URBAN DEVELOPMENT DIRECTORATE (UDD)

Ministry of Housing and Public Works
Government of the People's Republic of Bangladesh

SURVEY REPORT ON GEOPHYSICAL AND GEOTECHNICAL INVESTIGATIONS Under ENGINEERING GEOLOGICAL AND GEOPHYSICAL SURVEYS UNDER PREPARATION OF DEVELOPMENT PLAN FOR MEHERPUR ZILLA

October 2024

Submitted by

CENTER FOR GEOSERVICES & RESEARCH

In JointVenture with

CREATIVE SOIL INVESTIGATION

Address: Flat# D1, House # 64/1,
Lake Circus, Kalabagan, Dhaka-1205.

EXECUTIVE SUMMARY

Bangladesh has a long history of natural disasters. The geographical location, land characteristics, multiplicity of rivers and the monsoon climate render Bangladesh highly vulnerable to natural hazards. Land use planning is an impotent component for modern urban development. Prior to land use planning it is essential to access surface and subsurface geological conditions and the relevant geological hazard and risk in and around the site of future urban development. Therefore, rigorous geological and geotechnical site characterization, including potential risk analysis, need to be carried out for a risk resilient urban development. From this point of view, Urban Development Directorate (UDD) has initiated conducting a geological study and seismic hazard assessment for the Meherpur Zilla, which includes three upazilas and announced a project entitled "Preparation of Development Plan for Meherpur Zila" to accomplish this goal. "Engineering Geological and Geo-Physical Surveys" is a significant component of this project. Subsurface geology and geotechnical information are considered as essential tools for over time and sustainable urbanization in this geological Study and Seismic Risk Assessment.

To know the subsurface soil condition of the study area, several geophysical and geotechnical surveys have been carried out up to 30 meters depth. To accomplish “Engineering Geological and Geo-Physical Surveys” following investigations have been executed: Standard Penetration Tests (SPTs) and preparation of borehole logs; collection of undisturbed and disturbed soil; Down-hole seismic (PS Logging) test, Multi-Channel Analysis of Surface Wave (MASW) and single Microtremor Measurement. Laboratory tests of soil samples such as Grain Size analysis, Natural moisture Content, Atterberg Limits, Direct Shear Test, Unconfined Compression strength, and Triaxial (Unconsolidated Undrain) tests are ongoing, which will give more qualitative and quantitative information about the subsurface. Regarding these, 30 SPT boreholes, 11 nos. of MASW, 15 nos. of single Microtremor and 7 nos. of Downhole seismic (PS Logging) have been performed.

Field and laboratory investigations data will be analyzed, and results will be integrated with all information in a module which can generate; sub-surface lithological 3D model of different layers, engineering geological map based on AVS30, soil type map, seismic intensity map, peak ground acceleration (PGA) and liquefaction potential zone map etc.

From above engineering geological and geophysical 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 projects are going on and this mentioned investigation also gives an idea about the vulnerability of existing landscape of a particular area. Based on these results, proper management techniques as well as other necessary adaptation processes could be addressed before or after the development activities in the studied area. Finally, from the achieved result from the Engineering Geological and Geo-physical Surveys will be incorporated in the master plan.

Contents

1 INTRODUCTION 4
1.1 Background 4
1.2 Client: About Urban Development Directorate (UDD) 5
1.3 Location and Accessibility 6
2 AIMS AND OBJECTIVES 7
3 STRATEGIC METHODOLOGY 7
3.1 Brief Procedures of Surveys/Tests 14
3.1.1 Test Procedure of Downhole Seismic Test (Ps Logging) 14
3.1.2 Test Procedure for Multi-Channel Analysis of Surface Wave (MASW) 18
3.1.3 Test Detail and Procedure of Microtremor Measurement (Single Microtremor) 23
3.1.4 Standard Penetration Test (SPT) Method 24
4 GEOPHYSICAL AND GEOTECHNICAL SURVEY 26
4.1 Geophysical Investigations 26
4.1.1 Downhole Seismic Survey (PS-logging) 27
4.1.2 Multi-channel Analysis of Surface Wave (MASW) Test 28
4.1.3 Single Microtremor Survey 29
4.2 Geotechnical Investigations 29
4.2.1 Standard Penetration Test (SPT) 30
5 CONCLUSION 31
6 REFERENCES 32
7 APPENDICES 33
7.1 Appendix A: Photographic Representation of Downhole Seismic Survey (PS logging) 34
7.2 Appendix B: Photographic Representation of MASW Survey Work 37
7.3 Appendix C: Photographic Representation of Microtremor Survey Work 41
7.4 Appendix D: Photographic Representation of Geotechnical Survey (SPT) Work 45
7.5 Appendix E: Standard Penetration Test (SPT) Log sheet/ Borehole Log sheet 64

List of Table

Table 1 Location of Downhole Seismic Survey (PS-logging) 27
Table 2 MASW Survey Locations 28
Table 3 Test Locations of microtremor Survey 29
Table 4 Location of SPT Borehole 30

List of Figures

Figure 1 Location map of the project area....6
Figure 2 Methodology of the project.....8
Figure 3 All Geotechnical and Geophysical Tests locations in the project area....9
Figure 4 SPT location map....10
Figure 5 PS Logging location map....11
Figure 6 MASW location map....12
Figure 7 Microtremor location map....13
Figure 8 (a) Freedom Data PC with P-SV Downhole Source and 1 Tri-axial Geophone Receiver used in Crosshole Seismic Investigations; (b) Main Component of the Freedom Data PC; (c) Impact directions which are on the left, right and vertical directions; (d) Triaxial geophone behavior; (e) computer with cables which are connected to the geophone; (f) Field Data Acquisition by PS logger.....15
Figure 9 Calculation of Shear Wave Velocity and profiles by Downhole Seismic....17
Figure 10 Schematic of linear active source spread configuration....18
Figure 11 MASW Field Data Acquisition....19
Figure 12 MASW data processing....20
Figure 13 Wave dispersion in layer media....20
Figure 14 Active Source MASW Analysis (a) Phase Velocity Diagram; (b) Dispersion Curve; (c) 1D Layer Model; (d) 2D Layer Model....21
Figure 15 Passive Source MASW Analysis (a) Phase Velocity Diagram; (b) Dispersion Curve; (c) 1D Layer Model....22
Figure 16 Field data acquisition of Single microtremor....24
Figure 17 The SPT sampler in place in the boring with hammer and rope....24
Figure 18 SPT Sampler and Donut Hammer....25
Figure 19 Geophysical investigations activities and field data acquisition....27

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: Standard penetration resistance/Soil resistance or compactness
PGA: Peak Ground Acceleration
PS logging: Primary and Shear wave logging (Down-hole seismic test)
SA/PSA: Spectral Acceleration/ Peak Spectral Acceleration
SPT: Standard Penetration Tests
UDD: Urban Development Directorate
GWL: Ground Water Level

1 INTRODUCTION

1.1 Background

Bangladesh has a long history of natural disasters. The geographical location, land characteristics, multiplicity of rivers and the monsoon climate render Bangladesh highly vulnerable to natural hazards. Geological study and seismic hazard assessment is one of the important development modules of this project. In this development plan, subsurface geological and geotechnical information is considered as an important tool for modern urban development. Prior to land use planning it is essential to access surface and subsurface geological conditions and the relevant geological hazard and risk in and around the site of future urban development, therefore a rigorous geological and geotechnical site characterization, including a potential risk analysis need to carry out for a risk resilient urban development.

In this development plan, subsurface geological and geotechnical information has been considered to determine subsurface soil condition of the project area and evaluate natural geological hazards such as earthquake, liquefaction and landslide which integrate the consequence into the design of the infrastructure.

In this context, the Urban Development Department (UDD) has prepared a project proposal titled " Engineering Geological and Geo-Physical Studys Under Preparation of Development Plan for Meherpur Zila".

Moreover, Urban Development Directorate (UDD) has initiated a project to prepare Geological Study and Seismic Hazard Assessment. Bangladesh has a long history of natural disasters. The geographical location, land characteristics, multiplicity of rivers and the monsoon climate render Bangladesh highly vulnerable to natural hazards. Seismically, Bangladesh is divided into four zones i.e. highly risk zone (zone VI), risk zone (zone III), moderate risk zone (zone II) and low risk zone (zone I). Meherpur Zila is situated in zone I (BNBC, 2020). Geological Study and Seismic Hazard Assessment are one of the important studies of Preparation of Development Plan. In this perspective, subsurface geological and geotechnical information is considered as an important tool for durable and sustainable urbanization. To achieve this “Engineering Geological and Geo-Physical Surveys” is one of the important modules of this project.

1.2 Client: About Urban Development Directorate (UDD)

In the backdrop of rapid urbanization associated with increases in population and economic development in the early sixties. It was keenly felt that a regional and central office had to be created for physical Planning. Accordingly Urban Development Directorate (UDD) was created on the 17th July 1965, under the administrative control of works, Power and irrigation department. The functions of the Urban Development Directorate are as follows:

a. To advise the Government on matters of policy relating to urbanization, land use and land development.
b. To prepare and co-ordinate regional plans, master plans and detailed layout and site plans for the existing as well as the new urban centers excluding the areas covered by the present town development authorities of Dhaka, Chittagong, Khulna and Rajshahi.
c. To undertake socio-economic research and collection of data for determination of the location and pattern of future urban development.
d. To prepare programs for urban development for execution by the sectoral agencies and secure approval of those from the national Council and assist the agencies in selection of sites for implementation of those programs.
e. To act as a counterpart organization and focal point in the Government for all internationally aided physical planning and human settlement programs in the Country.
f. To organize seminars/workshops for creating better physical planning awareness and to disseminate information through regular publication of the research and planning materials on urbanization and human settlement planning and development.
g. To conduct in-service training of the officers and staff of organizations involved in spatial planning and development.
h. To advise the existing urban development authorities on their operations at their request.

1.3 Location and Accessibility

Meherpur Zilla area is 716.08 sq km, located in between 23°36' and 24°00' North latitudes and between 88°33' and 88°55' East longitudes.

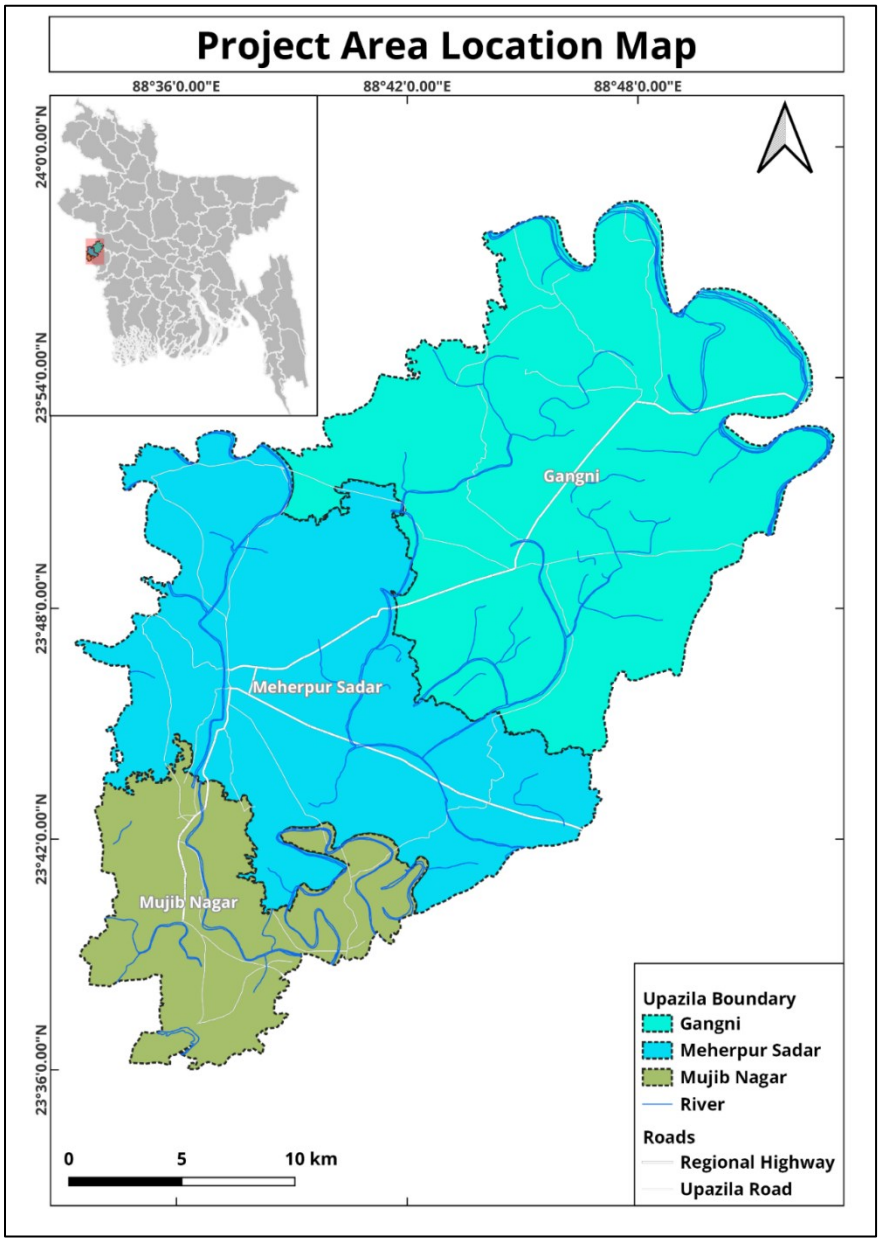


Figure 1 Location map of the project area

2 AIMS AND OBJECTIVES

In this development plan, subsurface geological and geotechnical information's has been considered to determine subsurface soil condition of the project area and evaluating of natural geological hazards such as earthquake, liquefaction and landslide which integrate the consequence into the design of the infrastructures. The main objective will be achieved through the completion of the following sub-objectives:

- GIS based Geological/ Geomorphological map of the project area.
- Sub-surface lithological 3D model development and relevant interpretation.
- Soil classification map using geophysical and geotechnical investigations
- Engineering geological map based on Average Shear Wave (AVS30).
- Seismic hazard assessment (PGA/PGV, and SA) map of the project area.
- Foundation layers delineation and developing engineering properties of the sub-soil.
- Landslide vulnerable zones identification.
- Liquefaction susceptibility map construction of the study area.
- Formulation of Policies and plans for mitigation of different types of hazards, minimizing the adverse impacts of climate change and recommend possible adaptation strategies for the region.

3 STRATEGIC METHODOLOGY

The methodology consists of both field and laboratory investigations. To conduct this project work, geomorphological, geotechnical and geophysical data of soil will be collected, analysed and interpreted. Geomorphological data will be collected from satellite image (provided by UDD or other secondary source) of the study area to prepare a geomorphological map. Geotechnical data will be collected from field investigations *i.e.,* boring, standard penetration test (SPT), and laboratory investigations *i.e.,* soil physical properties test, consolidation test, direct shear test and triaxial test of undisturbed soil sample. Geophysical data will be collected from down-hole seismic test (PS logging); multi-channel analysis of surface wave (MASW) and Singles Microtremor survey. The total works will be conducted through the following methodology (flowchart)-

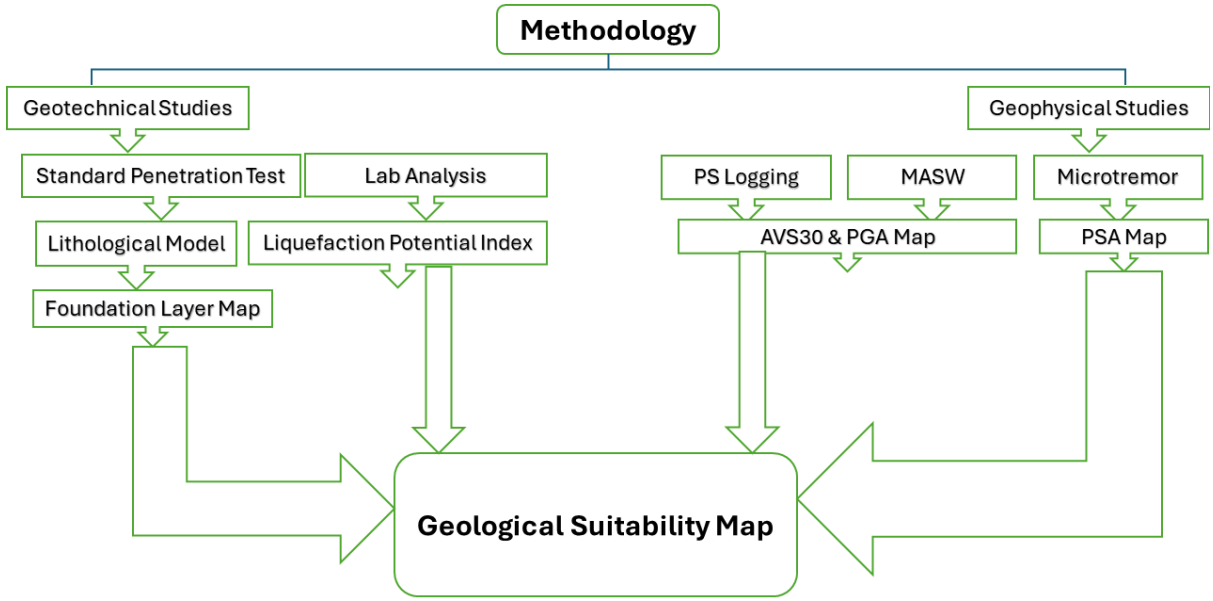


Figure 2 Methodology of the project.

However, following investigations will be conducted for collecting both engineering geological and geophysical data in the Project area (as per ToR):

Area	Name of investigations			
	Borelog with SPT *(upto 30m)*	PS logging *(30m depth)*	MASW *(30m depth)*	Single Microtremor
Meherpur Zilla (716.08 sq km)	30	7	11	15

Test locations of the project area are shown in following figure-

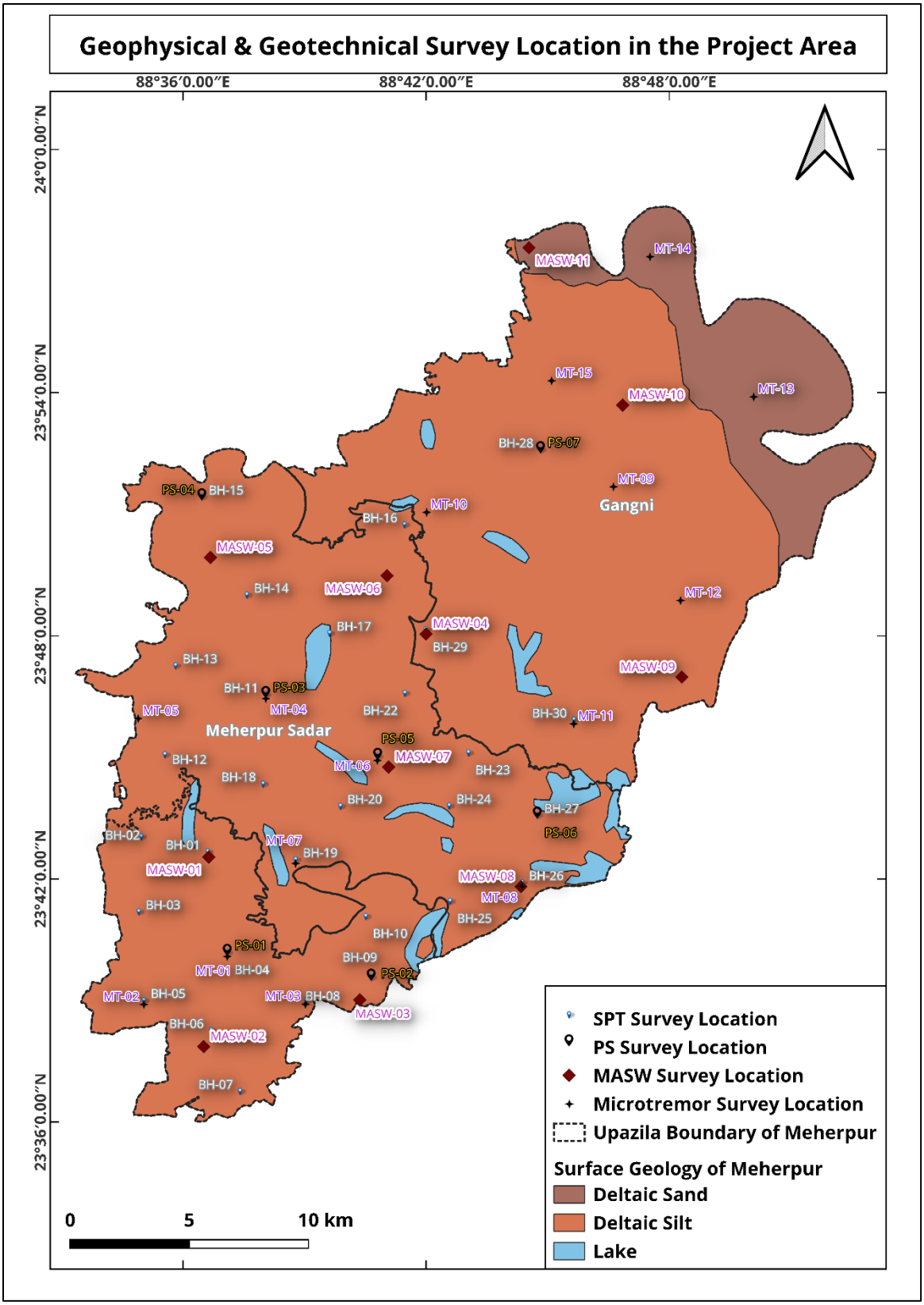


Figure 3 All Geotechnical and Geophysical Tests locations in the project area

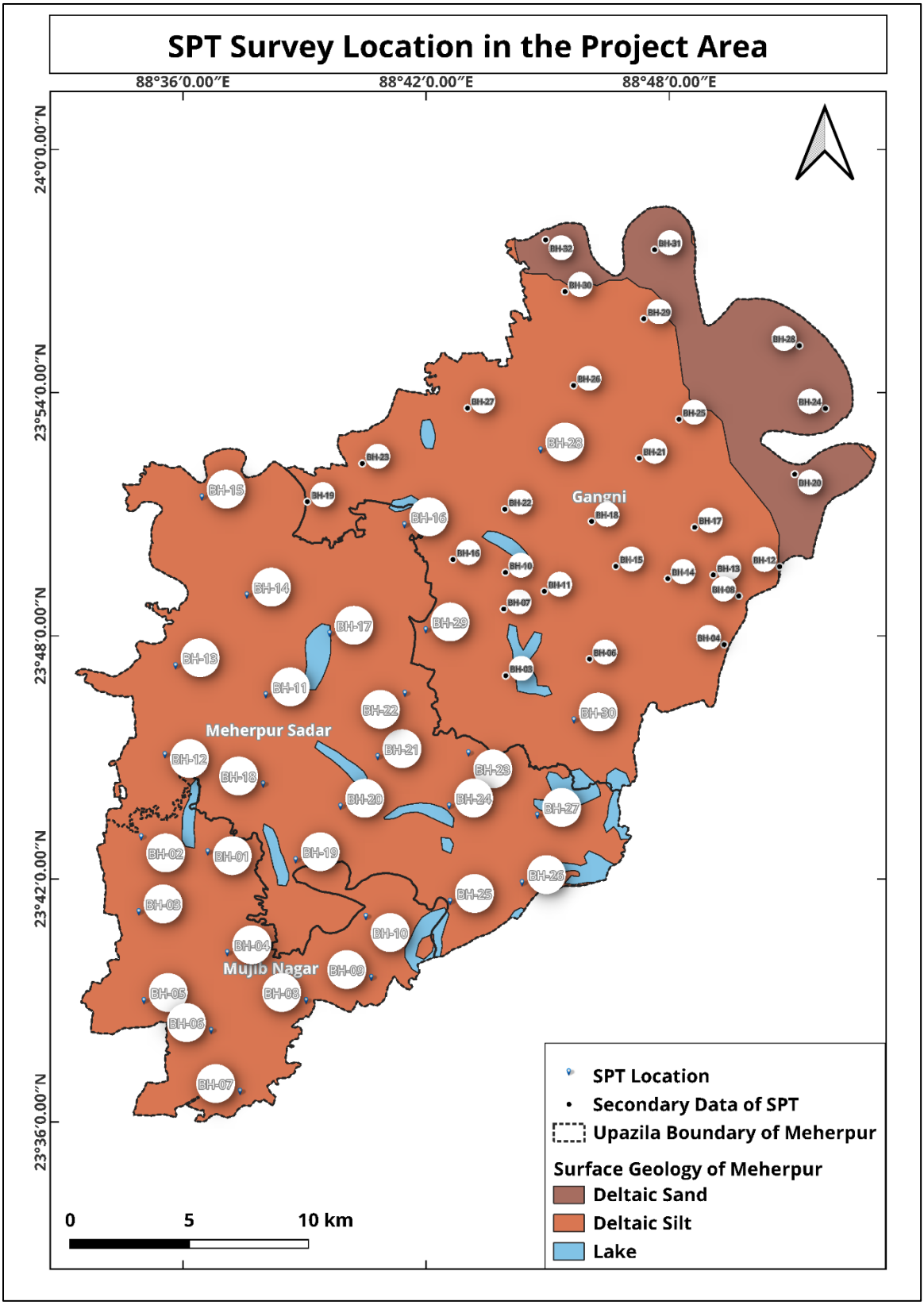


Figure 4 SPT location map

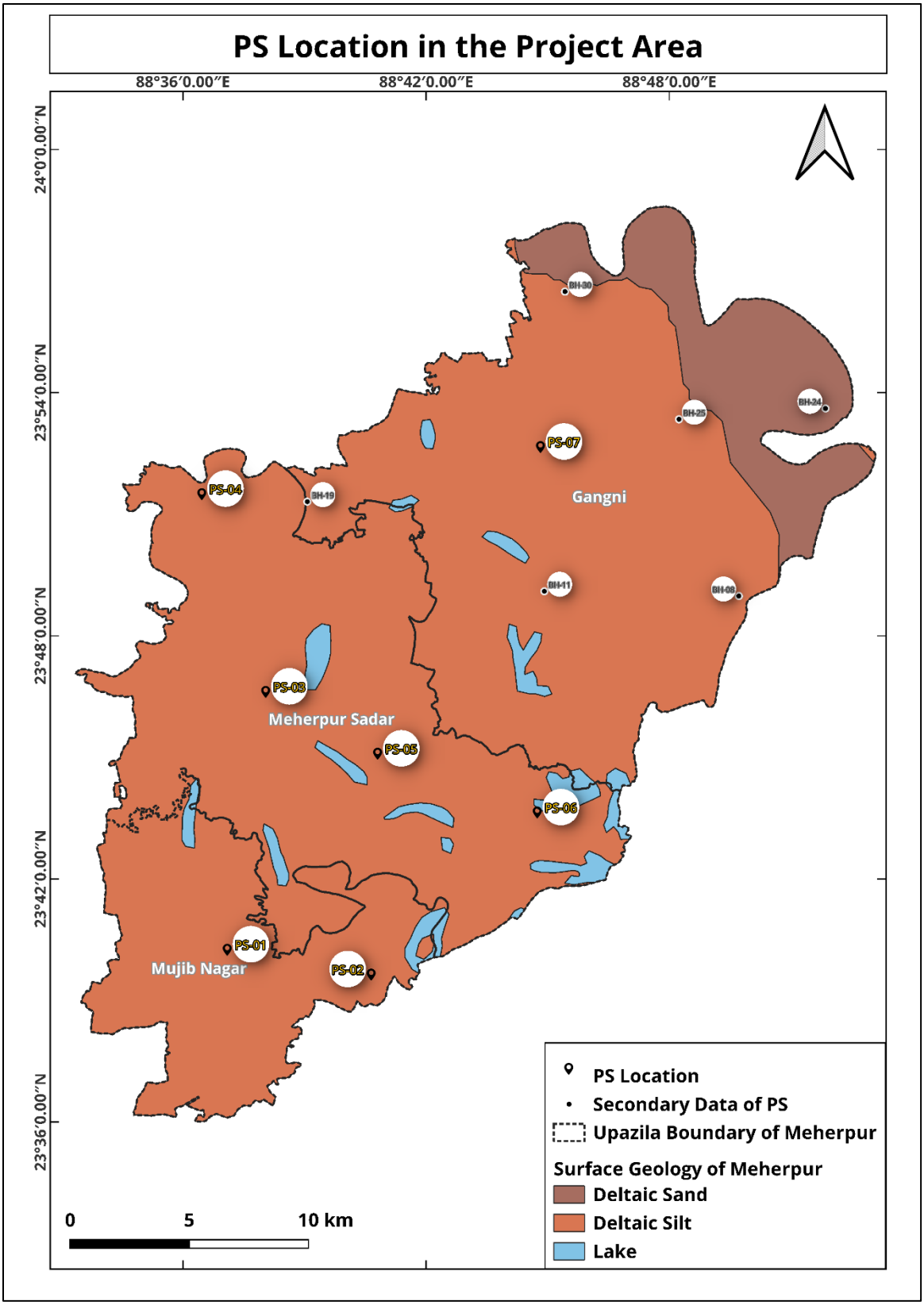


Figure 5 PS Logging location map

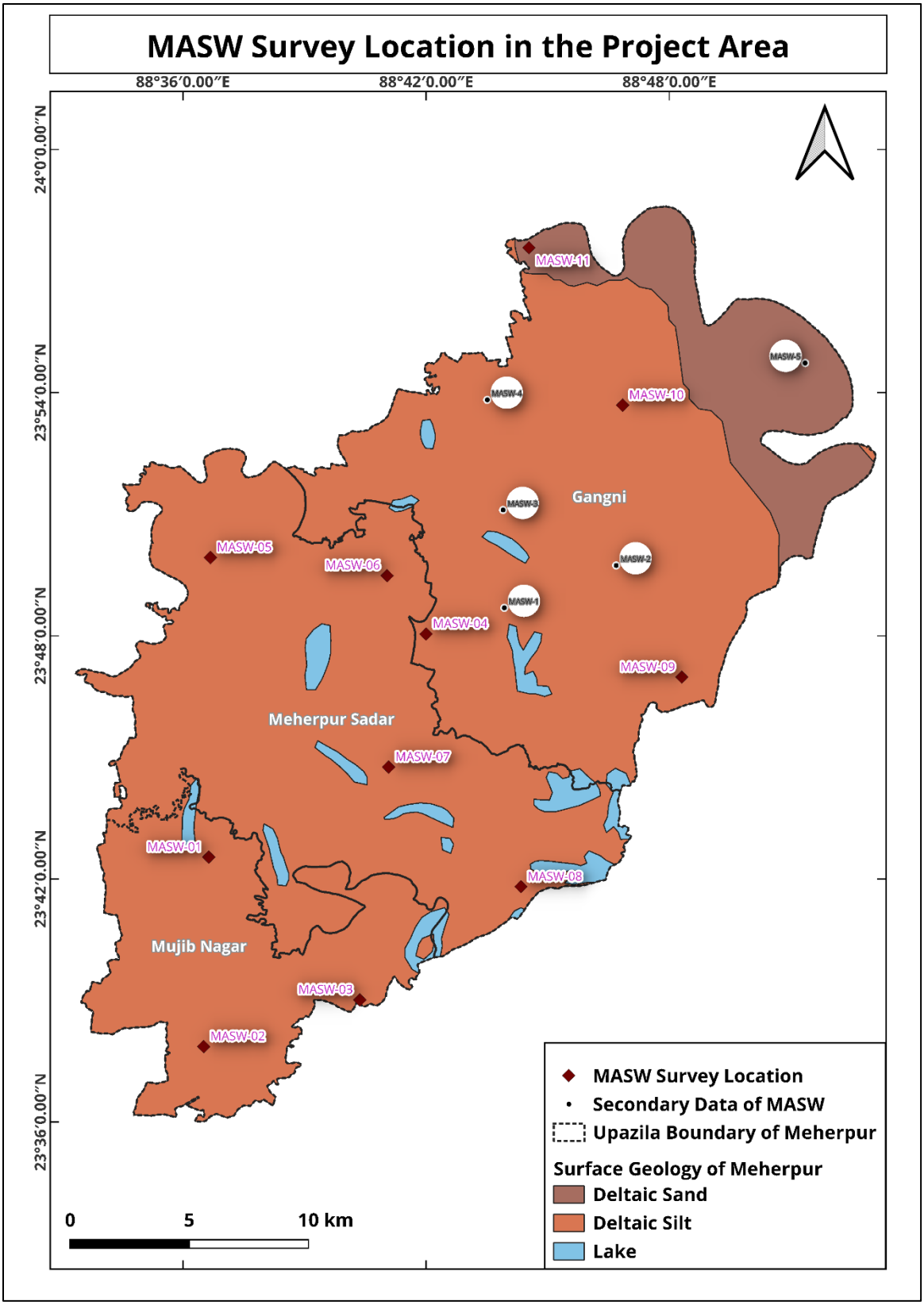


Figure 6 MASW location map

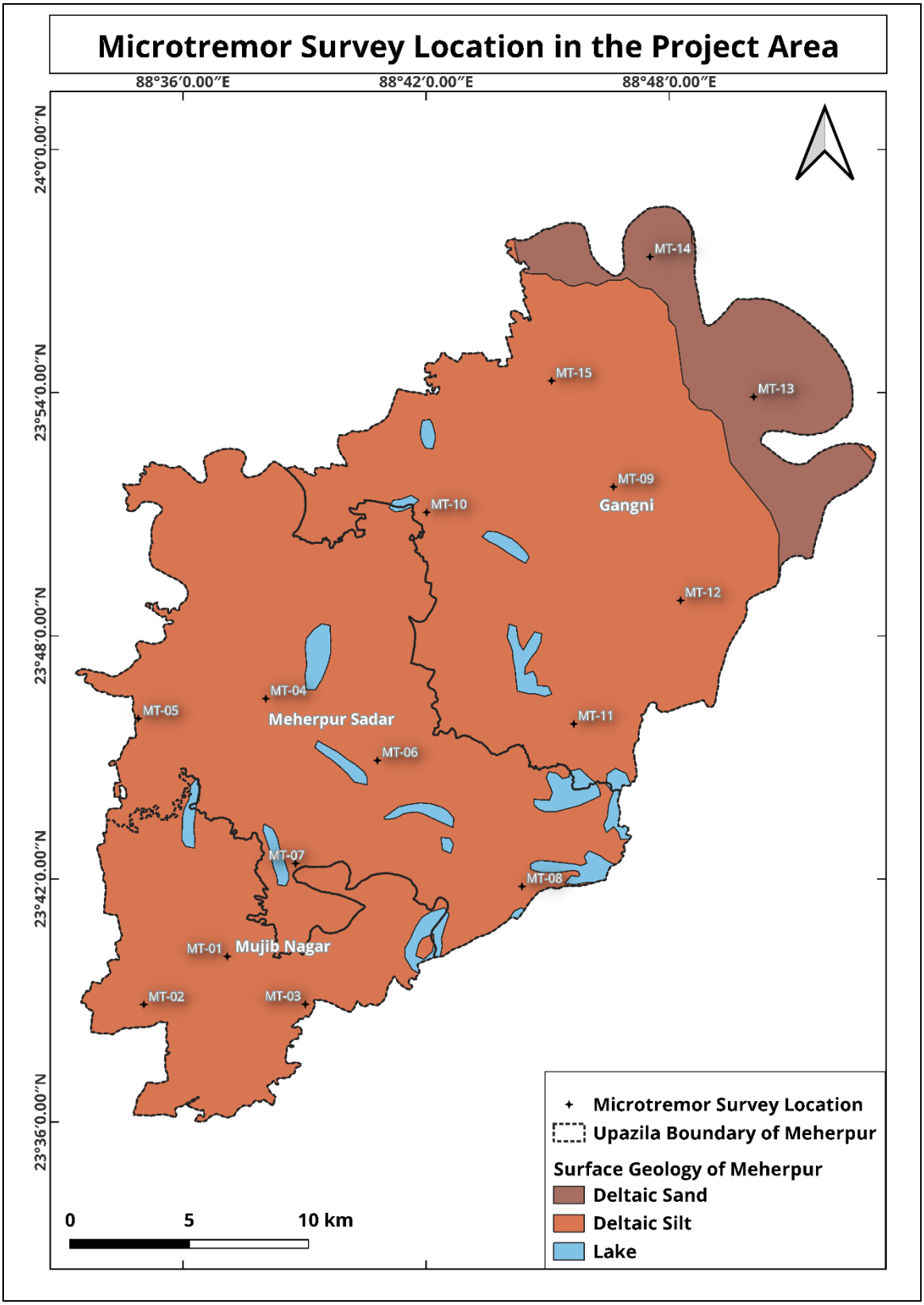


Figure 7 Microtremor location map

3.1 Brief Procedures of Surveys/Tests

The method of tests/surveys and application of Geophysical and Geotechnical investigation are given below-

3.1.1 Test Procedure of Downhole Seismic Test (Ps Logging)

Seismic downhole test is a direct measurement method for obtaining the shear wave velocity profile of soil stratum. The seismic downhole test aims to measure the travelling time of elastic wave from the ground surface to some arbitrary depths beneath the ground. The seismic wave is generated by striking a wooden plank with a 5-7 kg sledge hammer. The plank is placed on the ground surface at around 1 m in horizontal direction from the top of borehole. The plank is 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 emanating from the plank is detected by a tri-axial geophone. The geophone is lowered to 1 m below ground surface and attached to the borehole wall by inflating an air bladder (if necessary). Then, measurements are taken at every 1 m interval until the geophone is lowered to 30 m below ground surface. For each depth, 9 nos. data (3 times hammer hit in three directions) will be taken and used to calculate the shear wave velocity. The first arrival time of an elastic wave from the source to the receivers at each testing depth can be obtained from the downhole seismic test.

Instrument List

The PS logging test equipment is listed below-

1. One Freedom NDT PC
2. Highly Sensitive Tri-axial Geophones.
3. One set Cable/Airline Spool
4. Wooden Plank.
5. Hammer weighs 5-7kg.

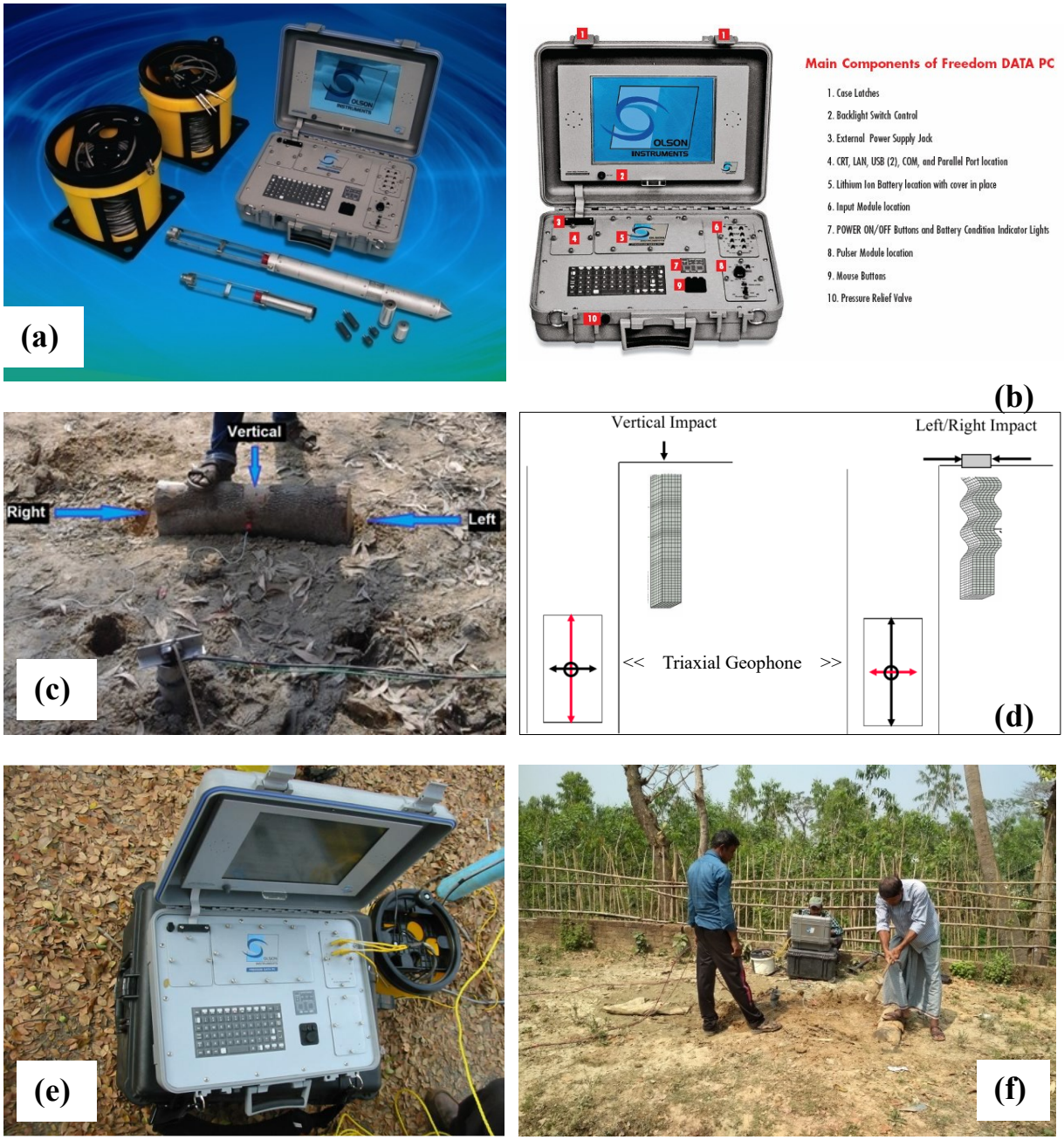


Figure 8 (a) Freedom Data PC with P-SV Downhole Source and 1 Tri-axial Geophone Receiver used in Crosshole Seismic Investigations; (b) Main Component of the Freedom Data PC; (c) Impact directions which are on the left, right and vertical directions; (d) Triaxial geophone behavior; (e) computer with cables which are connected to the geophone; (f) Field Data Acquisition by PS logger.

Analysis and Calculation from PS Logging

P-wave travel time is calculated by the first arrival of either peak or trough in the seismic trace and P-wave is characterized by higher frequency and lower amplitude. On the other hand, shear wave is characterized by lower frequency but high amplitude.

S wave travel time is calculated from the first cross as we hit in both directions of the wooden plank so there generate opposite phase shear waves in radial and transverse direction and cross at some points.

The recorded travel time then corrected using the Source Saint Distance (R) and Depth of the Geophone (D).

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

From the Corrected Travel Time t_c, Travel time Difference between top and bottom of the layer (Δt) provides layer's Shear wave velocity using following equation

$$V_i = \frac{H_i}{\Delta t}$$

Besides, the average shear wave velocity upto 30 m depth has been determined using the following equation.

$$T_{30} = \sum \frac{H_i}{V_i}$$

$$AVS_{30} = \frac{30}{T_{30}}$$

Where,

H_i: Thickness of i^{th} Layer and $30 = \sum H_i$

V_i: $S - wave$ velocity of i^{th} Layer

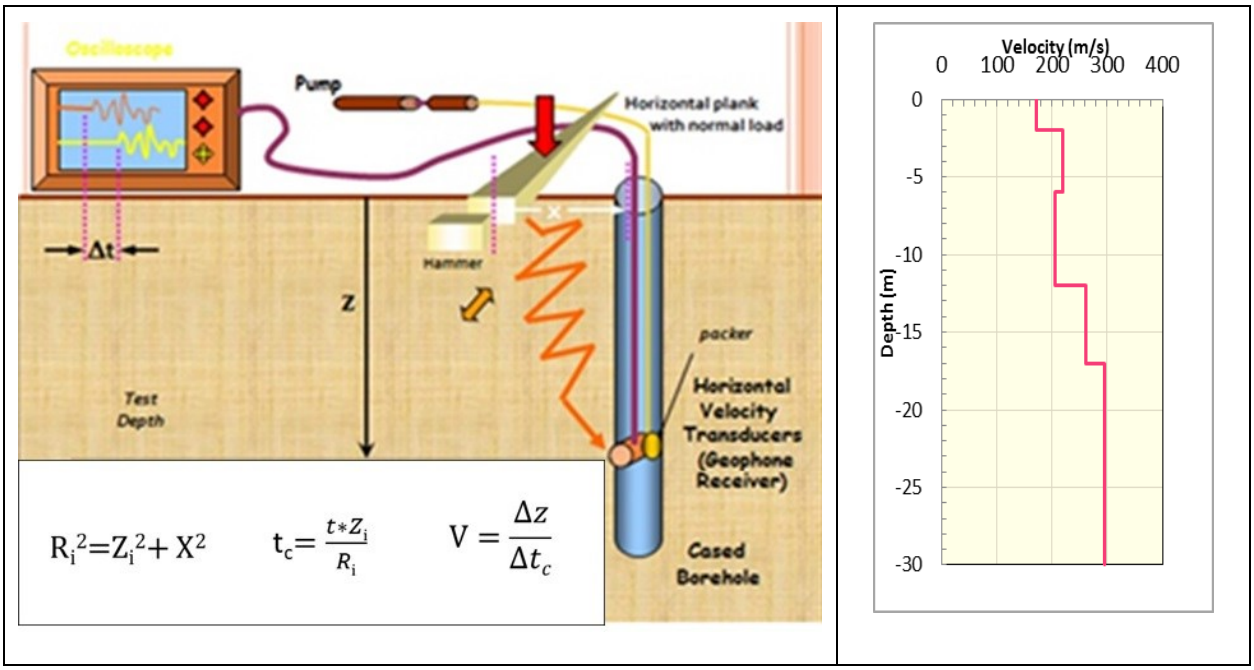


Figure 9 Calculation of Shear Wave Velocity and profiles by Downhole Seismic

3.1.2 Test Procedure for Multi-Channel Analysis of Surface Wave (MASW)

The active MASW method was introduced in GEOPHYSICS in 1999. This is the most common type of MASW survey that can produce a 2D VS profile. It adopts the conventional mode of survey using an active seismic source (e.g., a sledge hammer) and a linear receiver array, collecting data in a roll-along mode. It utilizes surface waves propagating horizontally along the surface of measurement directly from impact point to receivers. It gives this VS information in either 1D (depth) or 2D (depth and surface location) format in a cost-effective and time-efficient manner.

Seismic energy for active source surface wave surveys can be created in various ways, but we use a sledgehammer to impact a striker plate on the ground since it is a low-cost, readily available item. To signal to the seismograph when the energy generates, a trigger switch is used as the interface between the hammer and the seismograph. When the sledgehammer hits the ground, a signal is sent to the seismograph to tell it to start recording.

During field work, usually 12-24 channels are used with 2-4m intervals, 1-2 m source (sledge hammer) offset. In this study the Spread will be with 24 channels with 2-meter intervals, 1m source offset (active Source). The Data will be recorded in Geophone with 0.065 ms sample interval, 2 seconds record length for Active Source Data Acquisition and 2ms sample interval with 1-minute record length (total 10 Minute) for Passive Source Data Acquisition. Natural frequency of Geophone is 4.5 to 10 Hz. And the Geophone spread configuration is as below:

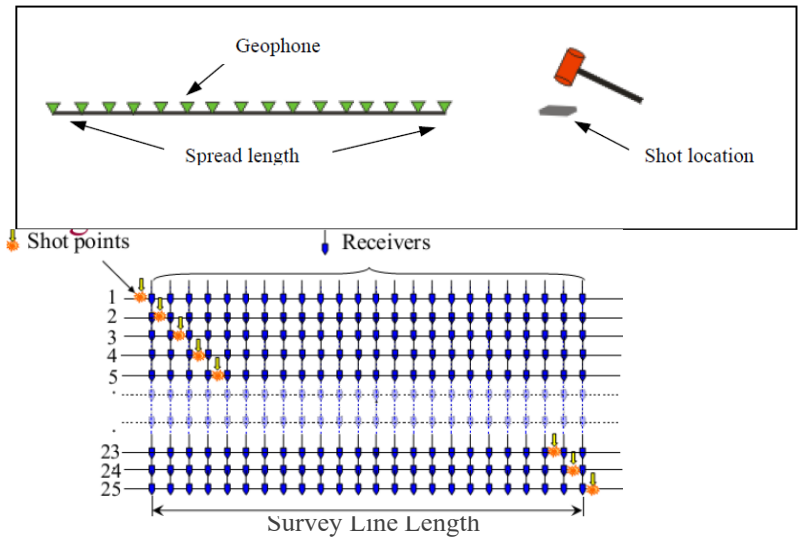


Figure 10 Schematic of linear active source spread configuration

Figure 11 MASW Field Data Acquisition

For active source at every station one data is acquired by stacking (3 times hammer hit) to enhance the data quality and for Passive Source data will be acquired 10 times with 1-minute recording length.

Analysis of MASW

MASW utilizes the frequency dependent property of surface wave velocity, or the dispersion property, for Vs profiling. It analyses frequency content in the data recorded from a geophone array deployed over a moderate distance.

The processing of MASW is schematically summarized in Figure 2.8. The principle MASW is to employ and arrange a number of sensors on the ground surface to capture propagating Rayleigh waves, which dominates two-thirds of the total seismic energy generated by impact sources. If the tested ground is not homogeneous, the observed waves will be dispersive, a phenomenon that waves propagate towards receivers with different phase velocities depending on their respective wavelength (Figure 2.9).

From field observation, the data in space-time domain is transformed to frequency-velocity domain by slant-stack and Fast Fourier transform using

$$S(\omega, c) = \int e^{-i\frac{\omega}{c}x} U(x, \omega) dx$$

where U(x, ω) is the normalized complex spectrum obtained from the Fourier transform of $u(x,t)$, ω is the angular frequency, c is the testing-phase velocity and S(ω, c) is the slant-stack amplitude for each ω and c which can be viewed as the coherency in linear arrival pattern along the offset range for that specific combination of ω and c. When c is equal to the true phase velocity of each frequency component, the S (ω, c) will show the maximum value. Calculating S (ω, c) over the frequency and phase-velocity range

of interest generates the phase-velocity spectrum where dispersion curves can be identified as high-amplitude bands. The dispersion curve is, then, used in the inversion process to determine the shear wave velocity profile of the ground.

In theory, a phase-velocity spectrum can be calculated for a known layer model **m** and the field setup geometry. This process is called forward modeling. The inversion process tries to adjust assumed layer model as much as possible through several iterations in order to make the calculated spectrum looks similar to the dispersion curve obtained from the field test. Once the algorithm can match the calculated with the measured one, the assumed model will be considered as the true profile.

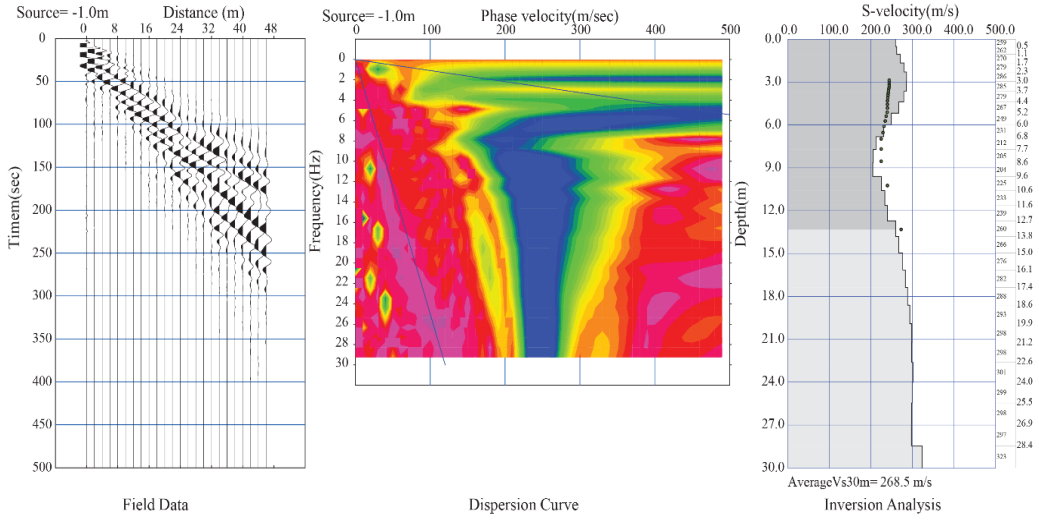


Figure 12 MASW data processing

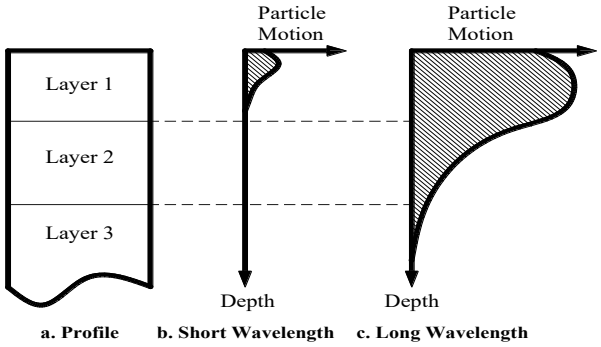


Figure 13 Wave dispersion in layer media

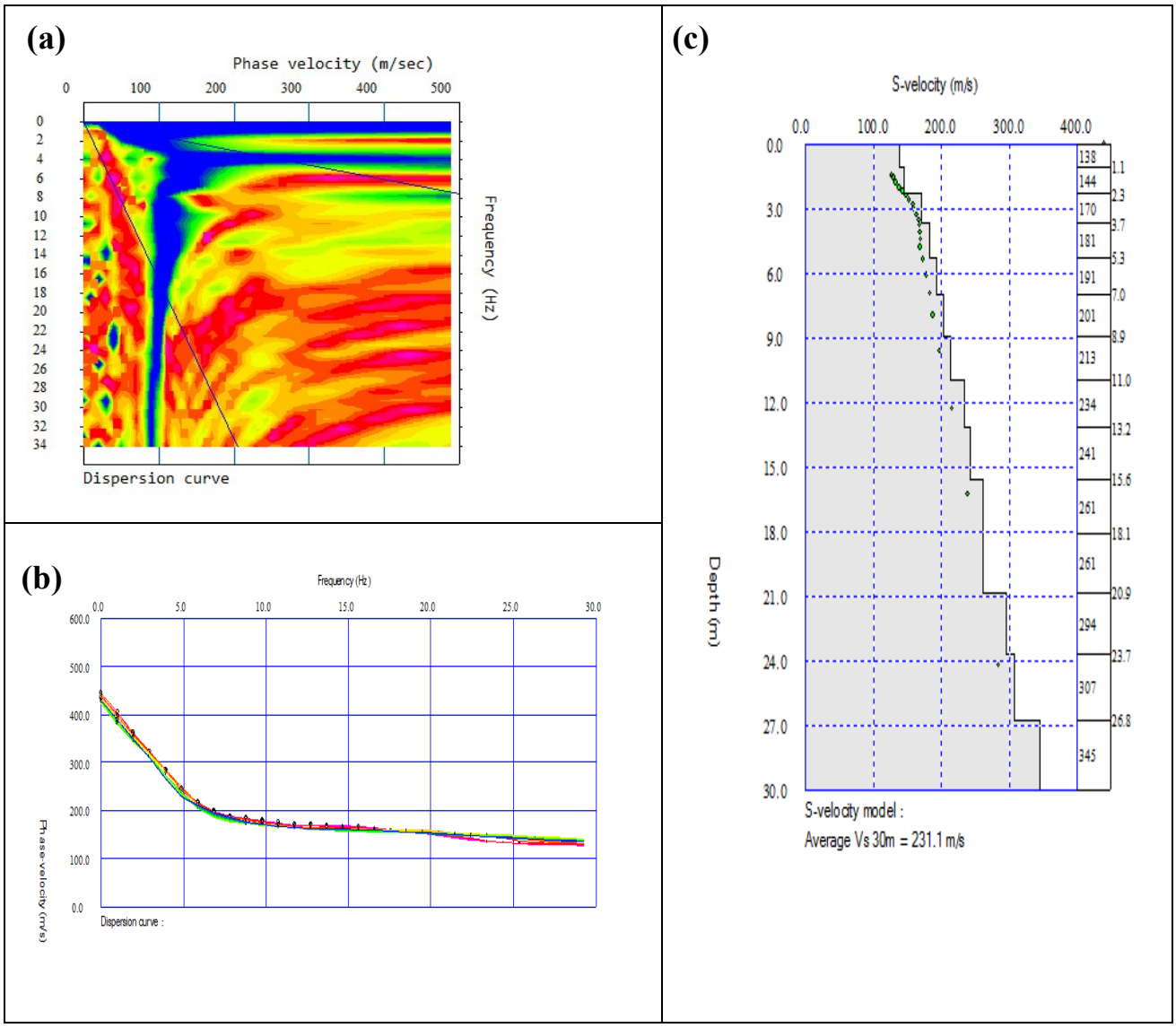


Figure 14 Active Source MASW Analysis (a) Phase Velocity Diagram; (b) Dispersion Curve; (c) 1D Layer Model; (d) 2D Layer Model

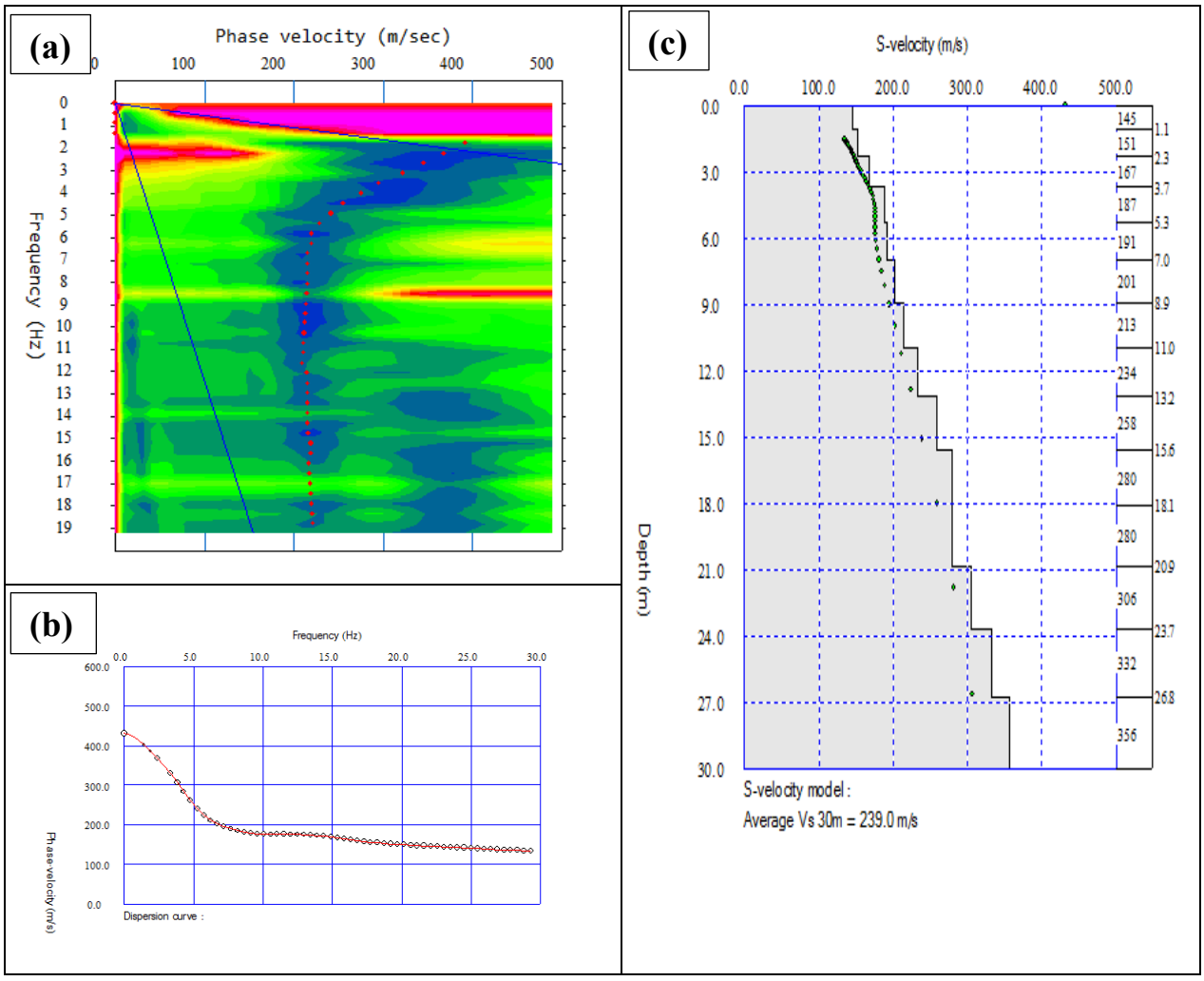


Figure 15 Passive Source MASW Analysis (a) Phase Velocity Diagram; (b) Dispersion Curve; (c) 1D Layer Model

In Addition, when passive source is used. In the phase velocity analysis, SPAC (Spatial Autocorrelation) method (Okada & Suto, 2003) is employed. (Okada & Suto, 2003) shows Spatial autocorrelation function $\rho(\omega, r)$ is expressed by Bessel function.

$$\rho(\omega, r) = J_0\left(\frac{\omega r}{c(\omega)}\right)$$

Where, r is the distance between receivers, ω is the angular frequency, $c(\omega)$ is the phase velocity of the waves, J_0 is the first kind of Bessel function. The phase velocity can be obtained at each frequency using equation.

These calculations are carried out along the measuring line and the acquired data was transformed into a

Phase Velocity Diagram via SeisImager Software. Figure 2.10 (a) and Figure 2.11 (a) shows an example of Phase Velocity Diagram for Active Source and Passive Source. From Phase velocity diagram the dispersion curve was drawn. Figure 2.10 (b) and Figure 2.11 (b) show an example of dispersion curve of the survey. A one-dimensional inversion using a non-linear least square method has been applied to the phase velocity curves and one-dimensional S-wave velocity structures drawn example in Figure 2.10 (c) and Figure 2.11 (c). SeisImager software can also give a 2-D velocity model a sample of which is shown in Figure 2.10 (d).

Calculation of AVS 30 from MASW

The AV_{S30} can be calculated as follows:

$$T_{30} = \sum(Hi/Vi)$$

$$AVS\ 30 = (30/\ T_{30})$$

Where,

Hi= Thickness of the i th layer and $\sum Hi = 30$

Vi= S wave velocity of the I th layer

3.1.3 Test Detail and Procedure of Microtremor Measurement (Single Microtremor)

Microtremor method is a practical and economical seismic survey since it has potential to explore deep soils without a borehole. Microtremors are the phenomenon of very small vibrations of the ground surface even during ordinary quiet time as a result of a complex stacking process of various waves propagating from remote man-made vibration sources caused by traffic systems or machineries in industrial plants and from natural vibrations caused by tidal and volcanic activities. Observation of microtremors can give useful information on dynamic properties of the site such as predominant period, amplitude.

Field Data Acquisition System

Microtremor observations are performed using portable equipment, which is equipped with a super-sensitive sensor, a wire comprising a jack on one site and USB port in another site, and a laptop computer is also used. The microtremor equipment needs to be set on the free surface and on the ground without any minor tilting of the equipment. The N-S and E-W directions are properly maintained following the directions arrowed on the body of the equipment. The sampling frequency for all equipment is set. Like the seismometer or accelerometer, the velocity sensor used can measure three components of vibrations:

two horizontal and one vertical. The natural period of the sensor is also set. A global positioning system (GPS) is used for recording the coordinates of the sites. The length of record for each observation is not less than 10 min.

Figure 16 Field data acquisition of Single microtremor

3.1.4 Standard Penetration Test (SPT) Method

The Standard Penetration test (SPT) is a common in situ testing method used to determine the geotechnical engineering properties of subsurface soils. The test procedure is described in the British Standard BS EN ISO 22476-3, ASTMD1586. A short procedure of SPT N-value test is described in the following paragraph.

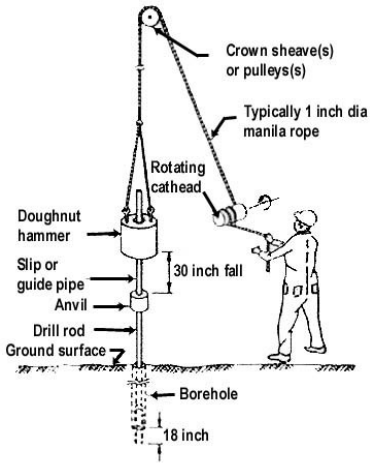


Figure 17 The SPT sampler in place in the boring with hammer and rope

The test in our field uses a thick-walled sample tube, with an outside diameter of 50 mm and an inside diameter of 35 mm, and a length of around 650 mm. This is driven into the ground at the bottom of a borehole by blows from a slide hammer with a weight of 63.5 kg (140 lb) falling through a distance of 760 mm (30 in). The sample tube is driven 150 mm into the ground and then the number of blows needed for the tube to penetrate each 150 mm (6 in) up to a depth of 450 mm (18 in) is recorded. The sum of the number of blows required for the second and third 6 in. of penetration is termed the "standard penetration resistance" or the "N-value". If the number of blows for 150mm drive exceeds 50, it is taken as refusal and the test is discontinued. SPT should be conducted at each 1.5m interval depth. When SPT "N-value" exceeds 50 times in consecutive 2/3 measurements, SPT process would be stopped.

The main objective of SPT is as follows:

a) Boring and recording soil stratification.
b) Sampling (both disturbed and undisturbed).
c) Recording of SPT N-value
d) Recording of ground water table.

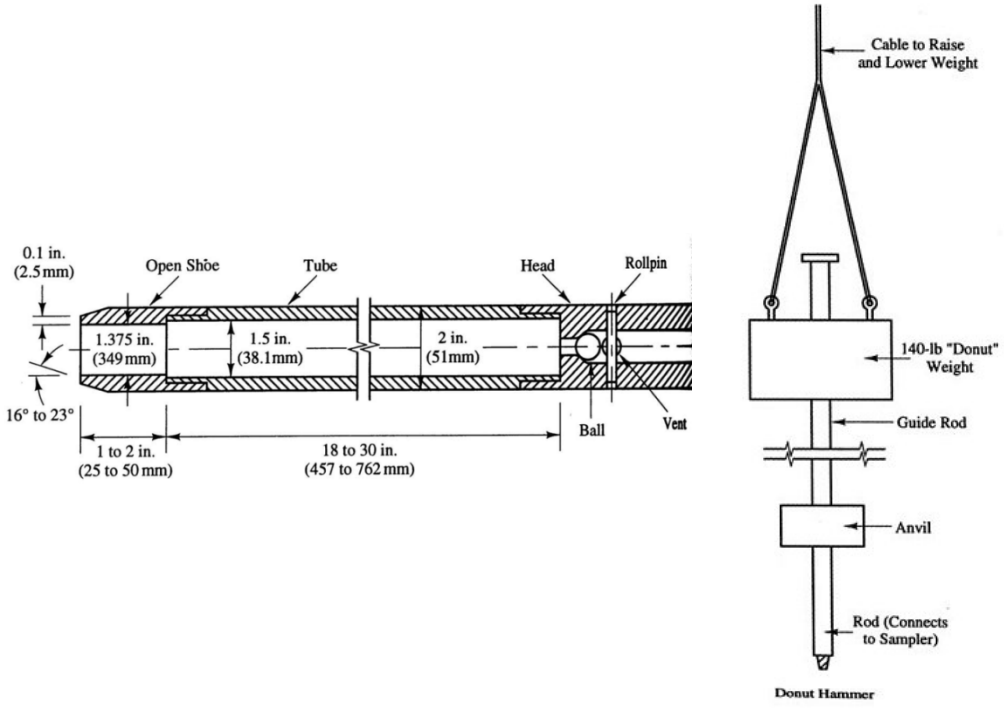


Figure 18 SPT Sampler and Donut Hammer

4 GEOPHYSICAL AND GEOTECHNICAL SURVEY

4.1 Geophysical Investigations

The main objectives of this 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 the study area and described below.

Shear wave velocity profile (Vs profile) in the field were carried out by three geophysical exploration methods namely 1) downhole seismic test (PS logging), 2) Multichannel Analysis of Surface Wave (MASW) and 3) Single Microtremor.

Downhole seismic test is a direct measurement method for obtaining the shear wave velocity profile of soil stratum. Multichannel analysis of surface waves (MASW) is a non-invasive technique which can be used to determine the Vs profile at sites. Single Microtremor is used to determine predominant period and compare with Vs data. In this project, the downhole seismic, MASW and Single Microtremor tests have been performed at 7, 11 and 15 locations respectively. Geophysical investigations activities and field data acquisition are shown in Figure 19.

MASW Data Acquisition

PS Logging Data Acquisition

Single Microtremor Data Acquisition

Figure 19 Geophysical investigations activities and field data acquisition

4.1.1 Downhole Seismic Survey (PS-logging)

As a fundamental parameter, shear wave velocity is required to define the dynamic properties of soils. If the soil velocity is less than 180m/s, it can be said to be loose or soft soil. Estimation of shear wave velocity (Vs) / average shear wave velocity (AVS) and mapping is a way to characterize variable 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 30 m of the subsurface. Supplementary, 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 survey data acquisition has been completed at Seven (7) different locations of Meherpur Sadar, Mujibnagar and Gangni Upazials of Meherpur Zilla area by 17th September to 20th September and the field raw data is being processed and interpreted.

Location of PS-logging is shown in Figure 5 and Table 1. The investigation of the PS-logging survey activities is enclosed in Appendix A in tabular format and also in graphical representation.

Table 1 Location of Downhole Seismic Survey (PS-logging)

Sl. No.	Point Name	Upazila	Lat	Long
PS-01	Vobanipur Primary School	Mujib Nagar	23.668205	88.61821
PS-02	Mohajonpur Uttarpara Govt Primary School	Mujib Nagar	23.658003	88.6774
PS-03	Meherpur Govt. High School	Meherpur Sadar	23.7742445	88.63402
PS-04	Sholmari Govt Primary School	Meherpur Sadar	23.8555441	88.60776
PS-05	Amjhupi Girls Govt. Primary School	Meherpur Sadar	23.7488266	88.68004
PS-06	Patkelpota Govt Primary School	Meherpur Sadar	23.7246763	88.74567
PS-07	Near Durlovpur Mosjid	Gangni	23.8749166	88.74699

4.1.2 Multi-channel Analysis of Surface Wave (MASW) Test

To predict subsurface shear wave interval velocities, Multi-Spectral Analyses of Surface Wave (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 compares 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 Eleven (11) different locations of Meherpur Sadar, Mujibnagar and Gangni Upazials of Meherpur Zilla area by 17th September to 20th September and the field raw data is being processed and interpreted.

Location of MASW tests is shown in Figure 6 and Table 2. The investigation of the MASW test activities is enclosed in Appendix B in tabular and also in graphical representation.

Table 2 MASW Survey Locations

Sl.No.	Point Name	Upazila	Lat	Long
MASW-01	Dariapur Playground	Mujib Nagar	23.709083	88.610578
MASW-02	Anandabash Playground behind Anandabash Girls High School	Mujib Nagar	23.631182	88.6084891
MASW-03	Mohajonpur Secondary School Playground	Mujib Nagar	23.650352	88.672655
MASW-04	Garadob	Meherpur Sadar	23.80079	88.69994
MASW-05	Teroghoria Eid Gagh Math	Meherpur Sadar	23.832305	88.61128
MASW-06	Shampur	Meherpur Sadar	23.824802	88.683888
MASW-07	Amjhupi High School	Meherpur Sadar	23.74608	88.68457
MASW-08	Baliarpur Purbopara	Meherpur Sadar	23.696909	88.738958
MASW-09	Sanghat Chandamari High School	Gangni	23.783093	88.805058
MASW-10	Debipur Government Primary School	Gangni	23.894892	88.780725
MASW-11	Kazipur Football Maath	Gangni	23.959642	88.742225

The shear wave velocity is a fundamental parameter required to define the dynamic properties of soils. If the soil velocity is less than 180m/s, it can be said to be 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 30 m of the subsurface. Furthermore, 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.

4.1.3 Single Microtremor Survey

Microtremor observations were performed using portable equipment, which is equipped with an ultra-sensitive sensor, a wire comprising a jack in one side and USB port in another side, and a laptop computer with GEODAS (Geophysical Data Acquisition System) made by Buttan Service Co. Japan, is used for the data acquisition. The microtremor equipment has been set on the free surface on the ground without any minor tilting of the equipment. The N-S and E-W directions are properly maintained following the directions arrowed on the body of the equipment. The sampling frequency for all the measurements is set at 200 Hz. The low-pass filter of 50 Hz is set in the data acquisition unit. Like the seismometer or accelerometer, the velocity sensor used can measure three components of vibration: two horizontal and one vertical. The natural period of the sensor is 2 sec. A Global Positioning System (GPS) is used for recording the coordinates of observation sites. Three components (NS, EW, and UD) of microtremors were observed for 20 minutes time period of data collection. In this perspective, Microtremor test has been completed at Fifteen (15) different locations of Meherpur Sadar, Mujibnagar and Gangni Upazials of Meherpur Zilla area by 17th September to 20th September and the field raw data is being processed and interpreted.

Location of Microtremor tests is shown in Figure 7 and Table 3. The investigation of the Microtremor survey activities is enclosed in Appendix C in tabular and also in graphical representation.

Table 3 Test Locations of microtremor Survey

Sl. No.	Point Name	Upazila	Lat	Long
MT-01	Vobanipur Primary School	Mujib Nagar	23.6681886	88.6182097
MT-02	Sonapur Govt Primary School School	Mujib Nagar	23.6484357	88.5839227
MT-03	Dholmary Primary School	Mujib Nagar	23.6485396	88.6503493
MT-04	Meherpur Govt High School	Meherpur Sadar	23.7742131	88.6340626
MT-05	Buripota Primary School	Meherpur Sadar	23.7660193	88.5815818
MT-06	Amjhupi Girls Govt. Primary School	Meherpur Sadar	23.7487754	88.6799311
MT-07	Ashrafpur Govt Primary School	Meherpur Sadar	23.7064439	88.6463092
MT-08	Boliarpur Govt. Primary School	Meherpur Sadar	23.696989	88.7393638
MT-09	Jorepukuria Secondary School	Gangni	23.861312	88.7769724
MT-10	Nowpara Primary School	Gangni	23.8508191	88.700172
MT-11	Bhatpara Govt. Primary School	Gangni	23.7638196	88.7606622
MT-12	K. A. B. High School	Gangni	23.8145666	88.8045911
MT-13	Motmura Govt Primary School	Gangni	23.8982973	88.8346479
MT-14	Betbaria Girl's School	Gangni	23.9558882	88.7920199
MT-15	Karamdi Secondary School	Gangni	23.9049062	88.7515474

4.2 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. The Standard Penetration Test (SPT) was conducted to know subsurface geological conditions. The bores with SPT were carried out at Thirty (30) different locations of Meherpur Sadar, Mujibnagar and Gangni Upazials of Meherpur Zilla area by 11th September to 28th September and the field raw data is being tested in laboratory.

4.2.1 Standard Penetration Test (SPT)

SPT is a common in-situ testing method used to determine the geotechnical engineering properties of subsurface soils. It was developed in the late 1920's 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.

All the borings were conducted, and preparation of field bore logs by visual classification in the presence of 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 borehole locations are given in the following Table 4 and the geotechnical activities and borehole Log sheet are enclosed in the Appendix D and Appendix E.

Table 4 Location of SPT Borehole

Sl. No.	Point Name	Upazila	Lat	Long
BH-01	Dariapur High School	Mujib Nagar	23.709654	88.610168
BH-02	Near Dariapur BDR Camp	Mujib Nagar	23.7158137	88.5828122
BH-03	Near Gourinagar Nagarmath Bottola	Mujib Nagar	23.684995	88.581826
BH-04	Vobanipur Primary School	Mujib Nagar	23.668205	88.6182135
BH-05	Sonapur Govt Primary School School	Mujib Nagar	23.6484837	88.5839159
BH-06	Anandabas Markajul Ulum Madrasa	Mujib Nagar	23.6362041	88.611549
BH-07	Joypur Primary School	Mujib Nagar	23.6111496	88.6234667
BH-08	Dholmary Primary School	Mujib Nagar	23.648497	88.6506179
BH-09	Mahajonpur Uttarpara Govt Primary School	Mujib Nagar	23.658003	88.6774004
BH-10	Komorpur Govt Primary School	Mujib Nagar	23.683074	88.675168
BH-11	Meher Govt. High School	Meherpur Sadar	23.7742445	88.6340245
BH-12	Shalika High School	Meherpur Sadar	23.749598	88.592546
BH-13	Harirampur Secondary School	Meherpur Sadar	23.7861621	88.5969308
BH-14	Ujalpur High School	Meherpur Sadar	23.8152581	88.62626
BH-15	Sholmary Govt Primary School	Meherpur Sadar	23.8555441	88.6077649
BH-16	Kaligangni Govt Primary School	Meherpur Sadar	23.844148	88.691053
BH-17	Ramnagar Government Primary School	Meherpur Sadar	23.7994972	88.6602618
BH-18	Amdah Primary School	Meherpur Sadar	23.7375161	88.6329218

BH-19	Ashrafpur Govt Primary School	Meherpur Sadar	23.7063712	88.6463158
BH-20	Kola Govt. Primary School	Meherpur Sadar	23.7283846	88.6647428
BH-21	Amjhupi Girls Govt. Primary School	Meherpur Sadar	23.7488266	88.6800397
BH-22	Khoksha Govt Primary School	Meherpur Sadar	23.7748401	88.6912091
BH-23	Hijuli Govt. Primary School	Meherpur Sadar	23.7503449	88.7173481
BH-24	Road site of Roghunathpur Area	Meherpur Sadar	23.7285247	88.7094087
BH-25	Kathalpota Govt Primary School	Meherpur Sadar	23.6892956	88.7098221
BH-26	Boliarpur (Purbopara) Govt. Primary School	Meherpur Sadar	23.6969634	88.7393762
BH-27	Patkelpota Primary School	Meherpur Sadar	23.7246763	88.7456695
BH-28	Near Durlovpur Mosjid	Gangni	23.8749166	88.7469947
BH-29	Garadob Govt. Primary School	Gangni	23.8009408	88.6997816
BH-30	Bhatpara Govt. Primary School	Gangni	23.7638714	88.7607088

5 CONCLUSION

Seismically, Bangladesh is divided into four zones i.e. highly risk zone (zone VI), risk zone (zone III), moderate risk zone (zone II) and low risk zone (zone I). Meherpur Zila is situated in zone I (BNBC, 2020). Geological Study and Seismic Hazard Assessment are one of the important studies of Preparation of Development Plan. In this perspective, subsurface geological and geotechnical information is considered as an important tool for durable and sustainable urbanization. To achieve this "Engineering Geological and Geo-Physical Surveys" is one of the important modules of this project. To propitiate the risk of earthquake some initiatives have been taken by the concerned authority (UDD).

In this project work, both geophysical and engineering geological investigations have been conducted. The duration of the project is twelve months. In engineering geological survey Thirty (30) numbers of SPT boring (up to 30 m depth) were performed and the soil samples collected from the field have been tested in the laboratory. And in geophysical Surveys, total Seven (7) numbers of PS-logging, eleven (11) numbers of MASW and Fifteen (15) numbers of Microtremor test have been conducted by using some sophisticated instruments. Finally, from engineering geological and geophysical data base will give a clear impression about the sub-surface and surface status of landscape where newly urban developing activities or any other megaprojects for infrastructure development are going on and the investigation mentioned also gives an idea about the vulnerability of existing landscape of a particular area. Based on these results, proper management techniques as well as other necessary adaptation processes could be addressed before or after the development activities in the studied area.

6 REFERENCES

I. The Bangladesh National Building Code (BNBC) 2020.
II. Okada, H., 2003, The microtremor survey method, Society of Exploration Geophysicist, Tulsa
III. Park CB, Miller RD, Xia J. Multi-channel analysis of surface waves. Geophysics 1999; 64(3):800–8.

7 APPENDICES

Appendix A: Photographic Representation of Downhole Seismic Survey (PS-logging) Work

Appendix B: Photographic Representation of MASW Survey

Appendix C: Photographic Representation of Microtremor Survey Work

Appendix D: Photographic Representation of Geotechnical Survey (SPT) Work

Appendix E: Standard Penetration Test (SPT) Log sheet/ Borehole Log sheet.

7.1 Appendix A: Photographic Representation of Downhole Seismic Survey (PS logging)

PS ID: PS-01 (BH-04)
Location: Vobanipur Primary School, Mujibnagar
Lat: 23.66821, Long: 88.61821

PS ID: PS-02 (BH-09)
Location:
Mohajonpur Uttarpara Govt Primary School, Mujibnagar
Lat: 23.65800,Long: 88.677400

PS ID: PS-03 (BH-11)
Location: Meher Govt. High School, Meherpur
Lat: 23.77424, Long: 88.63402

PS ID: PS-04 (BH-15)
Location: Sholmari Govt Primary School, Meherpur
Lat: 23.85554 ,Long: 88.60776

PS ID: PS-05(BH-21)
Location: Amjhupi Girls Govt. Primary School, Meherpur
Lat: 23.74883 ,Long: 88.74567

PS ID: PS-06 (BH-27)
Location: Patkelpota Govt Primary School ,Meherpur
Lat: 23.72468 ,Long: 88.74567

PS ID: PS-07 (BH-28)
Location: Near Durlovpur Mosjid, Gangni
Lat: 23.87492 ,Long: 88.74699

7.2 Appendix B: Photographic Representation of MASW Survey Work

MASW Id: 01
Location: Dariapur Play Ground, Mujibnagar
Lat: 23.709083, Long: 88.610578

MASW Id: 02
Location: Anandabas Play Ground, Mujibnagar
Lat: 23.6318201, Long: 88.6084891

MASW Id: 03
Location: Mohajaonpur High School, Mujibnagar
Lat: 23.650352, Long: 88.672655

MASW ID: 04
Location: Garadob
Lat: 23.800790 ; Long: 88.699940

MASW ID: 05
Location: Teroghoria Eidgah Math, Meherpur
Lat: 23.832305, Long: 88.611280

MASW ID: 06
Location: Shampur , Gangni
Lat: 23.824802, Long: 88.683888

MASW ID: 07
Location: Amjhupi High School , Meherpur

Lat: 23.7458060 Long: 88.6854168

MASW ID: 08
Location: Boliarpur Purbapara, Meherpur
Lat: 23.696909, Long: 88.738958

MASW ID: 09
Location: Sanghat Chandamari High School, Gangni
Lat: 23.7831396, Long: 88.8051658

MASW ID: 10
Location: Debipur Pirmary Scool, Gangni
Lat: 23.894892, Long: 88.780725

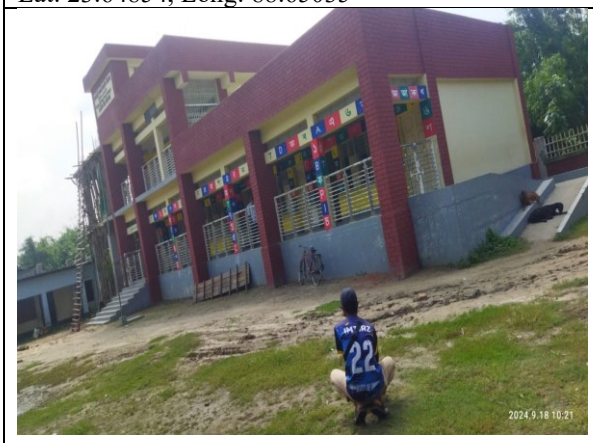
MASW ID: 11
Location: Kachari Bazar , Kajipur , Gangni
Lat: 23.959642, Long: 88.742225

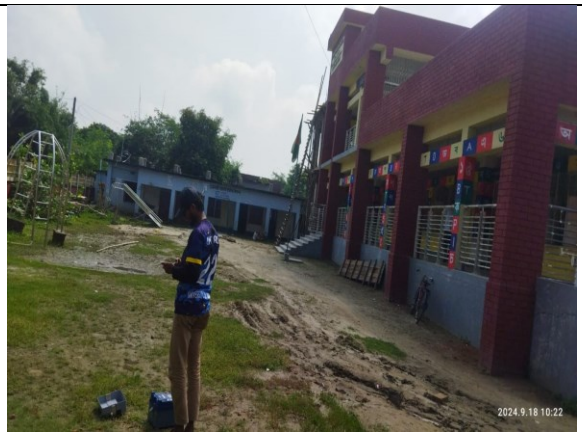
7.3 Appendix C: Photographic Representation of Microtremor Survey Work

Microtremor ID: 1
Location: Vobanipur Primary School, Mujib Nagar
Lat: 23.66819, Long: 88.61821

Microtremor ID: 2
Location; Sonapur Govt Primary School School, Mujibnagar
Lat: 23.64844, Long: 88.58392

Microtremor ID: 3
Location: Dholmary Primary School
Lat: 23.64854, Long: 88.65035



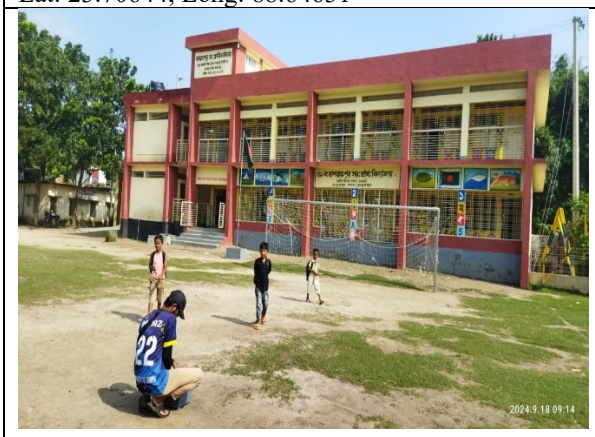


Microtremor ID: 4
Location: Meherpur Govt High School, Meherpur
Lat: 23.77421, Long: 88.63406

Microtremor ID: 5
Location: Buripota Primary School
Lat: 23.76602, Long: 88.58158

Microtremor ID: 6
Location: Amjhupi Girls Govt. Primary School
Lat 2374878, Long: 88.67993

Microtremor ID: 7
Location: Ashrafpur Govt Primary School, Meherpur
Lat: 23.70644, Long: 88.64631



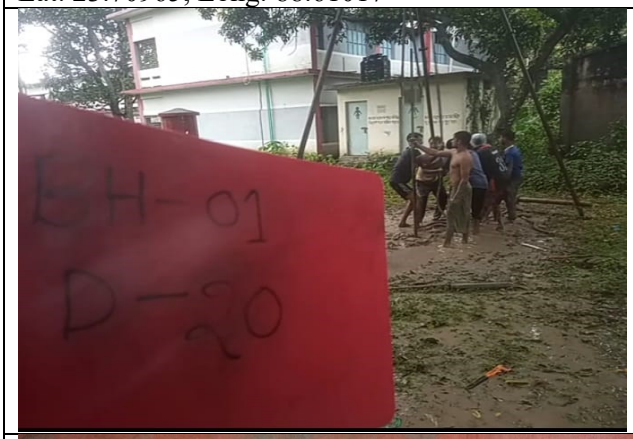
Microtremor ID: 8
Location: Boliarpur Govt. Primary School, Meherpur
Lat: 23.69699, Long: 88.73936

Microtremor ID: 9
Location: Jorepukuria Secondary School, Gangni
Lat: 23.86131, Long: 88.77697

Microtremor ID: 10
Location: Nowpara Primary School, Gangni
Lat: 23.85082, Long: 88’70017

7.4 Appendix D: Photographic Representation of Geotechnical Survey (SPT) Work

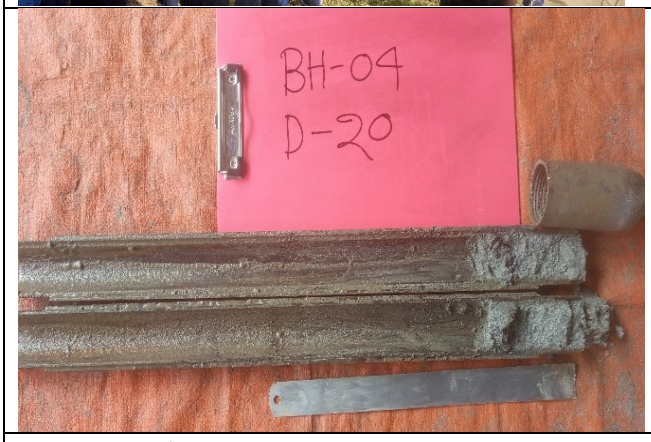
BH ID: BH-01
Location: Dariapur High School
Lat: 23.70965, Long: 88.61017



BH ID: BH-02
Location: Near Dariapur BDR Camp, Mujib Nagar
Lat: 23.71581, Long: 88.58281

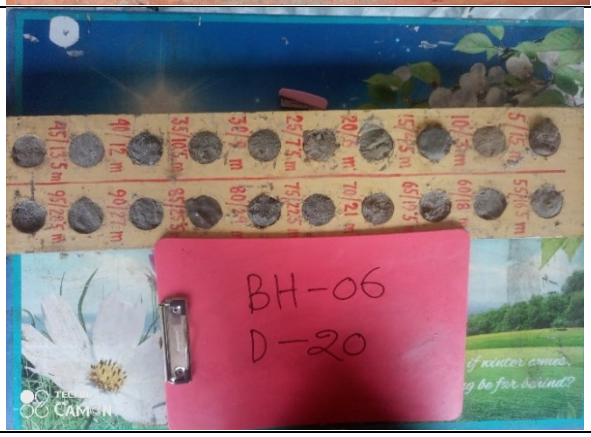
BH ID: BH-03
Location: Near Gourinagar Nagarmath Bottola, Mujib Nagar
Lat: 23.68500, Long: 88.58183

BH ID: BH-04
Location: Vobanipur Primary School, Mujib Nagar
Lat: 23.66821, Long: 88.61821



BH ID: BH-05
Location: Sonapur Govt Primary School School, mujib nagar
Lat: 23.64848, Long: 88.58392

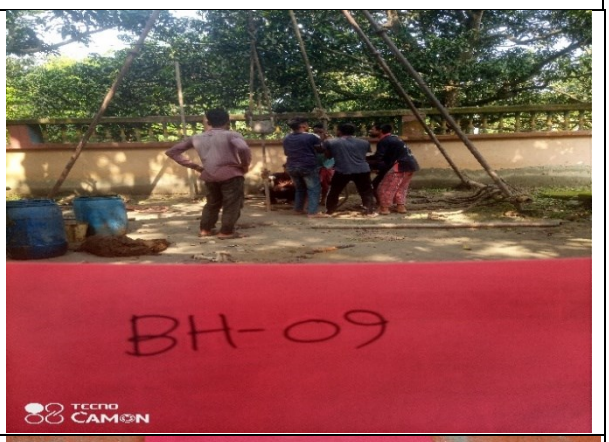
BH ID: BH-06
Location: Anandabas Markajul Ulum Madrasa, Mujib Nagar
Lat: 23.6362, Long: 88.61155



BH ID: BH-07
Location: Joypur Primary School, Mujib Nagar
Lat: 23.61115, Long: 88.62347

BH ID: BH-08
Location: Dholmary Primary School, Mujib Nagar
Lat: 23.6485, Long: 88.65062

BH ID: BH-09
Location:
Mahajonpur Uttarpara Govt Primary School, Mujib Nagar
Lat: 23.65800, Long: 88.67740



BH ID: BH-10
Location: Komorpur Govt Primary School, Mujib Nagar
Lat:23.68307, Long: 88.67517

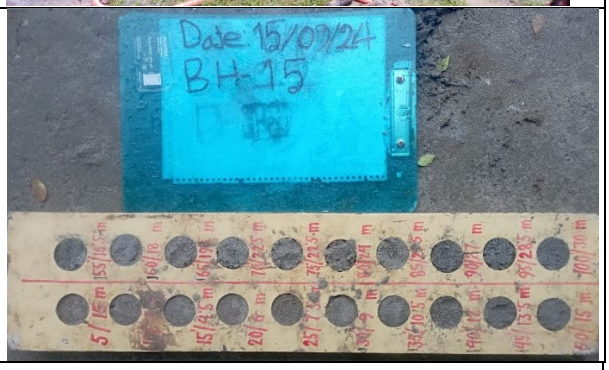
BH ID: BH-11
Location: Meher Govt. High School, Meherpur Sadar
Lat: 23.68500, Long: 88.58183

BH ID: BH-12
Location:. Shalika High School, Meherpur Sadar
Lat: 23.74960, Long: 88.59255

BH ID: BH-13
Location: Harirampur Secondary School, Meherpur Sadar
Lat: 23.78616, Long: 88.59693

BH ID: BH-14
Location: Ujalpur High School, Meherpur
Lat: 2381526, Long: 88.62626

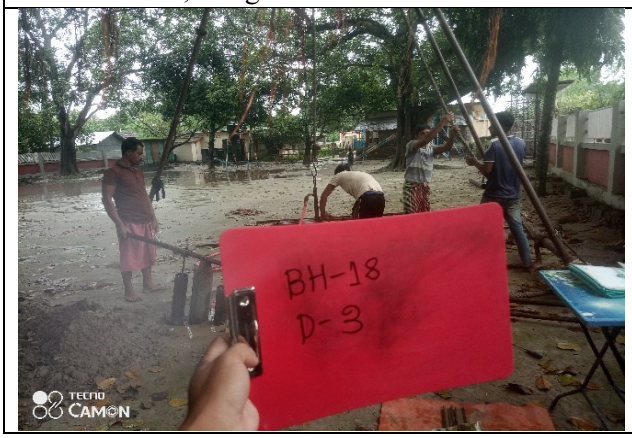
BH ID: BH-15
Location: Sholmary Govt Primary School, Meherpur
Lat: 23.85554, Long: 88.60776



BH ID: BH-16
Location:. Kaligangni Govt Primary School, Meherpur
Lat: 23.84415, Long: 88.69105

BH ID: BH-17
Location: Ramnagar Government Primary School, Meherpur
Lat: 23.799500, Long: 88.66026

BH ID: BH-18
Location: Amdah Primary School, Meherpur
Lat: 23.73752, Long: 88.63292

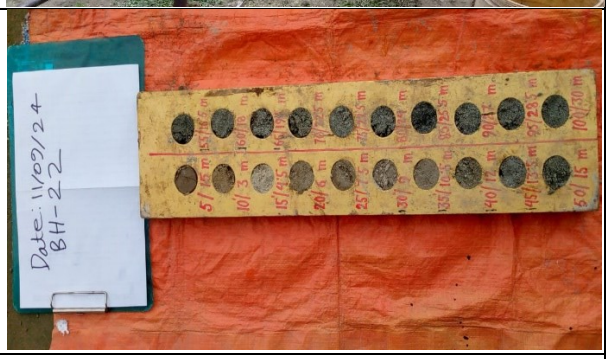


BH ID: BH-19
Location: Ashrafpur Govt Primary School, Meherpur
Lat: 23.70637, Long: 88.64632

BH ID: BH-20
Location: Kola Govt. Primary School, Meherpur sadar
Lat: 23.72838, Long: 88.66474

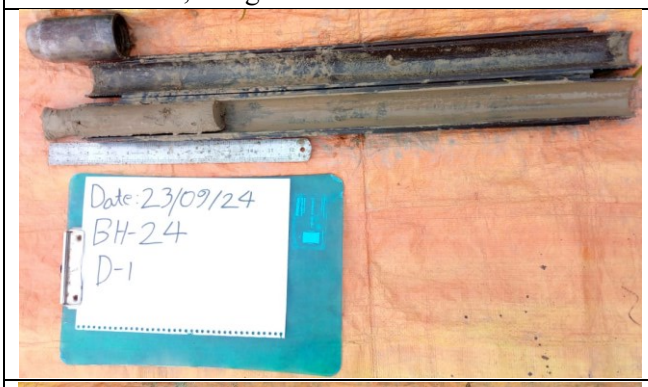
BH ID: BH-21
Location: Amjhupi Girls Govt. Primary School, Meherpur
Lat: 23.74883, Long: 88.68004

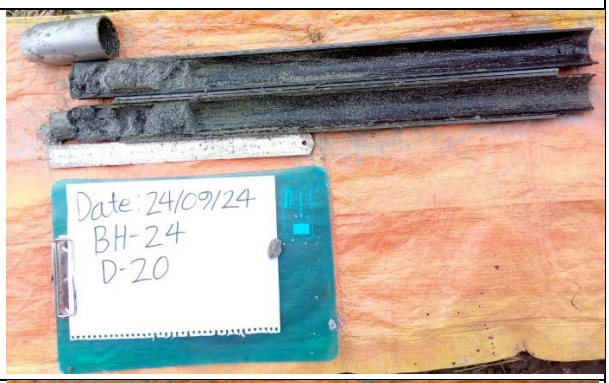
BH ID: BH-22
Location: Khoksha Govt Primary School, Meherpur
Lat: 23.77484, Long: 88.69121



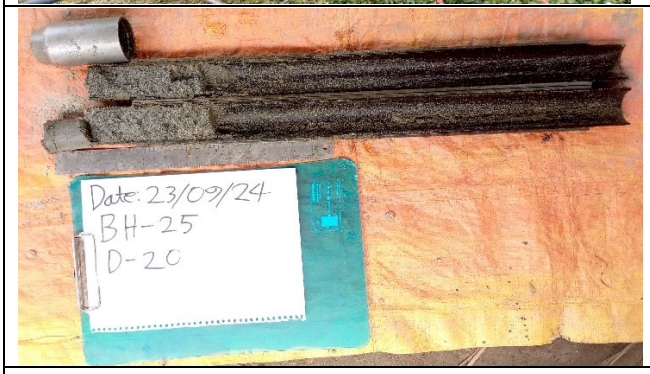
BH ID: BH-23
Location:. Hijuli Govt. Primary School, Meherpur
Lat: 23.75034, Long: 88.71735

BH ID: BH-24
Location: Road site of Roghunathpur Area, Meherpur
Lat: 23.72852, Long: 88.70941





BH ID: BH-25
Location: Kathalpota Govt Primary School, Meherpur
Lat: 23.68930, Long: 88.70982

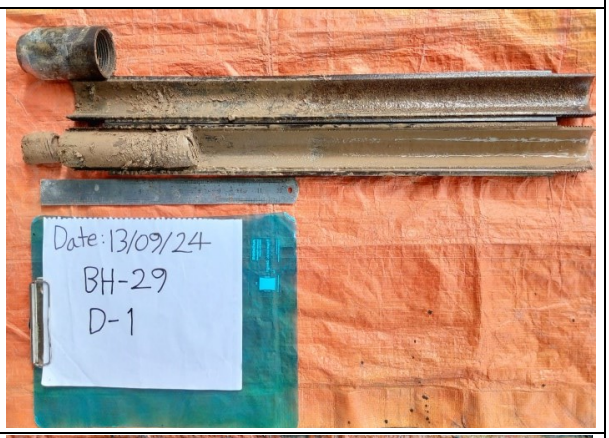


BH ID: BH-26
Location: Boliarpur (Purbopara) Govt. Primary School, Meherpur
Lat: 23.69696, Long: 88.73938

BH ID: BH-27
Location: Patkelpota Primary School, Meherpur
Lat: 23.72468, Long: 88.74567

BH ID: BH-28
Location: Near Durlovpur Mosjid, Gangni
Lat: 23.87492, Long: 88.74699

BH ID: BH-29
Location: Garadob Govt. Primary School, Gangni
Lat: 23.80094, Long: 88.69978



BH ID: BH-30
Location: Bhatpara Govt. Primary School, Gangni
Lat: 23.76387, Long: 88.76071

Date: 26/09/24
BH-30
D-20

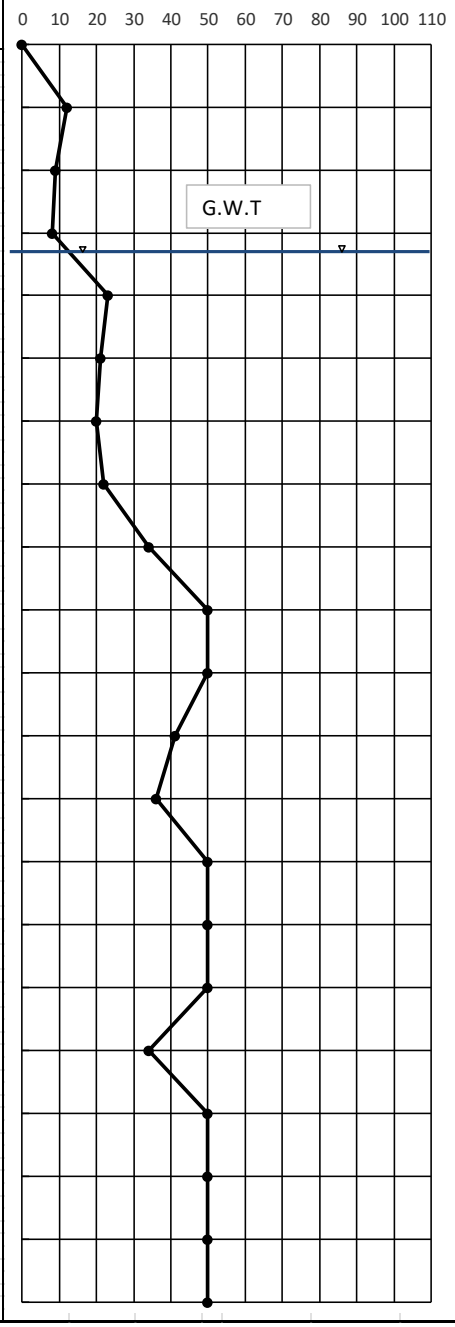
Date: 26-09-24
BH-30

7.5 Appendix E: Standard Penetration Test (SPT) Log sheet/ Borehole Log sheet

GEOTECHNICAL BOREHOLE LOG

Bore Hole No:	BH-01	**Ground Water Level:**	**4.8m**
Method of Boring and Diameter:	Percussion (100mm)	**Started on:**	**25/09/2024**
Boring Depth:	30m	**Completed on:**	**25/09/2024**
Client:	Urban Development Directorate (UDD)	**Legend:**	Clay/Silt | Sand | Shale
Project:	Preparation of Development Plan for Meherpur Zilla		
Location:	**Dariapur High School, Mujibnagar, Meherpur**	**Coordinates:**	**Lat. 23.709654**, **Long. 88.610168**

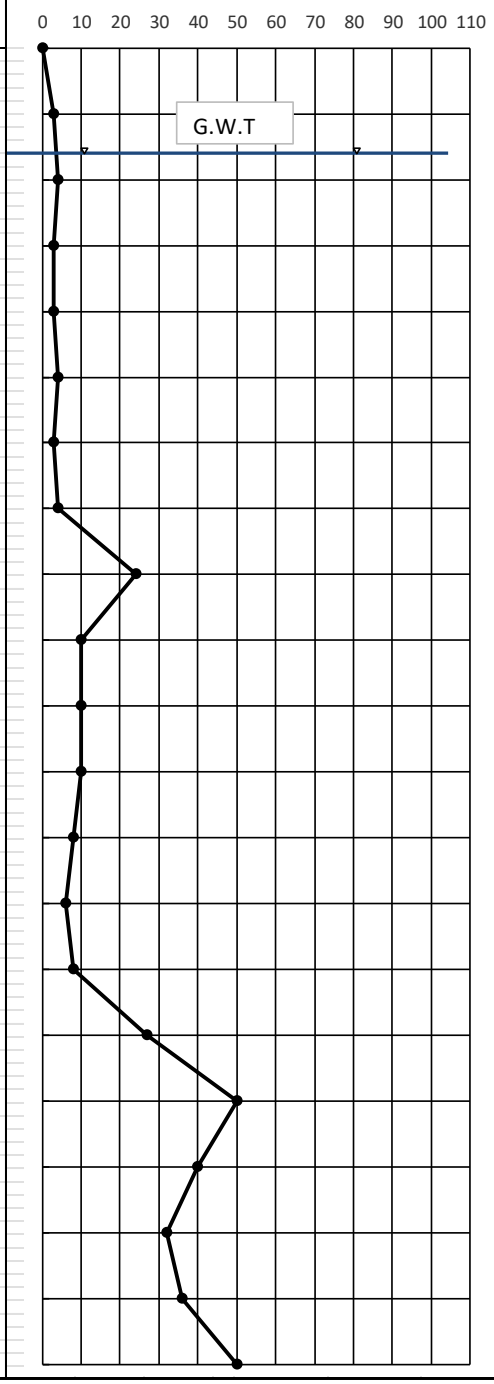
Depth	Visual Description	Symbols	Sample	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Brownish Gray Stiff **SILT** with Little Very Fine Sand			4.5	4	5	7	12
3.0					2	4	5	9
4.5					2	3	5	8
6.0	Gray Medium Dense very Fine to Fine **SAND**			6	5	8	15	23
7.5					4	7	14	21
9.0					4	7	13	20
10.5					5	7	15	22
12.0	Gray Dense to very Dense fine to very Fine **SAND** WITH Little Silt			13.5	8	12	22	34
13.5					16	50	0	50 6"Over
15.0					10	27	23	50 3"Over
16.5					13	16	25	41
18.0					10	15	21	36
19.5					20	50	0	50 6"Over
21.0					15	50	0	50 10"Over
22.5					27	50	0	50 9"Over
24.0					12	15	19	34
25.5	Gray Very Dense Fine to very Fine **SAND** with Little Silt			6	15	50	0	50 6"Over
27.0					50	0	0	50 13"Over
28.5					50	0	0	50 14"Over
30.0					18	29	21	50



GEOTECHNICAL BOREHOLE LOG

Bore Hole No:	BH-02	**Ground Water Level:**	**2.4m**
Method of Boring and Diameter:	Percussion (100mm)	**Started on:**	**23/09/2024**
Boring Depth:	30m	**Completed on:**	**23/09/2024**
Client:	Urban Development Directorate (UDD)	**Legend:**	Clay/Silt | Sand | Shale
Project:	Preparation of Development Plan for Meherpur Zilla		
Location:	**Near Dariapur BDR Camp, Mujibnagar , Meherpur**	**Coordinates:**	**Lat. 23.7158137**, **Long. 88.5828122**

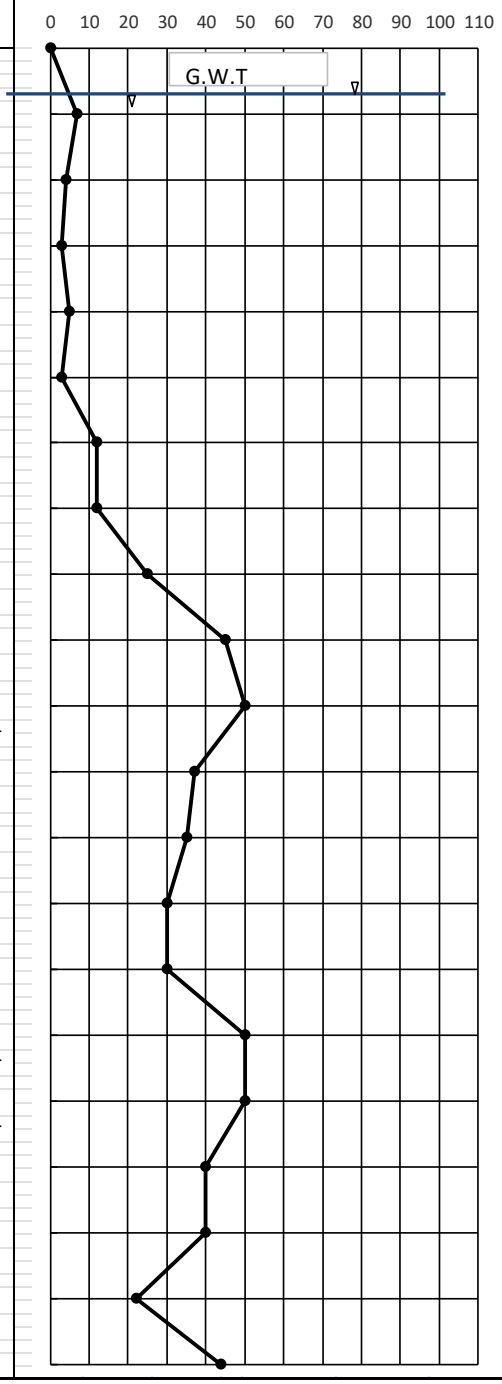
Depth	Visual Description	Symbols	Sample	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Brownish Gray to Gray Soft Clayey **SILT**, little very fine sand			10.5	1	1	2	3
3.0					1	2	2	4
4.5					1	1	2	3
6.0					1	1	2	3
7.5					1	2	2	4
9.0					1	1	2	3
10.5					1	2	2	4
12.0	Gray Medium Dense Very Fine **SAND** with Little Silt			1.5	8	12	12	24
13.5	Gray Loose Very Fine **SAND** with Little Silt			3	2	4	6	10
15.0					2	4	6	10
16.5	Gray Medium Stiff Clayey **SILT**			6	3	5	5	10
18.0					3	4	4	8
19.5					2	3	3	6
21.0					3	4	4	8
22.5	Gray Medium Dense to very Dense Fine **SAND**			9	6	9	18	27
24.0					18	50	0	50 6"Over
25.5					13	15	25	40
27.0					10	14	18	32
28.5					12	16	20	36
30.0					15	25	25	50



GEOTECHNICAL BOREHOLE LOG

Bore Hole No:	BH-03	**Ground Water Level:**	**1m**
Method of Boring and Diameter:	Percussion (100mm)	**Started on:**	**24/09/2024**
Boring Depth:	30m	**Completed on:**	**24/09/2024**
Client:	Urban Development Directorate (UDD)	**Legend:**	Clay/Silt | Sand | Shale
Project:	Preparation of Development Plan for Meherpur Zilla		
Location:	**Near Gourinagar Nagarmath Bottola, Mujibnagar, Meherpur**	**Coordinates:**	**Lat. 23.684995** / **Long. 88.581826**

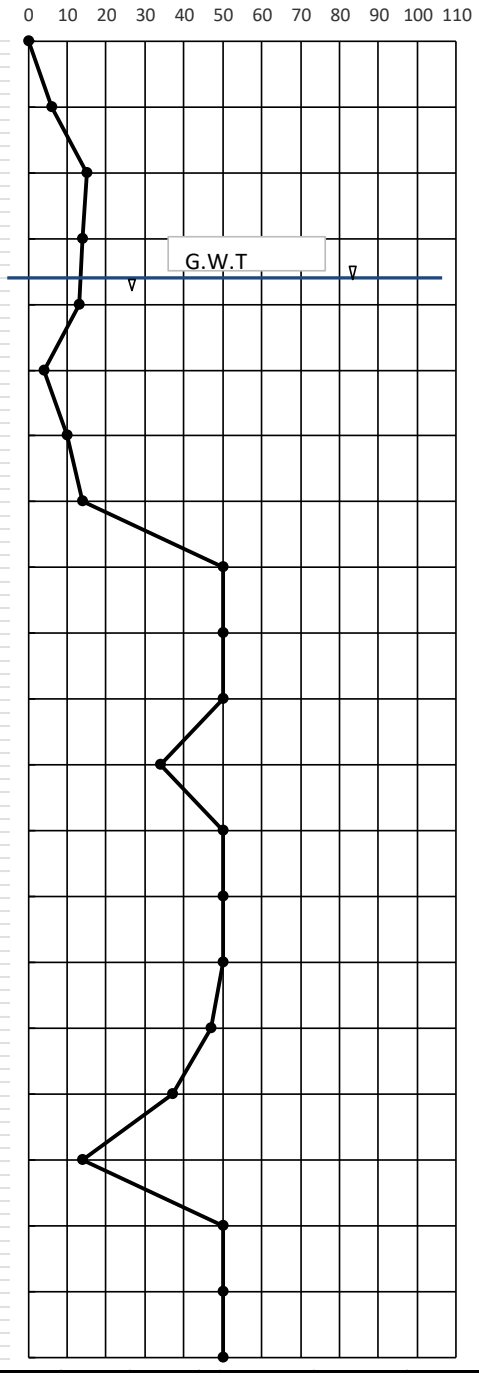
Depth	Visual Description	Symbols	Sample	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Brownish Gray to Gray very Loose to loose Very Fine **SAND**			3	2	3	4	7
3.0					1	2	2	4
4.5	Gray Soft to medium stiff **CLAY**			4.5	1	1	2	3
6.0					1	2	3	5
7.5					1	1	2	3
9.0	Gray Medium Dense Very Fine **SAND** with Little Silt and mica			4.5	4	5	7	12
10.5					3	6	6	12
12.0					6	9	16	25
13.5	Gray Dense fine to very fine **SAND**			6	15	20	25	45
15.0					10	30	20	50 4"Over
16.5					10	15	22	37
18.0					8	13	22	35
19.5	Gray Medium Dense Fine to Medium **SAND**			3	8	11	19	30
21.0					9	13	17	30
22.5	Gray Very Dense Fine to Medium **SAND**			4.5	16	50	0	50 8"Over
24.0					15	30	20	50 2"Over
25.5					13	18	22	40
27.0	Gray Medium Dense to dense Fine **SAND**			4.5	14	18	22	40
28.5					6	9	13	22
30.0					8	17	27	44



GEOTECHNICAL BOREHOLE LOG

Bore Hole No:	BH-04	**Ground Water Level:**	**5.5m**
Method of Boring and Diameter:	Percussion (100mm)	**Started on:**	**16/09/2024**
Boring Depth:	30m	**Completed on:**	**17/09/2024**
Client:	Urban Development Directorate (UDD)	**Legend:**	Clay/Silt, Sand, Shale
Project:	Preparation of Development Plan for Meherpur Zilla		
Location:	**Vobanipur Govt. Primary School, Mujibnagar, Meherpur**	**Coordinates:**	**Lat. 23.668205, Long. 88.6182135**

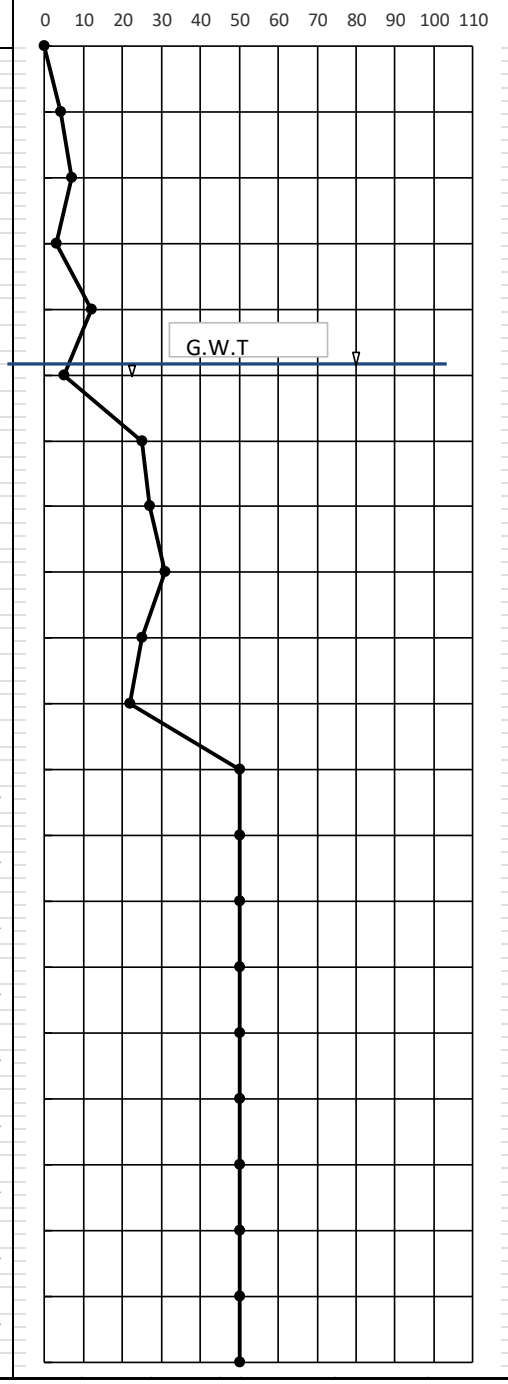
Depth	Visual Description	Symbols	Sample	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Brownish Gray Loose Very Fine **SAND** with Sufficient Silt			1.5	2	3	3	6
3.0	Brownish Gray Stiff **SILT** with Very Fine Sand			1.5	3	6	9	15
4.5	Brownish Gray Medium Dense Very Fine **SAND** with Little Silt			4.5	4	6	8	14
6.0					3	6	7	13
7.5					2	2	2	4
9.0	Gray Loose to Medium Dense Very Fine **SAND** with sufficient Silt			3	4	4	6	10
10.5					5	6	8	14
12.0	Gray Very Dense Very Fine to medium **SAND** with Trace of Silt			10.5	10	40	10	50 5"Over
13.5					15	50	0	50 7"Over
15.0					14	30	20	50 3"Over
16.5					10	14	20	34
18.0					20	50	0	50 8"Over
19.5					24	40	10	50 5"Over
21.0					15	50	0	50 7"Over
22.5	Gray Dense Very Fine **SAND** with Sufficient Silt			3	10	15	32	47
24.0					8	12	25	37
25.5	Brownish Gray Stiff **SILT** with Little Very Fine Sand			1.5	5	6	8	14
27.0	Gray Very Dense medium to very Fine **SAND**			4.5	18	40	10	50 5"Over
28.5					22	50	0	50 7"Over
30.0					24	50	0	50



GEOTECHNICAL BOREHOLE LOG

Bore Hole No:	BH-05	**Ground Water Level:**	**7.3m**
Method of Boring and Diameter:	Percussion (100mm)	**Started on:**	**12/9/2024**
Boring Depth:	30m	**Completed on:**	**12/9/2024**
Client:	Urban Development Directorate (UDD)	**Legend:**	Clay/Silt | Sand | Shale
Project:	Preparation of Development Plan for Meherpur Zilla		
Location:	**Sonapur Govt. Primary School, Mujibnagar, Meherpur**	**Coordinates:**	**Lat. 23.6484837**, **Long. 88.5839159**

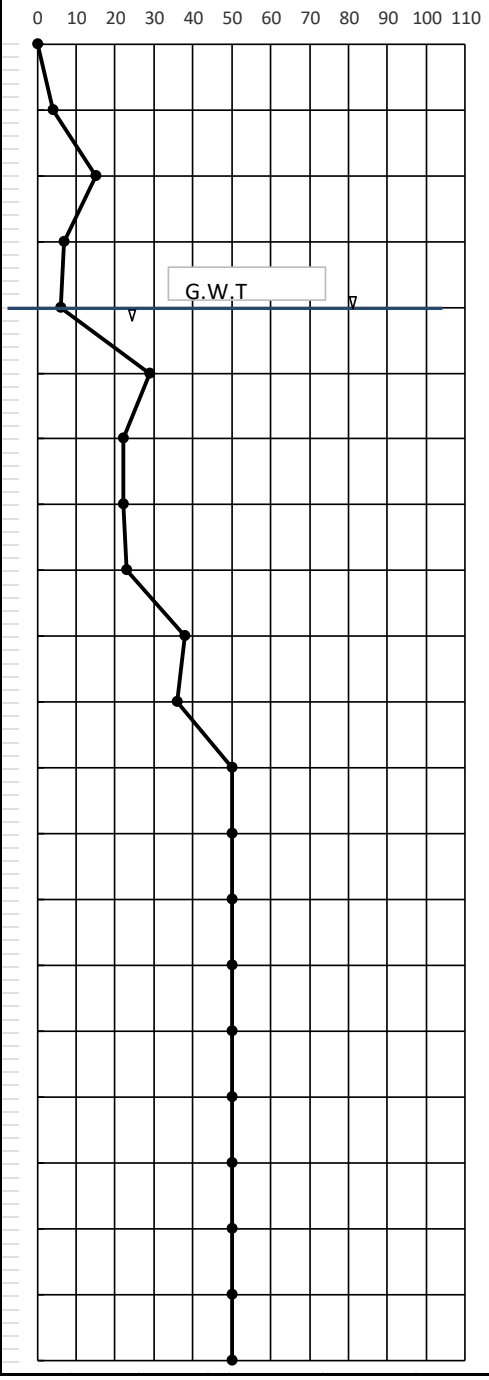
Depth	Visual Description	Symbols	Sample	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Brownish Gray Very Loose to Loose Fine **SAND**			3	1	2	2	4
3.0					2	3	4	7
4.5	Brownish Gray Stiff Silty **CLAY** with Little Very Fine Sand			3	1	1	2	3
6.0					3	4	8	12
7.5	Gray Loose to Medium Dense Fine **SAND** with Little Silt			9	2	2	3	5
9.0					6	10	15	25
10.5					10	12	15	27
12.0					8	13	18	31
13.5					8	10	15	25
15.0					6	9	13	22
16.5	Gray Very Dense Fine to Medium **SAND** trace silt			15	15	50	0	50 6"Over
18.0					18	50	0	50 7"Over
19.5					20	35	15	50 5"Over
21.0					20	25	25	50 2"Over
22.5					20	28	22	50 3"Over
24.0					20	30	20	50 4"Over
25.5					22	35	15	50 5"Over
27.0					20	32	18	50 5"Over
28.5					24	40	10	50 5"Over
30.0					28	50	0	50



GEOTECHNICAL BOREHOLE LOG

Bore Hole No:	BH-06	**Ground Water Level:**	**20ft**
Method of Boring and Diameter:	Percussion (100mm)	**Started on:**	**13/092024**
Boring Depth:	30m	**Completed on:**	**14/09/2024**
Client:	Urban Development Directorate (UDD)	**Legend:**	Clay/Silt | Sand | Shale
Project:	Preparation of Development Plan for Meherpur Zilla		
Location:	**Anandabas Markajul Ulum Madrasa, Mujibnagar, Meherpur**	**Coordinates:**	**Lat. 23.6362041**, **Long. 88.611549**

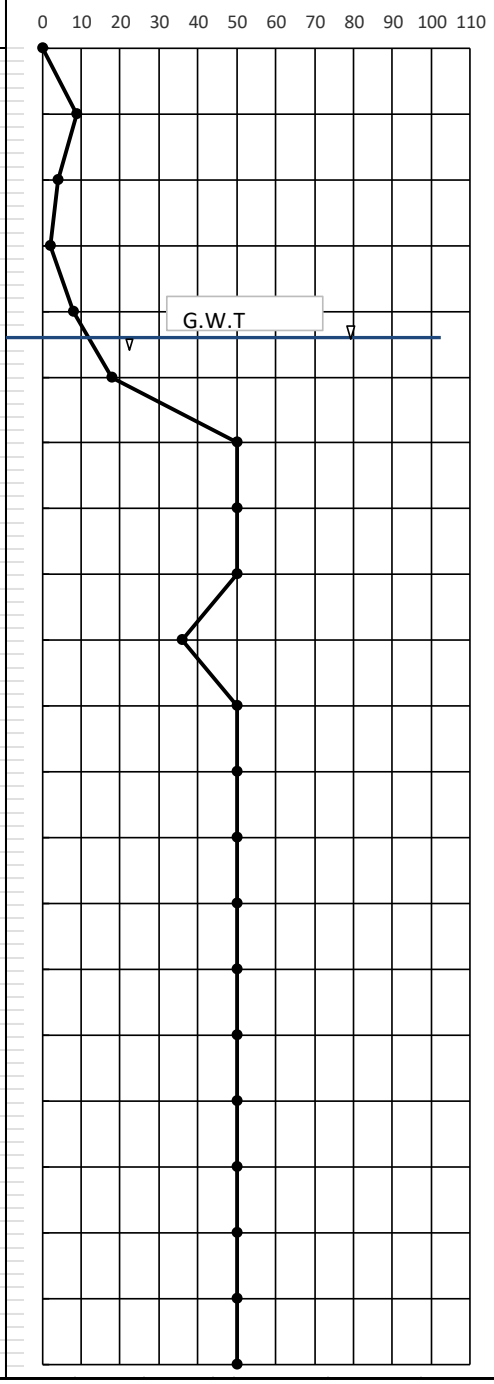
Depth	Visual Description	Symbols	Sample	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Brownish Gray Medium Stiff Clayey **SILT**			6	1	2	2	4
3.0					4	6	9	15
4.5					2	3	4	7
6.0					2	2	4	6
7.5	Gray Medium Dense Fine SAND with Little Silt			6	6	13	16	29
9.0					4	8	14	22
10.5					7	10	12	22
12.0	Gray Dense Fine to Medium **SAND**			3	5	8	15	23
13.5					8	16	22	38
15.0	Gray Very Dense Fine **SAND**			15	9	16	20	36
16.5					12	25	25	50 1"Over
18.0					13	25	25	50 3"Over
19.5					23	50	0	50 9"Over
21.0					25	50	0	50 10"Over
22.5					20	50	0	50 9"Over
24.0					23	50	0	50 8"Over
25.5					50	0	0	50 12"Over
27.0					25	50	0	50 10"Over
28.5					32	50	0	50 7"Over
30.0					37	50	0	50



GEOTECHNICAL BOREHOLE LOG

Bore Hole No:	BH-07	**Ground Water Level:**	**6.7m**
Method of Boring and Diameter:	Percussion (100mm)	**Started on:**	**11/9/2024**
Boring Depth:	30m	**Completed on:**	**12/9/2024**
Client:	Urban Development Directorate (UDD)	**Legend:**	Clay/Silt, Sand, Shale
Project:	Preparation of Development Plan for Meherpur Zilla		
Location:	**Joypur Govt. Primary School, Mujibnagar, Meherpur**	**Coordinates:**	**Lat. 23.6111496, Long. 88.6234667**

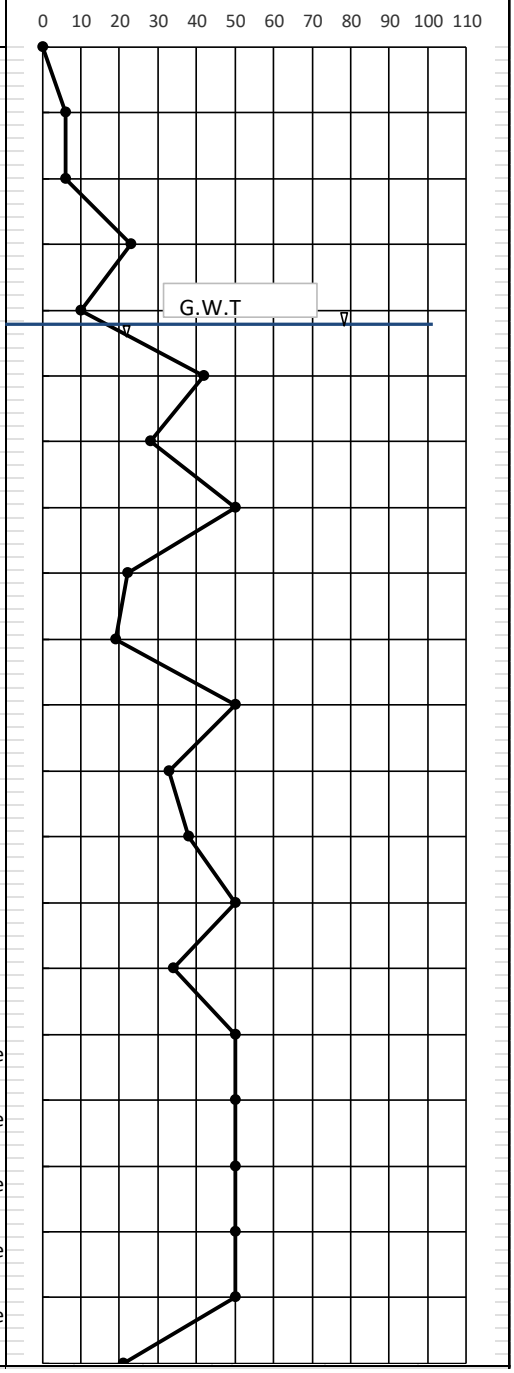
Depth	Visual Description	Symbols	Sample	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Brownish Gray Loose to Very Loose Very Fine **SAND** with Sufficient Silt			3	4	4	5	9
3.0					1	2	2	4
4.5	Gray Very Soft Clayey **SILT** with Very Fine Sand			1.5	1	1	1	2
6.0	Gray Medium Stiff Silty **CLAY**			1.5	2	3	5	8
7.5	Gray Medium to very Dense Fine to Medium **SAND**			24	5	8	10	18
9.0					10	25	25	50 2"Over
10.5					23	50	0	50 6"Over
12.0					28	50	0	50 8"Over
13.5					9	16	20	36
15.0					10	50	0	50 6"Over
16.5					18	50	0	50 7"Over
18.0					16	30	20	50 4"Over
19.5					24	50	0	50 9"Over
21.0					18	50	0	50 6"Over
22.5					22	50	0	50 8"Over
24.0					31	50	0	50 8"Over
25.5					29	50	0	50 9"Over
27.0					26	50	0	50 6"Over
28.5					28	50	0	50 7"Over
30.0					30	50	0	50



GEOTECHNICAL BOREHOLE LOG

Bore Hole No:	BH-08	**Ground Water Level:**	**1m**
Method of Boring and Diameter:	Percussion (100mm)	**Started on:**	**14/09/2024**
Boring Depth:	30m	**Completed on:**	**15/09/2024**
Client:	Urban Development Directorate (UDD)	**Legend:**	Clay/Silt | Sand | Shale
Project:	Preparation of Development Plan for Meherpur Zilla		
Location:	**Dholmary Govt. Primary School**	**Coordinates:**	**Lat.** 23.648497
			Long. 88.506179

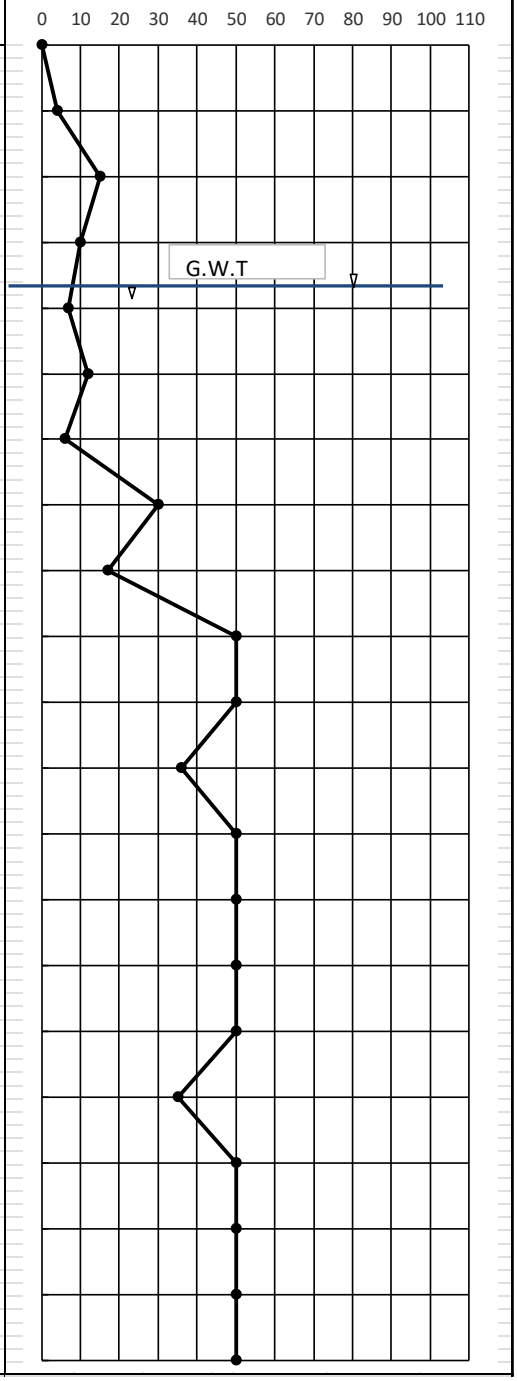
Depth	Visual Description	Symbols	Sample	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	Value 30cm
1.5	Brownish Gray Loose Very Fine **SAND** with Suffficient Silt			3	2	3	3	6
3.0					2	2	4	6
4.5	Brownish Gray Loose to Medium Dense Fine **SAND**			3	5	10	13	23
6.0					2	4	6	10
7.5	Gray Dense Fine **SAND** with Trace Silt			15	10	18	24	42
9.0					4	12	16	28
10.5					10	20	30	50
12.0					7	10	12	22
13.5					4	9	10	19
15.0					10	18	32	50
16.5					10	15	18	33
18.0					12	16	22	38
19.5					12	20	30	50
21.0					11	15	19	34
22.5	Gray Very Dense Fine **SAND**			7.5	15	30	20	50
24.0					12	29	21	50
25.5					18	50	0	50
27.0					17	50	0	50
28.5					15	26	24	50
30.0	Gray Very Stiff Clayey **SILT**			1.5	6	9	12	21



GEOTECHNICAL BOREHOLE LOG

Bore Hole No:	BH-09	**Ground Water Level:**	**5.5m**
Method of Boring and Diameter:	Percussion (100mm)	**Started on:**	**17/09/2024**
Boring Depth:	30m	**Completed on:**	**18/09/2024**
Client:	Urban Development Directorate (UDD)	**Legend:**	Clay/Silt, Sand, Shale
Project:	Preparation of Development Plan for Meherpur Zilla		
Location:	**Mohajonpur Uttarpara Govt. Primary School**	**Coordinates:**	**Lat. 23.658003, Long. 88.6774004**

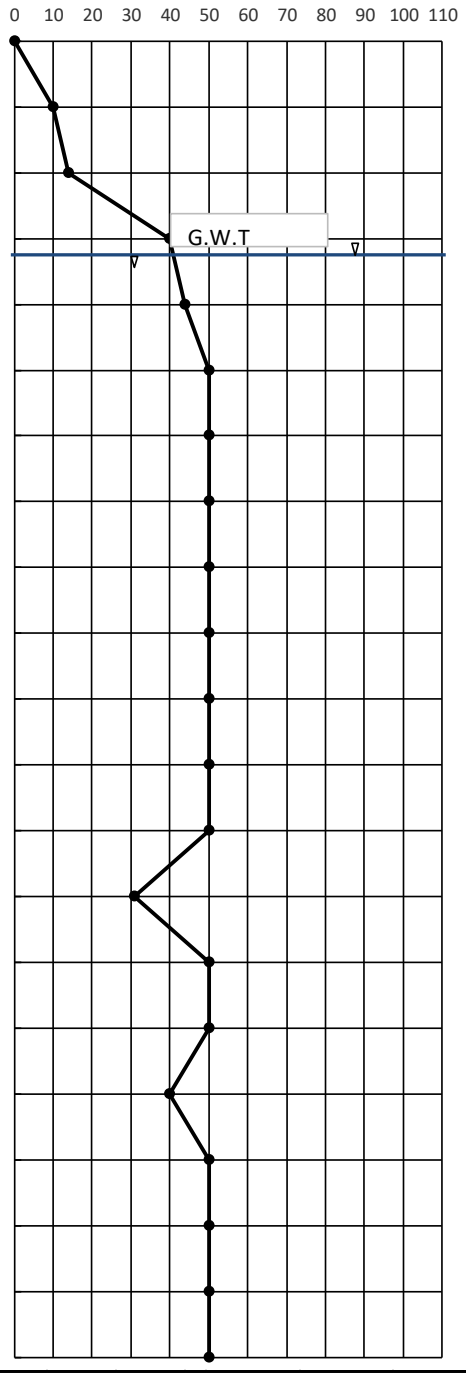
Depth	Visual Description	Symbols	Sample	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Brownish Gray Medium Stiff to Stiff **SILT**			6	1	2	2	4
3.0					3	7	8	15
4.5					2	4	6	10
6.0					2	3	4	7
7.5	Gray Medium Dense Very Fine **SAND** with Sufficient Silt			4.5	3	5	7	12
9.0					2	3	3	6
10.5					11	14	16	30
12.0	Gray Very Stiff Silty **CLAY**			1.5	4	7	10	17
13.5	Gray Very Dense Fine to Medium **SAND** with Organic Traces			18	18	50	0	50 7"Over
15.0					25	50	0	50 9"Over
16.5					10	17	19	36
18.0					12	30	20	50 4"Over
19.5					13	25	25	50 2"Over
21.0					12	29	21	50 4"Over
22.5					21	50	0	50 8"Over
24.0					10	15	20	35
25.5					16	27	23	50 2"Over
27.0					10	18	32	50 1"Over
28.5					27	40	10	50 5"Over
30.0					50	0	0	50



GEOTECHNICAL BOREHOLE LOG

Bore Hole No:	BH-10	**Ground Water Level:**	**4.9m**
Method of Boring and Diameter:	Percussion (100mm)	**Started on:**	**28/09/2024**
Boring Depth:	30m	**Completed on:**	**28/09/2024**
Client:	Urban Development Directorate (UDD)	**Legend:**	Clay/Silt, Sand, Shale
Project:	Preparation of Development Plan for Meherpur Zilla		
Location:	**Komorpur Govt .Primary School**	**Coordinates:**	**Lat. 23.683074, Long. 88.675168**

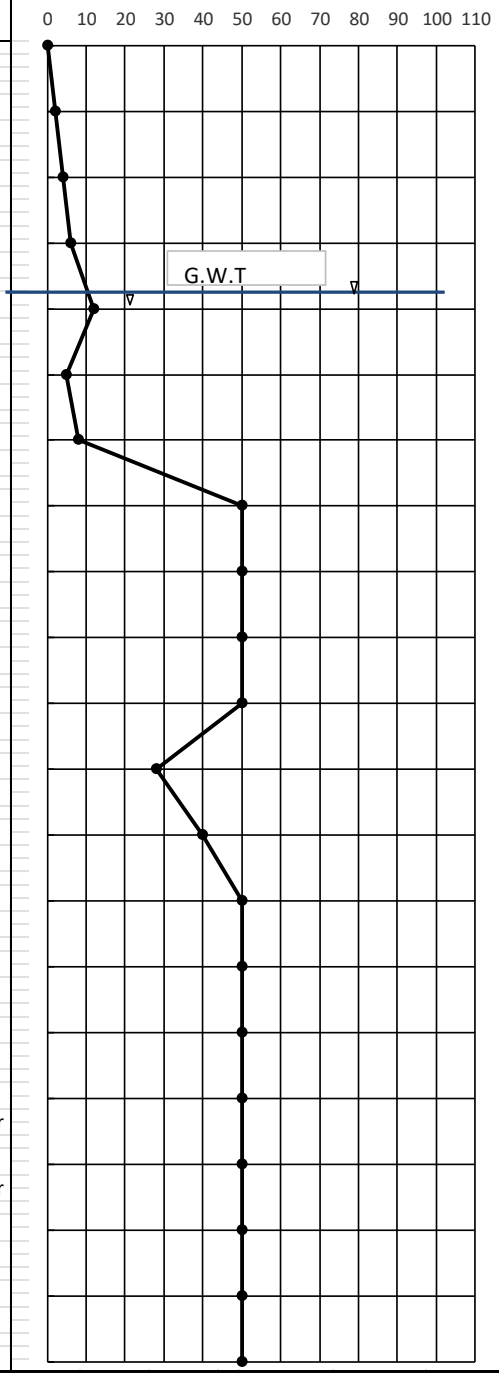
Depth	Visual Description	Symbols	Sample	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Brownish Gray Stiff **SILT** with Clay			1.5	2	5	5	10
3.0	Brownish Gray Dense Very Fine **SAND** with Sufficient Silt			4.5	3	6	8	14
4.5					10	18	22	40
6.0					12	20	24	44
7.5	Brownish Gray Very Dense Very Fine to very Fine **SAND** with Sufficient Silt			24	14	27	23	50 3"Over
9.0					16	50	0	50 6"Over
10.5					17	50	0	50 6"Over
12.0					20	50	0	50 8"Over
13.5					14	50	0	50 7"Over
15.0					50	0	0	50 12"Over
16.5					50	0	0	50 14"Over
18.0					33	50	0	50 9"Over
19.5					5	12	19	31
21.0					12	23	27	50
22.5					18	28	22	50 5"Over
24.0					7	16	24	40
25.5					12	50	0	50 6"Over
27.0					13	50	0	50 7"Over
28.5					14	35	15	50 3"Over
30.0					20	32	18	50



GEOTECHNICAL BOREHOLE LOG

Bore Hole No:	BH-11	**Ground Water Level:**	**5.8m**
Method of Boring and Diameter:	Percussion (100mm)	**Started on:**	**19/09/2024**
Boring Depth:	30m	**Completed on:**	**20/09/2024**
Client:	Urban Development Directorate (UDD)	**Legend:**	Clay/Silt | Sand | Shale
Project:	Preparation of Development Plan for Meherpur Zilla		
Location:	**Meherpur Govt. High School**	**Coordinates:**	**Lat. 23.7742445**, **Long. 88.6340245**

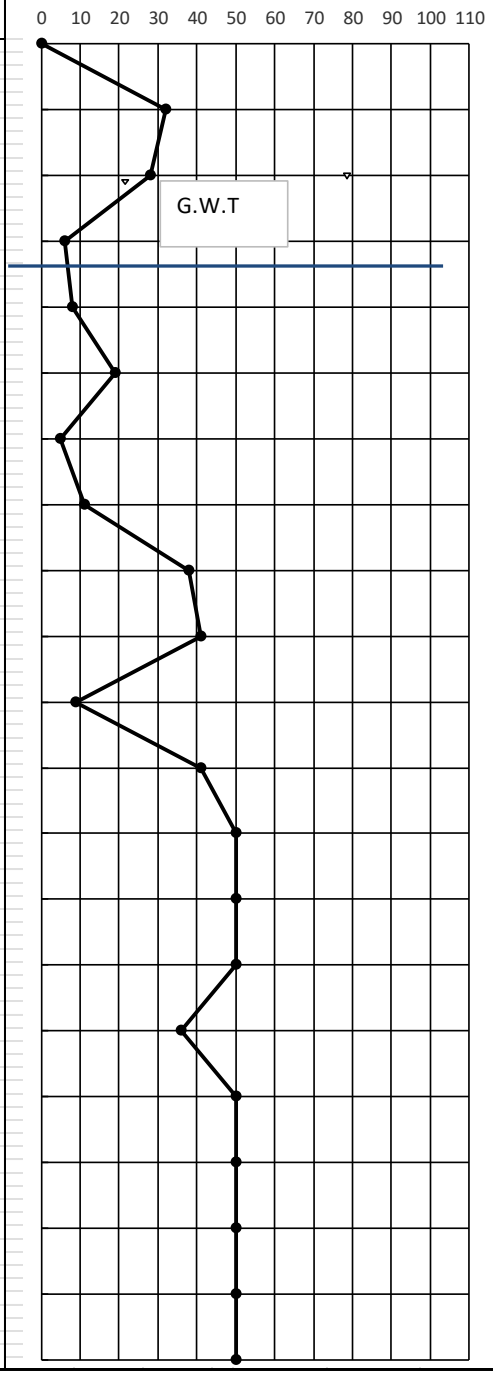
Depth	Visual Description	Symbols	Sample	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Brownish Gray Very Soft Clayey **SILT**			1.5	1	1	1	2
3.0	Brownish Gray Very Loose Very Fine **SAND**			1.5	1	2	2	4
4.5	Brownish Gray Medium Stiff Clayey **SILT**			4.5	2	3	3	6
6.0					3	5	7	12
7.5					2	2	3	5
9.0	Gray Loose Fine to Medium **SAND**			1.5	2	4	4	8
10.5	Gray Very Dense Very Fine to Fine **SAND** occationally Medium sand			21	16	40	10	50 5"Over
12.0					13	27	23	50 3"Over
13.5					16	50	0	50 9"Over
15.0					14	50	0	50 6"Over
16.5					10	12	16	28
18.0					16	18	22	40
19.5					18	25	25	50 4"Over
21.0					22	40	10	50 5"Over
22.5					28	50	0	50 6"Over
24.0					50	0	0	50 12"Over
25.5					50	0	0	50 12"Over
27.0					30	50	0	50 9"Over
28.5					18	50	0	50 8"Over
30.0					16	50	0	50



GEOTECHNICAL BOREHOLE LOG

Bore Hole No:	BH-12	**Ground Water Level:**	**5.1m**
Method of Boring and Diameter:	Percussion (100mm)	**Started on:**	**22/09/2024**
Boring Depth:	30m	**Completed on:**	**22/09/2024**
Client:	Urban Development Directorate (UDD)	**Legend:**	Clay/Silt, Sand, Shale
Project:	Preparation of Development Plan for Meherpur Zilla		
Location:	**Shalika High School Meherpur Sadar**	**Coordinates:**	**Lat. 23.749598, Long. 88.592546**

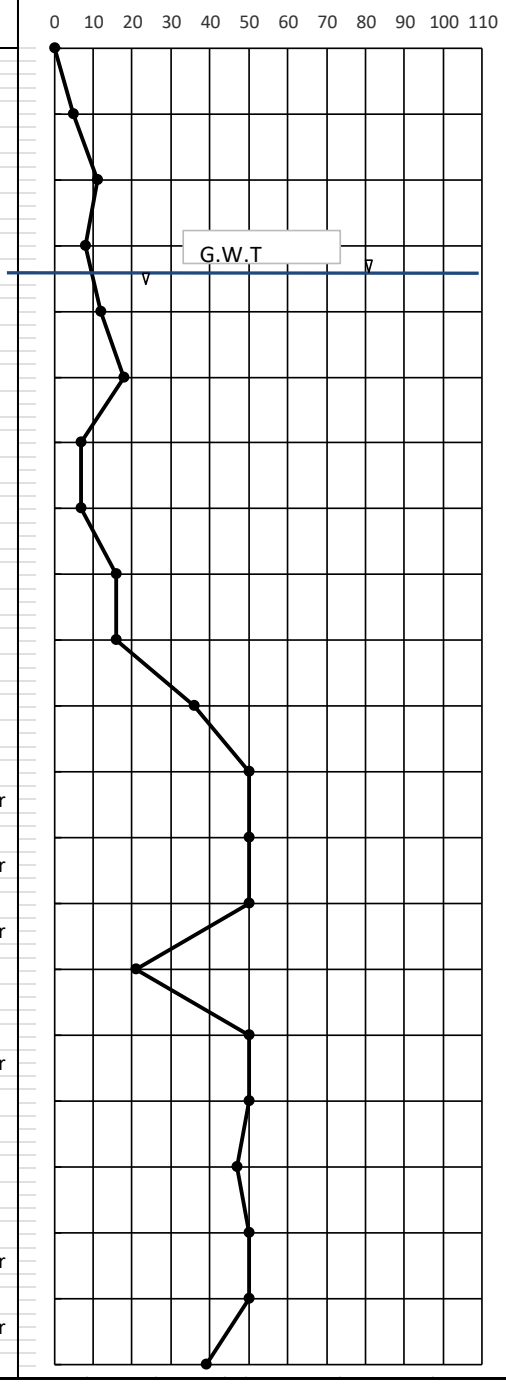
Depth	Visual Description	Symbols	Sample	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Brownish Gray Dense Very Fine **SAND** with Little Silt			3	5	11	21	32
3.0					8	12	16	28
4.5	Brownish Gray to Gray Medium Stiff to Stiff Silty **CLAY**			7.5	2	2	4	6
6.0					2	3	5	8
7.5					5	7	12	19
9.0					2	2	3	5
10.5					2	4	7	11
12.0	Gray Dense Fine to Very Fine **SAND** with Little Silt			3	10	16	22	38
13.5					13	18	23	41
15.0	Gray very Dense medium to Very Fine **SAND**			16.5	3	3	6	9
16.5					10	17	24	41
18.0					10	18	32	50
19.5					10	22	28	50 1"Over
21.0					12	25	25	50 2"Over
22.5					8	16	20	36
24.0					13	50	0	50 6"Over
25.5					18	50	0	50 6"Over
27.0					22	50	0	50 8"Over
28.5					20	50	0	50 10"Over
30.0					16	50	0	50



GEOTECHNICAL BOREHOLE LOG

Bore Hole No:	BH-13	**Ground Water Level:**	**5.18m**
Method of Boring and Diameter:	Percussion (100mm)	**Started on:**	**21/09/2024**
Boring Depth:	30m	**Completed on:**	**21/09/2024**
Client:	Urban Development Directorate (UDD)	**Legend:**	Clay/Silt | Sand | Shale
Project:	Preparation of Development Plan for Meherpur Zilla		
Location:	**Harirampur Secondary School, Meherpur Sadar**	**Coordinates:**	**Lat. 23.7861621**, **Long. 88.5969308**

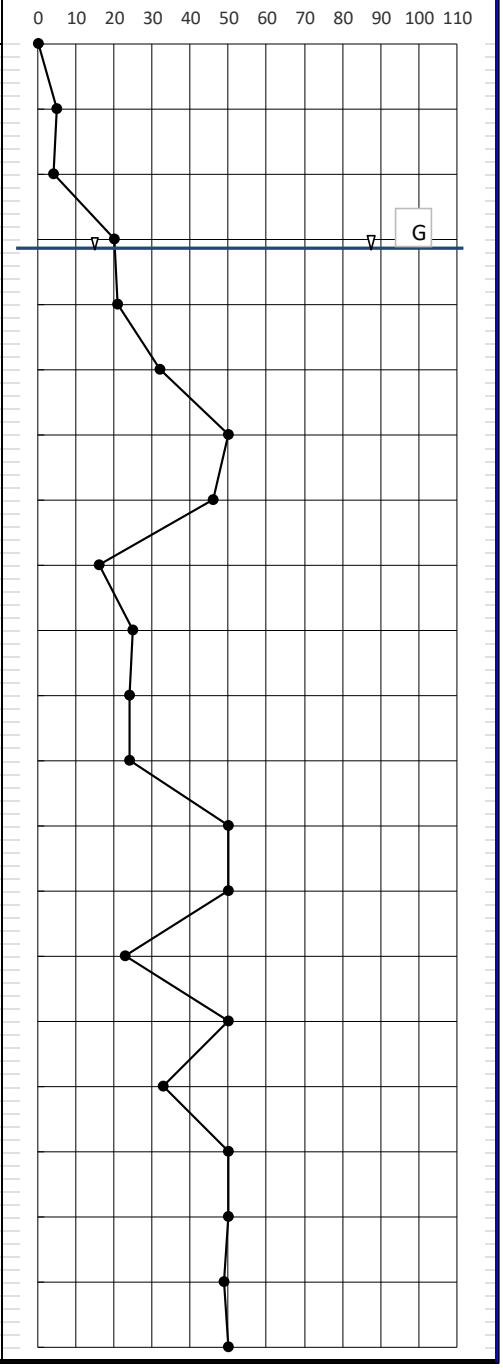
Depth	Visual Description	Symbols	Sample	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Brownish Gray to Gray Loose to Medium Dense Very Fine **SAND** with Little Silt			13.5	2	2	3	5
3.0					3	4	7	11
4.5					3	3	5	8
6.0					3	5	7	12
7.5					4	7	11	18
9.0					2	3	4	7
10.5					2	2	5	7
12.0					3	6	10	16
13.5					3	5	11	16
15.0	Gray Dense to Very Dense Fine **SAND**			6	5	15	21	36
16.5					20	50	0	50 6"Over
18.0					24	50	0	50 7"Over
19.5					18	50	0	50 8"Over
21.0	Gray Medium Dense Fine **SAND**			1.5	6	9	12	21
22.5	Gray Very Dense Fine to Medium **SAND**			7.5	14	30	20	50 2"Over
24.0					10	18	32	50
25.5					16	22	25	47
27.0					15	30	20	50 5"Over
28.5					11	17	33	50 3"Over
30.0	Gray Dense Fine to Medium **SAND**			1.5	10	13	26	39



GEOTECHNICAL BOREHOLE LOG

Borehole No:	BH- 14	**Ground Water Level:**	**4.57 m**
Method of Boring and Diameter:	Percussion (100 mm)	**Started on:**	**16/09/2024**
Boring Depth:	30m	**Completed on:**	**16/09/2024**
Client:	Urban Development Directorate (UDD)	**Legend:**	Clay/Silt | Sand | Shale
Project:	Preparation of Development for Meherpur Zilla		
Location:	**Ujalpur High School, Meherpur Sadar**	**Coordinates:**	**Lat. 23.8152581**, **Long. 88.62626**

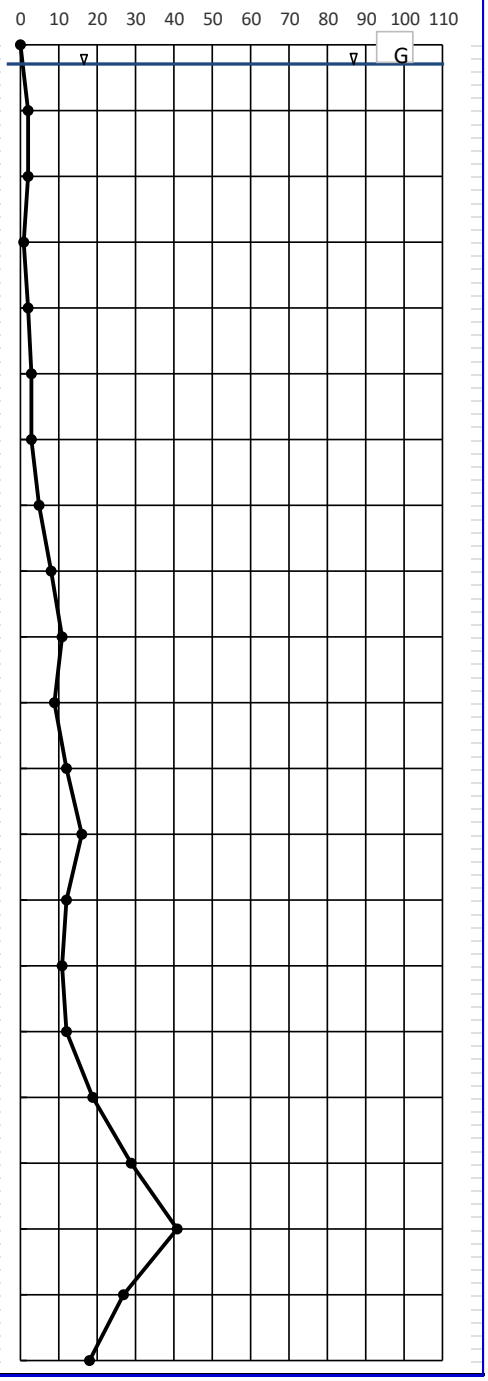
Depth	Visual Description	Symbols	Sample	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Brownish Gray Soft to Medium Stiff Clayey **SILT** with Little Organic Matter			3	2	2	3	5
3.0					2	2	2	4
4.5	Brownish Gray Medium Dense Very Fine to Fine **SAND** with Silt			1.5	4	8	12	20
6.0	Brownish Gray Very Stiff Clayey **SILT** with Fine Sand			1.5	6	7	14	21
7.5	Bluish Gray Dense Fine **SAND** with Trace of Clay			6	8	14	18	32
9.0					13	22	28	50
10.5					13	20	26	46
12.0					4	6	10	16
13.5	Dark Gray Medium Dense Medium **SAND** with Little Clay & Mica			4.5	7	11	14	25
15.0					5	10	14	24
16.5					8	10	14	24
18.0	Bluish Gray Dense to Very Dense Medium to Fine **SAND** trace Clay			13.5	16	50	0	50 7"Over
19.5					20	50	0	50 6"Over
21.0					7	10	13	23
22.5					18	25	25	50
24.0					12	14	19	33
25.5					15	20	30	50 3"Over
27.0					15	50	0	50 6"Over
28.5					18	22	27	49
30.0					12	20	30	50



GEOTECHNICAL BOREHOLE LOG

Borehole No:	BH-15	**Ground Water Level:**	**0.30 m**
Method of Boring and Diameter:	Percussion (100 mm)	**Started on:**	**15/09/2024**
Boring Depth:	30m	**Completed on:**	**16/09/2024**
Client:	Urban Development Directorate (UDD)	**Legend:**	Clay/Silt | Sand | Shale
Project:	Preparation of Development Plan for Meherpur Zilla		
Location:	**Sholmary Govt. Primary School, Meherpur Sadar**	**Coordinates:**	**Lat. 23.8555441**, **Long. 88.6077649**

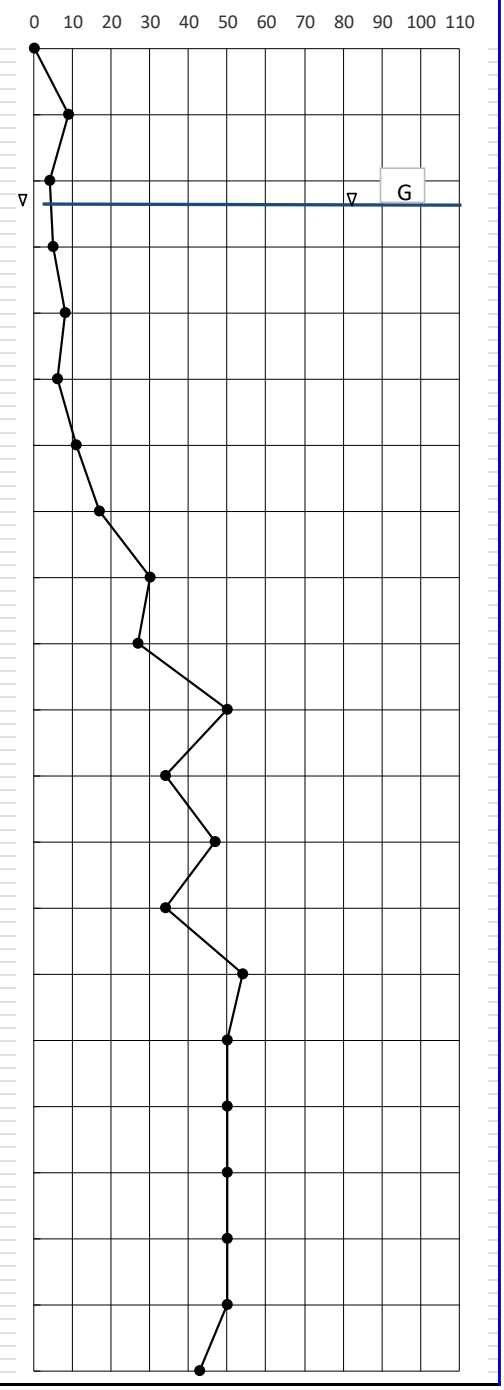
Depth	Visual Description	Symbols	Sample	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Gray Very Soft Silty **CLAY** with Organic Matter				1	1	1	2
3.0					1	1	1	2
4.5					1	0	1	1
6.0	Gray Soft to Medium Stiff clayey **SILT** with Trace of Very Fine Sand				1	1	1	2
7.5					1	1	2	3
9.0					1	1	2	3
10.5					1	2	3	5
12.0	Gray Medium Dense Very Fine to Fine **SAND** with Sufficient Silt				2	3	5	8
13.5					3	5	6	11
15.0	Gray Stiff **SILT** with Trace of Very Fine Sand				2	4	5	9
16.5					3	5	7	12
18.0	Gray Medium Dense Very Fine to Fine **SAND** with Trace of Silt				5	7	9	16
19.5					3	5	7	12
21.0					3	4	7	11
22.5					3	5	7	12
24.0					4	8	11	19
25.5					7	12	17	29
27.0					9	17	24	41
28.5					5	12	15	27
30.0					4	7	11	18



GEOTECHNICAL BOREHOLE LOG

Borehole No:	BH-16		**Ground Water Level:**	**3.66 m**	
Method of Boring and Diameter:	Percussion (100 mm)		**Started on:**	**14/09/2024**	
Boring Depth:	30m		**Completed on:**	**14/09/2024**	
Client:	Urban Development Directorate (UDD)		**Legend:**	Clay/Silt	Sand	Shale
Project:	Preparation of Development Plan for Meherpur Zilla				
Location:	**Kaligangni Govt. Primary School, Meherpur Sadar**		**Coordinates:**	**Lat.**	**23.844148**
				Long.	**88.691053**

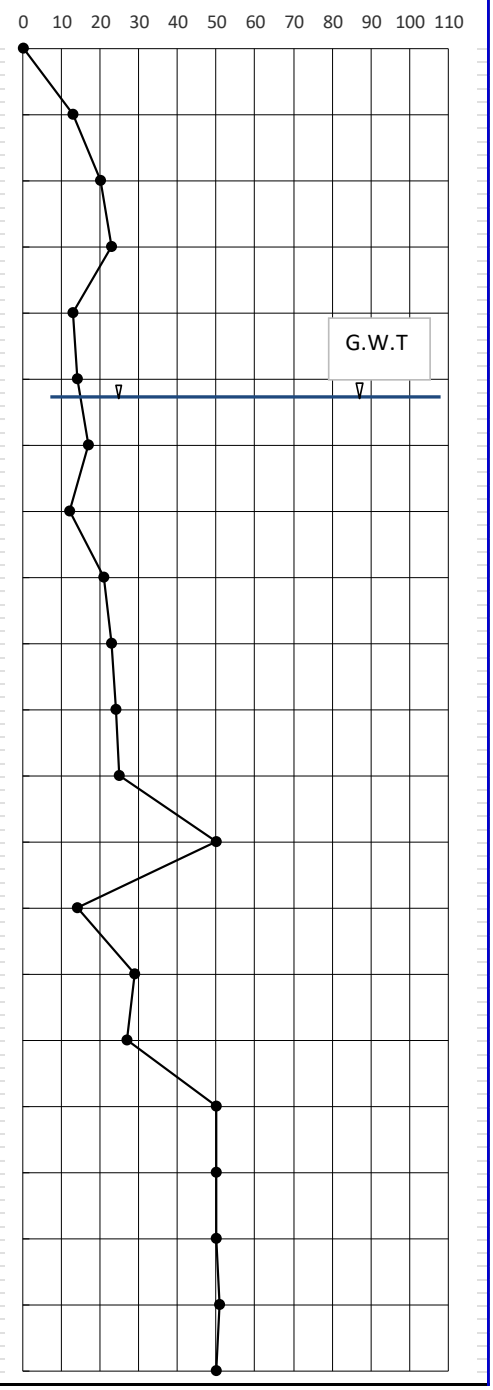
Depth	Visual Description	Symbols	Sample	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Brownish Gray Medium Stiff to Stiff Silty **CLAY** with Little Organic Matter			9	3	4	5	9
3.0					1	1	3	4
4.5					1	2	3	5
6.0					2	3	5	8
7.5					2	2	4	6
9.0					3	5	6	11
10.5	Bluish Gray Medium Dense Fine **SAND** with Little Clay & Organic Matter			4.5	4	7	10	17
12.0					8	13	17	30
13.5					7	11	16	27
15.0	Gray Dense to Very Dense Fine to Medium **SAND**			15	15	23	27	50
16.5					10	14	20	34
18.0					13	20	27	47
19.5					13	15	19	34
21.0					18	24	30	54
22.5					20	50	0	50 6"Over
24.0					12	20	30	50 2"Over
25.5					20	30	20	50 4"Over
27.0					20	30	20	50 4"Over
28.5					14	25	25	50
30.0	Gray Dense Medium to Coarse **SAND**			1.5	13	18	25	43



GEOTECHNICAL BOREHOLE LOG

Borehole No:	BH-17	**Ground Water Level:**	**7.92 m**
Method of Boring and Diameter:	Percussion (100 mm)	**Started on:**	**20/09/2024**
Boring Depth:	30m	**Completed on:**	**21/09/2024**
Client:	Urban Development Directorate (UDD)	**Legend:**	Clay/Silt | Sand | Shale
Project:	Preparation of Development Plan for Meherpur Zilla		
Location:	**Ramnagar Govt. Primary School, Meherpur Sadar**	**Coordinates:**	**Lat.** 23.7994972
			Long. 88.6602618

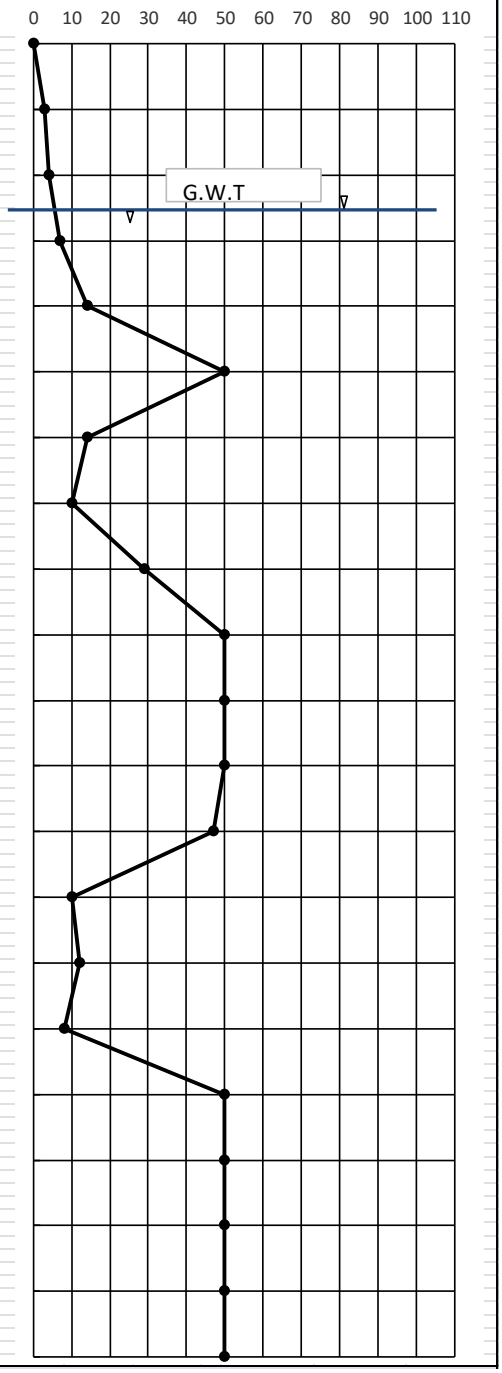
Depth	Visual Description	Symbols	Sample	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Bluish Gray Medium Dense Fine to Medium **SAND** Trace Silt, mica & Clay			16.5	3	5	8	13
3.0					5	8	12	20
4.5					9	10	13	23
6.0					3	6	7	13
7.5					3	6	8	14
9.0					6	8	9	17
10.5					5	5	7	12
12.0					6	8	13	21
13.5					7	11	12	23
15.0					6	12	12	24
16.5					9	11	14	25
18.0	Bluish Gray Very Dense Medium **SAND**			1.5	20	50	0	50 6"Over
19.5	Bluish Gray Medium Dense Medium **SAND** trace Silt & Organic Matter			4.5	4	5	9	14
21.0					5	12	17	29
22.5					7	12	15	27
24.0	Gray Very Dense Medium to Coarse **SAND** with Trace of Clay & Little Mica			7.5	22	50	0	50 8"Over
25.5					20	50	0	50 6"Over
27.0					16	20	30	50 2"Over
28.5					10	25	26	51
30.0					20	30	20	50



GEOTECHNICAL BOREHOLE LOG

Bore Hole No:	BH-18	**Ground Water Level:**	**4.2m**
Method of Boring and Diameter:	Percussion (100mm)	**Started on:**	**25/09/2024**
Boring Depth:	30m	**Completed on:**	**26/09/2024**
Client:	Urban Development Directorate (UDD)	**Legend:**	Clay/Silt | Sand | Shale
Project:	Preparation of Development Plan for Meherpur Zilla		
Location:	**Amdah Primary School**	**Coordinates:**	**Lat. 23.7375161**, **Long. 88.6329218**

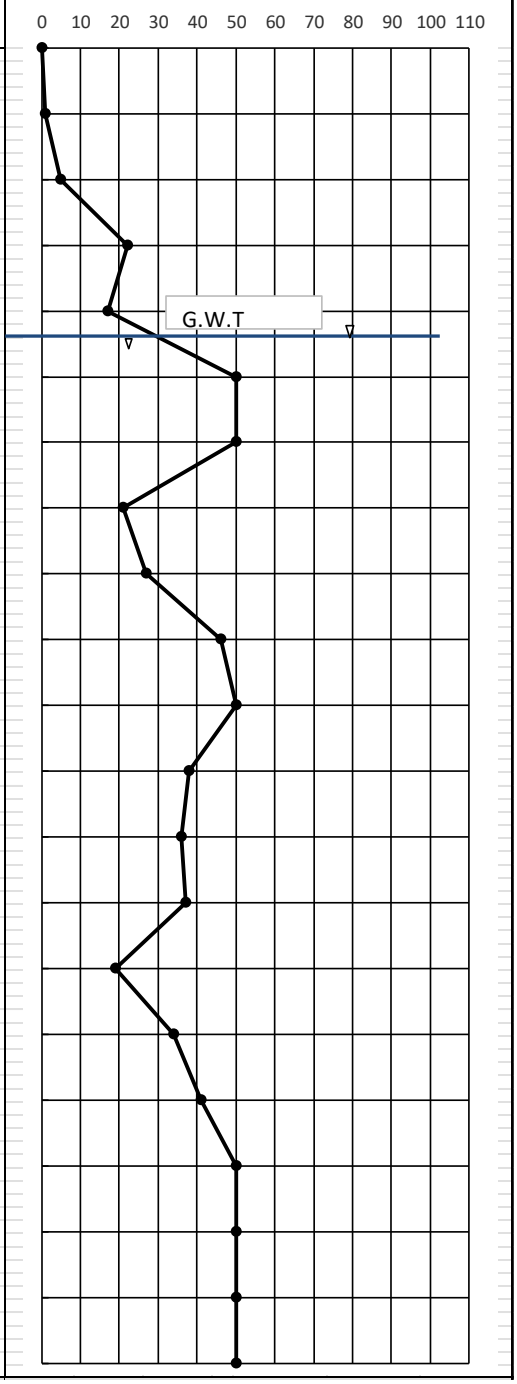
Depth	Visual Description	Symbols	Sample	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Brownish Gray Soft to Stiff **CLAY** with Sufficient Silt			4.5	1	1	2	3
3.0					1	2	2	4
4.5					2	3	4	7
6.0	Gray Medium Dense to very Dense Fine to Very Fine **SAND**			4.5	3	6	8	14
7.5					13	50	0	50
9.0					4	6	8	14
10.5	Gray Stiff **CLAY** with Little Silt			1.5	2	4	6	10
12.0	Gray Dense to very Dense Fine to Very Fine **SAND**			7.5	8	13	16	29
13.5					13	50	0	50 8"Over
15.0					15	22	28	50 3"Over
16.5					13	25	25	50 1"Over
18.0					15	23	24	47
19.5	Gray Medium Stiff to Stiff **CLAY** with Sufficient Silt			4.5	3	4	6	10
21.0					5	5	7	12
22.5					3	3	5	8
24.0	Gray Very Dense Fine to Medium **SAND**			7.5	18	50	0	50 6"Over
25.5					18	50	0	50 7"Over
27.0					23	50	0	50 9"Over
28.5					50	0	0	50 12"Over
30.0					50	0	0	50



GEOTECHNICAL BOREHOLE LOG

Bore Hole No:	BH-19	**Ground Water Level:**	**6.7m**
Method of Boring and Diameter:	Percussion (100mm)	**Started on:**	**27/09/2024**
Boring Depth:	30m	**Completed on:**	**27/09/2024**
Client:	Urban Development Directorate (UDD)	**Legend:**	Clay/Silt, Sand, Shale
Project:	Preparation of Development Plan for Meherpur Zilla		
Location:	**Ashrafpur Govt. Primary School, Meherpur Sadar**	**Coordinates:**	**Lat. 23.7063712**, **Long. 88.6463158**

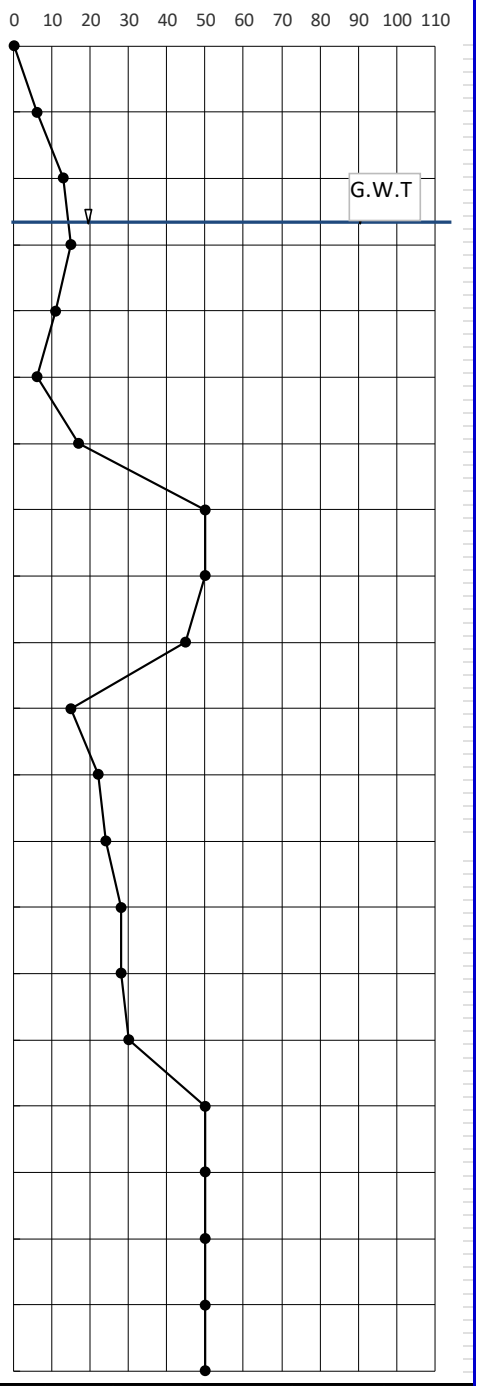
Depth	Visual Description	Symbols	Sample	Thickness (m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Brownish Gray Very Soft **CLAY**			1.5	1	0	1	1
3.0	Brownish Gray Loose to Medium Dense Fine to very Fine **SAND**			4.5	1	2	3	5
4.5					4	9	13	22
6.0					2	6	11	17
7.5	Brownish Gray Very Dense Very Fine **SAND** with Little Silt			3	16	50	0	50 6"Over
9.0					12	32	18	50 4"Over
10.5	Gray Medium Dense Very Fine to Fine **SAND**			3	4	8	13	21
12.0					5	12	15	27
13.5	Gray Dense Very Fine to Fine **SAND**			12	8	18	28	46
15.0					7	20	30	50
16.5					9	18	20	38
18.0					7	15	21	36
19.5					9	14	23	37
21.0					4	6	13	19
22.5					6	13	21	34
24.0					8	14	27	41
25.5	Gray Very Dense Very Fine to Fine **SAND**			6	12	50	0	50 7"Over
27.0					50	0	0	50 12"Over
28.5					27	50	0	50 10"Over
30.0					16	22	28	50



GEOTECHNICAL BOREHOLE LOG

Borehole No:	BH-20	**Ground Water Level:**	**4.27 m**
Method of Boring and Diameter:	Percussion (100 mm)	**Started on:**	**21/09/2024**
Boring Depth:	30m	**Completed on:**	**22/09/2024**
Client:	Urban Development Directorate (UDD)	**Legend:**	Clay/Silt, Sand, Shale
Project:	Preparation of Development Plan for Meherpur Zilla		
Location:	**Kola Govt. Primary School, Meherpur Sadar**	**Coordinates:**	**Lat. 23.7283846**, **Long. 88.6647428**

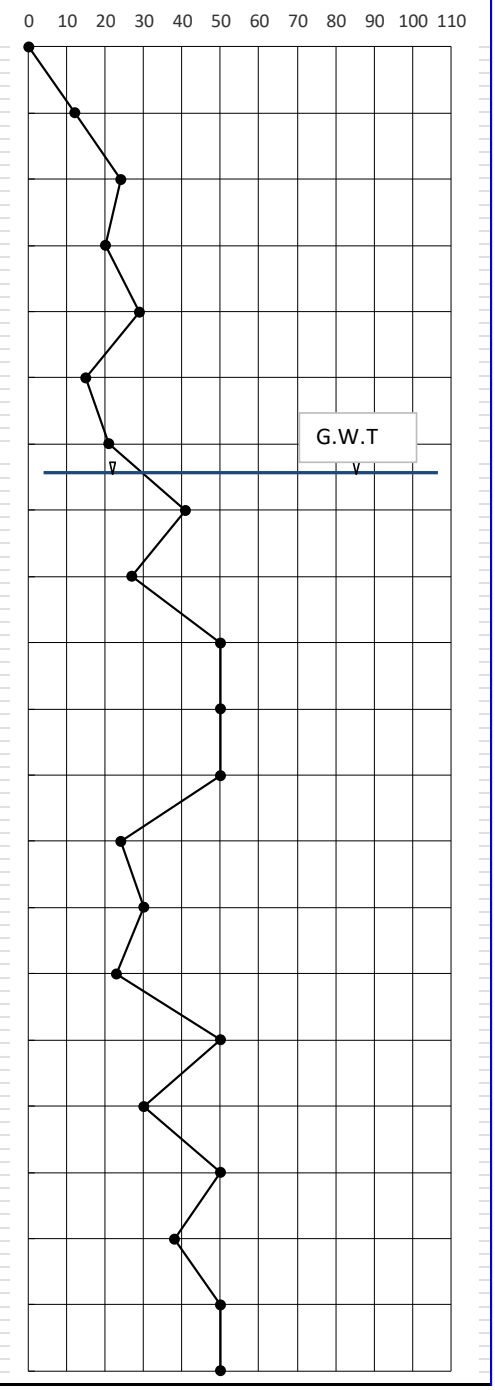
Depth	Visual Description	Symbols	Sample	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Brownish Gray Medium Stiff Clayey **SILT** with Little Organic Matter			1.5	2	3	3	6
3.0	Gray Medium Dense Fine to Very Fine **SAND** with Little Silt			4.5	3	5	8	13
4.5					5	7	8	15
6.0					3	4	7	11
7.5	Gray Medium Stiff Silty **CLAY**			1.5	2	2	4	6
9.0	Bluish Gray Dense to very Dense Fine to Very Fine **SAND** with Little Silt			6	5	7	10	17
10.5					18	23	27	50 3"Over
12.0					14	24	26	50 2"Over
13.5					16	20	25	45
15.0	Bluish Gray Medium Dense Medium **SAND** Trace of Clay, Mica & Organic Matter			10.5	7	7	8	15
16.5					7	9	13	22
18.0					11	11	13	24
19.5					6	13	15	28
21.0					8	13	15	28
22.5					8	14	16	30
24.0					12	25	25	50
25.5	Bluish Gray Very Dense Medium to Fine **SAND**			6	13	30	20	50 3"Over
27.0					22	50	0	50 7"Over
28.5					15	30	20	50
30.0					17	50	0	50



GEOTECHNICAL BOREHOLE LOG

Borehole No:	BH-21		**Ground Water Level:**	**9.75 m**	
Method of Boring and Diameter:	Percussion (100 mm)		**Started on:**	**12/9/2024**	
Boring Depth:	30m		**Completed on:**	**12/9/2024**	
Client:	Urban Development Directorate (UDD)		**Legend:**	Clay/Silt	Sand / Shale
Project:	Preparation of Development Plan for Meherpur Zilla				
Location:	**Amjhupi Girls Govt. Primary School, Meherpur Sadar**		**Coordinates:**	**Lat.**	**23.7488266**
				Long.	**88.6800397**

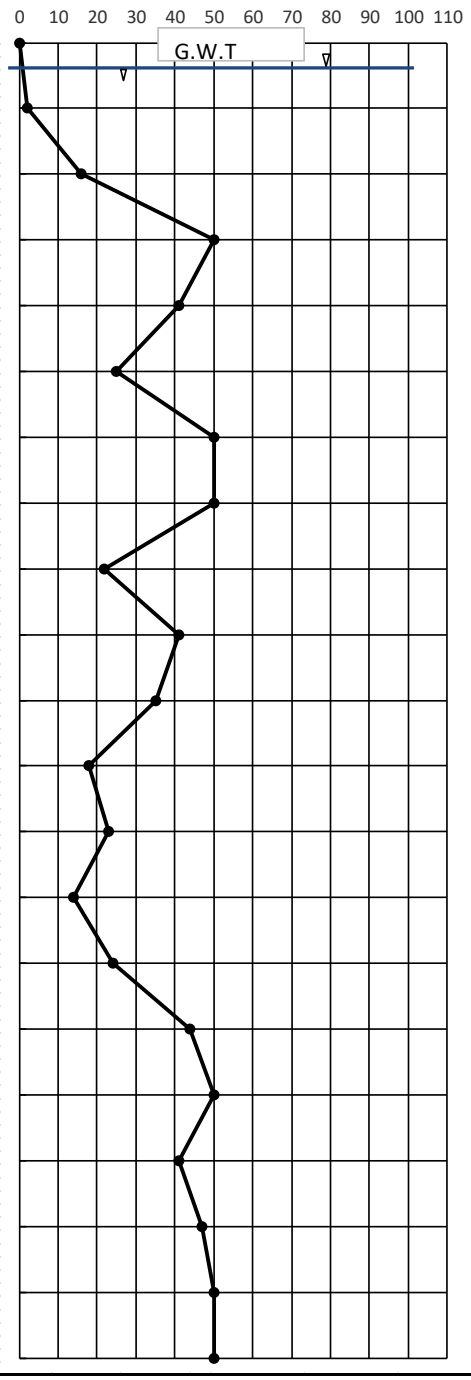
Depth	Visual Description	Symbols	Sample	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Brownish Gray Very Stiff Clayey **SILT** with Trace of Organic Matter			3	3	5	7	12
3.0					7	10	14	24
4.5	Bluish Gray Medium Dense Medium to Fine **SAND** Trace of Iron Pigments			9	4	8	12	20
6.0					8	13	16	29
7.5					5	7	8	15
9.0					4	9	12	21
10.5					9	18	23	41
12.0					6	12	15	27
13.5	Gray Very Dense Fine to Medium **SAND**			4.5	20	50	0	50 6"Over
15.0					25	50	0	50 7"Over
16.5					20	50	0	50 8"Over
18.0	Brownish Gray Medium Dense to very Dense Medium to Fine **SAND** with Little Clay			13.5	7	10	14	24
19.5					11	13	17	30
21.0					7	10	13	23
22.5					20	50	0	50 7"Over
24.0					9	13	17	30
25.5					12	50	0	50 6"Over
27.0					14	18	20	38
28.5					18	50	0	50 6"Over
30.0					17	22	28	50



GEOTECHNICAL BOREHOLE LOG

Bore Hole No:	BH-22	**Ground Water Level:**	**0.61m**
Method of Boring and Diameter:	Percussion (100mm)	**Started on:**	**11/9/2024**
Boring Depth:	30m	**Completed on:**	**11/9/2024**
Client:	Urban Development Directorate (UDD)	**Legend:**	Clay/Silt, Sand, Shale
Project:	Preparation of Development Plan for Meherpur Zilla		
Location:	**Khoksha Govt. Primary School, Meherpur**	**Coordinates:**	**Lat. 23.7748401, Long. 88.6912091**

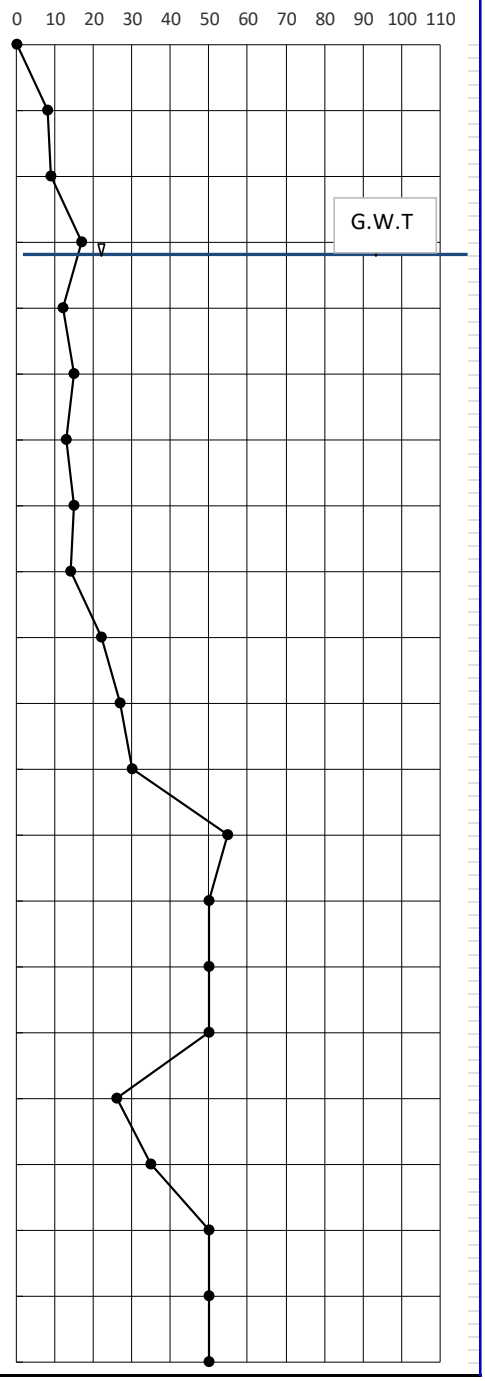
Depth	Visual Description	Symbols	Sample	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Bluish Gray Very Soft **CLAY**			1.5	1	1	1	2
3.0	Brownish Gray Medium Dense to Dense Medium to Fine **SAND**			6	4	6	10	16
4.5					12	22	28	50
6.0					13	18	23	41
7.5					10	11	14	25
9.0	Gray Very Dense Fine to Medium **SAND**			3	18	35	15	50 4"Over
10.5					18	28	22	50 2"Over
12.0	Gray Medium Dense to Dense Medium to Coarse **SAND** trace fine sand			12	4	9	13	22
13.5					10	18	23	41
15.0					9	15	20	35
16.5					5	8	10	18 1"Over
18.0					9	11	12	23
19.5					5	7	7	14
21.0					6	12	12	24
22.5					13	20	24	44
24.0	Bluish Gray Dense to Very Dense Coarse to Medium **SAND**			7.5	20	30	20	50 2"Over
25.5					13	18	23	41
27.0					16	21	26	47
28.5					18	50	0	50 6"Over
30.0					17	50	0	50



GEOTECHNICAL BOREHOLE LOG

Borehole No:	BH-23	**Ground Water Level:**	**4.88 m**
Method of Boring and Diameter:	Percussion (100 mm)	**Started on:**	**24/09/2024**
Boring Depth:	30m	**Completed on:**	**25/09/2024**
Client:	Urban Development Directorate (UDD)	**Legend:**	Clay/Silt, Sand, Shale
Project:	Preparation of Development Plan for Meherpur Zilla		
Location:	**Hijuli Govt. Primary School, Meherpur Sadar**	**Coordinates:**	**Lat. 23.7503449, Long. 88.7173481**

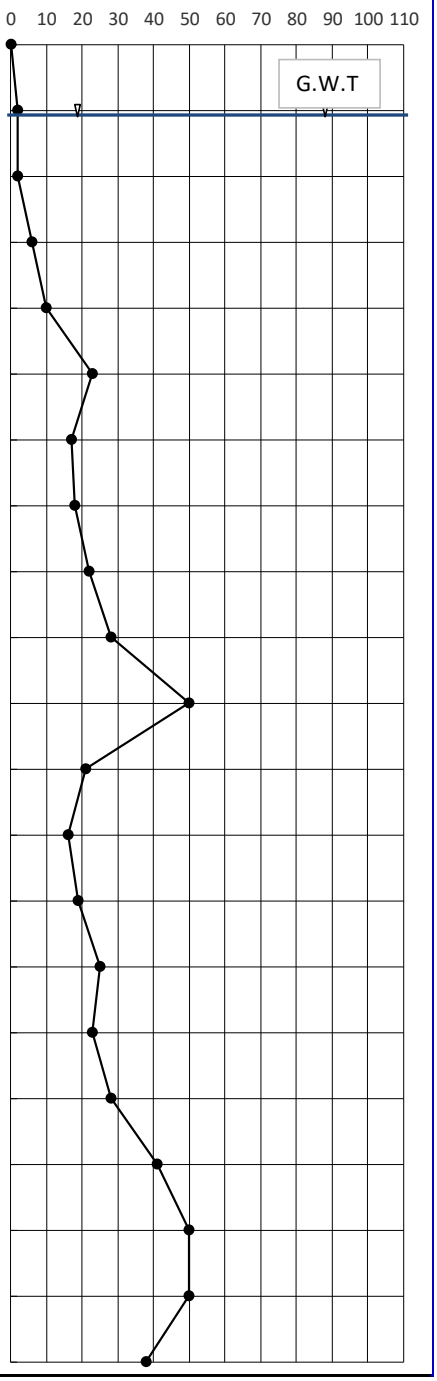
Depth	Visual Description	Symbols	Sample	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Brownish Gray Medium Stiff to Stiff **SILT** with Little Fine Sand			3	2	4	4	8
3.0					3	4	5	9
4.5	Bluish Gray Medium Dense Fine to Medium **SAND** Trace of Mica & Clay			13.5	4	7	10	17
6.0					4	6	6	12
7.5					3	6	9	15
9.0					4	5	8	13
10.5					6	7	8	15
12.0					5	6	8	14
13.5					7	10	12	22
15.0					8	12	15	27
16.5					8	13	17	30
18.0	Bluish Gray Very Dense Fine to Medium **SAND** Trace of Clay & Mica			6	10	25	30	55
19.5					10	22	28	50 1"Over
21.0					8	22	28	50 1"Over
22.5					12	50	0	50 6"Over
24.0	Bluish Gray Dense Fine to Medium **SAND** Trace of Clay & Mica			3	9	12	14	26
25.5					8	15	20	35
27.0	Bluish Gray Very Dense Fine to Medium **SAND** with Clay & Trace of Organic Matter			4.5	20	50	0	50 8"Over
28.5					15	50	0	50 6"Over
30.0					15	28	22	50



GEOTECHNICAL BOREHOLE LOG

Borehole No:	BH-24		**Ground Water Level:**	**1.52 m**	
Method of Boring and Diameter:	Percussion (100 mm)		**Started on:**	**23/09/2024**	
Boring Depth:	30m		**Completed on:**	**24/09/2024**	
Client:	Urban Development Directorate (UDD)		**Legend:**	Clay/Silt / Sand / Shale	
Project:	Preparation of Development Plan for Meherpur Zilla				
Location:	**Road Site of Roghunathpur Area, Roghunathpur, Maherpur Sadar**		**Coordinates:**	**Lat.**	**23.7285247**
				Long.	**88.7094087**

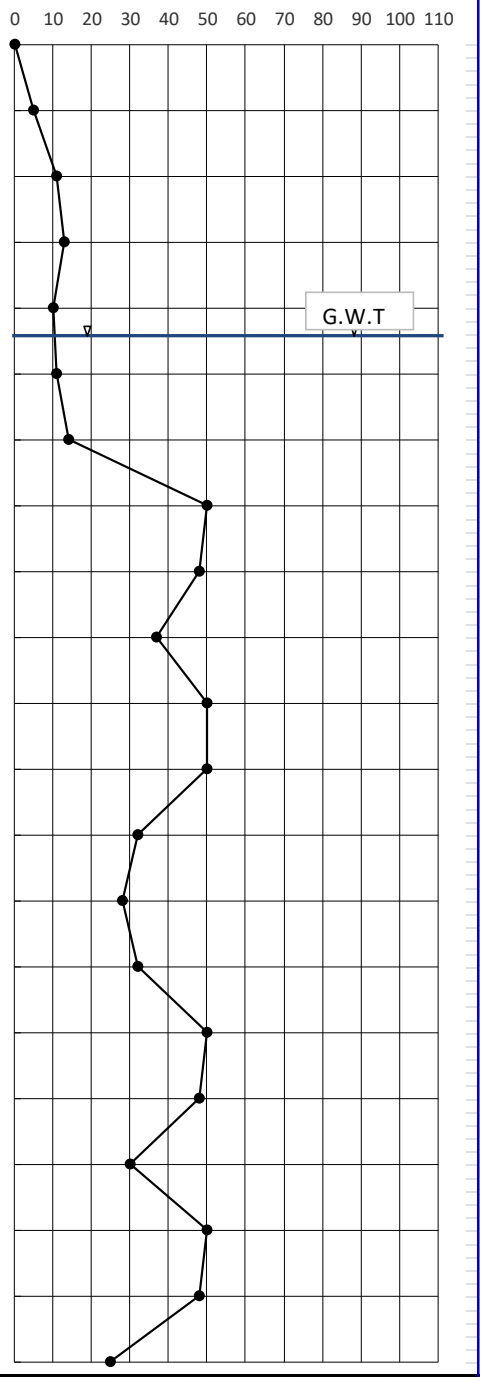
Depth	Visual Description	Symbols	Sample	Thickness(m)	Standard Penetration Spoon Val 15cm	15cm	15cm	30cm
1.5	Bluish Gray Very Soft to medium Stiff **CLAY** with Organic Matter			4.5	1	1	1	2
3.0					1	1	1	2
4.5					2	3	3	6
6.0	Bluish Gray to Gray Medium Dense Very Fine to Fine **SAND** with Trace of Mica			9	2	4	6	10
7.5					6	10	13	23
9.0					6	7	10	17
10.5					7	8	10	18
12.0					8	10	12	22
13.5					10	13	15	28
15.0	Gray Dense Medium **SAND**			1.5	15	24	26	50
16.5	Bluish Gray Medium Dense Fine to Medium **SAND** Little Clay			9	6	9	12	21
18.0					6	7	9	16
19.5					8	8	11	19
21.0					10	12	13	25
22.5					8	10	13	23
24.0					7	12	16	28
25.5	Bluish Gray Dense to very Dense Medium to Fine **SAND** Trace of Organic Matter			6	11	18	23	41
27.0					15	50	0	50 Ov
28.5					15	35	15	50 Ov
30.0					10	14	24	38



GEOTECHNICAL BOREHOLE LOG

Borehole No:	BH-25	**Ground Water Level:**	**6.71 m**
Method of Boring and Diameter:	Percussion (100 mm)	**Started on:**	**22/09/2024**
Boring Depth:	30m	**Completed on:**	**23/09/2024**
Client:	Urban Development Directorate (UDD)	**Legend:**	Clay/Silt, Sand, Shale
Project:	Preparation of Development Plan for Meherpur Zilla		
Location:	**Kathalpota Govt. Primary School, Meherpur Sadar**	**Coordinates:**	**Lat. 23.6892956, Long. 88.7098221**

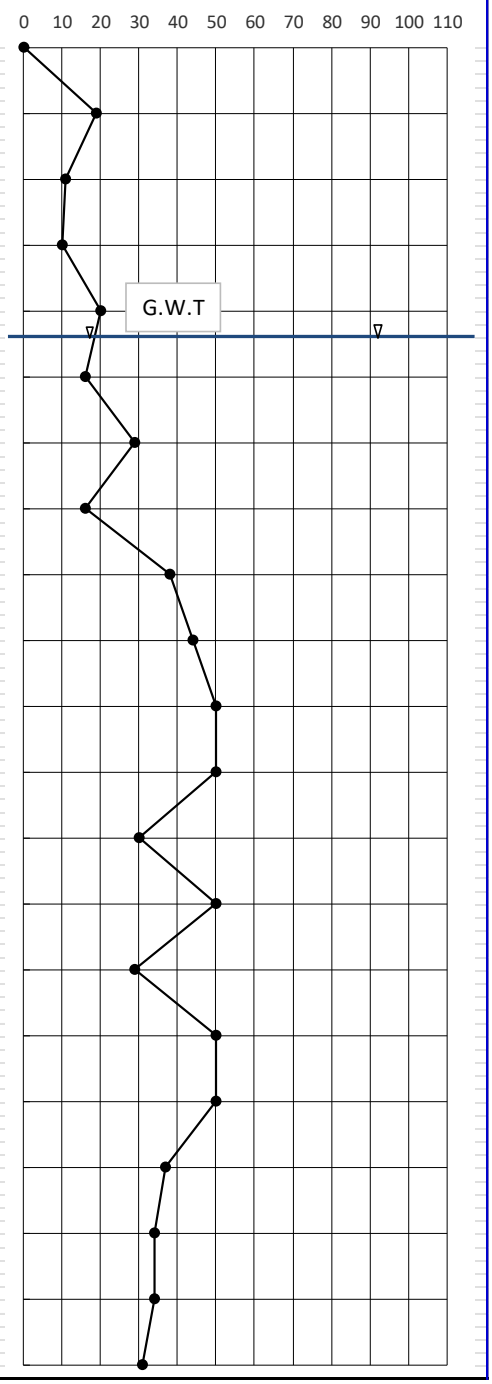
Depth	Visual Description	Symbols	Sample	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Brownish Gray Medium Stiff Silty **CLAY** Trace Organic Matter			1.5	1	2	3	5
3.0	Gray Medium Dense Fine to Medium **SAND** Little Silt, mica & organic matter			7.5	4	5	6	11
4.5					3	6	7	13
6.0					5	5	5	10
7.5					3	5	6	11
9.0					3	7	7	14
10.5	Bluish Gray Dense to very Dense Medium to Fine **SAND** Little Mica & Clay			9	13	25	25	50
12.0					15	20	28	48
13.5					13	17	20	37
15.0					15	50	0	50 6"Over
16.5					17	50	0	50 6"Over
18.0					7	14	18	32
19.5	Bluish Gray Medium Dense to Dense Fine to Medium **SAND** with Mica and Occationally Coarse Sand			12	6	12	16	28
21.0					15	15	17	32
22.5					14	50	0	50 6"Over
24.0					12	23	25	48
25.5					8	13	17	30
27.0					12	20	30	50
28.5					13	22	26	48
30.0					8	12	13	25



GEOTECHNICAL BOREHOLE LOG

Borehole No:	BH-26	**Ground Water Level:**	**6.71 m**
Method of Boring and Diameter:	Percussion (100 mm)	**Started on:**	**26/09/2024**
Boring Depth:	30m	**Completed on:**	**27/09/2024**
Client:	Urban Development Directorate (UDD)	**Legend:**	Clay/Silt, Sand, Shale
Project:	Preparation of Development Plan for Meherpur Zilla		
Location:	**Baliarpur (Purbopara) Govt. Primary School, Meherpur Sadar**	**Coordinates:**	**Lat. 23.6969634, Long. 88.7393762**

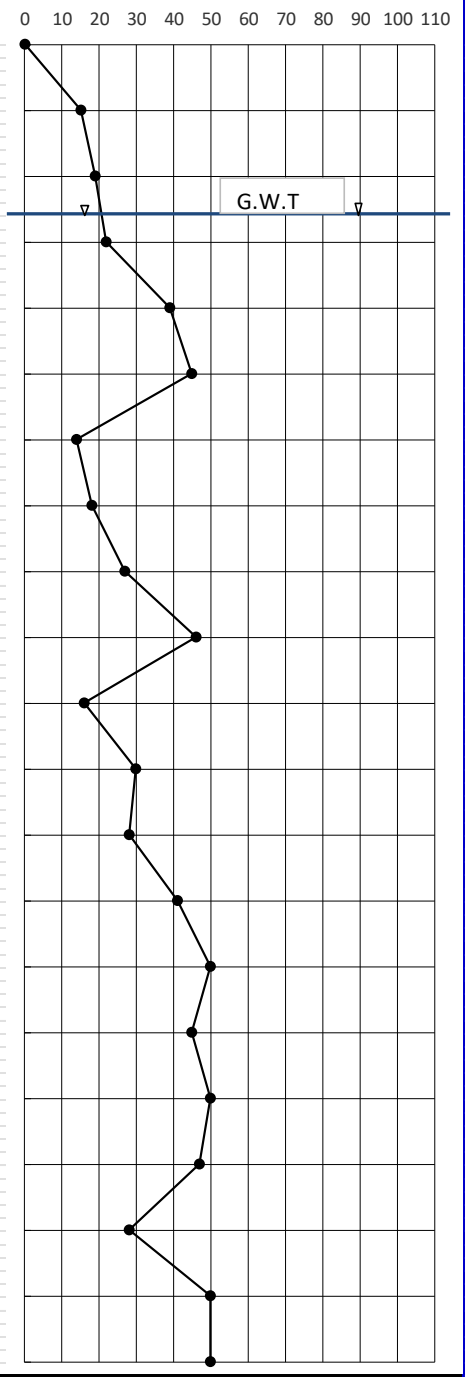
Depth	Visual Description	Symbols	Sample	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Yellowish Gray Very Stiff **SILT**			1.5	4	9	10	19
3.0	Gray to Bluish Gray Medium Dense Medium to Fine **SAND** Little Clyey Silt			9	4	5	6	11
4.5					2	4	6	10
6.0					5	8	12	20
7.5					3	8	8	16
9.0					6	13	16	29
10.5					5	6	10	16
12.0	Bluish Gray Medium Dense to Dense Fine to medium **SAND**			10.5	15	18	20	38
13.5					17	20	24	44
15.0					15	22	28	50
16.5					18	50	0	50 6"Over
18.0					10	13	17	30
19.5					13	35	15	50 4"Over
21.0					12	13	16	29
22.5	Bluish Gray Very Dense Medium to Fine **SAND** with Trace of Clay			3	18	50	0	50 7"Over
24.0					20	50	0	50 8"Over
25.5	Bluish Gray Dense Coarse SAND Trace of Clay & organic matter			6	10	17	20	37
27.0					13	14	20	34
28.5					14	14	20	34
30.0					10	14	17	31



GEOTECHNICAL BOREHOLE LOG

Borehole No:	BH-27	**Ground Water Level:**	**3.96 m**
Method of Boring and Diameter:	Percussion (100 mm)	**Started on:**	**18/09/2024**
Boring Depth:	30m	**Completed on:**	**18/09/2024**
Client:	Urban Development Directorate (UDD)	**Legend:**	Clay/Silt | Sand | Shale
Project:	Preparation of Development Plan for Meherpur Zilla		
Location:	**Patkelpota Govt. Primary School, Meherpur**	**Coordinates:**	**Lat. 23.7246763**, **Long. 88.7456695**

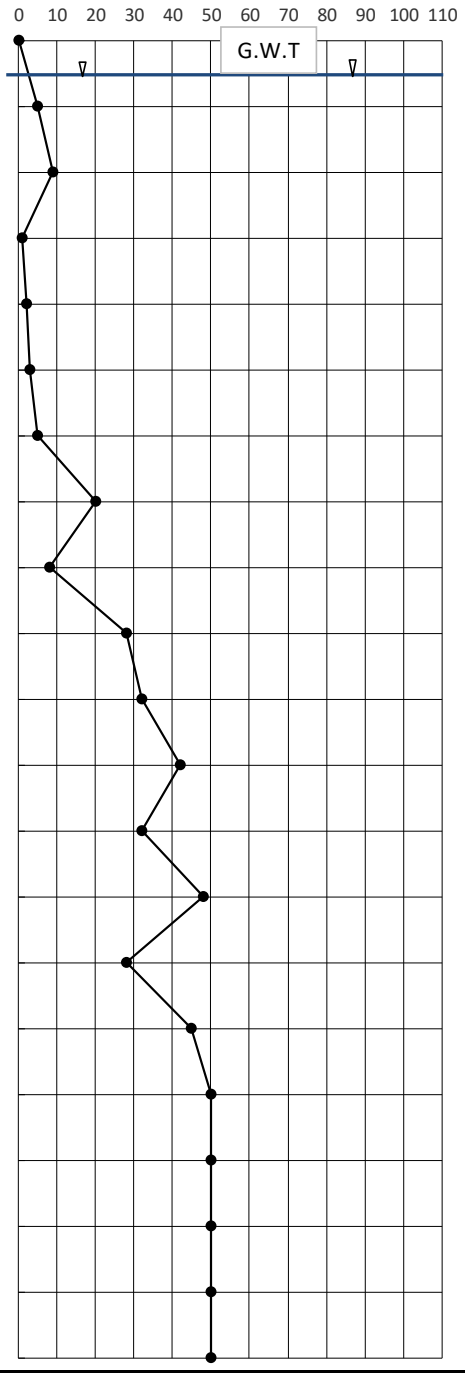
Depth	Visual Description	Symbols	Sample	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	Value 30cm
1.5	Brownish Gray Medium Dense Fine **SAND** with Silt & Little Mica			4.5	4	6	9	15
3.0					3	7	12	19
4.5					4	8	14	22
6.0	Bluish Gray Dense Fine **SAND** with Trace of Clay			3	9	17	22	39
7.5					12	20	25	45
9.0	Bluish Gray Medium Dense Fine to Medium **SAND** Little Clay & Mica			10.5	3	5	9	14
10.5					5	8	10	18
12.0					6	12	15	27
13.5					14	20	26	46
15.0					8	8	8	16
16.5					10	13	17	30
18.0					10	12	16	28
19.5	Bluish Gray Dense Coarse to Medium **SAND** with Clay			10.5	12	18	23	41
21.0					13	22	28	50
22.5					12	20	25	45
24.0					20	50	0	50 "Ove
25.5					13	23	24	47
27.0					10	12	16	28
28.5					12	20	30	50
30.0	Bluish Gray Very Dense Medium to Find **SAND**			1.5	17	50	0	50



GEOTECHNICAL BOREHOLE LOG

Borehole No:	BH-28	**Ground Water Level:**	**0.46 m**
Method of Boring and Diameter:	Percussion (100 mm)	**Started on:**	**19/09/2024**
Boring Depth:	30m	**Completed on:**	**19/09/2024**
Client:	Urban Development Directorate (UDD)	**Legend:**	Clay/Silt | Sand | Shale
Project:	Preparation of Development Plan for Meherpur Zilla		
Location:	**Near Durlovpur Masjid Road Site in Durlovpur Village, Gangni**	**Coordinates:**	**Lat. 23.8749166**, **Long. 88.7469947**

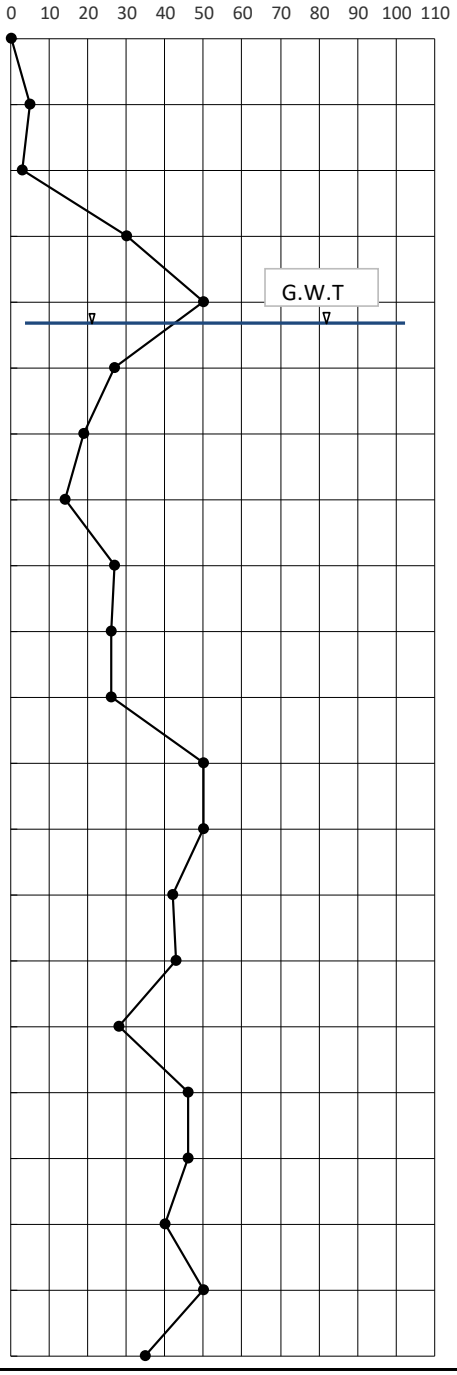
Depth	Visual Description	Symbols	Sample	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	N-Values 30cm
1.5	Brownish Gray Medium Stiff Clayey **SILT** with Little Organic Matter & Trace of Snail/Oysters			1.5	1	2	3	5
3.0	Bluish Gray Soft to Medium Stiff **CLAY** Little Sand & Trace Organic Matter			7.5	2	3	6	9
4.5					1	0	1	1
6.0					1	1	1	2
7.5					1	1	2	3
9.0					1	1	3	5
10.5	Bluish Gray Medium Dense Fine **SAND** Little Clay & Trace Organic Matter			1.5	5	7	13	20
12.0	Bluish Gray Medium Stiff **CLAY** Trace Organic Matter			1.5	3	4	4	8
13.5	Bluish Gray Dense Fine to Medium **SAND** with Clay			10.5	9	12	16	28
15.0					10	14	18	32
16.5					12	18	24	42
18.0					12	14	18	32
19.5					13	22	26	48
21.0					10	12	16	28
22.5					13	20	25	45
24.0	Bluish Gray Very Dense Medium to Coarse **SAND** with Trace of Clay			7.5	17	50	0	50 6"Over
25.5					15	50	0	50 6"Over
27.0					16	50	0	50 6"Over
28.5					20	50	0	50 7"Over
30.0					20	30	20	50



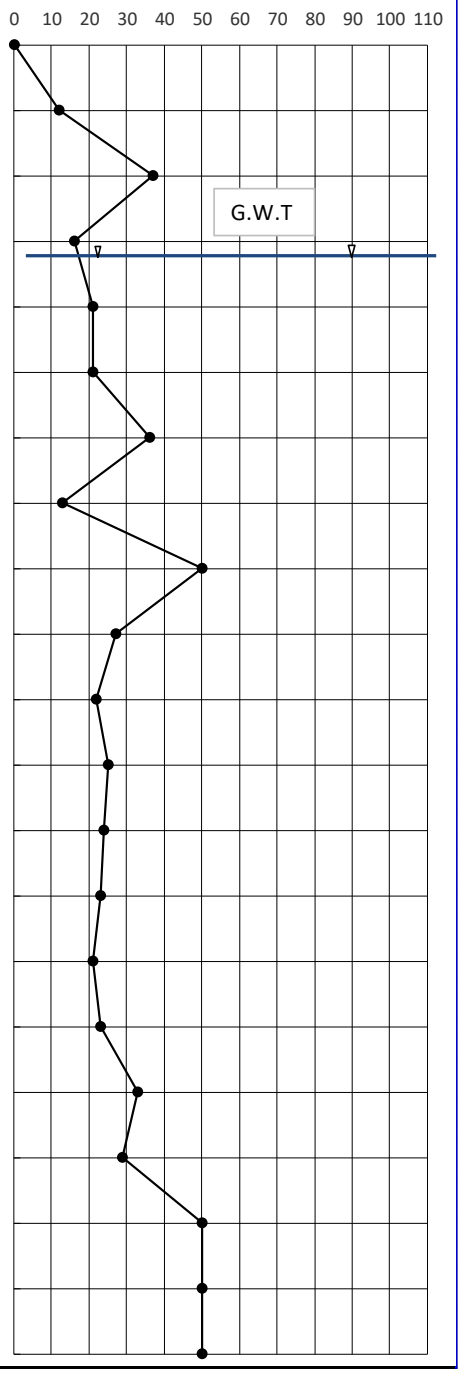
GEOTECHNICAL BOREHOLE LOG

Borehole No:	BH-29	**Ground Water Level:**	**6.71 m**
Method of Boring and Diameter:	Percussion (100 mm)	**Started on:**	**13/09/2024**
Boring Depth:	30m	**Completed on:**	**13/09/2024**
Client:	Urban Development Directorate (UDD)	**Legend:**	Clay/Silt | Sand | Shale
Project:	Preparation of Development Plan for Meherpur Zilla		
Location:	**Garadob Govt. Primary School, Gangni**	**Coordinates:**	**Lat. 23.8009408**, **Long. 88.6997816**

Depth	Visual Description	Symbols	Sample	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	Val 30cm
1.5	Brownish Gray Medium Stiff **CLAY** with Little Organic Matter			3	2	2	3	5
3.0					1	1	2	3
4.5	Bluish Gray Medium Dense Very Fine to Fine **SAND**			1.5	11	15	15	30
6.0	Bluish Gray Very Dense Very Fine to Fine **SAND**			1.5	15	50	0	50 'Ove
7.5	Bluish Gray Medium Dense Medium to Fine **SAND**			9	7	12	15	27
9.0					9	9	10	19
10.5					4	6	8	14
12.0					7	10	17	27
13.5					7	11	15	26
15.0					6	10	16	26
16.5	Bluish Gray Very Dense Medium to Fine **SAND**			3	10	20	30	50
18.0					10	22	28	50
19.5	Bluish Gray Dense Medium to Fine **SAND** Little Mica, occationally Coarse Sand			12	9	18	24	42
21.0					7	17	26	43
22.5					12	13	15	28
24.0					13	19	27	46
25.5					15	20	26	46
27.0					14	18	22	40
28.5					25	50	0	50 'Ove
30.0					15	15	20	35



GEOTECHNICAL BOREHOLE LOG

Borehole No:	BH-30	**Ground Water Level:**	**4.88 m**
Method of Boring and Diameter:	Percussion (100 mm)	**Started on:**	**25/09/2024**
Boring Depth:	30m	**Completed on:**	**26/09/2024**
Client:	Urban Development Directorate (UDD)	**Legend:**	Clay/Silt, Sand, Shale
Project:	Preparation of Development Plan for Meherpur Zilla		
Location:	**Bhatpara Govt. Primary School, Gangni**	**Coordinates:**	**Lat. 23.7638714, Long. 88.7607088**

Depth	Visual Description	Symbols	Sample	Thickness(m)	Standard Penetration Test: Blows on Spoon 15cm	15cm	15cm	Values 30cm
1.5	Brownish Gray Stiff to Hard **SILT** Trace of Organic Matter			3	2	5	7	12
3.0					7	15	22	37
4.5	Gray Medium Dense Very Fine to Fine **SAND** Little Silt			7.5	5	6	10	16
6.0					6	9	12	21
7.5					4	8	13	21
9.0					10	16	20	36
10.5					5	6	7	13
12.0	Bluish Gray Very Dense Fine to Very Fine **SAND**			1.5	15	30	20	50 4"Over
13.5	Bluish Gray Medium Dense Medium to Fine **SAND** trace Silt and Clay			13.5	7	12	15	27
15.0					6	10	12	22
16.5					7	10	15	25
18.0					6	9	15	24
19.5					9	10	13	23
21.0					6	9	12	21
22.5					8	9	14	23
24.0					8	15	18	33
25.5					11	13	16	29
27.0	Bluish Gray Very Dense Coarse **SAND** with Clay			4.5	15	30	20	50 4"Over
28.5					20	50	0	50 5"Over
30.0					20	30	20	50