Geotechnical Investigation Report

CLIENT: JABEZ PROJECTS, INC.

Location:

ADWEMADOR

Subject:

GEOTECHNICAL REPORT FOR A PROPOSED 3NO 5-STOREY CLASSROOM BLOCK AND 5-STOREY ADMINISTRATION BLOCK

Prepared by:
Engr. Samora Okoe (MSc, MEng, BEng, BSc, LLb)

Date:
APRIL, 2022

2.5 Geology

The geology of the region can be divided into three distinct i.e. Accraian, Togo and Dahomeyan series known as Accra formation. The Accraian series belong to the Devonian age are sedimentary deposits, and consists of upper interbedded sandstone and Shale, Middle clay shale and lower sandstone. The Togo series belong to the Upper Middle Precambrian age and consists of Quartzite, Shale and Phyllites. The Dahomeyan system belong to the middle Precambrian age and consists mainly of acid and basic horn blends Gneiss, Quartz mica schist, Muscovite-biotite gneiss and Biotite gneiss.

The project site is underlain by rocks belonging to the Dahomeyan series of early to Middle Precambrian age

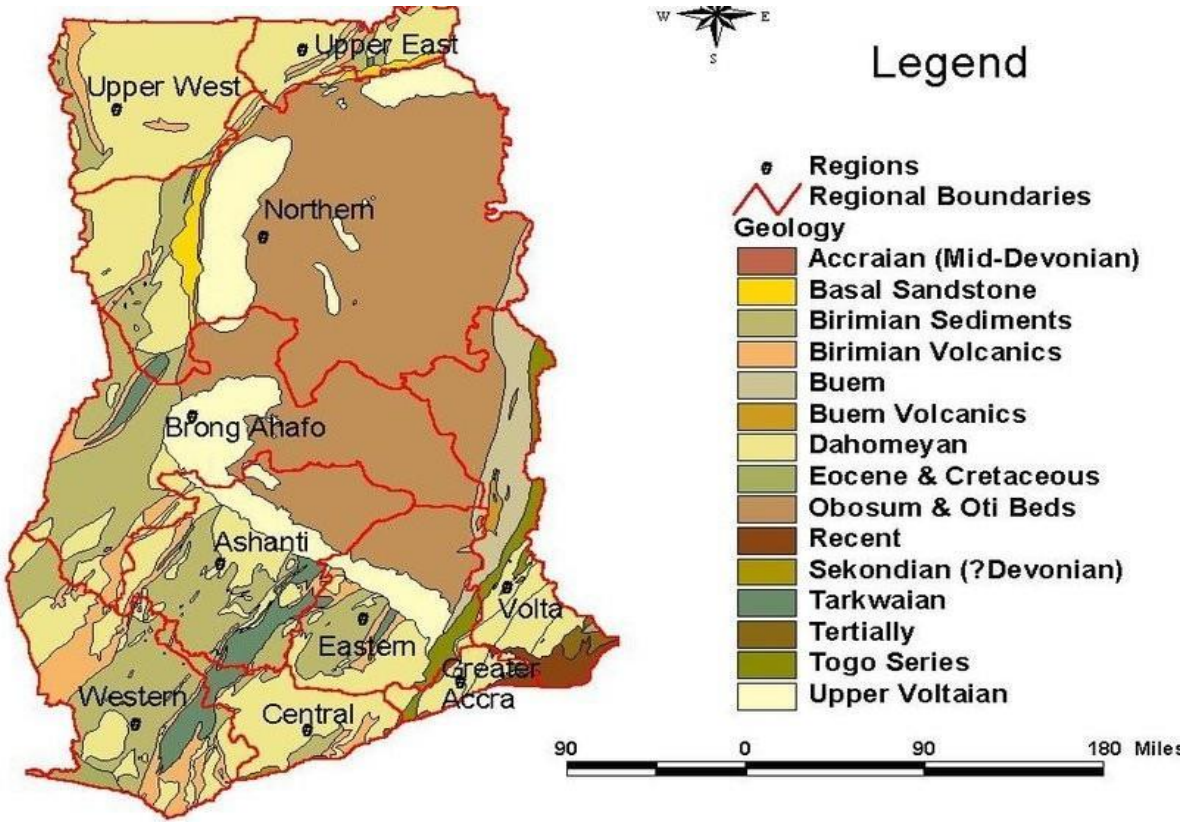


Fig 2: Geological Map of Ghana.

	ZONE 4	ZONE 3	ZONE 2
Max. Intensity (Imm)	IX	VII	V
Max. Magnitude (MI)	6.5	6.5	6.5
Average Epicentral Distance (R)	20km	40km	100km
Peak Ground Acceleration (a)	347cm/sec	112cm/sec	32cm/sec
a/g	0.35	0.12	0.03

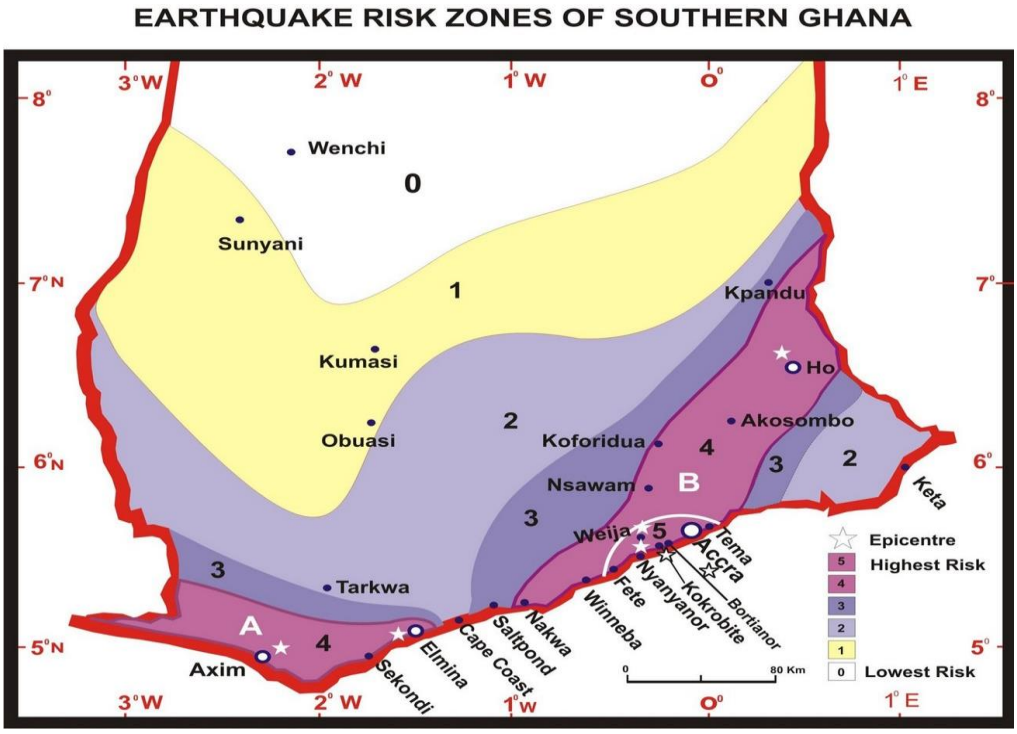


Fig 3: Earthquake Zones of Southern Ghana.

This suffices to state that, Project location qualifies within the Zone 4, or having a value of horizontal ground acceleration with peak ground acceleration of 347cm/sec.

Location	PGA values (g)				
	Present study	Previous studies			
Accra	0.20	0.14–0.57	0.15	0.08–0.16	0.35
		Amponsah et al. (2009)	Kumapley (1996)	GSHAP	CSDCS (BRRI 1990)
Weija (Accra—West)	0.20	0.2	0.15	0.08	0.35
Ho	0.10		0.10 Kumapley (1996)	0.04	0.25
Cape Coast	0.026		0.15 Kumapley (1996)	0.02	0.15
				Anon. (1988)	CSDCS (BRRI 1990)

Table 2: PGA Values of Southern Ghana.

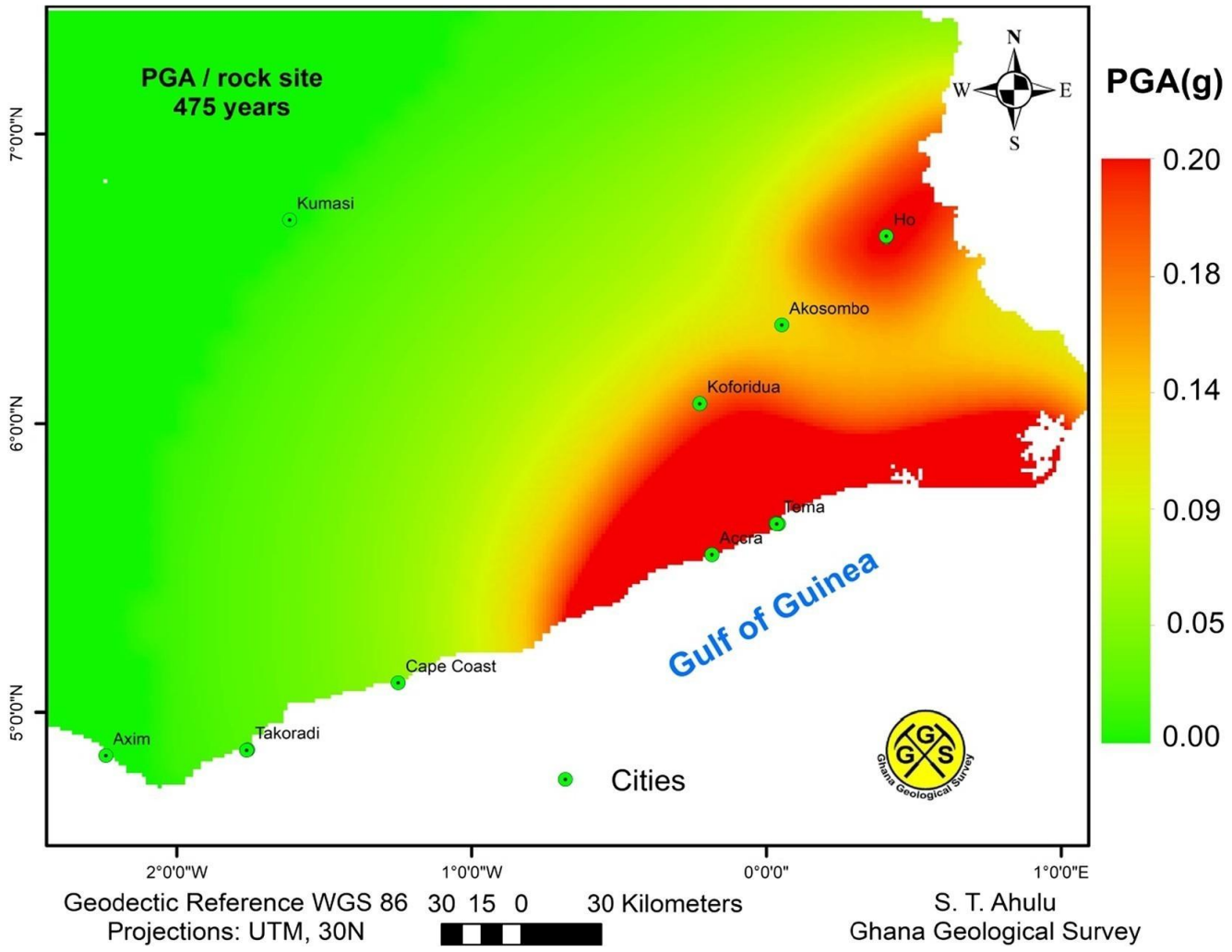


Fig 4; Earthquake Zones of Southern Ghana.

However, from the table and figure above by Sylvanus T. Ahulus; Sylvester Kojo Danuor; Daniel K. Asiedu , Probabilistic hazard assessment of Southern Part of Ghana, PGA value of 0.2g for Accra and Tema corresponds to probability of such events occurring to 0.1, and is expected to be exceeded with probabilities of 10, 30 and 60% in 10, 50 and 100 years respectively. Thus, the probability of occurrence of such a likely B scenario earthquake is moderate. In the same vein, if Accra and Tema zones are likely to experience 0.2 g every 10 years, then it means the acceleration to 475 years is high, and therefore Accra and Tema is a highly hazard zone.

The number of blows required for the cone to penetrate 10cm into the ground was recorded for various depths. The test was terminated when the number of blows required for the cone to penetrate 10cm exceeds 50 blows. The blow count per 10cm penetration are converted to soil resistance (kN/m ^{2}) or (Kpa).

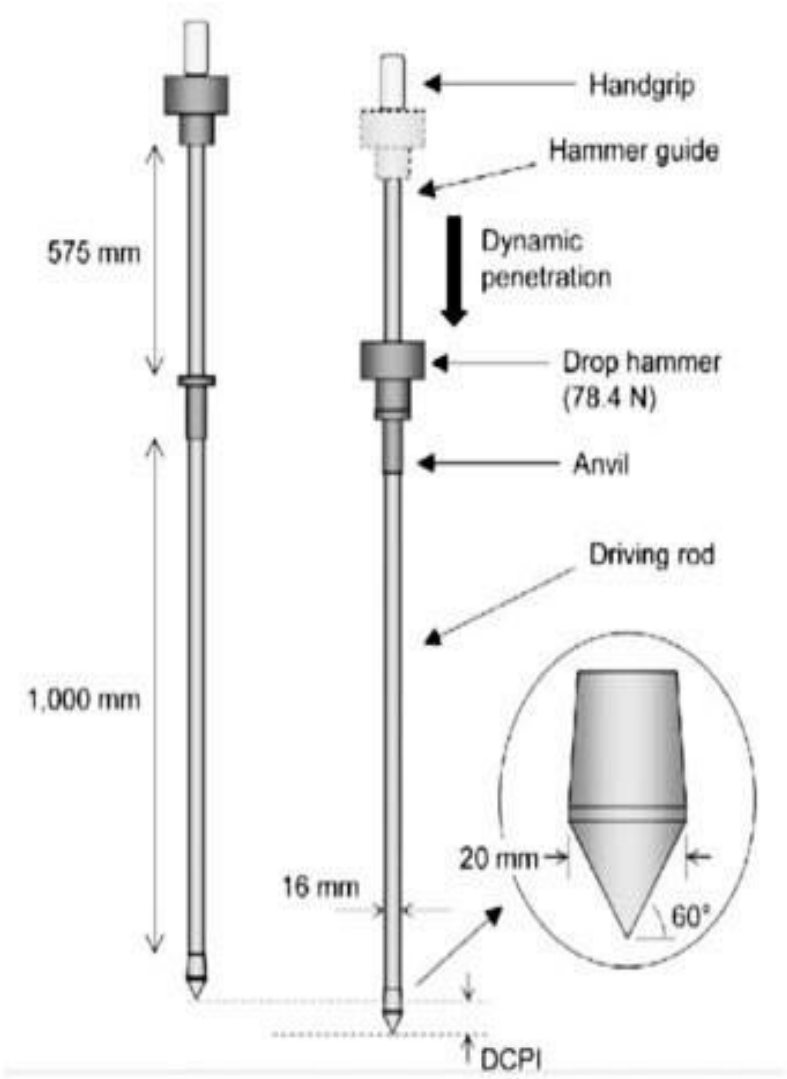


Fig 5: DCPT Equipment.

The cone penetrometer was used to probe at four test points in the vicinity of the proposed development at the discretion of the supervising structural engineer. (See the appendix B of this report for the test points).

0	40	25
5	50	25
2.0	50	25
2.5	120	25
3.0	300	25
3.5	500	25

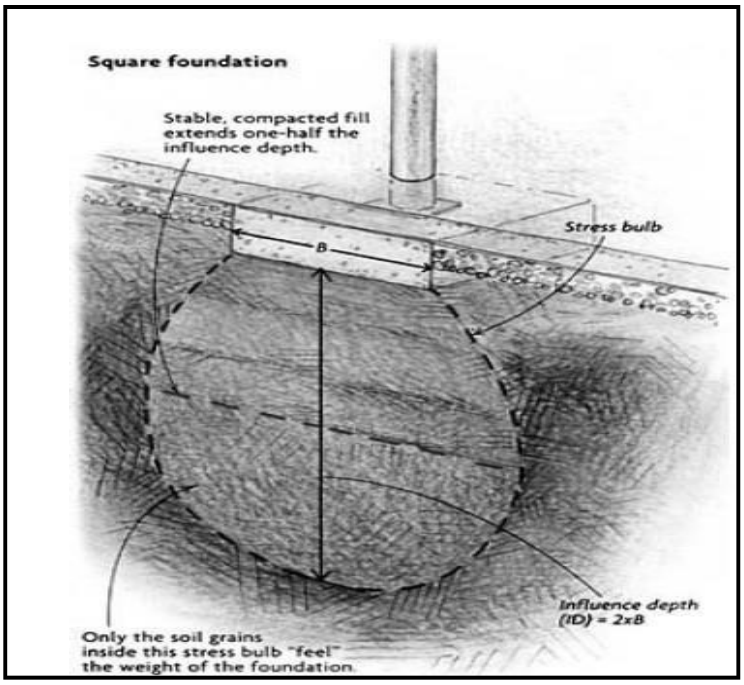


Fig 6: Foundation showing concentration of stress bulb

In the event whereby conventional pad and column style of foundation is to be used, we recommend that ground beams be incorporated to mitigate the probability of any long-term differential settlement and lateral movements of the individual pads.

Although the site is regarded as an area with low frequency of earthquake, it is advisable to design the foundation against possible earth movements. It is recommended that in the structural analysis of the structure against earth movement a horizontal ground acceleration of 0.2g be used. (g is acceleration due to gravity; 9.81m/s^2).

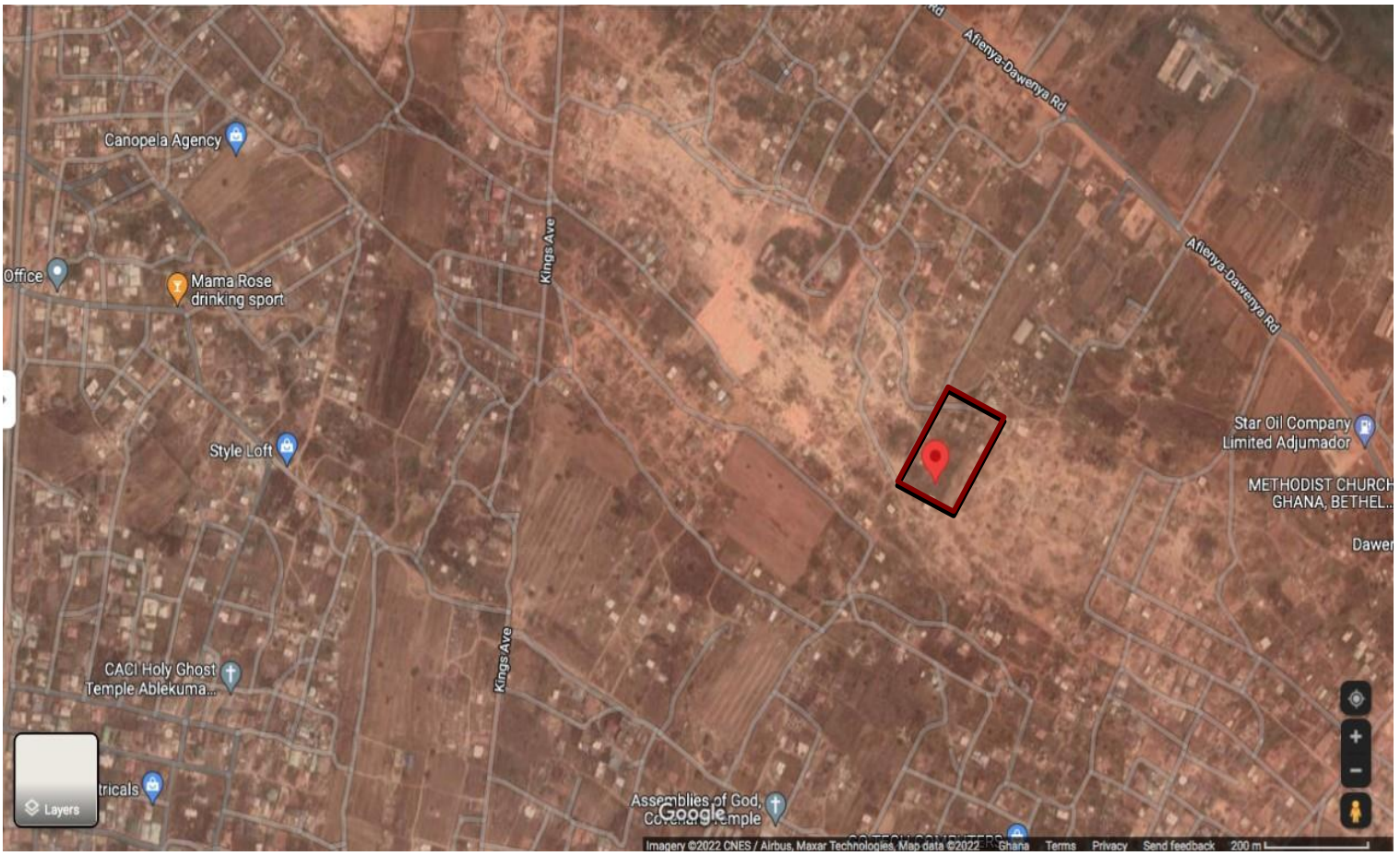
4.7 Excavation and Shoring

In accordance with Ref. [21], upper-surficial soils on the project site can be classified to range between Type A & B soils. Ref. [21] sets the maximum allowable slope for Type B soils with a maximum depth of 3 m to be 45˚. Maximum allowable slopes for the proposed excavation for the structures should thus be 45˚, or 1:1 (H:V). In cases where cut slopes are considered to be unstable, some form of shoring should be provided, or flatter slopes should be used.

Degree of Expansiveness	Differential Free Swell (DFS) (%)
Low	**Less than 20**
Moderate	**20-35**
High	**35-50**
Very High	**Greater than 50**

THE DCP TEST

GOOGLE MAP LOCATION

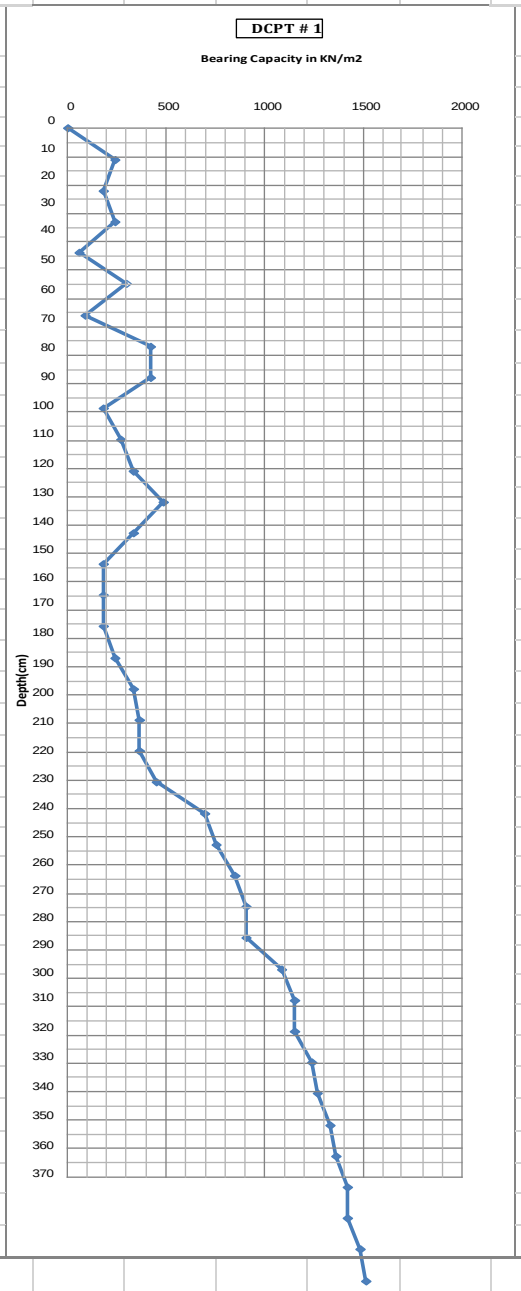


PROPOSED DEVELOPMENT

Project Title: PROPOSED 5-STOREY SCHOOL
Project Location: ADWEMADOR
Client: ANSAH AGYEMANG BARIMAH
Engineer:
Site ID:

Date 26-Mar-22
Coordinates

DCPT 1		Penetration Index (DPI)	Bearing Capaci	Equivalent CBR
Depth (cm)	Blows	mm/blow	kN/m²	%
0	0	0.0	0	0
10	8	12.5	240	17
20	6	16.7	180	13
30	8	12.5	240	17
40	2	50.0	60	4
50	10	10.0	300	22
60	3	33.3	90	6
70	14	7.1	420	32
80	14	7.1	420	32
90	6	16.7	180	13
100	9	11.1	270	20
110	11	9.1	330	25
120	16	6.3	480	37
130	11	9.1	330	25
140	6	16.7	180	13
150	6	16.7	180	13
160	6	16.7	180	13
170	8	12.5	240	17
180	11	9.1	330	25
190	12	8.3	360	27
200	12	8.3	360	27
210	15	6.7	450	35
220	23	4.3	690	56
230	25	4.0	750	62
240	28	3.6	840	70
250	30	3.3	900	76
260	30	3.3	900	76
270	36	2.8	1080	93
280	38	2.6	1140	99
290	38	2.6	1140	99
300	41	2.4	1230	108
310	42	2.4	1260	111
320	44	2.3	1320	116
330	45	2.2	1350	119
340	47	2.1	1410	125
350	47	2.1	1410	125
360	49	2.0	1470	131
370	50	2.0	1500	134



Correlation Between DCP and CBR

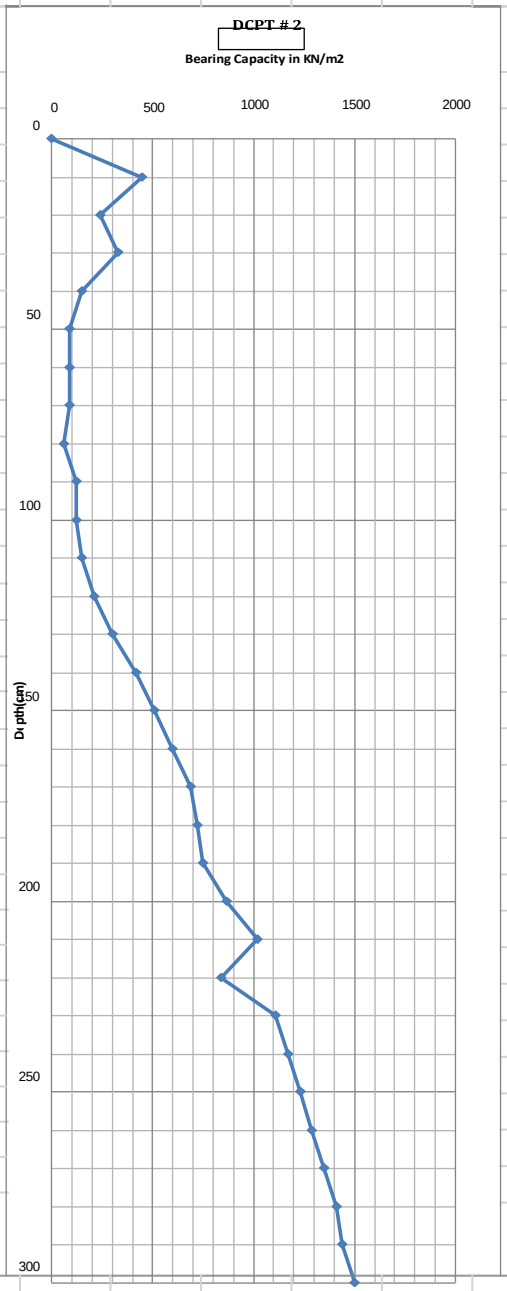
Log (CBR) = 2.465 - 1.12Log (DPI)

simplified: **CBR =** $\frac{292}{DPI^{1.12}}$

APPROVED BY:

Project Title:	PROPOSED 5-STOREY SCHOOL BUILDING	**Date**	26-Mar-22
Project Location:	ADWENADOR	**Project No.**	
Client:	ANSAH AGYEMANG BARIMAH	**Coordinates**	
Engineer:			
Site ID:			

DCPT 2		Penetration Index (DPI)	Bearing Capacity	Equivalent CBR
Depth (cm)	**Blows**	**mm/blow**	**kN/m²**	**%**
0	0	0.0	0	0
10	15	6.7	450	35
20	8	12.5	240	17
30	11	9.1	330	25
40	5	20.0	150	10
50	3	33.3	90	6
60	3	33.3	90	6
70	3	33.3	90	6
80	2	50.0	60	4
90	4	25.0	120	8
100	4	25.0	120	8
110	5	20.0	150	10
120	7	14.3	210	15
130	10	10.0	300	22
140	14	7.1	420	32
150	17	5.9	510	40
160	20	5.0	600	48
170	23	4.3	690	56
180	24	4.2	720	59
190	25	4.0	750	62
200	29	3.4	870	73
210	34	2.9	1020	87
220	28	3.6	840	70
230	37	2.7	1110	96
240	39	2.6	1170	102
250	41	2.4	1230	108
260	43	2.3	1290	113
270	45	2.2	1350	119
280	47	2.1	1410	125
290	48	2.1	1440	128
300	50	2.0	1500	134



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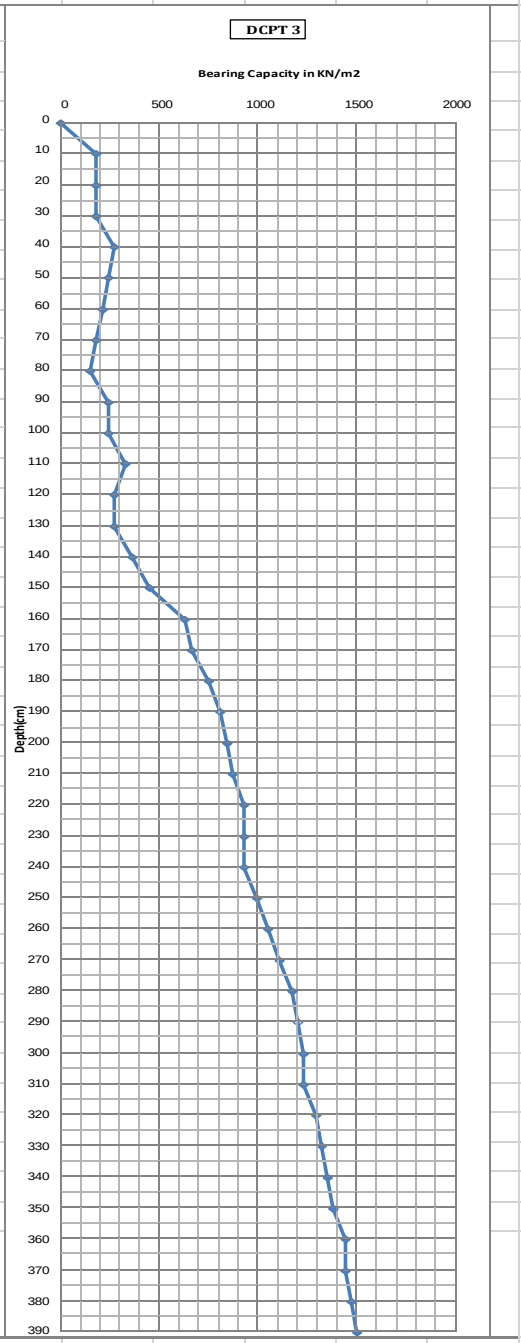
Log (CBR) = 2.465 - 1.12Log (DPI)

simplified: **CBR =** $\frac{292}{DPI^{1.12}}$

A PPROVED BY:

Project Title:	PROPOSED 5-STOREY SCHOOL BUILDING	**Date**	26-Mar-22
Project Location:	ADWEMADOR	**Project No.**	0
Client:	ANSAH AGYEMANG BARIMAH	**Coordinates**	
Engineer:			
Site ID:			

DCPT 3		Penetration Index (DPI)	Bearing Capacity	Equivalent CBR
Depth (cm)	**Blows**	**mm/blow**	**kN/m²**	**%**
0	0	0.0	0	0
10	6	16.7	180	13
20	6	16.7	180	13
30	6	16.7	180	13
40	9	11.1	270	20
50	8	12.5	240	17
60	7	14.3	210	15
70	6	16.7	180	13
80	5	20.0	150	10
90	8	12.5	240	17
100	8	12.5	240	17
110	11	9.1	330	25
120	9	11.1	270	20
130	9	11.1	270	20
140	12	8.3	360	27
150	15	6.7	450	35
160	21	4.8	630	51
170	22	4.5	660	54
180	25	4.0	750	62
190	27	3.7	810	67
200	28	3.6	840	70
210	29	3.4	870	73
220	31	3.2	930	79
230	31	3.2	930	79
240	31	3.2	930	79
250	33	3.0	990	84
260	35	2.9	1050	90
270	37	2.7	1110	96
280	39	2.6	1170	102
290	40	2.5	1200	105
300	41	2.4	1230	108
310	41	2.4	1230	108
320	43	2.3	1290	113
330	44	2.3	1320	116
340	45	2.2	1350	119
350	46	2.2	1380	122
360	48	2.1	1440	128
370	48	2.1	1440	128
380	49	2.0	1470	131
390	50	2.0	1500	134



Correlation Between DCP and CBR

Log (CBR) = 2.465 - 1.12Log (DPI)

simplified: **CBR =** $\frac{292}{DPI^{1.12}}$

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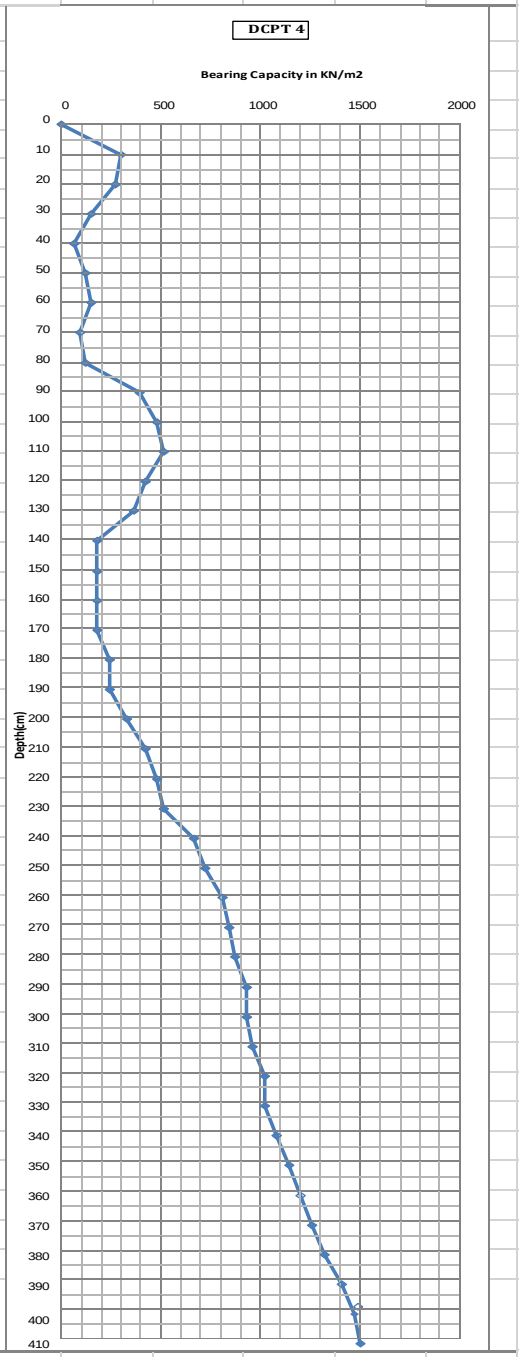
Project Location:	ADWEMADOR	**Project No**	0
Client:	ANSAH AGYEMANG BARIMAH	**Coordinates**	
Engineer:			
Site ID:			

DCPT 4		Penetration Index (DPI)	Bearing Capacity	Equivalent CBR
Depth (cm)	Blows	mm/blow	kN/m²	%
0	0	0.0	0	0
10	10	10.0	300	22
20	9	11.1	270	20
30	5	20.0	150	10
40	2	50.0	60	4
50	4	25.0	120	8
60	5	20.0	150	10
70	3	33.3	90	6
80	4	25.0	120	8
90	13	7.7	390	30
100	16	6.3	480	37
110	17	5.9	510	40
120	14	7.1	420	32
130	12	8.3	360	27
140	6	16.7	180	13
150	6	16.7	180	13
160	6	16.7	180	13
170	6	16.7	180	13
180	8	12.5	240	17
190	8	12.5	240	17
200	11	9.1	330	25
210	14	7.1	420	32
220	16	6.3	480	37
230	17	5.9	510	40
240	22	4.5	660	54
250	24	4.2	720	59
260	27	3.7	810	67
270	28	3.6	840	70
280	29	3.4	870	73
290	31	3.2	930	79
300	31	3.2	930	79
310	32	3.1	960	81
320	34	2.9	1020	87
330	34	2.9	1020	87
340	36	2.8	1080	93
350	38	2.6	1140	99
360	40	2.5	1200	105
370	42	2.4	1260	111
380	44	2.3	1320	116
390	47	2.1	1410	125
400	49	2.0	1470	131
410	50	2.0	1500	134



Correlation Between DCP and CBR

Log (CBR) = 2.465 - 1.12Log (DPI)

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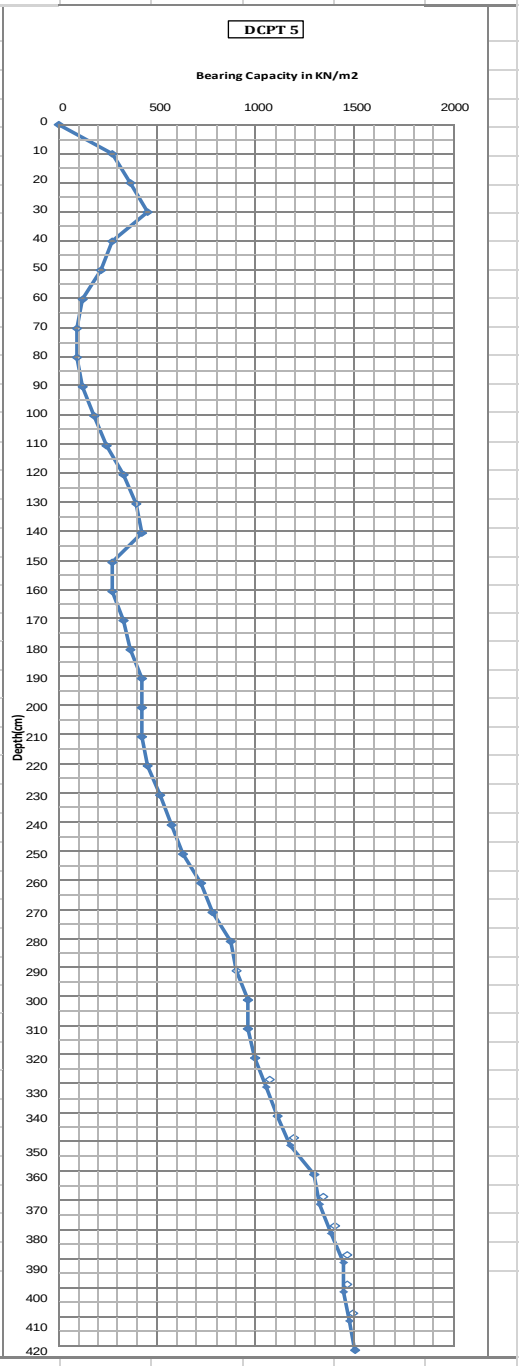
APPROVED BY:

Project Title:	PROPOSED 5-STOREY SCHOOL BUILDING	**Date**	26-Mar-22
Project Location:	ADWEMADOR	**Project No.**	0
Client:	ANSAH AGYEMANG BARIMAH	**Coordinates**	
Engineer:			
Site ID:			

DCPT 5		Penetration Index (DPI)	Bearing Capacity	Equivalent CBR
Depth (cm)	**Blows**	**mm/blow**	**kN/m²**	**%**
0	0	0.0	0	0
10	9	11.1	270	20
20	12	8.3	360	27
30	15	6.7	450	35
40	9	11.1	270	20
50	7	14.3	210	15
60	4	25.0	120	8
70	3	33.3	90	6
80	3	33.3	90	6
90	4	25.0	120	8
100	6	16.7	180	13
110	8	12.5	240	17
120	11	9.1	330	25
130	13	7.7	390	30
140	14	7.1	420	32
150	9	11.1	270	20
160	9	11.1	270	20
170	11	9.1	330	25
180	12	8.3	360	27
190	14	7.1	420	32
200	14	7.1	420	32
210	14	7.1	420	32
220	15	6.7	450	35
230	17	5.9	510	40
240	19	5.3	570	45
250	21	4.8	630	51
260	24	4.2	720	59
270	26	3.8	780	65
280	29	3.4	870	73
290	30	3.3	900	76
300	32	3.1	960	81
310	32	3.1	960	81
320	33	3.0	990	84
330	35	2.9	1050	90
340	37	2.7	1110	96
350	39	2.6	1170	102
360	43	2.3	1290	113
370	44	2.3	1320	116
380	46	2.2	1380	122
390	48	2.1	1440	128
400	48	2.1	1440	128
410	49	2.0	1470	131
420	50	2.0	1500	134



Correlation Between DCP and CBR

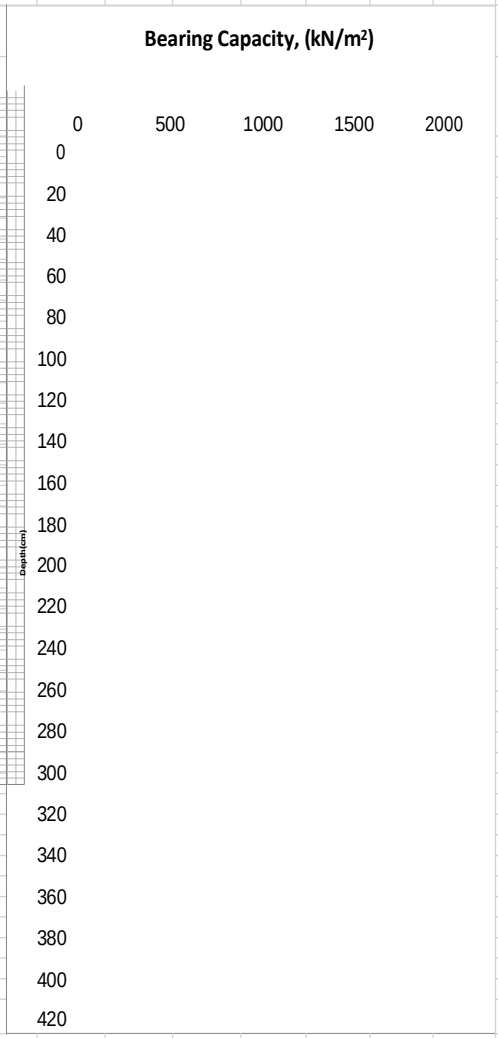
Log (CBR) = 2.465 - 1.12Log (DPI)

simplified: **CBR =** $\frac{292}{DPI^{1.12}}$

APPROVED BY:

Project Title:	PROPOSED 5-STOREYSCHOOL BUILDING							Date: 26/03/2022
Project Location	ADWEMADOR							
Client:	ANSAH AGYEMANG BARIMAH							
Architect:								
Site ID:								FOS: 3

	DCPT 1	DCPT 2	DCPT 3	DCPT 4	DCPT 5	Ultimate Capacities	Allowable Capacities
Depth (cm)	Bearing Capacities (KPa)	Bearing Capacities (KPa)	Bearing Capacities (KPa)	Bearing Capacities (KPa)	Bearing Capacities (KPa)	Bearing Capacities (KPa)	Bearing Capacities (KPa)
0	0	0	0	0	0	0	0
10	240	450	180	300	270	180	60
20	180	240	180	270	360	180	60
30	240	330	180	150	450	150	50
40	60	150	270	60	270	60	20
50	300	90	240	120	210	90	30
60	90	90	210	150	120	90	30
70	420	90	180	90	90	90	30
80	420	60	150	120	90	60	20
90	180	120	240	390	120	120	40
100	270	120	240	480	180	120	40
110	330	150	330	510	240	150	50
120	480	210	270	420	330	210	70
130	330	300	270	360	390	270	90
140	180	420	360	180	420	180	60
150	180	510	450	180	270	180	60
160	180	600	630	180	270	180	60
170	240	690	660	180	330	180	60
180	330	720	750	240	360	240	80
190	360	750	810	240	420	240	80
200	360	870	840	330	420	330	110
210	450	1020	870	420	420	420	140
220	690	840	930	480	450	450	150
230	750	1110	930	510	510	510	170
240	840	1170	930	660	570	570	190
250	900	1230	990	720	630	630	210
260	900	1290	1050	810	720	720	240
270	1080	1350	1110	840	780	780	260
280	1140	1410	1170	870	870	870	290
290	1140	1440	1200	930	900	900	300
300	1230	1500	1230	930	960	930	310
310	1260		1230	960	960	960	320
320	1320		1290	1020	990	990	330
330	1350		1320	1020	1050	1020	340
340	1410		1350	1080	1110	1080	360
350	1410		1380	1140	1170	1140	380
360	1470		1440	1200	1290	1200	400
370	1500		1440	1260	1320	1260	420
380			1470	1320	1380	1320	440
390			1500	1410	1440	1410	470
400				1470	1440	1440	480
410				1500	1470	1470	490
420					1500	1500	500



Note:

* The ultimate bearing capacities indicated, are the minimum measured bearing capacities at any given depth.

** A minimum factor of safety (FOS) of 3.0 should be applied accordingly;

i.e the ultimate bearing capacities is divided by the FOS to give the allowable bearing capacities values

*** Final FOS to be used is to be determined by the design engineer

APPROVED BY:

geo-materiaux engineering ltd

SOIL TEST SUMMARY RESULTS

GEO-MATERIAUX ENGINEERING LIMITED (GMEL LAB)

CLIENT: ANSAH AGYEMANG BARIMAH & RITA AGYEMANG BARIMAH **PROJECT: PROPOSED 5-STOREY SCHOOL PROJECT**

DATE : 29 / 03 /2022

SAMPLE IDENTIFICATION	SAMPLE SOURCE	SAMPLE DESCRIPTION	DEPTH (m)	SIEVE ANALYSIS			ATTERBERG LIMITS				MOISTURE CONTENT
				PERCENTAGE BY WEIGHT RETAIN ON BS SIEVE			LL %	PL %	PI %	SWELL %	NMC %
				GRAVEL %	SAND %	SILT / CLAY %					
				2mm - 75 mm	0.075mm - 2mm	0.002mm - <0.002mm	-	-	-		-
TRIAL PIT 3	1ST LAYER	Light reddish brown silty sandy gravel, mixed with broken concrete and household waste	0.0-0.5	50.7	32.1	17.2	22.5	17.6	4.9		6.7
	2ND LAYER	Dark greyish brown silty CLAY	0.5-3.2	8.6	28.3	63.1	47.2	32.6	14.6		15.8
	3RD LAYER	Light reddish brown silty sandy clay lateritic gravel	3.2-3.6	44.2	29.7	26.1	34.4	25.2	9.2	32.1	28.2

RANSFORD TETTEH
LABORATORY TECHNICIAN

WIREDU KWABENA ERIC
LABORATORY MANAGER / ENGINEER

GEO-MATERIAUX ENGINEERING LIMITED
LABORATORY MANAGER