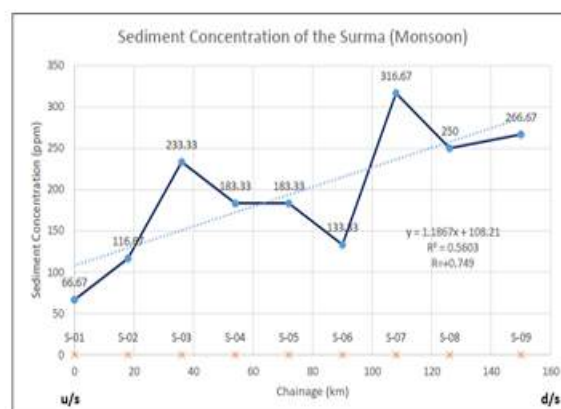Government of the People's Republic of Bangladesh
Ministry of Water Resources
Department of Bangladesh Haor & Wetlands Development

Model Validation on Hydro-Morphological Process of the River System in the Subsiding Sylhet Haor Basin

Volume 3
Appendix 3: Analysis of Sediment and Bed Material Samples of the Surma and the Kushiyara Rivers
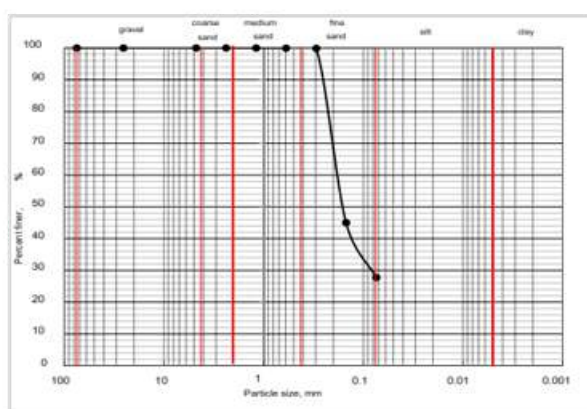

June, 2017

Government of the People's Republic of Bangladesh
Ministry of Water Resources
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Model Validation on Hydro-Morphological Process of the River System in the Subsiding Sylhet Haor Basin

Volume 3
Appenidx 3: Analysis of Sediment and Bed Material Samples of the Surma and the Kushiyara Rivers

June, 2017

Preface

The Volume 3 of the Report "Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin" contains the Appendix 3 "Analysis of Sediment and Bed Material Samples of the Surma and the Kushiyara Rivers" .

The Appendix 3 contains all the necessary details regarding the sediment concentration and bed materials of the Surma and the Kushiyara river including field survey, measurement methods, data collection, analysis and results.

The team deeply acknowledge the co-operation and guidance of the Technical Committee of the project. The team also acknowledge the 'Department of Bangladesh Haor and Wetlands Development' for providing logistic supports and helping the team to prepare the Report.

We are thankful to Mr. Majibur Rahman, Director General, Department of Bangladesh Haor and Wetlands Development and Mrs. Afroza Moazzam, former Director General, Department of Bangladesh Haor and Wetlands Development for their active support and co-operation. We appreciate the co-operation of Mr. Md. Nazmul Ahsan, Project Director and Md. Nurul Amin, Director (Admin and Finance), of the Department of Bangladesh Haor and Wetlands Development.

We acknowledge with deep appreciation the co-operation by M/S Globe Survey Company in carrying out the field survey works. We also thank the local people, particularly of the Northeast Region who in various ways helped the study team in conducting the field measurements and survey works.

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H.S. Mozaddad Faruque

Senior Morphologist

And

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</div>

Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin

Final Report

The Final Report on "Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin", submitted in June, 2017 contains the following volumes:

Volume. 1:   Main Report
              Appendix 1: Feedback from the Stakeholders

Volume 2:   Appendix 2: Bank Line Survey Report of the Surma and the Kushiyara Rivers

Volume 3:   Appendix 3: Analysis of Sediment and Bed Material Samples of the Surma and the Kushiyara Rivers

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APPENDIX 3

ANALYSIS OF SEDIMENT AND BED MATERIAL SAMPLES OF THE SURMA AND THE KUSHIYARA RIVERS

Chapter 1   Introduction

Most sediment in surface waters derives from surface erosion and comprises a mineral component, arising from the erosion of bedrock, and an organic component arising during soil-forming processes (including biological and microbiological production and decomposition). An additional organic component may be added by biological activity within the water body. Fine sediment can be found in nearly any body of water, carried along by the water flow. When the sediment is floating within the water column it is considered suspended. Sediment load is the movement of organic and inorganic particles by water. In general, the greater the flow, the more sediment that will be conveyed. Water flow can be strong enough to suspend particles in the water column as they move downstream, or simply push them along the bottom of a waterway

Sediment can be classified as deposited or suspended. Deposited sediment is that found on the bed of a river or lake. Suspended sediment is that found in the water column where it is being transported by water movements. Suspended sediment is also referred to as suspended matter, particulate matter or suspended solids.

The study of river suspended sediments is becoming more important, nationally and internationally. One of the most serious environmental problems is erosion and the consequent loss of topsoil. Although erosion is a natural phenomenon, the rate of soil loss is greatly increased by poor agricultural practices and deforestation which result, in turn, in increased suspended sediment loads in freshwaters. Loss of topsoil results in an economic loss to farmers through a reduction in soil productivity. Good environmental practice in agriculture, which may include contour ploughing and terracing, helps to protect against soil loss and against

contamination of surface waters. Sediment transport in rivers is associated with a wide variety of environmental and engineering issues which are outlined in Table 1.

Table 1 Issues associated with sediment transport in rivers

Sediment size	Environmental issues	Associated engineering issues
Silts and clays	Erosion, especially loss of topsoil in agricultural areas; gullying	
	High sediment loads to reservoirs	Reservoir siltation
	Chemical transport of nutrients, metals, and chlorinated organic compounds	Drinking-water supply
	Accumulation of contaminants in organisms at the bottom of the food chain (particulate feeders)	
	Silting of fish spawning beds and disturbance of habitats (by erosion or siltation) for benthic organisms	
Sand	River bed and bank erosion	River channel deposition: navigation problems Instability of river cross-sections
	Reservoir bed and bank erosion	Sedimentation in reservoirs
	Habitat disturbance	
Gravel	Channel instability when dredged for aggregate	Instability of river channel leads to problems of navigation and flood- control
	Habitat disturbance	

(Source: ASTM International, 1997))

In order to protect surface water resources and optimize their use, soil loss must be controlled and minimized. This requires changes in land use and land management, which may also have an impact on water quality. Understanding of sediment transport is very important for maintenance of navigation routes and flood management.

Chapter 2   Sediment Measurement

In the measurement of sediment transport, simplified assumptions are made. This is largely because sediment transport is a dynamic phenomenon and measurement techniques cannot register the ever-changing conditions that exist in water bodies, particularly in river systems. The rivers of Haor areas are very dynamic in nature and are continuously evolving. In this situation, it is a crucial demand to monitor the major rivers particularly the Surma and the Kushiyara to assess the maintenance work for new interventions. The key objective of the sediment and bed sample collection is to assess the impact of upstream interventions which changes the river course and bed elevation.

In this connection, it is necessary to collect relevant field data from the study area through proper way. M/S Prosoil Foundation Consultant Ltd. In collaboration with M/S Globe Survey Company, a local competent company collected the data. The collected data were analyzed in the Prosoil Laboratory located at Uttara, Dhaka.

Chapter 3   Field Survey

Sediment concentration and bed material samples of the Surma and the Kushiyara have been collected. Measurements have been taken from 9 stations in each river.

A number of 3 sets of measurements have been collected for determining sediment concentration. The first set of data was collected from August 22, 2016 to August 29, 2016 (monsoon season). The 2nd set of data have been collected from January 14, 2017 to January 24, 2017 (Dry season). The 3rd set of data have been collected from April 10, 2017 to April 18, 2017 (Pre Monsoon season).

A number of 2 sets of measurements have been done for bed material sampling. The 1st set of data have been collected from January 14, 2017 to January 24, 2017 (Dry season). The 2nd set of data have been collected from March 31, 2017 to April 15, 2017 (Pre Monsoon season).

3.1   Sediment Sample Collection

Fundamental methods were used to collect the sediment samples from 0.6h m depth from the surface of the river where, h is the depth of river in meter. The depth of the river was measured using an Echosounder. A weight of 20 kg with measured rope was dropped into the river water. A bottle, having a 10.0 litre capacity, was tied to the rope 1.0 m above the weight. The bottle was water tightened by cork and the cork was tied by the course thread. The cork was pulled off from the bottles after some time in the water. The bottle quickly filled with sediment laden water. Then the samples were picked up from the water and the bottles were stored. All the sediment samples thus collected from the Surma and the Kushiyara rivers were sent to the laboratory for testing.

Figure 2 Survey instruments: sample collection bottles, weight, cork

Figure 1 Sample collection bottle is being lowered by ropes

Figure 3 Sediment sample is being collected

Figure 4 Collected and labelled sediment samples

3.2   Bed Material Sample Collection

Direct measurements were done for collecting bed material samples. A box type sampler (Figure 5) was used by lowering the device into the water using ropes in contact with the bed. The sediment transported was accumulated or trapped as bedload inside the sampler for a certain amount of time, after which the sampler was raised to the surface and the samples were preserved in an ice box to maintain its natural temperature. The samples were tested in the Prosoil Laboratory.

Figure 5 Bed material collection sampler

Figure 6 Surveyors collecting bed material samples using the sampler

Figure 7 Surveyors transporting the bed material for restoration

Chapter 4   Sediment Concentration

4.1   Laboratory Testing

The sediment concentration has been determined in the Prosoil Laboratory by using the ASTM Standard Test Method D 3977-97 (Test Method B: Filtration).

4.1.1   Definitions of Terms Specific to This Standard

- Dissolved Solids—soluble constituents in water. The quantity is determined by evaporating a water sample to visible dryness at a temperature slightly below boiling. The temperature is then raised to 105 °C and held for about 2 h. This is followed by cooling in a desiccator and weighing the residue.
- Supernate—clear, overlying liquid in a sediment sample.
- Suspended Sediment—sediment supported by turbulent currents in flowing water or by Brownian movement.
- Tare—weights of empty containers used in analysis procedure.

4.1.2   Test Method B

Test Method B are normally used only on samples containing sand concentrations less than about 10000 ppm and clay concentrations less than about 200 ppm. The sediment need not be settle able because filters are used to separate water from the sediment. Correction factors for dissolved solids are not required. Even though a high-concentration sample may filter slowly, users should not divide the sample and use two or more filters. Instead, the entire sample should be filtered through one disk.

Summary of Test Method B

The sample consisting of river water, sediment, and dissolved solids is weighed and then filtered through a glass- fiber disk. The disk and sediment are dried and weighed, then the sediment concentration was calculated.

Apparatus

- Gooch Crucibles
- *Glass-fiber Filter Disks*
- Vacuum System
- Drying Oven
- Desiccator
- Laboratory Balance
- Laboratory Balance

4.2   Results

4.2.1   The Surma River

The location of the sediment collection stations and details of sediment collection plan of the Surma River are presented below in Table 2, Table 3 and Figure 8.

Table 2 List of Sediment Collection Stations on the Surma River

Station ID	Corresponding BWDB Station ID	Location		Upazilla
		Lat.	Long.	
S-01	SW266	25° 0' 16"N	92° 16' 11"E	Kanairghat
S-02		24° 56' 11"N	92° 11' 52"E	Kanairghat
S-03		24° 53' 58"N	92° 5' 40"E	Kanairghat
S-04		24° 51' 53"N	91° 57' 56"E	Golabganj
S-05	SW267	24° 54' 18"N	91° 50' 3"E	Sylhet Sadar
S-06		24° 55' 51"N	91° 42' 8"E	Sylhet Sadar
S-07	SW268	24° 59' 47"N	91° 41' 8"E	Companiganj
S-08		25° 0' 15"N	91° 36' 27"E	Chhatak
S-09		25° 3' 57"N	91° 31' 16"E	Dowarabazaar

Table 3 Sediment Collection Plan on the Surma River

No. of Data Sets	No. of Stations	Station ID	No. of Samples	Timeline
3	9 sections (15 km apart)	S01, S02, S03, S04, S05, S06, S07, S08, S09	6 samples per section Total measurements = 162	**1st set:** Aug 22, 2016 - Aug 29, 2016 (Monsoon) **2nd set:** Jan 14, 2017 – Jan 24, 2017 (Dry) **3rd set:** April 10- April 18, 2017 (Pre Monsoon)

Figure 8 Locations of Sediment Collection Stations on the Surma

The collected and analyzed sediment data are given in the following Tables (Table 4,5 and 6):

Table 4 1st set of Sediment Concentration Data of the Surma River (August 2017, Monsoon Season)

Section	Sample vol. (mL)	Retained Soil (gm)	Sediment Concentration (ppm)	Average Sediment Concentration (ppm)
S1-1	100	0.01	100	
S1-2	100	0.01	100	
S1-3	100	0	0	
S1-4	100	0	0	66.67
S1-5	100	0.01	100	
S1-6	100	0.01	100	
S2-1	100	0.02	200	
S2-2	100		0	
S2-3	100	0.02	200	
S2-4	100	0	0	116.67
S2-5	100	0.02	200	
S2-6	100	0.01	100	
S3-1	100	0.03	300	
S3-2	100	0.03	300	
S3-3	100	0.05	500	
S3-4	100		0	233.33
S3-5	100	0.02	200	
S3-6	100	0.01	100	
S4-1	100	0.02	200	
S4-2	100	0.03	300	
S4-3	100		0	
S4-4	100	0.03	300	183.33
S4-5	100		0	
S4-6	100	0.03	300	

Section	Sample vol. (mL)	Retained Soil (gm)	Sediment Concentration (ppm)	Average Sediment Concentration (ppm)
S5-1	100	0.02	200	183.33
S5-2	100	0.01	100	
S5-3	100	0.02	200	
S5-4	100	0.01	100	
S5-5	100	0.02	200	
S5-6	100	0.03	300	
S6-1	100	0.02	200	133.33
S6-2	100	0.01	100	
S6-3	100	0.02	200	
S6-4	100	0.02	200	
S6-5	100	0.01	100	
S6-6	100		0	
S7-1	100	0.03	300	316.67
S7-2	100	0.04	400	
S7-3	100	0.04	400	
S7-4	100	0.05	500	
S7-5	100	0.02	200	
S7-6	100	0.01	100	
S8-1	100	0.02	200	250
S8-2	100	0.03	300	
S8-3	100	0.02	200	
S8-4	100	0.05	500	
S8-5	100	0.02	200	
S8-6	100	0.01	100	

Section	Sample vol. (mL)	Retained Soil (gm)	Sediment Concentration (ppm)	Average Sediment Concentration (ppm)
S9-1	100	0.03	300	
S9-2	100	0.02	200	
S9-3	100	0.02	200	266.67
S9-4	100	0.03	300	
S9-5	100	0.03	300	
S9-6	100	0.03	300	

Table 5 2nd set of Sediment Concentration Data of the Surma River (January 2017, Dry season)

Section	Sample vol. (mL)	Retained Soil (gm)	Sediment Concentration (ppm)	Average Sediment Concentration (ppm)
S1-1	100	0.02	200	
S1-2	100	0.01	100	
S1-3	100	0	0	116.67
S1-4	100	0.01	100	
S1-5	100	0.01	100	
S1-6	100	0.02	200	
S2-1	100	0.02	200	
S2-2	100	0	0	
S2-3	100	0	0	66.67
S2-4	100	0.01	100	
S2-5	100	0	0	
S2-6	100	0.01	100	

Section	Sample vol. (mL)	Retained Soil (gm)	Sediment Concentration (ppm)	Average Sediment Concentration (ppm)
S3-1	100	0.01	100	
S3-2	100	0.02	200	
S3-3	100	0.01	100	116.67
S3-4	100	0.02	200	
S3-5	100	0	0	
S3-6	100	0.01	100	
S4-1	100	0.01	100	
S4-2	100	0	0	
S4-3	100	0.01	100	83.33
S4-4	100	0.01	100	
S4-5	100	0.01	100	
S4-6	100	0.01	100	
S5-1	100	0	0	
S5-2	100	0.01	100	
S5-3	100	0.01	100	83.33
S5-4	100	0.01	100	
S5-5	100	0.01	100	
S5-6	100	0.01	100	
S6-1	100	0	0	
S6-2	100	0.01	100	
S6-3	100	0	0	50
S6-4	100	0.02	200	
S6-5	100	0	0	
S6-6	100	0	0	
S7-1	100	0	0	50

Section	Sample vol. (mL)	Retained Soil (gm)	Sediment Concentration (ppm)	Average Sediment Concentration (ppm)
S7-2	100	0.01	100	
S7-3	100	0.02	200	
S7-4	100	0	0	
S7-5	100	0	0	
S7-6	100	0	0	
S8-1	100	0.02	200	
S8-2	100	0	0	
S8-3	100	0	0	100
S8-4	100	0.01	100	
S8-5	100	0.02	200	
S8-6	100	0.01	100	
S9-1	100	0.01	100	
S9-2	100	0	0	
S9-3	100	0.01	100	100
S9-4	100	0.01	100	
S9-5	100	0.01	100	
S9-6	100	0.02	200	

Table 6 3rd set of Sediment Concentration Data of the Surma River (April 2017, Pre Monsoon)

Section	Sample vol. (mL)	Retained Soil (gm)	Sediment Concentration (ppm)	Average Sediment Concentration (ppm)
S1-1	100	0.003	30	
S1-2	100	0.005	50	
S1-3	100	0.002	20	266.67
S1-4	100	0.01	100	
S1-5	100	0.07	700	
S1-6	100	0.07	700	
S2-1	100	0.02	200	
S2-2	100	0.07	700	
S2-3	100	0.02	200	283.33
S2-4	100	0.03	300	
S2-5	100	0.01	100	
S2-6	100	0.02	200	
S3-1	100	0.03	300	
S3-2	100	0.05	500	
S3-3	100	0.02	200	400
S3-4	100	0.04	400	
S3-5	100	0.02	200	
S3-6	100	0.08	800	
S4-1	100	0.01	100	
S4-2	100	0.06	600	
S4-3	100	0.06	600	366.67
S4-4	100	0.02	200	
S4-5	100	0.06	600	
S4-6	100	0.01	100	

Section	Sample vol. (mL)	Retained Soil (gm)	Sediment Concentration (ppm)	Average Sediment Concentration (ppm)
S5-1	100	0.08	800	
S5-2	100	0.05	500	
S5-3	100	0.09	900	
S5-4	100	0.08	800	733.33
S5-5	100	0.06	600	
S5-6	100	0.08	800	
S6-1	100	0.06	600	
S6-2	100	0.03	300	
S6-3	100	0.07	700	
S6-4	100	0.04	400	516.67
S6-5	100	0.06	600	
S6-6	100	0.05	500	
S7-1	100	0.07	700	
S7-2	100	0.06	600	
S7-3	100	0.09	900	
S7-4	100	0.05	500	666.67
S7-5	100	0.08	800	
S7-6	100	0.05	500	
S8-1	100	0.02	200	
S8-2	100	0.08	800	
S8-3	100	0.01	100	
S8-4	100	0.06	600	516.67
S8-5	100	0.07	700	
S8-6	100	0.07	700	

Section	Sample vol. (mL)	Retained Soil (gm)	Sediment Concentration (ppm)	Average Sediment Concentration (ppm)
S9-1	100	0.01	100	
S9-2	100	0.03	300	
S9-3	100	0.04	400	483.33
S9-4	100	0.08	800	
S9-5	100	0.07	700	
S9-6	100	0.06	600	

The first set of data have been plotted in Figure 9.

Figure 9 Analysis of Sediment Concentration in the Surma River (August 2016, Monsoon Season)

From the figure, it is apparent that the trend of sediment concentration along the river course is rising towards downstream (R= +0.749). The R value is statistically insignificant.

The 2nd set of data have been plotted in Figure 10.

Figure 10 Analysis of Sediment Concentration in the Surma River (January 2017, Dry Season)

The trend line shows slight decrease in the downstream direction in Dry Season (R= -0.224). The R value is statistically insignificant.

The 3rd set of data have been plotted in Figure 11.

Figure 11 Analysis of Sediment Concentration in the Surma River (April 2017, Pre Monsoon season)

From the figure, it can be observed that the change in sediment concentration in Pre Monsoon season shows an increasing trend towards downstream (R= +0.630). The R value is statistically insignificant.

4.2.2   The Kushiyara River

The location of the sediment collection stations and details of sediment collection plan of the Kushiyara River are presented below in Table 7, Table 8 and Figure 12.

Table 7 List of Sediment Collection Stations on the Kushiyara River

Station ID	Corresponding BWDB Station ID	Location		Upazilla
		Lat.	**Long.**	
K-01	SW173	24° 53' 14"N	92° 11' 22"E	Beani Bazar
K-02		24° 50' 15"N	92° 4' 49"E	Golab Ganj
K-03		24° 43' 39"N	92° 2' 6"E	Golab Ganj
K-04	SW174	24° 39' 55"N	91° 54' 16"E	Fenchuganj
K-05		24° 37' 60"N	91° 46' 53"E	Balaganj
K-06	SW175.5	24° 38' 25"N	91° 39' 18"E	Balaganj
K-07		24° 41' 48"N	91° 32' 27"E	Jagannathpur
K-08	SW270	24° 41' 37"N	91° 24' 30"E	Markuli
K-09		24° 37' 21"N	91° 18' 5"E	Sulla

Table 8 Sediment Collection Plan on Kushiyara River

No. of Data Sets	No. of Sections	Station ID	No. of Samples	Timeline
3	9 sections (15 km apart)	K01, K02, K03, K04, K05, K06, K07, K08, K09	8 samples per section, Total measurements = 216	**1st set:** Aug 22, 2016 - Aug 29, 2016 (Monsoon) **2nd set:** Jan 14, 2017 – Jan 24, 2017 (Dry) **3rd set:** April 10- April 18, 2017 (Pre Monsoon)

Figure 12 Location of Sediment Collection Station on the Kushiyara

The collected sediment data are given in the following Tables (Table 9,10 and 11):

Table 9 1st set of Sediment Concentration Data of the Kushiyara River (August 2016, monsoon)

Section	Sample vol. (mL)	Retained Soil (gm)	Sediment Concentration (ppm)	Average Sediment Concentration (ppm)
K1-1	100	0.01	100	
K1-2	100	0	0	
K1-3	100	0.01	100	
K1-4	100	0.01	100	66.67
K1-5	100	0	0	
K1-6	100	0.01	100	

Section	Sample vol. (mL)	Retained Soil (gm)	Sediment Concentration (ppm)	Average Sediment Concentration (ppm)
K2-1	100	0.01	100	
K2-2	100	0.02	200	
K2-3	100	0	0	
K2-4	100	0.02	200	116.67
K2-5	100	0.01	100	
K2-6	100	0.01	100	
K3-1	100	0.02	200	
K3-2	100	0.02	200	
K3-3	100	0.01	100	
K3-4	100	0.01	100	116.67
K3-5	100	0.01	100	
K3-6	100		0	
K4-1	100	0	0	
K4-2	100	0.01	100	
K4-3	100	0.01	100	
K4-4	100	0	0	33.33
K4-5	100	0	0	
K4-6	100	0	0	
K5-1	100	0.03	300	
K5-2	100	0.04	400	
K5-3	100	0.03	300	
K5-4	100	0.03	300	266.67
K5-5	100	0.02	200	
K5-6	100	0.01	100	

Section	Sample vol. (mL)	Retained Soil (gm)	Sediment Concentration (ppm)	Average Sediment Concentration (ppm)
K6-1	100	0.32	3200	1816.67
K6-2	100	0.32	3200	
K6-3	100	0.32	3200	
K6-4	100	0.05	500	
K6-5	100	0.05	500	
K6-6	100	0.03	300	
K7-1	100	0.05	500	600
K7-2	100	0.06	600	
K7-3	100	0.12	1200	
K7-4	100	0.04	400	
K7-5	100	0.04	400	
K7-6	100	0.05	500	
K8-1	100	0.12	1200	1150
K8-2	100	0.1	1000	
K8-3	100	0.09	900	
K8-4	100	0.11	1100	
K8-5	100	0.13	1300	
K8-6	100	0.14	1400	
K9-1	100	0.13	1300	1050
K9-2	100	0.12	1200	
K9-3	100	0.14	1400	
K9-4	100	0.1	1000	
K9-5	100	0.14	1400	
K9-6	100		0	

Table 10 2nd set of Sediment Concentration Data of the Kushiyara River (January 2017, Dry season)

Section	Sample vol. (mL)	Retained Soil (gm)	Sediment Concentration (ppm)	Average Sediment Concentration (ppm)
K1-1	100	0.5	5000	1800
K1-2	100	0.01	100	
K1-3	100	0.02	200	
K1-4	100	0.02	200	
K1-5	100	0.2	2000	
K1-6	100	0.33	3300	
K2-1	100	0.01	100	116.67
K2-2	100	0.01	100	
K2-3	100	0.01	100	
K2-4	100	0.01	100	
K2-5	100	0.01	100	
K2-6	100	0.02	200	
K3-1	100	0.01	100	266.67
K3-2	100	0.01	100	
K3-3	100	0.1	1000	
K3-4	100	0.02	200	
K3-5	100	0.01	100	
K3-6	100	0.01	100	
K4-1	100	0.01	100	266.67
K4-2	100	0.01	100	
K4-3	100	0.02	200	
K4-4	100	0.01	100	
K4-5	100	0.01	100	

Section	Sample vol. (mL)	Retained Soil (gm)	Sediment Concentration (ppm)	Average Sediment Concentration (ppm)
K4-6	100	0.1	1000	
K5-1	100	0.01	100	
K5-2	100	0	0	
K5-3	100	0.01	100	66.67
K5-4	100	0	0	
K5-5	100	0.01	100	
K5-6	100	0.01	100	
K6-1	100	0	0	
K6-2	100	0.01	100	
K6-3	100	0.07	700	316.67
K6-4	100	0.1	1000	
K6-5	100	0	0	
K6-6	100	0.01	100	
K7-1	100	0.01	100	
K7-2	100	0	0	
K7-3	100	0.1	1000	216.67
K7-4	100	0.01	100	
K7-5	100	0.01	100	
K7-6	100	0	0	
K8-1	100	0.01	100	
K8-2	100	0.01	100	
K8-3	100	0.02	200	83.33
K8-4	100	0	0	
K8-5	100	0	0	
K8-6	100	0.01	100	
K9-1	100	0.04	400	950

Section	Sample vol. (mL)	Retained Soil (gm)	Sediment Concentration (ppm)	Average Sediment Concentration (ppm)
K9-2	100	0.04	400	
K9-3	100	0.46	4600	
K9-4	100	0.01	100	
K9-5	100	0.01	100	
K9-6	100	0.01	100	

Table 11 3rd set of Sediment Concentration Data of the Kushiyara River (April 2017, Pre Monsoon)

Section	Sample vol. (mL)	Retained Soil (gm)	Sediment Concentration (ppm)	Average Sediment Concentration (ppm)
K1-1	100	0.13	1300	
K1-2	100	0.11	1100	
K1-3	100	0.05	500	883.33
K1-4	100	0.1	1000	
K1-5	100	0.03	300	
K1-6	100	0.11	1100	
K2-1	100	0.1	1000	
K2-2	100	0.01	100	
K2-3	100	0.06	600	550
K2-4	100	0.03	300	
K2-5	100	0.05	500	
K2-6	100	0.08	800	
K3-1	100	0.04	400	
K3-2	100	0.03	300	
K3-3	100	0.02	200	266.67
K3-4	100	0.01	100	
K3-5	100	0.01	100	
K3-6	100	0.05	500	
K4-1	100	0.05	500	
K4-2	100	0.07	700	
K4-3	100	0.04	400	500
K4-4	100	0.08	800	
K4-5	100	0.02	200	
K4-6	100	0.04	400	

Section	Sample vol. (mL)	Retained Soil (gm)	Sediment Concentration (ppm)	Average Sediment Concentration (ppm)
K5-1	100	0.04	400	
K5-2	100	0.09	900	
K5-3	100	0.01	100	516.67
K5-4	100	0.07	700	
K5-5	100	0.05	500	
K5-6	100	0.05	500	
K6-1	100	0.08	800	
K6-2	100	0.02	200	
K6-3	100	0.06	600	516.67
K6-4	100	0.05	500	
K6-5	100	0.08	800	
K6-6	100	0.02	200	
K7-1	100	0.08	800	
K7-2	100	0.1	1000	
K7-3	100	0.02	200	600
K7-4	100	0.07	700	
K7-5	100	0.05	500	
K7-6	100	0.04	400	
K8-1	100	0.06	600	
K8-2	100	0.02	200	
K8-3	100	0.09	900	483.33
K8-4	100	0.05	500	
K8-5	100	0.01	100	
K8-6	100	0.06	600	
K9-1	100	0.05	500	416.67
K9-2	100	0.02	200	

Section	Sample vol. (mL)	Retained Soil (gm)	Sediment Concentration (ppm)	Average Sediment Concentration (ppm)
K9-3	100	0.03	300	
K9-4	100	0.05	500	
K9-5	100	0.08	800	
K9-6	100	0.02	200	

The data of Monsoon season have been plotted in Figure 13.

Figure 13 Analysis of Sediment Concentration in the Kushiyara River (August 2016, Monsoon season)

From the figure, it is apparent that the trend of sediment concentration along the river course is rising towards downstream (R= +0.705). The R value is statistically insignificant. The sediment data of station K-06 shows an abnormally high value.

The 2nd set of (Dry season) data have been plotted in Figure 14.

Figure 14 Analysis of Sediment Concentration in the Kushiyara River (January 2017, Dry season)

The sediment concentration at station K-01 and K-09 show very high values. The trend line shows slight decrease in concentration towards downstream (R= -0.265). The R value is statistically insignificant.

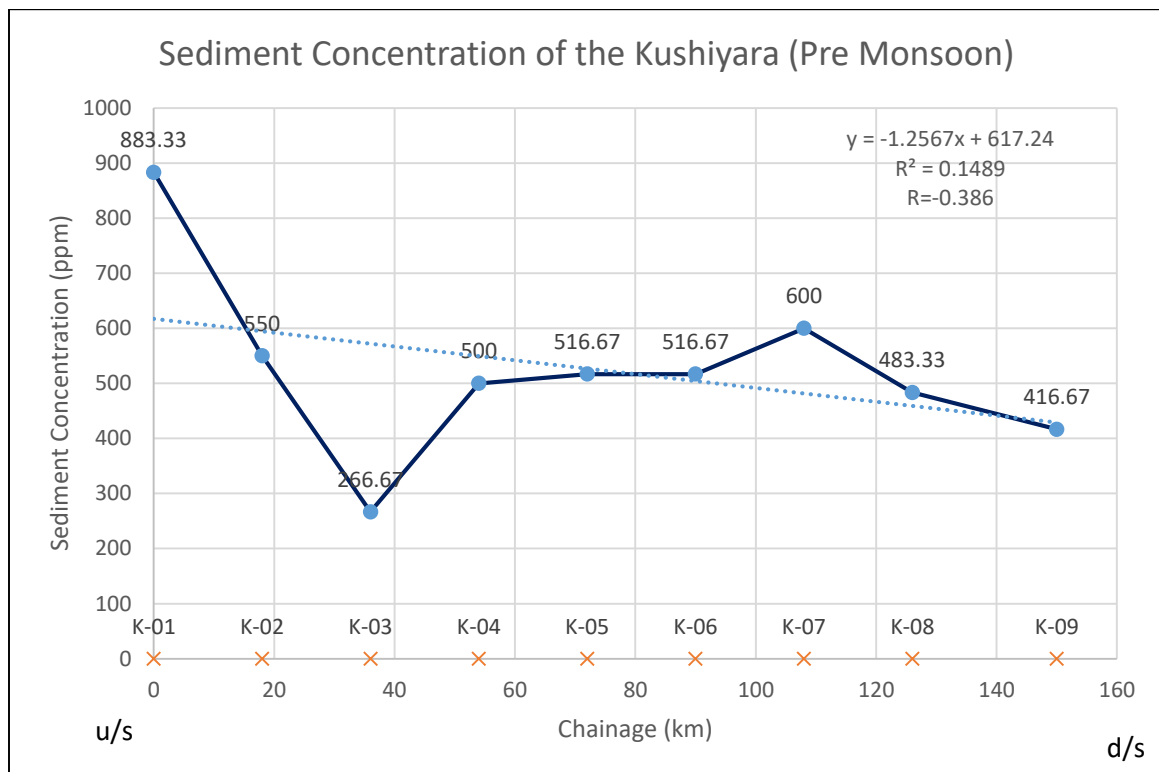The 3rd set of data (Pre Monsoon) have been plotted in Figure 15.

Figure 15 Analysis of Sediment Concentration in the Kushiyara River (April 2017, Pre Monsoon)

From the figure, it is observed that the change in sediment concentration in Pre Monsoon season show a slight decrease towards downstream direction (R= -0386). The R value is statistically insignificant.

Chapter 5   Bed Material Sampling

5.1   Laboratory Testing

The bed material samples have been analyzed in the Prosoil Laboratory to determine the Median Grain Size (D50) value. The value was determined by analyzing the sample using the ASTM Standard Test Method D422-63. This test method covers the quantitative determination of the distribution of particle sizes in soils. The distribution of particle sizes larger than 75 μm (retained on the No. 200 sieve) is determined by sieving, while the distribution of particle sizes smaller than 75 μm is determined by a sedimentation process, using a hydrometer to secure the necessary data.

5.1.1   Sieve Analysis

Need and Scope

The grain size analysis is widely used in classification of soils. The data obtained from grain size distribution curves is used in the design of filters for earth dams and to determine suitability of soil for road construction, air field etc. Information obtained from grain size analysis can be used to predict soil water movement although permeability tests are more generally used for this purpose.

Apparatus

- Stack of Sieves including pan and cover
- Balance (with accuracy to 0.01 g)
- Rubber pestle and Mortar (for crushing the soil if lumped or conglomerated)
- Mechanical sieve shaker
- Oven

5.1.2   Hydrometer Analysis

Hydrometer

A hydrometer is an instrument which is used to measure the relative density of a liquid. Hydrometer is made of glass and primarily consists of two parts;

- A cylindrical stem with graduation marks
- A bulb at bottom weighted with mercury

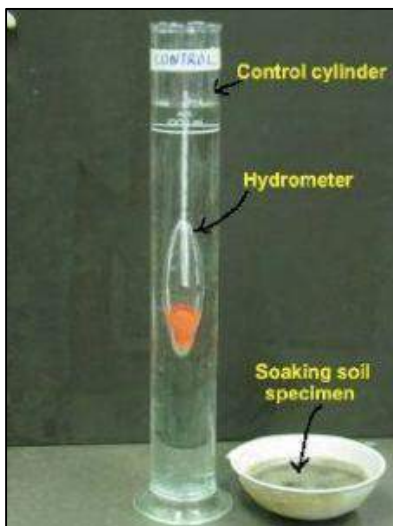The lower the density of the liquid the more the hydrometer will sink.

.

Figure 16 Hydrometer

Need and Scope

In case of fine grained soil, sieve analysis test does not give reliable test result. As fine grained soil consists of different sizes of particles starting from 0.075 mm to 0.002 mm. and it is not practicable to design sieve having so smaller screen size. Also there is a chance of loss of sample during sieving. Therefore, hydrometer analysis is done for grain size analysis of fine grained soils.

Theory

Hydrometer analysis is based on Stokes law. According to this law, the velocity at which grains settles out of suspension, all other factors being equal, is dependent upon the shape, weight and size of the grain. In case of soil, it is assumed that the soil particles are spherical and have the same specific gravity. Therefore, it is perceived that in a soil water suspension the coarser particles will settle more quickly than the finer ones.

If V is the terminal velocity of sinking of a spherical particle, it is given by;

$$V = 1/18 \; [(Gs\text{-}Gw)/n)]*D^2$$

Where,

V = Terminal velocity of soil particle (cm/s)

D = Diameter of soil particle (cm)

Gs = Specific gravity of soil particle

Gw = specific gravity of water

n = viscosity of water (g-s/cm^2)

Apparatus

- Hydrometer
- Dispersion cup with mechanical stirrer with complete accessories
- Two glass jar of 1 litre capacity
- Deflocculating agent (dissolve 33g of sodium hexa metaphosphate and 7g of sodium carbonate in distilled water to make one litre sodium hexa metaphosphate solution)
- Stop watch
- Thermometer
- Scale

5.2 Results

5.2.1 The Surma River

The locations of the sediment collection stations of the Surma River are given in Table 2 and Figure 8. Details of bed material sample collection plan are given below in Table 12.

Table 12 Data collection plan on the Surma river

No. of Data Sets	No. of Stations	Station ID	No. of Samples	Timeline
2	9 sections (15 km apart)	S01, S02, S03, S04, S05, S06, S07, S08, S09	4 samples per section Total measurements = 72	**1st set:** Jan 14, 2017 – Jan 24, 2017 (Dry) **2nd set:** April 10- April 18, 2017 (Pre Monsoon)

Bed Material Samples of the Surma have been collected from 9 stations. A number of 2 sets of measurements have been taken. The bed material samples have been analyzed in the Prosoil

Laboratory to determine the Median Grain Size (D_{50}) values. Particle size distribution has been presented in details in Section 5.2.3.

For the Surma River, generally the bed materials along the river course tend to be fine sand, but at the upstream and the downstream, the bed materials tend to be finer. D50 Value of the Surma River for both Dry and Pre Monsoon Seasons are given in Table 13 and Table 14. The Median Grain Size along the river course shows a scattered pattern (Figure 17 & Figure 18).

Table 13 Particle Size distribution of the Surma River (January 2017, Dry Season)

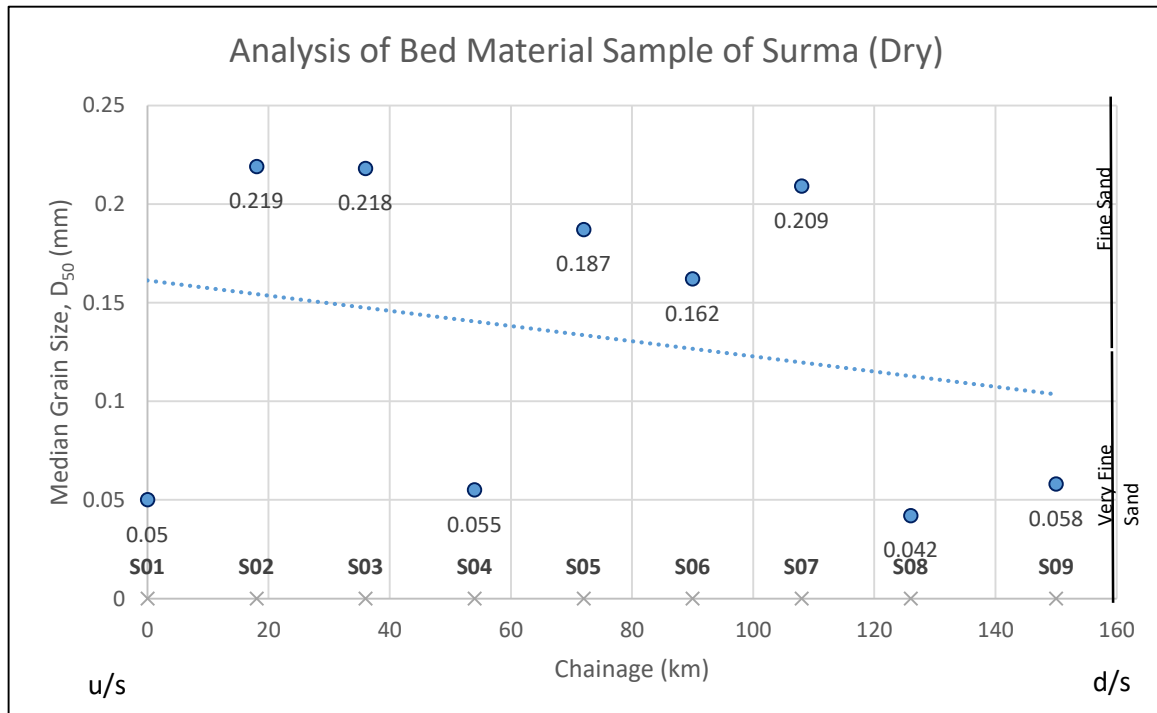| Station ID	D50 value (mm)
S-01	0.05
S-02	0.219
S-03	0.218
S-04	0.055
S-05	0.187
S-06	0.162
S-07	0.209
S-08	0.042
S-09	0.058

Figure 17 Analysis of Bed Material Samples of the Surma River (January 2017, Dry Season)

Table 14 Particle Size distribution of the Surma River (April 2017, Pre Monsoon Season)

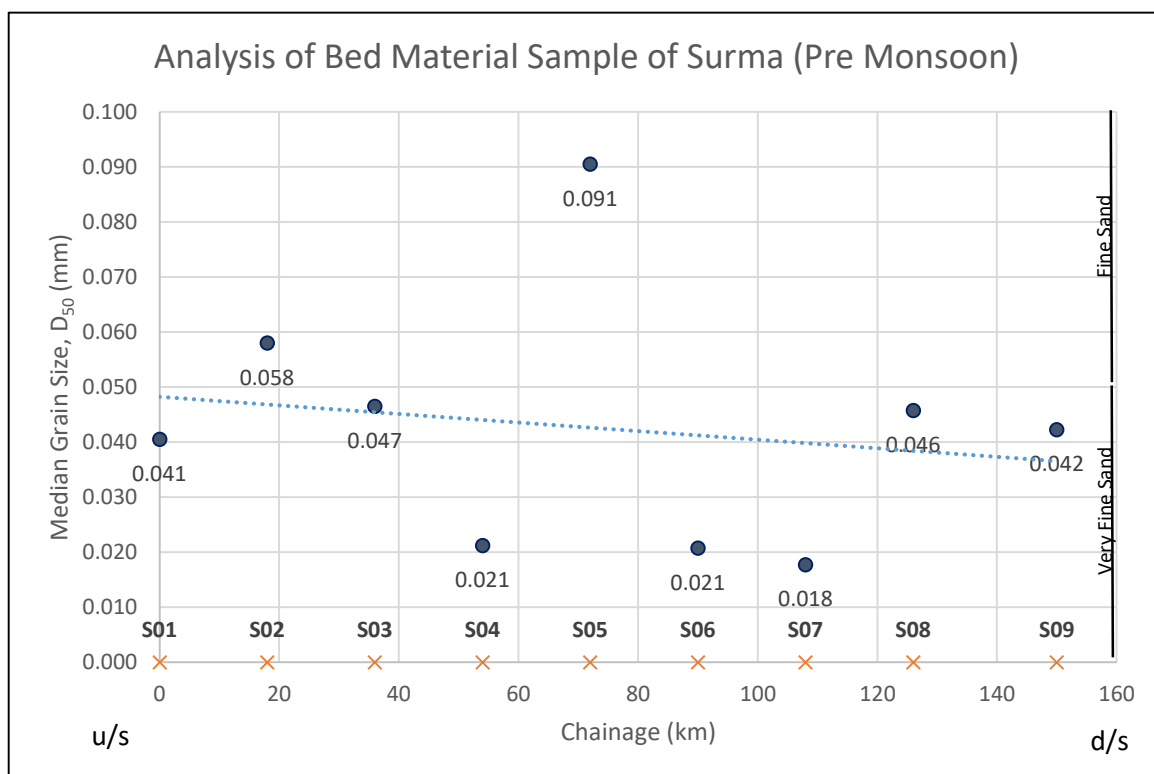| Station ID	D50 value (mm)
S-01	0.041
S-02	0.058
S-03	0.047
S-04	0.021
S-05	0.091
S-06	0.021
S-07	0.018
S-08	0.046
S-09	0.042

Figure 18 Analysis of Bed Material Samples of the Surma River (April 2017, Pre Monsson Season)

5.2.2 The Kushiyara River

The locations of the sediment collection stations of the Kushiyara River are given in Table 7 and Figure 12. Details of bed material collection plan are given below in Table 15.

Table 15 Data collection plan of Kushiyara River

No. of Data Sets	No. of Sections	Station ID	No. of Samples	Timeline
2	9 sections (15 km apart)	K01, K02, K03, K04, K05, K06, K07, K08, K09	4 samples per section, Total measurements = 72	**1st set:** Jan 14, 2017 – Jan 24, 2017 (Dry) **2nd set:** April 10- April 18, 2017 (Pre Monsoon)

Bed Material Samples of the Kushiyara have been collected from 9 stations. A number of 2 sets of measurements have been taken. The bed material samples have been analyzed in the Prosoil Laboratory to determine the Median Grain Size (D50) value. The value was determined by analyzing the sample with Sieve and Hydrometer. Particle size distribution has been discussed in Section 5.2.3.

Representative sizes (D50) of the bed materials along the river course for both Dry and Pre Monsoon seasons are given in Table 16 and Table 17 and presented in Figure 19 & Figure 20. Overall, the Median Grain Size along the river course shows a scattered pattern.

Table 16 Particle Size distribution of the Kushiyara River (January 2017, Dry Season)

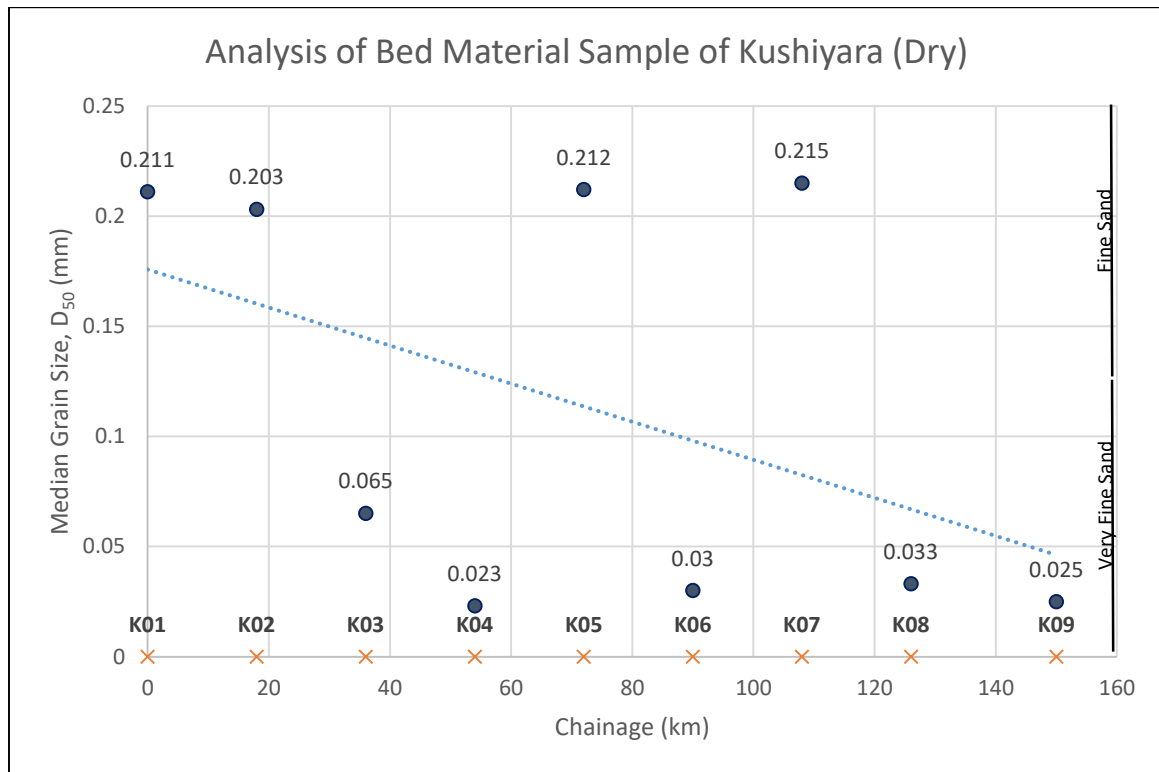| Station ID	D50 value (mm)
K-01	0.211
K-02	0.203
K-03	0.065
K-04	0.023
K-05	0.212
K-06	0.03
K-07	0.215
K-08	0.033
K-09	0.025

Figure 19 Analysis of Bed Material Samples of the Kushiyara River (January 2017, Dry Season)

Table 17 Particle Size distribution of the Kushiyara River (April 2017, Pre Monsoon Season)

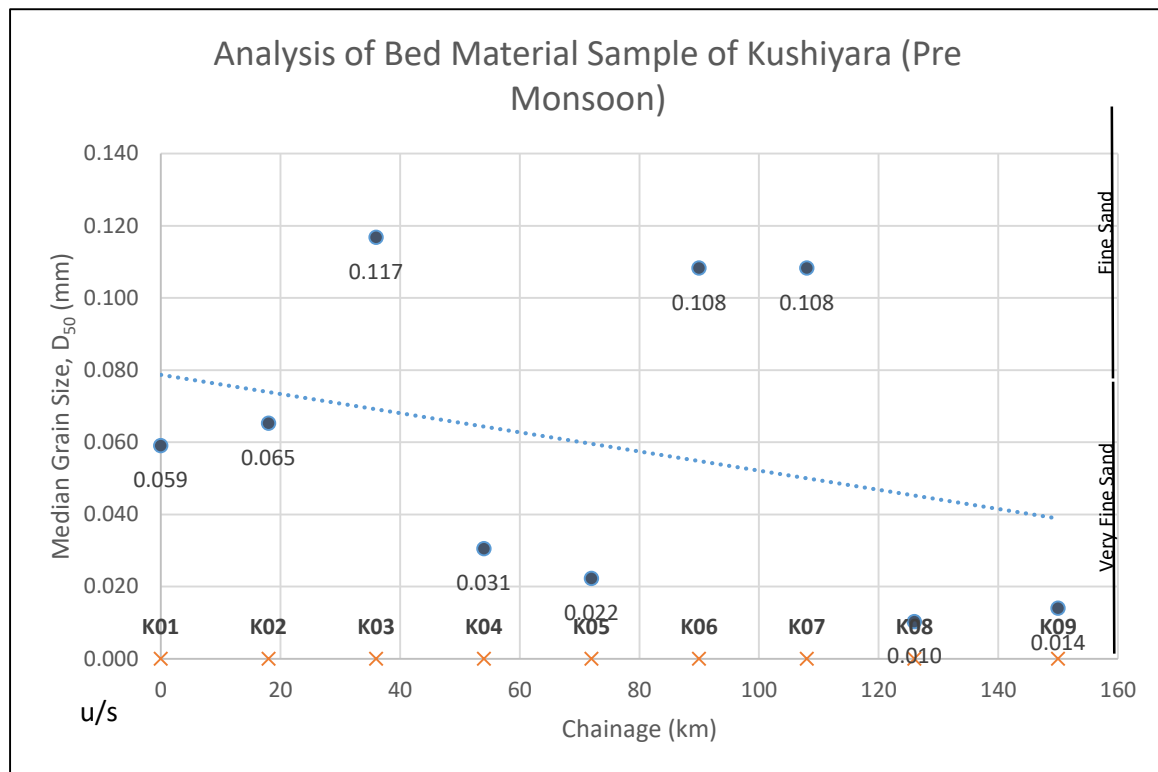| Station ID	D50 value (mm)
K-01	0.059
K-02	0.065
K-03	0.117
K-04	0.031
K-05	0.022
K-06	0.108
K-07	0.108
K-08	0.010
K-09	0.014

Figure 20 Analysis of Bed Material Samples of the Kushiyara River (April 2017, Pre Monsoon Season)

5.2.3   Particle Size Distribution

Results of the particle size distribution for the Dry season (January 2017) and the Pre Monsoon season (April 2017) have been presented in the Section 5.2.3.1 and 5.2.3.2. respectively.

Particle size distribution for both the Surma and the Kushiyara river have been presented. Summary tables for D50 grain size for each of the rivers have also been given in the Table 18 and Table 19.

Table 18 Summary of Analysis of Particle Size, Dry Season (Jan, 2017)

Station	Section	D50 Value (mm)	Average D50 Value (mm)
The Surma River			
S-01	01	.009	.05
	02	.05	
	03	.051	
	04	-	
S-02	01	.017	.219
	02	.216	
	03	.215	
	04	.219	
S-03	01	.03	.218
	02	.022	
	03	.218	
	04	.097	
S-04	01	.058	.055
	02	.055	
	03	.039	
	04	.065	
S-05	01	.067	.187
	02	.152	
	03	.187	
	04	.024	
S-06	01	.162	.162
	02	.145	
	03	.035	
	04	.052	
S-07	01	.035	.209
	02	.066	
	03	.209	
	04	.046	
S-08	01	-	.042
	02	.016	
	03	.026	
	04	.042	
S-09	01	.023	.058
	02	.058	
	03	.041	
	04	.055	

Station	Section	D50 Value (mm)	Average D50 Value (mm)
The Kushiyara River			
K-01	01	.038	.211
	02	.041	
	03	.211	
	04	.211	
K-02	01	.018	.203
	02	.059	
	03	.053	
	04	.203	
K-03	01	.011	.065
	02	.065	
	03	.063	
	04	.071	
K-04	01	.032	.023
	02	.023	
	03	.025	
	04	.02	
K-05	01	.044	.212
	02	.212	
	03	.213	
	04	.026	
K-06	01	.031	.03
	02	.032	
	03	.034	
	04	.030	
K-07	01	.031	.215
	02	.034	
	03	.215	
	04	.044	
K-08	01	.033	.033
	02	.063	
	03	.053	
	04	.026	
K-09	01	.009	.025
	02	.041	
	03	.025	
	04	.033	

Table 19 Summary of Analysis of Particle Size, Pre Monsoon Season (April, 2017)

Station	Section	D50 Value (mm)	Average D50 Value (mm)
The Surma River			
S-01	01	.032	.041
	02	.064	
	03	-	
	04	.066	
S-02	01	.073	.058
	02	.023	
	03	.063	
	04	.073	
S-03	01	.040	.047
	02	.069	
	03	.067	
	04	.010	
S-04	01	.052	.021
	02	.009	
	03	.020	
	04	.004	
S-05	01	.033	.091
	02	.108	
	03	.196	
	04	.025	
S-06	01	.025	.021
	02	.007	
	03	.014	
	04	.037	
S-07	01	.023	.018
	02	.021	
	03	.005	
	04	.022	
S-08	01	.051	.046
	02	.070	
	03	.016	
	04	.046	
S-09	01	.038	.042
	02	.063	
	03	.047	
	04	.021	

Station	Section	D50 Value (mm)	Average D50 Value (mm)
The Kushiyara River			
K-01	01	.005	.059
	02	.005	
	03	.047	
	04	.179	
K-02	01	.003	.065
	02	.162	
	03	.187	
	04	.009	
K-03	01	.025	.117
	02	.214	
	03	.22	
	04	.004	
K-04	01	.023	.031
	02	.017	
	03	.009	
	04	.009	
K-05	01	.017	.022
	02	.018	
	03	.031	
	04	.023	
K-06	01	.007	.108
	02	.202	
	03	.220	
	04	.004	
K-07	01	.202	.108
	02	.220	
	03	.007	
	04	.004	
K-08	01	.020	.010
	02	.011	
	03	.006	
	04	.004	
K-09	01	.004	.014
	02	.044	
	03	.003	
	04	.005	

5.2.3.1   Particle Size, Dry Season (January 2017)

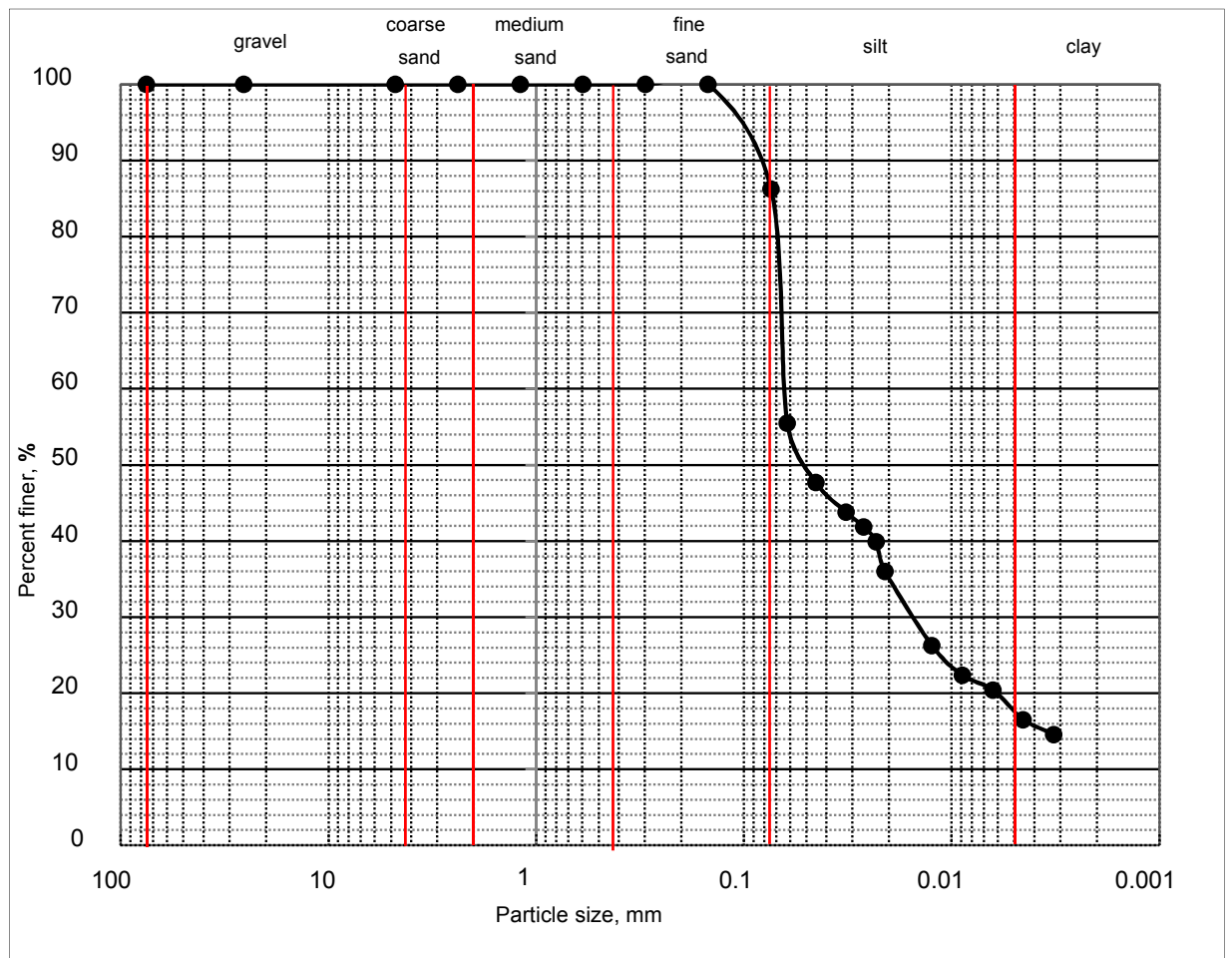January 2017, Dry Season
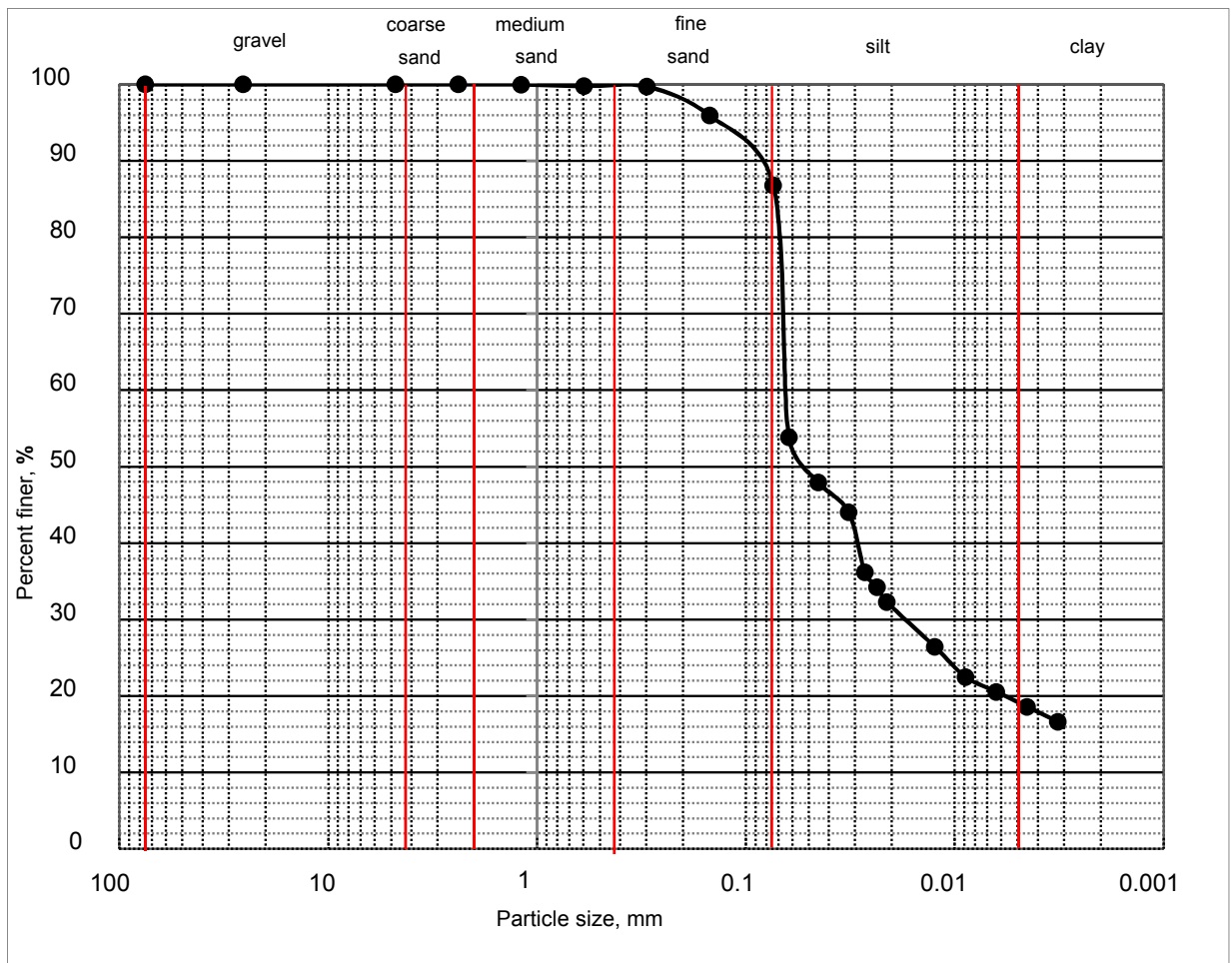
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PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S01
Location:	Surma (LB)	Sample No:	01
Sample Type:	Disturbed		

Test Results

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.002	0.004	0.009	0.013	0.070	0.90	99.10	0.57	6.12	-	-	

ASTM D-422
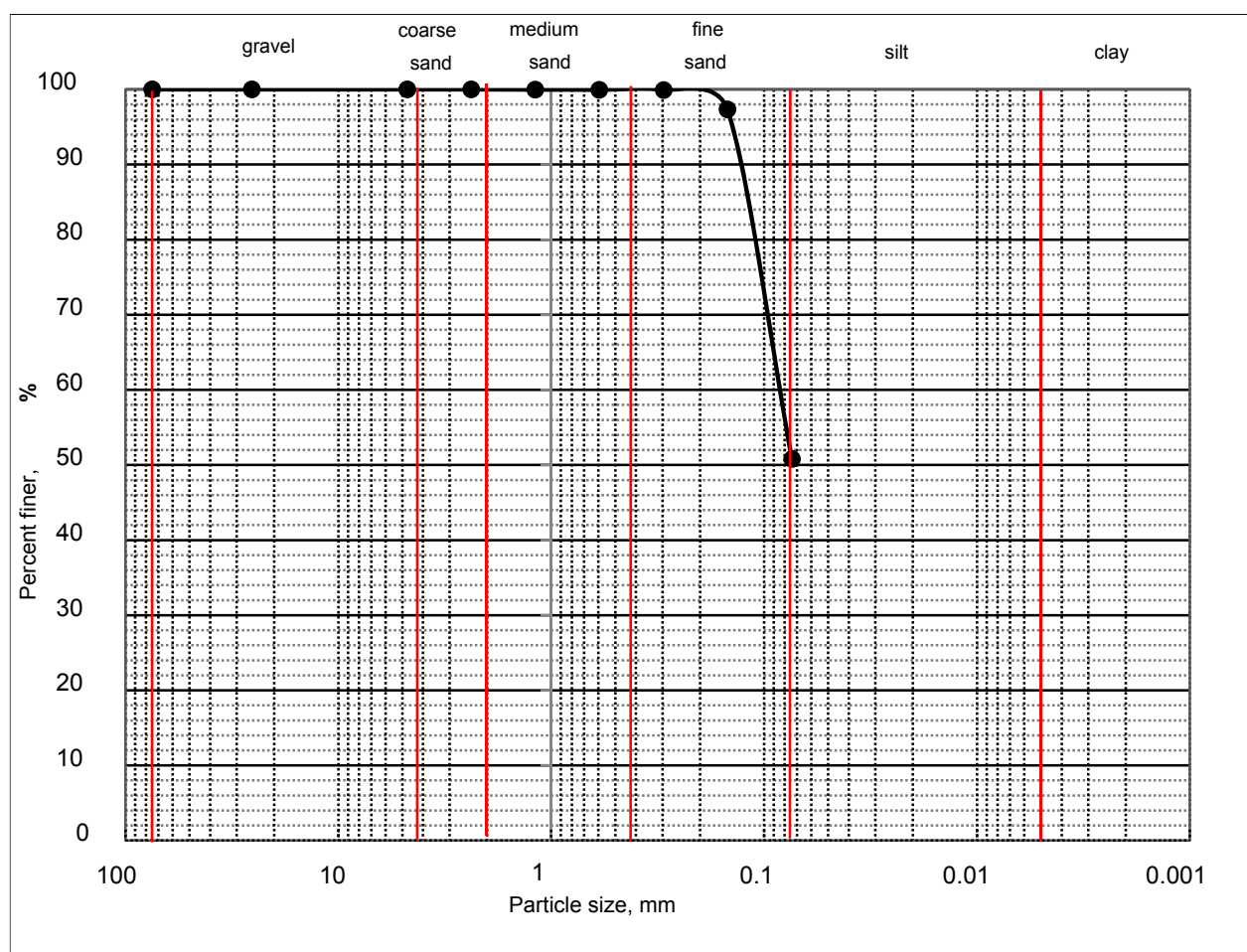
V-3:46

January 2017, Dry Season

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S01
Location:	Surma (LB)	Sample No:	02
Sample Type:	Disturbed		

Test Results

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.003	0.016	0.050	0.064	0.122	13.75	86.25	1.49	24.58	-	-	

ASTM D-422 V-3:47
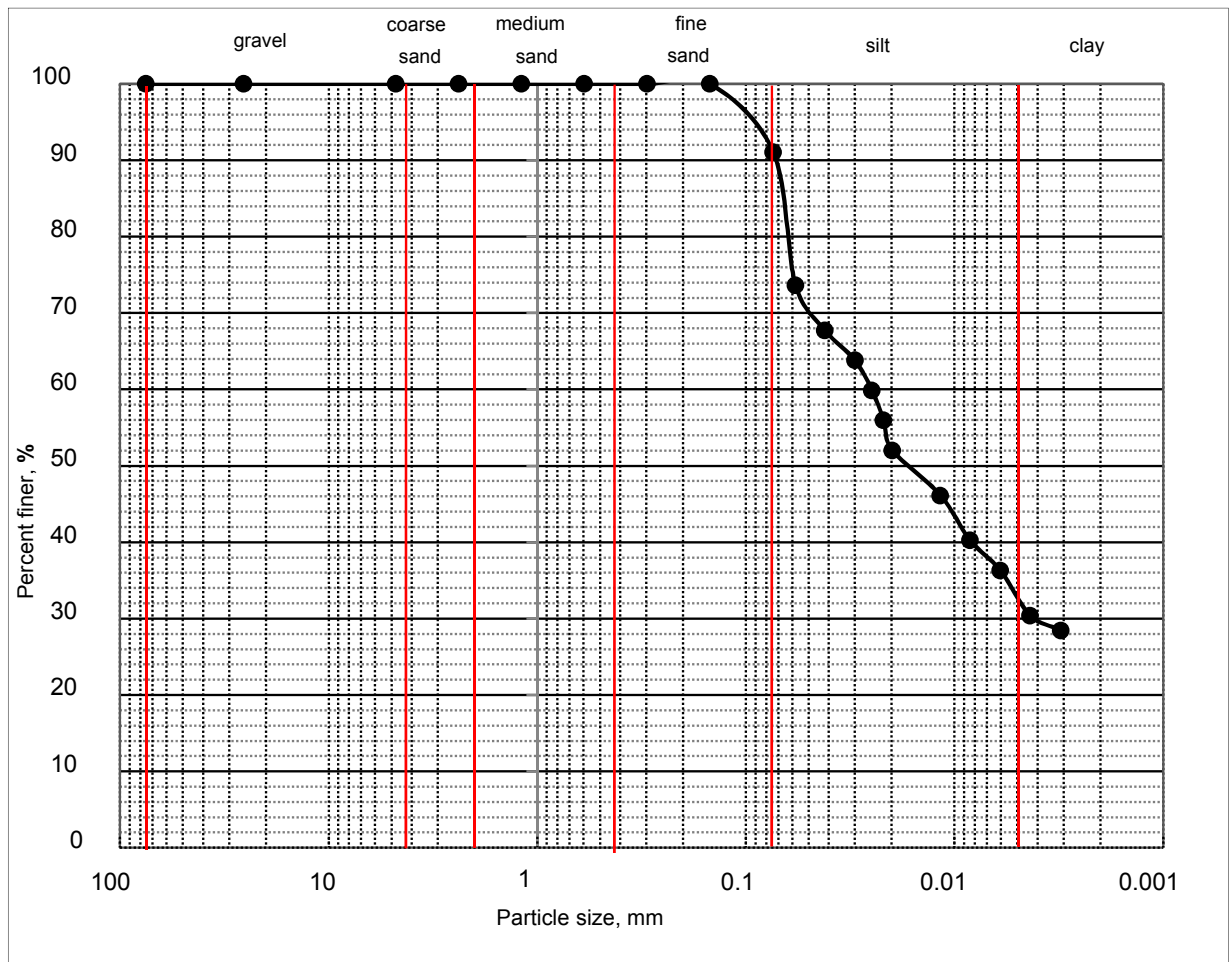
January 2017, Dry Season

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S01
Location:	Surma (RB)	Sample No:	03
Sample Type:	Disturbed		

Test Results

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.002	0.018	0.051	0.064	0.141	13.18	86.82	2.01	26.66	-	-	

ASTM D-422

January 2017, Dry Season
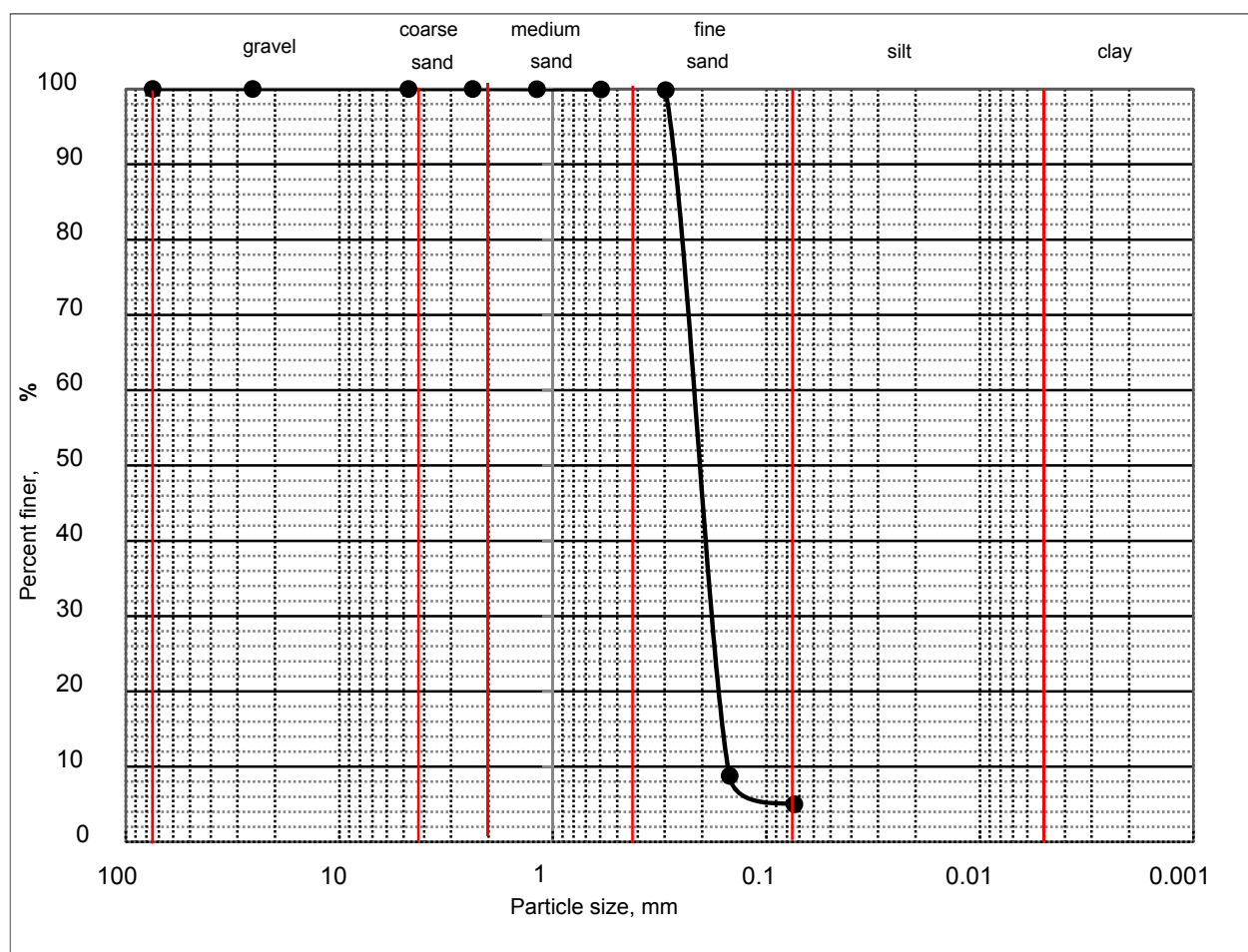
PROSOIL
FOUNDATION CONSULTANT

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S01
Location:	Surma (RB)	Sample No:	04
Sample Type:	Disturbed		

Test Results

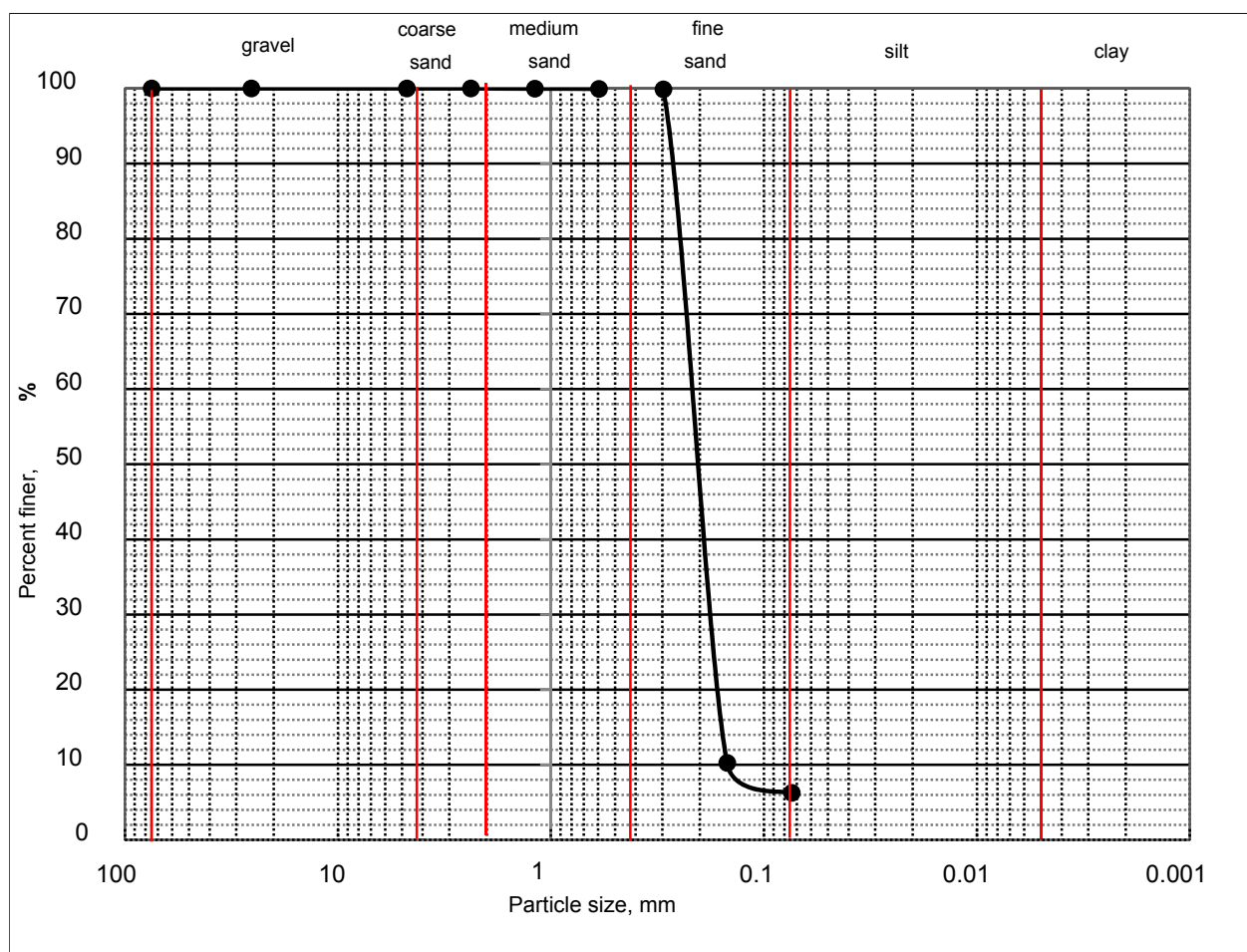| D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
-	-	-	0.089	0.145	49.21	50.79	-	-	-	-	

January 2017, Dry Season

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S02
Location:	Surma (LB)	Sample No:	01
Sample Type:	Disturbed		

Test Results

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.002	0.004	0.017	0.025	0.107	8.91	91.09	0.34	12.97	-	-	

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PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in		
	the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S02
Location:	Surma (LB)	Sample No:	02
Sample Type:	Disturbed		

Test Results

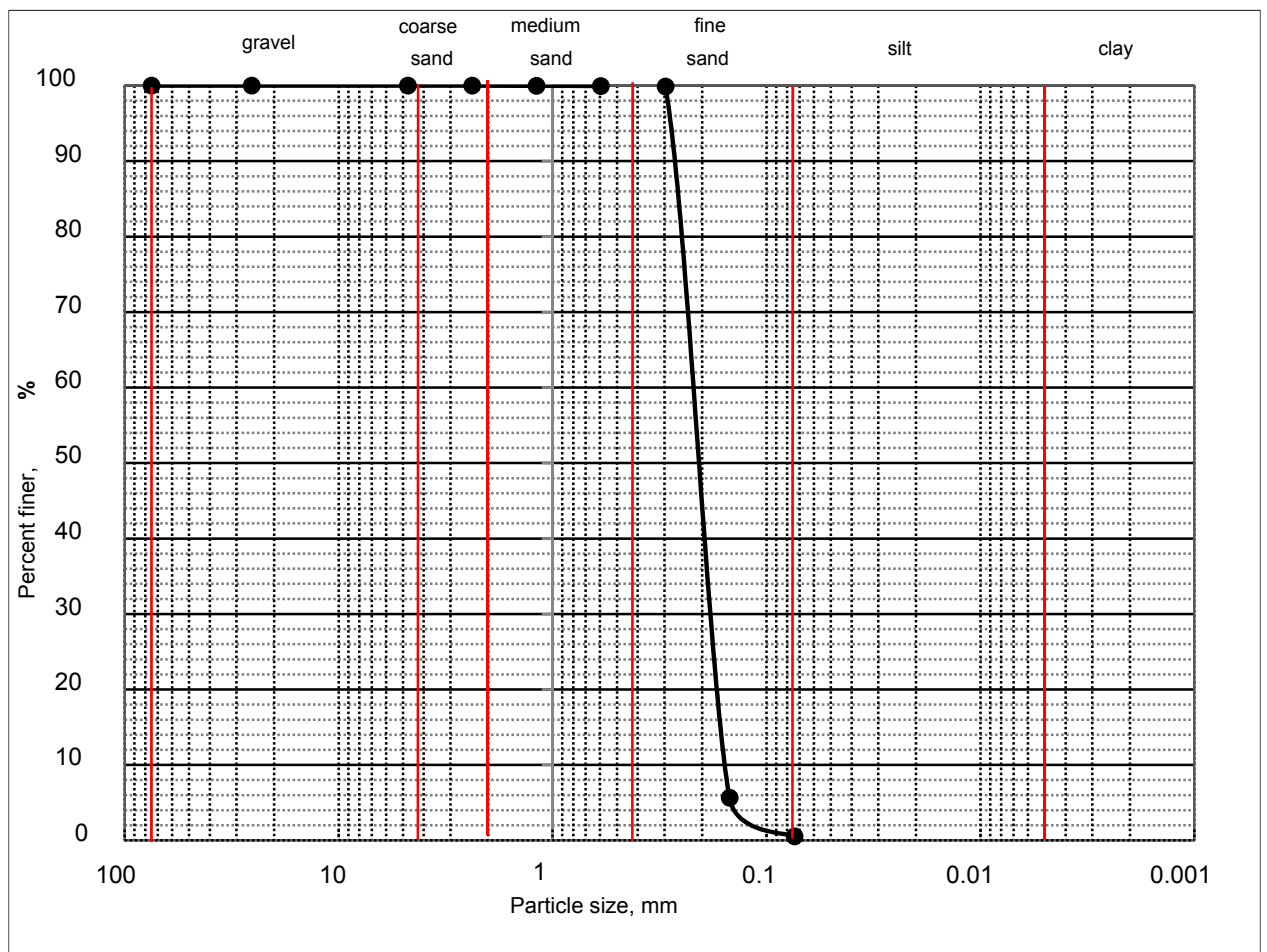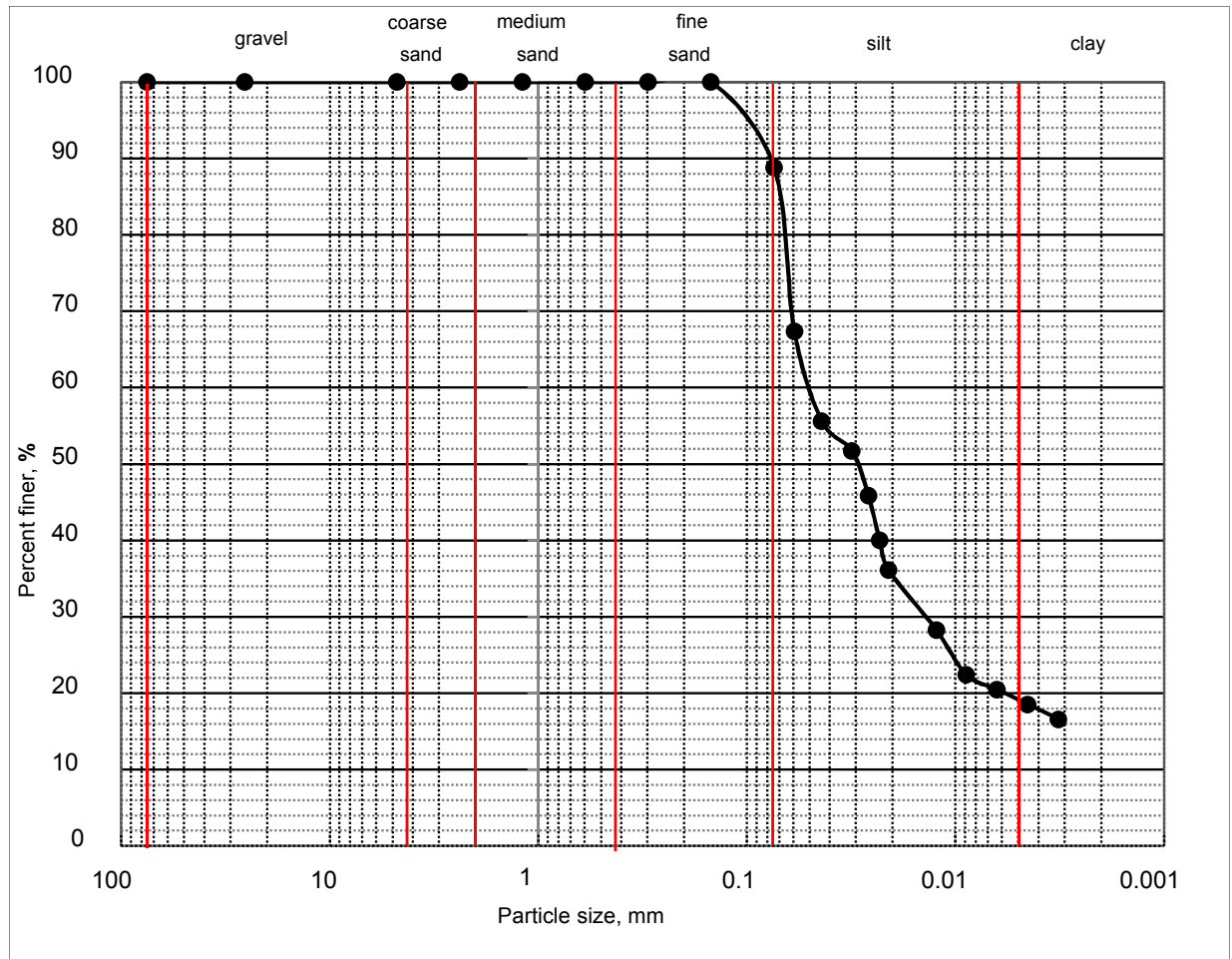| D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.151	0.183	0.216	0.232	0.289	94.97	5.03	0.96	1.54	-	-	

January 2017, Dry Season

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S02
Location:	Surma (LB)	Sample No:	03
Sample Type:	Disturbed		

Test Results

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.144	0.182	0.215	0.231	0.289	93.72	6.28	0.99	1.60	-	-	

ASTM D-422

January 2017, Dry Season

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.
Client:	Department of Bangladesh Haor and Wetlands Development Section: S02
Location:	Surma (RB) Sample No: 04
Sample Type:	Disturbed

Test Results

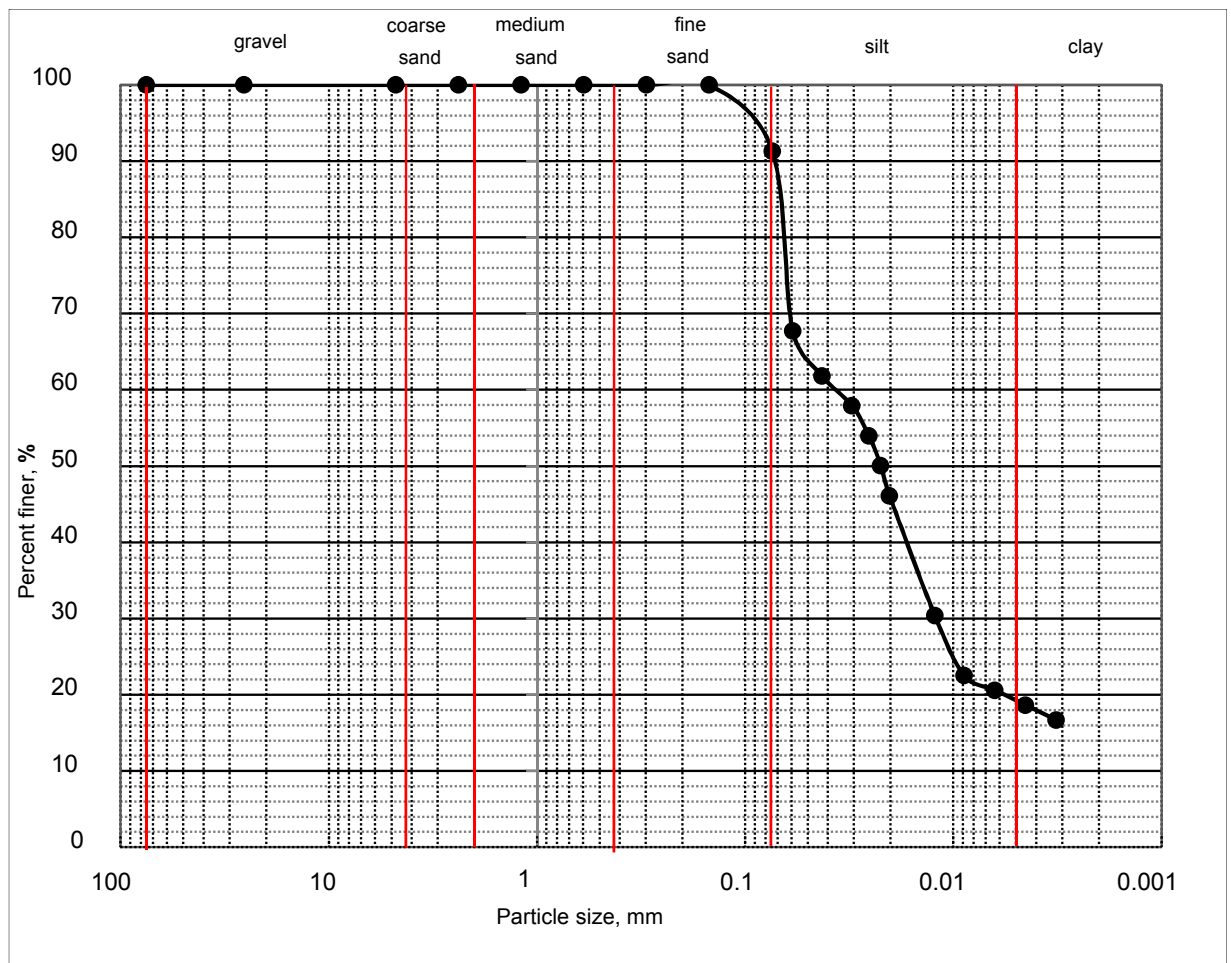| D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.156	0.187	0.219	0.234	0.289	99.44	0.56	0.96	1.50	-	-	

January 2017, Dry Season

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S03
Location:	Surma (LB)	Sample No:	01
Sample Type:	Disturbed		

Test Results

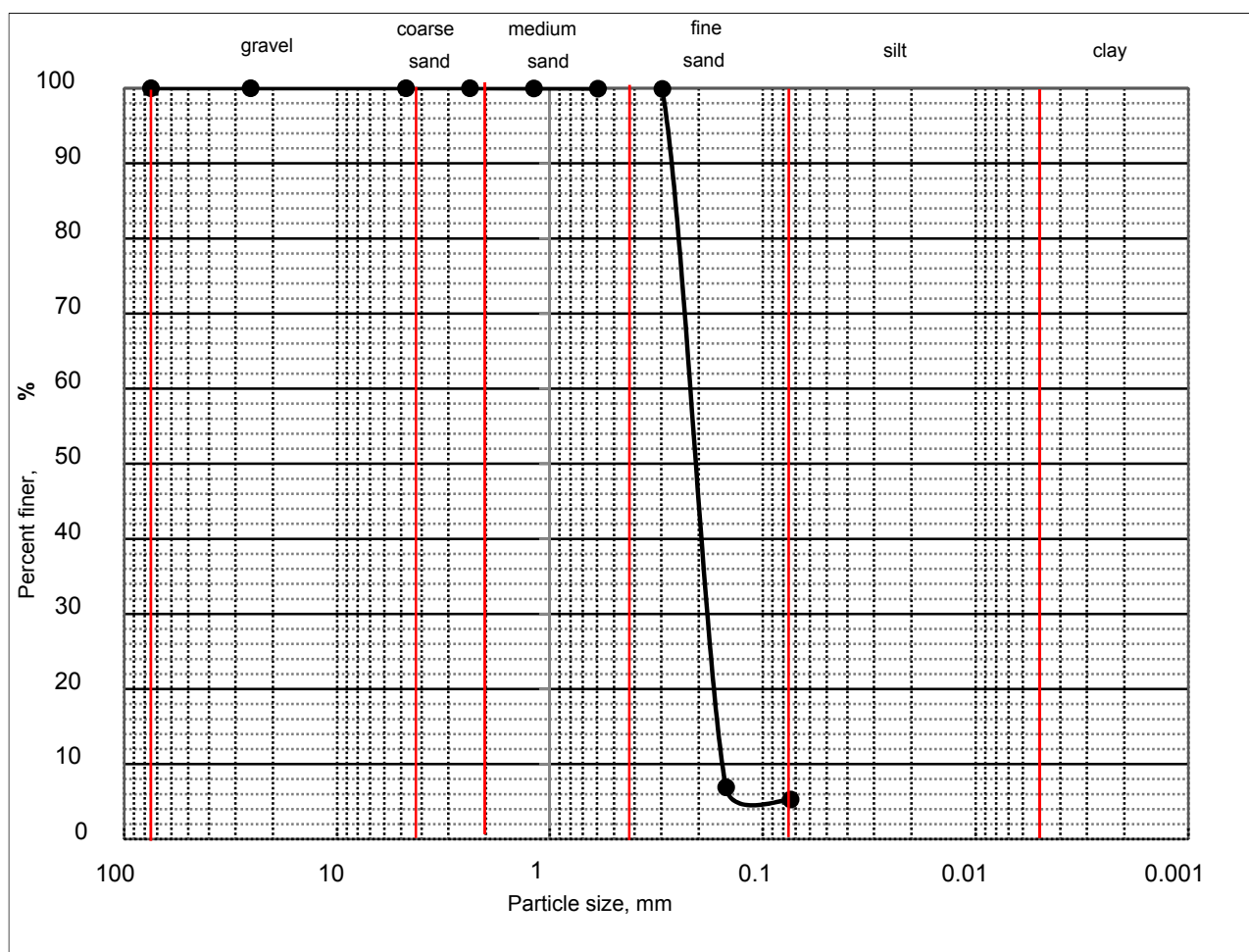| D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.002	0.014	0.030	0.049	0.115	11.16	88.84	1.68	20.43	-	-	

ProSoil Foundation Consultant

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S03
Location:	Surma (LB)	Sample No:	02
Sample Type:	Disturbed		

Test Results

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.002	0.012	0.022	0.037	0.106	8.68	91.32	1.63	15.34	-	-	

ASTM D-422   V-3:55
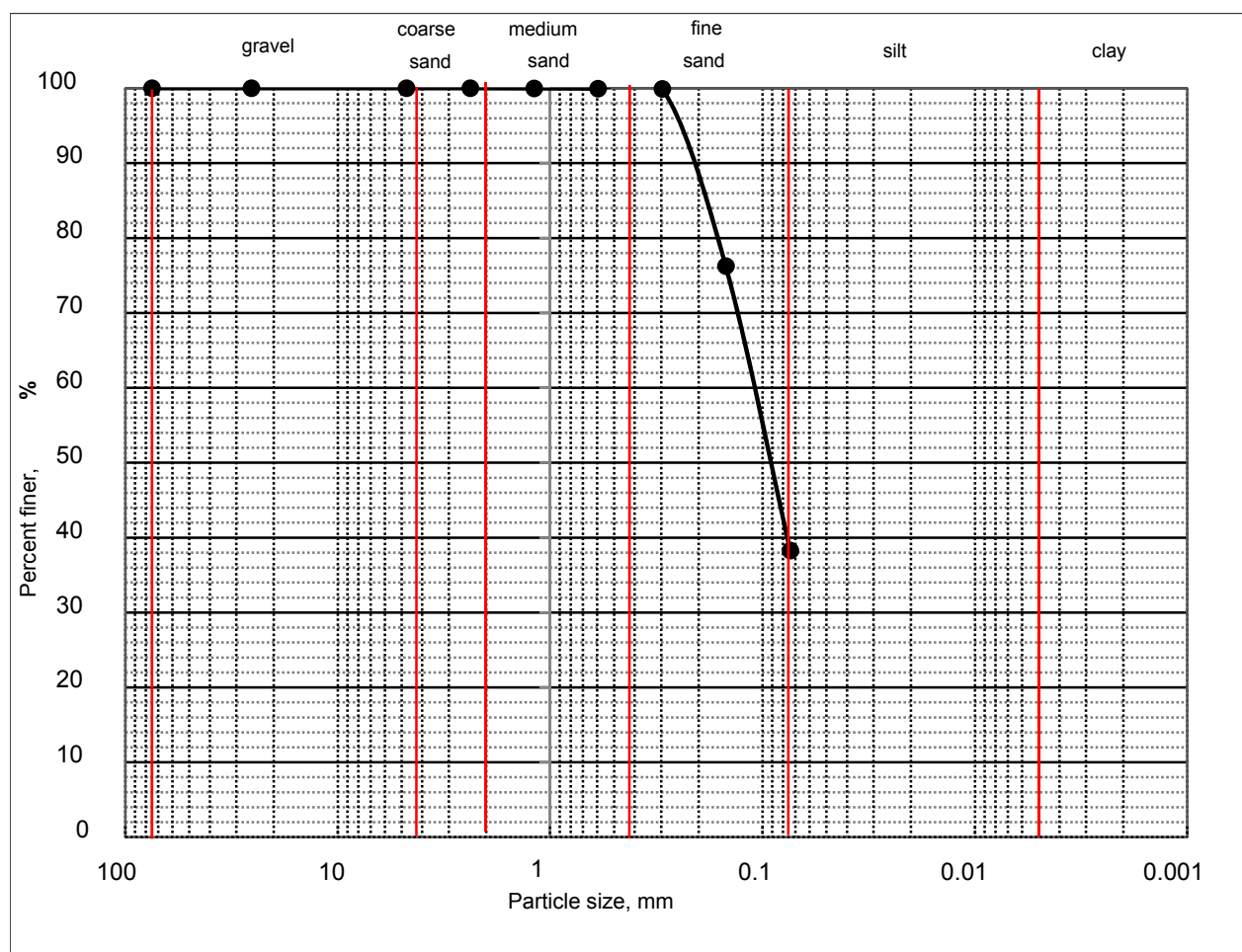
January 2017, Dry Season

PROSOIL
FOUNDATION CONSULTANT

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in		
	the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S03
Location:	Surma (LB)	Sample No:	03
Sample Type:	Disturbed		

Test Results

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.154	0.186	0.218	0.233	0.289	94.70	5.30	0.96	1.52	-	-	

January 2017, Dry Season
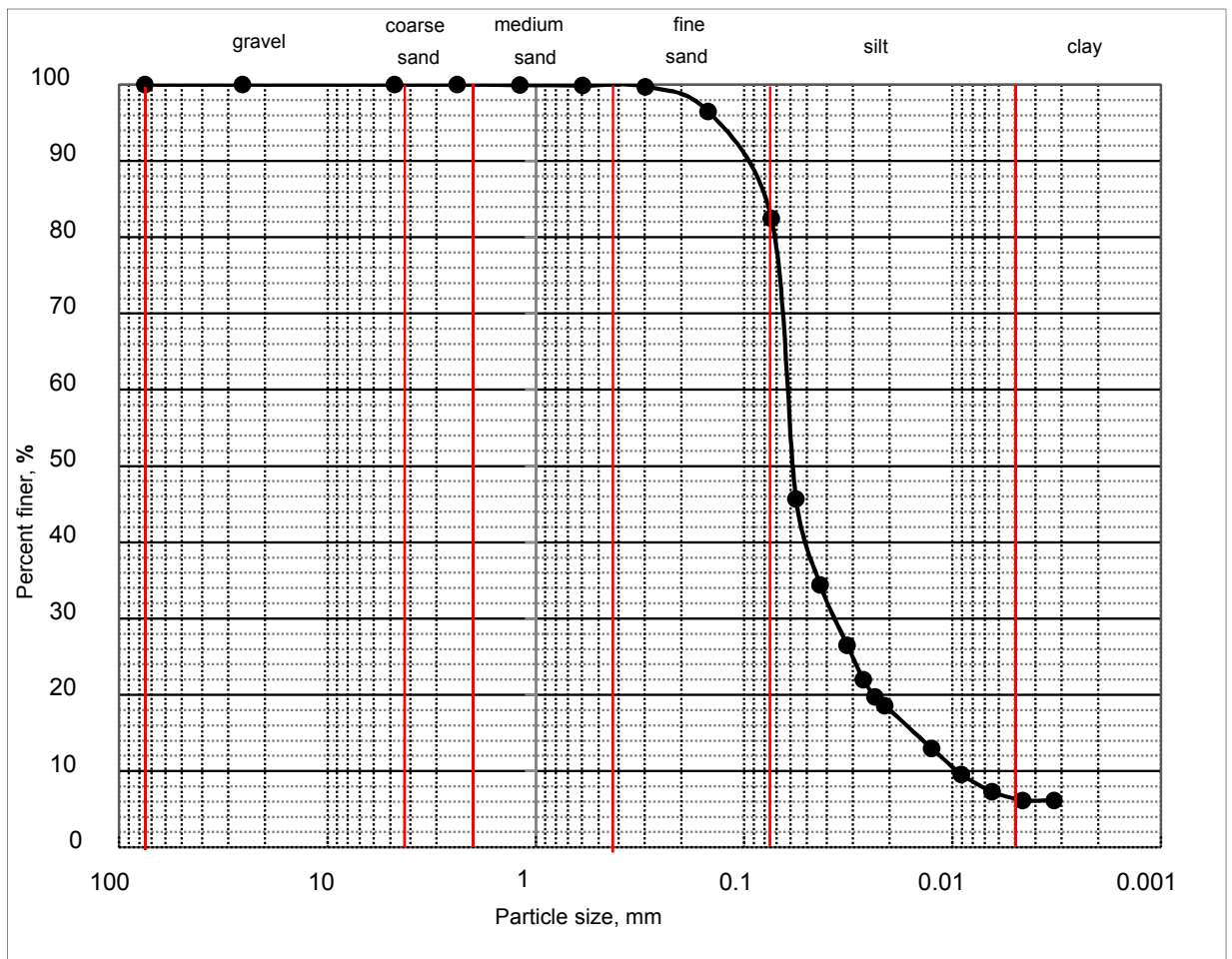
PROSOIL
FOUNDATION CONSULTANT

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S03
Location:	Surma (RB)	Sample No:	04
Sample Type:	Disturbed		

Test Results

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
-	-	0.097	0.117	0.266	61.74	38.26	-	-	-	-	

ASTM D-422

ProSoil Foundation Consultant
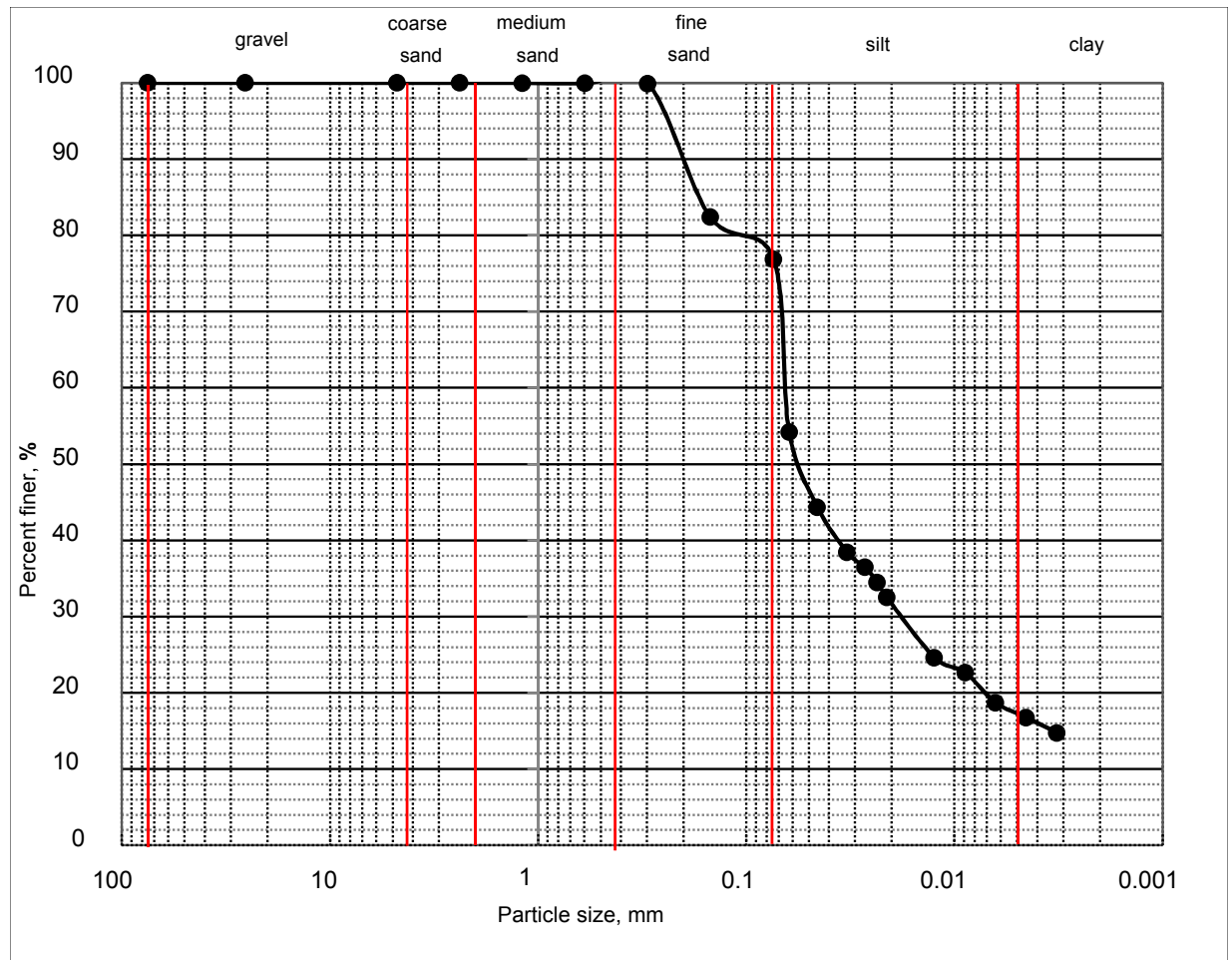
January 2017, Dry Season

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S04
Location:	Surma (LB)	Sample No:	01
Sample Type:	Disturbed		

Test Results

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.009	0.037	0.058	0.063	0.141	17.51	82.49	2.27	6.68	-	-	

January 2017, Dry Season
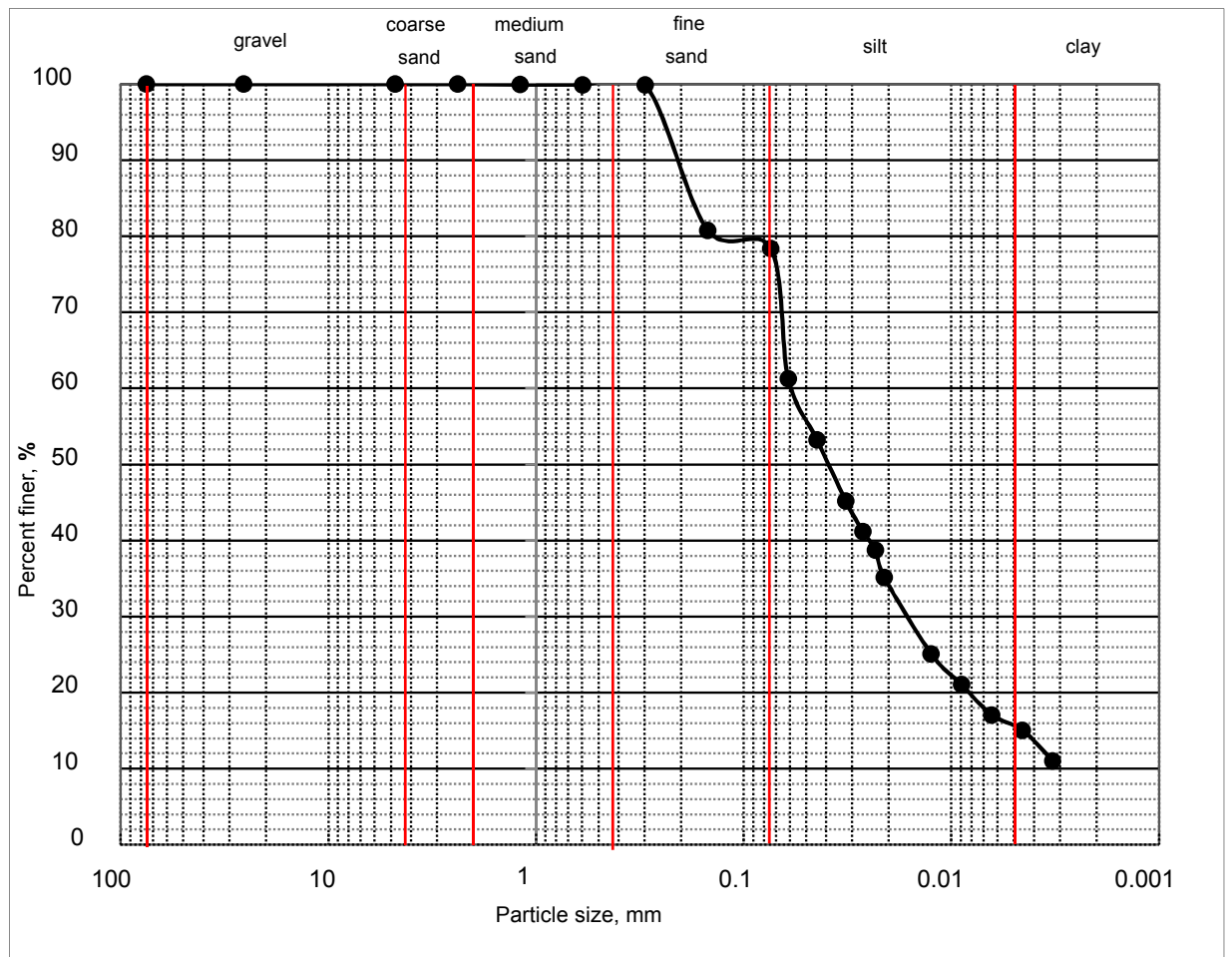
PROSOIL
FOUNDATION CONSULTANT

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S04
Location:	Surma (LB)	Sample No:	02
Sample Type:	Disturbed		

Test Results

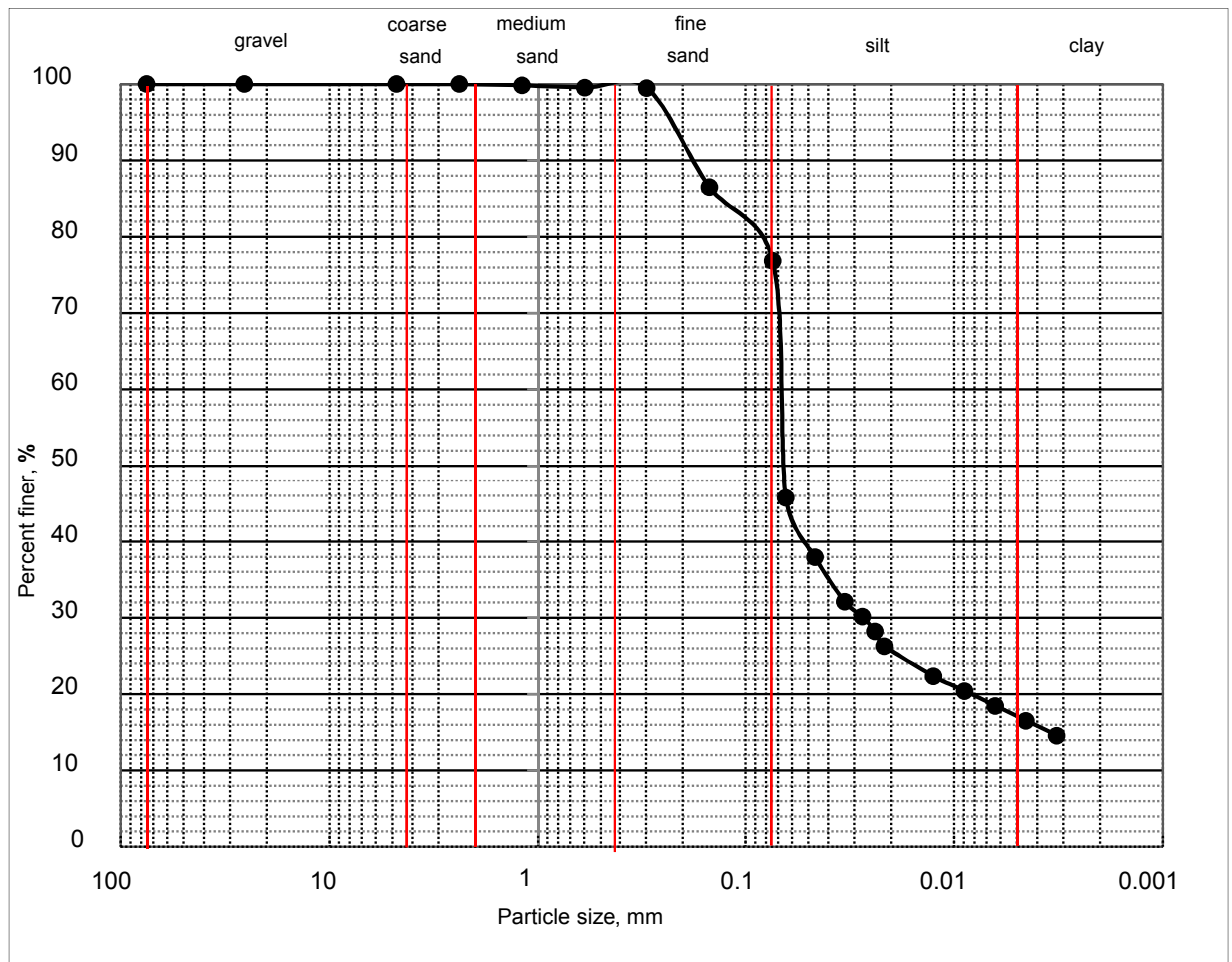| D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.003	0.018	0.055	0.065	0.255	23.10	76.90	2.01	25.38	-	-	

January 2017, Dry Season

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S04
Location:	Surma (LB)	Sample No:	03
Sample Type:	Disturbed		

Test Results

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.003	0.017	0.039	0.058	0.259	21.59	78.41	1.56	19.11	-	-	

ASTM D-422   V-3:60
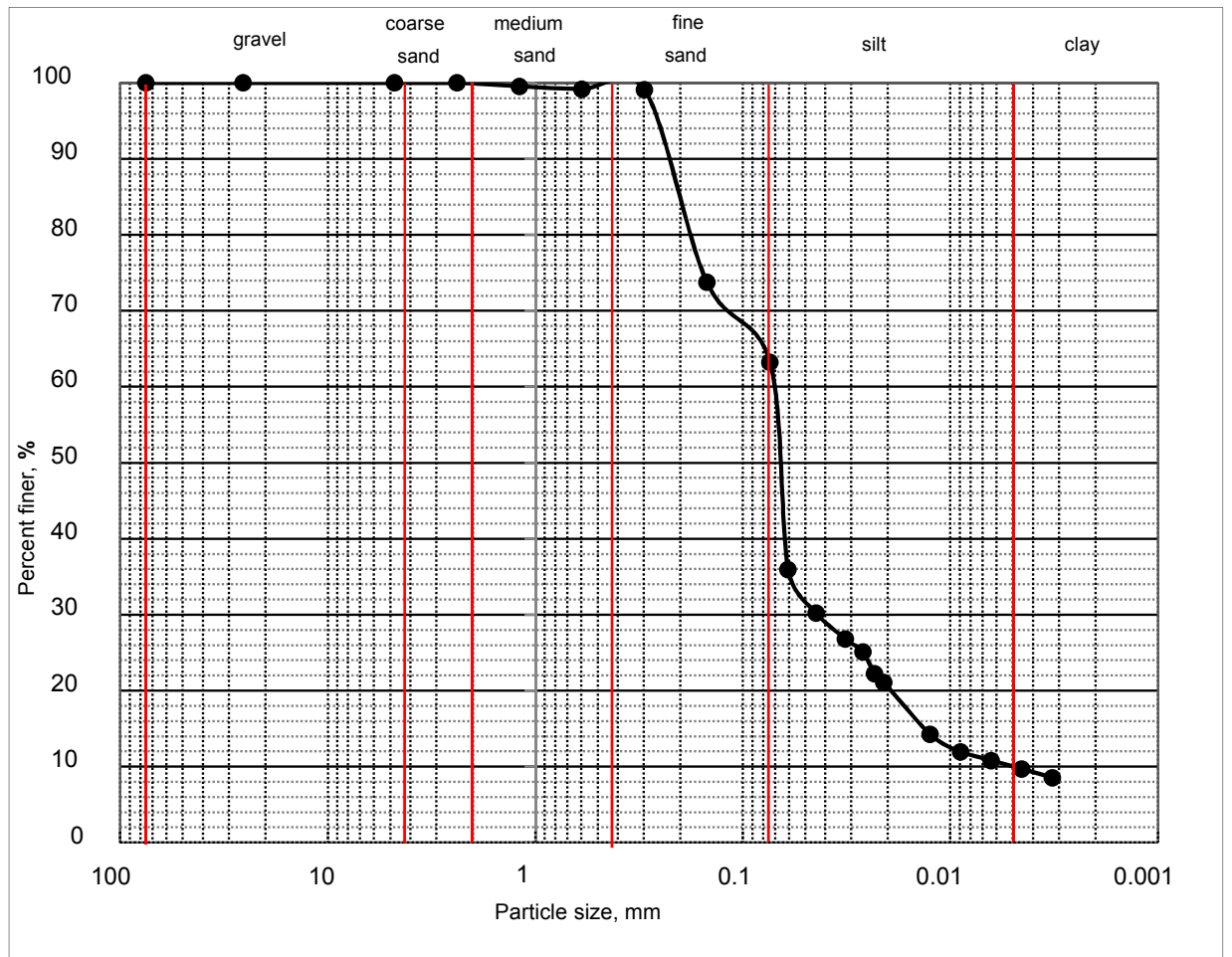
January 2017, Dry Season

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S04
Location:	Surma (RB)	Sample No:	04
Sample Type:	Disturbed		

Test Results

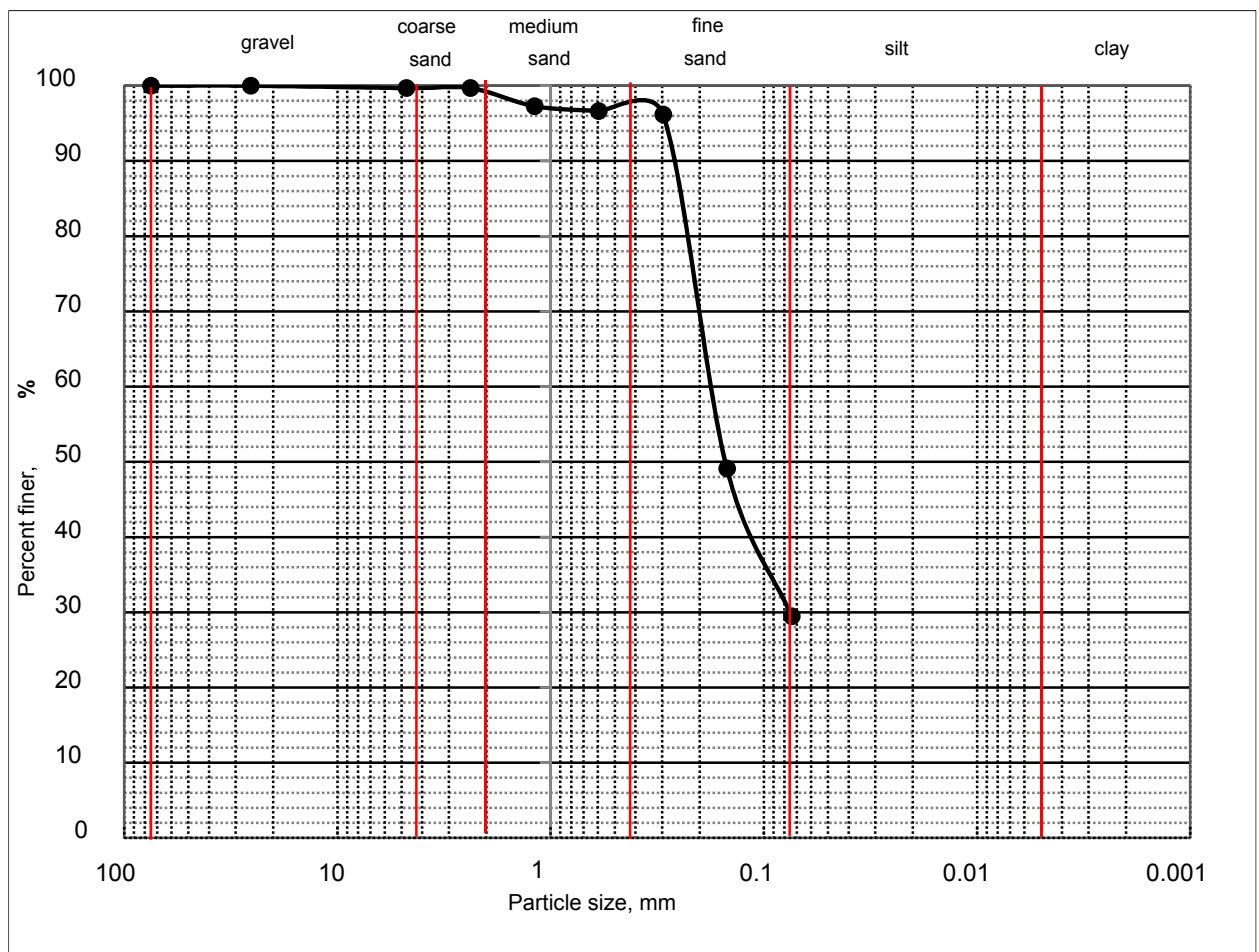| D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.003	0.027	0.065	0.069	0.246	23.15	76.85	4.15	26.49	-	-	

January 2017, Dry Season

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S05
Location:	Surma (LB)	Sample No:	01
Sample Type:	Disturbed		

Test Results

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.005	0.044	0.067	0.072	0.273	36.77	63.23	5.22	14.46	-	-	

ASTM D-422

January 2017, Dry Season
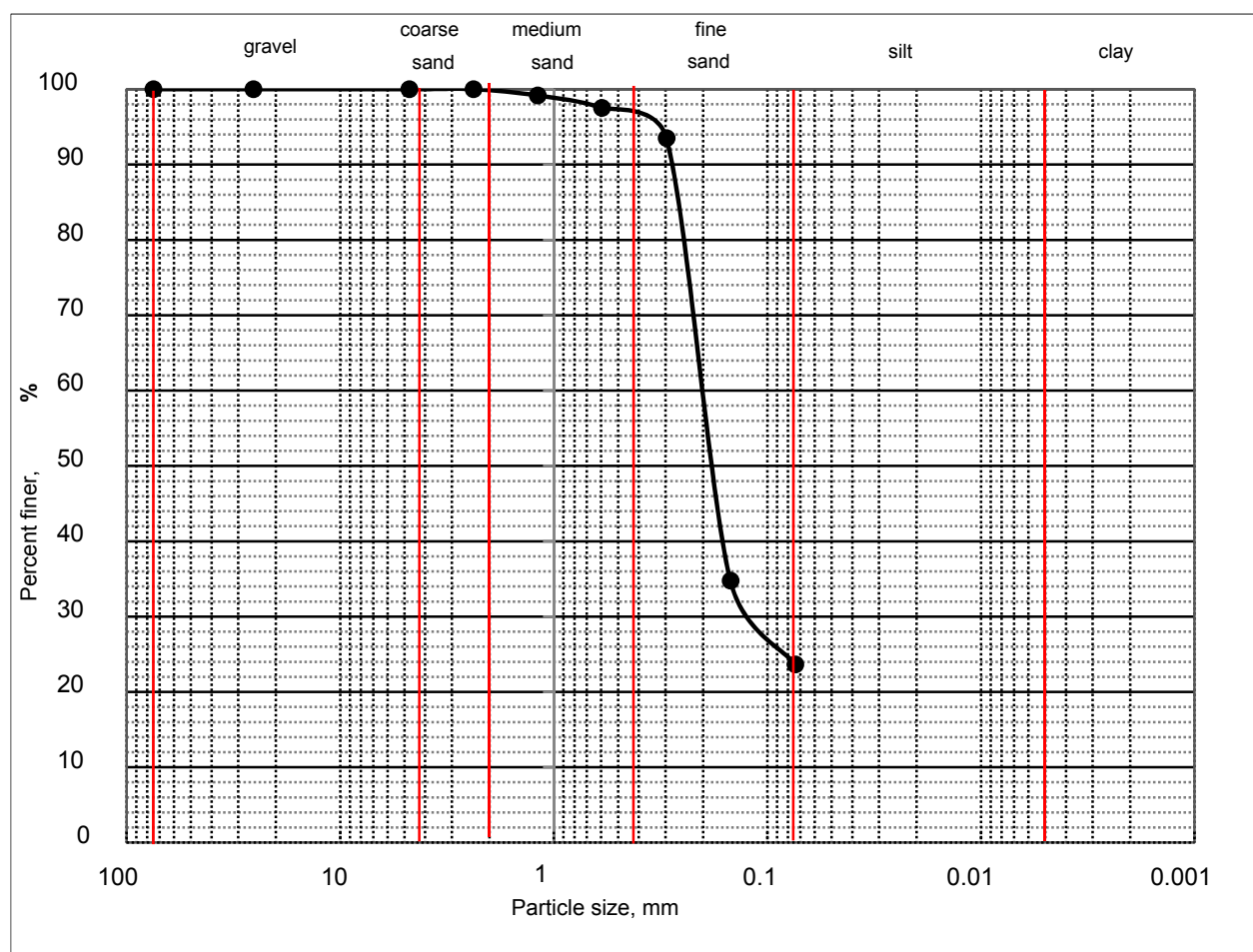
PROSOIL
FOUNDATION CONSULTANT

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S05
Location:	Surma (LB)	Sample No:	02
Sample Type:	Disturbed		

Test Results

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
-	0.076	0.152	0.183	0.293	70.23	29.46	-	-	-	-	

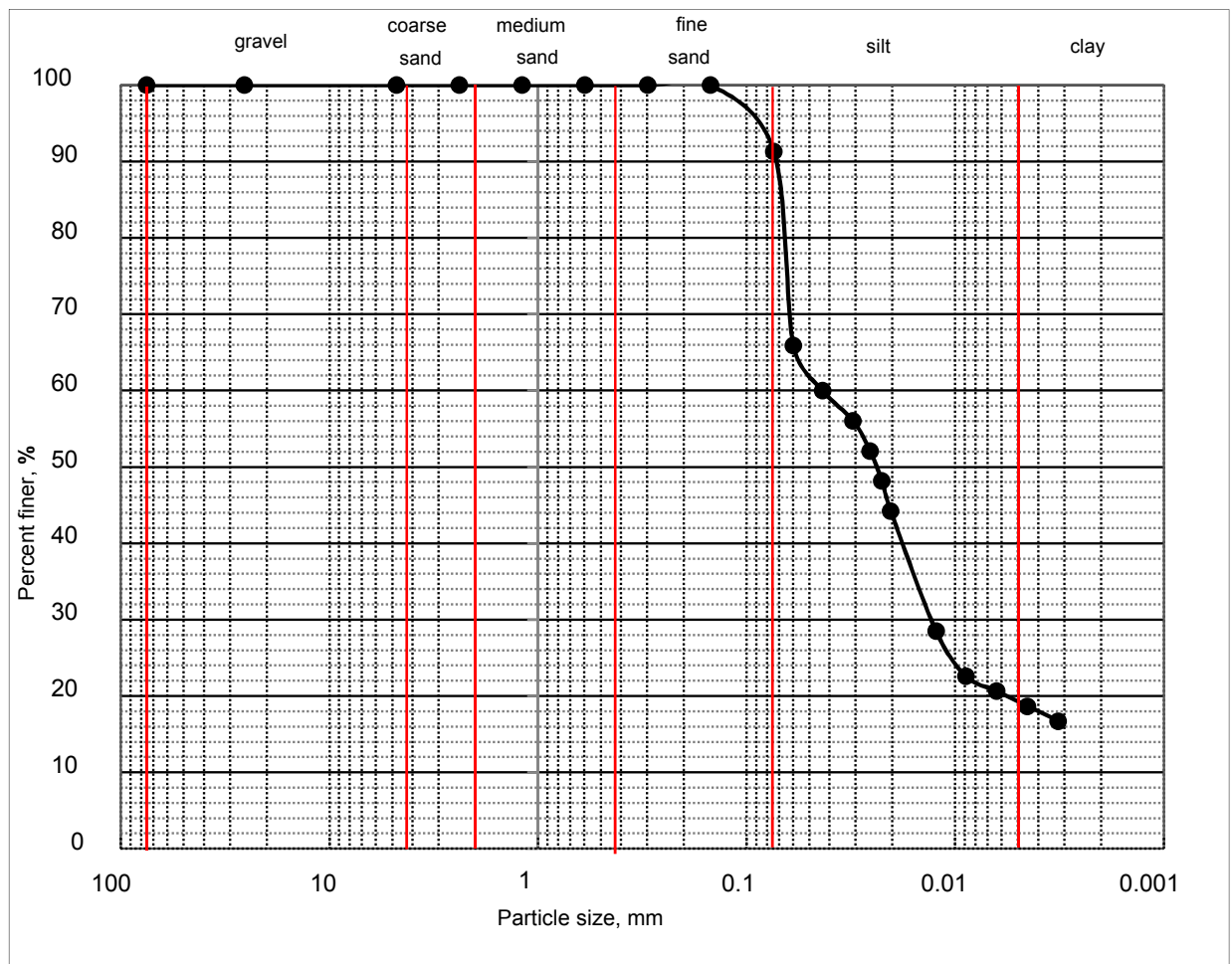ASTM D-422

January 2017, Dry Season

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S05
Location:	Surma (RB)	Sample No:	03
Sample Type:	Disturbed		

Test Results

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
-	0.117	0.187	0.213	0.407	76.34	23.66	-	-	-	-	

January 2017, Dry Season
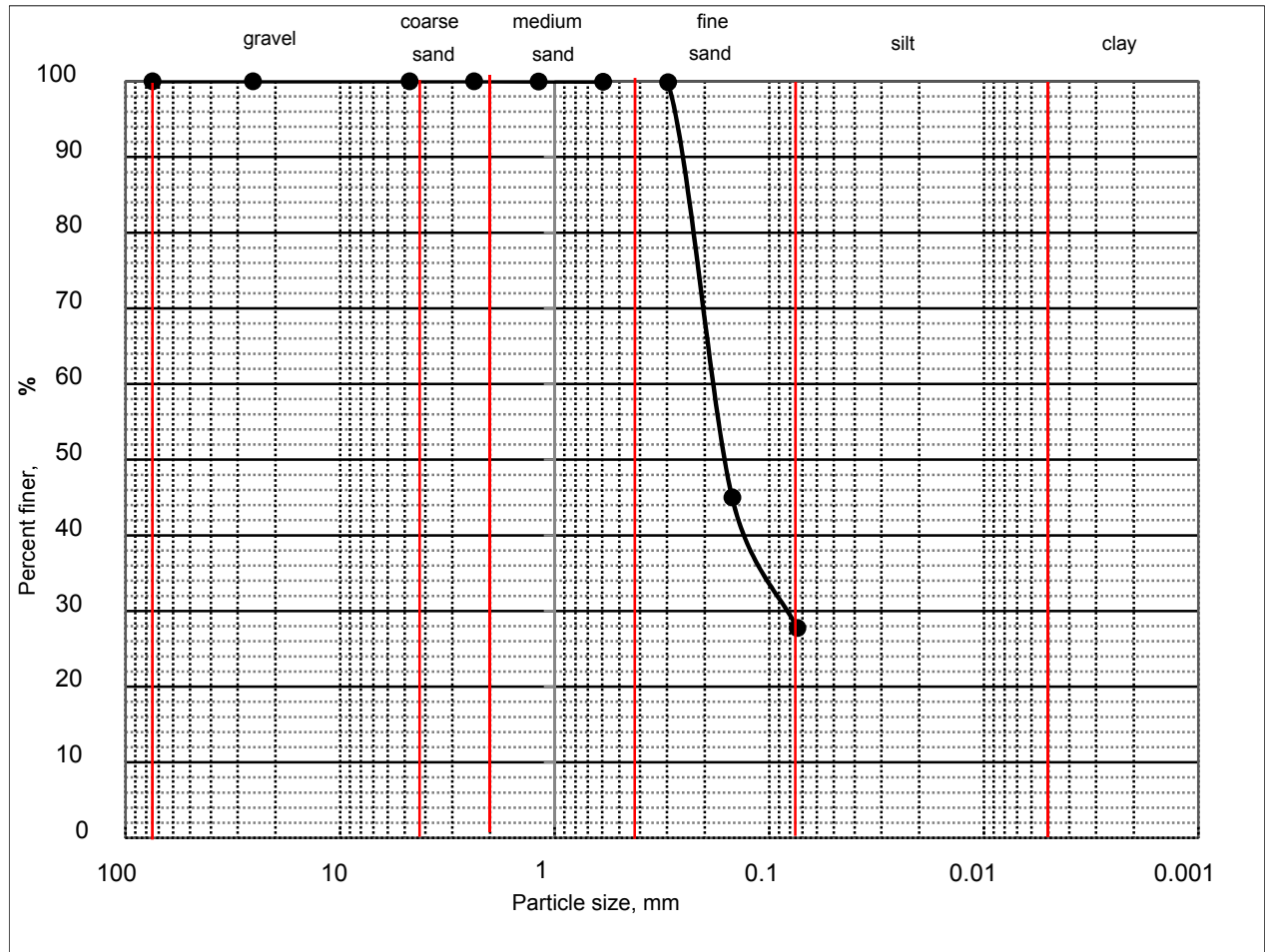
PROSOIL
FOUNDATION CONSULTANT

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S05
Location:	Surma (RB)	Sample No:	04
Sample Type:	Disturbed		

Test Results

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.002	0.013	0.024	0.043	0.106	8.70	91.30	1.65	17.87	-	-	

January 2017, Dry Season
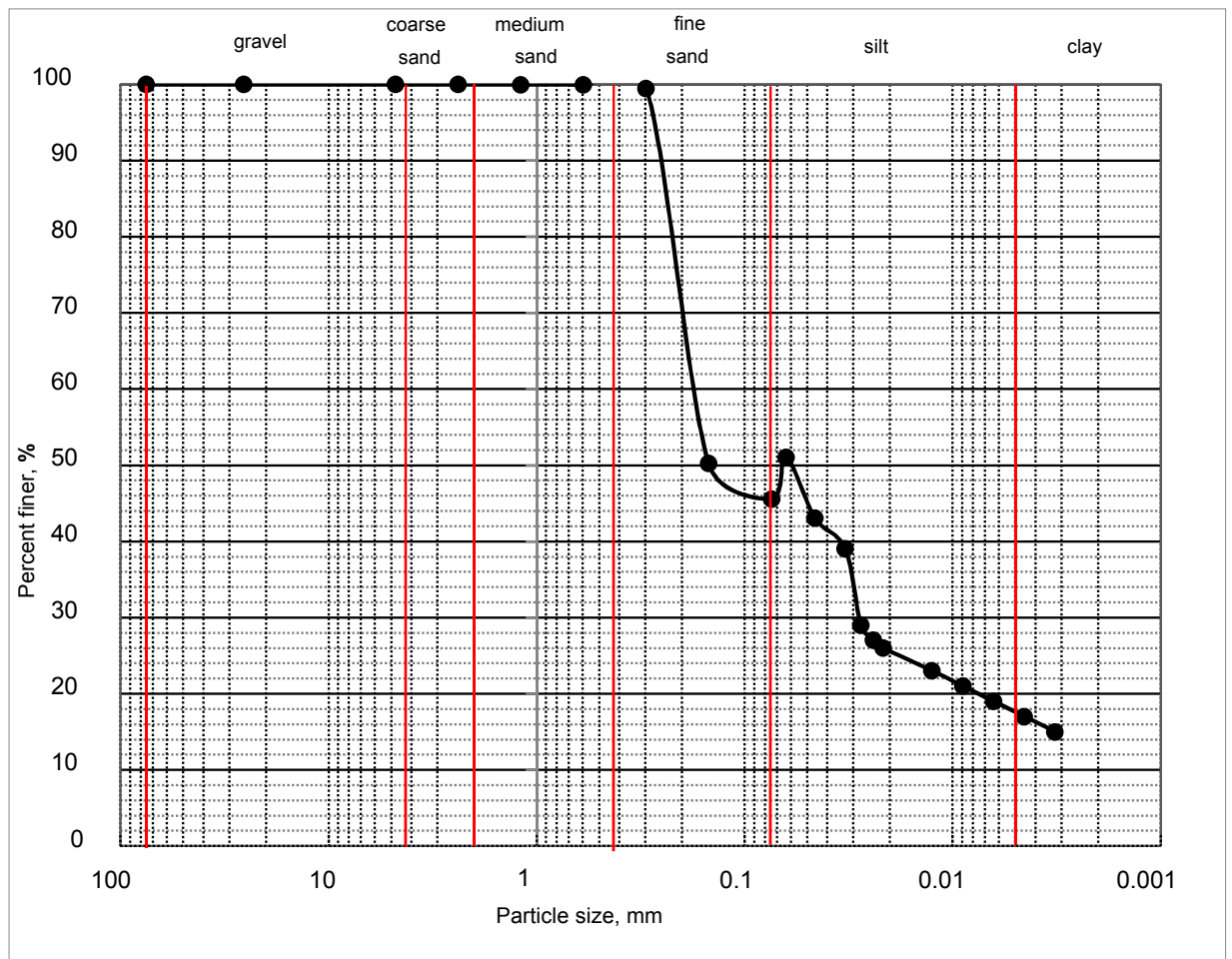
PROSOIL
FOUNDATION CONSULTANT

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S06
Location:	Surma (LB)	Sample No:	01
Sample Type:	Disturbed		

Test Results

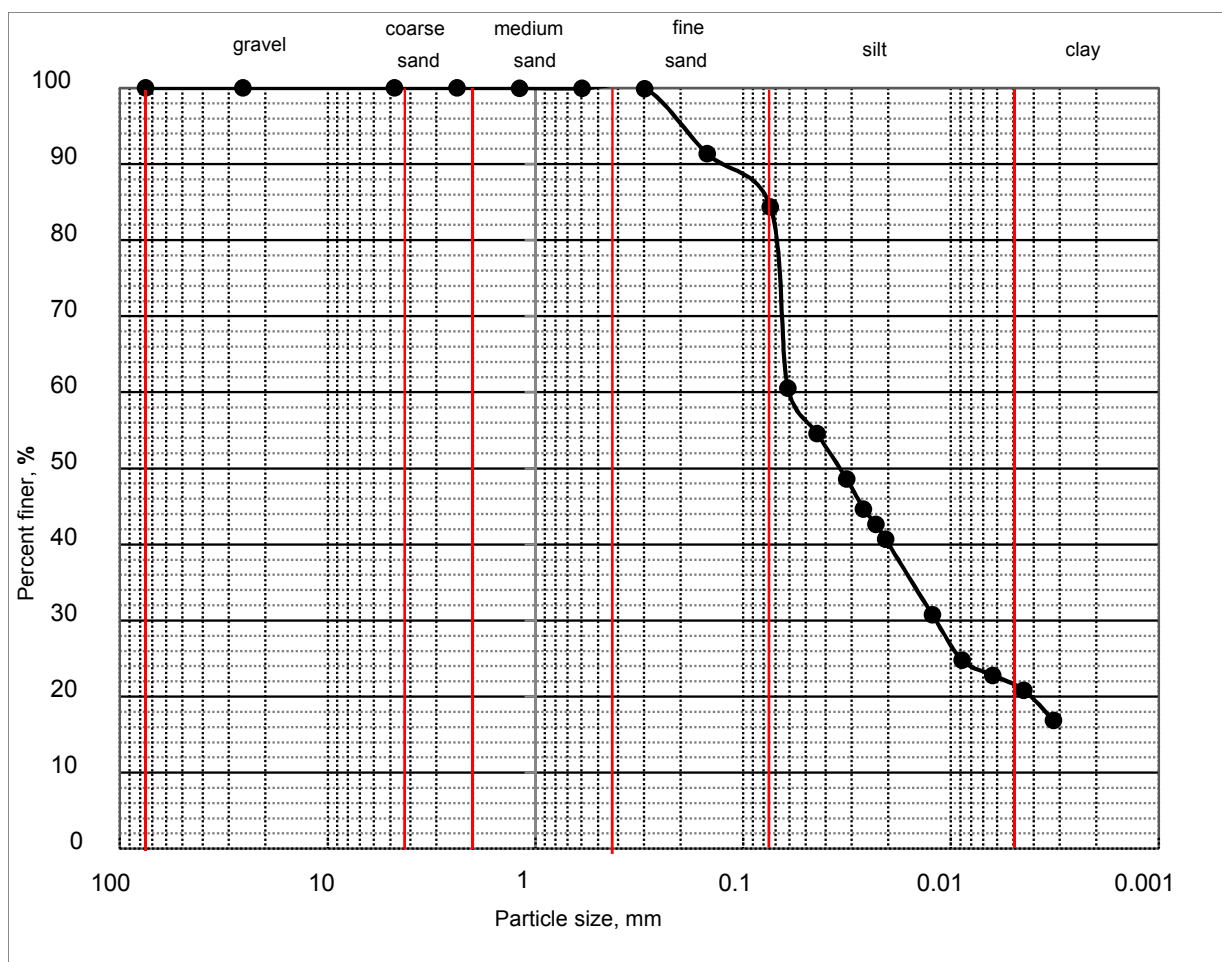| D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
-	0.084	0.162	0.189	0.284	72.26	27.74	-	-	-	-	

January 2017, Dry Season

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S06
Location:	Surma (LB)	Sample No:	02
Sample Type:	Disturbed		

Test Results

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.003	0.028	0.145	0.178	0.283	54.40	45.60	1.74	69.89	-	-	

ASTM D-422

January 2017, Dry Season
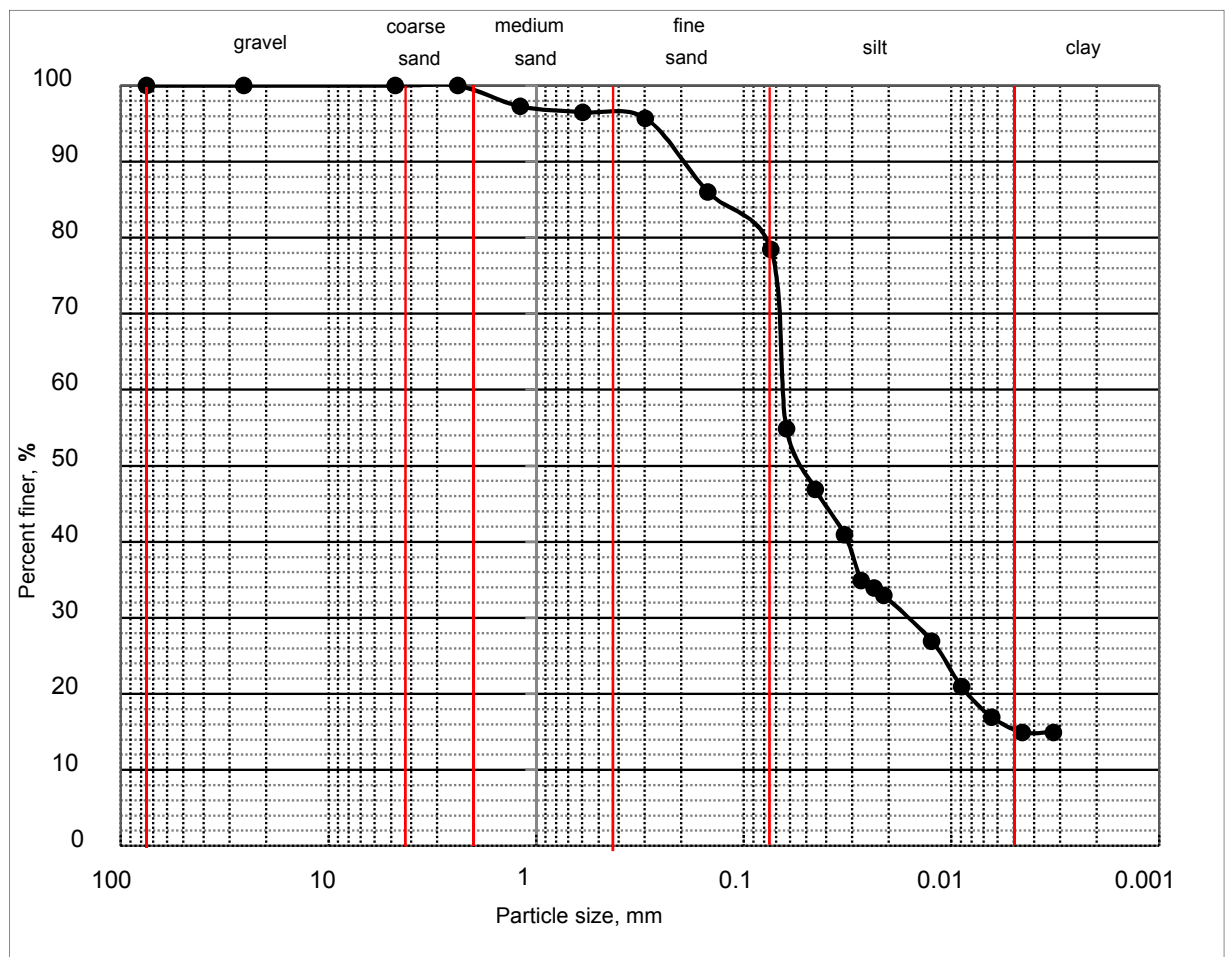
PROSOIL
FOUNDATION CONSULTANT

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S06
Location:	Surma (LB)	Sample No:	03
Sample Type:	Disturbed		

Test Results

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.002	0.012	0.035	0.059	0.212	15.60	84.40	0.98	24.74	-	-	

ProSoil Foundation Consultant
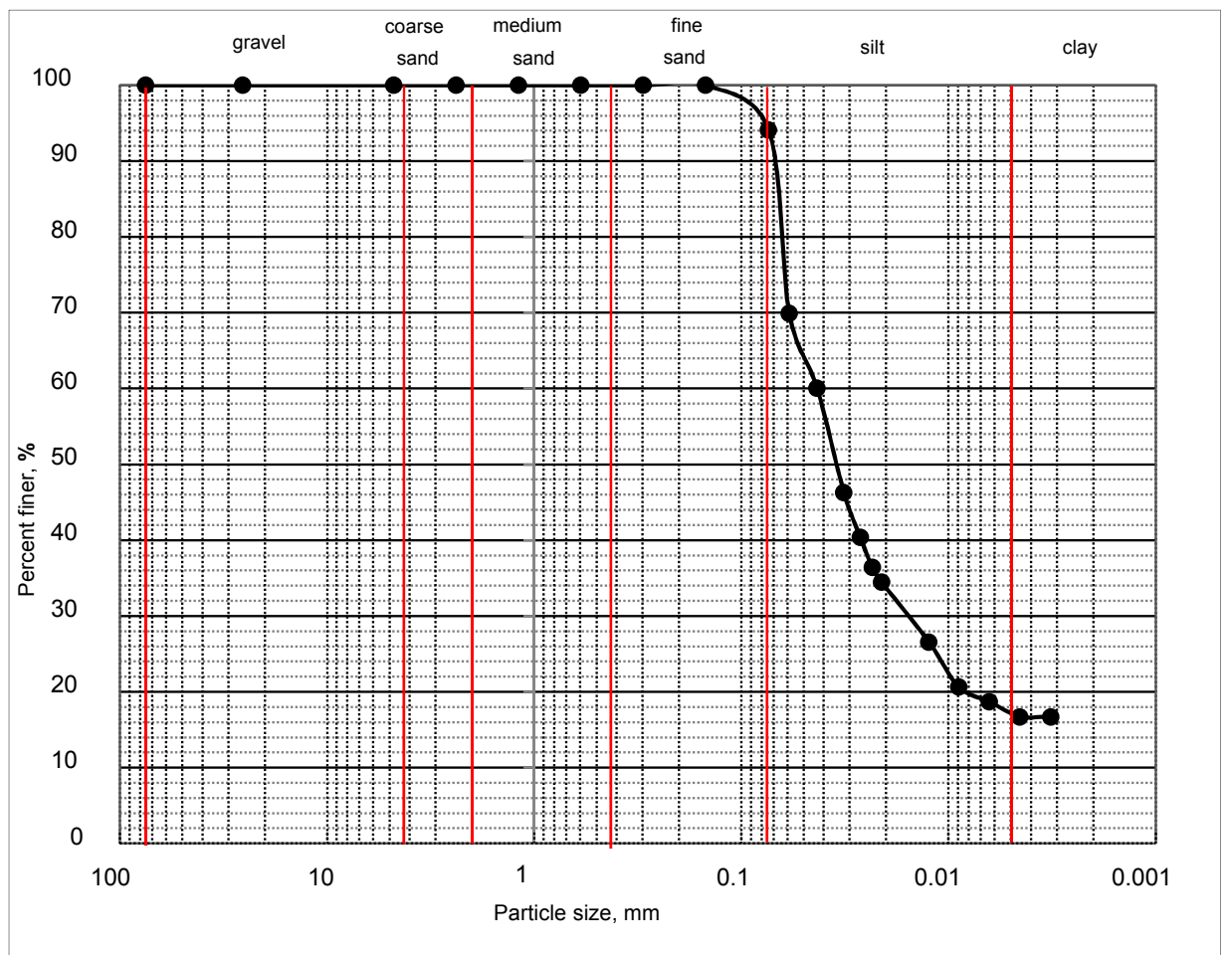
January 2017, Dry Season

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S06
Location:	Surma (RB)	Sample No:	04
Sample Type:	Disturbed		

Test Results

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.003	0.017	0.052	0.065	0.286	21.55	78.45	1.72	25.37	-	-	

ASTM D-422   V-3:69

ProSoil Foundation Consultant
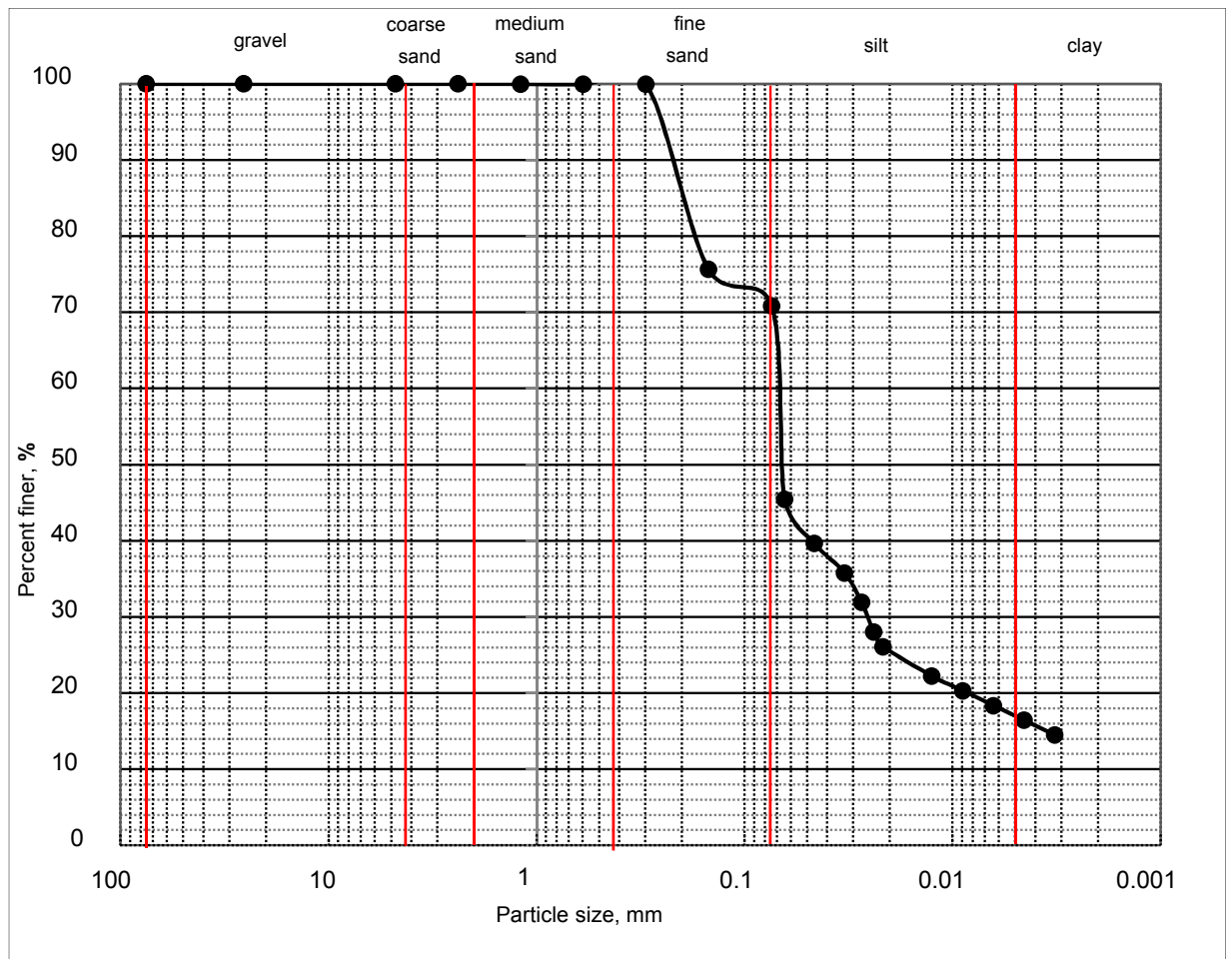
January 2017, Dry Season

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S07
Location:	Surma (LB)	Sample No:	01
Sample Type:	Disturbed		

Test Results

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.002	0.016	0.035	0.043	0.085	5.86	94.14	2.51	17.85	-	-	

ASTM D-422   V-3:70

January 2017, Dry Season

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.	
Client:	Department of Bangladesh Haor and Wetlands Development	Section: S07
Location:	Surma (LB)	Sample No: 02
Sample Type:	Disturbed	

Test Results

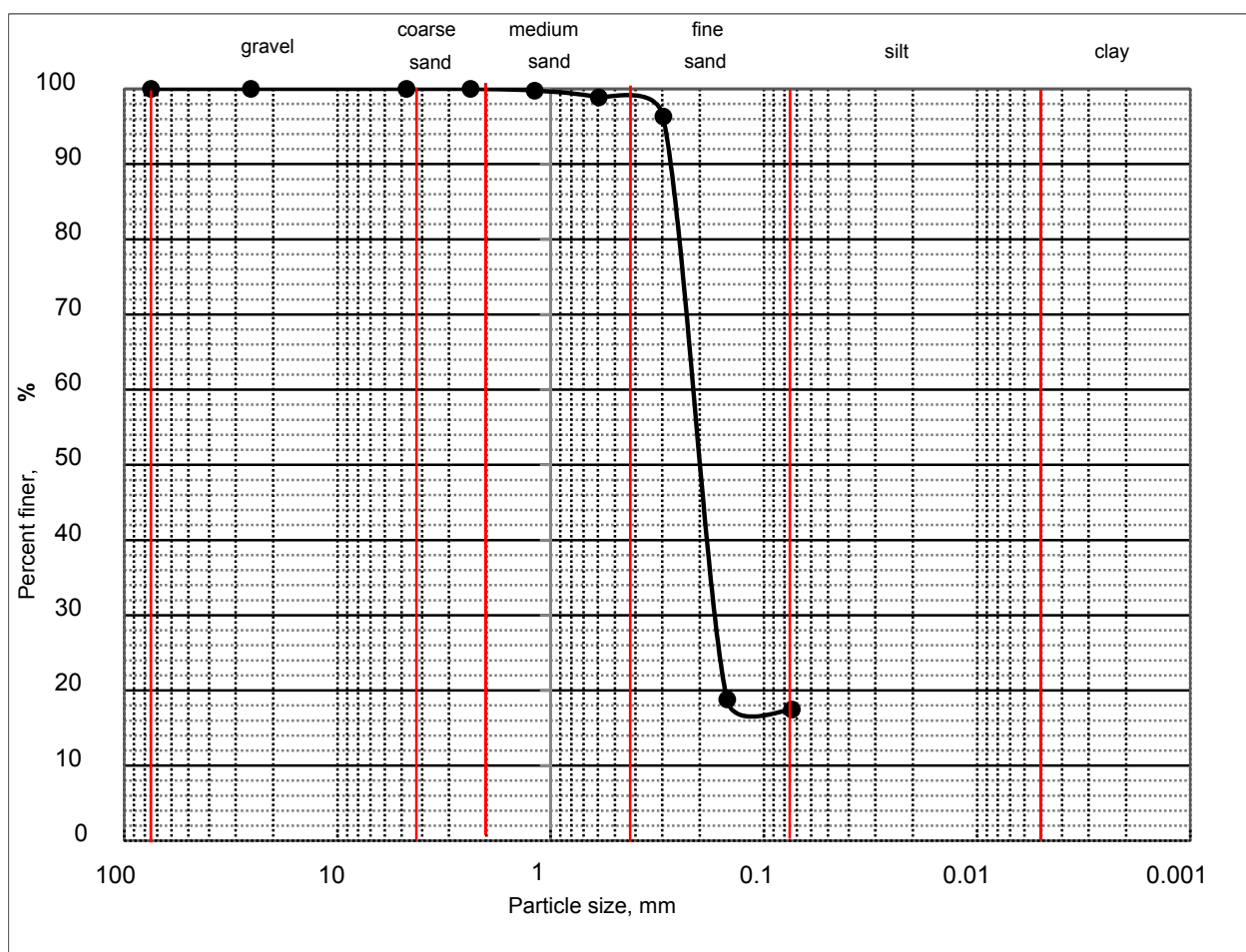| D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.003	0.026	0.066	0.070	0.267	29.14	70.86	3.63	26.85	-	-	

ASTM D-422

V-3:71

January 2017, Dry Season

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S07
Location:	Surma (LB)	Sample No:	03
Sample Type:	Disturbed		

Test Results

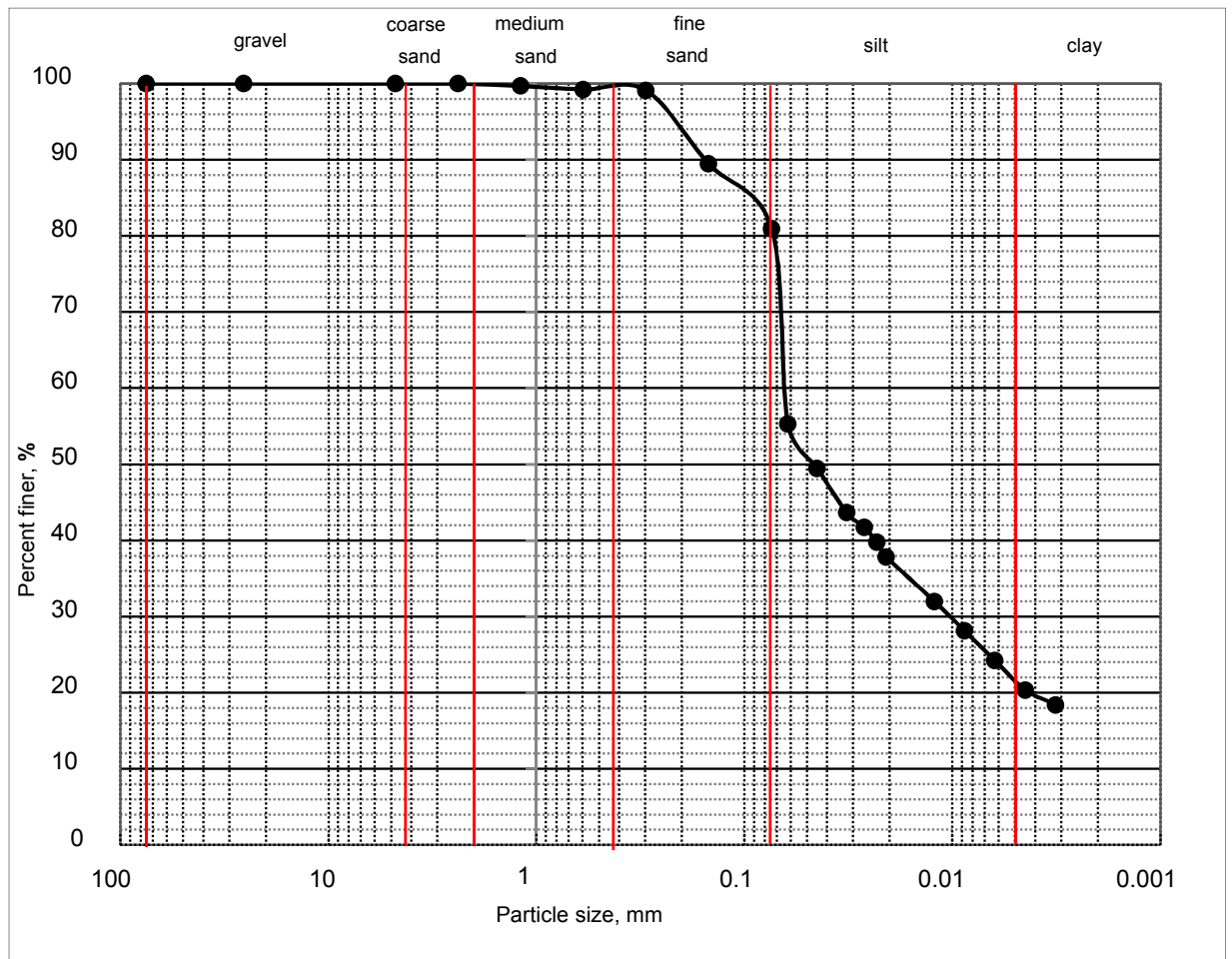| D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
-	0.170	0.209	0.228	0.294	82.55	17.45	-	-	-	-	

January 2017, Dry Season

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S07
Location:	Surma (RB)	Sample No:	04
Sample Type:	Disturbed		

Test Results

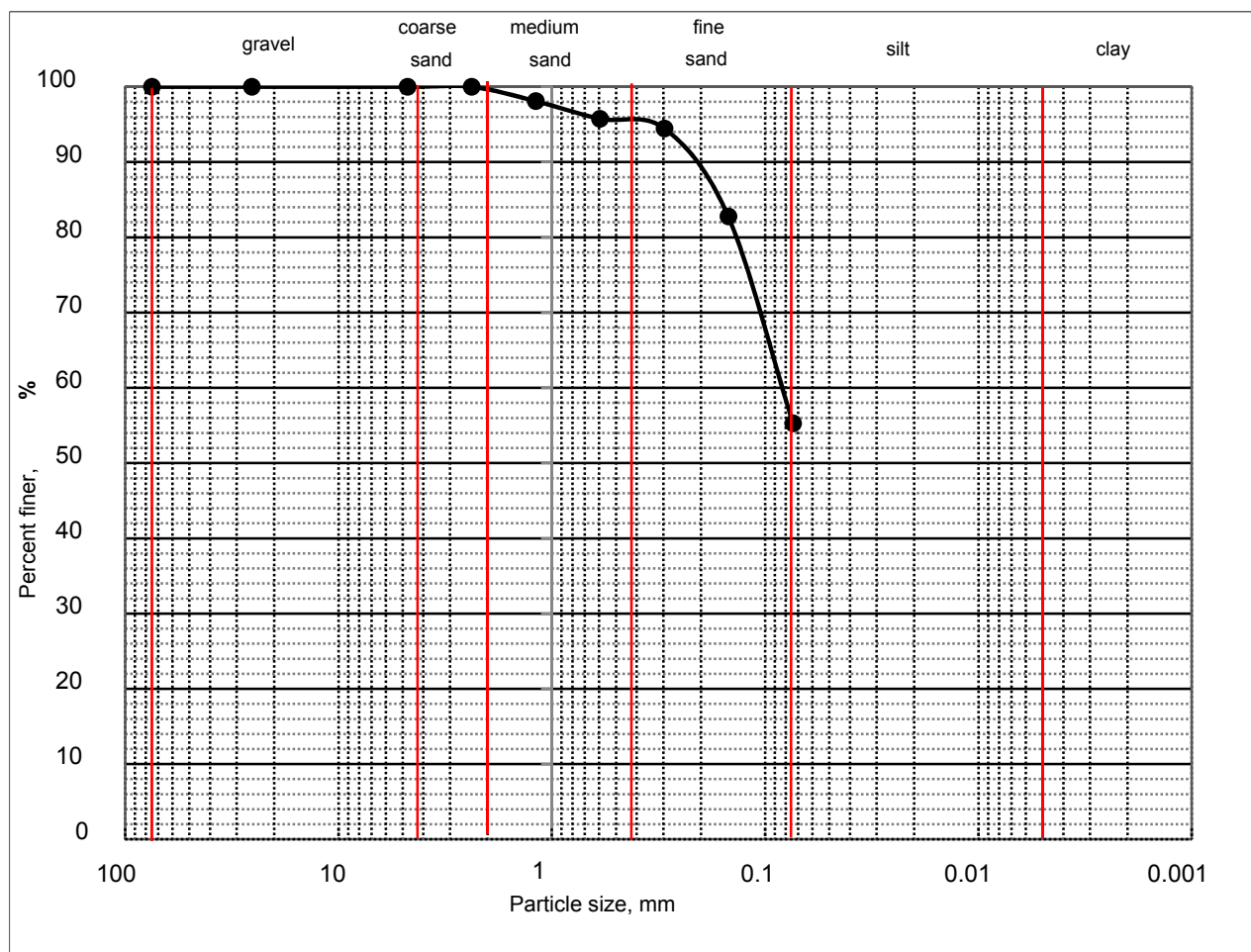| D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.002	0.010	0.046	0.064	0.234	19.04	80.96	0.73	27.84	-	-	

PROSOIL
FOUNDATION CONSULTANT

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S08
Location:	Surma (LB)	Sample No:	01
Sample Type:	Disturbed		

Test Results

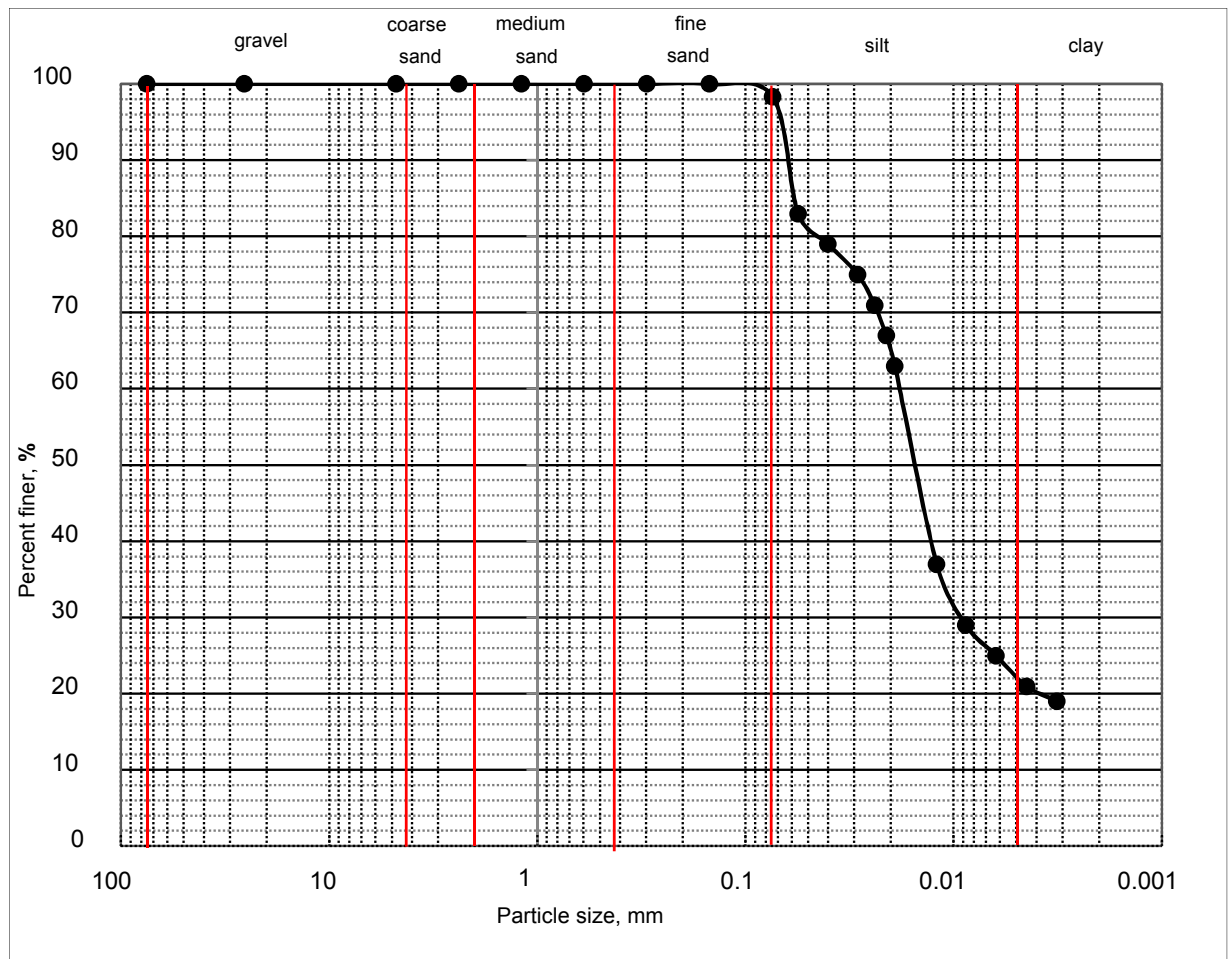| D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
-	-	-	0.087	0.421	44.72	55.28	-	-	-	-	

January 2017, Dry Season

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S08
Location:	Surma (LB)	Sample No:	02
Sample Type:	Disturbed		

Test Results

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.002	0.009	0.016	0.018	0.070	1.68	98.32	2.01	8.07	-	-	

January 2017, Dry Season
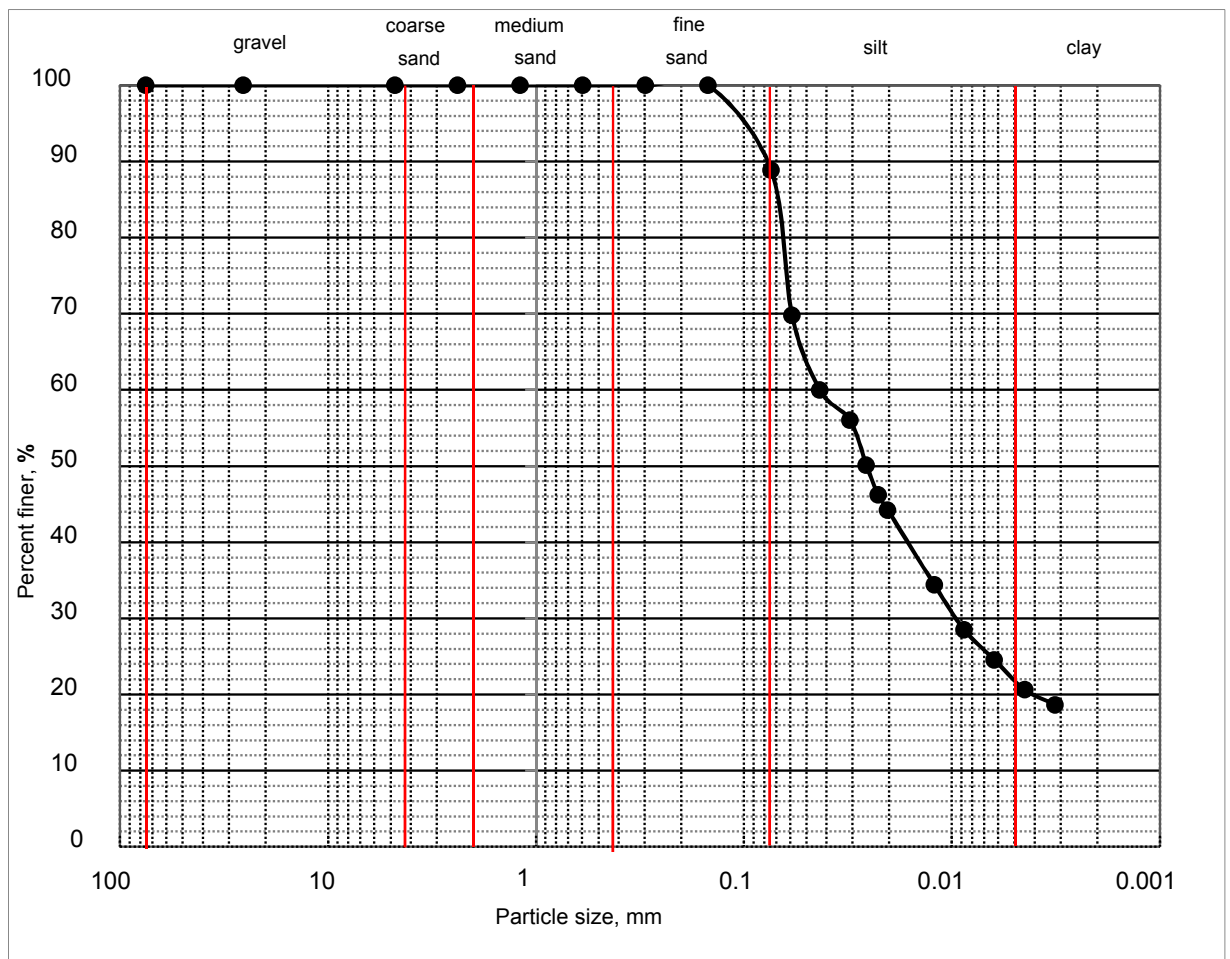
PROSOIL
FOUNDATION CONSULTANT

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S08
Location:	Surma (LB)	Sample No:	03
Sample Type:	Disturbed		

Test Results

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.002	0.010	0.026	0.043	0.115	11.09	88.91	0.93	18.85	-	-	

January 2017, Dry Season
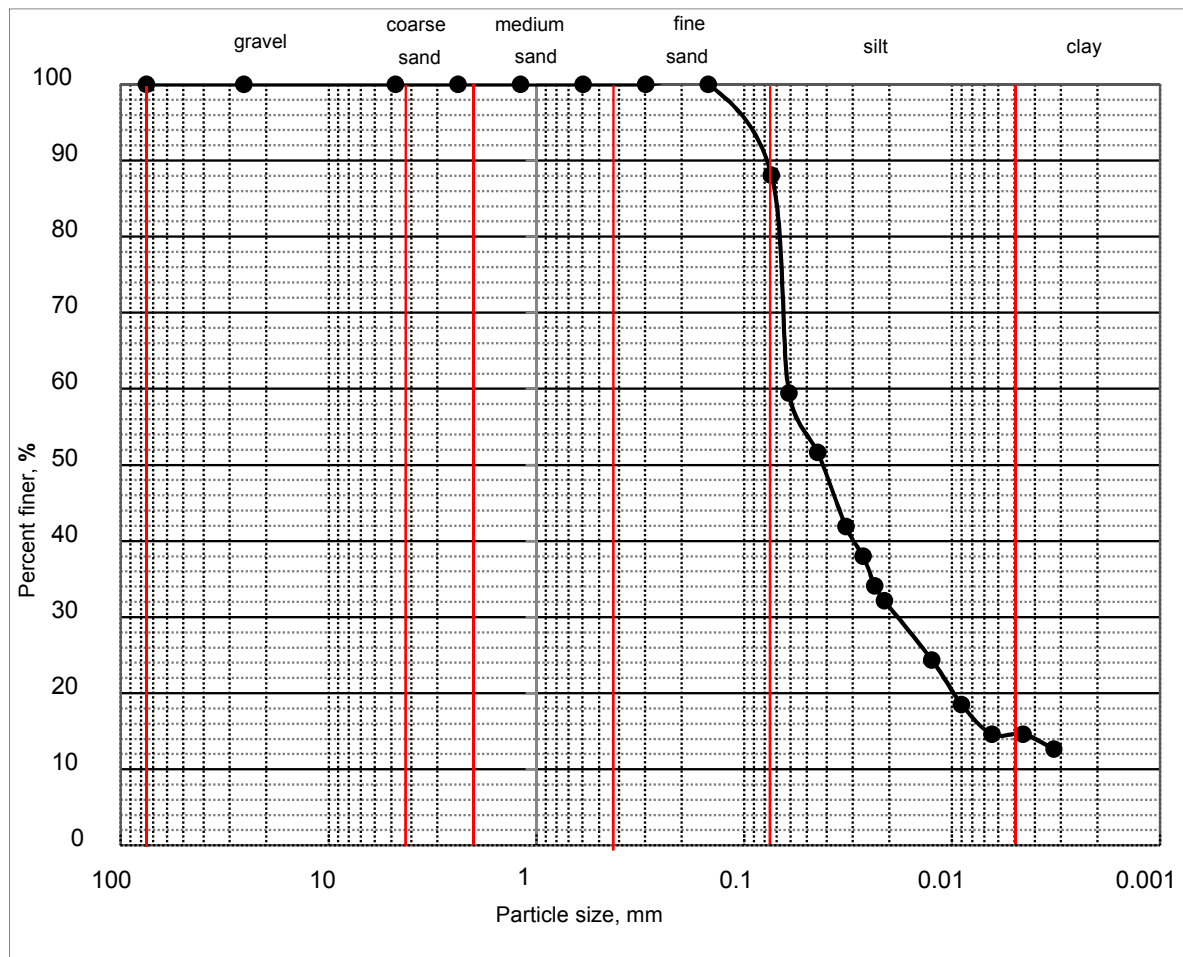
PROSOIL
FOUNDATION CONSULTANT

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S08
Location:	Surma (RB)	Sample No:	04
Sample Type:	Disturbed		

Test Results

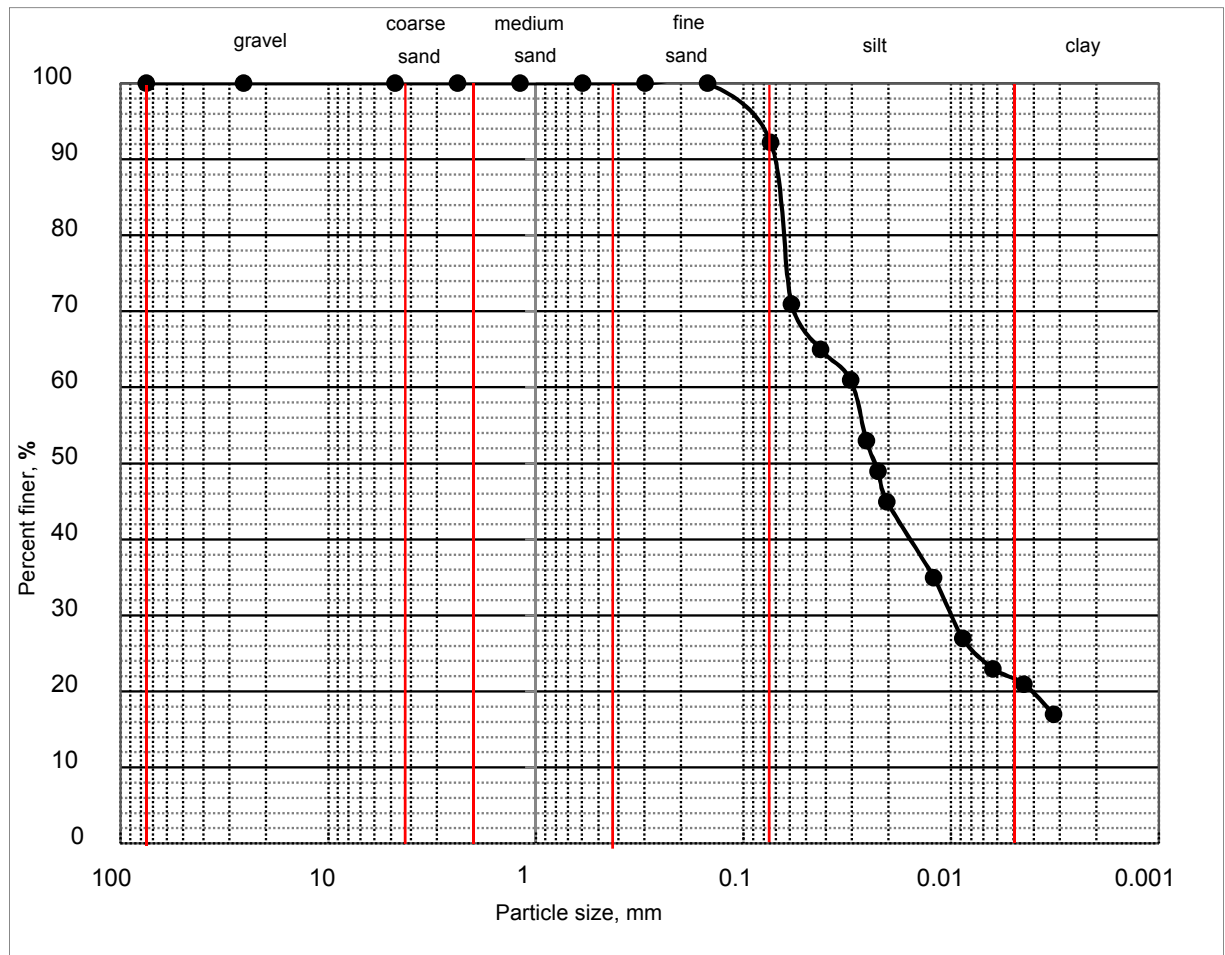| D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.003	0.019	0.042	0.061	0.117	11.89	88.11	2.05	21.82	-	-	

ASTM D-422

January 2017, Dry Season

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S09
Location:	Surma (LB)	Sample No:	01
Sample Type:	Disturbed		

Test Results

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.002	0.010	0.023	0.030	0.101	7.77	92.23	1.41	12.48	-	-	

ASTM D-422   V-3:78

January 2017, Dry Season
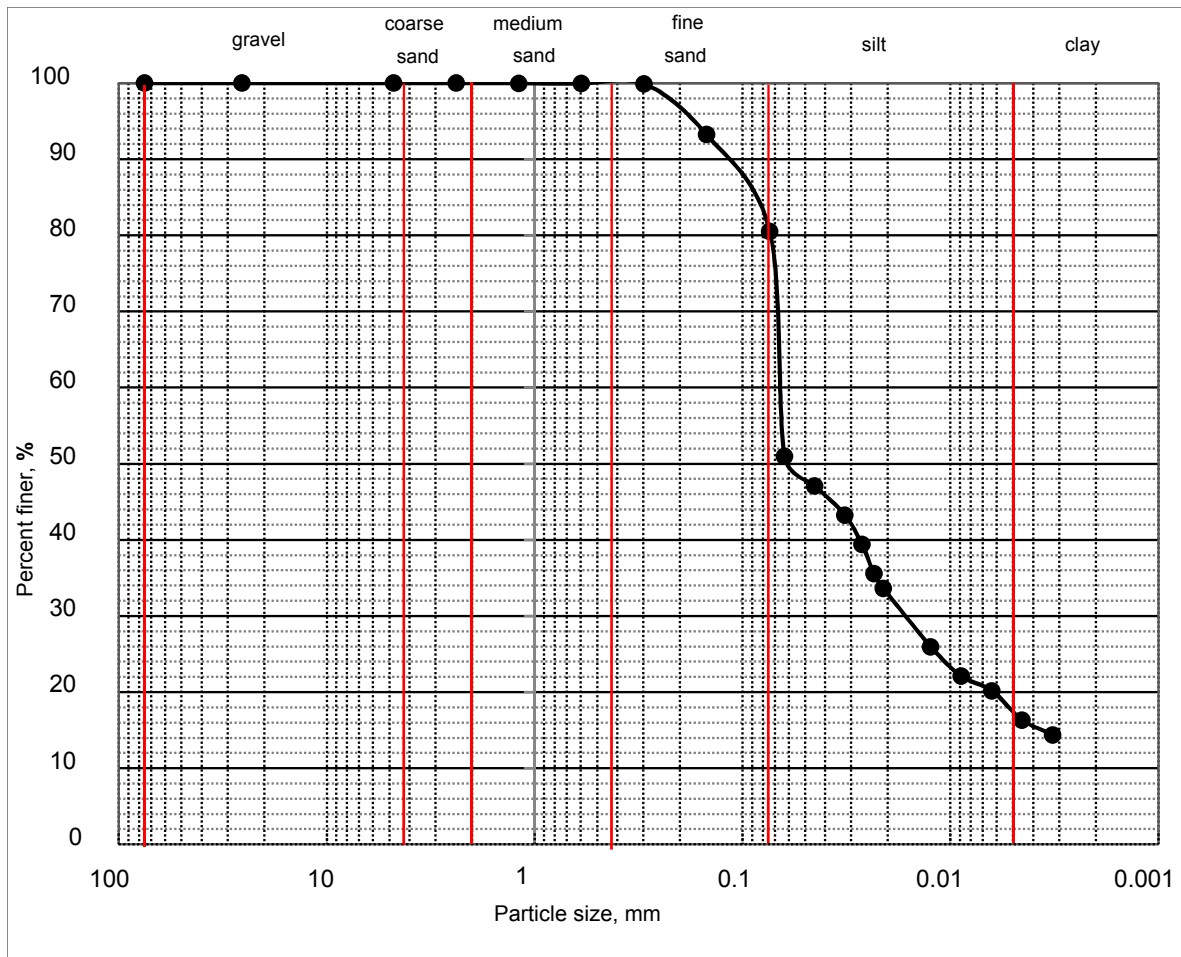
PROSOIL
FOUNDATION CONSULTANT

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S09
Location:	Surma (LB)	Sample No:	02
Sample Type:	Disturbed		

Test Results

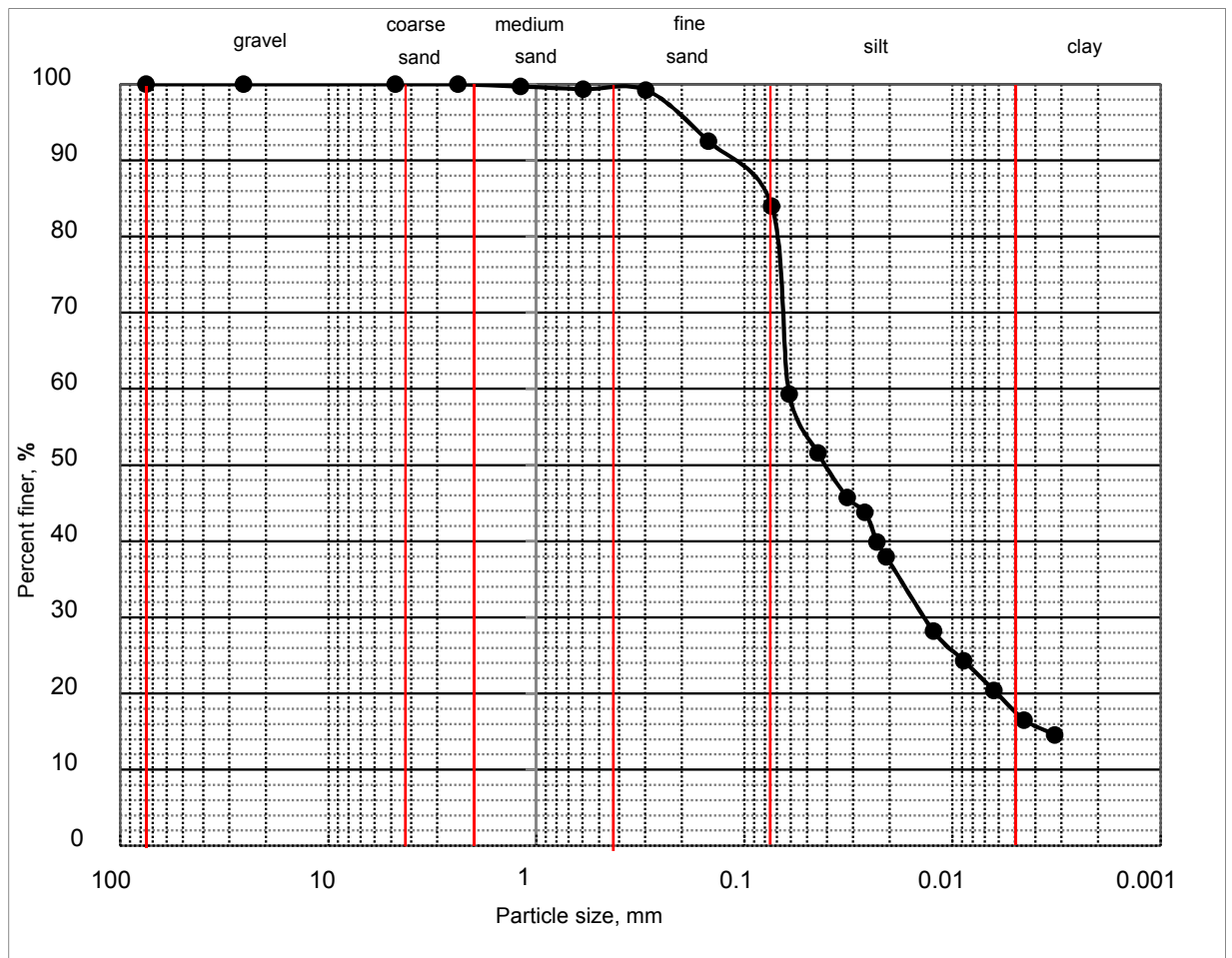| D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.003	0.017	0.058	0.066	0.188	19.46	80.54	1.66	25.39	-	-	

January 2017, Dry Season

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S09
Location:	Surma (LB)	Sample No:	03
Sample Type:	Disturbed		

Test Results

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.003	0.014	0.041	0.061	0.203	15.98	84.02	1.22	23.68	-	-	

January 2017, Dry Season
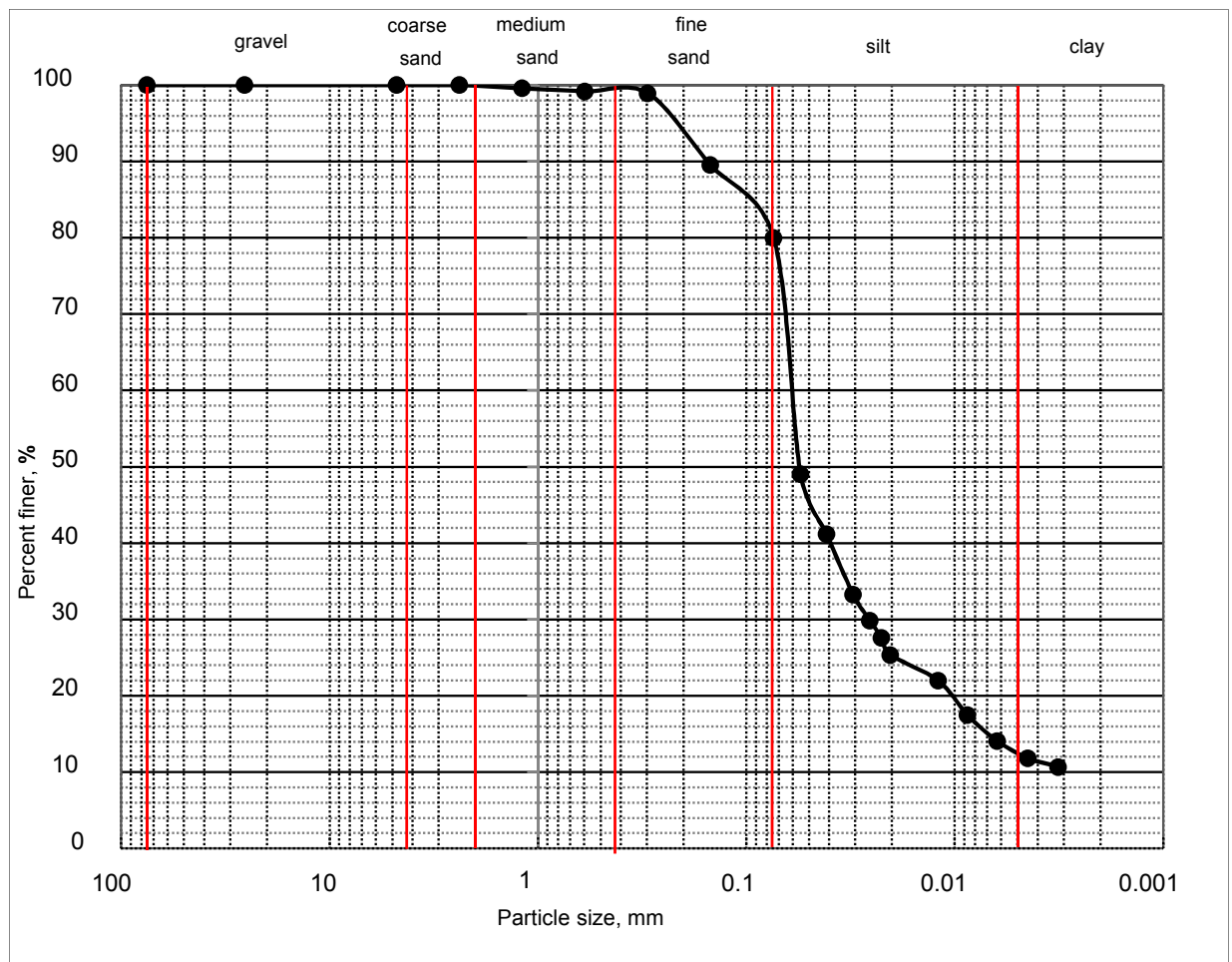
PROSOIL
FOUNDATION CONSULTANT

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	S09
Location:	Surma (RB)	Sample No:	04
Sample Type:	Disturbed		

Test Results

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.003	0.026	0.055	0.062	0.235	19.98	80.02	3.53	20.21	-	-	

January 2017, Dry Season
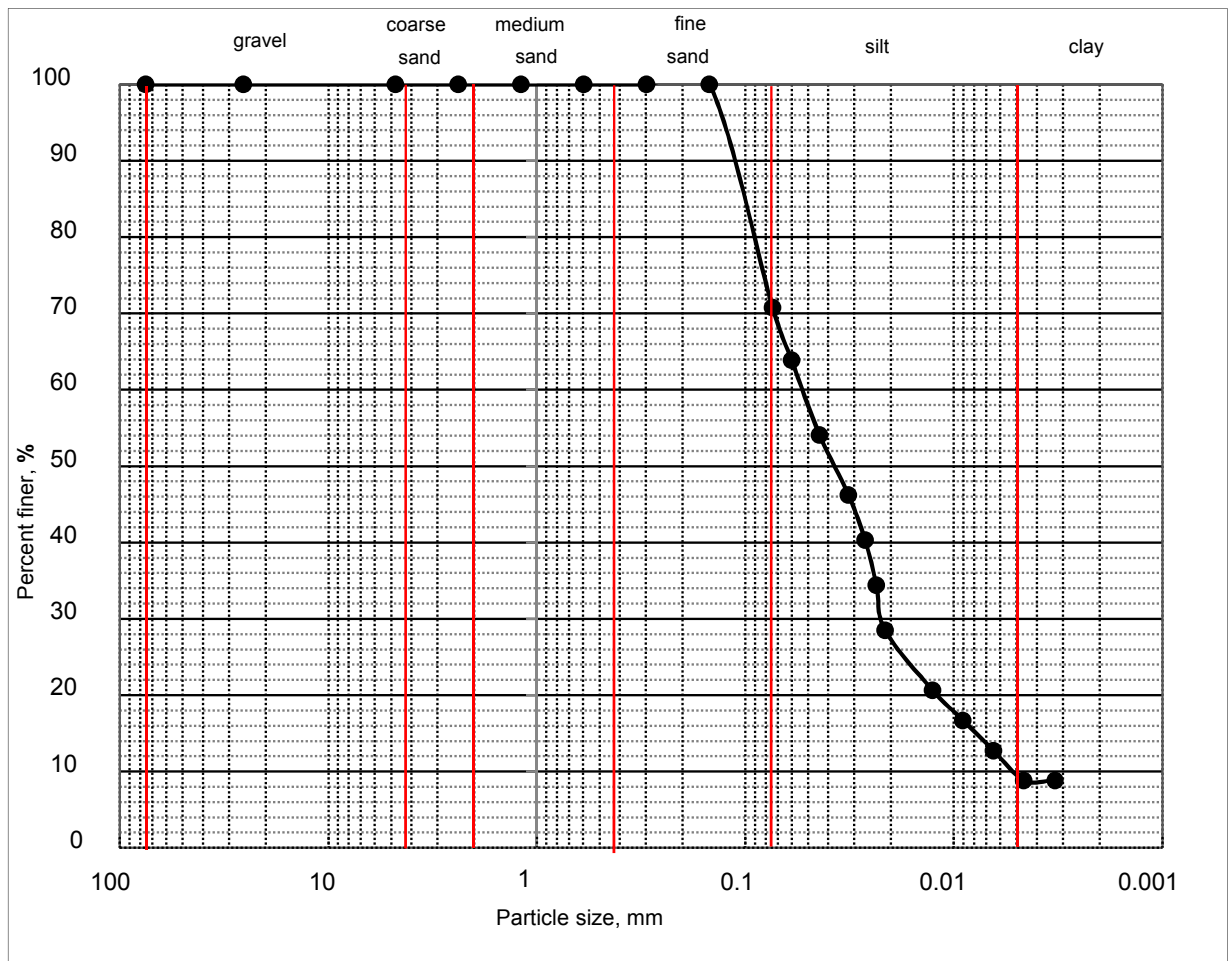
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PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	K01
Location:	Kushiyara (LB)	Sample No:	01
Sample Type:	Disturbed		

Test Results

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.005	0.022	0.038	0.054	0.136	29.24	70.76	1.74	10.40	-	-	

January 2017, Dry Season
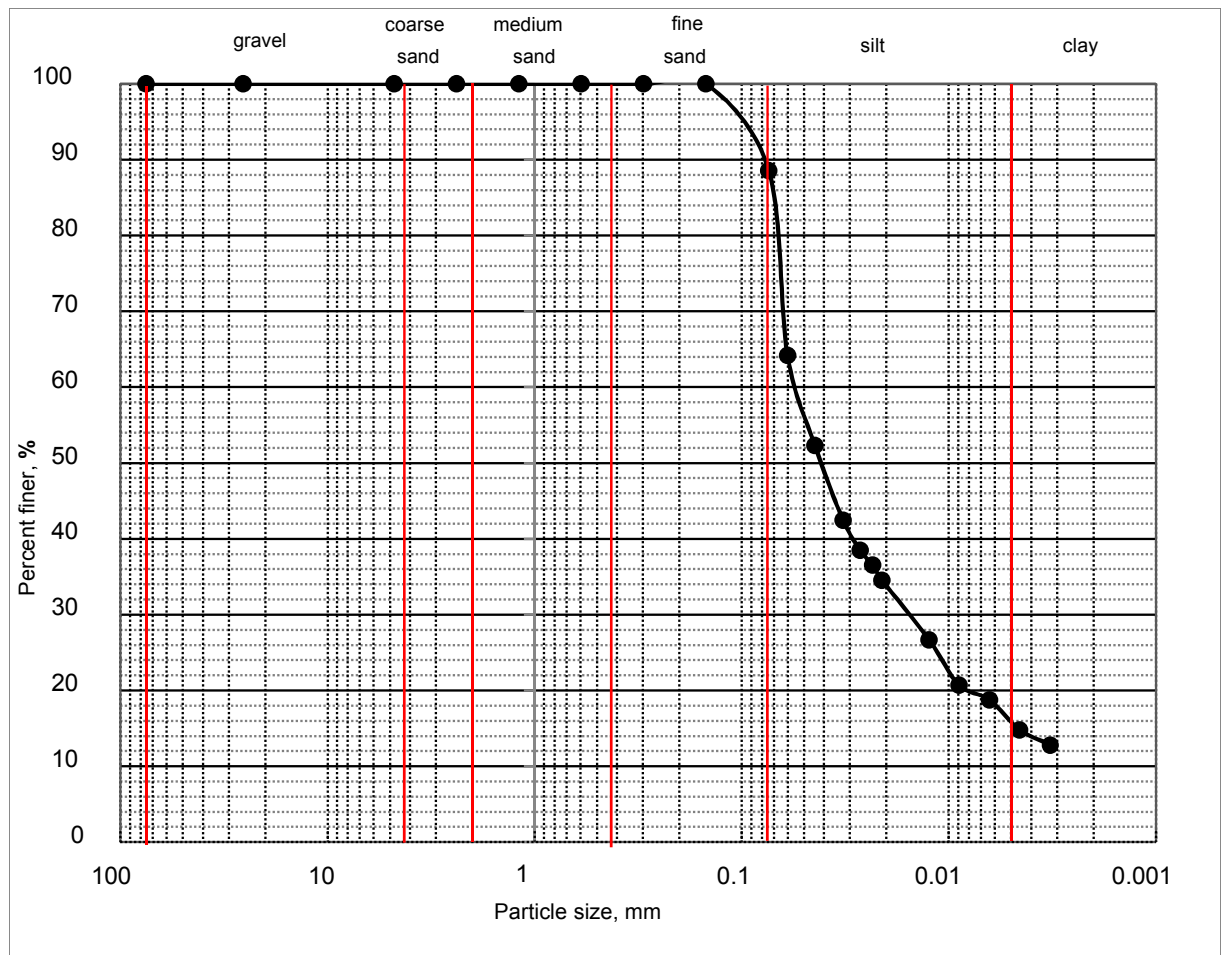
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PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	K01
Location:	Kushiyara (LB)	Sample No:	02
Sample Type:	Disturbed		

Test Results

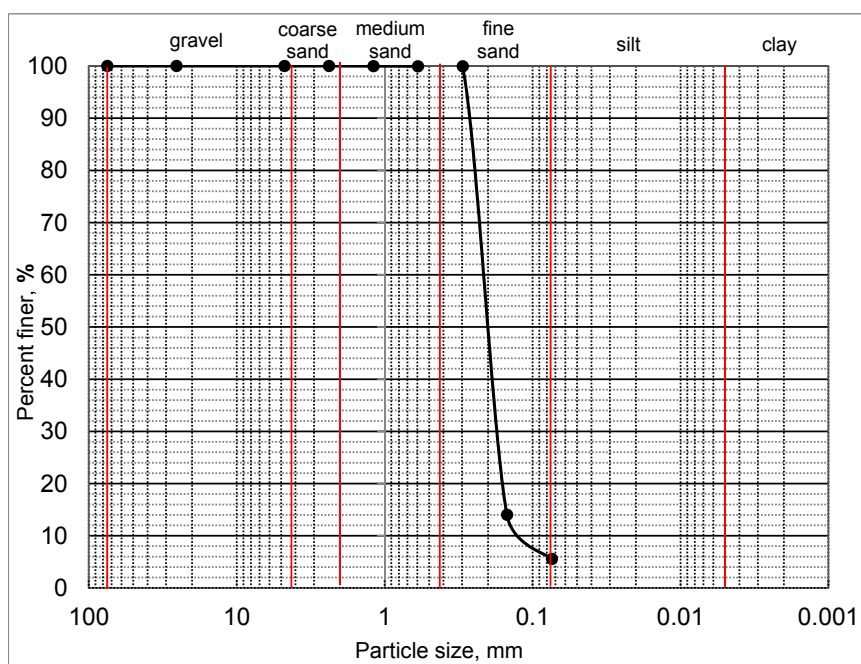| D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.002	0.016	0.041	0.054	0.116	11.45	88.55	2.53	29.19	-	-	

January 2017, Dry Season

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	K01
Location:	Kushiyara(LB)	Sample No:	03
Sample Type:	Disturbed		

Test Results

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.113	0.177	0.211	0.228	0.289	94.43	5.57	1.21	2.01	-	-	

No.	Wt. of soil (gm)	% of soil retained
4	0	0.00
8	0	0.00
16	0.02	0.02
30	0.04	0.03
50	0.02	0.02
100	103.6	85.90
200	10.2	8.46
pan	7.22	5.57
		100.00

Sieve

ProSoil Foundation Consultant

January 2017, Dry Season
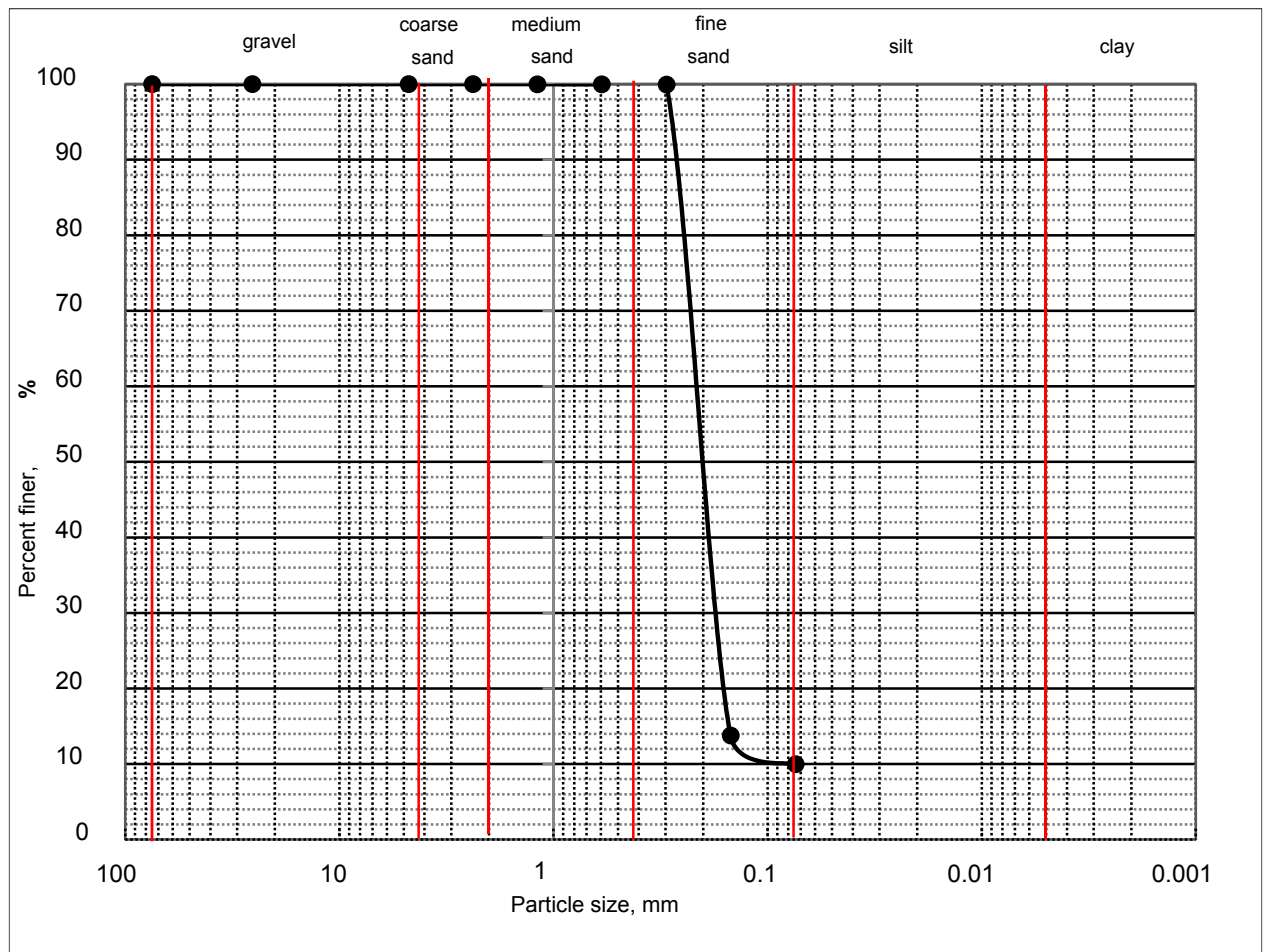
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PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	K01
Location:	Kushiyara(LB)	Sample No:	04
Sample Type:	Disturbed		

Test Results

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.075	0.177	0.211	0.228	0.289	90.03	9.97	1.84	3.06	-	-	

ASTM D-422   V-3:85

January 2017, Dry Season
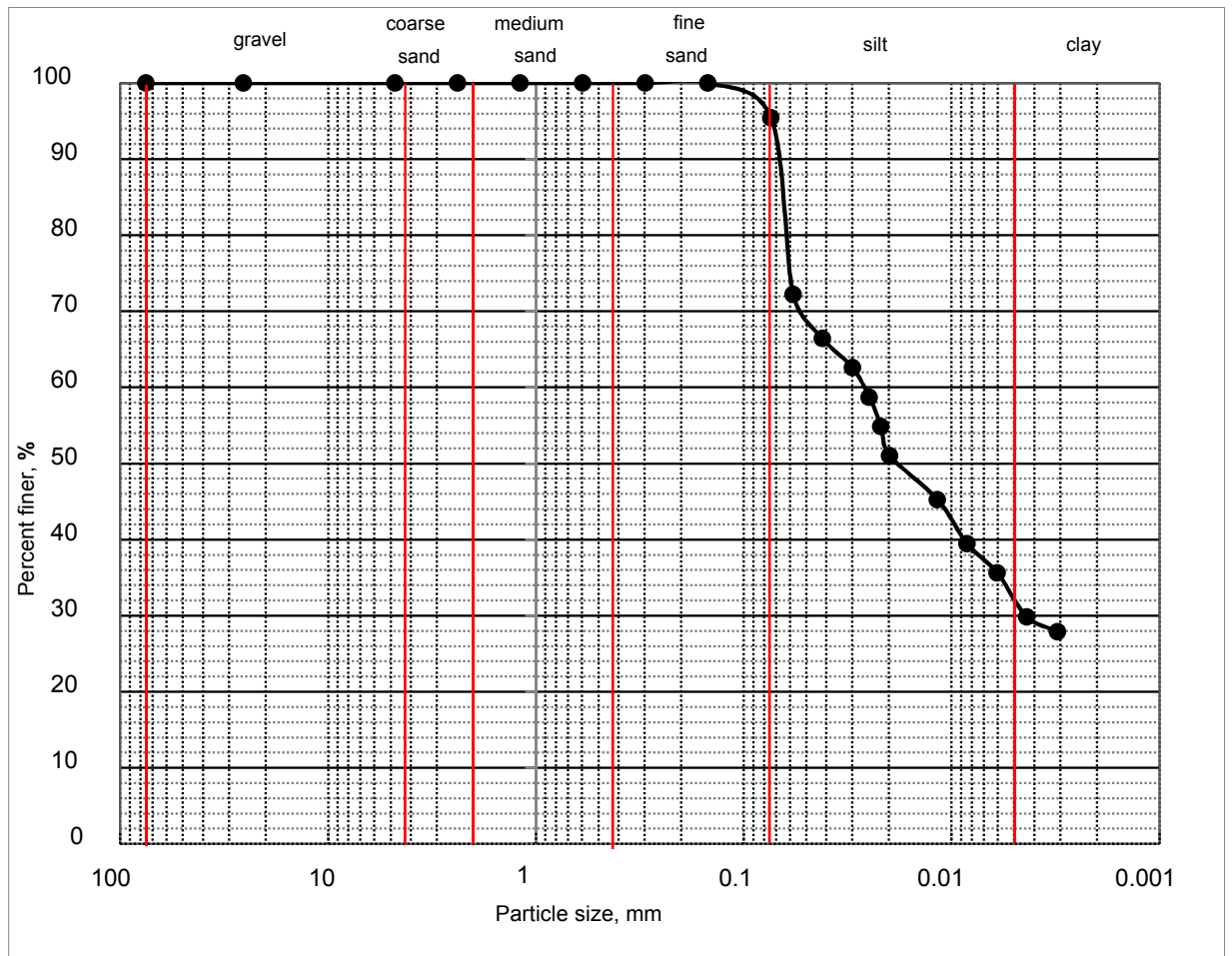
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PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	K02
Location:	Kushiyara (LB)	Sample No:	01
Sample Type:	Disturbed		

Test Results

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.002	0.004	0.018	0.027	0.074	4.55	95.45	0.37	13.68	-	-	

ASTM D-422   V-3:86
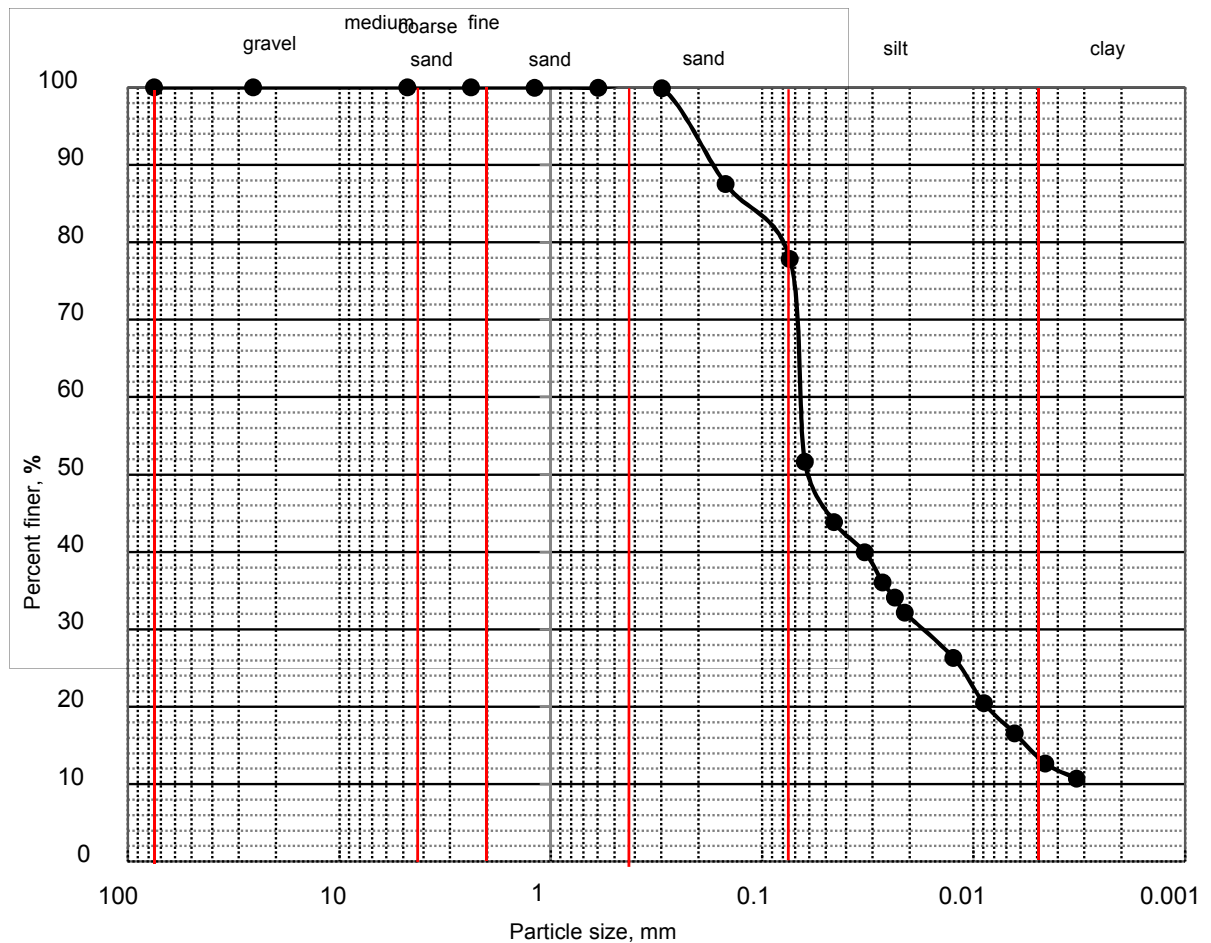
January 2017, Dry Season

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	K02
Location:	Kushiyara (LB)	Sample No:	02
Sample Type:	Disturbed		

Test Results

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.003	0.018	0.059	0.066	0.238	22.14	77.86	1.91	26.11	-	-	

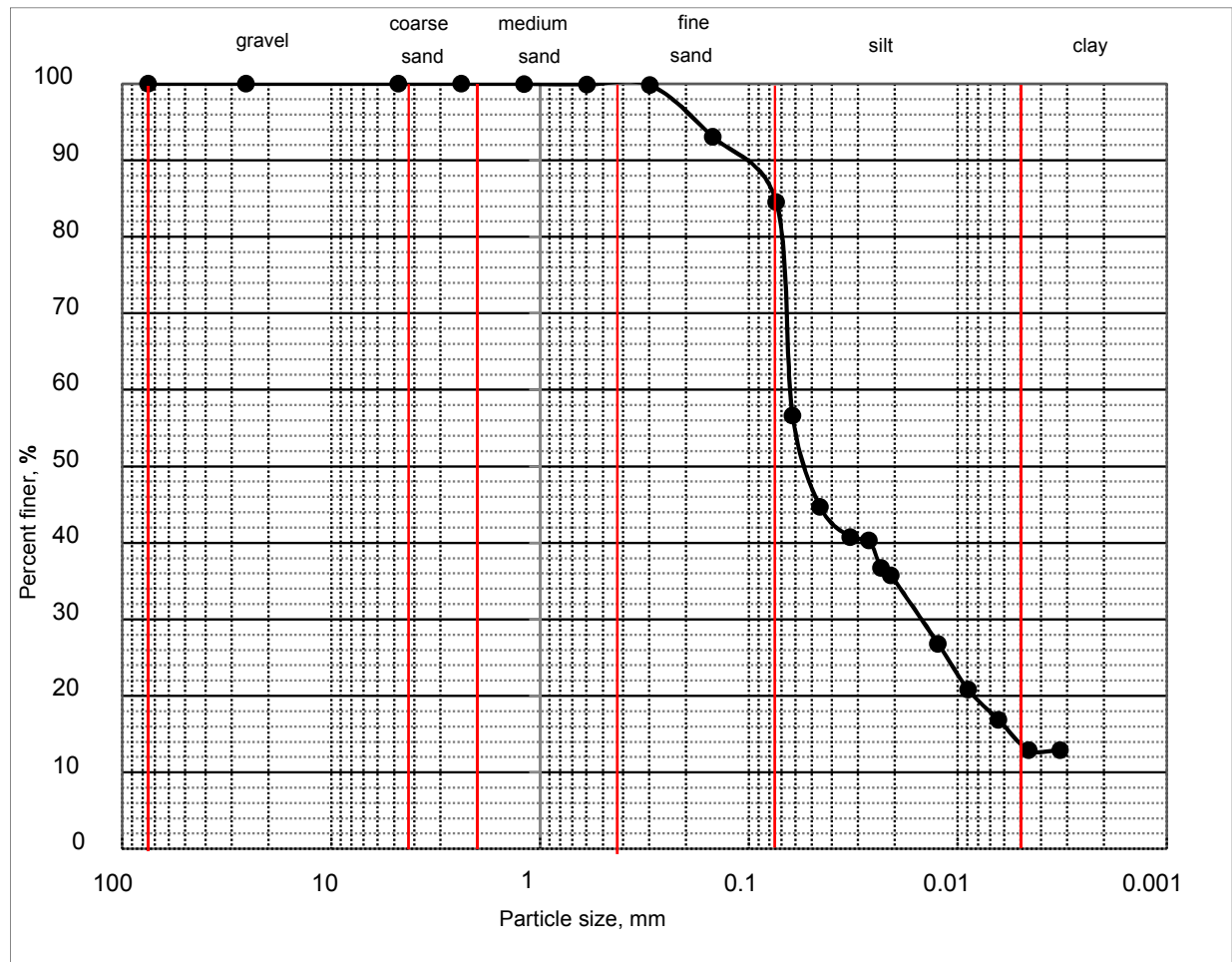ASTM D-422

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PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	K02
Location:	Kushiyara (LB)	Sample No:	03
Sample Type:	Disturbed		

Test Results

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.003	0.015	0.053	0.063	0.191	15.47	84.53	1.36	22.82	-	-	

ASTM D-422   V-3:88
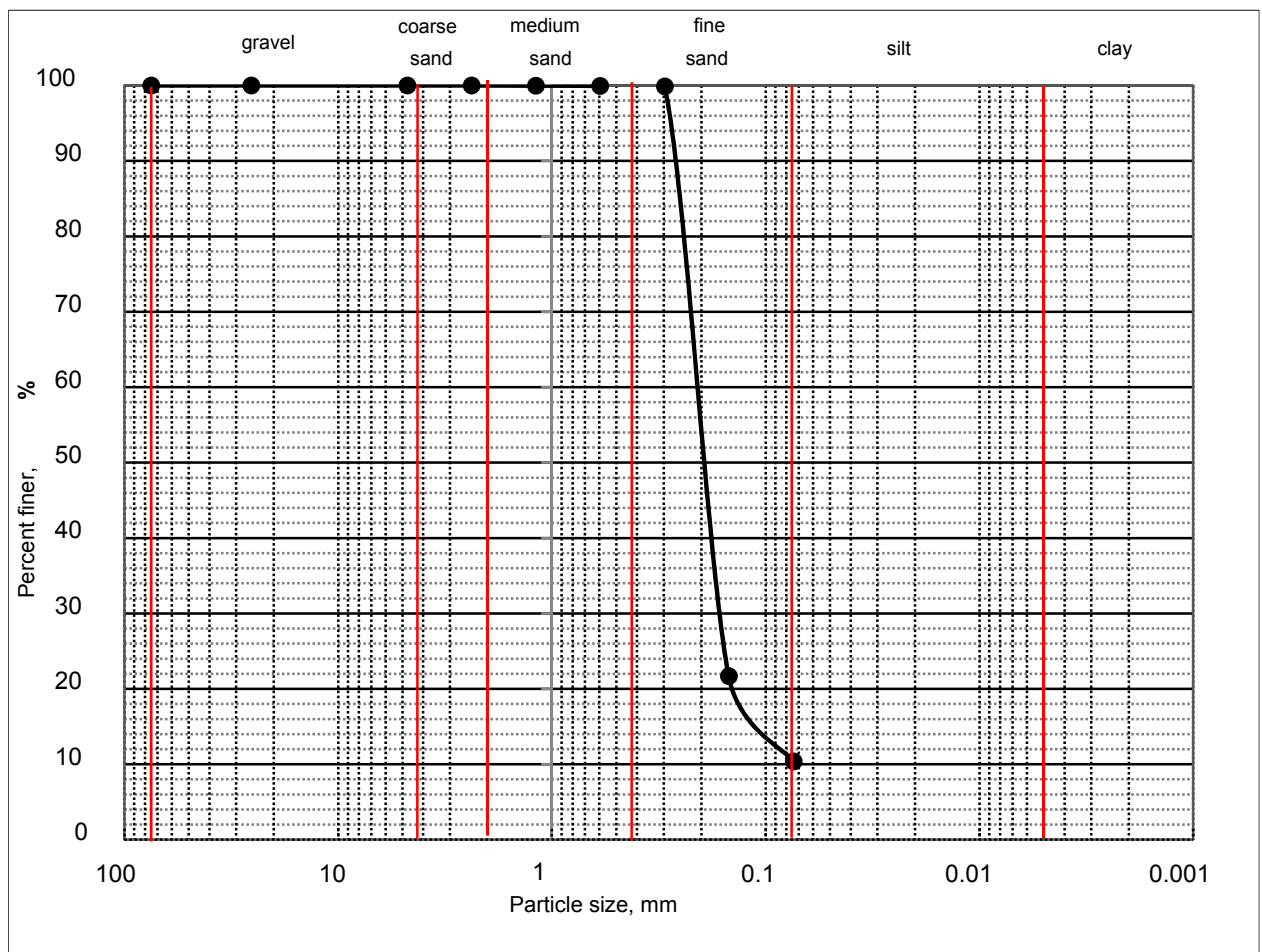
January 2017, Dry Season

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	K02
Location:	Kushiyara(RB)	Sample No:	04
Sample Type:	Disturbed		

Test Results

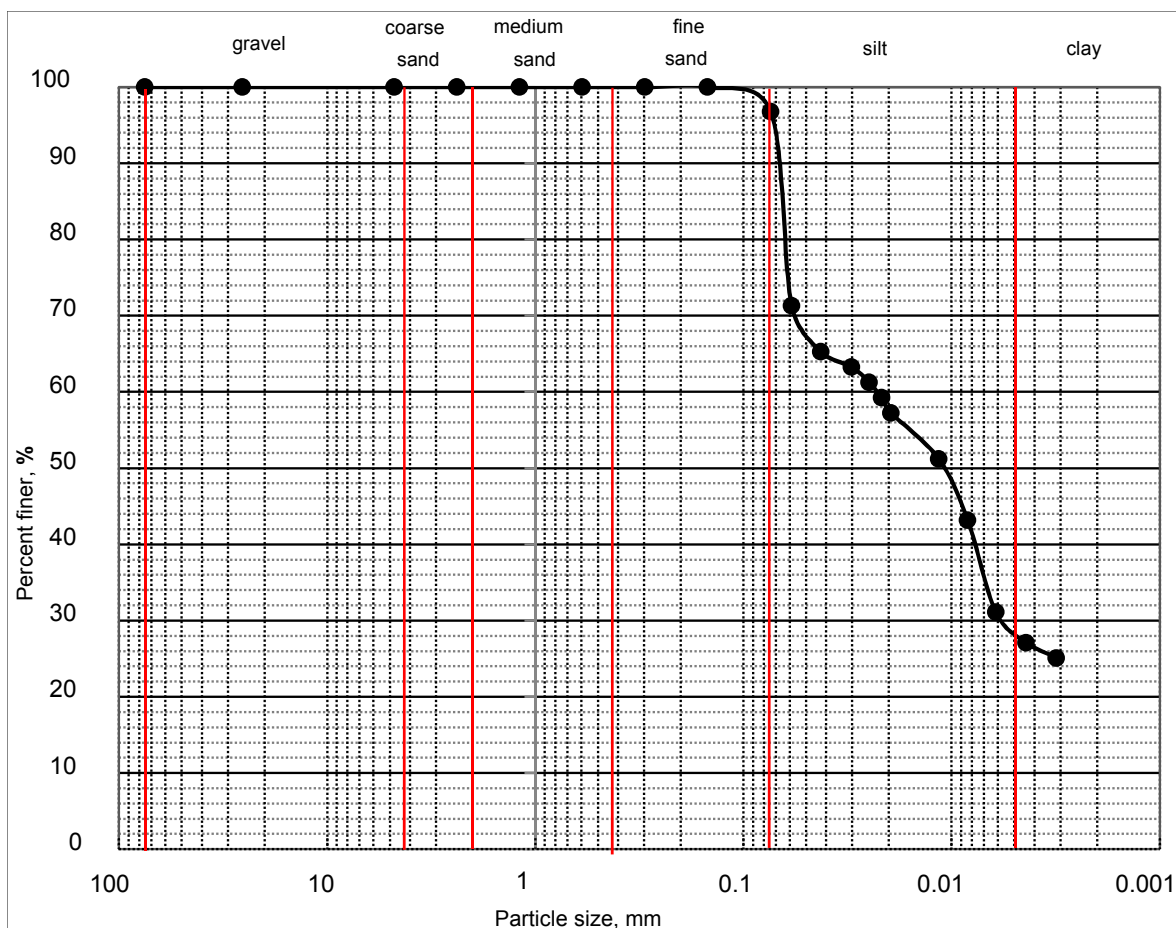| D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
-	0.165	0.203	0.222	0.288	89.61	10.39	-	-	-	-	

January 2017, Dry Season

PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	K03
Location:	Kushiyara (LB)	Sample No:	01
Sample Type:	Disturbed		

Test Results

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.002	0.006	0.011	0.023	0.073	3.22	96.78	0.69	11.32	-	-	

January 2017, Dry Season

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PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER

Project:	Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin.		
Client:	Department of Bangladesh Haor and Wetlands Development	Section:	K03
Location:	Kushiyara (LB)	Sample No:	02
Sample Type:	Disturbed		

Test Results

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
-	0.020	0.065	0.070	0.254	33.21	66.79	-	-	-	-	

V-3:91