Environmental
Geotechnical
Specialists

REPORT

job number J3954/17/E	site address Silsden Primary School
date 07/08/17	Hawber Lane
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GEOTECHNICAL ENVIRONMENTAL

Environmental Geotechnical Specialists

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Environmental Geotechnical Specialists

Report on a Geotechnical Investigation

Location:	Silsden Primary School Hawber Lane, Silsden, Keighley, BD20 0LR
For:	Bradford MDC
Consultants:	Sir Frederick Snow and Partners
Report No.	J3954/17/E
Report date:	August 2017

For and on behalf of **Rogers Geotechnical Services Ltd**

Rob Palmer MSc FGS
Geotechnical & Environmental Engineer

Imran Sakoor BEng
Geotechnical Engineer

Report Summary[1]

Item	Comments	Section
Development	Construction of a new school.	1.
Geology	Superficial geology – Till deposits. Solid geology – Millstone Grit Group.	4.
Strata Conditions	Nominal thickness of topsoil over soft becoming firm silty slightly sandy slightly gravelly CLAY. NHBC Class – Low.	5. & 5.1
Groundwater	3.0m (BH1).	5.2
Foundation Design	Shallow strip or spread foundations constructed within the natural deposits (minimum depth 2.0m bgl).	8.1
Ground-floor	Suspended ground-floor slab.	8.3
Pavement Design	Assumed CBR = <2%	8.4
Effect of Sulphates	DS-1, ACEC Classification AC-1s.	8.5

[1] This summary should not be relied upon to provide a comprehensive review. All of the information contained in this document should be considered.

1. Introduction

It is understood that the site is to be developed by the construction of a new primary school. Consequently, a site investigation has been undertaken in accordance with the instruction from the client. This work was required in order to determine the nature of the underlying soils, to assess their engineering properties and to assist in the design of safe and economical foundations for the proposed development. This report describes the work undertaken, presents the data obtained and discusses the ground conditions in relation to the proposed works.

2. Limitations

The recommendations made and opinions expressed in this report are based on the ground conditions revealed by the site works, together with an assessment of the site and of the laboratory test results. Whilst opinions may be expressed relating to sub-soil conditions in parts of the site not investigated, for example between borehole positions, these are for guidance only and no liability can be accepted for their accuracy.

This report has been prepared in accordance with our understanding of current best practice. However, new information or legislation, or changes to best practice may necessitate revision of the report after the date of issue.

3. Fieldworks

The fieldworks were undertaken on the 10th July 2017 and included the following:

- Four windowless sample boreholes.
- Four dynamic probes.
- Once light cable percussive borehole.

The investigatory locations are shown on the site plan which is presented in Appendix 1 to this report.

3.1 Windowless Sample Boreholes

These boreholes were sunk using a drive-in windowless sampler. The cores were undertaken in 1m lengths and reduced in diameter from 90mm for the first 1m through 80mm, 70mm and 60mm for subsequent 1m increments. The recovered cores were sealed and returned to the laboratory for logging and subsequent testing. The soils were described in general accordance with BS5930: 2015 and full descriptions are given on the windowless sample records which are presented in Appendix 2. Also included on these records are the core diameters and percentages of core recovered.

3.2 Dynamic Probes

Dynamic penetration tests were undertaken adjacent to the windowless sample boreholes in accordance with the procedure given in BS1377: 1990: Part 9, using the super heavy penetrometer (DPSH). This probe consists of a 63.5kg mass falling through 750mm onto an anvil, which drives a 50mm diameter cone into the ground. The number of blows required to drive the cone through successive 100mm increments are recorded as the N_{100} values. The results of the dynamic penetration tests are tabulated and presented as bar charts of N_{100} values versus depth in Appendix 3.

3.3 Light Cable Percussive Borehole

The borehole was sunk using a 1.5 tonne capacity light cable percussive (shell and auger) drilling rig with 150mm diameter tools and casing. During the boring operations, representative disturbed samples of the arisings were taken at regular depth intervals and sealed in plastic bags. Standard penetration tests (SPTs) were undertaken at regular depth increments; accept in cohesive materials where SPTs and undisturbed samples (U100s) were alternated. The SPTs were conducted in accordance with the procedures given in BS1377 : 1990 : Part 9 : 3.3, and the results are summarised on the borehole records. During this work an automatic trip hammer of 63.5kg falling through 760mm was employed to drive either a cone or split barrel sampler assembly into the ground, the barrel samples were retained in air tight plastic containers. It may be appreciated that the approximate cohesion of clay soils may be obtained by multiplying the equivalent SPT value by approximately 4.5 (after Stroud, 1975). The 100mm diameter undisturbed (U100) samples were sealed within a liner with wax and plastic caps. Groundwater levels were recorded when struck and boring stopped for a period of time to allow the water level to be monitored.

All recovered samples were returned to the laboratory for subsequent logging and testing. The soils were described in general accordance with BS5930: 2015, and full descriptions are given on the borehole records, which are presented as Appendix 4. Also included on these records are the water levels, casing details, standard penetration test results and a record of samples taken.

4. Geology

The available published geological data for the site has been examined and the following table presents the anticipated geology.

Table 1: Geological Data for the Site

Strata Type	Strata Name[2]	Previous Name[3]	Description[2]
Superficial Geology	Till	Boulder Clay	Group of sediments laid down by the direct action of glacial ice. Variable lithology, usually sandy, silty clay with pebbles, but can contain gravel-rich, or laminated sand layers; varied colour and consistency (generic description).

[2] Sources: British Geological Survey (NERC) Map Sheets 69; Bradford; Solid and Drift Edition, and Geology of Britain Viewer [*online resource from www.bgs.ac.uk*]
[3] Sources: British Geological Survey (NERC) Lexicon of Named Rock Units [*online resource from www.bgs.ac.uk*]

Solid Geology	Millstone Grit Group	Millstone Grit	Fine- to very coarse-grained feldspathic sandstones, interbedded with grey siltstones and mudstones, with subordinate marine shaly mudstone, claystone, coals and seatearths.

Markers within the same faulted block on the geological map suggest that the stratum generally dips at about 8° to the east.

5. Strata Conditions

In accordance with the geology of the area, the succession has been shown to include the following:

Table 2: Generalised Strata Profile

Depth m below ground level to underside of layer	**Strata Type**	**Positions Layer Revealed**	**Groundwater Strikes** m below ground level
0.1 – 0.2	Topsoil	All	None
+2.0 – 8.50	Silty sandy gravelly CLAY	All	3.0 (BH1)
3.6	Clayey silty sandy GRAVEL	BH1	None
+10.45	MUDSTONE	BH1	None

'+' denotes that the strata extended below the termination depth of the investigated positions, thus the extent of the deposit is only proven to the depths indicated.

5.1 General Lithology

Beneath a capping of topsoil, silty clay comprising variable amounts of sand and gravel throughout was revealed to the termination depths of boreholes WS1 to WS4 and to 8.5m in BH1. In addition, a 0.5mm thick lens of gravel was revealed within BH1 at 3.1m depth. It is considered that these soils are representative of the superficial till deposits which are indicated to underlie the site on the published geological map. Mudstone was revealed at the base of the superficial deposits within BH1 and was observed to the borehole termination at 10.45m.

5.2 Groundwater

The groundwater conditions entered on the borehole records are those observed at the time of the investigation. The normal rate of boring does not permit the recording of an equilibrium water level for any one strike. Moreover, groundwater levels are subject to seasonal variation or changes on local drainage conditions. Notwithstanding this, a groundwater strike was recorded within BH1 at a depth of 3.0m. It is considered that this water strike may not represent the phreatic surface, but perched groundwater. It should be appreciated that this water strike was recorded just above a 0.5m thick lens of gravel.

6. Insitu Testing

6.1 Dynamic Penetration Tests

Dynamic penetration tests were undertaken adjacent to the windowless sample borehole positions and a summary of the results is presented below:

Table 3: Summary of Dynamic Penetration Tests

Position	Blows/100mm			Refusal type (Effective/ Abrupt)[4]	Comments
	0 - 2	3 - 10	10+		
	Depth to which blow count range was observed (m)				
DP1	1.8	2.2 4.3	2.5 5.0	Effective	Low results recorded to 1.8m whereupon results sharply increase, with stronger zone present until 2.6m. Results then gradually increase until refusal.
DP2	1.7	4.3	5.3	Effective	Low results recorded to 1.8m whereupon results sharply increase, with stronger zone present until 2.5m. Results then gradually increase until refusal.
DP3	2.0	2.5 4.9	2.7 6.0	Effective	Low results recorded to 2.0m whereupon results sharply increase, with stronger zone present until 2.7m. Results then gradually increase until refusal.
DP4	1.9	5.0	6.3	Effective	Low results recorded to 1.8m. Results then gradually increase until refusal.

7. Laboratory Testing - Geotechnical

The following programme of laboratory testing has been undertaken on samples obtained during this investigation:

- Moisture content determinations — BS 1377: 1990: Pt2: 3.2
- Index properties (1 point) — BS 1377: 1990: Pt2: 4.4, 5.3 & 5.4
- Linear shrinkage — BS 1377: 1990: Pt2: 6.3
- Particle size distribution (Wet sieve) — BS 1377: 1990: Pt2: 9.2
- Soluble sulphate content — BS 1377: 1990: Pt3: 5
- pH value — BS 1377: 1990: Pt3: 9
- Undrained shear strength (Triaxial) — BS 1377: 1990: Pt7: 8 & 9

The test results are presented in Appendix 5 and are summarised below:

[4] Abrupt refusal: obstruction or bedrock encountered. Effective refusal: +25 blows/100mm.

Table 4: Summary of Geotechnical Test Results				
Test type	**Number of tests**	**Range of results**		**Comments**
Moisture content determinations	10	16 to 22%		Variable with depth.
Index Properties (1 Point)	7	LL PL PI LS	24% to 38% 14% to 20% 10% to 18% 07% to 11%	Clay of low to intermediate plasticity. Consistency index 0.6 to 1.1 NHBC Class – Negligible to Low
Particle size distribution (Wet sieve)	1	Cobbles Gravel Sand Fines	5% 74% 15% 6%	Gap-graded clayey sandy GRAVEL. Uniformity coefficient 140 Curvature coefficient 6.7
Soluble sulphate & pH	2	SO_4 pH	<10 mg/l 7.4 & 7.8	DS-1, ACEC Classification AC-1s.
Undrained shear strength (Triaxial)	1	c_u γ	42 kN/m^2 23.5 kN/m^3	Medium strength. Firm consistency.

7.1 Geotechnical Properties

The idealised geotechnical properties employed in design are summarised below.

Table 5: Summary of Geotechnical Properties			
Property	**Range of values**		**Comments**
Volume change potential (NHBC)	Low		Silty slightly sandy slightly gravelly CLAY
Shear strength parameters (at foundation level)	c_u	40kN/m^2	Based on dynamic probes, triaxial compression test results and consistency indices
Concrete classification	DC1		Natural ground locations (Static water)

8. Discussion of Ground Conditions - Geotechnical

It is understood that this site is to be developed by the construction of a primary school with areas of hard-standing, soft landscaping and access roads/paths. The precise structural details are not currently known, thus the discussion below is of a generalised nature.

8.1 Foundations

It cannot be recommended that foundations be constructed directly within the topsoil or soft near surface soils revealed at this site. These soils are present in a weak and variable condition such that excessive total and or differential settlement could occur under moderately light surface loading.

The results of this investigation indicate that till deposits, comprising firm silty slightly sandy slightly gravelly clay will be revealed from depths of between 1.8m and 2.0m. It is considered that these soils

will provide a suitable bearing stratum, provided that the foundations are placed within soil generally described as being present in a firm insitu condition. It is considered that strip or spread foundations constructed within this material, at a minimum depth of say 2.0m, could be designed assuming an allowable increase in stress given in the following table:

Table 6: Allowable increase in stress

Foundation Type		Strip Footings			Spread Footings		
Foundation Breadth	B (m)	0.6	1.0	1.5	1.0	2.0	3.0
Foundation Depth	D (m)		2.0			2.0	
Allowable increase in stress	(kN/m²)	100	95	90	145	130	125

The allowable increase in stress given above assumes a factor of safety of 3 against general shear failure, with cohesion of 40kN/m^2 at the foundation depths. Settlements at the above loading intensities should remain within tolerable limits for the type of structure proposed provided that the underlying soils are carefully inspected immediately final trimming has taken place. Should any soft or weak material be encountered they should be locally removed and replaced with lean-mix concrete or compacted granular soil. In addition, if the excavations are required to stand open for any period of time then a blinding layer of lean-mix concrete should be placed in the excavation bases. This expedient will reduce softening or loosening of the sub-grade due to the ingress of surface water.

Should seepages of groundwater be encountered it is considered that they could be dealt with using a simple form of de-watering. Such a system could include the excavation of sumps from which the water could be pumped.

The stability of the excavation faces cannot be guaranteed thus temporary support to the excavation faces may become necessary unless the foundations are constructed using trench-fill techniques. In this method the foundation trenches should be excavated, inspected and backfilled with concrete as a continuous operation. Under no circumstances should operatives be allowed to enter unsupported excavations.

8.2 Volume Change Potential

It should be appreciated that the cohesive soils revealed at this site possess a low volume change potential under the guidance of the NHBC standards. Therefore, it is will be necessary to ensure that the depths of the foundations are designed in accordance with the Chapter 4.2 of the NHBC standards[5]. The methodology provided in the guidance will require the identification of any trees, still present at, or recently removed from, the site and the distance from the proposed foundations. This may result in foundation depths greater than those given above and the requirement for heave protection to be employed against footings and below the underside of the floors and beams.

[5] NHBC Standards, Chapter 4.2, *Building near trees*

8.3 Ground-floors

In light of the soft near surface soils, which were revealed to depths of up to 2.0m, it is not recommended that ground bearing ground floor slabs be employed. In this instance it would be necessary to suspend floors between foundation positions, such that the floor loads are transmitted via the foundations to competent soils at depth.

8.4 Access Roads, Drive-ways and Hard-standing

It is considered that any roads or hard-standing at the site could be constructed employing traditional pavement design. A design California Bearing Ratio (CBR) of <2% could be employed in the pavement design[6]. However, it is recommended that proof rolling of the sub-grade be undertaken to establish the suitability of the soils, to expose any soft or weak ground and to ensure the sub-grade is well compacted prior to construction. Any areas of soft or weak ground should be remediated by increasing the sub-base thickness. Alternatively, weak material could be locally removed and replaced with a compacted granular capping layer. If construction were to be undertaken during the winter or after periods of prolonged rainfall, it may be prudent to employ a geotextile and/or a geogrid between the sub-base and sub-grade.

8.5 Effect of Sulphates

In view of the nature of the underlying soils it is considered that the design sulphate class be assessed with reference to Table C1[7], which is provided in BRE Special Digest 1, *Concrete in aggressive ground*: Part C. On the basis of this table and considering the soluble sulphate contents recorded, it can be shown that well compacted buried concrete should be designed in accordance with Class DS-1 requirements. Assuming static groundwater, the table also indicates that the aggressive chemical environment for concrete (ACEC) classification is AC-1s.

In order to evaluate the design chemical (DC) class for the buried concrete at this site reference should be made to Table D1[8], which can be found in Part D, *Specifying concrete for general cast-in-situ use,* of BRE Special Digest 1. From this table it may be shown that for an intended working life of at least 50 years the concrete design class DC-1 is required

9. Further Work

- This report should be forwarded to the relevant authorities as soon as practicable to ensure they have sufficient time to review and discuss any issues.
- Detailed design of the sub-structure.

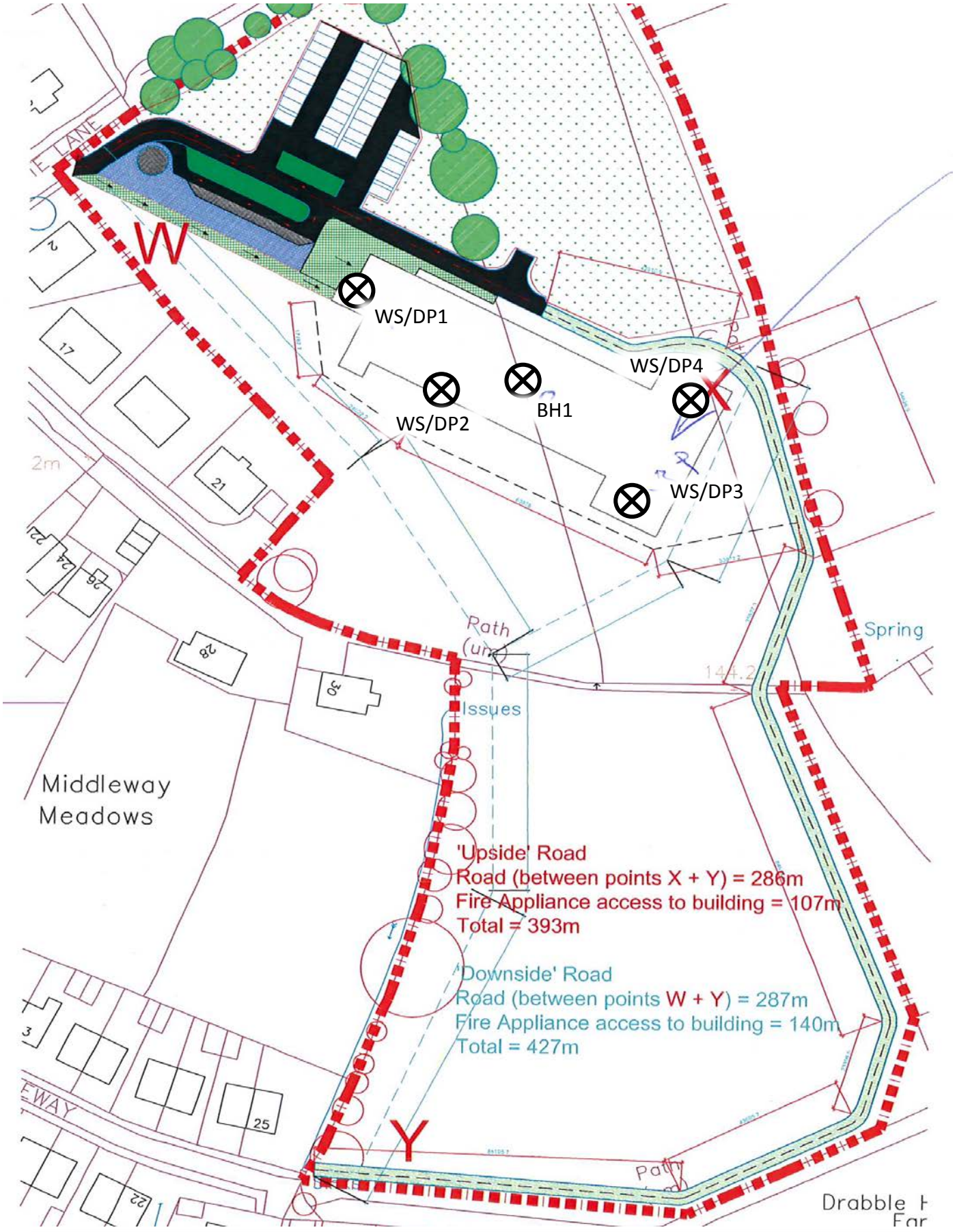
[6] Table 13/2 Design Manual for Roads and Bridges (1995), HA44/9: Volume 4 Section 1 Part 1, Highways Agency.
[7] Table C1, *Aggressive Chemical Environment for Concrete (ACEC) classification for green field locations*
[8] Table D1, *Selection of the DC Class and the number of APMs for concrete elements where the hydraulic gradient due to groundwater is 5 or less: for general in-situ use of concrete.*

10. References

- British Standards Institution (1990) BS1377: *British standard methods of test for soils for civil engineering purposes,* B.S.I., London.
- British Standards Institution (2015) BS5930: *Code of practice for site investigations*, B.S.I., London.
- British Geological Survey (NERC) (2017), BGS, Keyworth.
  - Geology of Britain Viewer: (*http://maps.bgs.ac.uk/geologyviewer_google/googleviewer.html)*
  - Lexicon of Named Rock Units: (*http://www.bgs.ac.uk/lexicon/)*
- Building Research Establishment (BRE) Special Digest 1 (2005), Third Edition: Concrete in aggressive ground.
  - Part C: *Assessing the aggressive chemical environment.*
  - Part D: *Specifying concrete for general cast-in-situ use.*
- NHBC Standards, Chapter 4.2, *Building near trees*
- Design Manual for Roads and Bridges (1995), HA44/9: Volume 4 Section 1 Part 1, Highways Agency

Appendix 1

Site Plan



Plan not to scale and investigation positions approximated from site operative's notes.

Title: **Investigation Location Plan**

Rogers Geotechnical Services Ltd	Site Name: **Silsden Primary School**	Job No: **J3954/17/E**

Appendix 2

Windowless Sample Borehole Records

Borehole Log

Borehole No. **WS1**

Sheet 1 of 1

Project Name: Silsden Primary School	Project No. J3954/17/E	Co-ords:	Hole Type WLS
Location: Keighley		Level:	Scale 1:50
Client: City of Bradford MDC		Dates: 10/07/2017	Logged By RAP

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Dia. (mm)	TCR (%)	Results	Depth (m)	Level (m)	Legend	Stratum Description
		0.60	D	90	70		0.20			TOPSOIL (Soft dark brown silty slightly sandy CLAY with occasional rootlets).
										Soft orangish brown mottled orange silty slightly sandy slightly gravelly CLAY with low cobble content. Gravel is sub-rounded and sub-angular fine to coarse of sandstone. Sandstone cobbles.
				80	10		1.00			No recovery: Cobble blocking sample tube.
				70	100		2.00			Firm silty slightly gravelly CLAY with low cobble content. Gravel is sub-angular fine to coarse of sandstone. Cobbles of sandstone.
							2.60			End of Borehole at 2.60m

Remarks

Borehole Log

Borehole No. **WS2**

Sheet 1 of 1

Project Name: Silsden Primary School	Project No. J3954/17/E	Co-ords:	Hole Type WLS
Location: Keighley		Level:	Scale 1:50
Client: City of Bradford MDC		Dates: 10/07/2017	Logged By RAP

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Dia. (mm)	TCR (%)	Results	Depth (m)	Level (m)	Legend	Stratum Description
							0.15			TOPSOIL (Soft dark brown silty slightly sandy CLAY with occasional rootlets).
		0.60	D		100					Soft orangish brown mottled orange silty slightly sandy slightly gravelly CLAY with low cobble content. Gravel is sub-rounded and sub-angular fine to coarse of sandstone. Cobbles of sandstone.
		1.20	D		90					
							1.90			Firm dark grey silty slightly sandy slightly gravelly CLAY. Gravel is sub-rounded fine to medium of various lithologies.
		2.10	D		90					
		2.60	D				2.60			Soft to firm dark grey silty very sandy CLAY with occasional horizons of fine sand.
							3.00			End of Borehole at 3.00m

Remarks

Borehole Log

Borehole No. **WS3**

Sheet 1 of 1

Project Name: Silsden Primary School	Project No. J3954/17/E	Co-ords:	Hole Type WLS
Location: Keighley		Level:	Scale 1:50
Client: City of Bradford MDC		Dates: 10/07/2017	Logged By RAP

Well	Water Strikes	Samples and In Situ Testing					Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Dia. (mm)	TCR (%)	Results				
		0.80	D	90	100		0.10			TOPSOIL (Soft dark brown silty slightly sandy CLAY with occasional rootlets).
							0.40			Soft orangish brown mottled orange silty slightly sandy slightly gravelly CLAY.
		1.70	D	80	90					Soft grey mottled orangish brown silty slightly sandy slightly gravelly CLAY with low cobble content. Gravel is sub-rounded and sub-angular fine to coarse of sandstone. Cobbles of sandstone.
		2.30	D	70	85		2.00			Firm dark brown silty gravelly CLAY. Gravel is sub-rounded and sub-angular fine to coarse of limestone.
							3.00			End of Borehole at 3.00m

Remarks

AGS

Borehole Log

Borehole No. **WS4**

Sheet 1 of 1

Project Name: Silsden Primary School	Project No. J3954/17/E	Co-ords:	Hole Type WLS
Location: Keighley		Level:	Scale 1:50
Client: City of Bradford MDC		Dates: 10/07/2017	Logged By RAP

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Dia. (mm)	TCR (%)	Results	Depth (m)	Level (m)	Legend	Stratum Description
				90	100		0.15			TOPSOIL (Soft dark brown silty slightly sandy CLAY with occasional rootlets).
							0.40			Soft orangish brown mottled orange silty slightly sandy slightly gravelly CLAY.
				80	40					Soft grey mottled orangish brown silty slightly sandy slightly gravelly CLAY with low cobble content. Gravel is sub-rounded and sub-angular fine to coarse of sandstone. Cobbles of sandstone.
							2.00			End of Borehole at 2.00m

1 2 3 4 5 6 7 8 9 10

Remarks

AGS

Appendix 3

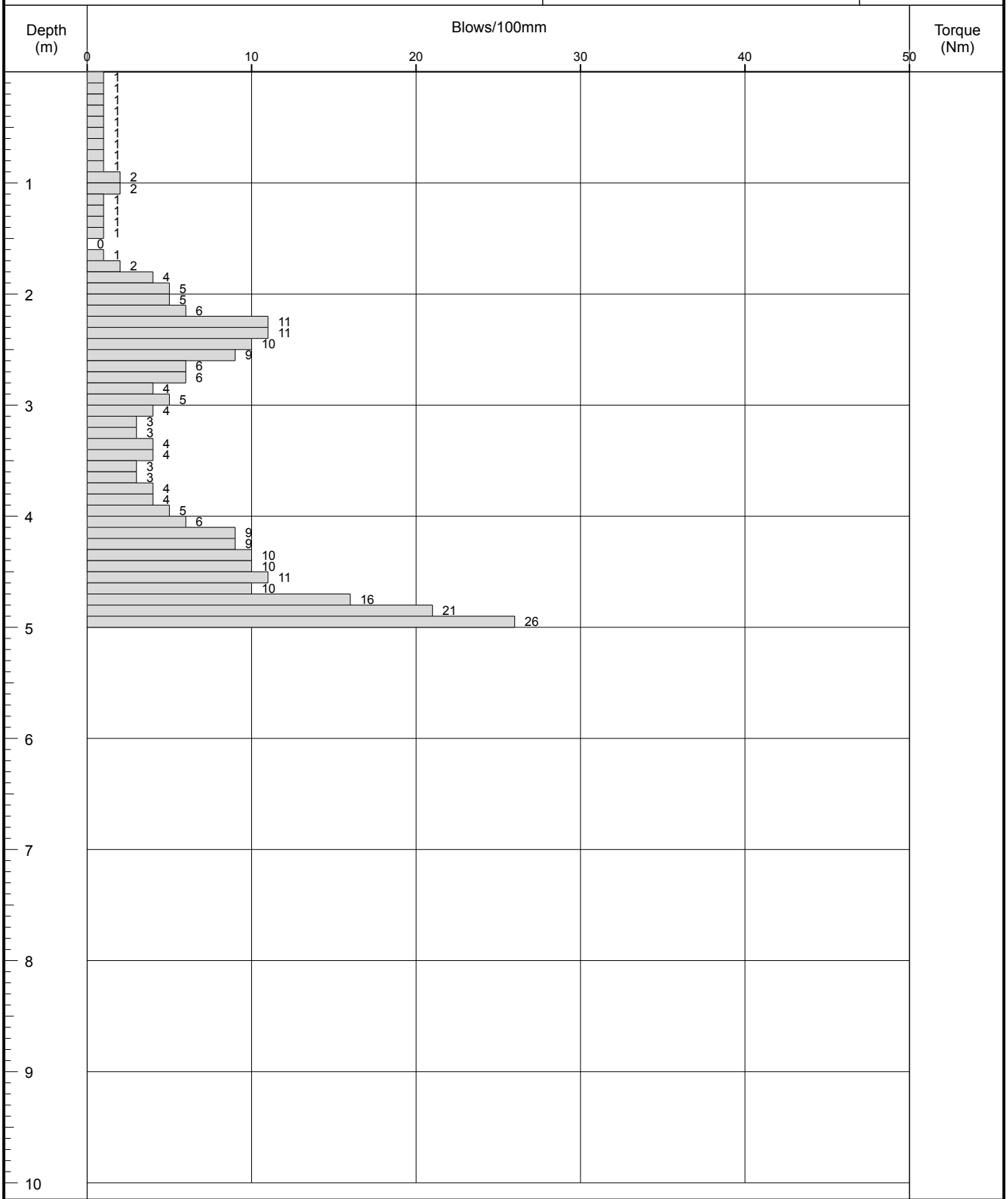
Dynamic Probe Results

Probe Log

Probe No. **DP1**

Sheet 1 of 1

Project Name: Silsden Primary School	Project No. J3954/17/E	Co-ords:	Hole Type DCP
Location: Keighley		Level:	Scale 1:50
Client: City of Bradford MDC		Dates: 10/07/2017	Logged By KW



Remarks:

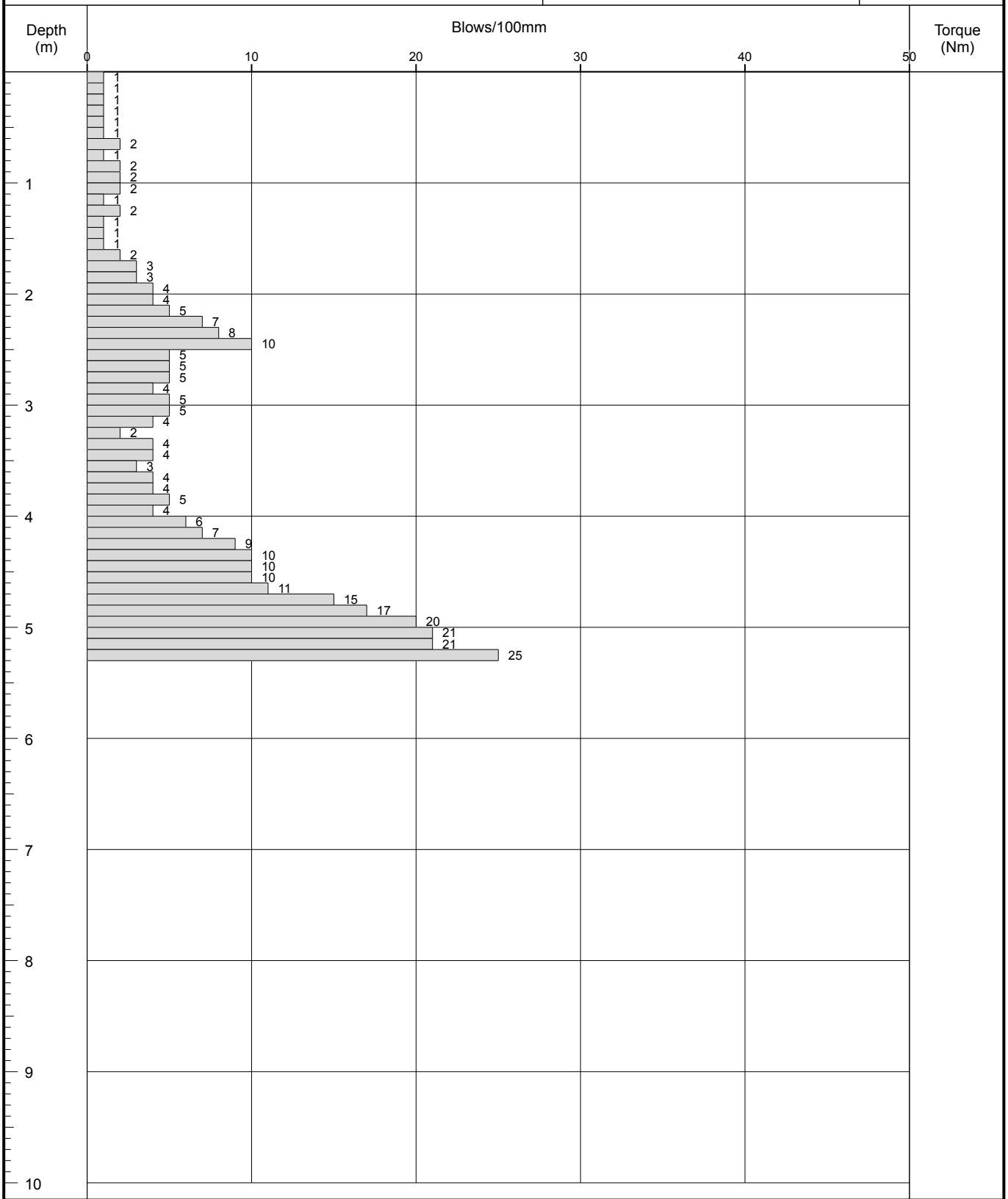
Fall Height	750mm	Cone Base Diameter	50.5mm
Hammer Wt	63.5kg	Final Depth	5m
Probe Type	DPSH-B		

Probe Log

Probe No. **DP2**

Sheet 1 of 1

Project Name: Silsden Primary School	Project No. J3954/17/E	Co-ords:	Hole Type DCP
Location: Keighley		Level:	Scale 1:50
Client: City of Bradford MDC		Dates: 10/07/2017	Logged By KW

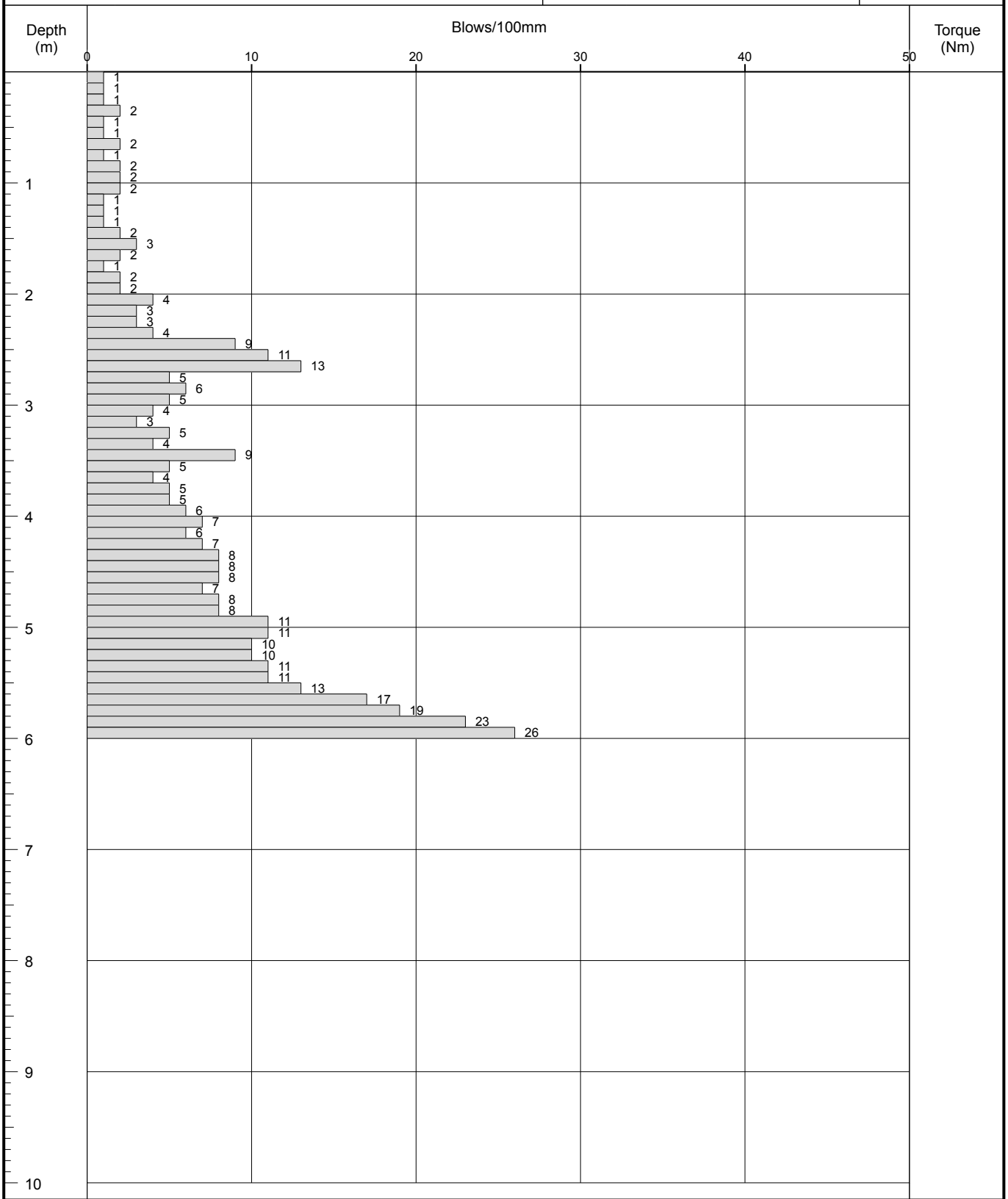


Remarks:	Fall Height	750mm	Cone Base Diameter	50.5mm
	Hammer Wt	63.5kg	Final Depth	5.3m
	Probe Type	DPSH-B		

Probe Log

Probe No.
DP3
Sheet 1 of 1

Project Name: Silsden Primary School	Project No. J3954/17/E	Co-ords:	Hole Type DCP
Location: Keighley		Level:	Scale 1:50
Client: City of Bradford MDC		Dates: 10/07/2017	Logged By KW



Remarks:

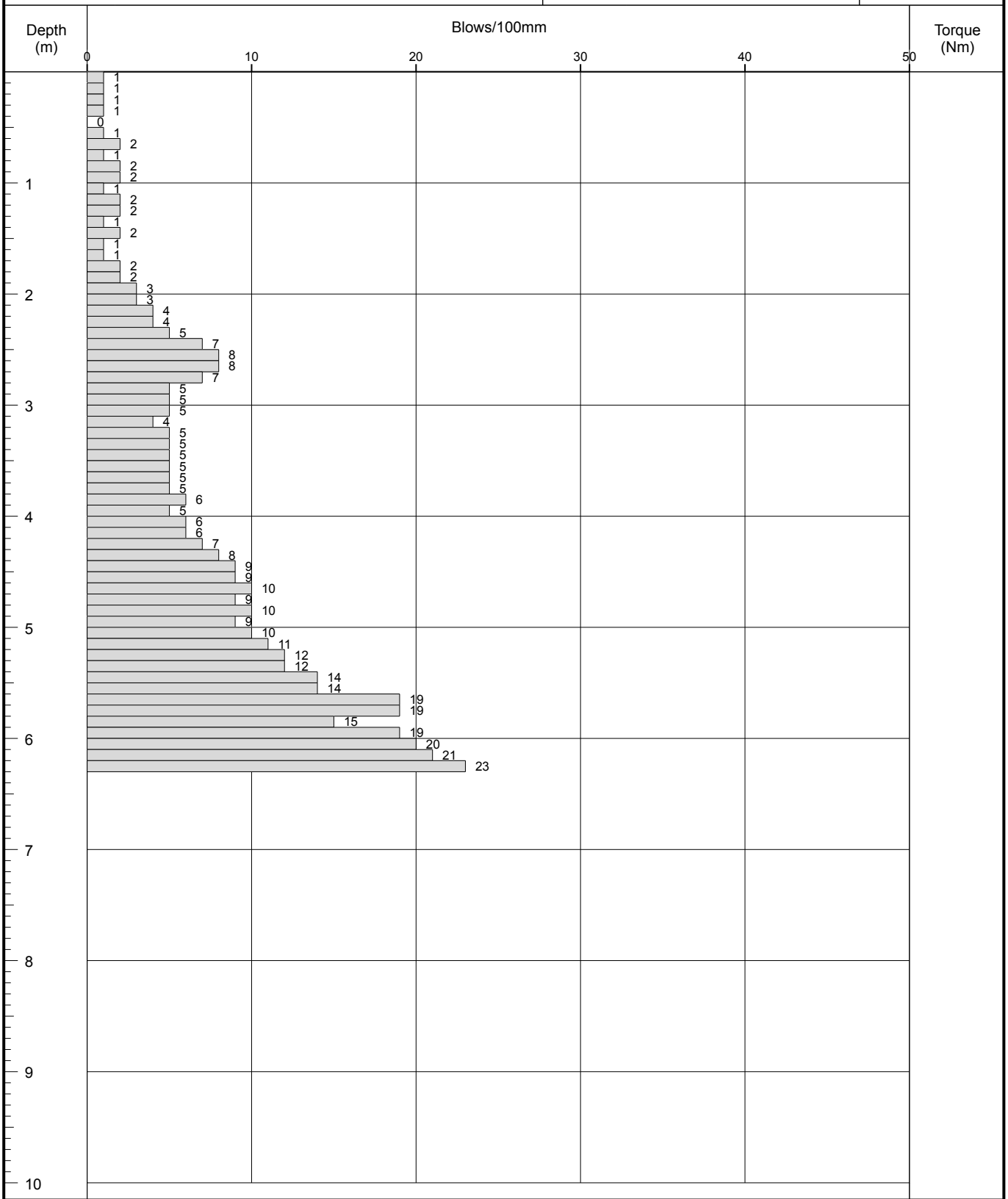
Fall Height	750mm	Cone Base Diameter	50.5mm
Hammer Wt	63.5kg	Final Depth	6m
Probe Type	DPSH-B		

Probe Log

Probe No. **DP4**

Sheet 1 of 1

Project Name: Silsden Primary School	Project No. J3954/17/E	Co-ords:	Hole Type DCP
Location: Keighley		Level:	Scale 1:50
Client: City of Bradford MDC		Dates: 10/07/2017	Logged By KW



Remarks:

Fall Height	750mm	Cone Base Diameter	50.5mm
Hammer Wt	63.5kg	Final Depth	6.3m
Probe Type	DPSH-B		

Appendix 4

Light Cable Percussive Borehole Records

Borehole Log

Borehole No. **BH1**

Sheet 1 of 2

Project Name: Silsden Primary School	Project No. J3954/17/E	Co-ords: -	Hole Type CP
Location: Keighley		Level:	Scale 1:50
Client: City of Bradford MDC		Dates: 10/07/2017 - 10/07/2017	Logged By RAP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.15 - 1.20	B		0.15			TOPSOIL (Soft dark brown silty slightly sandy CLAY with occasional rootlets).
		0.20	D					Soft orangish brown mottled orange silty slightly sandy slightly gravelly CLAY.
		0.50	D					
		1.20		N=7 (1,2/1,2,2,2)	1.30			
		1.20 - 1.65	B					Soft grey mottled orangish brown silty slightly sandy slightly gravelly CLAY with low cobble content. Gravel is sub-rounded and sub-angular fine to coarse of sandstone. Cobbles of sandstone.
		1.70	D					
		2.00 - 2.45	U					
	▼	2.00 - 2.50	B					
		2.60	D		2.60			Firm dark brown silty gravelly CLAY. Gravel is sub-rounded and sub-angular fine to coarse of limestone.
	▽	3.00		N=47 (5,15/25,8,7,7)	3.10			
		3.00 - 3.45	B					Medium dense brown clayey silty sandy sub-angular to rounded fine to coarse GRAVEL of various lithologies. Medium cobble content.
		3.50	D					
		3.60	D		3.60			Stiff dark brown silty gravelly CLAY. Gravel is sub-rounded and sub-angular fine to coarse of various lithologies.
		4.00 - 4.45	U					
		4.50	D					
		5.00		N=28 (3,5/6,7,8,7)				
		5.00 - 5.45	B					
		5.50	D					
		6.00 - 6.45	U					
		6.50	D					
		7.50		N=30 (4,6/7,7,8,8)				
		7.50 - 7.95	B					
		8.50	D		8.50			MUDSTONE recovered as very stiff brown gravelly CLAY.
		9.00		N=47 (5,9/10,12,12,13)				
		9.00 - 9.45	B					
		9.50	D					

Continued on next sheet

Remarks

1 hour waiting for access. 1 hour digging service pit. 0.5 hours pulling casing and backfilling hole. 0.33 hours monitoring water level.

Borehole Log

Borehole No. **BH1**

Sheet 2 of 2

Project Name: Silsden Primary School	Project No. J3954/17/E	Co-ords: -	Hole Type CP
Location: Keighley		Level:	Scale 1:50
Client: City of Bradford MDC		Dates: 10/07/2017 - 10/07/2017	Logged By RAP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		10.00		50 (6,10/50 for 255mm)				
		10.00 - 10.45	D		10.45			End of borehole at 10.45 m

Remarks

1 hour waiting for access. 1 hour digging service pit. 0.5 hours pulling casing and backfilling hole. 0.33 hours monitoring water level.

Appendix 5

Laboratory Testing - Geotechnical

Summary of Classification Test Results

Project No.: J3954/17/E

Project Name: Silsden Primary School

Hole No.	Sample Ref	Top	Base	Type	Soil Description	Density bulk Mg/m3	Density dry Mg/m3	w %	Passing 425µm %	LL %	PL %	PI %	Particle density Mg/m3	Remarks
BH1	5	1.70		D	Brown sandy CLAY.			16.0	78	34 -1pt	17	17		
BH1	8	2.60		D	Brown gravelly CLAY.			16.0	53	24 -1pt	14	10		
WS1	1	0.60		D	Orangish brown silty gravelly CLAY.			21.0	93	32 -1pt	18	14		
WS2	1	0.60		D	Orangish brown silty gravelly CLAY.			18.0						
WS2	2	1.20		D	Orangish brown silty gravelly CLAY.			17.0	94	29 -1pt	17	12		
WS2	3	2.10		D	Dark grey silty gravelly CLAY.			18.0						
WS2	4	2.60		D	Dark grey sandy CLAY.			20.0	67	26 -1pt	16	10		
WS3	1	0.80		D	Orangish brown silty gravelly CLAY.			18.0						
WS3	2	1.70		D	Brown gravelly CLAY.			22.0	85	38 -1pt	20	18		
WS3	3	2.30		D	Brown gravelly CLAY.			17.0	71	34 -1pt	18	16		

All tests performed in accordance with BS1377:1990 unless specified otherwise

Key

Density test | Liquid Limit | Particle density

Linear measurement unless : | 4pt cone unless : | sp - small pyknometer

wd - water displacement | cas - Casagrande method | gj - gas jar

wi - immersion in water | 1pt - single point test

Date Printed: 31/07/2017

Approved By: Jude

Table 1

sheet 1

Linear Shrinkage - Summary of Results

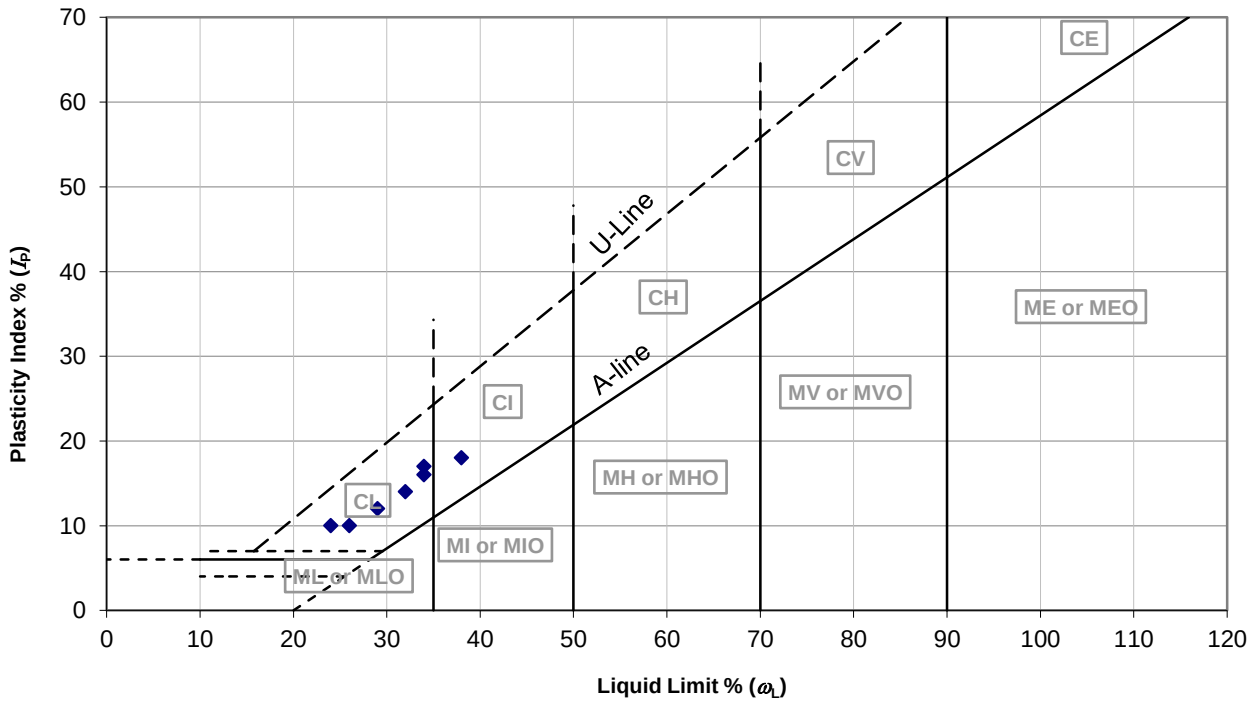
Project No.	Project Name
J3954/17/E	Silsden Primary School

Hole No.	Sample				Soil Description	Material <425µm %	Preparation	Linear Shrinkage %	Remarks
	Ref	Top	Base	Type					
BH1	5	1.70		D	Brown sandy CLAY.	78	Specimen prepared from natural material	11	
BH1	8	2.60		D	Brown gravelly CLAY.	53	Specimen prepared from natural material	7	
WS1	1	0.60		D	Orangish brown silty gravelly CLAY.	93	Specimen prepared from natural material	9	
WS2	2	1.20		D	Orangish brown silty gravelly CLAY.	94	Specimen prepared from natural material	7	
WS2	4	2.60		D	Dark grey sandy CLAY.	67	Specimen prepared from natural material	8	
WS3	2	1.70		D	Brown gravelly CLAY.	85	Specimen prepared from natural material	9	
WS3	3	2.30		D	Brown gravelly CLAY.	71	Specimen prepared from natural material	9	

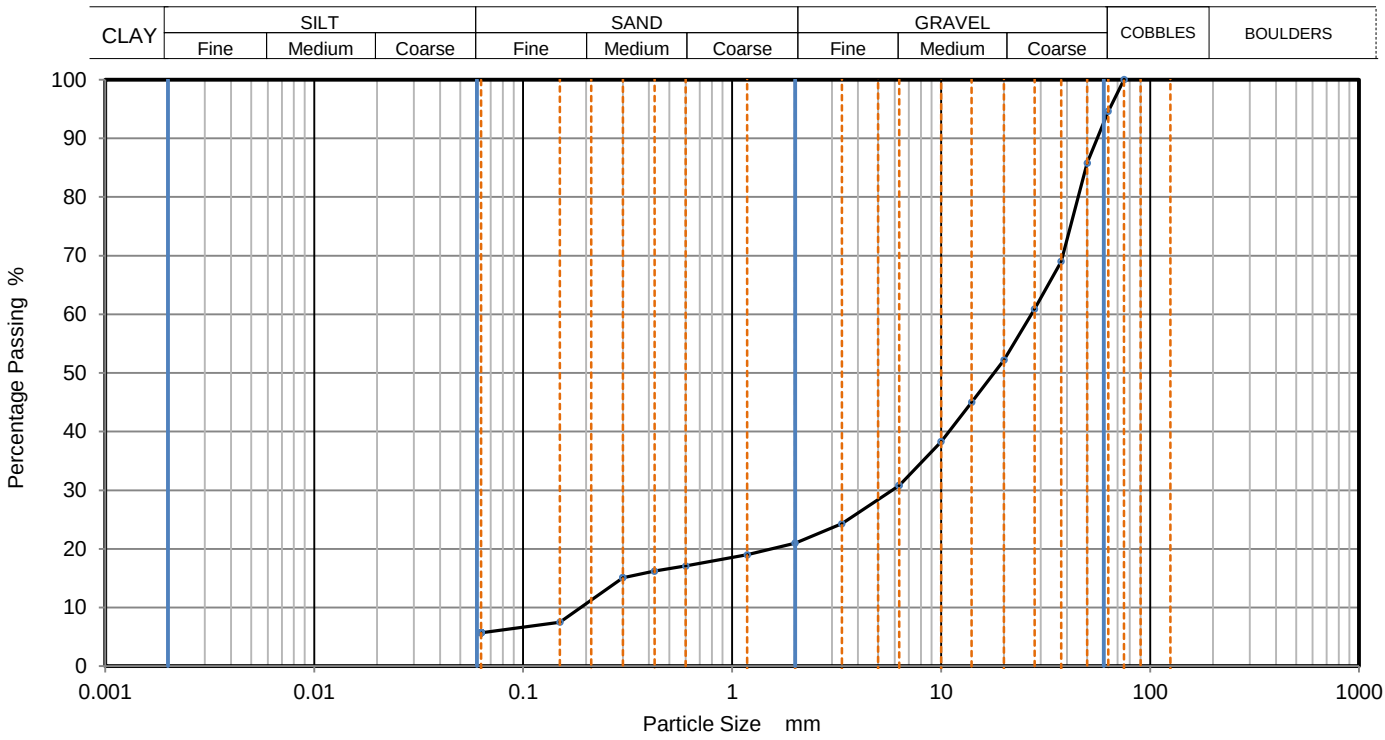
Notes	Date Printed	Approved By	Table
Tests performed in accordance with BS 1377 : Part 2 : 1990, clause 6.5 unless annotated otherwise	31/07/2017	Jude	2 sheet 1

Rogers Geotechnical Services Ltd. Offices 1&2, Barncliffe Business Park, Near Bank, Shelley, Huddersfield, HD8 8LU	**Interpretation of Moisture Content, Liquid and Plastic Limits**	**J3954/17/E**	
Project Name: Silsden Primary School	**B.S 1377: Part 2: 1990: 3.2, 4 and 5**	Fig. 3	Sheet. 1
Location:		Input By:	Jude
Client: City of Bradford MDC		Check By:	Jude

Location	Depth (m)	Moisture Content (w) (%)	Liquid Limit (wL) (%)	Plastic Limit (wP) (%)	Plasticity Index (IP) (%)	Retained by 425mm (%)	Modified (w) (w') (%)	Modified (IP) (IP') (%)	Liquidity/ Consistency (IL) (%)	Liquidity/ Consistency (IC) (%)	Casagrande Class	N.H.B.C Class (%)
BH1	1.70	16	34	17	17	22	21	13	-0.1	1.1	C L	LOW
BH1	2.60	16	24	14	10	47	30	5	0.2	0.8	C L	*
WS1	0.60	21	32	18	14	7	23	13	0.2	0.8	C L	LOW
WS2	1.20	17	29	17	12	6	18	11	0.0	1.0	C L	LOW
WS2	2.60	20	26	16	10	33	30	7	0.4	0.6	C L	*
WS3	1.70	22	38	20	18	15	26	15	0.1	0.9	C I	LOW
WS3	2.30	17	34	18	16	29	24	11	-0.1	1.1	C L	LOW



	PARTICLE SIZE DISTRIBUTION			Job Ref	J3954/17/E
				Borehole/Pit No.	BH1
Site Name	Silsden Primary School			Sample No.	9
Soil Description	Clayey silty sandy GRAVEL.			Depth, m	3.00
Specimen Reference		Specimen Depth	3.00-3.45 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	RGS_201707200



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	95		
50	86		
37.5	69		
28	61		
20	52		
14	45		
10	38		
6.3	31		
3.35	24		
2	21		
1.18	19		
0.6	17		
0.425	16		
0.3	15		
0.15	8		
0.063	6		

Dry Mass of sample, g: 6648

Sample Proportions	% dry mass
Very coarse	5
Gravel	74
Sand	15
Fines <0.063mm	6

Grading Analysis		
D100	mm	75
D60	mm	27
D30	mm	5.82
D10	mm	0.188
Uniformity Coefficient		140
Curvature Coefficient		6.7

Remarks

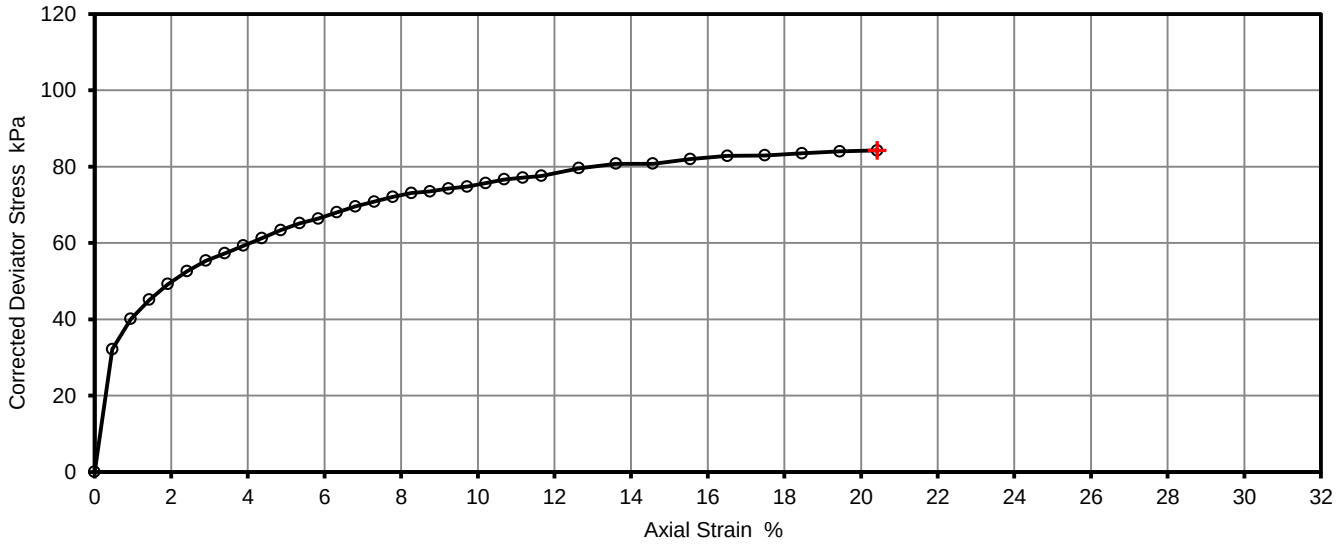
Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	Fig 4
Graham	Jude	Jude	31/07/2017	Sheet 1

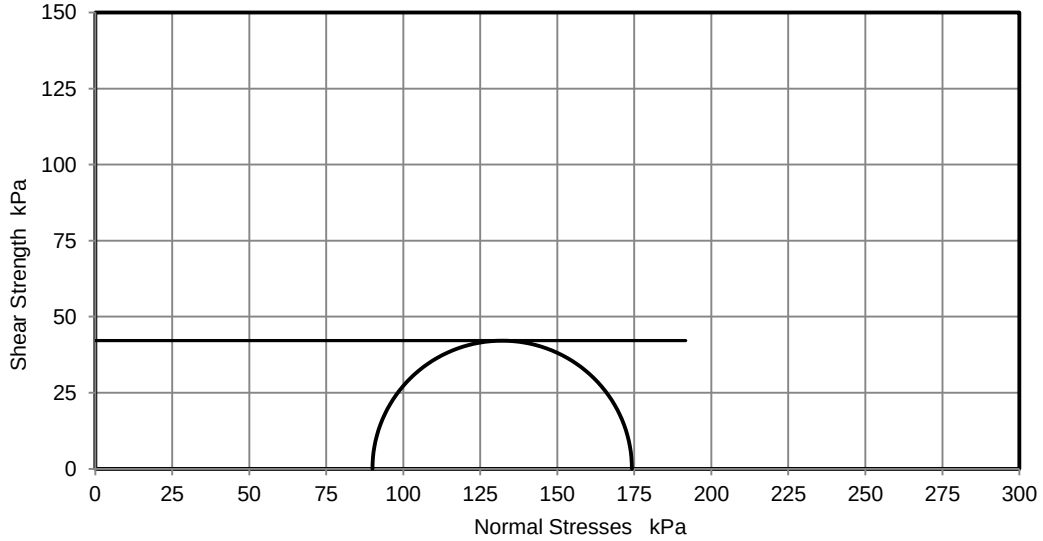
	Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen				Job Ref	J3954/17/E
					Borehole/Pit No.	BH1
Site Name	Silsden Primary School				Sample No.	12
Soil Description	Brown gravelly CLAY.				Depth	4.00
Specimen Reference		Specimen Depth	4.00-4.45	m	Sample Type	U
Specimen Description	Brown gravelly CLAY.				KeyLAB ID	RGS_2017072011
Test Method	BS1377 : Part 7 : 1990, clause 8, single specimen				Date of test	28.07.17

Test Number		1	
Length		200.0	mm
Diameter		100.0	mm
Bulk Density		2.35	Mg/m3
Moisture Content		11.9	%
Dry Density		2.10	Mg/m3
Rate of Strain		2.0	%/min
Cell Pressure		90	kPa
At failure	Axial Strain	20.4	%
	Deviator Stress, (σ1 - σ3)f	84	kPa
	Undrained Shear Strength, cu	42	kPa ½(σ1 - σ3)f
	Mode of Failure	Plastic	

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects

Mohr circles and their interpretation is not covered by BS1377.
This is provided for information only.

Remarks

Approved: Jude

Printed: 31/07/2017 16:42

Lab Sheet Reference :

Fig. No. 5

Sheet 1

Chemtest
The right chemistry to deliver results
Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.co.uk

Final Report

Report No.:	17-19107-1		
Initial Date of Issue:	26-Jul-2017		
Client	Rogers Geotechnical Services Ltd		
Client Address:	Unit 4, Barncliffe Business Park Near Bank Shelley Huddersfield West Yorkshire HD8 8LU		
Contact(s):	Rob Palmer		
Project	J3954/16/E Silsden Primary		
Quotation No.:		**Date Received:**	24-Jul-2017
Order No.:	0717-46	**Date Instructed:**	24-Jul-2017
No. of Samples:	2		
Turnaround (Wkdays):	3	**Results Due:**	26-Jul-2017
Date Approved:	26-Jul-2017		
Approved By:			

Details: Keith Jones, Technical Manager

Chemtest
The right chemistry to deliver results

Results - Soil

Project: J3954/16/E Silsden Primary

Client: Rogers Geotechnical Services Ltd		**Chemtest Job No.:**			17-19107	17-19107
Quotation No.:		**Chemtest Sample ID.:**			487527	487528
Order No.: 0717-46		Client Sample Ref.:			BH1	WS3
		Client Sample ID.:			D1	D1
		Sample Type:			SOIL	SOIL
		Top Depth (m):			0.50	0.40
		Date Sampled:			20-Jul-2017	20-Jul-2017
Determinand	**Accred.**	**SOP**	**Units**	**LOD**		
pH	M	2010		N/A	7.8	7.4
Sulphate (2:1 Water Soluble) as SO4	M	2120	g/l	0.010	< 0.010	< 0.010
Moisture	N	2030	%	0.020	14	15
Soil Colour	N	2040		N/A	Brown	Brown
Other Material	N	2040		N/A	Roots	Stones
Soil Texture	N	2040		N/A	Sand	Loam

Test Methods

SOP	Title	Parameters included	Method summary
2010	pH Value of Soils	pH	pH Meter
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2040	Soil Description(Requirement of MCERTS)	Soil description	As received soil is described based upon BS5930
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES

Report Information

Key

U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"

Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis
The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols
For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at the indicated laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container
E - Insufficient Sample

Sample Retention and Disposal

All soil samples will be retained for a period of 45 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.co.uk