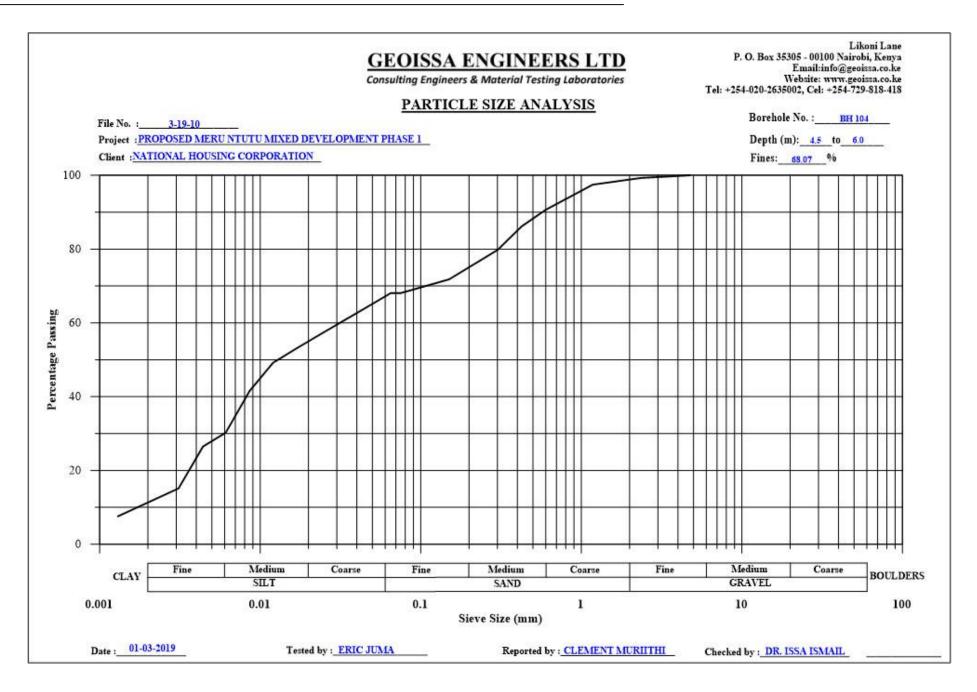
Figure B-1 Topographic map indicating site location

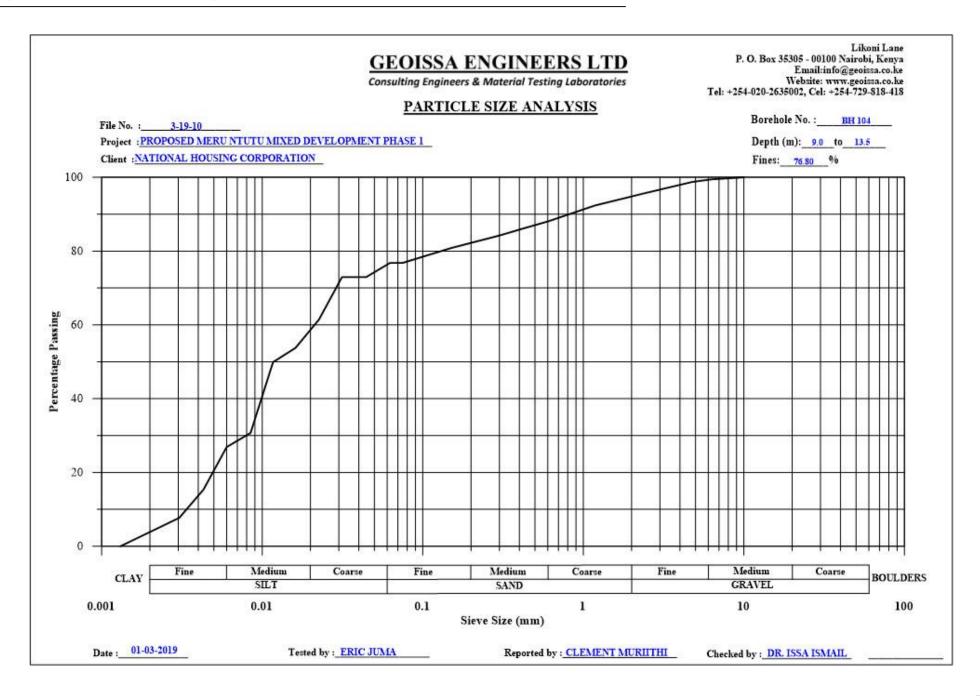
9. APPENDIX C- Laboratory Results

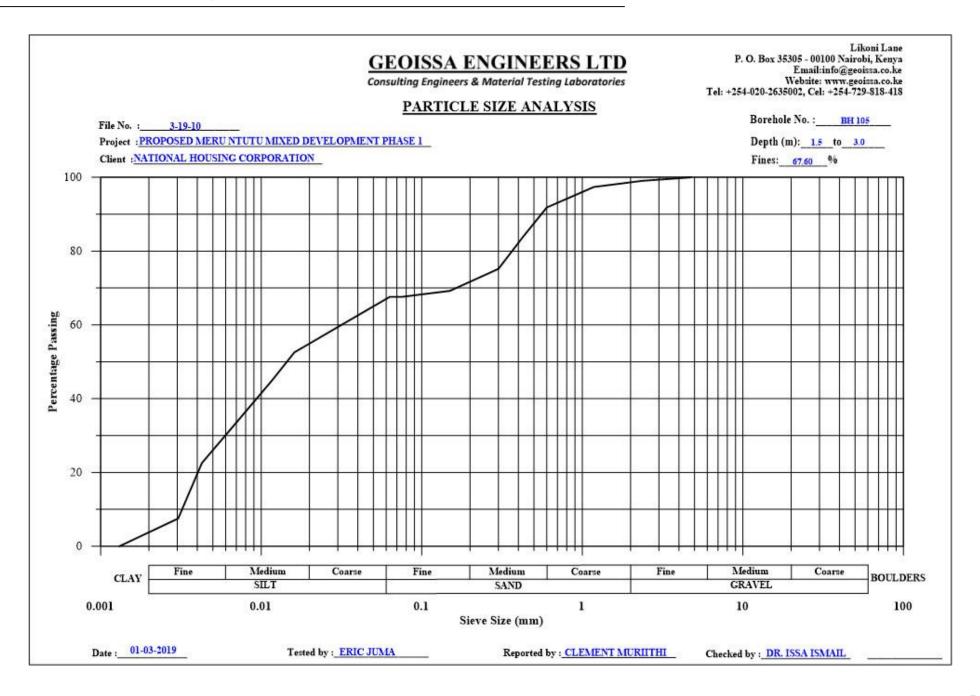


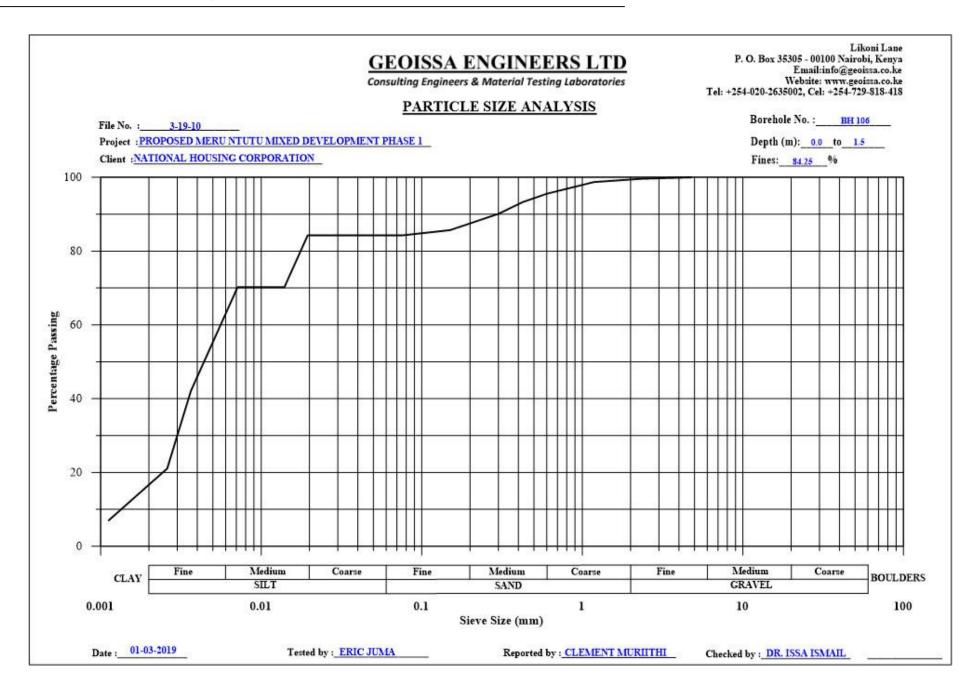


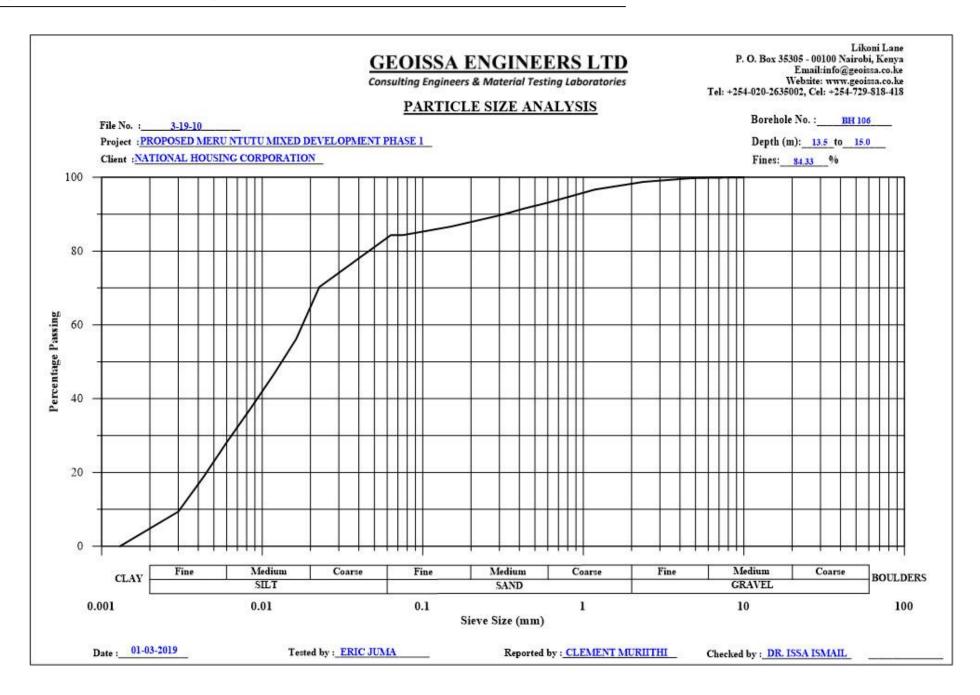












Consulting Engineers & Material Testing Laboratories

Likoni Lane P. O. Box 35035 - 00100 Nairobi, Kenya Emailinfy@geoissa.co.ke Website: www.geoissa.co.ke Tel: +254-020-2635002, Cel: +254-729-818-418

Date tested: 27-Feb-2019

LIQUID LIMIT (CONE PENETROMETER) AND PLASTIC LIMIT TEST RESULTS

Client: Project:

<u>NATIONAL HOUSING CORPORATION</u> <u>PROPOSED MERU NTUTU DEVELOPMENT PHASE 1</u> <u>BH 101 (6.0-7.5)M</u>

Test Method: BS1377-2: 1990

Sample Description :

LIQUID LIMIT				
TEST NUMBER	1	2	3	4
Cone penetration (mm)	19.95	21.16	23.18	
Container No.	н	T2	М	
Container weight (gm)	14.2	14.2	14.5	
Wet soil + container (gm)	65.2	62.4	66.5	
Wet soil (gm). W_w	51.0	48.2	52.0	
Dry soil + container (gm)	48.5	46.3	49.0	
Dry soil (gm), W_d	34.3	32.1	34.6	
Moisture loss (gm), W_w - W_d	16.7	16.1	17.5	
Moisture content (%), $(W_w - W_d)/W_d$	48.72	50.19	50.52	

PLASTIC LIMIT:

TEST NUMBER	1	2
Container No.	B8	Т8
Container weight (gm)	14.3	14.4
Wet soil + container (gm)	43.9	39.6
Wet soil (gm), Ww	29.6	25.2
Dry soil + container (gm)	35.2	32.1
Dry soil (gm), Wd	20.9	17.8
Moisture loss (gm), Ww - Wd	8.7	7.5
Moisture content (%), (Ww - Wd)/Wd	41.8	41.9
Average moisture content (%)	41.9	

SHRINKAGE LIMIT:

SAMPLE DESCRIPTION		
Initial Length, L o	mm	
Oven-dried Length, L _D	mm	
Clause 6.5.5 Linear Shrinkage = $\left(1 - \frac{L_D}{L_O}\right) \times 100$	%	

SUMMARY:	
49	
42	
7	
	<u>SUMMARY:</u> 49 42 7

PI	DESCRIPTION
0	Non-plastic
1 - 5	Slightly plastic
5 - 10	Low plasticity
10 - 20	Medium plasticity
20 - 40	High plasticity
> 40	Very high plasticity

GRACE MAINA

Tested by:

Checked by:

Consulting Engineers & Material Testing Laboratories

Likoni Lane P. O. Box 35035 - 00100 Nairobi, Kenya Emailinfo@geoissa.co.ke Website: www.geoissa.co.ke Tel: +254-020-2635002, Cel: +254-729-818-418

Date tested: 27-Feb-2019

LIQUID LIMIT (CONE PENETROMETER) AND PLASTIC LIMIT TEST RESULTS

Client: Project:

NATIONAL HOUSING CORPORATION PROPOSED MERU NTUTU DEVELOPMENT PHASE 1 BH 101 (13.5-15.0)M

Test Method: BS1377-2: 1990

Sample Description :

TEST NUMBER	1	2	3	4
Cone penetration (mm)	18.16	20.36	22.81	
Container No.	B7	GE07	T9	
Container weight (gm)	14.1	14.2	14.2	
Wet soil + container (gm)	66.7	72.0	61.2	
Wet soil (gm). W_w	52.6	57.9	47.0	
Dry soil + container (gm)	52.1	55.6	47.5	
Dry soil (gm), W_d	38.0	41.5	33.3	
Moisture loss (gm), $W_w - W_d$	14.6	16.4	13.7	
Moisture content (%), $(W_w - W_d)/W_d$	38.34	39.50	41.22	

PLASTIC LIMIT:

TEST NUMBER	1	2
Container No.	I	п
Container weight (gm)	14.2	14.3
Wet soil + container (gm)	38.1	37.8
Wet soil (gm), Ww	23.9	23.5
Dry soil + container (gm)	32.2	32.0
Dry soil (gm), Wd	18.0	17.7
Moisture loss (gm), Ww - Wd	5.9	5.8
Moisture content (%), (Ww - Wd)/Wd	32.9	33.0
Average moisture content (%)	32.9	

SHRINKAGE LIMIT:

SAMPLE DESCRIPTION		
Initial Length, L o	mm	
Oven-dried Length, L _D	mm	
Clause 6.5.5 Linear Shrinkage = $\left(1 - \frac{L_D}{L_O}\right) \times 100$	%	

	SUMMARY
Moisture Content at 20mm Penetration (%)	39
Plastic Limit (%)	33
Plasticity Index, PI = LL - PL	6

PI	DESCRIPTION
0	Non-plastic
1 - 5	Slightly plastic
5 - 10	Low plasticity
10 - 20	Medium plasticity
20 - 40	High plasticity
> 40	Very high plasticity

Tested by:

GRACE MAINA

Checked by:

Consulting Engineers & Material Testing Laboratories

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Date tested: 27-Feb-2019

LIQUID LIMIT (CONE PENETROMETER) AND PLASTIC LIMIT TEST RESULTS

Client: Project:

<u>NATIONAL HOUSING CORPORATION</u> <u>PROPOSED MERU NTUTU DEVELOPMENT PHASE 1</u> <u>BH 103 (3.0-4.5)M</u>

Test Method: BS1377-2: 1990

Sample Description :

LIQUID LIMIT				
TEST NUMBER	1	2	3	4
Cone penetration (mm)	18.10	20.11	22.36	
Container No.	GE03	K	GE05	
Container weight (gm)	14.5	14.1	14.2	
Wet soil + container (gm)	56.8	59.2	63.7	
Wet soil (gm). W_w	42.3	45.1	49.5	
Dry soil + container (gm)	41.0	41.9	44.4	
Dry soil (gm), W_d	26.5	27.8	30.2	
Moisture loss (gm), $W_w - W_d$	15.8	17.3	19.3	
Moisture content (%), $(W_w - W_d)/W_d$	59.58	62.11	64.03	

PLASTIC LIMIT:

TEST NUMBER	1	2
Container No.	V	G2
Container weight (gm)	14.2	14.2
Wet soil + container (gm)	35.2	33.1
Wet soil (gm), Ww	21.1	18.9
Dry soil + container (gm)	28.2	26.8
Dry soil (gm), Wd	14.0	12.5
Moisture loss (gm), Ww - Wd	7.0	6.3
Moisture content (%), (Ww - Wd)/Wd	50.1	50.5
Average moisture content (%)	50.3	

Tested by:

GRACE MAINA

SHRINKAGE LIMIT:

SAMPLE DESCRIPTION		
Initial Length, L _o	mm	
Oven-dried Length, L _D	mm	
Clause 6.5.5 Linear Shrinkage = $\left(1 - \frac{L_D}{L_O}\right) \times 100$	%	

	SUMMARY:
Moisture Content at 20mm Penetration (%)	62
Plastic Limit (%)	50
Plasticity Index, PI = LL - PL	12

PI	DESCRIPTION
0	Non-plastic
1 - 5	Slightly plastic
5 - 10	Low plasticity
10 - 20	Medium plasticity
20 - 40	High plasticity
> 40	Very high plasticity

DR. ISSA ISMAIL

Checked by:

Consulting Engineers & Material Testing Laboratories

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Date tested: 26-Feb-2019

LIQUID LIMIT (CONE PENETROMETER) AND PLASTIC LIMIT TEST RESULTS

Client: Project:

NATIONAL HOUSING CORPORATION PROPOSED MERU NTUTU DEVELOPMENT PHASE 1 BH 104 (4.5-6.0)M

Test Method: BS1377-2: 1990

Sample Description :

TEST NUMBER	1	2	3	4
Cone penetration (mm)	16.17	18.14	20.17	
Container No.	T65	G9	B10	
Container weight (gm)	14.3	14.3	14.1	
Wet soil + container (gm)	68.2	65.1	68.3	
Wet soil (gm). W_w	53.9	50.8	54.2	
Dry soil + container (gm)	50.8	48.5	50.1	
Dry soil (gm), W_d	36.5	34.2	36.0	
Moisture loss (gm), W_w - W_d	17.4	16.6	18.2	
Moisture content (%), $(W_w - W_d)/W_d$	47.65	48.65	50.53	

PLASTIC LIMIT:

TEST NUMBER	1	2
Container No.	B6	GE03
Container weight (gm)	14.3	14.2
Wet soil + container (gm)	38.9	40.9
Wet soil (gm), Ww	24.6	26.7
Dry soil + container (gm)	31.9	33.3
Dry soil (gm), Wd	17.7	19.1
Moisture loss (gm), Ww - Wd	7.0	7.6
Moisture content (%), (Ww - Wd)/Wd	39.6	39.6
Average moisture content (%)	3	9.6

SHRINKAGE LIMIT:

SAMPLE DESCRIPTION		
Initial Length, L o	mm	
Oven-dried Length, L _D	mm	
Clause 6.5.5 Linear Shrinkage = $\left(1 - \frac{L_D}{L_O}\right) \times 100$	%	

~	SUMMARY:
Moisture Content at 20mm Penetration (%)	50
Plastic Limit (%)	40
Plasticity Index, PI = LL - PL	11

PI	DESCRIPTION
0	Non-plastic
1 - 5	Slightly plastic
5 - 10	Low plasticity
10 - 20	Medium plasticity
20 - 40	High plasticity
> 40	Very high plasticity

GRACE MAINA

Tested by:

Checked by:

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Date tested: 26-Feb-2019

LIQUID LIMIT (CONE PENETROMETER) AND PLASTIC LIMIT TEST RESULTS

Client: Project:

NATIONAL HOUSING CORPORATION PROPOSED MERU NTUTU DEVELOPMENT PHASE 1 BH 104 (9.0-13.5)M

Test Method: BS1377-2: 1990

Sample Description :

TEST NUMBER	1	2	3	4
Cone penetration (mm)	19.45	21.32	23.11	
Container No.	4	D	5	
Container weight (gm)	14.2	14.2	14.0	
Wet soil + container (gm)	64.5	67.7	58.7	
Wet soil (gm). W_w	50.3	53.5	44.7	
Dry soil + container (gm)	47.8	49.5	43.1	
Dry soil (gm), W_d	33.6	35.3	29.1	
Moisture loss (gm), W_w - W_d	16.7	18.2	15.6	
Moisture content (%), $(W_w - W_d)/W_d$	49.63	51.59	53.66	

PLASTIC LIMIT:

TEST NUMBER	1	2
Container No.	T4	G1
Container weight (gm)	14.4	14.1
Wet soil + container (gm)	35.3	32.9
Wet soil (gm), Ww	20.9	18.8
Dry soil + container (gm)	29.6	27.7
Dry soil (gm), Wd	15.2	13.7
Moisture loss (gm), Ww - Wd	5.7	5.2
Moisture content (%), (Ww - Wd)/Wd	37.6	37.9
Average moisture content (%)	3'	7.8

SHRINKAGE LIMIT:

SAMPLE DESCRIPTION		
Initial Length, L o	mm	
Oven-dried Length, L _D	mm	
Clause 6.5.5 Linear Shrinkage = $\left(1 - \frac{L_D}{L_O}\right) \times 100$	%	

	SUMMARY:	
Moisture Content at 20mm Penetration (%)	50	
Plastic Limit (%)	38	
Plasticity Index, PI = LL - PL	13	

PI	DESCRIPTION
0	Non-plastic
1 - 5	Slightly plastic
5 - 10	Low plasticity
10 - 20	Medium plasticity
20 - 40	High plasticity
> 40	Very high plasticity

Checked by:

Tested by:

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Date tested: 27-Feb-2019

LIQUID LIMIT (CONE PENETROMETER) AND PLASTIC LIMIT TEST RESULTS

Client: Project:

<u>NATIONAL HOUSING CORPORATION</u> <u>PROPOSED MERU NTUTU DEVELOPMENT PHASE 1</u> <u>BH 105 (1.5-3.0)M</u>

Test Method: BS1377-2: 1990

Sample Description :

LIQUID LIMIT				
TEST NUMBER	1	2	3	4
Cone penetration (mm)	18.43	20.13	22.36	
Container No.	GE08	B8	T6	
Container weight (gm)	14.1	13.9	14.1	
Wet soil + container (gm)	64.8	60.9	61.9	
Wet soil (gm). W_w	50.6	47.0	47.8	
Dry soil + container (gm)	47.3	44.3	44.3	
Dry soil (gm), W_d	33.2	30.4	30.2	
Moisture loss (gm), $W_w - W_d$	17.4	16.6	17.7	
Moisture content (%), $(W_w - W_d)/W_d$	52.53	54.70	58.64	

PLASTIC LIMIT:

TEST NUMBER	1	2	
Container No.	R	Α	
Container weight (gm)	14.2	14.3	
Wet soil + container (gm)	38.9	38.7	
Wet soil (gm), Ww	24.7	24.4	
Dry soil + container (gm)	31.8	31.7	
Dry soil (gm), Wd	17.7	17.4	
Moisture loss (gm), Ww - Wd	7.1	6.9	
Moisture content (%), (Ww - Wd)/Wd	39.9	39.8	
Average moisture content (%)	39.9		

SHRINKAGE LIMIT:

SAMPLE DESCRIPTION		
Initial Length, L o	mm	
Oven-dried Length, L _D	mm	
Clause 6.5.5 Linear Shrinkage = $\left(1 - \frac{L_D}{L_O}\right) \times 100$	%	

	SUMMARY	:
Moisture Content at 20mm Penetration (%)	55	
Plastic Limit (%)	40	
Plasticity Index, PI = LL - PL	15	٦

PI	DESCRIPTION
0	Non-plastic
1 - 5	Slightly plastic
5 - 10	Low plasticity
10 - 20	Medium plasticity
20 - 40	High plasticity
> 40	Very high plasticity

Checked by:

Tested by:

GRACE MAINA

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Date tested: 27-Feb-2019

LIQUID LIMIT (CONE PENETROMETER) AND PLASTIC LIMIT TEST RESULTS

Client: Project:

<u>NATIONAL HOUSING CORPORATION</u> <u>PROPOSED MERU NTUTU DEVELOPMENT PHASE 1</u> <u>BH 106 (0.0-1.5)M</u>

Test Method: BS1377-2: 1990

Sample Description :

LIQUID LIMIT				
TEST NUMBER	1	2	3	4
Cone penetration (mm)	18.26	20.18	22.17	
Container No.	T7	T5	E	
Container weight (gm)	14.0	14.2	14.0	
Wet soil + container (gm)	54.8	53.0	50.0	
Wet soil (gm). W_w	40.8	38.8	36.0	
Dry soil + container (gm)	40.8	39.4	37.0	
Dry soil (gm), W_d	26.8	25.2	23.0	
Moisture loss (gm), $W_w - W_d$	14.0	13.6	13.0	
Moisture content (%), $(W_w - W_d)/W_d$	52.41	54.07	56.48	

PLASTIC LIMIT:

TEST NUMBER	1	2	
Container No.	100	5	
Container weight (gm)	14.0	14.1	
Wet soil + container (gm)	34.8	33.4	
Wet soil (gm), Ww	20.8	19.3	
Dry soil + container (gm)	28.5	27.5	
Dry soil (gm), Wd	14.5	13.4	
Moisture loss (gm), Ww - Wd	6.4	5.9	
Moisture content (%), (Ww - Wd)/Wd	43.9	43.7	
Average moisture content (%)	4.	3.8	

SHRINKAGE LIMIT:

SAMPLE DESCRIPTION		
Initial Length, L o	mm	
Oven-dried Length, L _D	mm	
Clause 6.5.5 Linear Shrinkage = $\left(1 - \frac{L_D}{L_O}\right) \times 100$	%	

	SUMMARY:
Moisture Content at 20mm Penetration (%)	54
Plastic Limit (%)	44
Plasticity Index, PI = LL - PL	10

PI	DESCRIPTION
0	Non-plastic
1 - 5	Slightly plastic
5 - 10	Low plasticity
10 - 20	Medium plasticity
20 - 40	High plasticity
> 40	Very high plasticity

Checked by:

Tested by:

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Date tested: 26-Feb-2019

LIQUID LIMIT (CONE PENETROMETER) AND PLASTIC LIMIT TEST RESULTS

Client: Project:

<u>NATIONAL HOUSING CORPORATION</u> <u>PROPOSED MERU NTUTU DEVELOPMENT PHASE 1</u> <u>BH 106 (13.5-15.0)M</u>

Test Method: BS1377-2: 1990

Sample Description :

LIQUID LIMIT				
TEST NUMBER	1	2	3	4
Cone penetration (mm)	18.75	20.45	22.17	
Container No.	V	B9	GEOJ	
Container weight (gm)	14.2	14.3	14.2	
Wet soil + container (gm)	62.4	61.8	70.0	
Wet soil (gm). W_w	48.3	47.5	55.8	
Dry soil + container (gm)	46.5	45.8	51.0	
Dry soil (gm), W_d	32.3	31.6	36.7	
Moisture loss (gm), W_w - W_d	15.9	15.9	19.0	
Moisture content (%), $(W_w - W_d)/W_d$	49.23	50.46	51.82	

PLASTIC LIMIT:

TEST NUMBER	1	2	
Container No.	B4	GE01	
Container weight (gm)	14.0	14.1	
Wet soil + container (gm)	37.6	36.4	
Wet soil (gm), Ww	23.6	22.3	
Dry soil + container (gm)	31.4	30.5 16.4	
Dry soil (gm), Wd	17.4		
Moisture loss (gm), Ww - Wd	6.2	5.9	
Moisture content (%), (Ww - Wd)/Wd	35.6	35.7	
Average moisture content (%)	3	5.7	

SHRINKAGE LIMIT:

SAMPLE DESCRIPTIO	N	
Initial Length, L o	mm	
Oven-dried Length, L _D	mm	
Clause 6.5.5 Linear Shrinkage = $\left(1 - \frac{L_D}{L_O}\right) \times 100$	%	

	SUMMARY:
Moisture Content at 20mm Penetration (%)	50
Plastic Limit (%)	36
Plasticity Index, PI = LL - PL	14

PI	DESCRIPTION
0	Non-plastic
1 - 5	Slightly plastic
5 - 10	Low plasticity
10 - 20	Medium plasticity
20 - 40	High plasticity
> 40	Very high plasticity

Checked by:

Tested by:

GRACE MAINA



FALLING HEAD PERMEABILITY TEST

Project: PROPOSED MERU NTUTU MIXED DEVELOPMENT PHASE 1

Client: NATIONAL HOUSING CORPORATION

Sample: BH 101 (1.5-3.0)M

Test	Standpipe Test readings (cm)		Length of soil sample	Cross-section area of the soil	Cross-section area of stand	Time	Permeability (cm/sec), k
	h _o	h ₁	(cm), L	sample (cm ²), A	pipe (cm²), a	(sec), t	(cm/sec), k
1	89.0	85.3	15.4	29.725	0.950	90	2.319E-04
2	84.0	81.7	15.4	29.725	0.950	60	2.275E-04
3	75.1	73.7	15.4	29.725	0.950	45	2.056E-04
			· · · · · · · · · · · · · · · · · · ·			Average	2.217E-04

Tested by: Clement Muriithi



FALLING HEAD PERMEABILITY TEST

Project: PROPOSED MERU NTUTU MIXED DEVELOPMENT PHASE 1

Client: NATIONAL HOUSING CORPORATION

Sample: BH 101 (5.5-6.0)M

Standpipe Test readings (cm)			Length of soil sample	Cross-section area of the soil	Cross-section area of stand	Time	Permeability (cm/sec), k
	h _o	h ₁	(cm), L	sample (cm ²), A	pipe (cm²), a	(sec), t	(cm/sec), k
1	89.0	86.5	15.4	29.725	0.950	165	8.489E-05
2	86.0	84.7	15.4	29.725	0.950	90	8.320E-05
3	84.1	82.5	15.4	29.725	0.950	120	7.869E-05
	· · · · · · · · · · · · · · · · · · ·					Average	8.226E-05

Tested by: Clement Muriithi



FALLING HEAD PERMEABILITY TEST

Project: PROPOSED MERU NTUTU MIXED DEVELOPMENT PHASE 1

Client: NATIONAL HOUSING CORPORATION

Sample: BH 102 (4.0-4.5)M

Standpipe Test readings (cm)		Length of soil sample	Cross-section area of the soil	Cross-section area of stand	Time (sec), t	Permeability (cm/sec), k	
	h _o	h ₁	(cm), L	sample (cm ²), A	pipe (cm²), a	(sec), t	(cm/sec), k
1	89.0	88.4	15.4	29.725	0.950	90	3.695E-05
2	88.0	87.2	15.4	29.725	0.950	120	3.741E-05
3	85.5	85.2	15.4	29.725	0.950	45	3.840E-05
			· · · · · · · · · · · · · · · · · · ·			Average	3.759E-05

Tested by: Clement Muriithi



FALLING HEAD PERMEABILITY TEST

Project: PROPOSED MERU NTUTU MIXED DEVELOPMENT PHASE 1

Client: NATIONAL HOUSING CORPORATION

Sample: BH 103 (4.5-6.0)M

Standpipe Test readings (cm)		Length of soil sample	Cross-section area of the soil	Cross-section area of stand	Time (sec), t	Permeability (cm/sec), k	
	h _o	h ₁	(cm), L	sample (cm ²), A	pipe (cm²), a	(sec), t	(cm/sec), k
1	89.0	83.3	15.4	29.725	0.950	60	5.423E-04
2	89.0	84.9	15.4	29.725	0.950	45	5.152E-04
3	89.0	86.2	15.4	29.725	0.950	30	5.238E-04
			· · · · · ·			Average	5.271E-04

Tested by: Clement Muriithi



FALLING HEAD PERMEABILITY TEST

Project: PROPOSED MERU NTUTU MIXED DEVELOPMENT PHASE 1

Client: NATIONAL HOUSING CORPORATION

Sample: BH 105 (1.0-1.5)M

Standpipe Test readings (cm)		Length of soil sample	Cross-section area of the soil	Cross-section area of stand	Time	Permeability (cm/sec), k	
	h _o	h ₁	(cm), L	sample (cm ²), A	pipe (cm²), a	(sec), t	(cm/sec), k
1	87.9	86.8	15.4	29.725	0.950	92	6.729E-05
2	86.2	84.7	15.4	29.725	0.950	120	7.192E-05
3	84.0	83.3	15.4	29.725	0.950	60	6.857E-05
			· · · · · · · · · · · · · · · · · · ·			Average	6.926E-05

Tested by: Clement Muriithi



FALLING HEAD PERMEABILITY TEST

Project: PROPOSED MERU NTUTU MIXED DEVELOPMENT PHASE 1

Client: NATIONAL HOUSING CORPORATION

Sample: BH 106 (7.5-9.0)M

Standpipe Test readings (cm)			Length of soil sample	Cross-section area of the soil	Cross-section area of stand	Time	Permeability (cm/sec), k
	h _o	h ₁	(cm), L	sample (cm ²), A	pipe (cm²), a	(sec), t	(cm/sec), k
1	89.0	86.5	15.4	29.725	0.950	60	2.335E-04
2	88.0	84.4	15.4	29.725	0.950	90	2.282E-04
3	85.5	83.4	15.4	29.725	0.950	60	2.038E-04
	· · · · · · · · · · · · · · · · · · ·		•			Average	2.218E-04

Tested by: Clement Muriithi

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ONE DIMENSIONAL CONSOLIDATION TEST

CLIENT: PROJECT: Sample: Test date: Specification	NATIONAL HOUSIN MERU NTUTU MIXE BH 101 (2.5-3.0)M 26-Feb-19 According to BS 1377:	D DEVELOPMENT PH	ASE 1				
DIA OF RING	50.4 mm	HEIGHT OF	RING 20).3 mm	AREA (A)	19.95	53 cm ²
		STAGE - A	FTER TEST				
MEASURED THICKN	NESS OF SPECIMEN (H1))				20.3	mm
WET SPECIMEN						77.98	g
MASS OF RING + TR	AY + SPECIMEN					1612.7	g
MASS OF RING						58.37	g
MASS OF TRAY						1483.11	g
MASS OF DRY SPEC	IMEN (ms)					57.16	g
MASS OF MOISTURI	E					20.82	g
MOISTURE CONTEN	VT (m)					48.5	%
BULK DENSITY (P)						1.76	g/cm ³
DRY DENSITY (Pd)						1.18	g/cm ³
INITIAL VOID RATIO	$D(e_o)$					1.28	
DEGREE OF SATUR	ATION (Sr) m	/(Pw/Pd - 1/Gs)				102.3	%
DENSITY OF SOIL P.	ARTICLES ASSUMED	Gs Øw				2.7	g/cm ³
HEIGHT OF SOIL PA	RTICLES (H0)	(ms x 1000)/(Gs Pw x A	.)		_	8.9	mm
APPLIED PRESSURE	TOTAL DEFLECTION D	THICKNESS OF SPECIMEN,H (H1-D)	PERCENTAGE THICKNESS H/H1 X 100	HEIGH VOII (H-H	os	VOIDS F H-H0	
kN/m ²	mm	mm		mm			
0	0	20.30	100.00	11.3	9	1.27	9

0	0	20.30	100.00	11.39	1.279
25	0.634	19.67	96.88	10.76	1.208
50	0.321	19.35	95.30	10.44	1.172
100	0.663	18.68	92.03	9.78	1.098
200	0.918	17.76	87.51	8.86	0.995
FLOODED 200	0.029	17.74	87.36	8.83	0.991
400	0.907	16.83	82.90	7.92	0.889

Tested by : CLEMENT MURIITHI

Reported by : _____ CLEMENT MURIITHI Checked by : _____ DR. ISSA ISMAIL

Consulting Engineers & Material Testing Laboratories

Likoni Lane P. O. Box 35035 - 00100 Nairobi, Kenya Email:info@geoissa.co.ke Website: www.geoissa.co.ke Tel: +254-020-2635002, Cel: +254-729-818-418

ONE DIMENSIONAL CONSOLIDATION TEST

CLIENT: PROJECT: Sample: Test date: Specification	NATIONAL HOUSING MERU NTUTU MIXE BH 102 (1.0-1.5)M 26-Feb-19 According to BS 1377:1	D DEVELOPMENT PH	ASE 1					
DIA OF RING	50.4 mm	AREA (A)	A (A) 19.953 cm ²					
		STAGE - A	FTER TEST					
MEASURED THICKN		20.3	mm					
WET SPECIMEN		76.2	g					
MASS OF RING + TRA		1602.1	g					
MASS OF RING		59.93	g					
MASS OF TRAY						1471.45	g	
MASS OF DRY SPEC	IMEN (ms)					55.91	g	
MASS OF MOISTURE							g	
MOISTURE CONTEN		48.7	%					
BULK DENSITY (\$)							g/cm ³	
DRY DENSITY (Pd)						1.17	g/cm ³	
INITIAL VOID RATIO (e_0)								
DEGREE OF SATURA		101.2	%					
DENSITY OF SOIL PARTICLES ASSUMED Gs Pw							g/cm ³	
HEIGHT OF SOIL PAI	RTICLES (H0)	(ms x 1000)/(Gs Pw x A)			8.8	mm	
APPLIED PRESSURE	TOTAL DEFLECTION D	THICKNESS OF SPECIMEN,H (H1-D)	PERCENTAGE THICKNESS H/H1 X 100	HEIGH VOII (H-H	DS			
kN/m ²	mm	mm		mm	1			
0	0	20.30	100.00	11.47		1.298		
25	1.053	19.25	94.81	10.41		1.179		

10.07

9.44

8.57

8.55

7.61

Tested by : CLEMENT MURIITHI

0.342

0.626

0.876

0.018

0.939

18.91

18.28

17.40

17.39

16.45

50

100

200

FLOODED 200

400

 Reported by :
 CLEMENT MURIITHI
 Checked by :
 DR. ISSA ISMAIL

93.13

90.04

85.73

85.64

81.01

1.140

1.069

0.970

0.968

0.862

Consulting Engineers & Material Testing Laboratories

Likoni Lane P. O. Box 35035 - 00100 Nairobi, Kenya Email:info@geoissa.co.ke Website: www.geoissa.co.ke Tel: +254-020-2635002, Cel: +254-729-818-418

ONE DIMENSIONAL CONSOLIDATION TEST

MERU NTUTU MIXI BH 102 (5.5-6.0)M 27-Feb-19	ED DEVELOPMENT PH	IASE 1						
50.4 mm	HEIGHT OF	RING	20.3	mm	AREA (A)	3 cm ²		
	STAGE - A	AFTER TEST						
MEASURED THICKNESS OF SPECIMEN (H1)								
WET SPECIMEN								
MASS OF RING + TRAY + SPECIMEN								
MASS OF RING								
MASS OF TRAY							g	
MASS OF DRY SPECIMEN (ms)							g	
MASS OF MOISTURE							g	
TT (m)						45.6	%	
BULK DENSITY (P)								
DRY DENSITY (Pd)								
INITIAL VOID RATIO (e_)								
DEGREE OF SATURATION (Sr) m/(Pw/Pd - 1/Gs)							%	
DENSITY OF SOIL PARTICLES ASSUMED Gs Pw							g/cm ³	
RTICLES (H0)	(ms x 1000)/(Gs Pw x A	A)				8.8	mm	
TOTAL DEFLECTION D	THICKNESS OF SPECIMEN,H (H1-D)	PERCENTAGE THICKNESS H/H1 X 100	Н	VOIDS	8	VOIDS RATIO H-H0/H0		
mm	mm			mm				
0	20.30	100.00		11.50	0 1.307		17	
0.567	19.73	97.21		10.93	3 1.24		3	
0.274	10.46	05.05		10.66		1.211		
	MERU NTUTU MIXI BH 102 (5.5-6.0)M 27-Feb-19 According to BS 1377 50.4 mm SSS OF SPECIMEN (H) AY + SPECIMEN IMEN (ms) 3 IT (m) O (e_o) ATION (Sr) m ARTICLES ASSUMED RTICLES (H0) DEFLECTION D 0 0 0 0 0	BH 102 (5.5-6.0)M 27-Feb-19 According to BS 1377:1990. 50.4 mm HEIGHT OF STAGE - A VESS OF SPECIMEN (H1) AY + SPECIMEN IMEN (ms) 3 IT (m) O (e_o) ATION (Sr) m /(Pw/Pd - 1/Gs) ARTICLES ASSUMED Gs Pw RTICLES (H0) (ms x 1000)/(Gs Pw x A DEFLECTION SPECIMEN,H D (H1-D) mm mm 0 20.30 0 20.30	MERU NTUTU MIXED DEVELOPMENT PHASE 1 BH 102 (5.5-6.0)M 27-Feb-19 According to BS 1377:1990. 50.4 mm HEIGHT OF RING STAGE - AFTER TEST WESS OF SPECIMEN (H1) AY + SPECIMEN IMEN (ms) 3 T (m) O (e _o) ARTICLES ASSUMED Gs pw RTICLES (H0) THICKNESS OF PERCENTAGE SPECIMEN,H TOTAL THICKNESS OF SPECIMEN,H DEFLECTION SPECIMEN,H THICKNESS OF SPECIMEN,H O (e _o) O (ms x 1000)/(Gs Pw x A)	MERU NTUTU MIXED DEVELOPMENT PHASE 1 BH 102 (5.5-6.0)M 27-Feb-19 According to BS 1377:1990. 20.3 50.4 mm HEIGHT OF RING 20.3 STAGE - AFTER TEST WESS OF SPECIMEN (H1) AY + SPECIMEN IMEN (ms) 3 T (m) O (e _a) ATION (St) m /(Pw/Pd - 1/Gs) ARTICLES ASSUMED Gs Pw RTICLES (H0) (ms x 1000)/(Gs Pw x A) THICKNESS OF PERCENTAGE H DEFLECTION SPECIMEN,H THICKNESS OF PERCENTAGE H DEFLECTION SPECIMEN,H MICKNESS OF PERCENTAGE H O (0 0 O (20.30 O (0 O (100.00	MERU NTUTU MIXED DEVELOPMENT PHASE 1 BH 102 (5.5-6.0)M 27-Feb-19 According to BS 1377:1990. 20.3 mm 50.4 mm HEIGHT OF RING 20.3 mm STAGE - AFTER TEST RESS OF SPECIMEN (H1) AY + SPECIMEN AY + SPECIMEN IMEN (ms) ST (m) O (e_o) ARTICLES ASSUMED Gs pw RTICLES (H0) (ms x 1000)/(Gs Pw x A) TOTAL THICKNESS OF PERCENTAGE HEIGHT THICKNESS POINT O (e_o) O (e_o) O (ms x 1000)/(Gs Pw x A)	MERU NTUTU MIXED DEVELOPMENT PILASE 1 BH 102 (5.5-6.0)M 27-Feb-19 According to BS 1377:1990. STAGE - AFTER TEST STAGE - AFTER TEST WESS OF SPECIMEN (H1) Attract test AY + SPECIMEN (H1) IMEN (ms) G T(m) MICN (ms) G O (e_o) ATION (Sr) m /(Pw/Pd - 1/Gs) ATION (Sr) m /(Pw/Pd - 1/Gs) THICLES ASSUMED Gs Pw THICKNESS OF PERCENTAGE HEIGHT OF VOIDS (H1+0) O (a) O (a) O (b) O (co) O (D) (MS x 100	MERU NTUTU MIXED DEVELOPMENT PHASE 1 BH 102 (5.5.6.6)M 27.Feb-19 According to BS 1377:1990. mm AREA (A) 19.95 STAGE - AFTER TEST ESS OF SPECIMEN (HI) 20.3 mm AREA (A) 19.95 AFTER TEST ESS OF SPECIMEN (HI) 20.3 A 441 AY + SPECIMEN 1618.8 MERN (ms) 55.55 Image: Specimen (HI) Stage - AFTER TEST MERN (ms) 55.55 Image: Specimen (HI) Stage - Sp.9.4 MEN (ms) 55.55 Image: Specimen (HI) Stage - Sp.9.4 Image: Specimen (HI) Stage - Sp.9.4 Image: Specimen (HI) Sp.9.4 Image: Specimen (HI) Stage - Sp.9.4 Image: Specimen (HI) Sp.9.4 Image: Specimen (HI) Sp.9.4 Image: Specimen (HI) Sp.0.1	

 200
 0.93
 17.94
 88.37

 FLOODED 200
 0.026
 17.91
 88.25

 400
 1.025
 16.89
 83.20

18.87

0.589

Tested by : CLEMENT MURIITHI

100

Reported by : _____ CLEMENT MURIITHI Checked by : _____ DR. ISSA ISMAIL

10.07

9.14

9.11

8.09

92.96

1.145

1.039

1.036

0.919

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Likoni Lane P. O. Box 35035 - 00100 Nairobi, Kenya Email:info@geoissa.co.ke Website: www.geoissa.co.ke Tel: +254-020-2635002, Cel: +254-729-818-418

ONE DIMENSIONAL CONSOLIDATION TEST

CLIENT: PROJECT: Sample: Test date: Specification	NATIONAL HOUSIN MERU NTUTU MIXE BH 103 (4.0-4.5)M 26-Feb-19 According to BS 1377:	D DEVELOPMENT PH	ASE 1				
DIA OF RING	50.4 mm	HEIGHT OF	RING 20	.3 mm	AREA (A)	19.95	53 cm ²
		STAGE - A	FTER TEST				
MEASURED THICKN	ESS OF SPECIMEN (H1)					20.3	mm
WET SPECIMEN		78.69	g				
MASS OF RING + TRA		1620.1	g				
MASS OF RING						58.7	g
MASS OF TRAY						1487.01	g
MASS OF DRY SPECI		61.12	g				
MASS OF MOISTURE	2					17.57	g
MOISTURE CONTEN	T (m)					37.5	%
BULK DENSITY (P)					_	1.84	g/cm ³
DRY DENSITY (Pd)						1.34	g/cm ³
INITIAL VOID RATIO) (e _o)					1.02	
DEGREE OF SATURA	TION (Sr) m	(Pw/Pd - 1/Gs)				99.0	%
DENSITY OF SOIL PA	ARTICLES ASSUMED	Gs Øw				2.7	g/cm ³
HEIGHT OF SOIL PAF	RTICLES (H0)	(ms x 1000)/(Gs Pw x A	.)			10.0	mm
APPLIED PRESSURE	TOTAL DEFLECTION D	THICKNESS OF SPECIMEN,H (H1-D)	PERCENTAGE THICKNESS H/H1 X 100	HEIGH VOII (H-H	os	VOIDS F H-H0	
kN/m ²	mm	mm		mm			
0	0	20.30	100.00	10.2	6	1.02	2

19.51

19.19

18.87

17.78

17.74

17.15

0.79

0.322

0.316

1.093

0.041

0.593

25

50

100

200

FLOODED 200

400

 Reported by :
 CLEMENT MURIITHI
 Checked by :
 DR. ISSA ISMAIL

9.47

9.15

8.83

7.74

7.70

7.10

96.11

94.52

92.97

87.58

87.38

84.46

0.943

0.911

0.879

0.771

0.766

0.707

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ONE DIMENSIONAL CONSOLIDATION TEST

CLIENT: PROJECT: Sample: Test date: Specification	NATIONAL HOUSING MERU NTUTU MIXE BH 105 (2.5-3.0)M 27-Feb-19 According to BS 1377:1	D DEVELOPMENT PH	ASE 1							
DIA OF RING	50.4 mm	HEIGHT OF	RING	20.3	mm	AREA (A)	19.95	3 cm ²		
		STAGE - A	FTER TEST							
MEASURED THICKN	ESS OF SPECIMEN (H1)						20.3	mm		
WET SPECIMEN		75.34	g							
MASS OF RING + TRA		1613.6								
MASS OF RING							58.41	g		
MASS OF TRAY							1487.98	g		
MASS OF DRY SPECI	MEN (ms)						54.95	g		
MASS OF MOISTURE		20.39	g							
MOISTURE CONTEN	Γ (m)						50.0	%		
BULK DENSITY (P)							1.66	g/cm ³		
DRY DENSITY (Pd)							1.11	g/cm ³		
INITIAL VOID RATIO	(e _o)						1.44			
DEGREE OF SATURA	TION (Sr) m /	(pw/pd - 1/Gs)					93.8	%		
DENSITY OF SOIL PA	RTICLES ASSUMED	Gs Pw					2.7	g/cm ³		
HEIGHT OF SOIL PAR	TICLES (H0)	(ms x 1000)/(Gs Pw x A	.)				8.3	mm		
APPLIED PRESSURE	TOTAL DEFLECTION D	THICKNESS OF SPECIMEN,H (H1-D)	PERCENTAGI THICKNESS H/H1 X 100	522 - C	HEIGHT VOID: (H-H0	5	VOIDS RATIO H-H0/H0			
kN/m ²	mm	mm			mm					
0	0	20.30	100.00		11.98		1.44	1		
25	0.278	20.02	98.63		11.71		1.40	7		
50	0.188	19.83	97.70		11.52		1.385			

0.438

0.92

0.008

1.121

19.40

18.48

18.47

17.35

100

200

FLOODED 200

400

 Reported by :
 CLEMENT MURIITHI
 Checked by :
 DR. ISSA ISMAIL

11.08

10.16

10.15

9.03

95.55

91.01

90.98

85.45

1.332

1.222

1.221

1.086

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ONE DIMENSIONAL CONSOLIDATION TEST

CLIENT: PROJECT: Sample: Test date: Specification	NATIONAL HOUSINO MERU NTUTU MIXE BH 106 (4.0-4.5)M 27-Feb-19 According to BS 1377:1	D DEVELOPMENT PH	ASE 1							
DIA OF RING	50.4 mm	HEIGHT OF	RING	20.3	mm	AREA (A)	19.95	53 cm ²		
		STAGE - A	FTER TEST							
MEASURED THICKN	ESS OF SPECIMEN (H1)						20.3	mm		
WET SPECIMEN	WET SPECIMEN									
MASS OF RING + TRA		1613.0	g							
MASS OF RING							58.69	g		
MASS OF TRAY							1486.44	g		
MASS OF DRY SPECI	MEN (ms)					c	54.32	g		
MASS OF MOISTURE		20.09	g							
MOISTURE CONTENT	Г (m)						50.1	%		
BULK DENSITY (P)							1.67	g/cm ³		
DRY DENSITY (Pd)							1.12	g/cm ³		
INITIAL VOID RATIO	(e ₀)						1.42			
DEGREE OF SATURA	TION (Sr) m /	(Pw/Pd - 1/Gs)					95.2	%		
DENSITY OF SOIL PA	RTICLES ASSUMED	Gs Pw					2.7	g/cm ³		
HEIGHT OF SOIL PAR	TICLES (H0)	(ms x 1000)/(Gs Pw x A)				8.4	mm		
APPLIED PRESSURE	TOTAL DEFLECTION D	THICKNESS OF SPECIMEN,H (H1-D)	PERCENTAG THICKNESS H/H1 X 100	3.12	HEIGHT VOID (H-H0	s	VOIDS R H-H0/			
kN/m ²	mm	mm	2 7		mm					
0	0	20.30	100.00		11.91		1.42	0		
25	0.44	19.86	97.83		11.47	4	1.36	8		
50	0.162	19.70	97.03		11.31		1.349			

Tested by : CLEMENT MURIITHI

0.416

0.839

0.001

1.051

19.28

18.44

18.44

17.39

100

200

FLOODED 200

400

Reported by : _____ CLEMENT MURIITHI ____ Checked by : _____ DR. ISSA ISMAIL

10.89

10.06

10.05

9.00

94.99

90.85

90.85

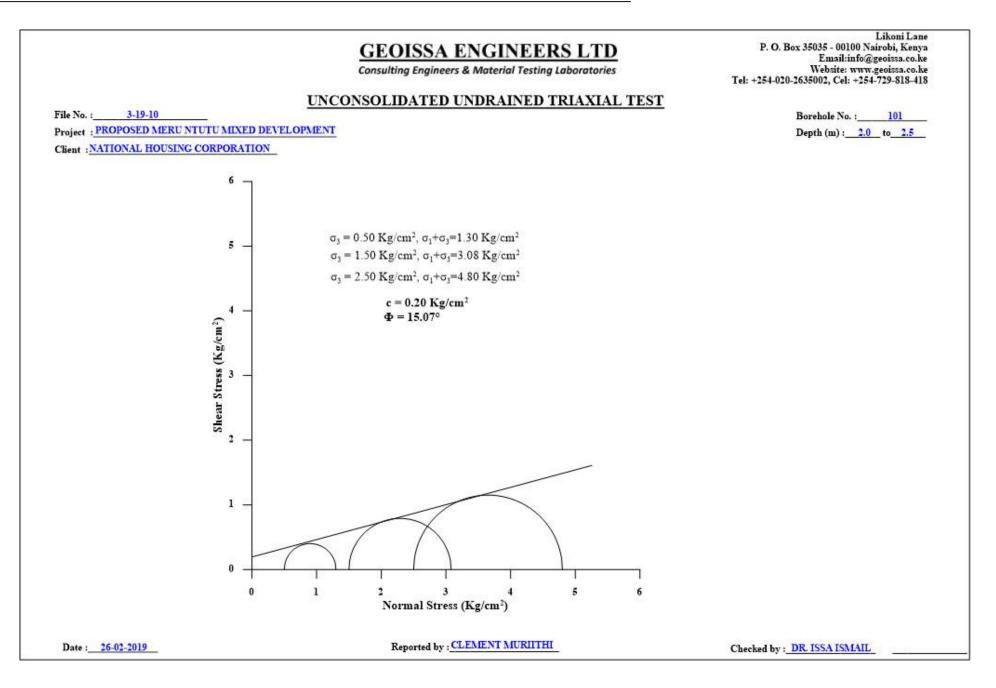
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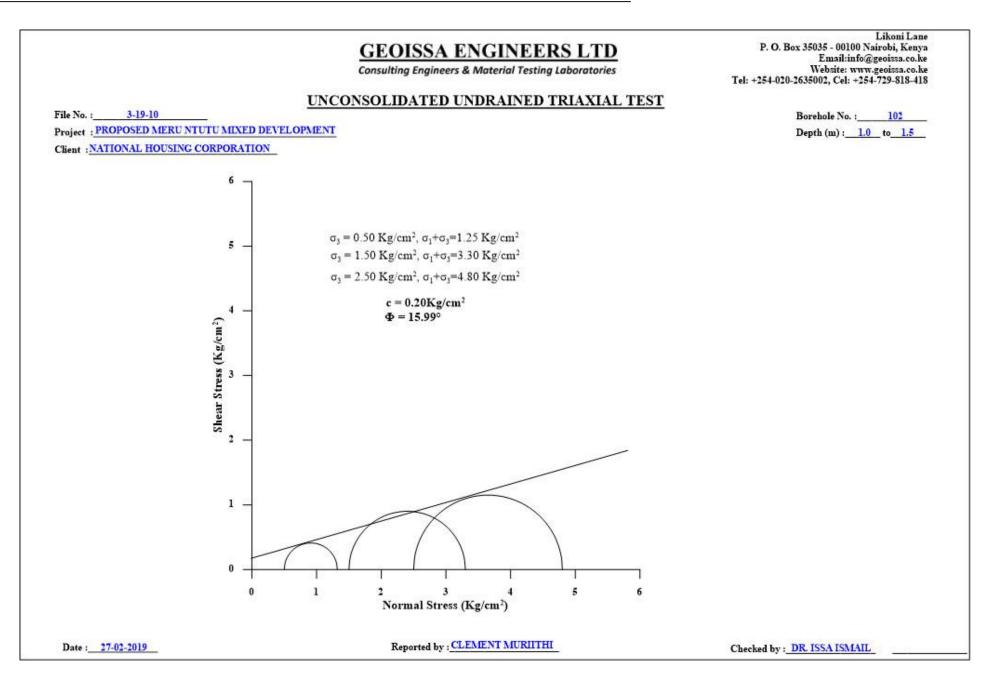
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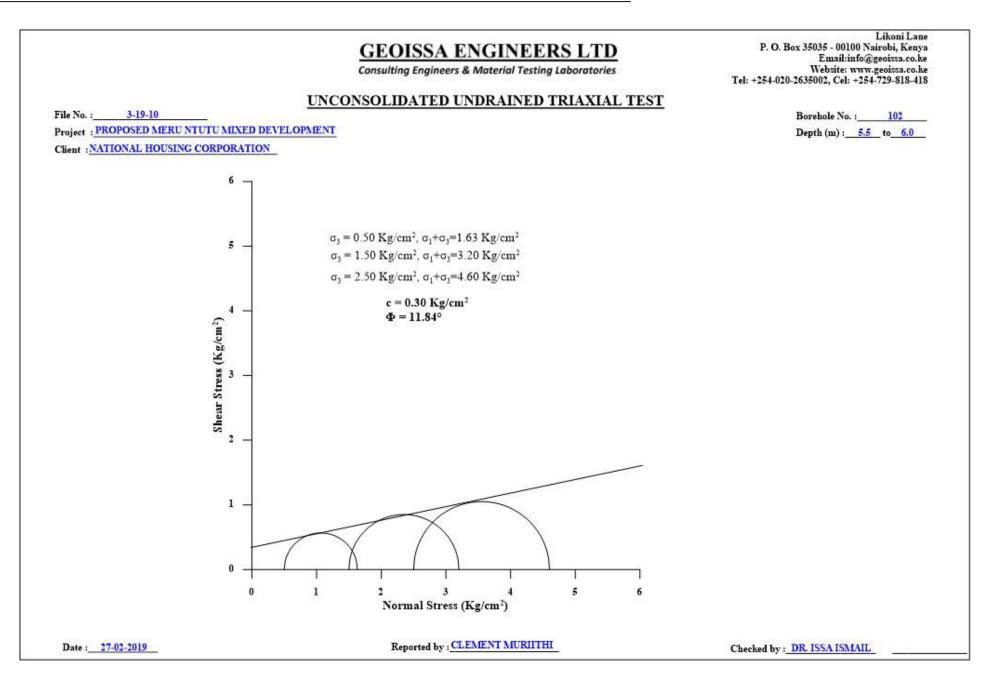
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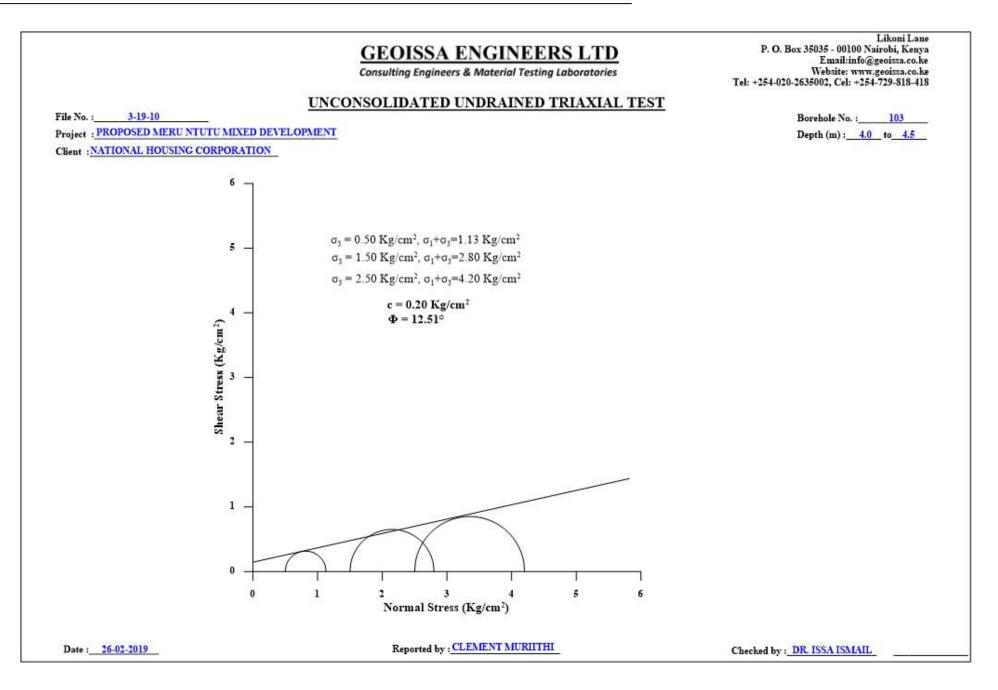
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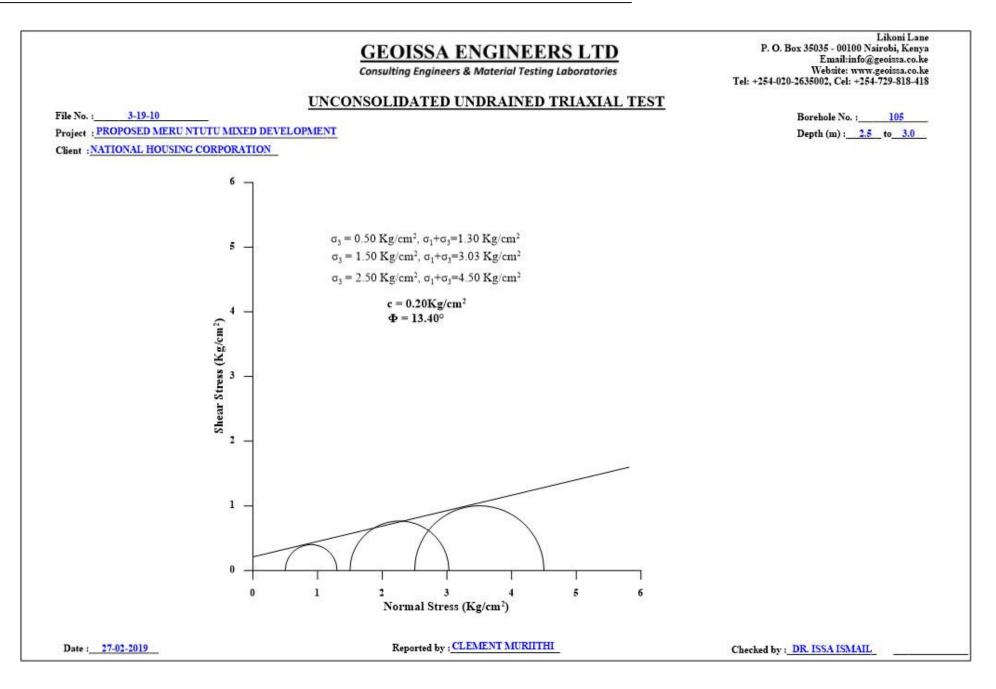
1.074

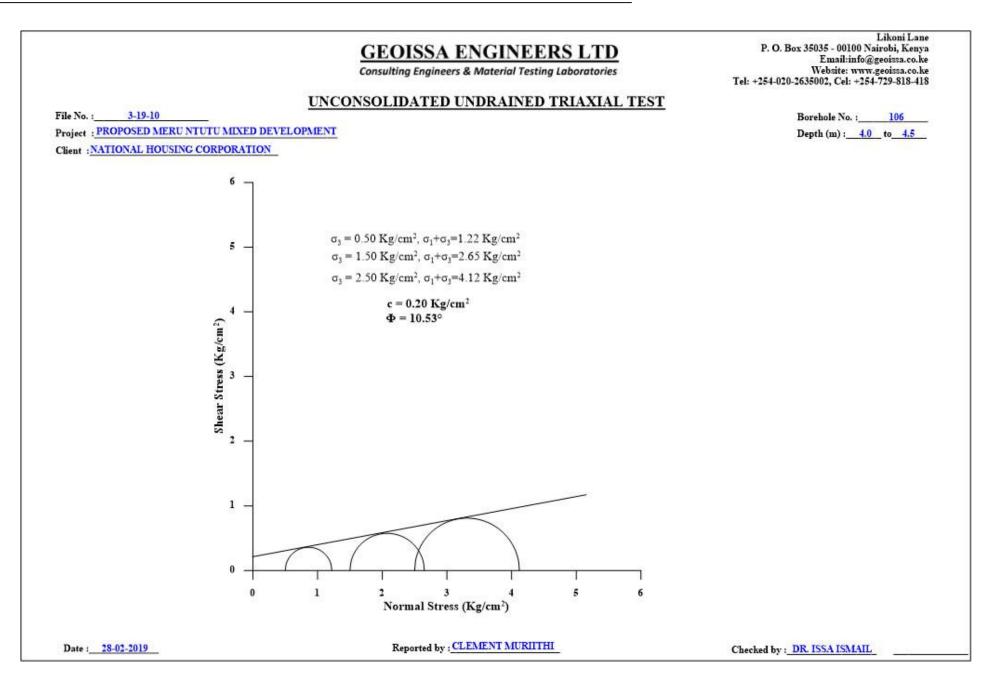












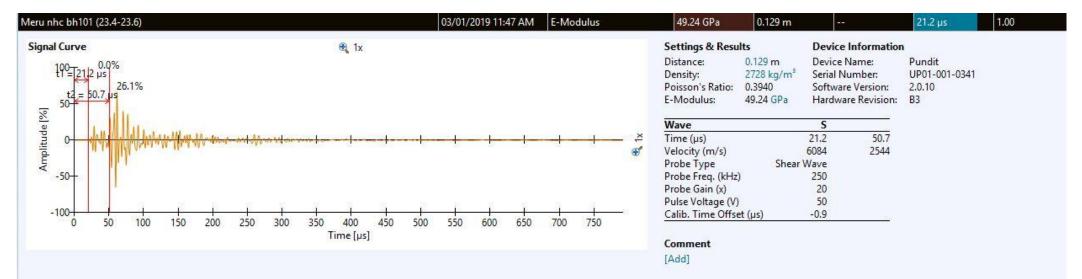
Likoni Lane

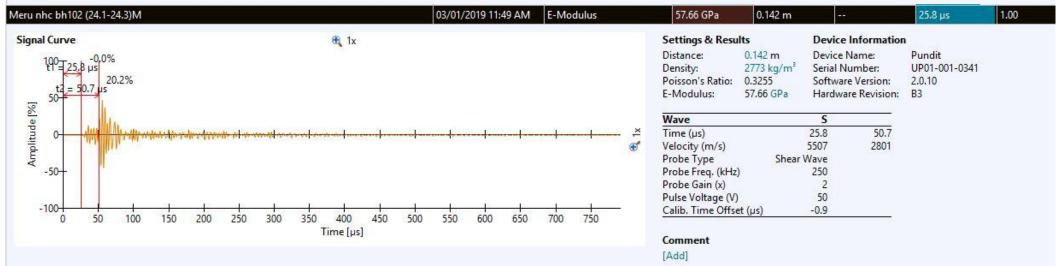
GEOISSA ENGINEERS LTD P. O. Box 35035 - 00100 Nairobi, Kenya Consulting Engineers & Material Testing Laboratories Email:info@geoissa.co.ke Website: www.geoissa.co.ke Tel: +254-020-2635002, Cel: +254-729-818-418 UNCONFINED COMPRESSION TEST Standard : ASTM D 7012 Date received : 23/2/19 Date tested 1/3/19

File No. :	3-19-10
Project :	PROPOSED MERU NTUTU MIXED DEVELOPMENT PHASE 1
Client :	NATIONAL HOUSING CORPORATION
Location :	MERU

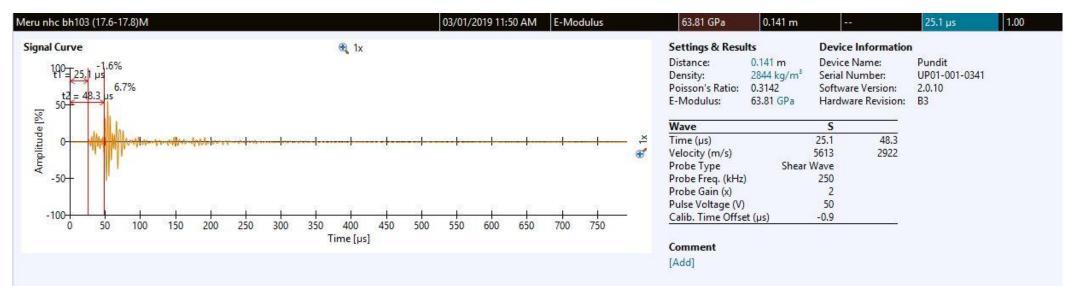
Sample Borehole	No						No	No	No	No	No	No	No	Depth (m)		Sample	Diameter	Length	L/D	Weight	Density	Failure Load	Corrected UCS	Failure	RMR Rating	Bearing	Safe Bearing	Remarks
No	From	То	Condition	(mm)	(mm)		(gms)	(Kg/m ³)	(kN)	(MPa)	Mode	(UCS)	Capacity(Mpa)	Capacity(Mpa)	Remarks													
BH101	23.40	23.60	dry	70	129	1.85	1357.4	2729	362.90	94.35	Multiple Fracturing	7	353.36	17.67	Strong													
BH102	24.10	24.30	dry	71	142	1.99	1554.6	2774	686.50	173.48	Multiple Fracturing	12	816.02	40.80	Very Strong													
BH103	17.60	17.80	dry	71	141	1.99	1571.1	2846	595.90	151.87	Axial Splitting	12	668.94	33.45	Very Strong													
BH103	20.50	21.50	dry	71	143	2.02	1614.0	2868	687.60	176.52	Multiple Fracturing	12	838.22	41.91	Very Strong													
BH104	23.10	23.50	dry	71	143	2.03	1558.1	2785	600.90	155.70	Axial Splitting	12	693.73	34.69	Very Strong													
BH106	22.50	22.70	dry	71	134	1.90	1426.3	2714	298.90	76.39	Axial Splitting	7	272.93	13.65	Strong													
BI BI BI BI	H101 H102 H103 H103 H104	From H101 23.40 H102 24.10 H103 17.60 H103 20.50 H104 23.10	From To H101 23.40 23.60 H102 24.10 24.30 H103 17.60 17.80 H103 20.50 21.50 H104 23.10 23.50	From To H101 23.40 23.60 dry H102 24.10 24.30 dry H103 17.60 17.80 dry H103 20.50 21.50 dry H104 23.10 23.50 dry	From To To H101 23.40 23.60 dry 70 H102 24.10 24.30 dry 71 H103 17.60 17.80 dry 71 H103 20.50 21.50 dry 71 H104 23.10 23.50 dry 71	From To To Composition H101 23.40 23.60 dry 70 129 H102 24.10 24.30 dry 71 142 H103 17.60 17.80 dry 71 141 H103 20.50 21.50 dry 71 143 H104 23.10 23.50 dry 71 143	No From To Condition (mm) (mm) H101 23.40 23.60 dry 70 129 1.85 H102 24.10 24.30 dry 71 142 1.99 H103 17.60 17.80 dry 71 141 1.99 H103 20.50 21.50 dry 71 143 2.02 H104 23.10 23.50 dry 71 143 2.03	No From To Condition (mm) (mm) (mm) (gms) H101 23.40 23.60 dry 70 129 1.85 1357.4 H102 24.10 24.30 dry 71 142 1.99 1554.6 H103 17.60 17.80 dry 71 141 1.99 1571.1 H103 20.50 21.50 dry 71 143 2.02 1614.0 H104 23.10 23.50 dry 71 143 2.03 1558.1	No From To Condition (mm) (mm) (mm) (mm) (gms) (Kg/m) H101 23.40 23.60 dry 70 129 1.85 1357.4 2729 H102 24.10 24.30 dry 71 142 1.99 1554.6 2774 H103 17.60 17.80 dry 71 141 1.99 1571.1 2846 H103 20.50 21.50 dry 71 143 2.02 1614.0 2868 H104 23.10 23.50 dry 71 143 2.03 1558.1 2785	No From To Condition (mm) (mm) (mm) (mm) (gms) (gms) (gms) (kg/m²) (kN) H101 23.40 23.60 dry 70 129 1.85 1357.4 2729 362.90 H102 24.10 24.30 dry 71 142 1.99 1554.6 2774 686.50 H103 17.60 17.80 dry 71 141 1.99 1571.1 2846 595.90 H103 20.50 21.50 dry 71 143 2.02 1614.0 2868 687.60 H104 23.10 23.50 dry 71 143 2.03 1558.1 2785 600.90	No From To Condition (mm) (mm) (mm) (gms) (Kg/m²) (kN) (MPa) H101 23.40 23.60 dry 70 129 1.85 1357.4 2729 362.90 94.35 H102 24.10 24.30 dry 71 142 1.99 1554.6 2774 686.50 173.48 H103 17.60 17.80 dry 71 141 1.99 1571.1 2846 595.90 151.87 H103 20.50 21.50 dry 71 143 2.02 1614.0 2868 687.60 176.52 H104 23.10 23.50 dry 71 143 2.03 1558.1 2785 600.90 155.70	No From To Condition (mm) (mm) (mm) (gms) (Ks/m) (KN) (MPa) Mode H101 23.40 23.60 dry 70 129 1.85 1357.4 2729 362.90 94.35 Multiple Fracturing H102 24.10 24.30 dry 71 142 1.99 1554.6 2774 686.50 173.48 Multiple Fracturing H103 17.60 17.80 dry 71 141 1.99 1571.1 2846 595.90 151.87 Axial Splitting H103 20.50 21.50 dry 71 143 2.02 1614.0 2868 687.60 176.52 Multiple Fracturing H104 23.10 23.50 dry 71 143 2.03 1558.1 2785 600.90 155.70 Axial Splitting	No From To Condition (mm) (mm) (mm) (gms) (Kg/m ²) (KN) (MPa) Mode (UCS) H101 23.40 23.60 dry 70 129 1.85 1357.4 2729 362.90 94.35 Multiple Fracturing 7 H102 24.10 24.30 dry 71 142 1.99 1554.6 2774 686.50 173.48 Multiple Fracturing 12 H103 17.60 17.80 dry 71 141 1.99 1571.1 2846 595.90 151.87 Axial Splitting 12 H103 20.50 21.50 dry 71 143 2.02 1614.0 2868 687.60 176.52 Multiple Fracturing 12 H104 23.10 23.50 dry 71 143 2.03 1558.1 2785 600.90 155.70 Axial Splitting 12	No From To Condition (mm) (mm) (gms) (Kg/m) (KN) (MPa) Mode (UCS) Capacity(Mpa) H101 23.40 23.60 dry 70 129 1.85 1357.4 2729 362.90 94.35 $Multiple$ Fracturing 7 353.36 H102 24.10 24.30 dry 71 142 1.99 1554.6 2774 686.50 173.48 Multiple Fracturing 12 816.02 H103 17.60 17.80 dry 71 141 1.99 1571.1 2846 595.90 151.87 Axial Splitting 12 668.94 H103 20.50 21.50 dry 71 143 2.02 1614.0 2868 687.60 176.52 Multiple Fracturing 12 838.22 H104 23.10 23.50 dry 71 143 2.03 1558.1 2785 600.90 155.70 Axial Splitting 12 693.73	No From To Condition (mm) (mm) (gms) (Kg/m) (KS) (MPa) Mode (UCS) Capacity(Mpa) Capacity(Mpa) H101 23.40 23.60 dry 70 129 1.85 1357.4 2729 362.90 94.35 Multiple Fracturing 7 353.36 17.67 H102 24.30 dry 71 142 1.99 1554.6 2774 686.50 173.48 Multiple Fracturing 12 816.02 40.80 H103 17.60 17.80 dry 71 141 1.99 1571.1 2846 595.90 151.87 Axial Splitting 12 816.02 40.80 H103 20.50 21.50 dry 71 143 2.02 1614.0 2868 687.60 176.52 Multiple Fracturing 12 838.22 41.91 H104 23.10 23.50 dry 71 143 2.03 1558.1 2785 600.90 15													

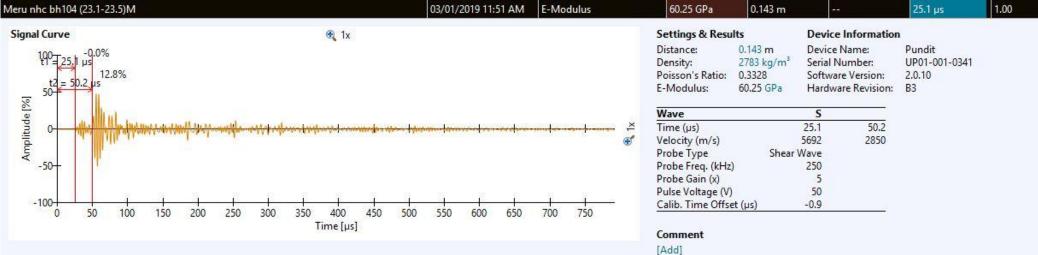
							ngineers &	& Materia	NEER Testing L OAD TI	aboratori							Tel: +2		ebsite: www.g	@geoissa.co.ke geoissa.co.ke
File No. :		3-19	9-10																	
Project :	PROPOSED	MERU NI	TUTU MIX	ED DEVEL	OPMENT											Standard :			ASTM D5731	
Client :	NATIO	ONAL HO		ORPORAT	ION											Date receiv				
Location -			MERU													Date tested	:	-	1/3/19	
Sample	Borehole	Dep	th (m)	Field Index		Test	Failure	L _d , L _a or	D _d W _a or	Density	De ²	De	Р	P/D_d^2	P/De ²	Is (50)	RMR	Estimated	Safe Bearing	Remarks
No.	No.	From	To	Strength	Moisture	Type	Type	D (mm)	W (mm)	(Kg/m ³)	(mm ²)	(mm ²)	(kN)	(MPa)	(MPa)	(MPa)	(Is (50))	UCS Is(50)*25	Capacity (Mpa)	RMR 15(50)
S1	BH101	20.50	20.60	EW	D	A	SP	63.4	69.5	1673	5609.55	74.90	0.060	-	0.01	0.01	0	0.32	0.05	Extremely Weak
S2	BH101	21.20	21.30	w	D	А	SP	63.3	71	1940	5721.58	75.64	0.600	(a)	0.10	0.13	1	3.16	0.47	Weak
S3	BH102	6.00	6.10	vs	D	А	TP	59	70.3	2531	5280.33	72.67	18.400		3.48	4.12	12	103.08	19.76	Very Strong
S4	BH102	18.50	18.60	vw	D	А	AF	63.4	70	2098	5649.90	75.17	0.100	<u></u>	0.02	0.02	0	0.53	0.08	Very Weak
S5	BH103	7.10	7.20	vs	D	А	TP	66.7	83.3	2798	7073.34	84.10	30.100		4.26	5.38	12	134.43	28.14	Very Strong
S6	BH103	16.50	16.60	w	D	Α	SP	71	70	1503	6327.18	79.54	0.800	1.50	0.13	0.16	1	3.90	0.58	Weak
S 7	BH103	17.50	17.60	vw	D	А	SP	65.5	70.3	2479	5862.06	76.56	0.100	543	0.02	0.02	0	0.52	0.08	Very Weak
S8	BH104	14.80	15.00	MW	D	А	SP	55.6	70.3	2284	4976.04	70.54	1.000		0.20	0.23	2	5.87	0.88	Moderately Weak
S 9	BH104	18.60	18.70	vw	D	А	SP	62.5	61	1473	4853.60	69.67	0.100	-	0.02	0.02	0	0.60	0.09	Very Weak
S10	BH104	19.10	19.20	w	D	А	SP	63.2	70.4	1839	5664.26	75.26	0.500	1943	0.09	0.11	1	2.65	0.40	Weak
S11	BH105	10.90	11.00	vw	D	А	SP	80	67.5	1332	6874.60	82.91	0.170		0.02	0.03	0	0.78	0.12	Very Weak
S12	BH105	19.00	19.10	EW	D	А	SP	54.2	70.2	1383	4843.84	69.60	0.060	12	0.01	0.01	0	0.36	0.05	Extremely Weak
S13	BH105	19.90	20.00	vs	D	А	TP	54.2	70.3	2848	4850.74	69.65	23.400	300	4.82	5.60	12	140.00	29.77	Very Strong
S14	BH105	24.50	24.60	vs	D	А	SP	57.6	71	2841	5206.37	72.16	26.700	1.00	5.13	6.05	12	151.22	33.24	Very Strong
S15	BH106	21.40	21.50	vs	D	А	TP	56.2	70.8	2758	5065.51	71.17	19.200	343	3.79	4.44	12	111.08	21.77	Very Strong
	Symbol "-" mean				and a						2. 2.254									2
Moistury D- Dry	e Fiel EW	d Index Stree Extreme	3.5.10	Test Tyj D- Dia		Sample Di	mensions t of Diametra	Sample		Failure Ty	pe e/Parallel)- Fa	ilures alono t	foliations		MR-	Is ₍₅₀₎ - Point loa index for the st size of 50mm d	andard core			
M- Mo		Weak		A- Axi			of Axial san				ions are inclin		ionations	Ro	ck mass ing	P-Load				
W- Wet			ely Weak	L- Lun			ter of Diamet	0.9.1		SP- Failu loading	re along single	plane contai	ning line of	sy	nig stem ieniawsk					
	MS				12.01	D- Distanc Lump Sam	e between Pl	aten Contacts	for	TP- Tripl	e Plane: Failu	e along three	extensional		1989)					
	S-	Strong					ter of Axial !	Samule		S - Shea	r Failure									
	VS- ES-	Very Stro Extreme	ng ly Strong					Width for Lu	mp	3 • 3ilea	Tanure									
fested by :	CLEM		2010/10/202																	



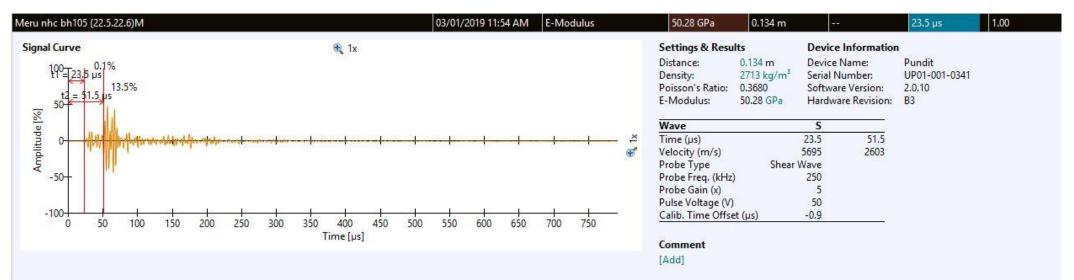


18 March 2019





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Ultrasonic Pulse Velocity Curves

10. APPENDIX D-Relevant Literature

SAMPLING METHOD	PENETRATION RESIST	ANCE		
SS split spoon ST Shelby tube AS auger sample WS wash sample RC rock core WH weight of hammer PH pressure, hydraulic	Standard Penetration T number of blows by a ham distance of 0.76 m (30 in.) split spoon sampler for a c Dynamic Cone Test (DC hammer weighing 63.6 kg required to advance a con sides on 'A' size drill rods	nmer weighing 63) required to adva distance of 0.3 m CT) resistance is d ((140 lb.) falling fr nical steel point of	.6 kg (140 lb.) falling fre nce a standard 50 mm (12 in.). efined as the number of eely for a distance of 0 50 mm (2 in.) diameter	eely for a (2 in.) diameter f blows by a .76 m (30 in.)
SOIL DESCRIPTION - COH	ESIONLESS SOILS	SOIL DESCRI	PTION - COHESIVE	SOILS
Relative Density	'N' value	Consistency	Undrained Shear Strength, kPa	'N' value
very loose loose	< 4 4 - 10		< 12	< 2
compact	10 - 30	very soft soft	12 - 25	< 2 2 - 4
dense	30 - 50	firm	25 - 50	4 - 8
very dense	> 50	stiff	50 - 100	8 - 16
		very stiff	100 - 200	16 - 32
		hard	> 200	> 30
SOIL COMPOSITION		TESTS, SYME	BOLS	
	% by weight		nical sieve and hydrom	eter analysis
'trace' (e.g. trace silt)	< 10	w _i liquid l	imit	
'some' (e.g. some gravel)	10 - 20	w _p plastic		
adjective (e.g. sandy)	20 - 35		ty index	
'and' (e.g. sand and gravel)	35 - 50	Press Press Press	ient of permeability	
			it weight, bulk	
(,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,			of internal friction	
		c' cohesi	of internal friction on shear strength ession index	

The conclusions and recommendations provided in this report are based on the factual information obtained from the boreholes and/or test pits. Subsurface conditions between the test holes may vary.

The engineering interpretation and report recommendations are given only for the specific project detailed within, and only for the original client. Any third party decision, reliance, or use of this report is the sole and exclusive responsibility of such third party. The number and siting of boreholes and/or test pits may not be sufficient to determine all factors required for different purposes.

Table D-1 Soil and Insitu Test Description

	PAR	AMETER		Ra	nge of values	// ratings				
	Strength of intact	Point-load strength index	> 10 MPa	4 - 10 MPa	2 - 4 MPa	1 - 2 MPa	uniaxial	his low ra compr. s preferre	treng	
A 8	rock material	Uniaxial com- pressive strength	> 250 MPa	100 - 250 MPa	50 - 100 MPa	25 - 50 MPa	5 - 25 MPa		< ' MP	
*	*****	RATING	15	12	7	4	2	1	0	
	Drill core qu	uality RQD	90 - 100%	75 - 90%	50 - 75%	25 - 50%		< 25%		
2		RATING	20	17	13	8	5			
	Spacing of	discontinuities	> 2 m	0.6 - 2 m	200 - 600 mm	60 - 200 mm	<	< 60 mm	8	
3		RATING	20	15	10	8	5			
-		Length, persistence	<1 m	1 - 3 m	3 - 10 m	10 - 20 m		> 20 m		
		Rating	6	4	2	1	0			
		Separation	none	< 0.1 mm	0.1 - 1 mm	1 - 5 mm		> 5 mm		
		Rating	6	5	4	1		0		
	o	Roughness	very rough	rough	slightly rough	smooth	slir	ckenside	he	
	of discon-	Rating	6	5	3	1	311			
	tinuities	raing	none	107.0	filling	100 NO.	ft filling			
		Infilling (gouge)	-	< 5 mm	> 5 mm	< 5 mm		> 5 mm		
		Rating	6	4	2	2	~ 5 mm			
		Weathering	unweathered	slightly w.	moderately w.	highly w.	dov	0		
		Rating	6	5	3	1 nigrily w.	uer		0 5 mm 0 0 0 5 litres /min > 0.5	
-		Inflow per 10 m		(50)	-					
	Ground	tunnel length	none	< 10 litres/min	10 - 25 litres/min	25 - 125 litres/min	> 12	5 litres	min	
	water	p _w / σ1	0	0 - 0.1	0.1 - 0.2	0.2 - 0.5	> 0.5			
		General conditions	completely dry	damp	wet	dripping	flowing			
- 1		DATINO	15	10	7	4	0			
	ioint water r	RATING pressure: σ1 = major	principal stress							
		pressure; σ1 = major		TY ORIENTATI	ONS					
		pressure; σ1 = major		TY ORIENTATI Favourable	ONS Fair	Unfavourable	Very (unfavou	rable	
		pressure; σ1 = major				Unfavourable -10	Very (unfavou -12	rable	
5. F		pressure; σ1 = major	DISCONTINUI Very favourable	Favourable	Fair		Very (90 0 0 0 0 0 0 0 0 2 9 0	rable	
5. F	RATING A	pressure; σ1 = major DJUSTMENT FOR Tunnels	DISCONTINUI Very favourable 0	Favourable -2	Fair -5	-10	Very (-12	rable	
R	RATING A	Tunnels Foundations Slopes	DISCONTINUI Very favourable 0 0 0	Favourable -2 -2 -5	Fair -5 -7 -25	-10 -15	Very t	-12 -25	rable	
8. F	RATING A ATINGS OCK MAS	pressure; σ1 = major DJUSTMENT FOF Tunnels Foundations Slopes S CLASSES DET	BISCONTINUI Very favourable 0 0 0 ERMINED FRO	Favourable -2 -2 -5 M TOTAL RAT	Fair -5 -7 -25	-10 -15 -50	Very	-12 -25 -60	rable	
8. F	RATING A ATINGS OCK MAS R	oressure; σ1 = major DJUSTMENT FOF Tunnels Foundations Slopes S CLASSES DET ating	DISCONTINUI Very favourable 0 0 0	Favourable -2 -2 -5 M TOTAL RAT 80 - 61	Fair -5 -7 -25 INGS 60 - 41	-10 -15 -50 40 - 21	Very	-12 -25	rable	
R/	ATING A ATINGS OCK MAS R Cla	Tunnels Foundations Slopes SCLASSES DET ating uss No.	BISCONTINUI Very favourable 0 0 0 ERMINED FRO 100 - 81 I	Favourable -2 -2 -5 M TOTAL RAT 80 - 61 II	Fair -5 -7 -25	-10 -15 -50		-12 -25 -60 < 20 V		
8. F R/	ATING A ATINGS OCK MAS R Cla Des	oressure; σ1 = major DJUSTMENT FOF Tunnels Foundations Slopes S CLASSES DET ating	BISCONTINUI Very favourable 0 0 0 ERMINED FRO 100 - 81 I VERY GOOD	Favourable -2 -2 -5 M TOTAL RAT 80 - 61	Fair -5 -7 -25 INGS 60 - 41 III	-10 -15 -50 40 - 21 IV		-12 -25 -60 < 20		
3. F R/ C. R	ATINGS OCK MAS Cla Des IEANING (Tunnels Foundations Slopes S CLASSES DET ating ass No. scription	BISCONTINUI Very favourable 0 0 0 ERMINED FRO 100 - 81 I VERY GOOD	Favourable -2 -2 -5 M TOTAL RAT 80 - 61 II	Fair -5 -7 -25 INGS 60 - 41 III	-10 -15 -50 40 - 21 IV		-12 -25 -60 < 20 V		
8. F R/	ATINGS OCK MAS Cla Des IEANING (Cla	Tunnels Foundations Slopes SCLASSES DET ating ass No. scription	BISCONTINUI Very favourable 0 0 0 ERMINED FRO 100 - 81 I VERY GOOD	Favourable -2 -2 -5 M TOTAL RAT 80 - 61 II GOOD	Fair -5 -7 -25 INGS 60 - 41 III FAIR	-10 -15 -50 40 - 21 IV POOR	VE	-12 -25 -60 < 20 V RY POO	DR s fo	
3. F R/ C. R	ATINGS ATINGS OCK MAS Cla Des IEANING (Cla Average s	Tunnels Foundations Slopes S CLASSES DET ating ass No. ccription DF ROCK MASS (ass No.	EDISCONTINUI Very favourable 0 0 ERMINED FRO 100 - 81 I VERY GOOD CLASSES I 10 years for	Favourable -2 -2 -5 M TOTAL RAT 80 - 61 II GOOD	Fair -5 -7 -25 INGS 60 - 41 III FAIR III 1 week for	-10 -15 -50 40 - 21 IV POOR IV 10 hours for	VE 30	-12 -25 -60 < 20 V RY POO V 0 minute	DR s fo	

Table D-2 Rock Mass Rating (RMR) after Bieniawski,1989

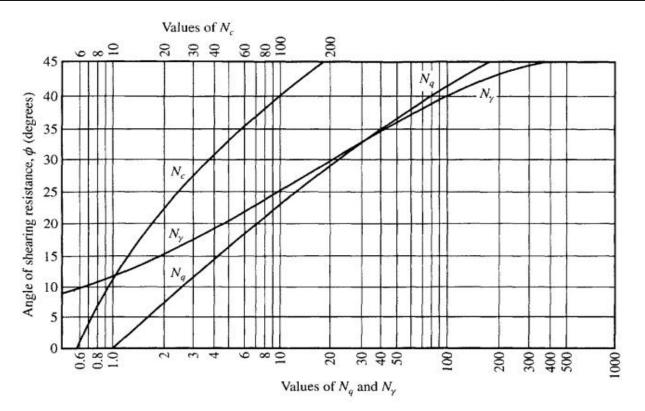


Figure D-1 Terzaghi's bearing capacity factors



Figure D-2 Site Photo



Figure D-3 Site Photo

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