Coolnabacky – 400kV GIS Substation Ground Investigation

Client:	ESB Networks
Client's Representative:	Killeen Civil Engineering
Report No.:	17-0439
Date:	July 2018
Status:	Final for Issue

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CONTENTS

APPENDICES

Document Control Sheet

Report No.:		17-0439			
Project Title:		Coolnabacky 400kV GIS Substation			
Client:		ESB Networks			
Client's Representative:		Killeen Civil Engineering			
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Prepared by:		**Reviewed by:**		**Approved by:**	
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The works were conducted in accordance with:

UK Specification for Ground Investigation 2nd Edition, published by ICE Publishing (2012)

British Standards Institute (2015) BS 5930:2015, Code of practice for site investigations.

BS EN 1997-2: 2007: Eurocode 7 - Geotechnical design - Part 2 Ground investigation and testing.

Geotechnical Society of Ireland (2016), Specification & Related Documents for Ground Investigation in Ireland

Laboratory testing was conducted in accordance with:

British Standards Institute BS 1377:1990 parts 2, 4, 5, 7 and 9

METHODS OF DESCRIBING SOILS AND ROCKS

Soil and rock descriptions are based on the guidance in BS5930:2015, The Code of Practice for Site Investigation.

Abbreviations used on exploratory hole logs	
U	Nominal 100mm diameter undisturbed open tube sample (thick walled sampler)
UT	Nominal 100mm diameter undisturbed open tube sample (thin walled sampler)
P	Nominal 100mm diameter undisturbed piston sample
B	Bulk disturbed sample
LB	Large bulk disturbed sample
D	Small disturbed sample
C	Core sub-sample (displayed in the Field Records column on the logs)
L	Liner sample from dynamic sampled borehole
W	Water sample
ES / EW	Soil sample for environmental testing / Water sample for environmental testing
SPT (s)	Standard penetration test using a split spoon sampler (small disturbed sample obtained)
SPT (c)	Standard penetration test using 60 degree solid cone
x,x/x,x,x,x	Blows per increment during the standard penetration test. The initial two values relate to the seating drive (150mm) and the remaining four to the 75mm increments of the test length. The length achieved is stated (mm) for any test increment less than 75mm
N=X	SPT blow count 'N' given by the summation of the blows 'X' required to drive the full test length (300mm)
N=X/Z	Incomplete standard penetration test where the full test length was not achieved. The blows 'X' represent the total blows for the given test length 'Z' (mm)
V VR	Shear vane test (borehole) Hand vane test (trial pit) Shear strength stated in kPa V: undisturbed vane shear strength VR: remoulded vane shear strength
dd/mm/yy: 1.0 dd/mm/yy: dry	Date & water level at the borehole depth at the end of shift and the start of the following shift
Abbreviations relating to rock core – reference Clause 36.4.4 of BS 5930: 2015	
TCR (%)	Total Core Recovery: Ratio of rock/soil core recovered (both solid and non-intact) to the total length of core run.
SCR (%)	Solid Core Recovery: Ratio of solid core to the total length of core run. Solid core has a full diameter, uninterrupted by natural discontinuities, but not necessarily a full circumference and is measured along the core axis between natural fractures.
RQD (%)	Rock Quality Designation: Ratio of total length of solid core pieces greater than 100mm to the total length of core run.
FI	Fracture Index: Number of natural discontinuities per metre over an indicated length of core of similar intensity of fracturing.
NI	Non Intact: Used where the rock material was recovered fragmented, for example as fine to coarse gravel size particles.
AZCL	Assessed zone of core loss: The estimated depth range where core was not recovered.
DIF	Drilling induced fracture: A fracture of non-geological origin brought about by the rock coring.
(xxx/xxx/xxx)	Spacing between discontinuities (minimum/average/maximum).

Coolnabacky – 400kV GIS Substation

1 AUTHORITY

On the instructions of Killeen Civil Engineering, ("the Client's Representative"), acting on the behalf of ESB Networks ("the Client"), a ground investigation was undertaken at the above location to provide geotechnical and environmental information for input to the design and construction of a proposed substation, accompanying structures and access roads.

This report details the work carried out both on site and in the geotechnical and chemical testing laboratories; it contains a description of the site and the works undertaken, the exploratory hole logs and the laboratory test results.

All information given in this report is based upon the ground conditions encountered during the site investigation works, and on the results of the laboratory and field tests performed. However, there may be conditions at the site that have not been taken into account, such as unpredictable soil strata, contaminant concentrations, and water conditions between or below exploratory holes. It should be noted that groundwater levels usually vary due to seasonal and/or other effects and may at times differ to those recorded during the investigation. No responsibility can be taken for conditions not encountered through the scope of work commissioned, for example between exploratory hole points, or beneath the termination depths achieved.

This report was prepared by Causeway Geotech Ltd for the use of the Client and the Client's Representative in response to a particular set of instructions. Any other parties using the information contained in this report do so at their own risk and any duty of care to those parties is excluded.

2 SCOPE

The extent of the investigation, as instructed by the Client's Representative, included boreholes, trial pits, soil sampling, groundwater monitoring, in-situ and laboratory testing, and the preparation of a factual report on the findings.

3 DESCRIPTION OF SITE

As shown on the site location plan in Appendix A, the works were conducted on the site of agricultural fields 2.5km north of Timahoe in Co. Laois with access off the R426. The site is bounded on all sides by agricultural land. An infilled quarry bounds the site immediately south of the site. The site is undulating ranging between 98 and 101mOD.

4 SITE OPERATIONS

4.1 Summary of site works

Site operations, which were conducted between 11th June and 22nd June 2018, comprised:

- nine light cable percussion boreholes;
- a standpipe installation in two boreholes;
- sixteen machine dug trial pits;
- an infiltration test performed in two trial pits; and
- indirect CBR tests at fifteen locations.

The exploratory holes and in-situ tests were located as instructed by the Client's Representative, as shown on the exploratory hole location plan in Appendix A.

4.2 Boreholes

Nine boreholes (BH01-BH04 and BH06-BH10) were put down to completion in minimum 200mm diameter using a Dando 2000 light cable percussion boring rig. All boreholes were terminated either at their scheduled completion depths, or else on encountering virtual refusal on obstructions or in very stiff deposits.

Hand dug inspection pits were carried out between ground level and 1.20m depth to ensure boreholes were put down at locations clear of services or subsurface obstructions.

Disturbed (bulk and small bag) samples were taken within the encountered strata. Undisturbed (U100) samples were taken where appropriate and as directed within fine soils.

Standard penetration tests were carried out in accordance with BS EN 22476-3: 2005 at standard depth intervals using the split spoon sampler ($SPT_{(s)}$) or solid cone attachment ($SPT_{(c)}$). The penetrations are stated for those tests for which the full 150mm seating drive or 300mm test drive was not possible. The N-values provided on the borehole logs are uncorrected and no allowance has been made for energy ratio corrections. The SPT hammer energy measurement report is provided in Appendix H.

Any water strikes encountered during boring were recorded along with any changes in their levels as the borehole proceeded.

4.3 Standpipe installations

A groundwater monitoring standpipe was installed in BH01 and BH04.

Details of the installations, including the depth range of the response zone, are provided in Appendix B on the individual borehole logs.

4.4 Trial Pits

Seventeen trial pits (TP01–TP07, TP09-TP16 and TP28) were excavated using a 3t tracked excavator fitted with a 600mm wide bucket, to depths of 2.5m.

Disturbed (small jar and bulk bag) samples were taken at standard depth intervals and at change of strata.

Any water strikes encountered during excavation were recorded along with any changes in their levels as the excavation proceeded. The stability of the trial pit walls was noted on completion.

Appendix C presents the trial pit logs with photographs of the pits and arising provided in Appendix D.

4.5 Infiltration tests

An infiltration/soakaway test was carried out at two locations (SATP15 and SATP16) in accordance with BRE Digest 365 - Soakaways (BRE, 2016). The tests were conducted in similarly numbered trial pits.

Appendix E presents the results and analysis of the infiltration test. The absence of the outflow from the pits precluded calculation of infiltration coefficients.

4.6 Indirect CBR tests

An indirect CBR test was conducted at fifteen locations (TP01-TP07 and TP09-TP16) using a Dynamic Cone Penetrometer (DCP). The equipment was developed in conjunction with the UK Transport Research Laboratory, is used widely throughout the world, and is referred to in the UK Highway Agency Interim Advice Note 73/06.

The test results are presented in Appendix F in the form of plots of the variation with depth of the penetration per blow. Straight lines have been fitted to the plots and the CBR for each depth range estimated using the following relationship, which is derived from Kleyn & Van Heerden (1983):

$$\text{Log CBR} = 2.48 - 1.057 \text{ Log (mm/blow)}$$

The frequently elevated CBR values are a consequence of the coarse-grained content of the penetrated soils and are often not representative of the soil matrix.

4.7 Surveying

The as-built exploratory hole positions were surveyed following completion of site operations by a Site Engineer from Causeway Geotech. Surveying was carried out using a Trimble R6 GPS system employing VRS and real time kinetic (RTK) techniques.

The plan coordinates (Irish National Grid) and ground elevation (mOD Malin) at each location are recorded on the individual exploratory hole logs. The exploratory hole plan presented in Appendix A shows these as-built positions.

4.8 Groundwater and ground gas monitoring

Following completion of site works, groundwater monitoring was conducted on two rounds. Ground water monitoring was carried out using a water interface probe.

Details of groundwater are presented in Table 1 below.

Date	Standing water levels (mbgl)	
	BH01	BH04
27/06/2018	1.1	1.24
11/07/2018	1.34	1.22

5 LABORATORY WORK

Upon their receipt in the laboratory, all disturbed samples were carefully examined and accurately described, and their descriptions incorporated into the borehole logs.

5.1 Geotechnical laboratory testing of soils

Laboratory testing of soils comprised:

- **soil classification:** moisture content measurement, Atterberg Limit tests and particle size distribution analysis.
- **soil chemistry:** pH and water soluble sulphate content

Laboratory testing of soils samples was carried out in accordance with British Standards Institute: *BS 1377, Methods of test for soils for civil engineering purposes; Part 1 (2016), and Parts 2-9 (1990).*

The test results are presented in Appendix G.

6 GROUND CONDITIONS

6.1 General geology of the area

Published geological mapping indicate the superficial deposits underlying the site comprise alluvium and glacial gravels. These deposits are underlain by limestones of the Ballyadams Formation

6.2 Ground types encountered during investigation of the site

A summary of the ground types encountered in the exploratory holes is listed below, in approximate stratigraphic order:

- **Topsoil:** encountered typically in 300-500mm thickness across the site.
- **Made Ground (fill):** reworked topsoil encountered to a depth of 700mm in TP10.
- **Alluvium/glacial gravels:** typically, soft to firm sandy gravelly clay/silt or medium dense sandy gravel/gravelly sand. Encountered to a depth of 3.8m in BH09.
- **Glacial Till:** sandy gravelly clay, frequently with low cobble content, typically firm or stiff in upper horizons, becoming very stiff with increasing depth.

6.3 Groundwater

Groundwater was encountered during percussion boring through soil as water strikes at a range of depths as shown in Table 2 below.

GI Location	Groundwater strikes (mbgl)	Comments
BH01	1.3	Slow
BH02	1.6	Slow
BH03	5.7	Slow
BH04	1.8	Slow
TP10	1.8	Slow
TP11	1.5	Slow
TP12	1.3	Slow
TP14	2.3	Slow
TP16	1.0	Fast

Details of the individual groundwater strikes, along with any relative changes in levels as works proceeded, are presented on the exploratory hole logs for each location.

Groundwater was not noted during drilling at any of the other borehole locations. However, it should be noted that the casing used in supporting the borehole walls during drilling may have sealed out additional groundwater strikes and the possibility of encountering groundwater during excavation works should not be ruled out. Seasonal variation in groundwater levels should also be factored into design considerations.

7 REFERENCES

Geotechnical Society of Ireland (2016), Specification & Related Documents for Ground Investigation in Ireland

IS EN 1997-2: 2007: Eurocode 7 - Geotechnical design - Part 2 Ground investigation and testing.

BS 1377: 1990: Methods of test for soils for civil engineering purposes. British Standards Institution.

BS 5930: 2015: Code of practice for ground investigations. British Standards Institution.

BS EN 1997-2: 2007: Eurocode 7 - Geotechnical design - Part 2 Ground investigation and testing. British Standards Institution.

BS EN ISO 14688-1:2018: Geotechnical investigation and testing. Identification and classification of soil. Part 1 Identification and description. British Standards Institution.

BS EN ISO 14688-2:2004+A1:2013: Geotechnical investigation and testing. Identification and classification of soil. Part 2 Principles for a classification.

BS EN ISO 22476-3:2005+A1:2011: Geotechnical investigation and testing. Field testing. Standard penetration test.

Building Research Establishment (2007), BRE Digest 365: Soakaways.

Project No.:	17-0439	**Client:**	ESB Networks
Project Name:	Coolnabacky 400kV GIS Substation	**Client's Representative:**	Killeen Civil Engineering

Legend Key

Title:
Site Location Plan

Last Revised:	**Scale:**
30/07/2018	1:15000

CAUSEWAY GEOTECH

Project No.:	17-0439	**Client:**	ESB Networks
Project Name:	Coolnabacky 400kV GIS Substation	**Client's Representative:**	Killeen Civil Engineering

Legend Key

Locations By Type - TP

Title:

Exploratory Hole Location Plan (1 of 3)

Last Revised:	**Scale:**
30/07/2018	1:2500

CAUSEWAY GEOTECH

Project No.:	17-0439	**Client:**	ESB Networks
Project Name:	Coolnabacky 400kV GIS Substation	**Client's Representative:**	Killeen Civil Engineering

Legend Key

Locations By Type - TP

Title:

Exploratory Hole Location Plan (2 of 3)

Last Revised:	**Scale:**
30/07/2018	1:2500

CAUSEWAY GEOTECH

Project No.:	17-0439	**Client:**	ESB Networks
Project Name:	Coolnabacky 400kV GIS Substation	**Client's Representative:**	Killeen Civil Engineering

Legend Key

- Locations By Type - CP
- Locations By Type - TP

Title:

Exploratory Hole Location Plan (3 of 3)

Last Revised:	**Scale:**
30/07/2018	1:2500

CAUSEWAY GEOTECH

APPENDIX B

Borehole logs

CAUSEWAY GEOTECH	**Project No.:** 17-0439	**Project Name:** Coolnabacky 400kV GIS Substation	**Borehole No.:** BH01
	Coordinates: 653744.29 E 692847.44 N	**Client:** ESB Networks	Sheet 1 of 1
		Client's Representative: Killeen Civil Engineering	**Scale:** 1:50
	Ground Level: 101.53 mOD	**Dates:** 22/06/2018	**Driller:** BM
			Logger: GH

Method	Plant Used	Top	Base
Cable Percussion	Dando 2000	0.00	6.50

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description
						(0.30)	TOPSOIL: Firm brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse
					101.23	0.30	Firm grey sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium.
0.50	B3						
1.00	B4					(1.50)	
1.20	D9						
1.20 - 1.65	SPT (C) N=11	1.20	Dry	N=11 (2,2/3,3,3,2) Slight Trace at 1.30m			
					99.73	1.80	Soft to firm grey slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse
2.00	B5 D10						
2.00 - 2.45	SPT (C) N=7	2.00	1.90	N=7 (2,2/2,1,2,2)		(1.20)	
3.00	B6				98.53	3.00	Firm to stiff grey sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles are subangular to subrounded
3.00 - 3.45	U1	3.00	Dry	Ublow=50 50%			
4.00	B7 D11						
4.00 - 4.45	SPT (S) N=17	4.00	Dry	N=17 (3,3/4,4,4,5)			
						(3.50)	
5.00	B8 D12						
5.00 - 5.45	SPT (S) N=28	4.20	Dry	N=28 (7,4/4,5,8,11)			
6.00 - 6.45	U2	4.20	Dry	Ublow=50 0%			
6.50 - 6.55	SPT (S)			N=50 (25 for 25mm/50 for 25mm)	95.03	6.50	End of Borehole at 6.50m

Remarks
Hand dug inspection pit excavated.

Terminated in stiff deposits

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
1.30			

Chiselling Details

From (m)	To (m)	Time (hh:mm)

Water Added

From (m)	To (m)

Casing Details

To (m)	Diam (mm)
4.50	200

CAUSEWAY GEOTECH

Method	Plant Used	Top	Base
Cable Percussion	Dando 2000	0.00	6.50

Project No.: 17-0439

Project Name: Coolnabacky 400kV GIS Substation

Borehole No.: BH02

Coordinates: 653763.55 E, 692855.61 N

Client: ESB Networks

Sheet 1 of 1

Client's Representative: Killeen Civil Engineering

Scale: 1:50

Ground Level: 101.02 mOD

Dates: 21/06/2018

Driller: BM

Logger: BM

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
						(0.30)		TOPSOIL: Firm brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse		
					100.72	0.30		Firm grey slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is rounded fine.		
0.50	B1									
1.00	B2					(1.40)				
1.20	D7									
1.20 - 1.65	SPT (C) N=12	1.20	Dry	N=12 (3,4/4,4,2,2)					▼	
				Water Strike at 1.60m	99.32	1.70				
2.00	B3 D8							Firm grey sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium.		
2.00 - 2.45	SPT (C) N=8	2.00	Dry	N=8 (4,3/2,2,2,2)						
						(1.90)				
3.00	B4 D9									
3.00 - 3.45	SPT (S) N=8	3.00	Dry	N=8 (2,2/2,2,2,2)						
					97.42	3.60		Firm to stiff grey slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles are subangular to subrounded		
4.00	B5 D10									
4.00 - 4.45	U12	4.00	Dry	Ublow=80 0%						
4.40 - 4.85	SPT (S) N=18	4.20	Dry	N=18 (3,4/4,4,5,5)						
5.00	B6 D11					(2.90)				
5.00 - 5.45	SPT (S) N=30	4.20	Dry	N=30 (25,10/5,5,6,14)						
6.00 - 6.45	U13	4.20	Dry	Ublow=67 0%						
6.50 - 6.55	SPT (S)	4.20	Dry	N=50 (25 for 25mm/50 for 25mm)	94.52	6.50		End of Borehole at 6.50m		

Remarks

Hand dug inspection pit excavated.

Terminated in stiff deposits

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
1.60			

Water Added

From (m)	To (m)

Casing Details

To (m)	Diam (mm)
6.50	200

Chiselling Details

From (m)	To (m)	Time (hh:mm)

CAUSEWAY GEOTECH	Project No.: 17-0439	Project Name: Coolnabacky 400kV GIS Substation	Borehole No.: BH03
	Coordinates: 653793.75 E 692877.00 N	Client: ESB Networks	Sheet 1 of 1
		Client's Representative: Killeen Civil Engineering	Scale: 1:50
	Ground Level: 100.92 mOD	Dates: 20/06/2018	Driller: BM
			Logger: GH

Method	Plant Used	Top	Base
Cable Percussion	Dando 2000	0.00	8.50

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description
						(0.30)	TOPSOIL: Firm brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse
					100.62	0.30	Medium dense grey gravelly silty fine to coarse SAND. Gravel is subangular to subrounded fine to medium.
0.50	B1						
1.00	B2					(1.50)	
1.20	D10						
1.20 - 1.65	SPT (C) N=12	1.00	Dry	N=12 (2,3/2,3,3,4)			
					99.12	1.80	Soft to firm grey sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse
2.00	B3						
	D11						
2.00 - 2.45	SPT (C) N=9	2.00	Dry	N=9 (2,2/3,2,2,2)		(1.20)	
3.00	B4				97.92	3.00	Firm to stiff grey sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles are subangular to subrounded
3.00 - 3.45	U16	2.00	Dry	Ublow=50 60%			
4.00	B5						
	D12						
4.00 - 4.45	SPT (S) N=20	4.00	Dry	N=20 (3,4/4,5,5,6)			
5.00	B6						
	D13						
5.00 - 5.45	SPT (S) N=26	4.20	Dry	N=26 (4,5/5,6,7,8)			
				Water Strike at 5.70m		(5.50)	
6.00	B7						
6.00 - 6.45	U17	4.20		Ublow=70 100%			
7.50	D14						
7.50 - 7.95	SPT (S) N=47	4.20		N=47 (6,6/9,10,13,15)			
8.00	B8						
8.50	B9				92.42	8.50	End of Borehole at 8.50m
	D15						
8.50 - 8.62	SPT (S)	4.20		N=50 (34 for 100mm/50 for 25mm)			

Remarks

Hand dug inspection pit excavated.

Terminated in stiff deposits

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
5.70			

Chiselling Details

From (m)	To (m)	Time (hh:mm)

Water Added

From (m)	To (m)

Casing Details

To (m)	Diam (mm)
4.20	200

CAUSEWAY GEOTECH

Method	Plant Used	Top	Base
Cable Percussion	Dando 2000	0.00	9.50

Project No.: 17-0439

Project Name: Coolnabacky 400kV GIS Substation

Borehole No.: BH04

Coordinates: 653775.62 E, 692876.75 N

Client: ESB Networks

Sheet 1 of 1

Client's Representative: Killeen Civil Engineering

Scale: 1:50

Driller: BM

Ground Level: 100.93 mOD

Dates: 22/06/2018

Logger: GH

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description
						(0.30)		TOPSOIL: Firm brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse
					100.63	0.30		Medium dense grey sandy clayey subangular to subrounded fine to coarse GRAVEL. Sand is fine to coarse
0.50	B1							
1.00	B2					(1.50)		
1.20	D9							
1.20 - 1.65	SPT (C) N=13	1.00	Dry	N=13 (2,2/3,3,3,4)				
				Slight Seepage at 1.80m	99.13	1.80		Soft grey sandy slightly gravelly SILT. Sand is fine to coarse. Gravel is subrounded fine to coarse.
2.00	B3							
	D10							
2.00 - 2.45	SPT (C) N=8	2.00	Dry	N=8 (3,1/2,2,2,2)		(1.30)		
3.00	B4							
	D11				97.83	3.10		Firm grey sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles are subangular to subrounded
3.00 - 3.45	SPT (S) N=12	3.00	Dry	N=12 (2,2/3,2,3,4)				
4.00	B5							
	D12							
4.00 - 4.45	SPT (S) N=22	4.00	Dry	N=22 (4,9/6,6,6,4)		(2.90)		
5.00	B6							
5.00 - 5.45	U16	4.20	Dry	Ublow=50 100%				
6.00	D13				94.93	6.00		Stiff grey slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles are subangular to subrounded
6.00 - 6.45	SPT (S) N=27	4.20	Dry	N=27 (4,5/6,6,7,8)				
7.00	B7					(1.50)		
7.50	D14				93.43	7.50		Very stiff grey slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles are subangular to subrounded
7.50 - 7.95	SPT (S) N=36	4.20	Dry	N=36 (7,7/8,8,9,11)				
9.00	B8					(2.00)		
	D15							
9.00 - 9.45	SPT (S) N=45	4.20	Dry	N=45 (7,8/8,11,12,14)				
					91.43	9.50		End of Borehole at 9.50m

Water

Backfill

Remarks

Hand dug inspection pit excavated.

Terminated in stiff deposits

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
1.80			

Water Added

From (m)	To (m)

Casing Details

To (m)	Diam (mm)
9.50	200

Chiselling Details

From (m)	To (m)	Time (hh:mm)

CAUSEWAY GEOTECH

Method	Plant Used	Top	Base
Cable Percussion	Dando 2000	0.00	9.00

Project No.: 17-0439

Project Name: Coolnabacky 400kV GIS Substation

Borehole No.: BH06

Coordinates: 653761.06 E, 692899.36 N

Client: ESB Networks

Sheet 1 of 1

Client's Representative: Killeen Civil Engineering

Scale: 1:50

Ground Level: 101.02 mOD

Dates: 19/06/2018

Driller: BM

Logger: GH

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
						(0.30)		TOPSOIL: Firm brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse		
					100.72	0.30				
0.50	B1 ES10							Firm grey sandy SILT. Sand is fine to medium.		
1.00	B2 ES11					(1.50)				
1.20	D12									
1.20 - 1.65	SPT (C) N=14	1.00	Dry	N=14 (2,3/4,3,3,4)						
					99.22	1.80				
2.00	B3 D13							Medium dense grey slightly sandy subangular to subrounded fine to coarse GRAVEL. Sand is fine to coarse		
2.00 - 2.45	SPT (C) N=24	2.00	1.60	N=24 (3,5/7,7,6,4)		(1.20)				
3.00	B4 D14				98.02	3.00		Firm to stiff grey slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium. Cobbles are subangular to subrounded		
3.00 - 3.45	SPT (S) N=21	3.00	2.90	N=21 (7,6/5,5,5,6)						
4.00	B5									
4.00 - 4.20	U19	4.00	Dry	Ublow=60 0%						
4.50 - 4.90	U20	4.20	Dry	Ublow=80 80%						
5.00	B6 D15									
5.00 - 5.45	SPT (S) N=39		Dry	N=39 (5,7/7,9,10,13)						
6.00	B7 D16					(6.00)				
6.00 - 6.45	SPT (S) N=47		Dry	N=47 (12,8/9,12,12,14)						
7.50	B8									
7.50 - 7.90	U21		Dry	Ublow=70 90%						
8.00	D17									
9.00	B9 D18				92.02	9.00		End of Borehole at 9.00m		
9.00 - 9.07	SPT (S)		Dry	N=50 (25 for 50mm/50 for 25mm)						

Remarks

Hand dug inspection pit excavated.

Terminated in stiff deposits

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Water Added

From (m)	To (m)
1.20	3.00

Casing Details

To (m)	Diam (mm)
4.20	200

Chiselling Details

From (m)	To (m)	Time (hh:mm)

CAUSEWAY GEOTECH

Project No.:	Project Name:	Borehole No.:
17-0439	Coolnabacky 400kV GIS Substation	BH07
Coordinates:	**Client:**	Sheet 1 of 1
653739.97 E	ESB Networks	
692885.11 N	**Client's Representative:** Killeen Civil Engineering	**Scale:** 1:50
Ground Level: 101.70 mOD	**Dates:** 18/06/2018	**Driller:** BM
		Logger: GH

Method	Plant Used	Top	Base
Cable Percussion	Dando 2000	0.00	6.00

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
						(0.40)		TOPSOIL: Firm brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse		
0.50	B1 ES7				101.30	0.40		Firm brownish grey sandy slightly gravelly SILT. Sand is fine to coarse. Gravel is subrounded fine.		
1.00	B2 ES8									
1.20	D9					(1.60)				
1.20 - 1.65	SPT (C) N=10	1.00	Dry	N=10 (2,2/2,3,3,2)						
2.00	B3 D10				99.70	2.00		Dense grey sandy subangular to subrounded fine to coarse GRAVEL. Sand is fine to coarse		
2.00 - 2.45	SPT (C) N=30	2.00	1.10	N=30 (4,6/7,9,9,5)		(0.80)				
3.00	B4 D11				98.90	2.80		Very stiff grey slightly sandy gravelly CLAY with high cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles and boulders are subangular to subrounded		
3.00 - 3.45	SPT (S) N=52	3.00	2.10	N=52 (22,9/9,14,14,15)						
4.00	B5 U14	4.10	Dry	Ublow=80 0%						
4.50	D12					(3.20)				
4.50 - 4.95	SPT (S) N=30	4.10	Dry	N=30 (5,6/6,8,8,8)						
5.00	B6 D13									
5.00 - 5.45	SPT (S) N=42	4.10	Dry	N=42 (6,7/7,9,11,15)						
6.00 - 6.10	SPT (S)	4.10	Dry	N=50 (25 for 75mm/50 for 25mm)	95.70	6.00		End of Borehole at 6.00m		

Remarks
Hand dug inspection pit excavated.

Terminated in stiff deposits

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Water Added

From (m)	To (m)
1.20	3.00

Casing Details

To (m)	Diam (mm)
4.20	200

Chiselling Details

From (m)	To (m)	Time (hh:mm)

CAUSEWAY GEOTECH

Method	Plant Used	Top	Base
Cable Percussion	Dando 2000	0.00	9.00

Project No.: 17-0439

Project Name: Coolnabacky 400kV GIS Substation

Borehole No.: BH08

Coordinates: 653723.11 E, 692880.20 N

Client: ESB Networks

Sheet 1 of 1

Client's Representative: Killeen Civil Engineering

Scale: 1:50

Ground Level: 101.81 mOD

Dates: 15/06/2018

Driller: BM

Logger: GH

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
					101.61	(0.20) 0.20		TOPSOIL: Firm brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse		
0.50	B1 ES10							Firm brownish grey sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subrounded to subangular fine to coarse.		
1.00	B2 ES11					(1.80)				
1.20	D12									
1.20 - 1.65	SPT (C) N=10	1.00	Dry	N=10 (1,3/3,3,3,1)						
2.00	B3 D13				99.81	2.00		Medium dense grey sandy clayey subangular to subrounded fine to coarse GRAVEL. Sand is fine to coarse		
2.00 - 2.45	SPT (C) N=18	2.00	1.00	N=18 (2,3/3,4,4,7)		(1.00)				
3.00	B4 D14				98.81	3.00		Very stiff grey slightly sandy gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles and boulders are subangular to subrounded		
3.00 - 3.45	SPT (S) N=56	3.00	1.40	N=56 (3,25/8,9,9,30)						
4.00	B5 D15									
4.50 - 4.90	U20	4.00	Dry	Ublow=80 60%						
5.00	B6 D16									
5.00 - 5.45	SPT (S) N=44	4.20	Dry	N=44 (5,7/9,9,11,15)						
6.00	B7 D17					(6.00)				
6.00 - 6.45	SPT (S) N=55	4.20	Dry	N=55 (8,11/11,13,13,18)						
7.50	B8									
7.50 - 7.90	U21			Ublow=70 100%						
8.00	D18									
9.00	B9 D19				92.81	9.00		End of Borehole at 9.00m		
9.00 - 9.02	SPT (S)			N=50 (25 for 10mm/50 for 15mm)						

Remarks

Hand dug inspection pit excavated.

Terminated in stiff deposits

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Water Added

From (m)	To (m)

Casing Details

To (m)	Diam (mm)
4.20	200

Chiselling Details

From (m)	To (m)	Time (hh:mm)

CAUSEWAY GEOTECH

Project No.:	Project Name:	Borehole No.:
17-0439	Coolnabacky 400kV GIS Substation	BH09
Coordinates:	**Client:**	Sheet 1 of 2
653714.90 E	ESB Networks	
692899.34 N	**Client's Representative:** Killeen Civil Engineering	**Scale:** 1:50
Ground Level: 102.48 mOD	**Dates:** 13/06/2018 - 14/06/2018	**Driller:** BM
		Logger: GH

Method	Plant Used	Top	Base
Cable Percussion	Dando 2000	0.00	10.70

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
						(0.50)		TOPSOIL: Soft to firm brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse		
0.50	B1 ES10				101.98	0.50		Stiff brown slightly sandy gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
1.00	B2 ES11									
1.20	D12					(1.70)				
1.20 - 1.65	SPT (C) N=26	1.20	0.60	N=26 (4,4/5,7,7,7)						
2.00	B3 D13									
2.00 - 2.45	SPT (C) N=31	2.00	1.30	N=31 (4,5/8,8,6,9)	100.28	2.20		Dense brown sandy subangular to subrounded fine to coarse GRAVEL. Sand is fine to coarse		
3.00	B4 D14					(1.60)				
3.00 - 3.45	SPT (C) N=34	3.00	1.40	N=34 (6,6/12,9,7,6)						
					98.68	3.80		Firm to stiff grey slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles are subangular to subrounded		
4.00	B5 D15									
4.00 - 4.40	U20	4.00	3.6	Ublow=60 100%						
5.00	B6 D16									
5.00 - 5.45	SPT (S) N=25	4.20	Dry	N=25 (4,5/5,5,7,8)						
6.50	B7 D17									
6.50 - 6.90	U21					(6.90)				
7.00 - 7.40	U22			Ublow=80 80%						
8.00	B8									
8.50	D18									
8.50 - 8.95	SPT (S) N=25	4.20	Dry	N=25 (4,5/5,5,7,8)						
9.50	B9									
~~10.00~~	D19									

Remarks
Hand dug inspection pit excavated.

Terminated in stiff deposits

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Water Added

From (m)	To (m)
1.00	3.80

Casing Details

To (m)	Diam (mm)
4.20	200

Chiselling Details

From (m)	To (m)	Time (hh:mm)

CAUSEWAY GEOTECH

Method	Plant Used	Top	Base
Cable Percussion	Dando 2000	0.00	10.70

Project No.: 17-0439

Project Name: Coolnabacky 400kV GIS Substation

Borehole No.: BH09

Coordinates: 653714.90 E, 692899.34 N

Client: ESB Networks

Sheet 2 of 2

Client's Representative: Killeen Civil Engineering

Scale: 1:50

Driller: BM

Ground Level: 102.48 mOD

Dates: 13/06/2018 - 14/06/2018

Logger: GH

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
10.00 - 10.40	U23			Ublow=80 50%				Firm to stiff grey slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles are subangular to subrounded		
10.60 - 10.82	SPT (S)	4.20	Dry	N=50 (2,25/50 for 75mm)	91.78	10.70		End of Borehole at 10.70m		

Remarks
Hand dug inspection pit excavated.

Terminated in stiff deposits

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Water Added

From (m)	To (m)
1.00	3.80

Casing Details

To (m)	Diam (mm)
4.20	200

Chiselling Details

From (m)	To (m)	Time (hh:mm)

CAUSEWAY GEOTECH

Method	Plant Used	Top	Base
Cable Percussion	Dando 2000	0.00	9.30

Project No.: 17-0439

Project Name: Coolnabacky 400kV GIS Substation

Borehole No.: BH10

Coordinates: 653768.14 E, 692928.33 N

Client: ESB Networks

Sheet 1 of 1

Client's Representative: Killeen Civil Engineering

Scale: 1:50

Driller: BM

Ground Level: 100.77 mOD

Dates: 12/06/2018 - 13/06/2018

Logger: GH

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description
					100.57	(0.20) 0.20	MADE GROUND: Reworked topsoil. Soft brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse
						(0.20) 0.40	MADE GROUND: Soft grey sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse
0.50	B1 ES9				100.37		Medium dense grey very sandy clayey subangular to subrounded fine to coarse GRAVEL. Sand is fine to coarse
1.00	B2 D13 ES10						
1.20 - 1.65	SPT (C) N=23	1.20	0.50	N=23 (6,6/7,5,4,7)		(2.50)	
2.00	B3 D14 ES11						
2.00 - 2.45	SPT (C) N=22	2.00	1.10	N=22 (3,4/4,7,6,5)			
					97.87	2.90	
3.00	B4 D15 ES12						Stiff grey slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles are subangular to subrounded
3.00 - 3.45	SPT (S) N=26	3.00	2.30	N=26 (4,3/5,6,9,6)		(1.10)	
4.00	B5				96.77	4.00	
4.00 - 4.45	U19	4.00	3.9	Ublow=60 100%			Stiff grey slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles and boulders are subangular to subrounded
5.00	B6 D16						
5.00 - 5.45	SPT (S) N=105	4.50	Dry	N=105 (10,10/19,20,25,41)			
6.00	B7						
6.50 - 6.95	U20	4.50	Dry	Ublow=75 100%		(5.30)	
7.00	D17						
8.00	B8 D18						
8.00 - 8.25	SPT (S)	4.50	Dry	N=75 (10,17/75 for 100mm)			
					91.47	9.30	End of Borehole at 9.30m

Water: Backfill

Remarks

Hand dug inspection pit excavated.

Terminated in stiff deposits

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Water Added

From (m)	To (m)
1.20	3.00

Casing Details

To (m)	Diam (mm)
4.50	200

Chiselling Details

From (m)	To (m)	Time (hh:mm)

CAUSEWAY GEOTECH

APPENDIX C

Trial pit logs

CAUSEWAY GEOTECH

Project No.: 17-0439	**Project Name:** Coolnabacky 400kV GIS Substation		**Trial Pit No.:** TP01
Co-ordinates: 652762.54 E	**Client:** ESB Networks		Sheet 1 of 1
Method: Trial Pitting	692473.30 N	**Client's Representative:** Killeen Civil Engineering	**Scale:** 1:25
Plant: 3T Excavator	**Ground Level:** 120.31 mOD	**Date:** 13/06/2018	**Logger:** ST

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water
				(0.20)		TOPSOIL	
			120.11	0.20		Brown very sandy rounded fine to coarse GRAVEL of mixed lithologies, predominantly limestone with low cobble content. Sand is fine to coarse. Cobbles are rounded	
0.50	B2						
0.50	D3						
0.50	ES1						
				(1.80)			
			118.31	2.00			
				(0.10)		Very stiff brownish grey CLAY	
			118.21	2.10		End of trial pit at 2.10m	

Remarks
No groundwater encountered

DCP carried out

Terminated on very stiff material

Water Strikes:	
Struck at (m):	Remarks:

Stability: Stable

Width: 1.20

Length: 2.00

CAUSEWAY GEOTECH	**Project No.:** 17-0439	**Project Name:** Coolnabacky 400kV GIS Substation	**Trial Pit No.:** TP02
	Co-ordinates: 652858.96 E	**Client:** ESB Networks	Sheet 1 of 1
Method: Trial Pitting	692449.29 N	**Client's Representative:** Killeen Civil Engineering	**Scale:** 1:25
Plant: 3T Excavator	**Ground Level:** 119.87 mOD	**Date:** 13/06/2018	**Logger:** ST

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water
			119.77	(0.10) 0.10		TOPSOIL	
0.50	B2					Firm brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular fine to coarse of mixed lithologies, predominantly limestone	
0.50	D3						
0.50	ES1			(1.10)			
			118.67	1.20		Grey sandy subrounded fine to coarse GRAVEL of mixed lithologies, predominantly limestone. Sand is fine to coarse	
				(0.30)			
1.50	B6		118.37	1.50		End of trial pit at 1.50m	
1.50	D5						
1.50	ES4						

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

Remarks
No groundwater encountered

DCP carried out.

Terminated on continual collapse of pit sides

Water Strikes:	
Struck at (m):	Remarks:

Stability: Unstable

Width: 1.20

Length: 2.00

CAUSEWAY GEOTECH

Project No.: 17-0439	**Project Name:** Coolnabacky 400kV GIS Substation		**Trial Pit No.:** **TP03**
Co-ordinates: 652957.52 E 692451.18 N	**Client:** ESB Networks		Sheet 1 of 1
Method: Trial Pitting	**Client's Representative:** Killeen Civil Engineering		**Scale:** 1:25
Plant: 3T Excavator	**Ground Level:** 117.37 mOD	**Date:** 13/06/2018	**Logger:** ST

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water
				(0.30)		TOPSOIL	
			117.07	0.30		Brown gravelly silty fine to coarse SAND with low cobble content. Gravel is subangular fine to coarse of mixed lithologies, predominantly limestone. Cobbles are subangular	
0.50	B1						
0.50	D2						
0.50	ES3						
				(1.40)			
1.50	B5						
1.50	D6						
1.50	ES4						
			115.67	1.70		Grey very sandy subrounded fine to coarse GRAVEL of mixed lithologies, predominantly limestone with low cobble content. Sand is fine to coarse. Cobbles are subrounded	
				(0.60)			
2.30	B7		115.07	2.30		End of trial pit at 2.30m	
2.30	D8						

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

Remarks
No groundwater encountered

DCP carried out.

Terminated due to continual collapse of pit sides.

Water Strikes:

Struck at (m):	Remarks:

Stability: Unstable

Width: 1.20

Length: 2.50

CAUSEWAY GEOTECH

Project No.: 17-0439	**Project Name:** Coolnabacky 400kV GIS Substation		**Trial Pit No.:** **TP04**
Co-ordinates: 653059.67 E	**Client:** ESB Networks		Sheet 1 of 1
Method: Trial Pitting	692459.07 N	**Client's Representative:** Killeen Civil Engineering	**Scale:** 1:25
Plant: 3T Excavator	**Ground Level:** 117.08 mOD	**Date:** 13/06/2018	**Logger:** ST

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water
			116.98	(0.10) 0.10		TOPSOIL	
0.50 0.50 0.50	B1 D3 ES2			(1.40)		Brown very gravelly fine to coarse SAND with low cobble content. Gravel is subrounded fine to coarse of mixed lithologies, predominantly limestone	
1.50 1.50 1.50	B4 D5 ES6		115.58	1.50		End of trial pit at 1.50m	

Remarks
No groundwater encountered

DCP carried out.

Terminated on continual collapse of pit sides.

Water Strikes:

Struck at (m):	Remarks:

Stability: Unstable

Width: 1.20

Length: 2.00

CAUSEWAY GEOTECH

Project No.: 17-0439	**Project Name:** Coolnabacky 400kV GIS Substation		**Trial Pit No.:** TP05
Co-ordinates: 653151.86 E	**Client:** ESB Networks		Sheet 1 of 1
Method: Trial Pitting	692414.82 N	**Client's Representative:** Killeen Civil Engineering	**Scale:** 1:25
Plant: 3T Excavator	**Ground Level:** 116.08 mOD	**Date:** 13/06/2018	**Logger:** ST

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water
				(0.20)		TOPSOIL	
			115.88	0.20		Brown very sandy clayey subangular fine to coarse GRAVEL of mixed lithologies predominately limestone. Sand is fine to coarse.	
0.50	B1						
0.50	D2						
0.50	ES3						
				(1.80)			
1.50	B4						
1.50	D5						
1.50	ES6						
			114.08	2.00		Light brown very gravelly fine to coarse SAND with high cobble content. Gravel is subangular fine to coarse of mixed lithologies, predominantly limestone. Cobbles are subangular	
				(0.50)			
2.50	B7		113.58	2.50		End of trial pit at 2.50m	
2.50	D8						

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

Remarks
No groundwater encountered

DCP carried out.

Terminated at scheduled depth.

Water Strikes:

Struck at (m):	Remarks:

Stability: Unstable

Width: 1.20

Length: 2.50

CAUSEWAY GEOTECH

Project No.: 17-0439	**Project Name:** Coolnabacky 400kV GIS Substation		**Trial Pit No.:** **TP06**
Co-ordinates: 653233.63 E	**Client:** ESB Networks		Sheet 1 of 1
Method: Trial Pitting	692471.63 N	**Client's Representative:** Killeen Civil Engineering	**Scale:** 1:25
Plant: 3T Excavator	**Ground Level:** 111.55 mOD	**Date:** 13/06/2018	**Logger:** ST

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water
				(0.30)		TOPSOIL	
			111.25	0.30		Brown gravelly fine to coarse SAND. Gravel is subrounded fine to coarse of mixed lithologies, predominantly limestone	
0.50	B2						
0.50	D3						
0.50	ES1			(0.70)			
			110.55	1.00		Firm brown sandy CLAY. Sand is fine to coarse	
1.50	B5			(1.00)			
1.50	D6						
1.50	ES4						
			109.55	2.00		Firm light brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is subrounded fine to coarse of mixed lithologies, predominantly limestone	
				(0.50)			
2.50	B7		109.05	2.50		End of trial pit at 2.50m	
2.50	D8						

Remarks
No groundwater encountered

DCP carried out.

Terminated at scheduled depth.

Water Strikes:

Struck at (m):	Remarks:

Stability: Stable

Width: 1.50

Length: 2.50

CAUSEWAY GEOTECH	**Project No.:** 17-0439	**Project Name:** Coolnabacky 400kV GIS Substation	**Trial Pit No.:** TP07
	Co-ordinates: 653297.01 E	**Client:** ESB Networks	Sheet 1 of 1
Method: Trial Pitting	692547.95 N	**Client's Representative:** Killeen Civil Engineering	**Scale:** 1:25
Plant: 3T Excavator	**Ground Level:** 110.02 mOD	**Date:** 12/06/2018	**Logger:** ST

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water
				(0.20)		TOPSOIL	
			109.82	0.20		Brown very gravelly clayey fine to coarse SAND. Gravel is subrounded fine to coarse of mixed lithologies, predominantly limestone	
0.50	B2						
0.50	D3						
0.50	ES1						
				(1.40)			
1.50	B4						
1.50	D6						
1.50	ES5		108.42	1.60		Firm brown slightly gravelly very sandy CLAY. Sand is fine to coarse. Gravel is subrounded fine to coarse of mixed lithologies, predominantly limestone	
				(0.90)			
2.50	B7		107.52	2.50		End of trial pit at 2.50m	
2.50	D8						

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

Remarks
No groundwater encountered

DCP carried out.

Terminated at scheduled depth.

Water Strikes:

Struck at (m):	Remarks:

Stability: Stable

Width: 1.20

Length: 2.00

CAUSEWAY GEOTECH	**Project No.:** 17-0439	**Project Name:** Coolnabacky 400kV GIS Substation	**Trial Pit No.:** TP09
	Co-ordinates: 653427.96 E	**Client:** ESB Networks	Sheet 1 of 1
Method: Trial Pitting	692700.83 N	**Client's Representative:** Killeen Civil Engineering	**Scale:** 1:25
Plant: 3T Excavator	**Ground Level:** 106.81 mOD	**Date:** 12/06/2018	**Logger:** ST

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description
0.50	B2			(0.80)		Brown gravelly silty fine to coarse SAND. Gravel is subrounded fine to medium of mixed lithologies, predominantly limestone.
0.50	D3					
0.50	ES1					
			106.01	0.80		Grey very gravelly fine to coarse SAND. Gravel is subrounded fine to coarse of mixed lithologies, predominantly limestone
				(0.40)		
			105.61	1.20		Light brown slightly gravelly fine to coarse SAND. Gravel is subrounded fine to coarse of mixed lithologies, predominantly limestone
1.50	B5					
1.50	D6					
1.50	ES4					
				(1.30)		
2.50	B7		104.31	2.50		End of trial pit at 2.50m
2.50	D8					

Water

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

Remarks
No groundwater encountered

DCP carried out.

Terminated at scheduled dpeth.

Water Strikes:

Struck at (m):	Remarks:

Stability: Stable

Width: 1.20

Length: 2.00

CAUSEWAY GEOTECH

Project No.: 17-0439	**Project Name:** Coolnabacky 400kV GIS Substation		**Trial Pit No.:** **TP10**
Co-ordinates: 653504.09 E 692762.58 N	**Client:** ESB Networks		Sheet 1 of 1
Method: Trial Pitting	**Client's Representative:** Killeen Civil Engineering		**Scale:** 1:25
Plant: 3T Excavator	**Ground Level:** 102.65 mOD	**Date:** 12/06/2018	**Logger:** ST

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water
				(0.70)		MADE GROUND: Reworked topsoil. Firm brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subrounded fine to coarse of mixed lithologies, predominantly limestone	
0.50	B2						
0.50	D3						
0.50	ES1						
			101.95	0.70		Grey gravelly fine to coarse SAND. Gravel is subrounded fine to coarse of mixed lithologies, predominantly limestone	
				(1.30)			
1.50	B5						
1.50	D6						
1.50	ES4						
		Seepage at 1.80m					▼
			100.65	2.00		End of trial pit at 2.00m	

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

Remarks
DCP carried out.

Terminated due to influx of water.

Water Strikes:

Struck at (m):	Remarks:
1.80	Seepage at 1.80m

Stability: Unstable

Width: 1.20

Length: 2.00

CAUSEWAY GEOTECH

Project No.: 17-0439	**Project Name:** Coolnabacky 400kV GIS Substation		**Trial Pit No.:** TP11
Co-ordinates: 653587.91 E	**Client:** ESB Networks		Sheet 1 of 1
Method: Trial Pitting	692815.56 N	**Client's Representative:** Killeen Civil Engineering	**Scale:** 1:25
Plant: 3T Excavator	**Ground Level:** 100.21 mOD	**Date:** 12/06/2018	**Logger:** ST

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water
				(0.30)		TOPSOIL	
			99.91	0.30		Grey gravelly fine to coarse SAND. Gravel is subrounded fine to coarse of mixed lithologies, predominantly limestone	
0.50	B2						
0.50	D3						
0.50	ES1						
				(1.20)			
1.50	B4		98.71	1.50		End of trial pit at 1.50m	▼
1.50	D5						
1.50	ES6						
		Seepage at 1.50m					

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

Remarks
DCP carried out.

Terminated due to continual collapse of pit sides.

Water Strikes:

Struck at (m):	Remarks:
1.50	Seepage at 1.50m

Stability: Unstable

Width: 1.20

Length: 2.00

CAUSEWAY GEOTECH

Project No.: 17-0439	**Project Name:** Coolnabacky 400kV GIS Substation		**Trial Pit No.:** TP12
Co-ordinates: 653685.71 E	**Client:** ESB Networks		Sheet 1 of 1
Method: Trial Pitting	692843.84 N	**Client's Representative:** Killeen Civil Engineering	**Scale:** 1:25
Plant: 3T Excavator	**Ground Level:** 100.91 mOD	**Date:** 12/06/2018	**Logger:** ST

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water
				(0.30)		TOPSOIL	
			100.61	0.30		Grey very gravelly silty fine to coarse SAND. Gravel is subrounded fine to coarse of mixed lithologies, predominantly limestone	
0.50	B2						
0.50	D3						
0.50	ES1						
				(1.00)			
		Seepage at 1.30m	99.61	1.30		Stiff greyish brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subrounded fine to coarse of mixed lithologies, predominantly limestone	▼
1.50	B5						
1.50	D6						
1.50	ES4						
				(1.20)			
2.50	B7		98.41	2.50		End of trial pit at 2.50m	
2.50	D8						

Remarks
DCP carried out.

Terminated at scheduled depth.

Water Strikes:

Struck at (m):	Remarks:
1.30	Seepage at 1.30m

Stability: Stable

Width: 1.20

Length: 2.00

CAUSEWAY GEOTECH	**Project No.:** 17-0439	**Project Name:** Coolnabacky 400kV GIS Substation	**Trial Pit No.:** **TP13**
	Co-ordinates: 653844.10 E	**Client:** ESB Networks	Sheet 1 of 1
Method: Trial Pitting	692856.30 N	**Client's Representative:** Killeen Civil Engineering	**Scale:** 1:25
Plant: 3T Excavator	**Ground Level:** 100.63 mOD	**Date:** 11/06/2018	**Logger:** ST

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water
				(0.30)		Topsoil	
			100.33	0.30			
				(0.10)		Stiff light brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subrounded fine to coarse of mixed lithologies.	
			100.23	0.40		Grey silty gravelly fine to coarse SAND. Gravel is subrounded fine to coarse of limestone.	
				(0.80)			
			99.43	1.20		Very soft grey slightly sandy slightly gravelly CLAY with high cobble content. Sand is fine to coarse. Gravel is subrounded fine to coarse of limestone. Cobbles are of limestone.	
				(1.40)			
			98.03	2.60		End of trial pit at 2.60m	

Remarks
No groundwater encountered

DCP carried out.

Terminated at scheduled depth.

Water Strikes:	
Struck at (m):	Remarks:

Stability: Unstable

Width: 1.20

Length: 2.40

CAUSEWAY GEOTECH

Project No.: 17-0439	**Project Name:** Coolnabacky 400kV GIS Substation		**Trial Pit No.:** **TP14**
Co-ordinates: 653727.14 E	**Client:** ESB Networks		Sheet 1 of 1
Method: Trial Pitting	692828.78 N	**Client's Representative:** Killeen Civil Engineering	**Scale:** 1:25
Plant: 3T Tracked Excavator	**Ground Level:** 101.57 mOD	**Date:** 12/06/2018	**Logger:** ST

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water
				(0.30)		TOPSOIL	
			101.27	0.30		Grey very gravelly fine to coarse SAND. Gravel is subrounded fine to coarse of mixed lithologies, predominantly limestone	
0.50	B2						
0.50	D3						
0.50	ES1			(0.70)			
			100.57	1.00		Firm brown slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular fine to coarse of mixed lithologies, predominantly limestone	
1.50	B4						
1.50	D5						
1.50	ES6			(1.20)			
			99.37	2.20		Grey very gravelly fine to coarse SAND. Gravel is subrounded fine to coarse of mixed lithologies, predominantly limestone	▼
		Seepage at 2.30m		(0.30)			
2.40	B7						
2.40	D8		99.07	2.50		End of trial pit at 2.50m	

Remarks
DCP carried out.

Terminated on scheduled depth at collapsing of pit sides.

Water Strikes:

Struck at (m):	Remarks:
2.30	Seepage at 2.30m

Stability: Unstable

Width: 1.20

Length: 2.50

CAUSEWAY GEOTECH

Project No.: 17-0439	**Project Name:** Coolnabacky 400kV GIS Substation		**Trial Pit No.:** TP15
Co-ordinates: 653811.99 E	**Client:** ESB Networks		Sheet 1 of 1
Method: Trial Pitting	692890.35 N	**Client's Representative:** Killeen Civil Engineering	**Scale:** 1:25
Plant: 3T Excavator	**Ground Level:** 100.21 mOD	**Date:** 11/06/2018	**Logger:** RS

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water
				(0.30)		TOPSOIL	
			99.91	0.30			
				(0.10)		Stiff light brown slightly sandy slightly gravelly silty CLAY. Sand is fine to coarse. Gravel is subrounded fine to coarse of unknown	
			99.81	0.40			
0.50	ES1					Stiff grey mottled brown slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subrounded fine to coarse of limestone	
0.50		HVP=177, HVR=86					
				(0.50)			
0.70	B2						
0.70	D3						
			99.31	0.90		Firm grey slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subrounded fine to coarse of limestone.	
				(1.10)			
1.50	ES4						
1.70	B5						
1.70	D6						
			98.21	2.00		End of trial pit at 2.00m	

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

Remarks
No groundwater encountered

DCP carried out.

Terminated due to continual collapse of pit sides.

Water Strikes:

Struck at (m):	Remarks:

Stability: Unstable

Width: 1.20

Length: 2.50

CAUSEWAY GEOTECH

Project No.: 17-0439	**Project Name:** Coolnabacky 400kV GIS Substation		**Trial Pit No.:** TP16
Co-ordinates: 653757.40 E	**Client:** ESB Networks		Sheet 1 of 1
Method: Trial Pitting	693080.19 N	**Client's Representative:** Killeen Civil Engineering	**Scale:** 1:25
Plant: 3T Excavator	**Ground Level:** 98.48 mOD	**Date:** 11/06/2018	**Logger:** RS

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water
				(0.30)		TOPSOIL	
0.30		HVP=196, HVR=80	98.18	0.30			
			98.13	(0.05) 0.35		Stiff light brown slightly sandy slightly gravelly silty CLAY. Sand is fine to coarse. Gravel is subrounded fine to coarse of unknown	
0.50	ES1					Grey slightly silty gravelly fine to coarse SAND. Gravel is subrounded fine to coarse of limestone	
				(0.65)			
0.80	B2						
0.80	D3						
		Rapid Inflow at 1.00m	97.48	1.00			▼
						Soft brownish grey slightly sandy gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subrounded fine to coarse of limestone. Cobbles are subrounded of limestone	
1.50	ES4						
				(1.30)			
2.00	B5						
2.00	D6						
			96.18	2.30		End of trial pit at 2.30m	

Remarks
DCP carried out.

Terminated due to continual collapse of pit sides.

Water Strikes:

Struck at (m):	Remarks:
1.00	Rapid Inflow at 1.00m

Stability: Unstable

Width: 1.40

Length: 2.20

CAUSEWAY GEOTECH

Project No.: 17-0439	**Project Name:** Coolnabacky 400kV GIS Substation		**Trial Pit No.:** **TP28**
Co-ordinates: 653757.40 E	**Client:** ESB Networks		Sheet 1 of 1
Method: Trial Pitting	693080.19 N	**Client's Representative:** Killeen Civil Engineering	**Scale:** 1:25
Plant: 3T Excavator	**Ground Level:** mOD	**Date:** 12/06/2018	**Logger:** ST

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water
				(0.20)		TOPSOIL	
				0.20		Brown gravelly fine to coarse SAND. Gravel is subrounded fine to coarse of mixed lithologies, predominantly limestone	
0.50	B2			(0.50)			
0.50	D3						
0.50	ES1			0.70		End of trial pit at 0.70m	

Remarks
No groundwater encountered.

Terminated on Archaeologists instructions.

Water Strikes:	
Struck at (m):	Remarks:

Stability: Stable

Width: 1.20

Length: 2.00

CAUSEWAY GEOTECH

APPENDIX D

Trial pit photographs

TP01

TP01

TP01

TP01

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TP02

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TP03

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TP15


CAUSEWAY
GEOTECH
Project: ESB S C
Project No.: 17-0439
TP 15
Date: 11/06/2018

TP15

TP15


CAUSEWAY
GEOTECH
Project: ESB S C
Project No.: 17-0439
EH No.: TP 15
Date: 11/06/2018
0.1
0.2
0.3
0.4

TP15


Project: ESB S C
Project No.: 17-0439
TP 16
Date: 11/06/2018

TP16


Project: ESB S C
Project No.: 17-0439
TP 16
Date: 11/06/2018

TP16

TP16

TP16


CAUSEWAY
Project: ESB S.C
Project No.: 17-0439
EH No.: TP16
Date: 11/06/2018

TP16

CAUSEWAY GEOTECH

APPENDIX E

Infiltration test results

Soakaway Infiltration Test

Project No.: 17-0439
Site: ESB Site in Coolnabacky, Co. Laois
Test Location: SA TP15
Test Date: 19 June 2018

	width (m)	length (m)
test pit top dimensions	0.70	1.30
test pit base dimensions	0.70	0.50

Analysis using method as described in BRE Digest 365 and CIRIA Report C697-The SUDS Manual

test pit depth (m) 1.30

depth to groundwater before adding water (m) = Dry

time (mins)	depth to water surface (m)	depth of water in pit (m)
0	0.22	1.08
1	0.22	1.08
2	0.22	1.08
4	0.23	1.07
6	0.23	1.07
8	0.23	1.07
10	0.24	1.06
15	0.24	1.06
20	0.25	1.05
25	0.25	1.05
30	0.25	1.05
45	0.26	1.04
60	0.26	1.04

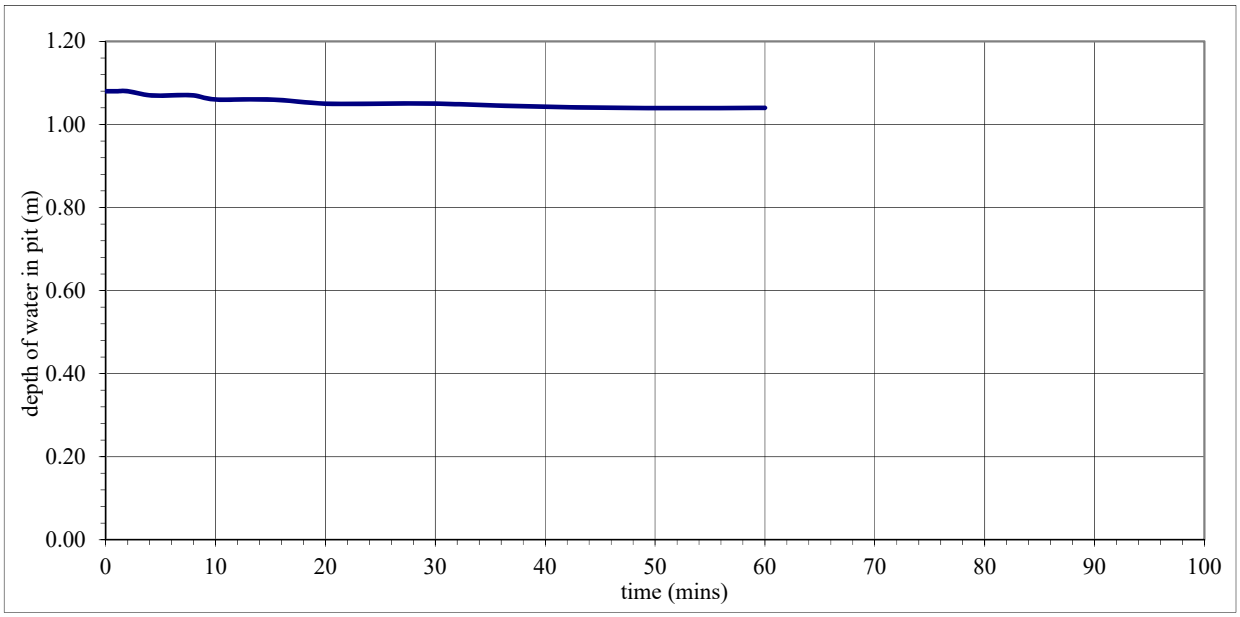
From graph below:

test start - 75% depth at
0.81 m water depth
time is not determined

test end - 25% depth at
0.27 m water depth
time is not determined

infiltration rate (q) is very low

time (mins)	depth to water (m)	depth of water in pit (m)	time elapsed (mins)	volume of water lost (m^3)	Area of walls and base at 50% drop (m^2)	q (m/min)	q (m/h)



Soakaway Infiltration Test

Project No.: 17-0439
Site: ESB Site in Coolnabacky, Co. Laois
Test Location: SA TP16
Test Date: 19 June 2018

	width (m)	length (m)
test pit top dimensions	0.80	1.30
test pit base dimensions	0.80	0.50
test pit depth (m)	2.30	

Analysis using method as described in BRE Digest 365 and CIRIA Report C697-The SUDS Manual

depth to groundwater before adding water (m) = Dry

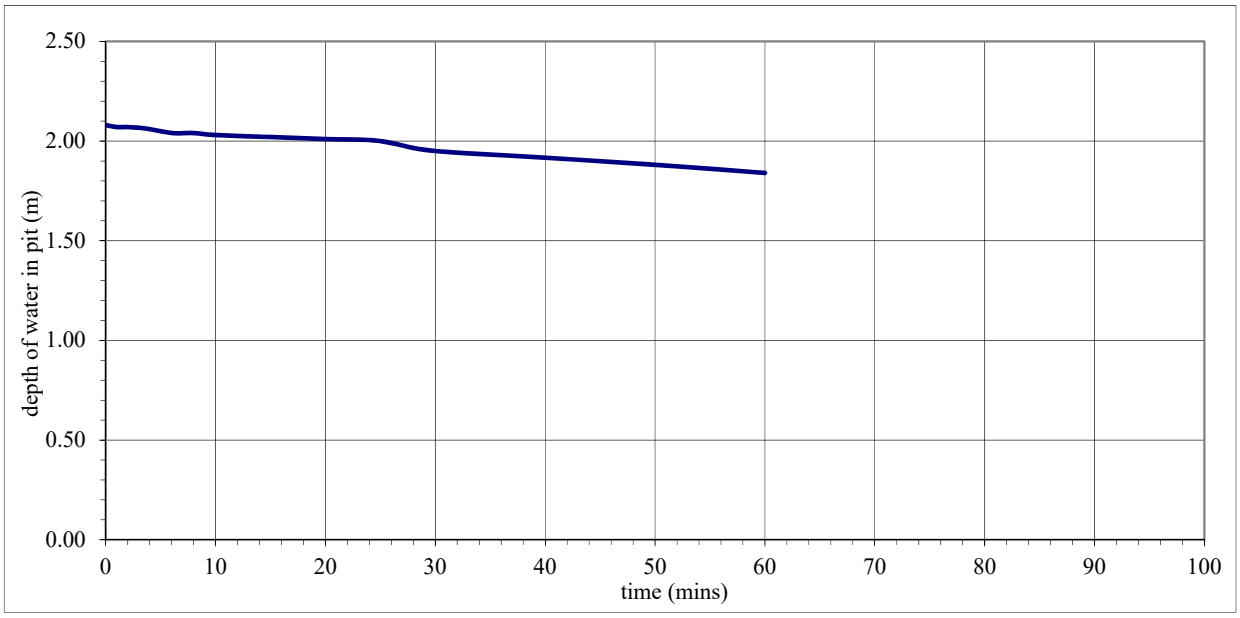
time (mins)	depth to water surface (m)	depth of water in pit (m)
0	0.22	2.08
1	0.23	2.07
2	0.23	2.07
4	0.24	2.06
6	0.26	2.04
8	0.26	2.04
10	0.27	2.03
15	0.28	2.02
20	0.29	2.01
25	0.30	2.00
30	0.35	1.95
45	0.40	1.90
60	0.46	1.84

From graph below:
test start - 75% depth at
1.56 m water depth
time is not determined

test end - 25% depth at
0.52 m water depth
time is not determined

infiltration rate (q) is very low

time (mins)	depth to water (m)	depth of water in pit (m)	time elapsed (mins)	volume of water lost (m^3)	Area of walls and base at 50% drop (m^2)	q (m/min)	q (m/h)



CAUSEWAY GEOTECH

APPENDIX F

Indirect CBR tests

Causeway Geotech Ltd

Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project: Coolnabacky 400kV GIS Substation

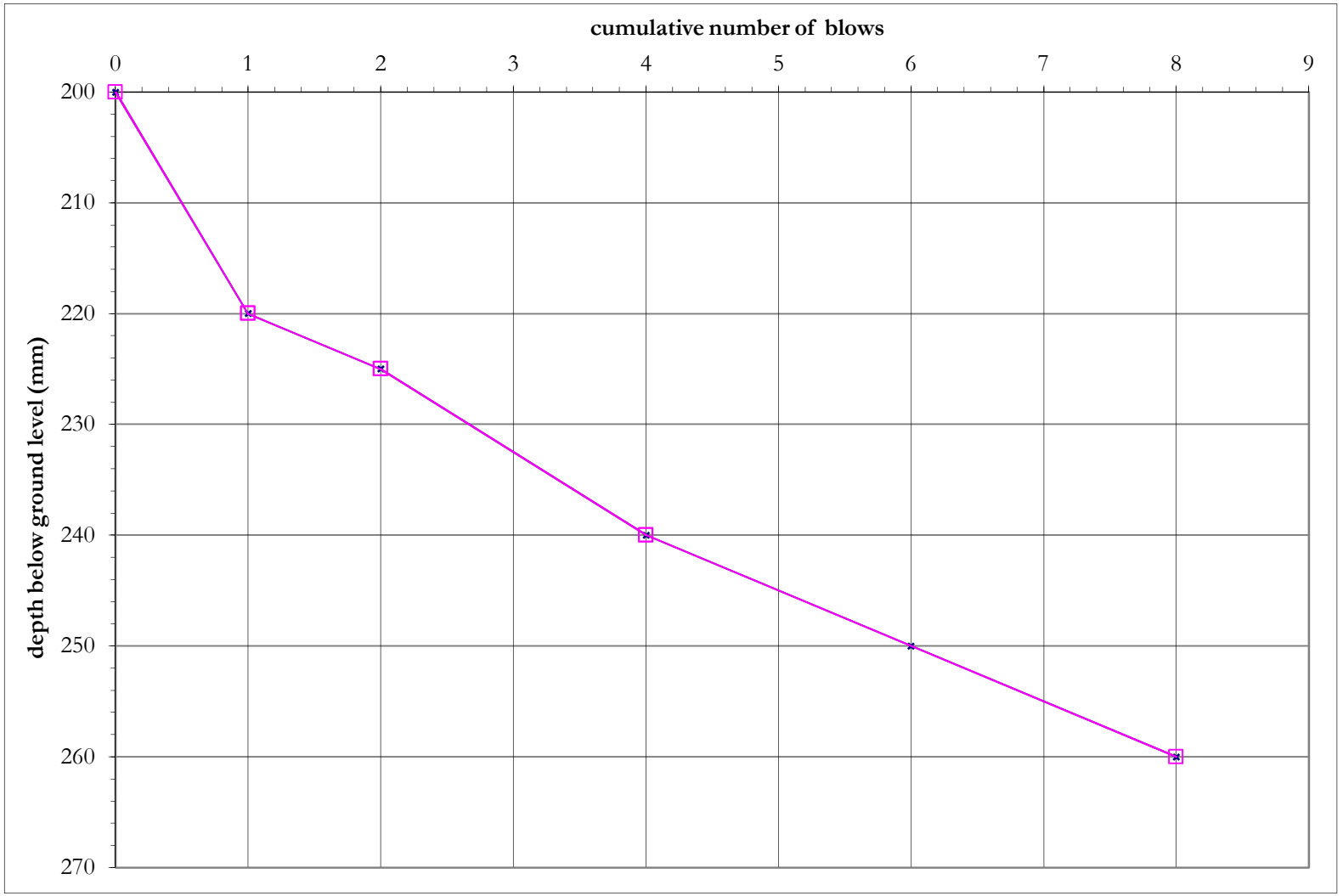
Test Number: TP01

CBR estimated using Kleyn & Van Heerden (1983):

Log CBR = 2.632-1.28 Log (mm/blow)

Project No: 17-0439

Date: 13-Jun-18



depth from to (mm)	mm/blow	CBR (%)
200	20	9.3
220		
220	5	55
225		
225	7.5	33
240		
240	5	55
260		

Causeway Geotech Ltd

Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project: **Coolnabacky 400kV GIS Substation**

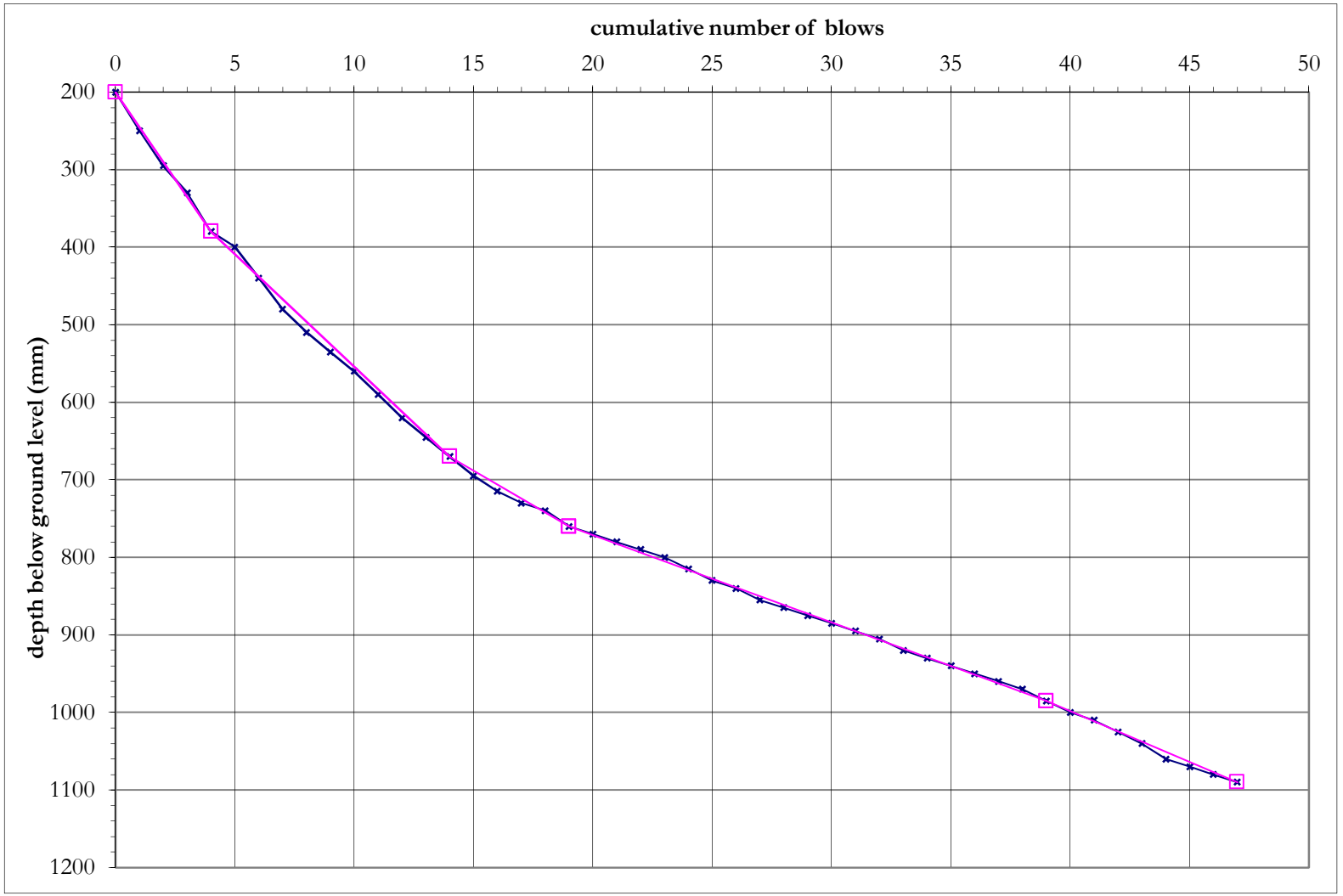
Test Number: **TP02**

CBR estimated using Kleyn & Van Heerden (1983):

Log CBR = 2.632-1.28 Log (mm/blow)

Project No: 17-0439

Date: 13-Jun-18



depth from to (mm)	mm/blow	CBR (%)
200	45	3.3
380		
380	29	5.8
670		
670	18	11
760		
760	11	19
985		
985	13	16
1090		

Causeway Geotech Ltd

Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project: **Coolnabacky 400kV GIS Substation**

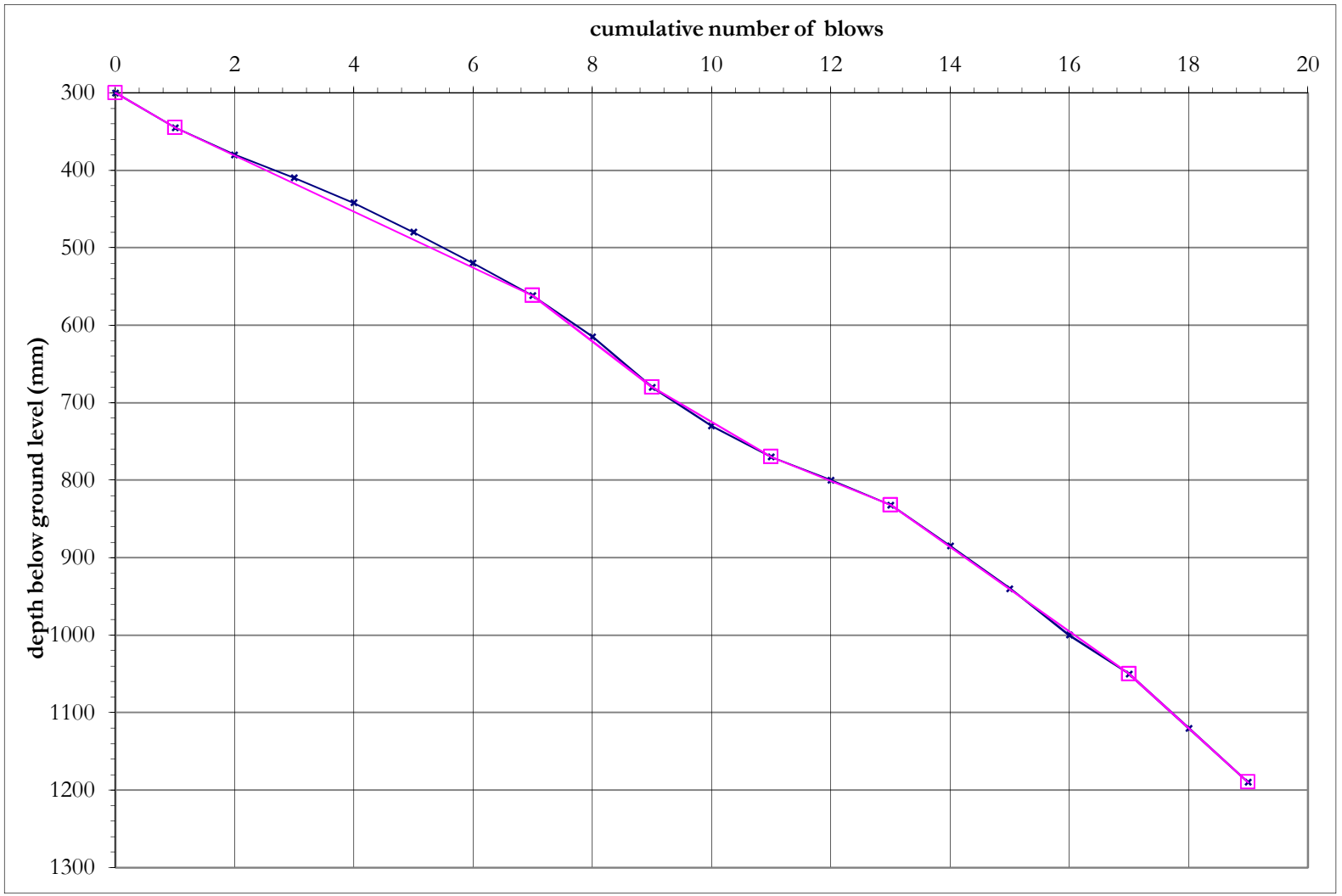
Test Number: **TP03**

CBR estimated using Kleyn & Van Heerden (1983):

Log CBR = 2.632-1.28 Log (mm/blow)

Project No: 17-0439

Date: 13-Jun-18



depth from to (mm)	mm/blow	CBR (%)
300	45	3.3
345		
345	36	4.3
562		
562	59	2.3
680		
680	45	3.3
770		
770	31	5.3
832		
832	55	2.6
1050		
1050	70	1.9
1190		

Causeway Geotech Ltd

Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project: Coolnabacky 400kV GIS Substation

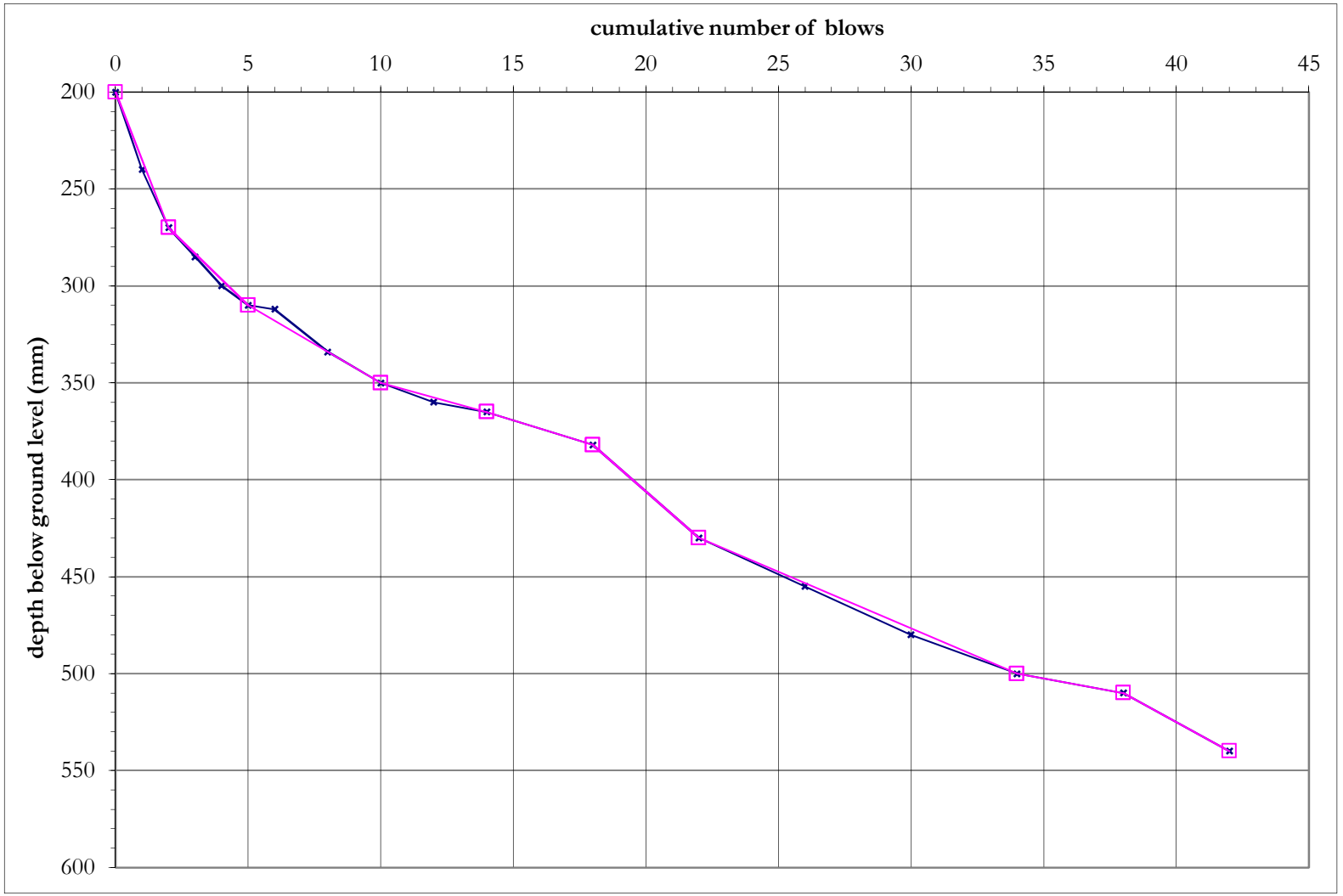
Test Number: TP04

CBR estimated using Kleyn & Van Heerden (1983):

Log CBR = 2.632-1.28 Log (mm/blow)

Project No: 17-0439

Date: 13-Jun-18



depth from to (mm)	mm/blow	CBR (%)
200	35	4.5
270		
270	13	16
310		
310	8	30
350		
350	3.8	79
365		
365	4.3	67
382		
382	12	18
430		
430	5.8	45
500		
500	2.5	>100
510		
510	7.5	33
540		

Causeway Geotech Ltd

CBR estimated using Kleyn & Van Heerden (1983):

Dynamic Cone Penetrometer (DCP) test results and estimated CBR

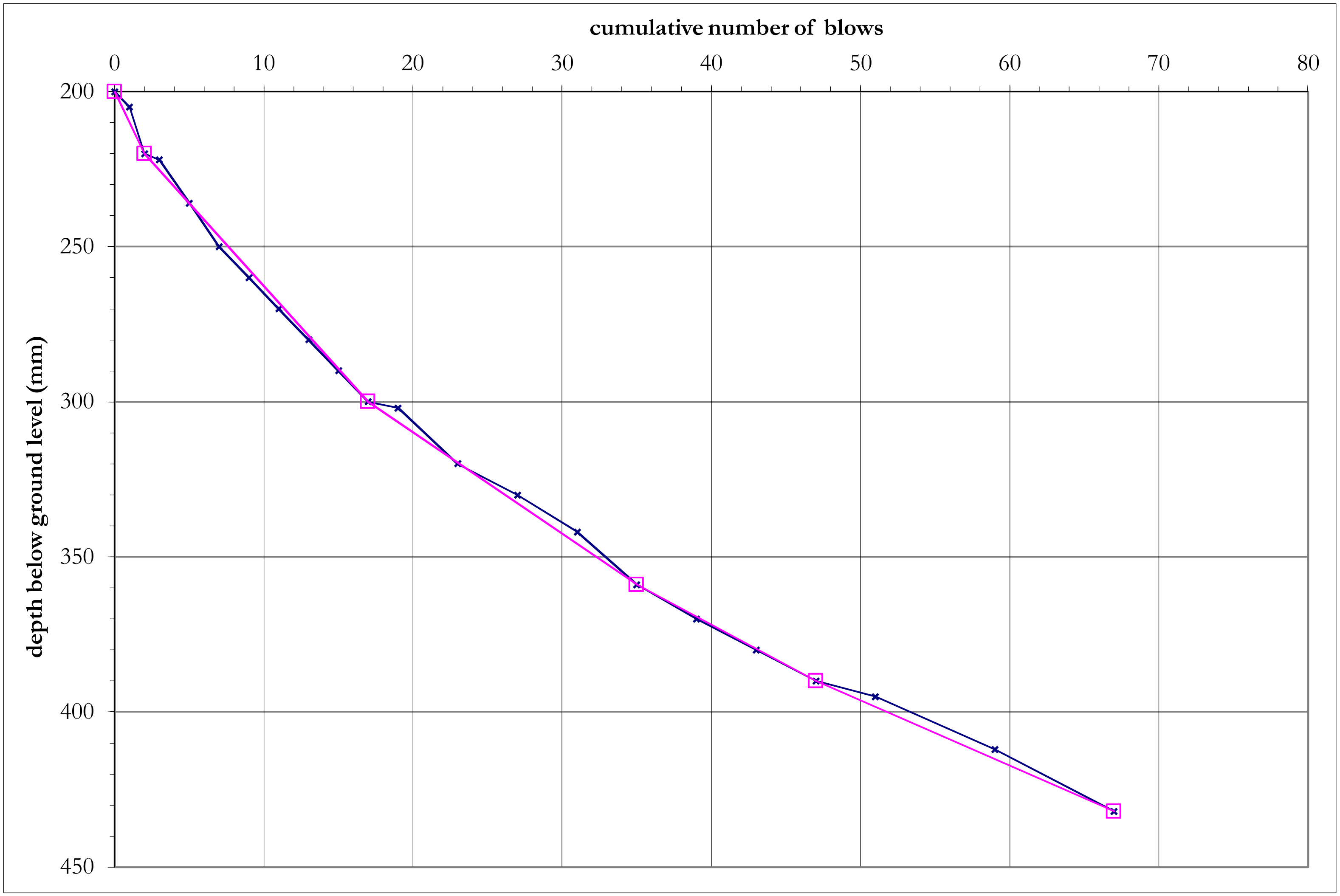
Log CBR = 2.632-1.28 Log (mm/blow)

Project: **Coolnabacky 400kV GIS Substation**

Project No: 17-0439

Test Number: **TP05**

Date: 13-Jun-18



depth from to (mm)	mm/blow	CBR (%)
200 220	10	22
220 300	5.3	50
300 359	3.3	94
359 390	2.6	>100
390 432	2.1	>100

Causeway Geotech Ltd

Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project: **Coolnabacky 400kV GIS Substation**

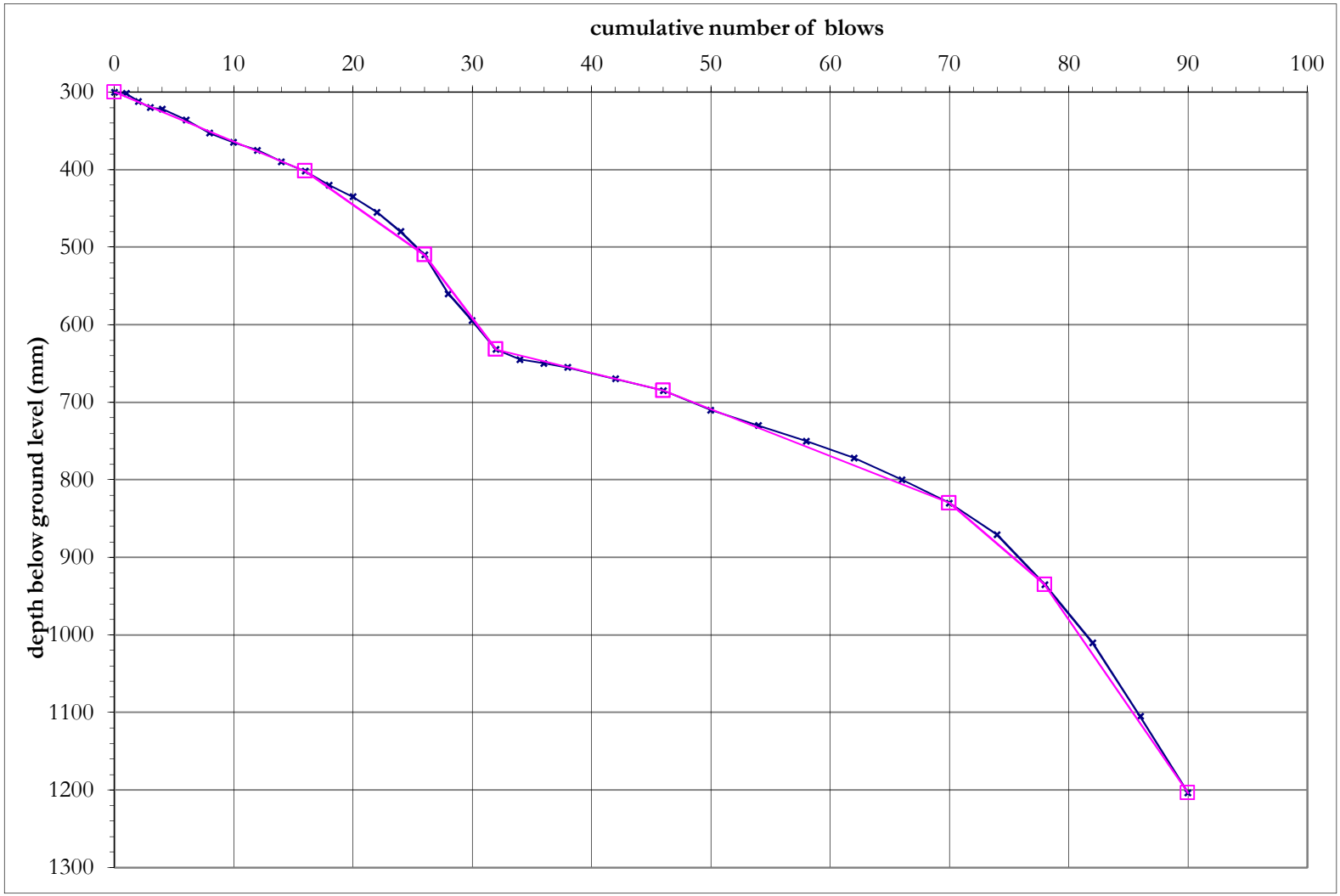
Test Number: **TP06**

CBR estimated using Kleyn & Van Heerden (1983):

Log CBR = 2.632-1.28 Log (mm/blow)

Project No: 17-0439

Date: 13-Jun-18



depth from to (mm)	mm/blow	CBR (%)
300	6.4	40
402		
402	11	20
510		
510	20	9.1
632		
632	3.8	78
685		
685	6	43
830		
830	13	16
935		
935	22	8
1204		

Causeway Geotech Ltd

Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project: **Coolnabacky 400kV GIS Substation**

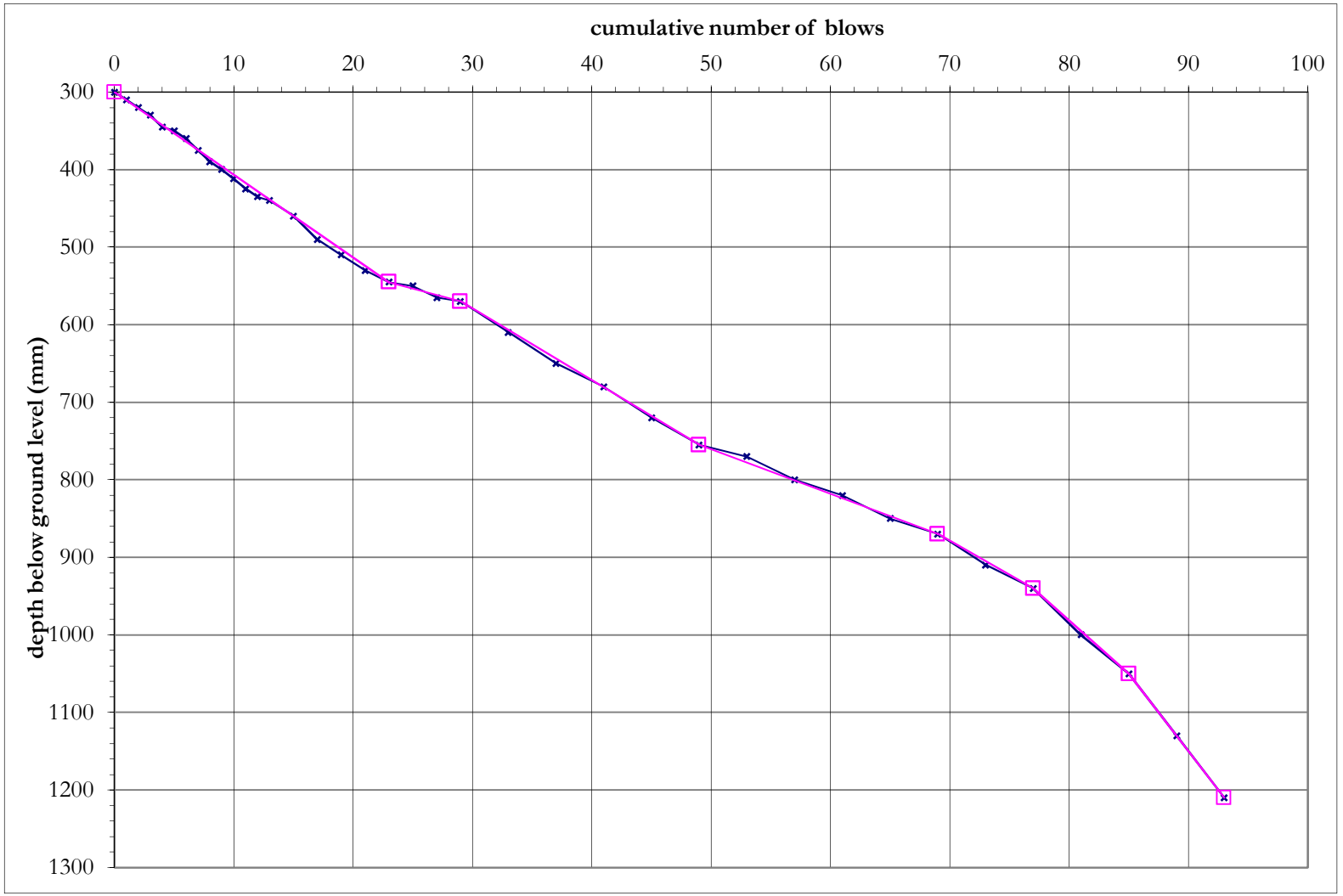
Test Number: **TP07**

CBR estimated using Kleyn & Van Heerden (1983):

Log CBR = 2.632-1.28 Log (mm/blow)

Project No: 17-0439

Date: 12-Jun-18



depth from to (mm)	mm/blow	CBR (%)
300	11	21
545		
545	4.2	69
570		
570	9.3	25
755		
755	5.8	46
870		
870	8.8	27
940		
940	14	15
1050		
1050	20	9.3
1210		

Causeway Geotech Ltd

Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project: **Coolnabacky 400kV GIS Substation**

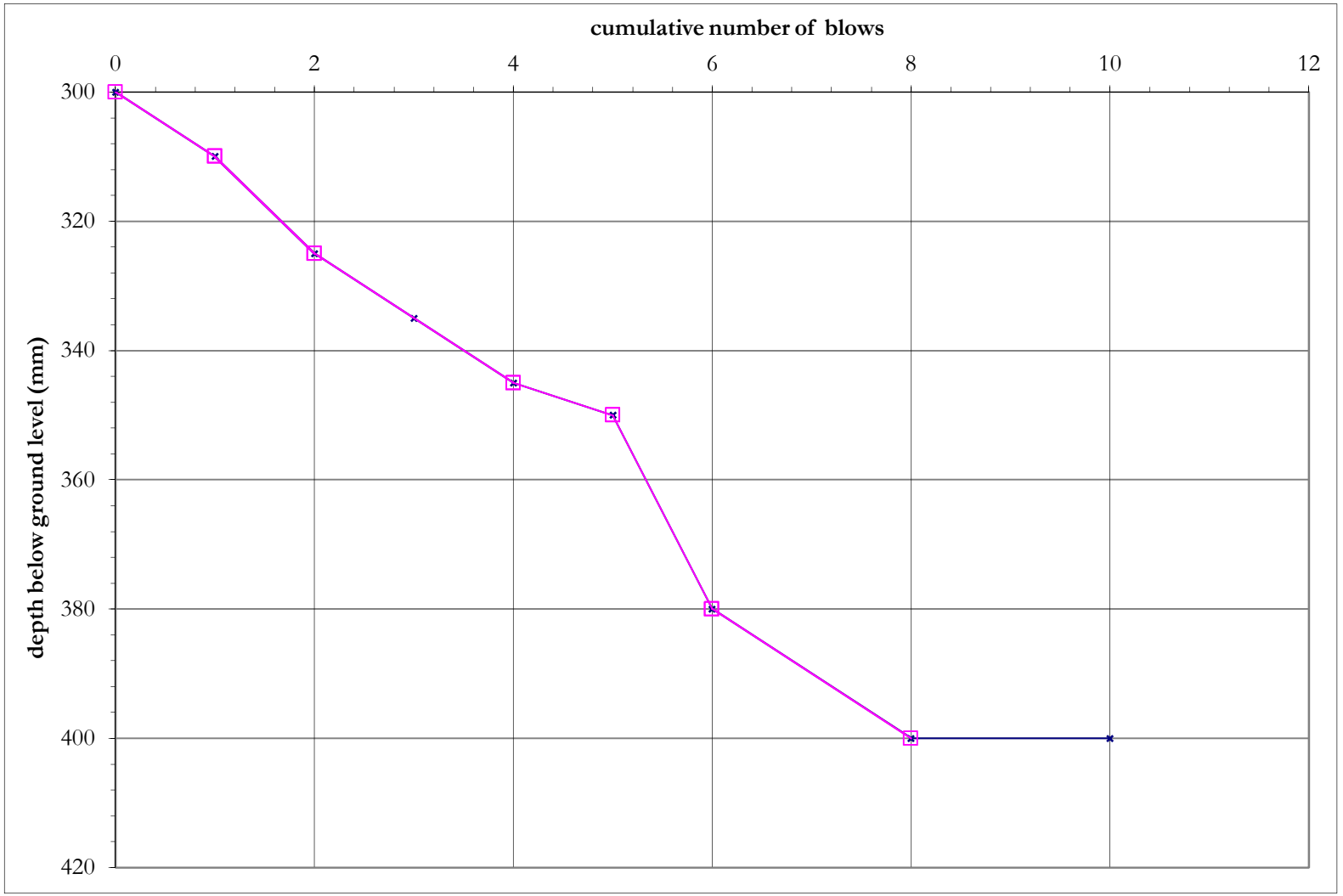
Test Number: **TP09**

CBR estimated using Kleyn & Van Heerden (1983):

Log CBR = 2.632-1.28 Log (mm/blow)

Project No: 17-0439

Date: 12-Jun-18



depth from to (mm)	mm/blow	CBR (%)
300	10	22
310		
310	15	13
325		
325	10	22
345		
345	5	55
350		
350	30	5.5
380		
380	10	22
400		

Causeway Geotech Ltd

Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project: **Coolnabacky 400kV GIS Substation**

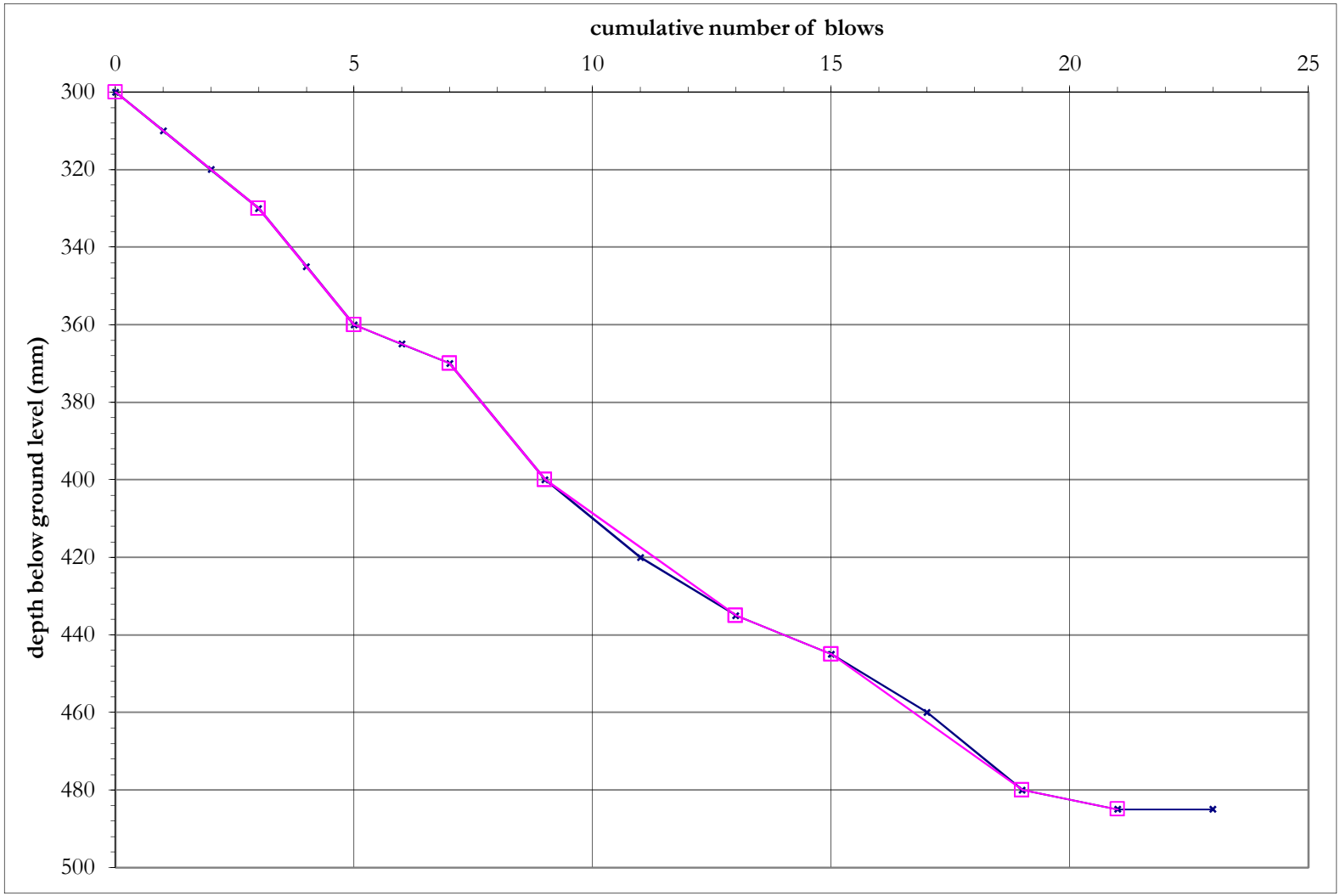
Test Number: **TP10**

CBR estimated using Kleyn & Van Heerden (1983):

Log CBR = 2.632-1.28 Log (mm/blow)

Project No: 17-0439

Date: 12-Jun-18



depth from to (mm)	mm/blow	CBR (%)
300	10	22
330		
330	15	13
360		
360	5	55
370		
370	15	13
400		
400	8.8	27
435		
435	5	55
445		
445	8.8	27
480		
480	2.5	>100
485		

Causeway Geotech Ltd

Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project: **Coolnabacky 400kV GIS Substation**

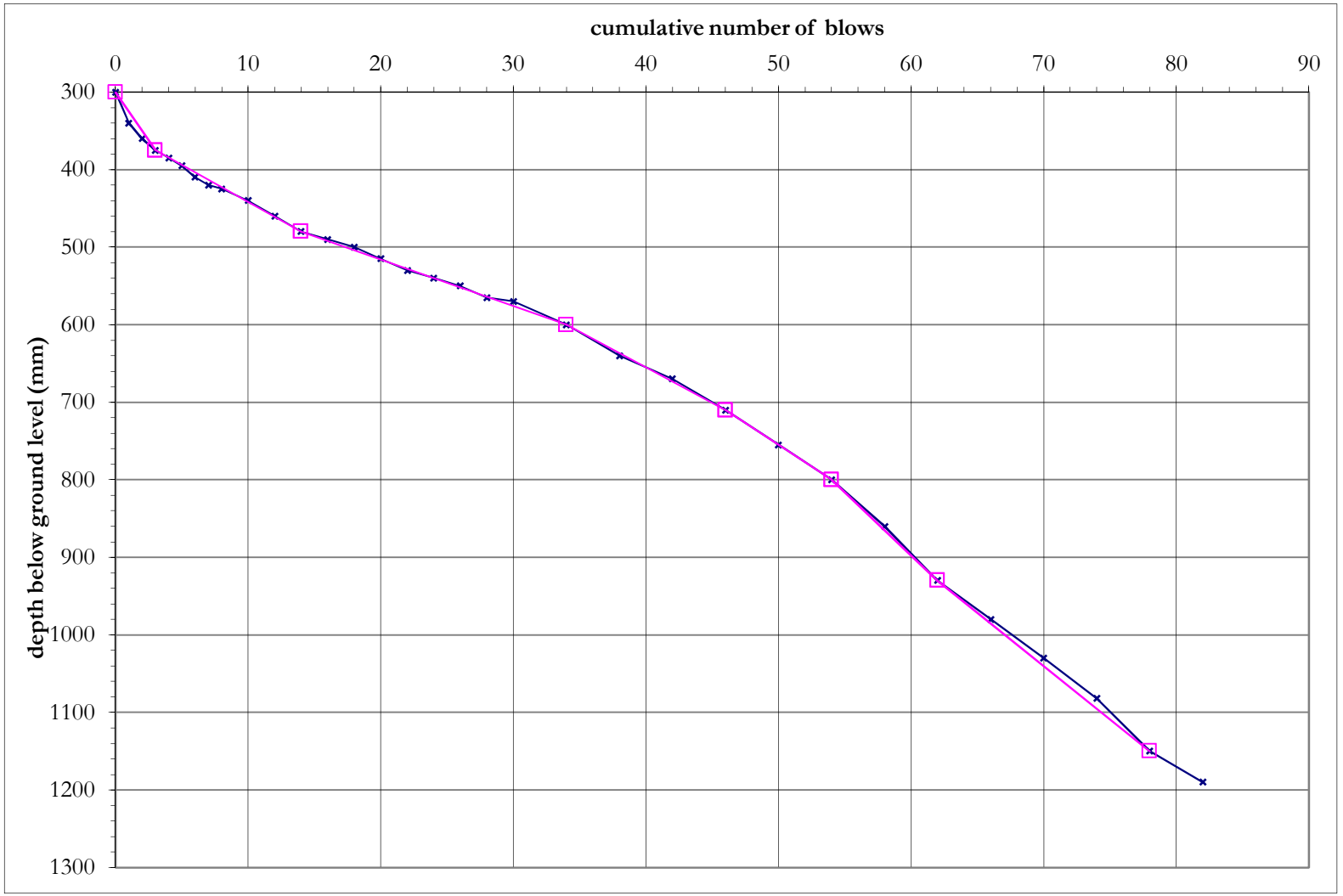
Test Number: **TP11**

CBR estimated using Kleyn & Van Heerden (1983):

Log CBR = 2.632-1.28 Log (mm/blow)

Project No: 17-0439

Date: 12-Jun-18



depth from to (mm)	mm/blow	CBR (%)
300	25	7
375		
375	9.5	24
480		
480	6	43
600		
600	9.2	25
710		
710	11	19
800		
800	16	12
930		
930	14	15
1150		

Causeway Geotech Ltd

Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project: Coolnabacky 400kV GIS Substation

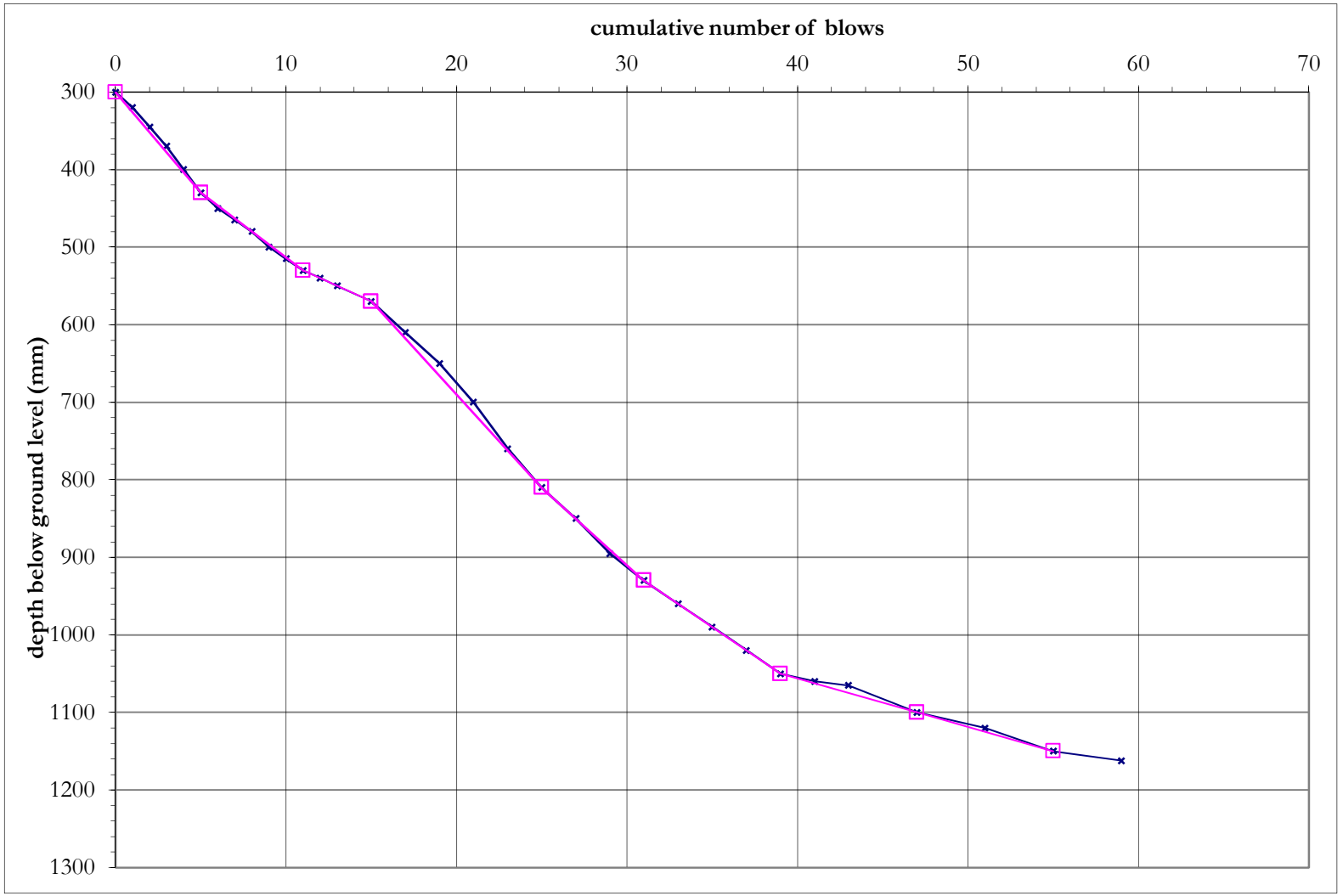
Test Number: TP12

CBR estimated using Kleyn & Van Heerden (1983):

Log CBR = 2.632-1.28 Log (mm/blow)

Project No: 17-0439

Date: 12-Jun-18



depth from to (mm)	mm/blow	CBR (%)
300	26	6.6
430		
430	17	12
530		
530	10	22
570		
570	24	7.3
810		
810	20	9.3
930		
930	15	13
1050		
1050	6.3	41
1100		
1100	6.3	41
1150		

Causeway Geotech Ltd

Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project: **Coolnabacky 400kV GIS Substation**

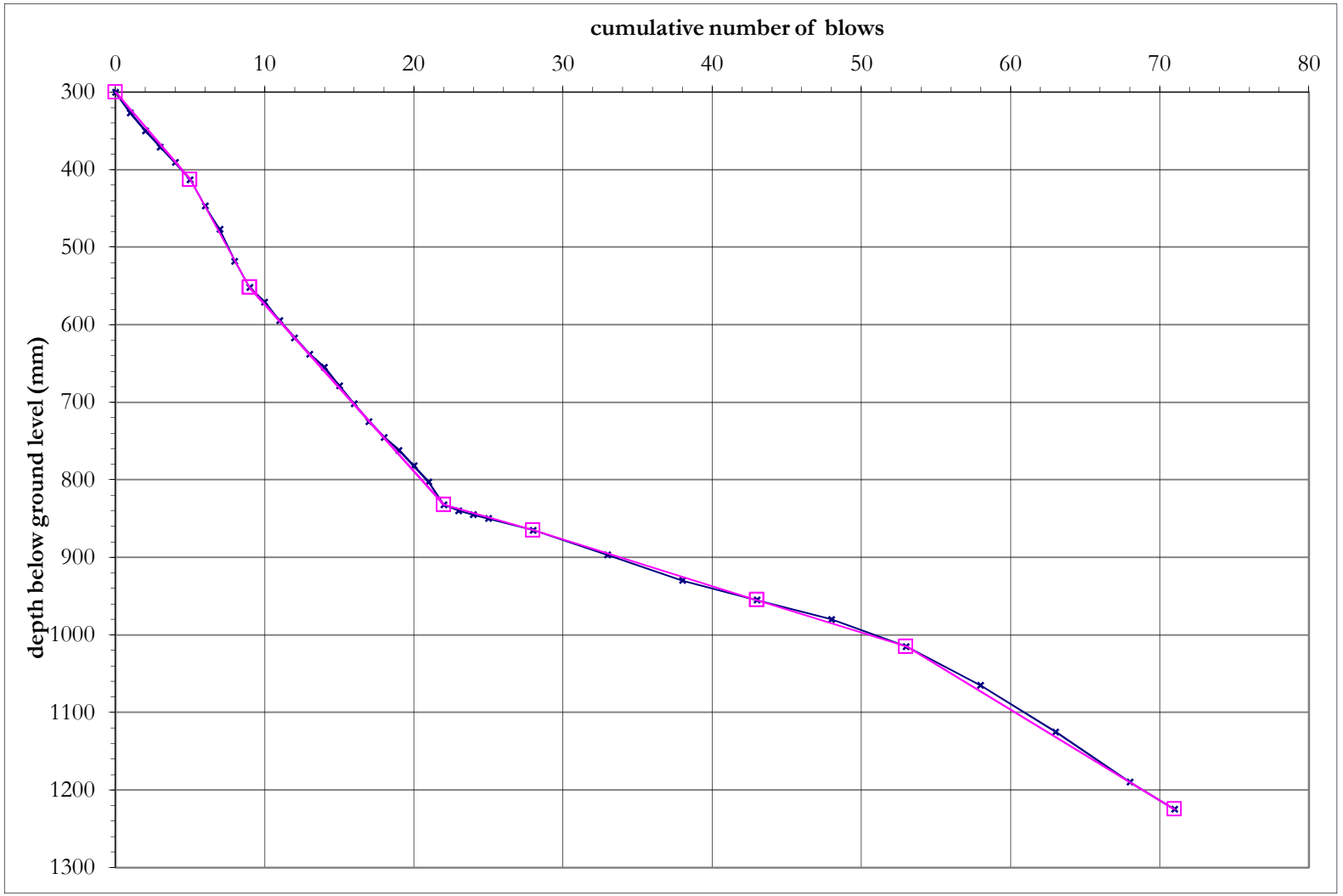
Test Number: **TP13**

CBR estimated using Kleyn & Van Heerden (1983):

Log CBR = 2.632-1.28 Log (mm/blow)

Project No: 17-0439

Date: 11-Jun-18



depth from to (mm)	mm/blow	CBR (%)
300	23	7.9
413		
413	35	4.6
552		
552	22	8.4
832		
832	5.5	48
865		
865	6	43
955		
955	6	43
1015		
1015	12	18
1225		

Causeway Geotech Ltd

Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project: **Coolnabacky 400kV GIS Substation**

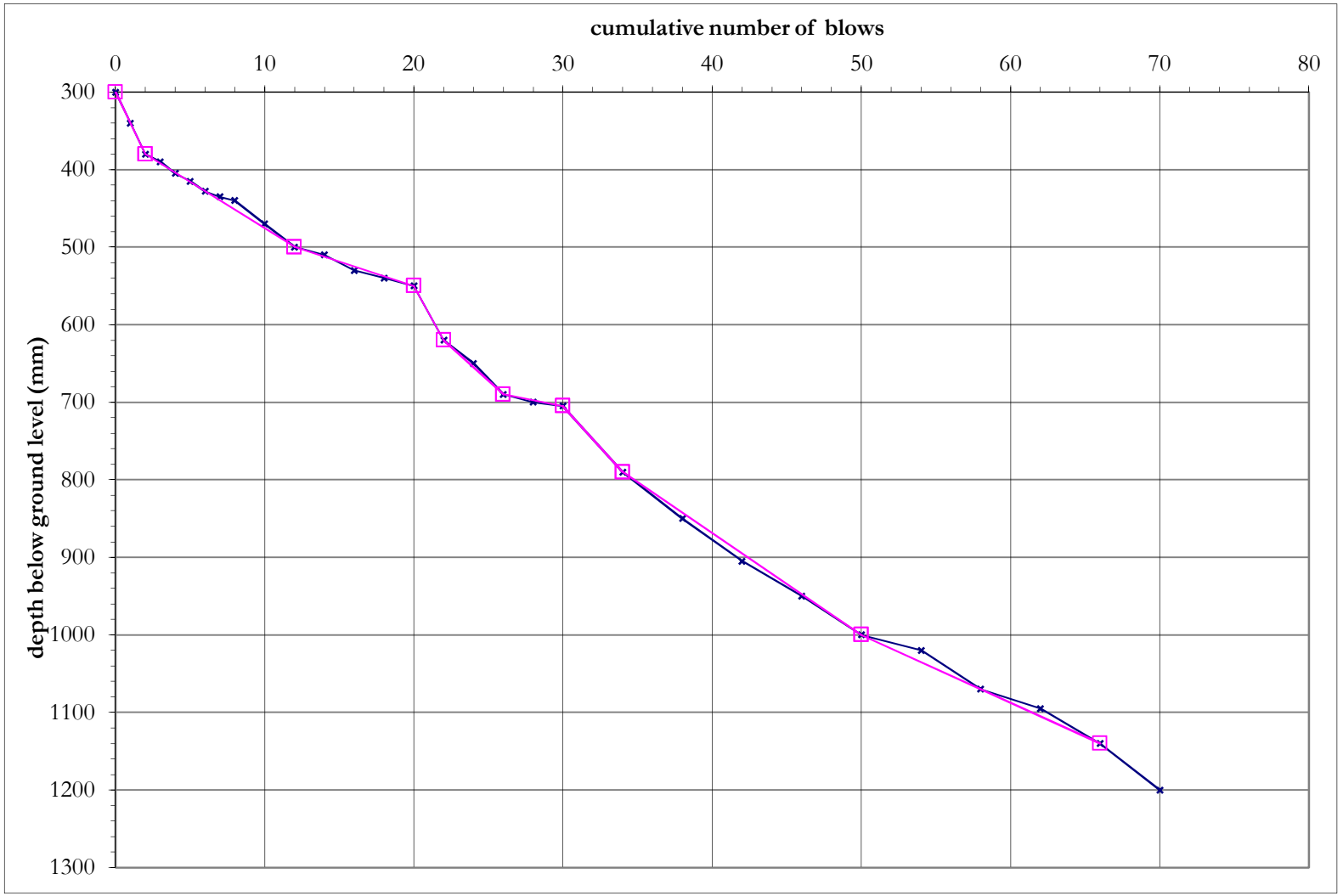
Test Number: **TP14**

CBR estimated using Kleyn & Van Heerden (1983):

Log CBR = 2.632-1.28 Log (mm/blow)

Project No: 17-0439

Date: 11-Jun-18



depth from to (mm)	mm/blow	CBR (%)
300	40	3.8
380		
380	12	18
500		
500	6.3	41
550		
550	35	4.5
620		
620	18	11
690		
690	3.8	79
705		
705	21	8.6
790		
790	13	16
1000		
1000	8.8	27
1140		

Causeway Geotech Ltd

Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project: **Coolnabacky 400kV GIS Substation**

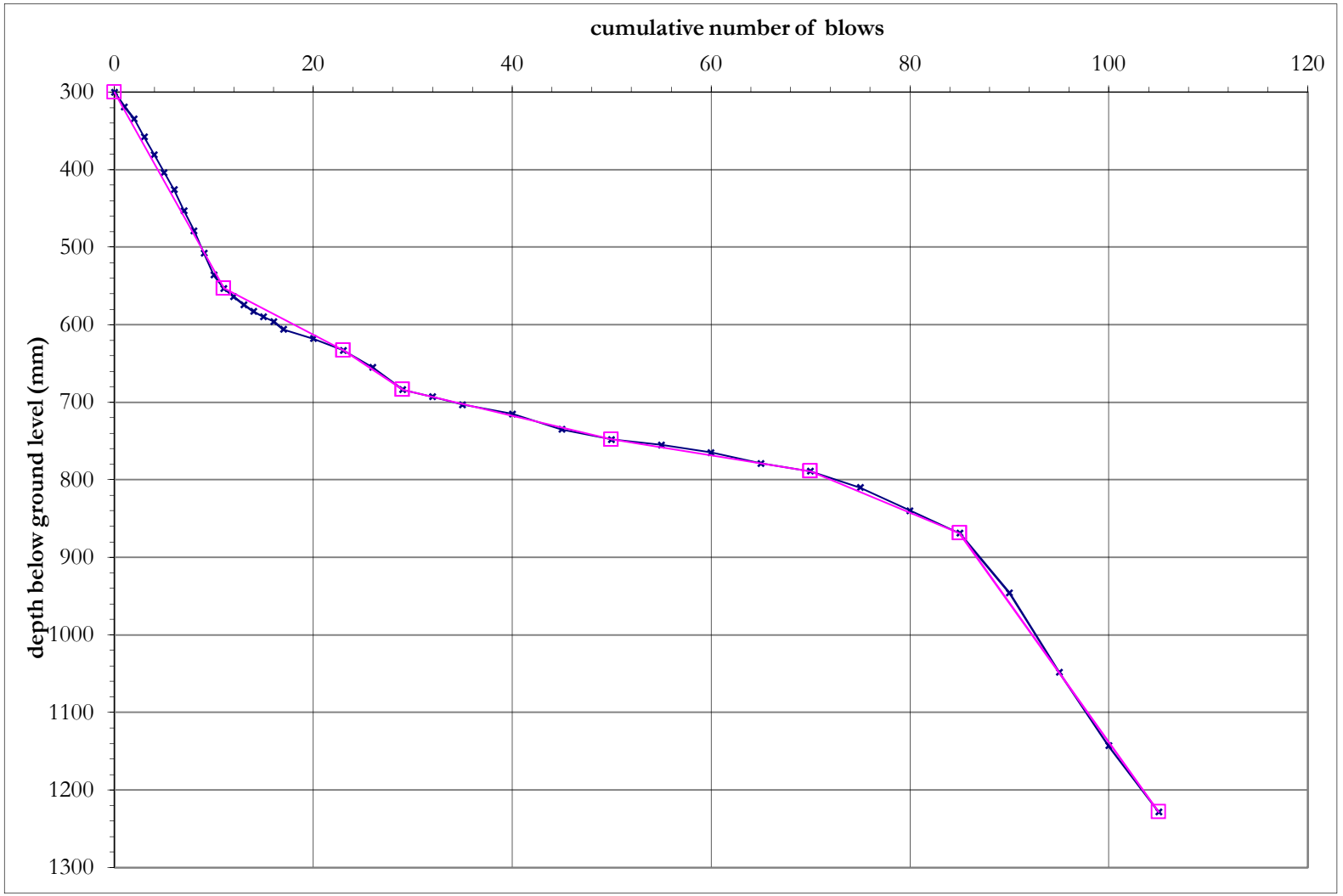
Test Number: **TP15**

CBR estimated using Kleyn & Van Heerden (1983):

Log CBR = 2.632-1.28 Log (mm/blow)

Project No: 17-0439

Date: 11-Jun-18



depth from to (mm)	mm/blow	CBR (%)
300	23	7.7
553		
553	6.7	38
633		
633	8.5	28
684		
684	3	>100
748		
748	2.1	>100
789		
789	5.3	50
869		
869	18	11
1228		

Causeway Geotech Ltd

Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project: **Coolnabacky 400kV GIS Substation**

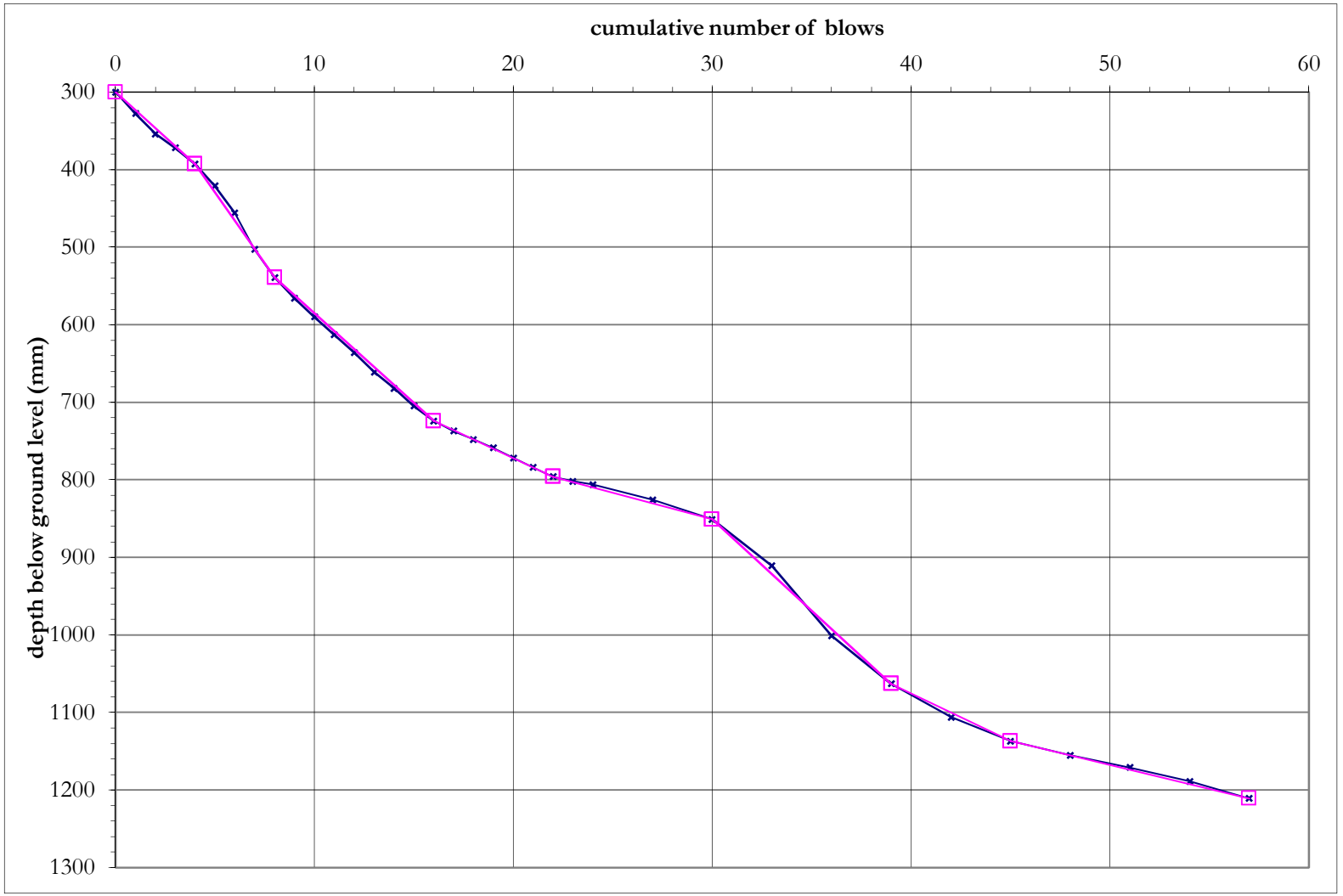
Test Number: **TP16**

CBR estimated using Kleyn & Van Heerden (1983):

Log CBR = 2.632-1.28 Log (mm/blow)

Project No: 17-0439

Date: 11-Jun-18



depth from to (mm)	mm/blow	CBR (%)
300	23	7.6
393		
393	37	4.3
539		
539	23	7.7
724		
724	12	18
796		
796	6.9	36
851		
851	24	7.5
1063		
1063	12	17
1137		
1137	6.2	42
1211		

CAUSEWAY GEOTECH

APPENDIX G

Geotechnical laboratory test results

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SOIL AND ROCK SAMPLE ANALYSIS
LABORATORY TEST REPORT

Client:	**Eirgrid/Kileens Civil Engineering Ltd.**
Engineer:	**Kileens Civil Engineering Ltd**
From:	**Stephen Watson** **Laboratory Manager** **Causeway Geotech Ltd**
Tel:	**+44(0)2827666640**
E-mail:	**stephen.watson@causewaygeotech.com**
Date:	**30/07/18**
Ref:	**17-0439**

Coolnabacky 400kV GIS Substation

We are pleased to attach the results of laboratory testing carried out for the above project**.** This memo and its attachments constitute a report of the results of tests as detailed in the *Contents page(s)*.

The attached results complete the testing requested and we would therefore wish to confirm that samples will be retained without charge for a period of 28 days from the above date after which they will be appropriately disposed of unless we receive written instructions to the contrary prior to that date.

We trust our report meets with your approval but if you have any queries or require additional information, please do not hesitate to contact the undersigned.

Approved Signatory

Stephen Watson
Laboratory Manager

Causeway Geotech Ltd
8 Drumahiskey Road, Ballymoney
Co. Antrim, N. Ireland, BT53 7QL

Registered in Northern Ireland. Company Number: NI610766
Approved: ISO 9001 • ISO 14001 • OHSAS 18001

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Project Name **Coolnabacky 400kV GIS Substation**

Report Reference. **17-0439**

The table below details the tests carried out, the specifications used, and the number of tests included in this report:

Material tested	Type of test/Properties measured/Range of measurement	Standard specifications	Number of test results included in the report
SOIL	Moisture Content of Soil	BS1377: Part 2: Clause 3.2: 1990	20
SOIL	Liquid and Plastic Limits of soil -1 point cone penetrometer method	BS1377: Part 2: Clauses 4.4, 5.3 & 5.4 1990	19
SOIL	Particle size distribution - wet sieving	BS1377: Part 2: Clause 9.2: 1990	25
SOIL	Particle size distribution -sedimentation hydrometer method	BS1377: Part 2: Clause 9.5: 1990	20
SOIL – subcontracted to Chemtest Ltd	pH Value of Soil		7
SOIL – subcontracted to Chemtest Ltd	Sulphate Content water extract		7
SOIL – subcontracted to Chemtest Ltd	Water soluble chloride content		7

CAUSEWAY GEOTECH

Summary of Classification Test Results

Project No.	Project Name
17-0439	Coolnabacky 400kV GIS Substation

Hole No.	Sample				Soil Description	Density bulk	Density dry	*w*	Passing 425µm	LL	PL	PI	Particle density	Casagrande Classification
	Ref	Top	Base	Type		Mg/m3		%	%	%	%	%	Mg/m3	
BH01	4	1.00		B	Grey sandy slightly gravelly silty CLAY.			8.5	51	21	14	7		CL
BH01	6	3.00		B	Grey sandy slightly gravelly silty CLAY.			9.3	70	21	17	7		CL
BH02	3	2.00		B	Grey sandy gravelly silty CLAY.			4.8	62	20	12	8		CL
BH03	2	1.00		B	Grey gravelly silty fine to coarse SAND.			12.0	37	26	NP			
BH03	5	4.00		B	Grey sandy gravelly silty CLAY.			7.0	69	24	14	10		CL
BH04	3	2.00		B	Grey sandy gravelly clayey SILT.			8.9	48	35	25	10		ML/MI
BH04	5	4.00		B	Grey sandy gravelly silty CLAY.			8.4	74	23	13	10		CL
BH06	4	3.00		B	Grey sandy gravelly silty CLAY.			11.0	67	20	13	7		CL
BH07	2	1.00		B	Brownish grey silty fine to coarse SAND.			21.0	91	20	17	3		ML
BH07	4	3.00		B	Grey slightly sandy clayey subangular fine to coarse GRAVEL with low cobble content.			12.0	69	23	10	13		CL
BH08	2	1.00		B	Brownish grey sandy gravelly silty CLAY.			12.0						
BH08	4	3.00		B	Grey slightly sandy gravelly silty CLAY with low cobble content.			6.6	58	20	13	7		CL
BH09	2	1.00		B	Brown sandy clayey silty subangular to subrounded fine to coarse GRAVEL.			6.0	48	20	14	6		ML/CL

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

Key

Density test — Linear measurement unless : wd - water displacement; wi - immersion in water

Liquid Limit — 4pt cone unless : cas - Casagrande method; 1pt - single point test

Particle density — sp - small pyknometer; gj - gas jar

Date Printed: 30/07/2018

Approved By: Stephen.Watson

Table 1

sheet 1

Summary of Classification Test Results

Project No.	Project Name
17-0439	Coolnabacky 400kV GIS Substation

Hole No.	Sample				Soil Description	Density bulk / dry Mg/m3		*w* %	Passing 425µm %	LL %	PL %	PI %	Particle density Mg/m3	Casagrande Classification
	Ref	Top	Base	Type										
BH09	5	4.00		B	Grey sandy gravelly silty CLAY.			8.3	65	23	13	10		CL
BH10	2	1.00		B	Grey sandy silty subangular to subrounded fine to coarse GRAVEL.			9.0	35	19	NP			
TP02	2	0.50		B	Brown sandy gravelly clayey SILT.			18.0	61	55	38	17		MH
TP05	1	0.50		B	Brown sandy slightly clayey subangular fine to coarse GRAVEL.			103.0	54	32	22	10		CL
TP09	2	0.50		B	Brown slightly gravelly silty fine to coarse SAND.			15.0	50	33	27	9		ML/CL
TP12	2	0.50		B	Grey gravelly slightly clayey fine to coarse SAND.			7.2	31	21	14	7		CL
TP15	5	1.70		B	Grey sandy gravelly silty CLAY.			7.3	46	20	13	7		CL

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

Key

Density test — Linear measurement unless : wd - water displacement; wi - immersion in water

Liquid Limit — 4pt cone unless : cas - Casagrande method; 1pt - single point test

Particle density — sp - small pyknometer; gj - gas jar

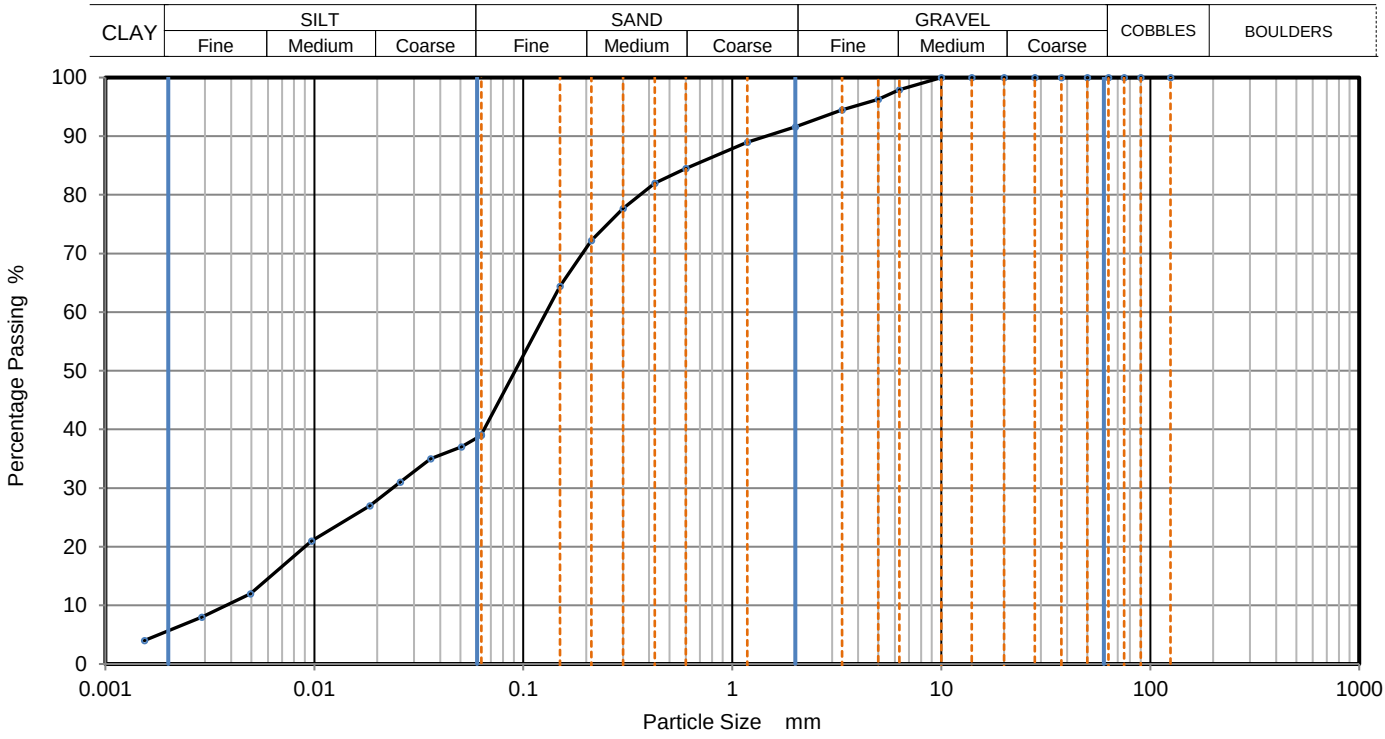
Date Printed: 30/07/2018

Approved By: Stephen.Watson

Table 1

sheet 2

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**17-0439**
				Borehole/Pit No.	BH01
Site Name	Coolnabacky 400kV GIS Substation			Sample No.	4
Soil Description	Grey sandy slightly gravelly silty CLAY.			Depth, m	1.00
Specimen Reference	6	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus201807040



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	39
90	100	0.0506	37
75	100	0.0360	35
63	100	0.0258	31
50	100	0.0184	27
37.5	100	0.0097	21
28	100	0.0050	12
20	100	0.0029	8
14	100	0.0015	4
10	100		
6.3	98		
5	96		
3.35	95		
2	92		
1.18	89		
0.6	85	Particle density	(assumed)
0.425	82	2.65	Mg/m3
0.3	78		
0.212	72		
0.15	64		
0.063	39		

Dry Mass of sample, g	873

Sample Proportions	% dry mass
Cobbles	0
Gravel	8
Sand	53
Silt	33
Clay	6

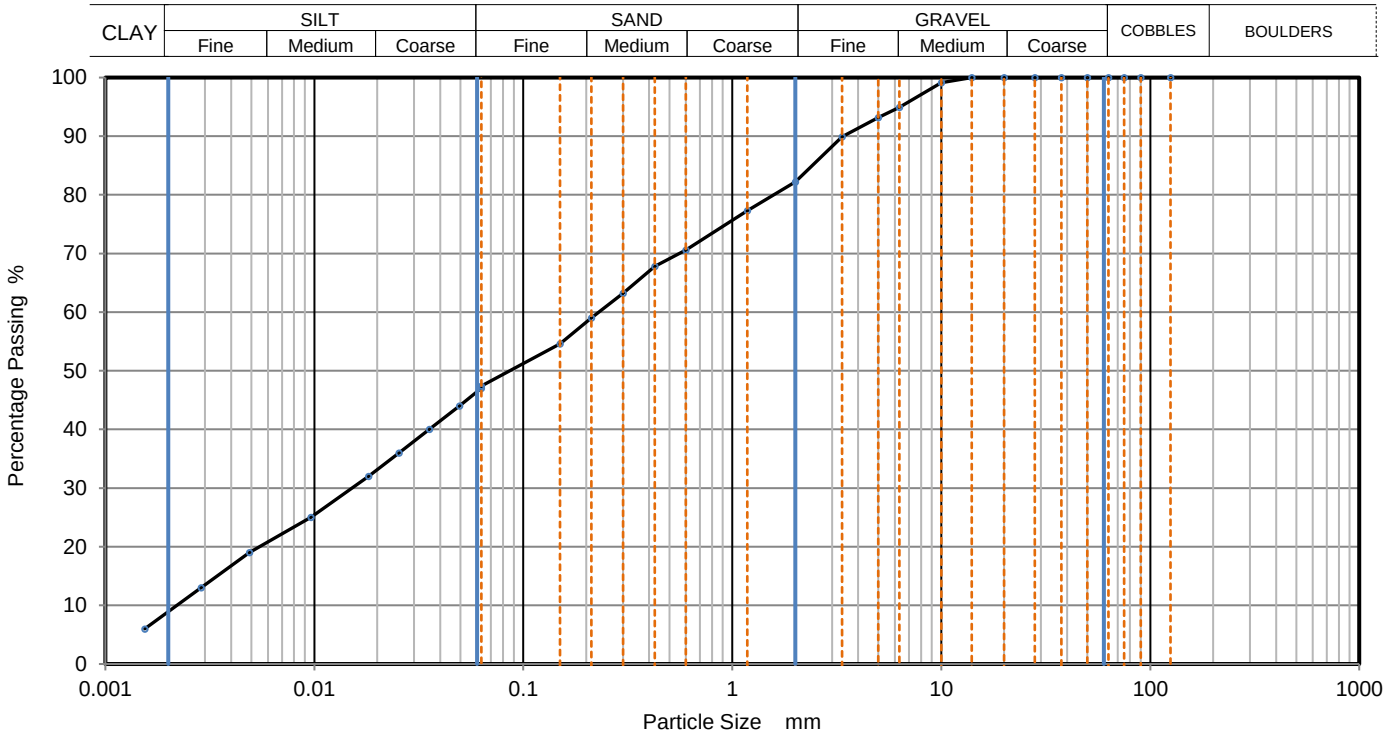
Grading Analysis		
D100	mm	
D60	mm	0.129
D30	mm	0.024
D10	mm	0.00364
Uniformity Coefficient		35
Curvature Coefficient		1.2

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	**Fig** 1
Stephen.Watson	30/07/2018 12:10	Sheet

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**17-0439**
				Borehole/Pit No.	BH01
Site Name	Coolnabacky 400kV GIS Substation			Sample No.	6
Soil Description	Grey sandy slightly gravelly silty CLAY.			Depth, m	3.00
Specimen Reference	6	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus201807041



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	47
90	100	0.0495	44
75	100	0.0355	40
63	100	0.0254	36
50	100	0.0182	32
37.5	100	0.0096	25
28	100	0.0049	19
20	100	0.0029	13
14	100	0.0015	6
10	99		
6.3	95		
5	93		
3.35	90		
2	82		
1.18	77		
0.6	71	Particle density	(assumed)
0.425	68	2.65	Mg/m3
0.3	63		
0.212	59		
0.15	55		
0.063	47		

Dry Mass of sample, g	1046

Sample Proportions	% dry mass
Cobbles	0
Gravel	18
Sand	35
Silt	39
Clay	9

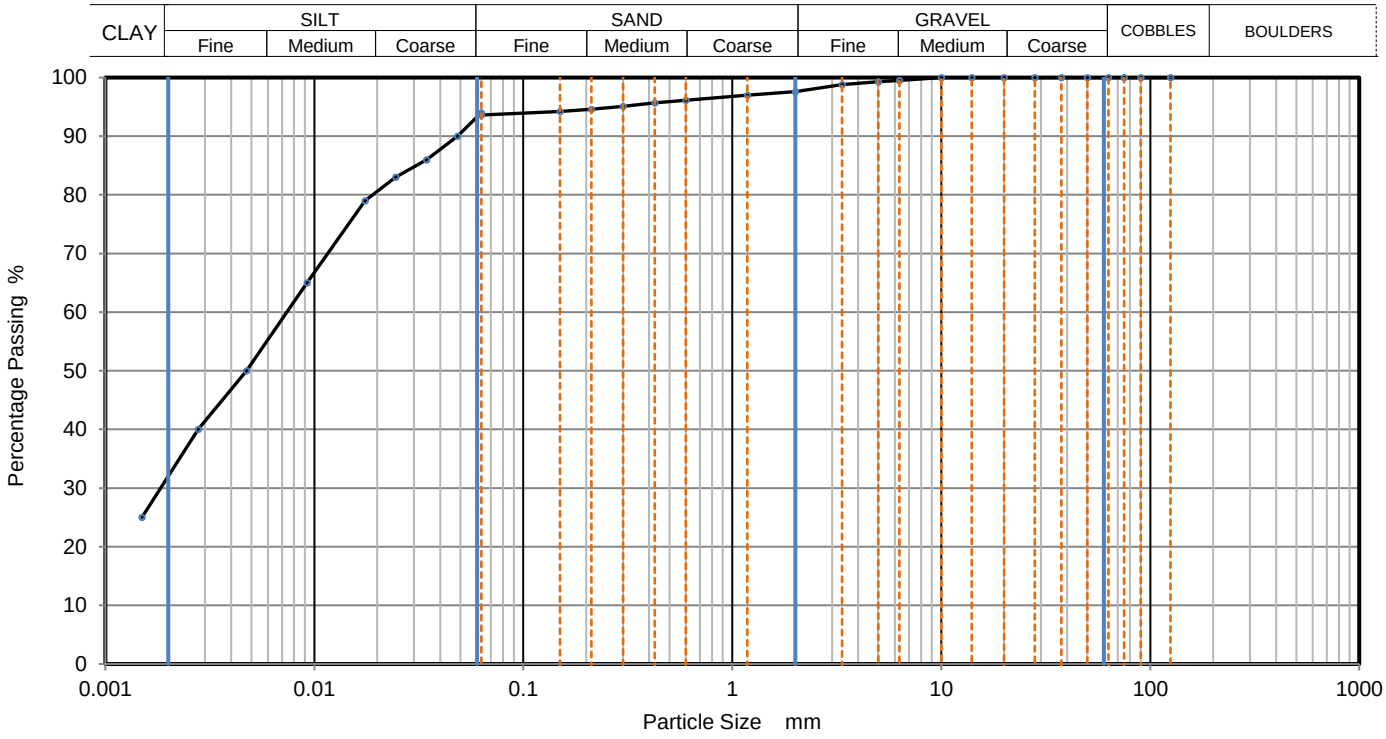
Grading Analysis		
D100	mm	
D60	mm	0.23
D30	mm	0.0151
D10	mm	0.0022
Uniformity Coefficient		100
Curvature Coefficient		0.45

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	**Fig** 1
Stephen.Watson	30/07/2018 12:10	Sheet

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**17-0439**
				Borehole/Pit No.	BH02
Site Name	Coolnabacky 400kV GIS Substation			Sample No.	2
Soil Description	Grey slightly sandy silty CLAY.			Depth, m	1.00
Specimen Reference	2	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus201807042



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	94
90	100	0.0484	90
75	100	0.0345	86
63	100	0.0245	83
50	100	0.0175	79
37.5	100	0.0092	65
28	100	0.0047	50
20	100	0.0028	40
14	100	0.0015	25
10	100		
6.3	100		
5	99		
3.35	99		
2	98		
1.18	97		
0.6	96	Particle density	(assumed)
0.425	96	2.65	Mg/m3
0.3	95		
0.212	95		
0.15	94		
0.063	94		

Dry Mass of sample, g	980

Sample Proportions	% dry mass
Cobbles	0
Gravel	2
Sand	4
Silt	62
Clay	32

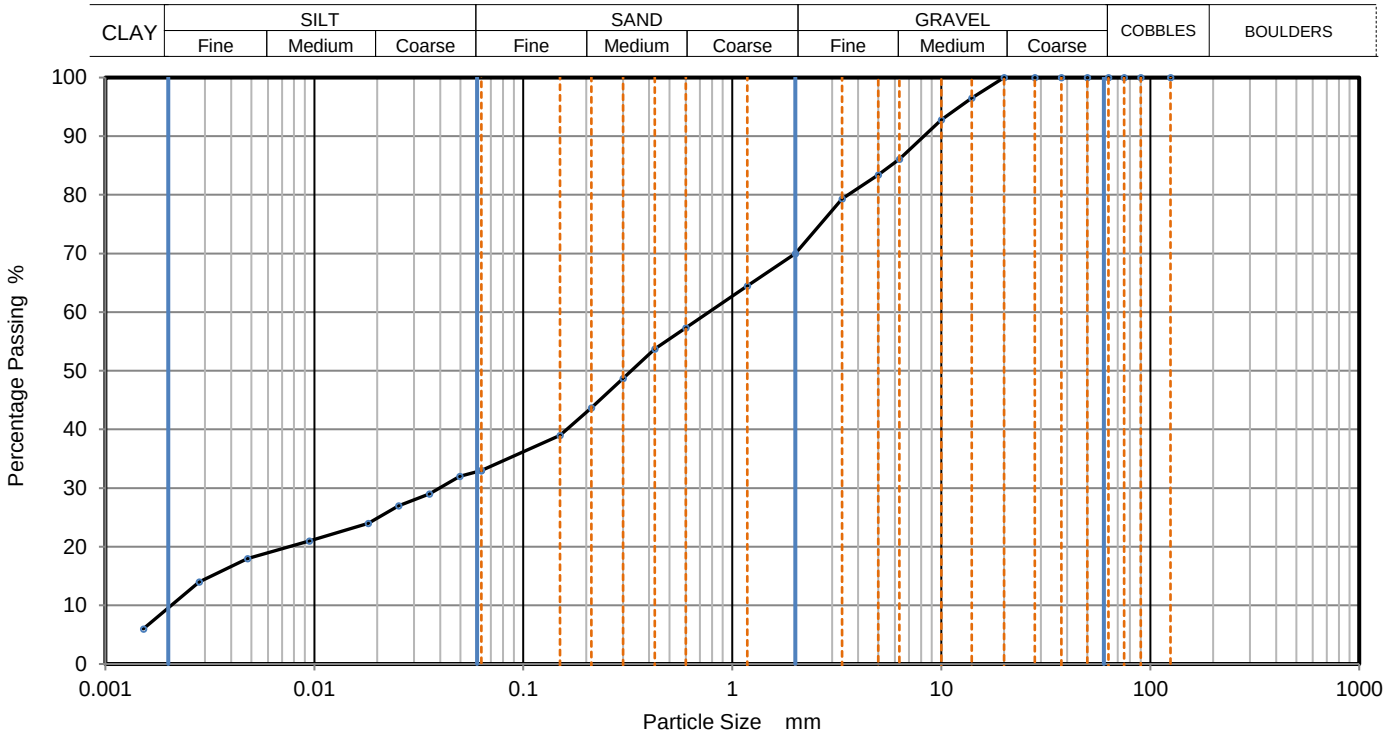
Grading Analysis		
D100	mm	
D60	mm	0.0074
D30	mm	0.00184
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	**Fig** 1
Stephen.Watson	30/07/2018 12:10	Sheet

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**17-0439**
				Borehole/Pit No.	BH02
Site Name	Coolnabacky 400kV GIS Substation			Sample No.	3
Soil Description	Grey sandy gravelly silty CLAY.			Depth, m	2.00
Specimen Reference	6	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus201807043



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	33
90	100	0.0497	32
75	100	0.0356	29
63	100	0.0253	27
50	100	0.0181	24
37.5	100	0.0095	21
28	100	0.0048	18
20	100	0.0028	14
14	97	0.0015	6
10	93		
6.3	86		
5	83		
3.35	79		
2	70		
1.18	65		
0.6	57	Particle density	(assumed)
0.425	54	2.65	Mg/m3
0.3	49		
0.212	44		
0.15	39		
0.063	33		

Dry Mass of sample, g	1220

Sample Proportions	% dry mass
Cobbles	0
Gravel	30
Sand	37
Silt	24
Clay	9

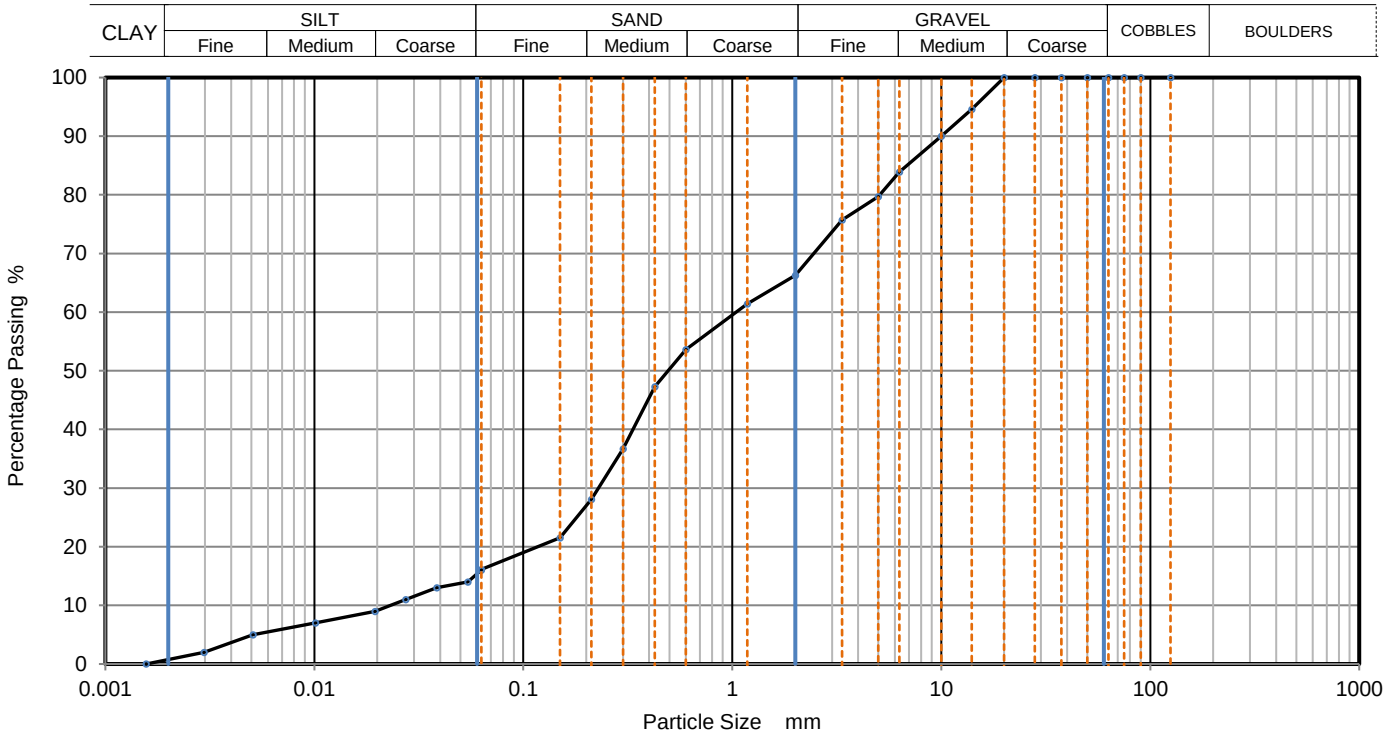
Grading Analysis		
D100	mm	
D60	mm	0.773
D30	mm	0.042
D10	mm	0.00211
Uniformity Coefficient		370
Curvature Coefficient		1.1

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	**Fig** 1
Stephen.Watson	30/07/2018 12:10	Sheet

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**	Job Ref	**17-0439**
		Borehole/Pit No.	BH03
Site Name	Coolnabacky 400kV GIS Substation	Sample No.	2
Soil Description	Grey gravelly silty fine to coarse SAND.	Depth, m	1.00
Specimen Reference	6 / Specimen Depth / m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5	KeyLAB ID	Caus201807044



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	16
90	100	0.0542	14
75	100	0.0385	13
63	100	0.0274	11
50	100	0.0195	9
37.5	100	0.0101	7
28	100	0.0051	5
20	100	0.0030	2
14	95	0.0016	0
10	90		
6.3	84		
5	80		
3.35	76		
2	66		
1.18	61		
0.6	54	Particle density	(assumed)
0.425	47	2.65	Mg/m3
0.3	37		
0.212	28		
0.15	22		
0.063	16		

Dry Mass of sample, g: 1011

Sample Proportions	% dry mass
Cobbles	0
Gravel	34
Sand	50
Silt	15
Clay	1

Grading Analysis		
D100	mm	
D60	mm	1.04
D30	mm	0.228
D10	mm	0.0238
Uniformity Coefficient		44
Curvature Coefficient		2.1

Remarks

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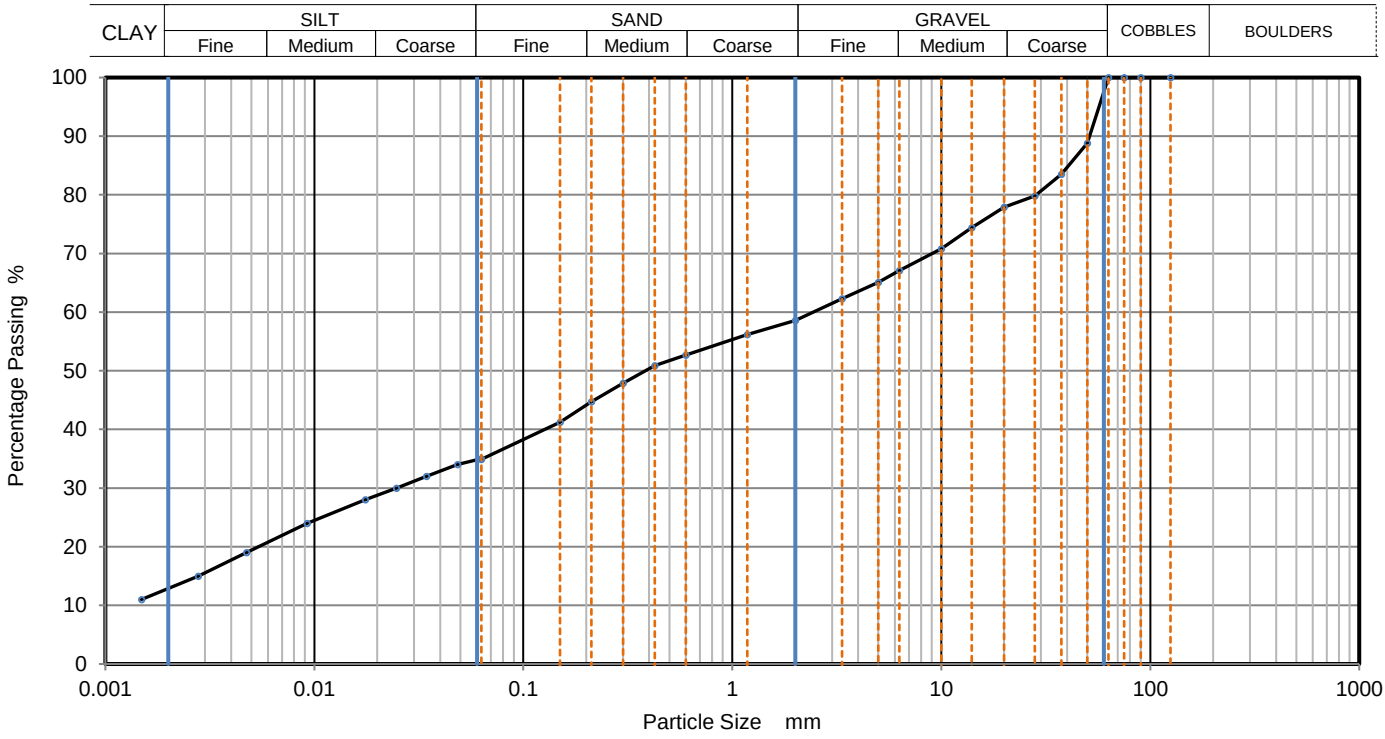
Approved	Sheet printed	**Fig** 1
Stephen.Watson	30/07/2018 12:10	Sheet

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**17-0439**
				Borehole/Pit No.	BH03
Site Name	Coolnabacky 400kV GIS Substation			Sample No.	5
Soil Description	Grey sandy gravelly silty CLAY.			Depth, m	4.00
Specimen Reference	6	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus201807045



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	35
90	100	0.0484	34
75	100	0.0345	32
63	100	0.0247	30
50	89	0.0176	28
37.5	84	0.0092	24
28	80	0.0047	19
20	78	0.0028	15
14	74	0.0015	11
10	71		
6.3	67		
5	65		
3.35	62		
2	59		
1.18	56		
0.6	53	Particle density	(assumed)
0.425	51	2.65	Mg/m3
0.3	48		
0.212	45		
0.15	41		
0.063	35		

Dry Mass of sample, g	4461

Sample Proportions	% dry mass
Cobbles	0
Gravel	41
Sand	24
Silt	22
Clay	13

Grading Analysis		
D100	mm	
D60	mm	2.43
D30	mm	0.0262
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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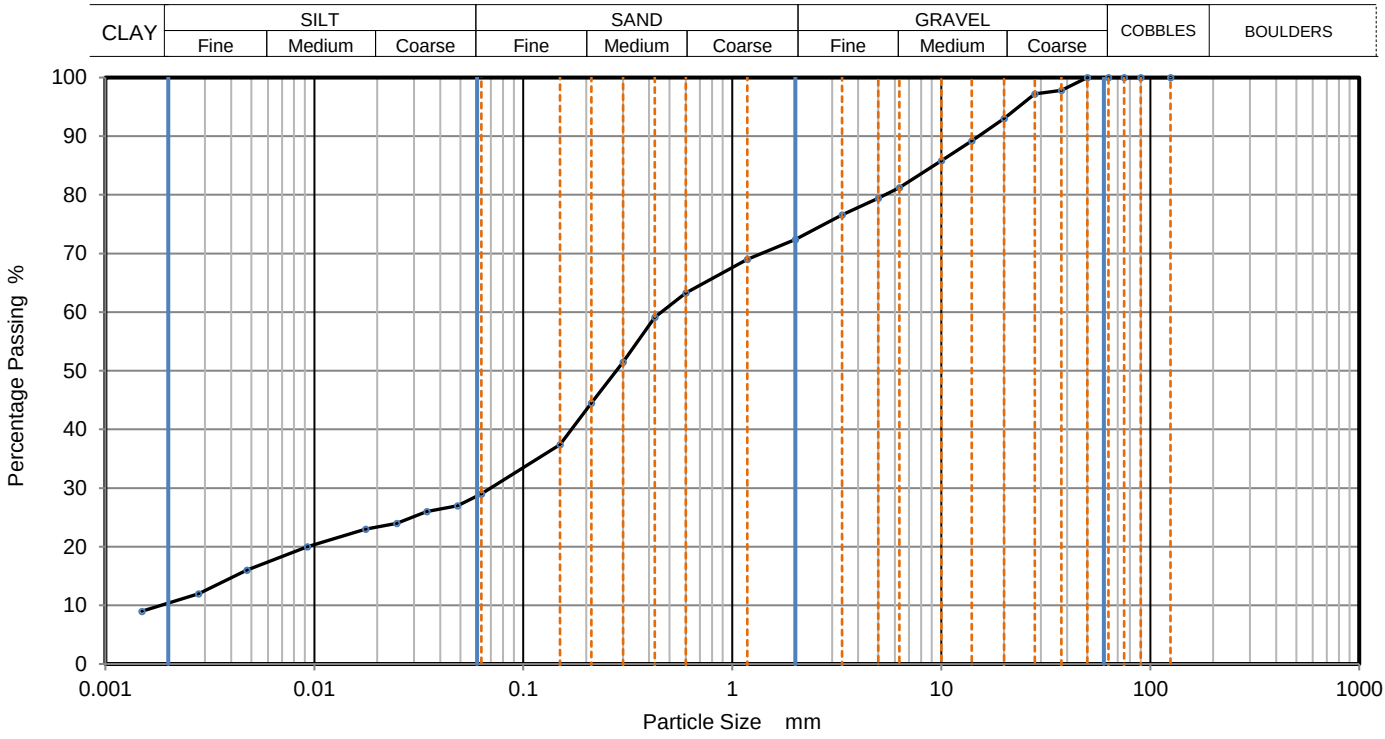
Approved	Sheet printed	**Fig** 1
Stephen.Watson	30/07/2018 12:10	Sheet

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**17-0439**
				Borehole/Pit No.	BH04
Site Name	Coolnabacky 400kV GIS Substation			Sample No.	3
Soil Description	Grey sandy gravelly clayey SILT.			Depth, m	2.00
Specimen Reference	6	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus201807046



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	29
90	100	0.0485	27
75	100	0.0346	26
63	100	0.0248	24
50	100	0.0176	23
37.5	98	0.0093	20
28	97	0.0048	16
20	93	0.0028	12
14	89	0.0015	9
10	86		
6.3	81		
5	79		
3.35	77		
2	72		
1.18	69		
0.6	63	Particle density	(assumed)
0.425	59	2.65	Mg/m3
0.3	52		
0.212	45		
0.15	37		
0.063	29		

Dry Mass of sample, g	5306

Sample Proportions	% dry mass
Cobbles	0
Gravel	28
Sand	43
Silt	18
Clay	11

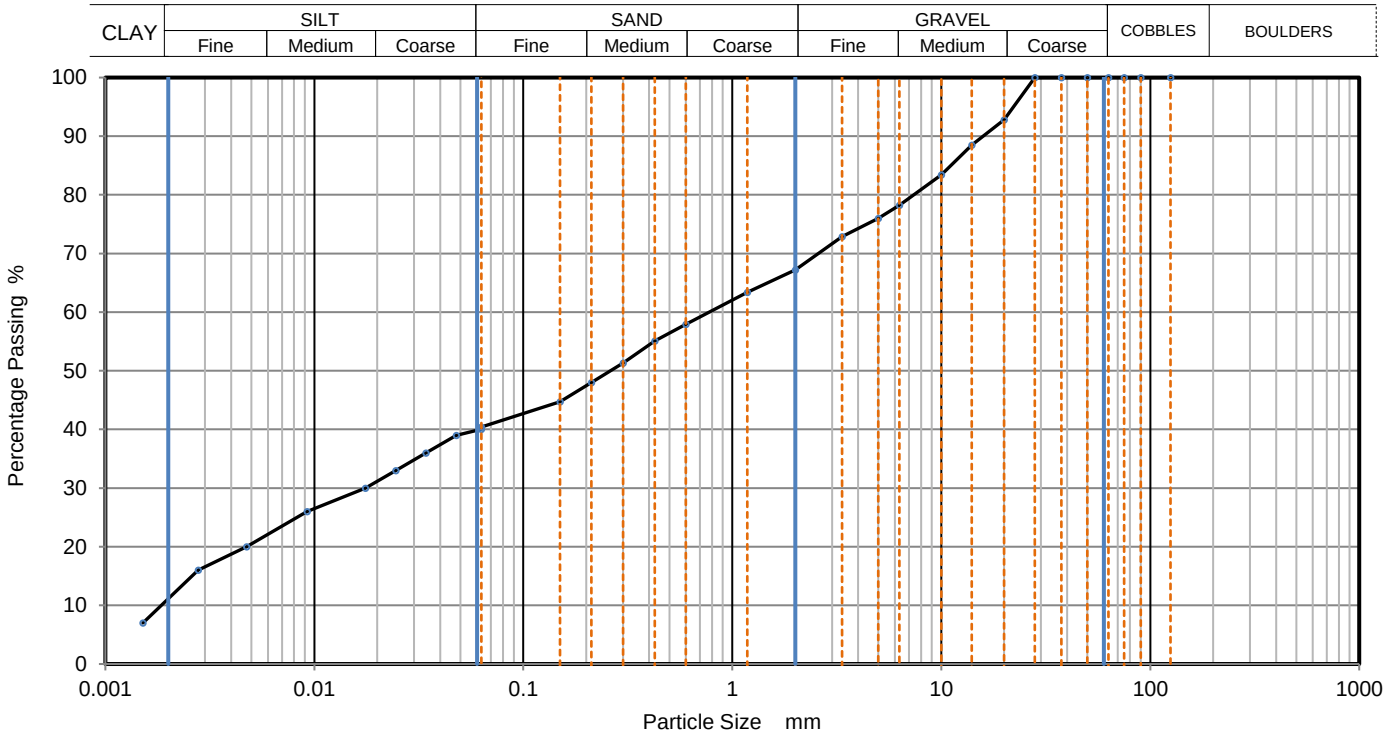
Grading Analysis		
D100	mm	
D60	mm	0.459
D30	mm	0.0701
D10	mm	0.00171
Uniformity Coefficient		270
Curvature Coefficient		6.3

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	**Fig** 1
Stephen.Watson	30/07/2018 12:10	Sheet

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**	Job Ref	**17-0439**
		Borehole/Pit No.	BH04
Site Name	Coolnabacky 400kV GIS Substation	Sample No.	5
Soil Description	Grey sandy gravelly silty CLAY.	Depth, m	4.00
Specimen Reference	6 / Specimen Depth / m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5	KeyLAB ID	Caus201807047



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	40
90	100	0.0478	39
75	100	0.0342	36
63	100	0.0245	33
50	100	0.0176	30
37.5	100	0.0092	26
28	100	0.0047	20
20	93	0.0028	16
14	89	0.0015	7
10	83		
6.3	78		
5	76		
3.35	73		
2	67		
1.18	63		
0.6	58	Particle density	(assumed)
0.425	55	2.65	Mg/m3
0.3	51		
0.212	48		
0.15	45		
0.063	40		

Dry Mass of sample, g	2221

Sample Proportions	% dry mass
Cobbles	0
Gravel	33
Sand	27
Silt	29
Clay	11

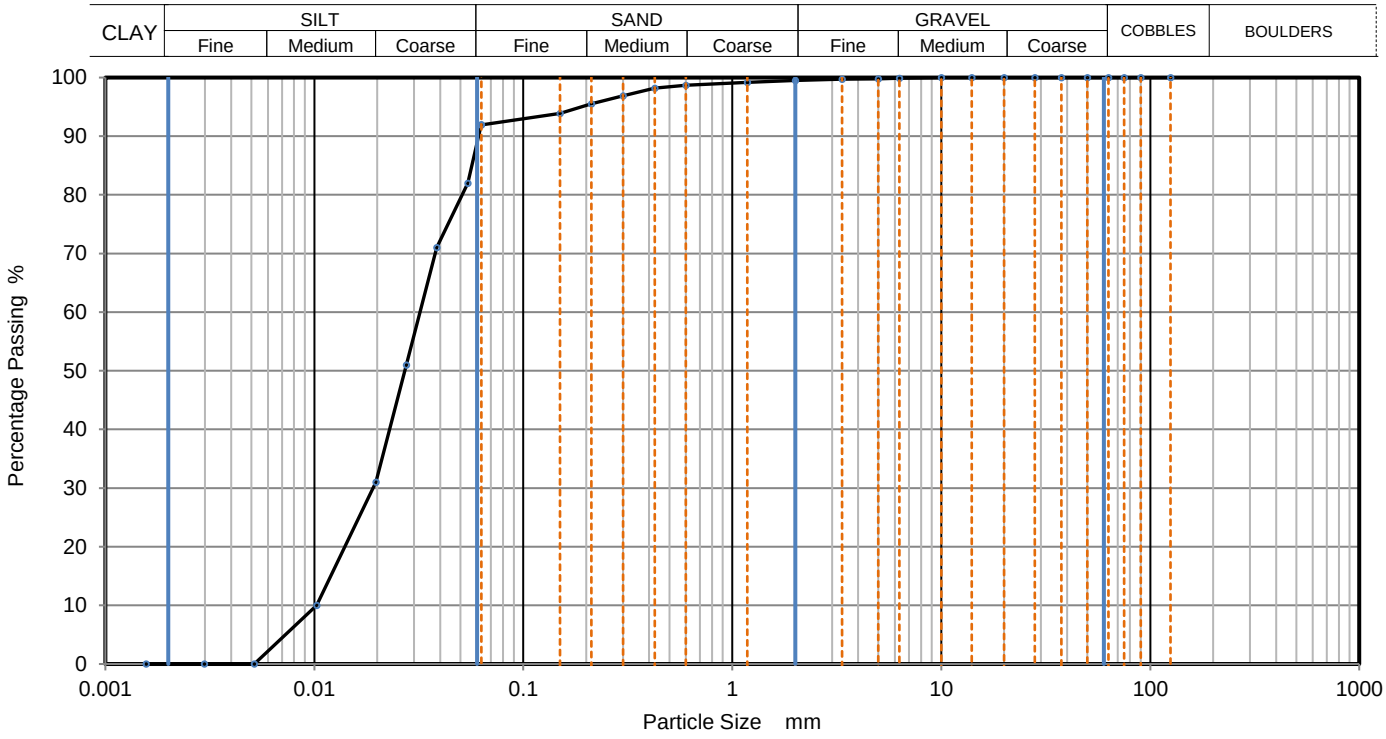
Grading Analysis		
D100	mm	
D60	mm	0.775
D30	mm	0.0168
D10	mm	0.00184
Uniformity Coefficient		420
Curvature Coefficient		0.2

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	**Fig** 1
Stephen.Watson	30/07/2018 12:10	Sheet

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**17-0439**
				Borehole/Pit No.	BH06
Site Name	Coolnabacky 400kV GIS Substation			Sample No.	2
Soil Description	Grey slightly sandy clayey SILT.			Depth, m	1.00
Specimen Reference	2	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus201807048



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	92
90	100	0.0542	82
75	100	0.0385	71
63	100	0.0275	51
50	100	0.0197	31
37.5	100	0.0103	10
28	100	0.0052	0
20	100	0.0030	0
14	100	0.0016	0
10	100		
6.3	100		
5	100		
3.35	100		
2	100		
1.18	99		
0.6	99	Particle density	(assumed)
0.425	98	2.65	Mg/m3
0.3	97		
0.212	96		
0.15	94		
0.063	92		

Dry Mass of sample, g	1135

Sample Proportions	% dry mass
Cobbles	0
Gravel	1
Sand	8
Silt	92
Clay	0

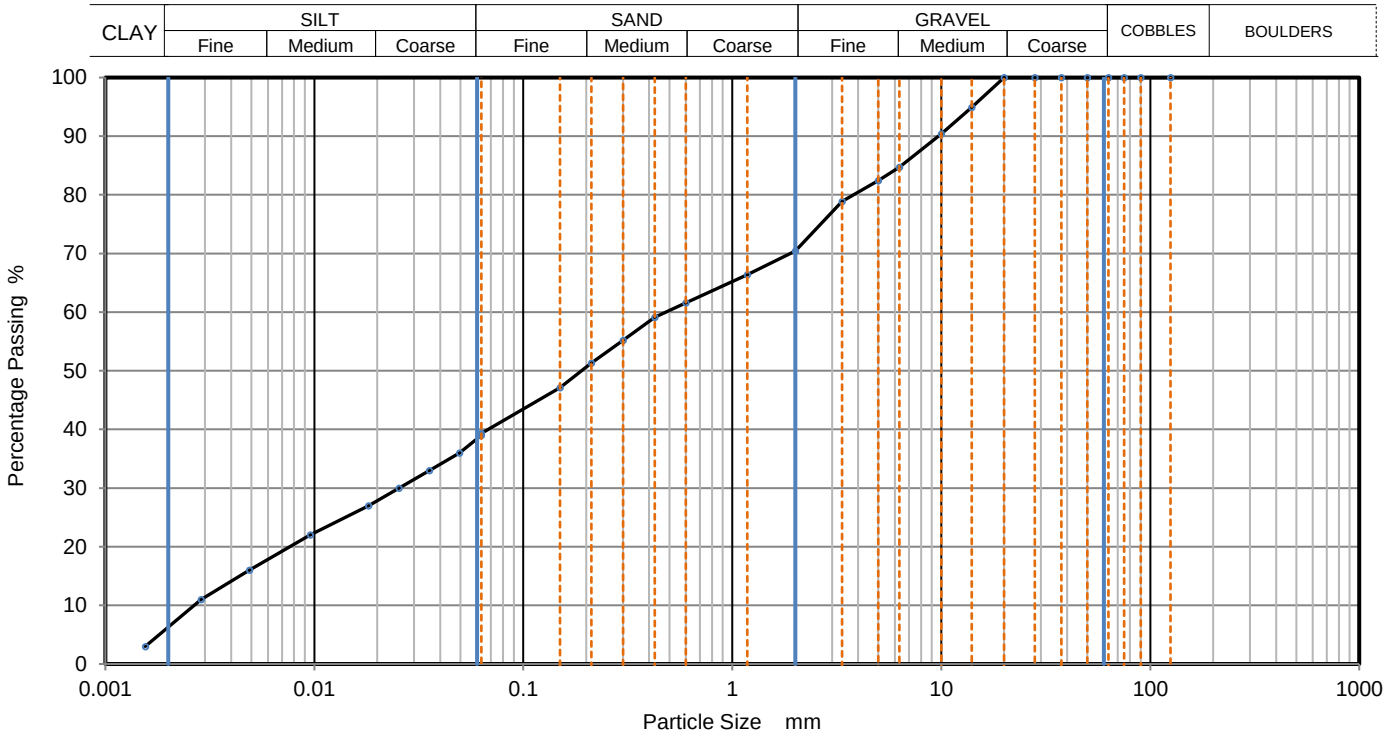
Grading Analysis		
D100	mm	
D60	mm	0.0319
D30	mm	0.0193
D10	mm	0.0101
Uniformity Coefficient		3.2
Curvature Coefficient		1.2

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	**Fig** 1
Stephen.Watson	30/07/2018 12:10	Sheet

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	17-0439
				Borehole/Pit No.	BH06
Site Name	Coolnabacky 400kV GIS Substation			Sample No.	4
Soil Description	Grey sandy gravelly silty CLAY.			Depth, m	3.00
Specimen Reference	6	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus201807049



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	39
90	100	0.0495	36
75	100	0.0355	33
63	100	0.0254	30
50	100	0.0182	27
37.5	100	0.0096	22
28	100	0.0049	16
20	100	0.0029	11
14	95	0.0016	3
10	90		
6.3	85		
5	82		
3.35	79		
2	70		
1.18	66		
0.6	62	Particle density	(assumed)
0.425	59	2.65	Mg/m3
0.3	55		
0.212	51		
0.15	47		
0.063	39		

Dry Mass of sample, g	2437

Sample Proportions	% dry mass
Cobbles	0
Gravel	30
Sand	31
Silt	33
Clay	6

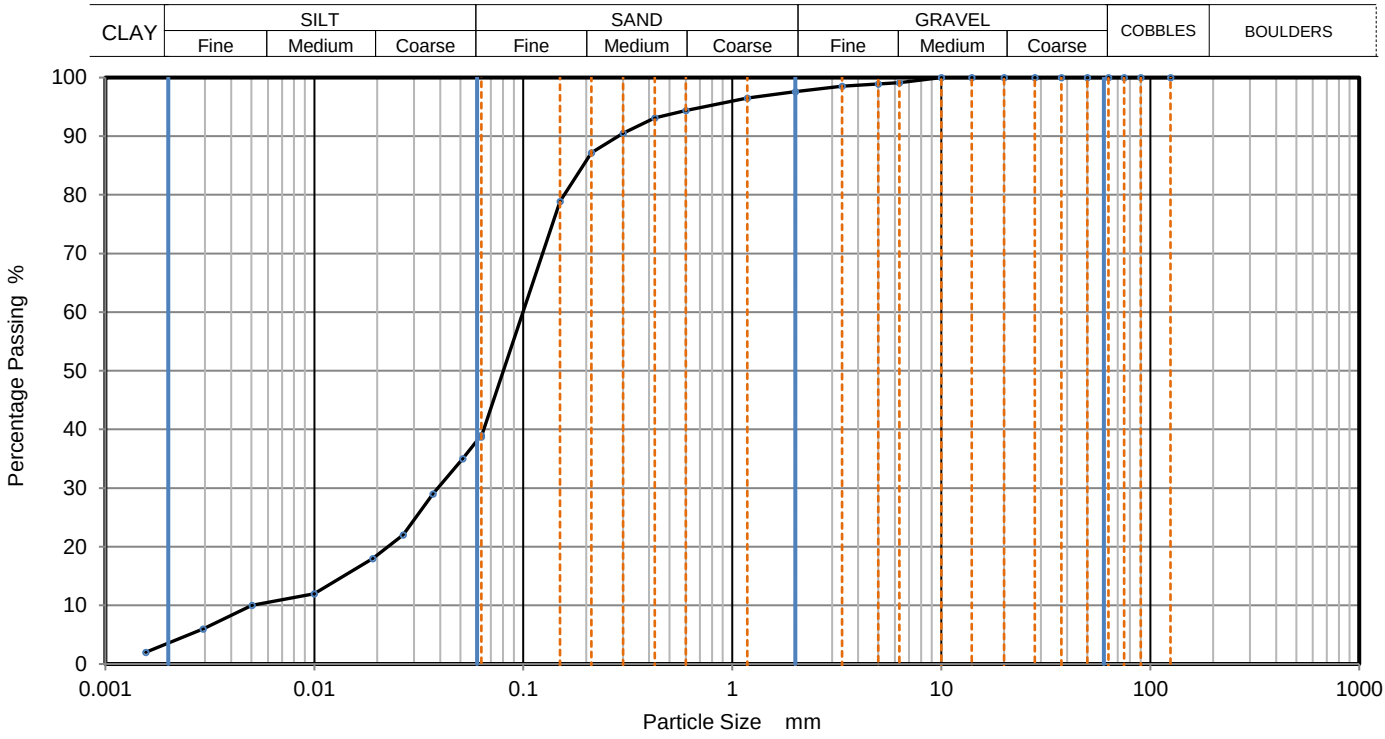
Grading Analysis		
D100	mm	
D60	mm	0.482
D30	mm	0.0258
D10	mm	0.00265
Uniformity Coefficient		180
Curvature Coefficient		0.52

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	Fig 1
Stephen.Watson	30/07/2018 12:10	Sheet

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**17-0439**
				Borehole/Pit No.	BH07
Site Name	Coolnabacky 400kV GIS Substation			Sample No.	2
Soil Description	Brownish grey silty fine to coarse SAND.			Depth, m	1.00
Specimen Reference	6	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2018070410



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	39
90	100	0.0513	35
75	100	0.0369	29
63	100	0.0266	22
50	100	0.0190	18
37.5	100	0.0100	12
28	100	0.0050	10
20	100	0.0029	6
14	100	0.0016	2
10	100		
6.3	99		
5	99		
3.35	99		
2	98		
1.18	97		
0.6	94	Particle density	(assumed)
0.425	93	2.65	Mg/m3
0.3	91		
0.212	87		
0.15	79		
0.063	39		

Dry Mass of sample, g	442

Sample Proportions	% dry mass
Cobbles	0
Gravel	2
Sand	59
Silt	35
Clay	4

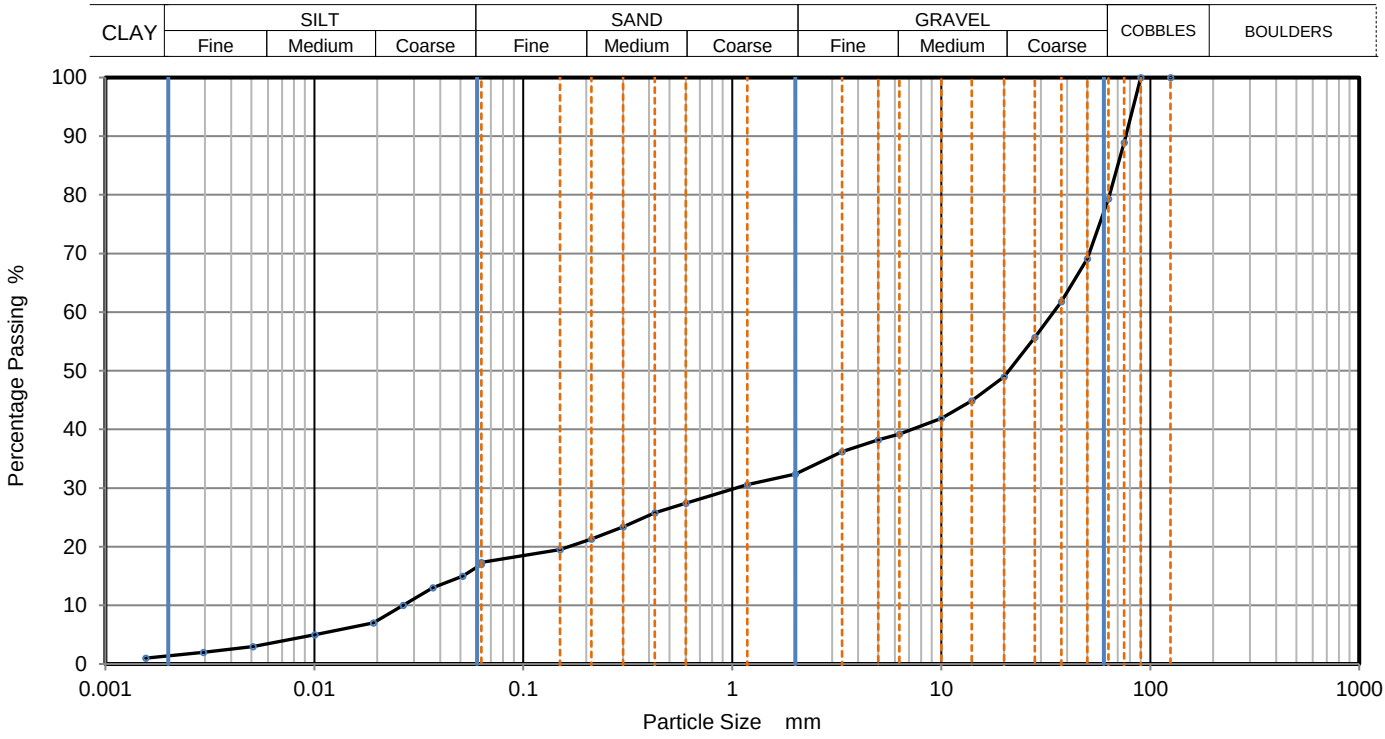
Grading Analysis		
D100	mm	
D60	mm	0.0998
D30	mm	0.04
D10	mm	0.0049
Uniformity Coefficient		20
Curvature Coefficient		3.3

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	**Fig** 1
Stephen.Watson	30/07/2018 12:10	Sheet

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	17-0439
				Borehole/Pit No.	BH07
Site Name	Coolnabacky 400kV GIS Substation			Sample No.	4
Soil Description	Grey slightly sandy clayey subangular fine to coarse GRAVEL with low cobble content.			Depth, m	3.00
Specimen Reference	6	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2018070411



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	17
90	100	0.0513	15
75	89	0.0369	13
63	79	0.0266	10
50	69	0.0191	7
37.5	62	0.0100	5
28	56	0.0051	3
20	49	0.0029	2
14	45	0.0016	1
10	42		
6.3	39		
5	38		
3.35	36		
2	32		
1.18	31		
0.6	27	Particle density	(assumed)
0.425	26	2.65	Mg/m3
0.3	23		
0.212	21		
0.15	20		
0.063	17		

Dry Mass of sample, g	14350

Sample Proportions	% dry mass
Cobbles	21
Gravel	47
Sand	15
Silt	16
Clay	1

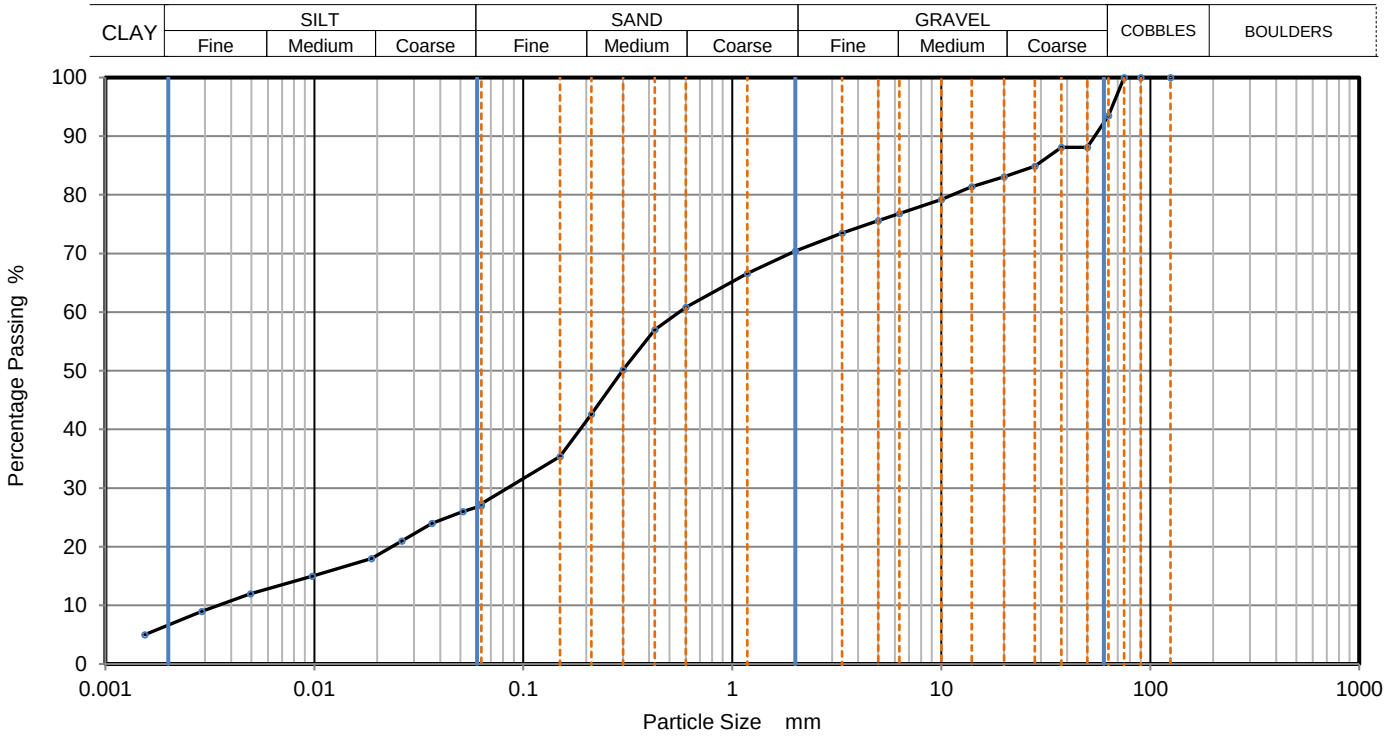
Grading Analysis		
D100	mm	
D60	mm	34.4
D30	mm	1.04
D10	mm	0.0265
Uniformity Coefficient		1300
Curvature Coefficient		1.2

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	Fig 1
Stephen.Watson	30/07/2018 12:10	Sheet

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**17-0439**
				Borehole/Pit No.	BH08
Site Name	Coolnabacky 400kV GIS Substation			Sample No.	2
Soil Description	Brownish grey sandy gravelly silty CLAY.			Depth, m	1.00
Specimen Reference	4	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2018070412



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	27
90	100	0.0514	26
75	100	0.0366	24
63	94	0.0262	21
50	88	0.0187	18
37.5	88	0.0098	15
28	85	0.0049	12
20	83	0.0029	9
14	81	0.0015	5
10	79		
6.3	77		
5	76		
3.35	74		
2	70		
1.18	67		
0.6	61	Particle density	(assumed)
0.425	57	2.65	Mg/m3
0.3	50		
0.212	43		
0.15	35		
0.063	27		

Dry Mass of sample, g	10924

Sample Proportions	% dry mass
Cobbles	7
Gravel	23
Sand	43
Silt	21
Clay	6

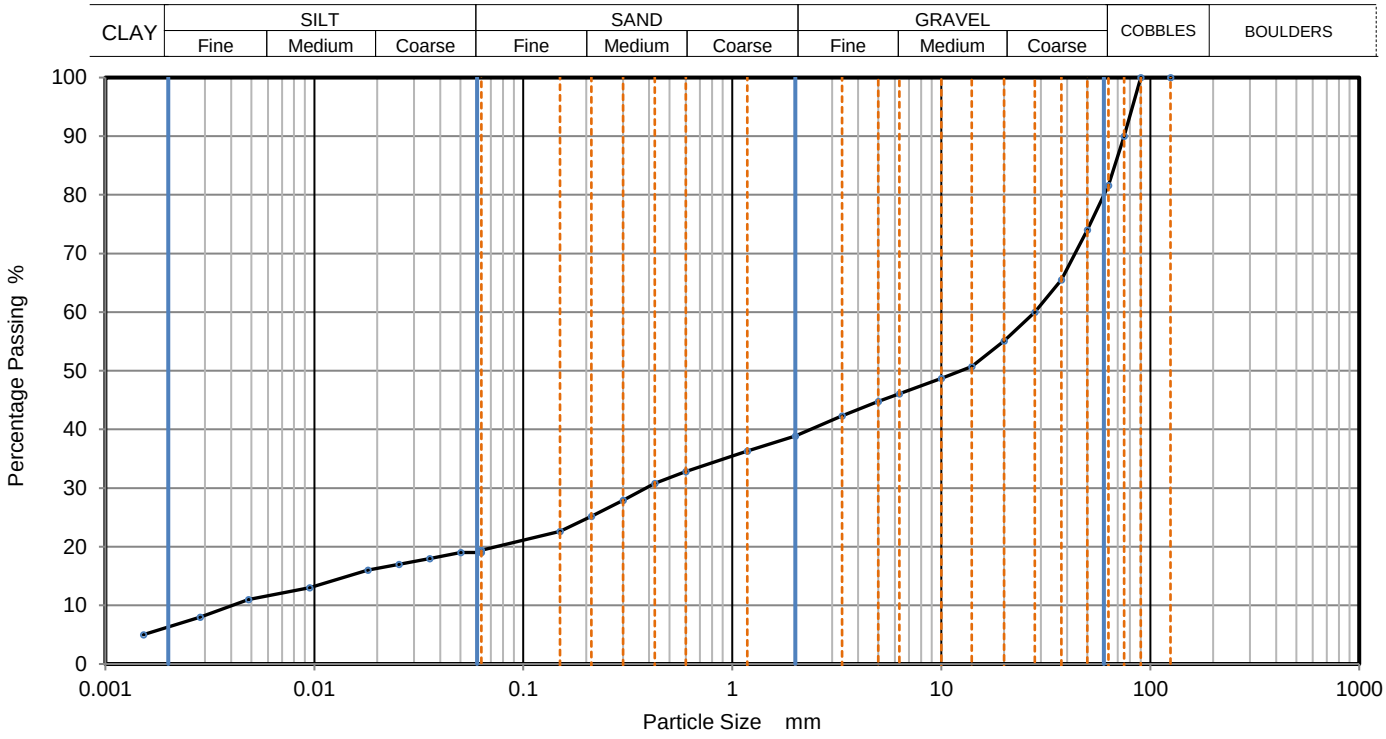
Grading Analysis		
D100	mm	
D60	mm	0.556
D30	mm	0.0843
D10	mm	0.00339
Uniformity Coefficient		160
Curvature Coefficient		3.8

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	**Fig** 1
Stephen.Watson	30/07/2018 12:10	Sheet

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**17-0439**
				Borehole/Pit No.	BH08
Site Name	Coolnabacky 400kV GIS Substation			Sample No.	4
Soil Description	Grey slightly sandy gravelly silty CLAY with low cobble content.			Depth, m	3.00
Specimen Reference	6	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2018070413



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	19
90	100	0.0502	19
75	90	0.0357	18
63	82	0.0254	17
50	74	0.0181	16
37.5	66	0.0095	13
28	60	0.0048	11
20	55	0.0028	8
14	51	0.0015	5
10	49		
6.3	46		
5	45		
3.35	42		
2	39		
1.18	36		
0.6	33	Particle density (assumed)	
0.425	31	2.65 Mg/m3	
0.3	28		
0.212	25		
0.15	23		
0.063	19		

Dry Mass of sample, g	15788

Sample Proportions	% dry mass
Cobbles	18
Gravel	43
Sand	19
Silt	13
Clay	7

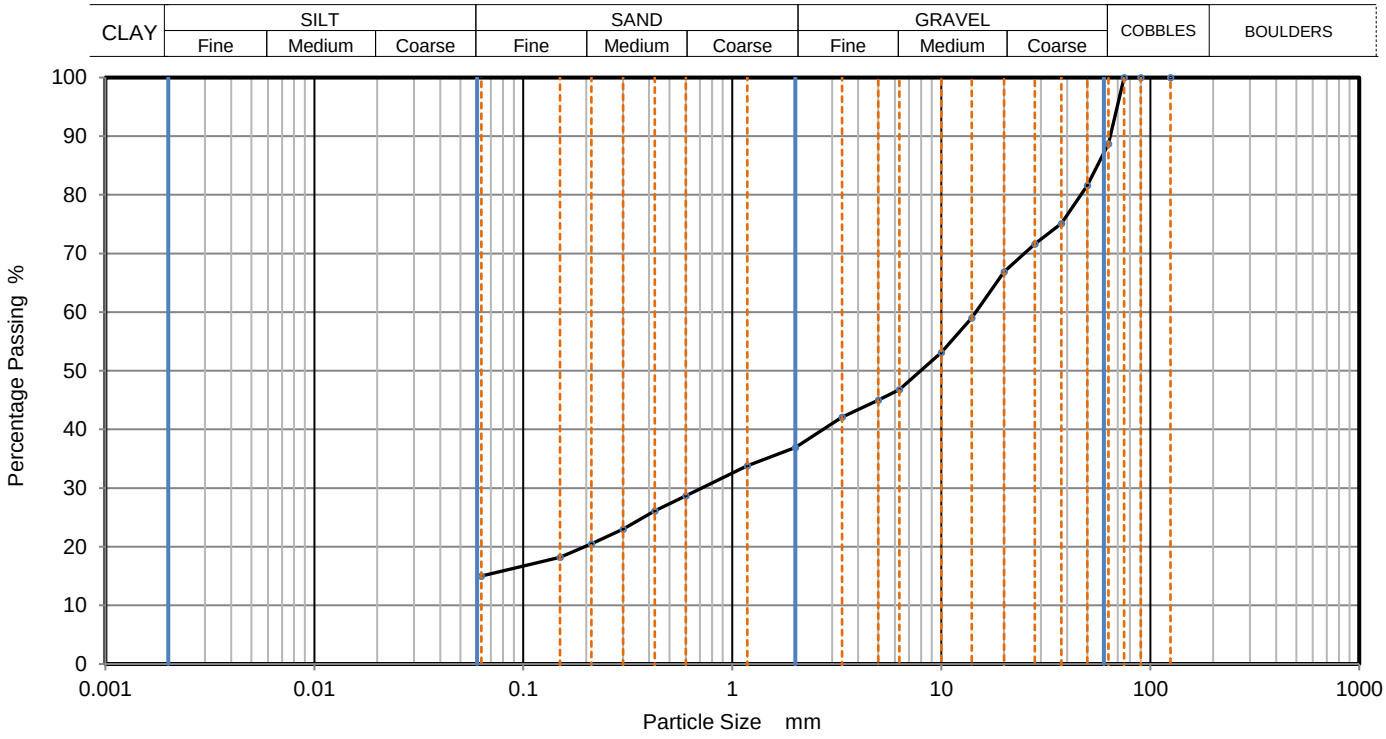
Grading Analysis		
D100	mm	
D60	mm	27.9
D30	mm	0.385
D10	mm	0.0043
Uniformity Coefficient		6500
Curvature Coefficient		1.2

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	**Fig** 1
Stephen.Watson	30/07/2018 12:10	Sheet

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**17-0439**
				Borehole/Pit No.	BH09
Site Name	Coolnabacky 400kV GIS Substation			Sample No.	2
Soil Description	Brown sandy clayey silty subangular to subrounded fine to coarse GRAVEL.			Depth, m	1.00
Specimen Reference	6	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	Caus2018070414



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	89		
50	82		
37.5	75		
28	72		
20	67		
14	59		
10	53		
6.3	47		
5	45		
3.35	42		
2	37		
1.18	34		
0.6	29		
0.425	26		
0.3	23		
0.212	21		
0.15	18		
0.063	15		

Dry Mass of sample, g	12798

Sample Proportions	% dry mass
Cobbles	11
Gravel	52
Sand	22
Fines <0.063mm	15

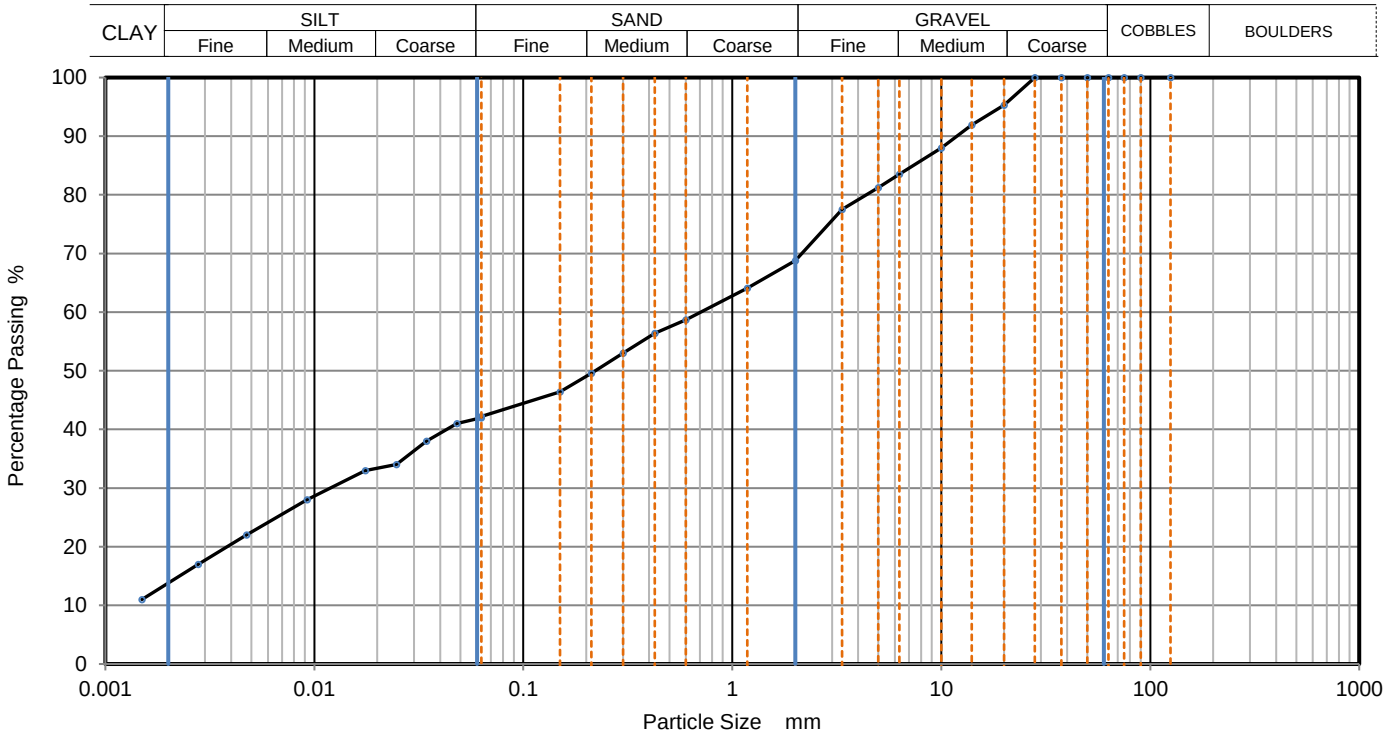
Grading Analysis		
D100	mm	
D60	mm	14.6
D30	mm	0.711
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	**Fig** 1
Stephen.Watson	30/07/2018 12:10	Sheet

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**17-0439**
				Borehole/Pit No.	BH09
Site Name	Coolnabacky 400kV GIS Substation			Sample No.	5
Soil Description	Grey sandy gravelly silty CLAY.			Depth, m	4.00
Specimen Reference	6	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2018070415



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	42
90	100	0.0481	41
75	100	0.0345	38
63	100	0.0247	34
50	100	0.0176	33
37.5	100	0.0092	28
28	100	0.0047	22
20	95	0.0028	17
14	92	0.0015	11
10	88		
6.3	84		
5	81		
3.35	78		
2	69		
1.18	64		
0.6	59	Particle density	(assumed)
0.425	56	2.65	Mg/m3
0.3	53		
0.212	50		
0.15	46		
0.063	42		

Dry Mass of sample, g	3094

Sample Proportions	% dry mass
Cobbles	0
Gravel	31
Sand	27
Silt	28
Clay	14

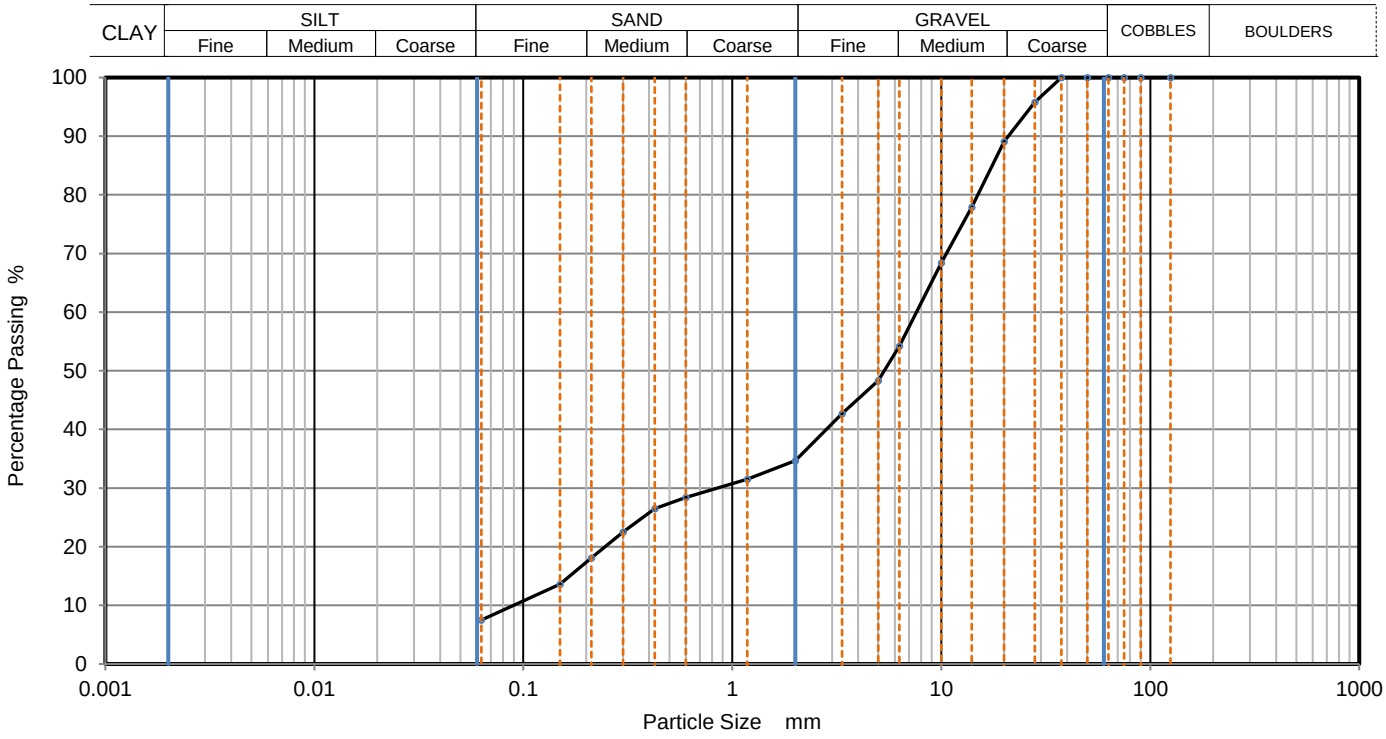
Grading Analysis		
D100	mm	
D60	mm	0.709
D30	mm	0.0119
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	**Fig** 1
Stephen.Watson	30/07/2018 12:10	Sheet

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**17-0439**
				Borehole/Pit No.	BH10
Site Name	Coolnabacky 400kV GIS Substation			Sample No.	2
Soil Description	Grey sandy silty subangular to subrounded fine to coarse GRAVEL.			Depth, m	1.00
Specimen Reference	6	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	Caus2018070416



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	96		
20	89		
14	78		
10	68		
6.3	54		
5	48		
3.35	43		
2	35		
1.18	32		
0.6	28		
0.425	27		
0.3	23		
0.212	18		
0.15	14		
0.063	8		

Dry Mass of sample, g	2522

Sample Proportions	% dry mass
Cobbles	0
Gravel	65
Sand	27
Fines <0.063mm	8

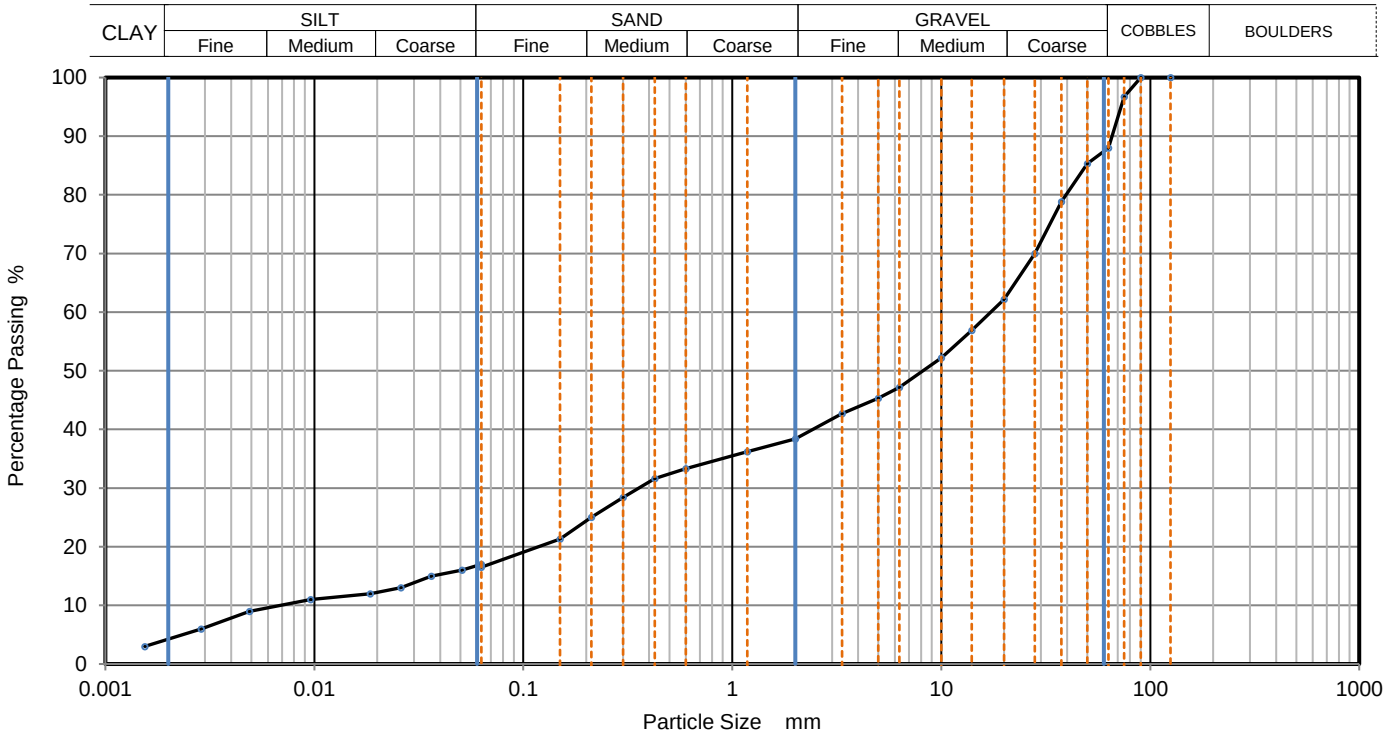
Grading Analysis		
D100	mm	
D60	mm	7.62
D30	mm	0.847
D10	mm	0.0897
Uniformity Coefficient		85
Curvature Coefficient		1

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	**Fig** 1
Stephen.Watson	30/07/2018 12:10	Sheet

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**17-0439**
				Borehole/Pit No.	TP01
Site Name	Coolnabacky 400kV GIS Substation			Sample No.	2
Soil Description	Brown sandy clayey rounded fine to coarse GRAVEL.			Depth, m	0.50
Specimen Reference	2	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2018070418



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	17
90	100	0.0510	16
75	97	0.0363	15
63	88	0.0260	13
50	85	0.0185	12
37.5	79	0.0096	11
28	70	0.0049	9
20	62	0.0029	6
14	57	0.0015	3
10	52		
6.3	47		
5	45		
3.35	43		
2	38		
1.18	36		
0.6	33	Particle density	(assumed)
0.425	32	2.65	Mg/m3
0.3	28		
0.212	25		
0.15	21		
0.063	17		

Dry Mass of sample, g: 18038

Sample Proportions	% dry mass
Cobbles	12
Gravel	50
Sand	22
Silt	13
Clay	4

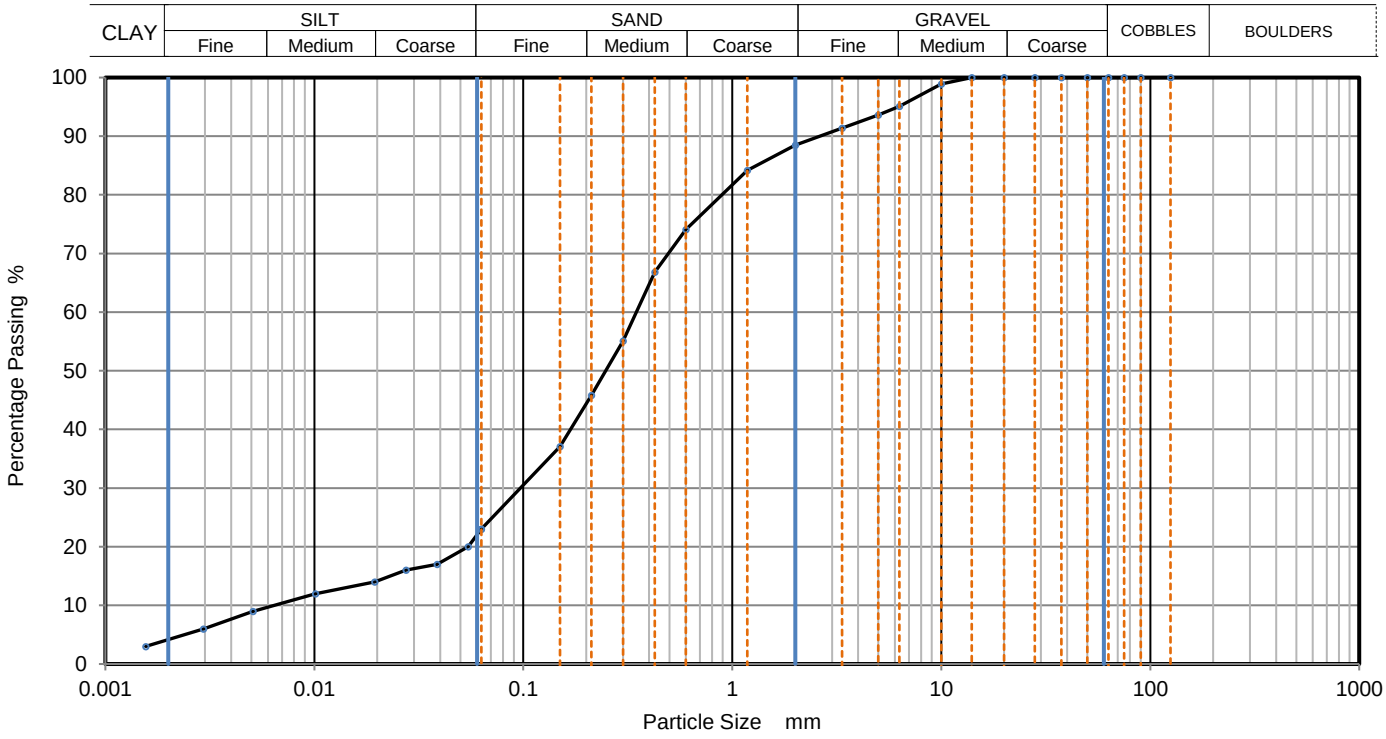
Grading Analysis		
D100	mm	
D60	mm	17.3
D30	mm	0.358
D10	mm	0.00687
Uniformity Coefficient		2500
Curvature Coefficient		1.1

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	**Fig** 1
Stephen.Watson	30/07/2018 12:10	Sheet

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**17-0439**
				Borehole/Pit No.	TP03
Site Name	Coolnabacky 400kV GIS Substation			Sample No.	1
Soil Description	Brown slightly gravelly silty fine to coarse SAND.			Depth, m	0.50
Specimen Reference	2	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2018070420



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	23
90	100	0.0544	20
75	100	0.0387	17
63	100	0.0274	16
50	100	0.0195	14
37.5	100	0.0101	12
28	100	0.0051	9
20	100	0.0029	6
14	100	0.0016	3
10	99		
6.3	95		
5	94		
3.35	91		
2	89		
1.18	84		
0.6	74	Particle density	(assumed)
0.425	67	2.65	Mg/m3
0.3	55		
0.212	46		
0.15	37		
0.063	23		

Dry Mass of sample, g	1027

Sample Proportions	% dry mass
Cobbles	0
Gravel	12
Sand	66
Silt	19
Clay	4

Grading Analysis		
D100	mm	
D60	mm	0.347
D30	mm	0.0969
D10	mm	0.00706
Uniformity Coefficient		49
Curvature Coefficient		3.8

Remarks

Preparation and testing in accordance with BS1377 unless noted below

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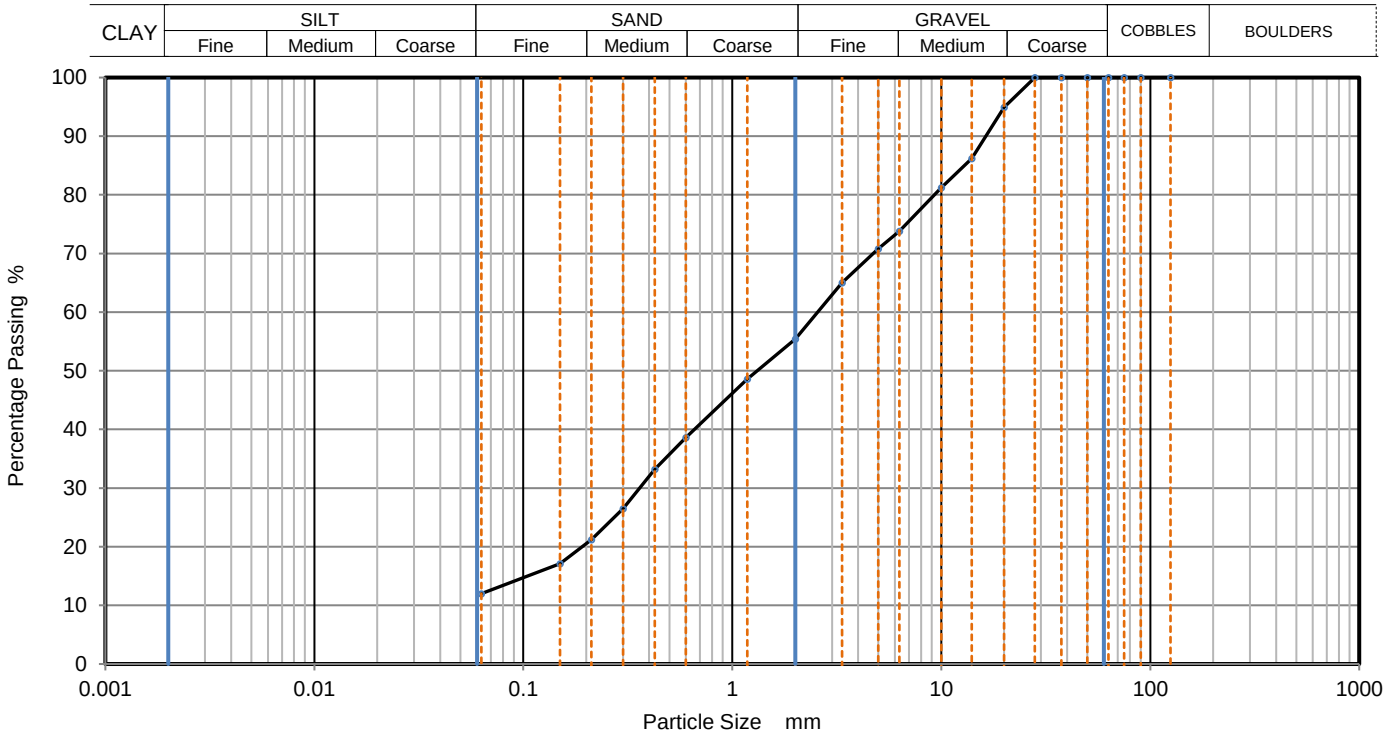
CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**17-0439**
				Borehole/Pit No.	TP05
Site Name	Coolnabacky 400kV GIS Substation			Sample No.	1
Soil Description	Brown sandy slightly clayey subangular fine to coarse GRAVEL.			Depth, m	0.50
Specimen Reference	6	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	Caus2018070421



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	95		
14	86		
10	81		
6.3	74		
5	71		
3.35	65		
2	55		
1.18	49		
0.6	39		
0.425	33		
0.3	27		
0.212	21		
0.15	17		
0.063	12		

Dry Mass of sample, g	2144

Sample Proportions	% dry mass
Cobbles	0
Gravel	45
Sand	43
Fines <0.063mm	12

Grading Analysis		
D100	mm	
D60	mm	2.56
D30	mm	0.36
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	**Fig** 1
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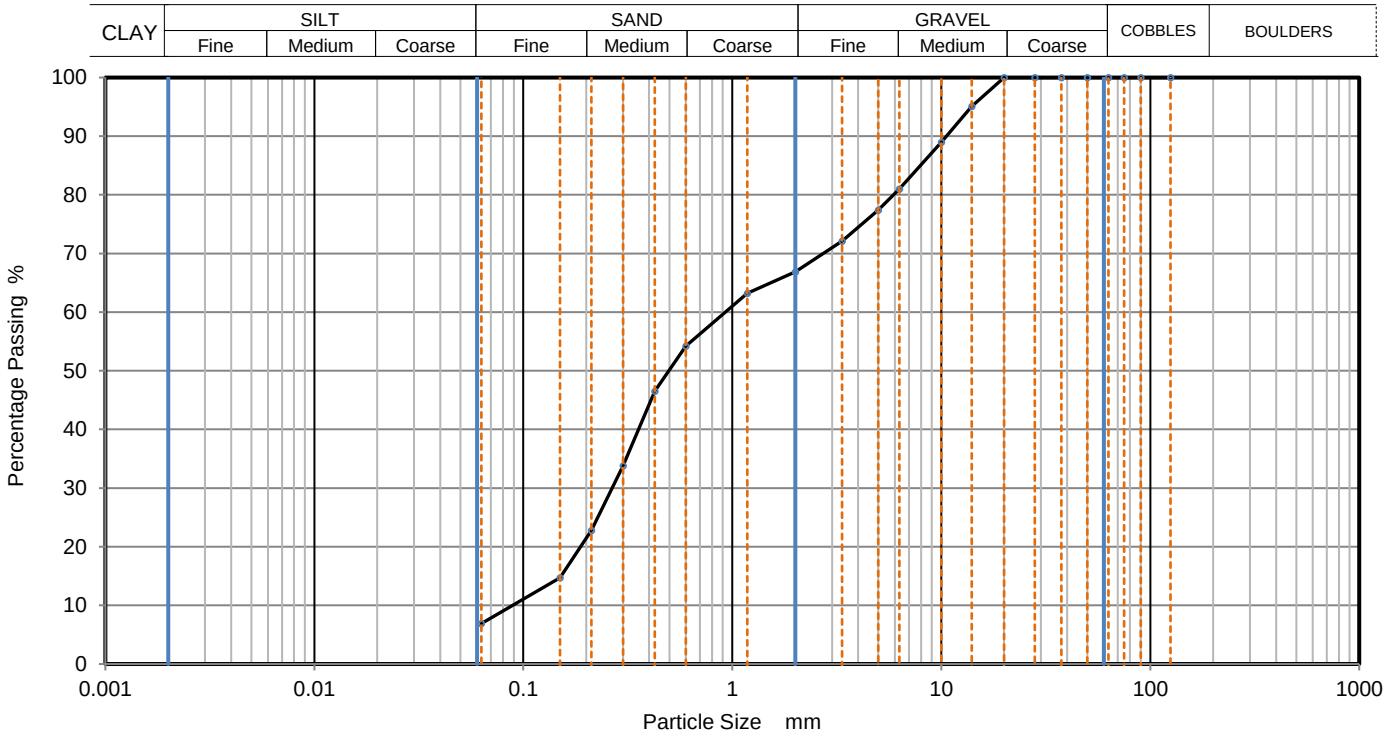
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	17-0439
				Borehole/Pit No.	TP07
Site Name	Coolnabacky 400kV GIS Substation			Sample No.	2
Soil Description	Brown gravelly fine to coarse SAND.			Depth, m	0.50
Specimen Reference	2	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	Caus2018070422



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	95		
10	89		
6.3	81		
5	77		
3.35	72		
2	67		
1.18	63		
0.6	54		
0.425	47		
0.3	34		
0.212	23		
0.15	15		
0.063	7		

Dry Mass of sample, g	1046

Sample Proportions	% dry mass
Cobbles	0
Gravel	33
Sand	60
Fines <0.063mm	7

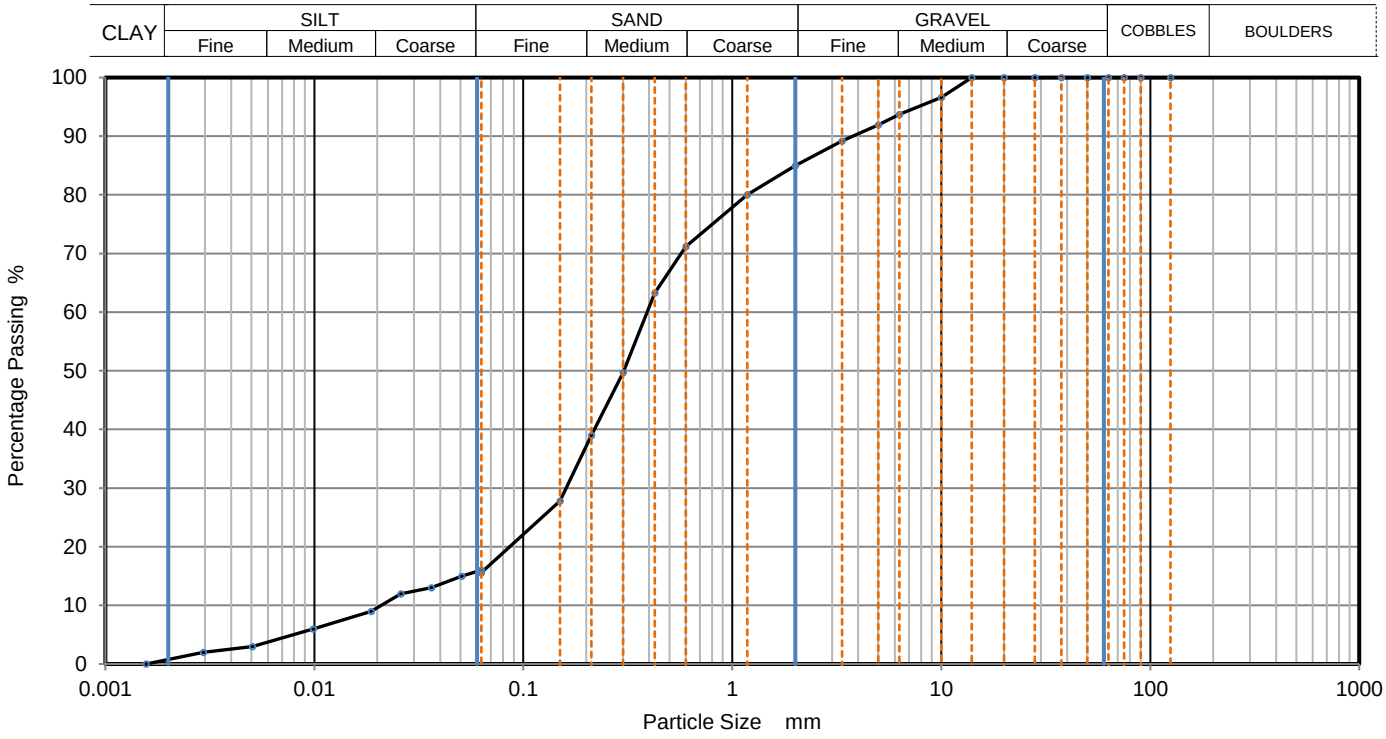
Grading Analysis		
D100	mm	
D60	mm	0.93
D30	mm	0.266
D10	mm	0.0886
Uniformity Coefficient		10
Curvature Coefficient		0.86

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	Fig 1
Stephen.Watson	30/07/2018 12:10	Sheet

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	17-0439
				Borehole/Pit No.	TP09
Site Name	Coolnabacky 400kV GIS Substation			Sample No.	2
Soil Description	Brown slightly gravelly silty fine to coarse SAND.			Depth, m	0.50
Specimen Reference	6	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2018070423



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	16
90	100	0.0507	15
75	100	0.0363	13
63	100	0.0260	12
50	100	0.0187	9
37.5	100	0.0099	6
28	100	0.0050	3
20	100	0.0029	2
14	100	0.0016	0
10	97		
6.3	94		
5	92		
3.35	89		
2	85		
1.18	80		
0.6	71	Particle density	(assumed)
0.425	63	2.65	Mg/m3
0.3	50		
0.212	39		
0.15	28		
0.063	16		

Dry Mass of sample, g	1320

Sample Proportions	% dry mass
Cobbles	0
Gravel	15
Sand	69
Silt	15
Clay	1

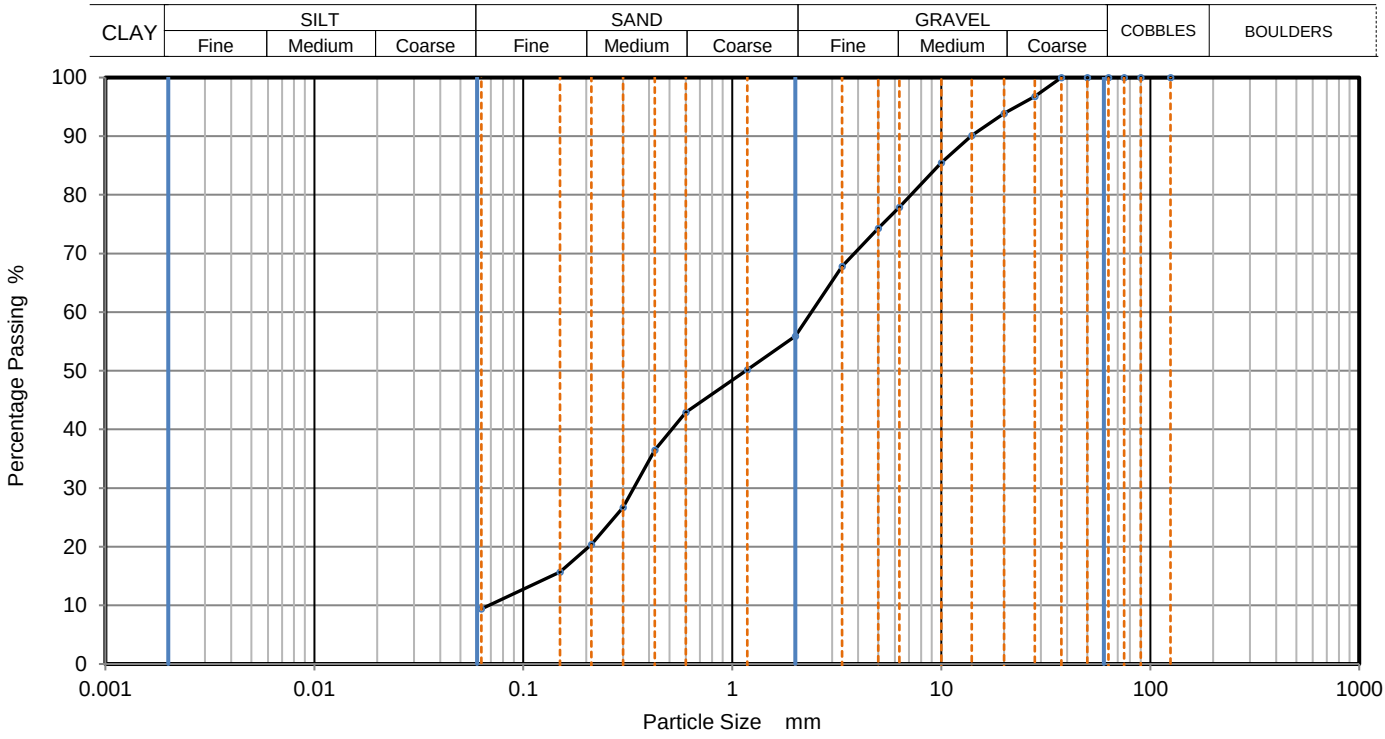
Grading Analysis		
D100	mm	
D60	mm	0.391
D30	mm	0.161
D10	mm	0.0201
Uniformity Coefficient		19
Curvature Coefficient		3.3

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	Fig 1
Stephen.Watson	30/07/2018 12:11	Sheet

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**17-0439**
				Borehole/Pit No.	TP12
Site Name	Coolnabacky 400kV GIS Substation			Sample No.	2
Soil Description	Grey gravelly slightly clayey fine to coarse SAND.			Depth, m	0.50
Specimen Reference	6	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	Caus2018070424



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	97		
20	94		
14	90		
10	86		
6.3	78		
5	74		
3.35	68		
2	56		
1.18	50		
0.6	43		
0.425	37		
0.3	27		
0.212	20		
0.15	16		
0.063	9		

Dry Mass of sample, g	2034

Sample Proportions	% dry mass
Cobbles	0
Gravel	44
Sand	46
Fines <0.063mm	9

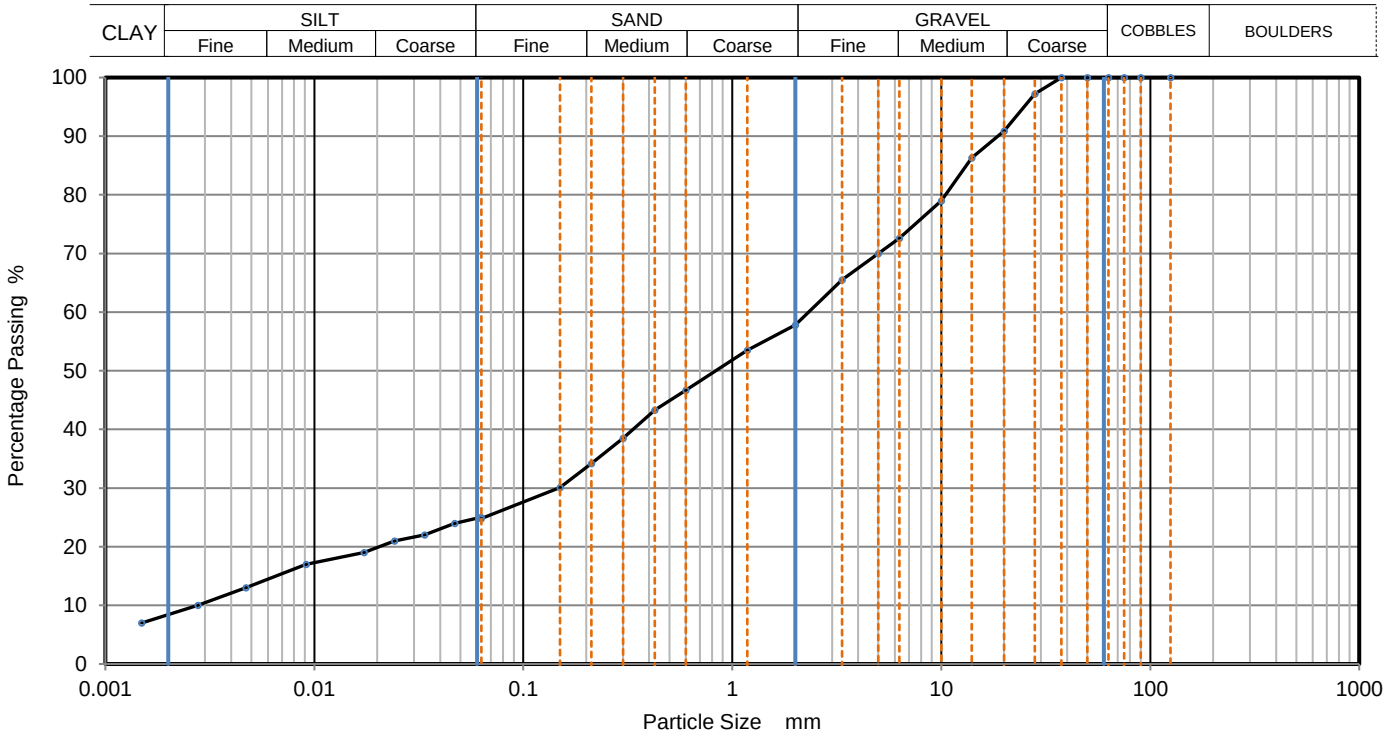
Grading Analysis		
D100	mm	
D60	mm	2.39
D30	mm	0.338
D10	mm	0.068
Uniformity Coefficient		35
Curvature Coefficient		0.7

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	**Fig** 1
Stephen.Watson	30/07/2018 12:11	Sheet

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	17-0439
				Borehole/Pit No.	TP14
Site Name	Coolnabacky 400kV GIS Substation			Sample No.	4
Soil Description	Brown sandy gravelly silty CLAY.			Depth, m	1.50
Specimen Reference	2	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2018070425



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0626	25
90	100	0.0469	24
75	100	0.0337	22
63	100	0.0241	21
50	100	0.0173	19
37.5	100	0.0091	17
28	97	0.0047	13
20	91	0.0028	10
14	86	0.0015	7
10	79		
6.3	73		
5	70		
3.35	66		
2	58		
1.18	54		
0.6	47	Particle density	(assumed)
0.425	43	2.65	Mg/m3
0.3	39		
0.212	34		
0.15	30		
0.063	25		

Dry Mass of sample, g	3957

Sample Proportions	% dry mass
Cobbles	0
Gravel	42
Sand	33
Silt	16
Clay	9

Grading Analysis		
D100	mm	
D60	mm	2.32
D30	mm	0.148
D10	mm	0.00256
Uniformity Coefficient		910
Curvature Coefficient		3.7

Remarks

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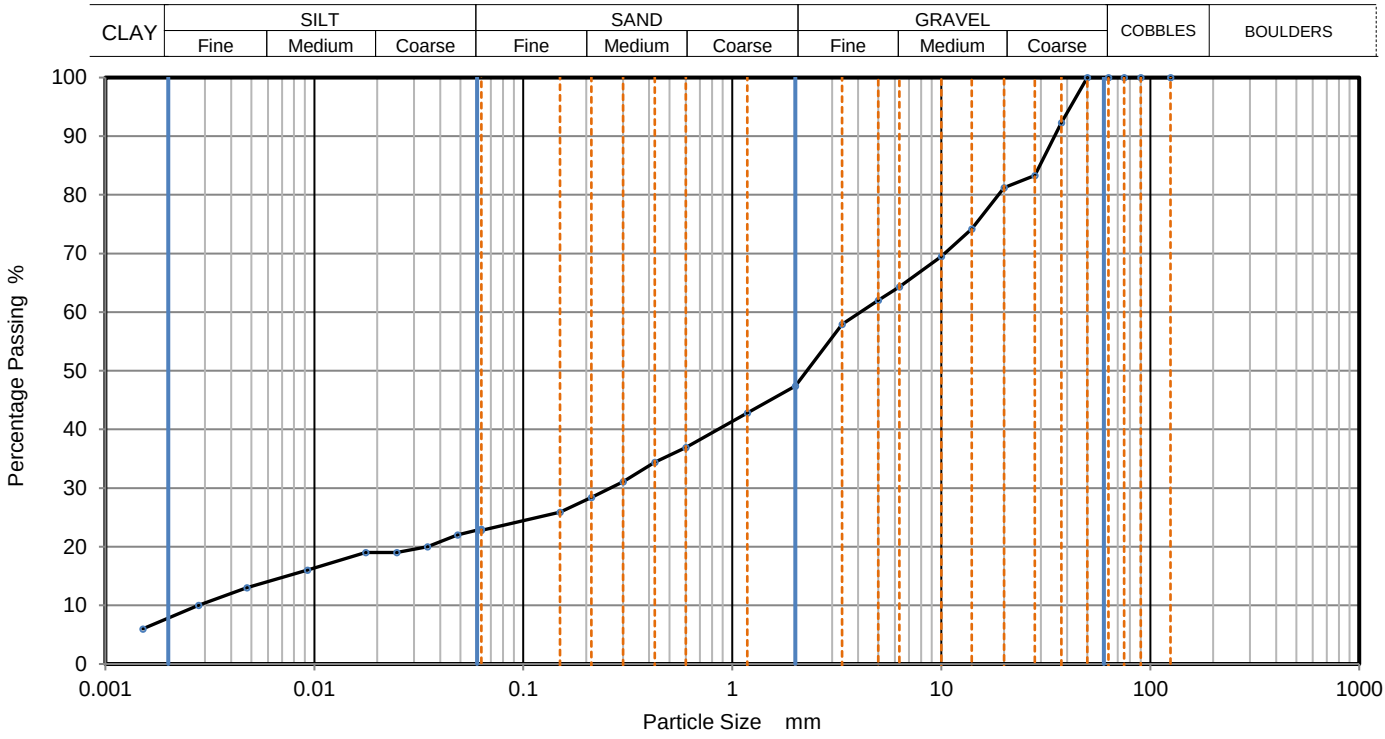
Approved	Sheet printed	Fig 1
Stephen.Watson	30/07/2018 12:11	Sheet

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**17-0439**
				Borehole/Pit No.	TP15
Site Name	Coolnabacky 400kV GIS Substation			Sample No.	5
Soil Description	Grey sandy gravelly silty CLAY.			Depth, m	1.70
Specimen Reference	6	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2018070426



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	23
90	100	0.0485	22
75	100	0.0348	20
63	100	0.0248	19
50	100	0.0176	19
37.5	92	0.0093	16
28	83	0.0048	13
20	81	0.0028	10
14	74	0.0015	6
10	70		
6.3	64		
5	62		
3.35	58		
2	47		
1.18	43		
0.6	37	Particle density	(assumed)
0.425	34	2.65	Mg/m3
0.3	31		
0.212	28		
0.15	26		
0.063	23		

Dry Mass of sample, g: 4983

Sample Proportions	% dry mass
Cobbles	0
Gravel	53
Sand	25
Silt	15
Clay	8

Grading Analysis		
D100	mm	
D60	mm	4.11
D30	mm	0.26
D10	mm	0.00274
Uniformity Coefficient		1500
Curvature Coefficient		6

Remarks

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Approved	Sheet printed	**Fig** 1
Stephen.Watson	30/07/2018 12:11	Sheet

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

UKAS TESTING
2183

Final Report

Report No.: 18-21719-1

Initial Date of Issue: 25-Jul-2018

Client Causeway Geotech Ltd

Client Address: 8 Drumahiskey Road
Balnamore
Ballymoney
County Antrim
BT53 7QL

Contact(s): Aisling O'Kane
Colm Hurley
Darren O'Mahony
Gabriella Horan
John Cameron
Lucy Newland
Matthew Gilbert
Neil Haggan
Paul Dunlop
Paul McNamara
Stephen Franey
Stephen Watson

Project 17-0439 ESB Site in Collnabacky, Co. Laois

Quotation No.:

Order No.:

No. of Samples: 7

Turnaround (Wkdays): 3

Date Approved: 25-Jul-2018

Approved By:

Date Received: 23-Jul-2018

Date Instructed: 23-Jul-2018

Results Due: 25-Jul-2018

Details: Robert Monk, Technical Manager

Chemtest
The right chemistry to deliver results

Results - Soil

Project: 17-0439 ESB Site in Collnabacky, Co. Laois

Client: Causeway Geotech Ltd			**Chemtest Job No.:**		18-21719	18-21719	18-21719	18-21719	18-21719	18-21719	18-21719
Quotation No.:			**Chemtest Sample ID.:**		658257	658258	658259	658260	658261	658262	658263
Order No.:			Client Location ID.:		BH01	BH02	BH03	BH07	BH09	TP02	TP09
			Client Sample Ref.:		2	2	4	3	5	2	2
			Sample Type:		SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Top Depth (m):		1.00	2.00	4.00	1.00	1.00	0.50	0.50
			Date Sampled:		20-Jul-2018	20-Jul-2018	20-Jul-2018	20-Jul-2018	20-Jul-2018	20-Jul-2018	20-Jul-2018
Determinand	**Accred.**	**SOP**	**Units**	**LOD**							
Moisture	N	2030	%	0.020	5.6	8.3	2.7	16	7.8	13	9.9
pH	U	2010		N/A	8.2	8.5	8.5	8.5	8.6	8.0	8.2
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Chloride (Water Soluble)	U	2220	g/l	0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010

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 (Applies to LOI in Trommel Fines Only)

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

LABORATORY RESTRICTION REPORT

Project Reference	17-0439	To	Colm Hurley
Project Name	Coolnabacky, Co. Laois	Position	Project Manager
TR reference	17-0439 / 1	From	Stephen Watson
		Position	Laboratory Manager

The following sample(s) and test(s) are restricted as detailed below. Could you please complete the "Required Action" column and return the completed form to the laboratory.

Hole Number	Sample			Test Type	Reason for Restriction	Required Action
	Number	Depth (m)	Type			
BH10	4	3	B	Moisture Content Atterberg limits PSD	Sample damaged in transit to laboratory	Cancel

For electronic reporting a form of electronic signature or printed name is acceptable

Laboratory Signature	Project Manager Signature
Stephen Watson	Colm Hurley
Date	Date
19 July 2018	19 July 2018

CAUSEWAY GEOTECH

APPENDIX H

SPT hammer energy measurement report

Southern Testing
Environmental & Geotechnical

SPT Hammer Energy Test Report

in accordance with BSEN ISO 22476-3:2005

Neil Burrows
Southern Testing Laboratories
Unit 11
Charlwoods Road
East Grinstead
RH19 2HU

SPT Hammer Ref:	NT5.
Test Date:	14/04/2018
Report Date:	15/04/2018
File Name:	NT5..spt
Test Operator:	CAUSEWAY

Instrumented Rod Data

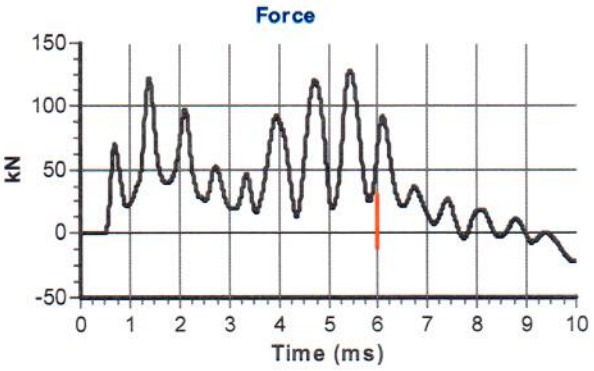
Diameter d_r (mm):	54
Wall Thickness t_r (mm):	6.0
Assumed Modulus E_a (GPa):	200
Accelerometer No.1:	6458
Accelerometer No.2:	9607

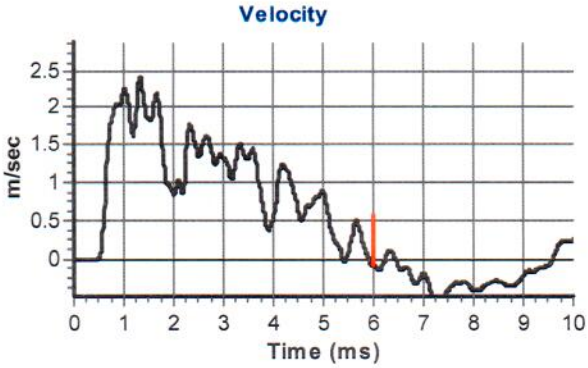
SPT Hammer Information

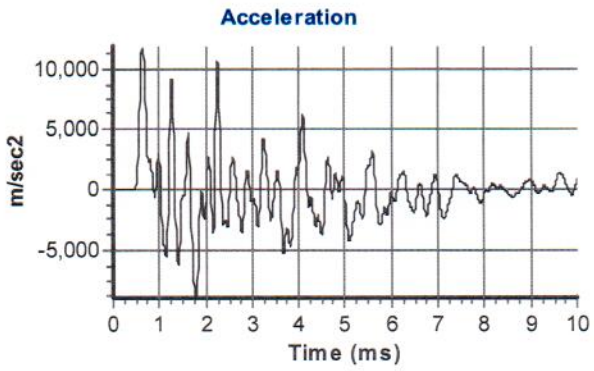
Hammer Mass m (kg):	63.5
Falling Height h (mm):	760
SPT String Length L (m):	10.5

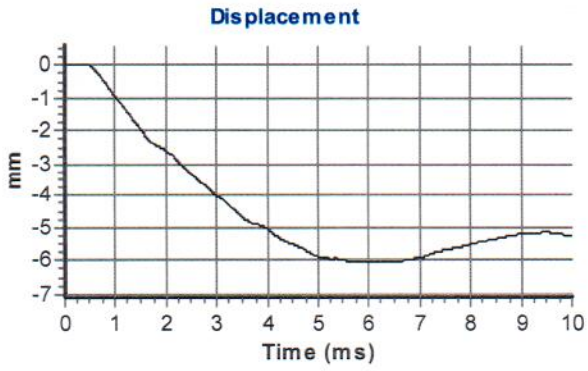
Comments / Location

Causeway Yard









Calculations

Area of Rod A (mm2):	905
Theoretical Energy E_{theor} (J):	473
Measured Energy E_{meas} (J):	299

Energy Ratio E_r (%): **63**

Signed: N P Burrows
Title: Field Operations Manager

The recommended calibration interval is 12 months