$\frac{\text{A-10-2 A REPORT ON SOIL INVESTIGATIONS AT THE SITES OF SIREN SYSTEM}}{(\text{EWANS}) \text{ IN JAMAICA}}$

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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.

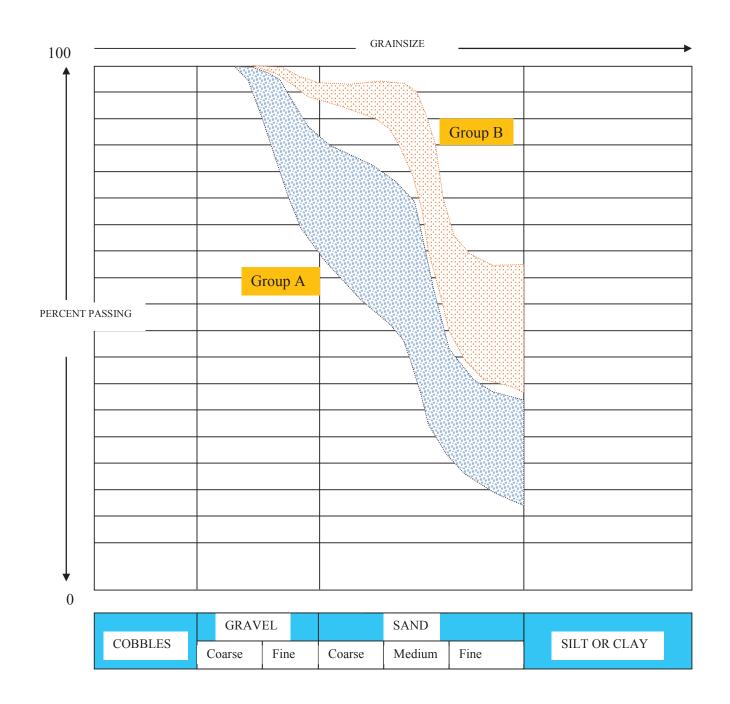


FIGURE 3.1 - GRADATION ENVELOPE – IMPROVEMENT OF EMERGENCY COMMUNICATION SYSTEMS IN JAMAICA (OLD HARBOUR BAY)

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) <u>TYPE 3</u>

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 $N_{55} = 15$ Borehole - # 011, 012, 014 & 015

C) TYPE 2

3) Very Stiff CLAYS
Depth Range; Variable 7.6-10.7+m
Average N₅₅ = 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 N₅₅ = 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

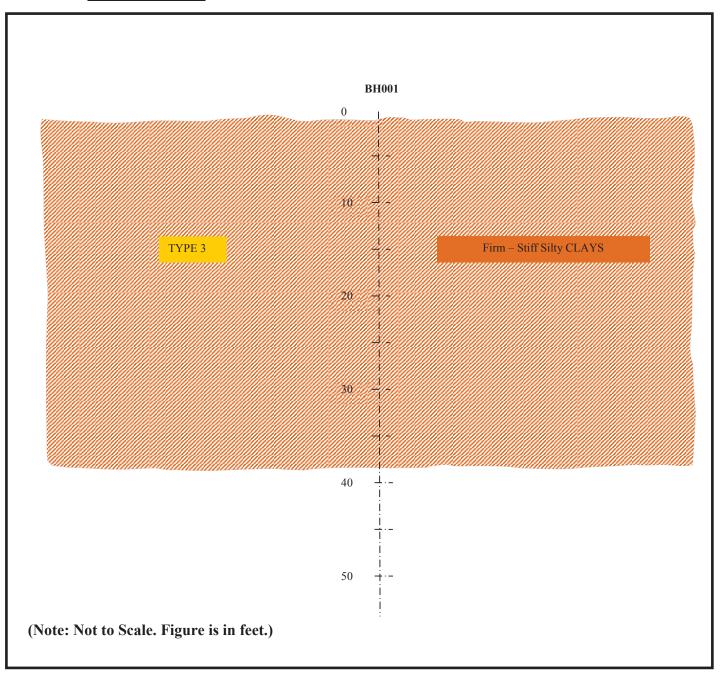


FIGURE 4.1 - Presumptive Profile — BOREHOLES #001

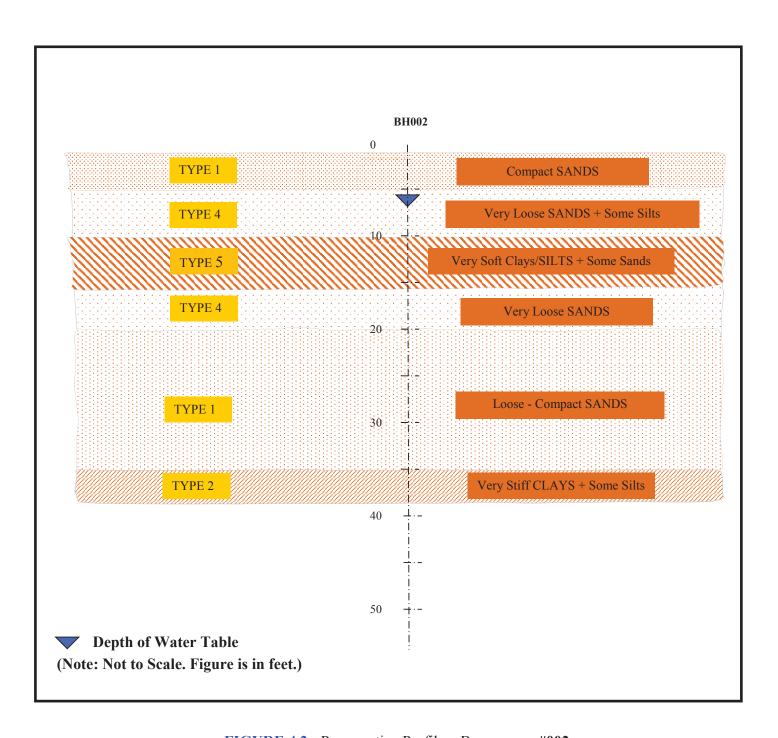
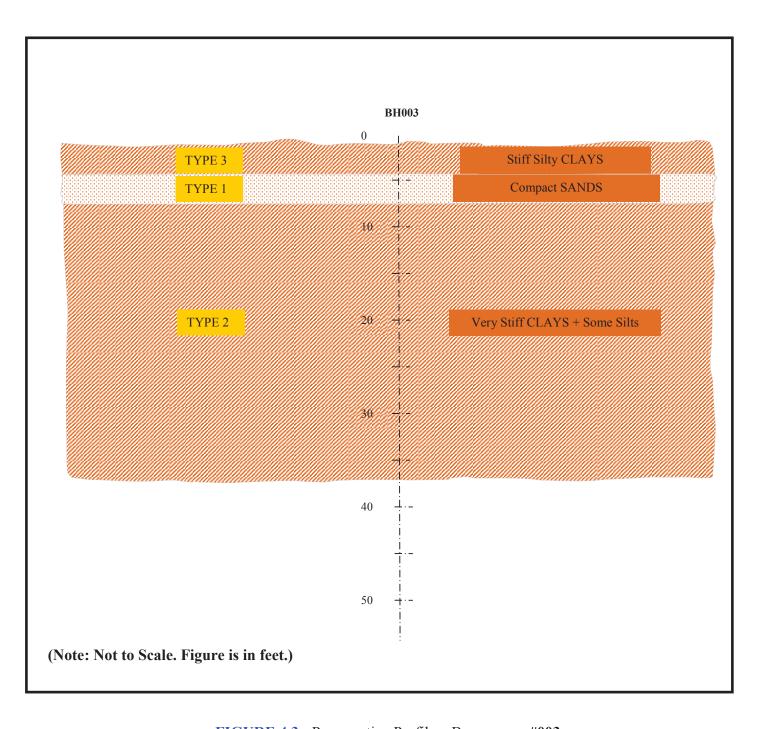
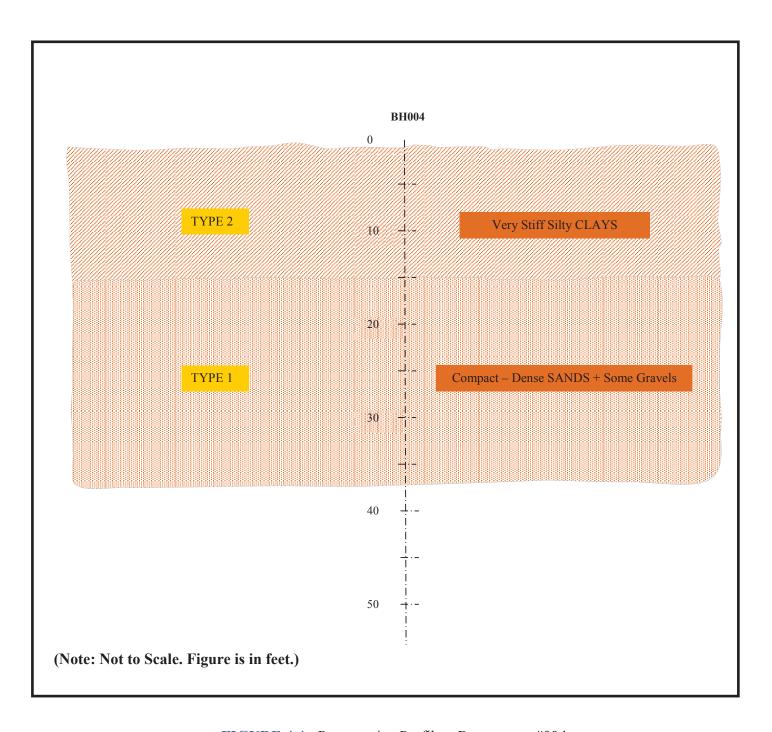


FIGURE 4.2 - Presumptive Profile – BOREHOLES #002



 $\pmb{FIGURE~4.3} - Presumptive~Profile - Boreholes~\#003$



 $\begin{tabular}{ll} FIGURE~4.4~-~Presumptive~Profile-Boreholes~\#004 \\ \end{tabular}$

Bog Walk

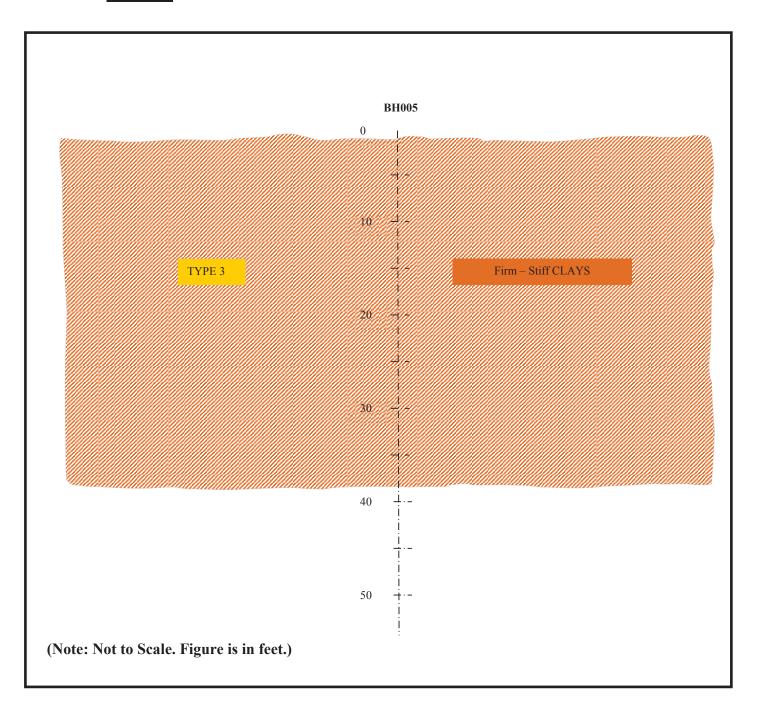
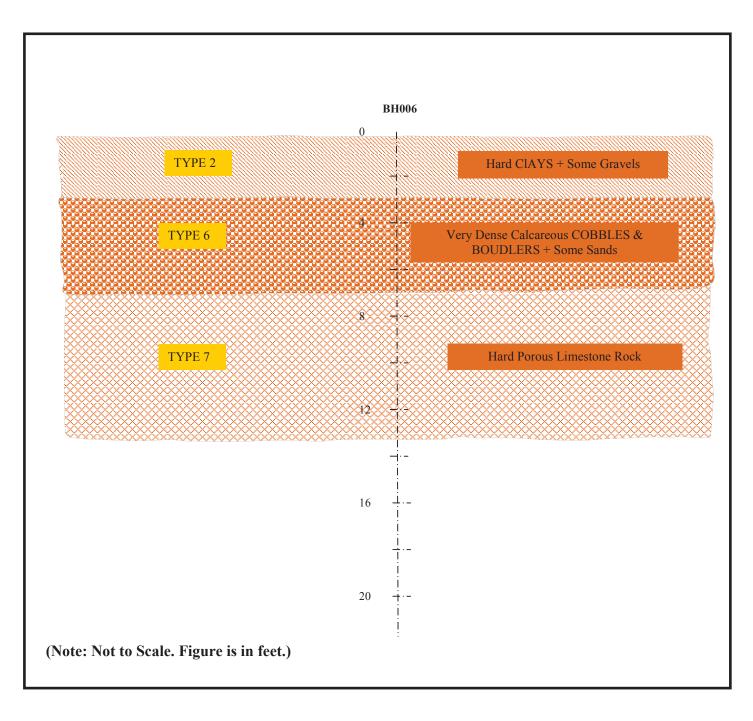


FIGURE 4.5 - Presumptive Profile – BOREHOLES #**005**



 $\pmb{FIGURE~4.6} \textbf{ -} Presumptive~Profile - Boreholes~\#006$

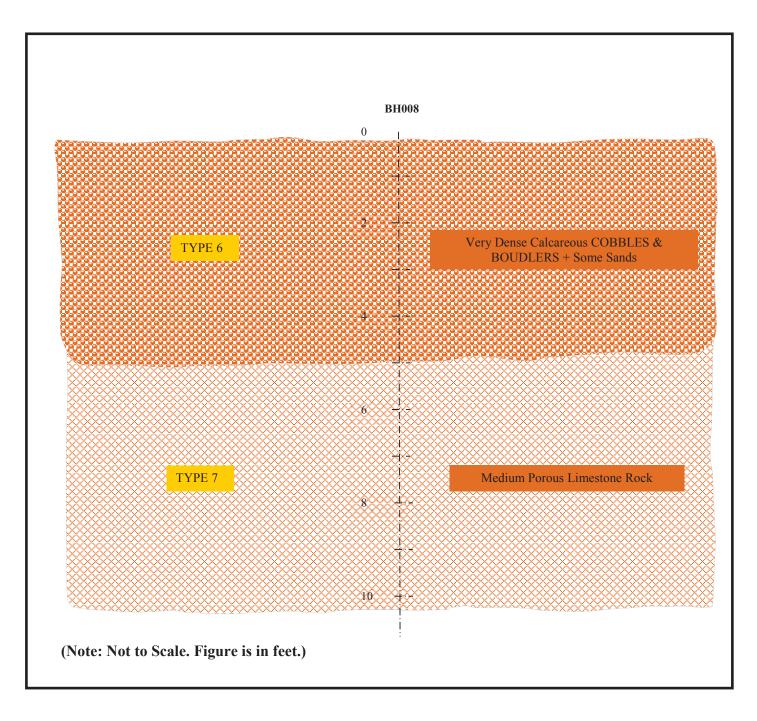
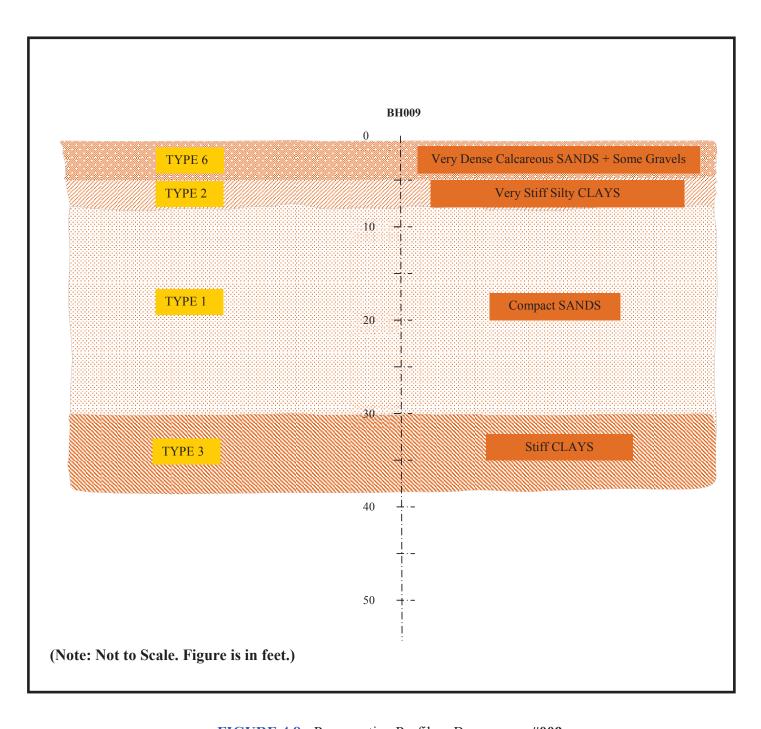


FIGURE 4.7 - Presumptive Profile – Boreholes #008



 $\begin{tabular}{ll} FIGURE~4.8~-~Presumptive~Profile-Boreholes~\#009 \\ \end{tabular}$

Port Maria

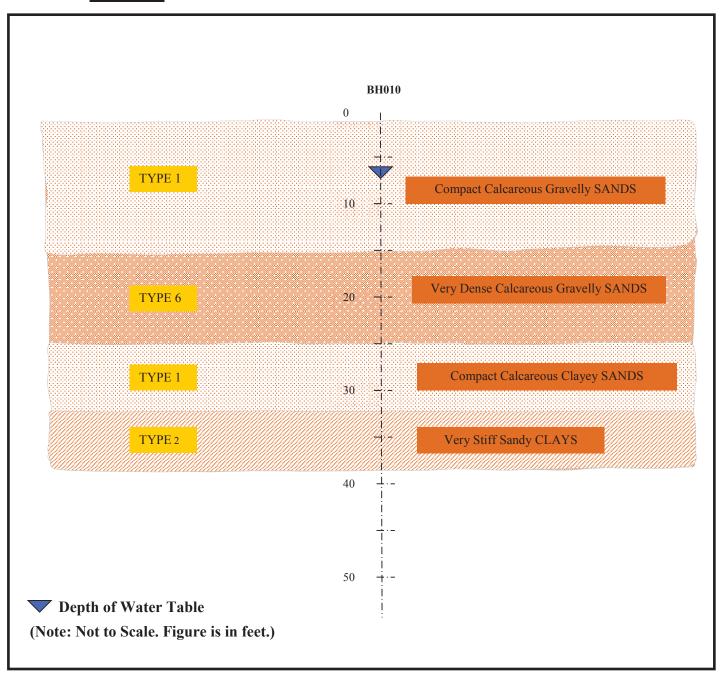


FIGURE 4.9 - Presumptive Profile – BOREHOLES #010

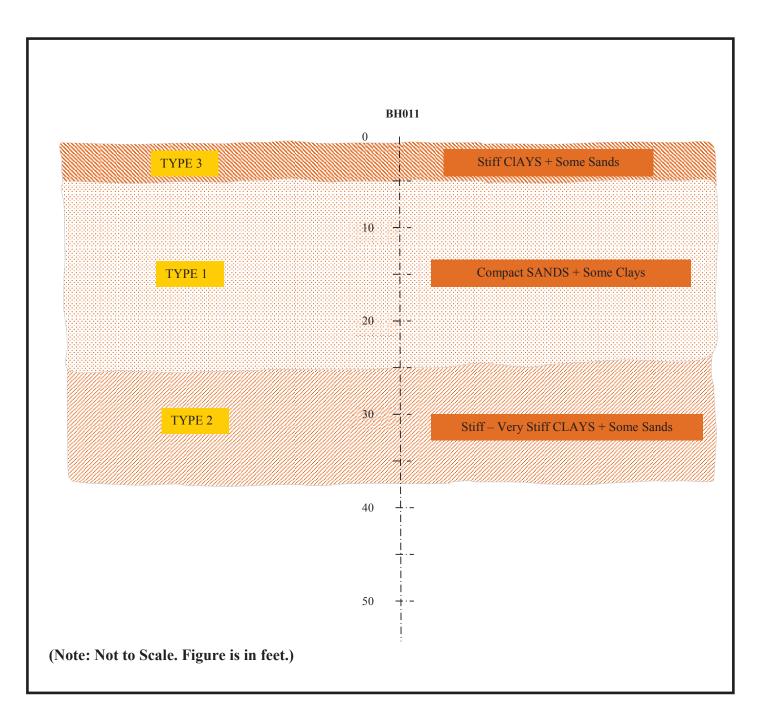


FIGURE 4.10 - Presumptive Profile - BOREHOLES #011

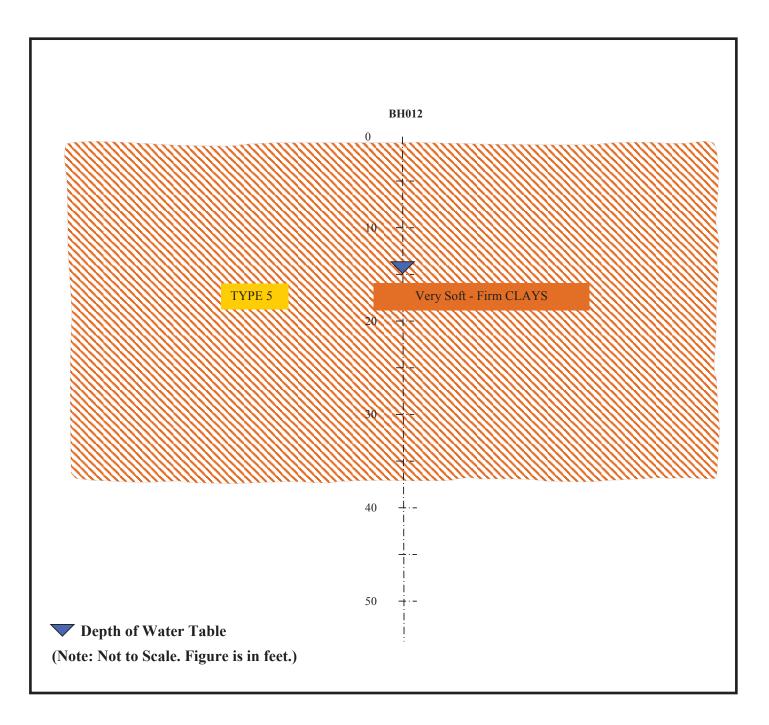


FIGURE 4.11 - Presumptive Profile — BOREHOLES #012

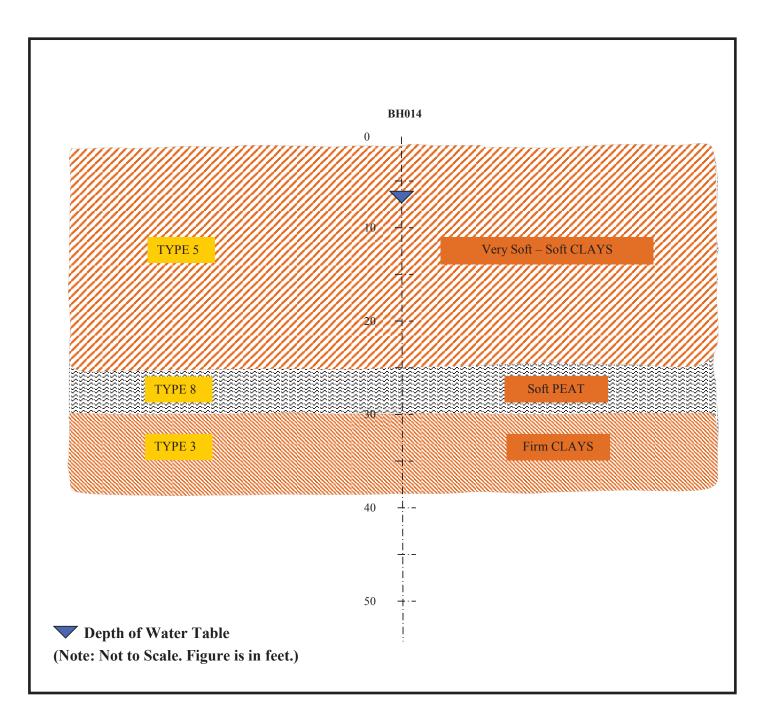
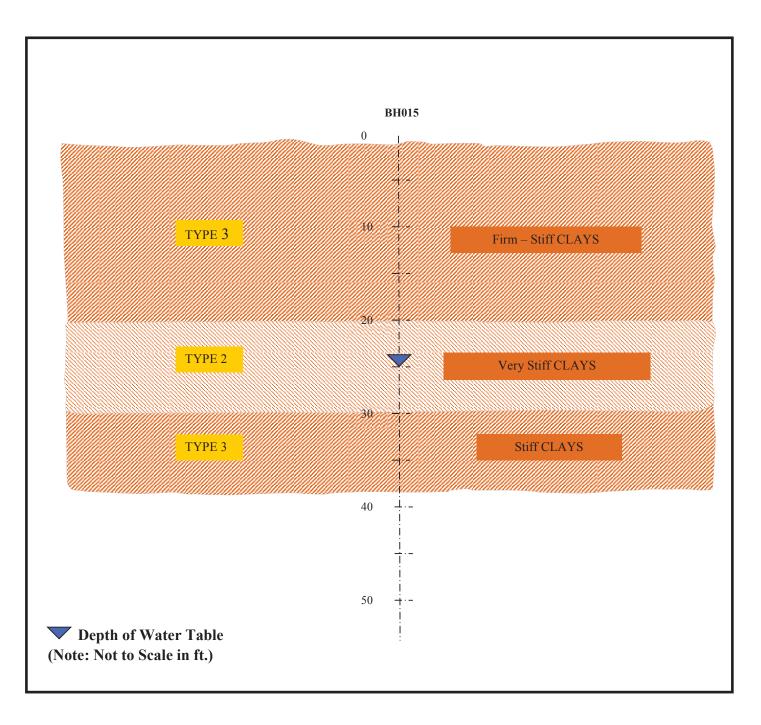


FIGURE 4.12 - Presumptive Profile — BOREHOLES #014



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

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)
$$K_S = 8399*(1+0.2*B/L)$$
 kN/m³

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

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)
$$K_S = 4104*(1+0.2*B/L)$$
 kN/m³

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)
$$K_S = 40936*(1-0.4*B/L)*B kNm^3$$

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 SOILS	TYPE 6 SOILS	TYPE 7	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

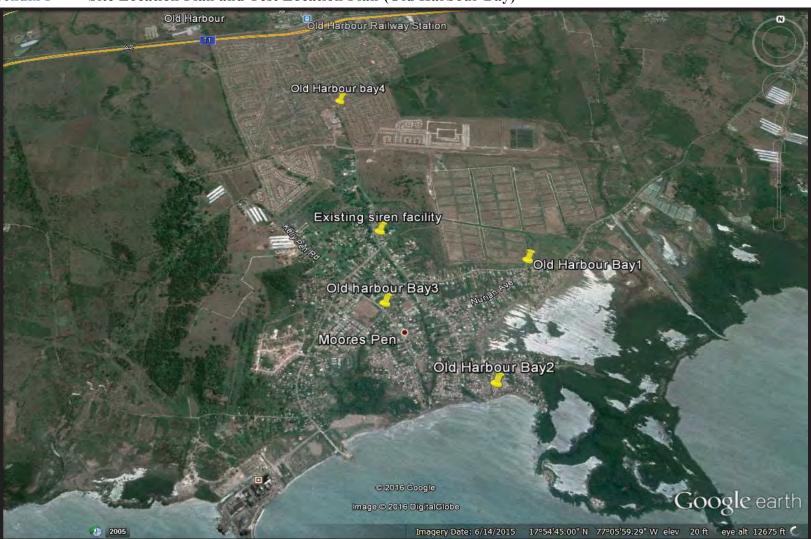
Dr. Carlton Hay

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

Registered Professional Engineer (PE)

Geotechnical Engineering

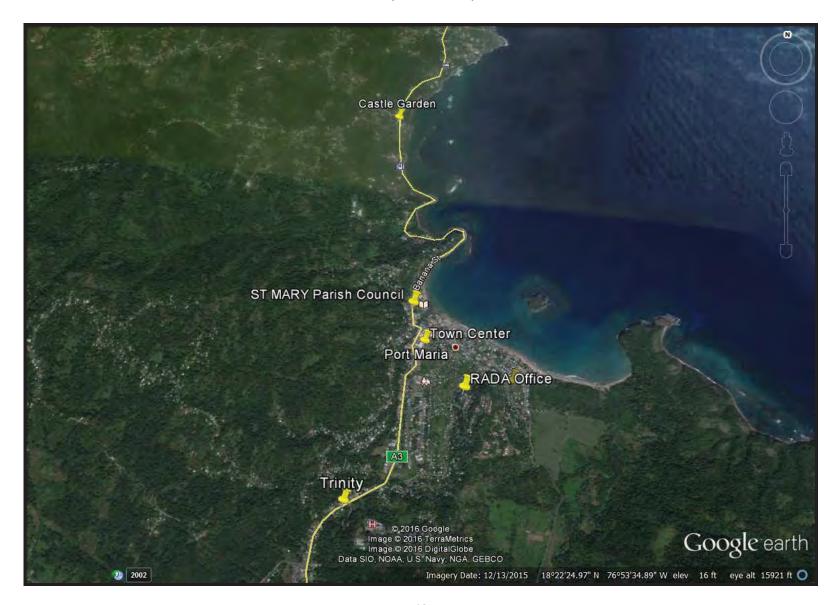
Appendix I - Site Location Plan and Test Location Plan (Old Harbour Bay)





Site Location Plan and Test Location Plan (Bog Walk)

Site Location Plan and Test Location Plan (Port Maria)



Appendix II - Soil Boring Log

PRO.	RESS: 2 - 4 Haining Road, Kingston 5 Jamiaca	Eastings: Emergency		Projec D			erine			5" I.D.	m 6.25' Stem,	e/Size " Diameter Au 140 lbs Cather ner for SPT.		
Sampl	ole Types Wash		Grab			Split Spoon		T. W. T	ube			R. Core		_
(F.)		Tog (曹	sam	ples	P	sticity			5	Standa	rd Penetration	Test	_
) u	Soil Description	Strata Ple	SPT Blove Count	0 4	4 8	20	***	80	20			(Blows/ft.)	100	
Depth	Our Description	2 V	圖	T STPSO	Recovery	Wet Unit	it Weight cu.ft)	it d		Undrain	ned Ur	nconfined Shea (kip/sq.ft)	ar Strength	
		Stra	8	9	Re	.07	1	13	10	Comp	Test	(kip/sq.ft) + Vane Shear	5.0	
0			TT	T					T	11	-	ПП		T
			4	7										1
-			5	1	18	5								
-	Stiff Brown Clayey Silt & Medium - Fine S	Sand	-											1
											11/			
5		W.		-										1
1			6	2	18									
	Firm Brown Silty Clay		4	7										
	Firm Brown Silty Clay		3 4 5	(3	18									
	1 mil somi say say		5/	1	1									
10			6	7	9									
			6 7	4	18									
	Stiff Brown Clay with some Silt & Traces	. 1	1	1										
	Stiff Brown Clay with some Silt & Traces Sand	of												
15			6	1.1	4									
-		s of	7 8	5	18									
	Stiff Brown Clay with some Silt & Traces				1									1
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T			5	6	18									
-	Stiff Brown Clay with some Silt & Traces		В								11		4111	
-	of Sand	*											1111	
-														
25	111000000000000000000000000000000000000		7											
			6 7	7	18									
	Stiff Brown Clay with some Silt & Trace	es												
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30	**note 51 represent refusal on spoon	98												
AHL E	NGINEERING LTD	1000	-1-1		1		-	1 1		1			1-1-1	-
	JLTING ENGINEERS				+		-	Date	8	Joi	b No.		1	_
9 Monr (ingstor	roe Road on 6, Jamaica					Start	2	28.04.16			В	.H. No.	Sht. 1 of	2
DEFICE	E BOREHOLE RECORD				_	Completion	2	28.04.16						Ī
A LIGH	, BUNEHOLE REGUND				+	Final W. L.	-		_	-	Вня	# Sir001		

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
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				7	8	18						
	Stiff Brown Clay with some Silt & Sand	. 8		1 1					11			1111
										11		
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		11		11		- 1						
-		11										
+		- 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	BOREHOLE RECORD		_			- 0	ompletion	28.04.16		P	H# Sienna	
	EHOLE RECORD					F:	nal W. L.	N/A	-	В	11# 311001	
		HOLE RECORD				E:	1 VALLen	20,45	BH# Sir001			

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	14	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										
-												
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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					11			
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											
-	7,000											
-						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
	a Road 5, Jamaica					+	J. Lance	20.04.10		В	B.H. No.	SIL TOTZ
FFICE	DREHOLE RECORD				_	_ (Completion	28.04.16		DI		
	- DONE INCOME					-	Final W. L.	7'		- Bn	# SIr002	

	ENT: C/O ODPEM DJECT: Soil Investigation	Eastings:		L	ocati	on Re	eference Nothin					T	ype/Size	9		
				ren Pr			Harbour	gs. Bay, Fishing Villa	ge					meter Aug		_
ADD	DRESS: 2 - 4 Haining Road, Kingston 5					Datu	n							bs Cathea	ıd	
	Jamiaca				E	evati	on:					огор па	immer fo	ISPI		
Sam	ple Types Wash		3	rab			< Sp	lit Spoon		∃T. W.	Tube			R. Core		_
3			0	MIRE	sam	ples	-	Plasticity		7.0	Maria	Sta		enetration ws/ft.)		_
Depth (ft.)	Soil Description		Strata Plot	SPT Blow Count	2 4	100	20	Wet Unit We		80	20	ndraina		ined Shea	100	
cb	200.200.400.		Straf	TB	ID Mark	Recovery	46	Wet Unit We (kip/cu.ft)			ama T	(kip	/sq.ft) ne Shear	7.7	,
				35	=	2	.07	- 1		3	1.0. 0	omp. n	asi + vai	ie oliesi	5.0	
30				4	1.	100										П
				5	8	18										
	Compact Brown Medium - Fine San with some Silt	d														
-	Will some Sit															
-								1 101 1								
	***************************************															1
35	Very Stiff Brown Clay with some Silt & Trac of Sand	es		8	9	18										
	(BH Ends @ 35Ft.)			9/	1	1							(A)			
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	**note 51 represent refusal on spoon ENGINEERING LTD			1		-			1				1-1			
ONS	BULTING ENGINEERS					+				Da	tes	Job	Vo.		1	_
	onroe Road					1	Start		28	04.16			P.11	Na	Sht. 2 d	of
ingst	ton 6, Jamaica					1	Onm-1-	tion.	0.0	04.40			В.Н.	NO.		-
OFFIC	CE BOREHOLE RECORD			_	_	-	Comple	tion	28.	.04.16			BH# S	ir002		
							Final W			7'						

	ENT: C/O ODPEM OJECT: Soil Investigation	Fee		Loca	ation	Reference					Type/Size	
		Eastings:	Siren P	roject	- Bla	Northi	ngs: rdens, St. Catherir		11.0			
AD	DRESS: 2 - 4 Haining Road,	Linergency	on unit	rojeci		tum	rdens, St. Catherir	ne	Hollo 3.2	ow Stem 5" I.D. S	6.25" Diameter A tem, 140 lbs Cath	iger;
	Kingston 5 Jamiaca				Elec	ation.			2.5		lammer for SPT.	wat.
San	nple Types Wash		Grab			ation:	olit Spoon	T. W	Tuha		R. Core	
~		121	A Z	Ts	imple		Plasticity		1000	C.		
(I)		Strata Plo	SPT Blow Count			20	Plasticity	80	20	St	andard Penetratio (Blows/ft)	1 Test
Depth	Soil Description	ata	SPI Blow Co.	The state of	dark		Wet Unit We	eight p	1	Undraine	ed Unconfined She	ear Strength
ă		Str		Other	ID Mark	.07	(kip/cu.ft)	.13	1.0	Comp.	(kip/sq.ft) Test + Vane Shea	r 5.0
0		777										1
-	Stiff Brown Sills Clauselle Towns S										1 11 1 1 1 3	
	Stiff Brown Silty Clay with Traces of S	and	6	M	1 3	10		111				
	The second secon		7	H						11		1111
	Compact Brown Coarse - Fine Sand			Ы								
	Sand Sand											
5												
~	Stiff Brown Silty Clay with Traces of S	and	.8		2							
-			9	Δ	2 8							
	Compact Brown Coarse - Fine Sand											
	Very Stiff Brown Sills Oleman St.	and of the control of	10		3 18	8						
	Very Stiff Brown Silty Clay with Traces of S	and	7	Δ.	18							
10												
			5 8 7	VI.	1 18	3						
			7	Δ				111				
-	Very Stiff Brown Silty Clay with Traces of Sand	of W						111				
	Garla	/////////////////////////////////////						111				14 1
15			6					1111				
			7	X 5	18							
	Very Stiff Brown Clay with some Silt & Tra		9	9						11		4 1 1
	of Sand	ces						1111				
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20	The state of the s		8									
			8	6	18							
	Very Stiff Brown Clay with some Silt & Trac	es 💹	1			111		11/11				
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-	W. L. C	es	9/		10							
-	Very Stiff Brown Clay with some Silt & Trac of Sand	es										
-	4.000000											
				1								
0	**note 51 represent refusal on spoon											
HL ONS	ENGINEERING LTD ULTING ENGINEERS							Dat	es	Job I	No.	
	roe Road					Start		No.		3001		
	roe Road n 6, Jamaica					Start		29.04.16			B.H. No.	Sht. 1 of 2
						Completi	on	29.04.16			200 1520	
FFIC	E BOREHOLE RECORD							122300			BH# Sir003	
	OKEHOLE RECORD					Final W.	Ĺ.	N/A				

	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						
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45										
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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	RING LTD NGINEERS			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	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		17								
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	on Re	ference Nothin						Ту	/pe/Siz	ze		
	SS: 2 - 4 Haining Road,		y Sir	en Proje		New F Datur	larbour '	Village, St. Catherin	ne	7					ameter Au Ibs Cathe		
	Kingston 5 Jamiaca				El	evati	on:					Dr	ор На	mmer t	for SPT.		
Sample T] (rab				it Spoon		T. W	Tube				R. Core		
3		Į į	ń	100 H	samp	oles		Plasticity					Star		enetration		
E) q	Sail Description	i i	1	20	老	8	20	Med Heit Wie	indak	80	50		en lu n e	1	ows/ft.)	100	
Depth (ft.)	Soil Description	Streets Diot	RECE	SPT Blow Count	ID Mark	Recovery	.07	Wet Unit Wei (kip/cu.ft)	ignt	13	1.0	Cor	np. Te	(ki	nfined She p/sq.ft) ane Shear	5.0	
30		vith		16	8	18						T	П			T	
	Dense Brown Medium - Fine Sand w	oth (18/													
Ш	some Gravel			Ш													
											11						
35	Dense Brown Medium - Fine Sand with some Gravel			12	9	18											
	(BH Ends @ 35Ft.)	100	1	22	a	10											
40																	
40																	
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60	**note 51 represent refusal on asset													1			
NHL EN	*note 51 represent refusal on spoon SINEERING LTD TING ENGINEERS				-				1	Г	ates		Job I	No.			
29 Monro	FING ENGINEERS						Start			29.04.16			5.50		. No.	Sh	t. 2 of 2
	Jamaica						Comple	etion		29.04.16	3				. No.		
OFFICE I	BOREHOLE RECORD					1			+	200		_	-	BH#	SITUU4		
						Ш	Final W	LL.		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		44.44	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	NGINEERING LTD JLTING ENGINEERS						Date	s	Jol	b No.				
9 Mon lingsto	onroe Road Ion 6, Jamaica						tart	30.04.16				.H. No.	Sht. 1 of	2
FFICE	DE BOREHOLE RECORD			_	_		ompletion	30.04.16			ВН	# Sir005		
		DREHOLE RECORD				E	inal W. L.	N/A			-	W. Williams		

	/O ODPEM : Soil Investigation	Eastings:					Reference Nothi	nas:						Type/S	ize		
	: 2 - 4 Haining Road, Kingston 5	Emerger	псу	Sire	n Pro	ject - Dati	Bog W	alk, St. Cath	nerine	+		3.25	"ID.S	tem, 14	Diameter Au 0 lbs Cathe for SPT.		
Sample Typ	Jamiaca es Wash		G	rab	E	leva		olit Spoon			T 10/ 7						
-			_		san	ples			asticity		T, W, 1	ube			R. Core		
Ę		Pic	-	3			20	ric	Suchy		30	20	31	andard (E	Penetration Blows/ft.)	Test 100	
Depth (ft.)	Soil Description	Strata Plon	15001	SPT Blow Count	ID Mark	Recovery	.07	Wet Ui (kir	nit Wei			U	Indraine Comp. 1	ed Unco	onfined She dp/sq.ft) ane Shear	ar Strengt	th
30		7		7	7			TI					-		TIT	+	
				8	8	18					H				111		- 1
	Stiff Light Brown Clay														111		П
															111		
				1													
35	Stiff Light Brown Clay			7 8	9	18											
	(BH Ends @ 35Ft.)			9/	1 9	18											
40																	
																1	
45																	
			1														
50																	
5																	
**no	te 51 represent refusal on spoon																
IHL ENGINE	ERING LTD ENGINEERS		-						-	-	Date	-	1	-			1
9 Monroe Ro	ad						Start			30.0	4.16		Job		110	Sht. 2 (of 2
ingston 6, Ja							Comple	tion		30.0	4.16				No.		
FFICE BOR	EHOLE RECORD					-							-	BH#	Sir005		
						- 1	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	O7	.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
-	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	E							
					4.7	h								
10	Hard Cream Porous Limestone				4									
		177			4									
					\mathbb{Z}^{2}				1 1 7					1
	(BH Ends @ 12')				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			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	4	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.	57			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													
								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				

	NT: C/O ODPEM JECT: Soil Investigation	Englishes	L	ocat	ion		eference Northings:			Туг	/pe/Size	
		Eastings: Emergency	y Sire			ct - C	Northings: Castel Garden, St. Mary	1	Hollow	Stem 6	.25" Diameter Aug	qer,
ADDRI	RESS: 2 - 4 Haining Road, Kingston 5					atum			3.25"	I.D. Sten	m, 140 lbs Cathea	
- 4	Jamiaca					vation			L	rop Harr	mmer for SPT.	
Sample	le Types Wash		Grab				Split Spoon	T.W.	Tube	F	R. Core	
2		Jol.	層	sa	ample		Plasticity			Stanr	dard Penetration	
Depth (ft.)	Soil Description	Suata Plot	SPT Blow Count	2	ark	CSX CSX	Wet Unit Wei	80 eight a	20 Un	Imined	(Blows/ft.) Unconfined Shea	100 ar Strength
Jepi	Service Control of the Control of th	in in	PT-BI	Type	ID Mark	Recovery	(kip/cu.ft)	aignt o	10 C	Jrannen Tr	(kip/sq.ft) est + Vane Shear	ar Strength
		15001	30	1	4	2	1 1	10	1.4	Jilipa	SI T VOID OUT	1
0			đợ		1							
		ous	10) X 1	1	12						
	Compact Cream - Brown Calcareo	ous	10.		1							
	Fine - Medium Gravelly Sand	10,500	47									
5		8.53.9										
	Access Comman Fina Madium Color	areous	11		2 1	13						
-	Compact Cream Fine - Medium Calcar Gravelly Sand	areous	11/						111			
inne	40************************************		9	H								
-	Compact Cream Fine - Medium Calcared	eous	12	X 3	3 1	12						
	Sand with some Fine Gravel		10	A	4					4		
10.			11									
-		(9.0)	10/	Ŋ.	4 1	16						
	Compact Cream Fine - Medium				1							
	Calcareous Sand & Gravel		1)		1							
		•										
15	(Refusal @ 5")		50			4						
	(Mainsai &)				5 5	5						
	Very Dense Cream Fine - Medium Calcare		1	1	1							
	Gravelly Sand	Sous										
1		*		Ally								
20		reous						4407		dill		
	(Refusal @5")		50	M 6	6 /	5						
	Very Dense Cream Fine - Medium		V	4	1	1						
-	Calcareous Sand with some Gravels							1117				
-												
25			7	V 7	7 8	0						
+		823	8/	1	1							
-	Compact Dark Brown Fine - Medium Clayey Sand	A				1		1111				
-	20167 111780											
	The series of the series and the series of t									111		
HL EN	**note 51 represent refusal on spoon					+				1		
ONSUL	JLTING ENGINEERS					-		Dar	ites	Job No	0.	1
	roe Road n 6, Jamaica					S	Start	23.04.16			BU No.	Sht. 1 of 2
ngston	, 6, Jamaica					1	Completion	23.04.16		1	B.H. No.	
FFICE	E BOREHOLE RECORD				_	1	ompletion	23.04.10		1	BH# Sir010	
						1	Final W. L.	N/A		AND		

	: C/O ODPEM CT: Soil Investigation	Eastings:	Lo	catio		eference Nothings	\$1				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	1			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	

PRO	ENT: C/O ODPEM OJECT: Soil Investigation	Eastings:	L	ocati	ion F		rence orthings:				T	ype/Size	9		
	DRESS: 2 - 4 Haining Road, Kingston 5	Emerger	ncy Sirer	ı Pro	Date	- Pari	orthings: ish Council, St. Ma	ary		3.25"	"I.D. Ste	em, 140 l	imeter Au lbs Cathe	ger, ad	_
Sam	Jamiaca sple Types Wash		Crob	E		ation:						ammer fo			
-	pie Types	12	Grab	- 20			Split Spoon		T. W.	Tube			R. Core		
1		Pio	Blow Count		nples	- 2	Plastic 20	city	80	20	Star	ndard Pe (Blo	enetration ws/ft.)	Test 100	
Depth (ft.)	Soil Description	Strata Ploi	SPT Blow Count	ID Mark	Recovery	O'AL ASSAULT	Wet Unit V (kip/cu	Weight J.ft)		Ur	ndrained omp. T	d Unconfi	fined Shea o/sq.ft) ne Shear	ar Strend	gth
0		and	5		Ī	Ī				İ				T	
	Stiff Dark Brown Clay with some Sa		6	1	10	0									
	Sun bull sixth any man sums as	and													
5	- Control of the Cont														
-	Company Park Denum Cond & Class		4 5	X 2	2 10	a l									
-	Compact Dark Brown Sand & Clay		6/	1	1	1									
1"	4		4	7											
	Compact Dark Brown Fine - Medium Sa With some Clay	and	5	3	18	E									
10	with some day		75	-4											
			6 5	4	8										1
	Automobile Williams Williams			7											
	Compact Dark Brown Fine - Medium Sand with some Clay					11									
15	***************************************		4	7		11									
			8 8	5	18										
	Compact Dark Brown Fine - Medium	d .		1											
	Sand with some Clay														
20	AND		5	7		11					11	11			
			5 5 9	5	18										
	Compact Brown Fine - Medium Sand	d		1											
	with Traces of Fine Gravels & Clay														
5	The state of the s		6	7											
-			5 X		16										
-	Stiff Brown Clay with some Sand														
													11		
0															
HL E	**note 51 represent refusal on spoon ENGINEERING LTD	W/A		-				4			11				
ONSI 9 Mon	SULTING ENGINEERS					Start		2:	Dat 3.04.16	es	Job N	0.		Sht. 1	1:
ingsto	on 6, Jamaica				1	5	pletion		23.04.16			В.Н. М	No.	Sin. ,	01 2
FFIC	CE BOREHOLE RECORD							-	3.04.10			BH# Sir	011		
					1	Final	I W. L.	- 7	N/A						

	IENT: C/O ODPEM OJECT: Soil Investigation	Eastings	s:		Loca	tion		erence Nothin								Тур	e/Size	3		
	DRESS: 2 - 4 Haining Road,	Eme	rgenc	y Sire	en Pr	ojeci Da	t - Pa	rish C	gs: council	l, St. Ma	iry	+		Holi 3.	low Ste	em 6.2 Stem	5" Diar	meter Au	uger; ead	
	Kingston 5 Jamiaca					Elev	ation								Drop	o Ham	mer fo	SPT.	000	
Sam	nple Types Wash	E		Grab					lit Spoo	on	E	T	. W. 7	Tube				R. Core	e	
2			5 1	198	sa	imple:	s			Plastic	city				-		ard Pe	netration		
h (1	Soil Description		2 P	W.Co	2 .	M 10	2	20	187			80		20			(Blov	ws/ft.)	10	00
Depth (ft.)	our coorport		Strata Plot	SPT Blow Count	Pype	ID Mark Recovery	Chryster	.07.	VVI	et Unit V (kip/cu.	.ft)	13		1.0	Undra	ined U	(kip/ + Van	ined She /sq.ft) ne Shear	ear Stre	ength .o
30				8		8 1	12	T				T	T	T	T					
	Very Stiff Brown Clay with Traces of Fi Gravels	ine		7																
	Glavela																			
35	Very Stiff Brown Clay with Traces of Fine Gr	ravels		7	V															
	(BH Ends @ 35Ft.)		122	7 8 8	4	9 14	4													
-																				
10																				
-																				
45																				
-																				
1																				
0																				
-																				
5																				
7																				
0	**note 51 represent refusal on spoon																			
HL	ENGINEERING LTD SULTING ENGINEERS				-				1		+		Date	es	Je	ob No.				
9 Moi	onroe Road ton 6, Jamaica						Star	rt				23.04.					3.H. N	No.	Sht	t. 2 of 2
	CE BOREHOLE RECORD				_		Con	npleti	on		2	23.04.	16				H# Sir			
							Ein	al W.				N/A			\neg		Im S	0.11		

	ENT: C/O ODPEM DJECT: Soil Investigation	Eastings:		Lo	cati	on R	eference Northing	16.				Ту	pe/Size	
				cy Sire	Pro	ject		nter, St. Man	У				25" Diameter A	
ADD	ORESS: 2 - 4 Haining Road, Kingston 5												m, 140 lbs Cath mmer for SPT.	ead
0-	Jamiaca				E	eval								
Sam	ple Types Wash			Grab			Split			T. W.	Tube		R. Core	
3			lor [lund	sam		20	Plastic	city	80	20	Stan	dard Penetratio (Blows/ft.)	n Test
Depth (ff.,	Soil Description		Strata Plot	SPT Blow Count	ID Mark	Recovery	.07	Wet Unit V (kip/cu	Veight i.ft)		U	ndrained	Unconfined Sh (kip/sq.ft) st + Vane Shea	ear Strength
-				los le	-	2					1.1			
0									P					
				2	1	14				13.4				
	Firm Dark Brown Sandy Clays wth some Gra	avels		2	1									
5	namanana lank													
9	aproximation to			4	2	14								
-	Firm Brown Clays			3	1	1								
4														
	Firm Brown Clays			2 2	3	15								
4	1 m didni diaya			2/_										
0 -				2										
				2 2	4	10								
	Firm Brown - Grey Clays													
	-0.000-0000-000-000-000							1 1				-14		
											110			
15			y											
Ħ				2	5	9								
7	Firm Brown - Grey Clays with Traces of Gra	vole		2/									1111	
+	The state of the state of the	vois												
+														
-												14		
20	The state of the s			2 2										
				2	6	15								
	Firm Grey - Brown Clays													
			y											
5 "				HW 7										
				HW X	7	14								
	Van Karlana and San													
	Very Soft Dark Grey Clays													
0	**note 51 represent refusal on spoon													
	ENGINEERING LTD SULTING ENGINEERS	- 2	-							D	ates	Job N	lo.	
	onroe Road						Start			22.04.16				Sht. 1 of
	onroe Road ston 6, Jamaica									2.04,10			B.H. No.	GHL 1.01
FFI	CE BOREHOLE RECORD						Completi	on		22.04.16			BH# Sir012	
-	A STATE OF THE STA						Final W.			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										
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30	**note 51 represent refusal on spoon									
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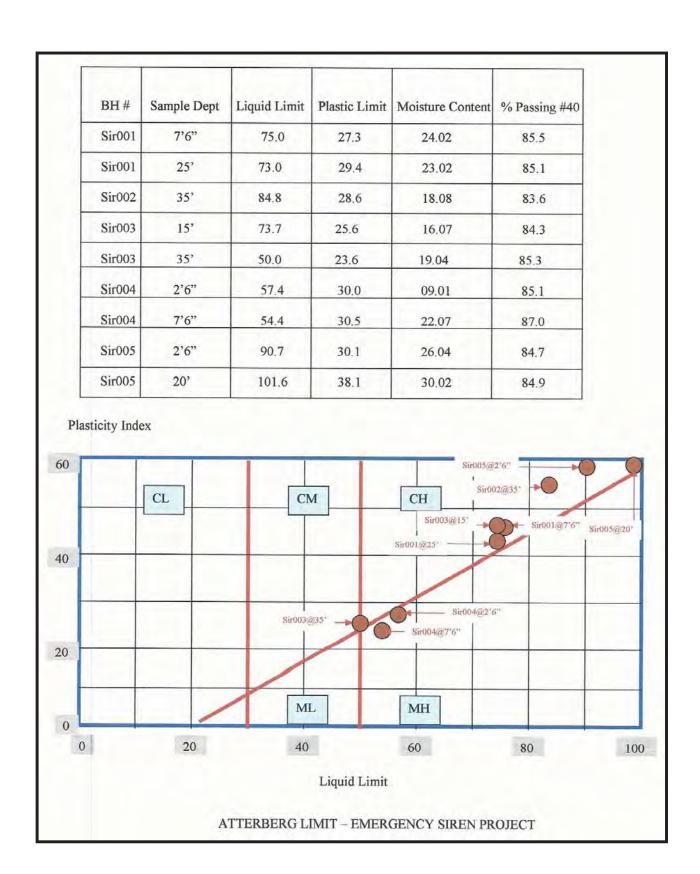
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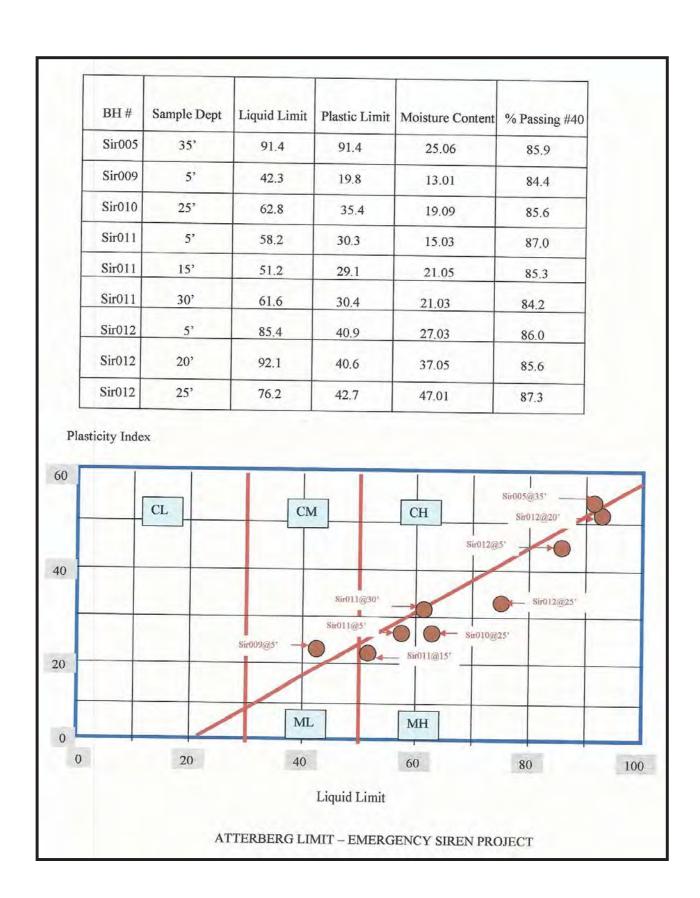
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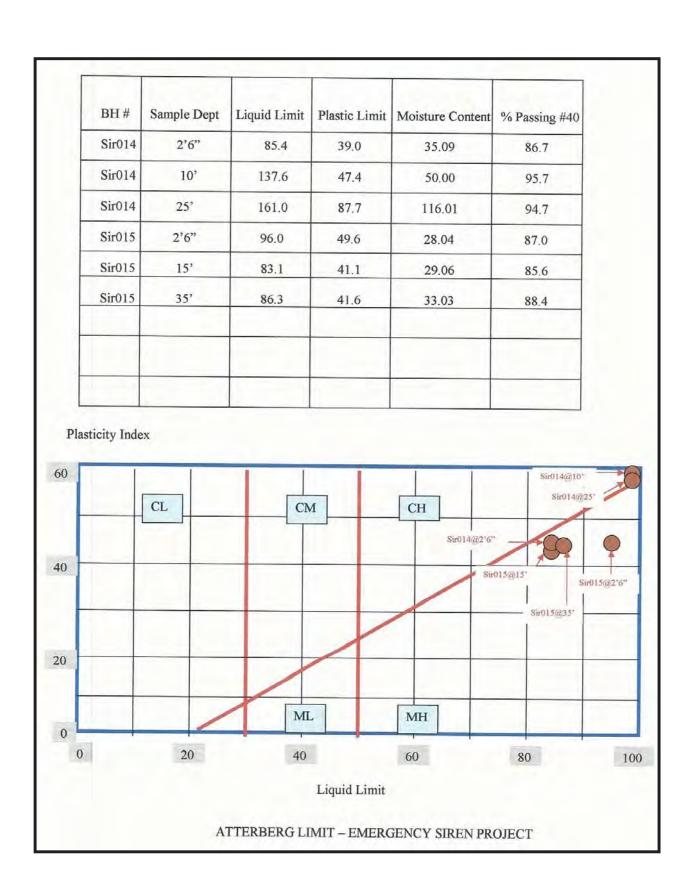
Appendix III Laboratory Physical Soil Test Results

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	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
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ISSIEVE	Sir008@2'6"	Sir009@26"	Sir009@15	Sir009@35"	Sir010@5	Sir010@20	Sir012@2'6"	100	
20	100	100	100	100	100	100	100		
14	100	100	100	100	100	100	100		
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		
0.8	53.3	81.6	95	86.9	72.2	92	82.3		
0.4	16.9	42.7	41.9	35.2	33	33	65.5		
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A-10-3 A report on concrete testing at the Telecommunication Tower site at Shotover, Portland (Rep006)

(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).

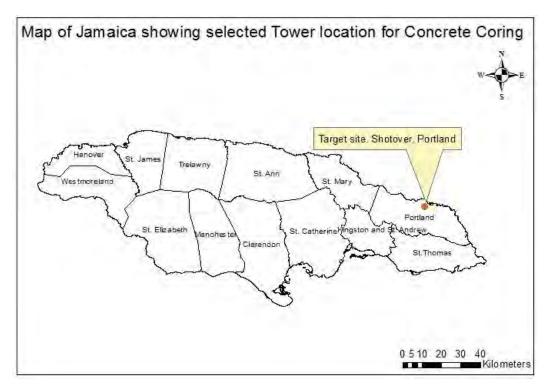


Figure 2. Map showing location of selected tower sites where soil investigations were conducted

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)

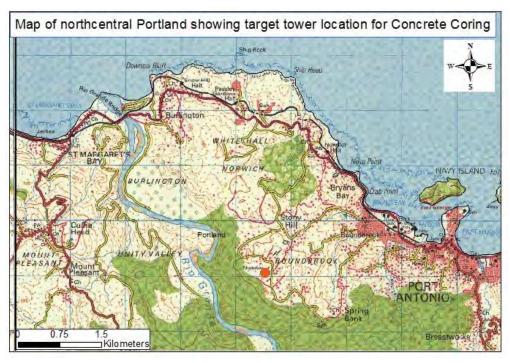


Figure 3 Map showing location of tower site in Mount Airy, Westmoreland

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)



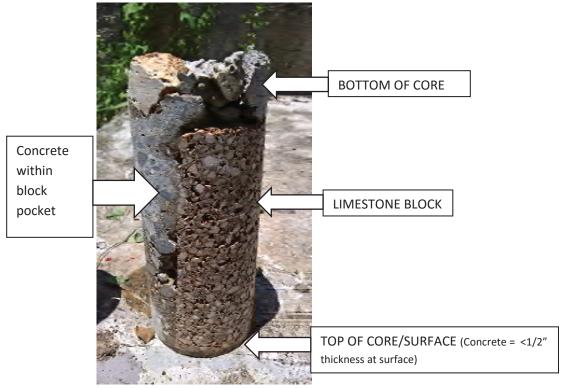


Figure 7. Picture of first core

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)

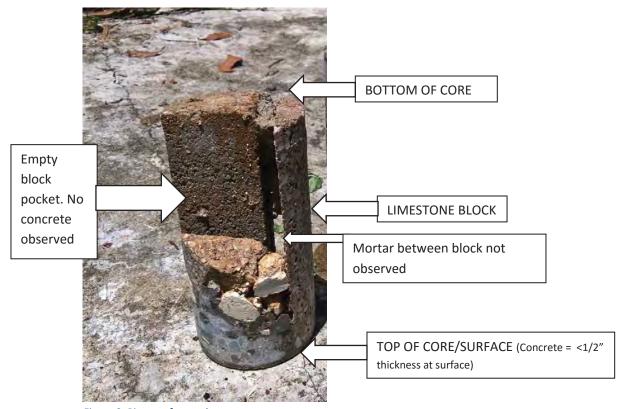


Figure 9. Picture of second core



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

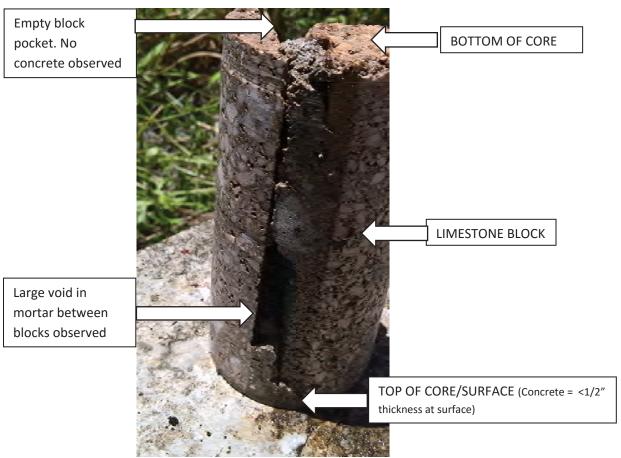


Figure 13. Picture of third core

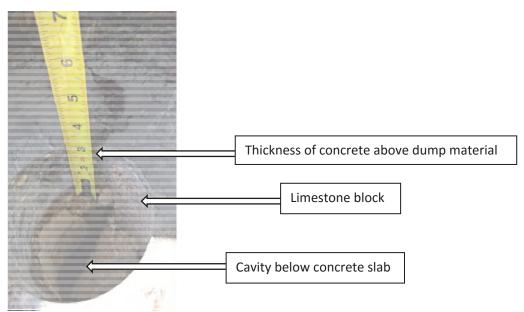


Figure 14. Picture showing thickness of partial infilling of block pocket at location of third boring

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

www.geoedgejamaica.com = info@geoedgejamaica.com = +1-876-366-9021

$^{ m Page}16$

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").

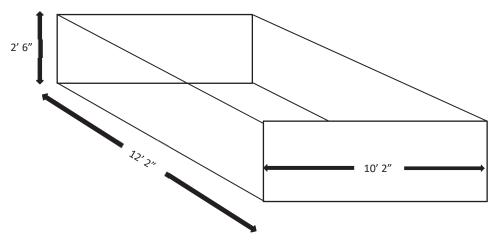


Figure 15. Schematic diagram of concrete slab

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.