Government of the People's Republic of Bangladesh

Ministry of Housing and Public Works

Urban Development Directorate (UDD)

Preparation of Development Plan for

Fourteen Upazilas

Package 03

Draft Survey Report

Geological Survey of Gangni Upazila

September 2016

Submitted By

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17 May, 2017

To
Project Director
Preparation of Development Plan for Fourteen Upazila Project
Urban Development Directorate (UDD)
82, Segun Bagicha, Dhaka-1000

Subject: Submission of Geological Survey Report (Hard copy).

Dear Sir,
I have the pleasure to submit herewith Draft Geological Survey Report in Hard copy for your Kind information and record keeping.

Thanking you,

Best Regards

Shamaun-Al-Noor
Team Leader,
Package-03.

Enclosed: (i) A Draft Geological Survey Report (Hard Copy).

Copy for your kind information:

1. Project Manager, "Preparation of Development Plan for Fourteen Upazilas" Project, Package-03;
2. Three Junior Urban Planners, "Preparation of Development Plan for Fourteen Upazilas" Project, Package-03;

EXECUTIVE SUMMARY

Development plan of Gangni Upazila, District Dhaka has been taken under package-3 and the project titled 'Preparation of Development Plan for Fourteen Upazilas' a initiative of Urban Development Directorate (UDD). In this development plan, subsurface geological and geotechnical information's has been considered for a durable and sustainable urban environment. This is basically done to determine the state of the soil below the surface of the project area and natural, such as earthquakes, landslides and soil erosion as a result of the design of the infrastructure development such as geological and hydro-meteorological hazards are evaluated.

To know the subsurface environment of the study area, surveys has been carried out up to 30 meter below the earth surface in the field. Investigations and surveys are geo-morphological survey; drilling of boreholes and preparation of borehole logs; collection of undisturbed and disturbed soil sample as per standard guide line; conducting standard penetration tests (SPTs); drilling of boreholes and casing by PVC pipe for conducting Down-hole seismic test; conducting Down-hole seismic test and conducting Multi-Channel Analysis of Surface Wave (MASW). Laboratory testing of soil samples such as Grain Size analysis, Natural moisture Content, Atterberg Limits, Specific Gravity, Direct Shear Test, Unconfined Compression strength, etc has been performing in the laboratory which will give more qualitative and quantitative information about the subsurface materials. To meet the above geological, geotechnical and geophysical task, 28 boreholes with SPT program, five MASW and Six Down-hole seismic survey programs have been conducted into the field at Gangni Upazila.

From geotechnical and geological data base would give a clear idea about the geo-hazard status of particular landscape where newly urban developing activities or any other mega infrastructure project is going on and this mentioned investigation also gives idea about the vulnerability of existing build up infrastructure of a particular area. Based on these results, proper management techniques as well as other necessary adaptation process could be addressed before or after the development activities in the studied area. On the other hand, if the infrastructures are built according to this risk informed physical land-use plan, the long-term maintenance cost will be reduced and the developed structure will withstand against the potential natural hazards.

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ABBREVIATIONS

ASTM	:	American Society for Testing and Materials
AVS30	:	Average Shear Wave velocity of 30 meter depth
BH	:	Borehole
MASW	:	Multi-Channel Analysis of Surface Wave
N value	:	Soil resistance or compactness
PGA	:	Peak Ground Acceleration
PGV	:	Peak Ground Velocity
PS logging	:	Primary and Shear wave logging (Down-hole seismic test)
SA	:	Spectral Acceleration
SPAC	:	Spatial Autocorrelation
SPT	:	Standard Penetration Tests
UDD	:	Urban Development Directorate
EGL		Existing Ground Level
GWL		Ground Water Level

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CHAPTER-01: INTRODUCTION

1.1. BACKGROUND:

Horizontal expansion of urban area is rapidly increasing in Bangladesh with respect to their rapid population growth and increasing life expectance of the peoples. But present trend of planning practice is mostly oriented towards planning of major cities and towns, not in all other towns or growth centers because huge amount of financial allocation/grants involvement. Recent policy of government, the upazila has been recognized as the most significant tier of administration. So that these areas are need to be planned and developed to accommodate all social, economic, administrative, infrastructure services and service facilities. The government's intention is to reflect the national policy of bringing development administrative and service facilities to the door step of rural masses and to ensure better delivery of government services to the people. Realizing the fact and importance of formulating development plans for upazilas, Urban Development Directorate has come up with a great initiative to plan those areas. At the first phase of this initiative UDD has decided to prepare development plan for 14 Upazilas all over Bangladesh into five different packages. For each package separate consultancy team has been appointed to carry out that job more fruitfully. Desh Upodesh Ltd. in Association with AAIMA International BD Ltd. and Tech-SUS Ltd has been selected for package-3 (covering Gagni Upazila, Dist: Meherpur; Faridpur Sadar Upazila, Dist: Faridpur; and Baghmara Upazila, Dist: Rajshahi) by project evaluation committee of UDD.

Subsurface geological and geotechnical information's has been considered for a durable and sustainable urban environment. Primarily this work is to determine subsurface soil condition of the project area and evaluating of natural geological and hydro-meterological hazards such as earthquake, landslide and ground failure which integrate the consequence into the design of the infrastructure.

Regarding this study, following investigations and surveys has been carried out in the field which are geo-morphological survey; drilling of boreholes and preparation of borehole logs; collection of undisturbed and disturbed soil sample as per standard guide line; conducting standard penetration tests (SPTs); drilling of boreholes and casing by PVC pipe for conducting Down-hole seismic test; conducting Down-hole seismic test and conducting Multi-Channel Analysis of Surface Wave (MASW). Geologically and structurally the area is not much complex, that's why geotechnical and geophysical investigations are covered whole floodplain area except low or marshy land up to 30 meter depth from ground level and almost everywhere soil sediments are fluvial type of deposit which are much soft and thicker.

Following laboratory testing of soil samples such as Grain size analysis, Natural moisture content, Atterberg limits, Specific Gravity, Direct Shear Test, Unconfined Compression strength, etc has been performing in the laboratory which will give more qualitative and quantitative information about the subsurface materials. These field and laboratory test data will be analyzed and integrated into a module to produce risk sensitive micro-zonation maps.

1.2. SCOPE OF WORK:

The aim of this work is to determine subsurface soil condition of the project area and evaluating of natural geological and hydro-meterological hazards such as earthquake, liquefaction, ground failure and integrate the consequence into the design of the infrastructure. The main objective will be achieved through accomplishment of the following sub-objectives:

a) Preparation of Geological map of the study area.
b) Preparation of sub-surface lithological 3D model of different layers through geo-technical investigation
c) Preparation of engineering geological mapping based on AVS30
d) Determination of soil type in the project area
e) Foundation layer identification
f) Preparation of Seismic Hazard Map
g) Finally intensity map is prepared for high rise and low rise building

CHAPTER-02: METHODOLOGY

The methods and materials used to carry out of these activities have been described below-

2.1. TEST DETAILS AND PROCEDURE OF DOWN-HOLE SEISMIC TEST (PS LOGGING)

Main objectives of downhole seismic test to measure the travelling time of elastic wave from the ground surface to some arbitrary depths beneath the ground. The seismic wave was generated by striking a wooden plank by a sledge hammer. The plank was placed on the ground surface at around 1 m in horizontal direction from the top of borehole. The plank was hit separately on both ends to generate shear wave energy in opposite directions and is polarized in the direction parallel to the plank.

The shear wave emanated from the plank is detected by a tri-axial geophone. The geophone was lowered to 1 m below ground surface and attached to the borehole wall by inflating an air bladder. Then, the measurements were taken at every 1 m interval until the geophone was lowered to 30 m below ground surface. For each elevation, 3 records were taken and then used to calculate the shear wave velocity.

Plate 1: Downhole Seismic Test data logger

2.2.1. Procedure of Field Work and Analysis

a) A wooden plank with an approximate dimension of 2 ft x 1 ft x 2 ft is fixed to the ground. The wooden plank is placed about 1m from the borehole as shown in Plate 2.

Plate 2: Wooden Plank as the Vibration Source

b) Cables are wired from the geophone Plate 3 and the trigger to the data acquisition unit Plate 4. Signals in the vertical, radial and transverse directions are recorded by the data acquisition unit.

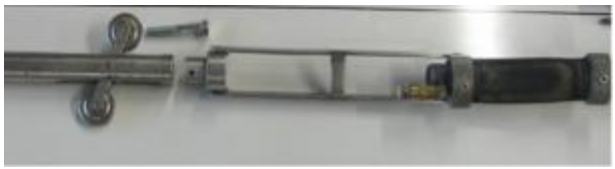


Plate 3: Geophone

Plate 4: Data Acquisition Unit

c) The geophone is lowered into the borehole as shown in Plate 5 Then, air is pumped into the air bag to fix the geophone to the casing (PVC pipe) at 1 m interval in depth basically.

Plate 5: Geophone Lowering In the Borehole

d) Excitations are generated by hitting the wooden plank in three directions by the hammer.

Plate 6: Direction of Excitations

e) Data is recorded in the data acquisition unit. Figure 1 illustrates a typical dataset in obtaining the arrival time of S-wave. Hitting the wooden plank in opposite directions generates signals as shown in the figure. The time that two curves begin to separate is the arrival time of shear wave. By doing the same analysis for every depth, S-wave profiles are obtained throughout the depth of the borehole.

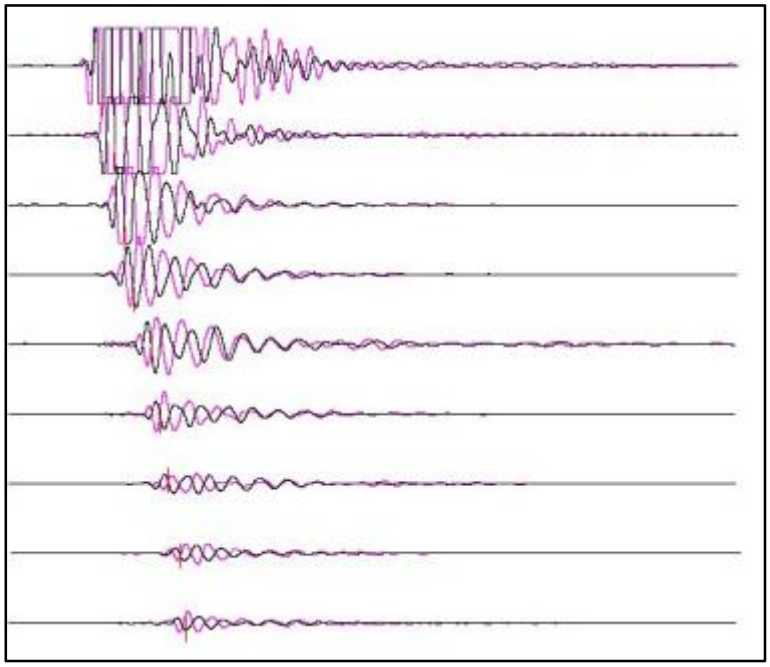
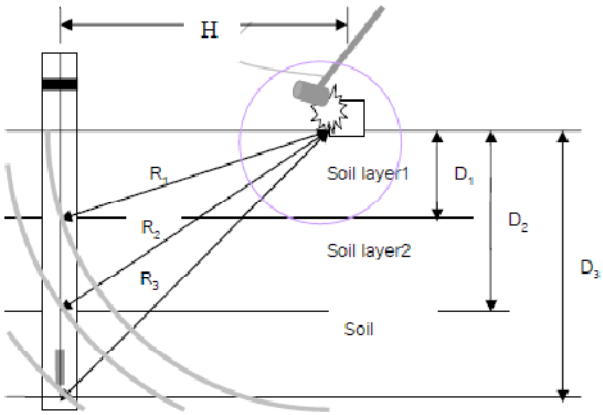


Figure 1: Determination of the Arrival Time of S-Wave

f) Using the raw data of the test depth (D), the shortest pass (R) and the recorded arrival time of S-wave (t) in the inclined path is calculated to the travel time, t_c, in the vertical path as shown in Figure 2.



$$t_c = D\frac{t}{R}$$

Where

t_c is the corrected travel time

D is the testing depth from ground surface,

t is the first arrival time from test

R is the distance between the source an receiver

[*Auld 1977*]

Figure 2: Calculation of the Travel Time

g) By plotting the corrected travel time versus depth, the velocity of every 1 m interval is calculated from (Auld 1977)

$$V_d = \frac{\Delta D}{\Delta t_c} [Auld\ 1977]$$

Where, ΔD is depth interval showing similar slope and Δt_c is the corrected travel time difference of ΔD.

2.2. TEST DETAILS AND PROCEDURE OF MULTI-CHANNEL ANALYSIS OF SURFACE WAVE (MASW)

Multichannel Analysis of Surface Wave (MASW) is recent and very popular method for computation of shear wave velocity. This method is widely used for seismic microzonation. A MASW is a seismic surface method, widely used for subsurface characterization and is increasingly being applied for seismic microzonation and site response studies (Anbazhagan and Sitharam, 2008). It is also used for the geotechnical characterization of near surface materials (Park and Miller, 1999; Xia et al., 1999; Miller et al., 1999; Anbazhagan and Sitharam, 2008). MASW is used to identify the subsurface material boundaries, spatial and depth variations of weathered and engineering rocks (Anbazhagan and Sitharam, 2009). We have used the MASW system consisting of 12 channels Geode seismograph with 12 vertical geophones of 10 Hz capacity.

The measuring procedure in this project is shown as follows:

I. To decide the measuring line
II. To set receivers along the line at the ground surface. The intervals of each geophone are 3m.
III. To set an acrylic board at a half interval outside the line
IV. To shoot it vertically. Then generated elastic waves are recorded by receivers.
V. To shift the acrylic board between second receiver and the third receiver, and shoot it vertically. Then generated elastic waves are recorded at receivers.
VI. To iterate this procedure up to setting the acrylic boards at a half interval outside the other side of the line.

The data acquisition parameters are given in table 1.

Table 1: MASW Data Acquisition Parameters

Seismic refraction	
Number of channels	12
Geophone spacing	3m
Array length	33m
Sampling rate	1ms
Record length	2 sec
Natural frequency of Geophone	10 Hz
Source	8 kg hammer
Shot number	13 points, 11 between geophones and 2 outside of measuring line

Source: Park and Miller, 1999; Xia et al. 1999; Miller et al. 1999; Anbazhagan and Sitharam, 2008

2.2.1. Analysis of MASW

Data processing consists of two main steps: (i) Obtaining the dispersion curves of Rayleigh wave phase velocity from the records; (ii) Determining the V s profiles from which the Vs30 values are calculated (see figure 3). In the phase velocity analysis, SPAC (Spatial Autocorrelation) method (Okada, 2003) is employed. Okada (2003) shows Spatial Autocorrelation function ρ (ώ, r) is expressed by Bessel function.

$$\rho(\omega, r) = J_0(\omega r / c(\omega))$$ [*Okada, 2003*]

Where, r is the distance between receivers, ώ is the angular frequency, c (ώ) is phase velocity of waves, J_0 is the first kind of Bessel function. The phase velocity was obtained at each frequency using equation (2). A one dimensional inversion using a non-linear least square method has been applied to the phase velocity

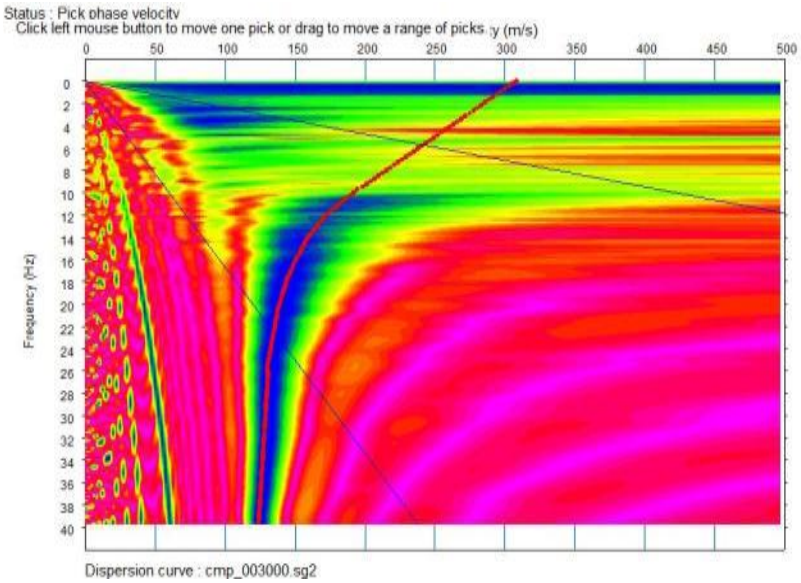
curves. In the inversion, the following relationship between P-wave velocity (Vp) and Vs (Kitsunezaki et. al., 1990):

$$Vp = 1.29 + 1.11Vs$$ [*Kitsunezaki et. al., 1990*]

Where, Vs is S-wave velocity (km/s), Vp is P-wave velocity (km/s). In order to assume density ρ (g/cm3) from S-wave velocity, the relationship of Ludwig et al. (1970) is used.

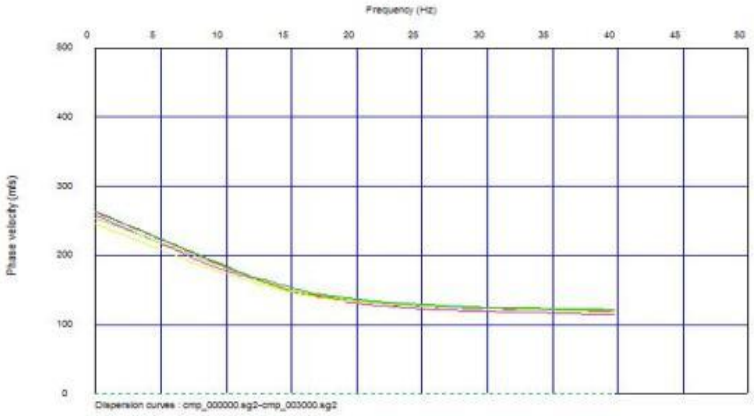
$$\rho = 1.2475 + 0.399Vp - 0.026Vp^2$$ [*Ludwig et al. (1970)]*

These calculations are carried out along the measuring line, and the S-wave velocity distribution section was analyzed.



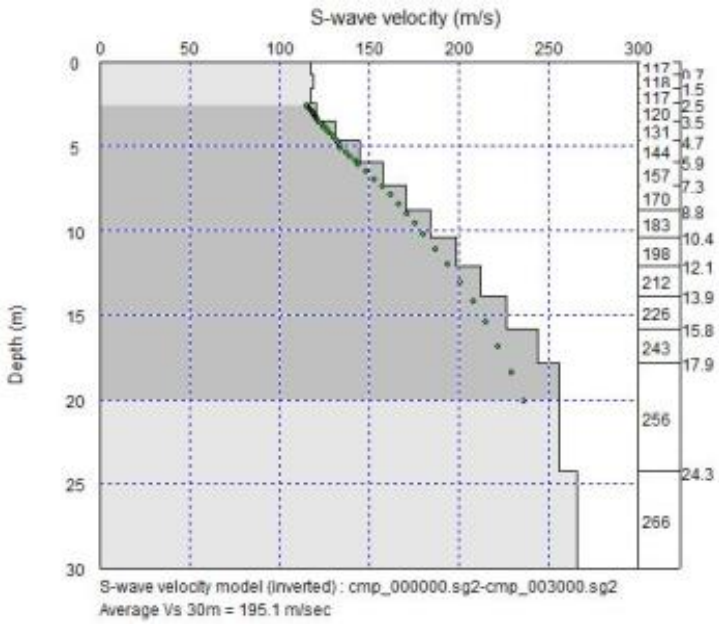
MASW Raw field data

F-K Transform



Dipersion for Rayleigh wave

Inversion



Shear wave velocity profile

Figure 3: Main Step of the MASW Processing Technique

2.3. TEST DETAILS AND PROCEDURE OF STANDARD PENETRATION TEST

The geotechnical boreholes have been constructed using wash boring method. In this investigation, 28 numbers of boreholes have been prepared at Gangni Upazila. The borehole logs are enclosed in the Appendix A. The boring method has been described in the following section.

2.3.1. Drilling

The bore holes are being drilled through mechanical percussion wash boring method at the locations previously decided. As 30 m boring is so complicated and time consuming moreover it has done continuously to the end to prevent the possibility of caving of the boring wall, is will been decided to send two sets of worker who will work in 8 hrs until desired depths will be achieved. In this manner the estimated time for boring execution will 13- shifts and 12- shifts are considered for mobilization, assemble and disassemble of the equipment, site cleanup and backfill the bore holes to their pre-existing condition.

2.3.2. Data Collection

The field data are being collected according to the respective standard methods. First of all the location, areal coverage, topography, geomorphology of the test site are note down. The soil sample collection procedure is mentioned in the section 2.3.4. While SPT soil samples are collected. At the same time, the ground water table is note down.

2.3.3. SPT Execution

As it mentioned earlier, the geotechnical boreholes will be constructed using mechanical boring method. The depth of those boreholes is to 30m. In this method N values (standard Penetration Test) is counted and soil sample also be taken in every 1.5m depth interval. The subsequent procedure which has been followed during the field work is furnished as follows:

I. Drill a 100-200 mm (2.5-8 in) diameter exploratory boring to the depth of the first test.

II. Insert the SPT sampler (also known as a Split-spoon Sampler) into the boring. The shape and dimensions of this sampler are shown in Figure 4. It is connected via steel rods to a 63.5 kg (140 lb) hammer, as shown in Figure 5.

III. An automatic tripping mechanism (in case of rotary drilling used this technique in this investigation), raise the hammer a distance of 760 mm (30 in) and allow it to fall. This energy drives the sampler into the bottom of the boring. Repeat this process until the sampler has penetrated a distance of 450 mm (18 in), recording the number of hammer blows required for each 150 mm (6 in) interval.

IV. Compute the N-value by summing the blow counts for the last 300 mm (12 in) of penetration. The blow count for the first 150 mm (6 in) is retained for reference purposes, but not used to compute N because the bottom of the boring is likely to be disturbed by the drilling process and may be covered with loose soil that fell from the sides of the boring.

V. Extract the SPT sampler, then remove and save the soil sample (disturbed sample).

VI. Drill the boring to the depth of the next test and repeat steps 2 through 6 as required.

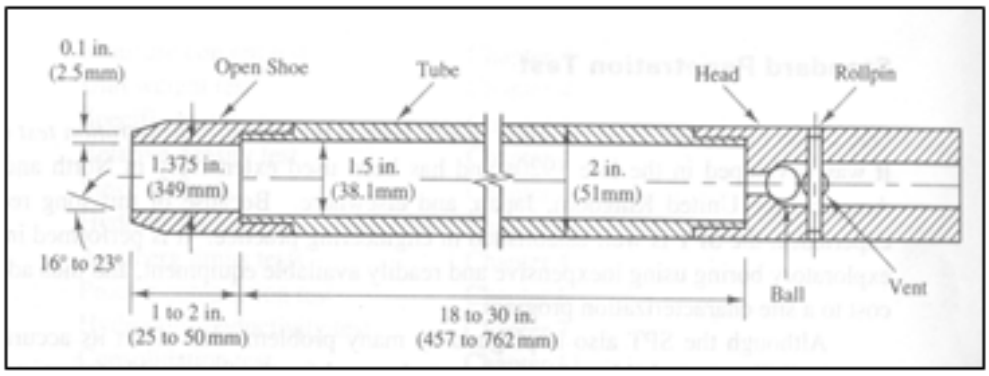


Figure 4: Split-spoon sampler.

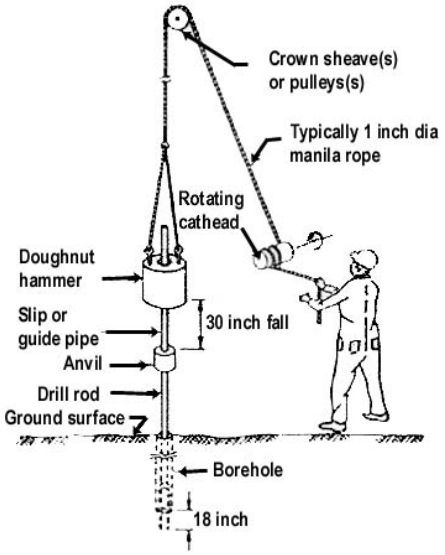


Figure 5: The SPT sampler in place in the boring with hammer

2.3.4. SOIL SAMPLING

Two main categories of soil samples are collected, undisturbed and disturbed. Undisturbed samples, which are required mainly for shear strength and consolidation tests, are obtained by techniques which aim at preserving the in-situ structure and water content of the soil. In boreholes, undisturbed samples can be obtained by withdrawing the boring tools (except when hollow-stem continuous-flight augers are used) and driving or pushing a sample tube into the soil at the bottom of the hole. The sampler is normally attached to a length of boring rod which can be lowered and raised by the cable of the percussion rig. When the tube is brought to the surface, some soil is removed from each end and molten wax is applied, in thin layers, to form a seal approximately 25mm thick: the ends of the tube are then covered by protective caps. Undisturbed block samples can be cut by hand from the bottom or sides of a trial pit. During cutting, the samples must be protected from water, wind and sun to avoid any change in water content: the samples should be covered with molten wax immediately they have been brought to the surface. It is impossible to obtain a sample that is completely undisturbed, no matter how elaborate or careful the ground investigation and sampling technique might be. In the case of clays, for example,

swelling will take place adjacent to the bottom of a borehole due to the reduction in total stresses when soil is removed and structural disturbance may be caused by the action of the boring tools; subsequently, when a sample is removed from the ground the total stresses are reduced to zero.

Soft clays are extremely sensitive to sampling disturbance, the effects being more pronounced in clays of low plasticity than in those of high plasticity. The central core of a soft clay sample will be relatively less disturbed than the outer zone adjacent to the sampling tube. Immediately after sampling, the pore water pressure in the relatively undisturbed core will be negative due to the release of the in-situ total stresses. Swelling of the relatively undisturbed core will gradually take place due to water being drawn from the more disturbed outer zone and resulting in the dissipation of the negative excess pore water pressure: the outer zone of soil will consolidate due to the redistribution of water within the sample. The dissipation of the negative excess pore water pressure is accompanied by a corresponding reduction in effective stresses. The soil structure of the sample will thus offer less resistance to shear and will be less rigid than the in-situ soil.

A disturbed sample is one having the same particle size distribution as the in-situ soil but in which the soil structure has been significantly damaged or completely destroyed; in addition, the water content may be different from that of the in-situ soil. Disturbed samples, which are used mainly for soil classification tests, visual classification and compaction tests, can be excavated from trial pits or obtained from the tools used to advance boreholes (e.g. from augers and the clay cutter). The soil recovered from the shell in percussion boring will be deficient in fines and will be unsuitable for use as a disturbed sample. Samples in which the natural water content has been preserved should be placed in airtight, non-corrosive containers: all containers should be completely filled so that there is negligible air space above the sample.

All samples should be clearly labeled to show the project name, date, location, borehole number, depth and method of sampling; in addition, each sample should be given a serial number. Special care is required in the handling, transportation and storage of samples (particularly undisturbed samples) prior to testing. The types of tube samplers used in this study are described below.

Thin-walled Sampler

Thin-walled samplers (Figure 6) have been used to collected undisturbed samples from boreholes. These samplers are used in soils which are sensitive to disturbance such as soft to firm clays and plastic silts. The sampler does not employ a separate cutting shoe, the lower end of the tube itself being machined to form a cutting edge. The internal diameter may range from 35 to 100 mm. The area ratio is approximately 10% and samples of first-class quality can be obtained provided the soil has not been disturbed in advancing the borehole. In trial pits and shallow boreholes the tube can often be driven manually

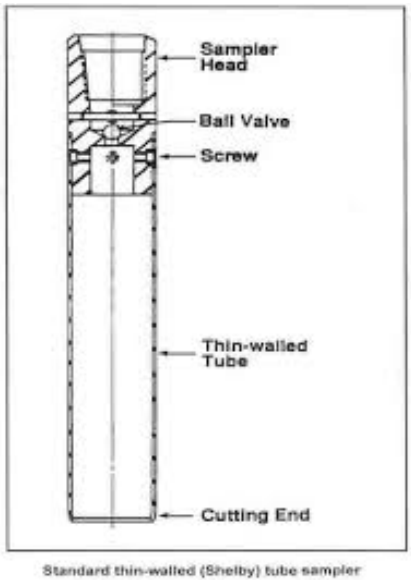


Figure 6: Thin-Walled (Shelby Tube) Sampler

Split-spoon sampler

Split-spoon samplers (Figure 7) have been to collect disturb samples. It consists of a tube which is split longitudinally into two halves: a shoe and a sampler head incorporating air-release holes are screwed onto the ends. The two halves of the tube can be separated when the shoe and head are detached to allow the sample to be removed. The internal and external diameters are 35 and 50 mm, respectively, the area ratio being approximately 100%, with the result that there is considerable disturbance of the sample. This sampler is used mainly in sands, being the tool specified in the standard penetration test (SPT).

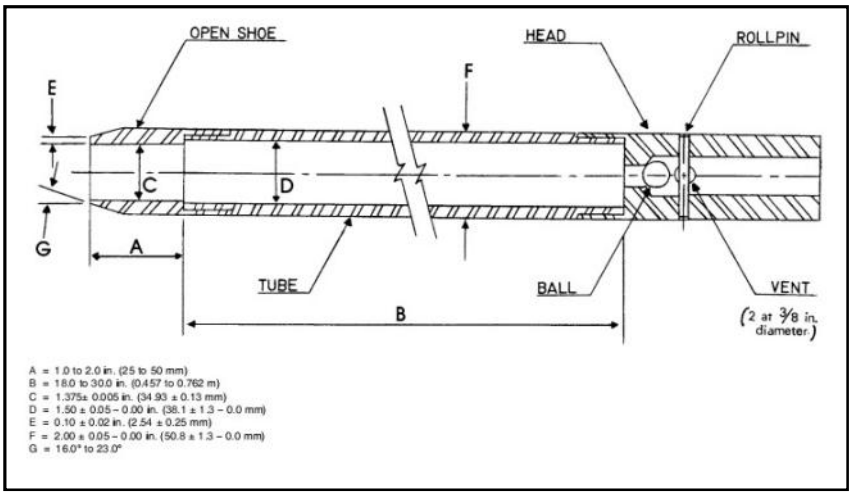


Figure 7: Undisturbed (Split-Spoon) Sampler

2.3.5. CARRYING OUT DIFFERENT ENGINEERING TESTS ON SOIL SAMPLE

A wide variety of laboratory tests is performing on soils to measure number of soil parameters. Some soil properties are intrinsic to the composition of the soil matrix and are not affected by sample disturbance, while other properties depend on the structure of the soil as well as its composition, and can only be effectively tested on relatively undisturbed samples. Some soil tests measure the direct properties of the soil, while others measure "index properties" which provide useful information about the soil without directly measuring the property desired.

The test types and standard which have been following given in the following section. Before explaining each of the engineering tests, the standard followed in each test is mentioned here:

- Natural Moisture Content Tests
- Attarbarge Limit Test
- Unconfined Compressional Test
- Traxial Test

All laboratory test result are given in Appendix D.

CHAPTER-03: SURVEY RESULT AT GANGNI UPAZILA

3.1. GEOPHYSICAL INVESTIGATIONS

The main objectives of these investigation to estimate local site effects against earthquakes and the task has been segregated by three-fold: 1) To determine shear wave velocity profile at various sites, 2) To classify soil conditions according to seismic design specifications and 3) To analyze soil amplifications in the area. Field measurements of shear wave velocities were conducted in Gangni Upazila and described in below.

Shear wave velocity profile (Vs profile) in the field were carried out by two geophysical exploration methods namely 1) seismic downhole test and 2) Multichannel Analysis of Surface Wave (MASW).

Seismic downhole test is a direct measurement method for obtaining the shear wave velocity profile of soil stratum. However, the test requires borehole which is not time and cost effective for the project. Multichannel analysis of surface waves (MASW) is a non-invasive technique which can be used to determine the Vs profile at sites. In this project, the seismic downhole and MASW tests were performed at 6 and 5 locations respectively. Locations of seismic downhole test and MASW tests are shown in Map 2. The GPS coordinate of the test locations are showing in Table 2.

Table 2: Down-hole Seismic Test (PS logging) and MASW test locations

Survey Type	Survey ID	Location	Lat	Long	Union
Downhole Seismic Test (PS Logging)	PS-1 (BH-11)	Gangni Pilot Girls school, Gangni Pourashava	23.81835	88.74858	Gangni Pourashava
	PS-4 (BH-19)	Kutubpur School and College, Garabaria, Kathuli Union	23.85518	88.65115	Kathuli Union
	PS-5 (BH-24)	Village- Akubpur, Near Khalishakundi Bridge, matmura Union	23.8935	88.86416	Matmura Union
	PS-2 (BH-25)	Bamandi Nishipur High School, Bamandi Bus stand, Bamandi Union	23.88907	88.80393	Bamandi Union
	PS-3 (BH-30)	Kazipur College Field, Kazipur Union	23.94155	88.75707	Kazipur Union
	PS-6 (BH-08)	Chadpur govt. primary school, Chadpur, Roypur union	23.8164	88.82855	Roypur Union
Multi-channel Analysis of Surface Wave (MASW)	MASW-1	Bashbari Madhamik School field, Gangni Pourashava	23.81154	88.73213	Gangni Pourashava
	MASW-2	Lutfarnessa Nimno Madhamik School, Gopalnagar, Roypur Union	23.82896	88.77811	Roypur Union
	MASW-3	Hegulbari Mahapur, Shaharbati Union Complex Office	23.85178	88.73162	Shaharbati Union
	MASW-4	Palashipara Govt Primary School, Opposite side of Tentulbaria Union Office	23.89705	88.7251	Tentulbaria Union
	MASW-5	Hegulbari Mahmadpur Hagi Boroshauddin High School, Mahamudpur, Matmura Union	23.9122	88.85581	Matmura Union

Source: Field Survey, 2016

3.1.1. Down-Hole Seismic (PS Logging) Test Results

As a fundamental parameter, shear wave velocity is required to define the dynamic properties of soils. If the soil velocity is less then 180m/s, it can be say as loose or soft soil. Estimation of shear wave velocity (Vs) / average shear wave velocity (AVS) and mapping is a way to characterize varying site conditions, and it can also be used

to model earthquake-related ground shaking. Estimation of AVS aims to generate a map of estimated shear wave velocities for the upper 30m of the subsurface. Further this map can be used for seismic site response analysis i.e., to determine peak ground acceleration (PGA) and spectral acceleration (SA) values of both bedrock and ground surface. In this context, Downhole seismic test data acquisition has been completed at Gangni Upazilla in Six different locations on date 10th to 11th February 2016.

The average shear wave velocity (AVS) of each PS logging test are tabulated in Table 3. Work plan of the test depth was 30m, however, in some locations did not reach the geophone to the 30 m in depth due to adverse conditions of PVC.
The shear wave velocities at every 1m interval of each site are given in Appendix A at tabular and also graphical format.

3.1.2. MASW Survey Result

To predict subsurface shear-wave interval velocities, multi-spectral analyses of surface waves (MASW) are popularly used. Shear wave velocities can also extract additional velocity-related information such as mechanical properties of soils and rocks. In general, MASW data compare favorably to other geophysical methods for predicting interval velocities. Furthermore, comparisons to vertical seismic profiles correlate well with MASW predicted shear wave interval velocities. In this perspective, MASW test has been completed at five different locations at Gangni Upazilla by 29TH November,2016 and field raw data has been processed and also interpreted.

The results of the MASW test are enclosed in Appendix B at tabular and also graphical format.

3.2. GEOTECHNICAL INVESTIGATIONS

To ensure safety of human beings and materials, geotechnical investigations have become an essential component of every construction, it includes a detailed investigation of soil strength, composition, water content, and other important soil characteristics. Investigation borings with standard penetration test were conducted in order to know vertical geological conditions. The borings with SPT were carried out at 28 points at Gangni Upazila.

3.2.1. Standard Penetration Test (SPT) Log Analysis and Interpretation

SPT is a common in-situ testing method used to determine the geotechnical engineering properties of subsurface soils. It was developed in the late 1920s and has been used extremely in North and South America, the United Kingdom, Japan, and elsewhere. Because of this long record of experience, the SPT is well-established in engineering practice. It is performed inside exploratory boring using inexpensive and readily available equipment, and thus adds little cost to a site characterization program. Although the SPT also is plagued by many problems that affect its accuracy and reproducibility, it probably will continue to be used for the foreseeable future, primarily because of its low cost. However, it is partially being replaced by other test methods, especially on larger and more critical projects.

All the borings has to be conducted and preparation of field bore log by visual classification has to be done in the presence of the experienced technical personnel. The borehole records have to be taken that include soil type, nature of sample, soil moisture content and consistency, SPT blow counts (N Value), ground water observation and apparent origin (fill, alluvium, recent sediments, etc.) and daily field logs have been prepared. The bore locations are given in following table 5 and the geotechnical borehole log are enclosed in the below section.

Table 3: Bore Hole Information Summary at Gangni Upazila

Survey_ ID	Location	Lat	Long	Union
BH-03	Chitla Madhamik School, Chitla bazar, Dhankhola Union	23.78366	88.73273	Dhankhola Union
BH-04	Shaldha Govt. primary school, Roypur Union	23.79642	88.82253	Roypur Union
BH-06	Dhankhola Govt. primary school, Near Dhankhola union complex, Dhankhola Bazar	23.79047	88.76714	Dhankhola Union
BH-07	Bashbari Madhamik School field, Gangni Pourashava	23.81105	88.73187	Gangni Pourashava
BH-08	Chadpur govt. primary school, Chadpur, Roypur union	23.8164	88.82855	Roypur Union
BH-10	Chougacha Parchim para Govt. primary school, Gangni Pourashava	23.82609	88.7326	Gangni Pourashava
BH-11	Gangni Pilot Girls school, Gangni Pourashava	23.81835	88.74858	Gangni Pourashava
BH-12	Gojaria Hamayetpur, Roypur Union	23.82847	88.84534	Roypur Union
BH-13	Ekuria Eid gha Mat, Roypur Union	23.82508	88.81804	Roypur Union
BH-14	Roypur high school, Roypur Bazar, Roypur Union	23.82355	88.79932	Roypur Union
BH-15	Lutfarnessa Nimno Madhamik School, Gopalnagar, Roypur Union	23.828636	88.777977	Roypur Union
BH-16	Shaharbati Govt. primary school, Charchara Bazar, Shaharbati Union	23.83142	88.71098	Shaharbati Union
BH-17	Juger gofa Govt. primary school, Shola taka Union	23.84463	88.81038	Shola taka Union
BH-18	Vill- Changara, Chok Tolar mor, Shola taka Union	23.84709	88.76802	Shola taka Union
BH-19	Kutubpur School and College, Garabaria, Kathuli Union	23.85518	88.65115	Kathuli Union
BH-20	Kumaridanga High School, Kumaridanga, Matmura union	23.86646	88.85149	Matmura Union
BH-21	Olinagar Daskinpara Jame Moshjid, Bamandi Union	23.87305	88.78759	Bamandi Union
BH-22	Shaharbati union complex	23.85206	88.73234	Shaharbati Union
BH-23	Radhagobindhopur Dhola Govt. Primary School, Kathuli Union	23.87088	88.67374	Kathuli Union
BH-24	Village- Akubpur, Near Khalishakundi Bridge, matmura Union	23.8935	88.86416	Matmura Union

BH-25	Bamandi Nishipur High School, Bamandi Bus stand, Bamandi Union	23.88907	88.80393	Bamandi Union
BH-26	Kormodi Kumarpara jame Moshjid, Tentulbaria Union	23.90297	88.76061	Tentulbaria Union
BH-27	Tentulbaria Doyapara govt. primary school, Doyapara, Tentulbaria Union	23.89365	88.717	Tentulbaria Union
BH-28	Mahamadhpur Hafizia Madrasha, Mahamadhpur Bazar, Matmura Union	23.91934	88.85344	Matmura Union
BH-29	Brojpur Govt. Primary school, Brojpur, Kazipur Union	23.93039	88.78947	Kazipur Union
BH-30	Kazipur College Field, Kazipur Union	23.94155	88.75707	Kazipur Union
BH-31	Betbaria private high school, Kazipur union	23.95878	88.7939	Kazipur Union
BH-32	Kazipur Mathavanga madhomik Girls School, Hazipara, Kazipur Union	23.96283	88.74911	Kazipur Union

Source: Field data, 2015

While boring and SPT testing, soil samples are being visually classified in the following way:

Sieve	**Soils**	**Designations**
+No 4 (4.76mm)	Gravel	
No.4 to No 10(2.00mm)	Coarse	Sand
No. 10 to No 40 (0.42mm)	Medium	Sand
No. 40 to No 200 (0.07mm)	Fine	Sand
No.200	Silt or Clay	

Some soil has one dominant lithology with minuscule amount of other soil type. In such cases, minor soil sample are written in the following manner with along with dominant soil type.

1. Trace 1 to 10%
2. Little 10 to 25%
3. With 25 to 35%

SPT- N value is also note down while SPT Testing. Then the collected soil samples are being cross checked with SPT-N values to ensure quality data collection.

Based on N-values, other very useful soil parameters may be obtained from the co-relation charts given by different research workers. Two such useful co-relations for cohesive and non-cohesive soils after K. Terzaghi are given below:

Table 4: Values of Relative Density (Dr.), Friction Angle and Unit Weight of Non-cohesive soil based on N-values

N-values	Condition	Relative Density	Angle of Internal friction (Degree)	Moist Unit Weight (Pcf)
0-4	Very Loose	0-15%	28^0	70-100
4-10	Loose	15-35%	28^0-30^0	95-125
10-30	Medium dense	35-65%	30^0-36^0	110-130
30-50	Dense	65-85%	36^0-41^0	110-140
Over 50	Very dense	85-100%	Over 41^0	> 130

Table 5**:** Values of Unconfined Compressive Strength based on N-values for Cohesive Soil (Approximate):

N-values	Condition	Unconfined Compressive Strength (Tsf)
Below 2	Very soft	Below 0.25
2-4	Soft	0.25-0.50
4-8	Medium stiff	0.50-1.00
8-16	Stiff	1.00-2.00
16-32	very stiff	2.00-4.00
Over 32	Hard	over 4.00

In the above table the shear strength of cohesive soil is equal to ½ of unconfined compressive strength and the angle of shearing resistance is equal to zero. It should be remembered that the co-relation for cohesive soil is not always much reliable.
The litholog are already written down in a standard format and has been attached in the appendix C.

CHAPTER-04: CONCLUSION

Gangni Upazila and its adjoining areas is mostly comprises by monotonous flood plain area except few depression. Soil quality of the project area is varying as morphological difference, that's why geological, geotechnical and geophysical investigations has been carried out such a pattern to cover all morphological unit. In this consequences, 28 boreholes with SPT, 6 downhole seismic tests and 5 MASW program has been completed in the field as a part of this survey investigation. During this survey, soil samples (disturbed and undisturbed) are also collected for further laboratory test which will give idea about the soil engineering properties. This investigation data will be analyzed and integrated in a module from which it can possible to generate geomorphologic map, sub-surface litho-logical 3D model of different layers, engineering geological mapping based on AVS30, Seismic Hazard Assessment Map, soil type map, seismic intensity map, Peak Ground Acceleration (PGA) and recommended building height maps for both high rise building and low rise building etc

Above investigation and outcomes would give a clear idea about the geo-hazard status of particular landscape where newly urban developing activities or any other mega infrastructure project is going on and this mentioned investigation also gives idea about the vulnerability of existing build up infrastructure of a particular area. Based on these results, proper management techniques as well as other necessary adaptation process could be addressed before or after the development activities in the studied area. It is to be mentioned that the long-term maintenance cost will be reduced and the developed structure will withstand against the potential natural hazards if the infrastructures are built following the risk informed physical land-use plan.

CHAPTER 5: REFERENCES

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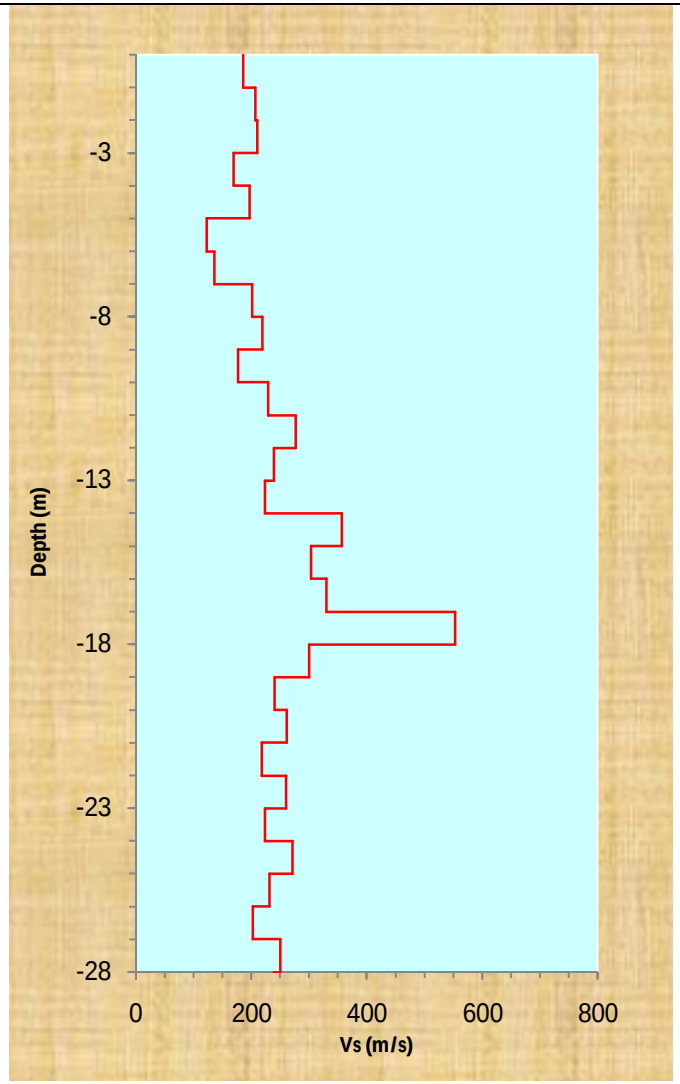
Appendix A

Downhole Seismic Test (PS Logging) Results and Graphs

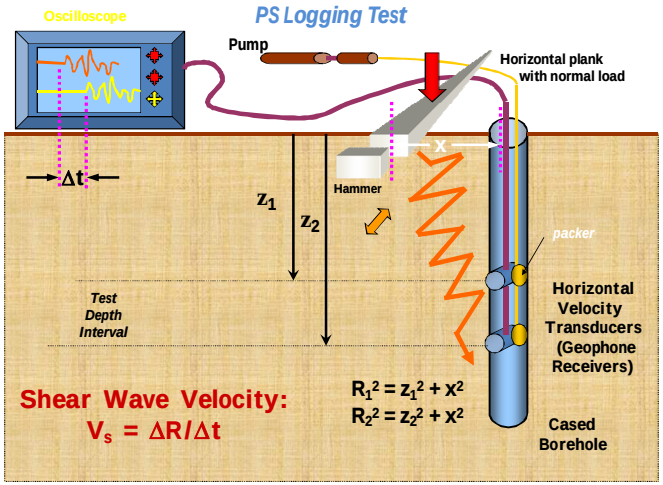
Tested Date	:	10 February 2016	Source	:	7kg Sledge Hammer
Location	:	Gangni Pilot Girls school, Gangni Pourashava	Downhole Receiver	:	Tri-axial Geophone
Test Id	:	PS-1 (BH-11)	Recording Equipment	:	Freedom Data PC
Coordinate	:	Latitude 23.81835 Longitude 88.74858	Borehole Information	:	Grouted Cased
Operator	:	The Olson Instruments Downhole Seismic system	Casing Diameter	:	75mm PVC Casing

Depth (m) Form EGL	S-wave Velocity
-1	186
-2	206
-3	210
-4	170
-5	197
-6	123
-7	136
-8	201
-9	219
-10	177
-11	229
-12	276
-13	239
-14	224
-15	356
-16	303
-17	330
-18	552
-19	300
-20	240
-21	261
-22	218
-23	260
-24	224
-25	272
-26	232
-27	202
-28	250
-29	239
-30	277
Average Vs 30m = 225m/sec	

Graphical Representation of S-wave Vellocity



Data Acquisition Procedure

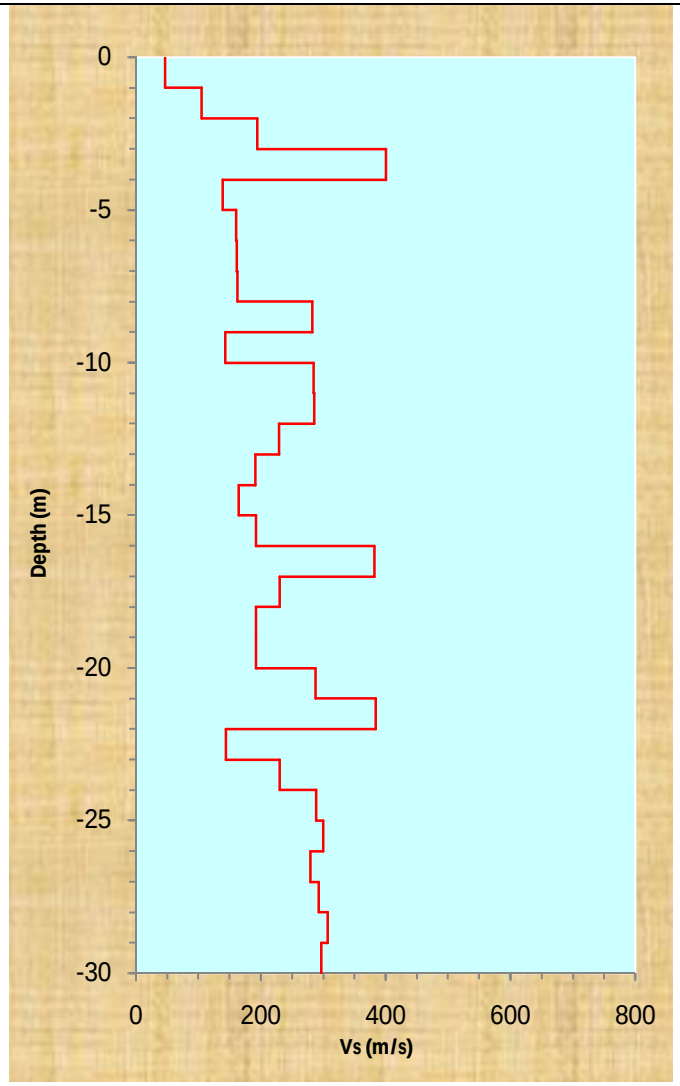


Downhole Seismic Test Data Acquisition

Tested Date	:	10 February 2016	Source	:	7kg Sledge Hammer
Location	:	Bamandi Nishipur High School, Bamandi Bus stand, Bamandi Union	Downhole Receiver	:	Tri-axial Geophone
Test Id	:	PS-2 (BH-25)	Recording Equipment	:	Freedom Data PC
Coordinate	:	Latitude 23.88907 Longitude 88.80393	Borehole Information	:	Grouted Cased
Operator	:	The Olson Instruments Downhole Seismic system	Casing Diameter	:	75mm PVC Casing

Depth (m) Form EGL	S-wave Velocity
-1	47
-2	105
-3	194
-4	401
-5	139
-6	160
-7	162
-8	163
-9	282
-10	144
-11	285
-12	286
-13	230
-14	192
-15	165
-16	192
-17	383
-18	230
-19	192
-20	192
-21	288
-22	384
-23	144
-24	231
-25	288
-26	300
-27	280
-28	293
-29	307
-30	297
Average Vs 30m = 190m/sec	

Graphical Representation of S-wave Vellocity



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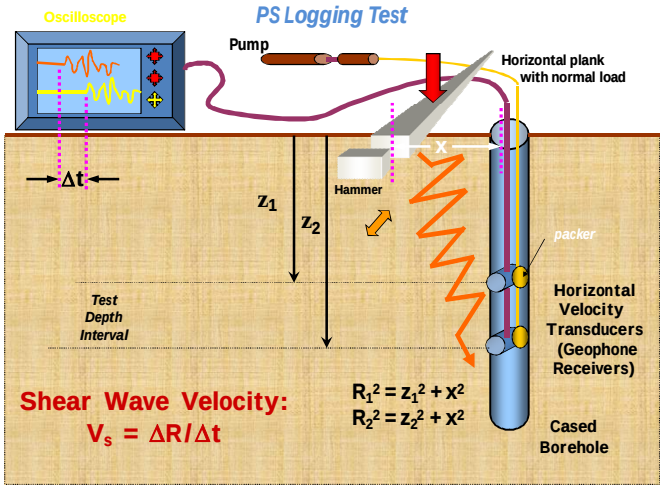
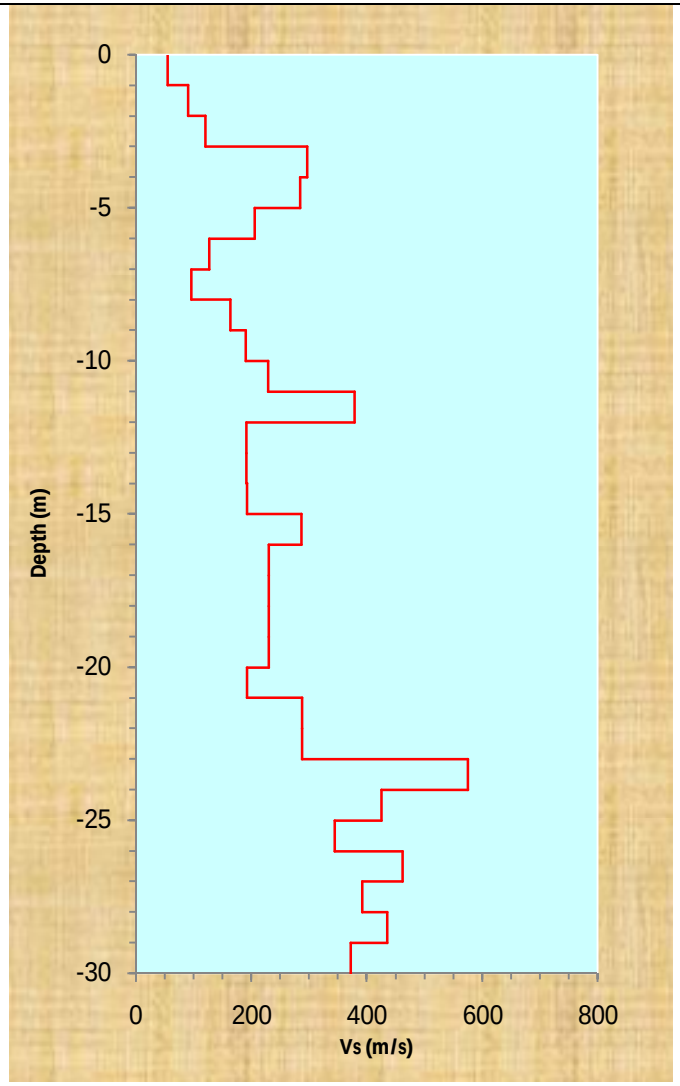


Downhole Seismic Test Data Acquisition

Tested Date	:	10 February 2016	Source	:	7kg Sledge Hammer
Location	:	Kazipur College Field, Kazipur Union	Downhole Receiver	:	Tri-axial Geophone
Test Id	:	PS-3 (BH-30)	Recording Equipment	:	Freedom Data PC
Coordinate	:	Latitude 23.94155 Longitude 88.75707	Borehole Information	:	Grouted Cased
Operator	:	The Olson Instruments Downhole Seismic system	Casing Diameter	:	75mm PVC Casing

Depth (m) Form EGL	S-wave Velocity
-1	55
-2	91
-3	120
-4	297
-5	284
-6	206
-7	127
-8	96
-9	163
-10	190
-11	229
-12	379
-13	192
-14	192
-15	192
-16	287
-17	230
-18	230
-19	231
-20	231
-21	192
-22	288
-23	288
-24	575
-25	425
-26	344
-27	461
-28	392
-29	436
-30	372
Average Vs 30m = 198m/sec	

Graphical Representation of S-wave Vellocity



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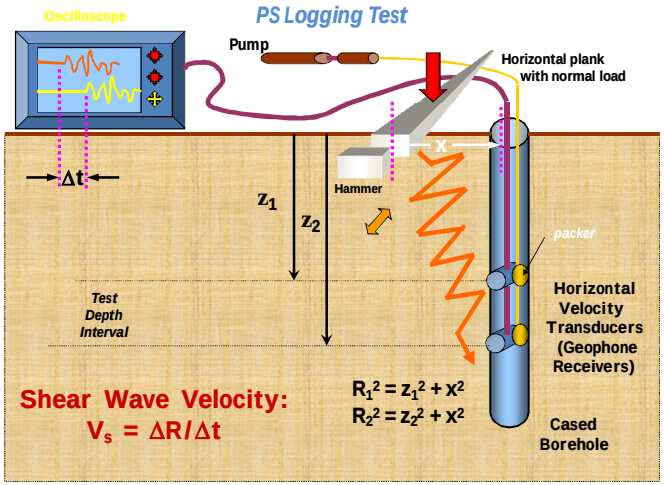
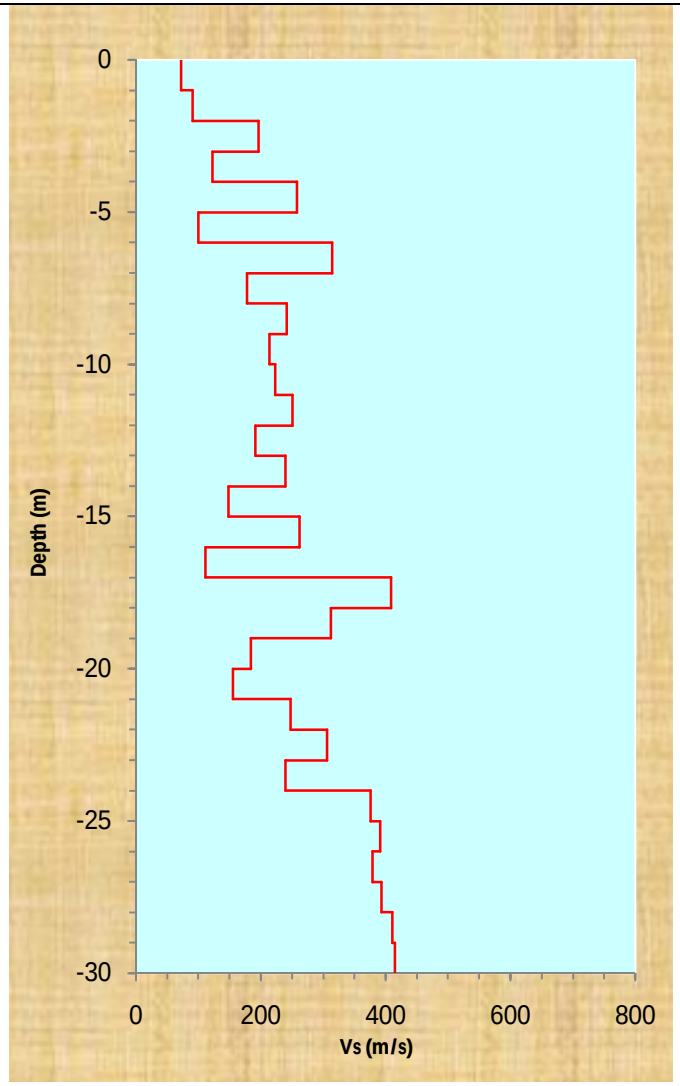


Downhole Seismic Test Data Acquisition

Tested Date	:	11 February 2016	Source	:	7kg Sledge Hammer
Location	:	Kutubpur School and College, Garabaria, Kathuli Union	Downhole Receiver	:	Tri-axial Geophone
Test Id	:	PS-4 (BH-19)	Recording Equipment	:	Freedom Data PC
Coordinate	:	Latitude 23.85518 Longitude 88.65115	Borehole Information	:	Grouted Cased
Operator	:	The Olson Instruments Downhole Seismic system	Casing Diameter	:	75mm PVC Casing

Depth (m) Form EGL	S-wave Velocity
-1	73
-2	90
-3	197
-4	122
-5	258
-6	100
-7	314
-8	178
-9	242
-10	214
-11	223
-12	251
-13	191
-14	239
-15	148
-16	262
-17	111
-18	409
-19	312
-20	184
-21	155
-22	247
-23	307
-24	240
-25	375
-26	391
-27	380
-28	393
-29	411
-30	415
Average Vs 30m = 198m/sec	

Graphical Representation of S-wave Vellocity



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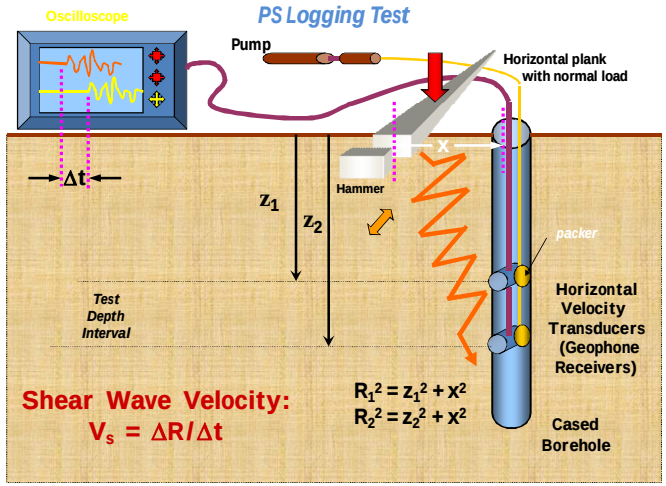
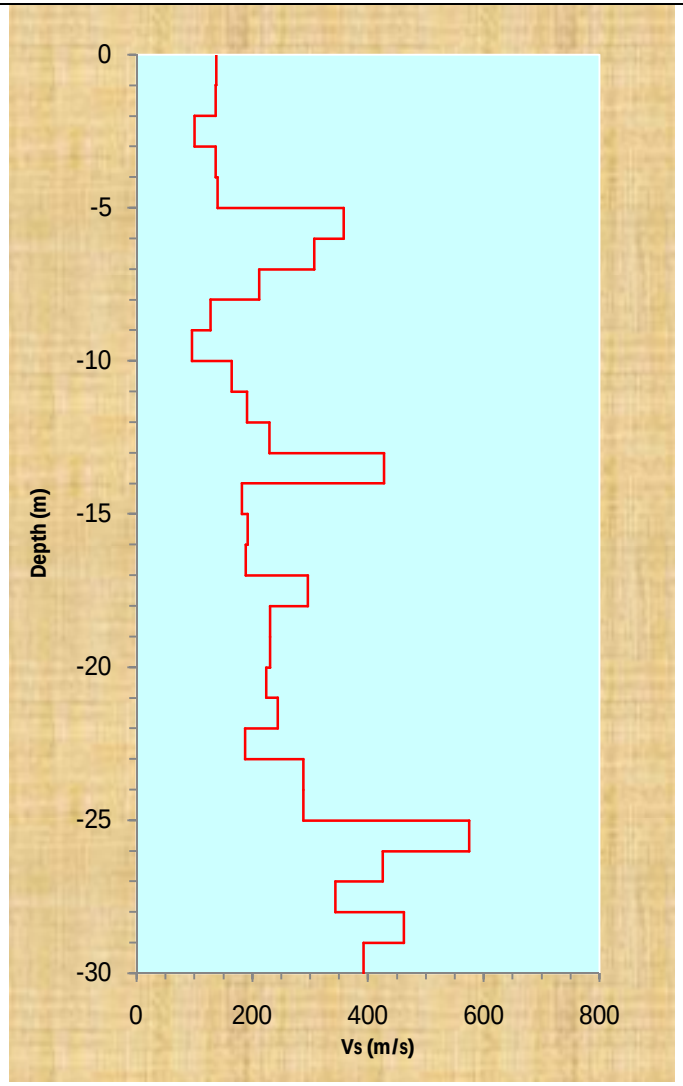


Downhole Seismic Test Data Acquisition

Tested Date	:	11 February 2016	Source	:	7kg Sledge Hammer
Location	:	Village- Akubpur, Near Khalishakundi Bridge, matmura Union	Downhole Receiver	:	Tri-axial Geophone
Test Id	:	PS-5 (BH-24)	Recording Equipment	:	Freedom Data PC
Coordinate	:	Latitude 23.893 Longitude 88.86416	Borehole Information	:	Grouted Cased
Operator	:	The Olson Instruments Downhole Seismic system	Casing Diameter	:	75mm PVC Casing

Depth (m) Form EGL	S-wave Velocity
-1	138
-2	137
-3	100
-4	138
-5	140
-6	358
-7	307
-8	212
-9	128
-10	96
-11	164
-12	192
-13	230
-14	427
-15	182
-16	192
-17	189
-18	296
-19	231
-20	231
-21	225
-22	244
-23	188
-24	288
-25	289
-26	575
-27	425
-28	344
-29	462
-30	392
Average Vs 30m = 205m/sec	

Graphical Representation of S-wave Vellocity



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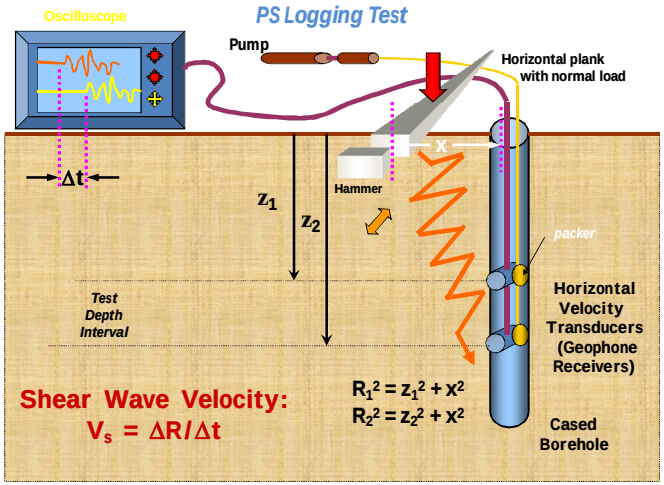
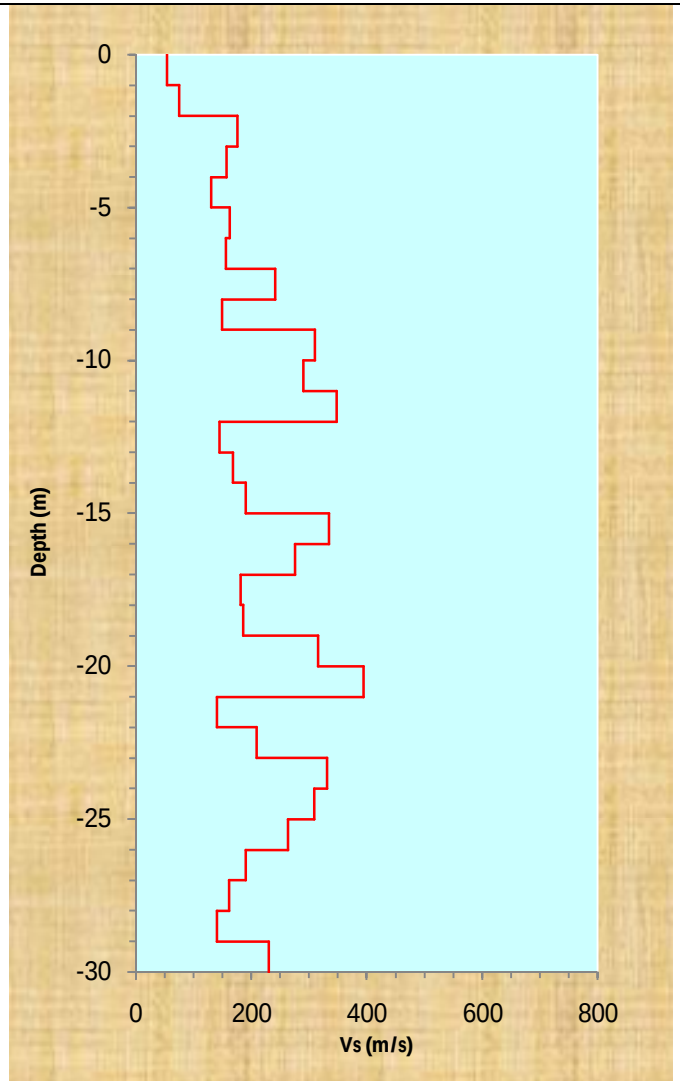


Downhole Seismic Test Data Acquisition

Tested Date	:	10 February 2016	Source	:	7kg Sledge Hammer
Location	:	Chadpur govt. primary school, Chadpur, Roypur union	Downhole Receiver	:	Tri-axial Geophone
Test Id	:	PS-6 (BH-8)	Recording Equipment	:	Freedom Data PC
Coordinate	:	Latitude 23.8164 Longitude 88.82855	Borehole Information	:	Grouted Cased
Operator	:	The Olson Instruments Downhole Seismic system	Casing Diameter	:	75mm PVC Casing

Depth (m) Form EGL	S-wave Velocity
-1	54
-2	75
-3	176
-4	157
-5	130
-6	162
-7	155
-8	241
-9	150
-10	310
-11	290
-12	348
-13	145
-14	168
-15	191
-16	335
-17	276
-18	181
-19	185
-20	315
-21	394
-22	141
-23	209
-24	331
-25	309
-26	263
-27	190
-28	162
-29	140
-30	230
Average Vs 30m = 176m/sec	

Graphical Representation of S-wave Vellocity



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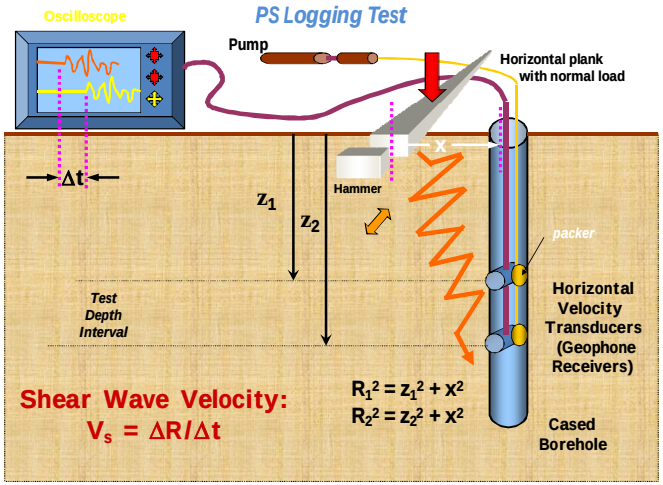


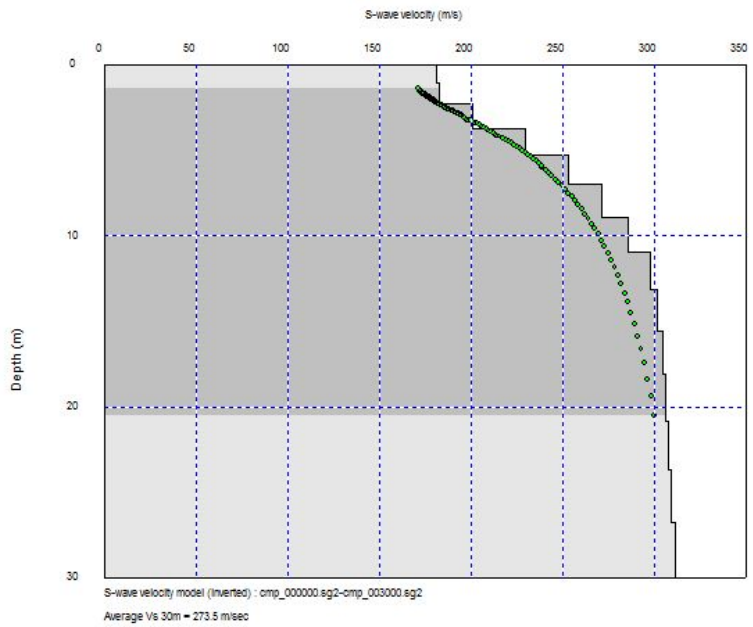
Downhole Seismic Test Data Acquisition

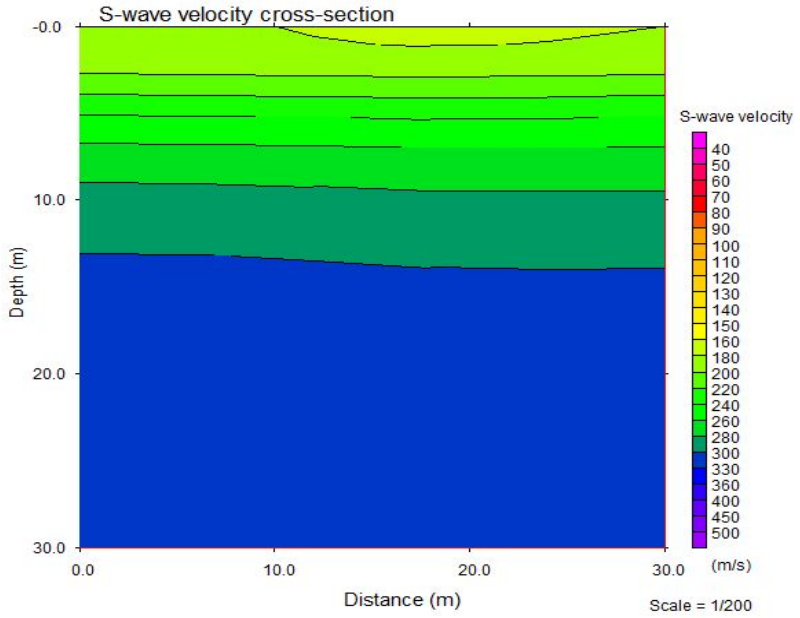
Appendix B

Multi-channel Analysis of Surface Wave (MASW) Results and Graphs

Survey ID	Location Name	Data Acquisition Date	Coordinate	
GANGNI MASW-1	Bashbari Madhamik School field, Gangni Pourashava	29/11/2016	Latitude	Longitude
			23.81154	88.73213

Depth (m)	S-wave (m/s)	P-wave (m/s)
0.00	181.24	1491.2
1.07	182.69	1492.8
2.31	200.68	1512.8
3.71	229.65	1544.9
5.27	253.33	1571.2
7.01	271.60	1591.5
8.90	286.04	1607.5
10.96	297.82	1620.6
13.19	302.13	1625.4
15.58	304.30	1627.8
18.13	306.14	1629.8
20.85	307.71	1631.6
23.74	309.31	1633.3
26.79	311.65	1635.9



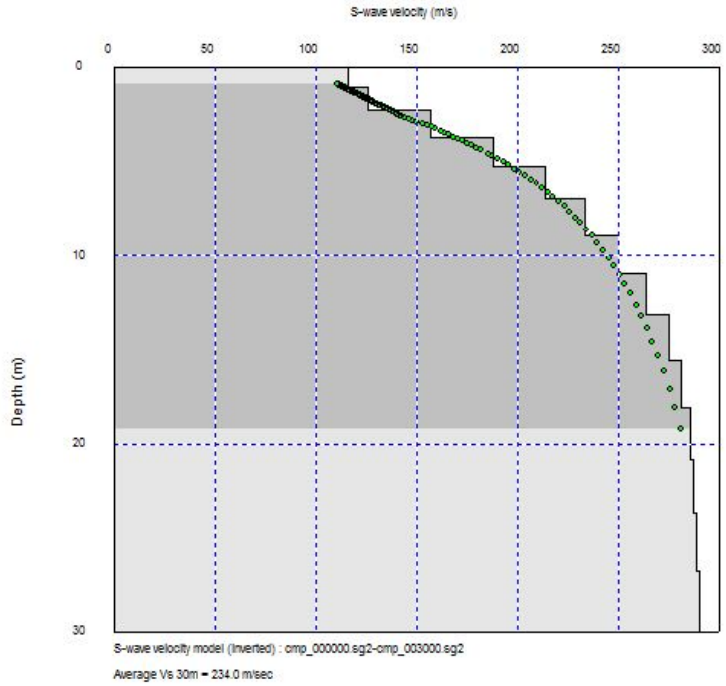


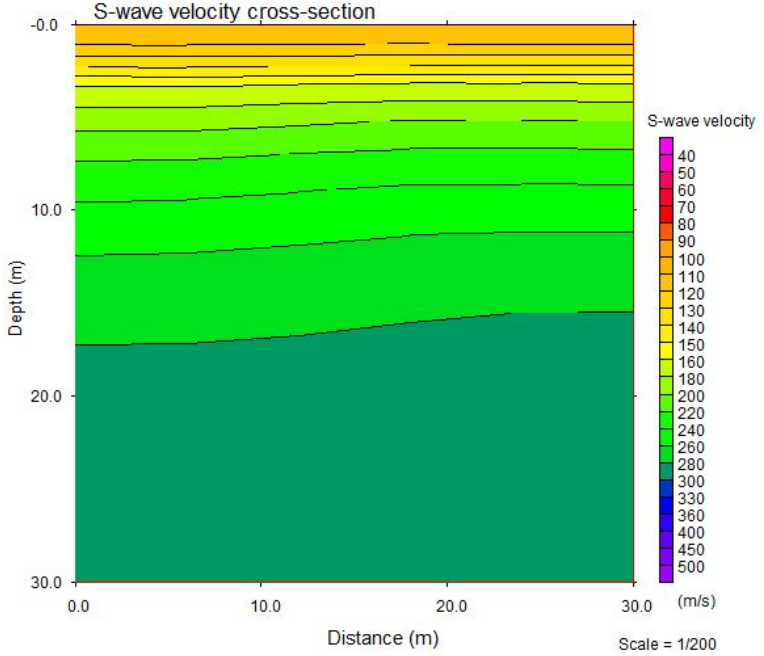
Average Vs 30m = 273.5m/sec	One Directional S-wave Velocity Profile	Two Directional S-wave Velocity Profile

MASW Survey Data Acquisition at Bashbari Madhamik School field

Survey ID	Location Name	Data Acquisition Date	Coordinate	
GANGNI MASW-2	Lutfarnessa Nimno Madhamik School, Gopalnagar, Roypur Union	29/11/2016	Latitude	Longitude
			23.82896	88.77811

Depth (m)	S-wave (m/s)	P-wave (m/s)
0.00	116.31	1419.1
1.07	125.45	1429.2
2.31	156.60	1463.8
3.71	188.36	1499.1
5.27	213.42	1526.9
7.01	233.48	1549.2
8.90	249.69	1567.2
10.96	263.99	1583.0
13.19	275.22	1595.5
15.58	281.68	1602.7
18.13	285.71	1607.1
20.85	287.16	1608.7
23.74	288.45	1610.2
26.79	290.17	1612.1





Average Vs 30m = 234m/sec

One Directional S-wave Velocity Profile

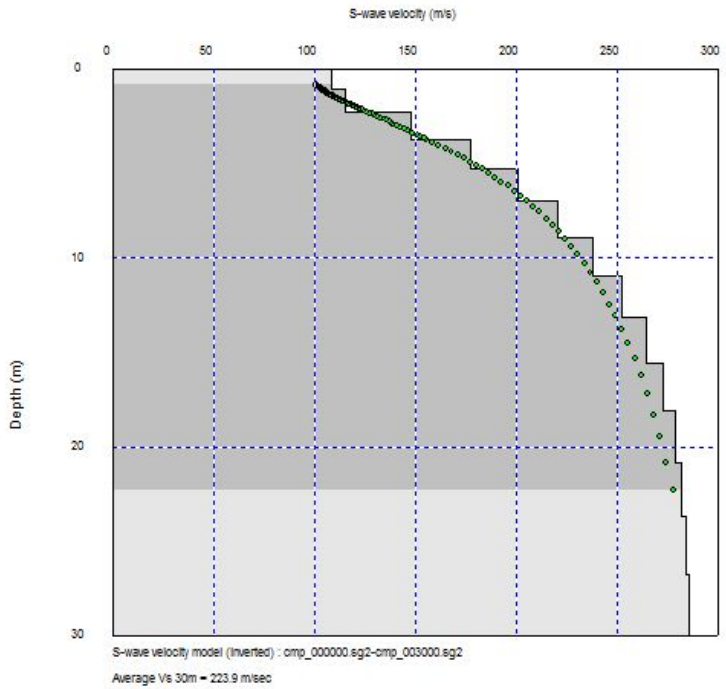
Two Directional S-wave Velocity Profile

MASW Survey Data Acquisition at Lutfarnessa Nimno Madhamik School field

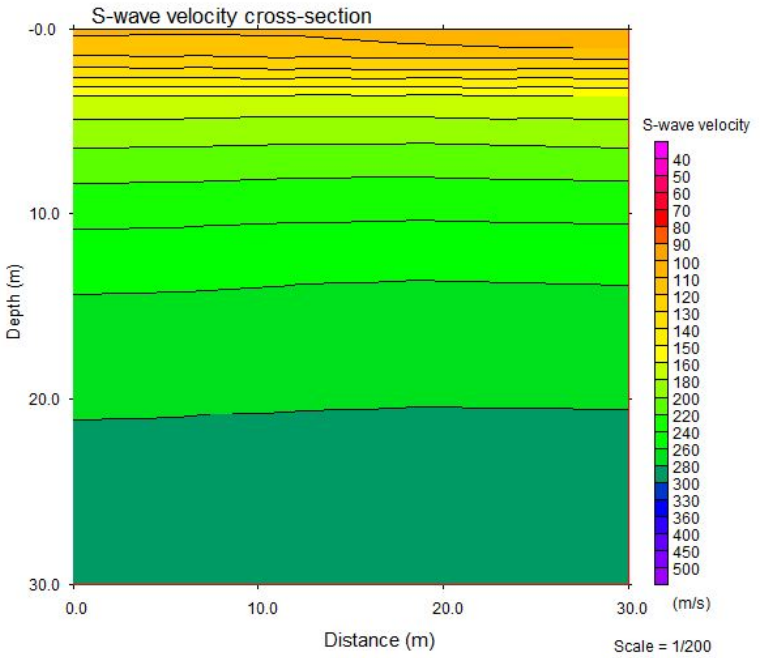
Survey ID	Location Name	Data Acquisition Date	Coordinate	
GANGNI MASW-3	Hegulbari Mahapur, Shaharbati Union Complex Office	29/11/2016	Latitude	Longitude
			23.85178	88.73162

Depth (m)	S-wave (m/s)	P-wave (m/s)
0.00	108.18	1410.1
1.07	115.22	1417.9
2.31	147.66	1453.9
3.71	177.56	1487.1
5.27	200.66	1512.7
7.01	220.67	1534.9
8.90	237.68	1553.8
10.96	252.05	1569.8
13.19	264.32	1583.4
15.58	273.33	1593.4
18.13	278.91	1599.6
20.85	282.24	1603.3
23.74	283.89	1605.1
26.79	286.14	1607.6

Average Vs 30m = 223.9m/sec



One Directional S-wave Velocity Profile

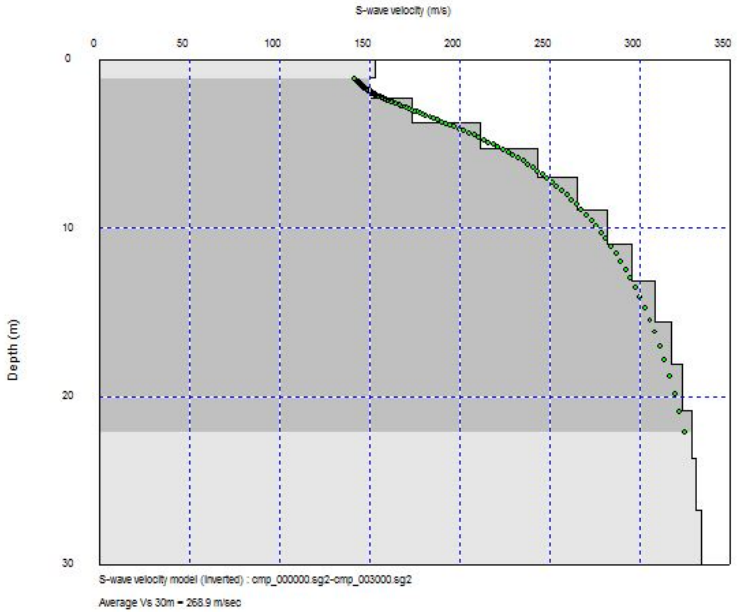


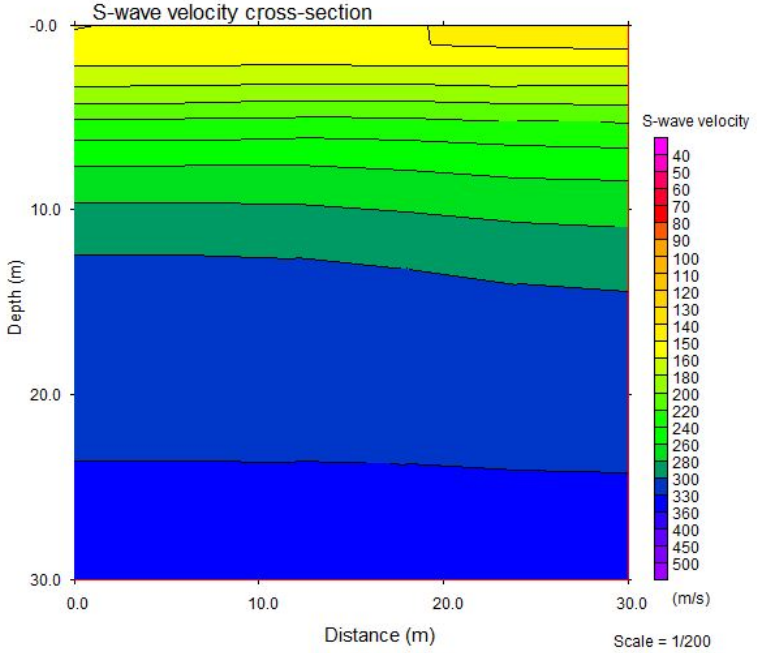
Two Directional S-wave Velocity Profile

MASW Survey Data Acquisition at near Shaharbati Union Complex Office

Survey ID	Location Name	Data Acquisition Date	Coordinate	
GANGNI MASW-4	Palashipara Govt Primary School, Opposite side of Tentulbaria Union Office	29/11/2016	Latitude	Longitude
			23.89705	88.72510

Depth (m)	S-wave (m/s)	P-wave (m/s)
0.00	153.08	1459.9
1.07	149.79	1456.3
2.31	173.75	1482.9
3.71	211.48	1524.7
5.27	243.28	1560.0
7.01	265.45	1584.7
8.90	281.74	1602.7
10.96	296.08	1618.6
13.19	308.91	1632.9
15.58	317.96	1642.9
18.13	323.47	1649.1
20.85	329.03	1655.2
23.74	331.23	1657.7
26.79	334.07	1660.8





Average Vs 30m = 268.9m/sec

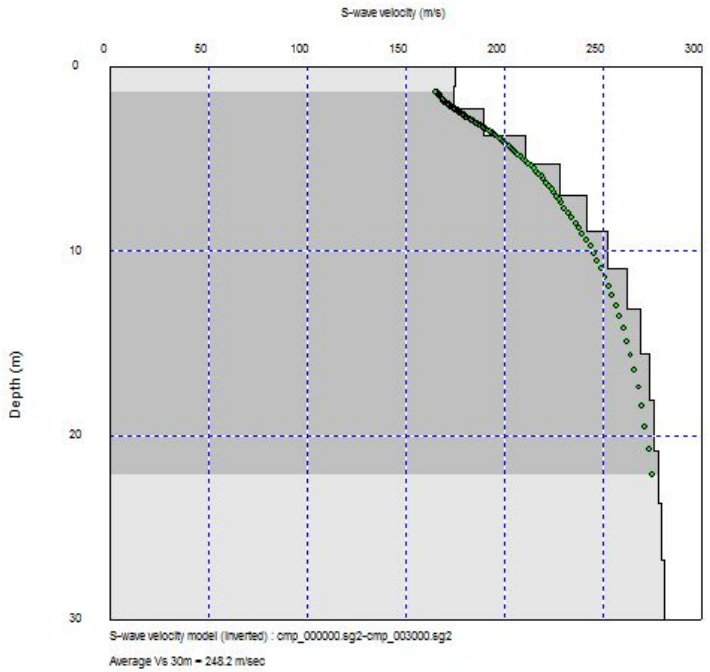
One Directional S-wave Velocity Profile

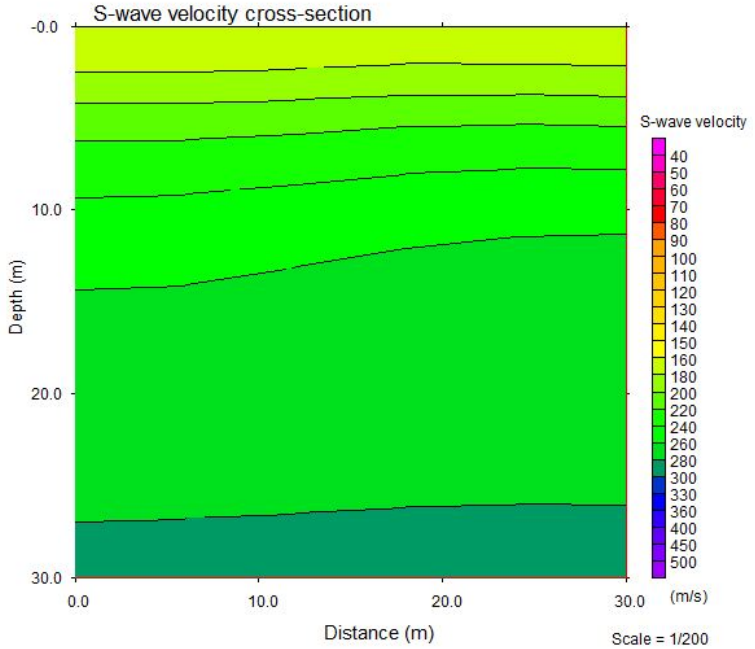
Two Directional S-wave Velocity Profile

MASW Survey Data Acquisition at Palashipara Govt Primary School, Opposite side of Tentulbaria Union Office

Survey ID	Location Name	Data Acquisition Date	Coordinate	
GANGNI MASW-5	Hegulbari Mahmadpur Hagi Boroshauddin High School, Mahamudpur, Matmura Union	29/11/2016	Latitude	Longitude
			23.91220	88.85581

Depth (m)	S-wave (m/s)	P-wave (m/s)
0.00	175.01	1484.3
1.07	174.18	1483.3
2.31	189.89	1500.8
3.71	210.98	1524.2
5.27	228.29	1543.4
7.01	241.84	1558.4
8.90	252.90	1570.7
10.96	262.47	1581.3
13.19	269.00	1588.6
15.58	273.69	1593.8
18.13	275.76	1596.1
20.85	278.18	1598.8
23.74	279.47	1600.2
26.79	281.34	1602.3





Average Vs 30m = 248.2m/sec	One Directional S-wave Velocity Profile	Two Directional S-wave Velocity Profile

MASW Survey Data Acquisition at Hegulbari Mahmadpur Hagi Boroshauddin High School field

Appendix C

Geotechnical Borehole Logs and Graphs

GEOTECHNICAL BOREHOLE LOG

Bore hole No: BH-03
Method of Boring: Percussion
Boring Dia.:100(mm)
Boring Depth: 30.0m

Exixting ground level: 17.48
Ground water level: 4.57m below EGL
Started on: 25.01.2016
Completed on: 25.01.2016

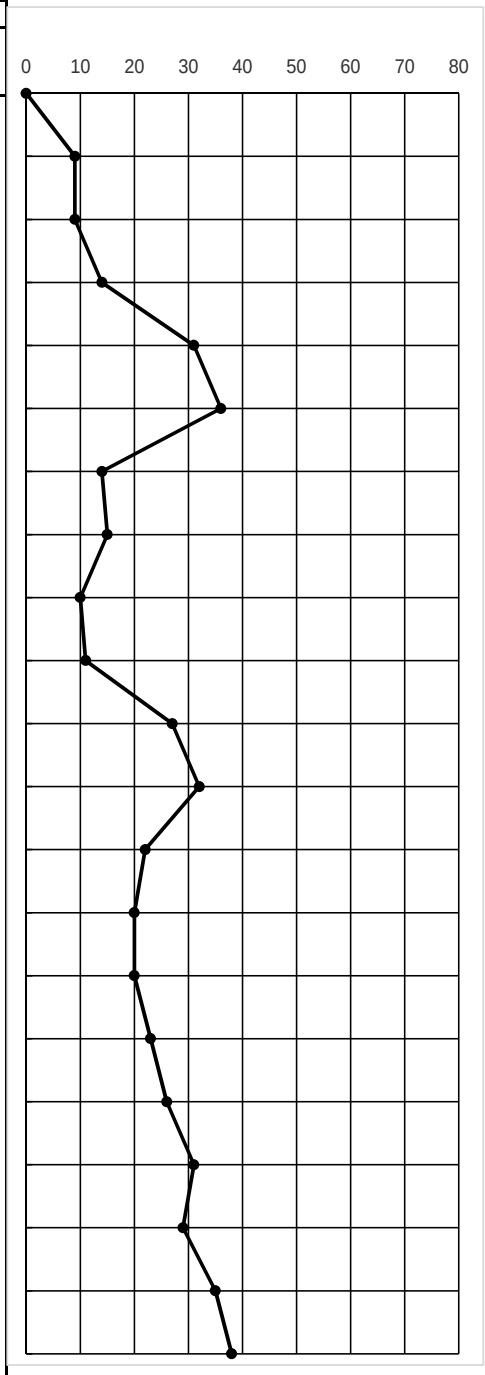
Client : Urban Development Directorate (UDD)
Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location : Chitla Madhamik School, Chitla bazar, Dhankhola Union

Legend: Clay, Silt, Sand

Coordinates Lat-23.78366 Long-88.73273

Depth (m)	Visual Description	Symbols	Sample	Layer Number	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Gray medium Dense very fine to fine SAND			2	15.0	3	4	5	9
3.0						3	4	5	9
4.5						4	6	8	14
6.0						8	14	17	31
7.5						8	16	20	36
9.0						10	7	7	14
10.5						6	7	8	15
12.0						3	4	6	10
13.5						4	4	7	11
15.0						6	12	15	27
16.5	Gray medium Dense to Dense fine to medium SAND			4	15.0	7	14	18	32
18.0						6	10	12	22
19.5						6	8	12	20
21.0						6	8	12	20
22.5						7	10	13	23
24.0						7	11	15	26
25.5						8	13	18	31
27.0						8	13	16	29
28.5						10	15	20	35
30.0	End of Boring					10	17	21	38

SPT blows per 0.3 m penetration



Disturbed Sample(Split Spoon)
Undisturbed Sample(Shelby Tube)
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6

GEOTECHNICAL BOREHOLE LOG

Bore hole No: BH-04
Method of Boring: Percussion
Boring Dia.:100(mm)
Boring Depth: 30.0m

Exixting ground level: 18.75
Ground water level: 3.96m below EGL
Started on: 23.01.2016
Completed on: 23.01.2016

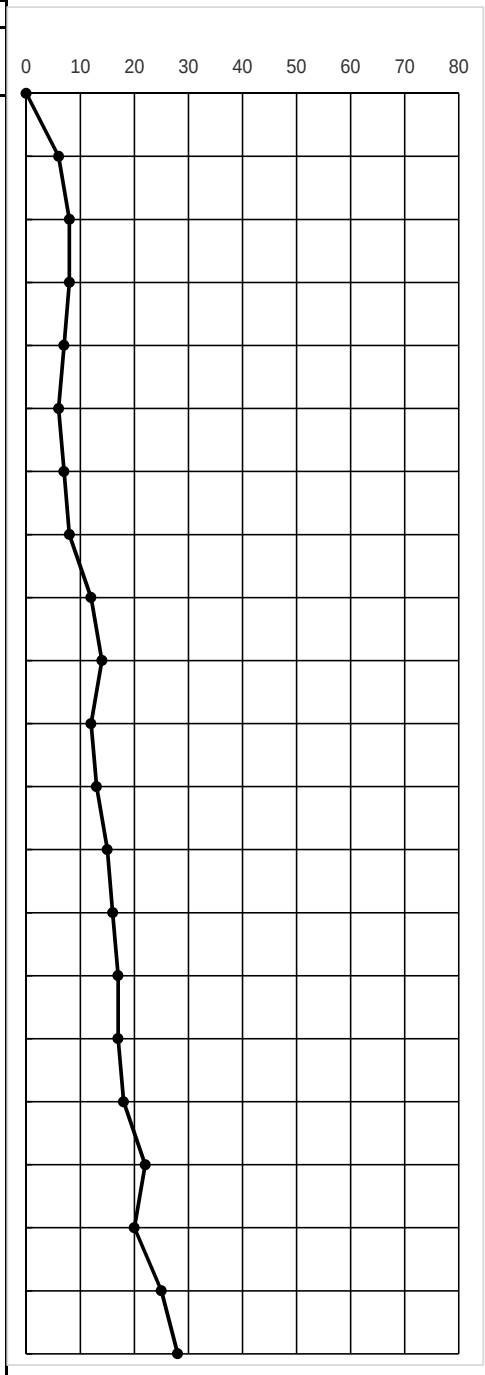
Client : Urban Development Directorate (UDD)
Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location : Shaldah Govt. Primary School, Roypur union

Legend: Clay, Silt, Sand

Coordinates: Lat-23.79642 Long-88.82253

Depth (m)	Visual Description	Symbols	Sample	Layer Number	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Light Grey loose to medium dense fine to medium SAND			2	12.0	2	2	4	6
3.0						3	3	5	8
4.5						3	4	4	8
6.0						2	3	4	7
7.5						2	3	3	6
9.0						2	3	4	7
10.5						3	4	4	8
12.0						3	5	7	12
13.5	Light Grey to Light brown medium dense medium to fine SAND			4	18.0	4	6	8	14
15.0						5	6	6	12
16.5						5	6	7	13
18.0						5	6	9	15
19.5						6	7	9	16
21.0						6	8	9	17
22.5						5	7	10	17
24.0						6	8	10	18
25.5						7	10	12	22
27.0						7	10	10	20
28.5						5	12	13	25
30.0	End of Boring					9	13	15	28

SPT blows per 0.3 m penetration



Disturbed Sample(Split Spoon)
Undisturbed Sample(Shelby Tube)
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6

GEOTECHNICAL BOREHOLE LOG

Bore hole No: BH-06
Method of Boring: Percussion
Boring Dia.:100(mm)
Boring Depth: 30.0m

Exixting ground level: 18.36
Ground water level: 3.96m below EGL
Started on: 21.01.2016
Completed on: 21.01.2016

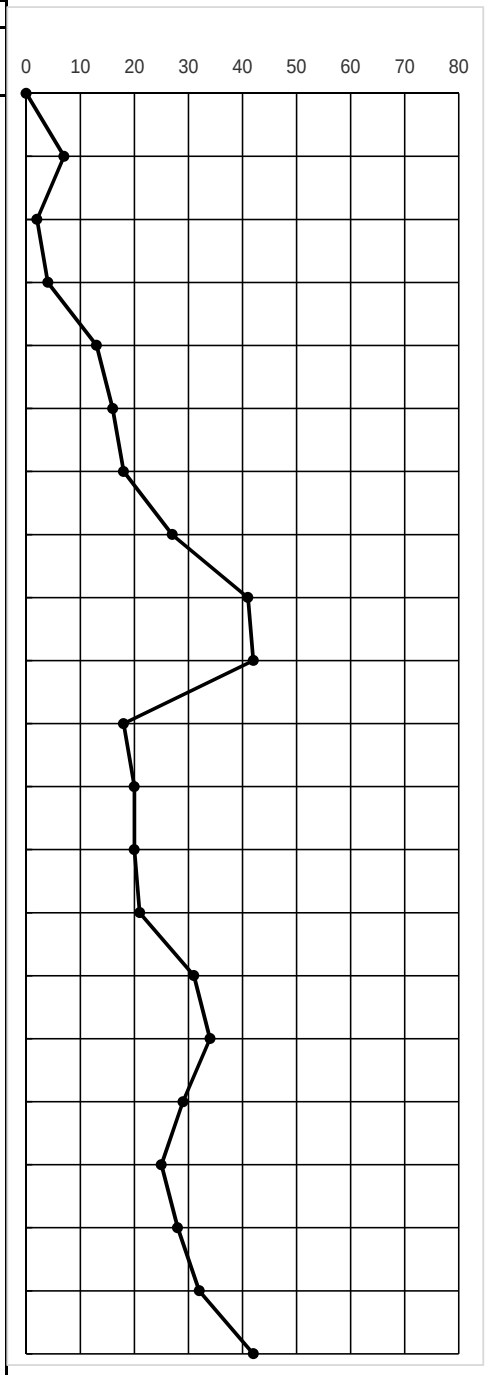
Client : Urban Development Directorate (UDD)
Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location : Dhankhola Govt. primary school, Near Dhankhola union complex, Dhankhola Bazar

Legend: Clay, Silt, Sand

Coordinates Lat-23.79047 Long-88.76714

Depth (m)	Visual Description	Symbols	Sample	Layer Number	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Brown very soft to medium stiff CLAY			1	3.0	2	3	4	7
3.0						1	1	1	2
4.5	Light brown loose to medium dense very fine to fine SAND with silt			2	4.5	1	2	2	4
6.0						3	5	8	13
7.5						5	7	9	16
9.0						5	8	10	18
10.5						7	12	15	27
12.0						7	18	23	41
13.5						8	18	24	42
15.0						4	8	10	18
16.5						5	9	11	20
18.0	Light brown to Light grey medium dense to dense fine to medium SAND with trace silt			4	22.5	7	7	13	20
19.5						7	8	13	21
21.0						8	13	18	31
22.5						8	15	19	34
24.0						8	12	17	29
25.5						7	10	15	25
27.0						8	11	17	28
28.5						10	14	18	32
30.0	End of Boring					11	16	26	42

SPT blows per 0.3 m penetration



Disturbed Sample(Split Spoon)
Undisturbed Sample(Shelby Tube)
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6

GEOTECHNICAL BOREHOLE LOG

Bore hole No: BH-07
Method of Boring: Percussion
Boring Dia.:100(mm)
Boring Depth: 30.0m

Exixting ground level: 17.62
Ground water level: 0.61m below EGL
Started on: 20.01.2016
Completed on: 20.01.2016

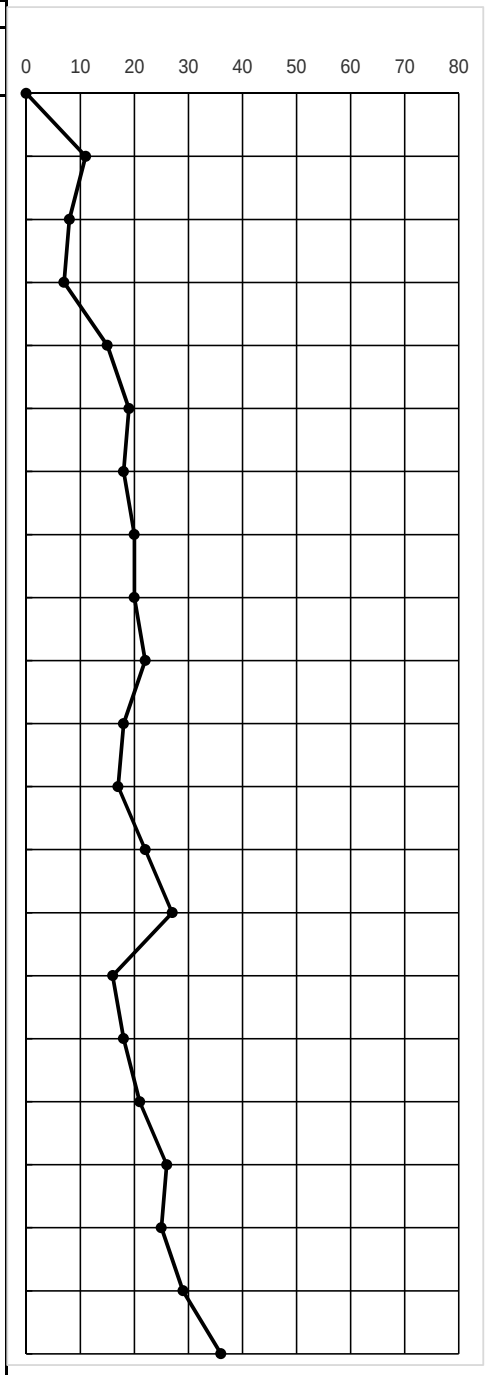
Client : Urban Development Directorate (UDD)
Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location : Bashbari Madhamik School field, Gangni Pourashava

Legend: Clay, Silt, Sand

Coordinates Lat-23.81105 Long-88.73187

Depth (m)	Visual Description	Symbols	Sample	Layer Number	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Light Grey loose to medium dense fine SAND little silt			2	10.5	3	5	6	11
3.0						4	4	4	8
4.5						3	3	4	7
6.0						4	5	10	15
7.5						5	7	12	19
9.0						3	8	10	18
10.5						4	8	12	20
12.0	Light Grey medium dense medium to fine SAND			4	19.5	5	8	12	20
13.5						6	9	13	22
15.0						5	8	10	18
16.5						5	7	10	17
18.0						6	10	12	22
19.5						7	13	14	27
21.0						6	8	8	16
22.5						6	8	10	18
24.0						6	9	12	21
25.5						7	11	15	26
27.0						8	10	15	25
28.5						8	13	16	29
30.0	End of Boring					10	16	20	36

SPT blows per 0.3 m penetration



Disturbed Sample(Split Spoon)
Undisturbed Sample(Shelby Tube)
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6

GEOTECHNICAL BOREHOLE LOG

Bore hole No: BH-8
Method of Boring: Percussion
Boring Dia.:100(mm)
Boring Depth: 30.0m

Exixting ground level: 17.44
Ground water level: 2.74m below EGL
Started on: 24.01.2016
Completed on: 24.01.2016

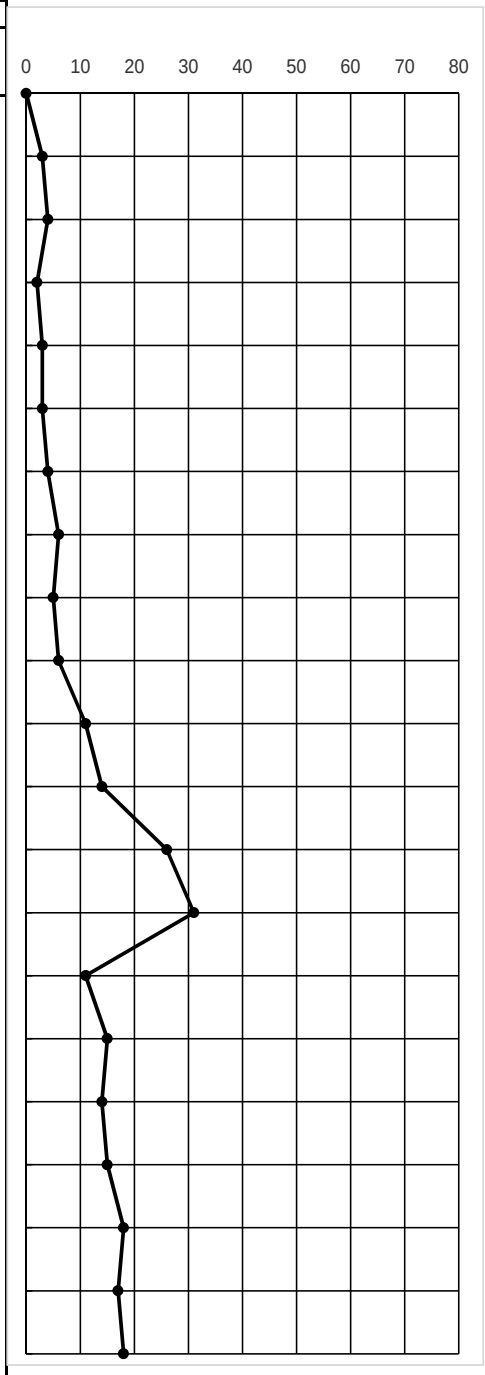
Client : Urban Development Directorate (UDD)
Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location : Chadpur govt. primary school, Chadpur, Roypur union

Legend: Clay, Silt, Sand

Coordinates Lat-23.8164 Long-23.8164

Depth (m)	Visual Description	Symbols	Sample	Layer Number	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Light Brown to Gray very soft to soft SILT with trace of very fine sand			1	6.0	1	1	2	3
3.0						1	2	2	4
4.5						1	1	1	2
6.0						1	1	2	3
7.5	Gray very loose to loose very fine to fine SAND trace silt			2	4.5	1	1	2	3
9.0						2	2	2	4
10.5						2	2	4	6
12.0	Gray medium stiff to stiff CLAY			3	6.0	2	2	3	5
13.5						2	3	3	6
15.0						3	5	6	11
16.5	Gray medium dense to dense medium to fine SAND			4	3.0	4	6	8	14
18.0						6	10	16	26
19.5						7	12	19	31
21.0	Gray stiff CLAY			5	10.5	4	6	5	11
22.5						4	7	8	15
24.0						3	7	7	14
25.5						3	7	8	15
27.0						4	8	10	18
28.5						5	8	9	17
30.0	End of Boring					6	8	10	18

SPT blows per 0.3 m penetration



Disturbed Sample(Split Spoon)
Undisturbed Sample(Shelby Tube)
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6

GEOTECHNICAL BOREHOLE LOG

Bore hole No: BH-10
Method of Boring: Percussion
Boring Dia.:100(mm)
Boring Depth: 30.0m

Exixting ground level: 18.79
Ground water level: 3.05m below EGL
Started on: 19.01.2016
Completed on: 19.01.2016

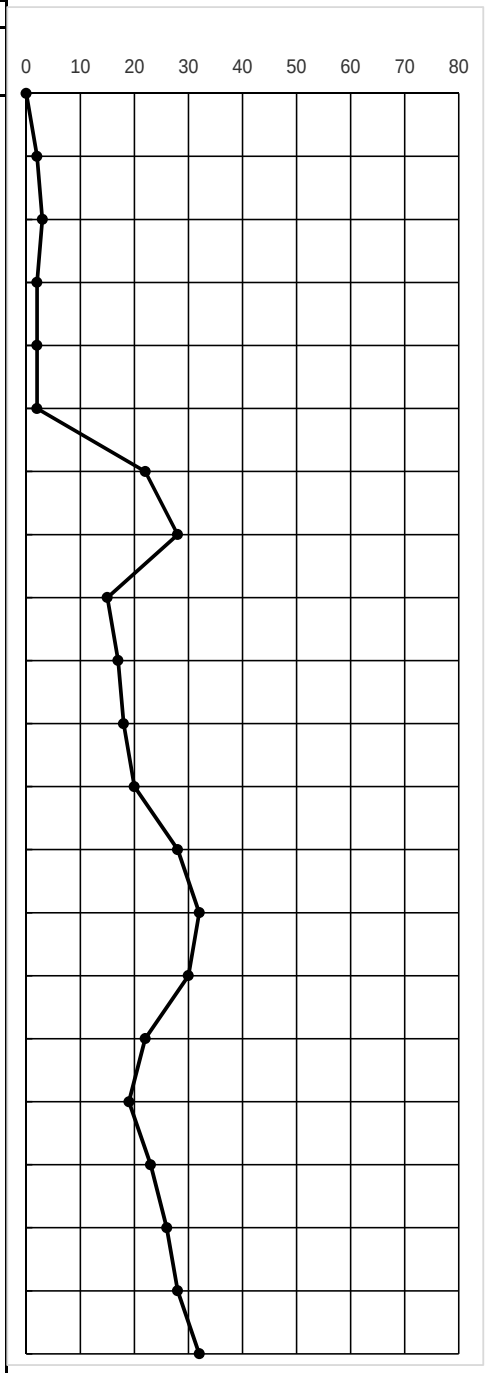
Client : Urban Development Directorate (UDD)
Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location : Chougacha Parchim para Govt. primary school, Gangni Pourashava

Legend: Clay, Silt, Sand

Coordinates Lat-23.82609 Long-88.7326

SPT blows per 0.3 m penetration

Depth (m)	Visual Description	Symbols	Sample	Layer Number	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Light Brown very soft to soft SILT with very fine sand			1	8.0	1	1	1	2
3.0						1	1	2	3
4.5						1	1	1	2
6.0						1	1	1	2
7.5						1	1	1	2
9.0	Light Gray medium dense fine SAND			2	10.0	6	10	12	22
10.5						7	12	16	28
12.0						4	5	10	15
13.5						5	7	10	17
15.0						5	8	10	18
16.5						6	10	10	20
18.0	Light Gray medium dense to dense medium to fine SAND			4	12.0	8	12	16	28
19.5						10	14	18	32
21.0						9	15	15	30
22.5						4	10	12	22
24.0						6	8	11	19
25.5						7	10	13	23
27.0						8	12	14	26
28.5						10	13	15	28
30.0	End of Boring					10	14	18	32



Disturbed Sample(Split Spoon)
Undisturbed Sample(Shelby Tube)
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6

GEOTECHNICAL BOREHOLE LOG

Bore hole No: BH-11
Method of Boring: Percussion
Boring Dia.:100(mm)
Boring Depth: 30.0m

Exixting ground level: 19.06
Ground water level: 4.27m below EGL
Started on: 20.01.2016
Completed on: 20.01.2016

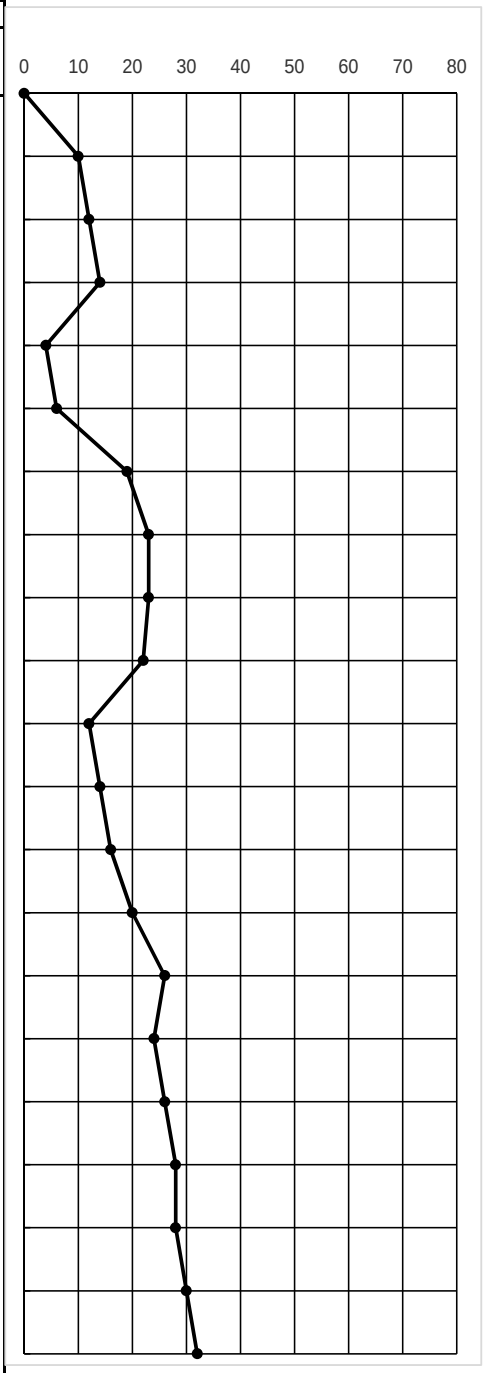
Client : Urban Development Directorate (UDD)
Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location : Gangni Pilot Girls school, Gangni Pourashava

Legend: Clay, Silt, Sand

Coordinates Lat-23.81835 Long-88.74858

Depth (m)	Visual Description	Symbols	Sample	Layer Number	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Light Gray loose to medium dense fine to medium SAND			2	13.5	3	4	6	10
3.0						4	5	7	12
4.5						4	7	7	14
6.0						2	2	2	4
7.5						2	3	3	6
9.0						4	8	11	19
10.5						5	10	13	23
12.0						9	12	11	23
13.5						7	10	12	22
15.0	Light Gray medium dense to dense medium to fine SAND			4	16.5	3	5	7	12
16.5						4	6	8	14
18.0						5	7	9	16
19.5						6	10	10	20
21.0						7	12	14	26
22.5						6	10	14	24
24.0						7	11	15	26
25.5						8	12	16	28
27.0						9	13	15	28
28.5						10	15	15	30
30.0	End of Boring					10	14	18	32

SPT blows per 0.3 m penetration



Disturbed Sample(Split Spoon)
Undisturbed Sample(Shelby Tube)
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6

GEOTECHNICAL BOREHOLE LOG

Bore hole No: BH-12
Method of Boring: Percussion
Boring Dia.:100(mm)
Boring Depth: 30.0m

Exixting ground level: 16.41
Ground water level: 3.05m below EGL
Started on: 25.01.2016
Completed on: 25.01.2016

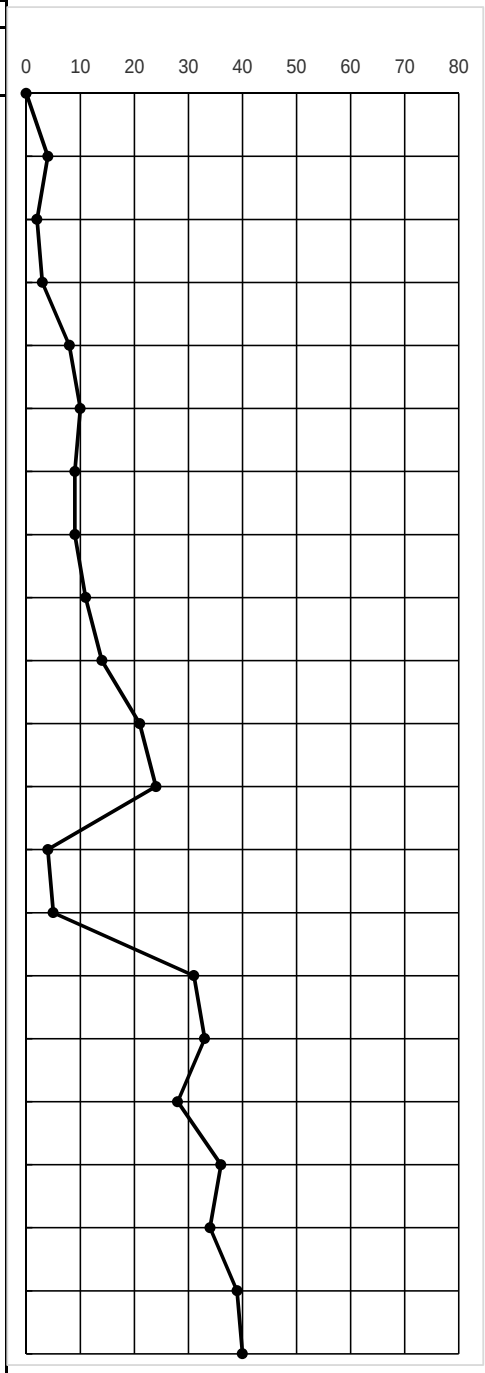
Client : Urban Development Directorate (UDD)
Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location : Gojaria Hamayetpur, Roypur Union

Legend: Clay, Silt, Sand

Coordinates Lat-23.82847 Long-88.84534

Depth (m)	Visual Description	Symbols	Sample	Layer Number	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Dark Gray soft SILT with sand			1	2.0	1	2	2	4
3.0						1	1	1	2
4.5						1	1	2	3
6.0						2	3	5	8
7.5						3	5	5	10
9.0	Brown to Light Gray loose to medium dense very fine to fine SAND with silt			2	14.5	3	4	5	9
10.5						3	4	5	9
12.0						4	5	6	11
13.5						5	7	7	14
15.0						7	10	11	21
16.5						8	11	13	24
18.0	Gray soft to medium stiff SILT with little sand			3	3.5	1	2	2	4
19.5						2	2	3	5
21.0	Gray dense medium to fine SAND			4	10.0	10	13	18	31
22.5						10	15	18	33
24.0						10	13	15	28
25.5						10	16	20	36
27.0						11	16	18	34
28.5						11	18	21	39
30.0	End of Boring					11	17	23	40

SPT blows per 0.3 m penetration



Disturbed Sample(Split Spoon)
Undisturbed Sample(Shelby Tube)
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6

GEOTECHNICAL BOREHOLE LOG

Bore hole No: BH-13
Method of Boring: Percussion
Boring Dia.:100(mm)
Boring Depth: 30.0m

Exixting ground level: 16.56
Ground water level: 2.74m below EGL
Started on: 24.01.2016
Completed on: 24.01.2016

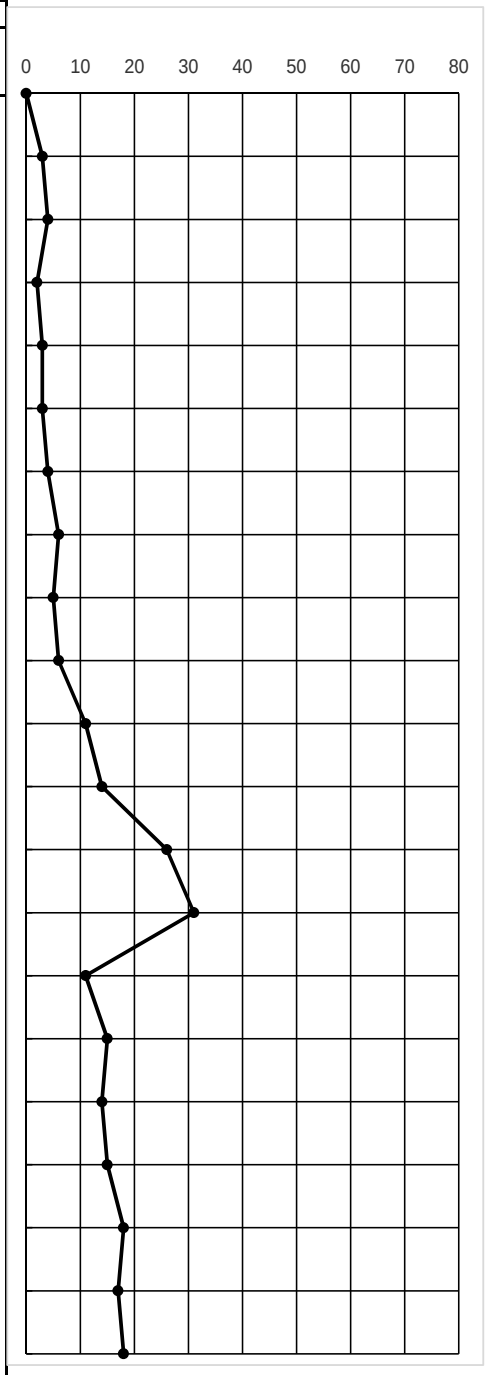
Client : Urban Development Directorate (UDD)
Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location : Ekuria Eid gha Mat, Roypur Union

Legend: Clay, Silt, Sand

Coordinates Lat-23.82508 Long-88.81804

Depth (m)	Visual Description	Symbols	Sample	Layer Number	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Light Brown to Gray very soft to soft SILT with trace of very fine sand			1	6.0	1	1	2	3
3.0						1	2	2	4
4.5						1	1	1	2
6.0						1	1	2	3
7.5	Gray very loose to loose very fine to fine SAND trace silt			2	4.5	1	1	2	3
9.0						2	2	2	4
10.5						2	2	4	6
12.0	Gray medium stiff to stiff CLAY			3	6.0	2	2	3	5
13.5						2	3	3	6
15.0						3	5	6	11
16.5	Gray medium dense to dense medium to fine SAND			4	3.0	4	6	8	14
18.0						6	10	16	26
19.5						7	12	19	31
21.0	Gray stiff CLAY			5	10.5	4	6	5	11
22.5						4	7	8	15
24.0						3	7	7	14
25.5						3	7	8	15
27.0						4	8	10	18
28.5						5	8	9	17
30.0	End of Boring					6	8	10	18

SPT blows per 0.3 m penetration



Disturbed Sample(Split Spoon)
Undisturbed Sample(Shelby Tube)
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6

GEOTECHNICAL BOREHOLE LOG

Bore hole No: BH-14
Method of Boring: Percussion
Boring Dia.:100(mm)
Boring Depth: 30.0m

Exixting ground level: 17.42
Ground water level: 4.27m below EGL
Started on: 25.01.2016
Completed on: 25.01.2016

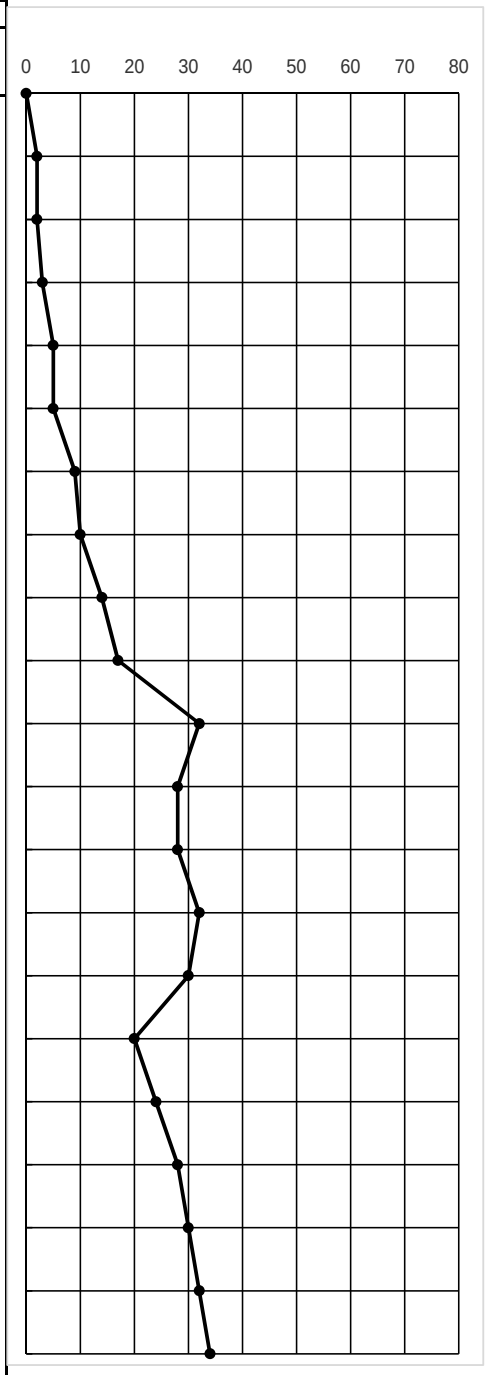
Client : Urban Development Directorate (UDD)
Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location : Roypur high school, Roypur Bazar, Roypur Union

Legend: Clay, Silt, Sand

Coordinates Lat-23.82355 Long-88.79932

Depth (m)	Visual Description	Symbols	Sample	Layer Number	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Brown to Gray very soft to medium stiff silty CLAY			1	10.5	1	1	1	2
3.0						1	1	1	2
4.5						1	1	2	3
6.0						1	2	3	5
7.5						2	2	3	5
9.0						3	4	5	9
10.5						3	4	6	10
12.0	Gray medium dense very fine SAND with silt			2	3.0	4	6	8	14
13.5						5	7	10	17
15.0	Gray medium dense to dense medium to fine SAND trace silt			4	16.5	8	12	20	32
16.5						8	13	15	28
18.0						7	12	16	28
19.5						7	15	17	32
21.0						8	14	16	30
22.5						5	8	12	20
24.0						6	10	14	24
25.5						7	12	16	28
27.0						8	13	17	30
28.5						8	14	18	32
30.0	End of Boring					10	16	18	34

SPT blows per 0.3 m penetration



Disturbed Sample(Split Spoon)
Undisturbed Sample(Shelby Tube)
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6

GEOTECHNICAL BOREHOLE LOG

Bore hole No: BH-15
Method of Boring: Percussion
Boring Dia.:100(mm)
Boring Depth: 30.0m

Exixting ground level: 17.68
Ground water level: 3.35m below EGL
Started on: 22.01.2016
Completed on: 22.01.2016

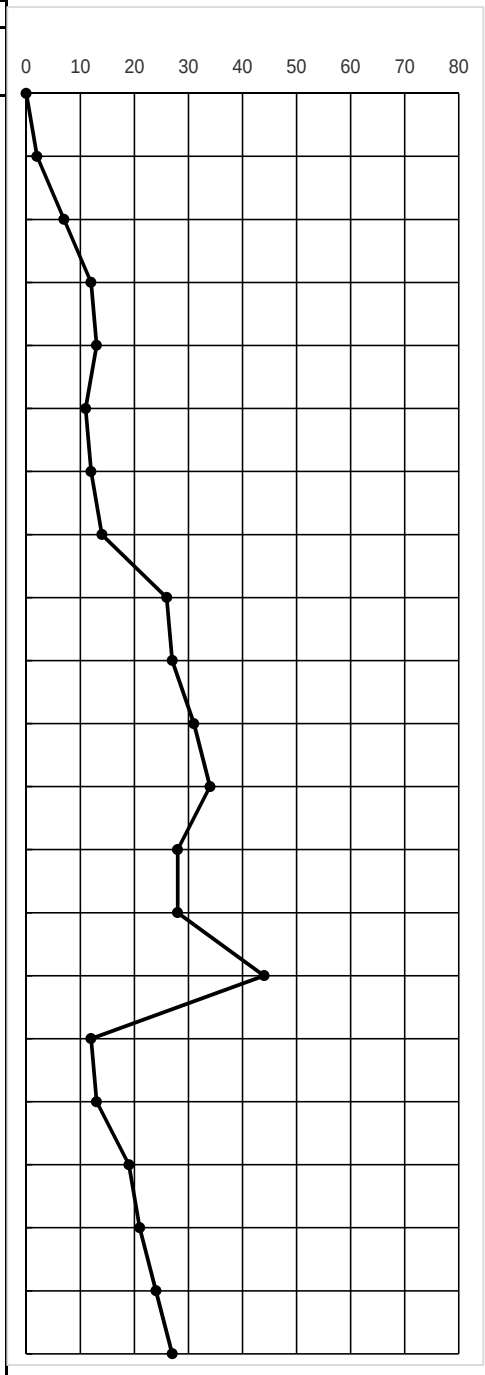
Client : Urban Development Directorate (UDD)
Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location : Lutfarnessa Nimno Madhamik School, Gopalnagar, Roypur Union

Legend: Clay, Silt, Sand

Coordinates Lat-23.828636 Long-88.777977

Depth (m)	Visual Description	Symbols	Sample	Layer Number	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Brownish Gray very soft SILT trace sand			1	2.0	1	1	1	2
3.0						2	3	4	7
4.5						4	5	7	12
6.0						6	8	5	13
7.5						4	5	6	11
9.0						2	4	8	12
10.5						3	5	9	14
12.0	Brown to Gray medium dense to dense fine to medium SAND			2	19.4	8	12	14	26
13.5						8	11	16	27
15.0						10	14	17	31
16.5						10	16	18	34
18.0						8	13	15	28
19.5						8	12	16	28
21.0						12	20	24	44
22.5	Brown stiff to very stiff SILT with same sand			3	5.6	5	5	7	12
24.0						5	6	7	13
25.5						5	9	10	19
27.0						7	9	12	21
28.5	Brown medium dense medium to fine SAND with some silt			4	3.0	8	10	14	24
30.0	End of Boring					8	11	16	27

SPT blows per 0.3 m penetration



Disturbed Sample(Split Spoon)
Undisturbed Sample(Shelby Tube)
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6

GEOTECHNICAL BOREHOLE LOG

Bore hole No: BH-16
Method of Boring: Percussion
Boring Dia.:100(mm)
Boring Depth: 30.0m

Exixting ground level: 17
Ground water level: 3.66m below EGL
Started on: 18.01.2016
Completed on: 18.01.2016

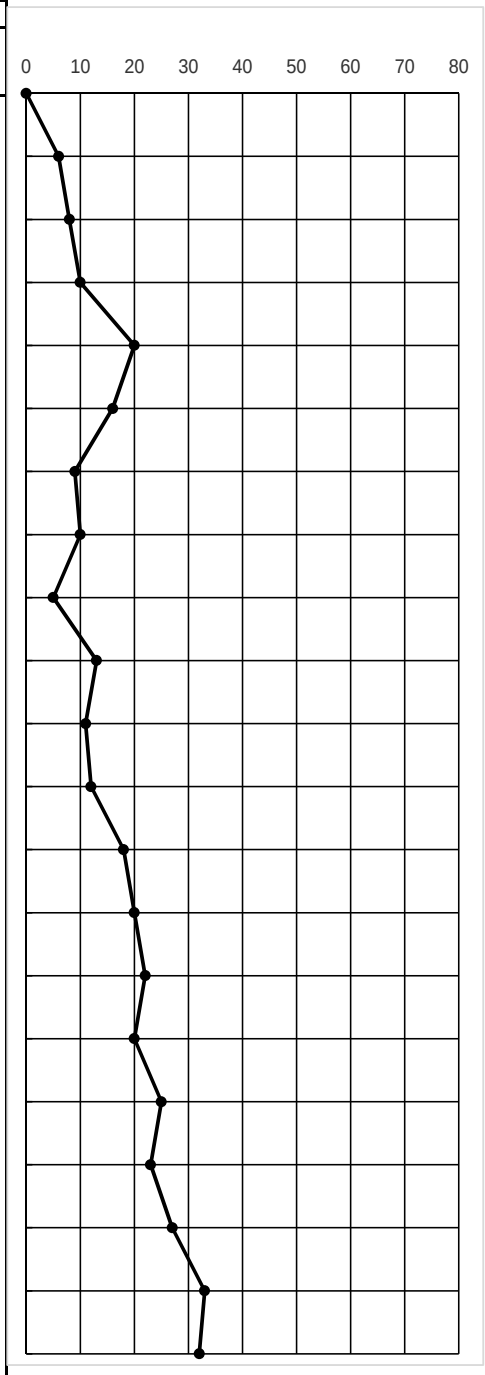
Client : Urban Development Directorate (UDD)
Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location : Shaharbati Govt. primary school, Charchara Bazar, Shaharbati Union

Legend: Clay, Silt, Sand

Coordinates Lat-23.83142 Long-88.71098

Depth (m)	Visual Description	Symbols	Sample	Layer Number	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Light Gray loose to medium dense fine to medium SAND			2	12.6	2	2	4	6
3.0						2	3	5	8
4.5						2	4	6	10
6.0						6	10	10	20
7.5						5	6	10	16
9.0						3	4	5	9
10.5						3	4	6	10
12.0						2	2	3	5
13.5	Light Gray medium dense to dense medium to fine SAND			4	17.4	3	5	8	13
15.0						3	5	6	11
16.5						3	5	7	12
18.0						6	8	10	18
19.5						7	8	12	20
21.0						8	10	12	22
22.5						7	8	12	20
24.0						7	10	15	25
25.5						7	10	13	23
27.0						7	12	15	27
28.5						8	15	18	33
30.0	End of Boring					10	16	16	32

SPT blows per 0.3 m penetration



Disturbed Sample(Split Spoon)
Undisturbed Sample(Shelby Tube)
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6

GEOTECHNICAL BOREHOLE LOG

Bore hole No: BH-17
Method of Boring: Percussion
Boring Dia.:100(mm)
Boring Depth: 30.0m

Exixting ground level: 17.43
Ground water level: 2.44m below EGL
Started on: 22.01.2016
Completed on: 22.01.2016

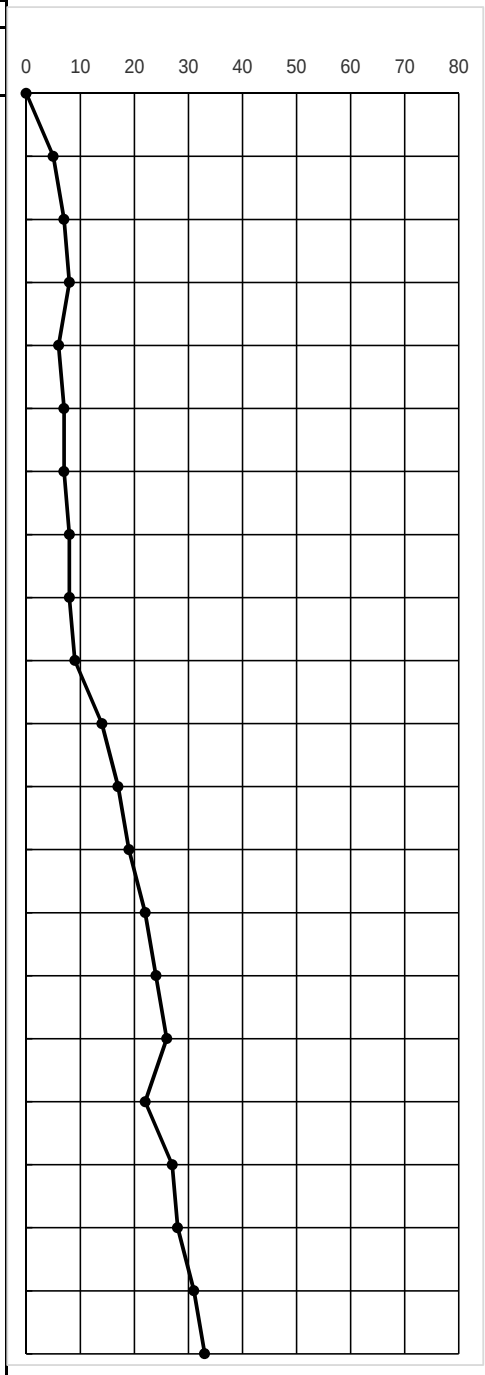
Client : Urban Development Directorate (UDD)
Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location : Juger gofa Govt. primary school, Shola taka Union

Legend: Clay, Silt, Sand

Coordinates Lat-23.84463 Long-88.81038

Depth (m)	Visual Description	Symbols	Sample	Layer Number	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Brown loose very fine to fine SAND with silt			2	4.5	2	2	3	5
3.0						2	3	4	7
4.5						3	4	4	8
6.0	Light Gray to Light Brown medium stiff SILT trace sand			3	9.0	2	2	4	6
7.5						2	3	4	7
9.0						2	3	4	7
10.5						3	4	4	8
12.0						3	4	4	8
13.5						3	4	5	9
15.0	Dark Gray to Gray medium dense to dense very fine to medium SAND			4	16.5	4	6	8	14
16.5						5	7	10	17
18.0						5	8	11	19
19.5						7	10	12	22
21.0						7	10	14	24
22.5						8	12	14	26
24.0						7	10	12	22
25.5						7	12	15	27
27.0						8	13	15	28
28.5						8	15	16	31
30.0	End of Boring					10	15	18	33

SPT blows per 0.3 m penetration



Disturbed Sample(Split Spoon)
Undisturbed Sample(Shelby Tube)
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6

GEOTECHNICAL BOREHOLE LOG

Bore hole No: BH-18
Method of Boring: Percussion
Boring Dia.:100(mm)
Boring Depth: 30.0m

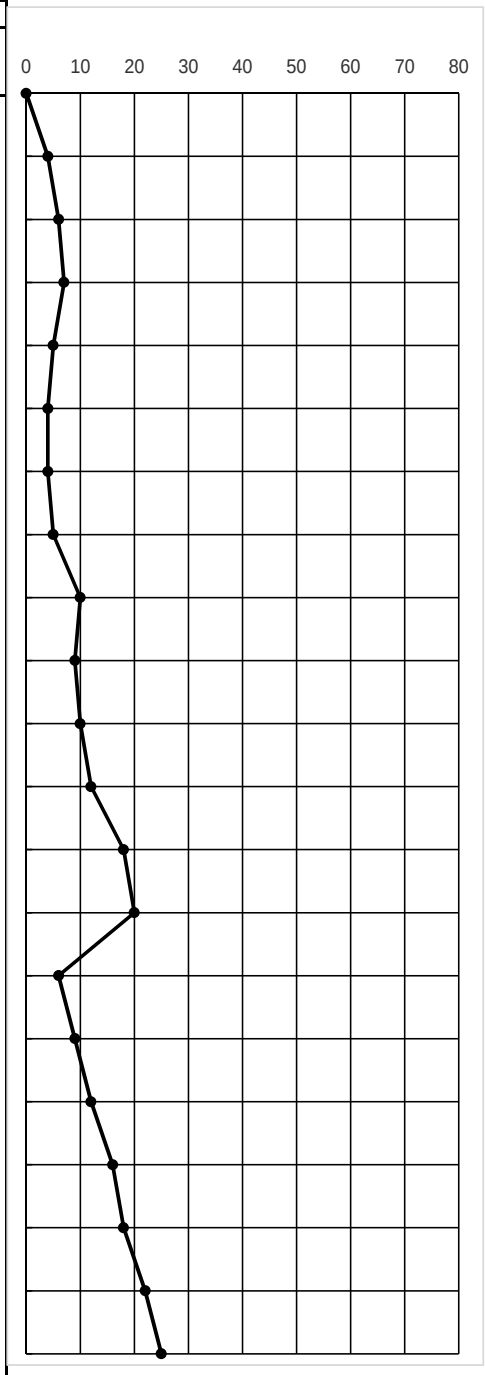
Exixting ground level: 17.01
Ground water level: 2.44m below EGL
Started on: 21.01.2016
Completed on: 21.01.2016

Client : Urban Development Directorate (UDD)
Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location : Vill- Changara, Chok Tolar mor, Shola taka Union

Legend: Clay, Silt, Sand
Coordinates Lat-23.84709 Long-88.76802

Depth (m)	Visual Description	Symbols	Sample	Layer Number	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Brown to Drak Gray very loose to medium dense very fine to fine SAND with silt			2	19.5	1	2	2	4
3.0						2	3	3	6
4.5						2	3	4	7
6.0						2	2	3	5
7.5						2	2	2	4
9.0						2	2	2	4
10.5						2	2	3	5
12.0						3	5	5	10
13.5						2	4	5	9
15.0						3	4	6	10
16.5						3	5	7	12
18.0						5	8	10	18
19.5	Gray medium stiff to stiff CLAY			3	4.5	6	9	11	20
21.0						3	3	3	6
22.5						3	4	5	9
24.0	Light Gray medium dense medium to fine SAND			4	6.0	4	5	7	12
25.5						5	7	9	16
27.0						6	8	10	18
28.5						7	10	12	22
30.0	End of Boring					8	12	13	25

SPT blows per 0.3 m penetration



Disturbed Sample(Split Spoon)
Undisturbed Sample(Shelby Tube)
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6

GEOTECHNICAL BOREHOLE LOG

Bore hole No: BH-19
Method of Boring: Percussion
Boring Dia.:100(mm)
Boring Depth: 30.0m

Exixting ground level: 22.02
Ground water level: 4.57m below EGL
Started on: 19.01.2016
Completed on: 19.01.2016

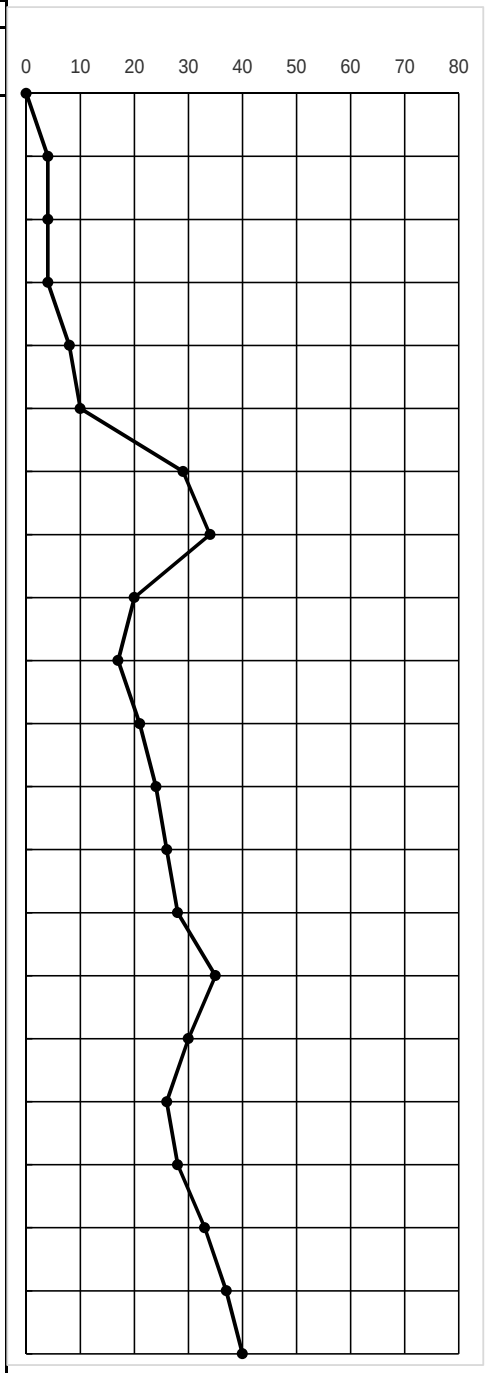
Client : Urban Development Directorate (UDD)
Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location : Kutubpur School and College, Garabaria, Kathuli Union

Legend: Clay, Silt, Sand

Coordinates Lat-23.85518 Long-88.65115

Depth (m)	Visual Description	Symbols	Sample	Layer Number	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Brown soft to medium stiff SILT with very fine sand			1	8.0	2	2	2	4
3.0						1	2	2	4
4.5						1	2	2	4
6.0						2	3	5	8
7.5						3	4	6	10
9.0	Light Gray medium dense fine to medium SAND			2	5.5	7	10	19	29
10.5						8	14	20	34
12.0						6	8	12	20
13.5	Light Gray medium dense to dense medium to fine SAND			4	16.5	6	7	10	17
15.0						6	8	13	21
16.5						7	10	14	24
18.0						8	11	15	26
19.5						8	11	17	28
21.0						9	13	22	35
22.5						8	13	17	30
24.0						7	12	14	26
25.5						8	13	15	28
27.0						8	16	17	33
28.5						10	16	21	37
30.0	End of Boring					10	17	23	40

SPT blows per 0.3 m penetration



Disturbed Sample(Split Spoon)
Undisturbed Sample(Shelby Tube)
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6

GEOTECHNICAL BOREHOLE LOG

Bore hole No: BH-20
Method of Boring: Percussion
Boring Dia.:100(mm)
Boring Depth: 30.0m

Exixting ground level: 15.87
Ground water level: 3.66m below EGL
Started on: 13.01.2016
Completed on: 13.01.2016

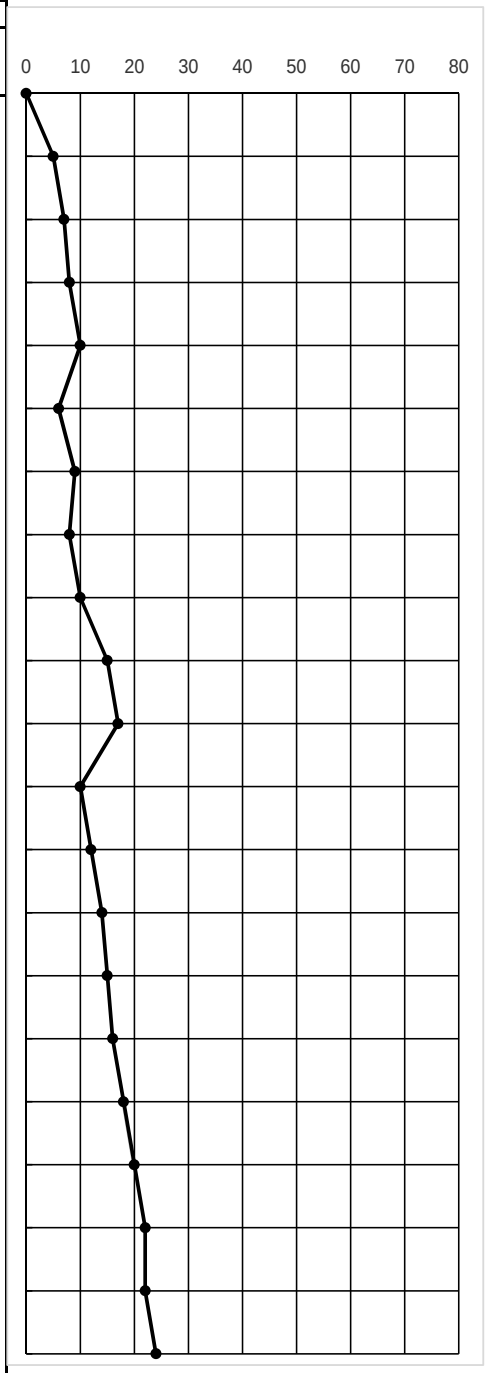
Client : Urban Development Directorate (UDD)
Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location : Kumaridanga High School, Kumaridanga, Matmura union

Legend: Clay, Silt, Sand

Coordinates Lat-23.86646 Long-88.85149

Depth (m)	Visual Description	Symbols	Sample	Layer Number	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Brown medium stiff SILT with very fine sand			1	4.5	2	2	3	5
3.0						2	3	4	7
4.5						2	3	5	8
6.0	Light Gray loose to medium dense fine to medium SAND			2	10.9	2	5	5	10
7.5						2	3	3	6
9.0						3	5	4	9
10.5						3	4	4	8
12.0						3	5	5	10
13.5						4	6	9	15
15.0						5	7	10	17
16.5	Light Gray medium dense medium to fine SAND			4	14.6	3	4	6	10
18.0						4	5	7	12
19.5						5	6	8	14
21.0						6	6	9	15
22.5						7	8	8	16
24.0						6	8	10	18
25.5						7	10	10	20
27.0						8	12	10	22
28.5						8	10	12	22
30.0						8	10	14	24
	End of Boring								

SPT blows per 0.3 m penetration



Disturbed Sample(Split Spoon)
Undisturbed Sample(Shelby Tube)
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6

GEOTECHNICAL BOREHOLE LOG

Bore hole No: BH-21
Method of Boring: Percussion
Boring Dia.:100(mm)
Boring Depth: 30.0m

Exixting ground level: 16.94
Ground water level: 3.05m below EGL
Started on: 14.01.2016
Completed on: 14.01.2016

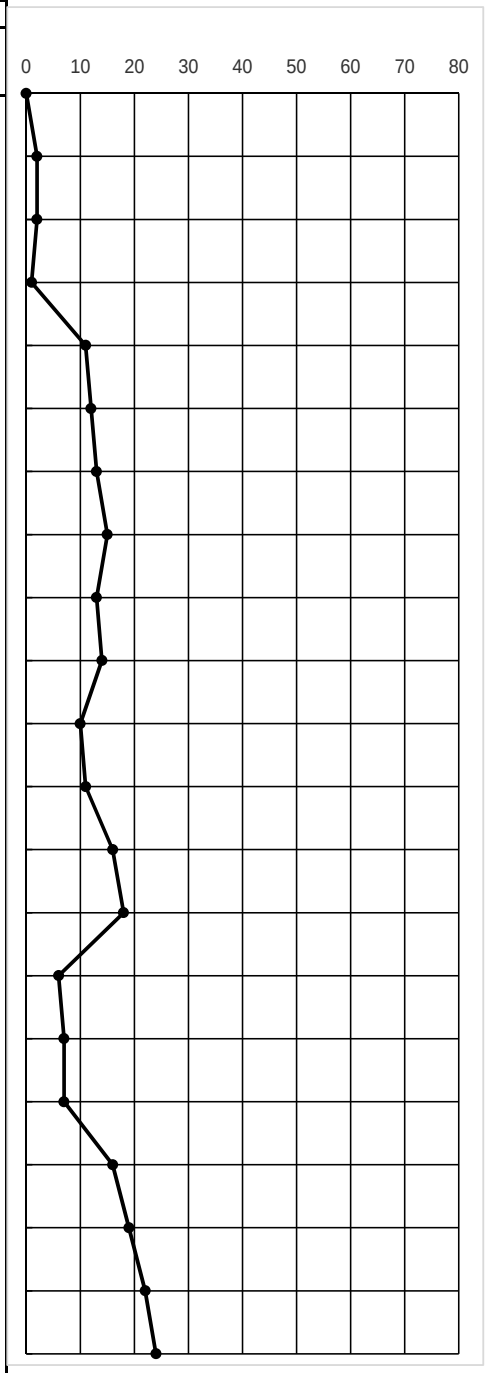
Client : Urban Development Directorate (UDD)
Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location : Olinagar Daskinpara Jame Moshjid, Bamandi Union

Legend: Clay, Silt, Sand

Coordinates Lat-23.87305 Long-88.78759

Depth (m)	Visual Description	Symbols	Sample	Layer Number	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Light Brown very soft SILT with very fine sand			1	5.0	1	1	1	2
3.0						1	1	1	2
4.5						1	0	1	1
6.0	Light Gray medium dense fine SAND			2	15.0	3	5	6	11
7.5						3	5	7	12
9.0						4	7	6	13
10.5						5	6	9	15
12.0						5	6	7	13
13.5						5	7	7	14
15.0						3	4	6	10
16.5						3	4	7	11
18.0						4	7	9	16
19.5						6	8	10	18
21.0	Ligth Gray medium stiff SILT with very fine sand			3	4.4	2	3	3	6
22.5						2	4	3	7
24.0						3	3	4	7
25.5	Light Gray medium dense medium to fine SAND			4	5.6	4	6	10	16
27.0						5	7	12	19
28.5						6	10	12	22
30.0	End of Boring					8	12	12	24

SPT blows per 0.3 m penetration



Disturbed Sample(Split Spoon)
Undisturbed Sample(Shelby Tube)
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6

GEOTECHNICAL BOREHOLE LOG

Bore hole No: BH-22
Method of Boring: Percussion
Boring Dia.:100(mm)
Boring Depth: 30.0m

Exixting ground level: 18.81
Ground water level: 3.05m below EGL
Started on: 17.01.2016
Completed on: 17.01.2016

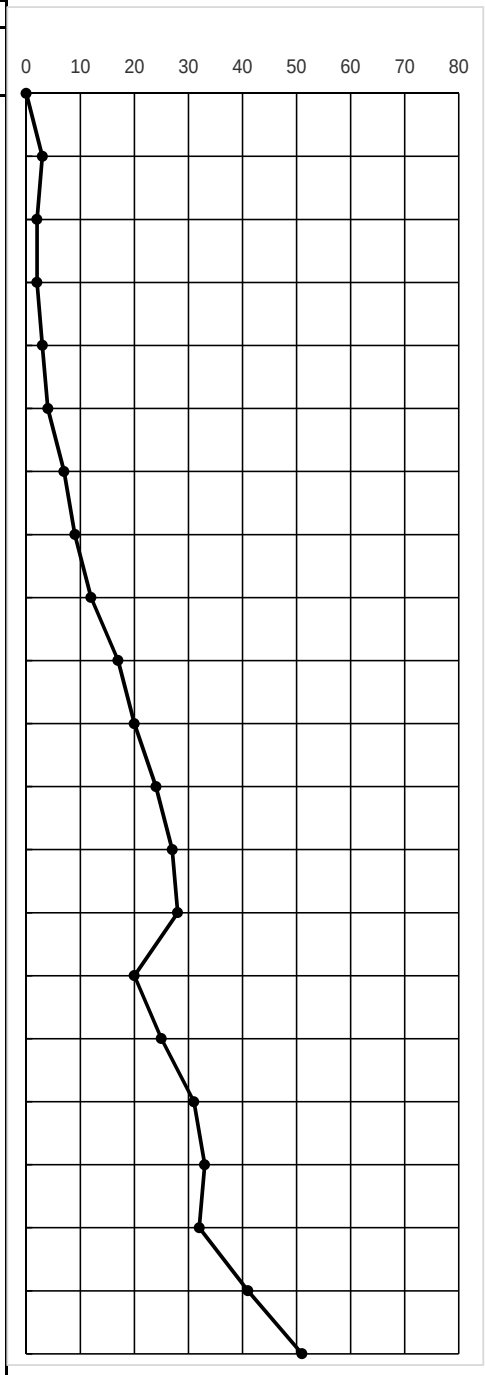
Client : Urban Development Directorate (UDD)
Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location : Shaharbati union complex

Legend: Clay, Silt, Sand

Coordinates Lat-23.85206 Long-88.73234

Depth (m)	Visual Description	Symbols	Sample	Layer Number	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Light Brown very soft to soft SILT with very fine sand			1	8.0	1	1	2	3
3.0						1	1	1	2
4.5						1	1	1	2
6.0						1	1	2	3
7.5						1	2	2	4
9.0	Light Gray loose to medium dense fine SAND			2	8.5	2	3	4	7
10.5						3	4	5	9
12.0						4	5	7	12
13.5						5	6	11	17
15.0						6	8	12	20
16.5	Light Gray medium dense to dense medium to fine SAND			4	13.5	7	10	14	24
18.0						8	12	15	27
19.5						9	12	16	28
21.0						6	9	11	20
22.5						8	11	14	25
24.0						10	14	17	31
25.5						9	13	20	33
27.0						10	14	18	32
28.5						11	17	24	41
30.0	End of Boring					12	19	32	51

SPT blows per 0.3 m penetration



Disturbed Sample(Split Spoon)
Undisturbed Sample(Shelby Tube)
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6

GEOTECHNICAL BOREHOLE LOG

Bore hole No: BH-23
Method of Boring: Percussion
Boring Dia.:100(mm)
Boring Depth: 30.0m

Exixting ground level: 17.81
Ground water level: 2.13m below EGL
Started on: 18.01.2016
Completed on: 18.01.2016

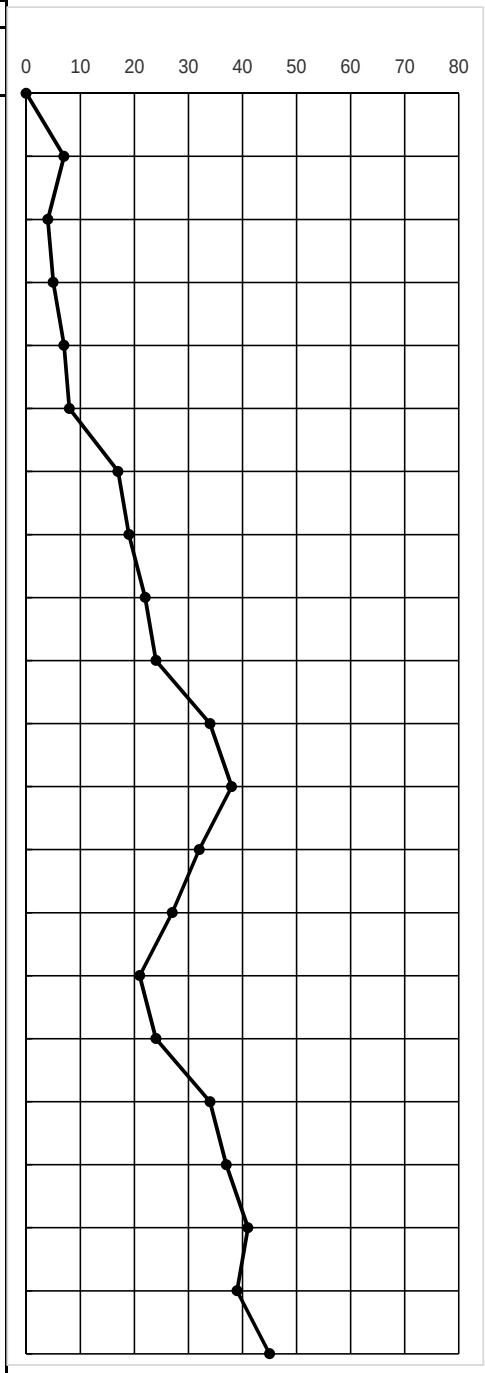
Client : Urban Development Directorate (UDD)
Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location : Radhagobindhopur Dhola Govt. Primary School, Kathuli Union

Legend: Clay, Silt, Sand

Coordinates Lat-23.87088 Long-88.67374

Depth (m)	Visual Description	Symbols	Sample	Layer Number	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Light Brown soft to medium stiff SILT with very fine sand			1	8.0	1	3	4	7
3.0						2	2	2	4
4.5						1	2	3	5
6.0						2	3	4	7
7.5						2	4	4	8
9.0	Light Gray medium dense to dense fine SAND			2	8.5	5	7	10	17
10.5						6	7	12	19
12.0						10	10	12	22
13.5						8	11	13	24
15.0						7	14	20	34
16.5	Light Gray medium dense to dense medium to fine SAND			4	13.5	9	17	21	38
18.0						10	14	18	32
19.5						10	12	15	27
21.0						8	10	11	21
22.5						8	12	12	24
24.0						8	14	20	34
25.5						9	16	21	37
27.0						9	19	22	41
28.5						10	18	21	39
30.0	End of Boring					11	21	24	45

SPT blows per 0.3 m penetration



Disturbed Sample(Split Spoon)
Undisturbed Sample(Shelby Tube)
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6

GEOTECHNICAL BOREHOLE LOG

Bore hole No: BH-24
Method of Boring: Percussion
Boring Dia.:100(mm)
Boring Depth: 30.0m

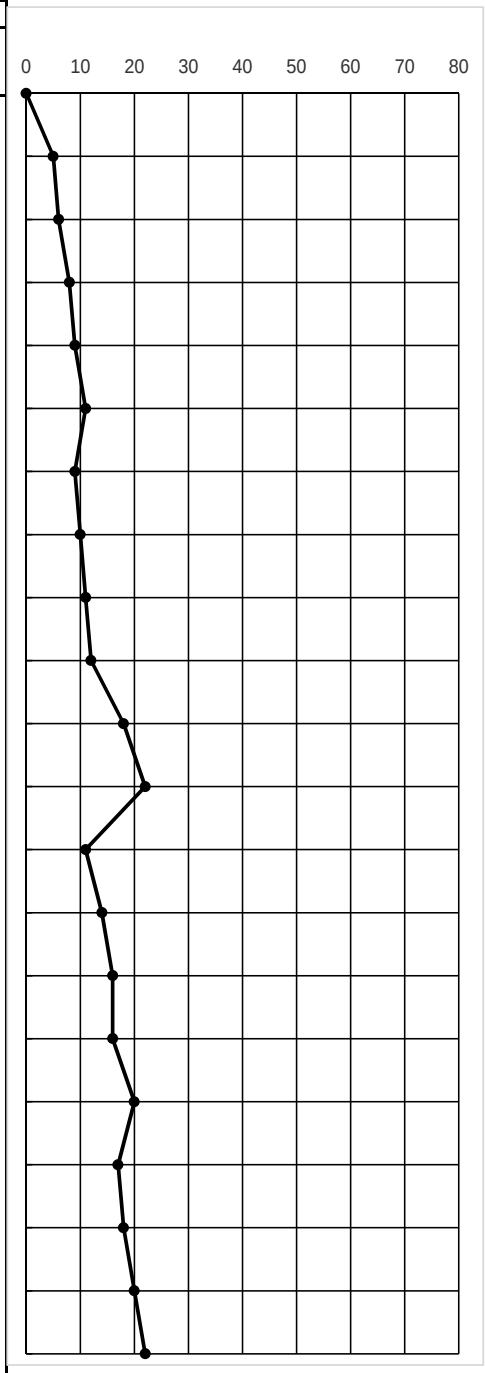
Exixting ground level: 17.05
Ground water level: 2.44m below EGL
Started on: 12.01.2016
Completed on: 12.01.2016

Client : Urban Development Directorate (UDD)
Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location : Village- Akubpur, Near Khalishakundi Bridge, matmura Union

Legend: Clay, Silt, Sand
Coordinates Lat-23.8935 Long-88.86416

Depth (m)	Visual Description	Symbols	Sample	Layer Number	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Light Brown medium stiff SILT with very fine sand			1	4.5	1	2	3	5
3.0						2	3	3	6
4.5						2	3	5	8
6.0	Light Gray medium dense fine SAND			2	7.5	2	3	6	9
7.5						3	4	7	11
9.0						3	4	5	9
10.5						4	4	6	10
12.0						4	5	6	11
13.5	Light Gray medium dense medium to fine SAND			4	18.0	4	6	6	12
15.0						5	8	10	18
16.5						6	10	12	22
18.0						4	5	6	11
19.5						5	6	8	14
21.0						6	7	9	16
22.5						7	9	7	16
24.0						7	10	10	20
25.5						5	7	10	17
27.0						6	8	10	18
28.5						7	10	10	20
30.0	End of Boring					8	10	12	22

SPT blows per 0.3 m penetration



Disturbed Sample(Split Spoon)
Undisturbed Sample(Shelby Tube)
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6

GEOTECHNICAL BOREHOLE LOG

Bore hole No: BH-25
Method of Boring: Percussion
Boring Dia.:100(mm)
Boring Depth: 30.0m

Exixting ground level: 18.19
Ground water level: 4.27m below EGL
Started on: 13.01.2016
Completed on: 13.01.2016

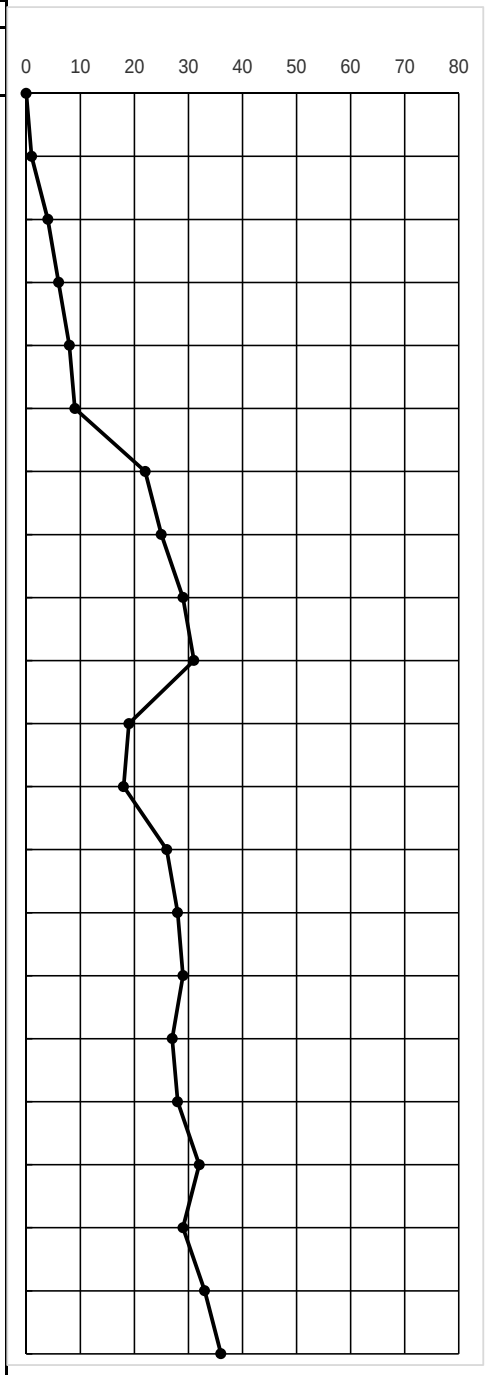
Client : Urban Development Directorate (UDD)
Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location : Bamandi Nishipur High School, Bamandi Bus stand, Bamandi Union

Legend: Clay, Silt, Sand

Coordinates Lat-23.88907 Long-88.80393

Depth (m)	Visual Description	Symbols	Sample	Layer Number	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Light Brown to Gray very soft to medium stiff SILT with very fine sand			1	6.0	1	0	1	1
3.0						2	1	3	4
4.5						2	3	3	6
6.0						2	3	5	8
7.5	Light Gray medium dense fine SAND			2	8.0	3	4	5	9
9.0						7	10	12	22
10.5						8	11	14	25
12.0						9	14	15	29
13.5						8	14	17	31
15.0	Light Gray medium dense to dense medium to fine SAND			4	16.0	6	9	10	19
16.5						6	8	10	18
18.0						7	10	16	26
19.5						7	12	16	28
21.0						8	12	17	29
22.5						8	11	16	27
24.0						7	10	18	28
25.5						8	13	19	32
27.0						8	12	17	29
28.5						8	13	20	33
30.0	End of Boring					10	15	21	36

SPT blows per 0.3 m penetration



Disturbed Sample(Split Spoon)
Undisturbed Sample(Shelby Tube)
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6

GEOTECHNICAL BOREHOLE LOG

Bore hole No: BH-26
Method of Boring: Percussion
Boring Dia.:100(mm)
Boring Depth: 30.0m

Exixting ground level: 17.33
Ground water level: 3.66m below EGL
Started on: 15.01.2016
Completed on: 15.01.2016

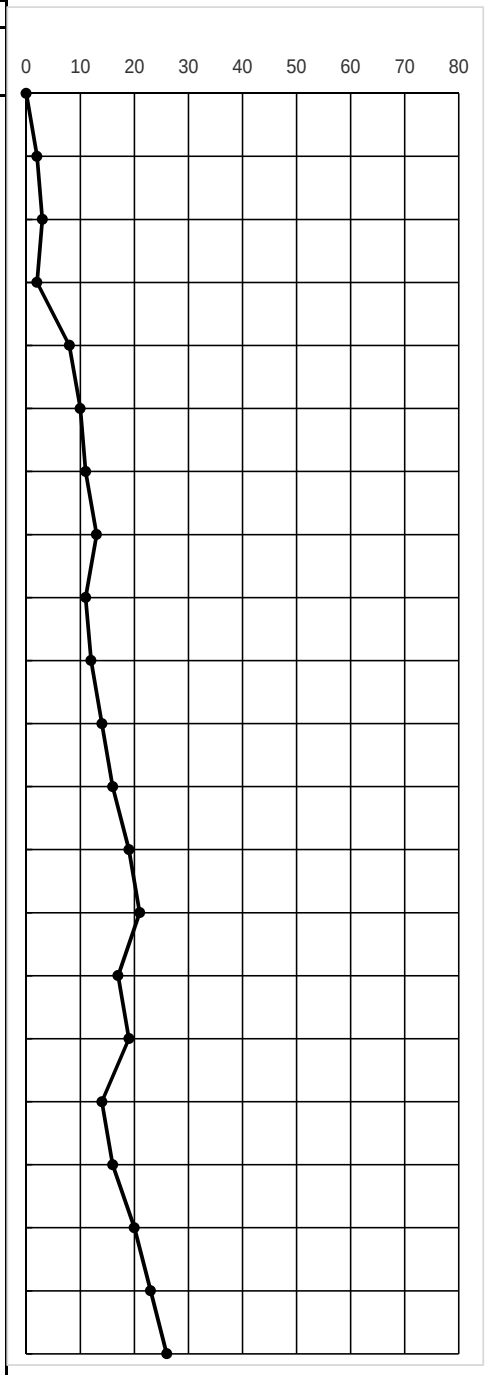
Client : Urban Development Directorate (UDD)
Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location : Kormodi Kumarpara jame Moshjid, Tentulbaria Union

Legend: Clay, Silt, Sand

Coordinates Lat-23.90297 Long-88.76061

Depth (m)	Visual Description	Symbols	Sample	Layer Number	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Light Browm very soft to soft SILT with very fine sand			1	5.0	1	1	1	2
3.0						1	1	2	3
4.5						1	1	1	2
6.0	Light Gray loose to medium dense fine SAND			2	5.5	2	3	5	8
7.5						3	4	6	10
9.0						4	5	6	11
10.5	Light Gray medium dense medium to fine SAND			4	19.5	4	5	8	13
12.0						3	5	6	11
13.5						3	6	6	12
15.0						5	6	8	14
16.5						5	7	9	16
18.0						5	9	10	19
19.5						6	9	12	21
21.0						5	7	10	17
22.5						6	7	12	19
24.0						5	7	7	14
25.5						6	6	10	16
27.0						7	10	10	20
28.5						7	10	13	23
30.0	End of Boring					8	12	14	26

SPT blows per 0.3 m penetration



Disturbed Sample(Split Spoon)
Undisturbed Sample(Shelby Tube)
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6

GEOTECHNICAL BOREHOLE LOG

Bore hole No: BH-27
Method of Boring: Percussion
Boring Dia.:100(mm)
Boring Depth: 30.0m

Exixting ground level: 16.63
Ground water level: 2.13m below EGL
Started on: 17.01.2016
Completed on: 17.01.2016

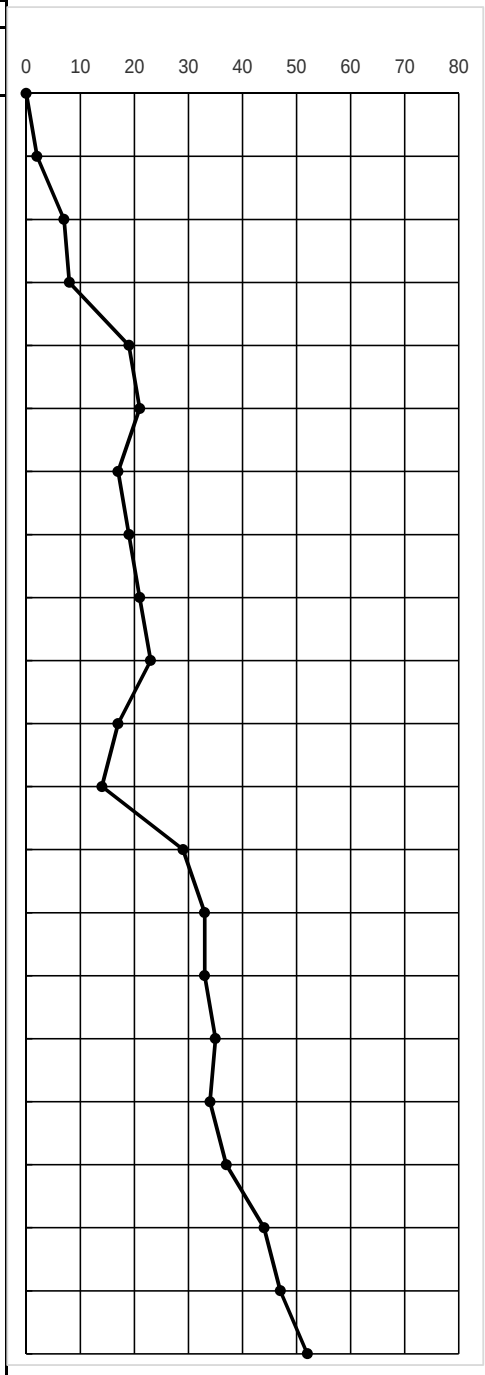
Client : Urban Development Directorate (UDD)
Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location : Tentulbaria Doyapara govt. primary school, Doyapara, Tentulbaria Union

Legend: Clay, Silt, Sand

Coordinates Lat-23.89365 Long-88.717

Depth (m)	Visual Description	Symbols	Sample	Layer Number	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Light Brown very soft to medium stiff SILT with very fine sand			1	4.5	1	1	1	2
3.0						2	3	4	7
4.5						3	3	5	8
6.0	Light Gray medium dense very fine to fine SAND			2	12.5	5	9	10	19
7.5						6	9	12	21
9.0						5	8	9	17
10.5						6	8	11	19
12.0						7	9	12	21
13.5						7	10	13	23
15.0						7	8	9	17
16.5						6	7	7	14
18.0	Light Gray medium dense to very dense medium to fine SAND			4	13.0	8	14	15	29
19.5						8	16	17	33
21.0						8	14	19	33
22.5						9	15	20	35
24.0						10	14	20	34
25.5						10	16	21	37
27.0						10	20	24	44
28.5						12	21	26	47
30.0	End of Boring					14	24	28	52

SPT blows per 0.3 m penetration



Disturbed Sample(Split Spoon)
Undisturbed Sample(Shelby Tube)
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6

GEOTECHNICAL BOREHOLE LOG

Bore hole No: BH-28
Method of Boring: Percussion
Boring Dia.:100(mm)
Boring Depth: 30.0m

Exixting ground level: 20.51
Ground water level: 3.35m below EGL
Started on: 12.01.2016
Completed on: 12.01.2016

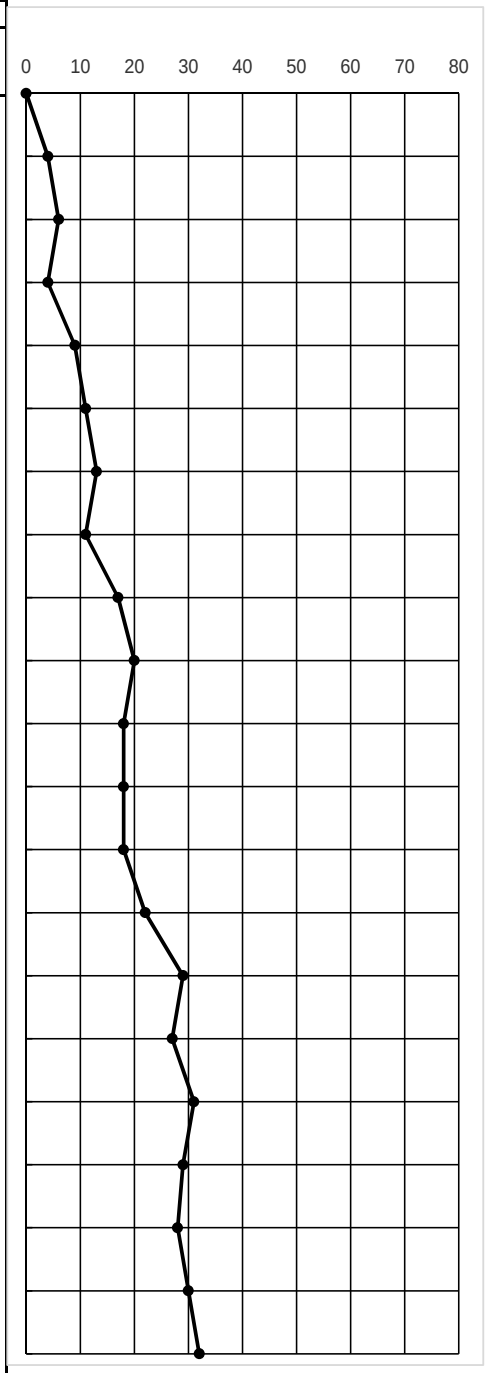
Client : Urban Development Directorate (UDD)
Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location : Mahamadhpur Hafizia Madrasha, Mahamadhpur Bazar, Matmura Union

Legend: Clay, Silt, Sand

Coordinates Lat-23.91934 Long-88.85344

Depth (m)	Visual Description	Symbols	Sample	Layer Number	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Light Brown soft to medium stiff SILT with very fine sand			1	4.5	1	2	2	4
3.0						2	3	3	6
4.5						1	1	3	4
6.0	Light Gray medium dense very fine SAND			2	6.5	2	4	5	9
7.5						3	5	6	11
9.0						4	6	7	13
10.5						5	5	6	11
12.0	Light Gray medium dense to dense medium to fine SAND			4	19.0	6	5	12	17
13.5						6	7	13	20
15.0						5	8	10	18
16.5						5	7	11	18
18.0						6	8	10	18
19.5						7	10	12	22
21.0						8	13	16	29
22.5						9	12	15	27
24.0						8	13	18	31
25.5						9	12	17	29
27.0						10	13	15	28
28.5						8	13	17	30
30.0	End of Boring					10	14	18	32

SPT blows per 0.3 m penetration



Disturbed Sample(Split Spoon)
Undisturbed Sample(Shelby Tube)
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6

GEOTECHNICAL BOREHOLE LOG

Bore hole No: BH-29
Method of Boring: Percussion
Boring Dia.:100(mm)
Boring Depth: 30.0m

Exixting ground level: 22.12
Ground water level: 5.79m below EGL
Started on: 14.01.2016
Completed on: 14.01.2016

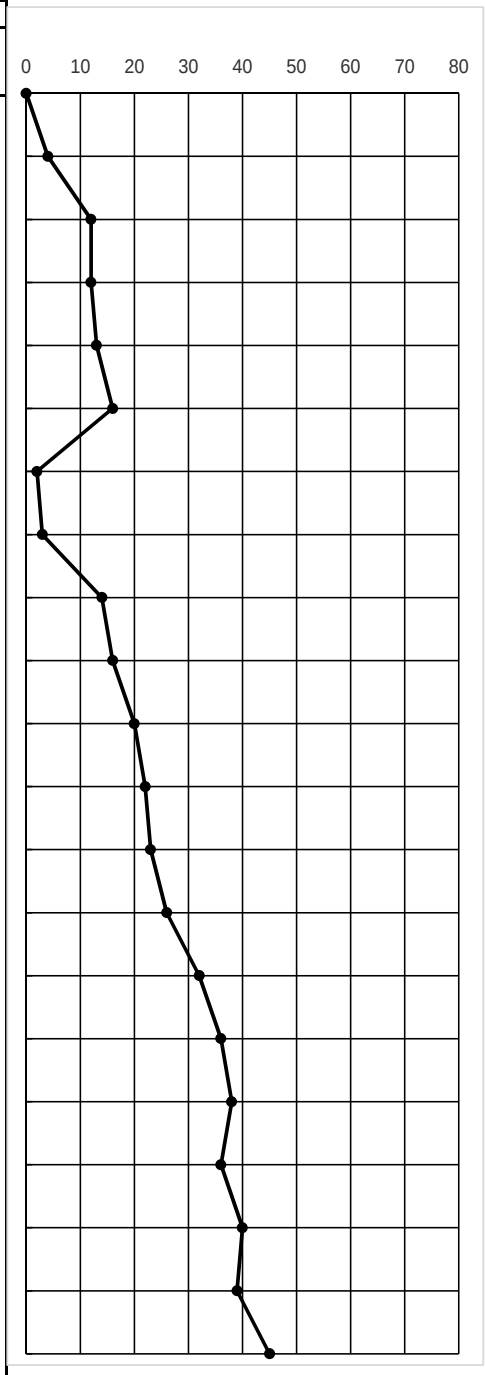
Client : Urban Development Directorate (UDD)
Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location : Brojpur Govt. Primary school, Brojpur, Kazipur Union

Legend: Clay, Silt, Sand

Coordinates Lat-23.93039 Long-88.78947

Depth (m)	Visual Description	Symbols	Sample	Layer Number	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Light Gray soft SILT with very fine sand			1	2.6	1	2	2	4
3.0						3	5	7	12
4.5	Light Gray medium dense fine SAND			2	5.4	3	5	7	12
6.0						4	6	7	13
7.5						4	6	10	16
9.0	Light Gray very soft SILT with very fine sand			3	3.0	1	1	1	2
10.5						1	1	2	3
12.0	Light Gray medium dense to dense medium to fine SAND			4	19.0	6	7	7	14
13.5						6	7	9	16
15.0						6	9	11	20
16.5						6	9	13	22
18.0						6	9	14	23
19.5						7	10	16	26
21.0						8	15	17	32
22.5						10	16	20	36
24.0						10	17	21	38
25.5						10	16	20	36
27.0						11	19	21	40
28.5						10	17	22	39
30.0	End of Boring					12	21	24	45

SPT blows per 0.3 m penetration



Disturbed Sample(Split Spoon)
Undisturbed Sample(Shelby Tube)
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6

GEOTECHNICAL BOREHOLE LOG

Bore hole No: BH-30
Method of Boring: Percussion
Boring Dia.:100(mm)
Boring Depth: 30.0m

Exixting ground level: 17
Ground water level: 3.96m below EGL
Started on: 16.01.2016
Completed on: 16.01.2016

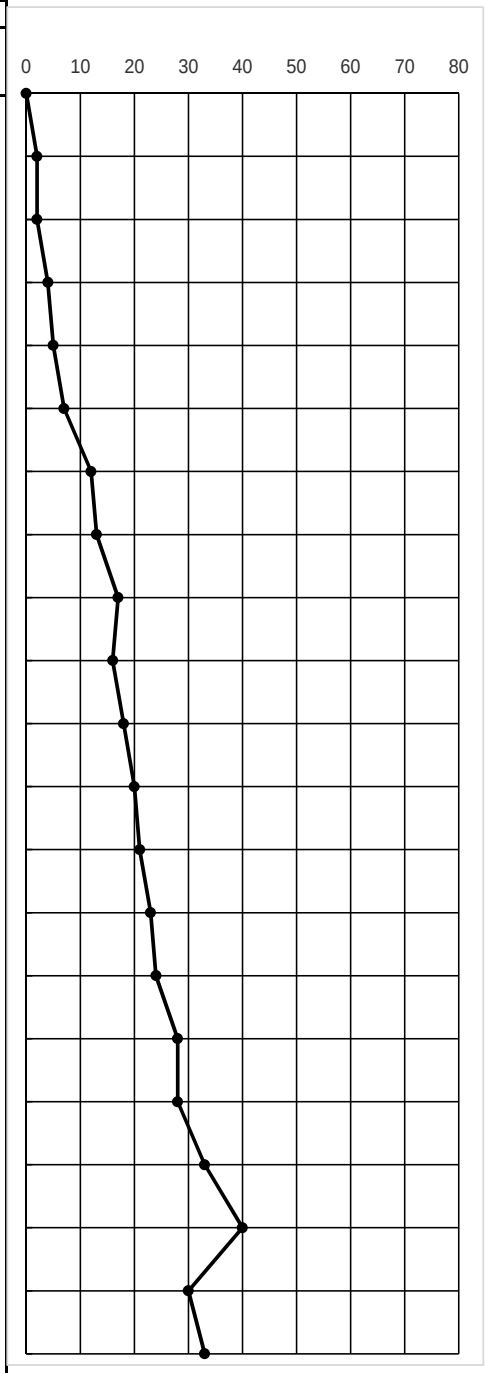
Client : Urban Development Directorate (UDD)
Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location : Kazipur College Field, Kazipur Union

Legend: Clay, Silt, Sand

Coordinates Lat-23.94155 Long-88.75707

Depth (m)	Visual Description	Symbols	Sample	Layer Number	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Light Brown very soft to medium stiff SILT with fine SAND			1	8.0	1	1	1	2
3.0						1	1	1	2
4.5						2	2	2	4
6.0						2	2	3	5
7.5						2	3	4	7
9.0	Light Gray medium dense fine to very fine SAND			2	11.5	4	5	7	12
10.5						5	6	7	13
12.0						6	6	11	17
13.5						6	6	10	16
15.0						5	8	10	18
16.5						6	8	12	20
18.0						6	9	12	21
19.5	Light Gray medium dense to dense medium to fine SAND			4	10.5	7	10	13	23
21.0						7	12	12	24
22.5						8	13	15	28
24.0						7	12	16	28
25.5						8	15	18	33
27.0						12	16	24	40
28.5						8	13	17	30
30.0	End of Boring					10	15	18	33

SPT blows per 0.3 m penetration



Disturbed Sample(Split Spoon)
Undisturbed Sample(Shelby Tube)
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6

GEOTECHNICAL BOREHOLE LOG

Bore hole No: BH-31
Method of Boring: Percussion
Boring Dia.:100(mm)
Boring Depth: 30.0m

Exixting ground level: 15.93
Ground water level: 4.27m below EGL
Started on: 15.01.2016
Completed on: 15.01.2016

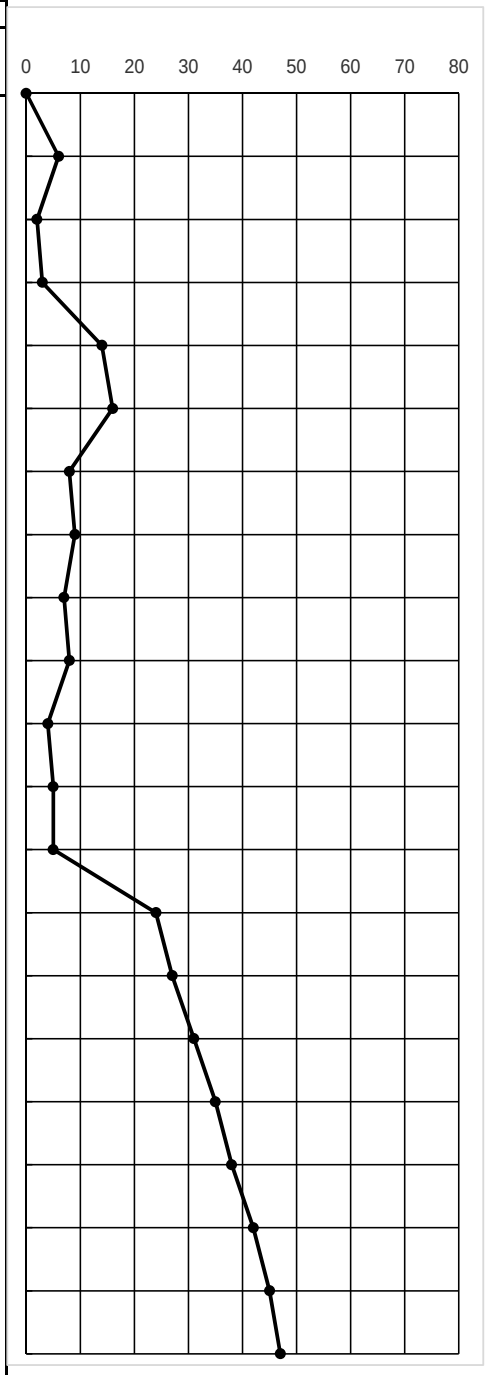
Client : Urban Development Directorate (UDD)
Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location : Betbaria private high school, Kazipur union

Legend: Clay, Silt, Sand

Coordinates Lat-23.95878 Long-88.7939

Depth (m)	Visual Description	Symbols	Sample	Layer Number	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Sand fill			0	2.0	2	3	3	6
3.0	Brown soft to stiff SILT with fine sand			1	4.0	1	1	1	2
4.5						1	1	2	3
6.0						5	6	8	14
7.5	Light Brown loose to medium dense very fine SAND			2	4.5	5	7	9	16
9.0						2	3	5	8
10.5	Light Gray medium stiff to soft SILT with very fine sand			3	8.0	3	3	6	9
12.0						3	3	4	7
13.5						3	4	4	8
15.0						2	2	2	4
16.5						1	2	3	5
18.0						2	2	3	5
19.5	Light Gray medium dense to dense medium to fine SAND			4	11.5	7	8	16	24
21.0						8	10	17	27
22.5						7	11	20	31
24.0						9	14	21	35
25.5						10	15	23	38
27.0						10	18	24	42
28.5						11	18	27	45
30.0	End of Boring					13	21	26	47

SPT blows per 0.3 m penetration



Disturbed Sample(Split Spoon)
Undisturbed Sample(Shelby Tube)
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6

GEOTECHNICAL BOREHOLE LOG

Bore hole No: BH-32
Method of Boring: Percussion
Boring Dia.:100(mm)
Boring Depth: 30.0m

Exixting ground level: 17.06
Ground water level: 4.88m below EGL
Started on: 16.01.2016
Completed on: 16.01.2016

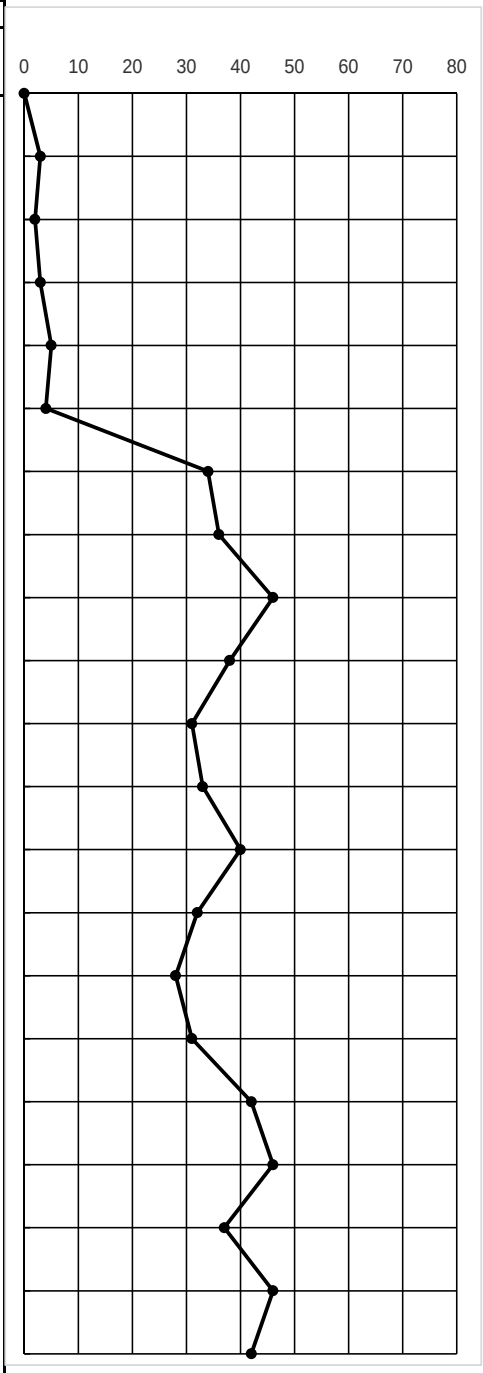
Client : Urban Development Directorate (UDD)
Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location : Kazipur Mathavanga madhomik Girls School, Hazipara, Kazipur Union

Legend: Clay, Silt, Sand

Coordinates Lat-23.96283 Long-88.74911

Depth (m)	Visual Description	Symbols	Sample	Layer Number	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Light Gray very soft to soft SILT with very fine sand			1	8.0	1	1	2	3
3.0						1	1	1	2
4.5						1	1	2	3
6.0						3	3	2	5
7.5						1	2	2	4
9.0	Light Gray dense fine SAND			2	7.0	7	14	20	34
10.5						7	16	20	36
12.0						12	20	26	46
13.5						11	17	21	38
15.0	Light Gray dense medium to fine SAND			4	15.0	10	14	17	31
16.5						10	14	19	33
18.0						10	16	24	40
19.5						10	11	21	32
21.0						8	10	18	28
22.5						8	12	19	31
24.0						12	20	22	42
25.5						13	21	25	46
27.0						12	17	20	37
28.5						12	22	24	46
30.0	End of Boring					10	19	23	42

SPT blows per 0.3 m penetration



Disturbed Sample(Split Spoon)
Undisturbed Sample(Shelby Tube)
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6

Appendix D

Geotechnical Laboratory Test Results and Graphs

Laboratory Test Results of Atterberg Limits of Soil
(ASTM Designation:D4318)

Client : Urban Development Directorate (UDD)

Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Project Location : Ekuria Eid gha Mat, Roypur Union

Sample Information:

Sample Date:	24/6/2016
Test Date:	11/9/2016
Boring Number	BH-13
Sample Number	D8
Depth of Sample(m)	12.0

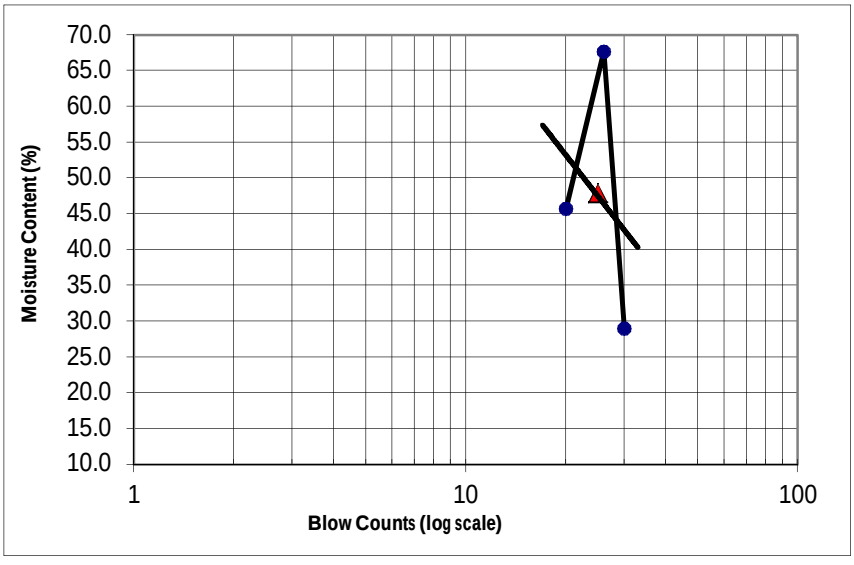
Determination of Liquid Limit

Cup Number	C10	C14	C220
Weight of Cup (g)	36.96	36.45	36.67
Weight of Wet Soil and Cup (g)	121.08	63.13	50.28
Weight of Dry Soil and Cup (g)	94.68	52.36	47.22
Moisure Content (%)	45.7	67.7	29.0
Blow Counts	20	26	30

Determination of Plastic Limit

Cup Number	Ct302	Ct302
Weight of Cup (g)	12.15	12.15
Weight of Wet Soil and Cup (g)	13.77	14.18
Weight of Dry Soil and Cup (g)	13.35	13.76
Moisure Content (%)	35.0	26.1

Compilation of Test Results



Liquid Limit	48
Plastic Limit	31
Plasticity Index	17

Laboratory Test Results of Atterberg Limits of Soil
(ASTM Designation:D4318)

Client : Urban Development Directorate (UDD)

Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Project Location : Roypur high school, Roypur Bazar, Roypur Union

Sample Information:

Sample Date:	25/6/2016
Test Date:	11/9/2016
Boring Number	BH-14
Sample Number	D3
Depth of Sample(m)	4.5

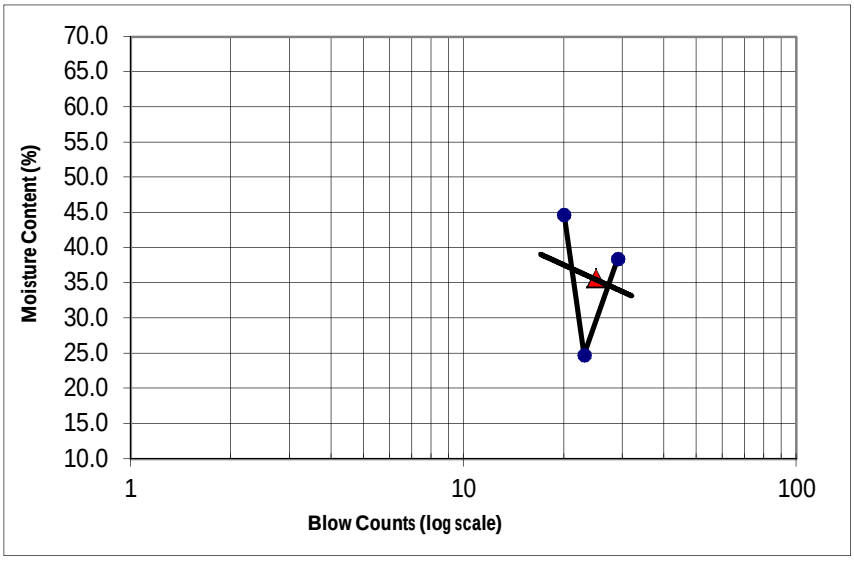
Determination of Liquid Limit

Cup Number	C03	C08	C09
Weight of Cup (g)	42.13	44.27	41.35
Weight of Wet Soil and Cup (g)	100.95	64.52	70.61
Weight of Dry Soil and Cup (g)	82.77	60.5	62.49
Moisure Content (%)	44.7	24.8	38.4
Blow Counts	20	23	29

Determination of Plastic Limit

Cup Number	Ct111	Ct111
Weight of Cup (g)	19.55	19.55
Weight of Wet Soil and Cup (g)	21.91	21.92
Weight of Dry Soil and Cup (g)	21.62	21.26
Moisure Content (%)	14.0	38.6

Compilation of Test Results



Liquid Limit	36
Plastic Limit	26
Plasticity Index	9

Laboratory Test Results of Atterberg Limits of Soil
(ASTM Designation:D4318)

Client : Urban Development Directorate (UDD)

Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Project Location : Vill- Changara, Chok Tolar mor, Shola taka Union

Sample Information:

Sample Date:	21/1/2016
Test Date:	11/9/2016
Boring Number	BH-18
Sample Number	D14
Depth of Sample(m)	21.0

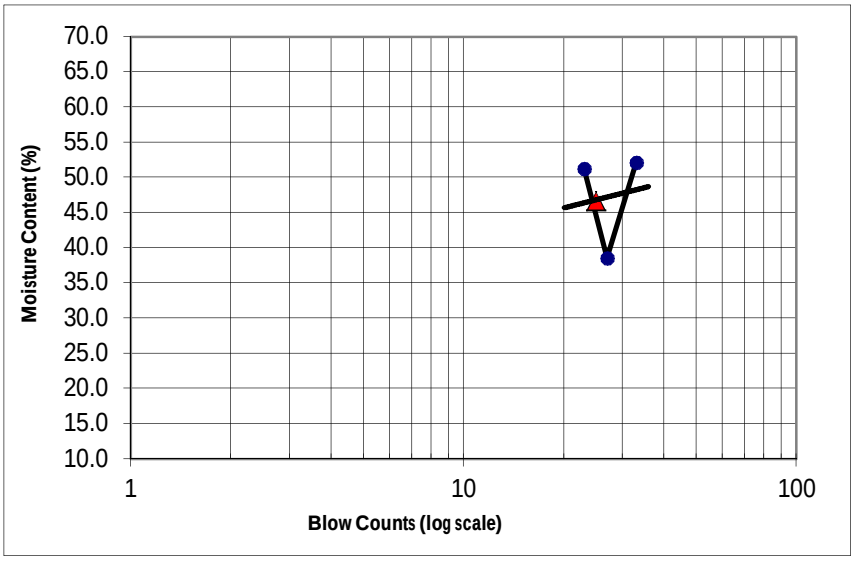
Determination of Liquid Limit

Cup Number	C01	C07	C11
Weight of Cup (g)	36.96	36.45	36.67
Weight of Wet Soil and Cup (g)	121.18	65.43	56.37
Weight of Dry Soil and Cup (g)	92.65	57.37	49.62
Moisure Content (%)	51.2	38.5	52.1
Blow Counts	23	27	33

Determination of Plastic Limit

Cup Number	Ct102	Ct102
Weight of Cup (g)	12.15	12.15
Weight of Wet Soil and Cup (g)	14.65	14.38
Weight of Dry Soil and Cup (g)	13.85	13.76
Moisure Content (%)	47.1	38.5

Compilation of Test Results



Liquid Limit	47
Plastic Limit	43
Plasticity Index	4

Laboratory Test Results of Atterberg Limits of Soil
(ASTM Designation:D4318)

Client : Urban Development Directorate (UDD)

Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Project Location : Dhankhola Govt. primary school, Near Dhankhola union complex,

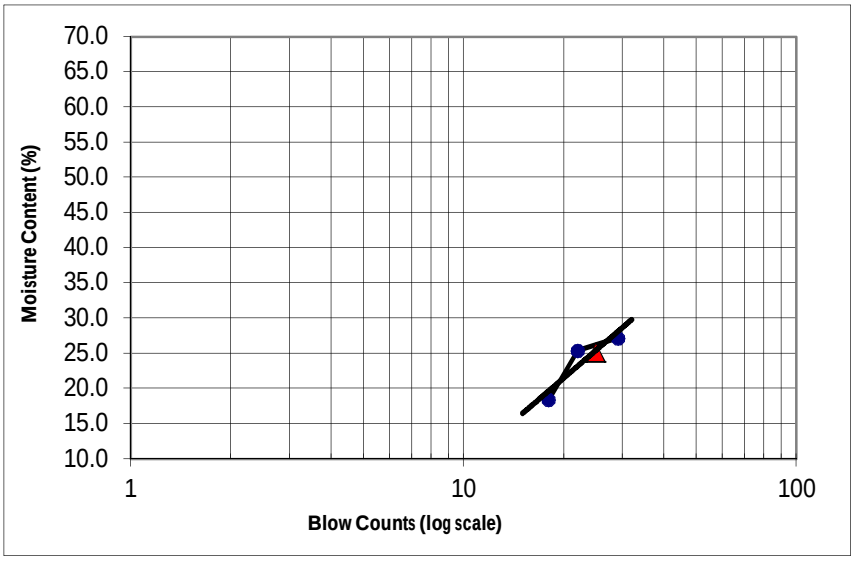
Sample Information:

Sample Date: 21/01/2016
Test Date: 11/9/2016
Boring Number BH-06
Sample Number D1
Depth of Sample(m) 1.5

Determination of Liquid Limit			
Cup Number	C55	C66	C77
Weight of Cup (g)	42.13	44.27	41.35
Weight of Wet Soil and Cup (g)	100.09	67.03	74.6
Weight of Dry Soil and Cup (g)	91.09	62.42	67.5
Moisure Content (%)	18.4	25.4	27.2
Blow Counts	18	22	29

Determination of Plastic Limit		
Cup Number	Ct103	Ct103
Weight of Cup (g)	19.55	19.55
Weight of Wet Soil and Cup (g)	21.06	21.65
Weight of Dry Soil and Cup (g)	21.04	21.33
Moisure Content (%)	1.3	18.0

Compilation of Test Results



Liquid Limit	25
Plastic Limit	10
Plasticity Index	15

Laboratory Test Results of Atterberg Limits of Soil
(ASTM Designation:D4318)

Client : Urban Development Directorate (UDD)

Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Project Location :Utrail Munsi kandi Sorkari Prathomic Bidloy, Shibchor

Sample Information:

Sample Date: 19/6/2016
Test Date: 12/8/2016
Boring Number BH-11
Sample Number D3
Depth of Sample(m) 4.5

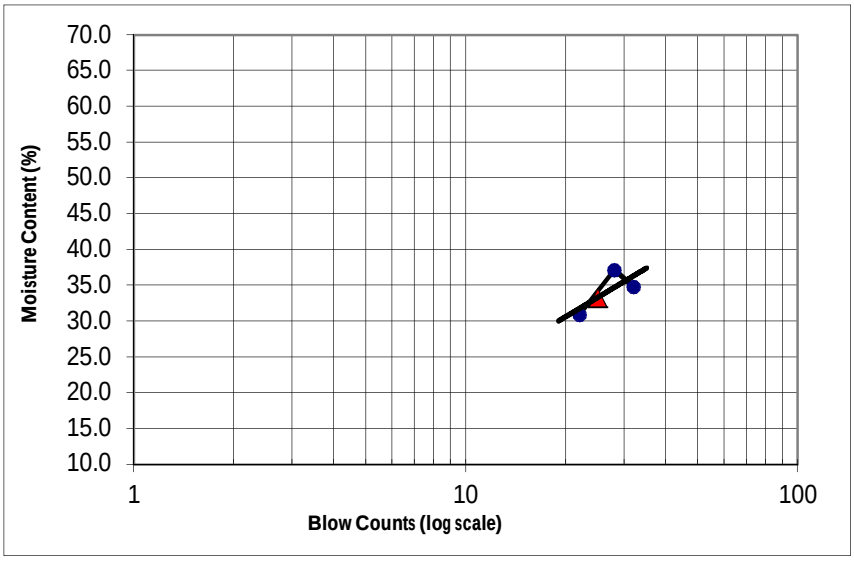
Determination of Liquid Limit

Cup Number	C10	C14	C220
Weight of Cup (g)	36.96	36.45	36.67
Weight of Wet Soil and Cup (g)	119.08	65.13	56.28
Weight of Dry Soil and Cup (g)	99.68	57.36	51.22
Moisure Content (%)	30.9	37.2	34.8
Blow Counts	22	28	32

Determination of Plastic Limit

Cup Number	Ct302	Ct302
Weight of Cup (g)	12.15	12.15
Weight of Wet Soil and Cup (g)	13.77	14.18
Weight of Dry Soil and Cup (g)	13.35	13.86
Moisure Content (%)	35.0	18.7

Compilation of Test Results



Liquid Limit	33
Plastic Limit	27
Plasticity Index	6

Laboratory Test Results of Atterberg Limits of Soil
(ASTM Designation:D4318)

Client : Urban Development Directorate (UDD)

Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Project Location : Sibchor Model Sorkari Pratomic Bidhaloy, Madaripur

Sample Information:

Sample Date: 15/6/2016
Test Date: 12/8/2016
Boring Number BH-12
Sample Number D3
Depth of Sample(m) 4.5

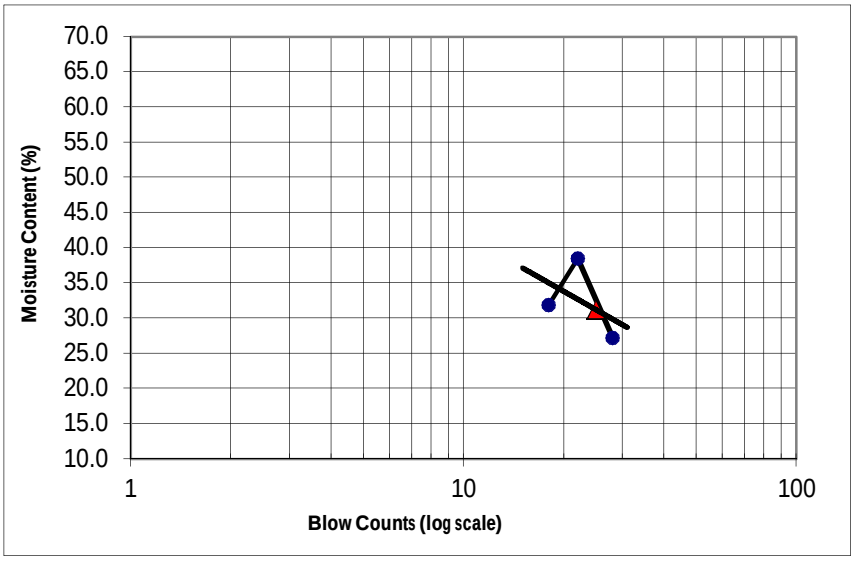
Determination of Liquid Limit

Cup Number	C03	C08	C09
Weight of Cup (g)	42.13	44.27	41.35
Weight of Wet Soil and Cup (g)	104.95	69.52	74.61
Weight of Dry Soil and Cup (g)	89.77	62.5	67.49
Moisure Content (%)	31.9	38.5	27.2
Blow Counts	18	22	28

Determination of Plastic Limit

Cup Number	Ct111	Ct111
Weight of Cup (g)	19.55	19.55
Weight of Wet Soil and Cup (g)	21.86	21.85
Weight of Dry Soil and Cup (g)	21.52	21.36
Moisure Content (%)	17.3	27.1

Compilation of Test Results



Liquid Limit	31
Plastic Limit	22
Plasticity Index	9

Laboratory Test Results of Atterberg Limits of Soil
(ASTM Designation:D4318)

Client : Urban Development Directorate (UDD)

Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Project Location :Chor kasi kata Adarsha Sorkari Prothomic Bidhaloy, Sibchor, Madaripur

Sample Information:

Sample Date: 19/6/2016
Test Date: 12/8/2016
Boring Number BH-13
Sample Number D2
Depth of Sample(m) 3.0

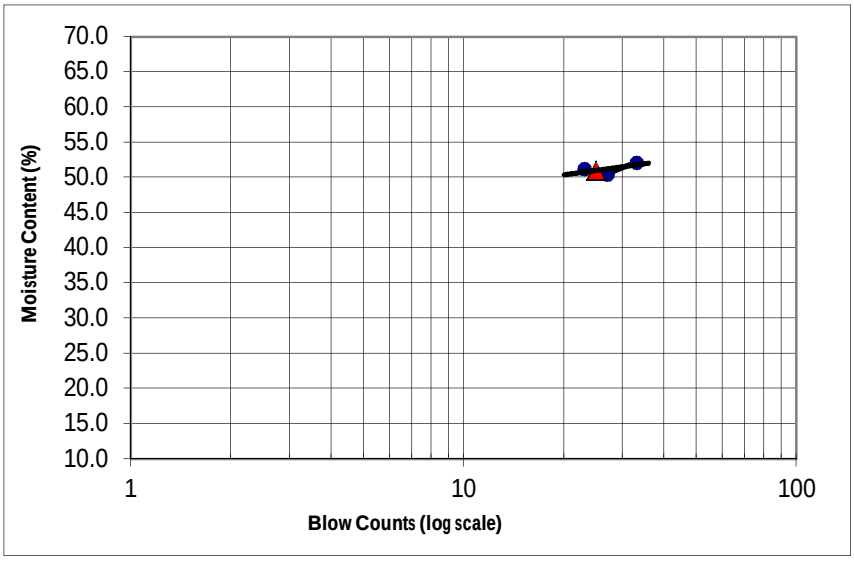
Determination of Liquid Limit

Cup Number	C01	C07	C11
Weight of Cup (g)	36.96	36.45	36.67
Weight of Wet Soil and Cup (g)	124.18	69.43	56.37
Weight of Dry Soil and Cup (g)	94.65	58.37	49.62
Moisure Content (%)	51.2	50.5	52.1
Blow Counts	23	27	33

Determination of Plastic Limit

Cup Number	Ct102	Ct102
Weight of Cup (g)	12.15	12.15
Weight of Wet Soil and Cup (g)	14.75	14.68
Weight of Dry Soil and Cup (g)	13.95	13.89
Moisure Content (%)	44.4	45.4

Compilation of Test Results



Liquid Limit	51
Plastic Limit	45
Plasticity Index	6

Laboratory Test Results of Atterberg Limits of Soil
(ASTM Designation:D4318)

Client : Urban Development Directorate (UDD)

Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Project Location :Bachamara Bablatola Sorkari Prathomic Bidhaloy,Shibchor, Madaripur

Sample Information:

Sample Date: 20/6/2016
Test Date: 12/8/2016
Boring Number BH-16
Sample Number D6
Depth of Sample(m) 9.0

Determination of Liquid Limit

Cup Number	C55	C66	C77
Weight of Cup (g)	42.13	44.27	41.35
Weight of Wet Soil and Cup (g)	98.09	63.03	70.6
Weight of Dry Soil and Cup (g)	86.09	58.42	63.5
Moisure Content (%)	27.3	32.6	32.1
Blow Counts	19	23	30

Determination of Plastic Limit

Cup Number	Ct103	Ct103
Weight of Cup (g)	19.55	19.55
Weight of Wet Soil and Cup (g)	21.66	21.55
Weight of Dry Soil and Cup (g)	21.44	21.23
Moisure Content (%)	11.6	19.0

Compilation of Test Results

Liquid Limit	31
Plastic Limit	15
Plasticity Index	16

Laboratory Test Results of Atterberg Limits of Soil
(ASTM Designation:D4318)

Client : Urban Development Directorate (UDD)

Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Project Location :Khan Kandi, Nilghora, Shibchor, Madaripur

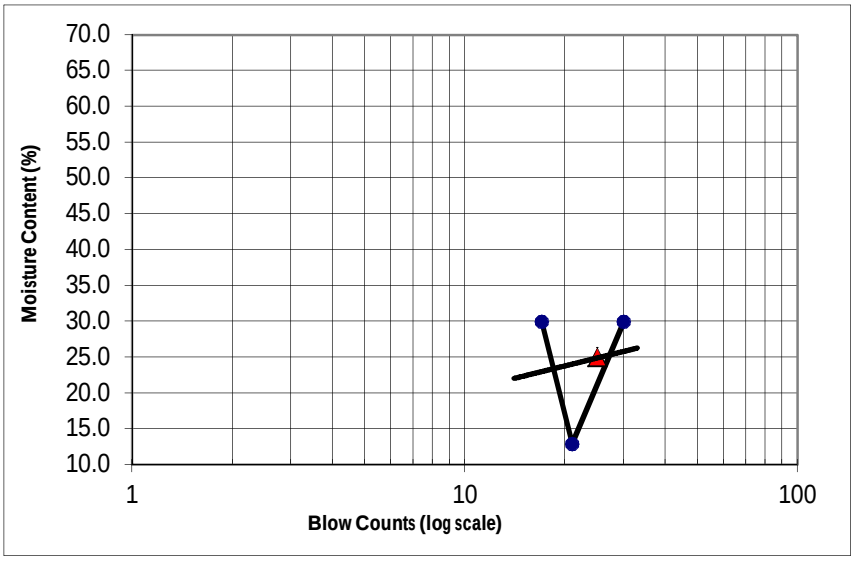
Sample Information:

Sample Date: 15/6/2016
Test Date: 12/8/2016
Boring Number BH-17
Sample Number D4
Depth of Sample(m) 6.0

Determination of Liquid Limit			
Cup Number	C44	C33	C88
Weight of Cup (g)	42.13	44.27	41.35
Weight of Wet Soil and Cup (g)	105.89	70.53	76.63
Weight of Dry Soil and Cup (g)	91.19	67.52	68.5
Moisure Content (%)	30.0	12.9	29.9
Blow Counts	17	21	30

Determination of Plastic Limit		
Cup Number	Ct104	Ct104
Weight of Cup (g)	19.55	19.55
Weight of Wet Soil and Cup (g)	21.76	21.35
Weight of Dry Soil and Cup (g)	21.34	21.03
Moisure Content (%)	23.5	21.6

Compilation of Test Results



Liquid Limit	25
Plastic Limit	23
Plasticity Index	2

Laboratory Test Results of Atterberg Limits of Soil
(ASTM Designation:D4318)

Client : Urban Development Directorate (UDD)

Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Project Location :Chor Kesobpur Howlader Bari Mosjid, Shibchor, Madaripur

Sample Information:

Sample Date: 18/6/2016
Test Date: 13/8/2016
Boring Number BH-18
Sample Number D3
Depth of Sample(m) 4.5

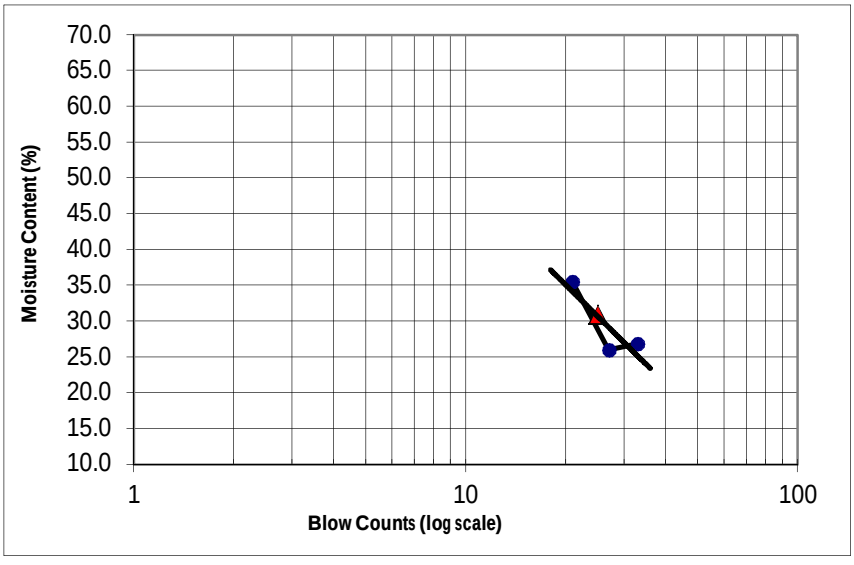
Determination of Liquid Limit

Cup Number	C10	C14	C220
Weight of Cup (g)	36.96	36.45	36.67
Weight of Wet Soil and Cup (g)	130.08	74.13	65.28
Weight of Dry Soil and Cup (g)	105.68	66.36	59.22
Moisure Content (%)	35.5	26.0	26.9
Blow Counts	21	27	33

Determination of Plastic Limit

Cup Number	Ct302	Ct302
Weight of Cup (g)	12.15	12.15
Weight of Wet Soil and Cup (g)	13.45	14.18
Weight of Dry Soil and Cup (g)	13.25	13.66
Moisure Content (%)	18.2	34.4

Compilation of Test Results



Liquid Limit	31
Plastic Limit	26
Plasticity Index	5

Laboratory Test Results of Atterberg Limits of Soil
(ASTM Designation:D4318)

Client : Urban Development Directorate (UDD)

Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Project Location : Kutubpur Uccho Bidhaloy, Shibchor, Madaripur

Sample Information:

Sample Date: 25/6/2016
Test Date: 13/8/2016
Boring Number BH-19
Sample Number D1
Depth of Sample(m) 1.5

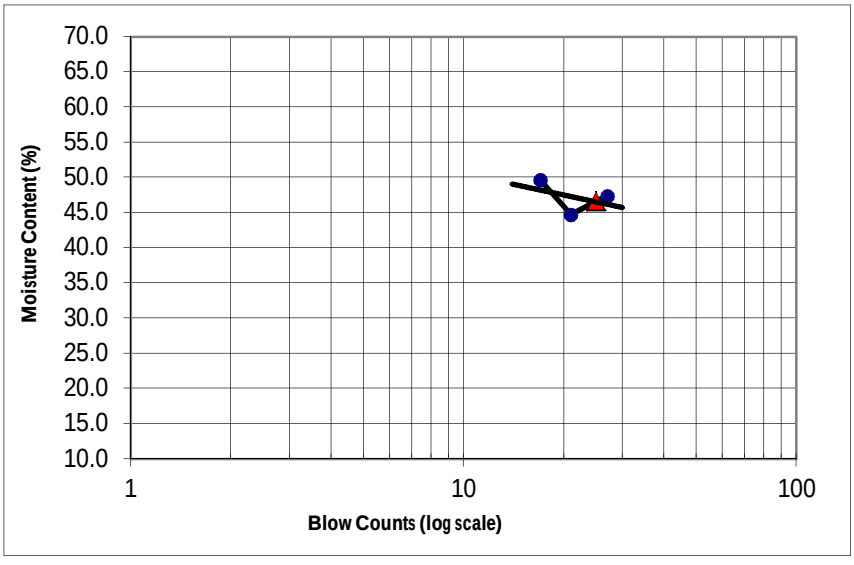
Determination of Liquid Limit

Cup Number	C03	C08	C09
Weight of Cup (g)	42.13	44.27	41.35
Weight of Wet Soil and Cup (g)	96.95	60.52	66.61
Weight of Dry Soil and Cup (g)	78.77	55.5	58.49
Moisure Content (%)	49.6	44.7	47.4
Blow Counts	17	21	27

Determination of Plastic Limit

Cup Number	Ct111	Ct111
Weight of Cup (g)	19.55	19.55
Weight of Wet Soil and Cup (g)	21.06	21.75
Weight of Dry Soil and Cup (g)	20.53	21.26
Moisure Content (%)	54.1	28.7

Compilation of Test Results



Liquid Limit	47
Plastic Limit	41
Plasticity Index	5

Laboratory Test Results of Atterberg Limits of Soil
(ASTM Designation:D4318)

Client : Urban Development Directorate (UDD)

Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Project Location :Al Jamiatul Koumi Madrasha, Shibchor, Madaripur

Sample Information:

Sample Date: 22/6/2016
Test Date: 13/8/2016
Boring Number BH-20
Sample Number D1
Depth of Sample(m) 1.5

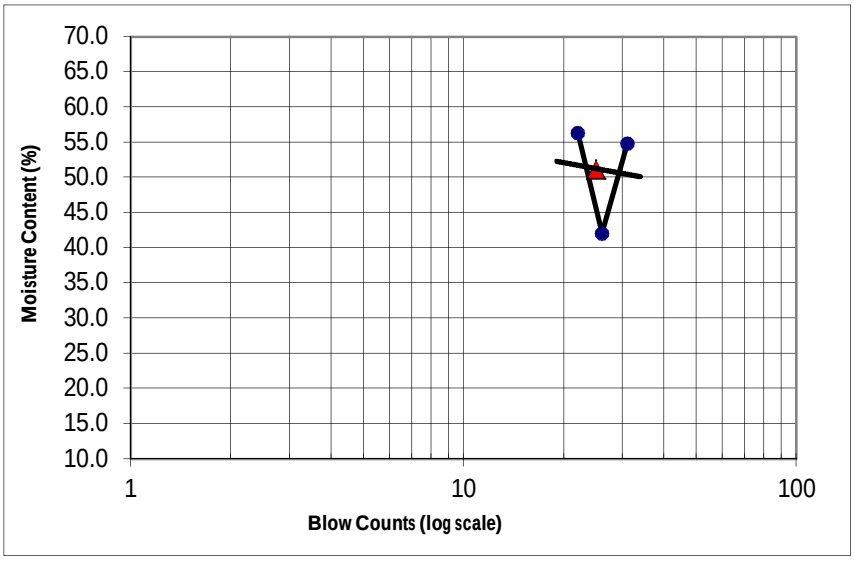
Determination of Liquid Limit

Cup Number	C01	C07	C11
Weight of Cup (g)	36.96	36.45	36.67
Weight of Wet Soil and Cup (g)	127.18	70.43	61.37
Weight of Dry Soil and Cup (g)	94.65	60.37	52.62
Moisure Content (%)	56.4	42.1	54.9
Blow Counts	22	26	31

Determination of Plastic Limit

Cup Number	Ct102	Ct102
Weight of Cup (g)	12.15	12.15
Weight of Wet Soil and Cup (g)	14.59	14.38
Weight of Dry Soil and Cup (g)	13.69	13.76
Moisure Content (%)	58.4	38.5

Compilation of Test Results



Liquid Limit	51
Plastic Limit	48
Plasticity Index	3

Laboratory Test Results of Atterberg Limits of Soil
(ASTM Designation:D4318)

Client : Urban Development Directorate (UDD)

Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Project Location :Pacchor Balika uccho Bidhaloy, Shibchor, Madaripur

Sample Information:

Sample Date: 16/6/2016
Test Date: 13/8/2016
Boring Number BH-22
Sample Number D7
Depth of Sample(m) 10.5

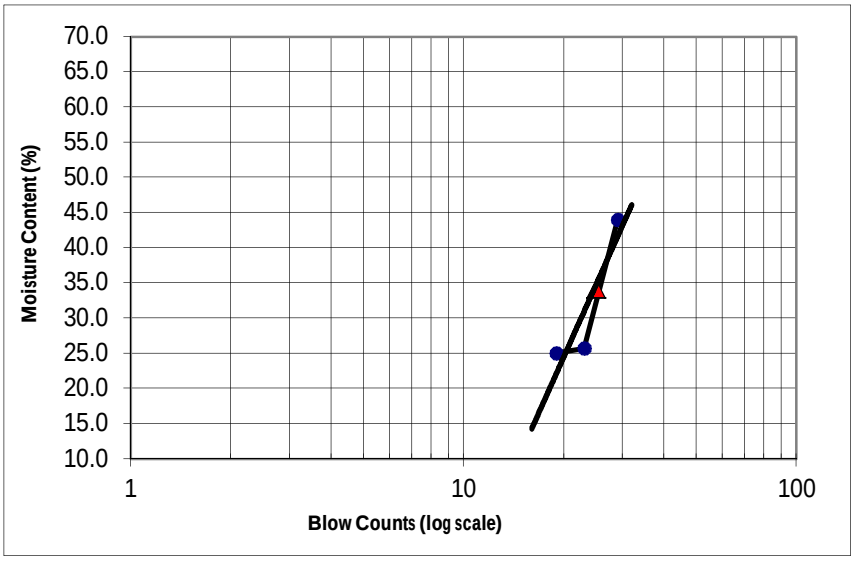
Determination of Liquid Limit

Cup Number	C55	C66	C77
Weight of Cup (g)	42.13	44.27	41.35
Weight of Wet Soil and Cup (g)	92.09	57.03	64.6
Weight of Dry Soil and Cup (g)	82.09	54.42	57.5
Moisure Content (%)	25.0	25.7	44.0
Blow Counts	19	23	29

Determination of Plastic Limit

Cup Number	Ct103	Ct103
Weight of Cup (g)	19.55	19.55
Weight of Wet Soil and Cup (g)	21.76	21.85
Weight of Dry Soil and Cup (g)	21.44	21.23
Moisure Content (%)	16.9	36.9

Compilation of Test Results



Liquid Limit	34
Plastic Limit	27
Plasticity Index	7

Laboratory Test Results of Atterberg Limits of Soil
(ASTM Designation:D4318)

Client : Urban Development Directorate (UDD)

Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Project Location :Omar Bapary Kandi Sorkari Prathomic Bidhaloy, Shibchor, Madaripur

Sample Information:

Sample Date: 17/6/2016
Test Date: 13/8/2016
Boring Number BH-23
Sample Number D5
Depth of Sample(m) 7.5

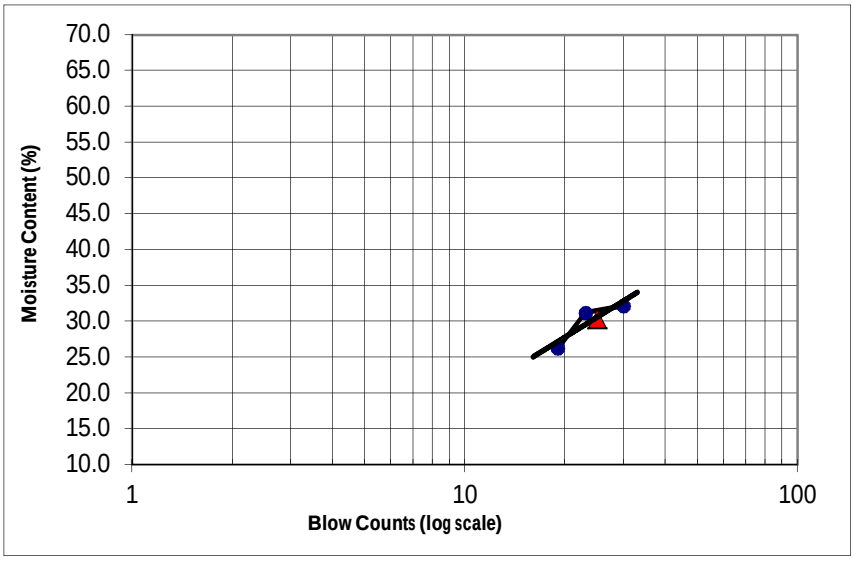
Determination of Liquid Limit

Cup Number	C44	C33	C88
Weight of Cup (g)	42.13	44.27	41.35
Weight of Wet Soil and Cup (g)	112.89	69.53	70.63
Weight of Dry Soil and Cup (g)	98.19	63.52	63.5
Moisure Content (%)	26.2	31.2	32.2
Blow Counts	19	23	30

Determination of Plastic Limit

Cup Number	Ct104	Ct104
Weight of Cup (g)	19.55	19.55
Weight of Wet Soil and Cup (g)	21.76	21.45
Weight of Dry Soil and Cup (g)	21.34	21.13
Moisure Content (%)	23.5	20.3

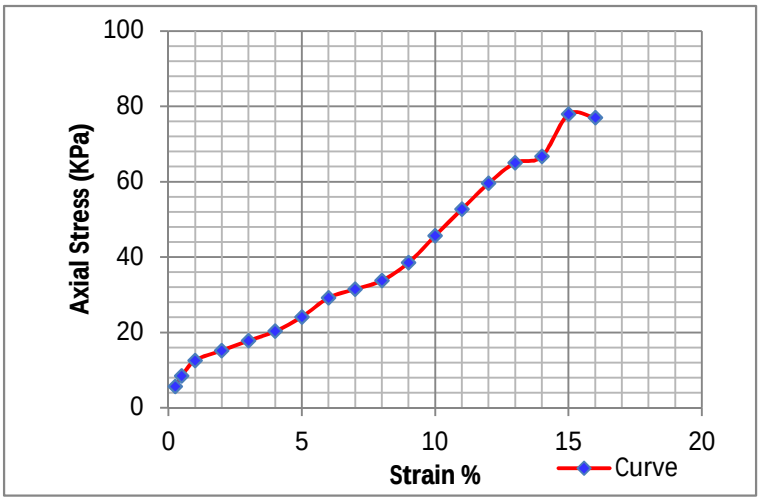
Compilation of Test Results



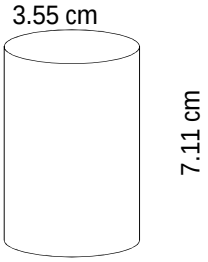
Liquid Limit	30
Plastic Limit	22
Plasticity Index	9

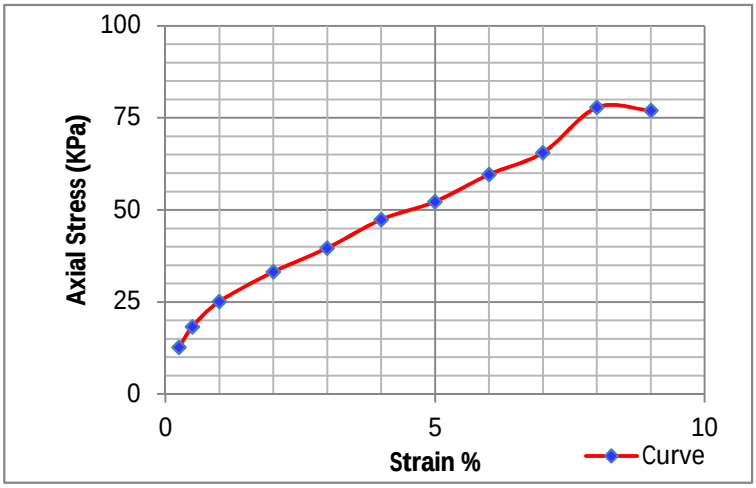
Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location: Dhankhola Govt. primary school, Near Dhankhola union complex, Dhankhola Bazar & Ekuria Eid gha Mat, Roypur Union

UNCONFINED COMPRESSION STRENGTH TEST

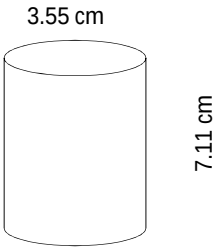


Bore hole No.	BH-06
Sample No.	UD-1
Depth (m)	2.10 to 2.55
Description of soil	Clay
qu (Kpa)	77.90
% Strain	15.0
γ_{wet} (gm/cc)	1.87
γ_{Dry} (gm/cc)	1.54
% Moisture	21.11
Cohesion (Kpa)	38.95



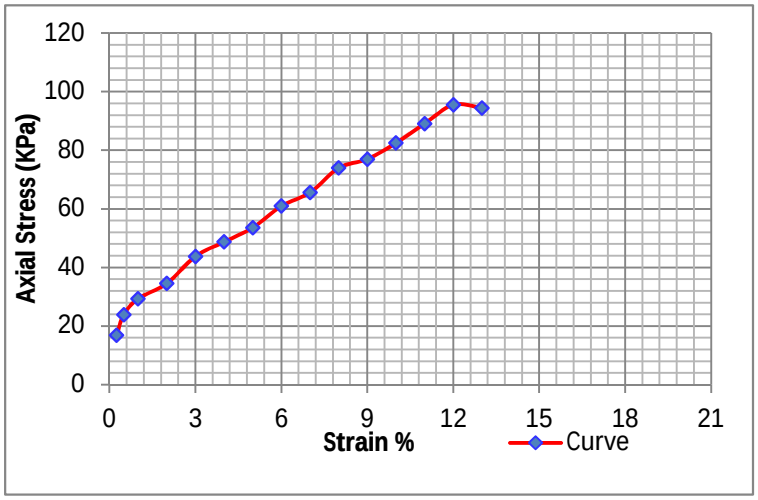


Bore hole No.	BH-13
Sample No.	UD-1
Depth (m)	3.10 to 3.55
Description of soil	Silt with Sand
qu (Kpa)	77.83
% Strain	8.0
γ_{wet} (gm/cc)	2.20
γ_{Dry} (gm/cc)	1.89
% Moisture	16.89
Cohesion (Kpa)	38.92

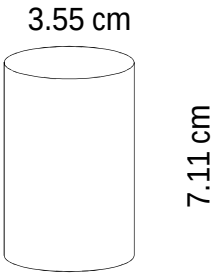


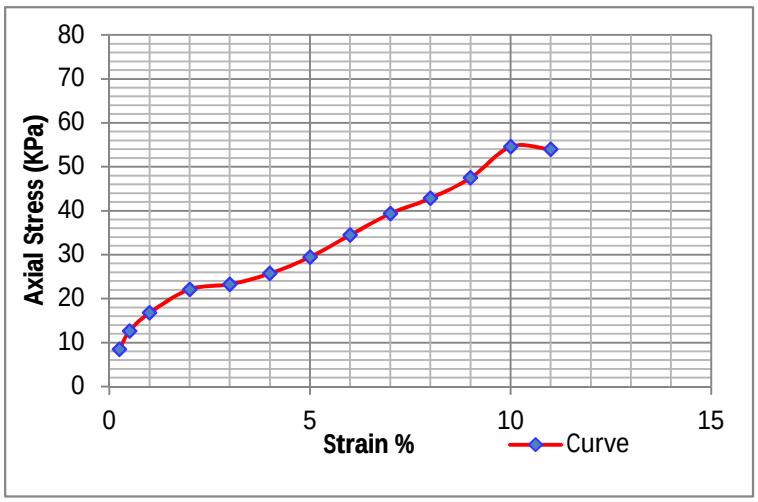
Project :Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location: Roypur high school, Roypur Bazar, Roypur Union & Juger gofa Govt. primary school, Shola taka Union

UNCONFINED COMPRESSION STRENGTH TEST

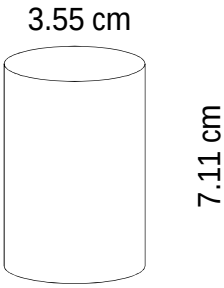


Bore hole No.	BH-14
Sample No.	UD-1
Depth (m)	5.10 to 5.55
Description of soil	Silty Clay
qu (Kpa)	95.54
% Strain	12.0
γ_{wet} (gm/cc)	1.90
γ_{Dry} (gm/cc)	1.49
% Moisture	27.87
Cohesion (Kpa)	47.77



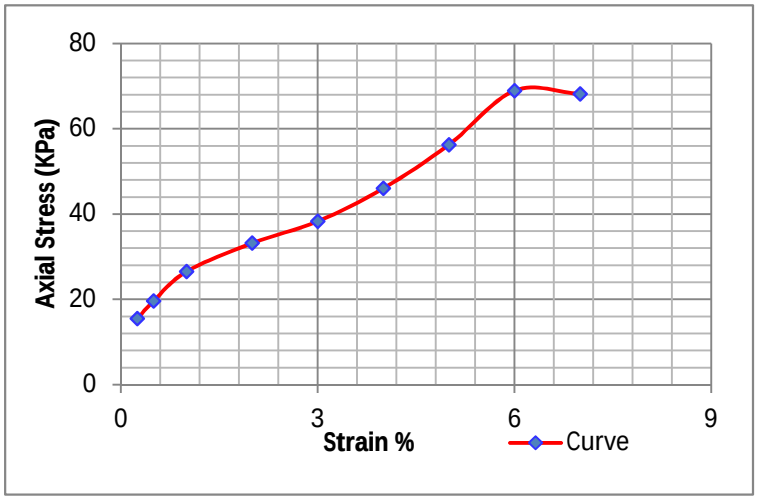


Bore hole No.	BH-17
Sample No.	UD-1
Depth (m)	5.10 to 5.55
Description of soil	Silt with Sand
qu (Kpa)	54.57
% Strain	10.0
γ_{wet} (gm/cc)	2.15
γ_{Dry} (gm/cc)	0.17
% Moisture	1159.17
Cohesion (Kpa)	27.28

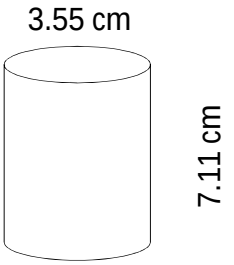


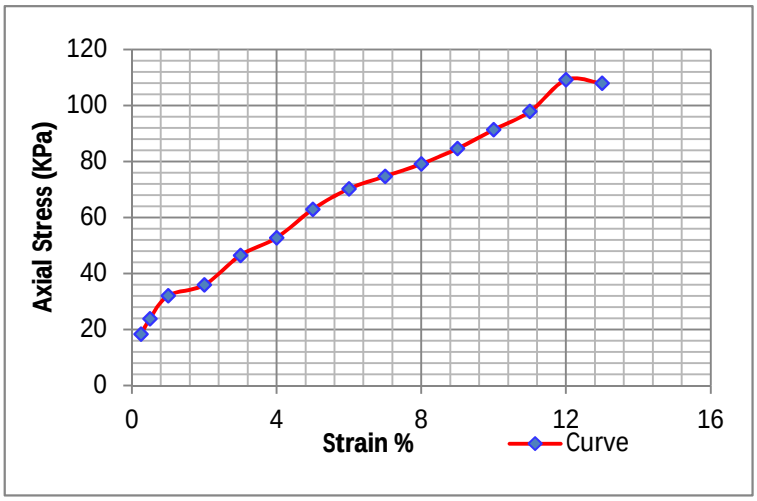
Project :Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location: Kutubpur School and College, Garabaria, Kathuli Union & 28 no. Malikandi govt. primary school field, Maghula Bazar, Narisha, Dohar

UNCONFINED COMPRESSION STRENGTH TEST

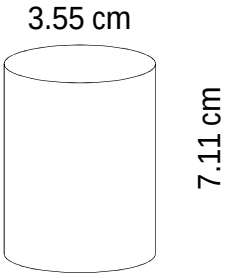


Bore hole No.	BH-19
Sample No.	UD-1
Depth (m)	5.10 to 5.55
Description of soil	Silt with Sand
qu (Kpa)	68.92
% Strain	6.0
γ_{wet} (gm/cc)	1.42
γ_{Dry} (gm/cc)	0.85
% Moisture	66.61
Cohesion (Kpa)	34.46



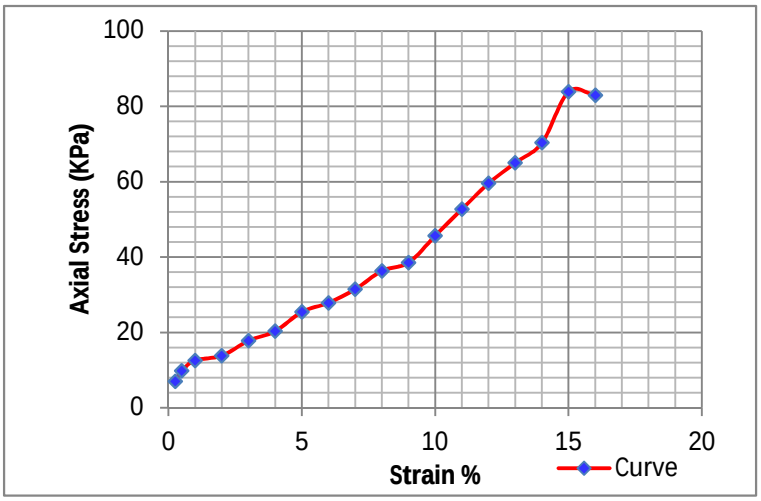


Bore hole No.	BH-20
Sample No.	UD-1
Depth (m)	3.10 to 3.55
Description of soil	SILT with Sand
qu (Kpa)	109.19
% Strain	12.0
γ_{wet} (gm/cc)	1.87
γ_{Dry} (gm/cc)	1.40
% Moisture	33.58
Cohesion (Kpa)	54.59

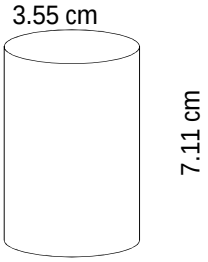


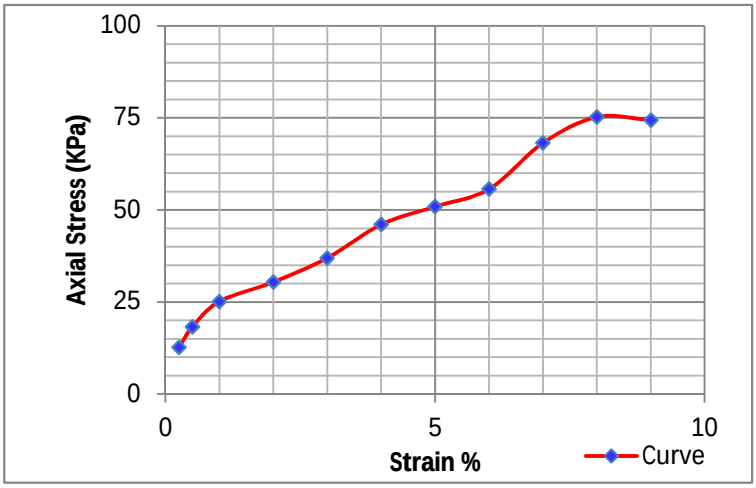
Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location: Tentulbaria Doyapara govt. primary school, Doyapara, Tentulbaria Union & Mahamadhpur Hafizia Madrasha, Mahamadhpur Bazar, Matmura Union

UNCONFINED COMPRESSION STRENGTH TEST

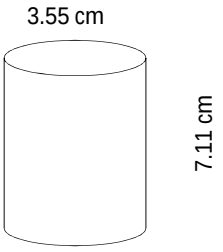


Bore hole No.	BH-27
Sample No.	UD-1
Depth (m)	3.10 to 3.55
Description of soil	Silt with Sand
qu (Kpa)	83.89
% Strain	15.0
γ_{wet} (gm/cc)	1.91
γ_{Dry} (gm/cc)	1.56
% Moisture	22.73
Cohesion (Kpa)	41.95



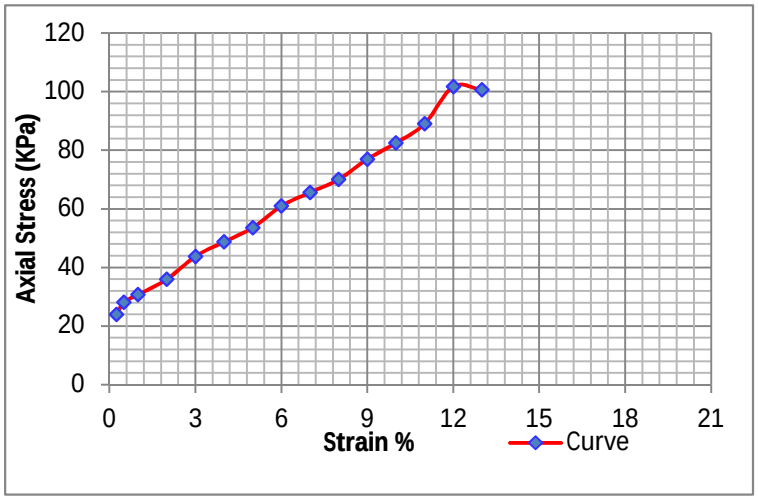


Bore hole No.	BH-28
Sample No.	UD-1
Depth (m)	3.10 to 3.55
Description of soil	Silt with Sand
qu (Kpa)	75.24
% Strain	8.0
γ_{wet} (gm/cc)	2.28
γ_{Dry} (gm/cc)	1.91
% Moisture	19.08
Cohesion (Kpa)	37.62

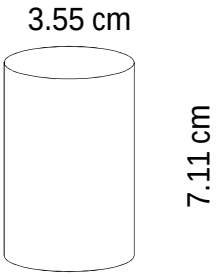


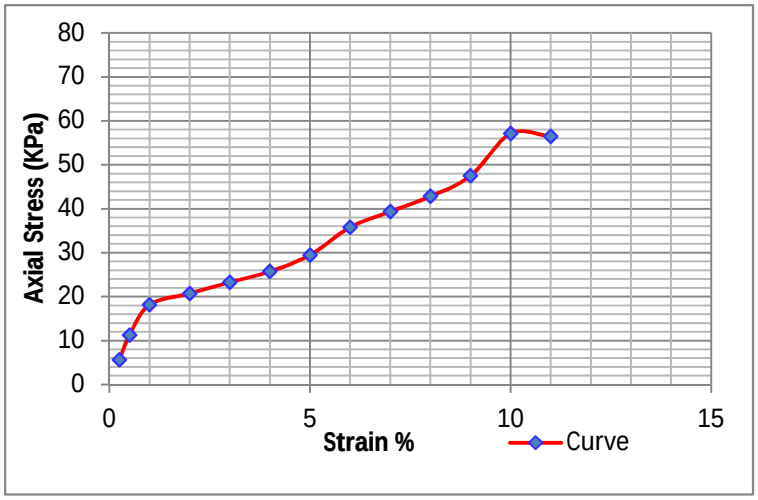
Project :Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location: Kazipur College Field, Kazipur Union & Betbaria private high school, Kazipur union

UNCONFINED COMPRESSION STRENGTH TEST

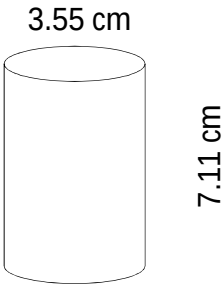


Bore hole No.	BH-30
Sample No.	UD-1
Depth (m)	3.10 to 3.55
Description of soil	Silty With Sand
qu (Kpa)	101.74
% Strain	12.0
γ_{wet} (gm/cc)	1.92
γ_{Dry} (gm/cc)	1.45
% Moisture	32.60
Cohesion (Kpa)	50.87



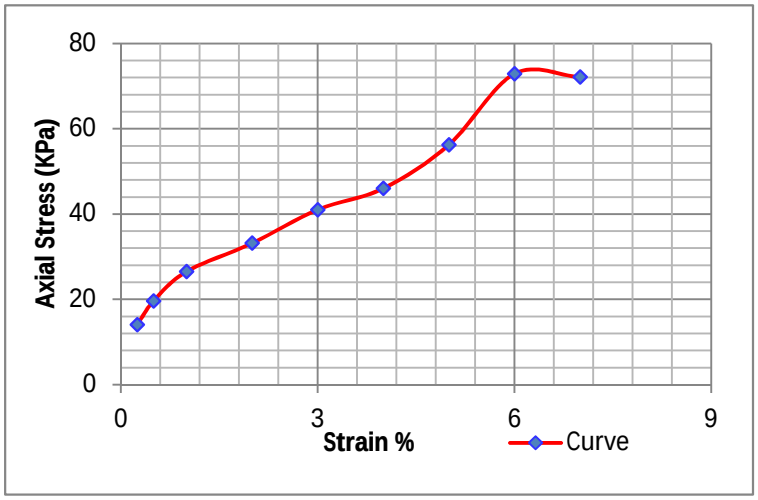


Bore hole No.	BH-31
Sample No.	UD-1
Depth (m)	3.10 to 3.55
Description of soil	Silt with Sand
qu (Kpa)	57.10
% Strain	10.0
γ_{wet} (gm/cc)	2.17
γ_{Dry} (gm/cc)	1.71
% Moisture	26.64
Cohesion (Kpa)	28.55

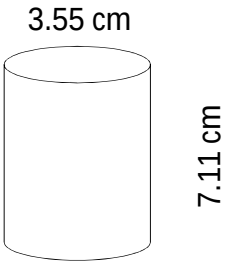


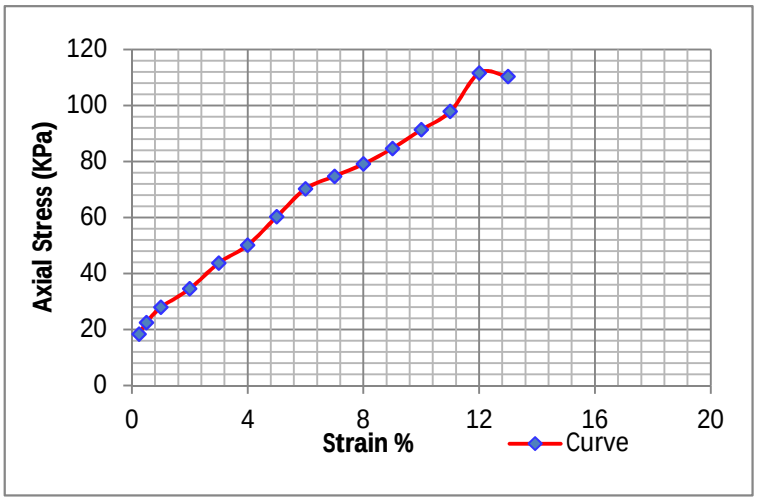
Project :Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location: Kazipur Mathavanga madhomik Girls School, Hazipara, Kazipur Union & Kormodi Kumarpara jame Moshjid, Tentulbaria Union

UNCONFINED COMPRESSION STRENGTH TEST

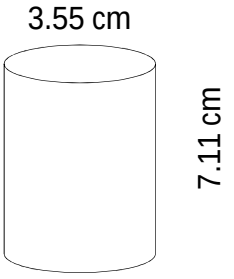


Bore hole No.	BH-32
Sample No.	UD-1
Depth (m)	5.10 to 5.55
Description of soil	Silt with Sand
qu (Kpa)	72.90
% Strain	6.0
γ_{wet} (gm/cc)	1.49
γ_{Dry} (gm/cc)	0.88
% Moisture	69.29
Cohesion (Kpa)	36.45



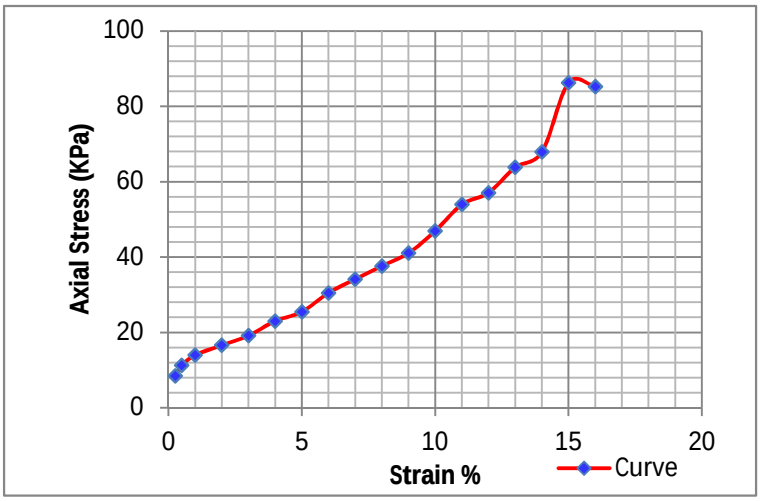


Bore hole No.	BH-26
Sample No.	UD-1
Depth (m)	3.10 to 3.55
Description of soil	SILT with Sand
qu (Kpa)	111.67
% Strain	12.0
γ_{wet} (gm/cc)	1.92
γ_{Dry} (gm/cc)	1.45
% Moisture	32.60
Cohesion (Kpa)	55.83

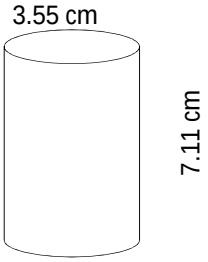


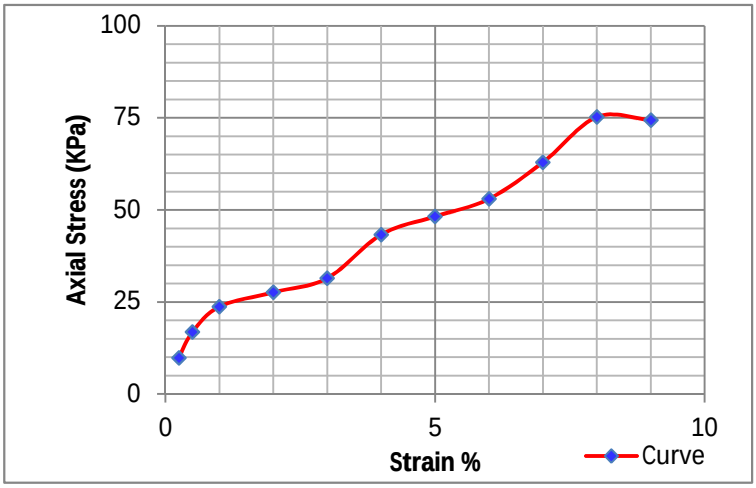
Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location: Chougacha Parchim para Govt. primary school, Gangni Pourashava & Olinagar Daskinpara Jame Moshjid, Bamandi Union

UNCONFINED COMPRESSION STRENGTH TEST

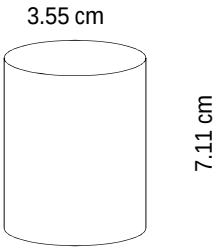


Bore hole No.	BH-10
Sample No.	UD-1
Depth (m)	3.10 to 3.55
Description of soil	Silt with Sand
qu (Kpa)	86.29
% Strain	15.0
γ_{wet} (gm/cc)	1.98
γ_{Dry} (gm/cc)	1.58
% Moisture	25.00
Cohesion (Kpa)	43.14



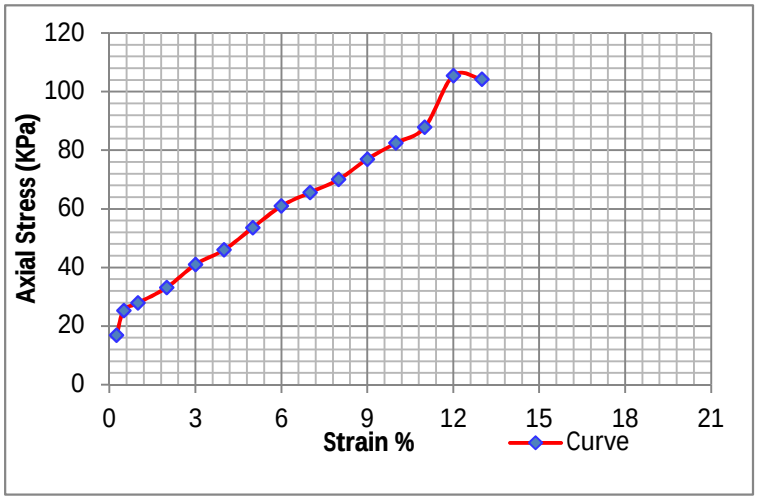


Bore hole No.	BH-21
Sample No.	UD-1
Depth (m)	3.10 to 3.55
Description of soil	Silt with Sand
qu (Kpa)	75.24
% Strain	8.0
γ_{wet} (gm/cc)	2.32
γ_{Dry} (gm/cc)	1.56
% Moisture	48.74
Cohesion (Kpa)	37.62

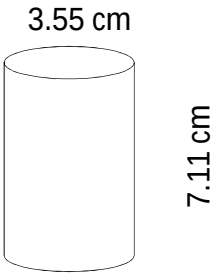


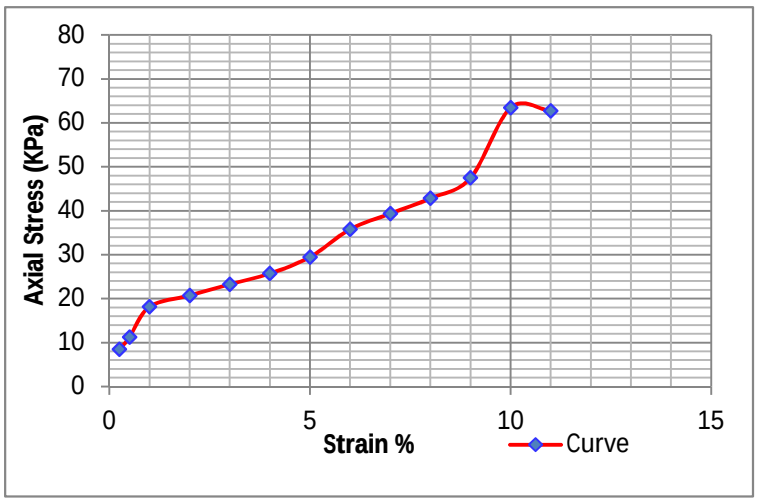
Project :Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location: Shaharbati union complex &Radhagobindhopur Dhola Govt. Primary School, Kathuli Union

UNCONFINED COMPRESSION STRENGTH TEST

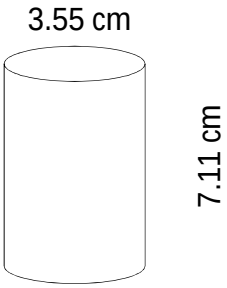


Bore hole No.	BH-22
Sample No.	UD-1
Depth (m)	3.10 to 3.55
Description of soil	Silty With Sand
qu (Kpa)	105.47
% Strain	12.0
γ_{wet} (gm/cc)	1.97
γ_{Dry} (gm/cc)	1.50
% Moisture	31.37
Cohesion (Kpa)	52.73



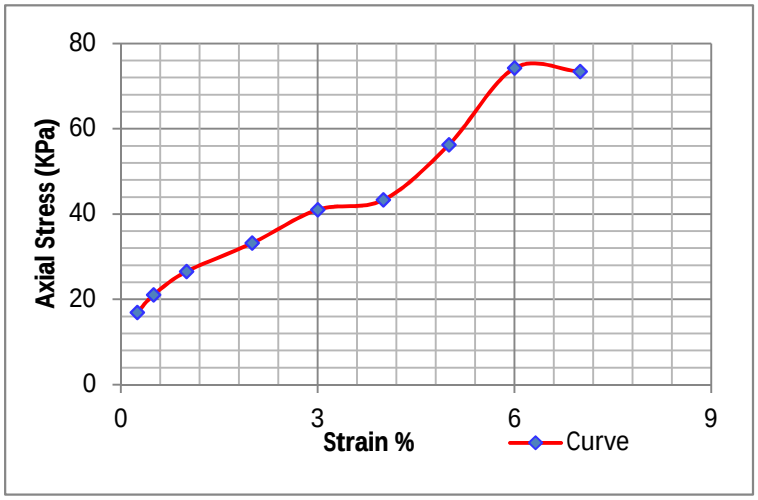


Bore hole No.	BH-23
Sample No.	UD-1
Depth (m)	3.10 to 3.55
Description of soil	Silt with Sand
qu (Kpa)	63.45
% Strain	10.0
γ_{wet} (gm/cc)	2.03
γ_{Dry} (gm/cc)	1.65
% Moisture	22.43
Cohesion (Kpa)	31.72

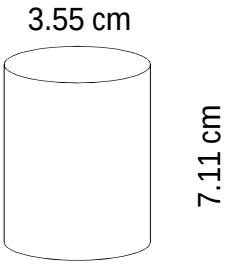


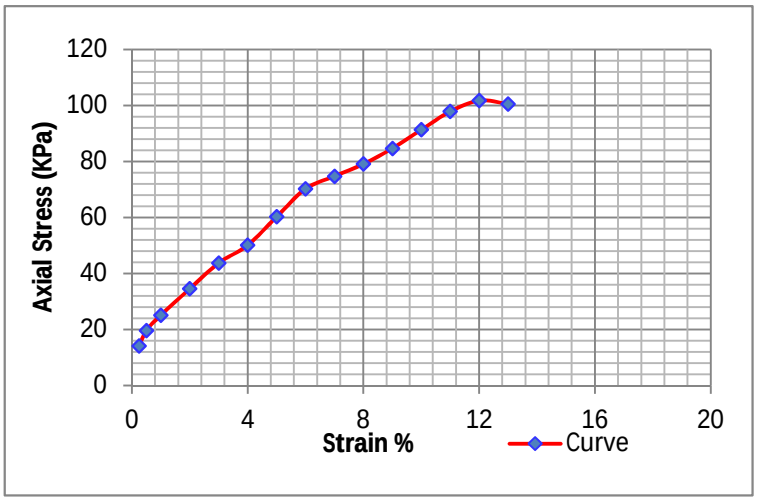
Project :Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location: Village- Akubpur, Near Khalishakundi Bridge, matmura Union & Bamandi Nishipur High School, Bamandi Bus stand, Bamandi Union

UNCONFINED COMPRESSION STRENGTH TEST

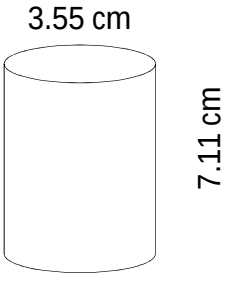


Bore hole No.	BH-24
Sample No.	UD-1
Depth (m)	5.10 to 5.55
Description of soil	Silt with Sand
qu (Kpa)	74.22
% Strain	6.0
γ_{wet} (gm/cc)	1.63
γ_{Dry} (gm/cc)	1.19
% Moisture	36.98
Cohesion (Kpa)	37.11





Bore hole No.	BH-25
Sample No.	UD-1
Depth (m)	3.10 to 3.55
Description of soil	SILT with Sand
qu (Kpa)	101.74
% Strain	12.0
γ_{wet} (gm/cc)	1.85
γ_{Dry} (gm/cc)	1.52
% Moisture	21.76
Cohesion (Kpa)	50.87

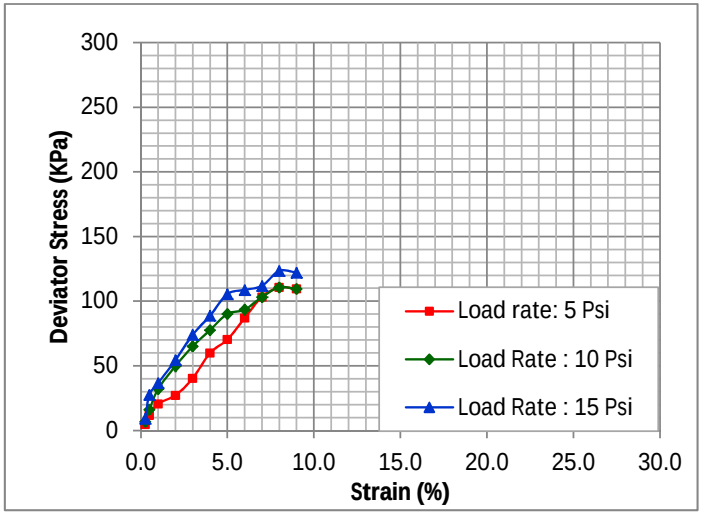


Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location: Dhankhola Govt. primary school, Near Dhankhola union complex, Dhankhola Bazar

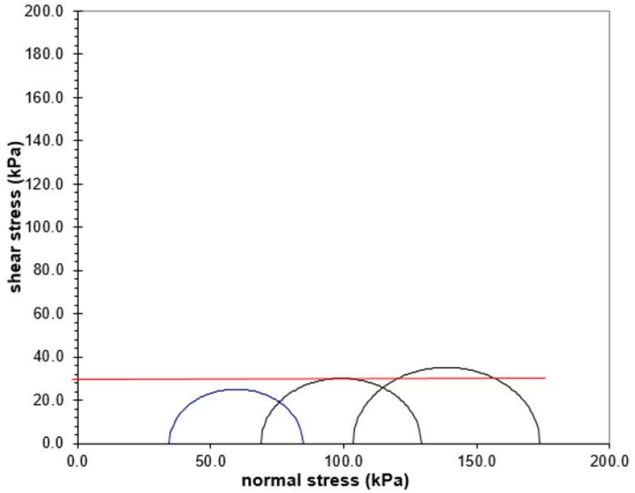
Triaxial Compression Test

(Unconsolidated Undrained)

STRESS-STRAIN DIAGRAM



MOHRS STRESS DIAGRAM



Symbol	Moisture Content (%)	Dry density (g/cc)
	20.15	1.73
	30.79	1.59
	21.92	1.72

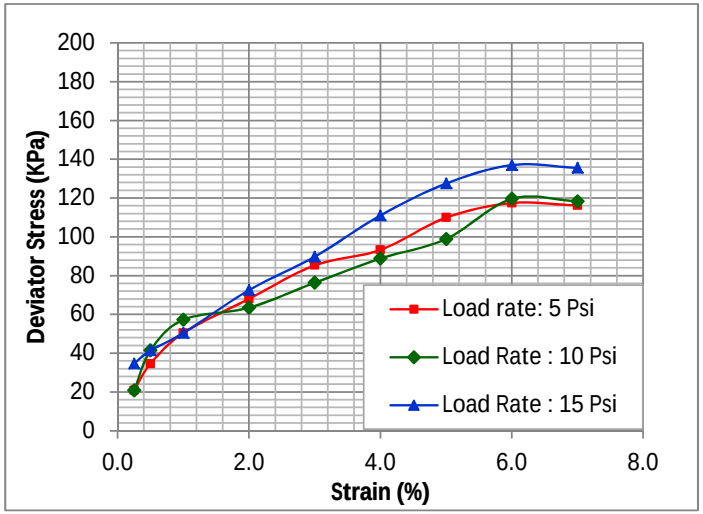
Borehole No.	BH-06
Sample No.	UD-01
Depth (m)	2.10 to 2.55
Cohesion (KPa)	30
Angle of Friction (Degree)	0

Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location: Ekuria Eid gha Mat, Roypur Union

Triaxial Compression Test

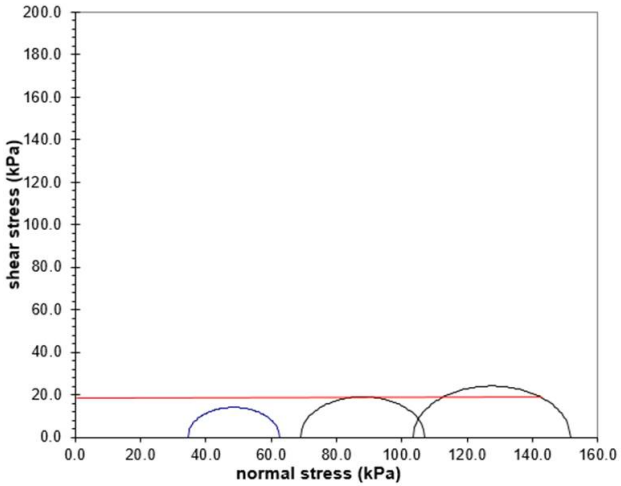
(Unconsolidated Undrained)

STRESS-STRAIN DIAGRAM



Symbol	Moisture Content (%)	Dry density (g/cc)
	29.60	1.55
	21.56	1.73
	19.26	1.72

MOHRS STRESS DIAGRAM



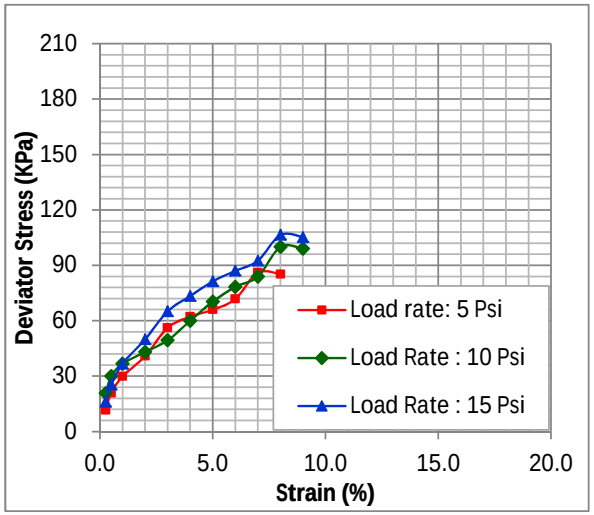
Borehole No.	BH-13
Sample No.	UD-02
Depth (m)	2.10 to 2.55
Cohesion (KPa)	18
Angle of Friction (degree)	0

Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location: Roypur high school, Roypur Bazar, Roypur Union

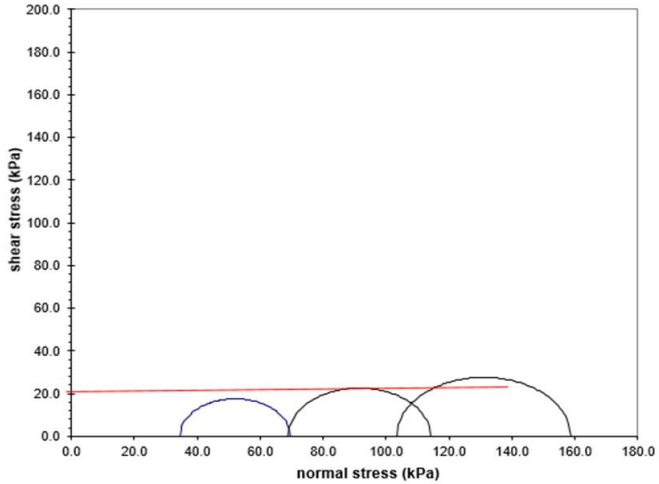
Triaxial Compression Test

(Unconsolidated Undrained)

STRESS-STRAIN DIAGRAM



MOHRS STRESS DIAGRAM



Symbol	Moisture Content (%)	Dry density (g/cc)
	24.32	1.62
	21.21	1.66
	25.38	1.62

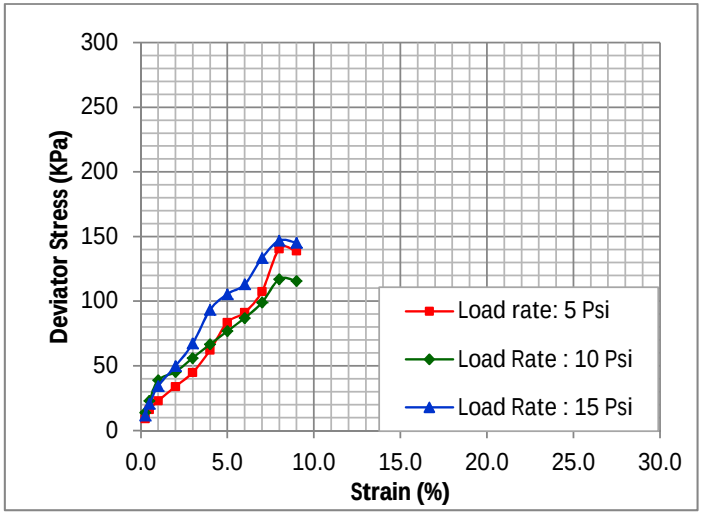
Borehole No.	BH-14
Sample No.	UD-01
Depth (m)	5.10 to 5.55
Cohesion (KPa)	21
Angle of Friction (degree)	0

Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location: Kutubpur School and College, Garabaria, Kathuli Union

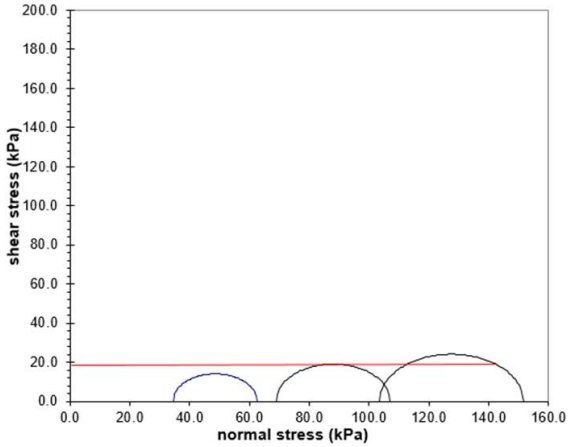
Triaxial Compression Test

(Unconsolidated Undrained)

STRESS-STRAIN DIAGRAM



MOHRS STRESS DIAGRAM



Symbol	Moisture Content (%)	Dry density (g/cc)
	31.15	1.62
	30.59	1.65
	26.37	1.54

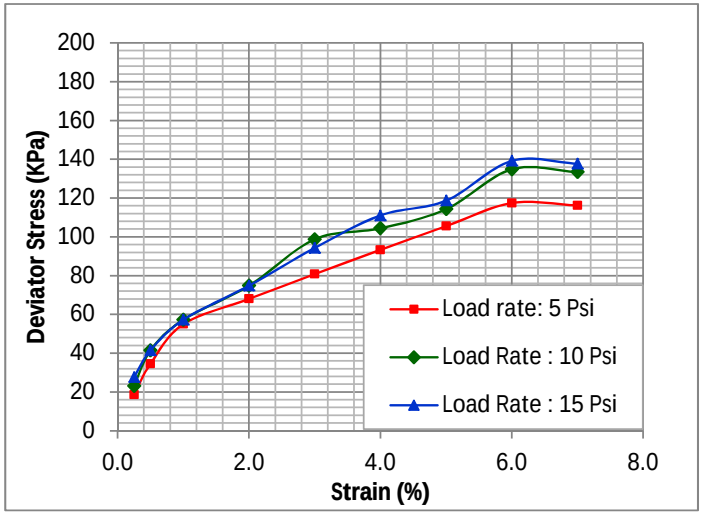
Borehole No.	BH-19
Sample No.	UD-01
Depth (m)	5.10 to 5.55
Cohesion (KPa)	18
Angle of Friction (Degree)	0

Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location: Kumaridanga High School, Kumaridanga, Matmura union

Triaxial Compression Test

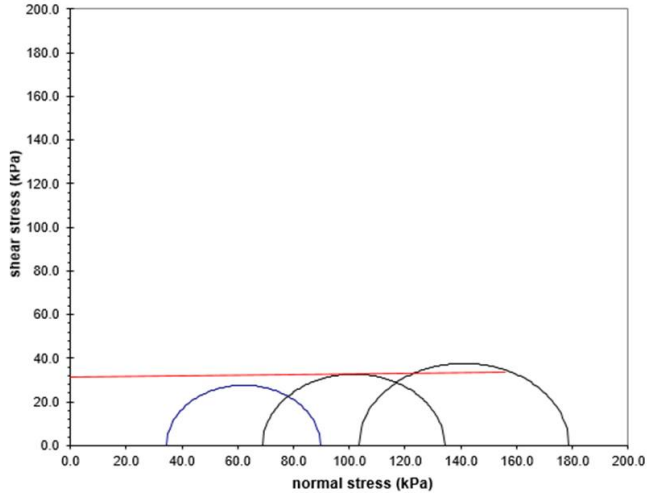
(Unconsolidated Undrained)

STRESS-STRAIN DIAGRAM



Symbol	Moisture Content (%)	Dry density (g/cc)
	28.29	1.52
	26.86	1.55
	28.55	1.60

MOHRS STRESS DIAGRAM



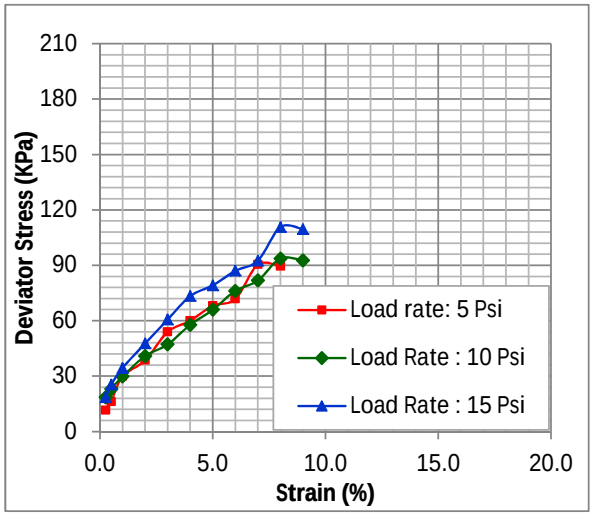
Borehole No.	BH-20
Sample No.	UD-02
Depth (m)	2.10 to 2.55
Cohesion (KPa)	32
Angle of Friction (degree)	0

Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location: Olinagar Daskinpara Jame Moshjid, Bamandi Union

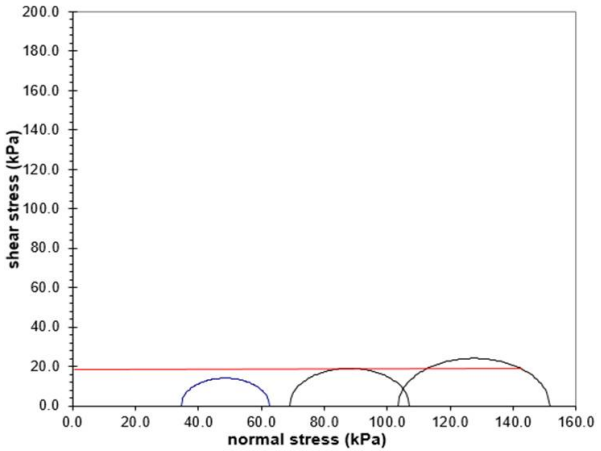
Triaxial Compression Test

(Unconsolidated Undrained)

STRESS-STRAIN DIAGRAM



MOHRS STRESS DIAGRAM



Symbol	Moisture Content (%)	Dry density (g/cc)
	29.63	1.52
	17.44	1.53
	23.88	1.66

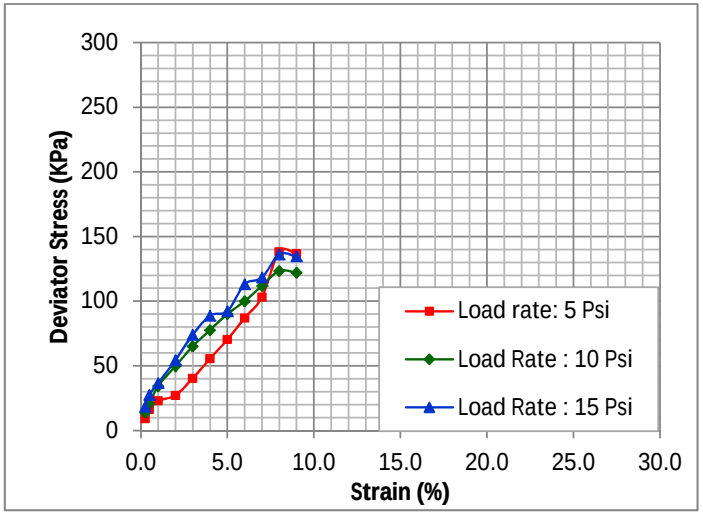
Borehole No.	BH-21
Sample No.	UD-01
Depth (m)	2.10 to 2.55
Cohesion (KPa)	19
Angle of Friction (degree)	0

Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location: Shaharbati union complex

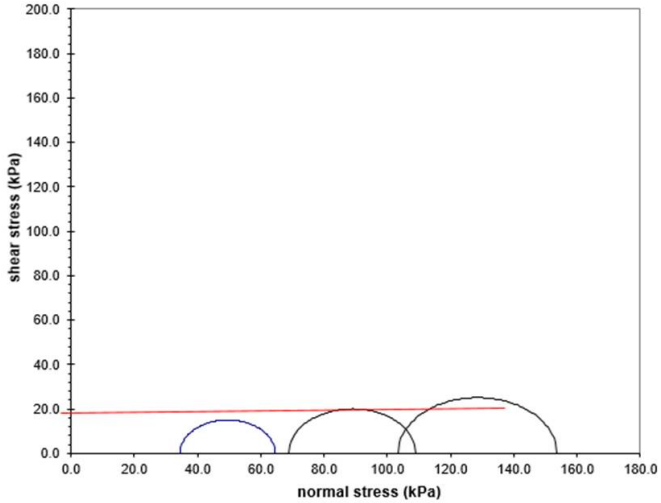
Triaxial Compression Test

(Unconsolidated Undrained)

STRESS-STRAIN DIAGRAM



MOHRS STRESS DIAGRAM



Symbol	Moisture Content (%)	Dry density (g/cc)
	27.34	1.69
	22.58	1.73
	30.83	1.64

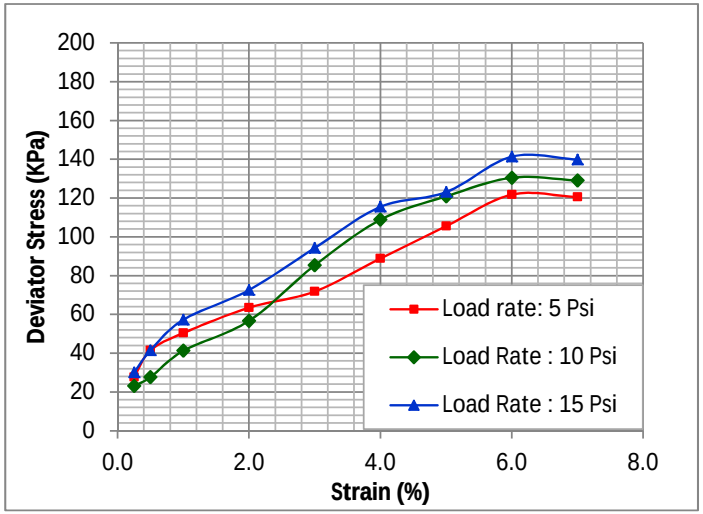
Borehole No.	BH-22
Sample No.	UD-01
Depth (m)	2.10 to 2.55
Cohesion (KPa)	18
Angle of Friction (Degree)	0

Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location: Radhagobindhopur Dhola Govt. Primary School, Kathuli Union

Triaxial Compression Test

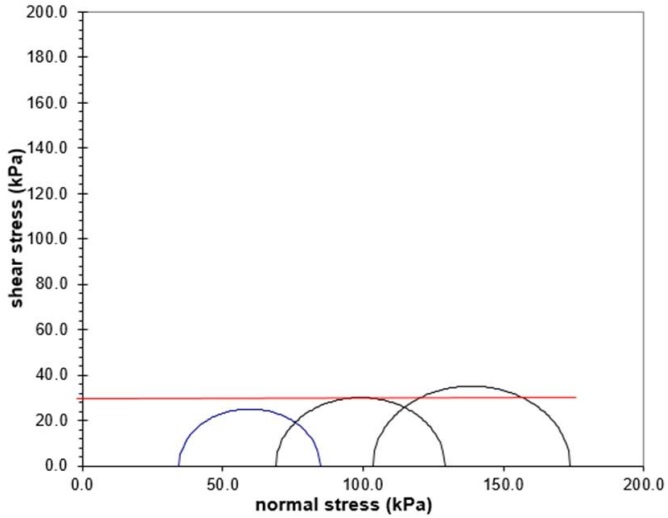
(Unconsolidated Undrained)

STRESS-STRAIN DIAGRAM



Symbol	Moisture Content (%)	Dry density (g/cc)
	22.09	1.69
	32.37	1.59
	28.55	1.60

MOHRS STRESS DIAGRAM



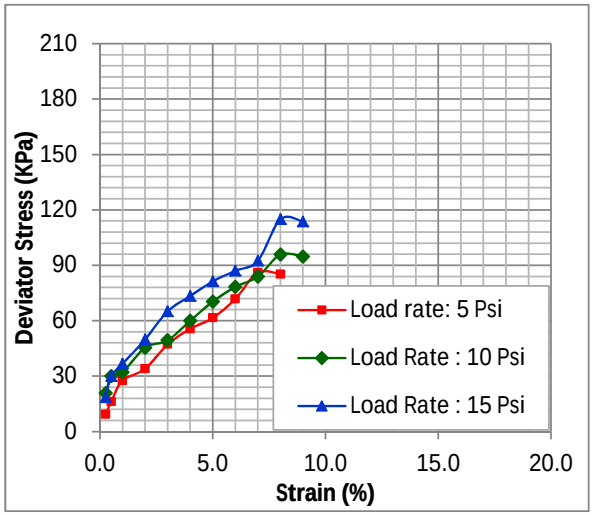
Borehole No.	BH-23
Sample No.	UD-01
Depth (m)	5.10 to 5.55
Cohesion (KPa)	30
Angle of Friction (degree)	0

Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location: Village- Akubpur, Near Khalishakundi Bridge, matmura Union

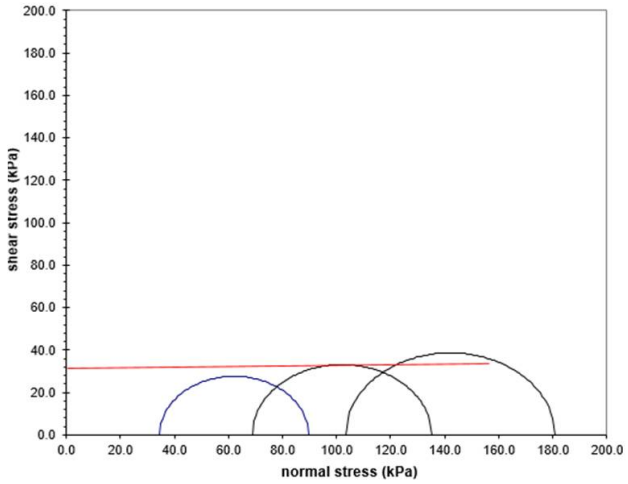
Triaxial Compression Test

(Unconsolidated Undrained)

STRESS-STRAIN DIAGRAM



MOHRS STRESS DIAGRAM



Symbol	Moisture Content (%)	Dry density (g/cc)
	16.20	1.73
	22.25	1.64
	23.43	1.63

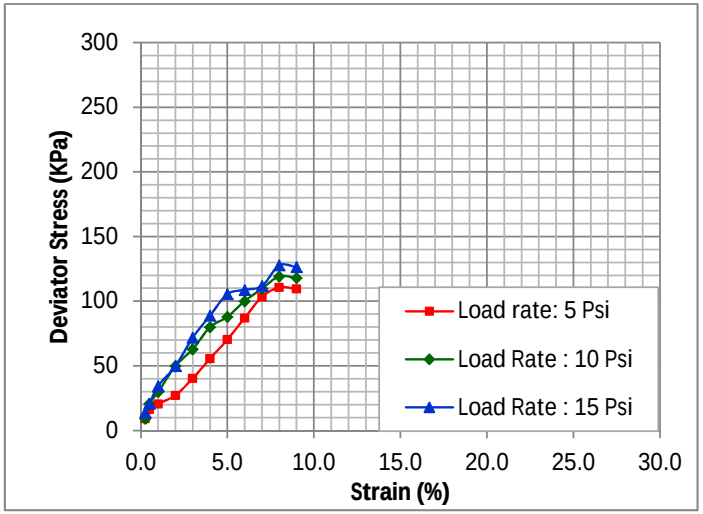
Borehole No.	BH-24
Sample No.	UD-01
Depth (m)	2.10 to 2.55
Cohesion (KPa)	32
Angle of Friction (degree)	0

Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location: Bamandi Nishipur High School, Bamandi Bus stand, Bamandi Union

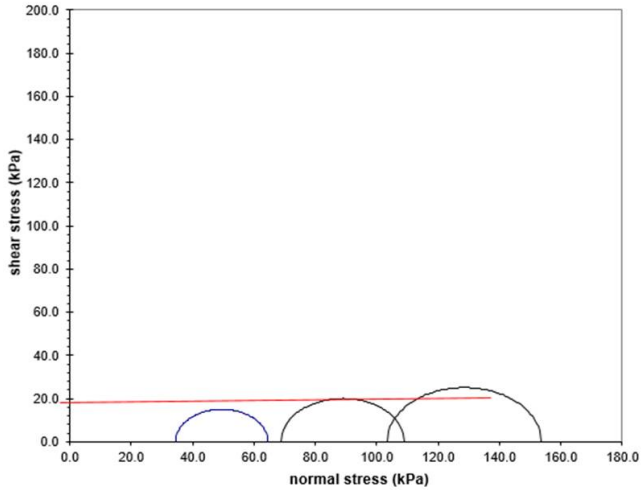
Triaxial Compression Test

(Unconsolidated Undrained)

STRESS-STRAIN DIAGRAM



MOHRS STRESS DIAGRAM



Symbol	Moisture Content (%)	Dry density (g/cc)
	27.42	1.63
	35.86	1.56
	36.16	1.55

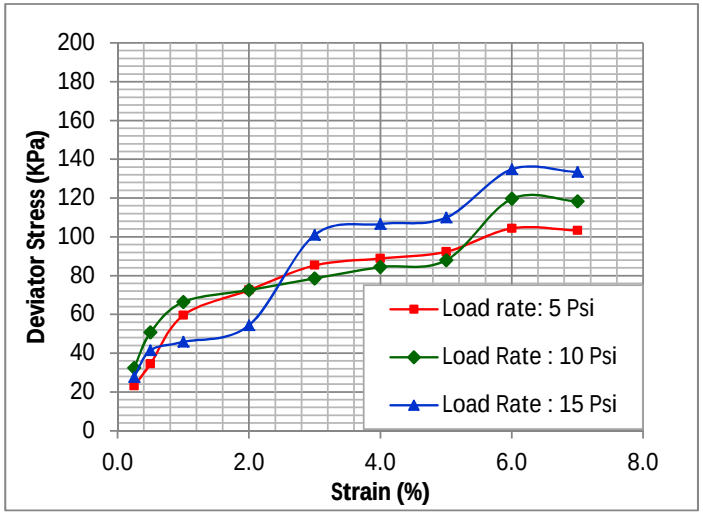
Borehole No.	BH-25
Sample No.	UD-01
Depth (m)	5.10 to 5.55
Cohesion (KPa)	19
Angle of Friction (Degree)	0

Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location: Kormodi Kumarpara jame Moshjid, Tentulbaria Union

Triaxial Compression Test

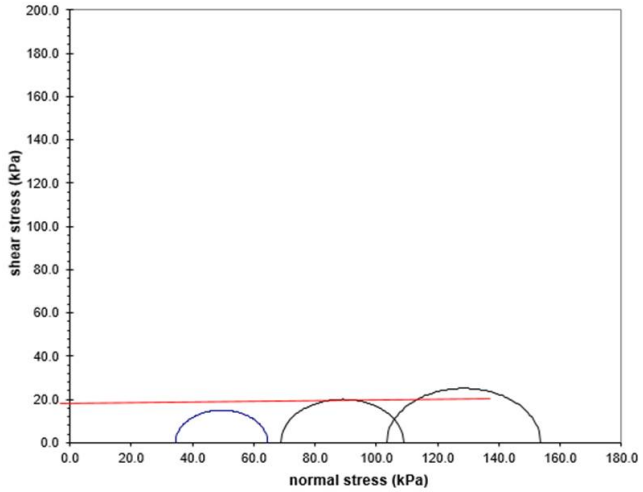
(Unconsolidated Undrained)

STRESS-STRAIN DIAGRAM



Symbol	Moisture Content (%)	Dry density (g/cc)
	27.77	1.55
	25.45	1.69
	25.44	1.69

MOHRS STRESS DIAGRAM



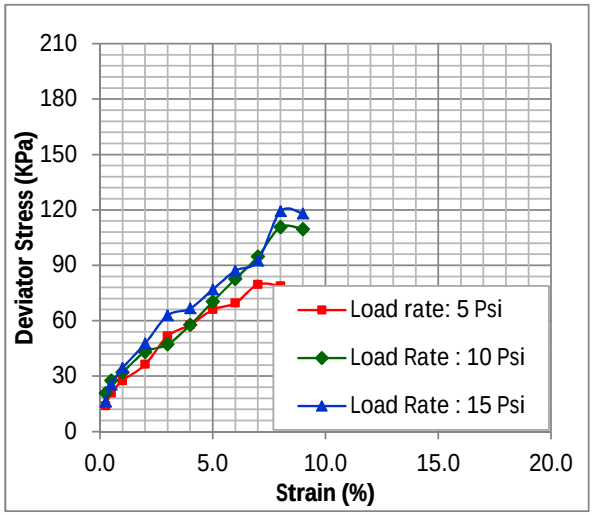
Borehole No.	BH-26
Sample No.	UD-01
Depth (m)	2.10 to 2.55
Cohesion (KPa)	19
Angle of Friction (degree)	0

Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location: Tentulbaria Doyapara govt. primary school, Doyapara, Tentulbaria Union

Triaxial Compression Test

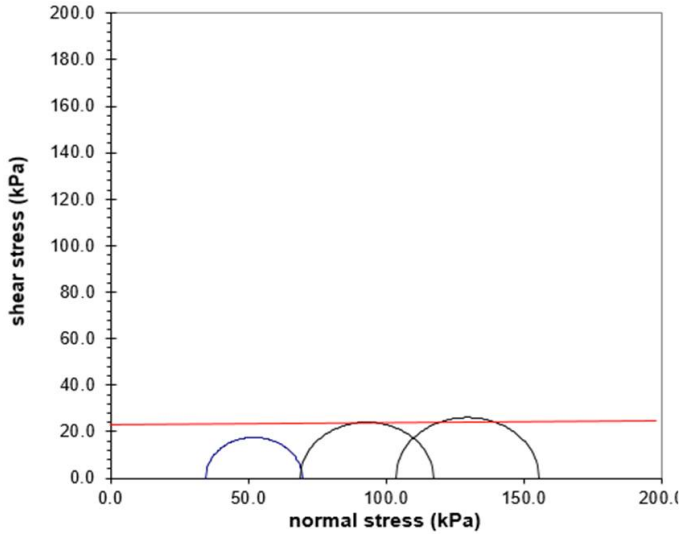
(Unconsolidated Undrained)

STRESS-STRAIN DIAGRAM



Symbol	Moisture Content (%)	Dry density (g/cc)
	27.26	1.55
	24.83	1.64
	21.81	1.69

MOHRS STRESS DIAGRAM



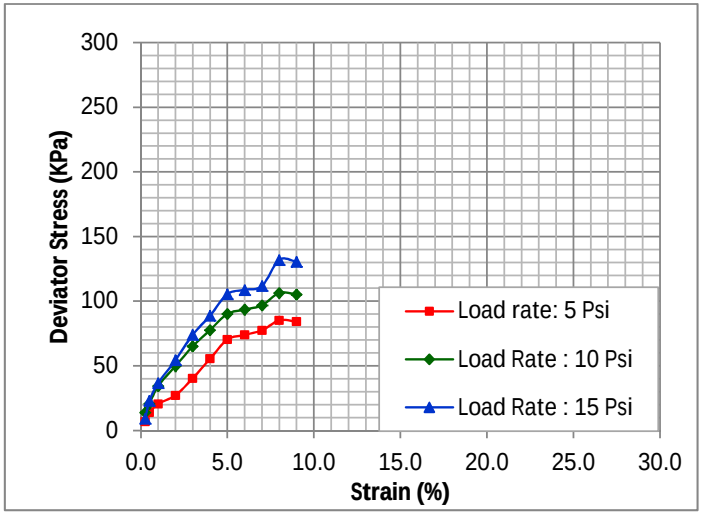
Borehole No.	BH-27
Sample No.	UD-01
Depth (m)	2.10 to 2.55
Cohesion (KPa)	46
Angle of Friction (degree)	0

Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location: Kazipur Mathavanga madhomik Girls School, Hazipara, Kazipur Union

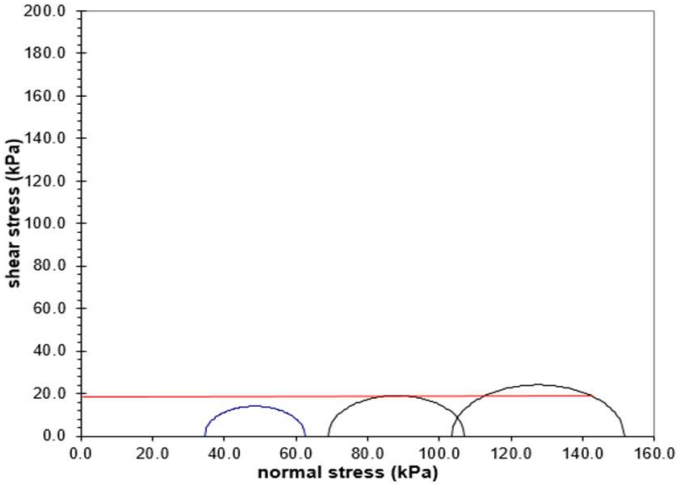
Triaxial Compression Test

(Unconsolidated Undrained)

STRESS-STRAIN DIAGRAM



MOHRS STRESS DIAGRAM



Symbol	Moisture Content (%)	Dry density (g/cc)
	26.33	1.65
	29.99	1.63
	29.71	1.65

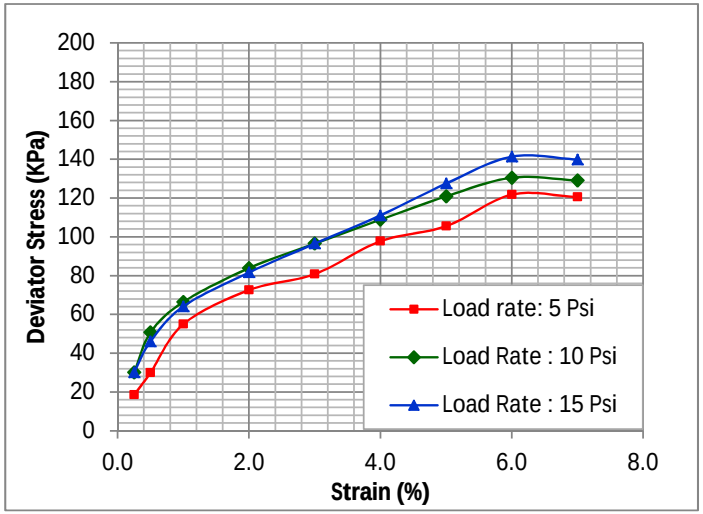
Borehole No.	BH-32
Sample No.	UD-01
Depth (m)	5.10 to 5.55
Cohesion (KPa)	19
Angle of Friction (Degree)	0

Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location: Kazipur College Field, Kazipur Union

Triaxial Compression Test

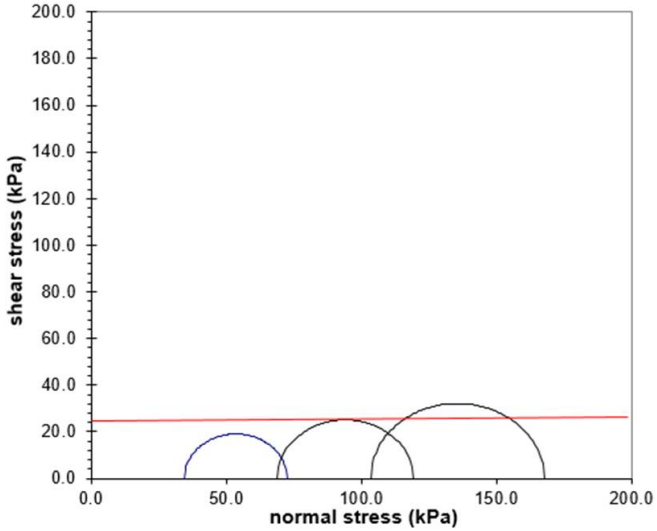
(Unconsolidated Undrained)

STRESS-STRAIN DIAGRAM



Symbol	Moisture Content (%)	Dry density (g/cc)
	28.93	1.63
	18.75	1.69
	31.80	1.62

MOHRS STRESS DIAGRAM



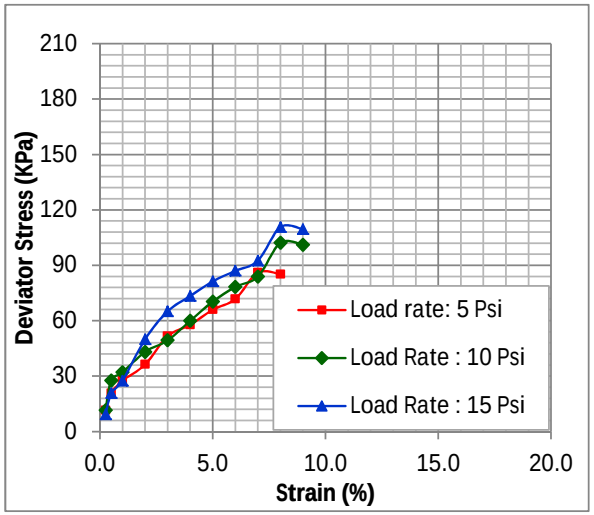
Borehole No.	BH-30
Sample No.	UD-01
Depth (m)	5.10 to 5.55
Cohesion (KPa)	25
Angle of Friction (degree)	0

Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location: Betbaria private high school, Kazipur union

Triaxial Compression Test

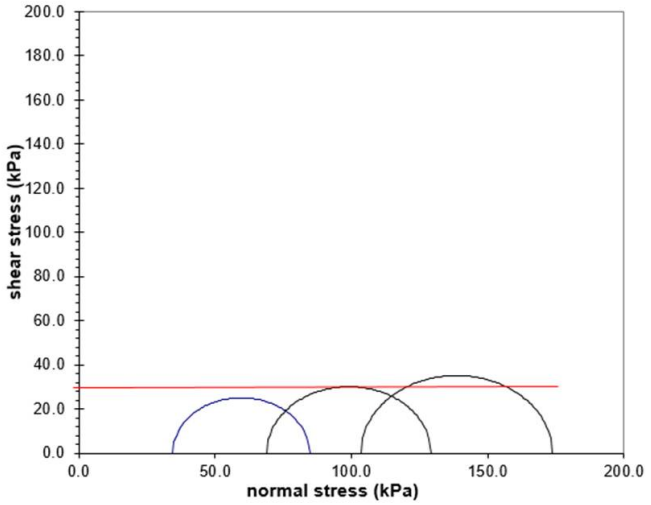
(Unconsolidated Undrained)

STRESS-STRAIN DIAGRAM



Symbol	Moisture Content (%)	Dry density (g/cc)
	23.24	1.63
	27.01	1.62
	26.49	1.60

MOHRS STRESS DIAGRAM



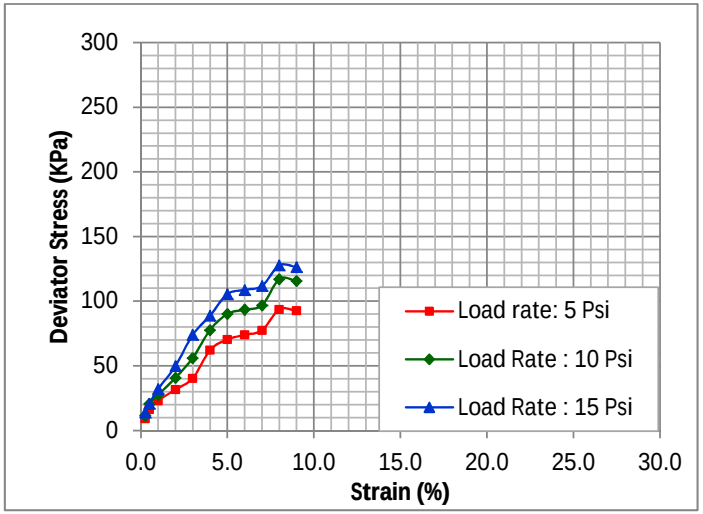
Borehole No.	BH-31
Sample No.	UD-01
Depth (m)	2.10 to 2.55
Cohesion (KPa)	30
Angle of Friction (degree)	0

Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location: Chougacha Parchim para Govt. primary school, Gangni Pourashava

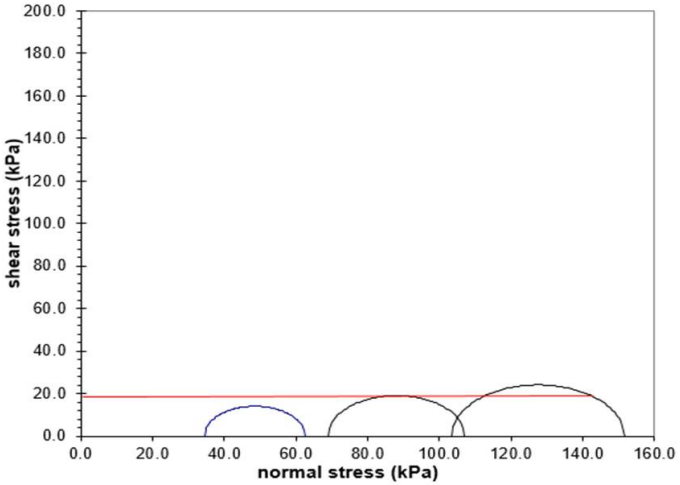
Triaxial Compression Test

(Unconsolidated Undrained)

STRESS-STRAIN DIAGRAM



MOHRS STRESS DIAGRAM



Symbol	Moisture Content (%)	Dry density (g/cc)
	35.25	1.59
	37.67	1.56
	30.49	1.61

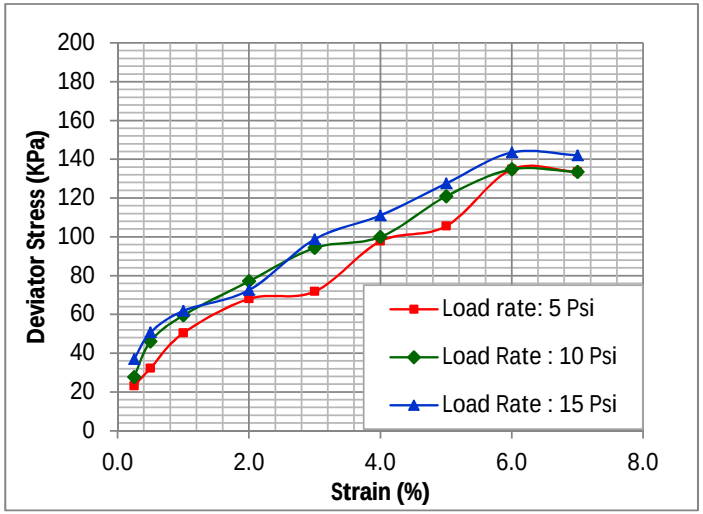
Borehole No.	BH-10
Sample No.	UD-01
Depth (m)	5.10 to 5.55
Cohesion (KPa)	19
Angle of Friction (Degree)	0

Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location: Mahamadhpur Hafizia Madrasha, Mahamadhpur Bazar, Matmura Union

Triaxial Compression Test

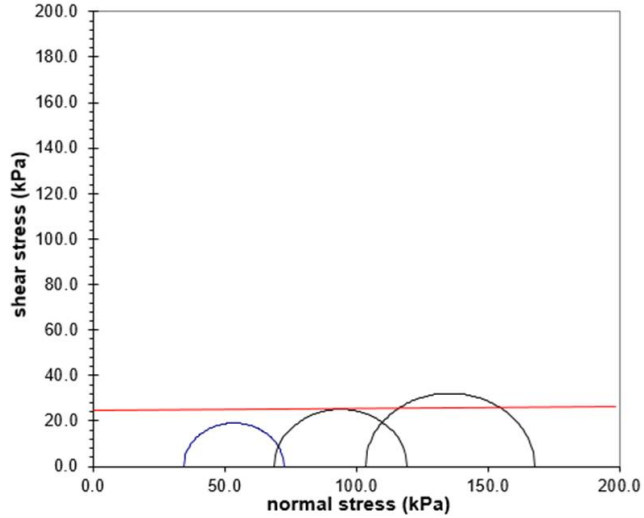
(Unconsolidated Undrained)

STRESS-STRAIN DIAGRAM



Symbol	Moisture Content (%)	Dry density (g/cc)
	31.81	1.62
	27.43	1.62
	32.39	1.63

MOHRS STRESS DIAGRAM



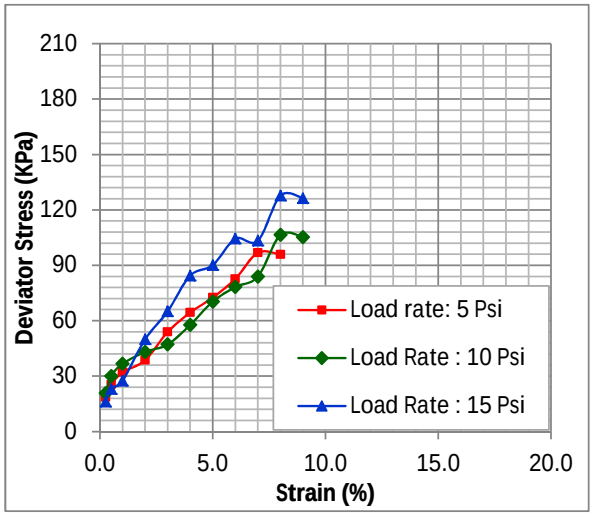
Borehole No.	BH-28
Sample No.	UD-01
Depth (m)	2.10 to 2.55
Cohesion (KPa)	25
Angle of Friction (degree)	0

Project : Preparation of Development Plan for Fourteen Upazilas(Package-3)
Location: Juger gofa Govt. primary school, Shola taka Union

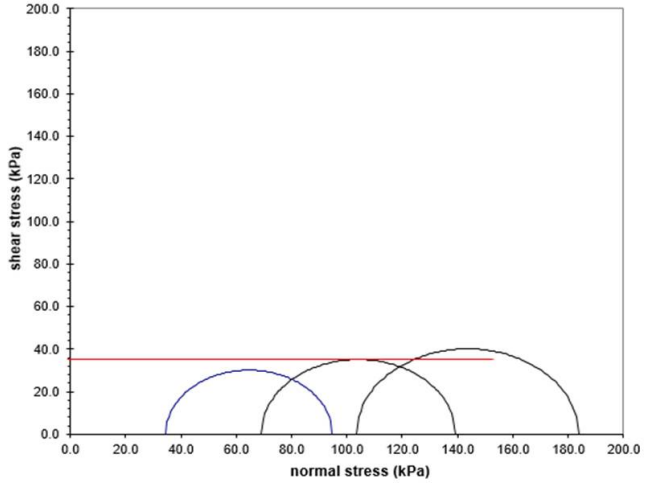
Triaxial Compression Test

(Unconsolidated Undrained)

STRESS-STRAIN DIAGRAM



MOHRS STRESS DIAGRAM

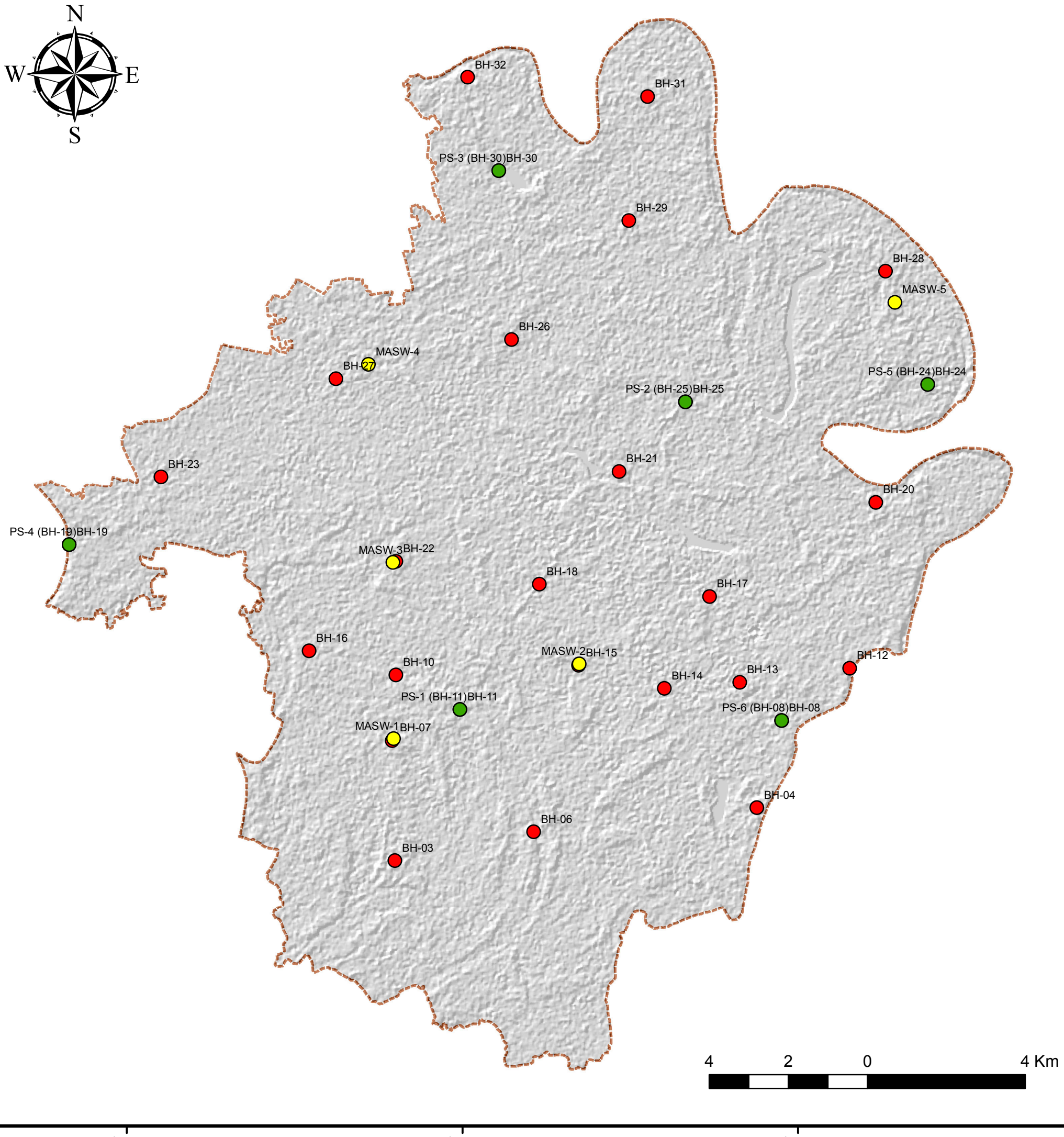


Symbol	Moisture Content (%)	Dry density (g/cc)
	28.31	1.59
	23.51	1.62
	24.73	1.66

Borehole No.	BH-17
Sample No.	UD-01
Depth (m)	2.10 to 2.55
Cohesion (KPa)	19
Angle of Friction (degree)	0

Appendix E

All Thematic Maps and Final Infrastructure Suitability Map



Geotechnical and Geophysical Test locations of Gangni Upazila

Legend

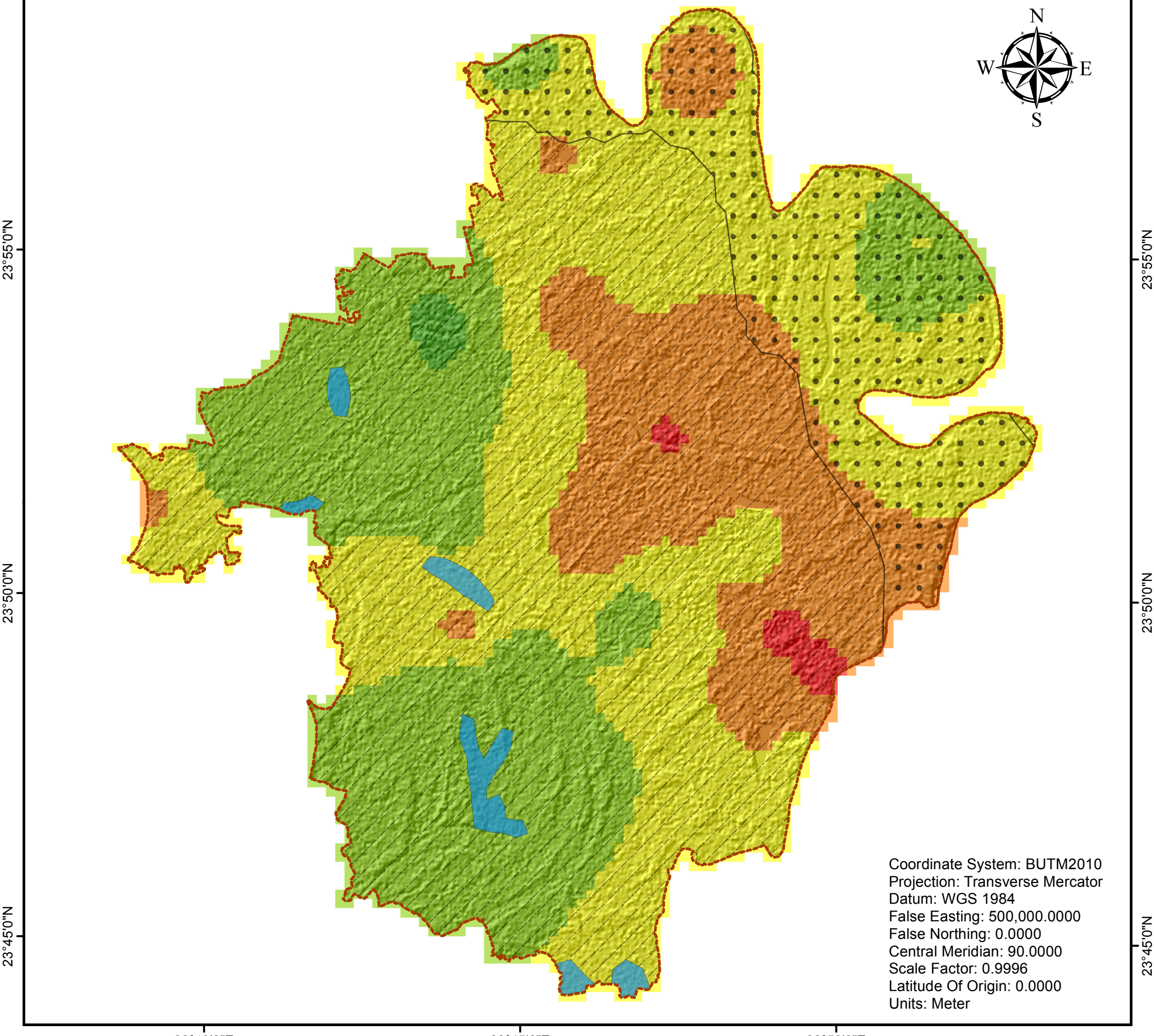
Work Locations

Geotechnical and Geophysical Test

- Standard Penetration Test (SPT) Drilling
- Multi-channel Analysis of Surface Wave (MASW)
- Downhole Seismic Test (PS Logging)
- Upazila Boundary

This map has been produced by ploting the co-ordinates of all the Geotchnical and Geophysical works which was aquired during field investigation. The drilling depth of those boroholes are up to 30m from the existing ground level (EGL).

Coordinate System: BUTM2010
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: 90.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter



Engineering Geological Map based on Avarage Shear wave Velocity (upto30m)

Legend

Upazila Boundary

Surface Geology Units

Deltaic sand

Deltaic silt

Water

Soil Classification Type

D2 - Stiff/Dense Soil

D3 - Medium Stiff to Stiff/Medium Dense to Dense Soil

D4 - Medium Stiff/Medium Dense Soil

D5 - Soft/Loose to Medium Stiff/Medium Dense Soil

E- Very Soft to Soft/ Very Loose to Loose Soil

Site Class	Site class description	Shear wave velocity (m/sec)	
		Min	Max
A	**HARD ROCK** Eastern United States only	1500	
B	**ROCK**	760	1500
C	**VERY DENSE SOIL AND SOFT ROCK** Unstrained shear strength u_s> 2000psf (u_s= 100kPa) or N = 50 blows/ft	360	760
D	**STIFF SOILS** Stiff soil with undrained shear strength 1000psf = u_s = 2000psf (50KPa < u_s< 100KPa) or 15 = N = 50 blows/ft	180	360
E	**SOFT SOILS** Profile with more than 10 ft (3m) of soft clay defined as soil with plasticity index PI > 20, moisture content w > 40% and undrained shear strength u_s< 1000psf (50kpa) (N = 15 blows/ft)		180
F	**SOILS REQUIRING SITE SPECIFIC EVALUATIONS** **1. Soils vulnerable potential failures or collapse under seismic loading:** e.g., liquefiable soils, quick and highly sensitive clays, collapse weakly connected soils. **2. Peats and/or highly organic clays:** (10ft (3m) or thicker layer) **3. Very high plasticity clays:** (25ft (8m) or thicker layer with plasticity index > 75) **4. Very thick soft/medium stiff clays:** (120ft (36m) or thicker layer)		

Site Classes, Soil Profile Names, and Minimum Criteria based on NEHRP (National Earthquake Hazard Reduction Program, USA) provisions

This map was produced by interpolating velocity of the soil layer in different Bore hole. Afterward it was classified by their velocity range according to according to a method provided by NEHRP (stands for National Earthquake Hazard Reduction Program, USA) Provisions but as most of the shear wave velocity of soil is within 173-268m/s the classification was modified as follows.

Ground Class	V_{s30}	Soil Type
C	360 - 760 m/sec	Very Dense/ Hard Soil and Soft rock
D1	300 - 360 m/sec	Stiff / Dense to very dense/Hard Soil
D2	250 - 300 m/sec	Stiff / Dense Soil
D3	220 - 250 m/sec	Medium Stiff to Stiff / Medium Dense to Dense Soil
D4	200 - 220 m/sec	Medium Stiff / Medium Dense Soil
D5	180 - 200 m/sec	Soft/Loose to Medium Stiff/ Medium Dense Soil
E	- 180 m/sec	Very Soft to Soft / Very Loose to Loose Soil

Modified classification of the soils applied in this study

Scale:

1 centimeter = 1.05 kilometers

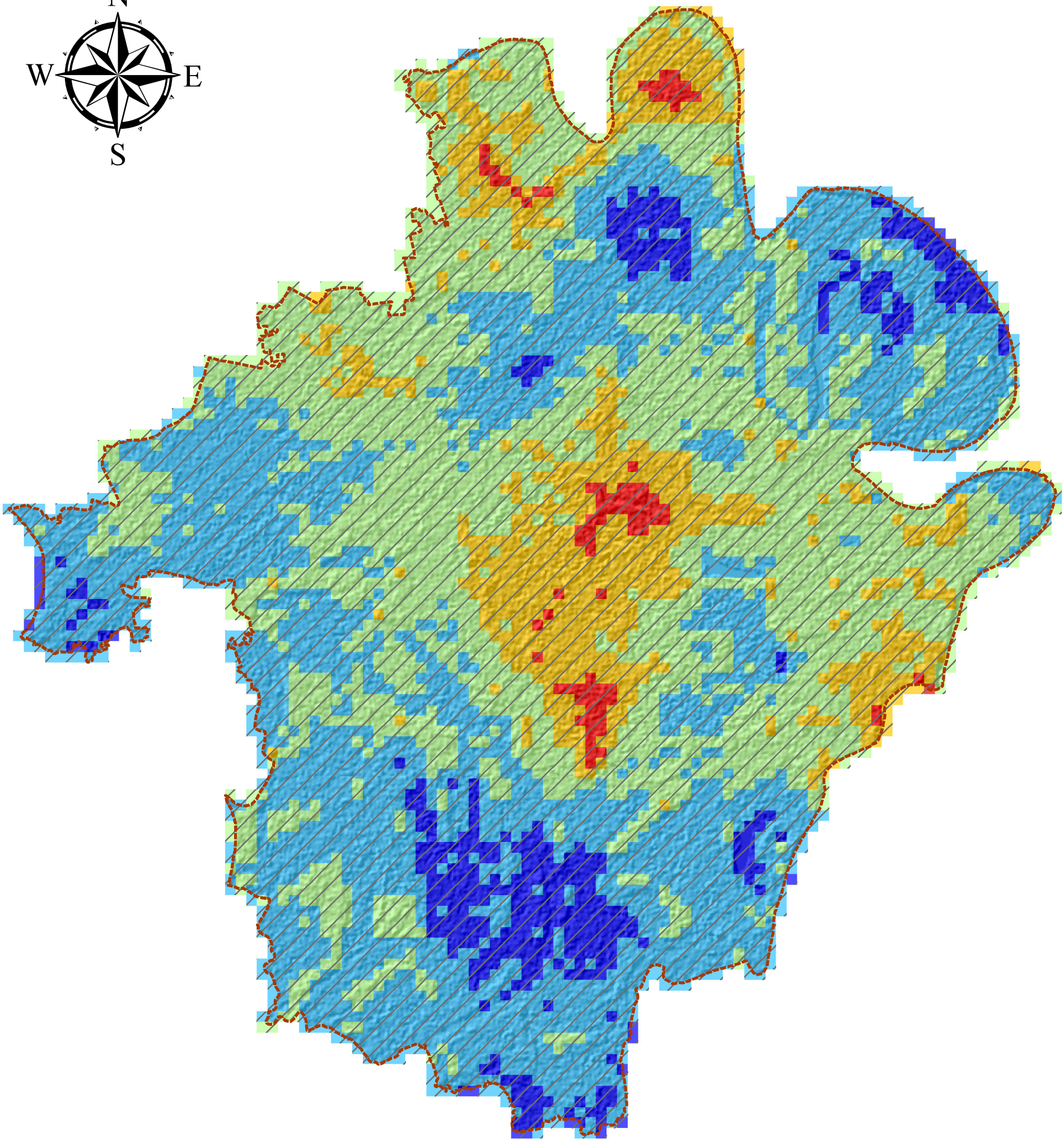
4 2 0 4 Km

Geological Survey of Gangni Upazila

88°40'0"E 88°45'0"E 88°50'0"E

23°55'0"N 23°50'0"N 23°45'0"N

N W E S



Foundation Layer Recommendation Map

Legend

Upazila Boundary

Engineering Soil Layers

Foundation Depth (m) from EGL

- 5.5 - 10.0
- 10.1 - 14.0
- 14.1 - 18.0
- 18.1 - 22.0
- 22.1 - 25.5

Foundation Classes

Deep Foundation (Depth Greater than 5m from EGL)

1 centimeter = 1 kilometers

4 2 0 4 Km

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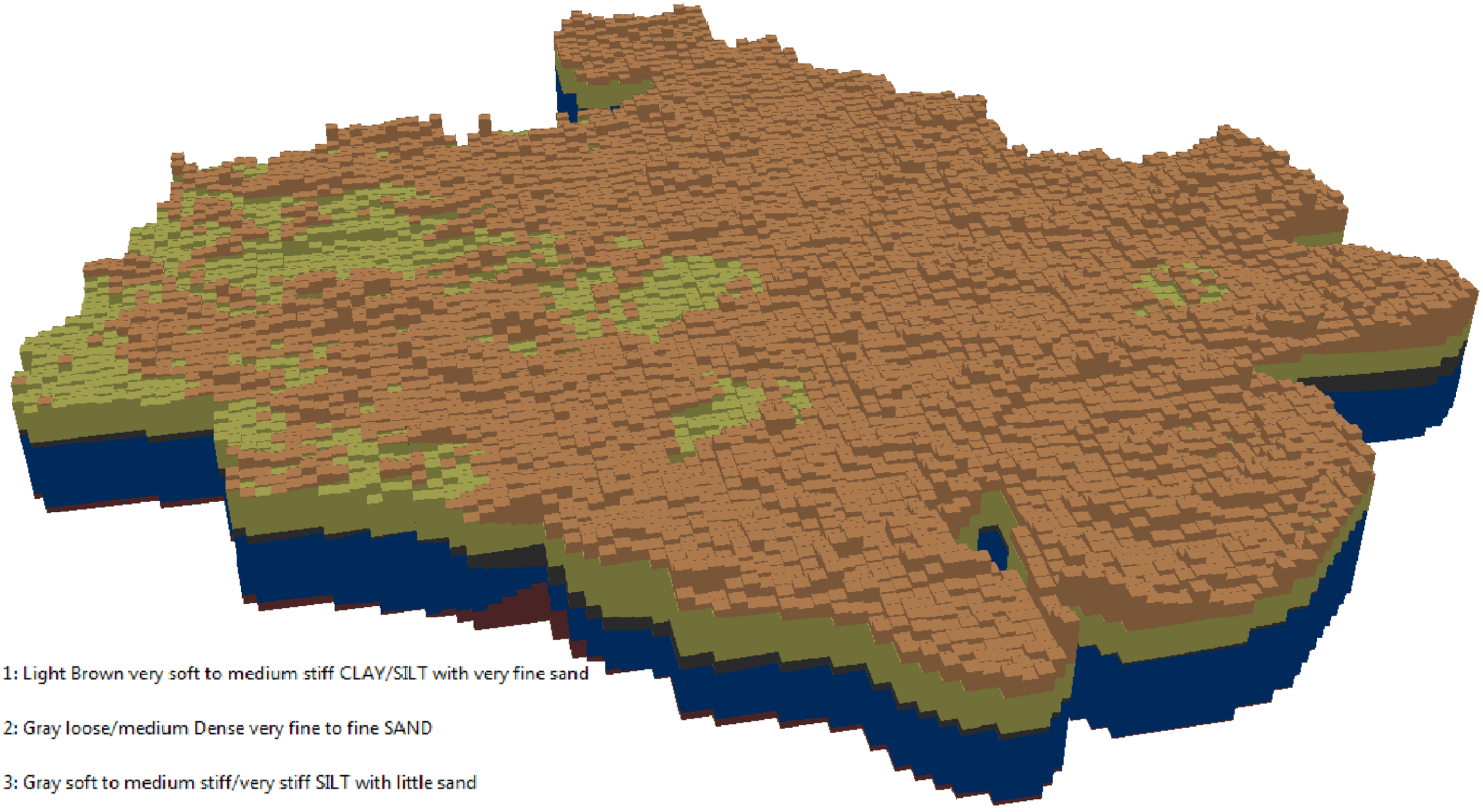
Coordinate System: BUTM2010
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: 90.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Subsurface Lithological 3D Model



Layer 1: Light Brown very soft to medium stiff CLAY/SILT with very fine sand

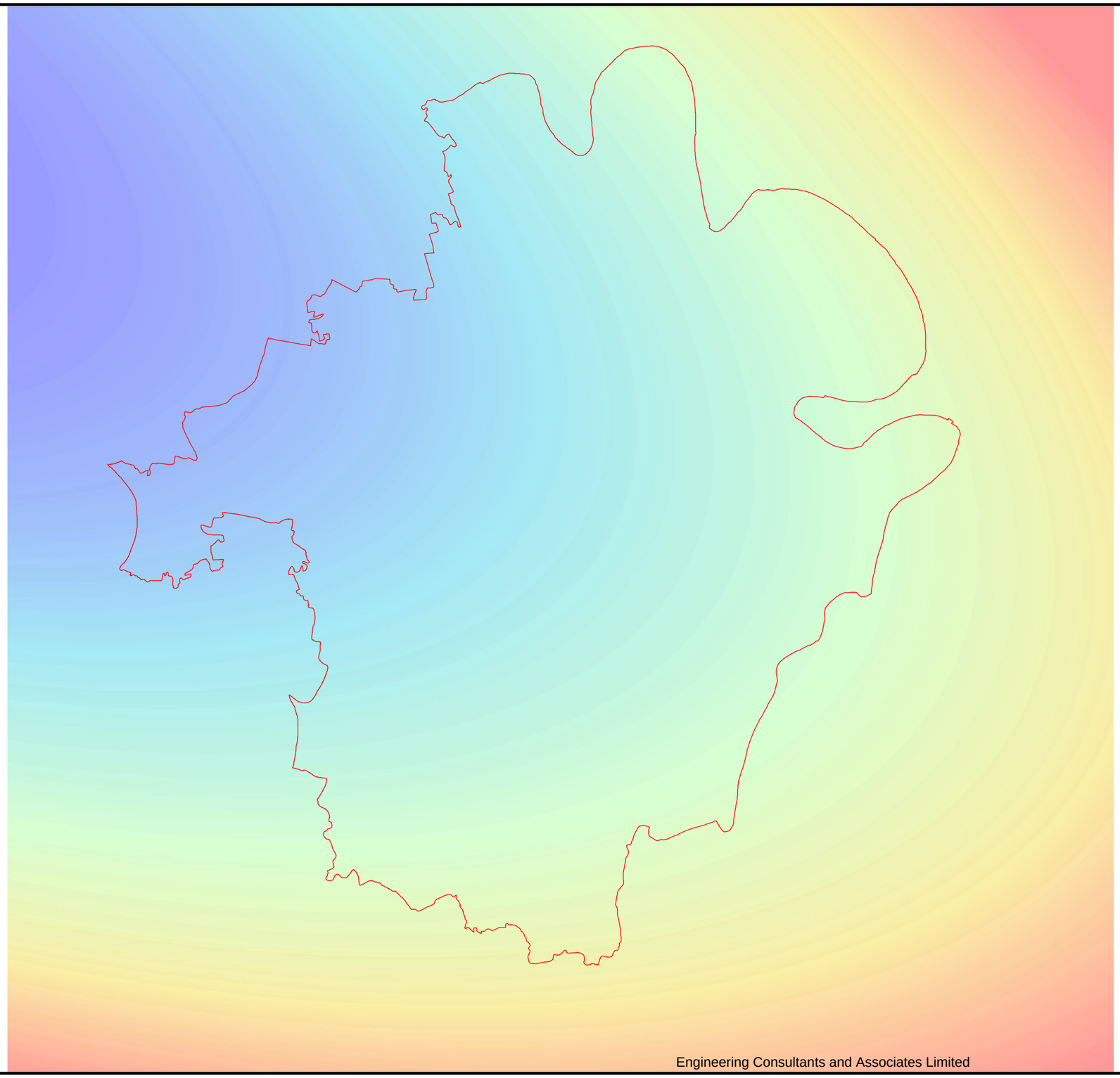
Layer 2: Gray loose/medium Dense very fine to fine SAND

Layer 3: Gray soft to medium stiff/very stiff SILT with little sand

Layer 4: Gray medium Dense to Dense fine to medium SAND

Layer 5: Gray stiff CLAY

Peak Ground Acceleration (PGA) (g) at Engineering SeismicBaserock (Vs30=760 m/sec) Corresponding to a Probabillity of Exceedance of 10% in 50 years



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PGA(g)

0.268
0.262
0.256
0.250
0.244

N
W
E
S

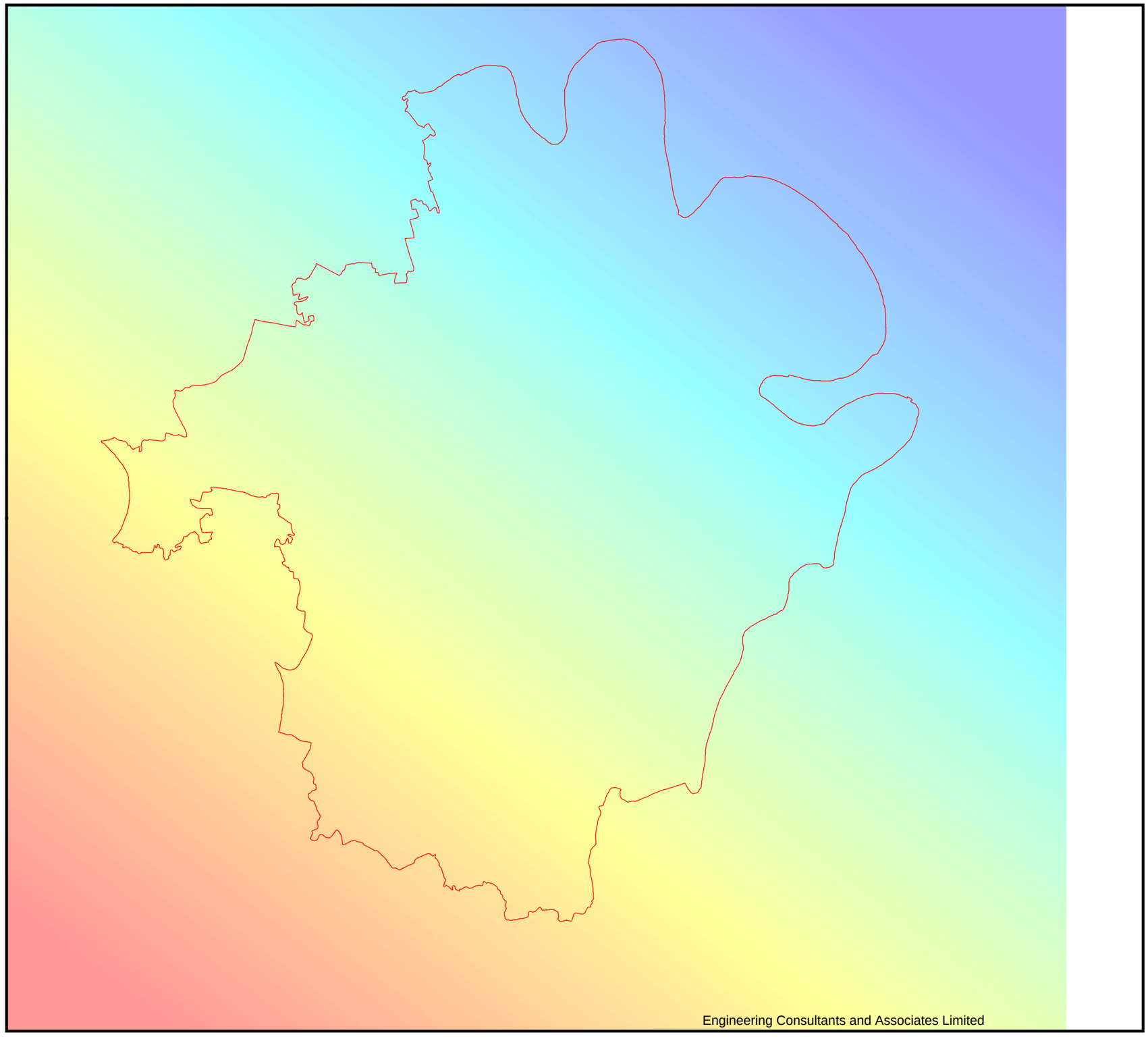
Coordinate System:
WGS 1984 UTM Zone 46N
Projection: Transverse Mercator
Datum: WGS 1984

1:125,000

0 1 2 4 6 8 10 Km

The probabilistic analysis was performed using the CRISIS2007 developed by Mario Ordaz et Al 2007), Engineering Institute National Autonomous University of Mexico (UNAM). This program calculates seismic hazard using the standard methodology for probabilistic seismic hazard analysis. Earthquake data of past hundred years and characteristics of tectonically active faults in and around Bangladesh were considered for this analysis.

Spectral Acceleration (SA) (g) for 0.2 sec Structural period at Engineering Seismic Baserock (Vs30=760 m/sec) Corresponding to a Probabillity of Exceedance of 10% in 50 years



Legend

SA 0.2 sec (g)

Value

0.540

0.507

0.475

0.442

N

W E

S

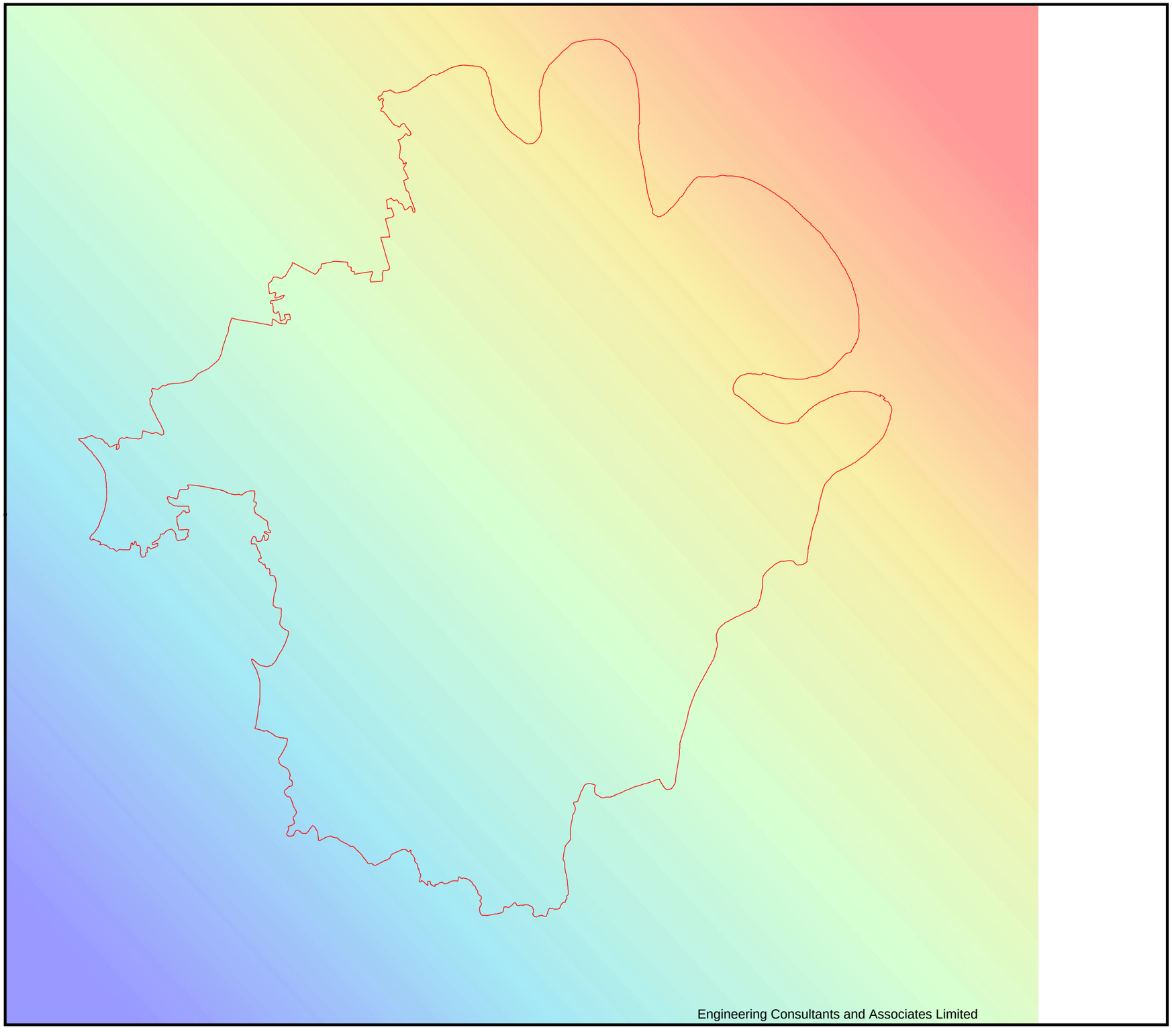
Coordinate System:
WGS 1984 UTM Zone 46N
Projection: Transverse Mercator
Datum: WGS 1984

1:125,000

0 1 2 4 6 8 10 Km

The probabilistic analysis was performed using the CRISIS2007 developed by Mario Ordaz et Al 2007), Engineering Institute National Autonomous University of Mexico (UNAM). This program calculates seismic hazard using the standard methodology for probabilistic seismic hazard analysis. Earthquake data of past hundred years and characteristics of tectonically active faults in and around Bangladesh were considered for this analysis.

Spectral Acceleration (SA) (g) for 1 sec Structural period at Engineering Seismic Baserock (Vs30=760 m/sec) Corresponding to a Probabillity of Exceedance of 10% in 50 years



Engineering Consultants and Associates Limited

SA for 1sec (g)

- 0.154
- 0.151
- 0.148
- 0.145
- 0.142

N
W E
S

Coordinate System:
WGS 1984 UTM Zone 46N
Projection: Transverse Mercator
Datum: WGS 1984

1:125,000

0 1 2 4 6 8 10 Km

The probabilistic analysis was performed using the CRISIS2007 developed by Mario Ordaz et Al 2007), Engineering Institute National Autonomous University of Mexico (UNAM). This program calculates seismic hazard using the standard methodology for probabilistic seismic hazard analysis. Earthquake data of past hundred years and characteristics of tectonically active faults in and around Bangladesh were considered for this analysis.

88°40'0"E 88°45'0"E 88°50'0"E

23°55'0"N 23°50'0"N 23°45'0"N

N

Coordinate System: BUTM2010
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: 90.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

5 2.5 0 5 Km

Peak Ground Acceleration (PGA) (g) at Engineering Seismic Ground Surface (Depth upto 30m) Corresponding to a Probabillity of Exceedance of 10% in 50 years

Boundary

Provable Earthquake Intensity

Intensity and Shaking

VII, Very Strong

Probabilities Seismic Hazard Assessment (PSHA)

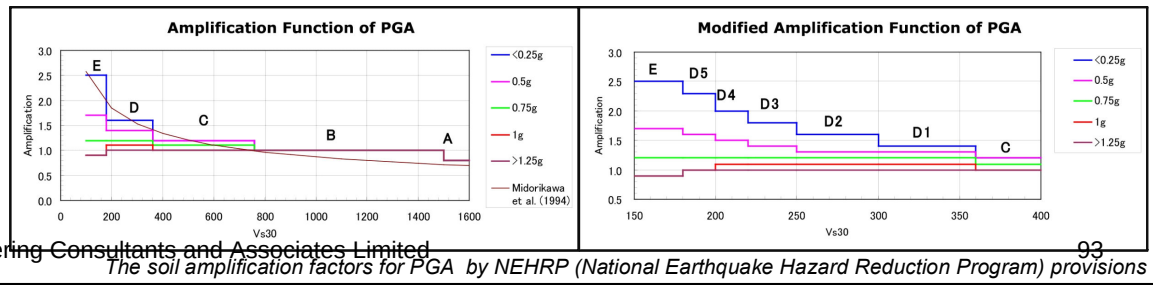
Earthquake Sensittivity with Peak Ground Acceleration (PGA)

1st Degree Sensetive (PGA 0.43g to 0.39g)

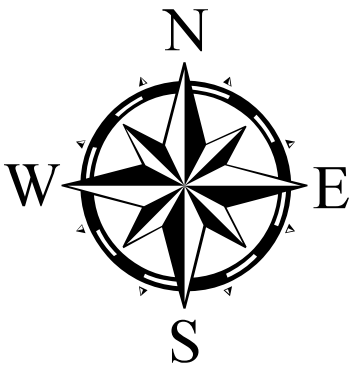
2nd Degree Sensetive (PGA 0.39g to 0.36)

3rd Degree Sensetive (PGA 0.36g to 0.32g)

This map was produced by multiplying PGA values with Amplification factors corresponded for different soil type. as the Vs is within 173-268m/s so soil was classified as (E,D5,D4,D3,D2). thus the amplification factor was also modified. Spectral Accelaration (PGA) (g) at Engneering Ground Surface(Depth upto 30) corresponging to probalility of exceedance of 10% in 50 year was count for each grid.



The soil amplification factors for PGA by NEHRP (National Earthquake Hazard Reduction Program) provisions



88°40'0"E 88°45'0"E 88°50'0"E

23°55'0"N 23°50'0"N 23°45'0"N

0 1 2 4 6 8 Km

Coordinate System: WGS 1984 UTM Zone 45N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: 87.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Spectral Acceleration (SA) (g) for 0.2 sec Structural period at Engineering Seismic Ground Surface (Depth upto 30m) Corr-esponding to a Probabillity of Exceedance of 10% in 50 years

Boundary

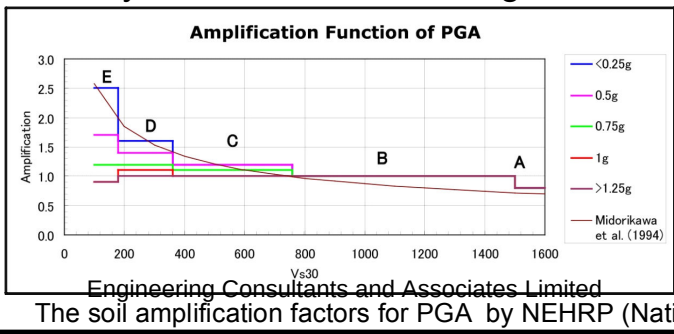
SA 0.2sec (g)

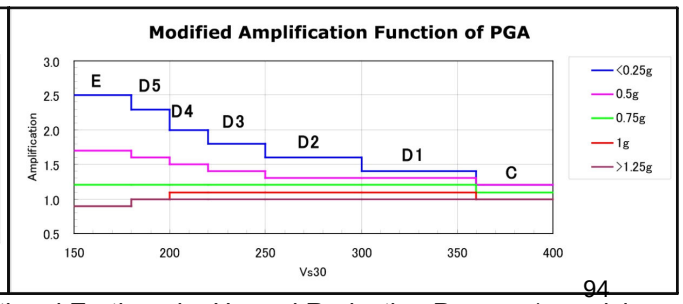
0.6000 - 0.6833

0.6834 - 0.7646

0.7647 - 0.8496

This map was produced by multiplying SA values with Amplification factors corresponded for different soil type. as the Vs is within 173-268m/s so soil was classified as (E,D5,D4,D3,D2). Thus the amplification factor was also modified. Spectral Accelaration for 0.2 sec at Engneering Ground Surface(Depth upto 30) corresponging to probalility of exceedance of 10% in 50 year was count for each grid.





The soil amplification factors for PGA by NEHRP (National Earthquake Hazard Reduction Program) provisions

88°40'0"E 88°45'0"E 88°50'0"E

23°55'0"N 23°50'0"N 23°45'0"N

N W E S

Coordinate System: BUTM2010
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: 90.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

0 1 2 4 6 8 Km

Spectral Acceleration (SA) (g) for 1 sec Structural period at Engineering Seismic Ground Surface (Depth upto 30m) Corr-esponding to a Probabillity of Exceedance of 10% in 50 years

Boundary

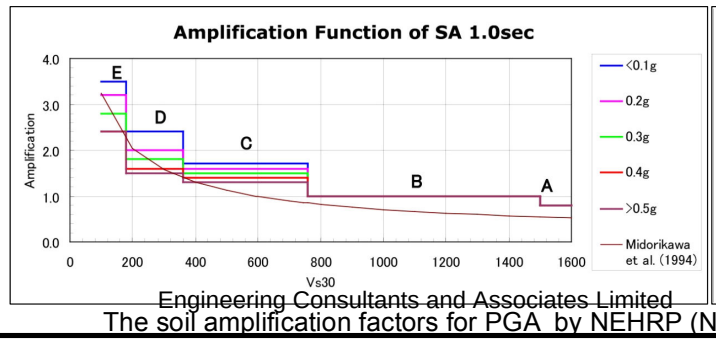
SA 1sec (g)

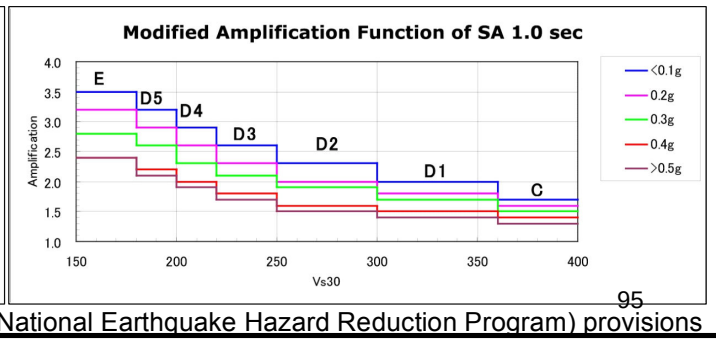
0.2960 - 0.3489

0.3490 - 0.3941

0.3942 - 0.4771

This map was produced by multiplying SA values with Amplification factors corresponded for different soil type. as the Vs is within 173-268m/s so soil was classified as (E,D5,D4,D3,D2). Thus the amplification factor was also modified. Spectral Accelaration (SA) (g) for 1 sec at Engneering Ground Surface(Depth upto 30)corresponging to probalility of exceedance of 10% in 50 year was count for each grid.



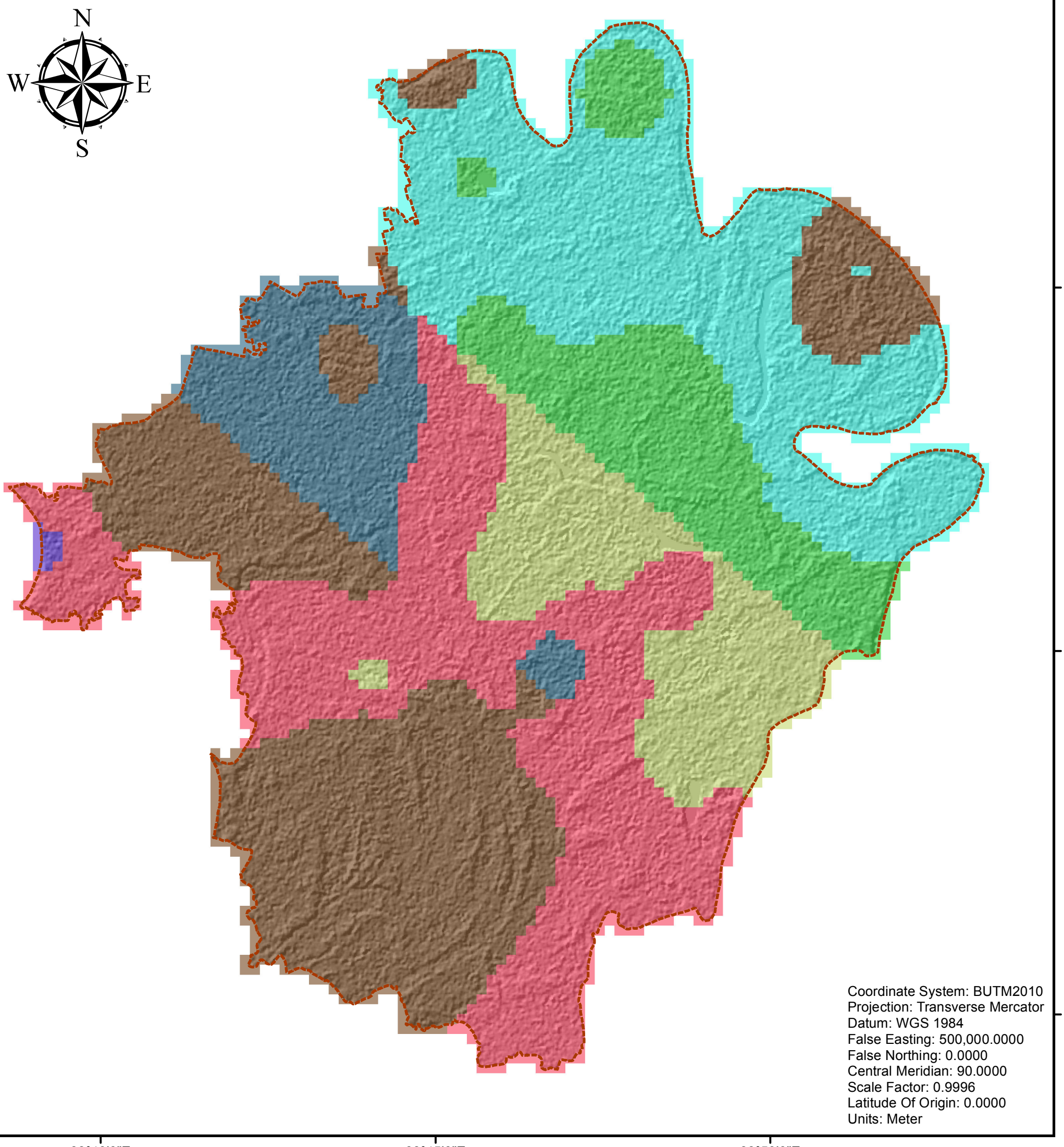


Engineering Consultants and Associates Limited

The soil amplification factors for PGA by NEHRP (National Earthquake Hazard Reduction Program) provisions

88°40'0"E 88°45'0"E 88°50'0"E

23°55'0"N 23°50'0"N 23°45'0"N



Coordinate System: BUTM2010
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: 90.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

88°40'0"E 88°45'0"E 88°50'0"E

Building Height Recommendation Map of Gangni Upazila

Legend

Upazila Boundary

Builing Sensitivity

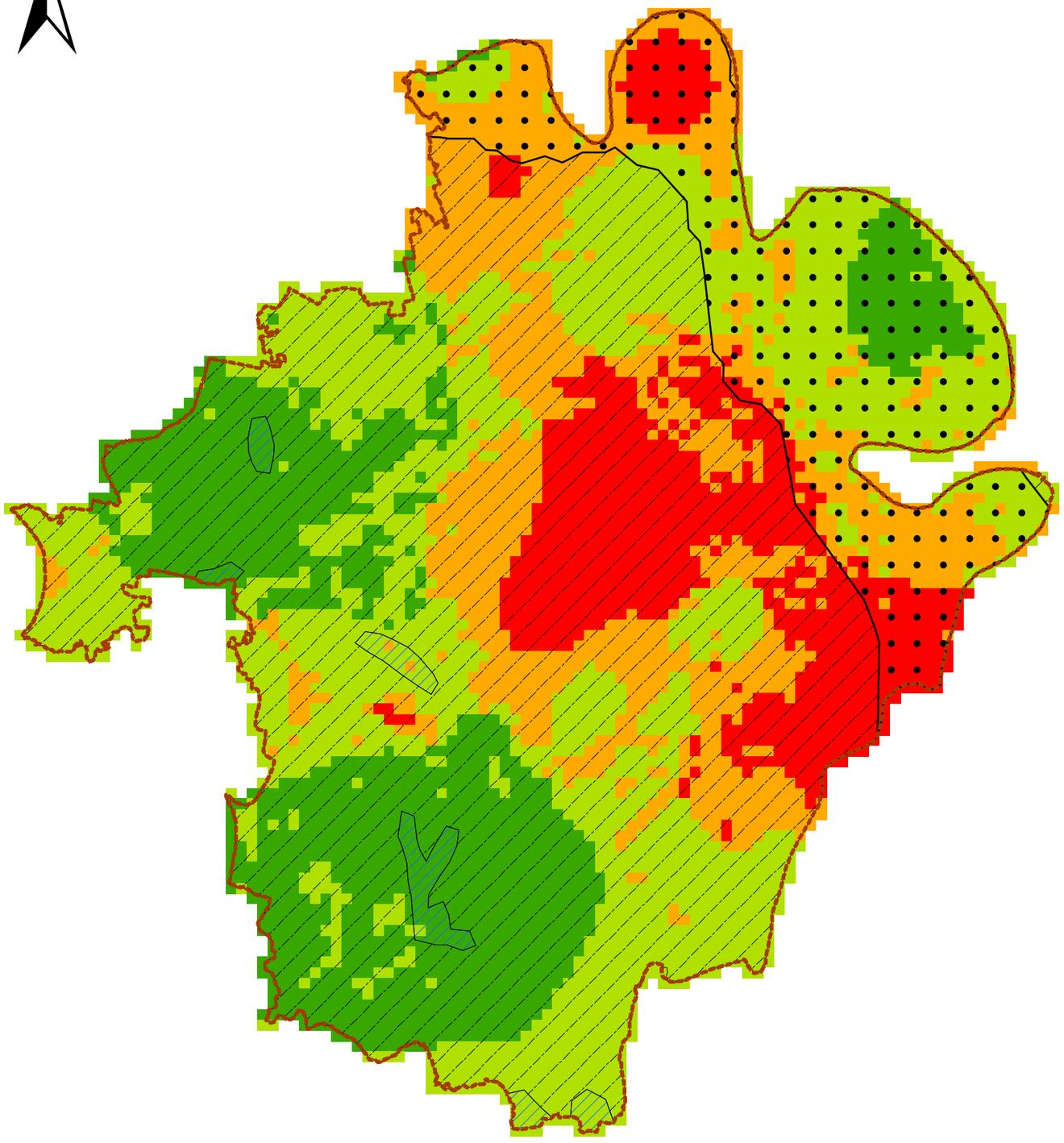
Low and High Rise Building

- 1st Degree Sensetive for Lowrise Building, 1st Degree Sensetive for Highrise Building
- 2nd Degree Sensetive for Lowrise Building, 1st Degree Sensetive for Highrise Building
- 2nd Degree Sensetive for Lowrise Building, 2nd Degree Sensetive for Highrise Building
- 2nd Degree Sensetive for Lowrise Building, 3rd Degree Sensetive for Highrise Building
- 3rd Degree Sensetive for Lowrise Building, 1st Degree Sensetive for Highrise Building
- 3rd Degree Sensetive for Lowrise Building, 2nd Degree Sensetive for Highrise Building
- 3rd Degree Sensetive for Lowrise Building, 3rd Degree Sensetive for Highrise Building

1 centimeter = 1 kilometers

4 2 0 4 Km

Infrastructrure Suitability Map
Gangni Upazila



Legend

Upazila Boundary

Infrastructure Suitibility Class

- Very Good
- Good
- Modarate
- Poor

Surface Geology Units

- Deltaic sand
- Deltaic silt
- Water

N
W E
S

6 3 0 6 Km

Infrastructure Suitability	Infrastructure Foundation Suitability	Suggested Land Use Suitability
Very Good	4-6 story light infrastructure is suitable with a foundation depth of up to 2 m. Large and tail infrastructure requires pile foundation placed on Soil layer no 3 or 5.	Commercial area Residential area Industrial zone
Good	4-6 story light infrastructure is suitable in Madhupur Clay. General foundation depth is within 5 m, at places higher Large and tall infrastructure requires pile foundation placed on layer no 3 or 5	Commercial area Residential area Industrial zone
Moderate	4-6 story light infrastructure requires on-site subsoil investigation and proper foundation design. Deep pile foundation is needed for large and tail infrastructure	Industrial zone Residential area Commercial area Agricultural Zone Park and Recreation
Poor	Detail subsoil investigation and proper foundation design is required for all types of infrastructure, due to low bearing capacity with hazard potential.	Agricultural zone Flood flow zone Wetland Rural settlement Park and Recreation
Very Poor	Detail subsoil investigation for deep pile foundation is essential, due to very low bearing capacity and high hazard potential. Shallow foundation is not preferred.	Agricultural zone Flood flow zone Wetland Rural settlement Park and Recreation