A REPORT ON SOIL INVESTIGATIONS AT THE SITES OF SIREN SYSTEM (EWANS) IN JAMAICA

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1.1. Authority

NHL Engineering Ltd. submitted a proposal for soil investigations for the investigation of the sites for the Emergency Siren Development Project throughout parts of the island. Our proposal was accepted and a package of 3 distributed areas located across the island was issued. This report is specific to the sites in St. Catherine and Portland.

The field investigation commenced on April 21 and was completed on May 1, 2016.

This report contains the results of the work done; the conclusions drawn; and the recommendations made regarding the main areas of engineering concerns as defined by the scope of this investigation.

1.2. Scope of Work

NHL Engineering Limited was to arrange:

- i) The field exploration based on the proposed test location point and
- ii) The laboratory testing programme, which in our judgment, was necessary to provide a satisfactory basis for evaluating the site for the design of the steel tower foundations and other infrastructural elements on site.

On completion, a report presenting the results obtained, together with our recommendations for the appropriate design parameters should be submitted to the Client.

1.3. Project Description

1. SITES LOCATION:

Old Harbour Bay

The general location of the four (4) locations can be seen in the report Appendices. The sites are located in Narine Lane, Old Harbour Bay Fishing Village, Black Wood Gardens and New Old Harbour Village in Old Harbour Bay, St. Catherine. The area is two fold in deposition history; it forms part of an alluvium along with intrusions of the white limestone deposits in the hilly regions. Insitu subsoil materials in the area were therefore likely to be a mixture of Clays, Sands and Gravels in varying mixed proportion as well as the Newport Formation which comprises mainly of white Limestone Group. This group is generally fractured, fossilerous and are usually overlain by residual soils typically silts and clays.



PLATE 1 – Picture showing the existing topography in the vicinity of borehole #SIR 001

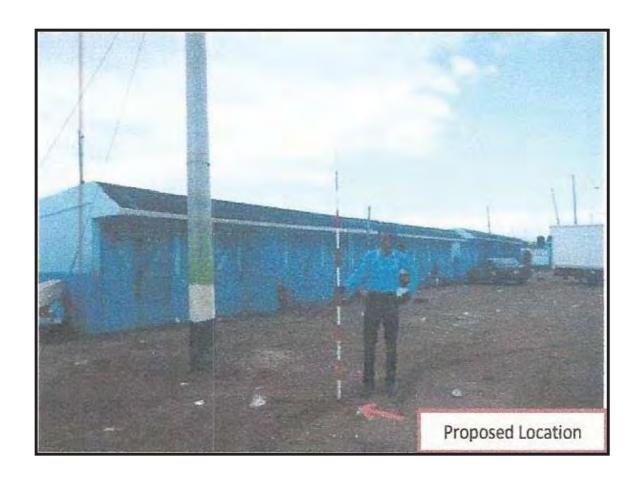


PLATE 2 – Picture showing the existing topography in the vicinity of borehole #SIR 002



PLATE 3 – Picture showing the existing topography in the vicinity of borehole #SIR 003



PLATE 4 – Picture showing the existing topography in the vicinity of borehole #SIR 004

Bog Walk

The general location of the five (5) locations can be seen in the report Appendices. The sites are located in Bog Walk, Kent Village, Steep Slope, Dam Head Tower and Angel's Round-A-Bout in Bog Walk, St. Catherine. Due to access issues at the Steep Slope Site, this location will not undergo a field investigated. The site generally forms part of the Newport, Formation which comprises mainly of white Limestone Group. This group is generally fractured, fossilerous and are usually overlain by residual soils typically silts and clays.

Alluvial soils such as clays, silts sands and gravels are also quite prevalent in the areas in close proximity to past and present river systems.



PLATE 5 – Picture showing the existing topography in the vicinity of borehole #SIR 005



PLATE 6 – Picture showing the existing topography in the vicinity of borehole #SIR 006



PLATE 7 – Picture showing the existing topography in the vicinity of borehole #SIR 007



PLATE 8 – Picture showing the existing topography in the vicinity of borehole #SIR 008



PLATE 9 – Picture showing the existing topography in the vicinity of borehole #SIR 009

Port Maria

The general location of the six (6) sites can be seen in the report Appendices. The sites are located in Castel Gardens, the Parish Council, in the Town Center, RADA Office, Clembhards Park and Trinity in Port Maria, Portland. Due to access issues with the RADA Office Site no field investigation will be done at this site, a desk study is proposed.

The general area is also characterized by the Walderston- Brown's Town Formation, which entails a mixture of Shales and Sandstones. The upper soils are likely to be alluvial, consisting of a mixture of Clays, Sands and Gravels in varying mixed proportion.



PLATE 10 – Picture showing the existing topography in the vicinity of borehole #SIR 010



PLATE 11 – Picture showing the existing topography in the vicinity of borehole **#SIR 011**



PLATE 12 – Picture showing the existing topography in the vicinity of borehole **#SIR 012**



PLATE 13 – Picture showing the existing topography in the vicinity of borehole #SIR 013



PLATE 14 – Picture showing the existing topography in the vicinity of borehole #SIR 014



PLATE 15 – Picture showing the existing topography in the vicinity of borehole #SIR 015

2. Superstructures:

According to the information obtained from the client, it is proposed to construct poles housing the sirens for the sites comprising of reinforced steel framed/tubular or reinforced precast concrete conical column. The investigation will seek therefore to consider foundation requirements for both types based on the anticipated critical lateral or vertical design loads.

2.1. Proposed Programme

The proposed investigation will seek to establish the following;

- i) The insitu density of the soils on site.
- ii) Soil stratification and distribution across the site including depth to bedrock (if necessary).
- iii) The design parameters relevant to the design of the anticipated structural and infrastructural elements required on site.

The field investigation entailed the drilling of one (1) borehole at each of the thirteen (13) locations. The Boreholes were to be taken to a maximum depth of 35ft (10.7m).

The methods of drilling and sampling were in accordance with the Standard Penetration Testing specifications, using the Split Spoon Sampling technique. The boreholes were to be used to recover representative samples of the soil for examination by the Soils Engineer and for the carrying out of the laboratory testing programme. These results were to be use along with site deductions during the sampling exercise and intuitive knowledge of the deposition history of the area, to arrive at a reasonable presumptive profile and subsequently a design profile across the site.

It was envisaged that laboratory testing would not include more than the conventional Classification and Index Tests, if however the information was insufficient to predict fairly accurately the required designed parameters, other tests would be specified (one dimensional consolidation).

2.2. Anticipated Design Approach

Given the nature of the proposed structures and projected uses, the pertinent loading conditions to be considered at all 15 locations are:

- i) Uplifting and overturning due to hurricane design wind speed and
- ii) Settlement of the foundation (mass concrete mat) in the upper clayey strata

The adjustment to depth and type of foundation should account for (i) and (ii) above, And will depend on soil type and structure/loading type at the specific location

In general shallow foundation should be appropriate for all sites under steady load condition. Macro instability should however be analyzed under seismic loading conditions for shallow foundations.

2.3. Soil Boring & Sampling

1. Methodology:

The borings were made by NHL Drillers using a truck mounted CME Drill Rig, with a 160 mm hollow stem auger string. Sampling was done with a Split Spoon in accordance with Standard Penetration Testing specifications, using a Cathead Hammer (N₅₅ values). In general, S.S samples were taken at 0.76 metre intervals of depth to the first 3 metres and thereafter at 1.5 metre interval to the maximum depth. The field logs are shown in the (Appendix II).

2. Discussion of results:

The results of the field and laboratory tests are shown in the appendix.

Old Harbour:

The soils encountered across the Old Harbour Bay were predominantly Very Stiff Clays. Insitu densities were generally in the Firm/Very Loose to Very Stiff/Dense range. No Refusal on the auger was encountered in any of the boreholes.

Water table was only encountered in one hole at approximately 2m below existing ground level in one of the Old Harbour Bay sites.

Bog Walk:

The soils encountered across the Bog Walk Sites were predominantly Very Dense Sands Cobbles & Boulders. Insitu densities were generally in the Compact/Firm to Very Dense/Hard range. Refusal was encountered on the auger in two (2) of the boreholes.

No water table was encountered below existing ground level at any of the Bog Walk sites.

Port Maria:

The soils encountered across the Port Maria Sites were predominantly Firm Clays. Insitu densities were generally in the Very Soft/Compact to Very Stiff/Very Dense range. No Refusal on the auger was encountered in any of the boreholes.

Water table was encountered at variable depths, about 2+m below existing ground level at the Port Maria sites.

The soils encountered were predominantly of the cohesive fraction. Forty one (41) samples were selected for testing; seventeen (17) Grainsize Distribution Tests and twenty four (24) Index Testings were done on the samples recovered. The chosen samples are, to the best of the engineer's judgment, representative of the samples recovered from the boreholes.

3.1. Classification & Index Testing:

1. Grainsize Distribution:

Figures 3.1 shows the grainsize distribution envelopes of the samples tested. The figure indicates that the samples have gradation that falls essentially into two significant groups. The following is the group descriptions:

- 1) Group A the Graded Coarse to Fine Sands plus some Gravels & Clays
- 2) Group B the Clays and Sands plus little Gravels

2. Soil Plasticity:

Appendix II gives a listing of the Atterberg Limits for the samples tested. The results indicate that the soils classified as Inorganic Clays of Medium to High Plasticity; the Liquid Limits ranged between 50.0% and 84.8%; the Plastic Limits between 23.6% and 30.5%; and the Moisture Contents between 9.0% and 24.0%. Based on these results, it is expected that the majority of these soils will exhibit moderate to high swell/shrinkage and compressibility. Given however their frequency of occurrence within the depths explored, it is expected that they will not have a significant impact on the design of the foundation soils and other infrastructural elements on site.

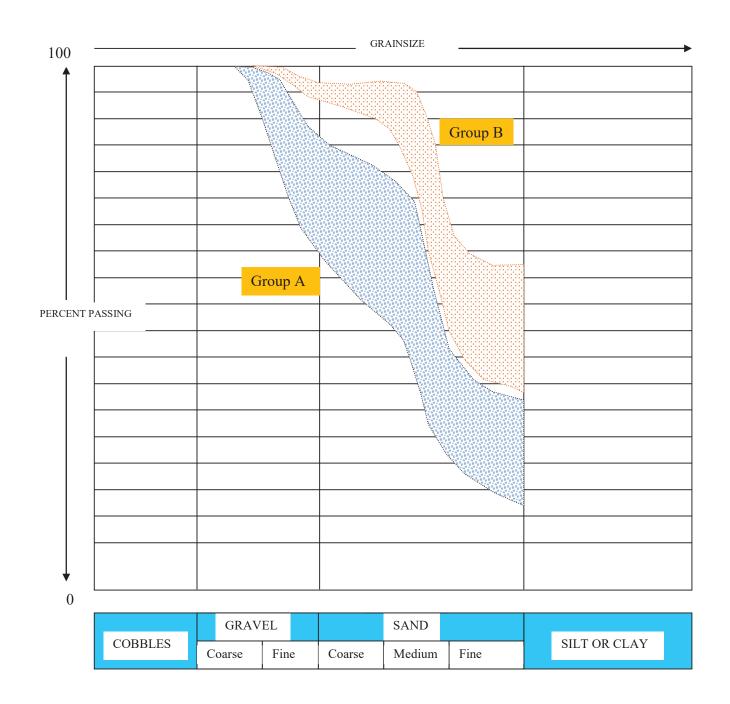


FIGURE 3.1 - GRADATION ENVELOPE – IMPROVEMENT OF EMERGENCY COMMUNICATION SYSTEMS IN JAMAICA (OLD HARBOUR BAY)

4.1. Presumptive Soil Profile

The Presumptive profiles shown are an extrapolation of the borehole information along with an understanding of the deposition history of the soils in the area. The profile boundaries shown are presumptive and should be viewed only as approximate representations of the insitu soil condition on site.

Old Harbour Bay

The subsoil layers applicable for evaluating engineering behavior and construction concerns can be characterized as five (5) distinct types found on the different sites in this area (see typical site profiles below). The type is as follows:

A) <u>TYPE 1</u>

 Loose - Compact SANDS + Some Gravels Depth Range; Variable 0-10.7+m Average N₅₅ = 6 Borehole - # 002, 003 & 004

B) TYPE 2

2) Very Stiff CLAYS
Depth Range; Variable 2.3-10.7+m
Average N₅₅ = 15
Borehole - # 002, 003 & 004

C) TYPE 3

3) Firm – Stiff CLAYS
Depth Range; Variable 0-10.7+m
Average N₅₅ = 9
Borehole - # 001 & 003

D) TYPE 4

4) Very Loose SANDS Depth Range; Variable 1.5-6m Average N₅₅ = 2 Borehole - # 002

E) <u>TYPE 5</u>

5) Very Soft CLAYS
Depth Range; Variable 3-5m
Average N₅₅ = 1
Borehole - # 002

BogWalk

The subsoil layers applicable for evaluating engineering behavior and construction concerns can be characterized as five (5) distinct types found on the different sites in this area (see typical site profiles below). The type is as follows:

A) TYPE 6

 Very Dense Calcareous COBBLES & BOULDERS + Some Sands Depth Range; Variable 0-2.1m Average N₅₅ = 40 Borehole - # 006, 008 & 009

B) <u>TYPE 3</u>

2) Firm – Stiff CLAYS
Depth Range; Variable 0-10.7+m
Average N₅₅ = 15
Borehole - # 0005 & 009

C) TYPE 2

3) Very Stiff – Hard CLAYS Depth Range; Variable 0-10.7+m Average N₅₅ = 40 Borehole - # 006 & 009

D) <u>TYPE 7</u>

4) Medium – Hard Porous Limestone Rock Depth Range; Variable 1.5-3.7+m Borehole - # 006 & 008

E) <u>TYPE 1</u>

5) Compact SANDS
Depth Range; Variable 2.3-9.1m
Average N₅₅ = 10
Borehole - # 009

Port Maria

The subsoil layers applicable for evaluating engineering behavior and construction concerns can be characterized as five (5) distinct types found on the different sites in this area (see typical site profiles below). The type is as follows:

A) TYPE 3

1) Firm – Stiff CLAYS
Depth Range; Variable 0-10.7+m
Average N₅₅ = 5
Borehole - # 011, 014 & 015

B) <u>TYPE 5</u>

2) Very Soft - Soft CLAYS
Depth Range; Variable 0-10.7+m
Average N₅₅ = 15
Borehole - # 011, 012, 014 & 015

C) TYPE 2

3) Very Stiff CLAYS
Depth Range; Variable 7.6-10.7+m
Average $N_{55} = 15$ Borehole - # 012 & 014

D) TYPE 1

4) Compact Calcareous SANDS + Some Gravels
 Depth Range; Variable 0-10m
 Average N₅₅ = 12
 Borehole - # 010 & 011

E) <u>TYPE 6</u>

5) Very Dense Calcareous Gravelly SANDS + Some Gravels Depth Range; Variable 4.6-7.6m Average $N_{55} = 50$ Borehole - # 010 & 011

Old Harbour Site:

Generally the Types 5 and 4 soils will exhibit significant settlement especially the Type 5 Soils. These soils will require modification or replacement. The Type 4 soils can be modified with mechanical compaction when they are close to the surface. The Type 4 soils however will need to be replacing part and or reinforced using geogrid to mitigate settlement.

In the case of the Types 3 and 2 soils, seasonal swell shrinkage could be problematic; deepening the footings and or soil replacement should mitigate the problems.

Port Maria Site:

Boreholes 12 and 14 show significant presence of the Type 5 soils (very soft clays). These soils will need replacement and reinforcement with geogrid. Passive resistance of these soils will be very low and lateral stability could be a major problem. The use of short bored piles is an option.

The soils at Location 13 (inaccessible) appear subjectively to be calcareous sands and gravels and are therefore likely to be similar in properties to the Type 1 soils summarized below. The assumption in that location is that lateral restraint is offered by the retaining wall along the slope in the vicinity of the proposed location.

BogWalk Site:

The soils in this area are generally good foundation soils and are not anticipated to present any significant problems. In areas where the Type 3 soils were encountered foundation deepening could be sufficient. To satisfy the requirements for lateral loading, the required depth of the foundation could mitigate swell shrinkage issues.

The site at Location 7 was inaccessible by our testing equipment. Based on our visual assessment the area is comprised of predominantly limestone rock. The outcroppings appear quite fractured and the RQDs are likely to be fairly low. The properties are therefore similar to that of the Type 7 soils summarized below and are recommended for foundation design purposes.

In general for all 3 locations, overturning will however govern the design of the footing. The passive resistance of the soil and the weight of the foundation and the soil above it will be the stabilizing forces in this design. Both problems will have to be accounted for in design.

For locations requiring soil replacement, it is recommended that a compact granular layer of soil placed below the footing to dissipate pore pressure development during saturated conditions. In addition use a stiff mat for the tower to mitigate settlement problems. The depth and size of the mat shall be chosen to ensure macro stability of the tower.

Old Harbour Bay

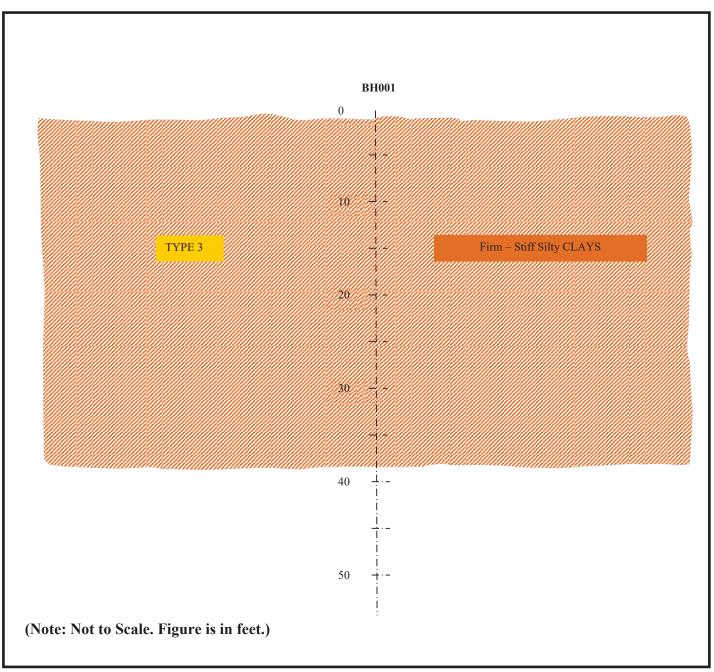


FIGURE 4.1 - Presumptive Profile — BOREHOLES #001

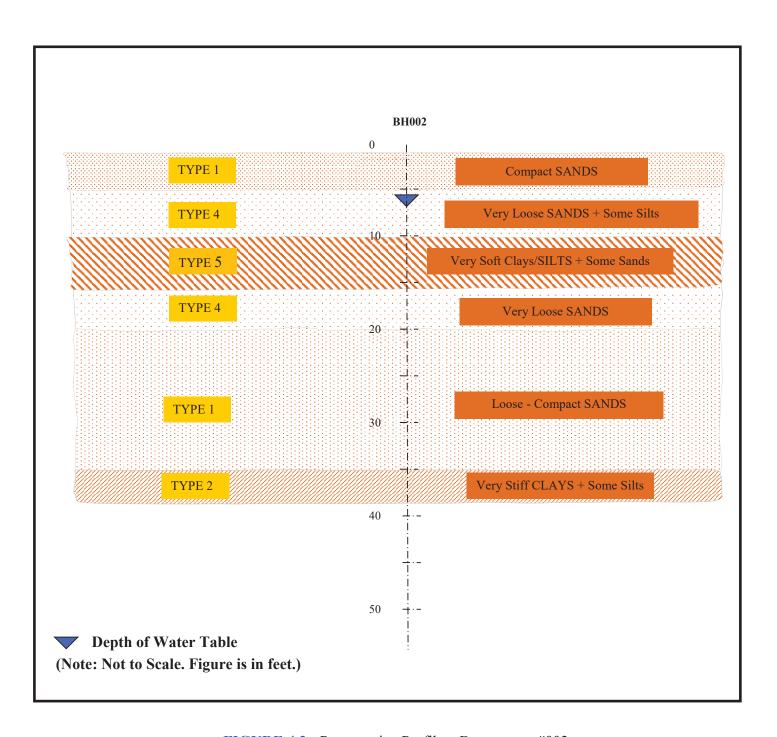
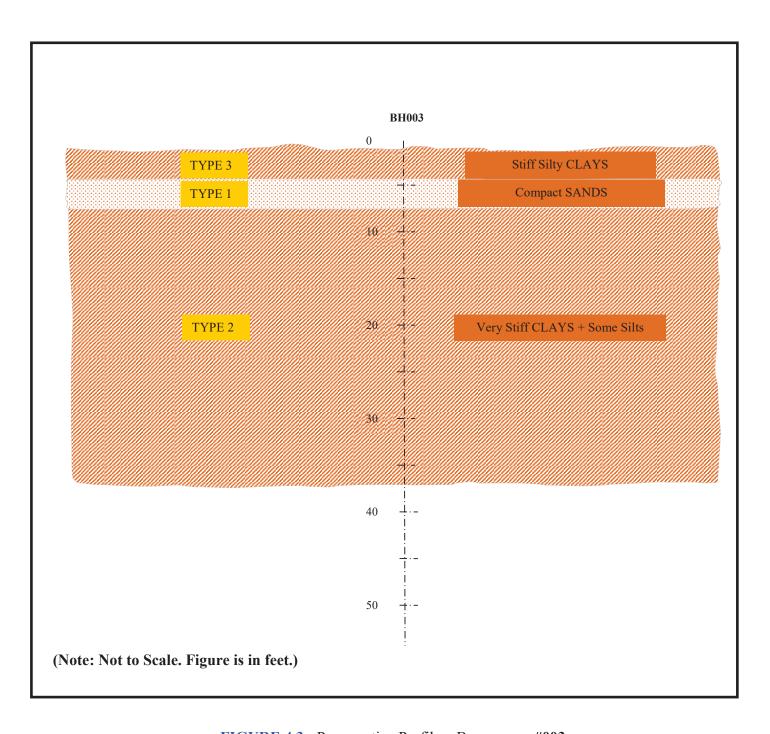
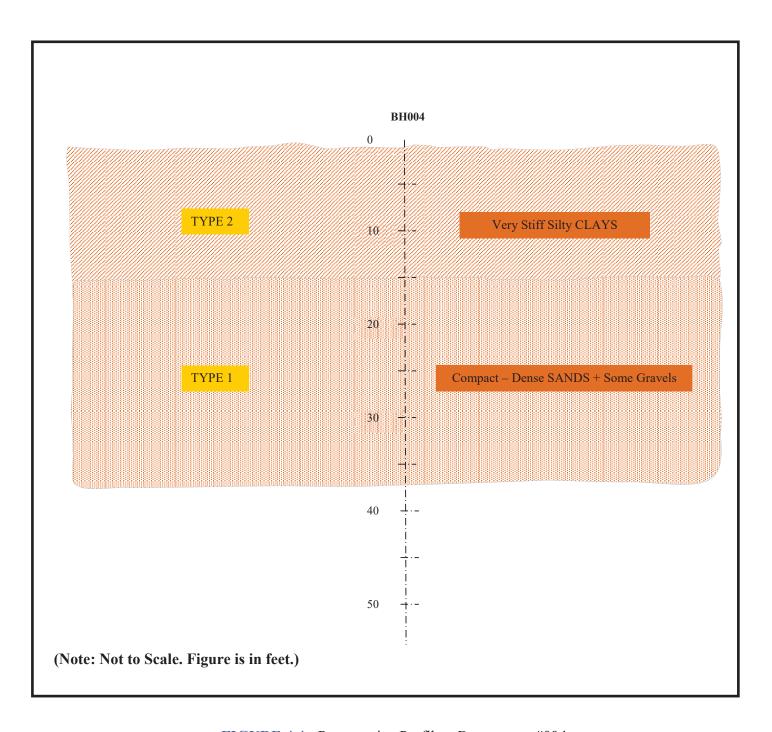


FIGURE 4.2 - Presumptive Profile – BOREHOLES #002



 $FIGURE\ 4.3\ -\ Presumptive\ Profile\ -\ BOREHOLES\ \#003$



 $\pmb{FIGURE~4.4} - Presumptive~Profile - Boreholes~\#\textbf{004}$

Bog Walk

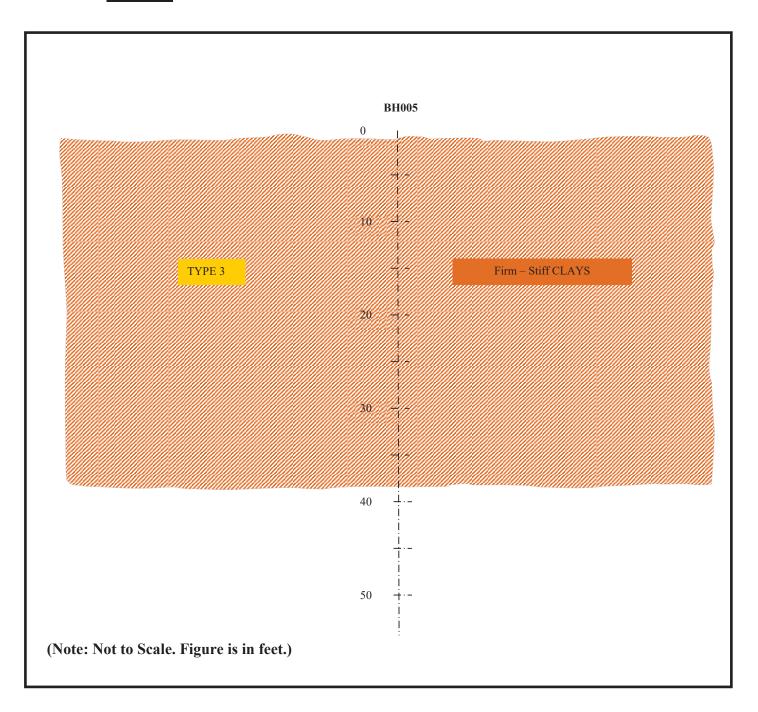
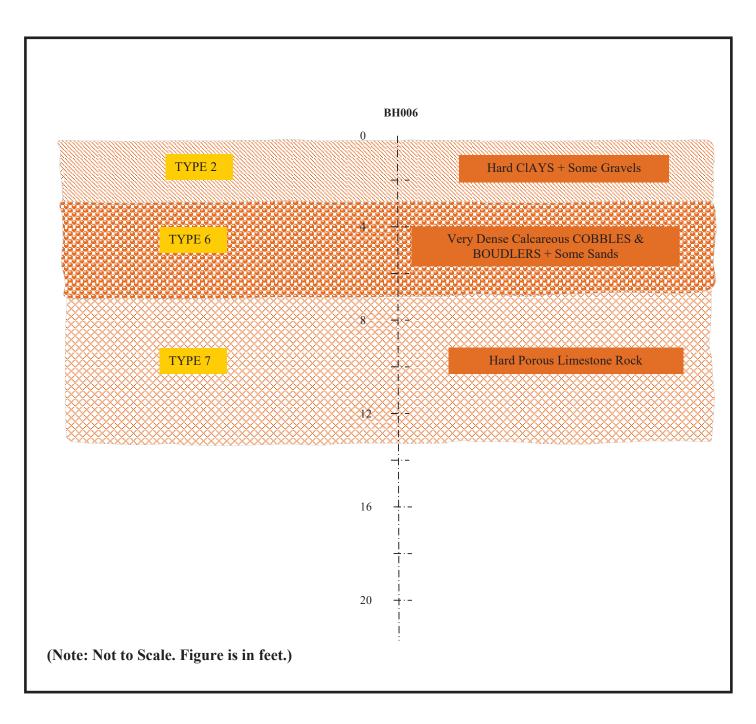
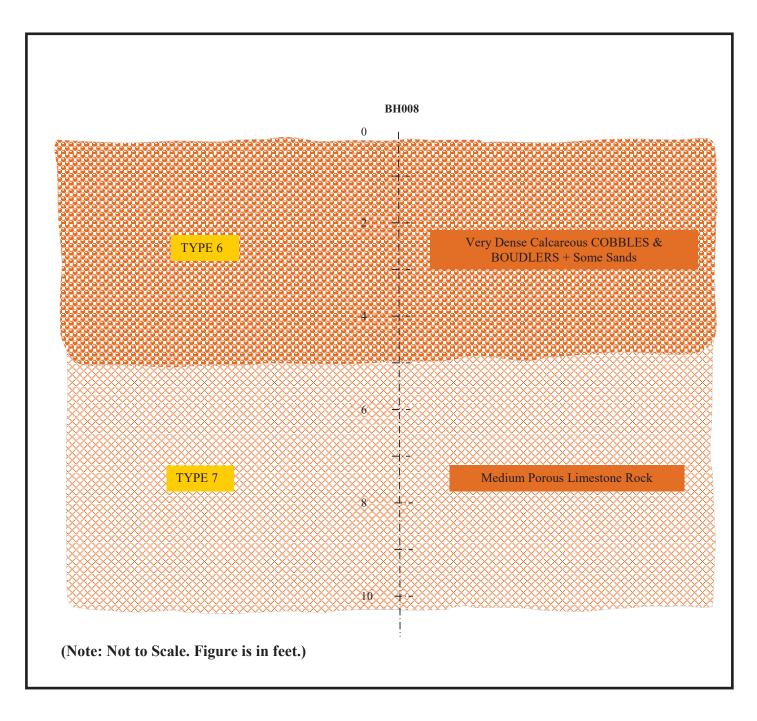


FIGURE 4.5 - Presumptive Profile – BOREHOLES #005



 $FIGURE\ 4.6\ -\ Presumptive\ Profile-Boreholes\ \#006$



 $FIGURE\ 4.7\ -\ Presumptive\ Profile\ -\ BOREHOLES\ \#008$

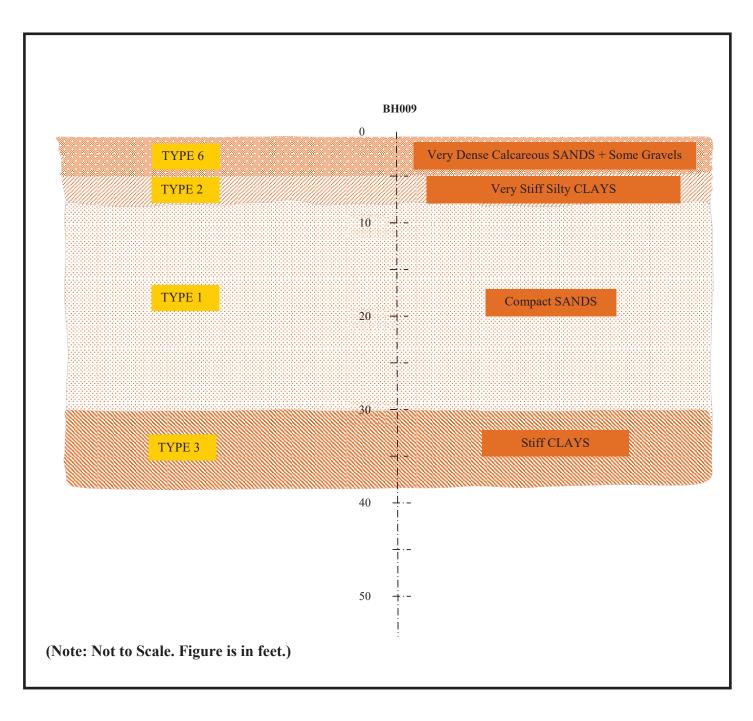


FIGURE 4.8 - Presumptive Profile – BOREHOLES #009

Port Maria

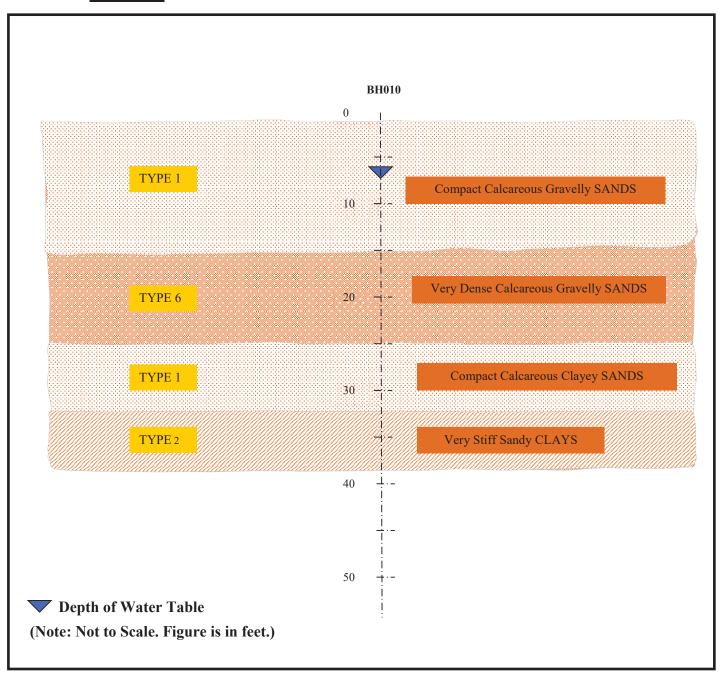


FIGURE 4.9 - Presumptive Profile – BOREHOLES #010

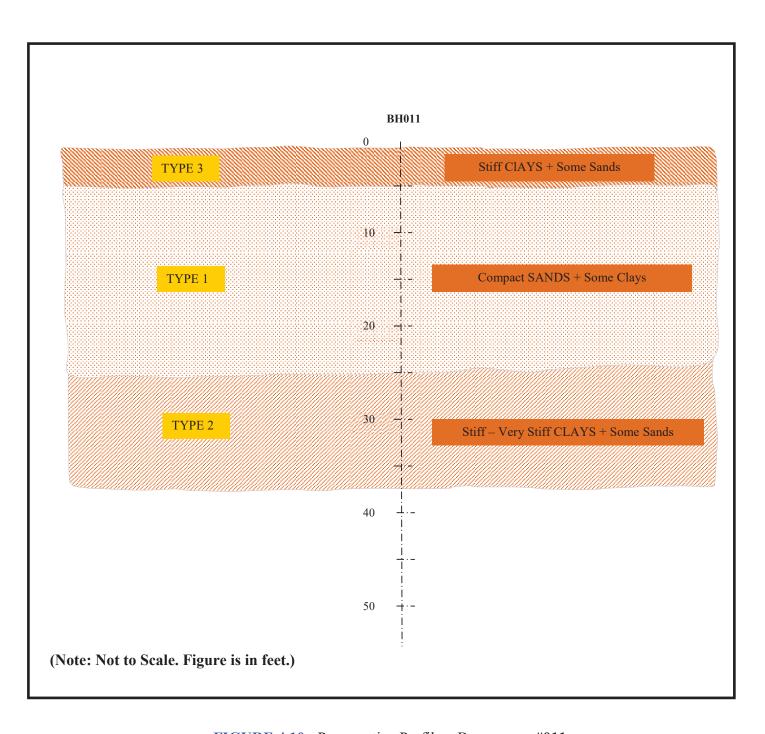


FIGURE 4.10 - Presumptive Profile - BOREHOLES #011

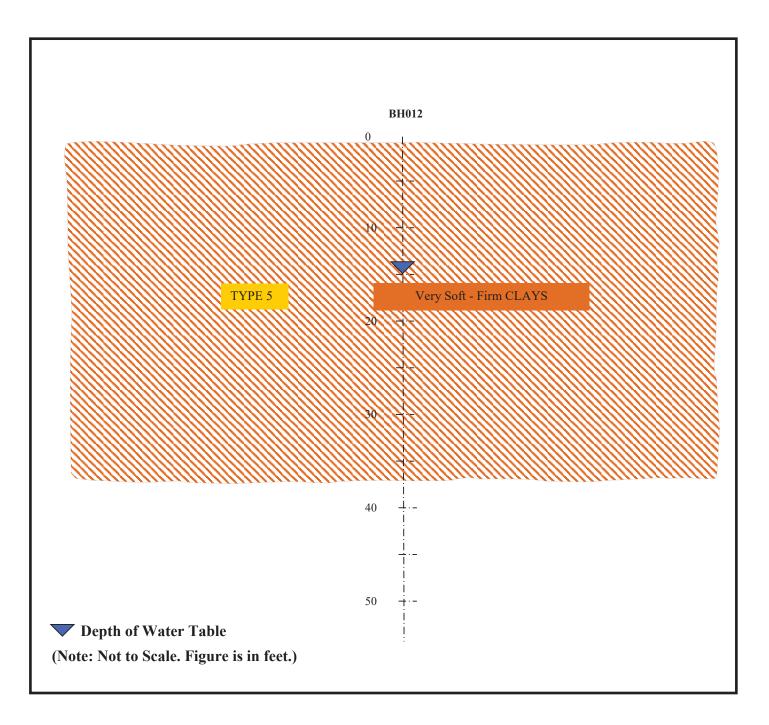


FIGURE 4.11 - Presumptive Profile — BOREHOLES #012

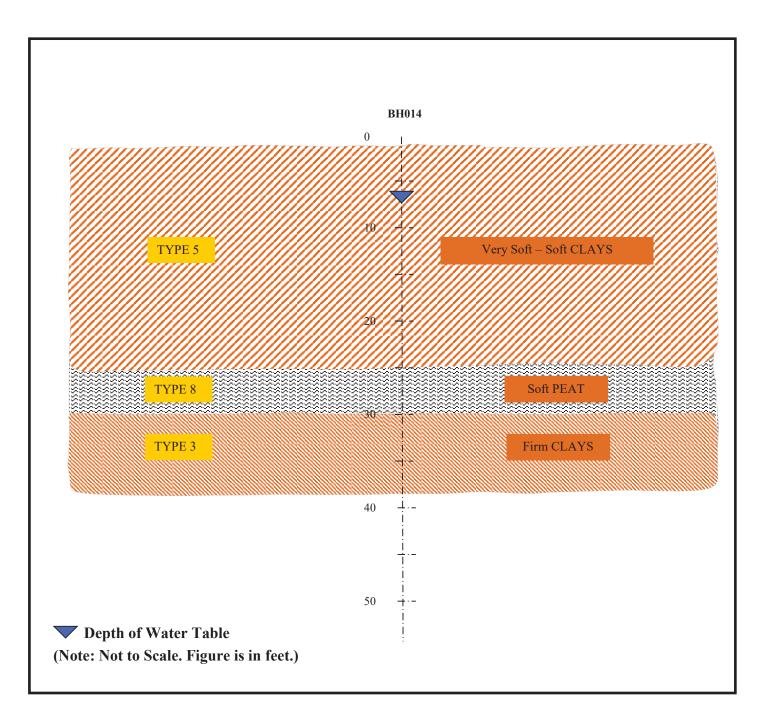
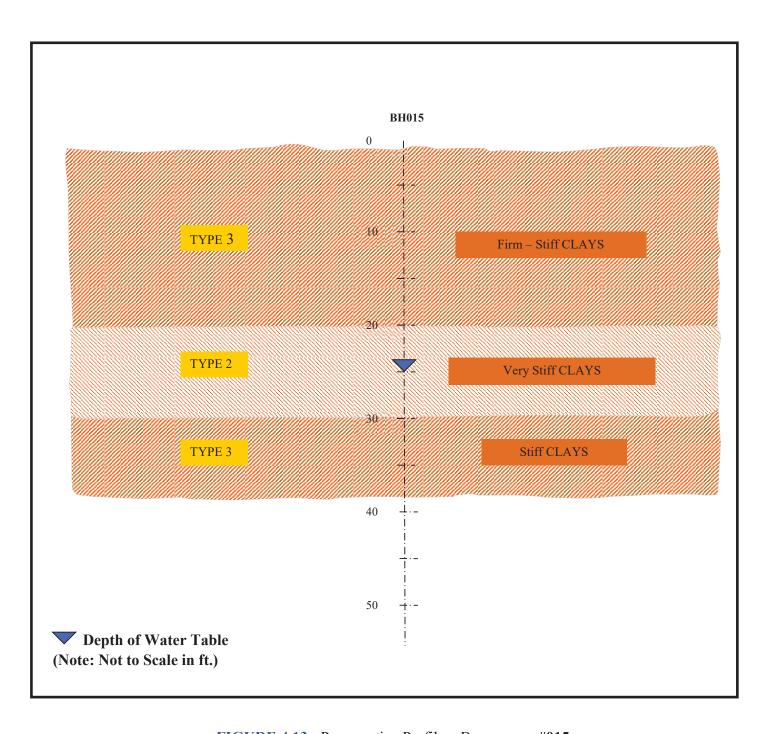


FIGURE 4.12 - Presumptive Profile — BOREHOLES #014



 $\begin{tabular}{ll} FIGURE~4.13~- Presumptive~Profile-Boreholes~\#015 \end{tabular}$

4.2. Bearing Capacity

4.2.1. Shear Considerations:

Note, if soil modification is chosen and the densities are verified; apply a multiplying factor of 1.25 to relevant bearing values.

Also note that Ultimate values are given for the insitu soils. A Factor Of Safety of 3 for maximum safe load capacity is recommended based on the high variability and compressibility of the soils on site.

TYPE 1 SOILS – Compact SANDS

The Modulus of Subgrade Reaction (Ks) is the parameter of relevance for raft design. Using the Design Profiles shown below, the recommended value for this parameter is:

i)
$$Ks = 7974*(1-0.4*B/L)*B kN/m^3$$

The Ultimate Bearing Capacity and other relevant parameters recommended on these soils are:

i)
$$Q_{ult} = 395.09*(1+0.34*B/L)*(1+0.18*D/B)$$
 kPa

TYPE 2 SOILS – Very Stiff CLAYS

The Modulus of Subgrade Reaction (Ks) is the parameter of relevance for raft design. Using the Design Profile shown in Figure 4.1 - 4.13, the recommended value for this parameter is:

i)
$$Ks = 12483*(1+0.2*B/L)$$
 kN/m³

The ultimate bearing capacity and other relevant parameters recommended for these soils are:

i)
$$Q_{ult} = 312.07*(1+0.20*B/L)*(1+0.2*D/B) + 15.45$$
 kPa

TYPE 3 SOILS – Firm – Stiff CLAYS

The Modulus of Subgrade Reaction (Ks) is the parameter of relevance for raft design. Using the Design Profile shown in Figure 4.1 - 4.13, the recommended value for this parameter is:

i)
$$Ks = 8399*(1+0.2*B/L)$$
 kN/m^3

The ultimate bearing capacity and other relevant parameters recommended for these soils are:

i)
$$Q_{ult} = 209.96*(1+0.20*B/L)*(1+0.2*D/B) + 15.45$$
 kPa

TYPE 4 SOILS – Very Loose SANDS

The Modulus of Subgrade Reaction (Ks) is the parameter of relevance for raft design. Using the Design Profiles shown in Figures 4.1 - 4.13, the recommended value for this parameter is:

i)
$$Ks = 4198*(1-0.4*B/L)*B kN/m^3$$

1The Ultimate Bearing Capacity and other relevant parameters recommended on these soils are:

i)
$$Q_{ult} = 251.23*(1+0.30*B/L)*(1+0.17*D/B)$$
 kPa

TYPE 5 SOILS – Soft – Very Soft CLAYS

The Modulus of Subgrade Reaction (Ks) is the parameter of relevance for raft design. Using the Design Profile shown in Figure 4.1 - 4.13, the recommended value for this parameter is:

i)
$$Ks = 4104*(1+0.2*B/L)$$
 kN/m^3

The ultimate bearing capacity and other relevant parameters recommended for these soils are:

i)
$$Q_{ult} = 102.6*(1+0.20*B/L)*(1+0.2*D/B) + 15.45$$
 kPa

TYPE 6 SOILS – Very Dense SANDS/COBBLES & BOULDER + Some Gravels

The Modulus of Subgrade Reaction (Ks) is the parameter of relevance for raft design. Using the Design Profiles shown in Figures 4.1 - 4.13, the recommended value for this parameter is:

i)
$$Ks = 12351*(1-0.4*B/L)*B kN/m^3$$

The Ultimate Bearing Capacity and other relevant parameters recommended on these soils are:

i)
$$Q_{ult} = 541.27*(1+0.38*B/L)*(1+0.19*D/B)$$
 kPa

TYPE 7 SOILS – Highly fractured Medium Limestone Rock Modeled As Very Dense Gravels and Sands

a) Mat/Raft Footing

The Modulus of Subgrade Reaction (Ks) is the parameter of relevance for raft design. Using the Design Profiles shown in Figures 4.1 - 4.13, the recommended value for this parameter is:

i)
$$Ks = 40936*(1-0.4*B/L)*B kNm3$$

b) Raft Pad/Beam Footing

The Ultimate Bearing Capacity and other relevant parameters recommended on this site are:

i)
$$Q_{ult} = 1291.77*(1+0.49*B/L)*(1+0.22*D/B)$$
 kPa

TYPE 8 SOILS – PEATY SOILS

Ignore Soil Contribution

Where,

Q_{ult} is the Ultimate Bearing Capacity, kPa Ks is the Modulus of Subgrade Reaction, kN/m³ D is the Depth of footing, m B is the Width of footing, m L is the Length of footing, m

TABLE 4.1 - SUMMARY OF SOIL BEARING CAPACITIES

LOCATION	ULTIMATE BEARING CAPACITY 1mx1m; D=0.5	ULTIMATE BEARING CAPACITY 1mx1m;D=1	Allowable Bearing Capacity 1mX1m; D=0.5	Allowable Bearing Capacity 1mX1m; D=1
BOREHOLE	KPa	KPa	KPa	KPa
001	292.6	317.8	97.5	105.9
002	354.4	382.1	118.1	127.4
003	292.6	317.8	97.5	105.9
004	427.4	464.8	142.5	154.9
006	817.9	888.9	272.6	296.3
007	817.9	888.9	272.6	296.3
008	817.9	888.9	272.6	296.3
009	427.4	464.8	142.5	154.9
010	577.7	624.7	192.6	208.2
011	292.6	317.8	97.5	105.9
012	150.9	163.2	50.3	54.4
013	817.9	888.9	272.6	296.3
014	150.9	163.2	50.3	54.4
015	292.6	317.8	97.5	105.9

Bearing Capacity at No. 005 and No.013 sites are presumed to be following.

*1 No.005 date is not described in this table. Each bearing capacity is presumed the same as No.003 that hall be calculated from same soil type.

*2 Boring is machine cannot enter into No.13. This site presumed to have minimum bearing capacity in this table from sight.

TABLE 4.2 - SUMMARY OF SOIL PARAMETERS

LAYER	TYPE 1	TYPE 2	TYPE 3	TYPE 4
IDENTIFICATION	SOILS	SOILS	SOILS	SOILS
Bulk Unit Weight KN/m3	16.1	19.3	19.3	15.3
Submerged Unit Weight	9.2	9.5	9.5	8.7
Compression Index				
Void Ratio				
Undrained Cohesion (KPa)		60.7	40.8	
Drained Cohesion (KPa)				
Effective PHI/PHI	33.1	18	15	29.7
Relative Density	49.9			19.0
Ka	0.293	0.691	0.741	0.338
Кр	3.409	1.447	1.349	2.957
Permeability Coef. (k)				

TABLE 4.3 - SUMMARY OF SOIL PARAMETERS

LAYER IDENTIFICATION	TYPE 5	TYPE 6 SOILS	TYPE 7 SOILS	TYPE 8 SOILS
				IGNORE
Bulk Unit Weight KN/m3	19.3	16.6	18.5	
Submerged Unit Weight	9.5	9.5	10.0	
Compression Index				
Void Ratio				
Undrained Cohesion (KPa)	20.0			
Drained Cohesion (KPa)				
Effective PHI/PHI	6	35.6	41.5	
Relative Density		69.5	100	
Ka	0.895	0.266	0.203	
Кр	1.117	3.756	4.923	
Permeability Coef. (k)				

4.3. Seismic Considerations

Information obtained from available seismic risk map for Jamaica indicates that the spectral acceleration for short periods/two second periods with 5% damped acceleration response spectrum for the maximum considered earthquake with a 2% probability of exceedance in 50 years, was deduced as S_1 =0.3g. According to the IBC code (2003) and the UBC (1997) code, the sites vary in classifications from Classes C to E from the fractured limestones to the soft Clays respectively.

4.4. Liquefaction Considerations

In a seismic event, the stresses developed on an element of soil are usually cyclic in nature. The manner in which soils response to these stresses is dependent on a number of factors, including but not limited to, insitu density (relative density), water table conditions, grainsize distribution and shape. For example, loose saturated sands having a contractive structure and subjected to shear deformation might develop very high pore water pressures and lose virtually all their resistance to deformation. This condition where a static (peak) or cyclic load leads to high pore or residual pressures that reduces the effective confining pressures to very low values or where the confining pressures becomes equal to the effective pore pressures leading to large deformation is called liquefaction.

The potential for a soil to liquefy has been determined to be dependent on the cyclic stress ratio τ_h/σ^2 , where τ_h is the average horizontal shear stress induced by an earthquake and σ^2 is the initial effective overburden pressure on the soil layer involved.

The Type 1 soils (encountered below the water table at Location 2, in Old Harbour) appear susceptible to liquefaction based only on its relative density, its grainsize distribution however shows fines content (retained #200 sieve size) of over 35%. Typically soils with over 20% fines content, rarely liquefies.

NHL ENGINEERING LIMITED

Dr. Carlton Hay

PhD., M.Sc. M.A.S.C.E.

Registered Professional Engineer (PE)

Geotechnical Engineering

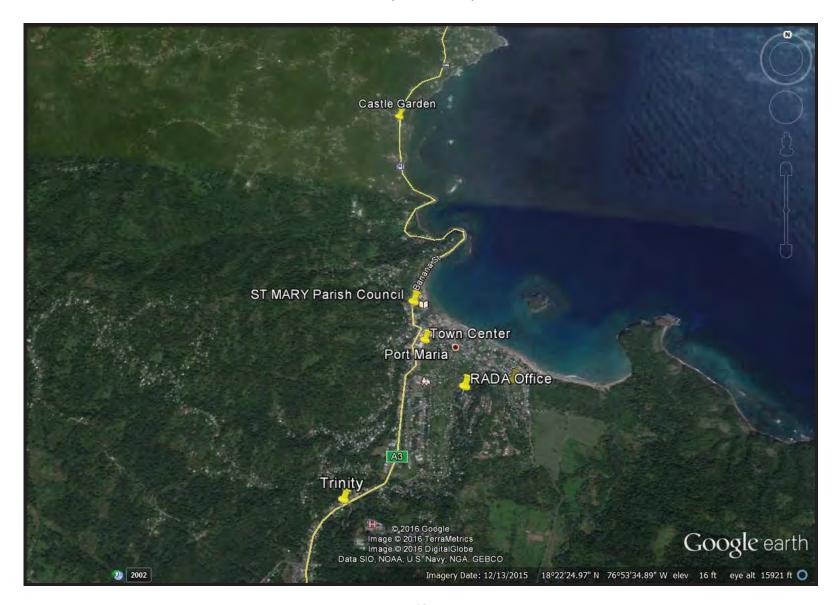
Appendix I - Site Location Plan and Test Location Plan (Old Harbour Bay)





Site Location Plan and Test Location Plan (Bog Walk)

Site Location Plan and Test Location Plan (Port Maria)



Appendix II - Soil Boring Log

	ENT: C/O ODPEM DJECT: Soil Investigation	Eastings:				eference Northings:	-161		2			e/Size	
ADE	DRESS: 2 - 4 Haining Road, Kingston 5 Jamiaca	Emergency	oiren P	D	atu	Narine Lane, St. Com	atherine			25" I.D.	Stem,	" Diameter Au 140 lbs Cathe ner for SPT.	
Sam	ple Types Wash		Grab	Lie		Split Spoon	E	T.W.	Tube			R. Core	
(ft.)		12/1	9	sam	ples		Plasticity		T			rd Penetration	Test
h (1	Soil Description	Strata Phol	SPT Blove Count	9 -2	2	20		80	20			(Blows/ft.)	100
Depth	con Description	1 ×	8	ID Mark	Recovery	Wet	Unit Weigi kip/cu.ft)	ht d		Undra	ined U	(kip/sq.ft) + Vane Shear	r Strength
		Ø =	8	9	8	.07	1	13	1.0	Comp	. Test	+ Vane Shear	5.0
0					T				T			1-1-1	
			4	7									
	Sliff Brown Clayey Silt & Medium - Fine S		5	13	18								
	Sim blown clayey Sin & Medium - Pine S	and											
5													
2			4	1	1								
	Firm Brown Silty Clay		6 4	2	18								
	The Same		3	3	18								
	Firm Brown Silty Clay		5	1								11114	
10	The state of the s		6										
			6 6 7	4	18								
	Stiff Brown Clay with some Silt & Traces	. 🦏	1	1									
	Sand Sand	or ///											
15										11			
			6	5	18								
-	Line is the second of the seco		8	-	,,,		3.1	11 11					
-	Stiff Brown Clay with some Silt & Traces of Sand												111
_								111					
0			5									1.1.7	
			8	6	18								
	Stiff Brown Clay with some Silt & Traces of Sand												
	or sand												
5	The state of the s	of	7										
			6	7	18								
	Stiff Brown Clay with some Silt & Trace	. //	7/\										
	of Sand												
0	**note 51 represent refusal on spoon	3											
HL	ENGINEERING LTD	200			-					-			
	ULTING ENGINEERS				1	50.7		Dat	es	Jo	D No.		
	nroe Road on 6, Jamaica					Start		28.04.16			P	H. No.	Sht. 1 of 2
						Completion		28.04.16			0		
FFIC	E BOREHOLE RECORD				7						ВН	# Sir001	
						Final W. L.		N/A					

PROJ	IT: C/O ODPEM ECT: Soil Investigation	Eastings:		L	ocati	on R	eference			Ty	/pe/Size	
		Emerge	ency	Siren	Prois	ect - N	Nothings: larine Lane, St. Catherin		Mallani	Ctron 0	OFFI DI	
ADDR	ESS: 2 - 4 Haining Road,		-	-		Datu	m	10	3.25"	I.D. Ste	.25" Diameter / m, 140 lbs Catl	Auger, nead
	Kingston 5 Jamiaca				-						mmer for SPT.	icau
Sample	e Types Wash		7 /	Grab	E	levati	on: Split Spoon					
~	37.20	-						T. W. T	ube		R. Co	
Depth (ft.)		2	Fector	SPT Blow Count	sam	ples	Plasticit		60	Stan	dard Penetratio	
4	Soil Description	3	5 0	SW.	4	Six	Wet Unit We	80	20		(Blows/ft.)	100
2			E V	200	ID Mark	Recovery	(kip/cu.ft)	Un	aramea	Unconfined Sh (kip/sq.ft) st + Vane Shea	ear Strength
_		Ó	0 1	31	3	2	.07	13	1.0 Co	mp. Te	st + Vane Shea	r 5,0
30		8		8	7				11			
				7	8	18						
	Stiff Brown Clay with some Silt & Sand	. 8		1 1					11			1111
										11		
	Stiff Brown Silty Clay with some Sand	1		1								
35				8	9	18						
	(BH Ends @ 35Ft.)			8	1				. 1. 1.			
		1										
		-							11	11		
				1					8 4	11		
10		- 1				- 1		4 1 1 1				
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-		- 44		14								
		- 11		11								
		11		11		- 1						
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+		- 11				-11						
	*note 51 represent refusal on spoon			171		7						
L ENG	GINEERING LTD TING ENGINEERS				-			-				
								Dates		Job No.		
Monroe agston 6	e Road 5. Jamaica					SI	art	28.04.16			B.11. 41	Sht. 2 of 2
						-	omeletter.				B.H. No.	
FICE B	REHOLE RECORD				- 0	ompletion	28.04.16		P	H# Sir001		
	EHOLE RECORD				F:	nal W. L.	N/A	-	В	11# 311001		
						E:	1 VALLen	20,45				

PRO.	ENT: C/O ODPEM DJECT: Soil Investigation	Eastings:	Sirer				Reference Northings: I Harbour Bay, Fishing Village		Hollow		e/Size 5" Diameter Au	ider
ADD	DRESS: 2 - 4 Haining Road, Kingston 5					Datur			3.25"	I.D. Stem,	, 140 lbs Cathe	
	Jamiaca				Ele	evatio			Б	rop Hamr	mer for SPT.	
	ple Types Wash		Gra	ab			Split Spoon	T. W. T	ube		R. Care	į.
(#)		Net	0	Number 1	sam	nples				Standa	ard Penetration	
d)	Soil Description	Strata Plo	TE OF	SPT Blow Count	4	13	20 Wet Unit Weis	80 abt 5	20		(Blows/ft.)	100
Depth	3000.5300.0000	trail	V	SPT Blow (ID Mark	Recovery	Wet Unit Weig (kip/cu.ft)		Uni	drained u	Inconfined She (kip/sq.ft) t + Vane Shear	ar Strength
2		80	4 8	75	=	2	.07	13	1.0 Co	omp. Test	+ Vane Shear	r 5.0
0			T							11	TIT	
			1	4	1							
	A			5	1	18	3					
	Compact Brown Medium - Fine Sand	d										
-												
-												
5				2 /								
	Very Loose Brown Medium - Fine Sand	d with		2	2	18						
	some Silt		ug	1								
-			7	1	1							
	Very Loose Brown Sandy Silt with Clay	y	1-1	1	3	18						
				1								
10		- 1		2		10						
-				1	4	18						
	Very Soft Brown Clayey Silt with some S	Sand				11						
	The second second		11									
			W									
15			10									
	Soft Brown Clayey Silt with some Sand		HV		5	18						
	THE STREET STREET, THE WINDSTREET STREET		By	-w								
	***************************************				1							
-	Very Loose Grey Coarse - Fine Sand											
-	with Traces of Silt			11								
20				2								
			1		6	18						
	Loose Grey Coarse - Fine Sand with			1								
	Traces of Silt & Shells			11								
5												
-			3	3 2	7	18						
4	and the second second		27	3						111		
-	Loose Grey Coarse - Fine Sand with Traces of Silt											
-												
-						4						
0	**note 51 represent refusal on spoon				1							
HL E	ENGINEERING LTD ULTING ENGINEERS							Date	S	Job No.		
	nroe Road					1	Start	28.04.16				Sht. 1 of 2
	on 6, Jamaica					+	J. Lance	20.04.10		В	B.H. No.	SIL TOTZ
FFICE	E BOREHOLE RECORD		_		_	_ (Completion	28.04.16		DI		
	- DONE INC. INC.					-	Final W. L.	7'		- Bn	# SIr002	

	ENT: C/O ODPEM DJECT: Soil Investigation	Eastings:					ference Nothin	gs:					1	ype/Siz	20	
	DRESS: 2 - 4 Haining Road,	Emergency \$	Sirer	Proj		Old F Datur	larbour	Bay, Fis	shing Villag	le			" I.D. St	em, 140	ameter Aug	
	Kingston 5 Jamiaca				Fle	evatio	on:								for SPT	
Sam	ple Types Wash		Gra	b	_		< Sp	it Spoo	in		∃T. W.	Tube			R. Core	
11.)		Not		ONLE	samp	les	20		Plasticity		7.	20	Sta		enetration ows/ft.)	Test 100
Depth (ft.)	Soil Description	Strata Plot	Curr lat	Type	ID Mark	Recovery	.07	W	et Unit Wei (kip/cu.ft)	ght	80	1.0 0	Indraine Comp. T	d Uncor	nfined Shea p/sq.ft) ane Shear	1
30			Ī	4	8	18				1	İT			T		
	Compact Brown Medium - Fine Sand	. 🕷		5		16										
	with some Silt															
35	Very Stiff Brown Clay with some Silt & Trace of Sand	d		4												
7	(BH Ends @ 35Ft.)			8	9	18										
										1						
							1									
10																1 / 9
		11														111
-																11
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45																
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-				П												111
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			1													
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-																
+				11	и											
1																
5		- 10			П											
		- 11														
30	**note 51 represent refusal on spoon				9											
	ENGINEERING LTD SULTING ENGINEERS					-				-	Da	ites	Job	No.		1
	onroe Road ton 6, Jamaica					5	Start			28	.04.16			В.н.	No.	Sht. 2 of
DEFIC	CE BOREHOLE RECORD		_	_		_	Comple	tion		28	.04.16			BH#	Sir002	
						F	inal W	1			7'					

	ENT: C/O ODPEM OJECT: Soil Investigation	Eastings:		Lo	cati	on F	Reference	14		T	ype/Size	
	DRESS: 2 - 4 Haining Road,	Emergenc	y Sirer	n Proj			Northings: kwood Gardens, St. Catheri	ne	Hollov	v Stem 6	6.25" Diameter A	Auger;
	Kingston 5					Date	um				em, 140 lbs Cath ammer for SPT.	nead
Sam	Jamiaca nple Types Wash		Gra	ah	E		tion: Split Spoon	- T.T.				
~		14		-	ean	nples			W. Tube		R. Cor	
(IF)		Strata Plot		SPI Brow Count			20	80	20	Sta	(Blows/ft.)	on Test
Depth	Soil Description	ata	ROL	Nel Bow	Mark	Negr	Wet Unit W	eight b	U	ndraine	Unconfined Sh	ear Strength
ă		TIS.	No.	5	ID Mark	Recovery	(kip/cu.ff	.13	1.0 (Comp. T	(kip/sq.ft) est + Vane She	ar 5.0
0		7//			Ė							
	Stiff Brown Silty Clay with Traces of S	and		6	1	310						
	Compact Brown Coarse - Fine Sand			7/_	7							
5 -												
	Stiff Brown Silty Clay with Traces of S	and		8 9	2	8						
	Compact Brown Coarse - Fine Sand			3								
	Very Stiff Brown Silty Clay with Traces of S	and		10 8	3	18						
10				5								
				5 8 7	4	18						
	Very Stiff Brown Silty Clay with Traces of Sand	and of ces										
15				6								
			11.	7 9	5	18						
	Very Stiff Brown Clay with some Silt & Tra	ces										
	of Sand											
0	THE THEOLOGICAL PROPERTY OF THE PARTY OF THE			8 /								
			1.0	8 8	6	18						
	Very Stiff Brown Clay with some Silt & Trace	es		9								
	of Sand											
5												
				7	7	18						
	Very Stiff Brown Clay with some Silt & Trac	es	1	PV-								
	of Sand											
5	**note 51 represent refusal on spoon								111			
HL E	ENGINEERING LTD ULTING ENGINEERS	1000	1		-							
Mor	nroe Road						Start	29.04.16	ates	Job N		Sht. 1 of 2
	in 6, Jamaica E BOREHOLE RECORD					Completion	29.04.16	1		B.H. No.		
						H				- 1	BH# Sir003	

	IT: C/O ODPEM ECT: Soil Investigation	Eastings:	,	ocati	on Re	eference Nothings:			Type/Size	
	ESS: 2 - 4 Haining Road,		ren Pr		- Black Datur	kwood Gardens, St. Cat	therine		Stem 6.25" Diameter Aug	
ADD: 12	Kingston 5								I.D. Stem, 140 lbs Cathea Drop Hammer for SPT.	ıd
Sample 1	Jamiaca Types Wash		Grab	E	levation	ion: Split Spoon	T. W		R. Core	
-				sam	nples	Plasti		1	Standard Penetration	
Depth (ft.)	Soil Description	F 6	SW Co			20	80	20	(Blows/ft.)	100
ept	Our Deadhpaon	Suata Plot	SPT Blow Count	Two ID Mark	Recovery	Wet Unit (kip/c	cu.ft)	One Co	ndrained Unconfined Shea (kip/sq.ft) omp. Test + Vane Shear	
			30	7 =	2	.07	.13	1.0 00	imp. Test + valie Silear	5.0
30		å å	7 8		18					
	Very Stiff Brown Clay with some Silt 8		97							
	Traces of Sand	·								
35	Very Stiff Dark Brown Clay with some Silt & Sand		8	y 9	18					
	(BH Ends @ 35FL)		9/	7						
			1							
40			11							
-										
45										
				1						
-										
50										
55										
5				111						
4										
-		8/1/4								
60 *	**note 51 represent refusal on spoon									
NHL ENG	NGINEERING LTD LTING ENGINEERS				1		Г	Dates	Job No.	
29 Monroe	oe Road				1	Start	29.04.16			Sht. 2 of
	6, Jamaica				-	Completion	29.04.16		B.H. No.	-
)FFICE B	BOREHOLE RECORD								BH# Sir003	
					1	Final W. L.	N/A			

	NT: C/O ODPEM JECT: Soil Investigation	Eastings:	Lo	catio	n Re	Reference Northing	ic.			Type/Siz	<i>1</i> e	
	RESS: 2 - 4 Haining Road,		en Proj		New H Datur	Harbour Villa	is: age, St. Catherine	F	3.25" 1	Stem 8.25" Dia I.D. Stem, 140	lbs Cathea	
	Kingston 5 Jamiaca			El	evati	don:				Drop Hammer f		
Sample	le Types Wash		Grab	bette		Split	Spoon	T.W.	Tube		R. Core	
3) let	ount	sam	ples	Per	Plasticity				Penetration * lows/ft.)	
9	Soil Description	ata Pl	Owo.C	Cox Ha	Kiter	20	Wet Unit Weig	ght p	20 Uno	ndrained Uncon	nfined Shea	100 ar Strength
Depth (ff.)	Access to a reference	Strata Plot	SPT Blow Count	T Syrace ID Mark	Recovery	.07	(kip/cu.ft)	.13	1.0 C	(kip Comp. Test + Va	p/sq.ft)	5.0
			00	1	~	17		1	17	Zings 1.2c.	2010	
0			12		10							
			15	1	10	3						
	Very Stiff Brown Silty Clay with Trac of Sand	ces	14/	1								
5			9	7								
	Very Stiff Brown Silty Clay with Traces of	of Sand	12	2	18							
			1									
	Com Dearm Citty Clay with Traces of		10	3	18							
	Very Stiff Brown Silty Clay with Traces of S	Sand	18/	1								
10			10	7								
			13	4	18							
	Very Stiff Brown Silty Clay with some	e Sand										
	The same of the sa	of Sand Sand		1								
15		*	14	7	U			HIII				
			14	5	6							
	Compact Brown Medium - Fine Sand		III									
	with some Gravel											
		*										
20			16									
			17	6	5							
	Dense Brown Medium - Fine Sand w	with	10									
	some Silty Clay											
								$A \cap A'$				
25			14	1								
			13 15	7	7							
	Compact Brown Medium - Fine Sand	d .										
	with some Gravel			11								
-												
30 EN	"note 51 represent refusal on spoon											
CONSU	ENGINEERING LTD ULTING ENGINEERS							Da	ates	Job No.		
9 Monr	nroe Road on 6, Jamaica				1	Start		29.04.16		ВН	Ma	Sht. 1 of
ingston	16, Jamaica					Completio	un.	29.04.16		- B.11.	. No.	
OFFICE	E BOREHOLE RECORD					Company	а	23.07.15		BH# S	Sir004	
					7	Final W. L		N/A				

	C/O ODPEM CT: Soil Investigation	Eastings:		Lo	catio		ference Nothin					177	ype/Si	ze		
	SS: 2 - 4 Haining Road,		y Sir	en Proje			larbour \	/illage, St. Catherin	ne					iameter Aug Ibs Cathea		
	Kingston 5 Jamiaca				El	evatio	on:					Drop H	ammer	for SPT.		
Sample T] (rab			Spl	t Spoon		T. W.	Tube	-		R. Core		
3		12	ń	3	samp	oles		Plasticity			T	Sta		Penetration 1		
D (E	Sail Description	ū	1	20	老	20	20	Mat Heit Mai	and the second	80	20	Indenius	1	lows/ft.)	100	a de la
Depth (ft.)	Soil Description	O tenanta Diot	ROE	SPT Blow Count	ID Mark	Recovery	.07	Wet Unit Wei (kip/cu.ft)	ignt	13	1.0	Comp. 7	est + V	nfined Shea ip/sq.ft) ane Shear	5.0	juri
30		with		16	8	18			T	П			П	111	П	T
	Dense Brown Medium - Fine Sand v	oth (18/												
	some Gravel														11	
										11						
35	Dense Brown Medium - Fine Sand with some Gravel	146		12	9	18										
	(BH Ends @ 35Ft.)			22	9											
. 7																
7																
40																
	Dense Brown Medium - Fine Sand with some Gravel (BH Ends @ 35Ft.)															
45																
45																
-																
50		1														
E																
55																
	**note 51 represent refusal on spoo	n														
NHL EN	"note 51 represent refusal on spoon GINEERING LTD FING ENGINEERS								-	D	ates	Jol	No.			
29 Monro Kingston	ING ENGINEERS						Start		2	29.04.16			В.Н	l. No.	Sht.	2 of 2
	Road Jamaica REHOLE RECORD					-	Comple	tion	2	9.04.16			BH#	Sir004		
							Final W	4		N/A						

PRO	IENT: C/O ODPEM OJECT: Soil Investigation DRESS: 2 - 4 Haining Road, Kingston 5	Eastings: Emergene	cy Si	iren P	rojec Da	ect - B				5" I.D.	m 6.25 Stem,	e/Size 5" Diameter Aug , 140 lbs Cather mer for SPT.		
Sami	Jamiaca nple Types Wash		Grai			vation	Split Spoon	T. W. 1	Toha	7				_
		17			samp		Plasticity		une	-		R. Core		
Depth (ft.)	Soil Description	Strata Plot	SPT Rings Comp	TAPECON	4		Wet Unit Wei (kip/cu.ft)	ight p	1.0	Undrair	ned Ur	ard Penetration (Blows/ft.) nconfined Shes (kip/sq.ft) + Vane Shear	100 ar Strength	
0			7								-		-	7
	Firm Light Brown Clay with some S	Silt		4 5	1	18								
5	Stiff Light Brown Clay with Traces of	Silt	18	3 5 5	2	18								
	Stiff Light Brown Clay			3 5 8	3	18								
10	Firm Light Brown Clay		1 7	3 4 5	4	18								
15	Stiff Light Brown Clay		44.	3 5 5	5	18								
20	Stiff Light Brown Clay		4 5 8	4 5 8	6	18								
25														
	Stiff Light Brown Clay		6 7 7	77	7 1	18								
30 E	**note 51 represent refusal on spoon					1								
ONSU	ENGINEERING LTD SULTING ENGINEERS							Date	s	Jol	b No.			
9 Mon lingsto	onroe Road Ion 6, Jamaica	roe Road					tart	30.04.16				.H. No.	Sht. 1 of	2
FFICE	DE BOREHOLE RECORD	BOREHOLE RECORD			_		ompletion	30.04.16			ВН	# Sir005		
						E	inal W. L.	N/A			-	W. Williams		

	/O ODPEM : Soil Investigation	Eastings:					eference Nothings:				Тур	oe/Size	
ADDRESS	: 2 - 4 Haining Road, Kingston 5	Emergen	cy S	iren	1	Datu	Bog Walk, St.	Catherine	-	3.25	I.D. Sten	25" Diameter Au n, 140 lbs Cathe nmer for SPT.	
Sample Typ	Jamiaca es Wash		Gral	5	El	evati	on: Split Spoo	NO.	F T A	V. Tube			
7	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		-		samı		- opiit opot	Plasticity		v, rube		R. Core	
ē	12.02.000	Ĭ.	Pom	6			20		80	20	Stant	(Blows/ft.)	100
Depth (ft.)	Soil Description	Strata Plot	SPT Rlow Count	T. Spilaco	1D Mark	Rucovery	.07	et Unit Wei (kip/cu.ft)	ght 🗆 .13	1.0 0	omp. Tes	Unconfined She (kip/sq.ft) t + Vane Shear	ar Strength
30			T	7/					T		11	1 - 1 - 1	
				8	8	18				111			
	Stiff Light Brown Clay												
								/ I I					
												1111	
35	Stiff Light Brown Clay			7 X	9	18							
	(BH Ends @ 35Ft.)				a	18							
40													
45													
50													
-													
5													
******	te 51 represent refusal on spoon												
HI ENGIN	ERING LTD ENGINEERS			-	1	+					1		
9 Monroe Ro	ad					S	tart		30.04.16	ates	Job No.	4.77	Sht. 2 of 2
ingston 6, Ja						C	ompletion		30.04.16	5		B.H. No.	
OFFICE BOR	EHOLE RECORD										В	H# Sir005	
						F	inal W. L.		N/A				

	T: C/O ODPEM ECT: Soil Investigation	Eastings:		Lo	cation	n Re					Type/Size			T
		Eastings: Emergency	y S	iren F	rojer	ct - Y	Kent	lorthings: Village, St. Catherine		Hollow 5	Stem 6.25" Diamete	er Auger	ey.	_
ADDRES	ESS: 2 - 4 Haining Road,			-		Datur		70000-1-		3,25" 1.0	I.D. Stem, 140 lbs Ca	Cathead		
	Kingston 5 Jamiaca				El	evation	ion:			Dr	Orop Hammer for SP	T _o		
Sample T			G	Grab	- Name			Split Spoon	T, W, 1	Tube	R. C	Core		
7		20	1	4	sam	nples		Plasticity		T	Standard Penetra	ration Tes	st	-
Liepth (ff.)		Strata Plot	3.5	SPT Blow Count				20	80	20	(Blows/ft.	ft.) 10	00	
bro	Soil Description	Carl	IS COE	Blow	Type ID Mark	Recovery	1	Wet Unit Weig (kip/cu.ft)	ight a	Und	drained Unconfined (kip/sq.ft	Shear S		
37		8	1	SPT	9	Reg	ily	07	.13	1.0 Co	(kip/sq.ft omp. Test + Vane Si	hear	5.0	
0				T	1	+	÷	1	7		1111			T
5			1	4	1	1								1
			1	19	1	12	2							
				21/	4	1								1
	Brown Silty Clay with some Gravel		()		11			1111						1
			1		1	1								1
-	Parker 2		1		47			4 1 1 1 1						
5	(Refusal @ 9")	9		40	1	6								
	Very Dense Cream Calcareous Cobble	bles &		50	2	2 6	1							1
	Boulders with some Sand	•												
			80%	6	3	60	F							
					4.7	h								
10	Hard Cream Porous Limestone				4									
		177			4									
					\mathbb{Z}^2				1 1 7					1
	(BH Ends @ 12')		41		1									
					1/									
15					17									
5														
					17								1	
					17									
					17							11		
					1							40		
20					17									
						1								
						1								
					17									
25						1								
					17									
													101	1
					17			44 1 1 7						
							11							
	**note 51 represent refusal on spoon	0					1		4 1 10					
HL ENG	NGINEERING LTD LTING ENGINEERS					7	T		Da	ates	Job No.			
29 Monroe	oe Road					1	Sta	art	30.04.16				Sht. 1 o	of
(ingston 6	6, Jamaica							empletion	30.04.16		B.H. No.	-	- Constitution	Ì
OFFICE P	BOREHOLE RECORD						-		1		BH# Sir006	6		
							Fir	nal W. L.	N/A					

	IENT: C/O ODPEM OJECT: Soil Investigation	Eastings:						eferen Nort	things	*				- 1	Type/S	ize		
ADI	DRESS: 2 - 4 Haining Road, Kingston 5	Emergency	Sire	en Pr	roje	D D	Dam Datum	Head	Towe	r, St. Cathe	erine		3.25"	1.D. S	Stem, 14	Diameter Au 40 lbs Cathe	uger, ead	
	Jamiaca					Ele	evatio	on:					1	Drop H	lammer	r for SPT.		
Sam	nple Types Wash		7	Grab					Split Sp	poon		T. W.	Tube			R. Core	3	
II.		Mod	ROD	Office	1	samp		1		Plasticit	ty			St		Penetration		
E)	Soil Description	ta I	0	SPT Blow Count	50	ark	King	20		Wet Unit W	/eight	80	20 Ur	-drain	0	Blows/ft.) onfined She	100 ear Stree	- with
Depth (ft.)		stira	4	E B	Type	ID Mark	Recovery	.07		Wet Unit W (kip/cu.fl	t)	.13	10 ('ama	Toet +	onlined She kip/sq.ft) Vane Shea	ear Strer	100
				SO	1	-	24	17				19	100	Onip.	los	Valic City	1.	
0			1		17										1			
-	Cream Calcareous Sand & Gravel/Cob	obles		1														
-	And the same of th		4															
	(Refusal @ 3") Very Dense Cream Calcareous Boulder	rs 8	1	50	X	1	3											
-	Cobbles with some Sand				(
5	Very Dense Cream Calcareous Boulders & C	Cobbles		50	X	2	23											
			109	26		3	40											
	Medium Cream Porous Limestone	- 13																
	Medium Gream Forous Emissions			1														
		3																
10	(BH Ends @ 10')	- 10			-													
15			1															
					1													
20																		
			1															
25			1															
1																		
1																		
1																		
0	**note 51 represent refusal on spoon																	
HL	ENGINEERING LTD SULTING ENGINEERS			-			+	1			+	Date		Job				
	onroe Road						ç	*tort			10	700000	2S	GOL	No.		-	00.70
	onroe Road ton 6, Jamaica						-	Start			U	11.05.16			В.Н	l. No.	Sht.	1 of
OFFIC	CE BOREHOLE RECORD		_		_		_C	Comple	etion		0	1.05.16			BH#	Sir008		
							-	inal V	1.10					1	D	311000		

	NT: C/O ODPEM JECT: Soil Investigation	Eastings:				eferend North	ings:					Тур	e/Size			
ADD	RESS: 2 - 4 Haining Road, Kingston 5	Emergency S	iren Pro		Datu	ls Round Im		t. Catherine			3.25" L	D. Stem		eter Aug s Cathea SPT.		
Samp	Jamiaca ole Types Wash		Grab	E	levat		plit Spoo	n =		W. Tub	B		F	R. Core		_
3		let	直	sar	nples			Plasticity		1		Stand	ard Pen	etration		
Depth (ft.)	Soil Description	Strata Plot	SPT Blow Count	Type	Recevery	.07	We	t Unit Weig (kip/cu.ft)	80 ht =	-	Und	rained l	Jnconfin	ed Shea q.ft) e Shear	5.0	ath
0	(Refusal @4")					Ħ	TT					TT	TT	TT	T	T
	Very Dense Cream Coarse - Fine Sa with some Gravel	1969	50	Χ.	2											
5	Very Stiff Brown Sandy Clay	•	5 8 9	XI:	2 12											
	Compact Compact Brown Coarse - Fine Sa		10 11 12	3	14											
0	Compact Brown Coarse - Fine Sand	d	8 13 10	4	15											
15	Compact Brown Coarse - Fine Sand		7 10 12,	5	10											
20	Compact Brown Coarse - Fine Sand		11 13 14	6	10											
25	Compact Brown Coarse - Fine Sans	d	10 12 15	X 7	В											
30	**note 51 represent refusal on spoon	W)				Ш	Ш					Ш				
NHL	ENGINEERING LTD SULTING ENGINEERS	143	-							Dates		Job N	0.		1 1	_
29 Mo	onroe Road					Start			01.05.	55			B.H. N	No.	Sht.	1 of 2
	ton 6, Jamaica					Comp	letion		01.05.	16						
OFFIC	CE BOREHOLE RECORD					Final	N. I.		N/A			1	BH# Sir	009		

	NT: C/O ODPEM ECT: Soil Investigation	Eastings:		Loc	atio	n Re	leference Nothing					Type/	Size	
	RESS: 2 - 4 Haining Road,	Emergency Sir	en P	rojec		Angels Datur	Is Round		, St. Catherine	E	3.25" 1.1	D. Stem, 1	" Diameter Aug 140 lbs Cathea	
	Kingston 5 Jamiaca				El	evati	ion:						ner for SPT.	
Sample	e Types Wash		Grab	1			Spl	lit Spo	on F	T. W. 1	Tube		R. Core	
3		lor C	Direct	8	samp		20		Plasticity	10.	12	Standar	rd Penetration 7 (Blows/ft.)	Test 100
Depth (ft.	Soil Description	Strata Plot	SPT Blow Count	1300	ark	Series.	20	V	Vet Unit Weig	ant 🗆	20 Und	drained Und	confined Shear	1
Sept 1	- The state of the	Stra	Ser B	Types.	1D Mark	Recovery	.07	1	Vet Unit Weigh (kip/cu.ft)	.13	1.0 Cor	mp. Test +	(kip/sq.ft) Vane Shear	5.0
						Ste	1	-			1	-		1
30			15	5	8	6								
	Dense Brown Coarse - Fine Sand		17	7										
	Dense brown Guarse - Fine Sand		1											
								17						
35	Dense Brown Coarse - Fine Sand			3										
-	(BH Ends @ 35Ft.)	- 50	16		9	6								
	100000		1											
-														
40														
								1						
								,						
45								1						
								1 /						
						1		17						
								17						
-								17						
50								17						
								17						
								1						
								1						
								1						
55				11				11						
				1				17						
								1						
								1						
				1										
	**note 51 represent refusal on spoon	0							200					
NHL EN	ENGINEERING LTD ULTING ENGINEERS									Da	ates	Job No.		
29 Monro	rroe Road						Start			01.05.16			W. L. A. S	Sht. 2 of
	on 6, Jamaica					1	Comple	etion		01.05.16			3.H. No.	
OFFICE	E BOREHOLE RECORD						1000			1		BH	H# Sir009	
						¥	Final W	1. L.		N/A				

PRO	NT: C/O ODPEM USECT: Soil Investigation	Eastings:	L	.ocati	on h		eference Northings:			Турс	e/Size	
	RESS: 2 - 4 Haining Road,		y Sire		oject -	t - Ca	Castel Garden, St. Mary				5" Diameter Aug	
	Kingston 5										mer for SPT.	a
Sampl	Jamiaca ole Types Wash		Grab		Eleva		on: Split Spoon	T.W.	Tube	E	R. Core	
3		10	八里	Sa	ample		Plasticity				ard Penetration	
Depth (ft.)	Soil Description	4 7	N CO			2.3	20 Wet Unit West	80 ight ==	20		(Blows/ft.)	100
ebn	Sull Description	Strata Plot	SPT Blow Count	Type	ID Mark	Recovery	Wet Unit Weig (kip/cu.ft)		Unc	drained u	Jnconfined Shear (kip/sq.ft) st + Vane Shear	r Strengtn
		(202)	3	H	3 2	Ko	.07	13	10 0	omp. Test	+ Vane Shear	5.0
0		*	1		1	7						
		eous	9 10	0 X 1	1 1	12						
	Compact Cream - Brown Calcareo		10		1			411				
17	Fine - Medium Gravelly Sand	EAN.	47									
5												
	Compact Cream Fine - Medium Calcar	areous	11	1 / 2	2 13	13						
-	Gravelly Sand	Prof.	11		ál)							
11.10	APPARTMENT OF THE PROPERTY OF	eous	8									
-	Compact Cream Fine - Medium Calcared Sand with some Fine Gravel	aous	12		3 12	12						
10	Sand with some rine Stave.		1		4	4						
10.	(0000000000000000000000000000000000000		11	X 4	4 1	16						
47			10/		1	1						
	Compact Cream Fine - Medium Calcareous Sand & Gravel											
	Secretary of the second second					1						
4						1						
15	(Refusal @ 5")		50			1						
			11	4	5 5							
4	Very Dense Cream Fine - Medium Calcare	reous										
	Gravelly Sand											
		•	11									
20	(Refusal @5")		50									
	transe @a l		11	6	6 5	4						
	Very Dense Cream Fine - Medium Calcareous Sand with some Gravels		11					A + 1				
25			7	7								
			7 8	7	7 8							
1	Compact Dark Brown Fine - Medium	m 💮										
4	Clayey Sand		11									
4			1							111		
IN F	**note 51 represent refusal on spoon					1						
ONSU	ENGINEERING LTD ULTING ENGINEERS					+		Da	tes	Job No.		
	nroe Road on 6, Jamaica					S	Start	23.04.16		,	B.H. No.	Sht. 1 of
						C	Completion	23.04.16	1			
FFICE	E BOREHOLE RECORD									BI	H# Sir010	
						F	Final W. L.	N/A				

	: C/O ODPEM CT: Soil Investigation	Eastings:	Lo	catio		eference Nothings	\$:				Тур	pe/Size			
	SS: 2 - 4 Haining Road,	Emergency	y Siren			Castel Ga		Mary		3.25"	"I.D. Stem	25" Diamete n, 140 lbs C	Cathead		
	Kingston 5 Jamiaca				levatio							nmer for SP			
Sample Ty			Grab			Split :		E	T, W.	Tube		R. (
3		Plo	5	samp		20	Plac	asticity	80	20	Stanu	dard Penetra (Blows/ft		est 100	
Depth (ft.)	Soil Description	Swala Plot	SPT Blow Count	1D Mark	Recovery	1	Wet Ur	nit Weigh p/cu.ft)		U	Indrained	Unconfined (kip/sq.fr	Shear	1	.h
Dep		Sm	SPITE	ID	Roco	.07	Inne	/cu.ny	.13	1.0 C	Jomp, Tes	(kip/sq.fr st + Vane Sh	hear	5.0	
30			7/	1					TIT	Ti			T	+	T
30			8	8	18										
	Very Stiff Dark Brown Clay with son Sand & Traces of Gravel	me		1											
11	Sand a Haces of Grave														
	Very Stiff Dark Brown Sandy Clay w	me	7	1											
35	Traces of Fine Gravels (BH Ends @ 35Ft.)		8	9	18										
	Section 2 have					111								117	
						(\cdot)									
														117	
40															
10															
7								11 7							
45															
40															
50															
50															
55															
20															
						(-1)									
				1											
	**note 51 represent refusal on spoo	on													
NHL ENG	IGINEERING LTD TING ENGINEERS								С	Dates	Job N	lo.			
29 Monroe					1	Start			23.04.16	5		B.H. No	٥.	Sht. 2	2 of
						Completi	ion		23.04.16	5		BH# Sir0*			
OFFICE	BOREHOLE RECORD				19							Dian -	10	All	

	ENT: C/O ODPEM OJECT: Soil Investigation	Eastings:	L	ocat	ion i		ference Northings:			Тур	pe/Size	
	DRESS: 2 - 4 Haining Road, Kingston 5	Emerge	ency Sire	n Pro	Dat	t - Pa	Parish Council, St. Mary		3.25"	"I.D. Stem	25" Diarneter Au m, 140 lbs Cather	ger, ead
	Jamiaca			F	Eleva	atio	in:		1	Drop Ham	mmer for SPT.	
	nple Types Wash		Grab				Split Spoon	T. W.	Tube		R. Core	
(E)		TON	自自	san	mples	15	Plasticity	4		Stand	dard Penetration	
9	Soil Description	4	i N	5 4	338	XX.	Wet Unit Weig	got 🖂	20 Un	- Peninad	(Blows/ft.) Unconfined Shea	100
Depth (ft.)	46.636.636	Strata Piol	SPT Blow Count	T North	ID Mark Recovery	1000	(kip/cu.ft)			Oldinou -	(kip/sq.ft) st + Vane Shear	ar Strengti
				E =	3 2	4		13	1.0 0,	Jmp. res	1 + Vane onea	5.0
0					T							
			5 6			10						
	Stiff Dark Brown Clay with some Sa	and	5		1	0				111		
					1							
5												
	Consent Dayle Dissuit Cond & Clay		4 5	V,	2 10	to						
-	Compact Dark Brown Sand & Clay		6/	4	1							
-		and	4									
-	Compact Dark Brown Fine - Medium Sa	and	5 6	3	18	18		1117				
-	with some Clay							1117				
10	,		7 6	V 4	8							
-			5/	7	0							
-	Compact Dark Brown Fine - Medium											
-	Sand with some Clay											
15	***************************************		4	7								
			8 8	5	18	1						
	Compact Dark Brown Fine - Medium											
	Sand with some Clay					1						
			111	117								
20				1								
		d	5	6	18	1				117		
	Compart Desire Cina Modium Con		9/	7								
	Compact Brown Fine - Medium Sand with Traces of Fine Gravels & Clay	1										
				1								
25												
3			6 5	7	16							
-					1	1						
-	Stiff Brown Clay with some Sand		11 17									
30												
	""note 51 represent refusal on spoon ENGINEERING LTD					-						
ONSU	BULTING ENGINEERS					-		Date	es	Job No.		
	enroe Road Ion 6, Jamaica				1	Sta	tart	23.04.16		1	B.H. No.	Sht. 1 of 2
OFFIC	DE BOREHOLE RECORD					Co	ompletion	23.04.16				
See .	a portarione rise erio				7	-	nal W. L.	N/A		- 0,	H# Sir011	

	ENT: C/O ODPEM OJECT: Soil Investigation	Eastings:		- 1	Loca	tion		erence							7	ype/S	ize		
	DRESS: 2 - 4 Haining Road,	Emerg	jency	Sire	n Pr	ojeci	t - Pa	rish C	gs: council	l, St. Man	у		F	Iollow 5	Stem D. St	6.25" [em, 14	Diameter /	Auger	X.
	Kingston 5 Jamiaca					Flov	ation							D	rop H	ammer	for SPT.		
Sam	nple Types Wash] G	Grab					lit Spoo	on	E	T. V	V. Tube	9	E	-	R. Co	ore	
3			50	SHE	sai	mple:				Plasticit	y		T			andard	Penetrati	ion Te	
9	Soil Description	5	7	W.C.	2 .	W 197	2	20	UA7	et Unit W	Name of the last	80	2			-	Blows/ft.)		100
Depth (ft.)	330000000000000000000000000000000000000	3	Strata Plot	SPT Blow Count	Type	ID Mark Recovery	A A A A A	.07	NA	(kip/cu.ft	eigini t)	.13	,	.o Cor	mp. T	est + V	onfined Sh kip/sq.ft) /ane Shea	near a	Strength 5.0
30				8		8 1	12	T							1			T	
	Vary Stiff Brown Clay with Transport E			7	4														
	Very Stiff Brown Clay with Traces of Fi Gravels	ine																	
1																			
35	Very Stiff Brown Clay with Traces of Fine Gr	ine		7	7														
	(BH Ends @ 35Ft.)		N.	7 8 8	X.	9 14	4												
10																			
-																			
-																			
-																			
45																			
1																			
0																			
-																			
5																			
4																			
4																			
HL.	"note 51 represent refusal on spoon ENGINEERING LTD						-				+								
ONS	SULTING ENGINEERS						Sta					2 7 7 7	ates		Job N	lo.			2.00
	ton 6, Jamaica						Sta	9			+	23.04.16	_			В.Н.	. No.	S	Sht. 2 of
FFIC	DE BOREHOLE RECORD				-		Con	mpleti	on		2	23.04.16	1			BH#	Sir011		
							Fin:	al W.	L.			N/A							

	ENT: C/O ODPEM OJECT: Soil Investigation	Eastings:	4	Lo	catio	on Re	Reference Northings:				Type/Size	
	DRESS: 2 - 4 Haining Road, Kingston 5			cy Siren	1 Pro	ject	t - Town Center, St. Mar	у		3.25" 1.1	Stem 6.25" Diameter Au D. Stem, 140 lbs Cathe	
	Jamiaca				E	levati					rop Hammer for SPT.	
Sami	nple Types Wash			Grab			Split Spoon		T. W. T.	ube	R. Core	
3			Total	CHID	samp	ples		city			Standard Penetration (Blows/ft.)	
Depth (1	Soil Description		Strata Plot	SPT Blew Count	1D Mark	Recevery	Wet Unit \(\(\)(kip/cL	Weight u.ft)	80 -13	Und	drained Unconfined She (kip/sq.ft) omp. Test + Vane Shear	ear Strength
0	Firm Dark Brown Sandy Clays wth some Gr.	ravels		2 2 2 2	1	14						
5				4 4	2	14						
1	Firm Brown Clays			3 /								
10	Firm Brown Clays			2 2	3	15						
0				2 2 2	4	10						
	Firm Brown - Grey Clays			2/_)								
15	Firm Brown - Grey Clays with Traces of Gra	avels	y	1 2 2	5	9						
20	Firm Grey - Brown Clays		y	2 2 2	6	15						
25	Very Soft Dark Grey Clays			HW X	7	14						
60	**note 51 represent refusal on spoon	1										
	ENGINEERING LTD ISULTING ENGINEERS		2						Date	es	Job No.	
29 Ma	lonroe Road ston 6, Jamaica						Start	2	22.04,16		B.H. No.	Sht. 1 of
OFFI	ICE BOREHOLE RECORD						Completion	1	22.04.16		BH# Sir012	
Mr.	DE BOREHOLE RECOND						Final W. L.		15'		-	

	IENT: C/O ODPEM OJECT: Soil Investigation	Eastings:				eference Nothings:			Type/Size	
ADI	DRESS: 2 - 4 Haining Road, Kingston 5	Emergen	cy Sire		ject - Datur	Town Center, St Mary	7	3.25" 1	Stem 6.25" Diameter A I.D. Stem, 140 lbs Catt Prop Hammer for SPT.	head
Sam	Jamiaca nple Types Wash		Grab		evatio					
_	A A A A A A A A A A A A A A A A A A A		-	samp		Split Spoon Plasticity	T. W.	Tube	Standard Penetration	
Œ	STATE AND THE ST	PIC	3			20	80	20	(Blows/ft.)	100
Depth (ft.)	Soil Description	Strata Plot	SPT Blow Count	ID Mark	Recovery	Wet Unit We (kip/cu.ft	eight 🗆)	1.0 Co	drained Unconfined St (kip/sq.ft) omp. Test + Vane Shea	near Strength ar 5.0
30			1						11111	
	Soft Dark Grey Clays		1/	8	18					
-	200.000.000.000.000.000.000.000.000.000									
35	Firm Brown - Grey Clays with Traces of Gra	avels	3 3	9	12					
	(BH Ends @ 35Ft.)		3/_\							
-										
-										
40		111								
		111								
								111		
45										
Ц										
		- 11								
50							1.11			
-										
-										
4										
5										
30	**note 51 represent refusal on spoon									
ON	ENGINEERING LTD SULTING ENGINEERS						Da	ates	Job No.	
9 Mo	onroe Road ston 6, Jamaica				9	Start	22.04.16		B.H. No.	Sht. 2 of 2
)FFI	CE BOREHOLE RECORD					Completion	22.04.16		BH# Sir012	
	rando de la mara de la companya del companya de la companya del companya de la co				F	inal W. L.	15'			

CLIENT: C/O	ODPEM Soil Investigation	Eastings:		L	catio	n R	eference Northin				Type/Size	
ADDRESS: 2	- 4 Haining Road, Kingston 5		cy Si	iren I		ct - C Datu	lembhar	igs: ds Park, St Mary	+	3.25" [.	Stem 6.25" Diameter Aug D. Stem, 140 lbs Cathea rop Hammer for SPT.	
J	Jamiaca	4	-	-0	El	evati						
Sample Types	Wash		Gra				Spl		■T W	Tube	R Core	
2		Not	0	ount	sam	ples	20	Plasticity	80	20	Standard Penetration (Blows/ft.)	Test 100
Depth (ft.)	Soil Description	ta I	0	OW	ank	100	-	Wet Unit Wei		Unc	drained Unconfined Shea	1
de		Strata Plot	ROD	SPT Blow Count	ID Mark	Recovery	.07	(kip/cu.ft)	.13	10 Co	(kip/sq.ft) mp. Test + Vane Shear	5.0
		2004	77	00 10		2	1-7		-10	1 1		1
0						1			14 / 11			
				1	1	8						
Sof	ft Dark Grey Clays with Traces of Gravels	Fine /		1/	1	0						
	Gravels											
-												
_												
5				HW	7							
	Soft Dark Grey Clay with some			1 2	2	8						
	Sand & Gravels				1							
1,,				HW	7		M.		344			
	Very Soft Grey Clay			HW/	3	9						
10												
10				HW)	4	11						111
	0.0000000000000000000000000000000000000			HW	7	11						
	Very Soft Dark Grey Clay											
15				HW	1					1137		
		//		HW HW	5	12						
	Les Anna Landau de la companya della companya de la companya della	//		-								1111
	Very Soft Dark Grey Clay	/////////////////////////////////////										
		//										1111
		//										
20				2	6	10						
				2/	1 8	18						
	Soft Dark Grey Clays											
		Fine										
25	***************************************											
				1	7	18						
	Soft Dark Brown - Black Peat			1/								
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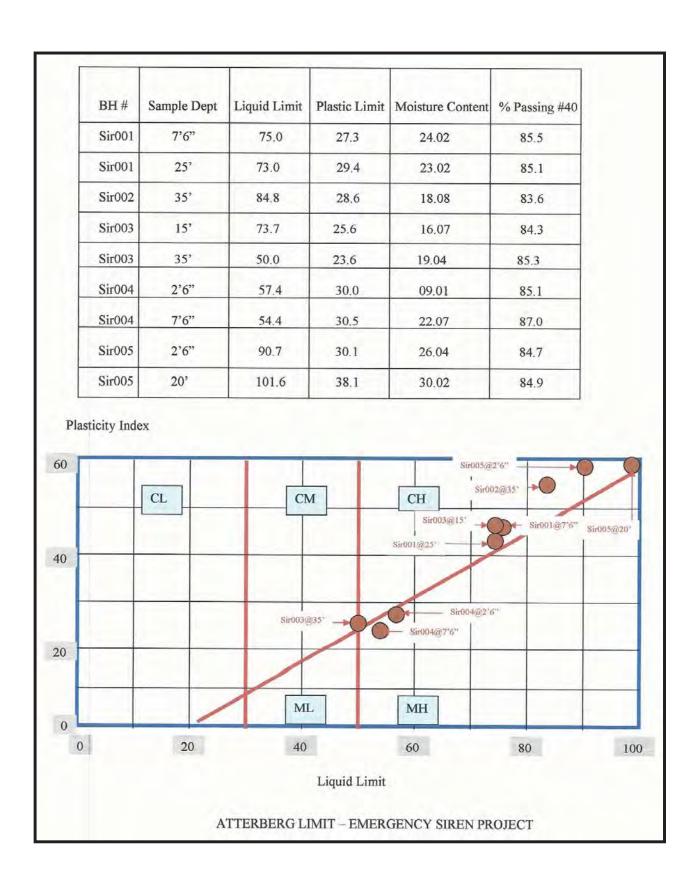
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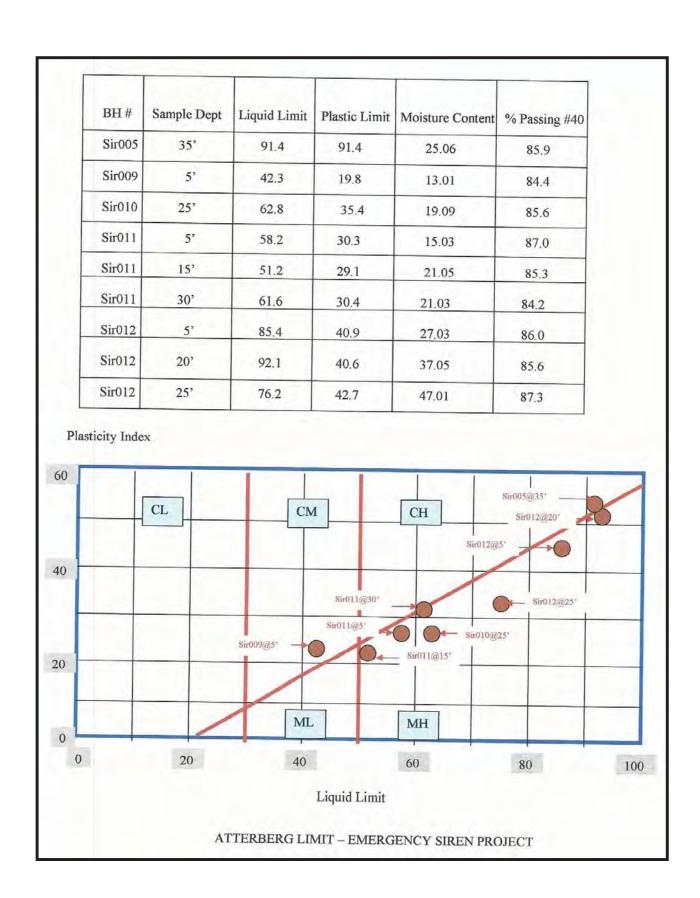
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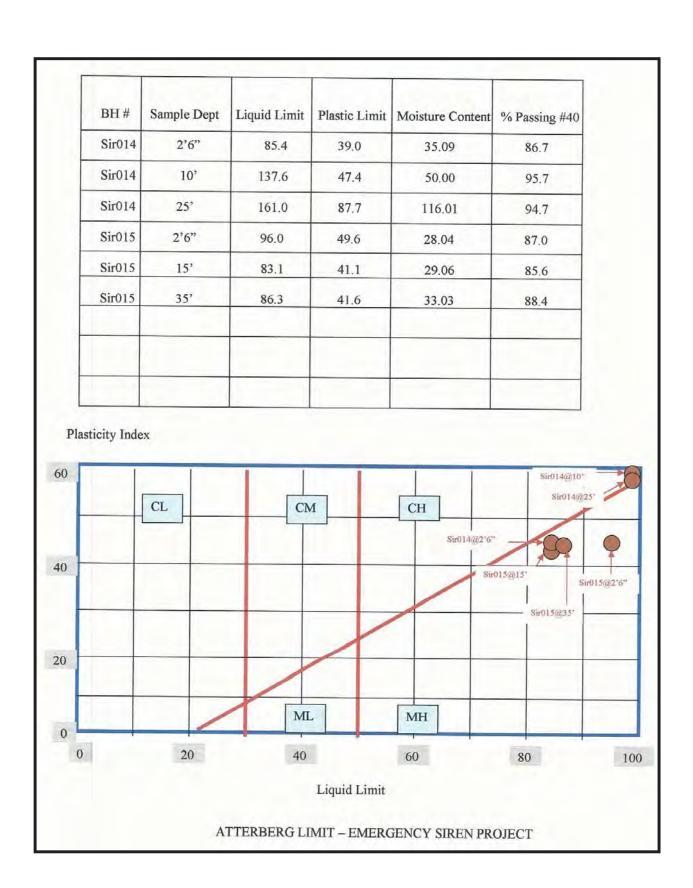
Appendix III Laboratory Physical Soil Test Results

SSIEVE	Sir001@26"	Sir002@2'6"	Sir002@7'6"	Sir002@25	Sir002@35' A	Sir003@2'6"	Sir004@25	Sir004@35'	SIr006@2'6"	Sir0066
20	100	100	100	100	100	100	100	100	100	100
14	100	100	100	100	100	100	100	100	100	100
9	100	100	100	100	100	100	100	100 98.2	93.5 85.7	91.9
5 2	98.7 97.1	91.7 84.7	98.7 97.3	98 95.7	99.3 98.7	98.6 97.7	76.5 74.2	92.5	66.4	54.3
0.8	96.8	81.3	95.1	94.4	95.3	97.5	68.2	90.6	57.4	48.2
0.4	88.8	48.6	54.9	50.6	65.3	83.5	52.6	45.4	19.6	20.5
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JSSIEVE	Sir008@2'6"	Sir009@12'6"	Sir009@15	Sir009@35	Sir010@5	Sir010@20	Sir012@2'6"		
20	100	100	100	100	100	100	100		
14	100	100	100	100	100	100	100	1	
9	93.1	100	100	100	100	100	95.9		
5	71.2	96.2	98.6	98	93.2	98.7	90.5		
2	58.6	86.5	96.4	97.4	77	95.6	85.7		
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Yachiyo Engineering Co. Ltd- Concrete testing at Shotover, Portland- June_2016.

Geo-Edge Ltd © 2016

A report on concrete testing at the Telecommunication Tower site at Shotover, Portland (Project for Improvement of Emergency Communication System in Jamaica

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1.0 INTRODUCTION

1.1 OBJECTIVES

The aim of this geotechnical report is to:

- Conduct materials testing on concrete base (slab) of control room at selected telecommunications site
- Present findings on analysis of concrete study
- Present recommendations based on findings

1.2 BACKGROUND

In recent years the Japan International Cooperation Agency; JICA, and the Jamaican Government have strengthened bilateral arrangements with the aim of promoting the islands social and economic development.

A crucial component of JICA's operation is aimed at strengthening the goals and strategic objectives of the islands Comprehensive Disaster Management Framework, which partly involves the improvement of Jamaica's emergency communication infrastructure.

Hence, the objective of the project is to improve the existing emergency communication infrastructure in Jamaica. This will be accomplished by upgrading the existing communication infrastructure which will inevitably result in more efficient and effective communication island wide, and by extension a stronger emergency response mechanism in the event of natural disasters

1.3 PROJECT SCOPE

The scope of works provided and commissioned by Yachiyo Engineering Company Limited (YEC) and guided by an addendum to contract dated April 14th 2016 included all activities necessary to produce findings of geotechnical investigations at target sites and recommendations for construction and design. The addendum covered concrete testing of concrete base below an existing control room at the location. Testing locations were guided by YEC. Results from the material testing should then form the basis of recommendations for the use of the existing base for new or replacement Control Room

This report was prepared for the exclusive use of our client and their consultants for design of this project. In the event that any changes are made in the character, design or layout of the improvements, we must be contacted to review the conclusions and recommendations contained in this report to determine whether modifications are necessary. This document may not be reproduced in whole or in part by any means whatsoever, nor may it be quoted or excerpted without our express written consent.

1.4 PROJECT DESCRIPTION

The purpose of this project is to improve the existing emergency telecommunication infrastructure in Jamaica. This involves installing the requisite wireless communication systems and relevant infrastructure.

The assessment of the structural integrity of the Control Room base serves as a component of the study, as it assesses the existing structure and its capability of supporting a new structure.

Page 6

The report hereby presents the findings of this concrete test.

No.	Name	Parish	Longitude	Latitude
??	Shotover	Portland	18°10'18.39"N	76°28'51.02"W

Figure 1 Table showing geographic coordinate locations of Shotover, Portland tower site

1.5 PROJECT LOCATION

This project involves concrete testing at the Telecommunication Tower located at Shotover, in the north-central section of the parish of Portland. (See fig.2).

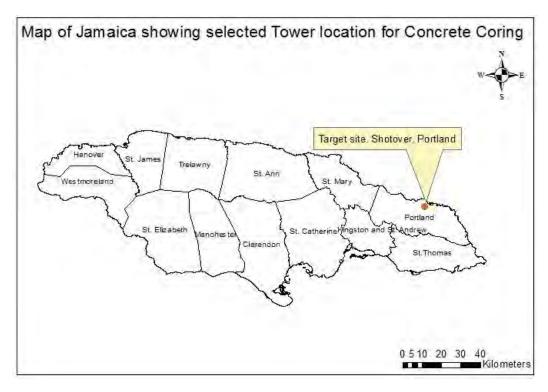


Figure 2. Map showing location of selected tower sites where soil investigations were conducted

The targeted Telecommunication Tower site is found in the rural community of Shotover, about four kilometers west southwest of the parish capital of Port Antonio. It is accessed via a parochial road that serves the District of Boundbrook leading to the rural community of Spring Bank. The site is located in highlands which rise in excess of three hundred feet above sea level, overlooking Unity Valley and Burlington which is separated by the Rio Grande, which empties at the coast, near the seaside town of St. Margret Bay. (See fig. 3)

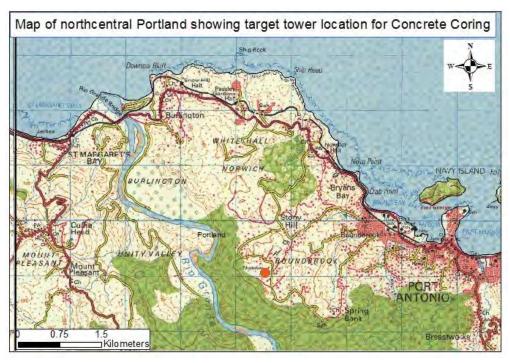


Figure 3 Map showing location of tower site in Mount Airy, Westmoreland

2.0 METHODOLOGY

2.1 TESTING LOCATIONS

Site selection for concrete testing was guided by representative of YEC. Three locations were identified on and along existing concrete slab. Two (2) holes on western side and one (1) on eastern side of concrete. (See fig. 4)



Figure 4. Pictures showing locations of coring sites on concrete base, Shotover, Portland

2.2 ACQUISITION OF SAMPLES

Sites for coring were initially identified and marked out on slab. Safety checks were conducted to ensure there were no services infront and behind the location to be cored. Wall anchor was then drilled and installed. Coring machine was then mounted, 4"diamond core bit was then affixed and centred on marked position. Water was then fed to core bit and coring occurred to a depth of eight inches (8"). At achievement of desired depth (8") machine was stopped and core removed for measurements, observations and packaging for transport to lab. Concrete mixture was then prepared and used to replace and fill cylindrical void created by coring exercise. This mixture had a ratio of 3:2:1 (cement:sand:fine gravel)



Figure 5. Pictures showing concrete preparation and infilled boring with prepared concrete mix

3.0 FINDINGS

Findings and results of the coring exercise at Shotover, Portland are presented below. This will be presented with respect to each coring site. All cores were drilled to a depth of eight inches (8"). Location of each target drilling position was also measured with respect to dimensions of concrete slab and its proximity to existing control room structure (metal container) siting on base. Presence of reinforcement steel bars was also noted if encountered.

3.1 FIRST CORE

CORE LOCATION

At the site of the first core the container sits twelve inches (12") away from the edge of concrete base. This is located on the western side of the concrete slab. Boring was done approximately four and half inches (4%") away from base of metal container. The boring had a diameter of four inches(4")







Figure 6. Location of first coring

CORE DESCRIPTION

NO	ITEM DESCRIPTION	OBSERVATIONS
1	LENGTH	8"
2	DIAMETER	4"
3	PRESENCE OF REBARS	None observed
4	CORE DESCRIPTION	Core composed of a section of 6" limestone block. Limestone block space infilled with concrete mixture of alluvial aggregate. Voids seen within infilled concrete. Limestone block is composed of limestone chips and limestone dust (crusher run)



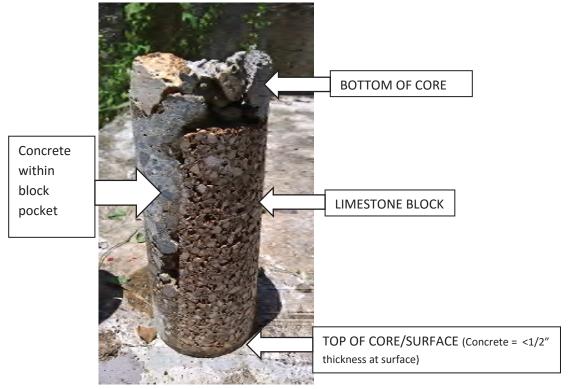


Figure 7. Picture of first core

3.2 SECOND CORE

CORE LOCATION

At the site of the second core the container sits twelve inches (12") away from the edge of concrete base and is located in the southwestern corner of the concrete base. Boring was done approximately two and half inches (2 $\frac{1}{2}$ ") away from base of metal container. The boring had a diameter of four inches(4")



Figure 8. Picture showing location of second boring in southwestern corner of concrete base

CORE DESCRIPTION

NO	ITEM DESCRIPTION	OBSERVATIONS
1	LENGTH	8"
2	DIAMETER	4"
3	PRESENCE OF REBARS	None observed
4	CORE DESCRIPTION	Core composed of a section of 6" limestone block. Limestone block space is partially infilled with concrete mixture of alluvial aggregate. Concrete observed to a thickness of less than three inches (3") within block pocket. Broken pieces of limestone blocks and limestone pebbles seen in block pocket. Limestone block is composed of limestone chips and limestone dust (crusher run)

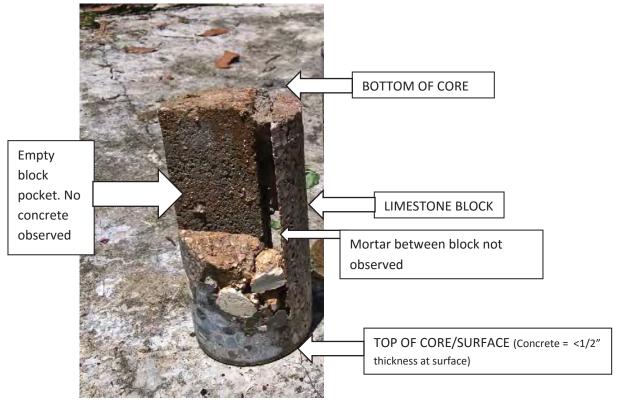


Figure 9. Picture of second core



Figure 10. Picture showing thickness of partial infilling of block pocket at location of second boring

MAJOR FINDING

At the second boring site, located in the southwestern corner of the concrete base we observed a cavity within the concrete structure. This became evident three inches (3") below the surface



Figure 11. Picture showing entrance to cavity found at second boring site

Page I 4

3.3 THIRD CORE

CORE LOCATION

At the site of the first core the container sits fifteen and a quarter inches (15 ¼ ") away from the edge of concrete base. This is located on the southeastern corner of the concrete slab. Boring was done approximately five and quarter inches (5 ¼ ") away from base of metal container. The boring had a diameter of four inches(4")



Figure 12. Picture location of third boring in southeastern corner of concrete base

CORE DESCRIPTION

NO	ITEM DESCRIPTION	OBSERVATIONS
1	LENGTH	8"
2	DIAMETER	4"
3	PRESENCE OF REBARS	None observed
4	CORE DESCRIPTION	Core composed of a section of 6" limestone block. Limestone block space is partially infilled with concrete mixture of alluvial aggregate. Concrete observed to a thickness of less than three inches (3") within block pocket. Broken pieces of limestone blocks and limestone pebbles seen in block pocket. Limestone block is composed of limestone chips and limestone dust (crusher run

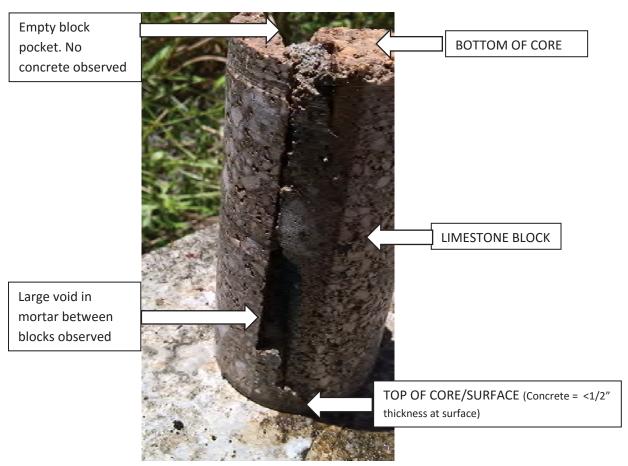


Figure 13. Picture of third core

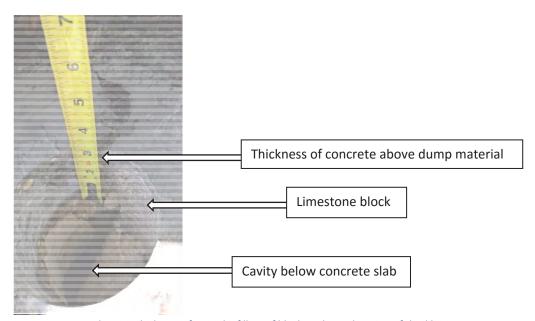


Figure 14. Picture showing thickness of partial infilling of block pocket at location of third boring

Directors : D.A.X. Williams (Managing Director) J.C. Francke (Director) T.A. Williams (Company Secretary)

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$^{Page}16$

MAJOR FINDING

At the third boring site, located in the southeastern corner of the concrete base we again observed a cavity within the concrete structure. This became evident six inches (6") below the surface. (See fig. 14)

4.0 LABORATORY RESULTS OF CORE TESTING

Concrete core samples won from the coring exercise at the Telecommunication tower found at Shotover, Portland were not suitable for laboratory testing. None of the cores produced a complete cylindrical shape or core. Core recovery ranged from 35-80% due mainly to the material used in the construction of this concrete structure.

5.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

CONCLUSIONS

The existing concrete base at the Shotover (Portland) Telecommunication Tower site is ten feet two inches wide (10'2"), twelve feet two inches (12'2") in length and two and a half feet high (2'6").

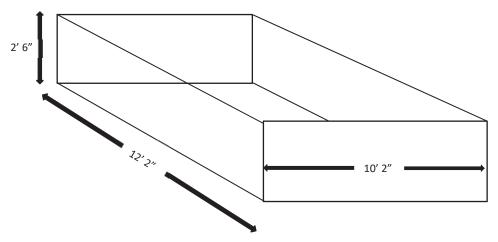


Figure 15. Schematic diagram of concrete slab

Cavities were observed in both the second and third borings which occurred on the southern side (front/entrance to container) of the concrete slab. We are unable to determine the size of the cavity but it is important to note that during the infilling of the boring it took three-four times the volume of concrete to fill space. We however stopped this seepage and siphoning of concrete by the use of limestone rocks found lying around site that was used to pack base of borings. From observation and also using stick to probe cavity, we believe that it extends beyond two feet from affected borings. This cavity was probably due to poor compaction of material used to fill this structure before the pouring of the concrete. These cavities could have also been formed post construction due to the weathering and breakdown of the inferior limestone fill used.

We did not encounter any rebars (reinforcement steel) in any of the won concrete cores. Coring done in the southwestern and southeastern corners are near the corners of the concrete structure where a stiffener (small

during the block laying process. Coring has revealed in two instances where the block pockets were not filled with concrete. We are unable to determine how pervasive this condition is throughout the structure. These instances indicate the construction of the

structural column), supported by rebars, would have normally been placed in the construction of the slab to support the anticipated weight. The cores however revealed that the construction (limestone) blocks were just tied (lapped)

concrete base suffered from poor workmanship and inappropriate and insufficient use of materials.

RECOMMENDATIONS

Based on the findings from this study we will highly recommend that the existing concrete structure be demolished and rebuilt, engineered for the anticipated purpose. This recommendation is based on the fact the structural integrity of the concrete base is questionable and compromised. Yachiyo Engineering Company has not shared the technical specification of use for concrete base, therefore this recommendation is solely based on findings and conditions at site. This recommendation is guided by the following:

- Absence of reinforcement steel in concrete slab
- Presence of large cavity observed on southern side of concrete slab
- Presence of unfilled block pockets in more than one testing location
- Poor compaction of fill within concrete structure
- Our inability to determine how pervasive are these instances of poor workmanship, insufficient use of building materials and poor structural design.